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ANALITIK KIMYO SXEMA VA JADVALLARDA

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MA’LUMOTNOMA

O’bekiston Respublikasi Oliy va o’rta maxsus ta’lim vazirligi universitetlar talabalari uchun qo’llanma sifatida tavsiya etgan

Buxoro–2019

UDK 543.06(075)

M.R. Amonov, G’.Q. Shirinov. **Analitik kimyo sxema va jadvallarda: oliy o’quv yurtlari talabalari uchun ma’lumotnoma.** BuxDU: Ziyo Rizograf, 2019 – 286 b.

Ma’lumotnoma universitetlarning 5140100-biologiya ta’lim yo’nalishi dasturi asosida yaratildi.

Ma’lumotnoma sifat va miqdoriy analizning umumiy va xususiy masalalariga tegishli jadvallar hamda sxemalarni, gomogen va geterogen sistemalarda muvozanat to’g’risidagi ma’lumotnomalarni o’z ichiga olgan. Laboratoriya ishlarini o’tkazish va masalalarni yechishda hisoblashlarni bajarish uchun kerakli ma’lumotlarni aks etgan jadvallar, tipik masalalarni yechish namunalari keltirilgan.

Ma’lumotnoma universitetlarining 5140100-biologiya ta’lim yo’nalishi va boshqa oliy o’quv yurtlarining biologiya mutaxassisligi talabalariga mo’ljallangan bo’lib, undan magistrantlar, aspirantlar hamda o’qituvchilar ham foydalanishlari mumkin.

Taqrizchilar:

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УДК 543.06(075)

М.Р. Амонов, Г.К. Ширинов. **Аналитическая химия в схемах и таблицах: справочник для студ. вузов.** – БухГУ: Зиё Ризограф, 2019 – 286 стр.

Справочник составлен на основе программы по 5140100–направлению образовния биологии.

Справочник содержит таблицы и схемы, касающиеся общих и частных вопросов качественного и количественного анализа, сведения о равновесиях в гомогенных и гетерогенных системах. Приведены примеры решения типовых задач, таблицы, содержащие сведения для выполнения расчетов при решении задач и проведение лабораторных работ.

Справочник предназначен студентам биологических факультетов университетов и биологических специальностей других высших учебных заведений. Будет полезно магистрантам, аспирантам, а также преподавателям.

UDC 543.06(075)

M. Amonov, G’. Shirinov. **Analytical chemistry in the schemas and tables: the reference book for the students of high schools.** – BukhSU: Ziyo Risograph, 2019 – 286 p.

The reference book is consisted on the basis of the program of direction of teaching 5140100-biology.

The reference book contains the tables and schemas tangent general and the incidental questions of quality and quantitative analysis, information about equal balances in homogeneous and heterogeneous systems. The examples of a solution of sample problems, tables containing information for implementation of accounts for reduced the problem solving and doing of laboratory operations.

The reference book is intended to the students of biological faculties of universities and biological specialities of other higher educational institutes. It will be useful for masters students, post-graduate students, and also teachers.

MUNDARIJA

KIRISH

Analitik kimyo oliy ma’lumotli biolog mutaxassislarni tayyorlashda muhim o’rin tutadi, shuningdek, u biokimyo, molekulyar biologiya kabi fanlarni o’rganishda tayanch bo’lib xizmat qiladi.

Har qanday fanni mukammal o’zlashtirishga yordam beruvchi omillardan biri o’qitishning ko’rgazmali bo’lishidir. Analitik kimyoni o’rganishda kimyoviy analizga tegishli turli hisoblash usullariga juda ko’p vaqt ajratiladi. Bu usullar asosan talabalarning mustaqil ishlari orqali o’rganiladi va turli ma’lumotnoma materiallarining bo’lishini talab etadi.

Analitik kimyo bo’yicha o’zbek tilida yozilgan ma’lumotnomalar yo’q. Shuni inobatga olib, ushbu ma’lumotnoma yaratildi.

Maq’lumotnoma uch qismdan: sifat analizi, miqdoriy analiz va ilovalardan iborat.

Sifat analizi bo’limida sxemalar ko’rinishida analitik kimyoning umumiy masalalariga oid ma’lumotlar, kation va anionlarning analiziga oid jadvallar va sxemalar, gomogen va geterogen sistemalarda muvozanatni hisoblash namunalari, shuningdek mustaqil yechish uchun masalalar keltirilgan.

Miqdoriy analiz bo’limi analiz usullarining klassifikatsiyasini aks ettiruvchi sxemalarni hamda titrimetriya va gravimetriyaning asosiy tushunchalari yoritilgan jadvallarni o’z ichiga olgan.

Hajmiy va gravimetrik analizga oid asosiy hisoblash formulalari, miqdoriy aniqlashlar natijalarini statistik qayta ishlash bo’yicha asosiy ma’lumotlar va hisoblash namunalari keltirilgan. Bu bo’limning oxirgi qismida analizning optik usulla-riga oid asosiy tushunchalar hamda hisoblashlar uchun zarur bo’lgan axborot materiallari yoritilgan.

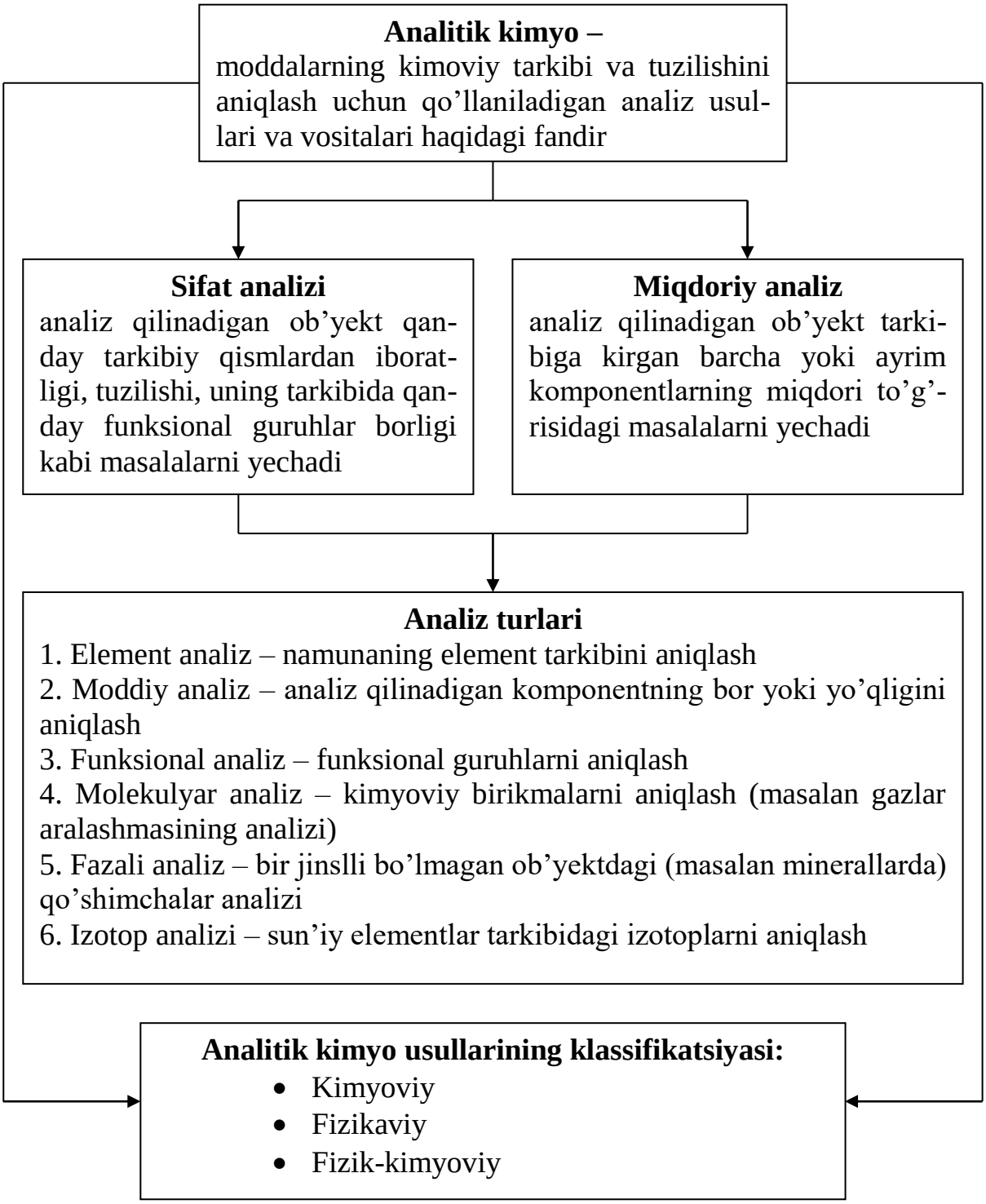
Ilovalar bo’limida kimyoviy-analitik aniqlashlarni o’tkazish uchun zarur bo’lgan amaliy materiallarni mujassamlashtirilgan jadvallar, analitik atamalarning qisqa lug’ati hamda analitik kimyoning rivojlanishiga o’z hissasini qo’shgan olimlar haqida ma’lumotlar keltirilgan.

Ma’lumotnoma analitik kimyoga oid kerakli barcha ma’lumotlarni qamrab olmagan, shuning uchun talabalar fanni o’zlashtirishda tegishli darslik, qo’llanma va monografiyalardan foydalanishlari zarur.

SIFAT ANALIZI

1-*jadval*

ZAMONAVIY ANALITIK KIMYONING TUZILISHI



2-*jadval*

ANALIZ QILINADIGAN MODDA MIQDORIGA KO'RA ANALIZ USULLARINING KLASSIFIKATSIYASI

Analiz usulining nomi		Analiz qilinadigan modda miqdori	
		Namuna massasi, g	Namuna hajmi, ml
Makroanaliz	Gramm-usul	1 – 10	10 – 100
Yarimmikroanaliz	Santigramm-usul	0,05 – 0,5	1 – 10
Mikroanaliz	Milligram-usul	$0,01 – 10^{-6}$	$0,1 – 10^{-4}$
Ultramikroanaliz	Mikrogram-usul	$10^{-6} – 10^{-9}$	$10^{-4} - 10^{-6}$
Submikroanaliz	Nanogram-usul	$10^{-9} – 10^{-12}$	$10^{-7} – 10^{-10}$

3-*jadval*

SIFAT ANALIZINING TURLARI

Bo'lib-bo'lib analiz qilish	Sistematik analiz
Bo'lib-bo'lib analiz qilishda moddaning tarkibi spetsifik reaksiyalar bilan aniqlanadi, bunday reaksiyalar yordamida boshqa ionlar ishtirokida ham analiz qilinadigan ionlarni aniqlash mumkin	Sistematik analizda ionlar aralashmasi *guruh reagentlari* yordamida bir nechta guruhlarga bo'linadi, so'ngra har qaysi guruhdagi ionlar muayyan ketma-ketlikda xarakterli reaksiyalar bilan aniqlanadi. *Guruh reagenti* – bu ionlarning analitik guruhlarini aniqlashda va ajratishda qo'llaniladigan reagentdir. *Guruh reagentiga qo'yiladigan talablar*: 1. Ionlar guruhlarini amalda to'liq ajratishi kerak; 2. Gurug reagenti ta'sirida ajratilgan analitik guruhga ishlov berish oson bo'lishi kerak; 3. Guruh reagentining ortiqcha miqdori keyingi analiz jarayoniga halaqit bermasligi kerak

4-*jadval*

ANALITIK REAKSIYALARNING BELGILARI

Analitik belgilar	**Misol**
1. Xarakterli cho'kma hosil bo'lishi	$3Fe^{2+} + 2[Fe(CN)_6]^{3-} \leftrightarrow Fe_3[Fe(CN_6)]_2\downarrow$
2. Eritma rangining o'zgarishi	$Cu^{2+} + 4NH_3 \leftrightarrow [Cu(NH_3)_4]^{2+}$ (havorang eritma)
3. Gaz ajralishi	$FeS + 2H^+ \leftrightarrow Fe^{2+} + H_2S\uparrow$ (xarakterli hid)
4. Issiqlik chiqishi yoki yutilishi	$HCN + NaOH \rightarrow NaCN + H_2O$ (issiqlik chiqishi bilan) $CaSO_4 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O$ (issiqlik yutilishi bilan)

5-*jadval*

KATIONLARNI ANALITIK KLASSIFIKATSIYALASH USULLARI

Analiz usuli	**Analiz usuli nimaga asoslangan**
Vodorod sulfidli analiz usuli (5.1.-jadval)	Metall sulfidlarining turlicha eruvchanligiga
Kislota-asosli analiz usuli (5.2-jadval)	Kationlarning kislotalar (HCl, H_2SO_4) va asoslar (NaOH, $NH_3 \cdot H_2O$) ga turlicha munosabatiga
Ammiak-fosfatli analiz usuli (5.3-jadval)	Kationlar fosfatlarining suvda va ammiak eritmasida turlicha eruvchanligiga

5.1-*jadval*

KATIONLARNING VODOROD SULFIDLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

Guruh	Kationlar	Guruh reagenti	Birikmalarning eruvchanligi
I	K^+, Na^+, NH_4^+, Mg^{2+}	Mavjud emas	Sulfidlar, karbonatlar*, xloridlar va gidroksidlar* suvda eriydi
II	Ba^{2+}, Sr^{2+}, Ca^{2+}	$(NH_4)_2CO_3$, $NH_3 \cdot H_2O + NH_4Cl$, pH = 9,25	Karbonatlar suvda erimaydi
III	Fe^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Mn^{2+}, Ni^{2+}, Zn^{2+}, Co^{2+}	$(NH_4)_2S$, $NH_3 \cdot H_2O + NH_4Cl$, pH = 8 – 9	Sulfidlar suvda erimaydi**, lekin suyultirilgan mineral kislotalarda eriydi
IV	Cu^{2+}, Hg^{2+}, Bi^{3+}, Sn^{2+}, Sn(IV), Sb(III), Sb(V), As(III), As(V)	H_2S, HCl, pH = 0,5	Sulfidlar suvda va suyultirilgan mineral kislotalarda erimaydi
V	Ag^+, Pb^{2+}, Hg_2^{2+}	HCl	Xloridlar suvda va suyultirilgan mineral kislotalarda erimaydi

* Mg^{2+} dan tashqari

** Cr^{3+}, Al^{3+} sulfidlari suvda parchalanadi va eritmada mavjud bo'lmaydi

5.2-*jadval*

KATIONLARNING KISLOTA-ASOSLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

Guruh	Kationlar	Guruh reagenti	Birikmalarning eruvchanligi
I	Na^+, K^+, NH_4^+,	Mavjud emas	Xloridlar, sulfatlar va gidroksidlar suvda eriydi.
II	Ag^+, Pb^{2+}, Hg_2^{2+}	2M HCl eritmasi	Xloridlar suvda erimaydi
III	Ba^{2+}, Sr^{2+}, Ca^{2+}	1M H_2SO_4 eritmasi + C_2H_5OH	Sulfatlar suvda erimaydi.
IV	Al^{3+}, Zn^{2+}, Cr^{3+}, Sn(II), Sn(IV), As(III). As(V)	mo'l 6M NaOH eritmasi + 3% H_2O_2	Gidroksidlar suvda erimaydi, lekin mo'l ishqorda eriydi.
V	Fe^{2+}, Fe^{3+}, Mg^{2+}, Mn^{2+}, Bi^{3+}, Sb(III), Sb (V)	mo'l kons. $NH_3 \cdot H_2O$	Gidroksidlar suvda, mo'l ishqorda va ammiakda erimaydi.
VI	Co^{2+}, Ni^{2+}, Cd^{2+}, Cu^{2+}, Hg^{2+}	mo'l kons. $NH_3 \cdot H_2O$	Gidroksidlar suvda mo'l ishqorda erimaydi, lekin mo'l ammiakda eriydi.

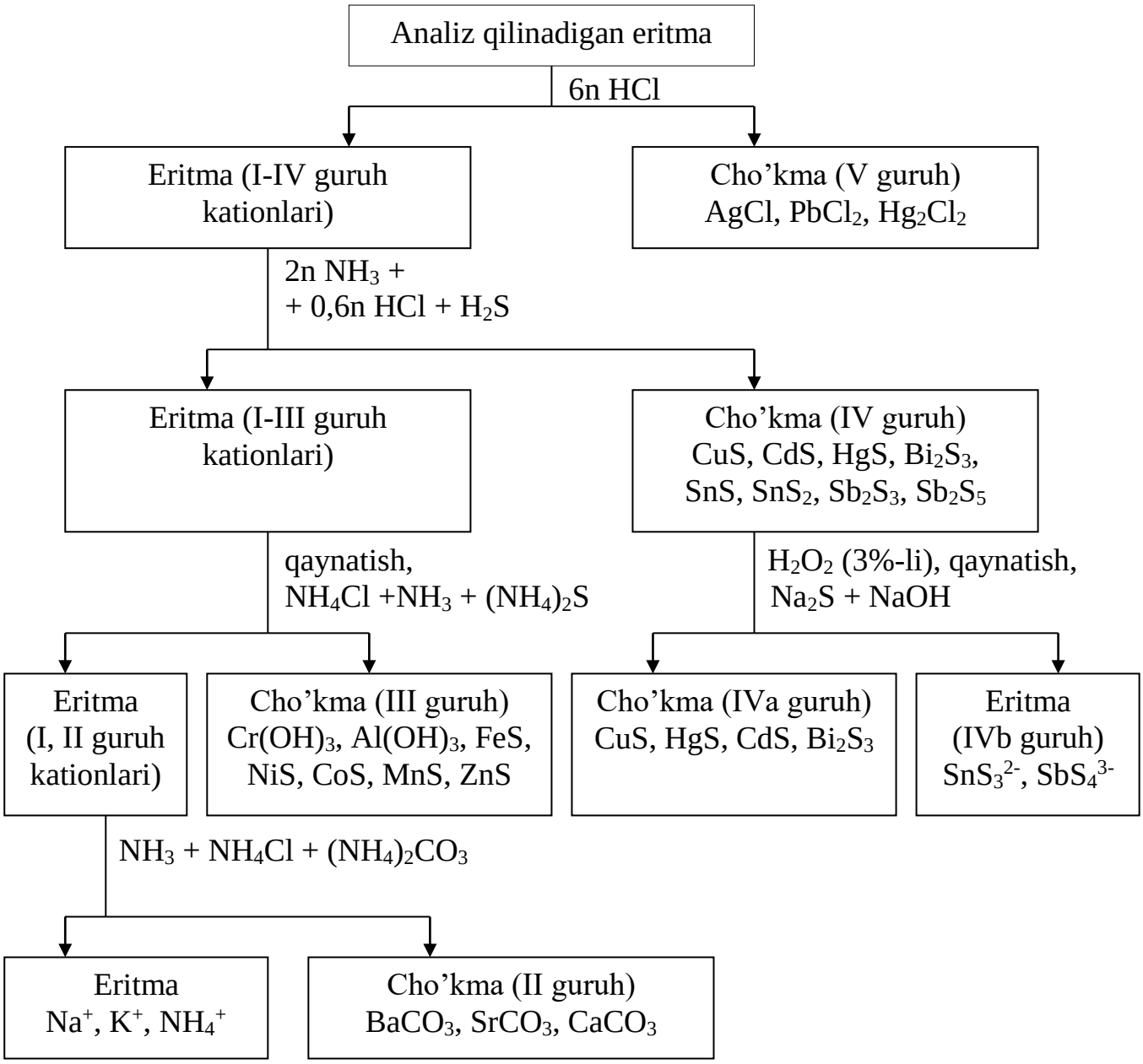
5.3-*jadval*

KATIONLARNING AMMIAK-FOSFATLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

Guruh	Kationlar	Guruh reagenti	Birikmalarning eruvchanligi
I	Ag^+, Pb^{2+}, Hg_2^{2+}	HCl	Xloridlar suvda erimaydi
II	Sn^{2+}, Sn(IV), Sb(III), Sb(V)	HNO_3	Metastibiat va metastanat kislotalar suvda erimaydi.
III	Ba^{2+}, Sr^{2+}, Ca^2, Mg^{2+}, Mn^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Fe^{3+}	$(NH_4)_2HPO_4$, kons. $NH_3 \cdot H_2O$	Fosfatlar suvda va mo'l ammiak eritmasida erimaydi.
IV	Cu^{2+}, Cd^{2+}, Hg^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}	$(NH_4)_2HPO_4$, kons. $NH_3 \cdot H_2O$	Fosfatlar suvda erimaydi, lekin mo'l ammiak eritmasida eriydi.
V	Na^+, K^+, NH_4^+	Mavjud emas	Xloridlar, nitratlar va fosfatlar suvda eriydi.

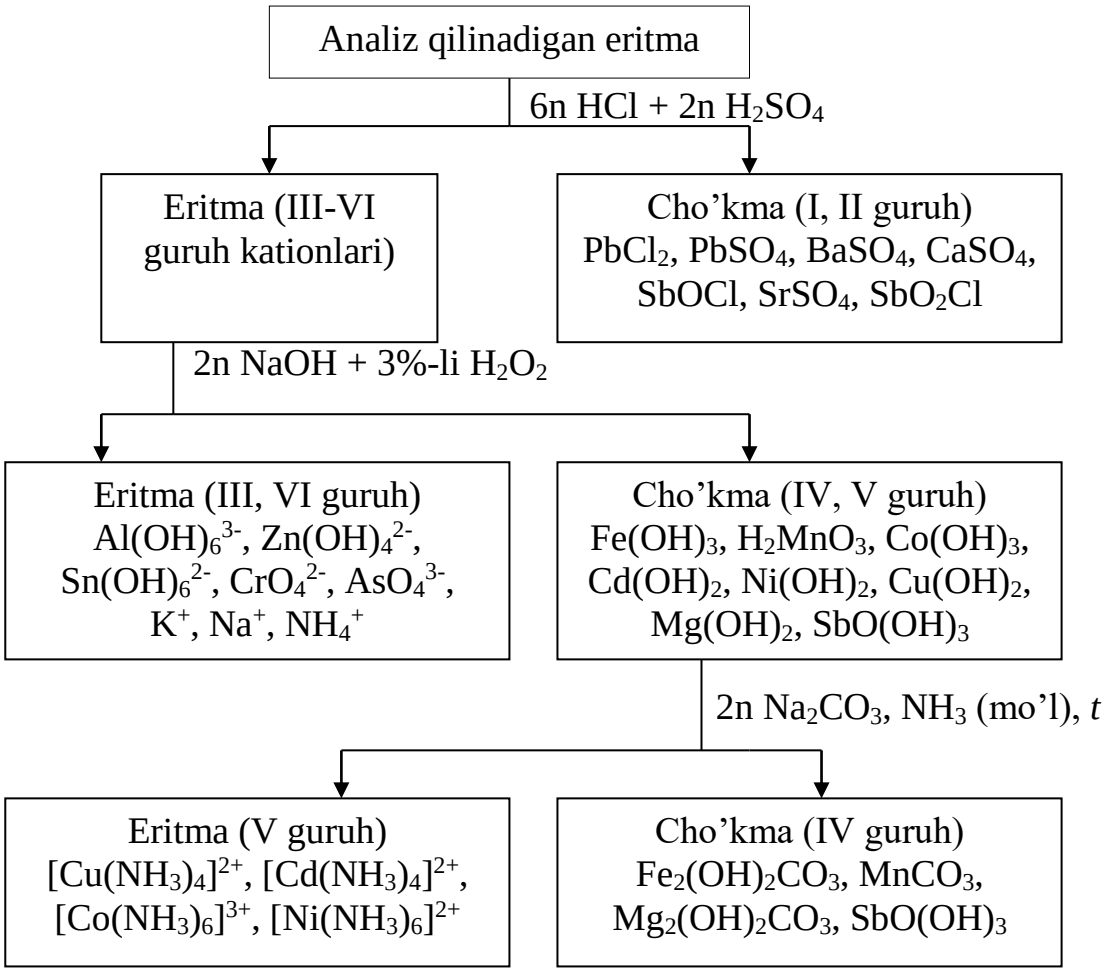
1-*sxema*

VODOROD SULFIDLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



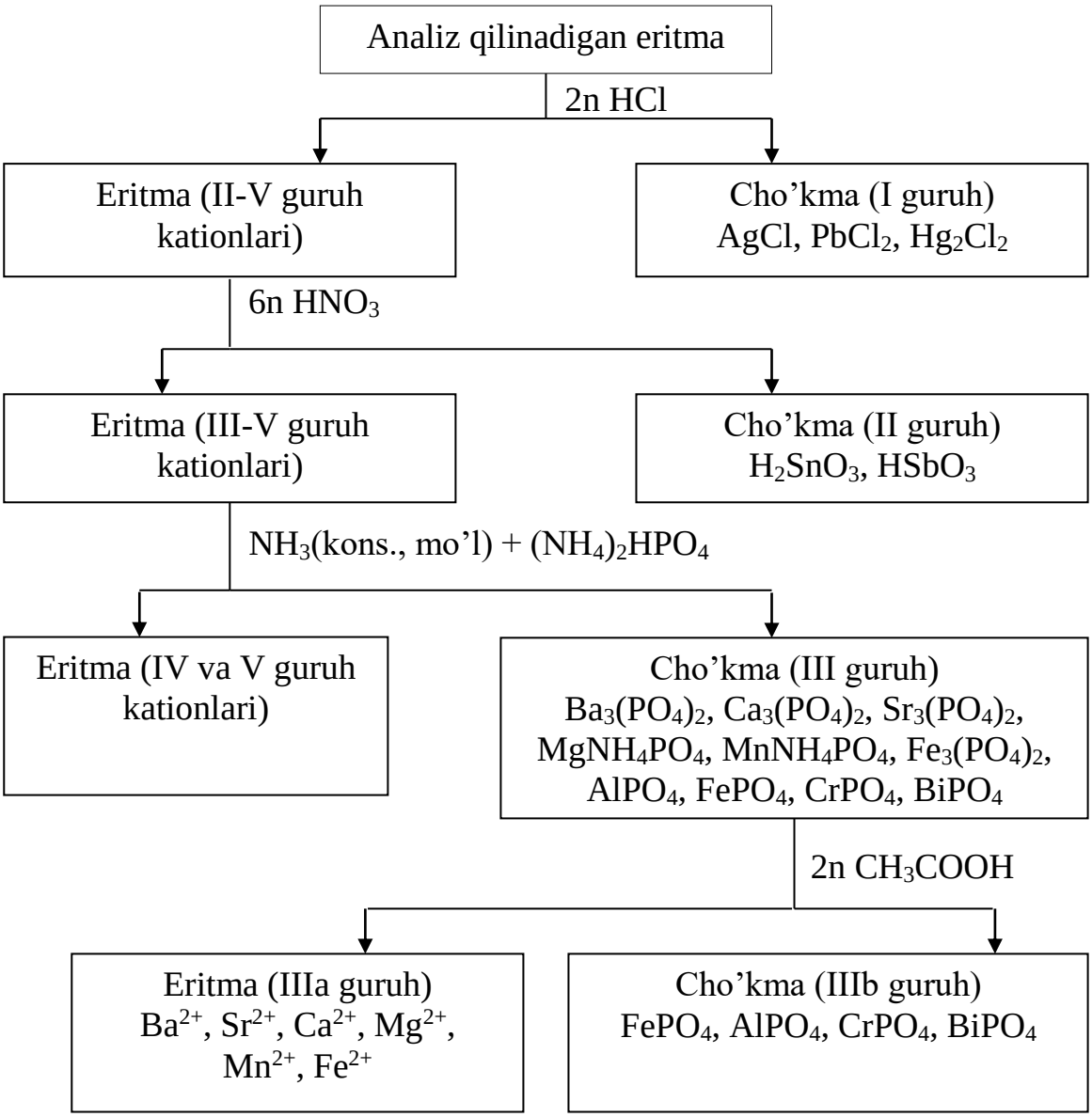
2-*sxema*

KISLOTA-ASOSLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



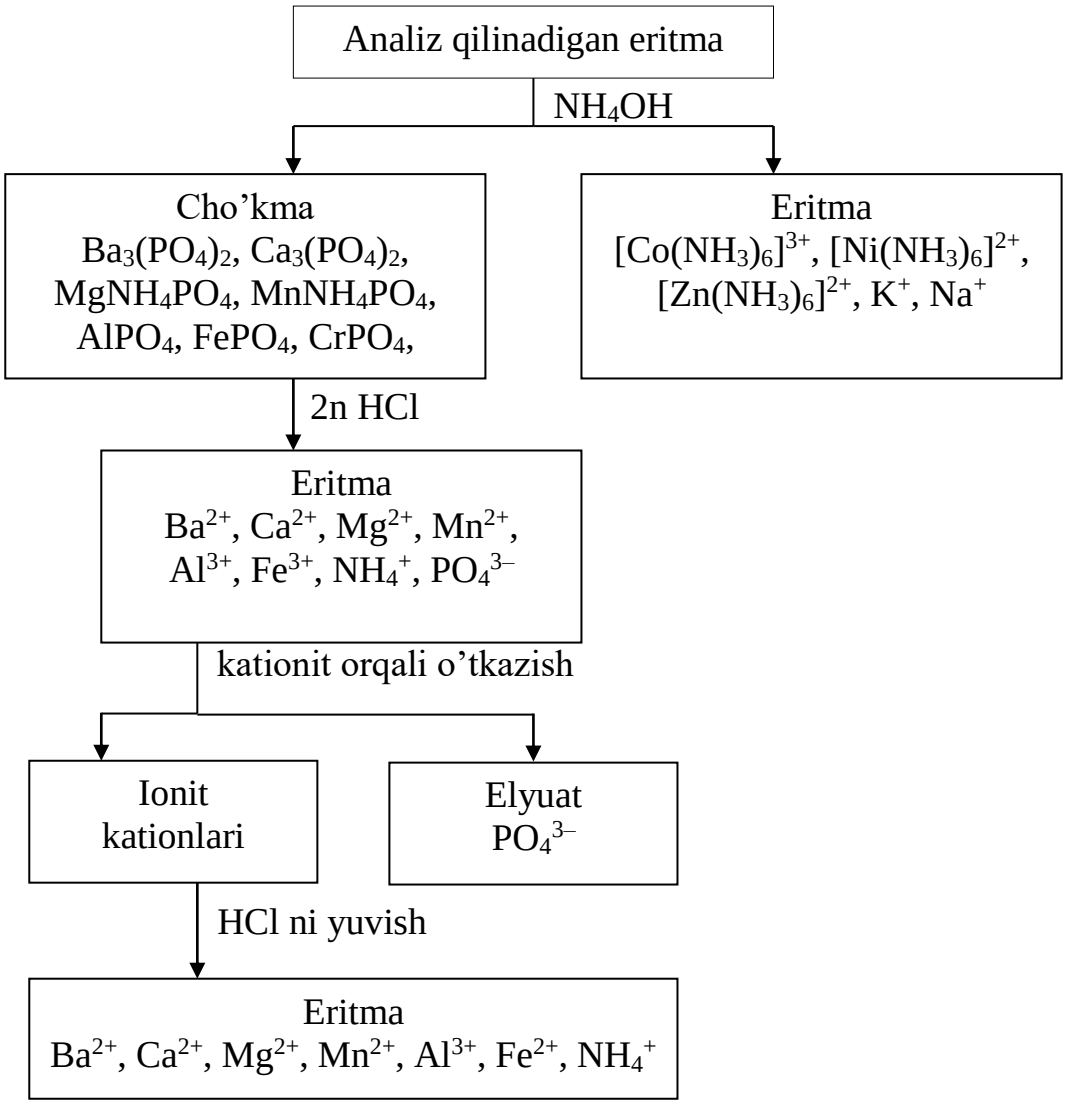
3-*sxema*

AMMAK-FOSFATLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



4-sxema

PO_4^{3-} IONLARI ISHTIROKIDA I – III GURUH KATIONLARI ARALASHMASINI ION ALMASHINISH REAKSIYALARI YORDAMIDA AJRATISH



6-jadval

I ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
NH_4^+	Nessler reaktivi	$NH_4Cl + 2K_2[HgI_4] + 4KOH = [O(Hg)_2NH_2]I\downarrow + 7KI + KCl + 3H_2O$ $NH_4^+ + 2[HgI_4]^{2-} + 4OH^- = [O(Hg)_2NH_2]I\downarrow + 7I^- + 3H_2O$	Sariq-qo'ng'ir cho'kma. Nessler reaktivi ortiqcha olinadi, chunki cho'kma ammoniy tuzlarida eriydi
	NaOH (KOH)	$NH_4Cl + NaOH = NaCl + NH_4OH$ $NH_4^+ + Cl^- + K^+ + OH^- = K^+ + Cl^- + NH_4OH$ $NH_4OH \xrightarrow{t} NH_3\uparrow + H_2O$	t °C va pH > 7 ga teng bo'lganda ajralib chiqqan NH_3 ni hididan yoki namlangan indikator qog'oz rangining o'zgarishidan bilish mumkin
K^+	$NaHC_4H_4O_6$ yoki vino kislotasi $[H_2C_4H_4O_6 + CH_3COONa]$	$KCl + NaHC_4H_4O_6 = KHC_4H_4O_6\downarrow + NaCl$ $K^+ + HC_4H_4O_6^- = KHC_4H_4O_6\downarrow$	pH = 7, past haroratda probirka devori shisha tayoqcha bilan ish-qalanganda oq kristalll cho'kma hosil bo'ladi.
	$Na_3[Co(NO_2)_6]$	$2KCl + Na_3[Co(NO_2)_6] = K_2Na[Co(NO_2)_6]\downarrow + 2NaCl$ $2K^+ + Na^+ + [Co(NO_2)_6]^{3-} = K_2Na[Co(NO_2)_6]\downarrow$	pH = 7, sariq cho'kma, kuchli kislotalarda eriydi
	$Na_2Pb[Cu(NO_2)_6]$	$2KCl + Na_2Pb[Cu(NO_2)_6] = K_2Pb[Cu(NO_2)_6]\downarrow + 2NaCl$ $2K^+ + Pb[Cu(NO_2)_6]^{2-} = K_2Pb[Cu(NO_2)_6]\downarrow$	Qora yoki qo'ng'ir rangli kub shakldagi kristalllar
	Alangani bo'yashi		Och binafsha

6-jadvalning davomi

Na^+	$K[Sb(OH)_6]$	$NaCl + K[Sb(OH)_6] = Na[Sb(OH)_6]\downarrow + KCl$ $Na^+ + [Sb(OH)_6]^- = Na[Sb(OH)_6]\downarrow$	Probirka devorlari shisha tayoqcha bilan ishqalanganda oq kristalll cho'kma paydo bo'ladi
	$Zn(UO_2)_3\times$ $\times(CH_3COO)_8$	$Na^+ + Zn(UO_2)_3(CH_3COO)_8 + 9H_2O =$ $= NaZn(UO_2)_3(CH_3COO)_9 \cdot 9H_2O\downarrow$	Sarg'ish kristalll cho'kma. Natriy uchun eng sezgir reagent
	Alangani bo'yashi		Natriyning uchuvchan tuzlari alangani to'q sariq rangga kiritadi

7-jadval

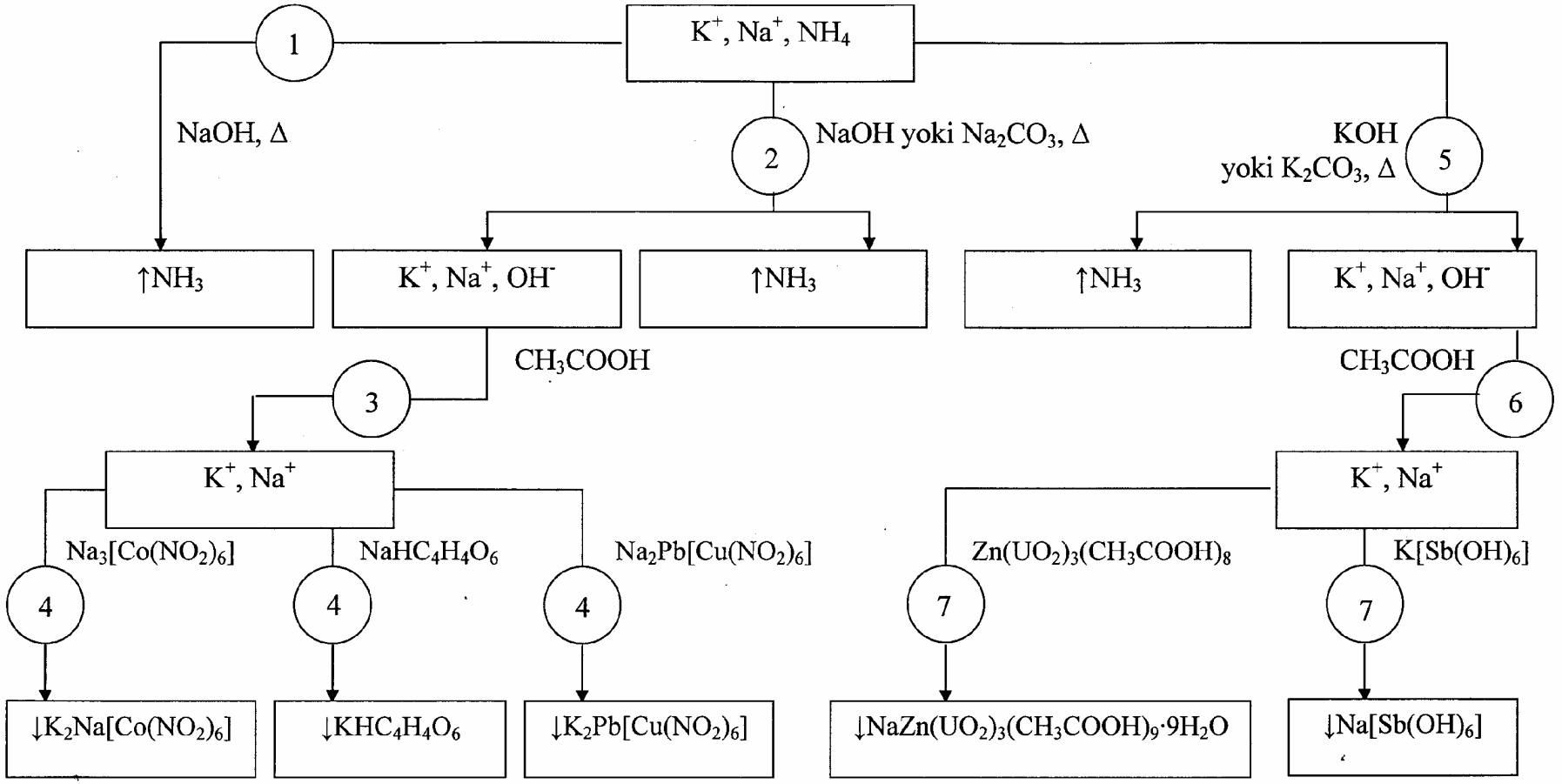
I ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

K^+, Na^+, NH_4^+

Bosqichning t/r	**Analiz bosqichlari**
1	Alohida namunadagi NH_4^+ ionlarini ishqor ta'sir ettirib, qizdirib aniqlash: $NH_4^+ \xrightarrow{NaOH,\ \Delta} NH_3\uparrow$
2	Alohida namunaga NaOH yoki Na_2CO_3 eritmasi ta'sir ettirib, qizdirib K^+ ionlarini topishdan oldin NH_4^+ ionlarni yo'qotish: $NH_4^+ \xrightarrow{NaOH\ (Na_2CO_3),\ \Delta} NH_3\uparrow$
3	Eritmani sirka kislota bilan neytrallash.
4	$NaHC_4H_4O_6$, $Na_3[Co(NO_2)_6]$, $Na_2Pb[Cu(NO_2)_6]$ reagentlari bilan 3 eritmadan K^+ ionlarini topish: $K^+ \xrightarrow{NaHC_4H_4O_6} KHC_4H_4O_6\downarrow$ $K^+ \xrightarrow{Na_3[Co(NO_2)_6]} K_2Na[Co(NO_2)_6]\downarrow$ $K^+ \xrightarrow{Na_2Pb[Cu(NO_2)_6]} K_2Pb[Cu(NO_2)_6]\downarrow$
5	Alohida namunadan KOH yoki K_2CO_3 eritmasi ta'sir ettirib, qizdirib Na^+ ionlarini topishdan oldin NH_4^+ ionlarini yo'qotish: $NH_4^+ \xrightarrow{KOH\ (K_2CO_3),\ \Delta} NH_3\uparrow$
6	5 eritmani sirka kislota bilan neytrallash.
7	$K[Sb(OH)_6]$, $Zn(UO_2)_3(CH_3COO)_8$ reagentlari bilan 6 eritmada Na^+ ionlarini topish: $Na^+ \xrightarrow{K[Sb(OH)_6]} Na[Sb(OH)_6]\downarrow$ $Na^+ \xrightarrow{Zn(UO_2)_3(CH_3COO)_8} NaZn(UO_2)_3(CH_3COO)_9 \cdot 9H_2O\downarrow$

5-sxema

I ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



8-jadval

II ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Ag^+	HCl	$AgNO_3 + HCl = AgCl\downarrow + HNO_3$ $Ag^+ + Cl^- = AgCl\downarrow$	Oq cho'kma, ortiqcha ammiakda eriydi
	KI	$AgNO_3 + KI = AgI\downarrow + HNO_3$ $Ag^+ + I^- = AgI\downarrow$	Sariq cho'kma $Na_2S_2O_3$ da eriydi
	K_2CrO_4	$2AgNO_3 + K_2CrO_4 = Ag_2CrO_4\downarrow + 2KNO_3$ $2Ag^+ + CrO_4^{2-} = Ag_2CrO_4\downarrow$	pH = 7, qizil g'isht tusli cho'kma ammiakda va nitrat kislotada eriydi
	Na_2HPO_4	$3AgNO_3 + 2Na_2HPO_4 = Ag_3PO_4\downarrow + NaH_2PO_4 + 3NaNO_3$ $3Ag^+ + 2HPO_4^{2-} = Ag_3PO_4\downarrow + H_2PO_4^-$	Sariq cho'kma, ammiakda va nitrat kislotada eriydi
Pb^{2+}	HCl	$Pb(NO_3)_2 + 2HCl = PbCl_2\downarrow + 2HNO_3$ $Pb^{2+} + 2Cl^- = PbCl_2\downarrow$	Oq cho'kma, issiq suvda eriydi
	H_2SO_4	$Pb(NO_3)_2 + H_2SO_4 = PbSO_4\downarrow + 2HNO_3$ $Pb^{2+} + SO_4^{2-} = PbSO_4\downarrow$	Oq cho'kma, o'yuvchi ishqorlar bilan qizdirilganda eriydi
	KI	$Pb(NO_3)_2 + 2KI = PbI_2\downarrow + 2KNO_3$ $Pb^{2+} + 2I^- = PbI_2\downarrow$	Yaltiroq tilla rangli kristalll cho'kma
	$K_2Cr_2O_7$	$2Pb(NO_3)_2 + K_2Cr_2O_7 + H_2O = 2PbCrO_4\downarrow + 2KNO_3 + 2HNO_3$ $2Pb^{2+} + Cr_2O_7^{2-} + H_2O = 2PbCrO_4\downarrow + 2H^+$	Sariq cho'kma ishqorlarda eriydi

8-jadvalning davomi

$[Hg_2]^{2+}$	HCl	$Hg_2(NO_3)_2 + 2HCl = Hg_2Cl_2\downarrow + 2HNO_3$ $[Hg_2]^{2+} + 2Cl^- = Hg_2Cl_2\downarrow$	Oq cho'kma
	K_2CrO_4	$Hg_2(NO_3)_2 + K_2CrO_4 = Hg_2CrO_4\downarrow + 2KNO_3$ $[Hg_2]^{2+} + CrO_4^{2-} = Hg_2CrO_4\downarrow$	Qizil cho'kma, ishqorlar va suyultirilgan nitrat kislotada erimaydi
	KI	$Hg_2(NO_3)_2 + 2KI = Hg_2I_2\downarrow + 2KNO_3$ $[Hg_2]^{2+} + 2I^- = Hg_2I_2\downarrow$	Yashil cho'kma
	NaOH yoki KOH	$Hg_2(NO_3)_2 + 2NaOH = Hg_2O\downarrow + 2NaNO_3 + H_2O$ $[Hg_2]^{2+} + 2OH^- = Hg_2O\downarrow + H_2O$	Qora cho'kma
	Qaytaruvchilar	$Hg_2(NO_3)_2 + Cu = 2Hg\downarrow + Cu(NO_3)_2$ $Hg_2^{2+} + Cu = Cu^{2+} + 2Hg\downarrow$	Mis plastinkada simobning kulrang dog'i paydo bo'ladi

9-*jadval*

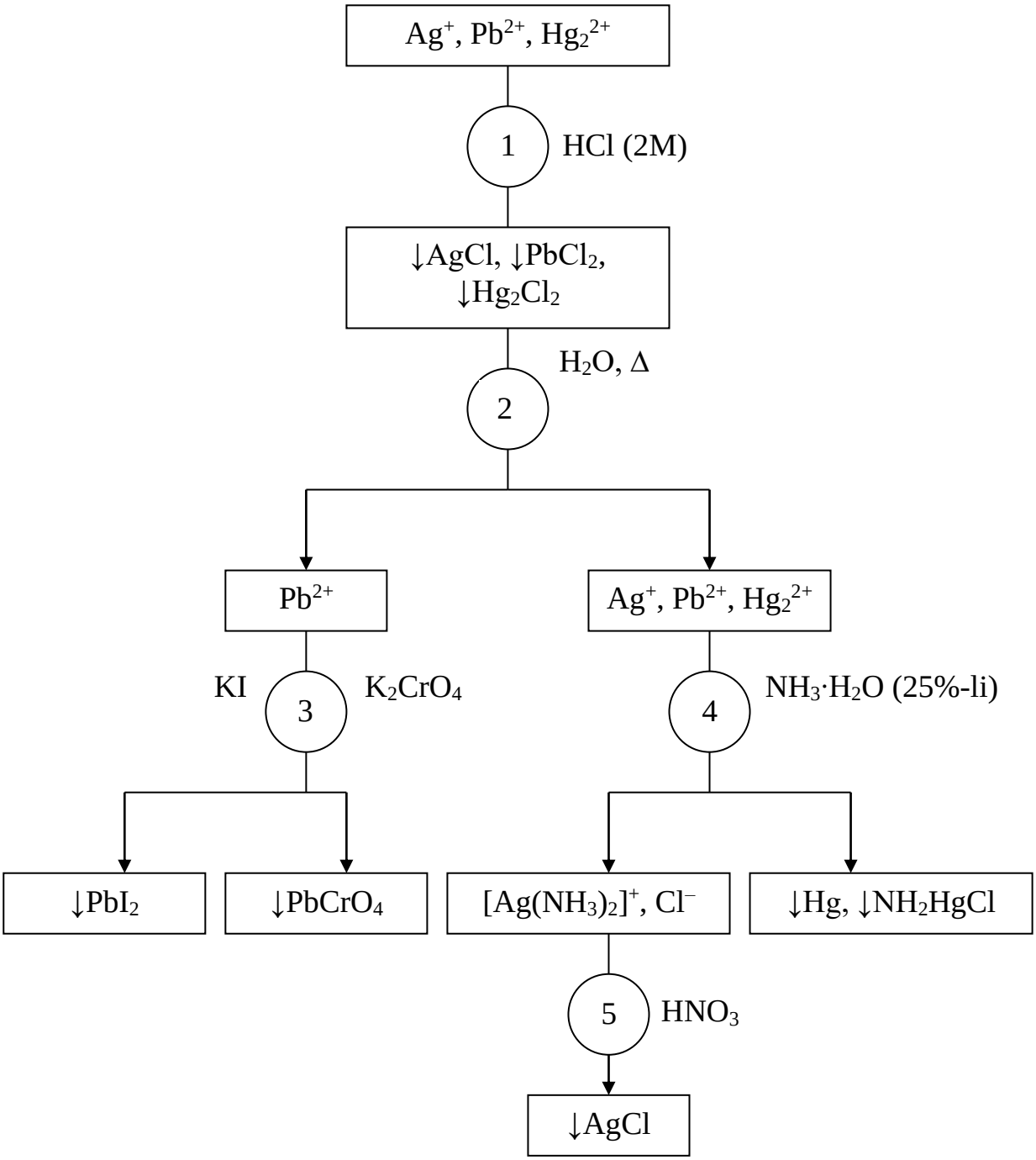
II ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Ag^+, Pb^{2+}, Hg_2^{2+}

Bosqichning t/r	**Analiz bosqichlari**
1	2M HCl ta'sir ettirib II analitik guruh kationlarini cho'ktirish: $Ag^+ \xrightarrow{HCl} AgCl\downarrow \quad EK_{AgCl} = 1{,}78 \cdot 10^{-10}$ $Pb^{2+} \xrightarrow{HCl} PbCl_2\downarrow \quad EK_{PbCl_2} = 1{,}6 \cdot 10^{-5}$ $Hg_2^{2+} \xrightarrow{HCl} Hg_2Cl_2\downarrow \quad EK_{Hg_2Cl_2} = 1{,}3 \cdot 10^{-18}$ HCl saqlagan cho'kmani suv bilan yuvish
2	1 cho'kmani issiq suv bilan yuvib qo'rg'oshin kationlarini ajratish: $PbCl_2\downarrow \xrightarrow{H_2O,\ \Delta} Pb^{2+}$
3	K_2CrO_4 yoki KI eritmalari ta'sir ettirib, 2 sentrifugatdan Pb^{2+} kationlarini topish: $Pb^{2+} \xrightarrow{K_2CrO_4} PbCrO_4\downarrow$ $Pb^{2+} \xrightarrow{KI} PbI_2\downarrow$
4	1 cho'kmaga NH_3 eritmasi ta'sir ettirib, Ag^+ kationlarini ajratish va Hg_2^{2+} kationlarini topish: $AgCl\downarrow \xrightarrow{NH_3 \cdot H_2O} [Ag(NH_3)_2]^+ + Cl^-$ (eritma) $Hg_2Cl_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [HgNH_2]Cl\downarrow + Hg\downarrow$
5	4 eritmaga kons. HNO_3 ta'sir ettirib, Ag^+ kationlarini topish: $[Ag(NH_3)_2]^+ + Cl^- \xrightarrow{kons.HNO_3} AgCl\downarrow$

6-*sxema*

II ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



10-*jadval*

III ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Ba^{2+}	$K_2Cr_2O_7$ (CH_3COONa)	$2BaCl_2 + K_2Cr_2O_7 + H_2O = 2BaCrO_4\downarrow + 2KCl + 2HCl$ $2Ba^{2+} + Cr_2O_7^{2-} + H_2O = 2BaCrO_4\downarrow + 2H^+$	pH > 7, sariq cho'kma, kuchli kislotalarda eriydi
	H_2SO_4	$BaCl_2 + H_2SO_4 = BaSO_4\downarrow + 2HCl$ $Ba^{2+} + SO_4^{2-} = BaSO_4\downarrow$	Oq cho'kma, kislotalarda erimaydi
	$(NH_4)_2C_2O_4$	$BaCl_2 + (NH_4)_2C_2O_4 = BaC_2O_4\downarrow + 2NH_4Cl$ $Ba^{2+} + C_2O_4^{2-} = BaC_2O_4\downarrow$	Oq cho'kma, kuchli kislotalarda va qizdirilganda konsentrlangan CH_3COOH da ham eriydi
	Na_2HPO_4	$BaCl_2 + Na_2HPO_4 = BaHPO_4\downarrow + 2NaCl$ $Ba^{2+} + HPO_4^{2-} = BaHPO_4\downarrow$ Agar reaksiya ishqor yoki ammiak ishtirokida olib borilsa, o'rta tuz cho'kmaga tushadi: $HPO_4^{2-} + OH^- = PO_4^{3-} + H_2O$ $3Ba^{2+} + 2PO_4^{3-} = Ba_3(PO_4)_2\downarrow$	Oq cho'kma, HCl, HNO_3 va CH_3COOH da eriydi
	Alangani bo'yashi		Rangsiz alangani sarg'ish-yashil rangga kiritadi
Ca^{2+}	$(NH_4)_2C_2O_4$	$CaCl_2 + (NH_4)_2C_2O_4 = CaC_2O_4\downarrow + 2NH_4Cl$ $Ca^{2+} + C_2O_4^{2-} = CaC_2O_4\downarrow$	Oq cho'kma, mineral kislotalarda eriydi

10-jadvalning davomi

Ca^{2+}	$K_4[Fe(CN)_6]$ (NH_4OH+NH_4Cl)	$CaCl_2 + K_4[Fe(CN)_6] + 2NH_4Cl = Ca(NH_4)_2[Fe(CN)_6]\downarrow + 4KCl$ $Ca^{2+} + [Fe(CN)_6]^{4-} + 2NH_4^+ = Ca(NH_4)_2[Fe(CN)_6]\downarrow$	Oq kristall cho'kma, sirka kislotada erimaydi
	Na_2HPO_4	$CaCl_2 + Na_2HPO_4 = CaHPO_4\downarrow + 2NaCl$ $Ca^{2+} + HPO_4^{2-} = CaHPO_4\downarrow$	Oq cho'kma, kislotalarda eriydi
	Alangani bo'yashi		Kalsiyning uchuvchan tuzlari rangsiz alangani qizil-g'isht rangiga kiritadi
Sr^{2+}	H_2SO_4	$SrCl_2 + H_2SO_4 = SrSO_4\downarrow + 2HCl$ $Sr^{2+} + SO_4^{2-} = SrSO_4\downarrow$	Oq cho'kma, kislotalarda amalda erimaydi
	Gipsli suv $(CaSO_4 \cdot 2H_2O)$	$SrCl_2 + CaSO_4 = SrSO_4\downarrow + CaCl_2$ $Sr^{2+} + SO_4^{2-} = SrSO_4\downarrow$	Eritma qizdirilganda oq loyqa hosil bo'ladi
	$(NH_4)_2C_2O_4$	$SrCl_2 + (NH_4)_2C_2O_4 = SrC_2O_4\downarrow + 2NH_4Cl$ $Sr^{+} + C_2O_4^{2-} = SrC_2O_4\downarrow$	Oq cho'kma, mineral kislotalarda va qizdirilganda konsentrlangan CH_3COOH da ham eriydi
	Na_2HPO_4	$SrCl_2 + Na_2HPO_4 = SrHPO_4\downarrow + 2NaCl$ $Sr^{2+} + HPO_4^{2-} = SrHPO_4\downarrow$	Oq cho'kma, kislotalarda eriydi
	Alangani bo'yashi		Rangsiz alangani och-qizil rangga kiritadi

11-*jadval*

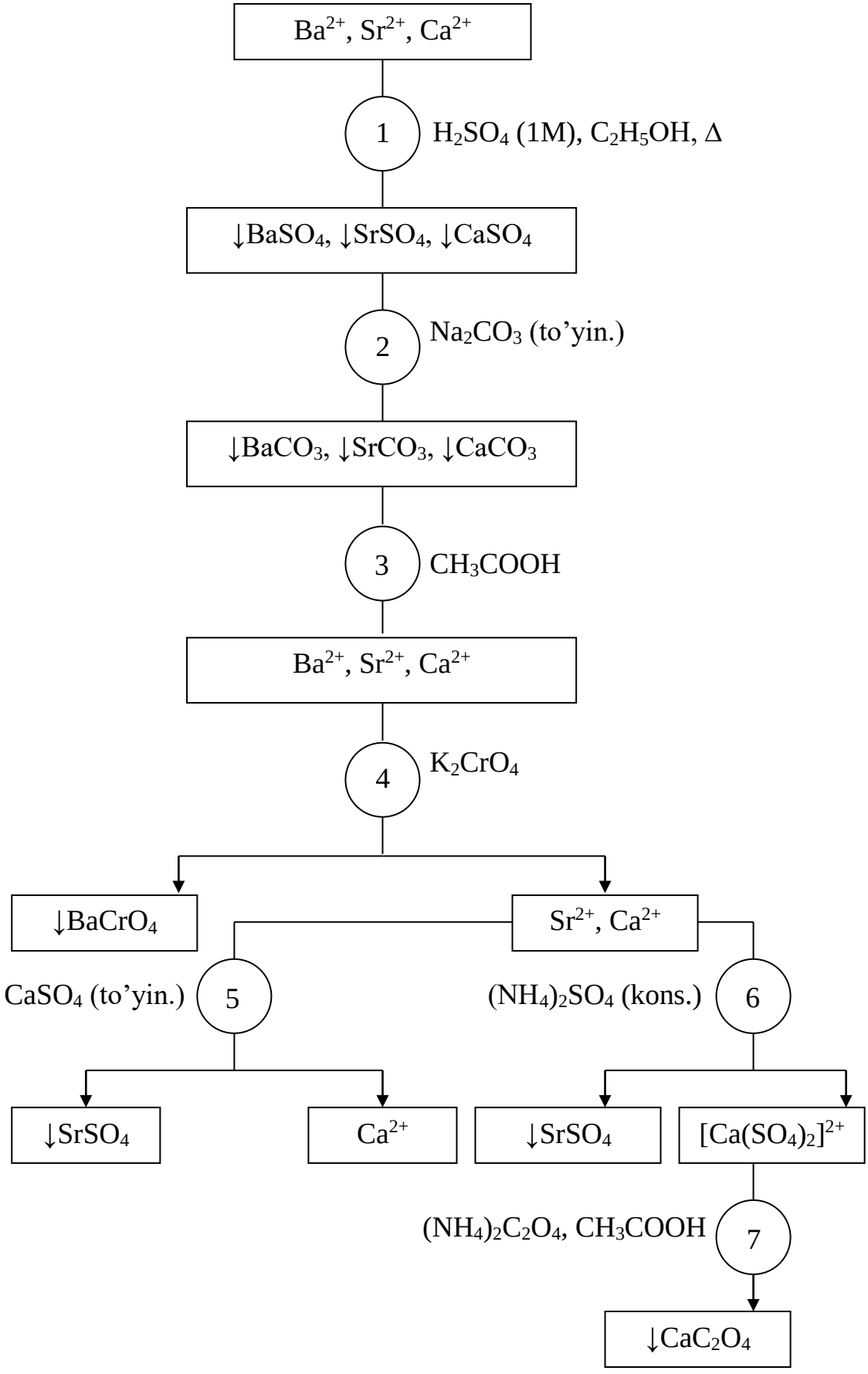
III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Ba^{2+}, Sr^{2+}, Ca^{2+}

Bosqichning t/r	**Analiz bosqichlari**
1	C_6H_5OH ishtirokida qizdirib 1,0 M H_2SO_4 ta'sir ettirib III analitik guruh kationlarini cho'ktirish: $Ba^{2+} \xrightarrow{H_2SO_4,\ \Delta} BaSO_4\downarrow \quad EK_{BaSO_4} = 1{,}1 \cdot 10^{-10}$ $Sr^{2+} \xrightarrow{H_2SO_4,\ \Delta} SrSO_4\downarrow \quad EK_{SrSO_4} = 3{,}2 \cdot 10^{-7}$ $Ca^{2+} \xrightarrow{H_2SO_4,\ C_2H_5OH,\ \Delta} CaSO_4\downarrow \quad EK_{CaSO_4} = 2{,}5 \cdot 10^{-5}$
2	III guruh analitik kationlari sulfatlarining cho'kmalariga qaynatib Na_2CO_3 to'yingan eritmasi ta'sir ettirib, qayta cho'ktirish: $BaSO_4\downarrow \xrightarrow{Na_2CO_3,\ \Delta} BaCO_3\downarrow \quad EK_{BaCO_3} = 4{,}0 \cdot 10^{-10}$ $SrSO_4\downarrow \xrightarrow{Na_2CO_3,\ \Delta} SrCO_3\downarrow \quad EK_{SrCO_3} = 1{,}1 \cdot 10^{-10}$ $CaSO_4\downarrow \xrightarrow{Na_2CO_3,\ \Delta} CaCO_3\downarrow \quad EK_{CaCO_3} = 3{,}8 \cdot 10^{-9}$
3	2 cho'kmani CH_3COOH eritmasi ta'sir ettirib eritish: $BaCO_3\downarrow \xrightarrow{CH_3COOH} Ba^{2+}$ $SrCO_3\downarrow \xrightarrow{CH_3COOH} Sr^{2+}$ $CaCO_3\downarrow \xrightarrow{CH_3COOH} Ca^{2+}$
4	3 eritmaning alohida ulushiga K_2CrO_4 eritmasi ta'sir ettirib Ba^{2+} kationlarini topish: $Ba^{2+} \xrightarrow{K_2CrO_4} BaCrO_4\downarrow$ Agar Ba^{2+} ishtiroki tasdiqlangan bo'lsa, unda u 3 eritmadan K_2CrO_4 eritmasi ta'sir ettirib ajratish.
5	4 sentrafugatning alohida ulushiga kalsiy sulfatning to'yingan eritmasi (gipsli suv) ta'sir ettirib Sr^{2+} kationlarini topish: $Sr^{2+} \xrightarrow{CaSO_4\ \text{to'yingan eritmasi}} SrSO_4\downarrow$
6	$(NH_4)_2SO_4$ ning konsentrlangan eritmasining ta'sir ettirib 4 sentrifugatdan Sr^{2+} kationlarini ajratish: $Sr^{2+} \xrightarrow{kons.(NH_4)_2SO_4} SrSO_4\downarrow$ $Ca^{2+} \xrightarrow{kons.(NH_4)_2SO_4} [Ca(SO_4)_2]^{2-}$
7	6 sentrifugatga $(NH_4)_2C_2O_4$ eritmasi ta'sir ettirib Ca^{2+} kationlarini topish: $Ca^{2+} \xrightarrow{(NH_4)_2C_2O_4,\ CH_3COOH} CaC_2O_4\downarrow$

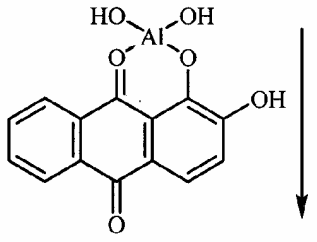
7-sxema

III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI

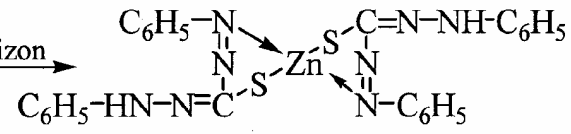


12-*jadval*

IV ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Al^{3+}	NaOH (KOH)	$AlCl_3 + 3NaOH = Al(OH)_3\downarrow + 3NaCl$ $Al^{3+} + 3OH^- = Al(OH)_3\downarrow$	Oq amorf cho'kma, amfoter xossaga ega, kislota va ishqorlarda eriydi
	Na_2HPO_4	$AlCl_3 + Na_2HPO_4 = AlPO_4\downarrow + 2NaCl + HCl$ $Al^{3+} + HPO_4^{2-} = AlPO_4\downarrow + H^+$	Oq kristall cho'kma, kuchli kislotalarda eriydi
	CH_3COONa	$AlCl_3 + CH_3COONa + 2H_2O = Al(OH)_2CH_3COO\downarrow + NaCl + 2HCl$ $Al^{3+} + CH_3COO^- + 2H_2O = Al(OH)_2CH_3COO\downarrow + 2H^+$	Oq rangli pag'a-pag'a cho'kma
	Alizarin	Al^{3+} —alizarin, NaOH→ 	"Alyuminiy loki" deb ataluvchi to'q-qizil rangli qiyin eruvchan birikma
Zn^{2+}	NaOH (KOH)	$ZnCl_2 + 2NaOH = Zn(OH)_2\downarrow + 2NaCl$ $Zn^{2+} + 2OH^- = Zn(OH)_2\downarrow$	Kislota va ishqorlarda eriydigan oq rangli cho'kma
	Na_2HPO_4	$3ZnCl_2 + 2Na_2HPO_4 = Zn_3(PO_4)_2\downarrow + 4NaCl + 2HCl$ $3Zn^{2+} + 2HPO_4^{2-} = Zn_3(PO_4)_2\downarrow + 2H^+$	Oq cho'kma, kislotalar, ishqorlar va ammiakda eriydi

12-jadvalning davomi

Zn^{2+}	$K_3[Fe(CN)_6]$	$3ZnCl_2 + 2K_3[Fe(CN)_6] = Zn_3[Fe(CN)_6]_2\downarrow + 6KCl$ $3Zn^{2+} + 2[Fe(CN)_6]^{3-} = Zn_3[Fe(CN)_6]_2\downarrow$	Jigarrang-sariq cho'kma, HCl va NH_4OH da eriydi
	$K_4[Fe(CN)_6]$	$3ZnCl_2 + 2K_4[Fe(CN)_6] = K_2Zn_3[Fe(CN)_6]_2\downarrow + 6KCl$ $3Zn^{2+} + 2K^+ + 2[Fe(CN)_6]^{4-} = K_2Zn_3[Fe(CN)_6]_2\downarrow$	Oq rangli cho'kma, ishqorlarda eriydi
	Ditizon	$[Zn(NH_3)_4]^{2+} \xrightarrow{\text{ditizon}}$ 	Pushti-qizil rangli ichki kompleks tuz
	H_2S	$ZnCl_2 + H_2S \rightleftarrows ZnS\downarrow + 2HCl$ $Zn^{2+} + H_2S \rightleftarrows ZnS\downarrow + 2H^+$	Oq cho'kma
Cr^{3+}	NaOH (KOH)	$Cr_2(SO_4)_3 + 6NaOH = Cr(OH)_3\downarrow + 3Na_2SO_4$ $2Cr^{3+} + 6OH^- = 2Cr(OH)_3\downarrow$	Xira-ko'k rangli cho'kma, amfoter xossaga ega
	Na_2HPO_4	$CrCl_3 + Na_2HPO_4 = CrPO_4\downarrow + 2NaCl + HCl$ $Cr^{3+} + HPO_4^{2-} = CrPO_4\downarrow + H^+$	Ko'kish rangli cho'kma, kislota va ishqorlarda eriydi
	Oksidlovchilar H_2O_2, $KMnO_4$, $(NH_4)_2S_2O_8$	$Cr_2(SO_4)_3 + 10NaOH + 3H_2O_2 = 2Na_2CrO_4 + 3Na_2SO_4 + 8H_2O$ $2Cr^{3+} + 10OH^- + 3H_2O_2 = 2CrO_4^{2-} + 8H_2O$	Ishqoriy muhitda eritmaning yashil rangi sariqqa o'tadi
Sn^{2+}	NaOH (KOH)	$SnCl_2 + 2NaOH = H_2SnO_2\downarrow + 2NaCl$ $Sn^{2+} + 2OH^- = H_2SnO_2\downarrow$	Oq iviq cho'kma, kislota va ishqorlarda eriydi
	$HgCl_2$	$SnCl_2 + 2HgCl_2 = Hg_2Cl_2\downarrow + SnCl_4$ $Hg_2Cl_2\downarrow + SnCl_2 = 2Hg\downarrow + SnCl_4$	Hg ning cho'kishi sababli oq cho'kma qorayib boradi

12-jadvalning davomi

Sn^{2+}	$Bi(OH)_3$	$3Na_2SnO_2 + 2Bi(OH)_3\downarrow = 2Bi\downarrow + 3Na_2SnO_3 + 3H_2O$ $3SnO_2^{2-} + 2Bi(OH)_3 = 2Bi\downarrow + 3SnO_3^{2-} + 3H_2O$	Metall holdagi vismut ajralib chiqadi (bu reaksiyadan Bi ni topishda ham foydalaniladi)
Sn^{IV}	NaOH (KOH)	$SnCl_4 + 4NaOH = H_4SnO_4\downarrow + 4NaCl$ $Sn^{4+} + 4OH^- = H_4SnO_4\downarrow$	Oq iviq cho'kma
	Qaytaruvchilar (Mg, Fe)	$H_2[SnCl_6] + Mg = MgCl_2 + SnCl_2 + 2HCl$ $[SnCl_6]^{2-} + Mg = Mg^{2+} + Sn^{2+} + 6Cl^-$	Agar eritmada kislota yetishmay qolsa, Sn ning kulrang cho'kmasi hosil bo'ladi, HCl ta'sirida cho'kma erib ketadi
	RbCl (CsCl)	$H_2[SnCl_6] + 2RbCl = Rb_2[SnCl_6]\downarrow + 2HCl$ $[SnCl_6]^{2-} + 2Rb^+ = Rb_2[SnCl_6]\downarrow$	Oq bulut shaklidagi kristall cho'kma
As^{III}	$AgNO_3$	$NaAsO_2 + H_2O + 3AgNO_3 = Ag_3AsO_3\downarrow + 2HNO_3 + NaNO_3$ $AsO_2^- + H_2O + 3Ag^+ = Ag_3AsO_3\downarrow + 2H^+$	Sariq cho'kma, NH_4OH da eriydi
	I_2 eritmasi	$NaAsO_2 + I_2 + 2H_2O = NaH_2AsO_4 + 2HI$ $AsO_2^- + I_2 + 2H_2O = H_2AsO_4^- + 2H^+ + 2I^-$	$pH \geq 7$, yod eritmasining qo'ng'ir rangi yo'qoladi
	$Zn + AgNO_3$ bilan hamlangan qog'oz	$Na_3AsO_3 + 3Zn + 9HCl = AsH_3\uparrow + 3ZnCl_2 + 3NaCl + 3H_2O$ $AsO_3^{3-} + 3Zn + 9H^+ = AsH_3\uparrow + 3Zn^{2+} + 3H_2O$ $AsH_3\uparrow + 6Ag^+ + 3H_2O = 6Ag\downarrow + H_3AsO_3 + 6H^+$	Ajralib chiqayotgan AsH_3 gazi Ag^+ ionini kumush metaligacha qaytargani sababli qog'oz tezda qorayadi
As^V	$AgNO_3$	$Na_3AsO_4 + 3AgNO_3 = Ag_3AsO_4\downarrow + 3NaNO_3$ $AsO_4^{3-} + 3Ag^+ = Ag_3AsO_3\downarrow$	Qo'ng'ir cho'kma, ammiakda eriydi

12-*jadvalning davomi*

As^{V}	KI	$Na_3AsO_4 + 2KI + 4HCl = NaAsO_2 + I_2\downarrow + 2NaCl + 2KCl + 2H_2O$ $AsO_4^{3-} + 2I^- + 3H^+ = AsO_2^- + I_2\downarrow + 2H_2O$	pH < 7, erkin yodning ajralishi natijasida eritma qo'ng'ir rangga kiradi
	$MoO_3 + NH_4NO_3$	$H_3AsO_4 + 12MoO_3 + 3NH_4NO_3 = (NH_4)_3[AsMo_{12}O_{40}]\downarrow + 3HNO_3$ $AsO_4^{3-} + 12MoO_3 + 3NH_4NO_3 = (NH_4)_3[AsMo_{12}O_{40}]\downarrow + 3NO_3^-$	Sariq rangli kristall cho'kma
	Zn + $AgNO_3$ bilan namlangan qog'oz	$AsO_4^{3-} + 7H^+ + 2Zn = AsH_3\uparrow + 2Zn^{2+} + 4H_2O$ $AsH_3\uparrow + 6Ag^+ + 3H_2O = 6Ag\downarrow + H_3AsO_3 + 6H^+$	Ag^+ ionining arsin ta'sirida metall holatdagi kumushgacha qaytarilishi sababli qog'oz qorayadi

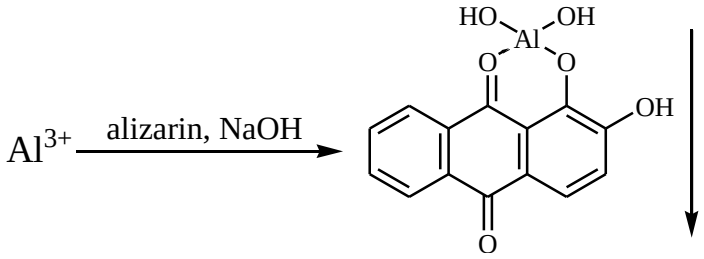
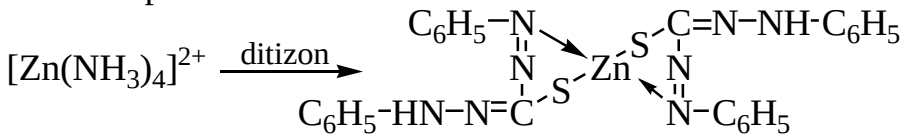
13-*jadval*

IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Al^{3+}, Zn^{2+}, Cr^{3+}, Sn^{2+}, Sn(IV), As(III), As(V)

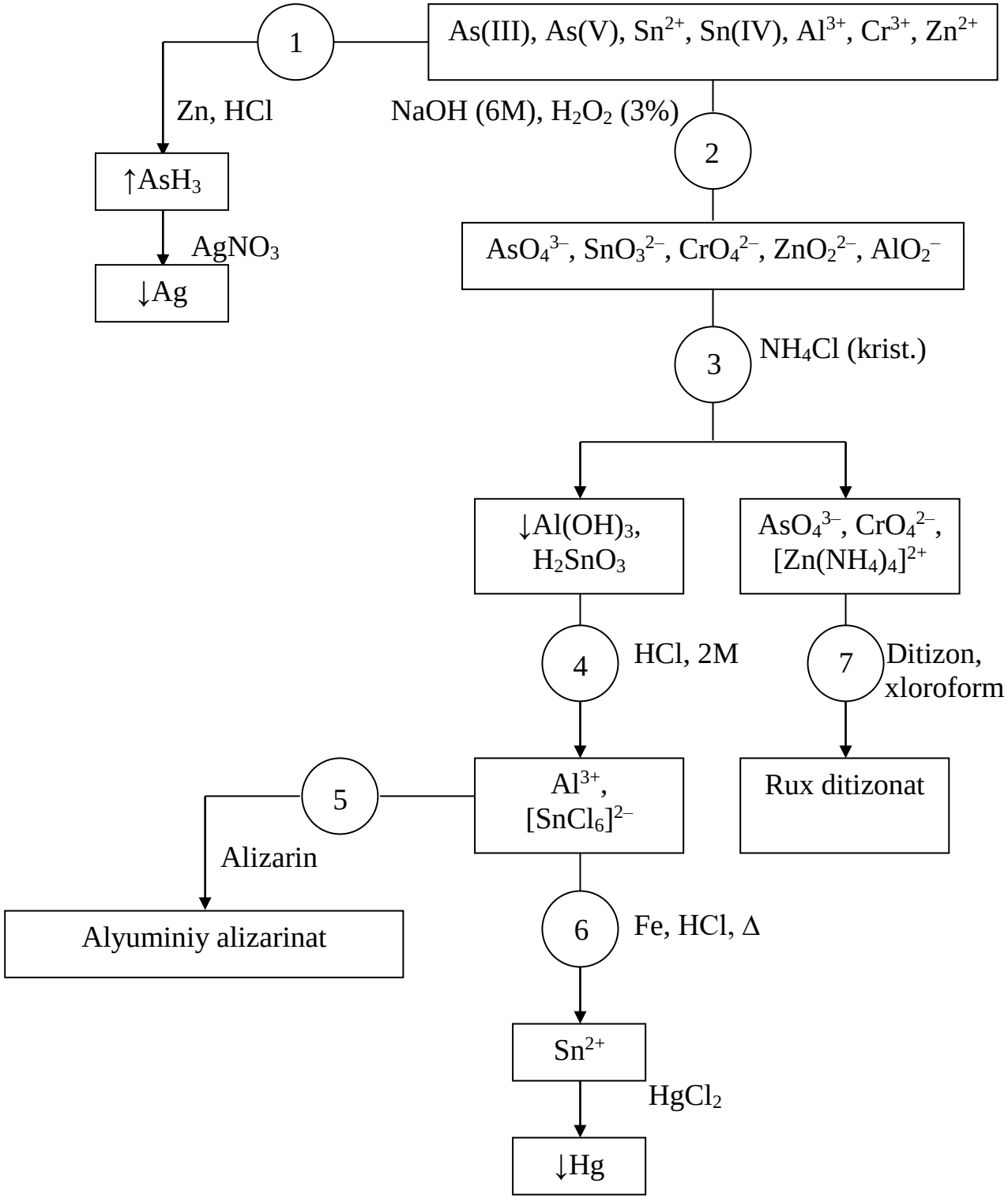
Bosqichning t/r	**Analiz bosqichlari**
1	Alohida namunadagi As(III), As(V) ionlarini HCl muhitida rux metali ta'sir ettirib aniqlash: As (III), (V) $\xrightarrow{Zn;\,HCl}$ $AsH_3\uparrow$ $AgNO_3$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ $Ag\downarrow$ (qora) (Gutsayt reaksiyasi) $[HgCl_2]$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ $AsH_2(HgCl)\downarrow$, $AsH(HgCl)_2\downarrow$, $As(HgCl)_3\downarrow$, $As_2Hg_3\downarrow$ (sarg'ish-qo'ng'ir) (Zanger-Blek reaksiyasi)
2	Qizdirilganda IV analitik guruh kationlariga H_2O_2 ishtirokida mo'l 6M NaOH ta'sir ettirish: $Al^{3+} \xrightarrow{NaOH} Al(OH)_3\downarrow \xrightarrow{mo'l\ NaOH} [Al(OH)_6]^{3-}$ $Zn^{2+} \xrightarrow{NaOH} Zn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH} [Zn(OH)_4]^{2-}$ $Cr^{3+} \xrightarrow{NaOH} Cr(OH)_3\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} CrO_4^{2-}$ $Sn^{2+} \xrightarrow{NaOH} Sn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} [Sn(OH)_6]^{2-}$ $Sn(IV) \xrightarrow{NaOH} Sn(OH)_4\downarrow \xrightarrow{mo'l\ NaOH} [Sn(OH)_6]^{2-}$ $As(III) \xrightarrow{NaOH} AsO_3^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_4^{3-}$ $As(V) \xrightarrow{NaOH} AsO_4^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_3^{3-}$
3	2 eritmadan qizdirilganda NH_4Cl kristallari ta'sir ettirib, $[Al(OH)_6]^{3-}$ gidroksoanionlarni ajratish: $[Al(OH)_6]^{3-} \xrightarrow{NH_4Cl,\ \Delta} Al(OH)_3\downarrow$ $[Sn(OH)_6]^{2-} \xrightarrow{NH_4Cl,\ \Delta} Sn(OH)_4\downarrow$
4	2M HCl ta'sirida 3 cho'kmani eritish: $Al(OH)_3\downarrow \xrightarrow{HCl} Al^{3+}$ $Sn(OH)_4\downarrow \xrightarrow{HCl} [SnCl_6]^{2-}$

13-*jadvalning davomi*

5	5 ertimaga alizarin yoki natriy atsetat ta'sir ettirib Al^{3+} ionlarini topish:  $Al^{3+} \xrightarrow{CH_3COONa} Al(OH)_2CH_3COO\downarrow$
6	HCl muhitida temir qirindilari bilan qaynatilgan 4 eritmaga simob (II) tuzini ta'sir ettirib Sn(IV) ionlarini aniqlash: $[SnCl_6]^{2-} \xrightarrow{Fe,\ HCl;\ \Delta} Sn^{2+} \xrightarrow{HgCl_2} Hg\downarrow$
7	3 sentrifugatga ditizon yoki $K_4[Fe(CN)_6]$ eritmasi ta'sir ettirib Zn^{2+} kationlarini topish:  $[Zn(NH_3)_4]^{2+} \xrightarrow{K_4[Fe(CN)_6]} K_2Zn_3[Fe(CN)_6]_2\downarrow$

8-*sxema*

IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



14-*jadval*

V ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Mg^{2+}	NaOH (KOH)	$MgCl_2 + 2NaOH = Mg(OH)_2\downarrow + 2NaCl$ $Mg^{2+} + 2OH^- = Mg(OH)_2\downarrow$	Oq amorf cho'kma, mineral kislotalarda va ammoniy tuzlarida eriydi
	Na_2HPO_4 $NH_4OH + NH_4Cl$	$MgCl_2 + Na_2HPO_4 + NH_4OH = MgNH_4PO_4\downarrow + 2NaCl + H_2O$ $Mg^{2+} + HPO_4^{2-} + NH_4OH = Mg\,NH_4PO_4\downarrow + H_2O$	Oq cho'kma mineral kislotalarda eriydi
	Na_2CO_3 (K_2CO_3)	$2MgCl_2 + 2Na_2CO_3 + H_2O = (MgOH)_2CO_3\downarrow + 4NaCl + CO_2\uparrow$ $2Mg^{2+} + 2CO_3^{2-} + H_2O = (MgOH)_2CO_3\downarrow + CO_2\uparrow$	Oq amorf cho'kma, kislotalar va ammoniy tuzlarida eriydi
Mn^{2+}	NaOH	$MnSO_4 + 2NaOH = Mn(OH)_2\downarrow + Na_2SO_4$ $Mn^{2+} + 2OH^- = Mn(OH)_2\downarrow$	Oq cho'kma, kuchli kislotalarda eriydi
	$NaOH + H_2O_2$	$MnSO_4 + 2NaOH + H_2O_2 = MnO_2{\cdot}nH_2O\downarrow + Na_2SO_4$ $Mn^{2+} + 2OH^- + H_2O_2 = MnO_2{\cdot}nH_2O\downarrow$	Qo'ng'ir cho'kma, H_2O_2 ta'sirida kislotalarda eriydi
	Na_2HPO_4	$MnSO_4 + 4Na_2HPO_4 = Mn_3(PO_4)_2\downarrow + 2NaH_2PO_4 + 3Na_2SO_4$ $Mn^{2+} + 4HPO_4^{2-} = Mn_3(PO_4)_2\downarrow + 2H_2PO_4^-$	Oq cho'kma, sirka kislotada eriydi
	Oksidlovchilar $(NH_4)_2S_2O_8$, PbO_2, $NaBiO_3$	$2MnSO_4 + 5(NH_4)_2S_2O_8 + 8H_2O = 2HMnO_4 + 5(NH_4)_2SO_4 + 7H_2SO_4$ $2Mn^{2+} + 5S_2O_8^{2-} + 8H_2O = 2MnO_4^- + 10SO_4^{2-} + 16H^+$	MnO_4^- ionining hosil bo'lishini binafsha rang ko'rsatadi (Ag^+ ionlari katalizator)

14-jadvalning davomi

Fe^{2+}	NaOH (KOH)	$FeSO_4 + 2NaOH = Fe(OH)_2\downarrow + Na_2SO_4$ $Fe^{2+} + 2OH^- = Fe(OH)_2\downarrow$	Oq cho'kma, havoda qisman oksidlanishi tufayli xira-yashil tusga kiradi, kislotalarda eriydi
	$K_3[Fe(CN)_6]$	$3FeCl_2 + 2K_3[Fe(CN)_6] = Fe_3[Fe(CN)_6]_2\downarrow + 6KCl$ $3Fe^{2+} + 2[Fe(CN)_6]^{3-} = Fe_3[Fe(CN)_6]_2\downarrow$	"Turunbul ko'ki' deb nomlanuvchi ko'k cho'kma, kislotalarda erimaydi, lekin ishqorlar ta'sirida parchalanadi
Fe^{3+}	NaOH (KOH, NH_4OH)	$FeCl_3 + 3NaOH = Fe(OH)_3\downarrow + 3NaCl$ $Fe^{3+} + OH^- = Fe(OH)_3\downarrow + 3NaCl$	Qizil–qo'ng'ir cho'kma, kislotalarda eriydi
	$K_4[Fe(CN)_6]$	$4FeCl_3 + 3K_4[Fe(CN)_6] = Fe_4[Fe(CN)_6]_3\downarrow + 12KCl$ $4Fe^{3+} + 3[Fe(CN)_6]^{4-} = Fe_4[Fe(CN)_6]_3\downarrow$	"Berlin lazuri" deb nomlanuvchi to'q-ko'k rangli cho'kma, ishqorlarda eriydi
	NH_4SCN	$FeCl_3 + 3NH_4SCN = [Fe(SCN)_3] + 3NH_4Cl$ $Fe^{3+} + 3SCN^- = [Fe(SCN)_3]$	Qizil rangli eritma
	Na_2HPO_4	$FeCl_3 + 2Na_2HPO_4 = FePO_4\downarrow + NaH_2PO_4 + 3NaCl$ $Fe^{3+} + 2HPO_4^{2-} = FePO_4\downarrow + H_2PO_4^{2-}$	Och-sariq cho'kma, kuchli kislotalarda eriydi
Bi^{3+}	NH_4OH	$Bi(NO_3)_3 + 2NH_4OH = Bi(OH)_2NO_3\downarrow + 2NH_4NO_3$ $Bi^{3+} + 2NH_4OH = Bi(OH)_2NO_3\downarrow + 2NH_4^+$ $Bi(OH)_2NO_3 = BiONO_3\downarrow + H_2O$	Oq cho'kma, mineral kislotalarda eriydi
	NaOH (KOH)	$Bi(NO_3)_3 + 3NaOH = Bi(OH)_3\downarrow + 3NaNO_3$ $Bi^{3+} + 3OH^- = Bi(OH)_3\downarrow$	Oq rangli cho'kma, kislotalarda eriydi

14-jadvalning davomi

Bi^{3+}	Na_2SnO_2	$3Na_2SnO_2 + 2Bi(OH)_3\downarrow = 2Bi\downarrow + 3Na_2SnO_3 + 3H_2O$ $3SnO_2^{2-} + 2Bi(OH)_3 = 2Bi\downarrow + 3SnO_3^{2-} + 3H_2O$	Metall holdagi vismut ajralib chiqadi
	KI	$Bi(NO_3)_3 + 3KI = BiI_3\downarrow + 3KNO_3$ $Bi^{3+} + 3I^- = BiI_3\downarrow$ $BiI_3 + KI = K[BiI_4]$	Qora cho'kma, reagentning ortiqcha miqdorida to'q-sariq rangli kompleks birikma hosil qiladi
	$K_2Cr_2O_7$	$2Bi(NO_3)_3 + K_2Cr_2O_7 + 2H_2O = (BiO)_2Cr_2O_7\downarrow + 2KNO_3 + 4HNO_3$ $2Bi^{3+} + Cr_2O_7^{2-} + 2H_2O = (BiO)_2Cr_2O_7\downarrow + H^+$	Sariq cho'kma, sirka kislotada eriydi, ishqorlarda erimaydi
	Na_2HPO_4	$Bi(NO_3)_3 + 2Na_2HPO_4 = BiPO_4\downarrow + NaH_2PO_4 + 3NaNO_3$ $Bi^{3+} + 2HPO_4^{2-} = BiPO_4\downarrow + H_2PO_4^-$	Oq kukunsimoh cho'kma, suyultirilgan HNO_3 da erimaydi
Sb^{III}	H_2O (gidroliz)	$Na_3[SbCl_6] + H_2O = SbOCl\downarrow + 3NaCl + 2HCl$ $[SbCl_6]^{3-} + H_2O = SbOCl\downarrow + 5Cl^- + 2H^+$	Oq cho'kma, kislotalarda, jumladan tartrat kislotada ham eriydi
	NaOH (KOH)	$H_3[SbCl_6] + 3NaOH = HSbO_2\downarrow + 3NaCl + 3HCl + H_2O$ $[SbCl_6]^{3-} + 3OH^- = HSbO_2\downarrow + 6Cl^- + H_2O$	Oq cho'kma, kislota va ishqorlarda eriydi
	HNO_3	$SbCl_3 + 2HNO_3 + H_2O = HSbO_3\downarrow + 4NO_2\uparrow + 3HCl$ $Sb^{3+} + 2NO_3^- + H_2O = HSbO_3\downarrow + 4NO_2\uparrow + H^+$	Oq cho'kma
	NaS_2O_3	$2SbCl_3 + 2Na_2S_2O_3 + 3H_2O = Sb_2OS_2\downarrow + 2Na_2SO_4 + 6HCl$ $2Sb^{3+} + 2S_2O_3^{2-} + 3H_2O = Sb_2OS_2\downarrow + 2SO_4^{2-} + 6H^+$	$pH \leq 7$, qizil cho'kma (surma kinovari), kislotalarda oson eriydi
	Qaytaruvchilar (Zn, Sn, Mg)	$2H_3[SbCl_6] + 3Zn\downarrow = 2Sb\downarrow + 3ZnCl_2 + 6HCl$ $2[SbCl_6]^{3-} + 3Zn\downarrow = 2Sb\downarrow + 3Zn^{2+} + 12Cl^-$	Qora cho'kma, HNO_3 da eriydi

14-*jadvalning davomi*

Sb^V	H_2O (gidroliz)	$Na[SbCl_6] + 2H_2O = SbO_2Cl\downarrow + NaCl + 4HCl$ $[SbCl_6]^- + 2H_2O = SbOCl\downarrow + 5Cl^- + 4H^+$	Oq cho'kma, qizdirilganda kislotalarda eriydi
	NaOH (KOH)	$H[SbCl_6] + 5NaOH = HSbO_3\downarrow + 5NaCl + HCl + 2H_2O$ $[SbCl_6]^- + 5OH^- = HSbO_3\downarrow + 6Cl^- + 2H_2O$	Oq cho'kma
	Qaytaruvchilar (Zn, Sn, Mg)	$2H[SbCl_6] + 5Zn\downarrow = 2Sb\downarrow + 5ZnCl_2 + 2HCl$ $2[SbCl_6]^{3-} + 5Zn\downarrow = 2Sb\downarrow + 5Zn^{2+} + 12Cl^-$	Qora cho'kma, HNO_3 da eriydi

15-*jadval*

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Mg^{2+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Bi^{3+}, Sb(III), Sb(V)

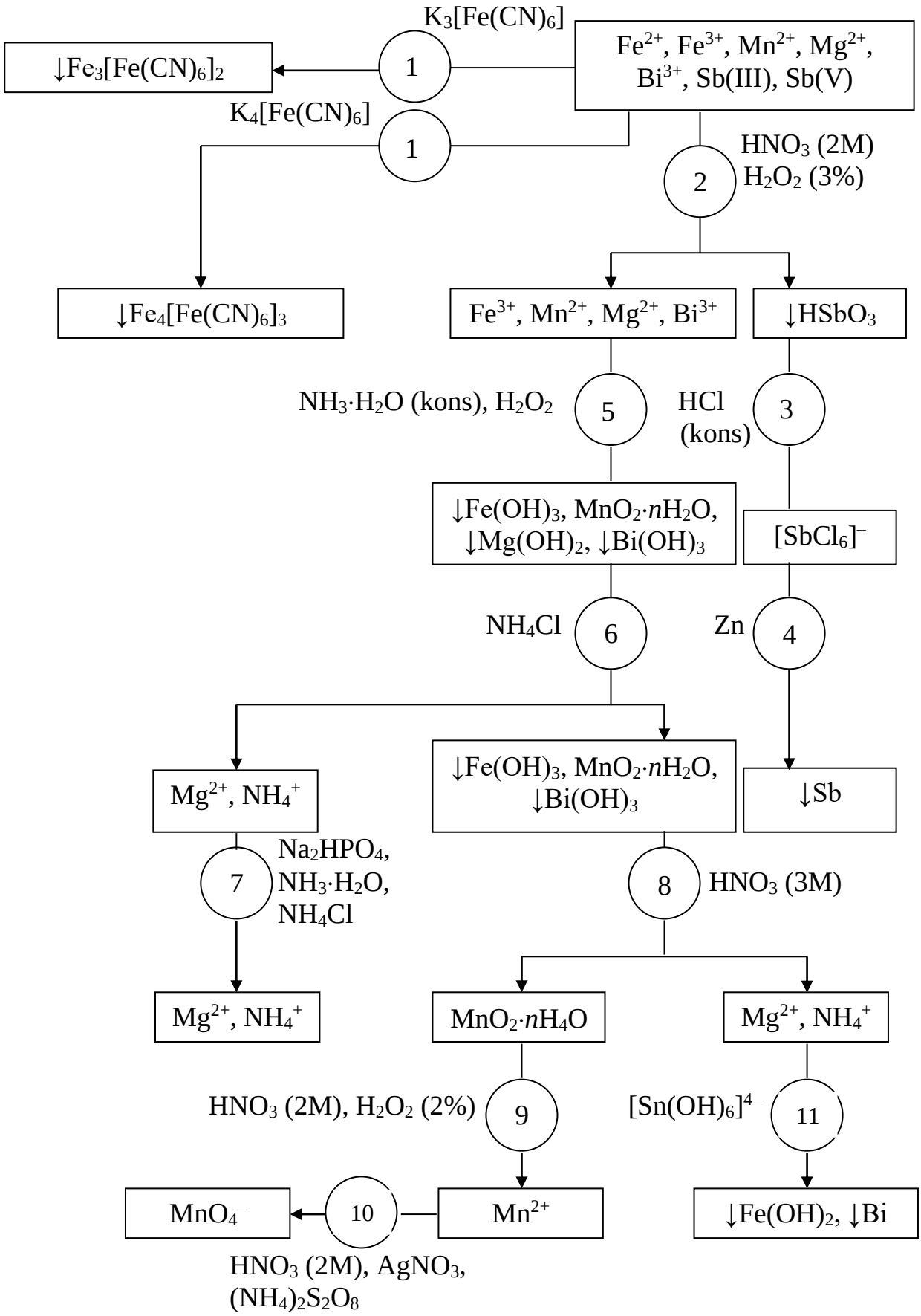
Bosqichning t/r	Analiz bosqichlari
1	Alohida namunadagi Fe(II), Fe(III) ionlarini tegishlicha $K_3[Fe(CN)_6]$ va $K_4[Fe(CN)_6]$ reagentlari bilan aniqlash: $Fe^{2+} \xrightarrow{K_3[Fe(CN)_6]} Fe_3[Fe(CN)_6]_2\downarrow$ $Fe^{3+} \xrightarrow{K_4[Fe(CN)_6]} Fe_4[Fe(CN)_6]_3\downarrow$
2	H_2O_2 bilan HNO_3 ta'sir ettirib, Sb(III) va Sb(V) ionlarini ajratish: Sb(III), Sb(V) $\xrightarrow{HNO_3} HSbO_3\downarrow$ $Fe^{2+} \xrightarrow{HNO_3} Fe^{3+}$
3	2 cho'kmani HCl eritmasida eritish: $HSbO_3\downarrow \xrightarrow{HCl} [SbCl_6]^-$
4	Nikel plastinkasida 3 eritmaga rux ta'sir ettirib, Sb(V) ionlarini aniqlash: $[SbCl_6]^- \xrightarrow{Zn} Sb\downarrow$
5	2 sentrifugatdan konsertlangan $NH_3\cdot H_2O$ ta'sir ettirib, V analitik guruh kationlarini cho'ktirish: $Mg^{2+} \xrightarrow{NH_3\cdot H_2O} Mg(OH)_2\downarrow$ $Mn^{2+} \xrightarrow{NH_3\cdot H_2O} Mn(OH)_2\downarrow$ $Fe^{3+} \xrightarrow{NH_3\cdot H_2O} Fe(OH)_3\downarrow$ $Bi^{3+} \xrightarrow{NH_3\cdot H_2O} BiONO_3\downarrow$
6	5 cho'kmaga NH_4Cl + 3%-li H_2O_2 eritmasi ta'sir ettirib, Mg^{2+} kationlarini ajratish: $Mg(OH)_2\downarrow \xrightarrow{NH_4Cl} Mg^{2+}$ $Mn(OH)_2\downarrow \xrightarrow{3\%\text{-li } H_2O_2} MnO_2\cdot nH_2O\downarrow$ 6 cho'kma tarkibi: $MnO_2\cdot nH_2O\downarrow$, $BiONO_3\downarrow$, $Fe(OH)_3\downarrow$
7	6 sentrifugatga ammiakli bufer eritma ishtirokida $NaHPO_4$ ta'sir ettirib, Mg^{2+} kationlarini aniqlash: $Mg^{2+} \xrightarrow{Na_2HPO_4,\ NH_3\cdot H_2O+NH_4Cl} MgNH_4PO_4\downarrow$

15-*jadvalning davomi*

8	6 cho'kmaga HNO_3 eritmasi ta'sir ettirib, Bi^{3+} va Fe^{3+} kationlarini ajratish: $BiONO_3\downarrow \xrightarrow{HNO_3} Bi^{3+}$ $Fe(OH)_3\downarrow \xrightarrow{HNO_3} Fe^{3+}$ cho'kma $MnO_2 \cdot nH_2O\downarrow$
9	8-bosqich bo'yicha olingan cho'kmani H_2O_2 ishtirokida HNO_3 eritmasi ta'sir ettirib, eritish: $MnO_2 \cdot nH_2O\downarrow \xrightarrow{HNO_3;\ H_2O_2} Mn^{2+}$
10	9 eritmaga $(NH_4)_2S_2O_8$ ta'sir ettirib, Mn^{2+}kationlarini aniqlash: $Mn^{2+} \xrightarrow{(NH_4)_2S_2O_8;\ HNO_3;\ AgNO_3} MnO_4^-$
11	8 sentrifugatga yangi tayyorlangan $[Sn(OH)_6]^{4-}$ ta'sir ettirib, Bi^{3+} ionlarini topish: $Bi^{3+} \xrightarrow{[Sn(OH)_6]^{4-}} Bi\downarrow$

9-*sxema*

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



16-*jadval*

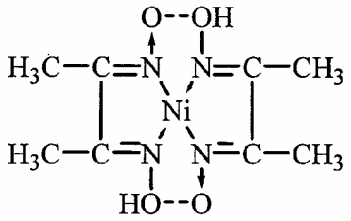
VI ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Cu^{2+}	NH_4OH	$2CuSO_4 + 2NH_4OH = (CuOH)_2SO_4\downarrow + (NH_4)_2SO_4$ $(CuOH)_2SO_4\downarrow + 10NH_4OH = 2[Cu(NH_3)_4](OH)_2 + + (NH_4)_2SO_4 + 8H_2O$	Havo rang cho'kma, ortiqcha ammiakda eriydi, ko'k tusli kompleks
	$Na_2S_2O_3$	$2CuSO_4 + 2Na_2S_2O_3 + 2H_2O = 2Na_2SO_4 + Cu_2S\downarrow + S\downarrow + + 2H_2SO_4$ $2Cu^{2+} + 2S_2O_3^{2-} + H_2O = Cu_2S\downarrow + S\downarrow + 4H^+ + 2SO_4^{2-}$	pH<7, $t°$, to'q-qo'ng'ir cho'kma
	$K_4[FeCN_6]$	$2CuSO_4 + K_4[Fe(CN)_6] = Cu_2[Fe(CN)_6]\downarrow + 2K_2SO_4$ $2Cu^{2+} + K_4[Fe(CN)_6]^{4-} = Cu_2[Fe(CN)_6]\downarrow$	pH < 7 qizil-qo'ng'ir cho'kma
	Qaytaruvchilar (Fe, Al)	$CuSO_4 + Fe\downarrow = FeSO_4 + Cu\downarrow$ $Cu^{2+} + Fe\downarrow = Fe^{2+} + Cu\downarrow$	Qizil g'ovak massa ko'rinishida mis metalligacha qaytariladi
Hg^{2+}	NaOH (KOH)	$Hg(NO_3)_2 + 2NaOH = Hg(OH)_2\downarrow$ $Hg^{2+} + 2OH^- = Hg(OH)_2\downarrow$ $Hg(OH)_2\downarrow = HgO\downarrow + H_2O$	Sariq cho'kma, kislotalarda eriydi. $Hg(OH)_2$ beqaror bo'lib, HgO va H_2O ga parchalanadi
	NH_4OH	$HgCl_2 + 2NH_4OH = [NH_2Hg]Cl\downarrow + NH_4Cl + 2H_2O$ $HgCl_2 + 2NH_4OH = [NH_2Hg]Cl\downarrow + NH_4^+ + Cl^- + 2H_2O$	Oq cho'kma, kislotalarda eriydi
	KI	$Hg(NO_3)_2 + KI = HgI_2\downarrow + 2KNO_3$ $HgI_2 + 2I^- = [HgI_4]^{2-}$	Sarg'ish-qizil cho'kma, kompleks ion hosil qilib eriydi

16-jadvalning davomi

Hg^{2+}	K_2CrO_4	$Hg(NO_3)_2 + K_2CrO_4 = HgCrO_4\downarrow + 2KNO_3$ $Hg^{2+} + CrO_4^{2-} = HgCrO_4\downarrow$	Sariq cho'kma
	$SnCl_2$	$2HgCl_2 + SnCl_2 = Hg_2Cl_2\downarrow + SnCl_4$ $2HgCl_2 + Sn^{2+} = Hg_2Cl_2\downarrow + Sn^{4+} + 2Cl^{2-}$ $Hg_2Cl_2\downarrow + SnCl_2 = 2Hg\downarrow + SnCl_4$ $Hg_2Cl_2\downarrow + Sn^{2}+ = 2Hg\downarrow + Sn^{4+} + 2Cl^{-}$	Avval oq cho'kma hosil bo'ladi, mo'l reaktiv ta'sirida kulrang tusga kiradi, ya'ni simob qaytariladi
Co^{2+}	NaOH (KOH)	$CoCl_2 + 2NaOH = CoOHCl\downarrow + 2NaCl$ $CoOHCl\downarrow + NaOH = Co(OH)_2\downarrow + NaCl$ $4Co(OH)_2\downarrow + O_2 + 2H_2O = 4Co(OH)_3\downarrow$	Oldin ko'k rangli asosli tuz cho'kmasi, keyin ortiqcha ishqor qo'shib qizdirganda pushti rangli cho'kma hosil bo'ladi. $Co(OH)_2$ havoda oksidlanib, qo'ng'ir rangli $Co(OH)_3$ ga aylanadi
	NH_4OH	$CoOHCl\downarrow + 7NH_4OH = [Co(NH_3)_6](OH)_2 + NH_4Cl + 6H_2O$ $CoOHCl\downarrow + 7NH_4OH = [Co(NH_3)_6]^{2+} + 2OH^- + NH_4^+ + Cl^- + 6H_2O$	Ko'k rangli asosli cho'kma mo'l NH_4OH da xira-sariq rangli kompleks hosil qilib eriydi
	NH_4SCN + amil spirt	$CoCl_2 + 4NH_4SCN = (NH_4)_2[Co(SCN)_4] + 2NH_4Cl$ $Co^{2+} + 4SCN^- = [Co(SCN)_4]^{2-}$	Ko'k rangli kompleks tuz eritmasi
Ni^{2+}	NaOH	$NiCl_2 + NaOH = Ni(OH)_2\downarrow + 2NaCl$ $Ni^{2+} + 2OH^- = Ni(OH)_2\downarrow$	Ko'k cho'kma, kislota, ammiak va ammoniy tuzlarida eriydi

16-*jadvalning davomi*

Ni^{2+}	NH_4OH	$Ni(NO_3)_2 + NH_4OH = Ni(OH)NO_3\downarrow + NH_4NO_3$ $Ni(OH)NO_3\downarrow + 7NH_4OH = (NO_3)_2[Ni(NH_3)_6] + NH_4NO_3 + 7H_2O$	Yashil rangli asosli tuz cho'kadi, ko'k qizil rangli kompleks
	Na_2HPO_4	$3Ni(NO_3)_2 + 4Na_2HPO_4 = Ni_3(PO_4)_2\downarrow + 2NaH_2PO_4 + 6NaNO_3$ $3Ni^{2+} + 4HPO_4^{2-} = Ni_3(PO_4)_2\downarrow + 2H_2PO_4^-$	Yashil cho'kma kislotalarda va ammiakda eriydi
	Dimetilglioksim (Chugayev reaktivi)	Ni $\xrightarrow{\text{dimetilglioksim}}$ 	Qizil rangli ichki kompleks tuz cho'kmasi

17-*jadval*

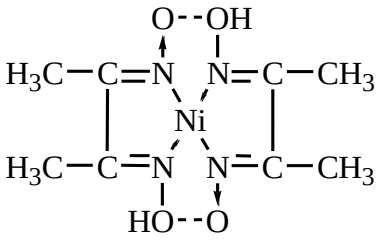
VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Cu^{2+}, Hg^{2+}, Co^{2+}, Ni^{2+}

Bosqichning t/r	**Analiz bosqichlari**
1*	IV analitik guruh kationlarining guruh reagenti (mo'l $NH_3 \cdot H_2O$) bilan o'zaro ta'siri: $Cu^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$ $Hg^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Hg(NH_3)_4]^{2+}$ $Co^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Co(NH_3)_6]^{2+}$ $Ni^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Ni(NH_3)_6]^{2+}$
2*	2 M H_2SO_4 ta'sirida ammiakatlarni parchalash.
3*	2 eritmaga $Na_2S_2O_3$ ta'sir ettirib Cu^{2+} va Hg^{2+} ionlarini IV analitik guruhining boshqa kationlardan ajratish: $Cu^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} Cu_2S\downarrow$ $Hg^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} HgS\downarrow$
4	Suyultirilgan HNO_3 da qizdirilganda 3 cho'kmani qisman eritib, Cu_2S ni HgS dan ajratish. $Cu_2S\downarrow \xrightarrow{HNO_3,\ \Delta} Cu^{2+}$
5	Konsentrlangan $NH_3 \cdot H_2O$ ta'sir ettirib 4 eritmadan Cu^{2+} ionlarni topish $Cu^{2+} \xrightarrow{NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$
6	HCl ishtirokida bromli suv yoki zar suvi ta'sir ettirib 3 cho'kmani eritish: $HgS\downarrow \xrightarrow{Br_2;\ HCl} [HgCl_2] + S\downarrow$ $HgS\downarrow \xrightarrow{\text{kons } HNO_3;\ \text{kons } HCl} [HgCl_2]$
7	Sentrifugalab S↓ dan $[HgCl_2]$ ni ajratish.
8	$SnCl_2$ ta'sirida 7 sentrifugatdan Hg^{2+} ionlarini topish $[HgCl_2] \xrightarrow{SnCl_2} Hg\downarrow$

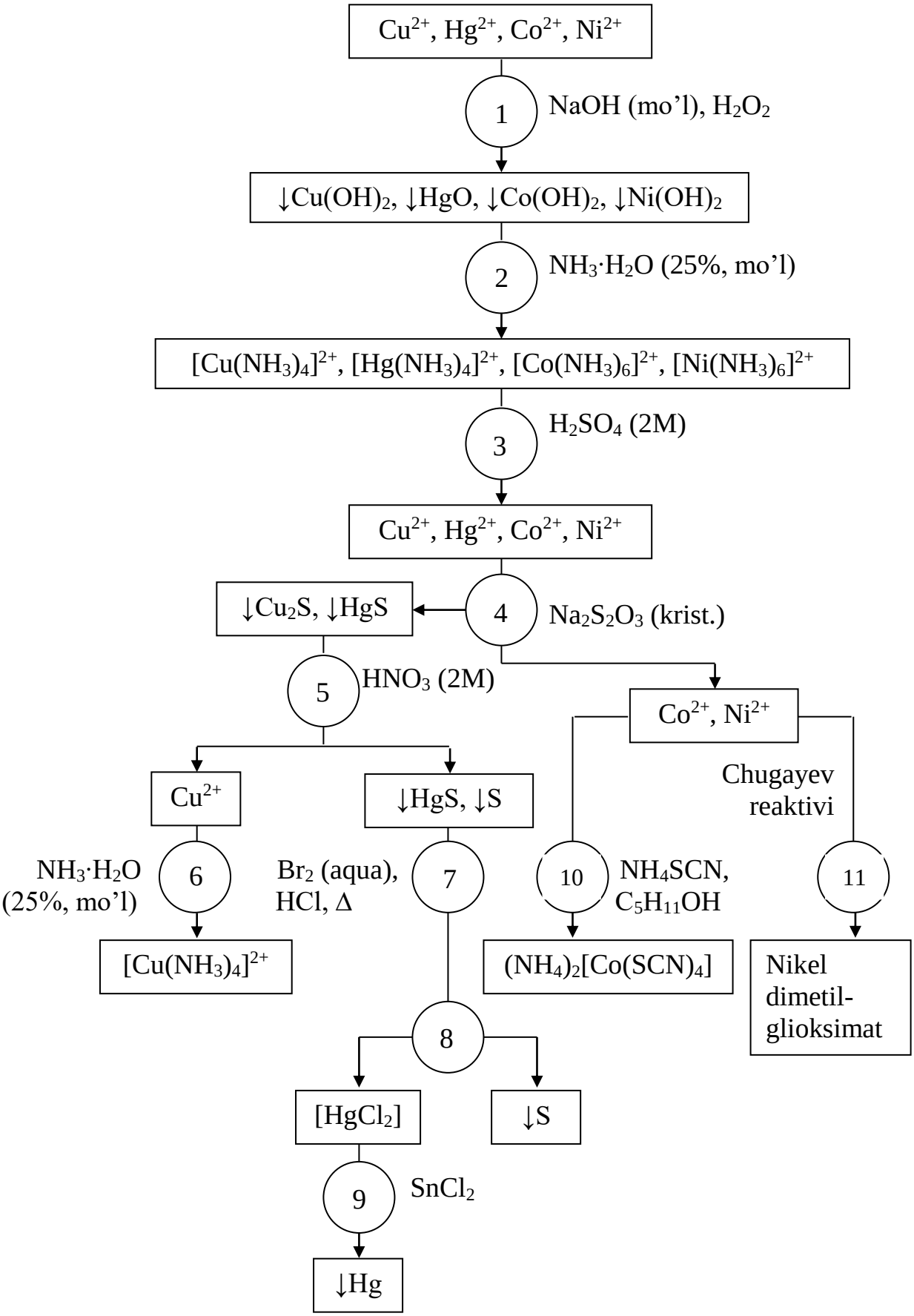
* 1-3 bosqichlar I-IV analitik guruh kationlari aralashmasining sistematik analizida bajariladi.

17-*jadvalning davomi*

9	Amil spirt ishtirokida NH_4SCN ta'sir ettirib, 3 sentrafugatdan Co^{2+} ionlarini topish: $Co^{2+} \xrightarrow{NH_4SCN} (NH_4)_2[Co(SCN)_4]$
10	Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, sentrifugatdan Ni^{2+} ionlarini topish Ni $\xrightarrow{\text{dimetilglioksim}}$ 

10-*sxema*

VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



18-*jadval*

I – VI ANALITIK GURUH KATIONLARI ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

Bosqichning t/r	**Analiz bosqichlari**
1	Alohida namunadagi NH_4 ionlarini ishqor ta'sir ettirib, qizdirib topish: $NH_4^+ \xrightarrow{NaOH,\ \Delta} NH_3\uparrow$
2	Alohida namunaga $K_3[Fe(CN)_6]$ eritmasi ta'sir ettirib, temir(II) ionlarini topish: $Fe^{2+} \xrightarrow{K_3[Fe(CN)_6]} Fe_3[Fe(CN)_6]_2\downarrow$
3	Alohida namunaga $K_4[Fe(CN)_6]$ eritmasi ta'sir ettirib, temir(III) ionlarini topish: $Fe^{3+} \xrightarrow{K_4[Fe(CN)_6]} Fe_4[Fe(CN)_6]_3\downarrow$
4	Alohida namunadagi Na_2CO_3 ta'sirida qizdirib K^+ ionlarini topishdan oldin NH_4^{3+} ionlarini yo'qotish: $NH_4^+ \xrightarrow{Na_2CO_3,\ \Delta} NH_3\uparrow$ $Me^{n+} \xrightarrow{Na_2CO_3,\ \Delta}$ II, III, V, VI analitik guruh kationlarining oksidlari, gidroksidlari, karbonatlari va asosli tuzlari cho'kmasi.
5	4 eritmani CH_3COOH eritmasi bilan pH~7gacha neytrallash. Bunda IV analitik guruh gidroksoanionlari parchalanadi va cho'kma hosil bo'ladi, uni sentrifugalab ajratiladi va keyingi analizda foydalaniladi: $[Me(OH)_6]^{6-n} \xrightarrow{CH_3COOH} Me(OH)_n\downarrow$
6	$HC_4H_4O_6$, $Na_3[Co(NO_2)_6]$, $Na_2Pb[Cu(NO_2)_6]$ reagentlari bilan 5 eritmadan K^+ ionlarini topish: $K^+ \xrightarrow{NaHC_4H_4O_6} KHC_4H_4O_6\downarrow$ $K^+ \xrightarrow{Na[Co(NO_2)_6]} K_2Na[Co(NO_2)_6]\downarrow$ $K^+ \xrightarrow{Na_2Pb[Cu(NO_2)_6]} K_2Pb[Cu(NO_2)_6]\downarrow$
7	Alohida namunadan K_2CO_3 ta'sirida qizdirib, Na^+ ionlarini topishdan oldin NH_4^+ ionlarini yo'qotish: $NH_4^+ \xrightarrow{K_2CO_3,\ \Delta} NH_3\uparrow$ $Me^{n+} \xrightarrow{K_2CO_3,\ \Delta}$ II, III, V, VI analitik guruh kationlarining oksidlari, gidroksidlari, karbonatlari va asosli tuzlari cho'kmasi.

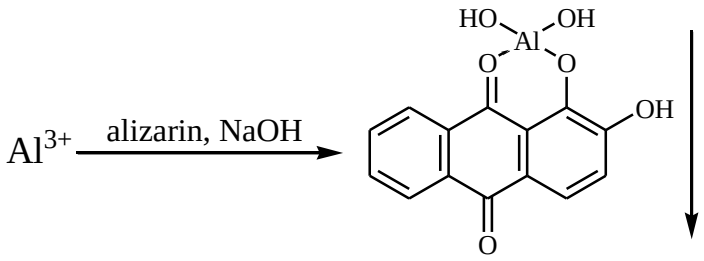
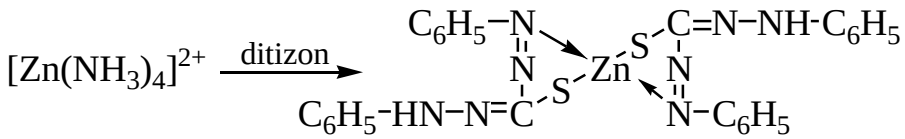
18-*jadvalning davomi*

8	7 eritmani CH_3COOH eritmasi bilan pH ~7gacha neytrallash. Bunda IV analitik guruh gidroksoanionlari parchalanadi va cho'kma hosil bo'ladi, u sentrifugalab ajratiladi va keyingi analizda foydalanilmaydi. $[Me(OH)_6]^{6-n} \xrightarrow{CH_3COOH} Me(OH)_n\downarrow$
9	$K[Sb(OH)_6]$, $Zn(UO_2)_3(CH_3COO)_8$ reagentlari bilan 8 eritmadan Na^+ ionlarini topish: $Na^+ \xrightarrow{K[Sb(OH)_6]} Na[Sb(OH)_6]\downarrow$ $Na^+ \xrightarrow{Zn(UO_2)_3(CH_3COOH)_8} NaZn(UO_2)_3(CH_3COOH)_9 \cdot 9H_2O\downarrow$
10	Boshlang'ich eritmadan 2 M HCl eritmasi ta'sir ettirib II analitik guruh kationlarini ajratish. $Ag^+ \xrightarrow{HCl} AgCl\downarrow$ $Pb^{2+} \xrightarrow{HCl} PbCl_2\downarrow$ $Hg_2^{2+} \xrightarrow{HCl} Hg_2Cl_2\downarrow$ HCl saqlagan cho'kmani suv bilan yuvish.
11	II analitik guruh kationlari aralashmasining analiz bosqichlari sxemasi bo'yicha 10 cho'kmani analiz qilish.
12	C_2H_5OH ishtirokida qizdirib H_2SO_4 eritmasi ta'sir ettirib III analitik guruh kationlarini va Pb^{2+} ionlarini cho'ktirish: $Ba^{2+} \xrightarrow{H_2SO_4,\ \Delta} BaSO_4\downarrow$ $Sr^{2+} \xrightarrow{H_2SO_4,\ \Delta} SrSO_4\downarrow$ $Ca^{2+} \xrightarrow{H_2SO_4,\ C_2H_5OH,\ \Delta} CaSO_4\downarrow$ $Pb^{2+} \xrightarrow{H_2SO_4,\ \Delta} PbSO_4\downarrow$ H_2SO_4 saqlagan cho'kmani suv bilan yuvish.
13	30 %-li NH_4CH_3COO eritmasi ta'sir ettirib, so'ng sentrifugalab, 12 cho'kmadan $PbSO_4\downarrow$ ni ajratish: $PbSO_4\downarrow \xrightarrow{NH_4CH_3COO} [PbSO_4 \cdot Pb(CH_3COO)_2]$ Sentrifugalangandan so'ng III analitik guruh kationlari sulfatlarining cho'kmasi III analitik guruh kationlari aralashmasining analiz bosqichlari bo'yicha analiz qilish.
14	III analitik guruh kationlari aralashmasining sistematik analiz bosqichlari sxemasi bo'yicha 13 cho'kmani analiz qilish.

18-*jadvalning davomi*

15	3 % li H_2O_2 ishtirokida mo'l 6M NaOH eritmasi ta'sir ettirib, IV guruh kationlarini V, VI analitik guruh kationlaridan ajratish: $Al^{3+} \xrightarrow{NaOH} Al(OH)_3\downarrow \xrightarrow{mo'l\ NaOH} [Al(OH)_6]^{3-}$ $Zn^{2+} \xrightarrow{NaOH} Zn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH} [Zn(OH)_4]^{2-}$ $Cr^{3+} \xrightarrow{NaOH} Cr(OH)_3\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} CrO_4^{2-}$ $Sn^{2+} \xrightarrow{NaOH} Sn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} [Sn(OH)_6]^{2-}$ $Sn(IV) \xrightarrow{NaOH} Sn(OH)_4\downarrow \xrightarrow{mo'l\ NaOH} [Sn(OH)_6]^{2-}$ $As(III) \xrightarrow{NaOH} AsO_3^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_4^{3-}$ $As(V) \xrightarrow{NaOH} AsO_4^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_4^{3-}$ Bunda V, VI analitik guruh kationlari cho'kmalar hosil qiladilar: $Fe(OH)_3$, $Mg(OH)_3$, $MnO_2 \cdot nH_2O$, BiOCl, SbO_2Cl, $Cu(OH)_2$, HgO, $Ni(OH)_2$, $Co(OH)_3$.
16	15 sentrufugatning alohida ulushiga HCl muhitida ruh metali ta'sir ettirib, As(V) ionlarini topish (topishga Sb(III), Sb(V) ionlari halaqit beradi): As (III), (V) $\xrightarrow{Zn;\ HCl} AsH_3\uparrow$ $AgNO_3$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ Ag↓ (qora) (Gutsayt reaksiyasi) $[HgCl_2]$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ $AsH_2(HgCl)\downarrow$, $AsH(HgCl)_2\downarrow$, $As(HgCl)_3\downarrow$, $As_2Hg_3\downarrow$ (sarg'ish-qo'ng'ir) (Zanger-Blek reaksiyasi)
17	Qizdirilganda NH_4Cl kristalllari ta'sirida 15 sentrifugatdan $[Al(OH)_6]^{3-}$, $[Sn(OH)_6]^{2-}$ gidroksoanionlarni ajratish: $[Al(OH)_6]^{3-} \xrightarrow{NH_4Cl,\ \Delta} Al(OH)_3\downarrow$ $[Sn(OH)_6]^{2-} \xrightarrow{NH_4Cl,\ \Delta} Sn(OH)_4\downarrow$
18	2 M HCl ta'sirida 17 cho'kmani eritish: $Al(OH)_3\downarrow \xrightarrow{HCl} Al^{3+}$ $Sn(OH)_4\downarrow \xrightarrow{HCl} [SnCl_6]^{2-}$

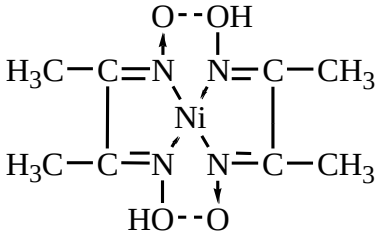
18-*jadvalning davomi*

19	18 sentrfugatga alizarin yoki natriy atsetat eritmalari ta'sir ettirib, Al^{3+} ionlarini topish:  $Al^{3+} \xrightarrow{CH_3COONa} Al(OH)_2CH_3COO\downarrow$
20	HCl muhitida temir qirindilari bilan qaynagan 18 eritmaga simob (II) tuzi eritmasi ta'sir ettirib, Sn(IV) ionlarini topish: $[SnCl_6]^{2-} \xrightarrow{Fe,\ HCl;\ \Delta} Sn^{2+} \xrightarrow{HgCl_2} Hg\downarrow$
21	17 sentrifugatga ditizon yoki $K_4[Fe(CN)_6]$ eritmasi ta'sir ettirib, Zn^{2+} kationlarini topish:  $[Zn(NH_3)_4] \xrightarrow{K_4[Fe(CN)_6]} K_2Zn_3[Fe(CN)_6]_2\uparrow$
22	15 cho'kmaga H_2O_2 bilan HNO_3 ta'sir ettirib Sb(V) ionlarini V, VI analitik guruhning boshqa kationlaridan ajratish: $SbO_2Cl \xrightarrow{HNO_3;\ H_2O_2} HSbO_3\downarrow$ Bunda V, VI guruh kationlarining erimaydigan birikmalari quyidagi kationlarining qaytarilishi bilan eriydi: $MnO_2{\cdot}nH_2O\downarrow \xrightarrow{HNO_3;\ H_2O_2} Mn^{2+}$ $Co(OH)_2\downarrow \xrightarrow{HNO_3;\ H_2O_2} Co^{2+}$
23	22 cho'kmani HCl eritmasida eritish: $HSbO_3\downarrow \xrightarrow{HCl} [SbCl_6]^-$
24	23 eritmaga nikel plastinkasida rux metali ta'sir ettirib, Sb(V) ionlarini ajratish: $[SbCl_6]^- \xrightarrow{Zn} Sb\downarrow$

18-*jadvalning davomi*

25	22 sentrifugatga konsetrlangan $NH_3 \cdot H_2O$ ta'sir ettirib, V analitik guruh kationlarini cho'ktirish: $Mg^{2+} \xrightarrow{NH_3 \cdot H_2O} Mg(OH)_2\downarrow$ $Mn^{2+} \xrightarrow{NH_3 \cdot H_2O} Mn(OH)_2\downarrow$ $Fe^{3+} \xrightarrow{NH_3 \cdot H_2O} Fe(OH)_3\downarrow$ $Bi^{3+} \xrightarrow{NH_3 \cdot H_2O} BiONO_3\downarrow$ Bunda VI analitik guruh kationlari ammiakatlar ko'rinishida eritmada qoladi: $Cu(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$ $HgO\downarrow \xrightarrow{NH_3 \cdot H_2O} [Hg(NH_3)_4]^{2+}$ $Co(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Co(NH_3)_6]^{2+}$ $Ni(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Ni(NH_3)_6]^{2+}$
26	25 cho'kmaga NH_4Cl+3% li H_2O_2 eritmasi ta'sir ettirib, Mg^{2+} kationlarini ajratish: $Mg(OH)_2\downarrow \xrightarrow{NH_4Cl} Mg^{2+}$ $Mn(OH)_2\downarrow \xrightarrow{3\%\ H_2O_2} MnO_2 \cdot nH_2O\downarrow$ Cho'kma tarkibi: $MnO_2 \cdot nH_2O\downarrow$, $BiONO_3\downarrow$, $Fe(OH)_3\downarrow$
27	27 sentrifugatga ammiakli bufer eritma ishtirokida Na_2HPO_4 ta'sir ettirib, Mg^{2+} ionlarini topish: $Mg^{2+} \xrightarrow{Na_2HPO_4,\ NH_3 \cdot H_2O + NH_4Cl} MgNH_4PO_4\downarrow$
28	26 cho'kmaga HNO_3 eritmasi ta'sir ettirib, Bi^{3+} kationlarini ajratish: $BiONO_3\downarrow \xrightarrow{HNO_3} Bi^{3+}$ $Fe(OH)_3\downarrow \xrightarrow{HNO_3} Fe^{3+}$ Cho'kmada: $MnO_2 \cdot nH_2O\downarrow$
29	28 bosqich bo'yicha olingan $MnO_2 \cdot nH_2O$ cho'kmani H_2O_2 ishtirokida HNO_3 eritmasi ta'sir ettirib eritish: $MnO_2 \cdot nH_2O\downarrow \xrightarrow{HNO_3;\ H_2O_2} Mn^{2+}$
30	29 eritmaga $(NH_4)_2S_2O_8$ ta'sir ettirib, Mn^{2+} ionlarini topish: $Mn^{2+} \xrightarrow{(NH_4)_2S_2O_8;\ HNO_3;\ AgNO_3} MnO_4^-$
31	28 sentrifugatga yangi tayyorlangan $Na_4[Sn(OH)_6]$ ta'sir ettirib, Bi^{3+} ionlarini topish: $Bi^{3+} \xrightarrow{Na_4[Sn(OH)_6]} Bi\downarrow$

18-*jadvalning davomi*

32	2 M H_2SO_4 ta'sirida 25 eritmadagi ammiakatlarni parchalash
33	32 eritmaga $Na_2S_2O_3$ ta'sir ettirib, VI analitik guruhning boshqa kationlaridan Cu^{2+} va Hg^{2+} ionlarini ajratish: $Cu^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} Cu_2S\downarrow$ $Hg^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} HgS\downarrow$
34	Qizdirilganda suyultirilgan HNO_3 ta'sir ettirib, 33 cho'kmadan Cu_2S ni HgS dan ajratish: $Cu_2S\downarrow \xrightarrow{HNO_3;\ \Delta} Cu^{2+}$ Bu sharoitda $HgS\downarrow$ erimaydi.
35	34 sentrifugatga konsentrlangan $NH_3 \cdot H_2O$ ta'sir ettirib, Cu^{2+} ionlarini topish: $Cu^{2+} \xrightarrow{NH_3 \cdot H_2O} [Cu(NH_3]_4]^{2+}$
36	Qizdirilganda HCl ishtirokida bromli suv yoki zar suvi ta'sir ettirib 34 cho'mani eritish: $HgS\downarrow \xrightarrow{Br_2;\ HCl} [HgCl_2] + S\downarrow$ $HgS\downarrow \xrightarrow{\text{kons } HNO_3;\ \text{kons } HCl} [HgCl_2]$
37	36 sentrifugatga $SnCl_2$ eritmasi ta'sir ettirib, Hg^{2+}ionlarini topish: $[HgCl_2] \xrightarrow{SnCl_2} Hg\downarrow$
38	33 sentrifugatga amil spirt ishtirokida NH_4SCN eritmasi ta'sir ettirib, Co^{2+} ionlarini topish: $Co^{2+} \xrightarrow{NH_4SCN} (NH_4)_2[Co(SCN)_4]$
39	33 sentrifugatga Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, Ni^{2+} ionlarini topish: Ni $\xrightarrow{\text{dimetilglioksim}}$ 

11-*sxema*

I – VI ANALITIK GURUH KATIONLARI ARALASHMASINING SISTEMATIK ANALIZ SXEMASI

1 → Alohida namunalardan NH_4^+, Fe^{2+}, Fe^{3+} kationlarini aniqlash

2 → Alohida namunadan NH_4^+ ionlarini Na_2CO_3 yoki NaOH ta'sirida yo'qotish va eritmadagi K^+ ionlarini aniqlash

3 → Alohida namunadan NH_4^+ ionlarini K_2CO_3 yoki KOH ta'sirida yo'qotish va eritmadagi Na^+ ionlarini aniqlash

4 → 2M HCl eritmasi ta'sirida II analitik guruh kationlarini cho'ktirish va olingan cho'kmani tekshirish

5 → II analitik guruhni ajratib olgandan so'ng, sentrifugatdan III analitik guruh kationlarini cho'ktirish

6 → 5 cho'kmadan $PbSO_4$ ni ajratish va qolgan cho'kmani III analitik guruh kationlari uchun tekshirish

7 → 3%-li H_2O_2 eritmasi ishtirokida 6M NaOH ta'sirida IV guruh kationlarini V va VI guruh kationlaridan ajratish va hosil bo'lgan eritmada ularni aniqlash

8 → Sb(V) ionlarini V va VI analitik guruhlarning boshqa kationlaridan ajratish

9 → Konsentrlangan $NH_3 \cdot H_2O$ eritmasi ta'sirida V va VI guruhlarni ajratish (V guruh cho'kmada; VI guruh eritmada)

10 → 9 cho'kmani V analitik guruh kationlari uchun tekshirish (Fe^{2+}, Fe^{3+} dan tashqari)

11 → 10 eritmani VI analitik guruh kationlari uchun tekshirish

19-*jadval*

Ba^{2+} VA Ag^{+} TUZLARINING TURLICHA ERUVCHANLIGIGA ASOSLANGAN ANIONLARNING ANALITIK KLASSIFIKATSIYASI

Analitik guruh	Anionlar	Guruh reagenti	Cho'kmalarning xossalari
I	SO_4^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CO_3^{2-}, AsO_4^{3-}, AsO_3^{3-}, $C_2O_4^{2-}$, CrO_4^{2-}, ($Cr_2O_7^{2-}$), SiO_3^{2-}, BO_2^- ($B_4O_7^{2-}$), F^-, IO_3^-, IO_4^-, PO_4^{3-}, $C_4H_4O_6^{2-}$.	$BaCl_2$ yoki $Ba(NO_3)_2$	Bariy tuzlarining cho'kmalari suvda erimaydi, lekin kislotalarda eriydi ($BaSO_4$ dan boshqa)
II	Cl^-, Br^-, I^-, CN^-, SCN^-, $C_6H_5COO^-$, S^{2-}	$AgNO_3$, HNO_3 da	Kumush tuzlarining cho'kmalari suvda va nitrat kislotada erimaydi.
III	NO_3^-, NO_2^-, CH_3COO^-, ClO_4^-, BrO_3^-	Mavjud emas	Bariy va kumush tuzlarining cho'kmalari suvda eriydi.

20-*jadval*

KUCHLI KISLOTALAR TA'SIRIDA GAZSIMON MAHSULOTLAR HOSIL QILADIGAN ANIONLAR

Eritmadagi anion	Ajralib chiqadigan gaz (mahsulot)	Analitik belgilari
CO_3^{2-}; HCO_3^-	CO_2	Ohakli suvning loyqalanishi
SO_3^{2-}; $S_2O_3^{2-}$	SO_2	Yongan oltingugurt hidi
NO_2^-	NO_2	Qizg'ish-qo'ng'ir bug'lar
S^{2-}; SO_3^{2-}; $S_2O_3^{2-}$	H_2S	Palag'da tuxum hidi
CH_3COO^-	CH_3COOH	Sirka hidi
Br^-	Br	Qizg'ish-qo'ng'ir bug'lar
Cl^-	HCl	Bo'g'uvchi gaz, $AgNO_3$ eritmasining loyqalanishi.

21-jadval

ANIONLARNING OKSIDLANISH-QAYTARILISH XOSSASI BO'YICHA KLASSIFIKATSIYASI

Oksidlovchi-anionlar	**Qaytaruvchi-anionlar**
$Cr_2O_7^{2-}$; AsO_4^{3-}; NO_3^-; IO_4^-; IO_3^-	Br^-; I^-; S^{2-}; $C_2O_4^{2-}$; AsO_3^{3-}; SO_3^{2-}; $S_2O_3^{2-}$; NO_2^-
Eritmada mavjudligini aniqlash	
KI ta'sirida I_2 rangi paydo bo'ladi	I_2 yoki $KMnO_4$ ta'sirida eritma rangsizlanadi
Misollar	
$+ 2e + AsO_4^{3-} + 2H^+ \rightleftarrows AsO_3 + H_2O$ | 1 $- 2e + 3I^- \rightleftarrows [I_3]$ | 1 $AsO_4^{3-} + 2H^+ + 3I^- \rightleftarrows AsO_3^{3-} + H_2O + [I_3]^-$ (kons. HCl muhitida) $+ 6e + Cr_2O_7^{2-} + 14H^+ \rightleftarrows 2Cr^{3+} + 7H_2O$ | 1 $- 2e + 3I^- \rightleftarrows [I_2]^-$ | 3 $Cr_2O_7^{2-} + 14H^+ + 9I^- \rightleftarrows 2Cr^{3+} + 7H_2O + 3[I_3]^-$	$- 2e + SO_3^{2-} + H_2O \rightleftarrows SO_4^{2-} + 2H^+$ | 1 $+ 2e + [I_3]^- \rightleftarrows 3I^-$ | 1 $SO_3^{2-} + H_2O + [I_3]^- \rightleftarrows SO_4^{2-} + 2H^+ + 3I^-$ $- 2e + C_2O_4^{2-} \rightleftarrows 2CO_2\uparrow$ | 5 $+ 5e + MnO_4^- + 8H^+ \rightleftarrows Mn^{2+} + 4H_2O$ | 2 $5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \rightleftarrows 10CO_2\uparrow + 2Mn^{2+} + 8H_2O$ $- 2e + AsO_3^{3-} + 2OH^- \rightleftarrows AsO_4^{3-} + H_2O$ | 1 $+ 2e + [I_3]^- \rightleftarrows 3I^-$ | 1 $AsO_3^{3-} + 2OH^- + [I_3]^- \rightleftarrows AsO_4^{3-} + 3I^- + H_2O$ ($NaHCO_3$ muhitida) Kons. H_2SO_4 ta'sirida I_2 va Br_2 ajraladi. $- 2e + 2I^- \rightleftarrows I_2$ | 4 $+ 8e + SO_4^{2-} + 10H^+ \rightleftarrows H_2S + 4H_2O$ | 1 $8I^- + SO_4^{2-} + 10H^+ \rightleftarrows 4I_2\uparrow + H_2S\uparrow + 4H_2O$ $- 2e + 2Br^- \rightleftarrows Br_2$ | 1 $+ 2e + SO_4^{2-} + 4H^+ \rightleftarrows SO_2 + H_2O$ | 1 $2Br^- + SO_4^{2-} + 4H^+ \rightleftarrows Br_2 + SO_2 + H_2O$

22-jadval

I ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
SO_4^{2-}	$Pb(NO_3)_2$	$Na_2SO_4 + Pb(NO_3)_2 = PbSO_4\downarrow + 2NaNO_3$ $SO_4^{2-} + Pb^{2+} = PbSO_4\downarrow$	Oq cho'kma, ishqorlarda eriydi
	$SrCl_2$	$Na_2SO_4 + SrCl_2 = SrSO_4\downarrow + 2NaCl$ $SO_4^{2-} + Sr^{2+} = SrSO_4\downarrow$	Oq cho'kma (loyqa), kislotalarda deyarli erimaydi
SO_3^{2-}	HCl	$Na_2SO_3 + 2HCl = 2NaCl + SO_2\uparrow + H_2O$ $SO_3^{2-} + 2H^+ = SO_2\uparrow + H_2O$	$SO_2\uparrow$ ajraladi
	$I_2 + H_2O$	$Na_2SO_3 + I_2 + H_2O = NaSO_4 + 2HI$ $SO_3^{2-} + I_2 + H_2O = SO_4^{2-} + 2H^+ + 2I^-$	Yodli suv eritmasi rangsizlanadi
	$SrCl_2$	$Na_2SO_3 + SrCl_2 = SrSO_3\downarrow + 2NaCl$ $SO_3^{2-} + Sr^{2+} = SrSO_3\downarrow$	Oq cho'kma, kislotalarda eriydi
$S_2O_3^{2-}$	HCl	$Na_2S_2O_3 + 2HCl = H_2S_2O_3 + 2NaCl$ $H_2S_2O_3 = S\downarrow + SO_2\uparrow + H_2O$	Reaksiya natijasida hosil bo'lgan S↓ eritmani loyqalantiradi
	I_2	$2Na_2S_2O_3 + I_2 = 2NaI + Na_2S_4O_6$ $2S_2O_3^{2-} + I_2 = 2I^- + S_4O_6^{2-}$	I_2 eritmasi rangsizlanadi

* Guruh reagenti $BaCl_2$ (yoki $Ba(NO_3)_2$) ta'sirida birinchi analitik guruh anionlarining barchasi cho'kmaga tushadi

22-jadvalning davomi

$S_2O_3^{2-}$	$AgNO_3$	$Na_2S_2O_3 + 2AgNO_3 = Ag_2S_2O_3\downarrow + 2NaNO_3$ $S_2O_3^{2-} + 2Ag^+ = Ag_2S_2O_3\downarrow$ $Ag_2S_2O_3 + H_2O = Ag_2S\downarrow + 2H^+ + SO_4^{2-}$	Oq rangli cho' kma, cho'kma tez sargayib, qo'ng'ir tusga kiradi va Ag_2S hosil bo'lishi sababli qorayib ketadi
CO_3^{2-}	HCl	$Na_2CO_3 + 2HCl = 2NaCl + CO_2\uparrow + H_2O$ $CO_3^{2-} + 2H^+ = CO_2\uparrow + H_2O$	Ohakli suvning loyqalanishidan CO_2 ajralishini bilish mumkin
	$AgNO_3$	$Na_2CO_3 + 2AgNO_3 = Ag_2CO_3\downarrow + 2NaNO_3$ $CO_3^{2-} + 2Ag^+ = Ag_2CO_3\downarrow$	Oq cho'kma, kislotalarda eriydi, HCl ta'sirida AgCl ga aylanadi, qaynatilganda Ag_2O va CO_2 ga parchalanadi
PO_4^{3-}	$AgNO_3$	$Na_3PO_4 + 3AgNO_3 = Ag_3PO_4\downarrow + 3NaNO_3$ $PO_4^{3-} + 3Ag^+ = Ag_3PO_4\downarrow$	Sariq cho'kma, nitrat kislota va ammiakda eriydi
	$MgCl_2$ $(NH_4Cl + NH_4OH)$	$Na_2HPO_4 + MgCl_2 + NH_4OH = MgNH_4PO_4\downarrow + 2NaCl + H_2O$ $HPO_4^{2-} + Mg^{2+} + NH_4OH = MgNH_4PO_4\downarrow + H_2O$	Oq kristall cho'kma.
	$(NH_4)_2MoO_4$	$Na_3PO_4 + 3NH_4Cl + 12(NH_4)_2MoO_4 + 24HNO_3 =$ $= \downarrow(NH_4)_3[PMo_{12}O_{40}] + 12H_2O + 24NH_4NO_3 + 3NaCl$ $PO_4^{3-} + 12MoO_4^{2-} + 24H^+ = (NH_4)_3[PMo_{12}O_{40}]\downarrow + 12H_2O$	Sariq kristall cho'kma
$B_4O_7^{2-}$	$AgNO_3$	$Na_2B_4O_7 + 2AgNO_3 + 3H_2O = 2AgBO_2\downarrow + 2NaNO_3 + 2H_3BO_3$ $B_4O_7^{2-} + 2Ag^+ + 3H_2O = 2AgBO_2\downarrow + 2H_3BO_3$	Oq cho'kma, nitrat kislota va ammiakda eriydi
	Alangani bo'yashi		Borning birikmalari rangsiz alangani yashil rangga kiritadi

22-jadvalning davomi

F^-	$CaCl_2$	$2NaF + CaCl_2 = CaF_2\downarrow + 2NaCl$ $2F^- + Ca^{2+} = CaF_2\downarrow$	Oq cho'kma, kislotalarda qiyin eriydi
	SiO_2	$SiO_2 + 4HF = SiF_4\uparrow + 2H_2O$ $SiF_4 + 4H_2O = H_4SiO_4 + 4HF\uparrow$	Ortosilikat kislotaning hosil bo'-lishi sababli suv loyqalanadi
SiO_3^{2-}	$AgNO_3$	$Na_2SiO_3 + 2AgNO_3 = Ag_2SiO_3\downarrow + 2NaNO_3$ $SiO_3^{2-} + 2Ag^+ = Ag_2SiO_3\downarrow$	Sariq cho'kma, nitrat kislotada eriydi
	Suyultirilgan kislotalar	$SiO_3^{2-} + H_2SO_4 + H_2O = mSiO_2 \cdot nH_2O\downarrow + SO_4^{2-}$	Silikat kislotalar oq iviq cho'k-ma (gel) holida cho'kadi
	Ammoniy tuzlari	$SiO_3^{2-} + 2H_2O + 2NH_4^+ = H_2SiO_3\downarrow + 2NH_4OH$	Qizdirilganda oq iviq cho'kma hosil bo'ladi
$C_2O_4^{2-}$	$CaCl_2$	$Na_2C_2O_4 + CaCl_2 = CaC_2O_4\downarrow + 2NaCl$ $C_2O_4^{2-} + Ca^{2+} = CaC_2O_4\downarrow$	Oq cho'kma, mineral kislotalar-da eriydi, lekin sirka kislotada erimaydi.
	$AgNO_3$	$Na_2C_2O_4 + 2AgNO_3 = Ag_2C_2O_4\downarrow + 2NaNO_3$ $C_2O_4^{2-} + 2Ag = Ag_2C_2O_4\downarrow$	Oq iviq cho'kma HNO_3 va NH_4OH da eriydi
	$KMnO_4$	$5Na_2C_2O_4 + 2KMnO_4 + 8H_2SO_4 = 2MnSO_4 + 5Na_2SO_4 + K_2SO_4 + 10CO_2 + 8H_2O$ $5C_2O_4^{2-} + 2MnO_4^- + 16H^+ = 2Mn^{2+} + 10CO_2 + 8H_2O$	Eritma rangsizlanadi
	H_2SO_4	$H_2C_2O_4 \xrightarrow{\text{kons. } H_2SO_4} H_2O + CO_2\uparrow + CO\uparrow$	CO yoqilganda ko'k alanga hosil qilib yonadi

22-jadvalning davomi

CrO_4^{2-}, $Cr_2O_7^{2-}$	$Pb(NO_3)_2$	$K_2CrO_4 + Pb(NO_3)_2 = PbCrO_4\downarrow + 2KNO_3$ $CrO_4^{2-} + Pb^{2+} = PbCrO_4\downarrow$	Sariq rangli cho'kma
	$AgNO_3$	$K_2CrO_4 + 2AgNO_3 = Ag_2CrO_4\downarrow + 2KNO_3$ $CrO_4^{2-} + 2Ag^{+} = Ag_2CrO_4\downarrow$	Qizil-g'isht rangli cho'kma
	H_2O_2	$K_2Cr_2O_7 + 4H_2O_2 + H_2SO_4 = 2H_2CrO_6 + 3H_2O + K_2SO_4$ $Cr_2O_7^{2-} + 4H_2O_2 + 2H^{+} = 2H_2CrO_6 + 3H_2O$	Ko'k rangli eritma, perxromat kislotaning parchalanishi sababli eritma tezda yashil rangga o'tadi
	Qaytaruvchilar Na_2SO_3, H_2S	$K_2Cr_2O_7 + 3Na_2SO_3 + 4H_2SO_4 = Cr_2(SO_4)_3 + 3Na_2SO_4 + K_2SO_4 + 4H_2O$ $Cr_2O_7^{2-} + 3SO_3^{2-} + 8H^{+} = 2Cr^{3+} + 3SO_4^{2-} + 4H_2O$	Eritma rangsizlanadi

23-jadval

II ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Cl^-	H_2SO_4 (kons.)	$NaCl + H_2SO_4 = NaHSO_4 + HCl\uparrow$	Quruq holdagi xloridlardan gaz holatdagi HCl ajraladi, ho'llangan ko'k lakmus qizaradi
	$KMnO_4$ (kris.)	$16HCl + 2KMnO_4 = 2MnCl_2 + 2KCl + 5Cl_2\uparrow + 8H_2O$ $16HCl + 2MnO_4^- = 2Mn^{2+} + 6Cl^- + 5Cl_2\uparrow + 4H_2O$	Erkin xlor ajraladi, yodokraxmal qog'ozi ko'karadi
Br^-	H_2SO_4 (kons.)	$KBr + H_2SO_4 = KHSO_4 + HBr\uparrow$	Quruq bromidlardan HBr gaz holatda ajralib chiqadi
	Oksidlovchilar ($KMnO_4$, PbO_2, $KClO_3$)	$2KMnO_4 + 8H_2SO_4 + 10KBr = 6K_2SO_4 + 2MnSO_4 + 5Br_2 + 8H_2O$ $2MnO_4^- + 8H^+ + 10Br^- = 2Mn^{2+} + 5Br_2 + 8H_2O$	Erkin Br_2 ajralib chiqishi sababli eritma qo'ng'ir tusga kiradi
I^-	$Pb(NO_3)_2$	$2KI + Pb(NO_3)_2 = PbI_2\downarrow + 2KNO_3$ $2I^- + Pb^{2+} = PbI_2\downarrow$	Tillarang kristall cho'kma
	H_2SO_4 (kons.)	$8HI + H_2SO_4 = H_2S\uparrow + 4I_2\downarrow + 4H_2O$ $8I^- + SO_4^{2-} + 10H^+ = H_2S\uparrow + 4I_2\downarrow + 4H_2O$	Hosil bo'lgan I_2 eritmani qo'ng'ir rangga bo'yaydi
S^{2-}	Kislotalar (H_2SO_4, HCl)	$Na_2S + H_2SO_4 = Na_2SO_4 + H_2S\uparrow$ $FeS + 2HCl = FeCl_2 + H_2S\uparrow$	Ajralib chiqayotgan H_2S ni bad-bo'y hididan bilish mumkin

* Guruh reagenti $AgNO_3$ ta'sirida ikkinchi analitik guruh anionlarining barchasi cho'kmaga tushadi

23-jadvalning davomi

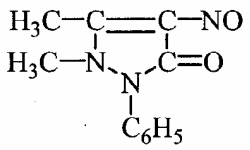
	$CdCl_2$	$CdCl_2 + H_2S = CdS\downarrow + 2HCl$ $Cd^{2+} + S^{2-} = CdS\downarrow$	pH ≥ 0,5; sariq cho'kma, kislotalarda eriydi
	Oksidlovchilar	$3Na_2S + K_2Cr_2O_7 + 7H_2SO_4 = 3S\downarrow + Cr_2(SO_4)_3 + K_2SO_4 + 3Na_2SO_4 + 7H_2O$ $3S^{2-} + Cr_2O_7^{2-} + 7H^+ = 3S\downarrow + 2Cr^{3+} + 7H_2O$	Oltingugurtning ajralishidan eritma loyqalanadi
SCN^-	$Hg(NO_3)_2$	$2NH_4SCN + Hg(NO_3)_2 = Hg(SCN)_2 + 2NH_4NO_3$ $2SCN^- + Hg^{2+} = Hg(SCN)_2\downarrow$ $Hg(SCN)_2\downarrow + 2SCN^- = [Hg(SCN)_4]^{2-}$	Ortiqcha reagentda kompleks birikma hosil qilib eriydigan oq cho'kma
	$FeCl_3$	$3NH_4SCN + FeCl_3 = [Fe(SCN)_3] + 3NHCl$ $3SCN^- + Fe^{3+} = [Fe(SCN)_3]$	Reagentning konsentratsiyasiga qarab sarg'ishdan qizil-qo'ng'irgacha eritma hosil bo'ladi
	Oksidlovchilar ($KMnO_4$, HNO_3)	$6KMnO_4 + 5HSCN + 4H_2SO_4 = 6MnSO_4 + 5HCN\uparrow + 3K_2SO_4 + 4H_2O$ $6MnO_4^- + 5SCN^- + 13H^+ = 6Mn^{2+} + 5HCN\uparrow + 5SO_4^{2-} + 4H_2O$	Permanganat eritmasi rangsizlanadi. *Tajribani juda oz miqdordagi (1-2 tomchi) rodanid eritmasi bilan mo'rili shkafda olib borish kerak, chunki HCN bug'lari nihoyatda zaharli!*
CN^-	$ZnCl_2$, $Pb(NO_3)_2$	$ZnCl_2 + 2KCN = Zn(CN)_2\downarrow + 2KCl$ $Zn(CN)_2\downarrow + 2KCN = K_2[Zn(CN)_4]$	Oq cho'kma, ortiqcha KCN da kompleks birikma hosil qilib eriydi
	Suyultirilgan mineral kislotalar	$KCN + H_2SO_4 = K_2SO_4 + HCN\uparrow$	*Mo'rili shkafda bajariladi!*

24-jadval

III ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
CH_3COO^-	H_2SO_4	$2CH_3COONa + H_2SO_4 \rightarrow Na_2SO_4 + 2CH_3COOH\uparrow$ $2CH_3COO^- + 2H^+ \rightarrow 2CH_3COOH\uparrow$	Eritma qizdirilganda CH_3COOH ajralib chiqadi, uni hididan bilish mumkin
	$FeCl_3$	$3CH_3COONa + FeCl_3 \rightarrow [(CH_3COO)_3Fe]\downarrow + 3NaCl$ $[(CH_3COO)_3Fe]\downarrow \xrightarrow{H_2O,\,t} [Fe_3(CH_3COO)_6(OH)_2]OH$	Qizil-qo'ng'ir cho'kma, suv bilan qizdirilganda asosli tuz cho'kmaga tushadi
	$H_2SO_4 + C_2H_5OH$	$2CH_3COONa + H_2SO_4 = Na_2SO_4 + 2CH_3COOH$ $CH_3COOH + C_2H_5OH = CH_3COOC_2H_5 + H_2O$	Xarakterli xushbo'y hidga ega bo'lgan etilatsetat hosil bo'ladi
NO_3^-	Difenilamin		NO_3^- ta'sirida difenilamin ko'k rangga kiradi
	Cu	$4HNO_3 + Cu = Cu(NO_3)_2 + 2NO_2\uparrow + 2H_2O$ $4H^+ + 2NO_3^- + Cu = Cu^{2+} + 2NO_2\uparrow + 2H_2O$	Qo'ng'ir gaz ajralib chiqadi, probirka oq qog'oz ustiga qo'yib qaralsa, gaz ajralgani oson seziladi
	$Cu + H_2SO_4$	$8NaNO_3 + 3Cu + 4H_2SO_4 = 2NO\uparrow + 3Cu(NO_3)_2 + 4Na_2SO_4 + 4H_2O$ $2NO_3^- + 3Cu + 8H^+ = 2NO\uparrow + 3Cu^{2+} + 4H_2O$ $2NO\uparrow + O_2 = 2NO_2\uparrow$	
	Al (Zn) + NaOH	$3NaNO_3 + 8Al + 5NaOH + 2H_2O = 8NaAlO_2 + 3NH_3\uparrow$ $3NO_3^- + 8Al + 5OH^- + 2H_2O = 8AlO_2^- + NH_3\uparrow$	Ajralib chiqayotgan NH_3 indikator qog'ozini ko'kartiradi

24-jadvalning davomi

NO_3^-	$FeSO_4$ (kris.)	$6FeSO_4 + 2NaNO_2 + 4H_2SO_4 = 3Fe_2(SO_4)_3 + 2NO + 2Na_2SO_4 + 4H_2O$ $6Fe^{2+} + 2NO_3^- + 8H^+ = 6Fe^{3+} + 2NO + 4H_2O$ $NO + Fe^{2+} + SO_4^{2-} = [Fe(NO)SO_4]$	Temir (II)-sulfat kristali atrofida qo'ng'ir xalqa vujudga keladi
NO_2^-	Kislotalar	$2NaNO_2 + 2H_2SO_4 = 2HNO_2 + Na_2SO_4$ $2HNO_2 \rightarrow NO_2\uparrow + NO\uparrow + H_2O$	Qo'ng'ir rangli gazlar aralashmasi hosil bo'ladi
	$KMnO_4$	$5NaNO_2 + 2KMnO_4 + 3H_2SO_4 = NaNO_3 + 2MnSO_4 + K_2SO_4 + 3H_2O$ $5NO_2^- + 2MnO_4^- + 6H^+ = 5NO_3^- + 2Mn^+ + 3H_2O$	$KMnO_4$ eritmasi rangsizlanadi
	NH_4Cl (kris.), $t°$	$NH_4Cl + NaNO_2 = N_2\uparrow + NaCl + 2H_2O$	Erkin azot ajralib chiqadi
	Antipirin	$NO_2^- \xrightarrow[H^+]{\text{antipirin}}$ 	Yashil rangli azobo'yoq hosil bo'ladi

25-*jadval*

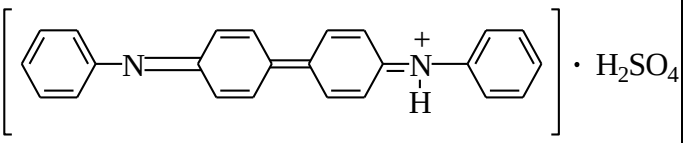
I – III GURUH ANIONLARINI BO'LIB-BO'LIB ANALIZ QILISH UCHUN FOYDALANILADIGAN REAGENTLAR VA TEGISHLI REAKSIYA MAHSULOTLARI

Anionlar	**Reagentlar (reaksiya sharoiti)**	**Reaksiya mahsuloti, analitik effekt**
SO_4^{2-}	Ba^{2+} (mineral kislotalar muhitida)	$BaSO_4\downarrow$ (oq cho'kma, kislotalar va ishqorlarda erimaydi)
	Sr^{2+} (mineral kislotalar muhitida)	$SrSO_4\downarrow$ (oq cho'kma, kislotalarda erimaydi)
SO_3^{2-}	H^+	$SO_2\uparrow$ (hid)
	$[I_3]^-$	I^- (yod eritmasi rangsizlanadi)
$S_2O_3^{2-}$	H^+	$SO_2\uparrow$ (hid) + $S\downarrow$ (oq cho'kma)
	$[I_3]^-$	I^- (yod eritmasi rangsizlanadi)
	Ag^+ mo'l	$A_2S_2O_3\downarrow$ (oq cho'kma, parchalanganda qorayadi $Ag_2S\downarrow$)
CO_3^{2-}	H^+	$CO_2\uparrow$
	Mg^{2+}	$MgCO_3\downarrow$ (oq cho'kma)
	Fenolftalein	Qizil
HCO_3^-	Mg^{2+} (qaynatilganda)	$MgCO_3\downarrow$ (oq cho'kma) + $CO_2\uparrow$
	Fenolftalein	Ranglanmaydi
PO_4^{3-}	$MgCl_2 + NH_4OH + NH_4Cl$ (magnezial alaralashma)	$MgNH_4PO_4\downarrow$ (oq cho'kma)
	Ag^+	$Ag_3PO_4\downarrow$ (sariq cho'kma, HNO_3; NH_4OH da eriydi)
$C_2O_4^{2-}$	Ca^{2+}	$CaC_2O_4\downarrow$ (oq cho'kma, sirka kislotada erimaydi)
	MnO_4^- (H_2SO_4 muhitida)	$CO_2\uparrow$ ($KMnO_4$ eritmasi rangsizlanadi)

25-*jadvalning davomi*

AsO_4^{2-}	$MgCl_2 + NH_4OH + NH_4Cl$ (magnezial aralashma)	$MgNH_4AsO_4\downarrow$ (oq cho'kma)
	Ag^+	$Ag_3AsO_4\downarrow$ (jigarrang, HNO_3 va NH_4OH da eriydi)
	I^- ($CHCl_3$ ishtirokida HCl muhitida)	$[I_3]^-$ – xloroformli qatlamning qizg'ish-binafsha rangi
AsO_3^{2-}	S^{2-}	$As_2S_3\downarrow$ (sariq cho'kma, kons HCl da erimaydi, NH_4OH da eriydi)
	Ag^+	$Ag_3AsO_4\downarrow$ (sariq, NH_4OH va kons. HNO_3 da eriydi)
	$[I_3]^-$ ($NaHCO_3$ muhitida)	I^- (yod eritmasi rangsizlanadi)
CrO_4^{2-} ($Cr_2O_7^{2-}$)	Ba^{2+}	$BaCrO_4\downarrow$ (sariq cho'kma)
	I^- ($CHCl_3$ ishtirokida HCl muhitida)	$[I_3]^-$ – xloroformli qatlamning qizg'ish-binafsha rangi
SiO_3^{2-}	Ba^{2+}	$BaSiO_3\downarrow$ (oq cho'kma, kislotalar ta'sirida $H_2SiO_3\downarrow$ hosil qilib parchalanadi.)
$B_4O_7^{2-}$	H_2SO_4, (C_2H_5OH)	$(C_2H_5O)_3B$ – alangani yashil rangga bo'yaydi.
F^-	Ba^{2+}	$BaF_2\downarrow$ (oq cho'kma, NH_4OH va mineral kislotalarda eriydi)
	H_2SO_4, ($SiO_2 \cdot H_2O$)	$H_2SiO_3\downarrow$ (gel)
Cl^-	Ag^+	$AgCl\downarrow$ (oq cho'kma, $(NH_4)_2CO_3$ va NH_4OH da eriydi)
Br^-	Ag^+	$AgBr\downarrow$ (sariq cho'kma, NH_4OH da qisman eriydi)
	Cl_2 ($CHCl_3$ ishtirokida kislotali muhitda)	Br_2 (xloroformli qatlam qo'ng'ir rangga bo'yaladi)
I^-	Ag^+	$AgI\downarrow$ (sariq cho'kma, NH_4OH da eriydi)
	Cl_2 ($CHCl_3$ ishtirokida kislotali muhitda) mo'l Cl_2	$[I_3]^-$ – xloroformli qatlam qizg'ish-binafsha rangga bo'yaladi. IO_3^- – xloroformli qatlam rangsizlanadi.

25-*jadvalning davomi*

S^{2-}	Ag^+	$Ag_2S\downarrow$ (qora cho'kma)
	H^+	$H_2S\uparrow$ (hid)
	Cd^{2+}	$CdS\downarrow$ (sariq cho'kma)
NO_3^-	Fe(II) (kons. H_2SO_4 muhitida)	$[Fe(NO)]SO_4$ (qo'ng'ir xalqa)
	Difenilamin	 · H_2SO_4 (ko'k rangli)
NO_2^-	H^+	$NO_2\uparrow + NO\uparrow$ (qo'ng'ir gaz)
	Antipirin	Nitrozoantipirin (yashil rang)
	MnO_4^- (kislotali muhitda)	$KMnO_4$ eritmasi rangsizlanadi.
	NH_4Cl, $t°$	$N_2\uparrow$
CH_3COO^-	H^+	CH_3COOH (sirka hidi)
	C_2H_5OH; H_2SO_4	$CH_3COOC_2H_5$ (olma hidi)
	Fe(III)	$[(CH_3COO)_6Fe(OH)_2]^+$ (qizg'ish-qo'ng'ir rang)

26-*jadval*

II – VI ANALITIK GURUH KATIONLARINING SODA ERITMASI BILAN REAKSIYALARI

Analitik guruh	Reaksiyalarning tenglamalari
II	$2Ag^+ + CO_3^{2-} \leftrightarrow Ag_2CO_3\downarrow \xrightarrow{\Delta} Ag_2O\downarrow + CO_2\uparrow$ $2Pb^{2+} + 2CO_3^{2-} + H_2O \rightarrow (PbOH)_2CO_3\downarrow + CO_2\uparrow$ $Hg_2^{2+} + CO_3^{2-} \leftrightarrow Hg_2CO_3\downarrow \leftrightarrow HgO\downarrow + Hg\downarrow + CO_2\uparrow$
III	$Ba^{2+} + CO_3^{2-} \leftrightarrow BaCO_3\downarrow$ $Sr^{2+} + CO_3^{2-} \leftrightarrow SrCO_3\downarrow$ $Ca^{2+} + CO_3^{2-} \leftrightarrow CaCO_3\downarrow$
IV	$2Al^{3+} + 3CO_3^{2-} + 3H_2O \rightarrow 2Al(OH)_3\downarrow + 3CO_2\uparrow$ $Al(OH)_3\downarrow + 3OH^- \rightarrow [Al(OH)_6]^{3-}$ $2Cr^{3+} + 3CO_3^{2-} + 3H_2O \leftrightarrow 2Cr(OH)_3\downarrow + 3CO_2\uparrow$ $Cr(OH)_3\downarrow + 3OH^- \rightarrow [Cr(OH)_6]^{3-}$ $Sn^{2+} + CO_3^{2-} + H_2O \leftrightarrow Sn(OH)_2\downarrow + CO_2\uparrow$ $Sn(OH)_2\downarrow + 4OH^- \rightarrow [Sn(OH)_6]^{4-}$ $[SnCl_6]^{2-} + CO_3^{2-} + 2H_2O \rightarrow Sn(OH)_4\downarrow + 2CO_2\uparrow + 6Cl^-$ $Sn(OH)_4\downarrow + 2OH^- \rightarrow [Sn(OH)_6]^{2-}$ $Zn^{2+} + CO_3^{2-} + H_2O \leftrightarrow Zn(OH)_2\downarrow + CO_2\uparrow$ $Zn(OH)_2\downarrow + 2OH^- \rightarrow [Zn(OH)_4]^{2-}$
V	$Fe^{2+} + CO_3^{2-} \leftrightarrow FeCO_3\downarrow$ havoda tez qo'ng'irlahsadi va quyidagi tenglama bo'yicha $Fe(OH)_3$ hosil bo'ladi: $4FeCO_3\downarrow + 6H_2O + O_2 \rightarrow 4Fe(OH)_3\downarrow + 4CO_2\uparrow$ $2Fe^{3+} + 3CO_3^{2-} + H_2O \leftrightarrow 2Fe(OH)_3\downarrow + 3CO_2\uparrow$ $Mn^{2+} + CO_3^{2-} \leftrightarrow MnCO_3\downarrow$ $2Mg^{2+} + 2CO_3^{2-} + H_2O \leftrightarrow (MgOH)_2CO_3\downarrow + CO_2\uparrow$ $2Bi^{3+} + 3CO_3^{2-} + H_2O \leftrightarrow 2BiOHCO_3\downarrow + CO_2\uparrow$ $2[SbCl_6]^{3-} + 3CO_3^{2-} + 3H_2O \leftrightarrow 2Sb(OH)_3\downarrow + CO_2\uparrow + 12Cl^-$ $[SbCl_6]^- + 3CO_3^{2-} + H_2O \leftrightarrow HSbO_3\downarrow + 2CO_2\uparrow + 6Cl^- + HCO_3^-$
VI	$2Co^{2+} + 2CO_3^{2-} + H_2O \leftrightarrow (CoOH)_2CO_3\downarrow + CO_2\uparrow$ $Ni^{2+} + CO_3^{2-} \rightarrow NiCO_3\downarrow$ $2Cu^{2+} + 2CO_3^{2-} + H_2O \leftrightarrow (CuOH)_2CO_3\downarrow + CO_2\uparrow$ $2Hg^{2+} + 2CO_3^{2-} + H_2O \leftrightarrow (HgOH)_2CO_3\downarrow + CO_2\uparrow$ $(HgOH)_2CO_3\downarrow \leftrightarrow 2HgO\downarrow + CO_2\uparrow + H_2O$

27-jadval

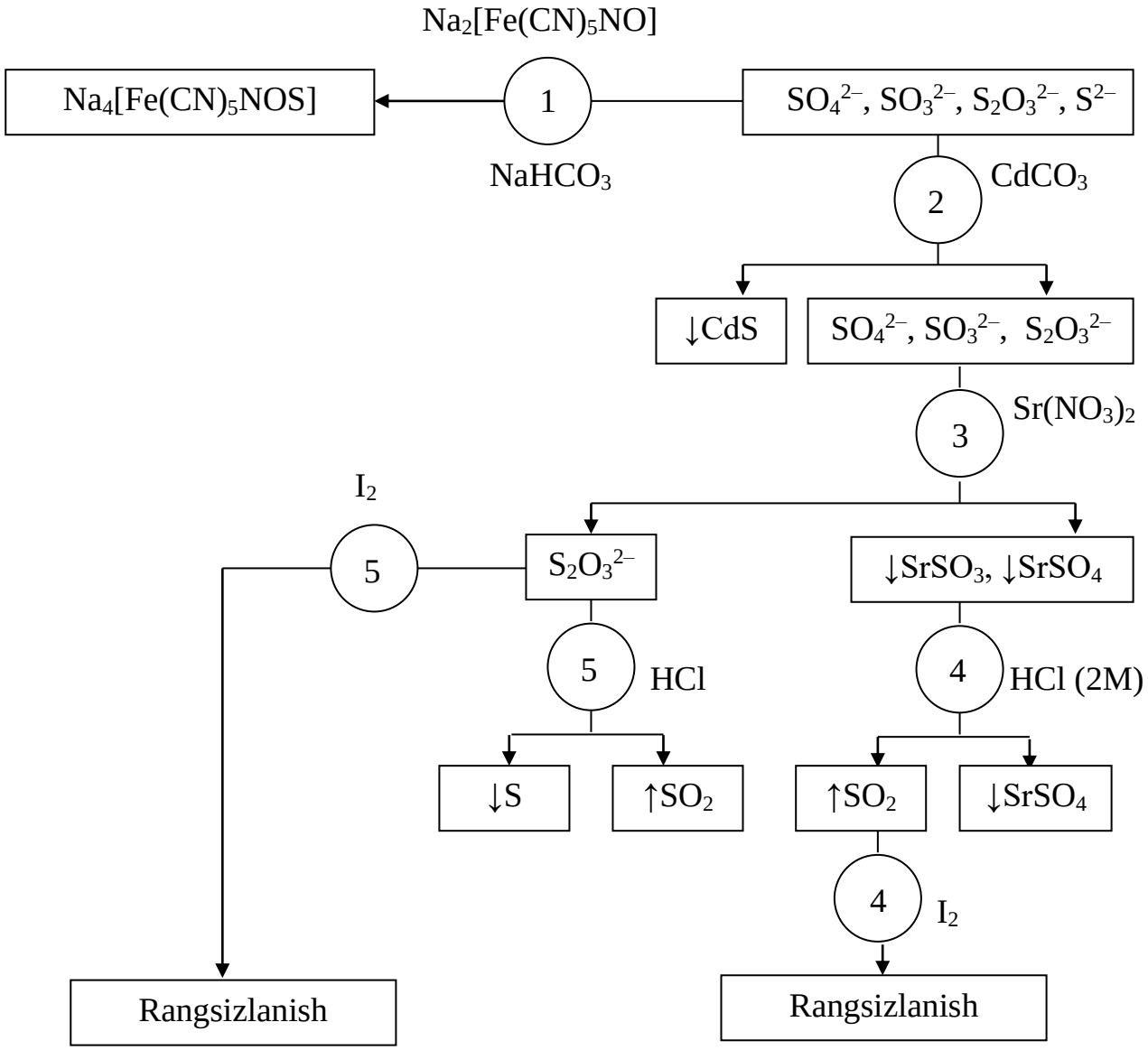
OLTINGUGURT SAQLAGAN ANIONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

S^{2-}, $S_2O_3^{2-}$, SO_4^{2-}, SO_3^{2-}

Bosqichning t/r	**Analiz bosqichlari**
1	Boshlang'ich eritmaning alohida ulushiga kuchsiz ishqoriy muhitda $Na_2[Fe(CN)_5NO]$ ta'sir ettirib S^{2-} ionlarini topish: $S^{2-} \xrightarrow{Na_2[Fe(CN)_5NO]} Na_2[Fe(CN)_5NOS]^{4-}$ Qizg'ish-binafsha rang S^{2-} ionlarining mavjudligidan dalolat beradi.
2	Boshlang'ich eritmaning alohida ulushidan $CdCO_3$ eritmasi ta'sir ettirib S^{2-} ionlarini ajratish: $S^{2-} \xrightarrow{CdCO_3} CdS\downarrow$ $CdS\downarrow$ cho'kmasi sentrifugalab ajratiladi
3	2 sentrifugatga stronsiy tuzlarining eritmasini ta'sir ettirib $S_2O_3^{2-}$ va SO_3^{2-}, SO_4^{2-} ionlarini ajratish: $SO_3^{2-} \xrightarrow{SrNO_3} SrSO_3\downarrow$ $SO_4^{2-} \xrightarrow{SrNO_3} SrSO_4\downarrow$ $SrSO_3$, $SrSO_4$ cho'kmalari sentrifugalab ajratiladi.
4	3 cho'kmaga 2 M HCl eritmasi ta'sir ettirib, SO_3^{2-} va SO_4^{2-} ionlarini topish: $SrSO_3\downarrow \xrightarrow{HCl} SO_2\uparrow$ Yod eritmasi ta'sir ettirib, SO_3^{2-} ionlarini aniqlash: $SO_2\uparrow \xrightarrow{I_2;\,HCl} SO_4^{2-}$ Yod eritmasi rangsizlanadi. 3 cho'kmani to'liq erimasligi SO_4^{2-} ionlarining mavjudligidan dalolat beradi.
5	3 sentrifugatga HCl eritmasi va yod eritmasi ta'sir ettirib $S_2O_3^{2-}$ ionlarini topish: $S_2O_3^{2-} \xrightarrow{HCl} S\downarrow$ $S_2O_3^{2-} \xrightarrow{I_2;\,HCl}$ yod eritmasi rangsizlanadi

12-*sxema*

SO_4^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, S^{2-} ARALASHMASINING ANALIZ SXEMASI



28-jadval

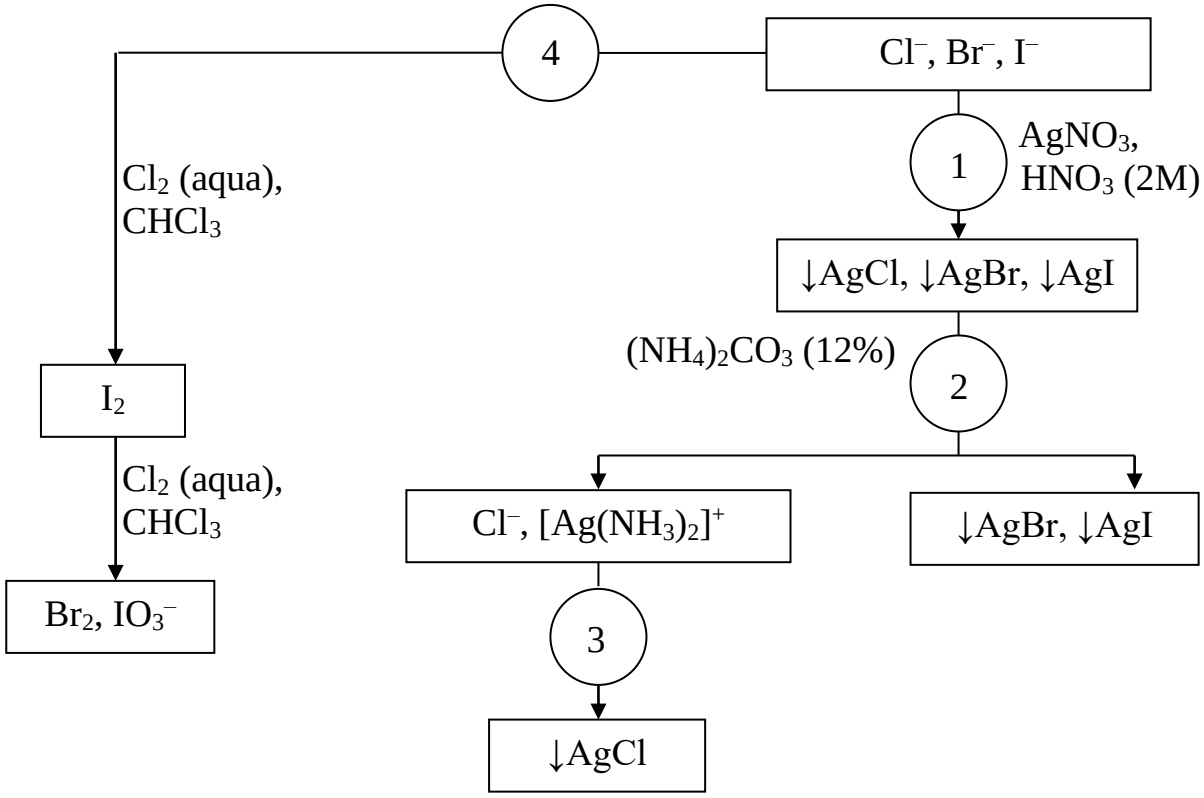
GALOGENID-IONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

Cl^-, Br^-, I^-

Bosqichning t/r	**Analiz bosqichlari**
1	Boshlang'ich eritmaning alohida-alohida ulushiga HNO_3 bilan nordonlashtirilgan $AgNO_3$ ta'sir ettirib Cl^-, Br^-, I^-, ionlarini cho'k-tirish: $Cl^- \xrightarrow{AgNO_3;\ HNO_3} AgCl\downarrow$ $Br^- \xrightarrow{AgNO_3;\ HNO_3} AgBr\downarrow$ $I^- \xrightarrow{AgNO_3;\ HNO_3} AgI\downarrow$ Sentrifugalab cho'kma ajratiladi. Sentrifugat analiz qilinmaydi.
2	1 cho'kmaga 12% li $(NH_4)_2CO_3$ eritmasi ta'sir ettirb, Cl^- ionlarini ajratish: $AgCl\downarrow \xrightarrow{(NH_4)_2CO_3,\ 12\%} [Ag(NH_3)_2]^+, Cl^-$ Sentrifugalab AgBr, AgI cho'kma ajratiladi va analiz qilinmaydi.
3	2 sentrifugatga HNO_3 eritmasi ta'sir ettirib, Cl^- ionlarini topish: $[Ag(NH_3)_2]^+, Cl^- \xrightarrow{HNO_3} AgCl\downarrow$
4	Boshlang'ich eritmaning alohida ulushiga xloroform ishtirokida xlorli suv ta'sir ettirib, I^- va Br^- ionlarini topish: $I^- \xrightarrow{Cl_2} I_2$ (xloroformli qatlam qizg'ish-binafsha rangga bo'yaladi) $Br^- \xrightarrow{Cl_2} Br_2$ (xloroformli qatlamning qizg'ish-binafsha rangi yo'qoladi va zarg'aldoq rang paydo bo'ladi)

13-*sxema*

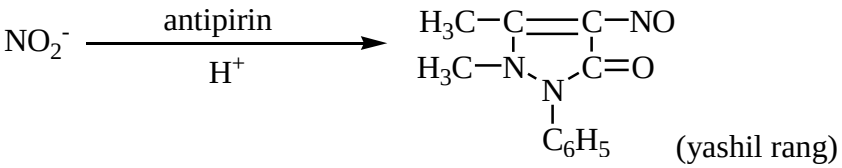
GALOGENID-IONLAR (Cl^-, Br^-, I^-) ARALASHMASINING ANALIZ SXEMASI



29-*jadval*

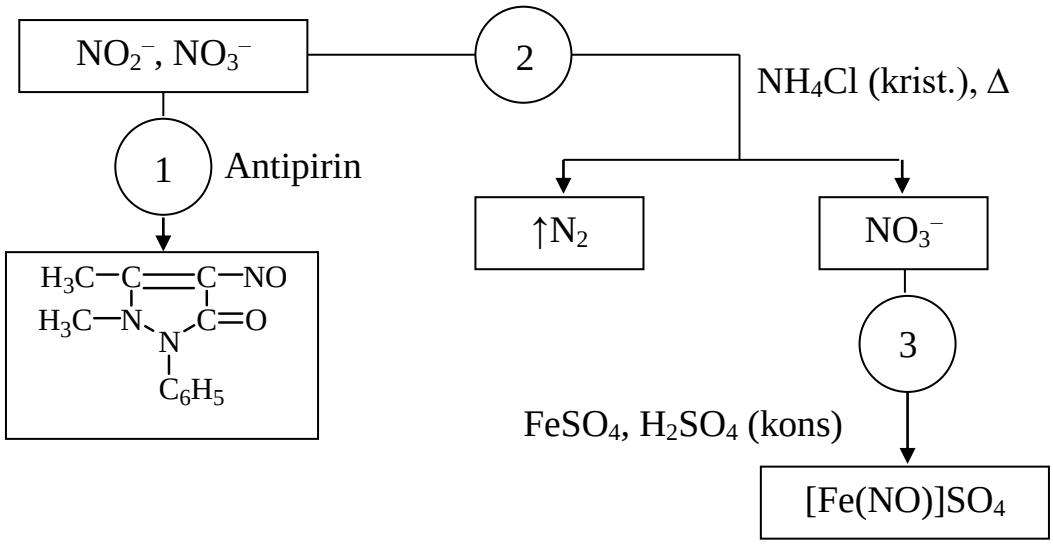
AZOT SAQLAGAN ANIONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

NO_2^-, NO_3^-

Bosqichning t/r	**Analiz bosqichlari**
1	Nordonlashtirilgan boshlang'ich eritmaning alohida ulushidan kristall holdagi antipirin ta'sir ettirib NO_2^- ionlarini topish:  (yashil rang)
2	Boshlang'ich eritmaning alohida ulushidan kristall NH_4Cl ta'sirida qizdirib NO_2^- ionlarini yo'qotish: $NO_2^- \xrightarrow{NH_4Cl,\ \Delta} N_2\uparrow$
3	2 eritmadan konsentrlangan H_2SO_4 ishtirokida $FeSO_4$ ta'sir ettirib NO_3^- ionlarini topish: $NO_3^- \xrightarrow{FeSO_4,\ H_2SO_4} [Fe(NO)SO_4]$ (qo'ng'ir xalqa) Agar eritmada Br^- yoki I^- ionlari bo'lsa, ular HCl eritmasi ishtirokida xlorli suv ta'sirida qizdirib yo'qotiladi: $Br^- \xrightarrow{Cl_2,\ HCl,\ \Delta} Br_2\uparrow;\ I^- \xrightarrow{Cl_2,\ HCl,\ \Delta} I_2\uparrow$

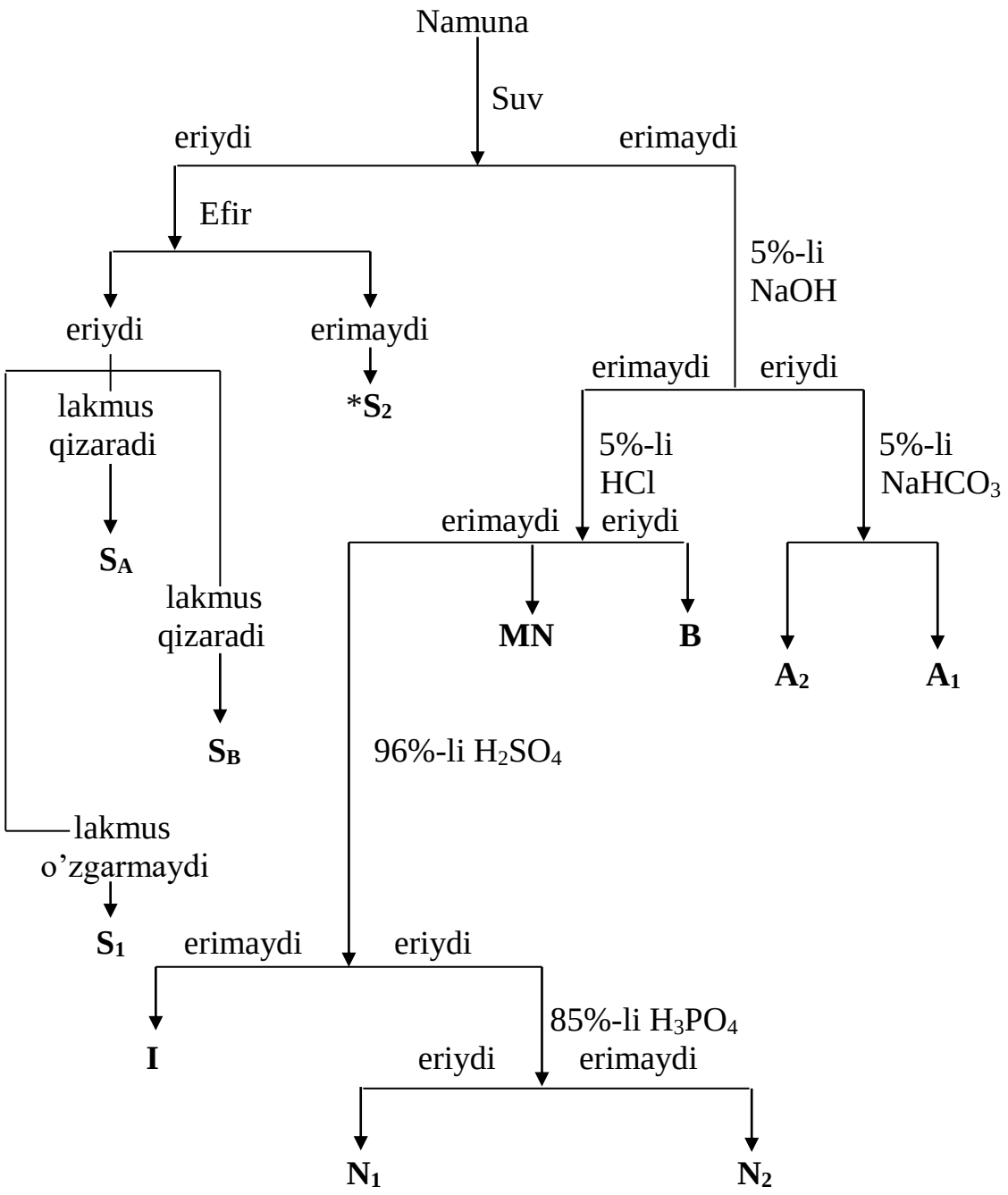
14-*sxema*

NO_2^-, NO_3^- ANIONLARI ARALASHMASINING ANALIZ SXEMASI



15-*sxema*

ERUVCHANLIKKA ASOSLANGAN ORGANIK BIRIKMALAR ARALASHMASINING AJRATILISHI

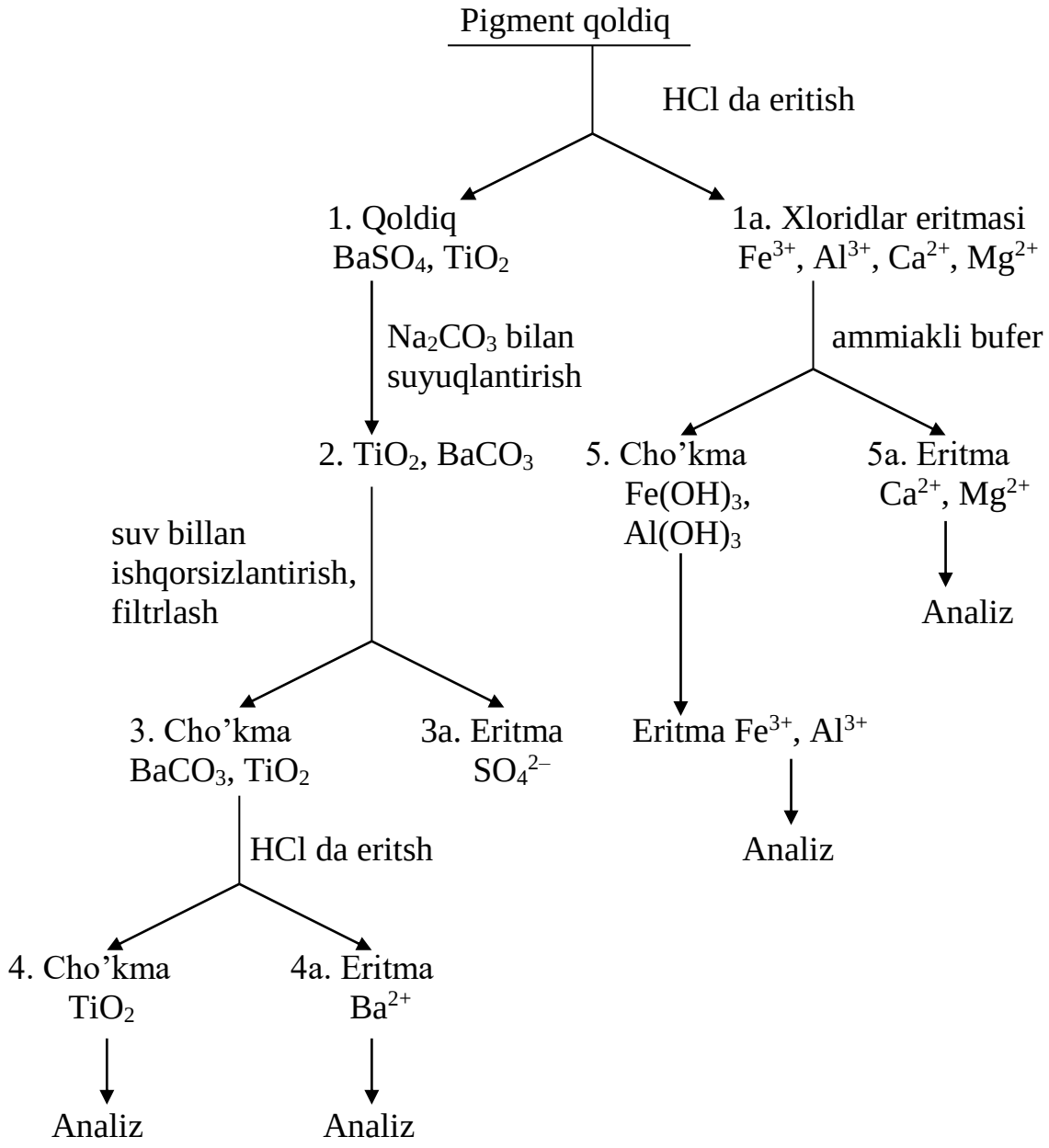


***S2** – organik kislotalarning tuzlari (RCOONa, RSO_3Na), aminlar gidroxloridlari ($RNH \cdot HCl$), aminokislotalar ($R - CHCNH_3^+COO^-$), uglevodlar, polioksibirikmalar, ko'p asosli kislotalar; **SA** – besh yoki undan kam C atomlarini saqlagan bir asosli karbon kislotalar, aromatik sulfokislotalar; **SB** – olti yoki undan kam C atomlarini saqlagan aminlar; **S1** – besh yoki undan kam C atomlarini saqlagan spirtlar, aldegidlar, ketonlar, murakkab efirlar, nitrillar va amidlar; **A1** – kuchli karbon kislotalar, *o*- va *p*-holatda o'rinbosarlarni saqlagan fenollar, β-diketonlar; **A2** – kuchsiz organik kislotalar, fenollar, yenollar, oksimlar, imidlar, sulfonamidlar, nitrobirikmalar; **B** – 8 tadan ko'p C atomlarini saqlagan alifatik aminlar, anilinlar, oksiefirlar; **MN** – azot yoki oltingugurt saqlagan turli neytral birikmalar (C atomlari 5 tadan ko'p); **N1** – spirtlar, aldegidlar, metilketonlar, siklik ketonlar, murakkab efirlar (5 – 9 C), oddiy efirlar (C atomlari 8 tadan kam), epoksidlar; **N2** – alkenlar, alkinlar, oddiy efirlar, ba'zi aromatik birikmalar, ketonlar (N_1 ga kiritilganlardan tashqari); **I** – to'yingan uglevodorodlar, alkilgalogenidlar, arilgalogenidlar, ba'zi aromatik birikmalar.

16-*sxema*

LAK-BO'YOQ MATERIALLAR ANALIZI

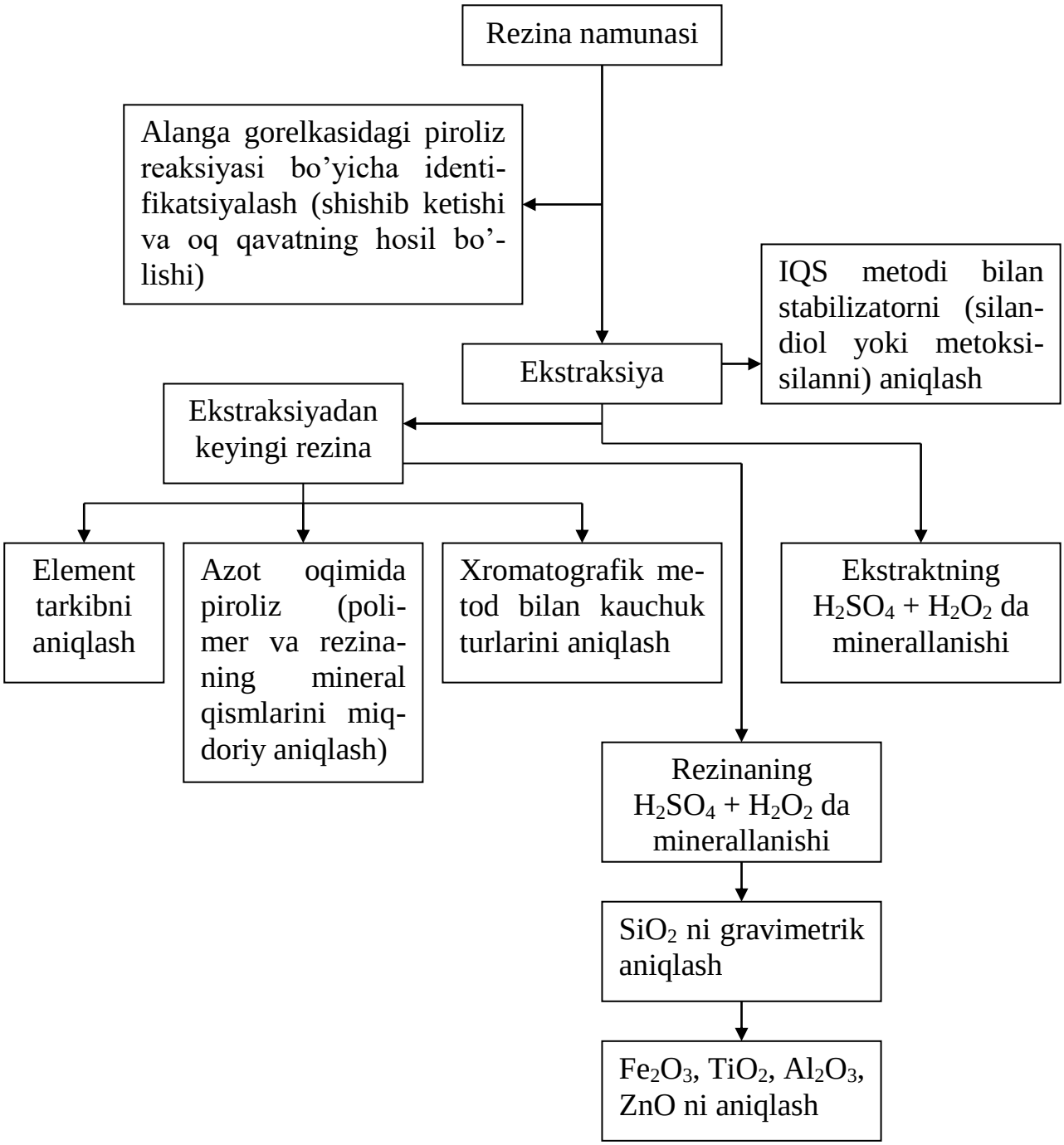
Pigment qoldiqning analizi



1. Namuna.
2. Erituvchini haydash→2a. Erituvchi analizi.
3. Plastifikatorni ajratish→3a. Plastifikator analizi.
4. Plyonka hosil qiluvchini ajratish→4a. Plyonka hosil qiluvchining analizi.
5. Pigment qoldiq→5a. Pigment qoldiqning analizi.

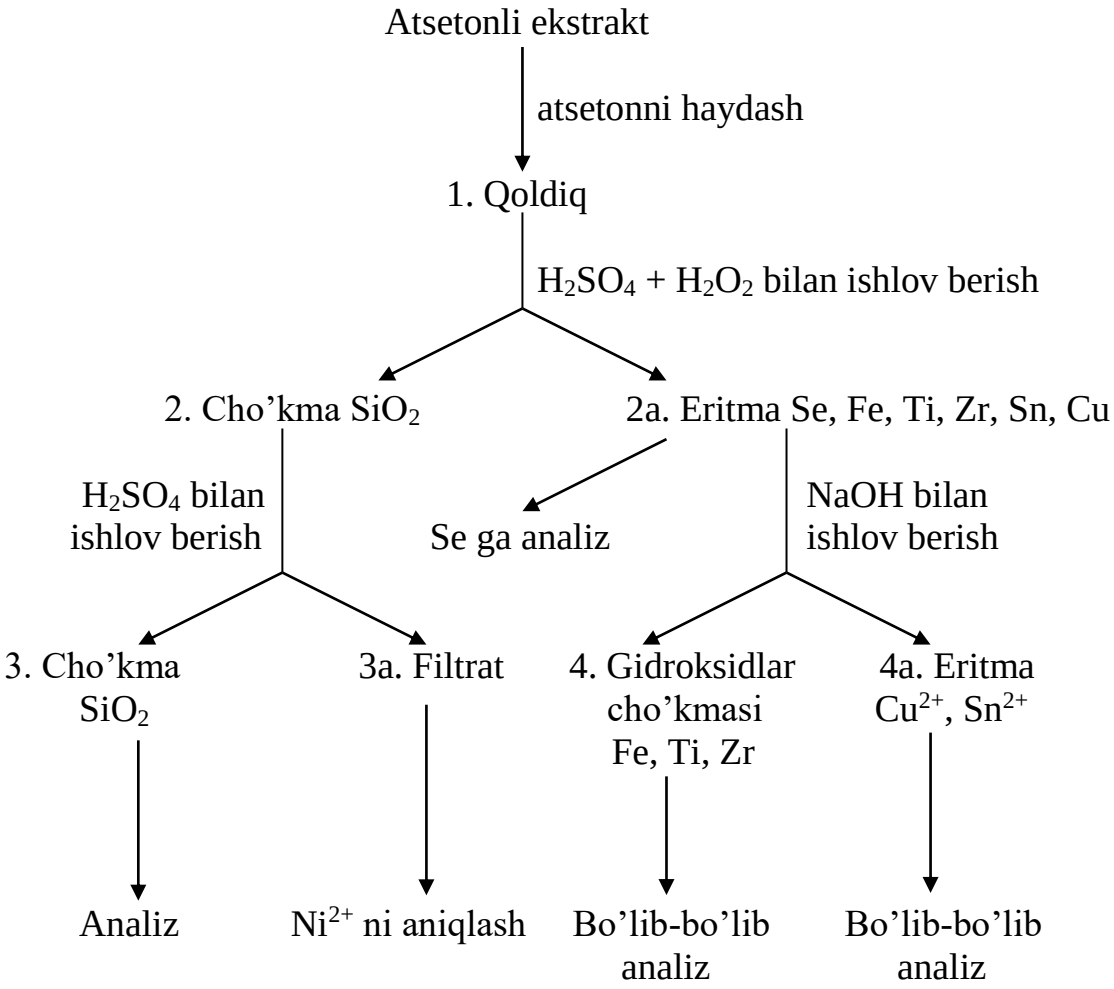
17-*sxema*

SILOKSAN KAUCHUKLAR ANALIZI



18-*sxema*

SILOKSAN REZINASI ATSETONLI EKSTRAKTINING ANALIZI
(KATALIZATORLAR VA SiO_2 NI ANIQLASH)



ELEKTROLITLAR ERITMALARIDA MUVOZANAT

Massalar ta’siri qonuni – sifat analizining nazariy asosidir. U turli kimyoviy jarayonlarning muvozanatlarini – cho’kma hosil bo’lishi va erishi, bir qiyin eriydigan birikmani boshqasiga aylanishi, gidroliz jarayoni, amfoterlik va hokazolarni ilmiy asoslab beradi.

Kimyoviy reaksiyalarning tezligi reaksiyaga kirishuvchi moddalarning tabiatiga, haroratga, bosimga hamda katalizatorga bog’liq. *Kimyoviy reaksiyalarning tezligi reaksiyaga kirishayotgan moddalar konsentratsiyasining vaqt birligi ichida o’zgarishi bilan o’lchanadi,* ya’ni

$$v = \pm \frac{\Delta C}{\Delta t}$$

bunda v – kimyoviy reaksiya tezligi; Δt – cheksiz kichik vaqt oralig’i; ΔC – reaksiyaga kirishuvchi moddalar konsentratsiyasining o’zgarishi; $\Delta C/\Delta t$ – konsentratsiyaning vaqt bo’yicha olingan hosilasi.

1867 yilda norvegiyalik olimlar Guldberg bilan Vaage tomonidan massalar ta’siri qonuni kashf etildi va u quyidagicha ta’riflandi: *kimyoviy reaksiya tezligi reaksiyaga kirishayotgan moddalarning konsentratsiyalari ko’paytmasiga to’g’ri proporsionaldir.* Masalan,

$$m\mathrm{A} + n\mathrm{B} \leftrightarrow p\mathrm{C} + q\mathrm{D}$$

qaytar reaksiya uchun massalar ta’siri qonuniga muvofiq to’g’ri va teskari reaksiyalarning tezligi mos ravishda quyidagicha bo’ladi:

$$v_1 = k_1[\mathrm{A}]^m \cdot [\mathrm{B}]^n$$
$$v_2 = k_2[\mathrm{C}]^p \cdot [\mathrm{D}]^q$$

bunda v_1 va v_2 – to’g’ri va teskari reatsiyalarning tezligi.

Vaqt o’tishi bilan $v_1 = v_2$ bo’ladi. *To’g’ri va teskari reaksiya tezliklarining o’zaro tenglashgan holati kimyoviy muvozanat deyiladi.* Kimyoviy muvozanat vaqtida $v_1 = v_2$ bo’lgani uchun:

$$k_1[\mathrm{A}]^m \cdot [\mathrm{B}]^n = k_2[\mathrm{C}]^p \cdot [\mathrm{D}]^q$$

$$\frac{k_1}{k_2} = \frac{[\mathrm{C}]^p \cdot [\mathrm{D}]^q}{[\mathrm{A}]^m \cdot [\mathrm{B}]^n} = K$$

bu oxirgi tenglama kimyoning eng asosiy qonunlaridan biri bo’lgan *massalar ta’siri qonuni*ning matematik ifodasi bo’lib, u quyidagicha ta’riflanadi: *muvozanat vujudga kelganda reaksiya natijasida hosil bo’lgan moddalar konsentratsiyalari ko’paytmasining reaksiya uchun olingan moddalar kotsentratsiyalari ko’paytmasiga bo’lgan nisbati ayni haroratda shu reaksiya uchun doimiy son bo’lib, kimyoviy muvozanat konstantasi deyiladi* va K harfi bilan belgilanadi.

Yuqori aniqlik bilan hisoblashlarda elektrolitlarning konsentratsiyalari ionlarning aktivliklariga almashtiriladi. Ion konsentratsiyasi va uning aktivligi orasida quyidagicha bog’liqlik mavjud:

$$a = f \cdot C$$

bunda f – aktivlik koeffitsiyenti.

Aktivlikni ionning haqiqiy konsentratsiyasiga nisbati *aktivlik koeffitsiyenti* (*f*) deyiladi:

$$f = \frac{a}{C}$$

Demak, aktivlik son jihatdan konsentratsiya (*C*) bilan aktivlik koeffitsiyenti (*f*) ko'paytmasiga teng.

Ionlarning aktivlik koeffitsiyenti faqat eritmadagi elektrolitning konsentratsiyasiga bog'liq bo'lib qolmay, balki shu eritmadagi tashqi ionlar konsentratsiyasiga ham bog'liqdir. Shu ionlarning o'zaro ta'sir kuchini ifodalovchi kattalik *ion kuchi* deb ataladi. Eritmaning ion kuchi (μ) eritmadagi barcha ionlar konsentratsiyalari bilan zaryadlari kvadrati ko'paytmasi yig'indisining yarmiga teng, ya'ni:

$$\mu = 1/2\ (C_1Z_1^2 + C_2Z_2^2 + \ldots C_nZ_n^2),$$

$$\mu = 1/2\sum C_iZ_i^2$$

bunda C_1, $C_2 \ldots C_n$ – eritmadagi ionlarning molyar konsentratsiyalari; Z_1, $Z_2 \ldots Z_n$ – ionlarning zaryadlari.

Suyultirilgan eritmalar $\mu \leq 0{,}01$ uchun aktivlik koeffitsiyenti quyidagi formula bo'yicha hisoblanadi:

$$\lg f = -0{,}5Z^2\sqrt{\mu}\ ;$$

Yuqori konsentratsiyali eritmalar $0{,}5 \geq \mu \geq 0{,}01$ uchun aktivlik koeffitsiyenti quyidagi formula yordamida topiladi:

$$\lg f = -0{,}5 \cdot Z^2 \frac{\sqrt{\mu}}{1+\sqrt{\mu}}$$

Kuchli konsentrlangan eritmalar uchun formula bir oz murakkablashadi:

$$\lg f = -\frac{0{,}5 \cdot Z^2\sqrt{\mu}}{1 + a \cdot 0{,}33 \cdot 10^8\sqrt{\mu}} + A$$

bunda *a* – ion radiusi, sm; *A* – empirik koeffitsiyent.

Kuchli elektrolitlar uchun juda suyultirilgan eritmalarda (~ 0,0001 *M*) $f = 1$ va $a = C$ bo'ladi.

Elektrolitlar eritmalarida kimyoviy muvozanat holati muvozanat konstantasi *K* bilan xarakterlanadi:

$$B_mA_n \rightleftarrows mB^{n+} + nA^{m-}$$

$$K = \frac{[B^{n+}]^m[A^{m-}]^n}{[B_mA_n]}$$

Suv bir vaqtning o'zida ham kislota va ham asos hisoblanib, quyidagicha muvozanat yuzaga keladi:

$$H_2O + H_2O \leftrightarrow H_3O^+ + OH^-$$

qisqartirilgan ko'rinishda:

$$H_2O \leftrightarrow H^+ + OH^-$$

Bu reaksiyaning muvozanat konstantasi 25 ^{0}C haroratda

$$K = \frac{[H^+][OH^-]}{[H_2O]} = 1{,}8 \cdot 10^{-16}$$ ga teng.

Suvdagi eritmalarda suvning massasi ko'pchilik hollarda eritilgan moddaning massasi bilan taqqoslaganda juda yuqori, uning 1 l eritmadagi miqdorini doimiy deb hisoblash mumkin. Unda muvozanat konstantasi uchun ifoda quyidagicha yoziladi:

$$K[H_2O] = [H^+][OH^-].$$

Suv juda kuchsiz elektrolit bo'lgani uchun, $K[H_2O]$ ko'paytma ham doimiy kattalik hisoblanadi. Bu konstantaga suvning *ion ko'paytmasi* K_w deyiladi va 25 ^{0}C haroratda

$$K_w = K_{H_2O} = [H^+][OH^-] = 1 \cdot 10^{-14}$$ ga teng.

Toza suvda $[H^+] = [OH^-] = 1 \cdot 10^{-7}$ M.

Agar $[OH^-]$ ortiq bo'lsa,

$$[H^+] = \frac{K_{H_2O}}{[OH^-]}$$

$[H^+]$ ortiq bo'lsa,

$$[OH^-] = \frac{K_{H_2O}}{[H^+]}$$

Vodorod ionlarining konsentratsiyasidan odatda muhitning tavsifi uchun foydalaniladi. Kislota-asosli muvozanatga tegishli ko'pgina hisoblashlarda konsentratsiyalar va boshqa kattaliklarni ifodalashda bu kattaliklarning manfiy logarifmidan foydalaniladi va «p» belgisi bilan ifodalaniladi:

$$-\lg[H^+] = pH;$$
$$-\lg[OH^-] = pOH.$$

Suvning ion ko'paytmasini ham logarifmik ko'rinishda ifodalash mumkin:

$$pH + pOH = pK_{H_2O} = 14.$$

Suvsiz eritmalar analitik kimyosida qo'llaniladigan ko'pgina erituvchilar suvga o'xshash avtoprotolizga uchraydi, masalan:

$$H_2O + H_2O \leftrightarrow H_3O^+ + OH^-,$$
$$C_2H_5OH + C_2H_5OH \leftrightarrow C_2H_5OH_2^+ + C_2H_5O^-,$$
$$2H_2NCH_2CH_2NH_2 \leftrightarrow H_2NCH_2CH_2NH_3^+ + H_2NCH_2CH_2NH^-,$$
$$2(CH_3)_2SO \leftrightarrow (CH_3)_2SOH^+ + CH_3 - SO - CH_2.$$

Umumiy holda bu jarayonlarni quyidagi tenglama bilan ifodalash mumkin:

$$2HM \leftrightarrow H_2M^+ + M^-$$

Erituvchilarning avtoprotolizidan hosil bo'lgan kationlar kuchli asoslarga nisbatan kislotalar singari, anionlar esa kuchli kislotalarga asoslar singari ta'sir etadi. Erituvchining avtoprotoliz jarayonida yuzaga keladigan muvozanat avtoprotoliz konstantasi K_s bilan ifodalandi:

$$K_s = a_{H_2M^+} \cdot a_{M^-}$$ (termodinamik avtoprotoliz konstantasi)

yoki

$K_s = [H_2M^+][M^-]$ (konsentratsion avtoprotoliz konstantasi).

Avtoprotolizning kislota-asosli muvozanati erituvchi tabiati va uning vodorod bog'lanishlarni hosil qilish moyilligi, donor-aktseptorlik xossalari, solvatlanish xususiyati va boshqalarga bog'liq bo'ladi.

Avtoprotoliz konstantasi ko'rsatkichi ($pK_s = -\lg K_s$) berilgan eituvchining kislotalik darajasini ifodalaydi (suv uchun – 14; etanol uchun – 18,75; dimetilformamid uchun – 27,0; atsetonitril uchun 33,3 va hokazo).

ANALITIK KIMYODA QO'LLANILADIGAN MUHIM SUVSIZ ERITUVCHILARNING DIELEKTRIK O'TKAZUVCHANLIKLARI (ε*) VA AVTOPROTOLIZ KONSTANTALARI (pK_s)

Erituvchi	ε* (25 °C)	pK_s
Spirtlar		
Metanol	32,6	17,31
Etanol	24,3	18,54
n-Propanol	20,1	19,46
izo-Propanol	18,3	20,30
Efirlar		
Metilatsetat	6,7	22,50
Etilatsetat	6,0	22,83
Ketonlar		
Atseton (dimetilketon)	20,9	21,40
Metiletilketon	18,4	21,53
Kislotalar		
Suyuq HF	84 (0 °C)	11,7
Sulfat kislota	100,5	3,62
Sirka kislota	662	12,22 14,45
Chumoli kislota	57,0 (20 °C)	6,66
Azot saqlovchi birikmalar		
Formamid	109,5	17,0
N,N-Dimetilformamid	36,71	23,10
Ammiak	22,7 (– 50 °C)	32,72
Oltingugurt saqlovchi birikmalar		
Dimetilsulfoksid	45,0	33,3
Sulfolan	42,0	25,45

Bir turdagi erituvchilarning kislotaligi ortishi bilan ularning pK_s qonuniyat bilan kamayib boradi. Masalan, quyida keltirilgan erituvchilar ucun pK_s ham shu tartibda o'zgarib boradi: $CH_3COOC_6H_{13}$ > $CH_3COOC_5H_{11}$ > $CH_3COOC_4H_9$ > $CH_3COOC_3H_7$ > $CH_3COOC_2H_5$ > CH_3COOCH_3 > CH_3COOH > HCOOH. Shu bilan birga ularning dielektrik o'tkazuvchanliklari (ε*) ham shu tartibda ortib boradi (jadvalga qarang).

Kuchsiz kislota eritmalarining muvozanat konstantasi K_a bilan ifodalanadi:

$$HA \leftrightarrow H^+ + A^-,$$

$$K_a = \frac{[H^+][A^-]}{[HA]}.$$

Kuchsiz asos eritmalarining muvozanat konstantasi K_b bilan ifodalanadi:

$$K_b = \frac{[B^+][OH^-]}{[BOH]}.$$

Ba'zi asoslarning ionlanish muvozanatini kislotalik konstanta bilan ham ifodalash mumkin. Masalan, ammiak – protonni biriktirib, ammoniy ionini hosil qiladigan asos hisoblanadi. Biroq, ammoniy ionini (NH_4^+) kuchsiz kislota sifatida ham qabul qilish mumkin, chunki u suvli eritmada qisman ionlanib, vodorod va ammiak molekulalariga parchalanadi:

$$NH_4^+ \leftrightarrow NH_3 + H^+$$

Shuning uchun:

$$K_a = \frac{[H^+][NH_3]}{[NH_4^+]}.$$

Bu konstanta 25 °C da $5{,}5 \cdot 10^{-10}$ ga teng ekanligi tajribada aniqlangan. Yuqorida keltirilgan tenglama umumiy holda ham tasvirlanishi mumkin:

$$K_a = \frac{[H^+][B]}{[BH^+]}.$$

Kuchsiz elektrolit eritmalarini miqdoriy xarakterlaydigan kattaliklardan biri ionlanish darajasi (α) hisoblanadi va u quyidagi nisbat bilan ifodalanadi:

$$\alpha = \frac{\text{ionlangan molekulalarning soni}}{\text{eritilgan molekulalarning umumiy soni}}.$$

Elektrolitning ionlanish konstantasi K va α orasida quyidagi bog'liqlik mavjud bo'lib, u Ostvaldning suyultirish qonunining matematik ifodasidir:

$$K = C\frac{\alpha^2}{1-\alpha}.$$

bunda C – kuchsiz elektrolitning molyar konsentratsiyasi.

Juda kuchsiz elektrolitlarda (α < 5%) α ning qiymati juda klichik bo'ladi va 1 – α ayirma birga teng deb olinadi. Shu sababli tenglamani qisqartirilgan ko'rinishda $K = C \cdot \alpha^2$ yozish mumkin.

Kislota va asoslarning eritmalarida muvozanat

Suvli eritmalarning kislotaligini vodorod ionlarining konsentratsiyasi belgilaydi va pH kattaligi bilan xarakterlanadi:

$$pH = -\lg[H^+],$$

$$pOH = -\lg[OH^-].$$

Bu ikki kattalik bir-biri bilan quyidagi nisbatda bog'lanadi:

$$pH + pOH = 14 \ (25\ ^\circ C \text{ da}).$$

Kuchli kislota va asoslar suvli eritmalarda to'liq ionlanadi. Masalan:

$$HCl \rightarrow H^+ + Cl^-,$$

$$NaOH \rightarrow Na^+ + OH^-.$$

Binobarin, bunday eritmalarda $[H^+] = C_a = [An^-]$ va $[OH^-] = C_b = [Kat^+]$.

0,001M HCl eritmasida $[H^+]$ ionlarining konsentratsiyasini hisoblash:

$$H_2O \rightleftarrows H^+ + OH^-; \ K_w = [H^+][OH^-] = 10^{-14}$$

$$HCl \rightarrow H^+ + Cl^-.$$

0,001M HCl eritmasida $[H^+]$ ionlarining konsentratsiyasi 10^{-3} mol/l ga teng, lekin $[H^+][OH^-] = 10^{-14}$ ko'paytma doimiy kattalik bo'lgani uchun $[OH^-]$ ionlarining konsentratsiyasi kamayadi va $[OH^-] = \frac{10^{-14}}{10^{-3}} = 10^{-11}$ mol/l ga teng bo'ladi.

Binobarin, $[H^+] > [OH^-]$ bo'lgan har qanday eritmada muhit kislotali bo'ladi.

0,001M NaOH eritmasida $[H^+]$ ionlarining konsentratsiyasini hisoblash:

$$H_2O \rightleftarrows H^+ + OH^-; \ K_w = [H^+][OH^-] = 10^{-14}$$

$$NaOH \rightarrow Na^+ + OH^-.$$

0,001M NaOH eritmasida $[OH^-]$ ionlarining konsentratsiyasi 10^{-3} mol/l ga teng bo'ladi, lekin $[H^+][OH^-] = 10^{-14}$ ko'paytmaning qiymati baribir doimiy qolaveradi, unda $[H^+]$ konsentratsiyalari kamayadi va $[H^+] = \frac{10^{-14}}{10^{-3}} = 10^{-11}$ mol/l ga teng bo'ladi.

Binobarin, $[H^+] < [OH^-]$ bo'lgan har qanday eritmada muhit ishqoriy bo'ladi.

Suvli eritmalar muhitini xarakterlashda $[H^+]$ o'rniga pH ni qo'llash qulaydir. Yuqoridagi eritmalarning pH qiymatlarini hisoblaymiz:

suv: $[H^+] = [OH^-] = 10^{-7}$ mol/l, unda pH = 7;

0,001M HCl eritmasida: $[H^+] = 10^{-3}$ mol/l, $pH = -\lg 10^{-3} = 3$; $pH < 7$;

0,001M NaOH eritmasida: $[H^+] = 10^{-11}$ mol/l, $pH = -\lg 10^{-11} = 11$; $pH > 7$.

Binobarin, agar: pH = 7 bo'lsa, muhit neytral;
pH < 7 bo'lsa, muhit kislotali;
pH > 7 bo'lsa, muhit ishqoriy.

Kuchsiz kislota va asoslar suvli eritmalarda qisman ionlanadi. Masalan:

$$CH_3COOH \leftrightarrow H^+ + CH_3COO^-$$

$$NH_3 \cdot H_2O \leftrightarrow NH_4^+ + OH^-$$

Bunday kislota asoslarning eritmalardagi muvozanat tegishli muvozanat konstantalari bilan xarakterlanadi:

$$K_{CH_3COOH} = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]};$$

$$K_{NH_3 \cdot OH} = \frac{[NH_4^+][OH^-]}{NH_3 \cdot H_2O}.$$

Kuchsiz kislota yoki kuchsiz asoslarning muvozanat konstantalaridan $[H^+]$ va $[OH^-]$ larning konsentratsiyalarini topish formulalarini keltirib chiqarish mumkin:

$$[H^+] = \sqrt{K_a \cdot C_a};$$

$$[OH^-] = \sqrt{K_b \cdot C_b}.$$

Ko'pchilik kislota va asoslarning K_a va K_b qiymatlari ushbu qo'llanmaning ilovasida berilgan.

Kislota yoki asosning boshlang'ich konsentratsiyalari (C_a yoki C_b) va ularning ionlanish darajalari (α) asosida $[H^+]$ yoki $[OH^-]$ ning qiymatlari quyidagi formulalar yordamida hisoblanadi:

$$[H^+] = \alpha \cdot C_a;$$

$$[OH^-] = \alpha \cdot C_b.$$

Bufer eritmalarda, ya'ni kuchsiz kislota va uning tuzi yoki kuchsiz asos va uning tuzidan tarkib topgan aralashmalarda $[H^+]$ yoki $[OH^-]$ qiymatlari kislota va uning tuzi yoki asos va uning tuzi konsentratsiyalariga bog'liq bo'ladi:

$$[H^+] = K_a \cdot \frac{C_a}{C_{tuz}};$$

$$[OH^-] = K_b \cdot \frac{C_b}{C_{tuz}}.$$

Shuni qayd etish joizki, yuqorida ko'rsatilgan formulalar bo'yicha masalalarni yechishda kislota, asos va ionlarning konsentratsiyalari mol/l da ifodalanishi kerak.

1-masala. Sianid kislotaning ionlanish konstantasi $7{,}9 \cdot 10^{-10}$ ga teng. 0,001M kislotaning ionlanish darajasi, pH va ionlanmagan qismining ulushini hisoblang.

Yechish. HCN ning ionlanish konstantasi juda kichik qiymatga ega bo'lgani uchun ionlanish darajasini hisoblashda Ostvaldning suyultirish qonunining qisqartirilgan formulasidan foydalanamiz:

$$\alpha = \sqrt{\frac{K_a}{C_a}} = \sqrt{\frac{7{,}9 \cdot 10^{-10}}{1 \cdot 10^{-3}}} = 8{,}9 \cdot 10^{-4}, \text{ yoki } 8{,}9 \cdot 10^{-2}\ \%.$$

Ionlanmagan qismining ulushi 100% – α = 100 – 0,089 = 99,91% ga teng.

$[H^+]$ qiymatini $[H^+] = \alpha \cdot C_a$ formula bo'yicha hisoblaymiz:

$$[H^+] = 8{,}9 \cdot 10^{-4} \cdot 1 \cdot 10^{-3} = 8{,}9 \cdot 10^{-7} \text{ mol/l}.$$

Bundan, $pH = -\lg 8{,}9 \cdot 10^{-7} = 6{,}05$.

2-masala. 0,4%-li natriy gidroksid eritmasining pH ini hisoblang.

Yechish. NaOH konsentratsiyasini mol/l da hisoblaymiz:

$$C_{\text{NaOH}} = \frac{10 \cdot \omega \cdot \rho}{M} = \frac{10 \cdot 0{,}4 \cdot 1}{40} = 0{,}1 \text{ mol/l},$$

bunda ρ – NaOH eritmasining zichligi, g/sm^3; ω – eritma konsentratsiyasi, %; *M* – NaOH ning molyar massasi, g.

NaOH kuchli asos bo'lgani uchun, $[OH^-] = C_{\text{NaOH}} = 0{,}1$ mol/l ga teng bo'ladi.

Unda, pOH = – lg 0,1 = 1,0; pH = 14 – pOH = 14 – 1 = 13.

3-masala. pH 10,80 ga teng bo'lgan eritmada gidroksid-ionlarning konsentratsiyasi qanday bo'ladi?

Yechish. pOH ni hisoblaymiz: pOH = 14 – pH = 14 – 10,80 = 3,20.

Bundan, $-\lg[OH^-] = 3{,}20$ yoki $\lg[OH^-] = -3{,}20$; $[OH^-] = 10^{-3,2}$,

Bundan, $[OH^-] = 6{,}31 \cdot 10^{-4}$ mol/l.

Mustaqil yechish uchun masalalar

4-masala. 0,2M chumoli kislotasining ionlanish darajasi 3% ga teng. Kislotaning ionlanish konstantasi va pH qiymatini hisoblang.

5-masala. Sirka kislotaning ionlanish darajasini ikki marta oshirish uchun, uning 600 ml 0,2M eritmasiga qancha suv qo'shish kerak?

6-masala. Sirka kislota konsentratsiyasi 0,01M va ionlanish darajasi 4,2% bo'lgan eritmaning pH ini hisoblang.

7-masala. pH = 7,36 bo'lgan eritmaning vodorod ionlari konsentartsiyasi pH = = 7,53 bo'lgan eritmaning vodorod ionlari konsentartsiyasidan nehca marta ortiq?

8-masala. pH = 4,8 bo'lgan sirka kislota eritmasining konsentratsiyasini hisoblang.

Geterogen sistemalarda muvozanat

Qiyin eruvchan elektrolitlarning suvli eritmalarida qattiq faza va eitma orasida muvozanat yuzaga keladi:

$$\downarrow A_aB_b \leftrightarrow aA^{b+} + bB^{a-}.$$

Bu muvozanat eruvchanlik ko'paytmasi (*EK*) deb nomlanuvchi konstanta bilan tavsiflanadi:

$$EK = [A^{b+}]^a \cdot [B^{a-}]^b.$$

Ushbu tenglama *EK* qiymati bo'yicha elektrolitning eruvchanligini (*S*, mol/l):

$$S = \sqrt[a+b]{\frac{EK}{a^a \cdot b^b}},$$

hamda elektrolitning eruvchanligi bo'yicha uning eruvchanlik ko'paytmasini (*EK*) hisoblashga imkon beradi. Bundan tashqari *EK* qiymatiga qarab cho'kmaning hosil bo'lishi yoki uning erib ketishi haqida xulosa chiqarish mumkin.

Cho'kmaning hosil bo'lish sharti: ionlar konsentratsiyasining ko'paytmasi eruvchanlik ko'paytmasidan yuqori bo'lishi kerak:

$$C^a_{A^{b+}} \cdot C^b_{B^{a-}} > EK.$$

Cho'kmaning erish sharti: ionlar konsentratsiyasining ko'paytmasi eruvchanlik ko'paytmasidan kam bo'lishi kerak:

$$C^{a}_{\mathrm{A}^{b+}} \cdot C^{b}_{\mathrm{B}^{a-}} < EK.$$

Ko'pchilik kam eruvchan elektrolitlarning *EK* qiymatlari ushbu qo'llanmaning ilovasida keltirilgan.

Yuqorida keltirilgan formulalarga muvofiq masalalrni yechishda kam eruvchan elektrolitlar va ionlar konsentartsiyasini mol/l da ifodalashni unutmaslik kerak.

1-masala. Qo'rg'oshin yodidning eruvchanlik ko'paytmasi 20 °C da $8{,}0\cdot10^{-9}$ ga teng. Tuzning eruvchanligini mol/l va g/l da hisoblang.

Yechish. Qo'rg'oshin yodidning to'yingan eritmasida cho'kma va ionlar orasida quyidagi muvozanat yuzaga keladi:

$$\downarrow PbI_2 \leftrightarrow Pb^{2+} + 2I^{-}.$$

Eruvchanlikni *S* mol/l bilan belgilaymiz. Tenglamaga muvofiq qo'rg'oshin yodidning to'yingan eritmasi *S* mol/l qo'rg'oshin ionlari va 2*S* mol/l yodid-ionlarni saqlaydi.

Unda, $EK_{PbI_2} = [Pb^{2+}]\cdot[I^{-}]^2 = S\cdot(2S^{2}) = 4S^{3}$.

Bundan, $S = \sqrt[3]{\dfrac{EK_{PbI_2}}{4}} = \sqrt[3]{8\cdot10^{-9}/4} = 1{,}3\cdot10^{-3}$ mol/l.

Qo'rg'oshin yodidning molyar massasi 461 g/mol ga teng. Unda cho'kmaning g/l da ifodalangan eruvchanligi $461\cdot1{,}3\cdot10^{-3} = 0{,}6$ ga teng bo'ladi.

2-masala. 250 ml to'yingan eritma $2{,}80\cdot10^{-5}$ g stronsiy fosfat saqlaydi. Tuzning eruvchanlik ko'paytmasini hisoblang.

Yechish. Stronsiy fosfatning to'yingan eritmasida qattiq faza va uning ionlangan qismi orasida muvozanat qaror topadi:

$$\downarrow Sr_3(PO_4)_2 \leftrightarrow 3Sr^{2+} + 2PO_4^{3-}.$$

Unda ushbu tuz uchun eruvchanlik ko'paytmasining ifodasi quyidagi ko'rinishni oladi:

$$EK_{Sr_3(PO_4)_2} = [Sr^{2+}]^3\cdot[PO_4^{3-}]^2.$$

Quyidagi proporsiyadan stronsiy fosfatning eruvchanligini g/l da hisoblaymiz:

0,25 litr eritma $2{,}80\cdot10^{-5}$ g stronsiy fosfat saqlaydi
1 litr eritma *x* g stronsiy fosfat saqlaydi

$$x = \frac{2{,}80\cdot10^{-5}\cdot1}{0{,}25} = 1{,}12\cdot10^{-4}\ \text{g/l}.$$

Hosil bo'lgan konsentratsiyani mol/l da ifodalaymiz:

$$S_x = \frac{x}{M_{Sr_3(PO_4)_2}} = \frac{1{,}12\cdot10^{-4}}{452{,}803} = 2{,}5\cdot10^{-7}\ \text{mol/l},$$

bunda $M_{Sr_3(PO_4)_2}$ – stronsiy fosfatning molyar massasi.

Stronsiy fosfatning muvozanat tenglamasidan ko'rinib turibdiki, *S* mol/l stronsiy fosfatdan 3*S* mol/l stronsiy ionlari va 2*S* mol/l fosfat-ionlar hosil bo'ladi. Unda $EK_{Sr_3(PO_4)_2} = (3S)^3(2S)^2 = 108S^5$.

S ning qiymatini *EK* tenglamasiga qo'yamiz:

$$EK = 108\cdot(2{,}5\cdot10^{-7})^5 = 0{,}7\cdot10^{-31}.$$

3-masala. Qo'rg'oshin yodidning 0,1M KI eritmasidagi eruvchanligi suvdagi eruvchanligiga nisbatan necha marta kam bo'ladi?

Yechish. Q'org'oshin yodidning suvdagi eruvchanligi 1-masalada hisoblangan. Shu tuzning 0,1M kaliy yodid eritmasidagi eruvchanligini *x* bilan belgilab, uni hisoblaymiz. Unda tenglamaga muvofiq (1-masalag qarang) qo'rg'oshin ionlarining konsentratsiyasi ham *x* ga teng bo'ladi, yodid-ionlarning konsentratsiyasi esa $2x + 0{,}1$ ni tashkil etadi. Faraz qilaylik, $2x << 0{,}1$, unda $2x$ kattalikni 0,1 ga nisbatan inobatga olmasak ham bo'ladi va $[I^-] = 0{,}1$ mol/l.

Qo'rg'oshin ionlari va yodid-ionlarning olingan konsentratsiya qiymatlarini *EK* ni topish tenglamasiga qo'yamiz:

$$EK_{PbI_2} = x\cdot(0{,}1)^2.$$

Bundan, $x = \dfrac{EK_{PbI_2}}{(0{,}1)^2} = \dfrac{8\cdot10^{-9}}{0{,}01} = 8\cdot10^{-7}$ mol/l.

Binobarin, kaliy yodid ishtirokida qo'rg'oshin yodidning eruvchanligi $1{,}3\cdot10^{-3}/8\cdot10^{-7} = 1{,}6\cdot10^3$ marta kamayadi

4-masala. $5\cdot10^{-3}$M kalsiy xlorid va natriy sulfat eritmalarining teng hajmlari qo'shildi. Kalsiy sulfat cho'kmasi hosil bo'ladimi ($EK_{CaSO_4} = 2{,}5\cdot10^{-5}$)?

Yechish. Bu savolga javob berish uchun $C_{Ca^{2+}}$ va $C_{SO_4^{2-}}$ ionlar konsentratsiyalarining ko'paytmasini kalsiy sulfatning eruvchanlik ko'paytmasi bilan taqqoslash kerak, ya'ni $C_{Ca^{2+}}\cdot C_{SO_4^{2-}} > EK_{CaSO_4}$ shartning bajarilishini tekshirish kerak.

Kalsiy xlorid va natriy sulfat eritmalarining teng hajmlari qo'shilganda Ca^{2+} va SO_4^{2-} ionlarining konsentratsiyalari boshlang'ich qiymatlariga nisbatan ikki marta kamayadi va $2{,}5\cdot10^{-3}$ mol/l ga teng bo'ladi. Unda $C_{Ca^{2+}}\cdot C_{SO_4^{2-}} = 2{,}5\cdot10^{-3}\cdot2{,}5\cdot10^{-3} = 6{,}25\cdot10^{-6}$, ya'ni hosil bo'lgan qiymat EK_{CaSO_4} dan kichik, demak cho'kma hosil bo'lmaydi.

Mustaqil echish uchun masalalar

5-masala. 1,16 g PbI_2 ni eritish uchun 2 litr suv talab etildi. Tuzning eruvchanlik ko'paytmasini hisoblang.

6-masala. 2 g bariy sulfatni 25 °C da eritish uchun zarur bo'ladigan suvning hajmini hisoblang.

7-masala. Agar 0,1M qo'rg'oshin nitrat eritmasiga teng hajmda 0,3M natriy xlorid eritmasi qo'shilsa, qo'rg'oshin xlorid cho'kmasi hosil bo'ladimi?

8-masala. Kalsiy ftoridning 0,05M kalsiy xlorid eritmasidagi eruvchanligi suvdagi eruvchanligiga nisbatan qanday o'zgaradi ($EK_{CaF_2} = 4\cdot10^{-11}$)?

9-masala. Magniy gidroksidning eruvchanlik ko'paytmasi $6\cdot10^{-10}$ ga teng. $1{,}6\cdot10^{-4}$M magniy xlorid eritmasidan pH ning qanday qiymatida magniy gidroksid cho'kishni boshlaydi?

Gidrolizlanadigan tuzlar eritmalarida muvozanat

Ko'pchilik tuzlar suvda eriganda gidrolizga uchraydi, natijada eritmaning muhitini kislotali yoki ishqoriy bo'lishiga olib keladi.

Agar gidrolizga kuchsiz asos va kuchli kislotadan tarkib topgan tuz (masalan, NH_4Cl) uchrasa, muhit kislotali bo'ladi. Kuchsiz kislota va kuchli asosdan tarkib topgan tuz (masalan, CH_3COOK) gidrolizga uchrasa, eritma muhiti ishqoriy bo'ladi. Kuchsiz asos va kuchsiz kislotadan tarkib topgan tuz gidrolizga uchraganda esa, muhit neytral (masalan, CH_3COONH_4 gidrolizlanganda), kuchsiz ishqoriy (NH_4CN) yoki kuchsiz kislotali (NH_4F) bo'ladi.

Masalalarni yechishda gidrolizlanadigan tuz qaysi turga mansub ekanligini aniqlab olish zarur hamda ionlar va tuzlar konsentratsiyalarini mol/lda ifodalashni unutmaslik kerak (jadvalga qarang).

GIDROLIZ PARAMETRLARINI HISOBLASH JADVALI

Tuz	**Gidroliz konstantasi, K_g**	**Gidroliz darajasi, h**	**$[H^+]$**	**$[OH^-]$**
Kuchli kislota va kuchsiz asosdan hosil bo'lgan tuz	$\frac{K_w}{K_b}$	$\sqrt{\frac{K_w}{K_b \cdot C_{BA}}}$	$\sqrt{\frac{K_w \cdot C_{BA}}{K_b}}$	$\sqrt{\frac{K_w \cdot K_b}{C_{BA}}}$
Kuchsiz kislota va kuchli asosdan hosil bo'lgan tuz	$\frac{K_w}{K_a}$	$\sqrt{\frac{K_w}{K_a \cdot C_{BA}}}$	$\sqrt{\frac{K_w \cdot K_a}{C_{BA}}}$	$\sqrt{\frac{K_w \cdot C_{BA}}{K_a}}$
Kuchsiz kislota va kuchsiz asosdan hosil bo'lgan tuz	$\frac{K_w}{K_a \cdot K_b}$	$\frac{\sqrt{\frac{K_w}{K_a \cdot K_b}}}{1+\sqrt{\frac{K_w}{K_a \cdot K_b}}}$	$\sqrt{\frac{K_w \cdot K_a}{K_b}}$	$\sqrt{\frac{K_w \cdot K_b}{K_a}}$

Izoh: K_w – suvning ion ko'paytmasi,

C_{BA} – tuzning konsentratsiyasi, mol/l.

1-masala. 100 ml da 0,9814 g tuz saqlagan kaliy atsetat eritmasining gidroliz darajasini va pH qiymatini hisoblang.

Yechish. Kaliy atsetat quyidagi tenglama bo'yicha dissotsilanadi:

$$CH_3COOK \leftrightarrow CH_3COO^- + K^+.$$

Kaliy atsetat kuchsiz kislota va kuchli asosdan tarkib topgan tuz bo'lgani sababli, gidroliz anion bo'yicha boradi:

$$CH_3COO^- + H_2O \leftrightarrow CH_3COOH + OH^-.$$

Gidroliz darajasi $h = \sqrt{\frac{K_w}{K_a \cdot C_{BA}}}$ formula asosida aniqlanadi.

Tuzning konsentartsiyasini mol/l da hisoblaymiz:

$$C_{tuz} = \frac{m}{M \cdot V} = \frac{0{,}9814}{98{,}143 \cdot 0{,}1} = 0{,}1 \text{ mol/l},$$

bunda m – tuz massasi, g; V – eritma hajmi, ml; M – tuzning molyar massasi, g/mol.

Kislotaning ionlanish konstantasini jadvaldan topamiz: $K_{CH_3COOH} = 1{,}74 \cdot 10^{-5}$. Olingan qiymatlarni gidroliz darajasini topish formulasiga qo'yamiz:

$$h = \sqrt{\frac{1 \cdot 10^{-14}}{1{,}74 \cdot 10^{-5} \cdot 0{,}1}} = 7{,}58 \cdot 10^{-5} \approx 7{,}6 \cdot 10^{-5}.$$

Atsetat-ionlarning gidrolizlanish tenglamasidan ko'rinadiki, hosil bo'ladigan gidroksid-ionlarning konsentratsiyasi atsetat-ionlarning konsentratsiyasiga teng. Demak, $[OH^-] = [CH_3COO^-] = h \cdot C_{tuz} = 7{,}6 \cdot 10^{-5} \cdot 0{,}1 = 7{,}6 \cdot 10^{-6}$ mol/l.

Bundan, $pOH = -\lg 7{,}6 \cdot 10^{-6} = 5{,}12$ va $pH = 14 - 5{,}12 = 8{,}88$.

2-masala. Ammoniy xloridning gidroliz konstantasini va uning 0,1 mol/l eritmasining pH ini hisoblang.

Yechish. Ammoniy xlorid quyidagi tenglama bo'yicha dissotsilanadi:

$$NH_4Cl \rightarrow NH_4^+ + Cl^-.$$

Ushbu tuz kuchsiz asos va kuchli kislotadan tarkib topganligi uchun, gidroliz kation bo'yicha boradi:

$$NH_4^+ + H_2O \leftrightarrow NH_3 \cdot H_2O + H^+.$$

Bunday turdagi tuzlarning gidroliz konstantasini hisoblashda quyidagi formuladan foydalaniladi:

$$K_g = \frac{K_w}{K_{NH_3 \cdot H_2O}} = \frac{10^{-14}}{1{,}76 \cdot 10^{-5}} = 5{,}68 \cdot 10^{-10}.$$

Amminiy xlorid eritmasidagi $[H^+]$ ning konsentatsiyasini $[H^+] = \sqrt{K_g \cdot C_{tuz}}$ formula bo'yicha topamiz:

$$[H^+] = \sqrt{5{,}68 \cdot 10^{-10} \cdot 0{,}1} = 7{,}63 \cdot 10^{-6} \text{ mol/l}.$$

$$pH = -\lg 7{,}63 \cdot 10^{-6} = 5{,}12.$$

3-masala. Ammoniy atsetat eritmasi 25°C dan 60°C gacha qizdirilganda, uning gidroliz darajasi necha marta ortadi? (60°C da $K_w = 10^{-13}$. Sirka kislota va ammoniy gidroksidlarning ionlanish konstantalari harorat ko'tarilishi bilan o'zgarmaydi deb qabul qilinadi.)

Yechish. Ammoniy atsetat quyidagicha ionlanadi:

$$CH_3COONH_4 \rightarrow CH_3COO^- + NH_4^+.$$

Bu tuz kuchsiz asos va kuchsiz kislotadan hosil bo'lgani uchun, gidroliz kation va anion bo'yicha boradi:

$$CH_3COO^- + NH_4^+ + H_2O \leftrightarrow CH_3COOH + NH_3 \cdot H_2O.$$

Bunday tuzlarning gidroliz darajasini topish uchun yuqoridagi jadvalda berilgan formuladan foydalanish kerak:

$$h = \frac{\sqrt{\frac{K_w}{K_a \cdot K_b}}}{1 + \sqrt{\frac{K_w}{K_a \cdot K_b}}}.$$

Gidroliz darajalarni masala shartida berilgan haroratlarda hisoblaymiz:

25°C $$h_{25^\circ C} = \frac{\sqrt{\frac{10^{-14}}{1{,}74 \cdot 10^{-5} \cdot 1{,}76 \cdot 10^{-5}}}}{1 + \sqrt{\frac{10^{-14}}{1{,}74 \cdot 10^{-5} \cdot 1{,}76 \cdot 10^{-5}}}} = 5{,}74 \cdot 10^{-3};$$

60°C $$h_{60^\circ C} = \frac{\sqrt{\frac{10^{-13}}{1{,}74 \cdot 10^{-5} \cdot 1{,}76 \cdot 10^{-5}}}}{1 + \sqrt{\frac{10^{-13}}{1{,}74 \cdot 10^{-5} \cdot 1{,}76 \cdot 10^{-5}}}} = 1{,}82 \cdot 10^{-2}.$$

Binobarin, gidroliz darajasi $\frac{h_{60^\circ C}}{h_{25^\circ C}} = \frac{1{,}82 \cdot 10^{-2}}{5{,}74 \cdot 10^{-3}} = 3{,}17$ marta ortgan.

Mustaqil yechish uchun masalalar

4-masala. 0,01M ammoniy xlorid eritmasining gidroliz konstantasini va pH ini hisoblang.

5-masala. 0,001M KOCl eritmasining 25°C va 60°C da pH ini va gidroliz darajasi necha marta ortishini hisoblang. (Suvning ion ko'paytmasi 60°C da 10^{-13} ga teng, gipoxlorit kislotaning ionlanish konstantasi harorat ko'tarilganda o'zgarmaydi deb qabul qilinsin.)

6-masala. pH = 5,12 bo'lgan 100 ml eritma bo'lishi uchun necha gramm ammoniy xlorid tuzidan olich kerak?

Bufer eritmalarda muvozanat

Keng ma'noda bufer sistemalarga quyidagicha ta'rif berish mumkin: tarkib o'zgarganda qandaydir parametrlarni muayyan qiymatlarda saqlab turuvchi sistemalar. Bufer eritmalar kislota-asosli (eritmaga kislota yoki asos kiritilganda pH ning qiymatini doimiy saqlab turuvchi); oksidlanish-qaytarishli (oksidlovchi yoki qytaruvchi kiritilganda sistemaning potensialini doimiy saqlab turuvchi); metallobuferlar

(pMe qiymatini doimiy saqlab turuvchi) kabi turlarga bo'linadi. Bufer eritmalar tutash juftlardan, xususan kislota-asosli buferlar kislota-asos juftidan tarkib topgan sistemalar hisoblanadi. Masalan, atsetatli bifer eritma CH_3COOH va CH_3COONa; ammoniyli bufer eritma $NH_3 \cdot H_2O$ va NH_4Cl; fosfatli bufer eritma NaH_2PO_4 va Na_2HPO_4 dan iborat aralashmalardir.

Kuchsiz kislota va uning tuzidan iborat bufer eritmalarning pH qiymati quyidagi tenglama bo'yicha hisoblanadi:

$$\mathrm{pH} = \mathrm{p}K_{\mathrm{a}} - \lg \frac{C_{\text{kislota}}}{C_{\text{tuz}}}.$$

Kuchsiz asos va uning tuzidan iborat bufer eritmalarning pH qiymati quyidagi tenglama bo'yicha aniqlanadi:

$$\mathrm{pOH} = \mathrm{p}K_{\mathrm{b}} + \lg \frac{C_{\text{asos}}}{C_{\text{tuz}}};$$

$$\mathrm{pH} = 14 - \mathrm{p}K_{\mathrm{b}} + \lg \frac{C_{\text{asos}}}{C_{\text{tuz}}}.$$

Agar bufer aralashma ikki asosli kislotaning o'rta tuzi (B_2A) va nordon tuzidan (BHA) tarkib topgan bo'lsa, unda

$$\mathrm{pH} = \mathrm{p}K_{\mathrm{a}_2} + \lg \frac{C_{\mathrm{A}^{2-}}}{C_{\mathrm{HA}^{-}}},$$

bunda $\tilde{N}_{\grave{A}^{2-}}$ va $\tilde{N}_{\acute{I}\grave{A}^{-}}$ – B_2A va BHA tuzlarning konsentratsiyasi; $\mathrm{p}K_{\mathrm{a}_2}$ – kislotaning ikkinchi bosqich bo'yicha dissotsilanish konstantasi.

Agar bufer aralashma uch asosli kislotaning nordon tuzlaridan (B_2HA, BH_2A) iborat bo'lsa, unda pH ni hisoblash uchun quyidagi tenglamadan foydalanish kerak:

$$\mathrm{pH} = \mathrm{p}K_{\mathrm{a}} + \lg \frac{C_{\mathrm{HA}^{2-}}}{C_{\mathrm{H_2A}^{-}}}.$$

1-masala. 1 litr eritmada har bir komponentdan 0,2 mol saqlagan atsetatli bufer aralashmaning pH ini hisoblang. Aralashmaga: a) 0,01 mol HCl; b) 0,01 mol NaOH qo'shilganda pH qanday o'zgaradi?

Yechish. Atsetatli bufer aralashma tarkibiga CH_3COOH va CH_3COONa kiradi:

CH_3COOH F $CH_3COO^- + H^+$ (kuchsiz elektrolit; ionlanishi qaytar);

$CH_3COONa \rightarrow CH_3COO^- + Na^+$ (kuchli elektrolit; to'liq dissotsilanadi).

CH_3COO^- ionlari ishtirokida sirka kislotaning ionlanishi yanada kamayib ketadi. Shuning uchun kislotaning ionlanmagan qismi konsentratsiyasini uning boshlang'ich konsentratsiyasiga teng deb olish mumkin, ya'ni $[CH_3COOH] = C_{\text{kislota}}$.

Eritmadagi atsetat-ionlarning deyarli barchasi tuzning dissotsilanishi natijasida hosil bo'ladi, ya'ni $[CH_3COO^-] = C_{\text{tuz}}$.

$$\eth\acute{I} = \eth K_{\grave{a}} - \lg \frac{C_{\text{kislota}}}{C_{\text{tuz}}}; \quad \mathrm{pH} = 4{,}76 - \lg \frac{0{,}2}{0{,}2} = 4{,}76.$$

a) agar 0,01 mol HCl qo'shilsa, HCl va CH_3COONa orasida reaksiya boradi:

$$CH_3COO^- + H^+ \leftrightarrow CH_3COOH,$$

natijada sirka kislotaning konsentratsiyasi ortadi va 0,2 + 0,01 = 0,21 mol/l ga teng bo'ladi, tuzning konsentartsiyasi esa, aksincha, kamayadi: 0,2 – 0,01 = 0,19 mol/l

$$pH = 4{,}76 - \lg\frac{0{,}21}{0{,}19} = 4{,}72.$$

b) agar eritmaga 0,01 mol NaOH qo'shilsa, unda NaOH va CH_3COOH orasida reaksiya boradi:

$$CH_3COOH + OH^- \leftrightarrow CH_3COO^- + H_2O,$$

natijada sirka kislotaning konsentratsiyasi 0,2 – 0,01 = 0,19 mol/l ga, tuzning konsentartsiyasi esa 0,2 + 0,01 = 0,21 mol/l ga teng bo'ladi

$$pH = 4{,}76 - \lg\frac{0{,}19}{0{,}21} = 4{,}80.$$

2-masala. Ammiak va ammoniy xloridning 0,1M eritmalaridan 1:9 nisbatda tayyorlangan bufer aralashmaning pH ini aniqlang.($K_{NH_3\cdot H_2O} = 1{,}8\cdot10^{-5}$; tuz to'liq dissotsilangan deb hisoblansin.)

Yechish. Ammiak va ammoniy xloridning 0,1M eritmalaridan 1:9 nisbatda (1 + 9 = 10 qism) aralashtirilganligini e'tiborga olib, ular eritmalarining konsentratsiyasini aniqlaymiz:

$$x = \frac{0{,}1\cdot1}{10} = 0{,}01\text{M NaOH};$$

$$x = \frac{0{,}1\cdot9}{10} = 0{,}09\text{M } NH_4Cl.$$

Quyidagi tenglama bo'yicha bufer aralashmaning pH ini aniqlaymiz:

$$pH = 14 - pK_{NH_3\cdot H_2O} + \lg\frac{C_{NH_3\cdot H_2O}}{C_{NH_4Cl}};$$

$$pH = 14 - (5 + 0{,}2553) + \lg\frac{0{,}01}{0{,}09} = 14 - 4{,}7447 - 0{,}9547 = 8{,}3006 \approx 8{,}30.$$

3-masala. 30 ml 0,1M Na_2CO_3 va 15 ml 0,1M $NaHCO_3$ eritmalari aralashtirilganda hosil bo'lgan eritmaning pH ini aniqlang. $K_{2(H_2CO_3)} = 4{,}69\cdot10^{-11}$

Yechish. Tuzlar eritmalari aralashtirilishidan hosil bo'lgan eritmada quyidagi muvozanat o'rnatiladi:

$$HCO_3^- + H_2O \leftrightarrow CO_3^{2-} + H_3O^+.$$

Eritmadagi H_3O^+ ionlarini H^+ ioni bilan ifodalaymiz. Hosil bo'lgan eritmadagi CO_3^2 va HCO_3^- ionlari konsentratsiyasini topamiz:

$$C_2(Na_2CO_3) = \frac{C_1(Na_2CO_3)\cdot V_1(Na_2CO_3)}{V_1(Na_2CO_3) + V_1(NaHCO_3)} = \frac{0{,}1\cdot30}{30+15} = 0{,}0667 \approx 6{,}67\cdot10^{-2}\text{ M};$$

$$C_2(\mathrm{NaHCO_3}) = \frac{C_1(\mathrm{NaHCO_3}) \cdot V_1(\mathrm{NaHCO_3})}{V_1(\mathrm{Na_2CO_3}) + V_1(\mathrm{NaHCO_3})} = \frac{0{,}1 \cdot 15}{30 + 15} = 0{,}0333 \approx 3{,}33 \cdot 10^{-2}\,\mathrm{M};$$

$$\mathrm{p}K_2 = -\lg K_{2(\mathrm{H_2CO_3})} = -\lg 4{,}69 \cdot 10^{-11} = 10{,}33.$$

Bufer eritmaning pH qiymatini topsak:

$$\mathrm{pH} = \mathrm{p}K_{2(\mathrm{H_2CO_3})} + \lg \frac{C_{\mathrm{CO_3^{2-}}}}{C_{\mathrm{HCO_3^-}}} = 10{,}33 + \lg \frac{6{,}67 \cdot 10^{-2}}{3{,}33 \cdot 10^{-2}} = 10{,}33 + 0{,}3 = 10{,}63.$$

Bufer ta'siri bufer sig'imi (π) bilan xarakterlanadi. Bufer sig'imi eritma pH ini bir birlikka o'zgartirish uchun unga qo'shish zarur bo'lgan kuchli asos (b) yoki kuchli kislota (a) miqdori bilan o'lchanadi.

$$\pi = \frac{\Delta C_\mathrm{b}}{\Delta \mathrm{pH}};$$

$$\pi = -\frac{\Delta C_\mathrm{a}}{\Delta \mathrm{pH}}.$$

bunda ΔC_b, ΔC_a – bufer sistemaga qo'shilgan tegishli asos yoki kislotaning konsentratsiyasi.

Kuchsiz kislota (HA) va uning tuzi (BA) ni saqlagan eritmaning eng yuqori bufer ta'siri sohasida bufer sig'imi quyidagi tenglama bilan ifodalanadi:

$$\pi = \frac{2{,}3 \cdot C \cdot K_\mathrm{a} \cdot [\mathrm{H^+}]}{(K_\mathrm{a} + [\mathrm{H^+}])^2}, \text{ yoki}$$

$$\pi = 2{,}3\frac{C_\mathrm{HA} C_{\mathrm{A^-}}}{C} = 2{,}3\frac{C_\mathrm{HA} C_{\mathrm{A^-}}}{C_\mathrm{HA} + C_{\mathrm{A^-}}};$$

bunda C_HA va $C_{\mathrm{A^-}}$ – kislota-asosli juft komponentlarining konsentartsiyasi; C – eritmaning umumiy konsentratsiyasi ($C = [\mathrm{HA}] + [\mathrm{A^-}]$).

Kuchsiz asos va uning tuzidan iborat eritmaning bufer sig'imi quyidagi formula bo'yicha aniqlanadi:

$$\pi = \frac{2{,}3 \cdot C \cdot K_\mathrm{b} \cdot [\mathrm{H^+}]}{(K_\mathrm{b} + [\mathrm{H^+}])^2}.$$

4-masala. pH = 4 bo'lgan va 1,140M CH_3COOH hamda 0,205M CH_3COONa dan tarkib topgan eritmaning bufer sig'imini hisoblang. $K_{\mathrm{CH_3COOH}} = 1{,}74 \cdot 10^{-5}$.

Yechish. Komponentlarning umumiy konsentratsiyasini topamiz:

$$C = 1{,}140 + 0{,}205 = 1{,}345 \text{ mol/l}.$$

Qiymatlarni quyidagi formulaga qo'yib, eritmaning bufer sig'imini aniqlaymiz:

$$\pi = \frac{2{,}3 \cdot C \cdot K_\mathrm{a} \cdot [\mathrm{H^+}]}{(K_\mathrm{a} + [\mathrm{H^+}])^2} = \frac{2{,}3 \cdot 1{,}345 \cdot 1{,}74 \cdot 10^{-5} \cdot 1 \cdot 10^{-4}}{(1{,}74 \cdot 10^{-5} + 1 \cdot 10^{-4})^2} = 0{,}39.$$

5-masala. Ammoniy xlorid va ammiak eritmalaridan tayyorlangan bufer eritmaning pH = 10 ga teng. Agar eritmaning umumiy konsentratsiyasi C = 0,337 mol/l bo'lsa, uning bufer sig'imini hisoblang. $K_{NH_3} = 1{,}76 \cdot 10^{-5}$.

Yechish. Ammiak eritmasi suvda quyidagicha dissotsilanadi:

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-.$$

Ammoniy ionining dissotsilanish konstantasi:

$$K_{NH_4^+} = \frac{1 \cdot 10^{-14}}{K_{NH_3}} = \frac{1 \cdot 10^{-14}}{1{,}76 \cdot 10^{-5}} = 5{,}68 \cdot 10^{-10} \text{ ga teng.}$$

$$\pi = \frac{2{,}3 \cdot 0{,}337 \cdot 5{,}68 \cdot 10^{-10} 1 \cdot 10^{-10}}{(1 \cdot 10^{-10} + 5{,}68 \cdot 10^{-10})^2} = 0{,}1.$$

Mustaqil yechish uchun masalalar

6-masala. 1 litrda 0,2M CH_3COONa va 0,2M CH_3COOH saqlagan bufer eritmaning pH ini hisoblang. Bu eritmaga 0,01M HCl qo'shilganda pH qanday o'zgaradi?

7-masala. 1 litr benzoatli bufer aralashma 0,35 mol C_6H_5COOH va 0,35 mol C_6H_5COONa saqlaydi. Bufer aralashmaning pH ini hisoblang.

8-masala. 25 ml 0,1M CH_3COOH eritmasiga 25 ml 0,1M CH_3COONa eritmasi qo'shildi. Hosil bo'lgan eritmaning pH ini hisoblang. Eritmaga 0,01M NaOH qo'shilganda pH qanday o'zgaradi?

9-masala. 1 litrda 0,5 mol $NH_3 \cdot H_2O$ va 0,5 mol NH_4Cl saqlagan ammoniyli bufer eritmaning pH ini hisoblang. 0,2M NaOH qo'shilganda pH qanday o'zgaradi?

10-masala. 0,4M CH_3COOH va 0,15M CH_3COONa saqlagan bufer eritmada pH = 4,35. Bu eritmaning bufer sig'imini hisoblang.

11-masala. π = 0,3 va pH = 5,0 bo'lgan bufer eritma tayyorlash uchun 2M NaOH va 2M CH_3COOH eritmalaridan necha ml dan olish kerak?

Kompleks birikmalarning eritmalarida muvozanat

Komplekslar – bu markaziy atom (kompleks hosil qiluvchi) va ligandlar deb nomlanuvchi ionlardan (yoki neytral molekulalardan) tarkib topgan kimyoviy birikmalardir.

Kompleks hosil bo'lish reaksiyalarining muvozanatini tavsiflashda eritmadagi ionlar doim solvatlangan holda bo'lishini e'tiborga olish kerak. Shuning uchun komplekslarning hosil bo'lishini erituvchi molekulalarining (S) ligand ionlari yoki neytral molekulalarga (L) bosqichma-bosqich almashinadi deb qarash mumkin:

$$MS_n + L = MS_{n-1}L + S$$
$$MS_{n-1}L + L = MS_{n-2}L_2 + S$$
$$\overline{MSL_{n-1} + L = ML_n + S}$$

Suyiltirilgan eritmalarda erituvchining aktivligi amalda doimiy va ionlarni solvatlovchi erituvchi molekulalarining soni doim ma'lum bo'lgani uchun kompleks eritmalardagi muvozanatni odatda quyidagi ko'rinishlarda ifodalash mumkin:

Bosqichli	**Umumiy**
$M + L = ML$	$M + L = ML$
$ML + L = ML_2$	$M + 2L = ML_2$
$ML_{n-1} + L = ML_n$	$M + nL = ML_n$

Massalar ta’siri qonuniga binoan komplekslarning bosqichli hosil bo’lishi tegishli termodinamik bosqichli barqarorlik konstantalari bilan ifodalanadi:

$$K_1^0 = \frac{a_{ML}}{a_M \cdot a_L};$$

$$K_2^0 = \frac{a_{ML_2}}{a_{ML} \cdot a_L};$$

$$K_n^0 = \frac{a_{ML_n}}{a_{M_{n-1}} \cdot a_L}.$$

Umumiy muvozanatning tegishli konstantalari umumiy barqarorlik konstantalari deb nomlanadi va β simvoli bilan belgilanadi:

$$\beta_1^0 = K_1^0 = \frac{a_{ML}}{a_M \cdot a_L};$$

$$\beta_2^0 = K_1^0 K_2^0 = \frac{a_{ML_2}}{a_{ML} \cdot a_L^2};$$

$$\beta_n^0 = K_1^0 K_2^0 ... K_n^0 = \frac{a_{ML_n}}{a_M \cdot a_L^n}.$$

Barqarorlik konstantaga teskari miqdor kompleksning beqarorlik konstantasi yoki kompleksning ionlarga parchalanish konstantasi deyiladi. Bu konstantaning qiymati qancha katta bo’lsa, berilgan kompleks shunchalik kuchli dissotsilanadi va shunchalik beqaror bo’ladi.

$$K_{beqar.} = \frac{[M][L]^n}{[ML_n]}$$

Barqarorlik va beqarorlik konstantalari orasida quyidagi nisbat mavjud:

$$K_{beqar.} = \frac{1}{K_{barqar.}} = \frac{1}{\beta}$$

1-masala. 0,05M $[Ag(NH_3)_2]Cl$ eritmasida kumush ionlari va ammiak molekulalarining muvozanat konsentartsiyalarini hisoblang.

Yechish. Tuzning dissotsilanishini quyidagi tenglamalar bilan ifodalash mumkin:

$$[Ag(NH_3)_2]Cl \rightarrow [Ag(NH_3)_2]^+ + Cl^- \quad (1)$$

$$[Ag(NH_3)_2]^+ \leftrightarrow Ag^+ + 2NH_3 \quad (2)$$

Ikkinchi qaytar jarayon uchun beqarorlik konstantasining ifodasini yozamiz:

$$K_{\text{beqar.}} = \frac{[Ag^+][NH_3]^2}{[[Ag(NH_3)_2]^+]}.$$

Jadvaldan komplek ionning barqarorlik konstantasini topamiz: lgβ = 7,23; binobarin, $\beta = 10^{7,23} = 1,7 \cdot 10^7$,

$$K_{\text{beqar.}} = \frac{1}{\beta} = 5,9 \cdot 10^{-8}.$$

$[Ag^+]$ ni *x* mol/l bilan belgilaymiz, unda (2) tenglamaga muvofiq $[NH_3] = 2x$ mol/l, $[Ag(NH_3)_2]^+$ esa $C - x$ mol/l ga teng bo'ladi. Bu qiymatlarni kompleksning beqarorlik konstantasi ifodasiga qo'yamiz:

$$K_{\text{beqar.}} = \frac{x \cdot (2x)^2}{C - x} = \frac{4x^3}{C - x}.$$

Kompleks ionning kam dissotsilanishini inobatga olsak, uning konsentartsiyasini doimiy deb qabul qilishimiz mumkin:

$$K_{\text{beqar.}} = \frac{4x^3}{C}.$$

Bundan, $x = \sqrt[3]{\frac{K_{\text{beqar.}} \cdot C}{4}} = \sqrt[3]{\frac{5,9 \cdot 10^{-8} \cdot 0,05}{4}} = 0,9 \cdot 10^{-3}$;

$$[Ag^+] = x = 0,9 \cdot 10^{-3} \text{ mol/l};$$

$$[NH_3] = 2x = 2 \cdot 0,9 \cdot 10^{-3} = 1,8 \cdot 10^{-3} \text{ mol/l}.$$

2-masala. 0,5M KI saqlagan 0,01M K_2HgI_4 eritmasidagi simob (II) ionlarining muvozanat konsentratsiyasini hisoblang.

Yechish. Kompleks ionning dissotsilanishi quyidagi tenglama asosida boradi:

$$HgI_4^{2-} \rightleftarrows Hg^{2+} + 4I^-$$

Jadvaldan HgI_4^{2-} kompleksi uchun $lg\beta_4 = 30,18$; $\beta_4 = 1,51 \cdot 10^{30}$ ekanligini aniqlaymiz. Bundan:

$$\beta_4 = \frac{[HgI_4^{2-}]}{[Hg^{2+}][I^-]^4} = 1,51 \cdot 10^{30}.$$

Bu kompleks barqaror bo'lganligi uchun uning dissotsilanishini hisobga olmasa ham bo'ladi, HgI_4^{2-} ning konsentratsiyasini esa K_2HgI_4 tuzining umumiy konsentratsiyasiga (0,01M) teng deb olish mumkin. I^- ning muvozanat konsentratsiyasini ortiqcha miqdorda olingan KI ning umumiy konsentratsiyasiga teng deb hisoblasak, unda:

$$[Hg^{2+}] = \frac{[HgI_4^{2-}]}{\beta_4[I^-]^4} = \frac{10^{-2}}{1,51 \cdot 10^{30} \cdot (0,5)^4} = 1,06 \cdot 10^{-31} \text{M}.$$

Mustaqil yechish uchun masalalar

3-masala. 0,1M $[Cu(NH_3)_4]SO_4$ eritmasida $[Cu^{2+}]$ va $[NH_3]$ ni hisoblang.

4-masala. 0,05M $K_3[Fe(CN)_6]$ eritmasida $[Fe^{3+}]$, $[CN^-]$ va $[K^+]$ ni hisoblang.

5-masala. 10 ml 0,25M kumush nitrat eritmasiga 40 ml 0,5M kaliy sianid eritmasi qo'shildi. Aralashmadagi $[Ag^+]$ ning muvozanat konsentratsiyasini hisoblang.

6-masala. 0,1M $K_2[Cd(CN)_4]$ va 0,1M $[Cd(NH_3)_4]SO_4$ eritmalarning qaysi birida $[Cd^{2+}]$ ionlarining konsentratsiyasi yuqori bo'ladi?

Oksidlanish-qaytarilish jarayonlari

Oksidlanish-qaytarilish reaksiyalari – elektronlar ishtirokida boradigan va reaksiyaga kirishuvchi elementlarning oksidlanish darajalari o'zgarishi bilan boradigan reaksiyalardir:

$$Ox_1 + ne \rightarrow Red_1$$
$$Red_2 - ne \rightarrow Ox_2$$
$$\overline{Ox_1 + Red_2 = Red_1 + Ox_2}$$

Elektronlarni berish va qabul qilish qobiliyati turli moddalarda turlichadir. Bu qobiliyatni baholash uchun reaksiyaning muvozanat konstantasi xizmat qiladi:

$$K = \frac{[Ox_2][Red_1]}{[Ox_1][Red_2]}.$$

Moddalarning oksiddlanish-qaytarilish xossalarini ifodalashda boshqa kattalik – potensialdan ko'proq foydalaniladi. Elektronlarning ko'chishida elektr toki hosil bo'ladi, binobarin, kimyoviy reaksiya energiyasini elektr energiyaga o'zgartirish mumkin. Bunday jarayonlar galvanik elementlarda sodir bo'ladi. Shuning uchun oksidlanish-qaytarilish reaksiyalarini muvozanat konstantasi bilan emas, balki galvanik elementning elektr yurituvchi kuchi – potensiali bilan tavsiflash mumkin.

Oksidlanish-qaytarilish potensialining konsentratsiya va haroratga bog'liqligi Nernst tenglamasi bilan hisoblanadi:

$$E = E^\circ + \frac{RT}{nF} \ln \frac{[Ox]^n}{[Red]^m},$$

bunda E – sistemaning redoks potensiali, V; E° - sistemaning standart redoks potensiali*, V; T – harorat, K; n – oksidlanish-qaytarilish reaksiyasida ishtirok etuvchi elektronlar; R – universal gaz doimiysi, 8,312 J/(mol·K); F – Faradey doimiysi, 96500 Kl; $[Ox]^n$, $[Red]^m$ – stexiometrik koeffitsiyentlarda olingan oksidlovchi va qaytaruvchining konsentartsiyasi.

Tenglamaga doimiyliklarning son qiymatlarini qo'yib, natural logarifmni o'nli logarimf bilan almashtirsak, tenglama quyidagi ko'rinishni oladi:

$$E = E^\circ + \frac{0{,}059}{n} \lg \frac{[Ox]^n}{[Red]^m}.$$

* Sistemaning standart redoks potensiali – bu yarim reaksiya ishtirokchilarining barchasi standart holatda (ya'ni aktivliklar 1 ga teng bo'lgan holatda), eritilgan moddalar esa standart eritmada bo'lgan sistemaning potensiali.

Agar oksidlanish-qaytarilish reaksiyasi vodorod protonlari ishtirokida borsa, unda massalar ta'siri qonuniga binoan vodorod ionlarining konsentartsiyasi ko'payishi bilan reaksiyaning tezligi ortadi.

Bunday holda sistemaning redoks potensiali ham ortadi. Masalan, quyidagi yarim reaksiyalarda bu yaqqol namoyon bo'ladi:

$$+3e + MnO_4^- + 4H^+ \rightarrow MnO_2\downarrow + 2H_2O \quad (1)$$

$$E = E^\circ + \frac{0{,}059}{3}\lg[MnO_4^-]\cdot[H^+]^4 \quad (25°C\ da)$$

$$+5e + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O \quad (2)$$

$$E = E^\circ + \frac{0{,}059}{3}\lg\frac{[MnO_4^-]\cdot[H^+]^8}{[Mn^{2+}]} \quad (25°C\ da)$$

$E°$ kattaligi ko'p jihatdan kislota konsentartsiyasiga bog'liq bo'ladi va konsentrlangan H_2SO_4 ishtirokida uning qiymati +1,51 V dan +1,9 V gacha ortib ketadi (2-reaksiya).

H^+ yoki OH^- ionlar konsentratsiyasining o'zgarishi nafaqat redoks-potensialning o'zgarishiga, balki reaksiya yo'nalishiga ham ta'sir etadi. Masalan, arsenit-ionlarning yod bilan reaksiyasi faqat natriy gidrokarbonat muhitida (pH = 9) borishi mumkin:

$-2e + AsO_2^- + 4OH^- \rightarrow AsO_4^{3-} + 2H_2O$	1	$E° = -0{,}71$ V
$+2e + [I_3]^- \rightarrow 3I^-$	1	$E° = 0{,}545$ V
$AsO_2^- + [I_3]^- + 4OH^- \rightarrow AsO_4^{3-} + 3I^- + 2H_2O$		

Kislotali muhitda esa bunday reaksiya bormaydi, chunki $E^\circ_{H_3AsO_4/HAsO_2} = 0{,}56$ V qiymat $E^\circ_{[I_3]^-/3I^-} = 0{,}545$ V dan katta va shuning uchun reaksiya yo'nalishi o'zgaradi:

$+2e + H_3AsO_4 + 2H^+ \rightarrow HAsO_2 + 2H_2O$	1	$E° = 0{,}56$ V
$-2e + 3I^- \rightarrow [I_3]^-$	1	$E° = 0{,}545$ V
$AsO_2^- + [I_3]^- + 4OH^- \rightarrow AsO_4^{3-} + 3I^- + 2H_2O$		

Oksidlanish-qaytarilish reaksiyalarining tezligiga reagentlar konsentratsiyasi, eritma muhiti va haroratdan tashqari kattalizatorlar ham jiddiy ta'sir ko'rsatadi. Katalizator sifatida begona modda yoki reaksiya mahsulotlaridan biri xizmat qilishi mumkin. Masalan, permanganat-ionlarning oksalat kislota bilan Mn^{2+} gacha qaytarilish reaksiyasining katalizatori marganes (II) kationlari, ya'ni reaksiya mahsuloti hisoblanadi.

Oksidlanish-qaytarilish reaksiyalarining to'liq borishi quyidagi faktrolarga bog'liq bo'ladi:

• reaksiyaning elektr yurituvchi kuchi (E.Yu.K) – o'zaro ta'sir etuvchi sistema potensiallarining farqi; odatda E.Yu.K. 0,4 V dan katta bo'lgan reaksiyalar boradi.

• quyidagi tenglamalar bilan hisoblanadigan redoks reaksiyaning muvozanat konstantasi:

$$K = 10^a, \text{ bu yerda } a = \frac{n(E_1^\circ - E_2^\circ)}{0{,}059} \quad (25°C\ da)$$

yoki

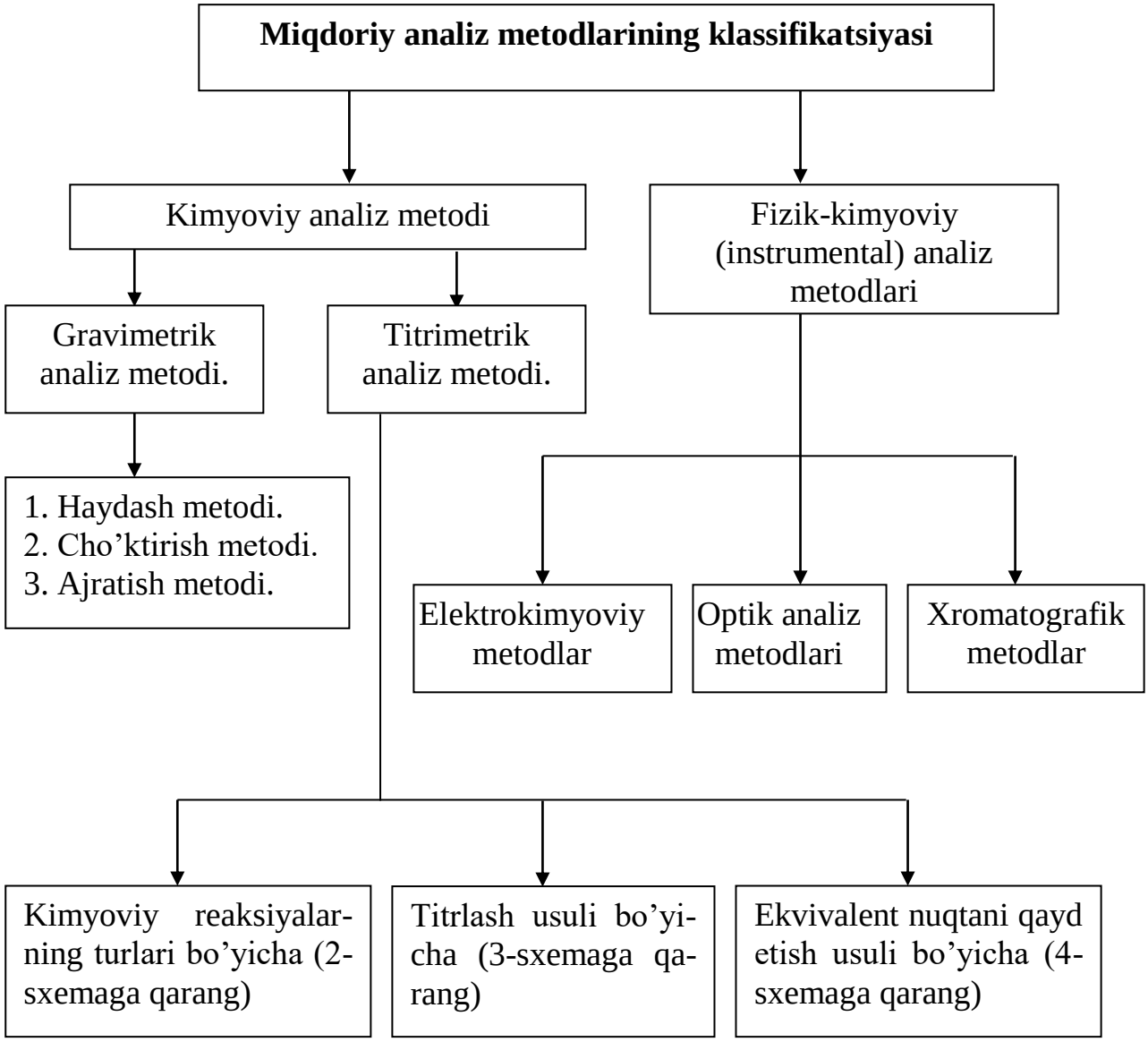
$$\lg K = \frac{n(E_1^\circ - E_2^\circ)}{0{,}059},$$

bunda, n – jarayonda ishtirok etuvchi elektronlar soni; E_1°, E_2° – tegishlicha oksidlovchi va qaytaruvchining standart redoks-potensiallari.

MIQDORIY ANALIZ

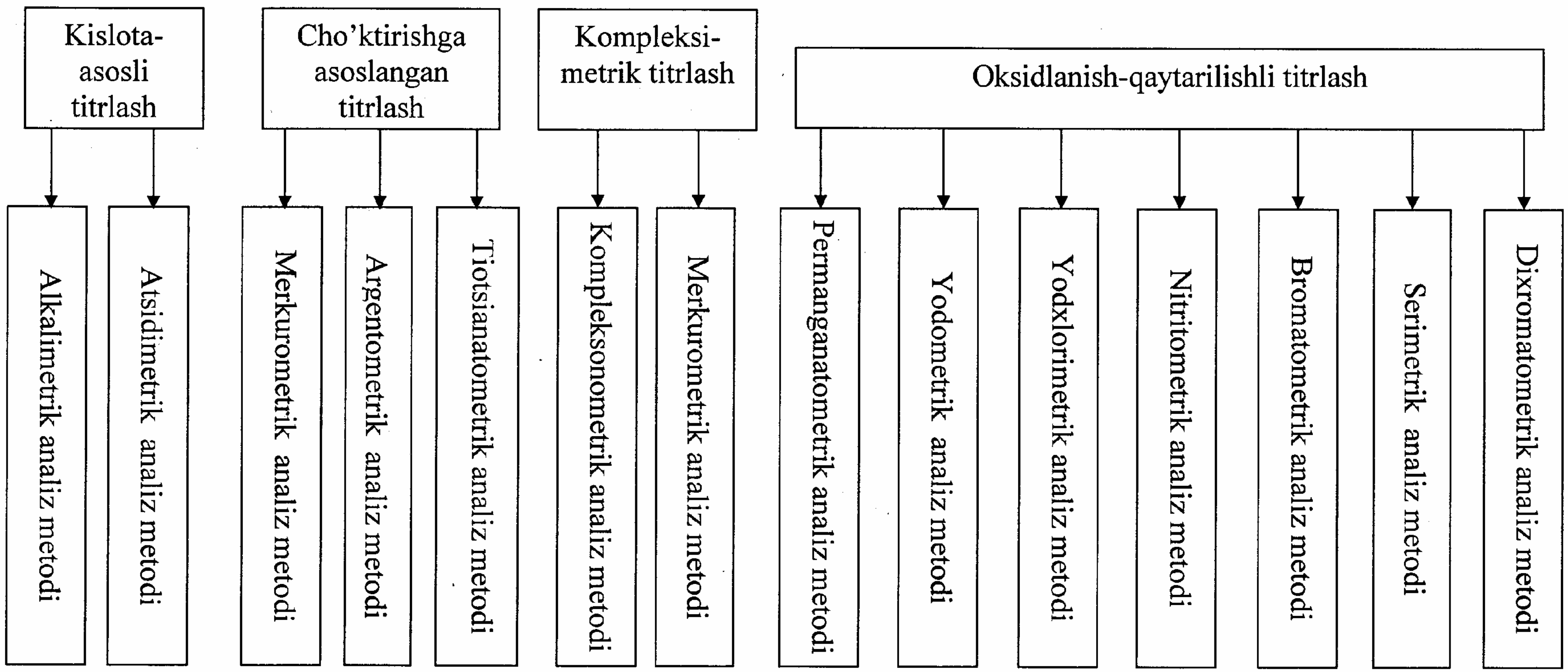
1-*sxema*

MIQDORIY ANALIZ USULLARINING KLASSIFIKATSIYASI



2-sxema

KIMYOVIY REAKSIYALARNING TURLARI BO'YICHA TITRIMETRIK ANALIZ METODLARINING KLASSIFIKATSIYASI



3-sxema

TITRLASH USULI BO'YICHA TITRIMETRIK ANALIZ METODLARINING KLASSIFIKATSIYASI

To'g'ri titrlash	**Teskari titrlash**	**Bilvosita titrlash**
Aniqlanuvchi modda eritmasiga bevosita titrant eritmasi qo'shiladi.	Aniqlanuvchi modda eritmasiga aniq konsentratsiyali titrant eritmasidan mo'l miqdor qo'shiladi, uning ortiqcha miqdori ikkinchi titrant bilan titrlanadi.	Aniqlanuvchi modda eritmasiga yordamchi reagent qo'shiladi, natijada ekvivalent miqdorda yangi modda hosil bo'ladi. Uni asosiy titrant bilan titrlab, aniqlovchi moddaning konsentratsiyasi aniqlanadi.
Misol: $H_2C_2O_4 + 2NaOH \rightleftarrows$ $\rightleftarrows Na_2C_2O_4 + 2H_2O$	Misol: $CH_3COOH + NaOH(mo'l) \rightleftarrows$ $\rightleftarrows CH_3COONa + H_2O$ $NaOH(qoldiq) + HCl \rightleftarrows NaCl + H_2O$	Misol: $+6e + Cr_2O_7^{2-} + 14H^+ \rightleftarrows 2Cr^{3+} + 7H_2O$ | 1 $-2e + 3I^- \rightleftarrows [I_3]^-$ | 3 $C_2O_7^{2-} + 14H^+ + 9I^- \rightarrow 2Cr^{3+} + 7H_2O + 3[I_3]^-$ $-2e + [I_3]^- \rightleftarrows 3I^-$ $-2e + 2S_2O_3^{2-} \rightleftarrows S_4O_6^{2-}$ $[I_3]^- + 2S_2O_3^{2-} \rightarrow 3I^- + S_4O_6^{2-}$

4-sxema

EKVIVALENT NUQTANI QAYD ETISH USULI BO'YICHA TITRIMETRIK ANALIZ METODLARINING KLASSIFIKATSIYASI

- **Indikatorsiz analiz metodlari**
  - Cho'ktirishga asoslangan titrlash, argentometriya
  - Oksidlanish-qaytarilishli titrlash, permanganometriya, dixromatometriya, yodxlorimetriya , serimetriya, yodometriya
  - Kompleksimetrik titrlash: merkurimetriya: I^- ionlarini aniqlash
- **Indikatorli analiz metodlari**
  - Spetsifik bo'lmagan indikatorlarning qo'llanilishi
    - Oksidlanish-qaytarilishli titrlash, bromatometriya: metiloranj va boshq.
    - Yodometriya: kraxmal
  - Spetsifik indikatorlarning qo'llanilishi
    - Oksidlanish-qaytarilishli titrlash: redoks indikatorlar
    - Kompleksonometrik titrlash: metalloxrom indikatorlar
    - Cho'ktirishga asoslangan titrlash: Mor metodi – K_2CrO_4, Folgard metodi – $(NH_4)_2Fe(SO_4)_2$, Fayans metodi – adsorbsion indikatorlar, merkurometriya metodi – difenilkarbazon, $[Fe(NCS)_3]$
    - Kislota-asosli titrlash – pH-indikatorlar

1-*jadval*

GRAVIMETRIK ANALIZ METODI

Gravimetrik analiz metodi moddaning erkin yoki muayyan tarkibli birikma ko'rinishida ajratib olingan tarkibiy qismlari massasining aniq o'lchanishiga asoslangan		
Cho'ktirish metodlari	**Haydash metodlari**	
	Haydash metodlarida aniqlanuvchi komponent uchuvchan birikma ko'rinishida miqdoriy haydaladi	
	Bevosita haydash metodlari	**Bilvosita haydash metodlari**
Cho'ktirish metodlarida aniqlanuvchi komponent muayyan tarkibli qiyin eruvchan kimyoviy birikma ko'rinishida miqdoriy cho'ktiriladi. *Masalan*, – SO_4^{2-} ni aniqlashda ular Ba^{2+} ionlari bilan cho'ktiriladi: $Ba^{2+} + SO_4^{2-} \rightarrow \underset{\text{cho'ktirilgan shakl}}{BaSO_4\downarrow}$ – qizdirilgandan keyin: $BaSO_4\downarrow \xrightarrow{\Delta} \underset{\text{gravimetrik shakl}}{BaSO_4}$ Bu holda cho'ktirilgan va gravimetrik shakllar mos tushadi.	Agar haydalgan mahsulot massasi bevosita o'lchansa, bunday usul bevosita haydash deb aytiladi. *Masalan*, kalsiy karbonat tortimining parchalanishidan hosil bo'lgan CO_2 ni aniqlash: $CaCO_3\downarrow + 2H^+ \xrightarrow{\Delta} CO_2\uparrow + Ca^{2+} + H_2O$ $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$ CO_2 ning miqdori natron ohaki (NaOH + CaO) bilan to'ldirilgan yutivchi nay massasining ortishiga qarab hisoblanadi	Agar haydalgan mahsulot massasi haydashgacha va haydashdan keyingi namuna massasining farqiga qarab aniqlansa, bunday usul bilvosita haydash deb aytiladi. *Masalan*, moddalarning namligini, kristallogidratlardagi kristallizatsion suvni aniqlash: $BaCl_2 \cdot 2H_2O \xrightarrow{\Delta} BaCl_2 + H_2O\uparrow$

1-*jadvalning davomi*

– Ca^{2+} ionlarini aniqlashda ular ammoniy oksalat bilan cho'ktiriladi: $Ca^{2+} + C_2O_4^{2-} \rightarrow \underset{\text{cho'ktirilgan shakl}}{CaC_2O_4\downarrow}$ – qizdirilganda keyin: $CaC_2O_4\downarrow \xrightarrow{\Delta} CO_2\uparrow + CO\uparrow + \underset{\text{gravimetrik shakl}}{CaO}$ Cho'ktirish metodi bo'yicha natijalarni hisoblash: $\omega, \% = \frac{m_{\text{gr.shakl}} \cdot F \cdot 100}{m_t},$ bunda: ω – aniqlanuvchi moddaning miqdori, %; $m_{\text{gr.shakl}}$ – garvimetrik shaklning massasi, g; F – gravimetrik faktor; m_t – analiz uchun olingan modda tortimining massasi, g.	Bevosita haydash metodi bo'yicha analiz natijalarini hisoblash: $\omega, \% = \frac{m_{\text{gr.shakl}} \cdot 100}{m_t},$ bunda: ω – aniqlanuvchi moddaning miqdori, %; m_t – analiz uchun olingan modda tortimining massasi, g; $m_{\text{gr.shakl}}$ –yutuvchi nay massasining ortishi bo'yicha aniqlanadigan garvimetrik shaklning massasi, g;	Bilvosita haydash metodi bo'yicha analiz natijalarini hisoblash: $\omega, \% = \frac{(m_t \cdot m_{\text{gr.shakl}}) \cdot 100}{m_t},$ bunda: ω – aniqlanuvchi moddaning miqdori, %; m_t – analiz uchun olingan modda tortimining massasi, g; $m_{\text{gr.shakl}}$ – analiz uchun olingan moddaning quritilgandan yoki qizdirilgandan keyingi massasi, g;

2-jadval

KISLOTA-ASOSLI TITRLASH

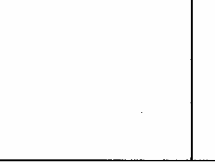
Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
0,1M - 0,001M HCl, H_2SO_4 va bosh. kislotalarning eritmalari (atsidimetriya)	Kislota - asosli indikatorlar (masalan, metiloranj, fenolftalein)	Standart moddalar ($Na_2B_4O_7 \cdot 10H_2O$, Na_2CO_3, K_2CO_3). Standart eritmalar (NaOH, KOH, $Ba(OH)_2$)	Bu metod bilan quyidagilar aniqlanadi • kuchli kislota va asoslar; • kuchsiz kislota va asoslar, $K_i \geq 5 \cdot 10^{-7}$; • kuchli kislota va kuchsiz asosdan ($K_b \leq 5 \cdot 10^{-7}$) yoki kuchli asos va kuchsiz kislotadan ($K_a \leq 5 \cdot 10^{-7}$) tarkib topgan tuzlar.	1. Reaksiya mahsulotlari yoki titrlash egri chiziqlari bo'yicha indikatorni to'g'ri tanlash. 2. Ekvivalent nuqtaga yaqinlashganda titrlashni sekin o'tkazish. 3. $t = 20 - 25°C$	$H^+ + OH^- \rightleftarrows HOH$ Masalan, to'g'ri titrlash: $Na_2CO_3 + HCl \xrightarrow{f.f.} NaHCO_3 + NaCl$ $Na_2CO_3 + 2HCl \xrightarrow{m.o.} NaCl + CO_2\uparrow + H_2O$ teskari titlash: $CH_3COOH + NaOH_{(mo'l)} \rightleftarrows CH_3COONa + H_2O$ $NaOH_{(qoldiq)} + HCl \rightleftarrows NaCl + H_2O$
0,1M - 0,001M KOH, NaOH va bosh. ishqorlarning eritmalari (alkalimetriya)		Standart moddalar ($H_2C_2O_4 \cdot 2H_2O$, $H_2C_2H_4O_6$). Standart eritmalar (HCl, H_2SO_4)			

3-jadval

CHO'KTIRISHGA ASOSLANGAN TITRLASH

Metodning nomi	**Titrant**	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
Mor metodi bo'yicha argentometrik titrlash	0,1M yoki 0,05M $AgNO_3$ eritmasi	5%-li K_2CrO_4	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^- va Br^- aniqlanadi	1. pH 6,3 – 10,5; 2. Ba^{2+}, CO_3^{2-}, Pb^{2+}, Hg_2^{2+}, PO_4^{3-} bo'lmasligi kerak (titrant yoki indikator bilan cho'kma hosil qiladi)	$Ag^+ + Cl^- \rightarrow AgCl\downarrow$ $2Ag^+ + CrO_4^{2-} \rightarrow$ $\rightarrow Ag_2CrO_4\downarrow$
Folgard metodi bo'yicha argentometrik titrlash (rodanometriya)	To'g'ri titrlash: 0,05M yoki 0,1M NH_4NCS, KNCS yoki $AgNO_3$ eritmalari Teskari tirlash: yuqorida ko'rsatilgan titrantlar	$(NH_4)_2[Fe(SO_4)_2]$ ning to'yingan eritmasi	$AgNO_3$, KCl va NaCl, KNCS larning standart eritmalari	To'g'ri titrlashda: Ag^+, Hg^{2+} hamda KNCS titrant eritmasi bilan Br^-, I^- aniqlanadi; Teskari titrlashda: Cl^-, Br^-, I^-, S^{2-}, AsO_4^{3-}, CO_3^{2-} $C_2O_4^{2-}$, NCS^-, CN^-, PO_4^{3-}, CrO_4^{2-} aniqlanadi	1. Titrlash kislotali muhitda o'tkaziladi; 2. Hg(I) tuzlari va F^- ionlari bo'lmasligi kerak; 3. I^- ionini aniqlashda indikatorni titrlashni oxirida qo'shish kerak; 4. Cl^- ionlarini aniqlashda CCl_4, $CHCl_3$ qo'shiladi yoki $AgNO_3$ filtrlab olinadi	To'g'ri titrlash: $Ag^+ + NCS^- \rightarrow$ $\rightarrow AgNCS\downarrow$ $3NCS^- + Fe^{3+} \rightarrow$ $\rightarrow [Fe(NCS)_3]\downarrow$ Teskari titrlash: $Ag^+ + Cl^- \rightarrow AgCl\downarrow$ $Ag^+ + NCS^- \rightarrow$ $\rightarrow AgNCS\downarrow$ $3NCS^- + Fe^{3+} \rightarrow$ $\rightarrow [Fe(NCS)_3]\downarrow$

3-jadvalning davomi

Fayans-Xodakov metodi bo'yicha argentometrik titrlash	0,1M yoki 0,05M $AgNO_3$ eritmasi	Adsorbsion indikatorlar: eozin, fluoressein va boshqalar	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^-, NCS^- aniqlanadi	Qo'llaniladigan indikatorga qarab titrlash pH ning muayyan qiymatlarida o'tkaziladi	$Ag^+ + I^- \rightarrow AgI\downarrow$
Merkurometrik metod	0,1M $Hg_2(NO_3)_2$ eritmasi	Temir (III)-rodanit $[Fe(NCS)_3]$, difenilkarbazon 	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^- aniqlanadi	Titrlash kislotali muhitda o'tkaziladi	$Hg_2^{2+} + 2Cl^- \rightarrow Hg_2Cl_2\downarrow$

4-jadval

MERKURIMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart modda-lar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
HNO_3 dagi 0,1M $Hg(NO_3)_2$ eritmasi	Natriy nitroprusid $Na_2[Fe(CN)_5NO]$, difenilkarbazid yoki difenilkarba-zon eritmalari, I^- ni aniqlashda indikator qo'lla-nilmaydi	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^-, NCS^-, CN^- aniqlanadi	Titrlash kislotali (HNO_3) muhitda o'tkaziladi	$Hg^{2+} + 2Cl^- \rightarrow$ $\rightarrow [HgCl_2]$ $Hg^{2+} + 2Br^- \rightarrow$ $\rightarrow [HgBr_2]$ $Hg^{2+} + 2NCS^- \rightarrow$ $\rightarrow [HgNCS_2]$ $Hg^{2+}+[Fe(CN)_5NO]^{2-}$ $\rightarrow Hg[Fe(CN)_5NO]\downarrow$ yoki Hg^{2+} ning difenilkarbazid yoki difenilkarbazon bilan rangli komplekslari $Hg^{2+} + 4I^- \rightarrow$ $\rightarrow [HgI_2]^{2-}$ $[HgI_2]^{2-} + Hg^{2+} \rightarrow$ $\rightarrow 2HgI_2\downarrow$

5-jadval

KOMPLEKSONOMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart modda-lar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
To'g'ri titrlash: 0,05M-0,1M trilon B (Na_2H_2L) eritmasi	Metalloxrom indikatorlar: erioxrom qora T, mureksid va boshqalar	Standart moddalar: Zn, ZnO, $CaCO_3$. Standart eritmalar: $ZnSO_4$, $MgSO_4$	Cu^{2+}, Co^{2+}, Pb^{2+}, Ni^{2+}, Sr^{2+}, Fe^{3+}, Al^{3+}, Ba^{2+}, Zn^{2+}, Ca^{2+}, Mg^{2+} va bosh. aniqlanadi	Titrlash pH ning muay-yan qiymat-larida o'tka-ziladi	$H_2L^{2-} + Me^{2+} \rightarrow [MeL]^{2-} + 2H^+$ Me^{2+} kationlarini saqlagan eritmaga ammiakli bufer eritma, indikator qo'shiladi va trilon B ning standart eritmasi bilan rang o'zgar-gunicha titrlanadi.
Teskari tirlash: 1. 0,05M-0,1M trilon B eritmasi 2. 0,05M-0,1M $MgSO_4$ yoki $ZnSO_4$ eritmalari			1. Maxsus indikator-lar mavjud emas. 2. Kationlar cho'k-masi bufer eritmada hosil bo'ladi. 3. Kompleks hosil bo'lishi sekin boradi. 4. Suvda erimaydigan cho'kmalar (CaC_2O_4, $MgNH_4PO_4$) dagi ka-tionlar aniqlanadi	Titrlash pH ning muay-yan qiymat-larida o'tka-ziladi	$H_2L^{2-}_{(mo'l)} + Me^{2+} \rightarrow [MeL]^{2-} + H^+$ $H_2L^{2-}_{(qoldiq)} + Mg^{2+} \rightarrow [MgL]^{2-} + H^+$ Metall kationlarini saqlagan eritmaga mo'l miqdorda tri-lon B eritmasi qo'shiladi va uning ortiqchasi metallo-xrom indikatori ishtirokida magniy tuzlari eritmasi bi-lan titrlanadi

5-jadvalning davomi

Bilvosita titrlash: 0,05M-0,1M trilon B eritmasi			Metallar aniqlanadi	–//–	$Me^{2+} + [MgL]^{2-} \rightarrow Mg^{2+} + + [MeL]^{2-}$ $H_2L^{2-} + Mg^{2+} \rightarrow [MgL]^{2-} + + H^+$ Eritmaga trilon B ning rux yoki magniy bilan kompleksidan mo'l miqdorda kiritiladi. Aniqlanuvchi kation mustahkamroq kompleks hosil qilib, ekvivalent miqdorda Zn^{2+} yoki Mg^{2+} ni ajratadi va ular trilon B eritmasi bilan yana titrlanadi
Kislota-asosli titrlash 1. 0,05M trilon B eritmasi; 2. 0,1M KOH (NaOH) eritmasi	Kislota-asosli indikatorlar		Metallar aniqlanadi		$H_2L^{2-} + Me^{2+} \rightarrow [MeL]^{2-} + + 2H^+$ $2H^+ + 2OH^- \rightarrow 2H_2O$

5-*sxema*

OKSIDLANISH-QAYTARISHLI TITRLASH USULLARI

Oksidlanish-qaytarishli titrlash usullari

Oksidimetriya

Bu usul oksidlovchilarning standart eritmalari bilan titrlab qaytaruvchilarni aniqlashga asoslangan:

p e r m a n g a n a t o m e t r i y a

(titrant – $KMnO_4$),

b r o m a t o m e t r i y a

(titrant – $KBrO_3$),

d i x r o m a t o m e t r i y a

(titrant – $K_2Cr_2O_7$),

y o d o m e t r i y a

(titrant – KI dagi I_2),

y o d x l o r i m e t r i y a

(titrant – ICl),

n i t r i t o m e t r i y a

(titrnat – $NaNO_2$),

s e r i m e t r i y a

(titrant – Ce^{4+} tuzlarining eritmalari)

va boshqalar

Reduktometriya

Bu usul qaytaruvchilarning standart eritmalari bilan titrlab oksidlovchilarni aniqlashga asoslangan:

y o d o m e t r i y a

(titrant – $Na_2S_2O_3$),

n i t r i t o m e t r i y a

(titrant – $NaNO_2$),

g i d r a z i n o m e t r i y a

(titrant – $N_2H_4 \cdot H_2SO_4$),

a s k o r b i n o m e t r i y a

(titrant – $C_6H_8O_6$),

f e r r o m e t r i y a

(titrant – $FeSO_4$) va boshqalar

6-jadval

PERMANGANATOMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M-0,05M $KMnO_4$ eritmasi	1. Indikatorsiz: – bir tomchi titrantning qo'shilishidan 30 sekund davomida yo'qolmaydigan pushti rangning paydo bo'lishi; 2. Indikatorli: – redoksindikatorlar, masalan ferroin	$H_2C_2O_4 \cdot 2H_2O$, $Na_2C_2O_4$, As_2O_3, Fe (met.), $(NH_4)_2Fe(SO_4)_2 \times 6H_2O$. Standart eritmalar $H_2C_2O_4$ va $NaAsO_2$	Quyidagilar aniqlanadi: 1) qaytaruvchilar: to'g'ri titrlash bilan $C_2O_4^{2-}$, Fe^{2+}, H_2O_2, NO_2^-; teskari yoki bilvosita titrlash bilan – Ca^{2+}. 2) oksidlovchilar: teskari titrlash bilan – MnO_2, PbO_2, $K_2Cr_2O_7$, $S_2O_8^{2-}$ (2-standart eritma – $H_2C_2O_4$, $NaAsO_2$); bilvosita titrlash bilan Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}.	Titrlash a) kuchli kislotali muhitda (H_2SO_4); b) qizdirilganda (t = 60-70°C) yoki xona haroratida o'tkaziladi. Titrlash sekin o'tkaziladi, har bir keyingi tomchi oldingisi rangsizlangandan keyin qo'shiladi.	$+5e + MnO_4^- + 8H^+ = Mn^+ + 4H_2O$ $E° = 1,51$ V. Teskari tirlash metodi bilan Ca^{2+} ni aniqlash 1. $Ca^{2+} + C_2O_4^{2-}{}_{(mo'l)} \rightarrow CaC_2O_4\downarrow +$ $+ C_2O_4^{2-}{}_{(qoldiq)}$ 2. $-2e + C_2O_4^{2-} \rightarrow 2CO_2\uparrow$ | 5 $+5e + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$ | 2 $2MnO_4^- + C_2O_4^{2-}{}_{(qoldiq)} + 16H^+ \rightarrow$ $\rightarrow 2Mn^{2+} + 8H_2O + 10CO_2\uparrow$ Bilvosita titrlash metodi bilan Ca^{2+} ni aniqlash 1. $Ca^{2+} + C_2O_4^{2-} \rightarrow CaC_2O_4\downarrow$ 2. $CaC_2O_4\downarrow + 2H^+ \rightarrow H_2C_2O_4 +$ $+ Ca^{2+}$ 3. $-2e + H_2C_2O_4 \rightarrow 2CO_2\uparrow + 2H^+$ | 5 $+5e + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O$ | 2 $2MnO_4^- + 5H_2C_2O_4 + 16H^+ \rightarrow 2Mn^{2+}$ $+ 8H_2O + 10CO_2\uparrow$

7-jadval

YODOMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
1. 0,1M-0,05M I_2 ning KI dagi eritmasi 2. $Na_2S_2O_3$ eritmasi	1. Indikatorsiz: titrantning (I_2) ortiqcha tomchisi eritma rangini och-sariqqa kiritadi.	As_2O_3, $N_2H_4 \cdot H_2SO_4$, BaS_2O_3. Standart eritmalar: $Na_2S_2O_3$, I_2 ning KI dagi eritmasi	Quyidagilar aniqlandi: 1) $N_2S_2O_3$ eritmasi yordamida to'g'ri titrlash bilan – oksidlovchilar (I_2); 2) I_2 ning KI dagi eritmasi yordamida to'g'ri titrlash bilan – qaytaruvchilar ($Na_2S_2O_3$, As_2O_3); 3) bilvosita titrlash bilan – kuchli oksidlovchilar Cl_2 $KBrO_3$, H_2O_2;	1. Titrlash sovuqda o'tkaziladi, chunki I_2 uchuvchan va indikator – kraxmalning sezgirligi pasayadi. 2. Titrlash neytral, kuchsiz kislotali yoki kuchsiz ishqoriy muhitda o'tkaziladi. a) kuchli ishqoriy muhitda yod disproporsiyalanadi $I_2 + 2OH^- \rightarrow IO^- + I^- + H_2O$; b) kuchli kislotali muhitda qo'shimcha reaksiyalar boradi $4I^- + O_2 + 4H^+ \xrightarrow{h\nu} 2I_2 + 2H_2O$ $S_2O_3^{2-} + 2H^+ \rightarrow SO_2\uparrow + S\downarrow + H_2O$	1) $+2e + [I_3]^- \rightarrow 3I^-$ | 1 $-2e + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-}$ | 1 $[I_3]^- + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 3I^-$ 2) $-2e + AsO_3^{3-} + 2OH^- \rightarrow AsO_4^{3-} + H_2O$ | 1 $+2e + [I_3]^- \rightarrow 3I^-$ | 1 $AsO_3^{3-} + [I_3]^- + 2OH^- \rightarrow AsO_4^{3-} + 3I^- + H_2O$ 3) $+6e + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$ | 1 $-2e + 3I^- \rightarrow [I_3]^-$ | 3 $Cr_2O_7^{2-} + 14H^+ + 9I^- \rightarrow 2Cr^{3+} + 7H_2O + 3[I_3]^-$

7-jadvalning davomi

1. 0,1M-0,05M $Na_2S_2O_3$ eritmasi	2. Indikatorli: 0,5%-li kraxmal eritmasi	$K_2Cr_2O_7$, $KBrO_3$, KIO_3, $K_3[Fe(CN)_6]$ va I_2 ning KI dagi, $KMnO_4$ standart eritmalar	4) to'g'ri titrlash bilan – kuchli kislotalar, teskari titrlash bilan – kuchsiz kislotalar; 5) aromatik va geterotsiklik birikmalar (fenol, difenol va aromatik aminlar;) 6) to'yinmagan uglevodorodlar	3. Bilvosita titrlash metodi bilan kuchli oksidlovchilarni aniqlashda ajralib chiqayotgan yodni eritish uchun KI eritmasidan qo'shib turish kerak: $I_2 + I^- \rightarrow [I_3]^-$; KI ni qo'shgandan keyin reaksion aralashma 10-15 min qorong'i joyda saqlanadi	4) $+10e + 2IO_3^- + 12H^+ \rightarrow I_2 + 6H_2O \mid 1$ $-2e + 2I^- \rightarrow I_2 \mid 5$ $IO_3^- + 6H^+ + 5I^- \rightarrow 3I_2 + 3H_2O$ $3I_2 + 3I^- \rightarrow 3[I_3]^-$ $IO_3^- + 6H^+ + 8I^- \rightarrow 3[I_3]^- + 3H_2O$

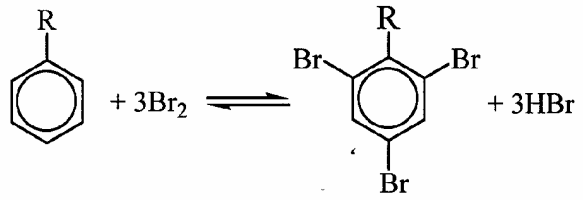
8-jadval

YODXLORIMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
0,1M ICl eritmasi	1. Kraxmal eritmasi 2. Indikatorsiz: ajralib chiqadigan yod eritmani och-sariq rangga bo'yaydi	As_2O_3, $N_2H_4 \cdot H_2SO_4$, $K_4[Fe(CN)_6]$ va KI, $Na_2S_2O_3$ standart eritmalari	Quyidagilar aniqlanadi: 1) to'g'ri titrlash bilan – Sn^{2+}, NCS^- SO_3^{2-}, antipirin, askorbin kislota; 2) teskari titrlash bilan – Hg^{2+}, Fe^{2+}; 3) bilvosita titrlash bilan – KI	Titrlash kislotali (HCl) muhitda o'tkaziladi	Titrantni tayyorlash $-2e + I^- + Cl^- \rightarrow ICl$ | 2 $+4e + IO_3^- + 6H^+ + Cl^- \rightarrow ICl + 3H_2O$ | 1 $2I^- + IO_3^- + 6H^+ + 3Cl^- \rightarrow 3ICl + 3H_2O$ $+2e + ICl \rightarrow I^- + Cl^-$ $E^\circ = +0{,}795$ V ($E \leq 0{,}4$ V da) $+2e + 2ICl \rightarrow I_2 + 2Cl^-$ $E^\circ = +1{,}06$ V ($E \leq 0{,}6$ V da) $-2e + SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+$ | 1 $+2e + ICl \rightarrow I^- + Cl^-$ | 1 $SO_3^{2-} + H_2O + ICl \rightarrow SO_4^{2-} + 2H^+ + Cl^- + I^-$ $ICl + 2I^- \rightarrow [I_3]^- + Cl^-$

9-jadval

BROMATOMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
0,1M $KBrO_3$ eritmasi	Kislota-asosli indikatorlar (metil qizil, metiloranj).	Standart modda As_2O_3. Standart eritma $Na_2S_2O_3$	Quyidagilar aniqlanadi: a) bevosita oksidlash yo'li bilan $N_2H_4 \cdot H_2SO_4$, Sb^{III}, Sn^{2+}, As^{III}, As_2O_3 kabi qaytaruvchilar; b) bromlash yo'li bilan fenol, rezorsin (teskari titrlash), salitsil kislota; c) aromatik aminlar, masalan streptotsid	Kislotali muhit	a) $+6e + BrO_3^- + H^+ \rightarrow Br^- + 3H_2O$ 2 $E° = 1{,}45$ V $-4e + AsO_3^- + H_2O \rightarrow AsO_4^{3-} + 2H^+$ 1 $E° = 0{,}56$ V $BrO_3^- + 3AsO_3^{3-} \rightarrow Br^- + 3AsO_4^{2-}$ b) $-2e + 2Br^- \rightarrow Br_2$ 5 $E° = 1{,}087$ V $+10e + 2BrO_3^- + 12H^+ \rightarrow Br_2 + 3H_2O$ 1 $E° = 1{,}52$ V $BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$  bunda R = –OH; –NH_2

10-*jadval*

NITRITOMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M; 0,05M $NaNO_2$ eritmasi	1. Tashqi: yod-kraxmalli qog'oz 2. Ichki: difenil-amin, tropeolin-00, neytral qizil va uning metilen ko'k bilan aralashmasi	*p*-Aminobenzoy kislota, sulfanil kislota, gidrazin sulfat. Standart eritmalar: $KMnO_4$ (teskari titrlash), gidrazin sulfat	Quyidagilar aniqlanadi: a) oksidlovchilar: $KMnO_4$, Ce^{IV}, Cl_2, H_2O_2; b) qaytaruvchilar: sulfanil kislota, gidrazin sulfat, Sn^{2+}, Fe^{2+}, As_2O_3; c) birlamchi va ikkilamchi aminlar (streptotsid, norsulfazol, sulfatsil va boshqalar)	1. Kislotali muhit (HCl ning mo'l miqdori). 2. "Sovuqda" yoki t=20-25°C da. 3. Sekin titrlanadi, ayniqsa titrlash oxirida. 4. Katalizator sifatida KBr qo'shiladi.	a) Oksidlanish: $-2e + HNO_2 + H_2O \rightarrow NO_3^- + 3H^+$ $E° = 0,94$ V. b) Qaytarilish: $+6e + 2HNO_2 + 6H^+ \rightleftarrows N_2\uparrow + 4H_2O$ $E° = 1,44$ V. c) Diazotirlash: $R–NH_2 + NaNO_2 + 2HCl \rightleftarrows$ $\rightleftarrows [R–N^+\equiv N]Cl^- + NaCl + 2H_2O$ d) Nitrozirlash: $R–NH–R' + NaNO_2 + HCl \rightarrow$ $\rightarrow R–N(NO)R' + NaCl + H_2O$

11-*jadval*

XROMATOMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
0,1M, 0,05M K_2CrO_4 eritmasi	1. Redoks indikatorlar: difenilamin, *o*-sulfokislota, difenilantranil kislota. 2. Indikatorsiz (Cr^{3+} – yashil rang; $Cr_2O_7^{2-}$ – sariq). 3. Tashqi indikator – yodkraxmal qog'oz	Standart modda: $(NH_4)_2Fe(SO_4)_2\times$ $\times 6H_2O$. Standart eritma: $Na_2S_2O_3$ (yodometrik metod bilan standartlashtiriladi)	Quyidagilar aniqlanadi: 1) teskari titrlash bilan – SO_3^{2-}, I^-, Fe^{2+}, Sn^{2+}, AsO_3^{3-}, $[Fe(CN)_6]^{4-}$, metanol, askorbin kislota; 2) kam eruvchan xromatlar (Ba^{2+}, Pb^{2+}, Ag^+); 3) Fe^{2+} tuzlari ta'sirida qaytarilgan oksidlovchilar	Titrlash kislotali muhitda o'tkaziladi (HCl, H_2SO_4, H_3PO_4)	$E°(Cr_2O_7^{2-}/Cr^{3+}) = +1{,}33$ V 1) $-e + Fe^{2+} \rightarrow Fe^{3+} \mid 6$ $+6e + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O \mid 1$ $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ 2) $Ba^{2+} + CrO_4^{2-} \rightarrow BaCrO_4\downarrow$ $2BaCrO_4\downarrow + 4H^+ \rightarrow 2Ba^{2+} + Cr_2O_7^{2-} + 2H_2O$ $Cr_2O_7^{2-}$ ionlari Fe^{2+} bilan titrlanadi 3) $3Fe^{2+} + NO_3^- + 4H^+ \rightarrow 3Fe^{3+} + NO\uparrow + 2H_2O$ $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

12-*jadval*

SERIMETRIK TITRLASH

Titrant	**Indikatorlar**	**Standart moddalar va standart eritmalar**	**Metodning imkoniyatlari**	**Titrlash shartlari**	**Reaksiya tenglamalari**
0,1M, 0,01M $Ce(SO_4)_2 \times \times 4H_2O$, eritmasi	1. Redoks indikatorlar: ferroin, *o*-fenantrolin, difenilamin. 2. Indikatorsiz – Ce^{4+} eritmalari sariq rangga ega. 3. pH-indikatorlar (metiloranj, metil qizil) – qaytmas oksidlanish	$Na_2C_2O_4$, $(NH_4)_2C_2O_4$. Titrant yodometrik metod bilan standartlashtiriladi	As^{III}, Fe^{2+}, Sb^{III}, Sn^{2+}, $[Fe(CN)_6]^{4-}$, H_2O_2, $C_2O_4^{2-}$, NO_2^-, organik birikmalar: fenollar, aminlar, aminokislotalar, organik kislotalar, uglevodlar aniqlanadi	Titrlash kislotali muhitda o'tkaziladi ($HClO_4$)	$Ce^{4+} + e \rightleftarrows Ce^{3+}$ $HClO_4$ muhitida $E° = +1{,}70$ V. Seriy kompleks tuzlari redoks juftlarining oksidlanish-qaytarilish potensiallari anionlar tabiatiga bog'liq: $E°[Ce(SO_4)_3]^{2-}/Ce^{3+} = 1{,}44$ V, $E°[Ce(SO_4)_6]^{2-}/Ce^{3+} = 1{,}61$ V, $E°[CeCl_6]^{2-}/Ce^{3+} = 1{,}28$ V. Masalan: $-2e + H_2C_2O_4 \rightarrow 2CO_2\uparrow + 2H^+$ | 1 $+e + Ce^{4+} \rightarrow Ce^{3+}$ | 2 $H_2C_2O_4 + 2Ce^{4+} \rightarrow 2CO_2\uparrow + 2Ce^{3+} + 2H^+$

Ayrim tortimlar usuli

1. Ekvivalent molyar massa bo'yicha:

- titrantlarni standartlash uchun qo'llaniladigan kimyoviy toza moddalar tortimining massasi quyidagi formula boyicha hisoblanadi:

$$m = \frac{C_M \cdot V \cdot E_M}{1000},$$

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3.

- tekshiriladigan modda tortimining massasi (m_t) quyidagi formula bo'yicha hisoblanadi:

$$m_t = \frac{C_M \cdot V \cdot E_M \cdot 100}{1000 \cdot \omega},$$

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3; ω – namunadagi aniqlanuvchi moddaning massa ulushi.

- titrantning molyar konsentratsiyasi (C_M) quyidagi formula bo'yicha aniqlanadi:

$$C_M = \frac{m \cdot 1000}{E_M \cdot V},$$

bunda, V – tortimni titrlashga sarf bo'lgan titrlangan eritmaning hajmi, sm^3.

- namunadagi aniqlanuvchi moddaning massa ulushi (ω) quyidagi formula bo'yicha aniqlanadi:

$$\omega,\% = \frac{C_M \cdot V_1 \cdot E_M \cdot 100}{1000 \cdot m_t} \text{ (to'g'ri va bilvosita titrlash),}$$

$$\omega,\% = \frac{(C_{M_1} \cdot V_1 - C_{M_2} \cdot V_2) \cdot E_M \cdot 100}{1000 \cdot m_t} \text{ (teskari titrlash),}$$

bunda, C_{M_1} va C_{M_2} – tegishlicha 1- va 2-titrantning molyar konsentratsiyalari mol/dm^3; V_1 va V_2 – tegishlicha 1 va 2-titrant eritmalarning hajmlari, sm^3.

2. Titrantning aniqlanuvchi modda titri bo'yicha:

- tekshiriladigan eritmadagi aniqlanuvchi moddaning massa ulushi quyidagi formula bo'yicha aniqlanadi:

$$\omega,\% = \frac{T_{(T/a)} \cdot K \cdot V \cdot 100}{m_t} \text{ (to'g'ri va bilvosita titrlash),}$$

$$\omega,\% = \frac{T_{1(T/a)} \cdot (K_1 \cdot V_1 - K_2 \cdot V_2) \cdot 100}{m_t} \text{ (teskari titrlash),}$$

bunda, $T_{(T/a)}$ – titrantning aniqlanuvchi modda bo'yicha titri, g/sm^3; $T_{1(T/a)}$ – aniqlanadigan modda bilan bevosita ta'sir etadigan titrantning aniqlanuvchi modda bo'yicha titri, g/sm^3; K, K_1, K_2 – tuzatish koeffitsiyentlari:

$$K = \frac{C_{M\,(\text{amal.})}}{C_{M\,(\text{nazar.})}} = \frac{V_{(\text{amal.})}}{V_{(\text{nazar.})}}.$$

Pipetkalash usuli

1. Ekvivalent molyar massa boyicha:

- titrantlarni standartlash uchun qo'llaniladigan kimyoviy modda tortimining massasi quyidagi formula bo'yicha aniqlanadi:

$$m = \frac{C_M \cdot V \cdot E_M \cdot V_{(\text{k})}}{1000 \cdot V_{\text{p}}},$$

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3; V_{k} – modda tortimi eritilgan kolba hajmi, sm^3; V_{p} – eritmaning alikvot qismini o'lchab olishga qo'llaniladigan pipetka hajmi, sm^3.

- aniqlanadigan modda tortimining massasi (m_{t}) quyidagi formula bo'yicha aniqlanadi:

$$m_{\text{t}} = \frac{C_M \cdot V \cdot E_M \cdot V_{\text{k}} \cdot 100}{1000 \cdot V_{\text{p}} \cdot \omega},$$

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3; V_{k} – modda tortimi eritilgan kolbaning hajmi, sm^3; V_{p} – eritmaning alikvot qismini o'lchab olishga qo'llaniladigan pipetka hajmi, sm^3.

- titrantning molyar konsentartsiyasi (C_M) quyidagi formula bo'yicha aniqlanadi:

$$C_M = \frac{m_{\text{t}} \cdot V_{\text{p}} \cdot 1000}{E_M \cdot V_{\text{k}} \cdot V},$$

bunda, V – standart moddaning alikvot qismiga sarflanadigan titrlangan eritmaning hajmi, sm^3; V_{k} – modda tortimi eritilgan kolbaning hajmi, sm^3; V_{p} – eritmaning alikvot qismini o'lchab olishga qo'llaniladigan pipetka hajmi, sm^3.

- tekshiriladigan namunadagi aniqlanuvchi moddaning massa ulushi (ω) quyidagi formula bo'yicha aniqlanadi:

$$\omega,\% = \frac{C_M \cdot V \cdot E_M \cdot V_{\text{k}} \cdot 100}{1000 \cdot m_{\text{t}} \cdot V_{\text{t}}}$$ (to'g'ri va bilvosita titrlash),

bunda, V – titrlashga sarflangan titrlangan eritmaning hajmi, sm^3.

$$\omega,\% = \frac{(C_{M_1} \cdot V_1 - C_{M_2} \cdot V_2) \cdot E_M \cdot V_{\text{k}} \cdot 100}{1000 \cdot m_{\text{t}} \cdot V_{\text{t}}}$$ (teskari titrlash),

bunda, V_1 – ortiqcha qo'shilgan titrlangan 1-eritmaning hajmi, sm^3; V_2 – titrlashga sarflangan titrlangan 2-eritmaning hajmi, sm^3.

2. Titrantning aniqlanuvchi modda titri bo'yicha:

$$\omega,\% = \frac{T_{(T/\text{a})} \cdot K \cdot V \cdot V_{\text{k}} \cdot 100}{m_{\text{t}} \cdot V_{\text{p}}}$$ (to'g'ri va bilvosita titrlash),

$$\omega,\% = \frac{T_{(T/a)} \cdot (K_1 \cdot V_1 - K_2 \cdot V_2) \cdot V_k \cdot 100}{m_t \cdot V_p}$$ (teskari titrlash).

Konsentratsiyasi aniq bo'lgan titrlangan eritma bo'yicha titrantning molyarligi quyidagi formula bo'yicha aniqlanadi:

$$C_M = \frac{C_{M_0} \cdot V_0}{V},$$

bunda, C_{M_0} – konsentratsiyasi aniq bo'lgan eritma konsentartsiyasi, mol/dm^3; V_0 – konsentratsiyasi aniq bo'lgan eritma hajmi, sm^3; V – konsentratsiyasi aniqlanadigan eritma hajmi, sm^3.

“NATIJALARNI STATISTIK QAYTA ISHLASH” MAVZUSI BO’YICHA MASALALAR YECHISH NAMUNALARI

Asosiy statistik xarakteristikalar

Har qanday analiz qanchalik e’tibor bilan bajarilmasin, olingan natija, odatda, aniqlanayotgan moddaning haqiqiy miqdoridan bir oz farq qiladi, ya’ni ba’zi xatoliklarga ega bo’ladi. Analiz xatolari o’z tabiatiga ko’ra, sistematik, tasodifiy va qo’pol xatolarga bo’linadi.

Sistematik xato deb, kattaligi doimiy bo’lgan yoki aniq qonun bo’yicha o’zgaradigan xatolarga aytiladi. Sistematik xatoni, odatda, oldindan nazarda tutish yoki tegishli tuzatishlar kiritish bilan ularni yo’qotish mumkin. Sistematik xatolar o’z navbatida usulik, operativ, instrumental va individual xatolarga bo’linadi.

Aniq bir qonuniyatga asoslanmaydigan, kattaligi va ishorasi no’malum bo’lgan xatolar *tasodifiy xato* deb ataladi. Bu xatolarni minimal qiymatga keltirish uchun ularni matematik statistika usuli yordamida ishlab chiqish kerak.

Qo’pol xatolar jumlasiga, masalan: tarozi bilan ishlashda tarozi toshlarini va tarozi shkalasining ko’rsatishini noto’g’ri hisoblash, titrlash vaqtida byuretka shkalasi bo’yicha noto’g’ri hisoblash, analiz vaqtida eritma yoki cho’kmaning bir qismini to’kib yuborish va shunga o’xshashlar kiradi.

Analiz paytida qo’pol xatoliklarga yo’l qo’yilishi analiz natijalarini noto’g’ri bo’lib chiqishiga sabab bo’ladi. Shuning uchun ham bir necha parallel analizlar olib borilib ularning o’rtachasi olinadi.

Analiz natijalarining to’g’riligi va aniqligini baholashda sistematik va tasodifiy xatolarni hisobga olish katta ahamiyatga ega. Sistematik xatolar analiz natijasining to’g’ri ekanligini ko’rsatadi. Sistematik xatolarning qiymati qancha kichik bo’lsa, natija shuncha to’g’ri bo’ladi. Analiz vaqtida yo’l qo’yilgan tasodifiy xatolar miqdori analiz natijalarining aniqligini ifodalaydi.

Analizda yo’l qo’yiladigan sistematik xatolarni turlicha ifodalash mimkin. Ifodalash usuliga qarab ular ikkiga, ya’ni absolyut va nisbiy xatolarga bo’linadi.

Aniqlanayotgan kattalikning haqiqiy (yoki eng ishonchli) miqdori bilan olingan natija o’rtasidagi farqqa *absolyut xato* deyiladi. Agar aniqlanadigan kattalikning qiymati noma’lum bo’lsa, u holda absolyut xato, nisbatan ishonchli kattalik bo’lgan bir necha aniqlashlar o’rtacha arifmetik qiymatidan olinadi.

O’lchashning *nisbiy xatosi* absolyut xatoning aniqlanadigan kattalikning haqiqiy qiymatiga yoki bir necha o’lchashlar o’rtacha arifmetik qiymatiga nisbati orqali aniqlanadi.

Tasodifiy kattaliklarning o’rtacha qiymati – bir xil aniqlikda o’tkazilgan o’lchash natijalaridan olingan ortacha arifmetik qiymat. Agar x_1, x_2, …, x_n lar a kattalikni n marta o’lchash natijalari bo’lsa, unda

$$\bar{x} = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{1}{n}\sum_{i=1}^{n} xi$$

Normal taqsimlanish qonuniga asoslanib, o’rtacha arifmetik qiymat aniqlanadigan kattalikning qiymatiga juda yaqin ekanligini ko’rsatish mumkin, ya’ni $\bar{x} \cong a$.

Dispersiya tasodifiy kattaliklarning o'rtacha qiymatiga nisbatan tarqalishidir. n marta aniqlangan x_1, x_2, …, x_n tasodifiy qiymatlar uchun tanlangan dispersiya quyidagiga teng bo'ladi:

$$S^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

O'lchash aniqligi qancha kichik bo'lsa, dispersiya shuncha katta bo'ladi. Dispersiyadan olingan kvadrat ildizning musbat qiymatiga aniqlashning *o'rtacha kvadratik xatosi* deyiladi va u tajriba natijalariga asoslanib hisoblanadi:

$$S = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n-1}}$$

Agar o'rtacha kvadratik xato alohida o'lchash uchun emas, balki alohida o'lchashning o'rtacha kvadratik xatosidan $\sqrt{n}$ marta kichik bo'lgan n marta o'lchash uchun hisobga olinsa, yanada aniqroq natijalar olish mumkin, ya'ni:

$$S_{\bar{x}} = \frac{S}{\sqrt{n}} = \sqrt{\frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n(n-1)}}$$

Yuqorida yozilgan tenglamalardagi n –1 kattalik *erkinlik darajasi* (f) deb ataladi.

Analizning ishonchlilik chegarasini hisoblash

Analiz natijalari o'rtacha qiymat $\bar{x}$ ning ishonchlilik chegarasi bilan xarakterlanadi va quyidagi formula bo'yicha hisoblanadi:

$$\Delta\bar{x} = t(P, f) \cdot S\bar{x},$$

bunda, $t(P, f)$ – Styudent koeffitsiyenti (1-*jadval*).

Ishonchlilik chegarasi sistematik xatolar mavjud bo'lmaganda analizning haqiqiy qiymatini saqlagan sohani cheklaydi:

$$(\bar{x} - \Delta\bar{x}) \le a \le (\bar{x} + \Delta\bar{x}).$$

O'rtacha natijaning nisbiy xatosi A(%) quyidagi formula bilan hisoblanadi:

$$A = \frac{\Delta\bar{x}}{x} \cdot 100\%.$$

Aniqlashlar ko'p marta qayta takrorlansa, uning natijasi asossiz u yoki bu tomonga chetlashadi. Bunda qo'pol xato yuzaga keladimi degan savol tug'iladi. Ko'p sonli aniqlashlardagi qo'pol xatoni ikki chetki qiymatlar orasidagi farqdan topish mumkin (x_i, $x_{max} - x_{min}$). Buning uchun quyidagi bog'liqlik tuziladi:

$$Q = \frac{x_1 - x_2}{R}$$

bunda x_1 – shubhali ko'ringan qiymat, $x_2 - x_1$ bilan qo'shni qiymat, R – birinchi va oxirgi natijalar farqi.

Hisoblab topilgan Q kattalik uning jadval qiymatlari $Q(p, n)$ bilan taqqoslanadi. Agar $Q > Q(p, n)$ bo'lsa, unda qop'pol xato mavjudligi isbotlanadi (2–jadval).

1-*jadval*

STYUDENT KRITERIYSINING SON QIYMATLARI, $t(P, f)$

O'lchovlar soni	Erkinlik darajasi ($f = n - 1$)	P (%)		
		0,10(90)	0,05(95)	0,01(99)
1	1	6,314	12,706	63,657
2	2	2,920	4,303	9,925
3	3	2,353	3,182	5,841
4	4	2,132	2,776	4,604
5	5	2,015	2,571	4,032
6	6	1,943	2,447	3,707
7	7	1,895	2,365	3,499
8	8	1,860	2,306	3,355
9	9	1,833	2,262	3,250
10	10	1,812	2,228	3,169

2-*jadval*

NAZORAT KRITERIYSINING SON QIYMATLARI, $Q(P, n)$

n	Q		
	$P = 0,90$	$P = 0,95$	$P = 0,99$
3	0,89	0,94	0,99
4	0,68	0,77	0,83
5	0,56	0,64	0,76
6	0,48	0,55	0,70
7	0,43	0,51	0,64
8	0,40	0,48	0,58

Analizning ikki usulini dispersiyalar (S_1^2 va S_2^2) bilan taqqoslash uchun Fisher (F) kriteriysi hisoblanadi, u S_1^2 va S_2^2 farqlarining haqiqiyligini xarakterlaydi:

$$F = \frac{S_1^1}{S_2^2}.$$

Hisoblab topilgan F ning qiymati jadval qiymatlari $F(P, f_1, f_2)$ bilan $P = 99\%$ da taqqoslanadi. Agar $F > F_{\text{jadval}}$ bo'lsa, S_1^2 va S_2^2 dispersiyalarning farqi 99% ehtimoliga yaqin, agar $S_1^2 < S_2^2$ bo'lsa, unda ikkinchi usul yuqoriroq aniqlikka ega.

3-*jadval*

FISHER KRITERIYSINING SON QIYMATLARI $F(P, f_1, f_2)$ ($P = 99\%$ da)

f_2	f_1										
	1	**2**	**3**	**4**	**5**	**6**	**8**	**10**	**12**	**16**	**20**
1	4052	4999	5403	5625	5764	5859	5981	6056	6106	6169	6208
2	98,49	99,00	99,17	99,25	99,30	99,33	99,36	99,40	99,42	99,44	99,45
3	34,12	30,81	29,46	28,71	28,24	27,91	27,49	27,23	27,05	26,83	26,65
4	21,20	18,00	16,69	15,98	15,52	15,21	14,80	14,54	14,37	14,15	14,02
5	16,26	13,27	12,06	11,39	10,97	10,77	10,27	10,05	9,89	9,68	9,55
6	13,74	10,92	9,78	9,15	8,75	8,47	8,10	7,87	7,72	7,52	7,39
7	12,25	9,55	8,45	7,85	7,46	7,19	6,84	6,62	6,47	6,27	6,15
8	11,26	8,65	7,59	7,01	6,63	6,37	6,03	5,82	5,67	5,48	5,36
9	10,56	8,02	6,99	6,42	6,06	5,80	5,47	5,26	5,11	4,92	4,80
10	10,04	7,56	6,55	5,99	5,64	5,39	5,06	4,85	4,71	4,52	4,41
11	9,65	7,20	6,22	5,67	5,32	5,07	4,74	4,54	4,40	4,21	4,10
12	9,33	6,93	5,95	5,41	5,06	4,82	4,50	4,30	4,16	3,98	3,86
13	9,07	7,70	5,74	5,20	4,86	4,62	4,30	4,10	3,96	3,78	3,67
14	8,86	6,51	5,56	5,03	4,60	4,46	4,14	3,94	3,80	3,62	3,51
15	8,68	6,36	5,42	4,89	4,56	4,32	4,00	3,80	3,67	3,48	3,36
16	8,53	6,23	5,29	4,77	4,44	4,20	3,89	3,69	3,55	3,37	3,25
17	8,40	6,11	5,18	4,67	4,34	4,10	3,79	3,59	3,45	3,27	3,16
18	8,28	6,01	5,09	4,58	4,25	4,01	3,71	3,51	3,37	3,19	3,07
19	8,18	5,93	5,01	4,50	4,17	3,94	3,63	3,43	3,30	3,12	3,00
20	8,10	5,85	4,94	4,43	4,10	3,87	3,56	3,37	3,23	3,05	2,94
25	7,77	5,57	4,48	4,18	3,86	3,63	3,32	3,13	2,99	2,81	2,70
30	7,56	5,39	4,51	4,02	3,70	3,47	3,17	2,93	2,84	2,66	2,55
40	7,31	5,18	4,31	3,83	3,51	3,29	2,99	2,80	2,66	2,49	2,37
60	7,08	4,98	4,13	3,65	3,34	3,12	2,82	2,63	2,50	2,32	2,20

1-masala. Beshta po’lat namunalaridagi turli xil tarkibli marganesning o’rtacha aniqlik xatosini hisoblang. Analizning natijasi, %Mn

1. 0,31; 0,30; 0,29; 0,32;
2. 0,52; 0,57; 0,58; 0,57;
3. 0,71; 0,69; 0,71; 0,71;
4. 0,92; 0,92; 0,95; 0,95;
5. 1,18;1,17; 1;21; 1,19.

Yechish. Quyidagi formula asosida namunadagi o’rtacha qiymatni aniqlaymiz:

$$\bar{x} = \frac{\tilde{o}_1 + \tilde{o}_2 + \tilde{o}_3 + \ldots + \tilde{o}_n}{n} = \frac{\sum x_i}{n},$$

1. $\bar{x} = \frac{0{,}31 + 0{,}30 + 0{,}29 + 0{,}32}{4} = 0{,}305.$
2. $\bar{x} = \frac{0{,}51 + 0{,}57 + 0{,}58 + 0{,}57}{4} = 0{,}578.$
3. $\bar{x} = \frac{0{,}71 + 0{,}69 + 0{,}71 + 0{,}71}{4} = 0{,}705.$
4. $\bar{x} = \frac{0{,}92 + 0{,}92 + 0{,}95 + 0{,}95}{4} = 0{,}935.$
5. $\bar{x} = \frac{1{,}18 + 1{,}17 + 1{,}21 + 1{,}19}{4} = 1{,}19.$

Har bir namuna uchun kvadratlar farqini, so'ng esa

$$S = \sqrt{\frac{\sum_1^m \sum_1^n (x_{ji} - x_j)^2}{n - m}}$$

formuladan xatolikni hisoblaymiz.

Kvadratlar farqining qiymatlari:

1) $0{,}005^2 + 0{,}005^2 + 0{,}015^2 + 0{,}015^2 = 0{,}500 \cdot 10^{-3}$.
2) $0{,}012^2 + 0{,}008^2 + 0{,}002^2 + 0{,}008^2 = 0{,}276 \cdot 10^{-3}$.
3) $0{,}005^2 + 0{,}015^2 + 0{,}005^2 + 0{,}005^2 = 0{,}300 \cdot 10^{-3}$.
4) $0{,}015^2 + 0{,}015^2 + 0{,}015^2 + 0{,}015^2 = 0{,}900 \cdot 10^{-3}$.
5) $0{,}01^2 + 0{,}02^2 + 0{,}02^2 + 0{,}0^2 = 0{,}90 \cdot 10^{-3}$.

$f = 4 \cdot 5 - 5 = 15$ uchun o'rtacha xanolikni hisoblaymiz:

$$S = \sqrt{\frac{10^{-3}(0{,}500 + 0{,}276 + 0{,}300 + 0{,}900 + 0{,}900)}{15}};$$

$$S = 0{,}014\%.$$

2-masala. Kulrang cho'yandagi grafit aniqlanganida quyidagi tartibda bo'lgan kattaliklar qiymatlari olindi (% grafit): 2,86; 2,89; 2,90; 2,91; 2,99. Oxirgi natijani qo'pol xato deb hisoblash mumkinmi?

Yechish. $Q = \frac{x_1 - x_2}{R}$ formuladan quyidagi munosabat tuziladi:

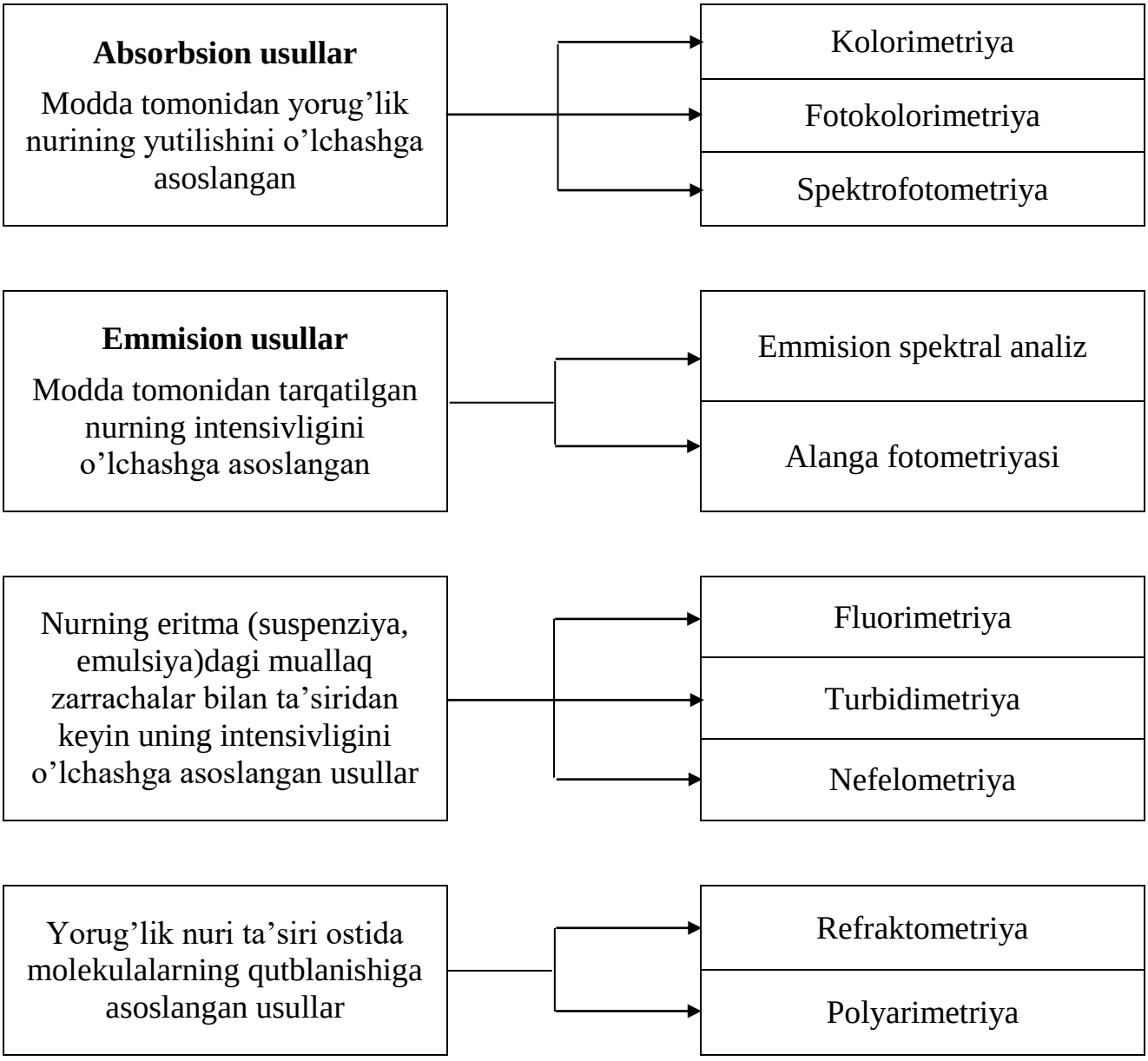
$$Q = \frac{2{,}99 - 2{,}91}{2{,}99 - 2{,}86} = 0{,}62.$$

Jadvaldan $Q(P = 0{,}95;\ n = 5) = 0{,}64$ ekanligini topamiz. $Q < Q(P; n)$ ni hisobga olsak, oxirgi qiymat 2,99 qo'pol xato emasligini ko'ramiz, hamda uni boshqa natija qiymatlari bilan birgalikda hisobga olish kerak.

ANALIZNING OPTIK USULLARI

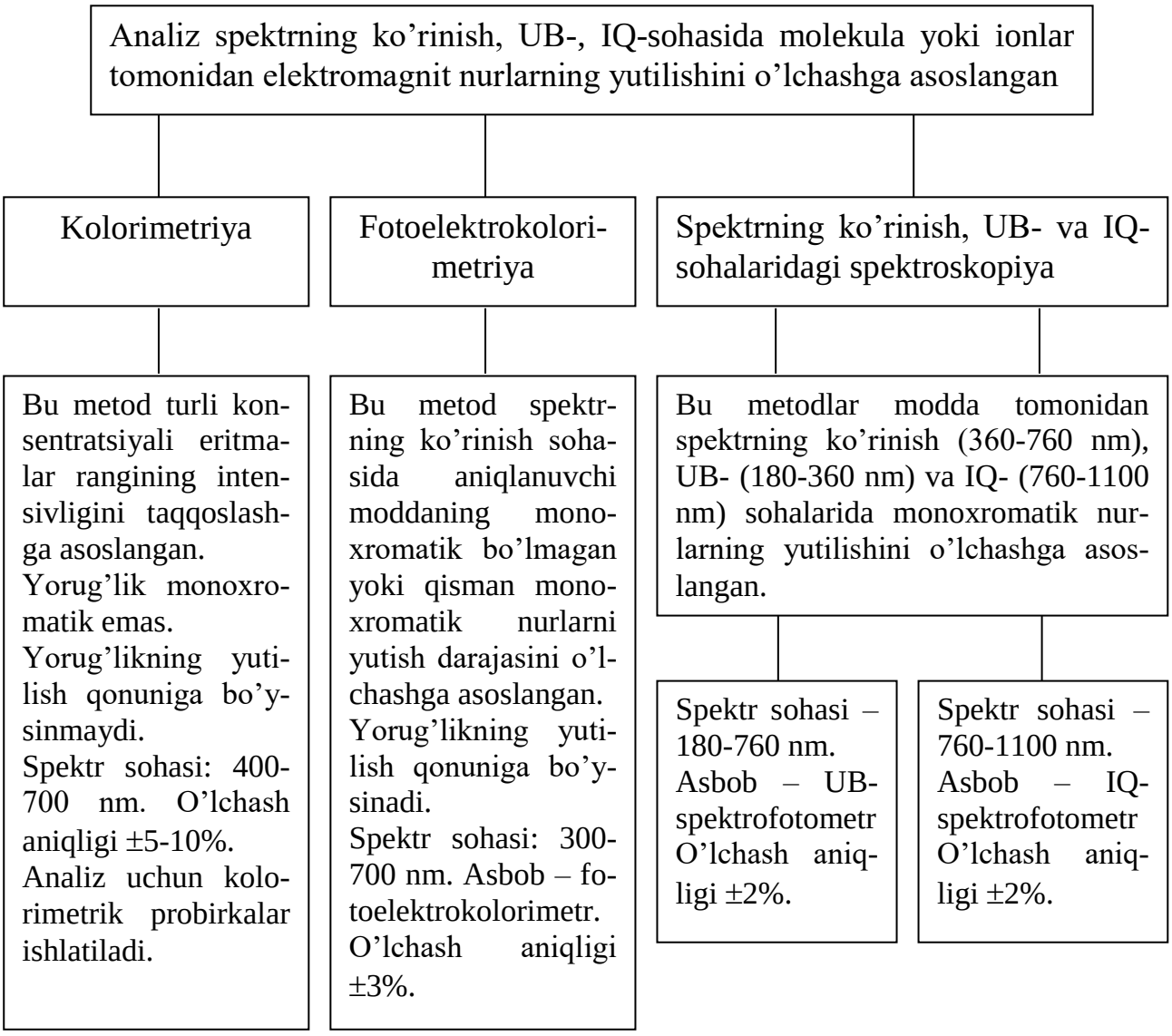
1-*sxema*

OPTIK ANALIZ USULLARINING KLASSIFIKATSIYASI



2-*sxema*

MOLEKULYAR-ABSORBSION ANALIZ USULLARI



1-*jadval*

IQ- VA UB-SPEKTROSKOPIYANING ANALIZDA QO'LLANILISHI

IQ-spektroskopiya	**UB-spektroskopiya**
Sifat analizi	
Bu metod yordamida: – tegishli xarakteristik chastotalardagi (600-1500 sm^{-1}) o'ziga xos maksimumlar bo'yicha; – aniqlanuvchi modda spektri bilan standart-modda spektrining taqqoslanishi bo'yicha moddalar identifikatsiyalanadi. Har bir atomlar guruhi uchun xarakterli bo'lgan (3-jadval) yutilish (spektrdagi maksimum) bo'yicha organik va anorganik birikmalarning strukturasi aniqlanadi.	Bu metod yordamida: – organik birikmalarning srukturasi aniqlanadi (ayrim kimyoviy bog'lar uchun xarakterli bo'lgan yutilish maksimumlari yoki minimumlarining to'lqin uzunliklari bo'yicha hamda yutilish intensivligi bo'yicha); – molekulalararo ta'sir, zaryad ko'chishi bilan komplekslar (π-komplekslar) hosil bo'lish mexanizmlari o'rganiladi; – ma'lum konsentratsiyali eritmalarning maksimum nuqtasidagi ε kattalik va yutilish chiziqlarining to'lqin kattaliklari bo'yicha moddalar identifikatsiyalanadi; – organik birikmalardagi elektronlarning energetik pog'onalari tavsiflanadi
Miqdoriy analiz	
Analiz asosida Buger-Lambert-Ber qonuni yotadi, biroq bu qiyinchiliklarni tug'diradi, chunki *l* kattalik juda kichik (o'lchashlar tor kyuvetada o'tkaziladi). 1) darajalangan grafik usuli; 2) qo'shish usuli.	Analiz asosida Buger-Lambert-Ber qonuni yotadi. Moddalar konsentratsiyasi 2-jadvalda keltirilgan metodlarning biri bilan aniqlanadi. Analizni yutuvchi moddalar aralashmasi uchun ham o'tkazish mumkin.

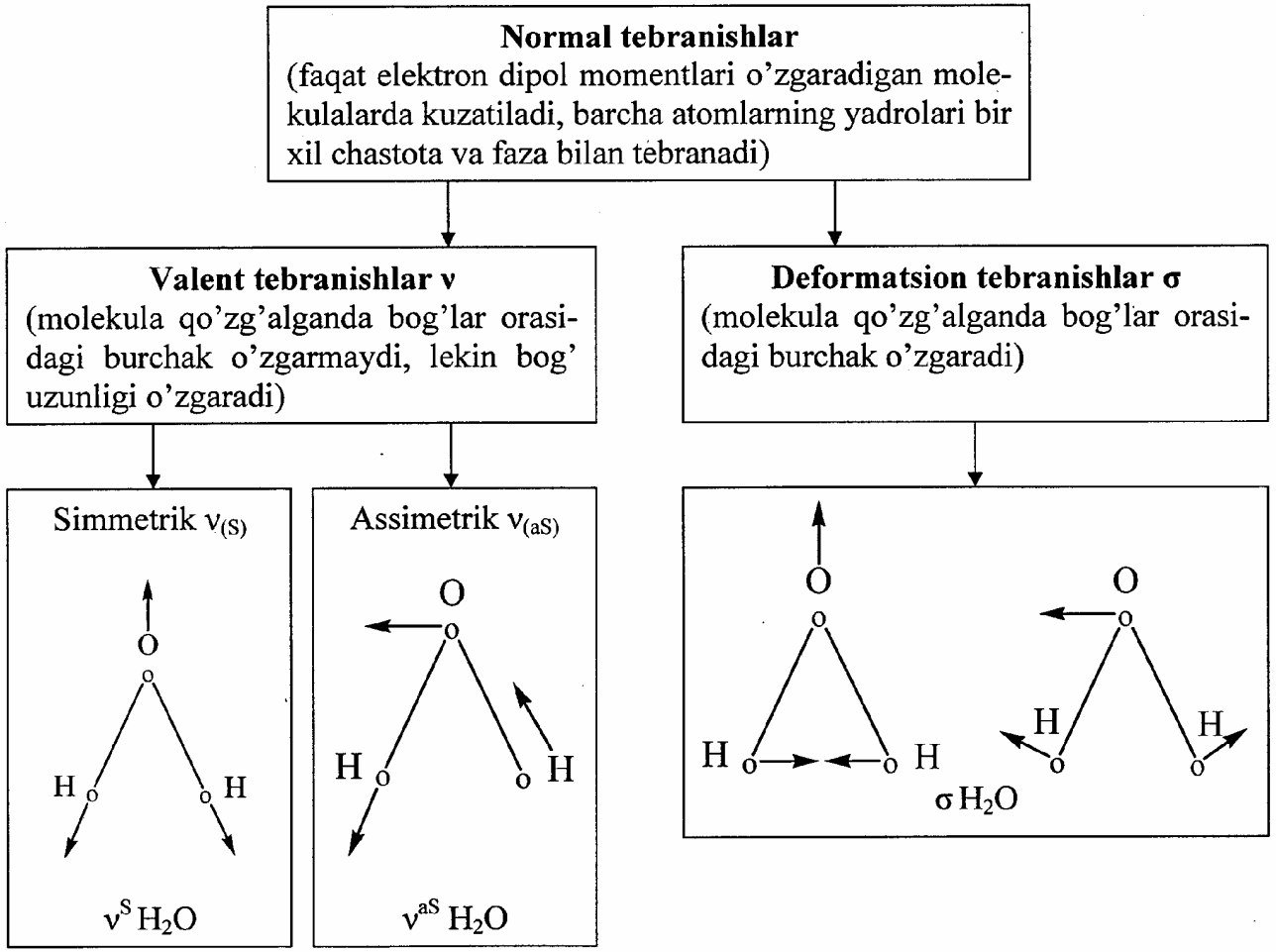
2-jadval

KOLORIMETRIYA VA FOTOKOLORIMETRIYA METODLARINING TAVSIFLARI

Kolorimetriya	Fotokolorimetriya
Bu metod rangli eritmalarning konsentratsiyalarini taxminiy baholashda qo'llaniladi. Agar eritma rangsiz bo'lsa, rangli birikma hosil bo'lishi bilan boradigan fotometrik reaksiya o'tkaziladi. Buger-Lambert-Ber qonuniga bo'ysinishi talab etilmaydi. Miqdoriy aniqlashlar quyidagi metodlar bilan o'tkaziladi: **1. Taqqoslash metodi:** tekshiriladigan va standart eritmalar qatlamining qalinligini o'zgartirib, ularning rang intensivligi tenglashtiriladi. Tekshiriladigan eritmaning konsentratsiyasi (C_x) quyidagi formula bo'yicha topiladi: $$C_x = \frac{C_{st} \cdot l_{st}}{l_x}$$ bunda C_{st} – standart eritma konsentratsiyasi; l_{st}, l_x – tegishlicha standart va tekshiriladigan eritmalar qatlamining qalinligi. **2. Standart seriyalar metodi:** aniqlanadigan moddani saqlagan ma'lum konsentratsiyali standart eritmalar seriyasi tayyorlanadi va ranglar intensivligi analiz qilinadigan eritmaning rang intensivligi bilan taqqoslanadi. Analiz qilinadigan eritmaning konsentratsiyasi rang intensivligi bilan bir xil bo'lgan standart eritmaning konsentratsiyasiga teng bo'ladi. **3. Kolorimetrik titrlash:** fotometrik reagent tekshiriladigan eritmaga va suvga teng sharoitlarda qo'shiladi. So'ng byuretkadan suvga aniqlanayotgan moddaning standart eritmasi qo'shiladi. Bir vaqtning o'zida suyuqliklar hajmlarini tenglashtirish uchun aniqlanayotgan eritmaga suv qo'shiladi va ikki eritmaning ranglari tenglashtiriladi.	Bu metod eritmalarning optik zichligi (A) yoki o'tkazishini (T) o'lchash yoli bilan rangli eritmalarning konsentratsiyasini aniqlashda qo'llaniladi. Buger-Lambert-Ber qonuniga bo'ysinishi shart. $$A = \lg\frac{I_0}{I};\quad I = I_0 \cdot 10^{-\varepsilon C l};\quad A = \varepsilon \cdot C \cdot l;$$ $$T = \frac{I}{I_0};\quad A = \lg\frac{l}{T};\quad \varepsilon^{\lambda} = \frac{A^{\lambda}}{C \cdot l};\quad E_{1sm}^{1\%} = \frac{A^{\lambda}}{C \cdot l}.$$ bunda ε – yorug'lik yutilishining molyar koeffitsiyenti, qatlam qalinligi l = 1 sm va konsentratsiyasi C = 1 mol/l bo'lgan eritmaning optik zichligiga (A) teng; $E_{1sm}^{1\%}$ – yorug'lik yutilishining solishtirma koeffitsiyenti, qatlam qalinligi 1 sm va konsentratsiyasi C = 1% bo'lgan eritmaning optik zichligiga (A) teng. $\varepsilon = E_{1sm}^{1\%} \cdot \frac{M}{10}$, bunda M – moddaning molekulyar massasi. Konsentratsiya quyidagi metodlar bilan aniqlanadi: 1. Darajalangan grafik metodi. 2. ε koeffitsiyentlarning o'rtacha qiymatlari bo'yicha. 3. Qo'shimchalar metodi. 4. Differensial fotometriya metodi. 5. Ekstraksion-fotometrik metod.

3-sxema

TEBRANMA IQ-SPEKTRLARNING KLASSIFIKATSIYASI



Yutilish spektri – yutilish (*A* yoki ε) yoki o'tkazish (*T*) intensivligining to'lqin uzunligi (λ) yoki to'lqin soni (ν) ga bog'liqlik egri chizig'i.

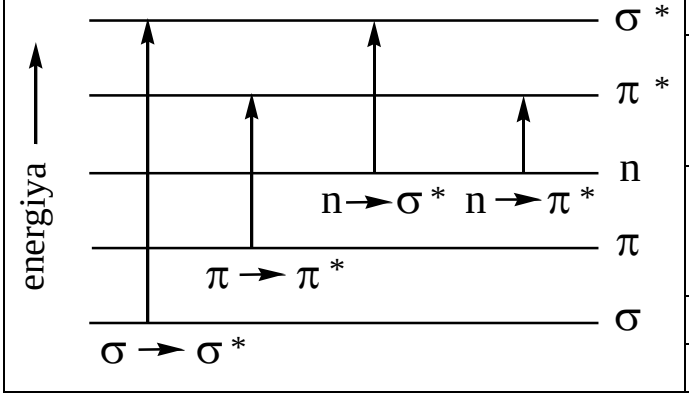
Spektr xarakteristikasi – maksimumlar (yutilish chiziqlari) soni; ularning to'lqin uzunligi (yoki chastotalar) shkalasidagi o'rni; maksimumlar (intensivlik) balandligi; yutilish chiziqlarining shakli.

T**ebranma spektr (IQ-spektroskopiya)** – 4000-400 sm^{-1} sohasidagi xarakterli maksimumlar (kimyoviy bog'lardagi atomli tebranishlar keltirib chiqaradi); energiyaning yutilishiga bog'liq.

Xarakteristik chastotalar – muayyan bog'lar va atom guruhlariga mos keladigan to'lqin uzunliklari hamda molekula strukturasi o'zgarganda ular kam o'zgaradi. (2000-4000 sm^{-1} oraliq C – H; O – H; N – H bog'larning valent tebranishlariga mos keladi; 1500-1950 sm^{-1} oraliq C = O; C = C; C = N; N = N bog'larning valent tebranishlariga mos keladi). Moddaning sifat tarkibi va molekula strukturasi haqida ma'lumot beradi.

"Barmoq izlari" sohasi (IQ-spektroskopiya) – (600-1500 sm^{-1}) oraliqda yutilish spektrlaridagi chiziqlar to'plami. Berilgan modda uchun xarakterli maksimumlarni saqlaydi (identifikatsiyalash uchun qo'llaniladi).

Elektron spektr (UB-spektroskopiya) – modda elektron sistemasining qo'zg'alishiga bog'liq. Yorug'lik kvanti (muayyan energiyali nurlar) yutilganda bir energetik holatdan ikkinchisiga o'tishi natijasida elektron qo'zg'algan holatga o'tadi.



O'tish	Birikma
σ → σ*	metan, etan, to'yinmagan uglevodorodlar
n → σ*	spirtlar, efirlar, xlororganik birikmalar
π → π*	aromatik birikmalar
n → π*	

Elektron pog'onalarning sxemasi va elektron o'tishlarning energiyasi

Batoxrom siljish – yutilish chizig'ining uzunroq to'lqin sohasiga siljishi.

Gipsoxrom siljish – yutilish chizig'ining qisqaroq to'lqin sohasiga siljishi.

3-*jadval*

BA'ZI STRUKTUR ELEMENTLAR VA UGLEROD-UGLEROD BOG'LARNING IQ-SOHASIDAGI XARAKTERISTIK TEBRANISH CHASTOTALARI

To'lqin soni, sm^{-1}	**Tebranishlar turi va tegishli struktur element**	**Modda**
3700…3600 (tor chiziq) 3500…3300 (keng chiziq)	Valent tebranish, – O – H (erkin, assitsilanmagan guruh) Valent tebranish, – O – H (bog'langan guruh)	Spirtlar, fenollar, kislotalar, oksiketonlar, oksikislota efirlari
3550…3350	Valent, – N – H (assitsilanmagan guruh)	Birlamchi va ikkilamchi aminlar va amidlar
3500…3100	Valent, – N – H (assitsilangan guruh)	
3300…3270	Valent, ≡ C – H	Atsetilenning monoalmashingan hosilalari
3350…3150 (keng chiziq)	Valent, – NH_3	Aminlar va aminokislotalar gidroxloridlari
3300…2500 (juda keng chiziq)	Valent, – O – H (assitsilangan guruh)	Karbon kislotalar, xelatlar
3100…3000	Valent, = C – H	Aromatik uglevodorodlar, olefinlar
3000…2800	Valent, – C – H	Parafinlar, siklopara-finlar
2962, 2872	Valent, – CH_3	Parafinlar
2962, 2853	Valent, – CH_2 –	Parafinlar
2900…2400	Valent, – O – D, – N – D	Spirtlar, aminlar
2820	Valent, – O – CH_3	Oddiy metil efirlar
2820…2730	Valent, N – CH_3	N-metilamin
2820…2720	Valent, OC – H	Aldegidlar
2600…2550	Valent, – S – H	Merkaptanlar, tiofenollar
2300…2100	Valent, – C ≡ X (X = C, N, O)	Atsetilen, nitrillar, uglerod oksidlari
2270…2000	Valent, – Y = C = X (Y = N, C; X = O, S)	Izotsianat va ketonlar

3-*jadvalning davomi*

2260…2190	Valent, – C ≡ C –	Atsetilenning 1,2-di-almashingan hosila-lari
2260	Valent, – N^+ ≡ N	Diazoniy tuzlarining hosilalari
2245…2220	Valent, – C ≡ N	Nitrillar
2185…2120	Valent, – N = C –	Izonitrillar
2140…2100	Valent, – C ≡ C –	Monoalmashingan atsetilenlar
1900…1600	Valent, – C = O	Karbonil birikmalar
1850…1740	Valent, – C – O	Karbon kislotalar-ning galogenangid-ridlari
1840…1780 1780…1720	Valent, – C = O	Karbon kislotalar-ning angidridlari (2 ta chiziq)
1780…1750 1760…1700	Valent, – C = O Valent, – C = O	Fenilkarbon kislota-lar, karbon kislota-larning vinil efirlari
1750…1730	Valent, – C – O	To’yinmagan karbon kislotalarning alkil efirlari
1730…1710	Valent, – C = O	To’yinmagan alde-gidlar va ketonlar, α, β-aromatik karbon kislotalarning efirlari
1745	Valent, – C = O	Siklopentanon
1715	Valent, – C – O	Siklogeksanon
1705	Valent, – C – O	Siklogeptanon
1715…1680	Valent, – C – O	α, β-to’yinmagan va aromatik aldegidlar
1690…1630	Valent, – C = N	Azometinlar, oksi-ranlar
1690…1660	Valent, – C = O	α, β-to’yinmagan va aromatik ketonlar
1680…1630	Valent, – C = O	Karbon kislotalar bir-lamchi, ikkilamchi va uchlamchi amidlari

3-*jadvalning davomi*

1660…1600	Valent, – C = C –	Aromatik birikmalar, olefinlar
1650…1620	Deformatsion, – NH_2	Karbon kislotalarning birlamchi amidlari
1650…1580	Deformatsion, – N – H	Birlamchi va ikkilamchi aminlar
1630…1615	Deformatsion, H – O – H	Gidratlardagi kristallizatsion suv
1610…1590	Aromatik xalqadagi uglerod-uglerod bog'lar	Aromatik birikmalar
1570…1510	Deformatsion, – N – H	Karbon kislotalarning amidlari
1560	Valent, – NO_2	Alifatik nitrobirikmalar
1518	Valent, – NO_2	Aromatik nitrobirikmalar
1500…1480	Aromatik xalqadagi uglerod-uglerod bog'lar	Aromatik birikmalar
1480…1430	Deformatsion, – CH_3, – CH_2 –	Uglevodorodlar, murakkab efirlar
1420…1340	Deformatsion, – OH	Spirtlar, fenollar, karbon kislotalar
1390…1370	Deformatsion, – CH_3	Uglevodorodlar
1360…1030	Valent, – C – N <	Amidlar, aminlar
1350…1240	Valent, – NO_2	Alifatik va aromatik nitrobirikmalar
1335…1310 1200…1130	Valent, – SO_2	Organik sulfonlar
1290…1050	Valent, – C – O	Oddiy efirlar, spirtlar, laktonlar, ketallar va atsetallar
1250…1200	Valent, – C – O –	Fenollar
1250…1180	Valent, – C – O –	To'yingan karbon kislotalarning efirlari
1200…1150	Valent, – C – O –	Uchlamchi spirtlar
1150…1080	Valent, – C – O –	Ikkilamchi spirtlar

3-*jadvalning davomi*

1050…1010	Valent, – C – O –	Birlamchi spirtlar
1070…1030	Valent, – S = O	Sulfoksidlar
970…960	Deformatsion, = C – H	Etilenning 1,2-dialmashingan hosilalar (*trans*-izomerlar)
995…985 915…905	Deformatsion, = C – H	Etilenning monoalmashingan hosilalari
900…860 810…750	Deformatsion, – C – H	Benzolning 1,3-dialmashingan hosilalari
725…680 885…855	Deformatsion, = C – H	Etilenning 1,1-dialmashingan hosilalari
860…800	Deformatsion, – C – H	Benzolning 1,4-dialmashingan hosilalari
780…500	Valent, – C – Hal	Aromatik va alifatik galogen hosilalar
770…735	Deformatsion, = C – H	Benzolning 1,2-dialmashingan hosilalari
770…730	Deformatsion, = C – H	Benzolning monoalmashingan hosilalari
710…690 780…720	Deformatsion, – C – H	To’rttadan ko’proq $–CH_2–$ guruhini saqlagan *n*-parafinlar
705…550	Valent, – C – S	Oltingugurt saqlagan organik birikmalar (merkaptanlar, tioefirlar)
730…680	Deformatsion, – C – H	Etilenning 1,2-dialmashingan hosilalari (*sis*-izomerlar)
670	Deformatsion, – C – H	Benzol

4-jadval

SPEKTRNING TO'LQIN UZUNLIKLARI VA ULARGA TEGISHLI RANGLAR

Yutiladigan yorug'lik-ning to'lqin uzunliklari	**Yutiladigan nurning rangi**	**Qo'shimcha rang (eritmada kuzatiladigan rangi)**
400-435	Binafsha	Sarg'ish-yashil
435-480	Ko'k	Sariq
480-490	Yashil-ko'k	Zarg'aldoq
490-500	Ko'kimtir-yashil	Qizil
500-560	Yashil	Qirmizi
560-580	Sarg'ish-yashil	Binafsha
580-595	Sariq	Ko'k
595-605	Zarg'aldoq	Yashil-ko'k
605-730	Qizil	Ko'kimtir-yashil
730-760	Qirmizi	Yashil

5-jadval

To'lqin uzunligi λ			**Chastota ν, Ghz**	**To'lqin soni σ, sm^{-1}**
m	mkm	nm		
10^{-7}	0,1	100	$3 \cdot 10^{15}$	10^5
10^{-6}	1	1000	$3 \cdot 10^{14}$	10^4
10^{-5}	10	10000	$3 \cdot 10^{13}$	10^3

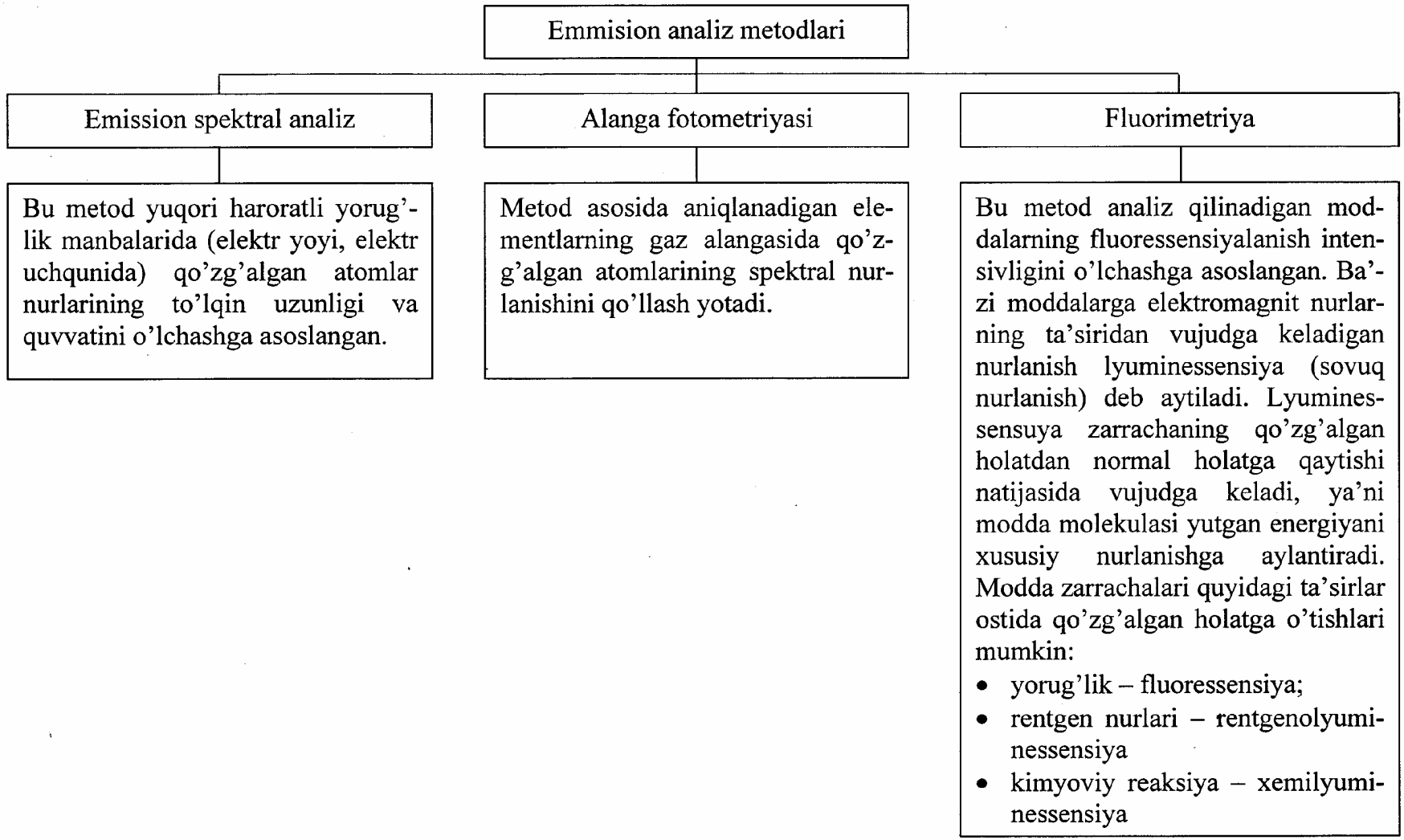
5.1-jadval

Bir kattalikdan ikkinchi kattalikka o'tish		
Kattaliklar		Matematik amallar
σ, sm^{-1}	ν, Ghz	σ ni $3 \cdot 10^{10}$ ga ko'paytirish
λ, mkm	ν, Ghz	$3 \cdot 10^{14}$ ni λ ga bo'lish
λ, nm	ν, Ghz	$3 \cdot 10^{17}$ ni λ ga bo'lish
λ, mkm	σ, sm^{-1}	10^{14} ni λ ga bo'lish
ν, Ghz	λ, mkm	$3 \cdot 10^{14}$ ni ν ga bo'lish
ν, Ghz	σ, sm^{-1}	ν ni $3 \cdot 10^{10}$ ga bo'lish
σ, sm^{-1}	λ, mkm	10^4 ni ν ga bo'lish

Izoh: σ – to'lqin soni; ν – tebranish chastotasi; λ – to'lqin uzunligi.

4-sxema

EMISSION ANALIZ METODLARI



6-jadval

EMISSION SPEKTRAL ANALIZ

Sifat analizi	Miqdoriy analiz
Metod asosini analiz qilinadigan elementning qo'zg'algan atomi chiziqli spektr chiqarishi tashkil etadi. Sifat analizining vazifasi – namuna spektrida aniqlanadigan elementga xos chiziqlarni topish. Analitik chiziqning berilgan elementga tegishli ekanligi to'lqin uzunligi va chiziq intensivligi bo'yicha aniqlanadi. Aniqlash chegarasi $10^{-2} - 10^{-5}$ %.	Metod asosini spektral chiziq intensivligi va element konsentratsiyasi orasidagi bog'liqlik tashkil etadi. Odatda alohida chiziqning intensivligi emas, balki turli elementlarga tegishli ikki spektral chiziqlarning nisbati qo'llaniladi. Aniqlanadigan komponentning analitik chizig'q intensivligi boshqa komponentning (ichki standartning) analitik chiziq intensivligi bilan bir xil spektrda solishtiriladi va element konsentratsiyasi aniqlanadi. Intensivlikni aniqlash usullariga qarab, miqdoriy emission spektral analizni quyidagi metodlarga bo'lish mumkin: • vizual; • fotografik; • fotoelektrik. Aniqlash chegarasi – 0,1% gacha, $10^{-7} - 10^{-9}$ g gacha.

7-jadval

EMISSION ALANGALI FOTOMETRIYA

Sifat analizi	Miqdoriy analiz
Metod asosini analiz qilinadigan element atomlarining alanga spektrida qo'zg'alihi tashkil etadi. Gaz-yonilg'i va gaz-oksidlovchidan tarkib topgan (masalan: atsetilen+kislorod) gazlar aralashmasining alangasi qo'llaniladi. Aniqlanadigan element atomining nurlanishi yorug'lik filtri yoki monoxromator yordamida ajratiladi. Yorug'lik filtrlarining maksimumlari aniqlanadigan element atomlari spektral chiziqlarining to'lqin uzunliklariga mos tushishi kerak. Analiz atomlarning alangada nurlanadigan spektrlari bo'yicha o'tkaziladi. Asosan ishqoriy va ishqoriy-yer elementlari, taliy aniqlanadi.	Elementning aniqlanishi spektral chiziq intensivligi (I) va elementning eritmadagi konsentratsiyasi (C) orasidagi funksional bog'liqlikka asoslangan. Asosiy tenglama: $\lg I = \lg a + b \cdot \lg C$, bunda: a – proporsionallik koeffitsiyenti (yorug'lik manbaining harioratiga bog'liq); b – qo'zg'almagan atomlarning yorug'lik kvantini yutishini hisobga oluvchi koeffitsiyent. Miqdoriy aniqlash quyidagi metodlar bilan o'tkaziladi: • darajalangan grafik ($\lg I = f(\lg C)$ chziqli bog'liqlik); • qo'shimchalar metodi; Aniqlashning o'rtacha chegarasi – $10^{-3} - 10^{-4}$ %.

8-jadval

FLUORIMETRIYA

Sifat analizi	Miqdoriy analiz
Bu metod aniqlanadigan moddaning tegishli sharoitlarda lyuminessensiyalanishiga asoslangan. Organik birikmalar fluoressensiyaning xarakteristik spektral chiziqlari yoki fluoressentli nurlanishning rangi bo'yicha identifikatsiyalanadi. Anorganik ionlar uchun lyuminessensuyani keltirib chiqaradigan organik reagentlar bilan kompleks hosil bo'lish reaksiyalari qo'llaniladi. Masalan: natriy-rux-uranilatsetat sarg'ish-yashil rang bilan lyuminessensiyalanadi. Lyuminessensiyalanadigan moddalar aralashmasining analizida muayyan to'lqin uzunlikdagi lyuminessensiyani ajratuvchi yorug'lik filtrlari qo'llaniladi.	Miqdoriy analiz asosini eritma fluoressensiyasi intensivligining fluoressensiyalanadigan moddalar konsentratsiyasiga bo'lgan bog'liqligi tashkil etadi. $10^{-7} - 10^{-4}$ mol/dm^3 konsentratsiyali suyultirilgan eritmalarning fluoressensiya intensivligi quyidagi formula bo'yicha topiladi: $$F = I_0 \cdot 2{,}3 \cdot \varepsilon \cdot C \cdot b \cdot \varphi$$ bunda: F – fluoressensiya intensivligi, kvant·c^{-1}; I_0 – ta'sir etuvchi nurning intensivligi, kvant·c^{-1}; ε – yutilishning molyar koeffitsiyenti; b – fluoressensiyalanadigan qatlamning qalinligi; φ – fluoressensiya unumi (modda tabiatiga bog'liq). Aniqlash chegarasi 10^{-7} mol/dm^3. Analizga halaqit beruvchi begona qo'shimchalarni saqlagan moddalar analizida ***ekstraksion-lyuminessentli miqdoriy analiz*** qo'llaniladi. Tekshiriladigan modda organik erituvchi bilan ekstraksiyalanadi va yuqorida bayon etilgan usul bilan aniqlanadi.

5-sxema

ERITMADAGI MUALLAQ ZARRACHALAR BILAN TA'SIRLANISHDA YORUG'LIK INTENSIVLIGINI O'LCHASHGA ASOSLANGAN METODLAR

Suspenziyalar bilan ta'sirlanishda yorug'lik intensivligini o'lchashga asoslangan metodlar

Turbidimetriya

Konsentratsiyani aniqlash metodi muallaq zarrachalarni saqlagan muhitdan (suspenziya, emulsiyadan) o'tgan yorug'likning intensivligini o'lchashga asoslangan.

$$S = A = \lg\frac{I_0}{I} = -k \cdot l \cdot C,$$

bunda:

S – eritmaning loyqalanuvchanligi (optik zichlik (A) ga mos keladi va Buger-Lambert-Ber qonuni bo'yicha aniqlanadi);

k – eritmaning loyqalanuvchanlik koeffitsiyenti;

l – qatlam qalinligi;

C – muallaq zarrachalar konsentratsiyasi.

Bu tenglama faqat juda suyultirilgan eritmalar uchun qo'llaniladi.

Nefelometriya

Konsentratsiyani aniqlash metodi muallaq zarrachalar tomonidan tarqatilgan va ularning konsentratsiyasiga proporsional bo'lgan yorug'lik intensivligini I_t o'lchashga asoslangan.

$$I_t = k \cdot C.$$

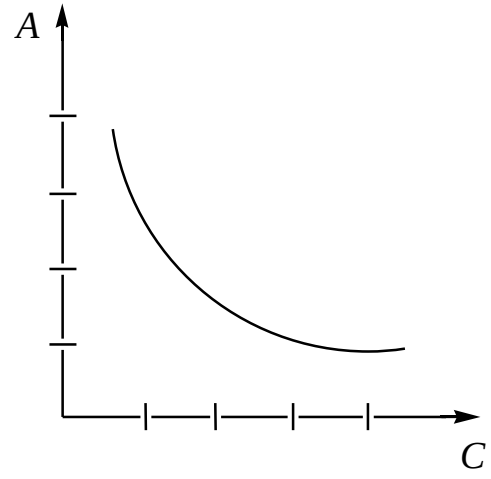
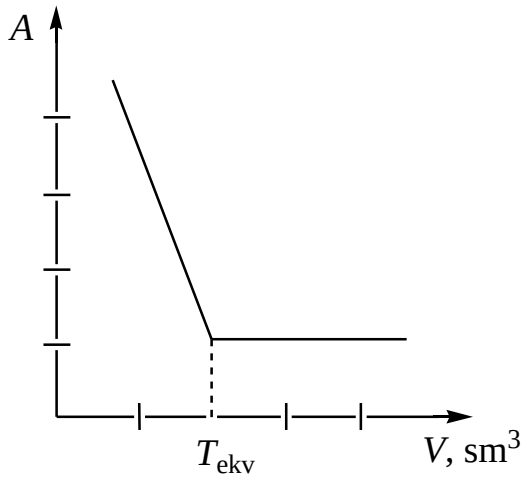
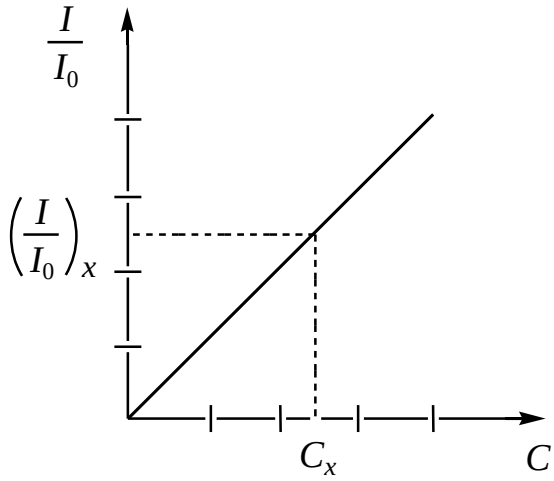
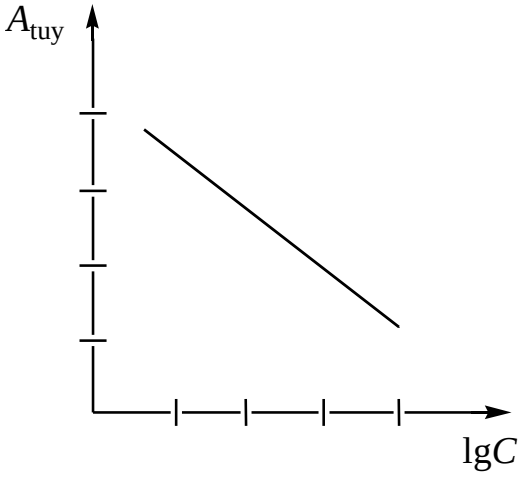
Bir xil shakl va o'lchamli zarrachalarni saqlagan ikki loyqa muhitning yorug'lik tarqatish intensivliklari nisbati eritmalar konsentratsiyalarining nisbatiga teng bo'ladi:

$$\frac{I_t^1}{I_t^2} = \frac{C_1}{C_2};\ C_1 = \frac{I_t^1 \cdot C_2}{I_t^2}.$$

9-*jadval*

TURBIDIMETRIYA VA NEFELOMETRIYA USULLARIDA MIQDORIY ANIQLASH USULLARI

Turbidimetriya	**Nefelometriya**

1. *Darajalangan grafik usuli*
Ma'lum konsentratsiyali standart eritmalarning turbidimetrik analiz natijalariga asosan $A = f(C)$ bog'liqlik grafigi tuziladi (bog'liqlik chiziqli emas).
 
 	
2. *Turbidimetrik titrlash*
Bu usul titrantning aniqlanadigan mod-da bilan qiyin eruvchan birikmalar cho'kmasini hosil qilish reaksiyasiga asoslangan.
Ekvivalent nuqtada loyqalanish maksimumga yetadi. Titrantning keyingi qo'shilishi loyqalanish darajasiga ta'sir etmaydi.
 
 	
Turbidimetrik titrlash egri chizig'i
	1. *Darajalangan grafik usuli*
	Ma'lum konsentratsiyali standart eritmalarning nefelometrik analiz natijalariga asosan grafiklar tuziladi:
	a) $\frac{I}{I_0} = f(C)$ bog'liqlik bo'yicha;
	 
	
	Konsentratsiya ortishi bilan tarqalgan yorug'likning intensivligi ham ortadi.
	b) $A_{tuy} = f(\lg C)$ bog'liqlik bo'yicha;
	 
	
	Konsentratsiya ortishi bilan tuyulma optik zichlik (A_{tuy}) kamayib boradi.

6-sxema

YORUG'LIK NURI TA'SIRIDA MOLEKULANING QUTBLANISH HODISASIGA ASOSLANGAN METODLAR

Yorug'lik ta'sirida molekulaning qutblanish hodisasiga asoslangan metodlar

Refraktometriya

Aniqlash metodi tekshiriladigan moddaning nisbiy yorug'lik sindirish ko'rsatkichini o'lchagsha asoslanadi.

$$n = \frac{v_1}{v_2} = \frac{\sin\alpha}{\sin\beta},$$

bunda:

n – havodagi yorug'lik tarqalish tezligining (v_1) tekshiriladigan eritmadagi yorug'lik tezligiga (v_2) yoki nur tushish burchagi sinusining ($\sin\alpha$) sindirish burchagi sinusiga ($\sin\beta$) nisbati;

n ning qiymatlari quyidagi shartlarda hisoblanadi:

$t^\circ = 20°C$;

$\lambda = 589{,}3$ nm (natriyning sariq chizig'i).

O'lchash uchun asbob – n-refraktometr.

O'lchash aniqligi – $2 \cdot 10^{-4}$.

Bunda sindirish ko'rsatkichi n_D^{20} bilan ifodalanadi.

Polyarimetriya

Bu metod optik faol muhitdan o'tgan qutblangan yorug'lik nuri qutblanish tekisligining aylanish burchagi (α) ni o'lchashga asoslangan.

$$[\alpha]_D^{20} = \frac{\alpha \cdot 100}{l \cdot C},$$

bunda:

$[\alpha]_D^{20}$ – nisbiy aylanish kattaligi (const);

α – graduslarda o'lchangan aylanish burchagi;

l – qatlam qalinligi, dm;

C – eritma konsentratsiyasi, g/100 ml.

α quyidagilarga bog'liq:

- erituvchi tabiati;
- optik faol moddaning konsentratsiyasi (C);
- optik faol modda qatlamining qalinligi (l).

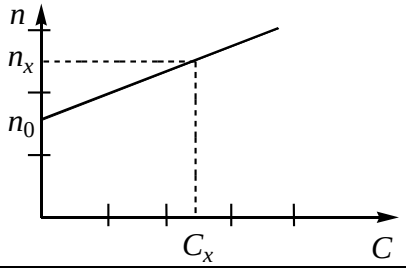
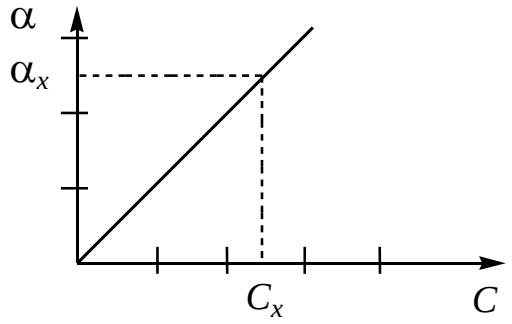
Shartlar: $t^\circ = 20°C$; $\lambda = 589{,}3$ nm $[\alpha]_D^{20}$

O'lchash uchun asbob – α-polyarimetr.

O'lchash aniqligi $\pm 0{,}02°$.

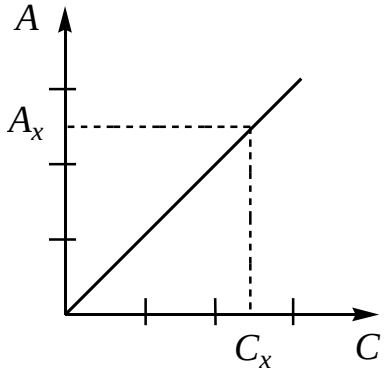
10-*jadval*

REFRAKTOMETRIYA VA POLYARIMETRIYA USULLARINING IMKONIYATLARI

Refraktometriya	**Polyarimetriya**
Sifat analizi	
1. *n* kattaligi bo'yicha moddalarni identifikatsiyalash. 2. Birikmalarning, shu jumladan dorivor preparatlarning tozaligini aniqlash.	1. $[\alpha]_D^{20}$ kattalik bo'yicha optik faol moddalarni identifikatsiyalash. α ning qiymati o'lchanadi, formula bo'yicha $[\alpha]_D^{20}$ topiladi va ma'lumotnoma qiymatlari bilan solishtiriladi.
Miqdoriy analiz	
1. Eritmaning sindirish ko'rsatkichi *n* additiv kattalik ekanligini hisobga olgan holda, moddalarning konsentratsiyasi (*C*) quyidagi formulaga muvofiq aniqlanadi: $C_x = \frac{n - n_0}{F}$, bunda: *n* – aniqlanadigan moddaning sindirish ko'rsatkichi; n_0 – erituvchining sindirish ko'rsatkichi; *F* – muayyan konsentratsiya uchun refraktometrik faktor (const), u konsentratsiya 1% ga ko'payganda sindirish ko'rsatkichi necha marta ortishini ko'rsatadi. 2. Ikki va undan ortiq komponentli aralashmalardagi moddalarning konsentratsiyasi quyidagi formula bo'yicha hisoblanadi: $C_2 = \frac{n - n_0 - F_1 C_1}{F_2}$, bunda: C_1 – boshqa usul bilan aniqlangan komponentning konsentratsiyasi; F_1 – konsentratsiyasi boshqa usul bilan aniqlangan moddaning refraktometrik faktori; F_2 – tekshiriladigan modda tarkibidagi ikkinchi komponenntning refraktometrik faktori. 3. Darajalangan grafik usuli:  	1. Optik faol moddalarning konsentratsiyasi quyidagi formulaga muvofiq topiladi: $C = \frac{\alpha \cdot 100}{[\alpha]_D^{20} \cdot l}$. 2. Darajalangan grafik usuli: 

FOTOMETRIYADA KONSENTRATSIYANI ANIQLASHNING ASOSIY USULLARI

1. *Darajalangan grafik usuli*
(faqat monoxromatik nurlar uchun qo'llaniladi).



$$A = \varepsilon \cdot l \cdot C$$
$$A = f(C)$$

2. *Molyar yutilish koeffitsiyentining o'rtacha qiymati bo'yicha aniqlash usuli*
(tekshiriladigan konsentratsiyalar sohasida Buger-Lambert-Ber qonuniga amal qilinishi shart: $A = \varepsilon \cdot l \cdot C$).

$$\varepsilon_{o'rt} = \frac{A_{st}}{l \cdot C_{st}};\ C_x = \frac{A_x}{\varepsilon \cdot l},$$

bunda:

A_{st} – standart eritmaning optik zichligi;
C_{st} – standart eritmaning konsentratsiyasi;
$\varepsilon_{o'rt}$ – molyar yutilish koeffitsiyentining o'rtacha qiymati.

Bir nechta standart eritmalarning optik zichligi A_{st} aniqlanadi, ε hisoblanadi va $\varepsilon_{o'rt}$ topiladi, A_x o'lchanadi va C_x formula bo'yicha topiladi.

3. *Qo'shimchalar usuli*
(murakkab tarkibli eritmalar analizida qo'llaniladi).

$$A_x = \varepsilon \cdot l \cdot C_x,$$

bunda:

A_x – aniqlanadigan eritmaning optik zichligi;
C_x – aniqlanadigan eritmaning konsentratsiyasi.

$$A_{x+st} = \varepsilon \cdot l \cdot (C_x + C_{st}),$$

bunda:

A_{x+st} – aniqlanadigan eritmaga qo'shilgan standart eritmaning optik zichligi;
C_{st} – standart eritmaning konsentratsiyasi.

$$\frac{A_x}{A_{x+st}} = \frac{C_x}{C_x + C_{st}} \quad \text{yoki} \quad A_x \cdot (C_x + C_{st}) = A_{x+st} \cdot C_x,$$

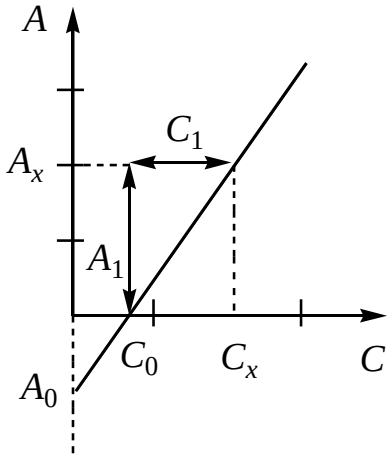
$$C_x = C_{st} \cdot \frac{A_x}{A_{x+st} - A_x}.$$

Qo'shimchalar usulida C_x ni, shuningdek $A_x = f(C_{st})$ koordinatalaridagi grafik bo'yicha ham topish mumkin.

4. *Differensial fotometriya usuli*
(rangli eritmalar analizida qo'llaniladi).

Hisoblash usullari:

I



Differensial fotometriyaning
darajalangan grafigi

$$C_x = C_0 + C_1$$
$$A_x = A_0 + A_1$$

bunda:

A_1 – yutilishning ko'payishi;
C_1 – konsentratsiyaning ko'payishi;
C_0 – ma'lum konsentratsiyali rangli eritmaning konsentratsiyasi (taqqoslash eritmasi);
A_0 – taqqoslash eritmasining optik zichligi;
C_x – tekshiriladigan eritmaning konsentratsiyasi;
A_x – tekshiriladigan eritmaning optik zichligi.

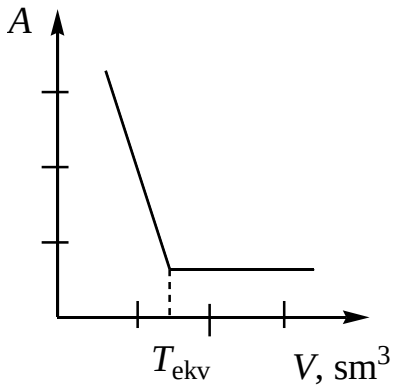
II

$$F = \frac{(C_x - C_0)}{A_n};\ C_x = C_0 + A_x \cdot F_{\text{taq}},$$

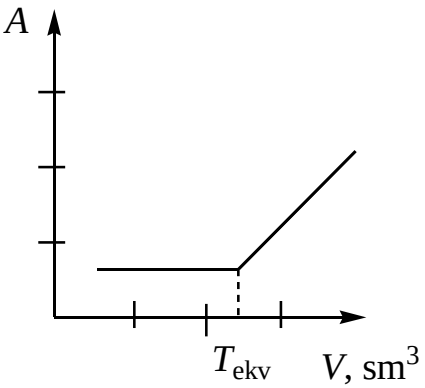
bunda:

F – analitik faktor;
C_0 – taqqoslash eritmasidagi modda miqdori;
A_n – ma'lum konsentratsiyali bir qator eritmalarning yutishi;
A_x – tekshiriladigan eritmaning yutishi.

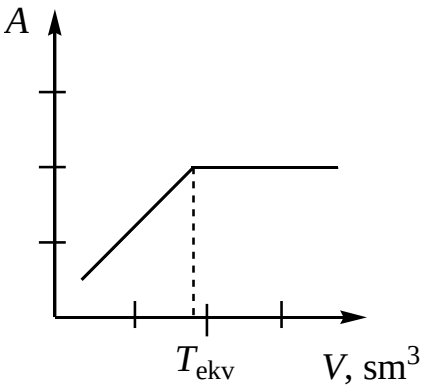
5. *Fotometrik titrlash usuli*
(ekvivalent nuqtani fotometrik aniqlash usuliga asoslangan, namunadagi ko'p sonli moddalar analizida qo'llaniladi).



Tekshiriladigan eritmaning yutish kattaligi bo'yicha fotometrik titrlash egri chizig'i



Titrantning yutish kattaligi bo'yicha fotometrik titrlash egri chizig'i



Reaksiya mahsulotining yutish kattaligi bo'yicha fotometrik titrlash egri chizig'i

6. *Ko'p to'lqinli spektrofotometriya*
(ko'p komponentli aralashmalar analizida qo'llaniladi).

$$C_1 = \frac{A^{\lambda_1} \cdot \varepsilon_2^{\lambda_2} - A^{\lambda_2} \cdot \varepsilon_2^{\lambda_1}}{\varepsilon_1^{\lambda_1} \cdot \varepsilon_2^{\lambda_2} - \varepsilon_1^{\lambda_2} \cdot \varepsilon_2^{\lambda_2}};$$

$$C_2 = \frac{A^{\lambda_2} \cdot \varepsilon_1^{\lambda_1} - A^{\lambda_1} \cdot \varepsilon_1^{\lambda_2}}{\varepsilon_1^{\lambda_1} \cdot \varepsilon_2^{\lambda_2} - \varepsilon_1^{\lambda_2} \cdot \varepsilon_2^{\lambda_2}},$$

bunda:

λ_1 – birinchi analitik to'lqin uzunligi;
λ_2 – ikkinchi analitik to'lqin uzunligi;
A^{λ_1} – λ_1 to'lqin uzunlikdagi aralashmaning optik zichligi;
A^{λ_2} – λ_2 to'lqin uzunlikdagi aralashmaning optik zichligi;
C_1 – 1-komponentning konsentratsiyasi;
C_2 – 2-komponentning konsentratsiyasi;
$\varepsilon_1^{\lambda_1}; \varepsilon_2^{\lambda_2}; \varepsilon_1^{\lambda_2}; \varepsilon_2^{\lambda_1}$ – tegishlicha λ_1 va λ_2 to'lqin uzunliklaridagi 1- va 2-komponentlarning molyar yutilish koeffitsiyentlari.

11-*jadval*

KONSENTRATSIYASI %(UM.) DA IFODALANGAN SPIRT-SUVLI ERITMALARNING SINDIRISH KO'RSATKICHLARI

Spirt konsentratsiyasi	Sindirish ko'rsatkichi (20°C da)	Har 1% spirt uchun tuzatish koeffitsiyenti	Harorat koeffitsiyenti
0	1,33300		$1{,}0\cdot10^{-4}$
1	1,33345	$4{,}5\cdot10^{-4}$	$1{,}0\cdot10^{-4}$
2	1,33400	$5{,}5\cdot10^{-4}$	$1{,}0\cdot10^{-4}$
3	1,33444	$4{,}4\cdot10^{-4}$	$1{,}1\cdot10^{-4}$
4	1,33493	$4{,}9\cdot10^{-4}$	$1{,}1\cdot10^{-4}$
5	1,33535	$4{,}2\cdot10^{-4}$	$1{,}2\cdot10^{-4}$
6	1,33587	$5{,}2\cdot10^{-4}$	$1{,}2\cdot10^{-4}$
7	1,33641	$5{,}4\cdot10^{-4}$	$1{,}3\cdot10^{-4}$
8	1,33700	$5{,}9\cdot10^{-4}$	$1{,}3\cdot10^{-4}$
9	1,33760	$6{,}0\cdot10^{-4}$	$1{,}3\cdot10^{-4}$
10	1,33808	$4{,}8\cdot10^{-4}$	$1{,}4\cdot10^{-4}$
11	1,33870	$6{,}2\cdot10^{-4}$	$1{,}4\cdot10^{-4}$
12	1,33924	$5{,}4\cdot10^{-4}$	$1{,}4\cdot10^{-4}$
13	1,33977	$5{,}3\cdot10^{-4}$	$1{,}4\cdot10^{-4}$
14	1,34043	$6{,}6\cdot10^{-4}$	$1{,}4\cdot10^{-4}$
15	1,34096	$5{,}3\cdot10^{-4}$	$1{,}5\cdot10^{-4}$
16	1,34158	$6{,}2\cdot10^{-4}$	$1{,}5\cdot10^{-4}$
17	1,34209	$5{,}1\cdot10^{-4}$	$1{,}5\cdot10^{-4}$
18	1,34270	$6{,}1\cdot10^{-4}$	$1{,}5\cdot10^{-4}$
19	1,34330	$6{,}0\cdot10^{-4}$	$1{,}5\cdot10^{-4}$
20	1,34390	$6{,}0\cdot10^{-4}$	$1{,}6\cdot10^{-4}$
21	1,34452	$6{,}2\cdot10^{-4}$	$1{,}6\cdot10^{-4}$
22	1,34512	$6{,}0\cdot10^{-4}$	$1{,}7\cdot10^{-4}$
23	1,34573	$6{,}1\cdot10^{-4}$	$1{,}8\cdot10^{-4}$
24	1,34635	$6{,}2\cdot10^{-4}$	$1{,}9\cdot10^{-4}$
25	1,34697	$6{,}2\cdot10^{-4}$	$2{,}0\cdot10^{-4}$
30	1,35000	$6{,}0\cdot10^{-4}$	$2{,}0\cdot10^{-4}$
35	1,35320	$6{,}4\cdot10^{-4}$	$2{,}1\cdot10^{-4}$
40	1,35500	$4{,}0\cdot10^{-4}$	$2{,}4\cdot10^{-4}$
45	1,35700	$4{,}0\cdot10^{-4}$	$2{,}4\cdot10^{-4}$
50	1,35900	$4{,}0\cdot10^{-4}$	$2{,}6\cdot10^{-4}$
55	1,36060	$3{,}2\cdot10^{-4}$	$2{,}6\cdot10^{-4}$
60	1,36180	$2{,}4\cdot10^{-4}$	$3{,}4\cdot10^{-4}$
65	1,36300	$2{,}4\cdot10^{-4}$	$3{,}6\cdot10^{-4}$
70	1,36380	$1{,}6\cdot10^{-4}$	$3{,}8\cdot10^{-4}$
75	1,36450	$1{,}4\cdot10^{-4}$	$4{,}0\cdot10^{-4}$

12-*jadval*

TURLI KONSENTRATSIYALI DORIVOR MODDALAR SUVLI ERITMALARINING SINDIRISH KO'RSATKICHI FAKTORLARI (*F*)

Konsentra-tsiya, %	Eritmalarning sindirish ko'rsatkichlari faktorlari			
	Ammiak eritmasi	**Analgin**	**Antipirin**	**Barbamil**
1	1 – 5%-li konsentra-tsiyalari uchun 0,00050	0,00190	0,00225	0,00181
2		0,00190	0,00225	0,00180
3		0,00180	0,00226	0,00180
4		0,00185	0,00226	0,00180
5		0,00192	0,00226	0,00180
6		0,00188	0,00226	0,00179
7		0,00186	0,00226	0,00179
8		0,00187	0,00227	0,00178
9		0,00187	0,00227	0,00178
10		0,00192	0,00227	0,00178
Konsentra-tsiya, %	**Natriy barbital**	**Geksametilen-tetramin**	**Glyukoza, suvsiz**	**Glyukoza, nam miqdorli 10%**
1	Hamma konsentra-tsiyalar uchun 0,00182	0,00164	Hamma konsentra-tsiyalar uchun 0,00142	Hamma konsentra-tsiyalar uchun 0,00129
2		0,00164		
3		0,00165		
4		0,00165		
5		0,00165		
6		0,00165		
7		0,00165		
8		0,00166		
9		0,00166		
10		0,00166		

12-*jadvalning davomi*

Konsentra-tsiya, %	**Izoniazid**	**Kaliy atsetat**	**Kaliy bromid**	**Kaliy yodid**
1	0,00200	0,00130	0,00121	Hamma konsentra-tsiyalar uchun 0,00130
2	0,00215	0,00125	0,00120	
3	0,00213	0,00123	0,00120	
4	0,00215	0,00120	0,00119	
5	0,00214	0,00116	0,00119	
6	0,00213	0,00113	0,00119	
7	0,00211	0,00110	0,00118	
8	0,00210	0,00111	0,00118	
9	0,00210	0,00110	0,00117	
10	0,00210	0,00110	0,00117	
Konsentra-tsiya, %	**Kaliy xlorid**	**Kalsiy glyukanat**	**Kalsiy xlo-rid·6H_2O**	**Aminokapron kislota**
1	0,00140	0,00164	0,00120	Hamma konsentra-tsiyalar uchun 0,00185
2	0,00135	0,00163	0,00120	
3	0,00133	0,00162	0,00120	
4	0,00132	0,00161	0,00117	
5	0,00132	0,00160	0,00116	
6	0,00131	0,00159	0,00116	
7	0,00131	0,00158	0,00116	
8	0,00130	0,00157	0,00115	
9	0,00130	0,00156	0,00115	
10	0,00130	0,00155	0,00115	

12-*jadvalning davomi*

Konsentra-tsiya, %	**Askorbin kislota**	**Borat kislota**	**Nikotin kislota**	**Kodein fosfat**
1	0,00160	Hamma konsentra-tsiyalar uchun 0,00067	Hamma konsentra-tsiyalar uchun 0,00210	Hamma konsentra-tsiyalar uchun 0,00180
2	0,00160			
3	0,00160			
4	0,00159			
5	0,00159			
6	0,00158			
7	0,00158			
8	0,00158			
9	0,00157			
10	0,00157			
Konsentra-tsiya, %	**Natriy kofeinbenzoat**	**Magniy sulfat $\times 7H_2O$**	**Natriy benzoat**	**Natriy bromid**
1	Hamma konsentra-tsiyalar uchun 0,00192	Hamma konsentra-tsiyalar uchun 0,00090	0,00211	0,00130
2			0,00211	0,00130
3			0,00210	0,00133
4			0,00210	0,00133
5			0,00210	0,00134
6			0,00210	0,00133
7			0,00210	0,00133
8			0,00209	0,00133
9			0,00209	0,00132
10			0,00209	0,00132

12-*jadvalning davomi*

Konsentra-tsiya, %	**Natriy gidrokarbonat**	**Natriy yodid**	**Natriy salitsilat**	**Natriy tetraborat**
1	Hamma konsentra-tsiyalar uchun 0,00125	Hamma konsentra-tsiyalar uchun 0,00143	0,00206	0,00110
2			0,00206	0,00110
3			0,00206	0,00110
4			0,00206	0,00107
5			0,00206	0,00106
6			0,00205	0,00103
7			0,00205	0,00100
8			0,00205	0,00100
9			0,00205	0,00100
10			0,00205	0,00100
Konsentra-tsiya, %	**Natriy tiosulfat**	**Natriy xlorid**	**Natriy gidrotsitrat**	**Natriy sitrat**
1	0,00120	0,00170	0,00100	0,00120
2	0,00120	0,00170	0,00150	0,00120
3	0,00130	0,00170	0,00140	0,00120
4	0,00127	0,00170	0,00150	0,00120
5	0,00122	0,00170	0,00140	0,00118
6	0,00117	0,00170	0,00136	0,00120
7	0,00123	0,00170	0,00143	0,00120
8	0,00125	0,00165	0,00137	0,00120
9	0,00122	0,00164	0,00144	0,00118
10	0,00121	0,00165	0,00140	0,00118

12-jadvalning davomi

Konsentra-tsiya, %	**Novokain**	**Novokain-amid**	**Natriy norsulfazol, suvsiz**	**Pilokarpin gidroxlorid**
1	0,00221	Hamma konsentra-tsiyalar uchun 0,00230	0,00239	0,00160
2	0,00221		0,00238	0,00165
3	0,00221		0,00238	0,00166
4	0,00221		0,00238	0,00167
5	0,00220		0,00237	0,00166
6	0,00220		0,00237	0,00166
7	0,00220		0,00237	0,00166
8	0,00220		0,00236	0,00166
9	0,00220		0,00236	0,00166
10	0,00220		0,00235	0,00166
Konsentra-tsiya, %	**Rezorsin**	**Natriy sulfatsilat**		**Eruvchan streptotsid**
1	1 – 5%-li konsentra-tsiyalar uchun 0,00200	0,00198		0,00190
2		0,00195		0,00190
3		0,00197		0,00190
4		0,00197		0,00190
5		0,00198		0,00188
6		0,00198		0,00188
7		0,00198		0,00188
8		0,00198		0,00188
9		0,00198		0,00188
10		0,00197		0,00188

ILOVALAR

1-*jadval*

TURLI HARORATLARDA SUVNING ION KO'PAYTMASI K_{H_2O}

t °C	K_{H_2O}	$aH^+ = aOH^-$	t °C	K_{H_2O}	$aH^+ = aOH^-$
0	$0{,}13\cdot10^{-14}$	$0{,}36\cdot10^{-7}$	28	$1{,}62\cdot10^{-14}$	$1{,}27\cdot10^{-7}$
5	$0{,}21\cdot10^{-14}$	$0{,}46\cdot10^{-7}$	29	$1{,}76\cdot10^{-14}$	$1{,}33\cdot10^{-7}$
10	$0{,}36\cdot10^{-14}$	$0{,}59\cdot10^{-7}$	30	$1{,}89\cdot10^{-14}$	$1{,}37\cdot10^{-7}$
15	$0{,}58\cdot10^{-14}$	$0{,}76\cdot10^{-7}$	35	$0{,}27\cdot10^{-13}$	$1{,}65\cdot10^{-7}$
16	$0{,}63\cdot10^{-14}$	$0{,}79\cdot10^{-7}$	40	$0{,}38\cdot10^{-13}$	$1{,}95\cdot10^{-7}$
17	$0{,}68\cdot10^{-14}$	$0{,}82\cdot10^{-7}$	50	$0{,}56\cdot10^{-13}$	$2{,}4\cdot10^{-7}$
18	$0{,}74\cdot10^{-14}$	$0{,}86\cdot10^{-7}$	60	$1{,}26\cdot10^{-13}$	$3{,}55\cdot10^{-7}$
19	$0{,}79\cdot10^{-14}$	$0{,}89\cdot10^{-7}$	70	$2{,}10\cdot10^{-13}$	$0{,}49\cdot10^{-6}$
20	$0{,}86\cdot10^{-14}$	$0{,}93\cdot10^{-7}$	80	$3{,}40\cdot10^{-13}$	$0{,}58\cdot10^{-6}$
21	$0{,}93\cdot10^{-14}$	$0{,}96\cdot10^{-7}$	90	$0{,}52\cdot10^{-12}$	$0{,}72\cdot10^{-6}$
22	$1{,}00\cdot10^{-14}$	$1{,}00\cdot10^{-7}$	100	$0{,}74\cdot10^{-12}$	$0{,}86\cdot10^{-6}$
23	$1{,}10\cdot10^{-14}$	$1{,}05\cdot10^{-7}$	120	$1{,}25\cdot10^{-12}$	$1{,}12\cdot10^{-6}$
24	$1{,}19\cdot10^{-14}$	$1{,}09\cdot10^{-7}$	140	$1{,}80\cdot10^{-12}$	$1{,}34\cdot10^{-6}$
25	$1{,}27\cdot10^{-14}$	$1{,}13\cdot10^{-7}$	160	$2{,}50\cdot10^{-12}$	$1{,}58\cdot10^{-6}$
26	$1{,}38\cdot10^{-14}$	$1{,}17\cdot10^{-7}$	180	$3{,}20\cdot10^{-12}$	$1{,}80\cdot10^{-6}$
27	$1{,}50\cdot10^{-14}$	$1{,}23\cdot10^{-7}$	200	$0{,}40\cdot10^{-11}$	$2{,}0\cdot10^{-6}$

2-jadval

BA'ZI KISLOTA VA ISHQOR ERITMALARINING ZICHLIGI VA KONSENTRATSIYASI
(*t* = 20 °C)

Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l	Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l
Kislotalar: **n i t r a t**					
1,000	0,333	0,052	1,280	45,27	9,195
1,020	3,982	0,645	1,300	48,42	9,990
1,040	7,530	1,243	1,320	51,71	10,83
1,060	10,97	1,845	1,340	55,13	11,72
1,080	14,31	2,453	1,360	58,78	12,68
1,100	17,58	3,068	1,380	62,70	13,73
1,130	22,38	4,012	1,400	66,97	14,88
1,150	25,48	4,649	1,420	71,63	16,14
1,170	28,51	5,293	1,440	76,71	17,53
1,190	31,47	5,943	1,460	82,39	19,09
1,200	32,94	6,273	1,480	89,07	20,92
1,210	34,41	6,607	1,500	96,73	23,02
1,220	35,93	6,956	1,510	99,26	23,79
1,240	39,02	7,679	1,513	100,00	24,01
1,260	42,14	8,426			
s u l f a t					
1,000	0,261	0,027	1,340	44,17	6,035
1,020	3,242	0,337	1,360	46,33	6,424
1,040	6,237	0,661	1,380	48,45	6,817
1,060	9,129	0,987	1,400	50,50	7,208
1,080	11,96	1,317	1,420	52,51	7,603
1,100	14,73	1,652	1,440	54,49	8,000
1,120	17,43	1,990	1,460	56,41	8,397
1,140	20,08	2,334	1,480	58,31	8,799
1,160	22,67	2,681	1,500	60,17	9,202
1,180	25,21	3,033	1,520	62,00	9,608
1,200	27,72	3,391	1,580	67,35	10,85
1,220	30,18	3,754	1,640	72,52	12,13
1,240	32,61	4,123	1,700	77,63	13,46
1,260	35,01	4,498	1,750	82,09	14,65
1,280	37,36	4,876	1,800	87,69	16,09
1,300	39,68	5,259	1,820	91,11	16,91
1,320	41,95	5,646	1,835	95,72	17,91

2-jadvalning davomi

Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l	Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l
o r t o f o s f a t					
1,000	0,296	0,030	1,340	50,66	6,928
1,020	4,000	0,416	1,380	55,28	7,84
1,040	7,643	0,811	1,420	59,74	8,658
1,060	11,19	1,210	1,460	64,03	9,541
1,080	14,60	1,609	1,500	68,10	10,42
1,100	17,87	2,005	1,540	72,00	11,32
1,120	21,03	2,403	1,580	75,76	12,22
1,140	24,07	2,800	1,620	79,40	13,12
1,160	27,05	3,203	1,660	82,96	14,06
1,180	29,94	3,606	1,700	86,38	14,98
1,200	32,75	4,010	1,740	89,72	15,93
1,220	35,50	4,420	1,780	92,97	16,89
1,240	38,17	4,829	1,820	96,15	17,85
1,260	40,79	5,245	1,840	97,71	18,34
1,280	43,37	5,655	1,860	99,24	18,84
1,300	45,88	6,087	1,870	100,00	19,08
x i o r i d					
1,000	0,360	0,099	1,110	22,33	6,796
1,010	2,364	0,655	1,120	24,25	7,449
1,020	4,388	1,227	1,130	26,20	8,118
1,030	6,433	1,817	1,140	28,18	8,809
1,040	8,490	2,421	1,150	30,14	9,505
1,050	10,52	3,029	1,160	32,14	10,225
1,060	12,51	3,638	1,170	34,18	10,97
1,070	14,50	4,253	1,180	36,23	11,73
1,080	16,47	4,878	1,190	38,32	12,50
1,090	18,43	5,510	1,198	40,00	13,14
1,100	20,39	6,150			
x l o r a t					
1,005	0,00	0,100	1,300	40,10	5,189
1,020	3,61	0,366	1,350	44,81	6,021
1,060	10,06	1,061	1,400	49,23	6,860
1,100	16,00	1,752	1,450	53,27	7,689
1,140	21,64	2,456	1,500	57,06	8,519
1,180	26,82	3,150	1,550	60,78	9,377
1,220	31,61	3,839	1,600	64,50	10,27
1,260	36,03	4,519	1,675	70,15	11,70

2-jadvalning davomi

Zichlik, kg/m^3	**Massa ulushi, %**	**Molyarlik, mol/l**	**Zichlik, kg/m^3**	**Massa ulushi, %**	**Molyarlik, mol/l**
Ishqorlar: **a m m i a k e r i t m a s i**					
0,880	34,35	17,75	0,940	14,88	8,21
0,884	32,84	17,05	0,958	9,87	5,55
0,888	31,37	16,36	0,960	9,34	5,23
0,892	30,00	15,71	0,980	4,27	2,46
0,896	28,67	15,08	0,990	1,89	1,10
0,900	27,33	14,44	0,994	0,98	0,57
0,908	24,68	13,16	0,998	0,05	0,03
0,920	20,88	11,28			
k a l i y g i d r o k s i d (o’yuvchi kaliy)					
1,000	0,20	0,035	1,330	33,97	8,05
1,005	0,74	0,133	1,400	40,37	10,07
1,050	5,66	1,06	1,450	44,79	11,58
1,080	8,89	1,71	1,500	49,10	13,13
1,095	10,49	2,05	1,510	49,95	13,45
1,110	12,08	2,39	1,520	50,80	13,76
1,200	21,38	4,57	1,530	51,64	14,08
1,290	30,21	6,95	1,535	52,05	14,24
n a t r i y g i d r o k s i d (o’yuvchi natriy)					
1,000	0,159	0,040	1,330	30,20	10,04
1,005	0,602	0,151	1,400	36,99	12,95
1,050	4,655	1,222	1,450	42,07	15,25
1,080	7,38	1,992	1,500	47,33	17,75
1,095	8,74	2,391	1,510	48,38	18,26
1,110	10,10	2,802	1,520	49,44	18,78
1,200	18,26	5,476	1,530	50,50	19,31
1,290	26,48	8,539			

3-*jadval*

KISLOTALARNING IONLANISH KONSTANTALARI
(KISLOTALILIK KONSTANTALARI)

Kislota nomi	**Formulasi**	K_a	$pK_a = -\lg K_a$
Bir asosli			
Nitrit	HNO_2	$6{,}9\cdot10^{-4}$	3,16
Azid	HN_3	$2{,}0\cdot10^{-5}$	4,70
Vodorod per-oksid	H_2O_2	$2{,}6\cdot10^{-12}$	11,58
Rodanid	HSCN	$1{,}4\cdot10^{-1}$	0,85
Ftorid	HF	$6{,}2\cdot10^{-4}$	3,21
Xlorit	$HClO_2$	$1{,}1\cdot10^{-2}$	1,97
Gipoxlorit	HClO	$2{,}95\cdot10^{-8}$	7,53
Sianat	HCNO	$2{,}7\cdot10^{-4}$	3,57
Sianid	HCN	$5{,}0\cdot10^{-10}$	9,30
Aminosirka (glisin)	NH_2CH_2COOH	$1{,}7\cdot10^{-10}$	9,77
Benzoy	C_6H_5COOH	$6{,}3\cdot10^{-5}$	4,20
Xlorbenzoy	ClC_6H_4COOH	$1{,}2\cdot10^{-3}$	2,92
Glikol	$CH_2(OH)COOH$	$1{,}5\cdot10^{-4}$	3,83
Glyukon	$CH_2OH(CHOH)_4COOH$	$1{,}4\cdot10^{-4}$	3,86
Kroton (β-metilakril)	$CH_3CH = COOH$	$2{,}0\cdot10^{-5}$	4,69
Laurin	$CH_3(CH_2)_{10}COOH$	$1{,}1\cdot10^{-5}$	4,95
Sut	$CH_3CHOHCOOH$	$1{,}38\cdot10^{-4}$	3,86
Chumoli	HCOOH	$1{,}78\cdot10^{-4}$	3,75
o-Nitrobenzoy	$O_2NC_6H_4COOH(1,2)$	$6{,}8\cdot10^{-3}$	2,17
Pikrin	$HOC_6H_2(NO_2)_3$	$4{,}2\cdot10^{-1}$	0,38
Propion	CH_3CH_2COOH	$1{,}35\cdot10^{-5}$	4,87
Moy	$CH_3(CH_2)_2COOH$	$1{,}5\cdot10^{-5}$	4,82
Sirka	CH_3COOH	$1{,}75\cdot10^{-5}$	4,75
Fenol	C_6H_5OH	$1{,}05\cdot10^{-10}$	9,98

3-*jadvalning davomi*

Monoxlorsirka	$CH_2ClCOOH$	$1{,}41\cdot10^{-3}$	2,85
Dixlorsirka	$CHCl_2COOH$	$5{,}0\cdot10^{-2}$	1,30
Trixlorsirka	CCl_3COOH	$2{,}0\cdot10^{-1}$	0,70
Monoyodsirka	CH_2ICOOH	$6{,}7\cdot10^{-4}$	3,17
Ikki asosli			
Sulfit	H_2SO_3	$K_1 = 1{,}4\cdot10^{-2}$ $K_2 = 6{,}2\cdot10^{-8}$	1,85 7,20
Sulfid	H_2S	$K_1 = 1{,}0\cdot10^{-7}$ $K_2 = 2{,}5\cdot10^{-13}$	7,00 12,60
Karbonat	H_2CO_3	$K_1 = 4{,}5\cdot10^{-7}$ $K_2 = 5{,}0\cdot10^{-11}$	6,35 10,30
Xromat	H_2CrO_4	$K_1 = 2{,}1\cdot10^{-1}$ $K_2 = 3{,}2\cdot10^{-7}$	0,67 6,50
Vino	$H_2C_4H_4O_6$	$K_1 = 1{,}3\cdot10^{-3}$ $K_2 = 3{,}0\cdot10^{-5}$	2,89 4,52
Selenat	H_2SeO_3	$K_1 = 1{,}8\cdot10^{-3}$ $K_2 = 3{,}2\cdot10^{-9}$	2,75 8,5
Tellurit	H_2TeO_3	$K_1 = 2{,}7\cdot10^{-3}$ $K_2 = 1{,}8\cdot10^{-8}$	2,57 7,74
Oksalat	$H_2C_2O_4$	$K_1 = 5{,}6\cdot10^{-2}$ $K_2 = 5{,}4\cdot10^{-5}$	1,25 4,27
Qahrabo	$H_2C_4H_4O_4$	$K = 6{,}17\cdot10^{-5}$ $K = 2{,}29\cdot10^{-6}$	4,21 5,64
Salitsil	$C_6H_4(OH)COOH$	$K_1 = 1{,}1\cdot10^{-3}$ $K_2 = 3{,}6\cdot10^{-14}$	2,97 13,59
Sulfosalitsil	$HSO_3C_6H_3(OH)COOH$	$K_2 = 3{,}1\cdot10^{-3}$ $K_3 = 2{,}0\cdot10^{-12}$	2,51 11,70
Uch asosli			
Borat	H_3BO_3	$K_1 = 7{,}1\cdot10^{-10}$ $K_2 = 1{,}8\cdot10^{-13}$ $K_3 = 1{,}6\cdot10^{-14}$	9,15 12,74 13,80

3-*jadvalning davomi*

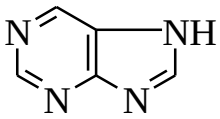
Arsenat	H_3AsO_4	$K_1 = 5{,}6\cdot10^{-3}$ $K_2 = 1{,}7\cdot10^{-7}$ $K_3 = 2{,}95\cdot10^{-12}$	2,25 6,77 11,53
Ortofosfat	H_3PO_4	$K_1 = 7{,}1\cdot10^{-3}$ $K_2 = 6{,}2\cdot10^{-8}$ $K_3 = 5{,}0\cdot10^{-13}$	2,15 7,21 12,3
Fosfit	H_3PO_3	$K_1 = 2{,}5\cdot10^{-2}$ $K_2 = 2{,}0\cdot10^{-7}$	1,6 6,7
To'rt asosli			
Etilendiamin-tetrasirka	$(CH_2)_2N_2(CH_2COOH)_4(H_4Y)$	$K_1 = 1{,}0\cdot10^{-2}$ $K_2 = 2{,}1\cdot10^{-3}$ $K_3 = 6{,}9\cdot10^{-7}$ $K_4 = 5{,}5\cdot10^{-11}$	2,00 2,67 6,16 10,26
Ortosilikat	H_4SiO_4	$K_1 = 1{,}3\cdot10^{-10}$ $K_2 = 1{,}6\cdot10^{-12}$ $K_3 = 2{,}0\cdot10^{-14}$	9,9 11,8 13,7

4-*jadval*

ASOSLARNING IONLANISH KONSTANTALARI
(ASOSLILIK KONSTANTALARI)

Asos nomi	**Formulasi**	K_b	$pK_b = -\lg K_b$
Bir kislotali			
Ammiak	$NH_3\cdot H_2O$	$1{,}76\cdot10^{-5}$	4,76
Litiy gidroksid	LiOH	$6{,}8\cdot10^{-1}$	0,17
Anilin	$C_6H_5NH_2$	$3{,}31\cdot10^{-10}$	9,48
Butilamin	$CH_3(CH_2)_2CH_2NH_2 + H_2O$	$6{,}0\cdot10^{-4}$	3,22
Dimetilamin	$(CH_3)_2NH$	$7{,}24\cdot10^{-4}$	3,14
Dimetilanilin	$C_6H_5N(CH_3)_2$	$2{,}4\cdot10^{-10}$	9,62
Dietilamin	$(C_2H_5)_2NH$	$9{,}55\cdot10^{-4}$	3,02
Metilamin	CH_3NH_2	$5{,}37\cdot10^{-4}$	3,27

4-jadvalning davomi

Piridin	C_5H_5N	$1{,}51\cdot10^{-9}$	8,82
Trietilamin	$(C_2H_5)_3N + H_2O$	$1{,}0\cdot10^{-3}$	2,99
Xinolin	C_9H_7N	$8{,}71\cdot10^{-10}$	9,06
Etilamin	$C_2H_5NH_2$	$4{,}68\cdot10^{-4}$	3,33
Etilanilin	$C_6H_5NHC_2H_5$	$4{,}0\cdot10^{-10}$	9,40
Ikki kislotali			
Bariy gidroksid	$Ba(OH)_2$	$K_2 = 2{,}29\cdot10^{-1}$	0,64
Kalsiy gidroksid	$Ca(OH)_2$	$K_2 = 4{,}27\cdot10^{-2}$	1,37
Qo'rg'oshin gidroksid	$Pb(OH)_2$	$K_1 = 8{,}71\cdot10^{-4}$ $K_2 = 1{,}51\cdot10^{-8}$	3,06 7,82
Rux gidroksid	$Zn(OH)_2$	$K_2 = 1{,}5\cdot10^{-9}$	8,82
Gidrazin	N_2H_4	$K_1 = 9{,}33\cdot10^{-7}$ $K_2 = 1{,}86\cdot10^{-14}$	6,03 13,73
Gidroksilamin	NH_2OH	$9{,}33\cdot10^{-9}$	8,03
Pirazin	$N = CHCH = NCH = CH + H_2O$	$4{,}5\cdot10^{-14}$	13,35
Purin	 $+ H_2O$	$2{,}45\cdot10^{-12}$	11,61
Tiomochevina	$CS(NH_2)_2 + H_2O$	$1{,}1\cdot10^{-12}$	11,97
Fenilgidrazin	$C_6H_5NHNH_2 + H_2O$	$1{,}6\cdot10^{-9}$	8,80

5-*jadval*

BUFER ARALASHMALAR

Universal bufer aralashma

100 ml H_3PO_4, CH_3COOH, H_3BO_3 aralashmasi (har bir komponentning nisbati 0,04M bo'lgan eritma) + *a* ml 0,2M NaOH

pH	*a*	pH	*a*
1,81	0	6,80	50,0
1,89	2,5	7,00	52,5
1,98	5,0	7,24	55,0
2,09	7,5	7,54	57,5
2,21	10,0	7,96	60,0
2,36	12,5	8,36	62,5
2,56	15,0	8,69	65,0
2,87	17,5	8,95	67,5
3,29	20,0	9,15	70,0
3,78	22,5	9,37	72,5
4,10	25,0	9,69	75,0
4,35	27,5	9,91	77,5
4,56	30,0	10,38	80,0
4,78	32,5	10,88	82,5
5,02	35,0	11,20	85,0
2,33	37,5	11,40	87,5
5,72	40,0	11,58	90,0
6,09	42,5	11,70	92,5
6,37	45,0	11,82	95,0
6,59	47,5	11,98	100,0

Atsetatli bufer aralashma

pH ning talab etiladigan qiymatidagi bufer eritmani tayyorlash uchun ko'rsatilgan hajmdagi 1M sirka kislotadan o'lchab olinadi, 50,0 ml 1M NaOH eritmasi qo'shiladi va 500 ml gacha distillangan suv bilan suyultiriladi

pH	Sirka kislota, 1M, ml	pH	Sirka kislota, 1M, ml	pH	Sirka kislota, 1M, ml
3,8	421,5	4,67	100,0	5,5	57,4
3,9	345,1	4,7	96,8	5,6	55,9
4,0	284,4	4,8	87,2	5,7	54,7
4,1	136,2	4,9	79,5	5,8	53,7
4,2	197,9	5,0	73,4	5,9	53,0
4,3	167,4	5,1	68,6	6,0	52,3
4,4	143,3	5,2	64,8	6,1	51,9
4,5	124,1	5,3	61,7	6,2	51,5
4,6	108,9	5,4	59,3	6,3	51,2

5-*jadvalning davomi*

Fosfatli bufer aralashma *a* ml 1/15M Na_2HPO_4 va (100 – *a*) ml 1/15M KH_2PO_4 dan iborat aralashma			
pH	***a***	**pH**	***a***
4,80	0,35	6,45	28,70
4,85	0,45	6,50	31,30
4,90	0,60	6,55	34,10
4,95	0,75	6,60	37,10
5,00	0,95	6,65	40,00
5,05	1,15	6,70	43,00
5,10	1,35	6,75	46,00
515	1,55	6,80	49,20
5,20	1,80	6,85	52,20
5,25	2,05	6,90	55,20
5,30	2,30	6,95	58,20
5,35	2,65	7,00	61,20
5,40	3,00	7,05	64,20
5,45	3,45	7,10	67,00
5,50	3,90	7,15	69,80
5,55	4,35	7,20	72,60
5,60	4,90	7,25	75,40
5,65	5,50	7,30	77,70
5,70	6,20	7,35	79,90
5,75	7,00	7,40	81,80
5,80	7,90	7,45	83,50
5,85	8,80	7,50	85,20
5,90	9,80	7,55	86,90
5,95	10,80	7,60	88,50
6,00	12,10	7,65	89,90
6,05	13,50	7,70	91,20
6,10	15,00	7,75	92,40
6,15	16,70	7,80	93,60
6,20	18,40	7,85	94,60
6,25	20,10	7,90	95,50
6,30	22,10	7,95	96,20
6,35	24,20	8,00	96,90
6,40	26,40		

5-*jadvalning davomi*

Ayrim moddalarning bufer eritmalari	
modda	**pH**
0,05M kaliy tetraoksalat digidrat eritmasi ($KH_3C_4H_4O_8 \cdot 2H_2O$; M.m. 254,19)	1,679 (25 °C)
Kaliy gidrotartratning to'yingan eritmasi (≈ 0,025M) ($KHC_4H_4O_6$; M.m. 188,178)	3,567 (25 °C)
0,05M kaliy digidrotsitrat ($KH_2C_6H_5O_7$; M.m. 230,215)	3,776 (25 °C)
0,05M kaliy gidroftalat eritmasi ($KHC_8H_4O_4$; M.m. 204,223)	4,008 (25 °C)
Piperazinfosfatning to'yingan eritmasi* (≈ 0,065M) ($C_4H_{12}N_2HPO_4 \cdot H_2O$; M.m. 202,147)	6,36 (16 °C); 6,34 (18 °C)
0,05M natriy tetraborat eritmasi ($Na_2B_4O_7 \cdot 10H_2O$; M.m. 381,372)	9,18 (25 °C); 9,07 (38 °C)

* xona haroratida ekvimolekulyar miqdorda piperazin va fosfat kislotalarni aralashtirib va qayta kristallab piperazin-fosfat tayyorlanadi

6-*jadval*

BA'ZI ELEKTROLITLARNING TERMODINAMIK (EK^T) VA KONSENTRATSION (EK^K) ERUVCHANLIK KO'PAYTMALARI HAMDA ERUVCHANLIGI (S)

Birikma formulasi	EK^T	EK^K	S_M, mol/l	S, g/100 ml
a r s e n a t l a r				
Ag_3AsO_4		$1{,}12\cdot10^{-20}$	$3{,}59\cdot10^{-6}$	$1{,}66\cdot10^{-4}$
$AlAsO_4$	$1{,}6\cdot10^{-16}$	$1{,}6\cdot10^{-16}$	$1{,}27\cdot10^{-8}$	$2{,}10\cdot10^{-7}$
$Ba_3(AsO_4)_2$		$7{,}76\cdot10^{-51}$	$3{,}73\cdot10^{-11}$	$2{,}57\cdot10^{-9}$
$BiAsO_4$		$4{,}37\cdot10^{-10}$	$2{,}09\cdot10^{-5}$	$7{,}27\cdot10^{-4}$
$Ca_3(AsO_4)_2$		$6{,}76\cdot10^{-19}$	$9{,}11\cdot10^{-5}$	$3{,}62\cdot10^{-3}$
$Co_3(AsO_4)_2$		$7{,}6\cdot10^{-29}$	$2{,}34\cdot10^{-6}$	$1{,}06\cdot10^{-4}$
$CrAsO_4$	$7{,}8\cdot10^{-21}$	$7{,}8\cdot10^{-21}$	$8{,}33\cdot10^{-11}$	$1{,}69\cdot10^{-9}$
$Cu_3(AsO_4)_2$	$7{,}6\cdot10^{-36}$	$7{,}6\cdot10^{-36}$	$9{,}32\cdot10^{-8}$	$4{,}37\cdot10^{-6}$
$FeAsO_4$	$5{,}8\cdot10^{-21}$	$5{,}8\cdot10^{-21}$	$7{,}61\cdot10^{-11}$	$1{,}48\cdot10^{-9}$
$Mg_3(AsO_4)_2$		$2{,}09\cdot10^{-20}$	$4{,}54\cdot10^{-5}$	$1{,}59\cdot10^{-3}$
$Mn_3(AsO_4)_2$	$1{,}9\cdot10^{-29}$	$1{,}9\cdot10^{-29}$	$7{,}07\cdot10^{-7}$	$3{,}13\cdot10^{-5}$
$Ni_3(AsO_4)_2$	$3{,}1\cdot10^{-26}$	$3{,}1\cdot10^{-26}$	$3{,}10\cdot10^{-6}$	$1{,}41\cdot10^{-4}$
$Pb_3(AsO_4)_2$	$4{,}1\cdot10^{-36}$	$4{,}1\cdot10^{-36}$	$3{,}28\cdot10^{-8}$	$2{,}95\cdot10^{-6}$
$Sr_3(AsO_4)_2$		$1{,}62\cdot10^{-18}$	$1{,}09\cdot10^{-4}$	$5{,}87\cdot10^{-3}$
$Zn_3(AsO_4)_2$	$1{,}07\cdot10^{-16}$	$1{,}07\cdot10^{-27}$	$1{,}58\cdot10^{-6}$	$7{,}50\cdot10^{-4}$
a r s e n i t l a r				
Ag_3AsO_3	$1{,}0\cdot10^{-17}$	$1{,}22\cdot10^{-17}$	$2{,}60\cdot10^{-5}$	$5{,}99\cdot10^{-4}$
b r o m i d l a r				
$AgBr$	$4{,}90\cdot10^{-13}$	$4{,}90\cdot10^{-13}$	$7{,}12\cdot10^{-7}$	$1{,}34\cdot10^{-5}$
$CuBr$	$5{,}25\cdot10^{-9}$	$5{,}25\cdot10^{-9}$	$7{,}24\cdot10^{-5}$	$1{,}04\cdot10^{-3}$
$HgBr_2$	$5{,}75\cdot10^{-23}$	$5{,}75\cdot10^{-23}$	$1{,}38\cdot10^{-6}$	$7{,}73\cdot10^{-5}$
$PbBr_2$	$9{,}12\cdot10^{-6}$	$2{,}76\cdot10^{-5}$	$2{,}73\cdot10^{-2}$	1,00
g i d r o k s i d l a r				
$AgOH$	$1{,}60\cdot10^{-8}$	$1{,}63\cdot10^{-8}$	$1{,}61\cdot10^{-4}$	$2{,}01\cdot10^{-3}$
$Al(OH)_3$	$1{,}10\cdot10^{-33}$	$1{,}10\cdot10^{-33}$	$2{,}52\cdot10^{-9}$	$1{,}97\cdot10^{-8}$
$Bi(OH)_3$	$4{,}27\cdot10^{-31}$	$4{,}27\cdot10^{-31}$	$1{,}12\cdot10^{-8}$	$2{,}92\cdot10^{-7}$

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$Ca(OH)_2$	$5{,}49\cdot10^{-6}$	$7{,}96\cdot10^{-6}$	$1{,}26\cdot10^{-2}$	$9{,}32\cdot10^{-2}$
$Cd(OH)_2$ passiv shakl	$3{,}98\cdot10^{-15}$	$3{,}98\cdot10^{-15}$	$1{,}07\cdot10^{-5}$	$1{,}57\cdot10^{-4}$
$Ce(OH)_2$	$6{,}32\cdot10^{-22}$	$6{,}32\cdot10^{-22}$	$2{,}21\cdot10^{-6}$	$4{,}20\cdot10^{-5}$
$Co(OH)_2$ havorang	$6{,}31\cdot10^{-15}$	$6{,}31\cdot10^{-15}$	$1{,}16\cdot10^{-5}$	$1{,}08\cdot10^{-4}$
$Co(OH)_2$	$1{,}59\cdot10^{-15}$	$1{,}59\cdot10^{-15}$	$7{,}35\cdot10^{-6}$	$6{,}83\cdot10^{-5}$
$Co(OH)_2$ pushti, yangi	$2{,}00\cdot10^{-16}$	$2{,}00\cdot10^{-16}$	$3{,}68\cdot10^{-6}$	$3{,}42\cdot10^{-5}$
$Co(OH)_3$ pushti, eskirgan	$1{,}00\cdot10^{-43}$	$1{,}00\cdot10^{-43}$	$7{,}80\cdot10^{-12}$	$8{,}58\cdot10^{-11}$
$Cr(OH)_3$	$6{,}31\cdot10^{-31}$	$6{,}31\cdot10^{-31}$	$1{,}24\cdot10^{-8}$	$1{,}27\cdot10^{-7}$
$Fe(OH)_2$	$7{,}94\cdot10^{-16}$	$7{,}94\cdot10^{-16}$	$1{,}05\cdot10^{-5}$	$9{,}45\cdot10^{-5}$
$Fe(OH)_3$	$3{,}72\cdot10^{-40}$	$3{,}72\cdot10^{-40}$	$1{,}80\cdot10^{-9}$	$1{,}93\cdot10^{-8}$
$Hg_2(OH)_2$ (Hg_2O)	$1{,}60\cdot10^{-23}$	$1{,}60\cdot10^{-23}$	$1{,}59\cdot10^{-8}$	$6{,}92\cdot10^{-7}$
$Hg(OH)_2$ (HgO)	$3{,}0\cdot10^{-26}$	$3{,}0\cdot10^{-26}$	$1{,}95\cdot10^{-8}$	$4{,}57\cdot10^{-7}$
$LiOH$	$4{,}0\cdot10^{-2}$	$6{,}25\cdot10^{-2}$	0,3425	0,8202
$Mg(OH)_2$ barq. shakli	$1{,}12\cdot10^{-11}$	$1{,}31\cdot10^{-11}$	$1{,}49\cdot10^{-4}$	$8{,}67\cdot10^{-4}$
$Mn(OH)_2$	$1{,}59\cdot10^{-13}$	$1{,}70\cdot10^{-13}$	$3{,}49\cdot10^{-5}$	$3{,}11\cdot10^{-4}$
$Ni(OH)_2$	$3{,}16\cdot10^{-16}$	$3{,}16\cdot10^{-16}$	$4{,}40\cdot10^{-6}$	$4{,}08\cdot10^{-5}$
$Ni(OH)_2$ eskirgan	$6{,}3\cdot10^{-18}$	$6{,}3\cdot10^{-18}$	$1{,}17\cdot10^{-6}$	$1{,}08\cdot10^{-5}$
$Pb(OH)_2 \leftrightarrow Pb^{2+} + 2OH^-$	$1{,}0\cdot10^{-20}$	$1{,}0\cdot10^{-20}$	$1{,}36\cdot10^{-7}$	$3{,}29\cdot10^{-6}$
$Pb(OH)_2 \leftrightarrow PbOH^+ + OH^-$	$8{,}7\cdot10^{-14}$	$8{,}7\cdot10^{-14}$	$2{,}96\cdot10^{-7}$	$7{,}13\cdot10^{-6}$
$Pt(OH)_2$	$1{,}0\cdot10^{-35}$	$1{,}0\cdot10^{-35}$	$1{,}23\cdot10^{-12}$	$2{,}82\cdot10^{-11}$
$Pt(OH)_4$ (PtO_2)	$1{,}6\cdot10^{-72}$	$1{,}6\cdot10^{-72}$	$1{,}44\cdot10^{-15}$	$3{,}79\cdot10^{-14}$
$Sb(OH)_3$	$3{,}99\cdot10^{-42}$	$3{,}99\cdot10^{-42}$	$2{,}0\cdot10^{-5}$	$3{,}45\cdot10^{-4}$
$Sn(OH)_2 \leftrightarrow Sn^{2+} + 2OH^-$	$1{,}41\cdot10^{-28}$	$1{,}41\cdot10^{-28}$	$1{,}39\cdot10^{-7}$	$2{,}12\cdot10^{-6}$
$Sn(OH)_2 \leftrightarrow SnOH^+ + 2OH^-$	$4{,}6\cdot10^{-15}$	$4{,}6\cdot10^{-15}$	$2{,}84\cdot10^{-6}$	$4{,}34\cdot10^{-5}$
$Sn(OH)_4$	$1{,}0\cdot10^{-57}$	$1{,}0\cdot10^{-57}$	$1{,}31\cdot10^{-12}$	$2{,}45\cdot10^{-11}$
y o d a t l a r				
$AgIO_3$	$3{,}09\cdot10^{-8}$	$3{,}22\cdot10^{-8}$	$1{,}79\cdot10^{-4}$	$5{,}07\cdot10^{-3}$
$Ba(IO_3)_2$	$1{,}51\cdot10^{-9}$	$2{,}05\cdot10^{-9}$	$7{,}99\cdot10^{-4}$	$3{,}89\cdot10^{-2}$
$Ce(IO_3)_2$	$3{,}16\cdot10^{-10}$	$1{,}15\cdot10^{-9}$	$2{,}56\cdot10^{-3}$	$1{,}70\cdot10^{-1}$
$Pb(IO_3)_2$	$2{,}63\cdot10^{-13}$	$2{,}83\cdot10^{-13}$	$4{,}14\cdot10^{-5}$	$2{,}30\cdot10^{-3}$

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y o d i d l a r				
AgI	$9{,}98\cdot10^{-17}$	$9{,}98\cdot10^{-17}$	$1{,}03\cdot10^{-8}$	$2{,}41\cdot10^{-7}$
CuI	$1{,}10\cdot10^{-12}$	$1{,}10\cdot10^{-12}$	$1{,}05\cdot10^{-6}$	$2{,}00\cdot10^{-5}$
Hg_2I_2	$4{,}47\cdot10^{-29}$	$4{,}47\cdot10^{-29}$	$2{,}24\cdot10^{-10}$	$1{,}46\cdot10^{-8}$
PbI_2	$8{,}71\cdot10^{-9}$	$8{,}71\cdot10^{-8}$	$1{,}51\cdot10^{-3}$	$6{,}96\cdot10^{-2}$
k a r b o n a t l a r				
Ag_2CO_3	$8{,}13\cdot10^{-12}$	$9{,}49\cdot10^{-12}$	$1{,}33\cdot10^{-4}$	$3{,}68\cdot10^{-3}$
$BaCO_3$	$5{,}13\cdot10^{-9}$	$5{,}93\cdot10^{-9}$	$7{,}70\cdot10^{-5}$	$1{,}52\cdot10^{-3}$
$CaCO_3$	$2{,}88\cdot10^{-9}$	$3{,}26\cdot10^{-9}$	$5{,}71\cdot10^{-5}$	$5{,}72\cdot10^{-4}$
$CdCO_3$	$5{,}25\cdot10^{-12}$	$5{,}25\cdot10^{-9}$	$2{,}29\cdot10^{-6}$	$3{,}95\cdot10^{-5}$
$CoCO_3$	$1{,}45\cdot10^{-13}$	$1{,}45\cdot10^{-13}$	$3{,}80\cdot10^{-7}$	$3{,}94\cdot10^{-6}$
$CuCO_3$	$2{,}34\cdot10^{-10}$	$2{,}34\cdot10^{-10}$	$1{,}37\cdot10^{-5}$	$1{,}69\cdot10^{-4}$
$FeCO_3$	$2{,}09\cdot10^{-11}$	$2{,}09\cdot10^{-11}$	$4{,}57\cdot10^{-6}$	$5{,}30\cdot10^{-5}$
Hg_2CO_3	$8{,}91\cdot10^{-17}$	$8{,}91\cdot10^{-17}$	$2{,}81\cdot10^{-6}$	$1{,}30\cdot10^{-4}$
$MgCO_3\cdot3H_2O$	$1{,}00\cdot10^{-5}$	$3{,}08\cdot10^{-5}$	$5{,}55\cdot10^{-3}$	$7{,}68\cdot10^{-2}$
$MnCO_3$	$5{,}01\cdot10^{-10}$	$5{,}11\cdot10^{-10}$	$2{,}26\cdot10^{-5}$	$2{,}60\cdot10^{-4}$
$NiCO_3$	$1{,}35\cdot10^{-7}$	$1{,}63\cdot10^{-7}$	$4{,}03\cdot10^{-4}$	$4{,}79\cdot10^{-3}$
$PbCO_3$	$7{,}41\cdot10^{-14}$	$7{,}41\cdot10^{-14}$	$2{,}72\cdot10^{-7}$	$7{,}27\cdot10^{-6}$
$SrCO_3$	$1{,}10\cdot10^{-10}$	$1{,}10\cdot10^{-10}$	$1{,}05\cdot10^{-5}$	$1{,}55\cdot10^{-4}$
$ZnCO_3$	$1{,}45\cdot10^{-11}$	$1{,}45\cdot10^{-11}$	$3{,}80\cdot10^{-6}$	$4{,}77\cdot10^{-5}$
o k s a l a t l a r				
$Ag_2C_2O_4$	$3{,}57\cdot10^{-11}$	$4{,}10\cdot10^{-11}$	$2{,}27\cdot10^{-4}$	$6{,}89\cdot10^{-3}$
BaC_2O_4	$1{,}10\cdot10^{-7}$	$1{,}49\cdot10^{-7}$	$3{,}85\cdot10^{-4}$	$8{,}68\cdot10^{-3}$
CaC_2O_4	$2{,}29\cdot10^{-9}$	$2{,}60\cdot10^{-9}$	$4{,}86\cdot10^{-5}$	$6{,}22\cdot10^{-4}$
CdC_2O_4	$1{,}59\cdot10^{-8}$	$1{,}96\cdot10^{-8}$	$1{,}40\cdot10^{-4}$	$2{,}81\cdot10^{-3}$
CoC_2O_4	$6{,}31\cdot10^{-8}$	$8{,}53\cdot10^{-8}$	$2{,}92\cdot10^{-4}$	$4{,}29\cdot10^{-3}$
CuC_2O_4	$3{,}16\cdot10^{-8}$	$4{,}10\cdot10^{-8}$	$2{,}02\cdot10^{-4}$	$3{,}06\cdot10^{-3}$
FeC_2O_4	$2{,}00\cdot10^{-7}$	$3{,}05\cdot10^{-7}$	$5{,}52\cdot10^{-4}$	$7{,}94\cdot10^{-3}$
$Hg_2C_2O_4$	$1{,}00\cdot10^{-13}$	$1{,}00\cdot10^{-13}$	$3{,}16\cdot10^{-7}$	$1{,}55\cdot10^{-5}$
MgC_2O_4	$7{,}94\cdot10^{-5}$	$1{,}47\cdot10^{-4}$	$1{,}65\cdot10^{-2}$	0,1852

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MnC_2O_4	$2{,}00\cdot10^{-6}$	$4{,}88\cdot10^{-6}$	$3{,}50\cdot10^{-3}$	$5{,}01\cdot10^{-2}$
NiC_2O_4	$3{,}98\cdot10^{-10}$	$4{,}42\cdot10^{-10}$	$2{,}11\cdot10^{-5}$	$3{,}10\cdot10^{-4}$
PbC_2O_4	$4{,}79\cdot10^{-10}$	$5{,}32\cdot10^{-10}$	$2{,}31\cdot10^{-5}$	$6{,}82\cdot10^{-4}$
SrC_2O_4	$5{,}63\cdot10^{-8}$	$7{,}61\cdot10^{-8}$	$2{,}41\cdot10^{-4}$	$4{,}23\cdot10^{-3}$
ZnC_2O_4	$1{,}59\cdot10^{-9}$	$1{,}77\cdot10^{-9}$	$2{,}64\cdot10^{-5}$	$4{,}05\cdot10^{-4}$
s u l f a t l a r				
Ag_2SO_4	$1{,}455\cdot10^{-5}$	$5{,}02\cdot10^{-5}$	$2{,}32\cdot10^{-2}$	0,7244
$BaSO_4$	$1{,}05\cdot10^{-10}$	$1{,}05\cdot10^{-10}$	$1{,}02\cdot10^{-5}$	$2{,}39\cdot10^{-4}$
$CaSO_4$	$9{,}12\cdot10^{-6}$	$2{,}30\cdot10^{-5}$	$4{,}79\cdot10^{-3}$	$6{,}52\cdot10^{-2}$
Hg_2SO_4	$6{,}76\cdot10^{-7}$	$1{,}11\cdot10^{-6}$	$1{,}05\cdot10^{-3}$	$5{,}22\cdot10^{-2}$
$PbSO_4$	$1{,}59\cdot10^{-8}$	$1{,}96\cdot10^{-8}$	$1{,}40\cdot10^{-4}$	$4{,}24\cdot10^{-3}$
$SrSO_4$	$3{,}47\cdot10^{-7}$	$5{,}29\cdot10^{-7}$	$7{,}27\cdot10^{-4}$	$1{,}34\cdot10^{-2}$
s u l f i d l a r				
Ag_2S	$6{,}31\cdot10^{-50}$	$6{,}31\cdot10^{-50}$	$2{,}51\cdot10^{-17}$	$6{,}22\cdot10^{-16}$
CdS	$7{,}94\cdot10^{-27}$	$7{,}94\cdot10^{-27}$	$8{,}91\cdot10^{-14}$	$1{,}15\cdot10^{-12}$
CoS_α	$3{,}98\cdot10^{-21}$	$3{,}98\cdot10^{-21}$	$6{,}31\cdot10^{-11}$	$5{,}74\cdot10^{-10}$
$CoS_ß$	$2{,}00\cdot10^{-25}$	$2{,}00\cdot10^{-25}$	$4{,}47\cdot10^{-13}$	$4{,}06\cdot10^{-12}$
CuS	$6{,}31\cdot10^{-36}$	$6{,}31\cdot10^{-36}$	$2{,}51\cdot10^{-18}$	$2{,}40\cdot10^{-17}$
Cu_2S	$2{,}51\cdot10^{-48}$	$2{,}51\cdot10^{-48}$	$8{,}56\cdot10^{-17}$	$1{,}36\cdot10^{-15}$
FeS	$5{,}13\cdot10^{-18}$	$5{,}13\cdot10^{-18}$	$2{,}27\cdot10^{-9}$	$1{,}99\cdot10^{-8}$
HgS qora	$(1{,}59\cdot10^{-52})$	$(1{,}59\cdot10^{-52})$		
HgS qizil	$(3{,}98\cdot10^{-53})$	$(3{,}98\cdot10^{-53})$		
MnS pushti	$2{,}51\cdot10^{-10}$	$2{,}51\cdot10^{-10}$	$1{,}59\cdot10^{-5}$	$1{,}38\cdot10^{-4}$
MnS yashil	$2{,}51\cdot10^{-13}$	$2{,}51\cdot10^{-13}$	$5{,}01\cdot10^{-7}$	$4{,}36\cdot10^{-6}$
NiS_α	$3{,}16\cdot10^{-19}$	$3{,}16\cdot10^{-19}$	$5{,}62\cdot10^{-10}$	$5{,}10\cdot10^{-9}$
$NiS_ß$	$1{,}00\cdot10^{-24}$	$1{,}00\cdot10^{-24}$	$1{,}00\cdot10^{-12}$	$9{,}08\cdot10^{-12}$
NiS_γ	$2{,}00\cdot10^{-26}$	$2{,}00\cdot10^{-26}$	$1{,}41\cdot10^{-13}$	$1{,}28\cdot10^{-12}$
PbS	$2{,}51\cdot10^{-27}$	$2{,}51\cdot10^{-27}$	$5{,}04\cdot10^{-14}$	$1{,}20\cdot10^{-12}$
SnS	$1{,}00\cdot10^{-25}$	$1{,}00\cdot10^{-25}$	$3{,}16\cdot10^{-13}$	$4{,}77\cdot10^{-12}$
ZnS_α	$1{,}59\cdot10^{-24}$	$1{,}59\cdot10^{-24}$	$1{,}26\cdot10^{-12}$	$1{,}23\cdot10^{-11}$
$ZnS_ß$	$2{,}51\cdot10^{-22}$	$2{,}51\cdot10^{-22}$	$1{,}59\cdot10^{-11}$	$1{,}54\cdot10^{-10}$

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sulfitlar				
Ag_2SO_3	$1{,}51\cdot10^{-14}$	$1{,}51\cdot10^{-14}$	$1{,}56\cdot10^{-5}$	$4{,}61\cdot10^{-4}$
$BaSO_3$	$7{,}94\cdot10^{-7}$	$1{,}31\cdot10^{-6}$	$1{,}14\cdot10^{-3}$	$2{,}48\cdot10^{-2}$
$CaSO_3$	$1{,}29\cdot10^{-8}$	$1{,}59\cdot10^{-8}$	$1{,}26\cdot10^{-4}$	$1{,}51\cdot10^{-3}$
Hg_2SO_3	$1{,}00\cdot10^{-27}$	$1{,}00\cdot10^{-27}$	$3{,}16\cdot10^{-14}$	$1{,}52\cdot10^{-12}$
$MgSO_3$	$3{,}16\cdot10^{-3}$	$1{,}88\cdot10^{-2}$	0,14	1,43
$SrSO_3$	$3{,}98\cdot10^{-8}$	$5{,}14\cdot10^{-8}$	$2{,}27\cdot10^{-4}$	$3{,}81\cdot10^{-3}$
fosfatlar				
Ag_3PO_4	$1{,}29\cdot10^{-20}$	$1{,}29\cdot10^{-20}$	$4{,}67\cdot10^{-6}$	$1{,}96\cdot10^{-4}$
$AlPO_4$	$5{,}75\cdot10^{-19}$	$5{,}75\cdot10^{-19}$	$6{,}61\cdot10^{-10}$	$8{,}06\cdot10^{-9}$
$BaHPO_4$		$9{,}12\cdot10^{-8}$	$3{,}02\cdot10^{-4}$	$7{,}05\cdot10^{-3}$
$Ba_3(PO_4)_2$		$3{,}39\cdot10^{-23}$	$1{,}26\cdot10^{-5}$	$7{,}57\cdot10^{-4}$
$BiPO_4$	$1{,}29\cdot10^{-23}$	$1{,}29\cdot10^{-23}$	$3{,}59\cdot10^{-12}$	$1{,}09\cdot10^{-10}$
$CaHPO_4$	$2{,}75\cdot10^{-7}$	$4{,}20\cdot10^{-7}$	$8{,}58\cdot10^{-4}$	$1{,}17\cdot10^{-2}$
$Ca_3(PO_4)_2$		$1{,}00\cdot10^{-26}$	$2{,}47\cdot10^{-6}$	$7{,}67\cdot10^{-4}$
$Cd_3(PO_4)_2$	$2{,}51\cdot10^{-33}$	$2{,}51\cdot10^{-33}$	$1{,}18\cdot10^{-7}$	$6{,}24\cdot10^{-6}$
$CoHPO_4$	$2{,}00\cdot10^{-7}$	$7{,}03\cdot10^{-7}$	$6{,}73\cdot10^{-4}$	$1{,}04\cdot10^{-2}$
$Co_3(PO_4)_2$	$2{,}00\cdot10^{-35}$	$2{,}00\cdot10^{-35}$	$4{,}50\cdot10^{-8}$	$1{,}65\cdot10^{-6}$
$CrPO_4$ yashil		$2{,}40\cdot10^{-23}$	$4{,}90\cdot10^{-12}$	$7{,}20\cdot10^{-11}$
$CrPO_4$ binafsha		$1{,}00\cdot10^{-17}$	$3{,}16\cdot10^{-9}$	$4{,}65\cdot10^{-8}$
$Cu_3(PO_4)_2$	$1{,}26\cdot10^{-37}$	$1{,}26\cdot10^{-37}$	$1{,}63\cdot10^{-8}$	$6{,}22\cdot10^{-7}$
$FePO_4$	$1{,}29\cdot10^{-22}$	$1{,}29\cdot10^{-22}$	$1{,}14\cdot10^{-11}$	$1{,}71\cdot10^{-10}$
$MgNH_4PO_4$		$2{,}51\cdot10^{-13}$	$6{,}31\cdot10^{-5}$	$8{,}66\cdot10^{-4}$
$Ni_3(PO_4)_2$	$5{,}01\cdot10^{-31}$	$5{,}01\cdot10^{-31}$	$3{,}41\cdot10^{-7}$	$1{,}25\cdot10^{-5}$
$PbHPO_4$		$1{,}41\cdot10^{-10}$	$1{,}19\cdot10^{-5}$	$3{,}60\cdot10^{-4}$
$Pb_3(PO_4)_2$	$7{,}94\cdot10^{-43}$	$7{,}94\cdot10^{-43}$	$1{,}49\cdot10^{-9}$	$1{,}21\cdot10^{-7}$
$SrHPO_4$		$5{,}75\cdot10^{-7}$	$7{,}59\cdot10^{-4}$	$1{,}39\cdot10^{-2}$
$Sr_3(PO_4)_2$		$4{,}07\cdot10^{-23}$	$1{,}30\cdot10^{-6}$	$2{,}82\cdot10^{-5}$
$Zn_3(PO_4)_2$	$9{,}12\cdot10^{-33}$	$9{,}12\cdot10^{-33}$	$1{,}53\cdot10^{-7}$	$5{,}92\cdot10^{-6}$

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f t o r i d l a r				
BaF_2	$1{,}05\cdot10^{-26}$	$2{,}43\cdot10^{-6}$	$8{,}47\cdot10^{-3}$	$1{,}48\cdot10^{-1}$
CaF_2	$3{,}98\cdot10^{-11}$	$4{,}70\cdot10^{-11}$	$2{,}27\cdot10^{-4}$	$1{,}78\cdot10^{-3}$
SrF_2	$2{,}46\cdot10^{-9}$	$3{,}37\cdot10^{-9}$	$9{,}44\cdot10^{-4}$	$1{,}19\cdot10^{-2}$
x l o r i d l a r				
$AgCl$	$1{,}78\cdot10^{-10}$	$1{,}78\cdot10^{-10}$	$1{,}35\cdot10^{-5}$	$1{,}93\cdot10^{-4}$
Hg_2Cl_2	$1{,}32\cdot10^{-18}$	$1{,}32\cdot10^{-18}$	$6{,}91\cdot10^{-7}$	$3{,}25\cdot10^{-5}$
$PbCl_2$	$1{,}74\cdot10^{-5}$	$6{,}02\cdot10^{-5}$	$4{,}13\cdot10^{-2}$	1,15
x r o m a t l a r				
Ag_2CrO_4	$1{,}29\cdot10^{-12}$	$1{,}44\cdot10^{-12}$	$7{,}12\cdot10^{-5}$	$2{,}36\cdot10^{-3}$
$BaCrO_4$	$1{,}18\cdot10^{-10}$	$1{,}18\cdot10^{-10}$	$1{,}08\cdot10^{-5}$	$2{,}75\cdot10^{-4}$
$CaCrO_4$	$7{,}10\cdot10^{-4}$	$3{,}67\cdot10^{-3}$	$6{,}06\cdot10^{-2}$	$9{,}45\cdot10^{-1}$
Hg_2CrO_4	$5{,}00\cdot10^{-9}$	$1{,}13\cdot10^{-8}$	$1{,}06\cdot10^{-4}$	$5{,}50\cdot10^{-3}$
$PbCrO_4$	$1{,}18\cdot10^{-14}$	$1{,}18\cdot10^{-14}$	$1{,}33\cdot10^{-7}$	$4{,}31\cdot10^{-6}$
$SrCrO_4$		$2{,}24\cdot10^{-5}$	$4{,}73\cdot10^{-3}$	$9{,}63\cdot10^{-2}$

7-jadval

VODOROD ELEKTRODGA NISBATAN SUVLI ERITMALARDAGI STANDART OKSIDLANISH-QAYTARILISH POTENSIALLARI (*E*°)

(jadvaldagi potensiallar qiymatlari μ = 0 va t = 25°C uchun keltirilgan)

Element	Yarim reaksiyalar tenglamalari	*E*°, V
Ag	$Ag^+ + e \leftrightarrow Ag_{(q)}$	+0,799
	$Ag^{2+} + e \leftrightarrow Ag^+$	+1,998
	$AgO^+ + 2H^+ + e \leftrightarrow Ag^{2+} + H_2O$	+2,016
	$2AgO_{(q)} + 2H^+ + 2e \leftrightarrow Ag_2O + H_2O$	+1,41
	$2AgO_{(q)} + H_2O + 2e \leftrightarrow Ag_2O + OH^-$	+0,599
	$Ag_2O_{(q)} + 2H^+ + 2e \leftrightarrow 2Ag_{(q)} + H_2O$	+1,173
	$Ag_2O_{(q)} + H_2O + 2e \leftrightarrow 2Ag_{(q)} + 2OH^-$	+0,342
	$Ag_2CrO_{4(q)} + 2e \leftrightarrow 2Ag_{(q)} + CrO_4^{2-}$	+0,447
	$Ag_2S_{(q)} + 2H^+ + 2e \leftrightarrow 2Ag_{(q)} + H_2S_{(g)}$	–0,036
	$Ag_2S_{(q)} + 2e \leftrightarrow Ag_{(q)} + S^{2-}$	–0,712
	$AgCl_{(q)} + e \leftrightarrow 2Ag_{(q)} + Cl^-$	+0,222
	$AgBr_{(q)} + e \leftrightarrow Ag_{(q)} + Br^-$	+0,071
	$AgI_{(q)} + e \leftrightarrow Ag_{(q)} + I^-$	–0,152
Al	$Al^{3+} + 3e \leftrightarrow Al_{(q)}$	–1,66
	$Al^{3+} + 2e \leftrightarrow Al^+$	–2,76
	$Al^{3+} + e \leftrightarrow Al_{(q)q}$	–0,55
	$AlO_2^- + 4H^+ + 3e \leftrightarrow Al_{(q)} + 2H_2O$	–1,262
	$Al(OH)_{3(q)} + 3e \leftrightarrow Al_{(q)} + 3OH^-$	–2,31
	$[AlF_6]^{3-} + 3e \leftrightarrow Al_{(q)} + 6F^-$	–2,07
As	$H_3AsO_4 + 3H^+ + 2e \leftrightarrow AsO^+ + 3H_2O$	+0,55
	$H_3AsO_4 + 2H^+ + 2e \leftrightarrow HAsO_2 + 2H_2O$	+0,559
	$H_2AsO_4^- + 3H^+ + 2e \leftrightarrow HAsO_2 + 2H_2O$	+0,666
	$HAsO_4^{2-} + 4H^+ + 2e \leftrightarrow HAsO_2 + 2H_2O$	+0,881
	$HAsO_4^{2-} + 3H^+ + 2e \leftrightarrow AsO_2^- + 2H_2O$	+0,609
	$AsO_4^{3-} + 2H_2O + 2e \leftrightarrow AsO_2^- + 4OH^-$	–0,67
	$2H_3AsO_4 + 4H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+0,58
	$2H_2AsO_4^- + 6H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+0,687
	$2HAsO_4^{2-} + 8H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+0,901
	$2AsO_4^{3-} + 10H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+1,27
	$AsO_4^{3-} + 8H^+ + 5e \leftrightarrow As_{(q)} + 4H_2O$	+0,648

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As	$As_2O_{3(q)} + 6H^+ + 6e \leftrightarrow 2As_{(q)} + 3H_2O$	+0,234
	$AsO^+ + 2H^+ + 3e \leftrightarrow As_{(q)} + H_2O$	+0,254
	$HAsO_2 + 3H^+ + 3e \leftrightarrow As_{(q)} + 2H_2O$	+0,248
	$AsO_2^- + 4H^+ + 3e \leftrightarrow As_{(q)} + 2H_2O$	+0,429
	$AsO_2^- + 2H_2O + 3e \leftrightarrow As_{(q)} + 4OH^-$	–0,68
	$As_{(q)} + 3H^+ + 3e \leftrightarrow AsH_{3(g)}$	–0,608
Au	$Au^{3+} + 2e \leftrightarrow Au^+$	+1,41
	$Au^{3+} + 3e \leftrightarrow Au_q$	+1,50
	$Au^+ + e \leftrightarrow Au_{(q)}$	+1,68
	$AuCl_4^- + 2e \leftrightarrow AuCl_2^- + 2Cl^-$	+0,926
	$AuBr_4^- + 2e \leftrightarrow AuBr_2^- + 2Br^-$	+0,805
	$AuCl_4^- + 3e \leftrightarrow Au_{(q)} + 4Cl^-$	+1,002
	$AuBr_4^- + 3e \leftrightarrow Au_{(q)} + 4Br^-$	+0,858
	$AuCl_2^- + e \leftrightarrow Au_{(q)} + 2Cl^-$	+1,154
	$AuBr_2^- + e \leftrightarrow Au_{(q)} + 2Br^-$	+0,963
B	$H_3BO_3 + 3H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,869
	$H_2BO_3^- + 4H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,687
	$HBO_3^{2-} + 5H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,437
	$BO_3^{3-} + 6H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,165
	$B(OH)_3 + 3H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,87
	$[BF_4]^- + 3e \leftrightarrow B_{(q)} + 4F^-$	–1,04
	$H_2B_4O_7 + 12H^+ + 12e \leftrightarrow 4B_{(q)} + 7H_2O$	–0,836
	$B_4O_7^{2-} + 14H^+ + 12e \leftrightarrow 4B_{(q)} + 7H_2O$	–0,792
Ba	$Ba^{2+} + 2e \leftrightarrow Ba_{(q)}$	–2,905
	$BaO + 2H^+ + 2e \leftrightarrow Ba_{(q)} + H_2O$	–2,166
Be	$Be^{2+} + 2e \leftrightarrow Be_{(q)}$	–1,85
	$Be_2O_3^{2-} + 3H_2O + 4e \leftrightarrow 2Be_{(q)} + 6OH^-$	–2,62
Bi	$Bi^{3+} + 3e \leftrightarrow Bi_{(q)}$	+0,215
	$BiOH^{2+} + H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O$	+0,254
	$BiO^+ + 2H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O$	+0,320
	$BiOCl_{(q)} + 2H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O + Cl^-$	+0,160
	$Bi_2O_{3(q)} + 3H_2O + 6e \leftrightarrow 2Bi_{(q)} + 6OH^-$	–0,46
	$Bi_2O_{5(q)} + 10H^+ + 4e \leftrightarrow 2Bi^{3+} + 5H_2O$	+1,759
	$Bi_2O_{5(q)} + 8H^+ + 4e \leftrightarrow 2BiOH^{2+} + 3H_2O$	+1,700

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Bi	$Bi_2O_{5(q)} + 6H^+ + 4e \leftrightarrow 2BiO^+ + 3H_2O$	+1,605
	$NaBiO_{3(q)} + 4H^+ + 2e \leftrightarrow BiO^+ + Na^+ + H_2O$	> +1,8
	$Bi_{(q)} + 3H^+ + 3e \leftrightarrow BiH_{3(g)}$	–0,800
Br	$Br_{2(s)} + 2e \leftrightarrow 2Br^-$	+1,09
	$[Br_3]^- + 2e \leftrightarrow 3Br^-$	+1,05
	$HBrO_3 + 5H^+ + 6e \leftrightarrow Br^- + 3H_2O$	+1,42
	$3HBrO_3 + 15H^+ + 16e \leftrightarrow [Br_3]^- + 9H_2O$	+1,462
	$BrO_3^- + 3H_2O + 6e \leftrightarrow Br^- + 6OH^-$	+0,61
	$2HBrO_3 + 10H^+ + 10e \leftrightarrow Br_{2(s)} + 6H_2O$	+1,48
	$HBrO_3 + 4H^+ + 4e \leftrightarrow HBrO + 2H_2O$	+1,46
	$HBrO_3 + 3H^+ + 4e \leftrightarrow BrO^- + 2H_2O$	+1,33
	$2HBrO + 2H^+ + 2e \leftrightarrow Br_{2(s)} + 2H_2O$	+1,59
	$2BrO^- + 4H^+ + 2e \leftrightarrow Br_{2(s)} + 2H_2O$	+2,09
	$2BrO^- + 2H_2O + 2e \leftrightarrow Br_{2(s)} + 4OH^-$	+0,45
	$BrO^- + H_2O + 2e \leftrightarrow Br^- + 2OH^-$	+0,76
C	$CO_{2(g)} + 2H^+ + 2e \leftrightarrow CO_{2(g)} + H_2O$	–0,12
	$2CO_{2(g)} + 2H^+ + 2e \leftrightarrow H_2C_2O_4$	–0,49
	$CO_{2(g)} + 2H^+ + 2e \leftrightarrow HCOOH$	–0,20
	$CNO + 2H_2O + 2e \leftrightarrow CN^- + 2OH^-$	–0,97
	$2HCNO + 2H^+ + 2e \leftrightarrow 2H_2O + (CN)_{2(g)}$	+0,33
	$(CN)_{2(g)} + 2H^+ + 2e \leftrightarrow 2HCN$	+0,37
Ca	$Ca^{2+} + 2e \leftrightarrow Ca_{(q)}$	–2,87
	$CaO_{gidr} + 2H^+ + 2e \leftrightarrow Ca_{(q)} + H_2O$	–2,19
	$CaO_{(q)} + 2H^+ + 2e \leftrightarrow Ca_{(q)} + H_2O$	–1,90
	$Ca(OH)_{2(q)} + 2e \leftrightarrow Ca_{(q)} + 2OH^-$	–3,03
Cd	$Cd^{2+} + 2e \leftrightarrow Cd_{(q)}$	–0,40
	$Cd(CN)_4^{2-} + 2e \leftrightarrow Cd_{(q)} + 4CN^-$	–1,09
	$[Cd(NH_3)_4]^{2+} + 2e \leftrightarrow Cd_{(q)} + 4NH_3$	–0,61
	$Cd(OH)_{2(q)} + 2e \leftrightarrow Cd_{(q)} + 2OH^-$	–0,81
	$CdS_{(q)} + 2e \leftrightarrow Cd_{(q)} + S^{2-}$	–1,17
Ce	$Ce^{3+} + 3e \leftrightarrow Ce$	–2,48
	$[Ce(OH)_2]^{2+} + 2H^+ + e \leftrightarrow Ce^{3+} + 2H_2O$	+1,73
	$[Ce(OH)]^{2+} + H^+ + e \leftrightarrow Ce^{3+} + H_2O$	+1,71
	$[Ce(ClO_4)_6]^{2-} + e \leftrightarrow Ce^{3+} + 6ClO_4^-$	+1,70

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Ce	$[Ce(NO_3)_6]^{2-} + e \leftrightarrow Ce^{3+} + 6NO_3^-$	+1,60
	$[Ce(SO_4)_3]^{2-} + e \leftrightarrow Ce^{3+} + 3SO_4^{2-}$	+1,44
Cl	$Cl_{2(g)} + 2e \leftrightarrow 2Cl^-$	+1,35
	$Cl_{2(aqua)} + 2e \leftrightarrow 2Cl^-$	+1,39
	$ClO_4^- + 2H^+ + 2e \leftrightarrow ClO_3^- + H_2O$	+1,19
	$ClO_4^- + H_2O + 2e \leftrightarrow ClO_3^- + 2OH^-$	+0,36
	$2ClO_4 + 16H^+ + 14e \leftrightarrow Cl_{2(g)} + 8H_2O$	+1,39
	$ClO_3^- + 3H^+ + 2e \leftrightarrow HClO_2 + H_2O$	+1,21
	$ClO_3^- + H_2O + 2e \leftrightarrow ClO_2^- + 2OH^-$	+0,33
	$ClO_2^- + H_2O + 2e \leftrightarrow ClO^- + 2OH^-$	+0,66
	$2HClO + 2H^+ + 2e \leftrightarrow Cl_{2(g)} + H_2O$	+1,63
	$2ClO^- + 2H_2O + 2e \leftrightarrow ClO_{2(g)} + 4OH^-$	+0,40
Co	$Co^{3+} + e \leftrightarrow Co^{2+}$	+1,81
	$Co^{3+} + 3e \leftrightarrow Co_{(q)}$	+0,46
	$Co^{2+} + 2e \leftrightarrow Co_{(q)}$	–0,28
	$Co_3O_{4(q)} + 8H^+ + 2e \leftrightarrow 3Co^{2+} + 4H_2O$	+2,11
	$Co_2O_{3(q)} + 6H^+ + 2e \leftrightarrow 2Co^{2+} + 3H_2O$	+1,75
	$Co(OH)_{2(q)} + 2e \leftrightarrow Co_{(q)} + 2OH^-$	–0,73
	$[Co(NH_3)_6]^{3+} + e \leftrightarrow [Co(NH_3)_6]^{2+}$	+0,1
	$CoO(OH)_{(q)} + H_2O + e \leftrightarrow Co(OH)_{2(q)} + OH^-$	+0,17
Cr	$Cr^{3+} + e \leftrightarrow Cr^{2+}$	–0,41
	$Cr^{3+} + 3e \leftrightarrow Cr_q$	–0,74
	$Cr^{2+} + 2e \leftrightarrow Cr_q$	–0,91
	$Cr_2O_7^{2-} + 14H^+ + 6e \leftrightarrow 2Cr^{3+} + 7H_2O$	+1,33
	$Cr_2O_7^{2-} + 12H^+ + 6e \leftrightarrow 2Cr^{2+} + 5H_2O$	+1,26
	$Cr_2O_7^{2-} + 10H^+ + 6e \leftrightarrow 2[Cr(OH)_2]^+ + 3H_2O$	+1,14
	$Cr_2O_7^{2-} + 14H^+ + 12e \leftrightarrow 2Cr_{(q)} + 7H_2O$	+0,29
	$HCrO_4^- + 7H^+ + 3e \leftrightarrow Cr^{3+} + 4H_2O$	+1,20
	$CrO_4^{2-} + 4H_2O + 3e \leftrightarrow Cr(OH)_{3(q)} + 5OH^-$	–0,13
	$HCrO_4^- + 6H^+ + 3e \leftrightarrow [CrOH]^{2+} + 3H_2O$	+1,28
	$CrO_4^{2-} + 7H^+ + 3e \leftrightarrow [CrOH]^{2+} + 3H_2O$	+1,40
	$CrO_4^{2-} + 6H^+ + 3e \leftrightarrow Cr(OH)_2 + 2H_2O$	+1,28
	$CrO_4^{2-} + 4H^+ + 3e \leftrightarrow CrO_2^- + 2H_2O$	+0,95
	$CrO_4^{2-} + 2H^+ + 3e \leftrightarrow CrO_3^{3-} + H_2O$	+0,36

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Cu	$Cu^{2+} + e \leftrightarrow Cu^{+}$	+0,16
	$Cu^{2+} + 2e \leftrightarrow Cu_{(q)}$	+0,34
	$Cu^{+} + e \leftrightarrow Cu_{(q)}$	+0,52
	$HCuO_2^{-} + 3H^{+} + e \leftrightarrow Cu^{+} + 2H_2O$	+1,73
	$CuO_2^{2-} + 4H^{+} + e \leftrightarrow Cu^{+} + 2H_2O$	+2,51
	$HCuO_2^{-} + 3H^{+} + 2e \leftrightarrow Cu_{(q)} + 2H_2O$	+1,13
	$CuO_2^{2-} + 4H^{+} + 2e \leftrightarrow Cu_{(q)} + 2H_2O$	+1,52
	$2Cu^{2+} + H_2O + 2e \leftrightarrow Cu_2O_{(q)} + 2H^{+}$	+0,20
	$2HCuO_2^{-} + 4H^{+} + 2e \leftrightarrow Cu_2O_{(q)} + 3H_2O$	+1,78
	$2CuO_2^{2-} + 6H^{+} + 2e \leftrightarrow Cu_2O_{(q)} + 3H_2O$	+2,56
	$CuO + 2H^{+} + e \leftrightarrow Cu^{+} + H_2O$	+0,62
	$Cu^{2+} + Br^{-} + e \leftrightarrow CuBr_{(q)}$	+0,64
	$Cu^{2+} + Cl^{-} + e \leftrightarrow CuCl_{(q)}$	+0,54
	$Cu^{2+} + I^{-} + e \leftrightarrow CuI_{(q)}$	+0,86
	$[Cu(NH_3)_4]^{2+} + e \leftrightarrow [Cu(NH_3)_2]^{+} + 2NH_3$	–0,01
	$[Cu(NH_3)_2]^{+} + e \leftrightarrow Cu_{(q)} + 2NH_3$	–0,12
	$[Cu(NH_3)_4]^{2+} + 2e \leftrightarrow Cu_{(q)} + 4NH_3$	–0,07
F	$F_{2(g)} + 2H^{+} + 2e \leftrightarrow 2HF$	+2,81
	$F_{2(g)} + 2e \leftrightarrow 2F^{-}$	+2,87
	$F_2O + 2H^{+} + 4e \leftrightarrow 2HF + H_2O$	+2,12
	$F_2O + 2H^{+} + 4e \leftrightarrow 2F^{-} + H_2O$	+2,15
	$F_2O + 2H^{+} + 2e \leftrightarrow F_{2(g)} + H_2O$	+1,44
Fe	$Fe^{3+} + e \leftrightarrow Fe^{2+}$	+0,77
	$Fe^{3+} + 3e \leftrightarrow Fe_{(q)}$	–0,04
	$Fe^{2+} + 2e \leftrightarrow Fe_{(q)}$	–0,44
	$Fe(OH)^{2+} + H^{+} + e \leftrightarrow Fe^{2+} + H_2O$	+0,91
	$Fe(OH)_2^{+} + 2H^{+} + e \leftrightarrow Fe^{2+} + 2H_2O$	+1,19
	$FeO_4^{2-} + 8H^{+} + 3e \leftrightarrow Fe^{3+} + 4H_2O$	+1,70
	$FeO_4^{2-} + 7H^{+} + 3e \leftrightarrow Fe(OH)^{2+} + 3H_2O$	+1,65
	$FeO_4^{2-} + 3H^{+} + 3e \leftrightarrow Fe(OH)_2^{+} + 2H_2O$	+1,56
	$FeO_4^{2-} + 5H^{+} + 3e \leftrightarrow HFeO_2 + 2H_2O$	+1,00
	$HFeO_2^{-} + 3H^{+} + 2e \leftrightarrow Fe_{(q)} + 2H_2O$	+0,49
	$[Fe(CN_6)]^{3-} + e \leftrightarrow [Fe(CN_6)]^{4-}$	+0,36
	$Fe(C_{12}H_8N_2)_3^{3+} + e \leftrightarrow Fe(C_{12}H_8N_2)_3^{2+}$	+1,06

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H	$2H^+ + 2e \leftrightarrow H_{2(g)}$	±0,0000
	$2H^+ (10^{-7}\ M) + 2e \leftrightarrow H_{2(g)}$	–0,41
	$H_{2(g)} + 2e \leftrightarrow 2H^+$	–2,25
	$2H_2O + 2e \leftrightarrow H_{2(g)} + 2OH^-$	–0,83
	$H_2O_2 + 2H^+ + 2e \leftrightarrow 2H_2O$	+1,77
	$HO_2^- + H_2O + 2e \leftrightarrow 3OH^-$	+0,88
Hg	$2Hg^{2+} + 2e \leftrightarrow Hg_2^{2+}$	+0,91
	$Hg_2^{2+} + 2e \leftrightarrow 2Hg_{(s)}$	+0,79
	$HgO_{(q)} + H_2O + 2e \leftrightarrow Hg_{(s)} + 2OH^-$	+0,10
	$HgO_{(q)} + 2H^+ + 2e \leftrightarrow Hg_{(s)} + H_2O$	+0,93
	$2Hg(OH)_{2(q)} + 4H^+ + 2e \leftrightarrow Hg_2^{2+} + 4H_2O$	+1,28
	$Hg_2Cl_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2Cl^-$	+0,27
	$Hg_2Br_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2Br^-$	+0,14
	$Hg_2I_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2I^-$	–0,04
	$Hg_2C_2O_{4(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2C_2O_4^{2-}$	+0,42
	$HgS_{(q.,\ qora)} + 2e \leftrightarrow Hg_{(s)} + S^{2-}$	–0,67
	$HgS_{(q.,\ qizil)} + 2e \leftrightarrow Hg_{(s)} + S^{2-}$	–0,70
	$[Hg(CN)_4]^{2-} + 2e \leftrightarrow Hg_{(s)} + 4CN^-$	–0,37
I	$[I_3]^- + 2e \leftrightarrow 3I^-$	–0,536
	$I_{2(aqua)} + 2e \leftrightarrow 2I^-$	+0,621
	$3I_2 + 2e \leftrightarrow 2[I_3]^-$	+0,789
	$H_5IO_6 + H^+ + 2e \leftrightarrow IO_3^- + 3H_2O$	+1,6
	$HIO_5^{2-} + 3H^+ + 2e \leftrightarrow IO_3^- + 2H_2O$	+1,898
	$HIO_5^{2-} + 8H^+ + 6e \leftrightarrow HIO + 4H_2O$	+1,389
	$2HIO_5^{2-} + 18H^+ + 14e \leftrightarrow I_{2(q)} + 10H_2O$	+1,384
	$3HIO_5^{2-} + 27H^+ + 22e \leftrightarrow [I_3]^- + 15H_2O$	+1,357
	$HIO_5^{2-} + 9H^+ + 8e \leftrightarrow I^- + 5H_2O$	+1,288
	$HIO_4 + 2H^+ + 2e \leftrightarrow HIO_3 + H_2O$	+1,626
	$IO_4^- + 2H^+ + 2e \leftrightarrow IO_3^- + H_2O$	+1,653
	$HIO_4 + 6H^+ + 6e \leftrightarrow HIO + 3H_2O$	+1,290
	$IO_4^- + 7H^+ + 6e \leftrightarrow HIO + 3H_2O$	+1,235
	$2HIO_4 + 14H^+ + 14e \leftrightarrow I_{2(q)} + 8H_2O$	+1,300
	$3HIO_4 + 21H^+ + 22e \leftrightarrow [I_3]^- + 12H_2O$	+1,276
	$HIO_4 + 7H^+ + 8e \leftrightarrow I^- + 4H_2O$	+1,215

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I	$IO_3^- + 6H^+ + 4e \leftrightarrow I^+ + 3H_2O$	+1,155
	$IO_3^- + 4H^+ + 4e \leftrightarrow IO^- + 2H_2O$	+0,972
	$2HIO_3 + 10H^+ + 10e \leftrightarrow I_2 + 6H_2O$	+1,169
	$3HIO_3 + 15H^+ + 16e \leftrightarrow [I_3]^- + 9H_2O$	+1,145
	$HIO_3 + 5H^+ + 6e \leftrightarrow I^- + 3H_2O$	+1,0777
	$2HIO + 2H^+ + 2e \leftrightarrow I_{2(q)} + 2H_2O$	+1,354
	$2IO^- + 4H^+ + 2e \leftrightarrow I_{2(q)} + 2H_2O$	+2,005
	$3HIO + 3H^+ + 4e \leftrightarrow [I_3]^- + 3H_2O$	+1,213
	$3IO^- + 6H^+ + 4e \leftrightarrow [I_3]^- + 3H_2O$	+1,701
	$IO^- + 2H^+ + 2e \leftrightarrow I^- + H_2O$	+1,313
	$HIO + H^+ + 2e \leftrightarrow I^- + H_2O$	+0,987
	$2ICl_{3(q)} + 6e \leftrightarrow I_{2(q)} + 6Cl^-$	+1,28
	$ICl_{(q)} + 2e \leftrightarrow I_{2(q)} + 2Cl^-$	+1,22
	$ICl + 2e \leftrightarrow I_{2(q)} + 2Cl^-$	+1,19
	$2IBr_{(s)} + 2e \leftrightarrow I_{2(q)} + 2Br^-$	+1,02
K	$K^+ + e \leftrightarrow K_{(q)}$	–2,925
Li	$Li^+ + e \leftrightarrow Li_{(q)}$	–3,03
Mg	$Mg^{2+} + 2e \leftrightarrow Mg_{(q)}$	–2,37
	$Mg(OH)_{(q)} + 2e \leftrightarrow Mg_{(q)} + 2OH^-$	–2,69
	$MgO_{(q)} + 2H^+ + 2e \leftrightarrow Mg_{(q)} + H_2O$	–1,869
	$MgO_{(q.\ suvsiz)} + 2H^+ + 2e \leftrightarrow Mg_{(q)} + H_2O$	–1,722
Mn	$Mn^{2+} + 2e \leftrightarrow Mn_{(q)}$	–1,18
	$Mn^{IV} + e \leftrightarrow Mn^{III}$ (3,5M H_2SO_4)	+1,65
	$Mn^{III} + e \leftrightarrow Mn^{II}$ (3,5M H_2SO_4)	+1,59
	$MnO_4^- + e \leftrightarrow MnO_4^{2-}$	+0,576
	$MnO_4^- + 2H_2O + 3e \leftrightarrow MnO_{2(q)} + 4OH^-$	+0,588
	$MnO_4^- + 4H^+ + 3e \leftrightarrow MnO_{2(\alpha,\ q)} + 2H_2O$	+1,695
	$MnO_4^- + 4H^+ + 3e \leftrightarrow MnO_{2(\beta,\ q)} + 2H_2O$	+1,679
	$MnO_4^- + 8H^+ + 4e \leftrightarrow Mn^{3+} + 4H_2O$	+1,506
	$MnO_4^- + 8H^+ + 5e \leftrightarrow Mn^{2+} + 4H_2O$	+1,507
	$MnO_4^{2-} + 4H^+ + 2e \leftrightarrow MnO_{2(q)} + 2H_2O$	+2,257
	$MnO_4^{2-} + 5H^+ + 4e \leftrightarrow HMnO_2^- + 2H_2O$	+1,234
	$MnO_4^{2-} + 2H_2O + 2e \leftrightarrow MnO_{2(q)} + 4OH^-$	+0,51
	$MnO_{2(q)} + 2H_2O + 2e \leftrightarrow Mn(OH)_2 + 2OH^-$	–0,05

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Mn	$MnO_{2(q)} + 4H^+ + 2e \leftrightarrow Mn^{2+} + 2H_2O$	+1,23
	$MnO_{2(q)} + 4H^+ + 2e \leftrightarrow Mn^{3+} + 2H_2O$	+0,948
	$Mn(OH)_{3(q)} + e \leftrightarrow Mn(OH)_{2(q)} + OH^-$	+0,1
	$Mn^{2+} + 2e \leftrightarrow Mn_{(q)}$	–1,18
	$Mn(OH)_{2(q)} + 2e \leftrightarrow Mn_{(q)} + 2OH^-$	–1,55
	$HMnO_2^- + 3H^+ + 2e \leftrightarrow Mn_{(q)} + 2H_2O$	–0,163
N	$NO_3^- + 2H^+ + e \leftrightarrow NO_{2(g)} + H_2O$	+0,775
	$2NO_3^- + 4H^+ + 2e \leftrightarrow N_2O_{4(g)} + 2H_2O$	+0,80
	$NO_3^- + 3H^+ + 2e \leftrightarrow HNO_2 + H_2O$	+0,94
	$NO_3^- + 2H^+ + 2e \leftrightarrow NO_2^- + H_2O$	+0,835
	$NO_3^- + 4H^+ + 3e \leftrightarrow NO_2^- + 2H_2O$	+0,96
	$NO_{2(g)} + e \leftrightarrow NO_2^-$	+0,893
	$NO_{2(g)} + H^+ + e \leftrightarrow HNO_2$	+1,093
	$NO_{2(g)} + 2H^+ + 2e \leftrightarrow NO_{(g)} + H_2O$	+1,049
	$2NO_{2(g)} + 6H^+ + 6e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,229
	$2NO_{2(g)} + 8H^+ + 8e \leftrightarrow N_{2(g)} + 4H_2O$	+1,363
	$NO_2^- + 2H^+ + e \leftrightarrow NO_{(g)} + H_2O$	+1,202
	$HNO_2 + H^+ + e \leftrightarrow NO_{(g)} + H_2O$	+1,004
	$2NO_2^- + 6H^+ + 4e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,396
	$2HNO_2 + 4H^+ + 4e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,297
	$2NO_2^- + 8H^+ + 6e \leftrightarrow N_{2(g)} + 4H_2O$	+1,520
	$2HNO_2 + 6H^+ + 6e \leftrightarrow N_{2(g)} + 4H_2O$	+1,454
	$NO_2^- + 7H^+ + 6e \leftrightarrow NH_{3(g)} + 2H_2O$	+0,789
	$HNO_2 + 7H^+ + 6e \leftrightarrow NH_4^+ + 2H_2O$	+0,864
	$N_{2(g)} + 6H^+ + 6e \leftrightarrow 2NH_{3(g)}$	+0,057
	$N_{2(g)} + 2H_2O + 6H^+ + 6e \leftrightarrow 2NH \cdot H_2O$	+0,92
	$N_{2(g)} + 8H^+ + 6e \leftrightarrow 2NH_4^+$	+0,275
Na	$Na^+ + e \leftrightarrow Na_{(q)}$	–2,713
Ni	$Ni^{2+} + 2e \leftrightarrow Ni_{(q)}$	–0,250
	$NiO_{2(q)} + 4H^+ + 2e \leftrightarrow Ni^{2+} + 2H_2O$	+1,593
	$NiO_{2(q)} + 2H_2O + 2e \leftrightarrow Ni(OH)_{2(q)} + 2OH^-$	+0,49
	$Ni_2O_{3(q)} + 6H^+ + 2e \leftrightarrow 2Ni^{2+} + 3H_2O$	+1,753
	$Ni_3O_{4(q)} + 2H_2O + 2e \leftrightarrow 3HNiO_2^- + H^+$	–0,718
	$Ni_3O_{4(q)} + 8H^+ + 2e \leftrightarrow 3Ni^{2+} + 4H_2O$	+1,977

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Ni	$HNiO_2^- + 3H^+ + 2e \leftrightarrow Ni_{(q)} + 2H_2O$	+0,648
	$[Ni(NH_3)_6]^{2+} + 2e \leftrightarrow Ni_{(q)} + 6NH_3$	–0,49
O	$O_{2(g)} + 4H^+ + 4e \leftrightarrow 2H_2O$	+1,229
	$O_{2(g)} + 2H_2O + 4e \leftrightarrow 4OH^-$	+0,401
	$O_{3(g)} + 2H^+ + 2e \leftrightarrow O_{2(g)} + H_2O$	+2,076
	$O_{3(g)} + 6H^+ + 6e \leftrightarrow 3H_2O$	+1,501
	$O_{3(g)} + H_2O + 3e \leftrightarrow O_{2(g)} + 2OH^-$	+1,24
	$O_{2(g)} + 2H^+ + 2e \leftrightarrow H_2O_2$	+0,69
	$H_2O_2 + 2H^+ + 2e \leftrightarrow 2H_2O$	+1,776
P	$P_{(qizil)} + 3H^+ + 3e \leftrightarrow PH_{3(g)}$	–0,111
	$P_{(oq)} + 3H^+ + 3e \leftrightarrow PH_{3(g)}$	–0,063
	$PO_4^{3-} + 3H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	+0,121
	$HPO_4^{2-} + 2H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	–0,234
	$H_2PO_4^- + H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	–0,447
	$H_2PO_4^- + 2H^+ + 2e \leftrightarrow H_2PO_3^- + H_2O$	–0,260
	$H_3PO_4 + H^+ + 2e \leftrightarrow H_2PO_3^- + H_2O$	–0,329
	$H_3PO_4 + 2H^+ + 2e \leftrightarrow H_3PO_3 + H_2O$	–0,276
	$PO_4^{3-} + 8H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,128
	$PO_4^{3-} + 8H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,156
	$HPO_4^{2-} + 7H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,288
	$HPO_4^{2-} + 7H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,316
	$H_2PO_4^- + 6H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,358
	$H_2PO_4^- + 6H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,386
	$H_3PO_4 + 5H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,383
	$H_3PO_4 + 5H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,411
	$H_3PO_3 + 2H^+ + 2e \leftrightarrow H_3PO_2 + H_2O$	–0,499
	$HPO_3^{2-} + 5H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,298
	$HPO_3^{2-} + 5H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,346
	$H_2PO_3^- + 4H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,419
	$H_2PO_3^- + 4H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,467
	$H_3PO_3 + 3H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,454
	$H_3PO_3 + 3H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,502
	$H_4P_2O_6 + 2H^+ + 2e \leftrightarrow 2H_3PO_3$	+0,38
	$2H_3PO_4 + 2H^+ + 2e \leftrightarrow H_4P_2O_6 + 2H_2O$	–0,94

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Pb	$Pb^{2+} + 2e \leftrightarrow Pb_{(q)}$	–0,126
	$Pb^{4+} + 2e \leftrightarrow Pb^{2+}$	+1,694
	$PbO_{2(q)} + 4H^{+} + 2e \leftrightarrow Pb^{2+} + 2H_2O$	+1,455
	$PbO_{2(q)} + 4H^{+} + SO_4^{2-} + 2e \leftrightarrow PbSO_{4(q)} + 2H_2O$	+1,685
	$PbO_{2(q)} + H^{+} + 2e \leftrightarrow HPbO_2$	+0,621
	$3PbO_3^{2-} + 10H^{+} + 4e \leftrightarrow HPb_3O_{4(q)} + 5H_2O$	+2,515
	$PbO_3^{2-} + 4H^{+} + 2e \leftrightarrow PbO_{(q)} + 2H_2O$	+2,001
	$PbO_3^{2-} + 3H^{+} + e \leftrightarrow HPbO_2^{-} + H_2O$	+1,547
	$PbO_3^{2-} + 6H^{+} + 2e \leftrightarrow Pb^{2+} + 3H_2O$	+2,375
	$Pb_3O_{4(q)} + H_2O + 2e \leftrightarrow 2PbO_{(q)} + 2OH^{-}$	+0,249
	$Pb_3O_{4(q)} + 8H^{+} + 2e \leftrightarrow 3Pb^{2+} + 3H_2O$	+2,094
	$Pb_3O_{4(q)} + 2H_2O + 2e \leftrightarrow 3HPbO_2 + H^{+}$	+0,390
	$PbO_{(q)} + 2H^{+} + 2e \leftrightarrow Pb_{(q)} + H_2O$	+0,249
	$PbSO_{4(q)} + 2e \leftrightarrow Pb_{(q)} + SO_4^{2-}$	–0,335
	$HPbSO_2^{-} + 3H^{+} + 2e \leftrightarrow Pb_{(q)} + 2H_2O$	+0,702
	$Pb_{(q)} + 2H^{+} + 2e \leftrightarrow PbH_2$	–1,507
Pt	$Pt^{2+} + 2e \leftrightarrow Pt_{(q)}$	+1,2
	$PtO_{2(q)} + 2H^{+} + 2e \leftrightarrow Pt(OH)_{2(q)}$	+1,1
	$Pt(OH)_{2(q)} + 2e \leftrightarrow Pt_{(q)} + 2OH^{-}$	+0,15
	$Pt(OH)_{2(q)} + 2H^{+} + 2e \leftrightarrow Pt_{(q)} + 2H_2O$	+0,98
S	$SO_4^{2-} + 4H^{+} + 2e \leftrightarrow H_2SO_3 + H_2O$	+0,17
	$SO_4^{2-} + 4H_2O + 2e \leftrightarrow SO_3^{2-} + 2OH^{-}$	–0,93
	$SO_4^{2-} + 8H^{+} + 6e \leftrightarrow S_{(q)} + 4H_2O$	+0,357
	$HSO_4^{-} + 7H^{+} + 6e \leftrightarrow S_{(q)} + 4H_2O$	+0,339
	$SO_4^{2-} + 8H^{+} + 8e \leftrightarrow S^{2-} + 4H_2O$	+0,149
	$SO_4^{2-} + 9H^{+} + 8e \leftrightarrow HS^{-} + 4H_2O$	+0,252
	$SO_4^{2-} + 10H^{+} + 8e \leftrightarrow H_2S_{(g)} + 4H_2O$	+0,303
	$HSO_4^{-} + 9H^{+} + 8e \leftrightarrow H_2S_{(g)} + 4H_2O$	+0,289
	$S_2O_8^{2-} + 2e \leftrightarrow 2SO_4^{2-}$	+2,010
	$S_2O_8^{2-} + 2H^{+} + 2e \leftrightarrow 2HSO_4^{-}$	+2,123
	$S_4O_6^{2-} + 2e \leftrightarrow 2S_2O_3^{2-}$	+0,219
	$S_4O_6^{2-} + 12H^{+} + 10e \leftrightarrow 4S_{(q)} + 6H_2O$	+0,416
	$S_2O_6^{2-} + 2e \leftrightarrow 2SO_3^{2-}$	+0,026
	$SO_{2(g)} + 4H^{+} + 4e \leftrightarrow S_{(q)} + 2H_2O$	+0,451

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S	$H_2SO_3 + 4H^+ + 4e \leftrightarrow S_{(q)} + 3H_2O$	+0,449
	$2SO_3^{2-} + 6H^+ + 4e \leftrightarrow S_2O_3^{2-} + 3H_2O$	+0,705
	$2HSO_3^- + 4H^+ + 4e \leftrightarrow S_2O_3^{2-} + 3H_2O$	+0,491
	$4HSO_3^- + 8H^+ + 6e \leftrightarrow S_4O_6^{2-} + 6H_2O$	+0,581
	$SO_3^{2-} + 6H^+ + 6e \leftrightarrow S^{2-} + 3H_2O$	+0,231
	$S_{(q)} + 2e \leftrightarrow S^{2-}$	–0,476
	$S_{(q)} + H^+ + 2e \leftrightarrow HS^-$	–0,065
	$S_{(q)} + 2H^+ + 2e \leftrightarrow H_2S_{(g)}$	+0,142
	$S_2^{2-} + 2H^+ + 2e \leftrightarrow 2HS^-$	+0,298
	$S_2^{2-} + 2e \leftrightarrow 2S^{2-}$	–0,524
	$S_3^{2-} + 3H^+ + 4e \leftrightarrow 3HS^-$	+0,097
	$S_4^{2-} + 4H^+ + 6e \leftrightarrow 4HS^-$	+0,033
	$S_5^{2-} + 5H^+ + 8e \leftrightarrow 5HS^-$	+0,003
Sb	$Sb^V + 2e \leftrightarrow Sb^{III}$ (6M HCl)	+0,818
	$Sb^V + 2e \leftrightarrow Sb^{III}$ (3,5M HCl)	+0,746
	$Sb_2O_{5(q)} + 6H^+ + 4e \leftrightarrow 2SbO^+$	+0,581
	$SbO^+ + 2H^+ + 3e \leftrightarrow Sb_{(q)} + H_2O$	+0,212
	$SbO_3^- + 2H^+ + 2e \leftrightarrow SbO_2^- + H_2O$	+0,353
	$SbO_3^- + 3H^+ + 2e \leftrightarrow HSbO_2 + H_2O$	+0,678
	$SbO_3^- + 4H^+ + 2e \leftrightarrow SbO^+ + 2H_2O$	+0,704
	$SbO_2^+ + 2H^+ + 2e \leftrightarrow SbO^- + H_2O$	+0,720
	$2SbO_3^- + 6H^+ + 4e \leftrightarrow Sb_2O_{3(q)} + 3H_2O$	+0,772
	$SbO_2^- + 4H^+ + 3e \leftrightarrow Sb_{(q)} + 2H_2O$	+0,446
	$HSbO_2 + 3H^+ + 3e \leftrightarrow Sb_{(q)} + 2H_2O$	+0,230
	$Sb_2O_{5(q)} + 4H^+ + 4e \leftrightarrow Sb_2O_{3(q)} + 2H_2O$	+0,692
	$Sb_2O_{3(q)} + 6H^+ + 6e \leftrightarrow 2Sb_{(q)} + 3H_2O$	+0,152
	$Sb_{(q)} + 3H^+ + 3e \leftrightarrow SbH_{3(g)}$	–0,510
Si	$SiO_{2(q)} + 4H^+ + 4e \leftrightarrow Si_{(q)} + 2H_2O$	–0,86
	$SiO_3^{2-} + 6H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,455
	$HSiO_3^- + 5H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,632
	$H_2SiO_3 + 4H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,780
	$SiO_{2(q)} + 8H^+ + 8e \leftrightarrow SiH_{4(g)} + 2H_2O$	–0,377
	$SiO_3^{2-} + 10H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,176
	$HSiO_3^- + 9H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,265

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Si	$H_2SiO_3 + 8H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,339
	$Si_{(q)} + 4H^+ + 4e \leftrightarrow SiH_{4(g)}$	+0,102
	$SiF_6^{2-} + 4e \leftrightarrow Si_{(q)} + 6F^-$	–1,2
Sn	$Sn^{IV} + 2e \leftrightarrow Sn^{II}$	+0,154
	$Sn^{IV} + 4e \leftrightarrow Sn_{(q)}$	+0,01
	$Sn^{II} + 2e \leftrightarrow Sn_{(q)}$	–0,136
	$SnO_3^{2-} + 3H^+ + 2e \leftrightarrow HSnO_2^- + H_2O$	+0,374
	$SnO_3^{2-} + 6H^+ + 2e \leftrightarrow Sn^{2+} + 3H_2O$	+0,844
	$HSnO_2^- + 3H^+ + 2e \leftrightarrow Sn_{(q)} + 2H_2O$	+0,33
	$Sn_{(q)} + 4H^+ + 4e \leftrightarrow SnH_{4(g)}$	–1,074
Sr	$Sr^{2+} + 2e \leftrightarrow Sr_{(q)}$	–2,89
Zn	$Zn^{2+} + 2e \leftrightarrow Zn_{(q)}$	–0,763
	$ZnO_2^{2-} + 4H^+ + 2e \leftrightarrow Zn_{(q)} + 2H_2O$	+0,441
	$HZnO_2^- + 3H^+ + 2e \leftrightarrow Zn_{(q)} + 2H_2O$	–0,054
	$ZnO_2^{2-} + 2H_2O + 2e \leftrightarrow Zn_{(q)} + 4OH^-$	–1,216
	$Zn(OH)_{2(q)} + 2e \leftrightarrow Zn_{(q)} + 2OH^-$	–1,245
	$ZnS_{(q)} + 2e \leftrightarrow Zn_{(q)} + S^{2-}$	–1,40
	$[Zn(NH_3)_4]^{2+} + 2e \leftrightarrow Zn_{(q)} + 4NH_3$	–1,04
	$[Zn(CN)_4]^{2+} + 2e \leftrightarrow Zn_{(q)} + 4CN^-$	–1,26

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NOORGANIK LIGANDLI KOMPLEKSLAR VA ULARNING BARQARORLIK KONSTANTALARI (β)

Kompleks ion	β_1	$lg\beta_1$	β_2	$lg\beta_2$	β_3	$lg\beta_3$	β_4	$lg\beta_4$	β_5	$lg\beta_5$	β_6	$lg\beta_6$
Ammiakli												
$[Ag(NH_3)_2]^+$	$2,09\cdot10^3$	3,32	$1,62\cdot10^7$	7,21								
$[Cd(NH_3)_4]^{2+}$	$3,24\cdot10^2$	2,51	$2,95\cdot10^4$	4,47	$5,89\cdot10^5$	5,77	$3,63\cdot10^6$	6,56				
$[Co(NH_3)_6]^{2+}$	97,7	1,99	$3,16\cdot10^3$	3,50	$2,69\cdot10^4$	4,43	$1,18\cdot10^5$	5,07	$1,35\cdot10^{30}$	5,13	$2,45\cdot10^4$	4,39
$[Co(NH_3)_6]^{3+}$	$2,00\cdot10^7$	7,3	$1,00\cdot10^{14}$	14	$1,26\cdot10^{20}$	20,1	$5,01\cdot10^{25}$	25,7	$6,31\cdot10^{30}$	30,8	$4,57\cdot10^{33}$	33,66
$[Cu(NH_3)_2]^+$	$8,51\cdot10^5$	5,93	$5,50\cdot10^8$	8,74								
$[Cu(NH_3)_4]^{2+}$	$9,77\cdot10^3$	3,99	$2,14\cdot10^7$	7,33	$1,15\cdot10^{10}$	10,06	$1,07\cdot10^{12}$	12,03				
$[Fe(NH_3)_4]^{2-}$	25,1	1,4	$1,59\cdot10^2$	2,2			$5,01\cdot10^3$	3,7				
$[Hg(NH_3)_4]^{2+}$	$6,31\cdot10^8$	8,8	$3,16\cdot10^{17}$	17,5	$3,16\cdot10^{18}$	18,5	$1,82\cdot10^{19}$	19,26				
$[Ni(NH_3)_6]^{2+}$	$4,68\cdot10^2$	2,67	$4,17\cdot10^4$	4,62	$2,51\cdot10^6$	6,40	$2,09\cdot10^7$	7,32	$1,26\cdot10^8$	8,10	$1,02\cdot10^8$	8,01
$[Zn(NH_3)_4]^{2+}$	$1,51\cdot10^2$	2,18	$2,69\cdot10^4$	4,43	$5,50\cdot10^6$	6,74	$2,51\cdot10^9$	9,40				
Bromidli												
$[AgBr_5]^{4-}$	$2,40\cdot10^4$	4,38	$2,19\cdot10^7$	7,34	$7,08\cdot10^8$	8,85	$5,01\cdot10^8$	8,70	$2,00\cdot10^9$	9,30		
$[BiBr_6]^{3-}$	$1,82\cdot10^2$	2,26	$2,82\cdot10^4$	4,45	$2,14\cdot10^6$	6,33	$6,61\cdot10^7$	7,82	$2,63\cdot10^9$	9,42	$5,01\cdot10^9$	9,70
$[CdBr_4]^{2-}$	$1,70\cdot10^2$	2,23	$6,31\cdot10^2$	2,80	$3,98\cdot10^3$	3,60	$5,01\cdot10^3$	3,70				
$[HgBr_4]^{2-}$	$1,12\cdot10^9$	9,05	$2,14\cdot10^{17}$	17,33	$5,50\cdot10^{19}$	19,74	$4,37\cdot10^{21}$	21,64				
$[PbBr_4]^{2-}$	$1,70\cdot10^2$	2,23	$3,02\cdot10^2$	2,48	$1,82\cdot10^3$	3,26	$2,00\cdot10^3$	3,30				
$[SnBr_3]^-$	5,37	0,73	13,8	1,14	22,39	1,35						

Gidrokso-												
$[Ag(OH)_3]^{2-}$	$2{,}00\cdot10^{2}$	2,30	$1{,}00\cdot10^{4}$	4,0	$1{,}59\cdot10^{5}$	5,2						
$[Al(OH)_4]^{-}$	$1{,}10\cdot10^{9}$	9,04					$1{,}00\cdot10^{33}$	33,0				
$[Bi(OH)_4]^{-}$	$2{,}51\cdot10^{12}$	12,4	$6{,}31\cdot10^{15}$	15,8			$1{,}59\cdot10^{35}$	35,2				
$[Cd(OH)_4]^{2-}$	$1{,}48\cdot10^{4}$	4,17	$2{,}14\cdot10^{8}$	8,33	$1{,}05\cdot10^{9}$	9,02	$3{,}98\cdot10^{8}$	8,6				
$[Co(OH)_3]^{-}$	$2{,}51\cdot10^{4}$	4,4	$3{,}98\cdot10^{4}$	4,6	$3{,}16\cdot10^{10}$	10,5						
$[Cr(OH)_4]^{-}$	$1{,}26\cdot10^{10}$	10,1	$6{,}31\cdot10^{17}$	17,8			$7{,}94\cdot10^{29}$	29,9				
$[Cu(OH)_4]^{2-}$	$1{,}00\cdot10^{7}$	7,0	$4{,}79\cdot10^{13}$	13,68	$13{,}68\cdot101^{7}$	17,0	$3{,}16\cdot10^{18}$	18,5				
$[Fe(OH)_4]^{2-}$	$3{,}63\cdot10^{5}$	5,56	$5{,}89\cdot10^{9}$	9,77	$9{,}77\cdot10^{9}$	9,67	$3{,}63\cdot10^{8}$	8,56				
$[Fe(OH)_3]$	$7{,}41\cdot10^{11}$	101,87	$1{,}48\cdot10^{21}$	21,17	$21{,}17\cdot10^{30}$	30,67						
$[Hg(OH)_3]^{-}$	$2{,}00\cdot10^{10}$	10,30	$5{,}01\cdot10^{21}$	21,70	$21{,}70\cdot10^{21}$	21,20						
$[Ni(OH)_3]^{-}$	$9{,}33\cdot10^{4}$	4,97	$3{,}55\cdot10^{8}$	8,55	$8{,}55\cdot10^{11}$	11,33						
$[Pb(OH)_3]^{-}$	$7{,}94\cdot10^{6}$	6,9	$6{,}31\cdot10^{10}$	10,08	$10{,}08\cdot10^{11}$	11,3						
$[Sb(OH)_4]^{-}$			$2{,}00\cdot10^{24}$	24,3	$24{,}3\cdot10^{36}$	36,7	$2{,}00\cdot10^{38}$	38,3				
$[Sn(OH)_3]^{-}$	$7{,}24\cdot10^{11}$	11,86	$4{,}37\cdot10^{20}$	20,64	$20{,}64\cdot10^{25}$	25,13						
$[Zn(OH)_4]^{2-}$	$2{,}51\cdot10^{4}$	4,40	$2{,}00\cdot10^{11}$	11,30	$11{,}30\cdot10^{13}$	13,14	$4{,}57\cdot10^{14}$	14,64				
$[Zr(OH)_4]$	$2{,}09\cdot10^{14}$	14,32	$1{,}82\cdot10^{28}$	28,26	$28{,}26\cdot10^{41}$	41,91	$1{,}86\cdot10^{55}$	55,27				
Yodatli												
$[Ag(IO_3)_2]^{-}$	4,27	0,63	79,4	1,90								
Yodidli												
$[AgI_4]^{3-}$	$3{,}80\cdot10^{6}$	6,58	$5{,}50\cdot10^{11}$	11,74	$4{,}79\cdot10^{13}$	13,68	$1{,}00\cdot10^{14}$	14,00				

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$[BiI_6]^{3-}$	$7{,}76\cdot10^{2}$	2,89					$8{,}91\cdot10^{14}$	14,95	$6{,}31\cdot10^{16}$	16,8	$1{,}26\cdot10^{19}$	19,1
$[CdI_4]^{2-}$	$1{,}91\cdot10^{2}$	2,28	$2{,}69\cdot10^{3}$	3,43	$3{,}09\cdot10^{4}$	4,49	$2{,}57\cdot10^{5}$	5,41				
$[HgI_4]^{2-}$	$7{,}41\cdot10^{12}$	12,87	$6{,}61\cdot10^{23}$	23,82	$3{,}98\cdot10^{27}$	27,60	$1{,}51\cdot10^{30}$	30,18				
$[PbI_4]^{2-}$	18,2	1,26	$1{,}41\cdot10^{3}$	3,15	$8{,}32\cdot10^{3}$	3,92	$2{,}95\cdot10^{4}$	4,47				
Nitritli												
$[Ag(NO_2)_2]^{-}$	75,9	1,88	$6{,}76\cdot10^{2}$	2,83								
$[Cd(NO_2)_4]^{2-}$	63,1	1,80	$1{,}02\cdot10^{3}$	3,01	$6{,}46\cdot10^{3}$	3,81	$1{,}26\cdot10^{3}$	3,1				
$[Cu(NO_2)_3]^{-}$	18,2	1,26	36,3	1,56	14,45	1,16						
Rodanidli												
$[Ag(SCN)_4]^{3-}$	$5{,}62\cdot10^{4}$	5,75	$6{,}03\cdot10^{9}$	9,78			$1{,}51\cdot10^{11}$	11,18				
$[Bi(SCN)_6]^{3-}$	14,1	1,15	83,18	1,92	$5{,}50\cdot10^{2}$	2,74	$2{,}51\cdot10^{3}$	3,40			$1{,}70\cdot10^{4}$	4,23
$[Co(SCN)_4]^{2-}$	$1{,}00\cdot10^{3}$	3,0	$1{,}00\cdot10^{3}$	3,0	$2{,}00\cdot10^{2}$	2,3	$1{,}59\cdot10^{2}$	2,2				
$[Cr(SCN)_6]^{3-}$	$1{,}20\cdot10^{3}$	3,08	$6{,}31\cdot10^{4}$	4,80	$3{,}31\cdot10^{5}$	5,8	$1{,}26\cdot10^{6}$	6,1	$2{,}51\cdot10^{5}$	5,4	$6{,}31\cdot10^{3}$	3,8
$[Cu(SCN)_6]^{5-}$			$1{,}29\cdot10^{12}$	12,11	$7{,}94\cdot10^{9}$	9,90	$1{,}23\cdot10^{10}$	10,09	$3{,}89\cdot10^{9}$	9,59	$1{,}86\cdot10^{9}$	9,27
$[Cu(SCN)_4]^{2-}$	$2{,}00\cdot10^{2}$	2,30	$4{,}47\cdot10^{3}$	3,65	$1{,}55\cdot10^{5}$	5,19	$3{,}31\cdot10^{6}$	6,52				
$[Fe(SCN)_6]^{3-}$	$1{,}07\cdot10^{3}$	3,03	$2{,}14\cdot10^{4}$	4,33	$3{,}27\cdot10^{4}$	4,63	$3{,}39\cdot10^{4}$	4,53	$1{,}70\cdot10^{4}$	4,23	$1{,}70\cdot10^{3}$	3,23
$[Hg(SCN)_3]^{-}$			$1{,}51\cdot10^{29}$	29,18	$2{,}00\cdot10^{30}$	30,3						
$[Ni(SCN)_3]^{-}$	15,14	1,18	43,65	1,64	64,57	1,81						
$[Zn(SCN)_4]^{2-}$	50,12	17	$1{,}48\cdot10^{2}$	2,17	$2{,}19\cdot10^{2}$	2,34	$1{,}02\cdot10^{2}$	2,01				
							$5{,}03\cdot10^{3}$	3,7				

Sulfitli												
$[Ag(SO_3)_3]^{5-}$	$3{,}98\cdot10^{5}$	5,60	$4{,}79\cdot10^{8}$	8,68	$1{,}01\cdot10^{9}$	9,00						
$[Cu(SO_3)_3]^{5-}$	$7{,}08\cdot10^{7}$	7,85	$5{,}01\cdot10^{8}$	8,70	$2{,}29\cdot10^{9}$	9,36						
$[Hg(SO_3)_3]^{4-}$			$1{,}18\cdot10^{24}$	24,07	$9{,}12\cdot10^{24}$	24,96						
Tiosulfatli												
$[Ag(S_2O_3)_3]^{5-}$	$6{,}61\cdot10^{8}$	8,82	$2{,}88\cdot10^{13}$	13,46	$1{,}41\cdot10^{14}$	14,15						
$[Cd(S_2O_3)_3]^{4-}$	$8{,}71\cdot10^{3}$	3,94	$3{,}02\cdot10^{6}$	6,48	$1{,}59\cdot10^{8}$	8,20						
$[Cu(S_2O_3)_3]^{5-}$	$1{,}86\cdot10^{10}$	10,27	$1{,}66\cdot10^{12}$	12,22	$6{,}92\cdot10^{13}$	13,84						
$[Hg(S_2O_3)_4]^{6-}$			$7{,}24\cdot10^{29}$	29,86	$1{,}82\cdot10^{32}$	32,26	$4{,}07\cdot10^{33}$	33,61				
$[Pb(S_2O_3)_4]^{6-}$	$5{,}01\cdot10^{2}$	2,7	$1{,}35\cdot10^{5}$	5,13	$2{,}24\cdot10^{6}$	6,35	$1{,}59\cdot10^{7}$	77,20				
$[Zn(S_2O_3)_4]^{6-}$	$1{,}95\cdot10^{2}$	2,29	$3{,}89\cdot10^{4}$	4,59			4,0	0,6				
Fosfatli												
$[Al(H_2PO_4)_3]$	10^{3}	3	$2{,}00\cdot10^{5}$	5,3	$3{,}98\cdot10^{7}$	7,6						
$[Fe(H_2PO_4)_4]^{-}$	$3{,}16\cdot10^{3}$	3,5					$1{,}41\cdot10^{9}$	9,15				
Ftoridli												
[AgF]	2,29	0,36										
$[AlF_6]^{3-}$	$1{,}26\cdot10^{7}$	7,10	$9{,}55\cdot10^{11}$	11,98	$6{,}76\cdot10^{15}$	15,83	$3{,}39\cdot10^{18}$	18,53	$1{,}59\cdot10^{20}$	20,20	$4{,}68\cdot10^{20}$	20,67
$[CrF_3]$	$1{,}59\cdot10^{5}$	5,20	$3{,}47\cdot10^{8}$	8,54	$1{,}05\cdot10^{11}$	11,02						
$[FeF_5]^{2-}$	$1{,}1\cdot10^{6}$	6,04	$5{,}50\cdot10^{10}$	10,74	$5{,}5\cdot10^{13}$	13,74	$5{,}5\cdot10^{15}$	15,74	$1{,}26\cdot10^{16}$	16,10		

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Xloridli												
$[AgCl_4]^{3-}$	$1{,}10\cdot10^{3}$	3,04	$1{,}74\cdot10^{5}$	5,24	$1{,}10\cdot10^{5}$	5,04	$1{,}38\cdot10^{6}$	6,14				
$[BiCl_6]^{3-}$	$2{,}69\cdot10^{2}$	2,43	$5{,}01\cdot10^{4}$	4,7	$1{,}00\cdot10^{5}$	5,0	$3{,}98\cdot10^{5}$	5,6	$1{,}26\cdot10^{6}$	6,1	$2{,}63\cdot10^{6}$	6,42
$[CdCl_4]^{2-}$	$1{,}12\cdot10^{2}$	2,05	$3{,}98\cdot10^{2}$	2,60	$2{,}51\cdot10^{32}$	2,40	$7{,}94\cdot10^{2}$	2,90				
$[FeCl_2]$	2,29	0,36	2,51	0,40								
$[FeCl_3]$	28,18	1,45	$1{,}26\cdot10^{2}$	2,10	12,6	1,10						
$[HgCl_4]^{2-}$	$5{,}50\cdot10^{6}$	6,74	$1{,}66\cdot10^{13}$	13,22	$1{,}18\cdot10^{14}$	14,07	$1{,}66\cdot10^{16}$	16,22				
$[PbCl_4]^{2-}$	41,70	1,62	$2{,}75\cdot10^{2}$	2,44	$1{,}10\cdot10^{2}$		10,0	1,00				
$[SnCl_4]^{2-}$	32,4	1,51	$1{,}74\cdot10^{2}$	2,24	$1{,}07\cdot10^{2}$		30,20	1,48				
$[SnCl_6]^{3-}$											6,61	0,82
$[SbCl_6]^{3-}$			$3{,}09\cdot10^{3}$	3,49	$1{,}57\cdot10^{4}$	4,18	$5{,}25\cdot10^{2}$	4,72	$5{,}25\cdot10^{4}$	4,72	$1{,}29\cdot10^{4}$	4,11
Sianidli												
$[Ag(CN)_4]^{3-}$			$7{,}08\cdot10^{19}$	19,85	$3{,}55\cdot10^{20}$	20,55	$2{,}63\cdot10^{19}$	19,42				
$[Cd(CN)_4]^{2-}$	$1{,}51\cdot10^{5}$	5,18	$3{,}98\cdot10^{9}$	9,60	$8{,}32\cdot10^{13}$	13,92	$1{,}29\cdot10^{17}$	17,11				
$[Co(CN)_6]^{4-}$											$1{,}23\cdot10^{19}$	19,09
$[Co(CN)_6]^{3-}$											$1{,}00\cdot10^{64}$	64
$[Cu(CN)_4]^{3-}$			$1{,}00\cdot10^{24}$	24,0	$3{,}98\cdot10^{28}$	28,6	$2{,}00\cdot10^{30}$	30,3				
$[Fe(CN)_6]^{4-}$											$1{,}00\cdot10^{24}$	24,0
$[Fe(CN)_6]^{3-}$											$1{,}00\cdot10^{31}$	31,0
$[Hg(CN)_4]^{2-}$	$1{,}00\cdot10^{18}$	18,00	$5{,}01\cdot10^{34}$	34,70	$3{,}16\cdot10^{38}$	38,53	$3{,}24\cdot10^{41}$	41,51				

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ORGANIK LIGANDLI KOMPLEKSLAR VA ULARNING BARQARORLIK KONSTANTALARI (β)

Kompleks ion	β_1	$lg\beta_1$	β_2	$lg\beta_2$	β_3	$lg\beta_3$	β_4	$lg\beta_4$	β_5	$lg\beta_5$	β_6	$lg\beta_6$
Atsetatli ($L - CH_3COO^-$)												
$[AgL_2]^-$	5,37	0,73	4,37	0,64								
$[CdL_4]^{2-}$	20,0	1,30	$1,91 \cdot 10^2$	2,28	$2,63 \cdot 10^2$	2,42	$1,0 \cdot 10^2$	2,00				
$[CoL_2]$			85,10	1,93								
$[CuL_2]$	$1,74 \cdot 10^2$	2,24	$2,00 \cdot 10^3$	3,30								
$[FeL_2]^-$	$1,59 \cdot 10^3$	3,2	$1,26 \cdot 10^6$	6,1	$2,0 \cdot 10^8$	8,3						
$[HgL_2]$			$2,62 \cdot 10^8$	8,43								
$[NiL_2]$	13,2	1,12	64,57	1,81								
Oksalatli ($L - C_2O_4^{2-}$)												
$[AlL_3]^{3-}$	$2,0 \cdot 10^7$	7,3	$1,00 \cdot 10^{13}$	13,0	$2,0 \cdot 10^{16}$	16,3						
$[CdL_2]^{2-}$	$1,00 \cdot 10^4$	4,0	$4,57 \cdot 10^5$	5,66								
$[CoL_3]^{4-}$	$5,01 \cdot 10^4$	4,7	$5,01 \cdot 10^6$	6,7	$5,01 \cdot 10^9$	9,7						
$[CuL_2]^{2-}$	$5,01 \cdot 10^6$	6,7	$2,51 \cdot 10^9$	9,4								
$[FeL_3]^{4-}$	$5,01 \cdot 10^4$	4,7			$1,66 \cdot 10^5$	5,22						
$[FeL_3]^{3-}$	$2,51 \cdot 10^9$	9,4	$1,59 \cdot 10^{16}$	16,2	$3,98 \cdot 10^{19}$	19,6						
$[MgL_2]^{2-}$	$3,55 \cdot 10^2$	2,55	$2,40 \cdot 10^4$	4,38								
$[MnL_2]^{2-}$	$6,61 \cdot 10^3$	3,82	$1,78 \cdot 10^5$	5,25								
$[NiL_3]^{4-}$	$\sim 2 \cdot 10^5$	~5,3	$\sim 3 \cdot 10^6$	6,5	$\sim 10 \cdot 10^{14}$	~14						

$[PbL_2]^{2-}$			$3,47 \cdot 10^6$	6,54								
$[ZnL_3]^{4-}$	$1,0 \cdot 10^5$	5,0	$2,29 \cdot 10^7$	7,36	$1,41 \cdot 10^8$	8,15						
Salitsilatli ($L - C_6H_4(COO)O^{2-}$)												
$[CuL_2]^{2-}$	$2,0 \cdot 10^7$	7,3	$1,00 \cdot 10^{13}$	13,0								
$[FeL_2]^{2-}$	$1,00 \cdot 10^4$	4,0	$4,57 \cdot 10^5$	5,66								
$[FeL_3]^{3-}$	$3,02 \cdot 10^{16}$	16,48	$1,44 \cdot 10^{28}$	25,16	$6,92 \cdot 10^{36}$	36,84						
$[NiL_2]^{2-}$	$8,91 \cdot 10^6$	6,95	$5,62 \cdot 10^{11}$	11,75								
Sulfosalitsilatli ($L - C_6H_3(COO)(SO_3)^{3-}$)												
$[AlL_3]^{6-}$	$1,59 \cdot 10^{13}$	13,20	$6,76 \cdot 10^{22}$	22,83	$7,76 \cdot 10^{28}$	28,89						
$[CuL_2]^{4-}$	$3,31 \cdot 10^9$	9,52	$2,82 \cdot 10^{16}$	16,45								
$[FeL_2]^{4-}$	$7,94 \cdot 10^5$	5,90	$7,94 \cdot 10^9$	9,90								
$[FeL_3]^{6-}$	$1,05 \cdot 10^{15}$	15,02	$5,75 \cdot 10^{25}$	25,76	$3,98 \cdot 10^{32}$	32,60						
$[MnL_2]^{4-}$	$1,74 \cdot 10^5$	5,24	$1,74 \cdot 10^8$	8,24								
Tartratli ($L - (CHOH)_2(COO)_2^{2-}$)												
$[AlL_2]^-$			$3,98 \cdot 10^8$	9,6								
$[BaL]^-$	$3,47 \cdot 10^2$	2,54										
$[BiL_2]^-$			$2,00 \cdot 10^{11}$	11,3								
$[CaL_2]^{2-}$	$9,55 \cdot 10^2$	2,98	$1,02 \cdot 10^9$	9,01								
[CdL]	$5,01 \cdot 10^2$	2,7										
[CoL]	$6,31 \cdot 10^2$	2,8										
$[CuL_4]^{6-}$	$1,00 \cdot 10^3$	3,0	$1,29 \cdot 10^5$	5,11	$5,75 \cdot 10^5$	5,76	$1,59 \cdot 10^6$	6,20				

$[FeL_2]^{2-}$			$6{,}31 \cdot 10^4$	4,8								
$[FeL_2]^-$	$3{,}09 \cdot 10^7$	7,49	$7{,}94 \cdot 10^{11}$	11,9								
[MgL]	22,91	1,36										
[MnL]	$7{,}94 \cdot 10^2$	2,9										
$[NiL_2]^{2-}$			$2{,}51 \cdot 10^5$	5,4								
[PbL]	$6{,}03 \cdot 10^3$	3,78										
[SrL]	38,90	1,59										
[ZnL]	$1{,}20 \cdot 10^2$	2,08										

10-*jadval*

TITRIMETRIK ANALIZ NATIJALARINI HISOBLASH

Aniqlanadigan modda	Ekvivalentlik faktori	Ekvivalent molyar massa, g/mol
1. Kislota-asosli titrlash		
$Ba(OH)_2$	1/2	85,67
$Ba(OH)_2 \cdot 8H_2O$	1/2	157,73
HCOOH (chumoli)	1	46,026
CH_3COOH (sirka)	1	60,052
$H_2C_4H_4O_4$ (qahrabo)	1/2	59,045
$H_2C_4H_4O_6$ (vino)	1/2	75,044
$H_2C_2O_4$ (oksalat)	1/2	45,018
$H_2C_2O_4 \cdot 2H_2O$	1/2	63,033
HCl	1	36,461
HNO_3	1	63,0128
H_2SO_4	1/2	49,037
K_2CO_3 (fenolftalein bilan)	1	138,206
K_2CO_3 (metiloranj bilan)	1/2	69,103
$KHCO_3$	1	100,115
KOH	1	56,1056
NH_3	1	17,0304
$Na_2B_4O_7 \cdot 10H_2O$	1/2	190,68
Na_2CO_3 (fenolftalein bilan)	1	105,989
Na_2CO_3 (metiloranj bilan)	1/2	52,9942
$Na_2CO_3 \cdot 10H_2O$	1/2	143,070
$NaHCO_3$	1	84,007
NaOH	1	39,9971
2. Oksidlanish-qaytarilish usullari		
As_2O_3	1/4	49,4604
$BaS_2O_3 \cdot H_2O$	1	267,48
$Ce(NH_4)_4(SO_4)_4 \cdot 2H_2O$	1	632,53
$Ce(SO_4)_2 \cdot 4H_2O$	1	404,30
Fe (Fe^{3+} F Fe^{2+})	1	55,847
$Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$	1	392,13
$FeSO_4$	1	151,90
$FeSO_4 \cdot 7H_2O$	1	278,01
$H_2C_2O_4$ (oksalat)	1/2	45,018

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$H_2C_2O_4 \cdot 2H_2O$	1/2	63,033
H_2O_2	1/2	17,0073
H_2S (yodometrik)	1/2	17,04
I_2	1/2	126,9045
ICl	1/2	81,1785
$KBrO_3$	1/6	27,833
$KClO_3$	1/6	20,425
K_2CrO_4	1/3	64,730
$K_2Cr_2O_7$	1/6	49,031
$K_3Fe(CN)_6$	1	329,25
$K_4Fe(CN)_6$	1	368,35
$K_4Fe(CN)_6 \cdot 3H_2O$	1	422,40
KIO_3	1/6	35,6668
$KMnO_4$	1/5	31,6068
KNO_2	1/2	42,552
$NaAsO_2$	1/2	69,955
Na_2HAsO_3	1/2	84,954
$Na_2C_2O_4$	1/2	67,000
$NaNO_2$	1/2	34,4977
Na_2S ($S^{2-} \rightarrow S^0$)	1/2	39,02
Na_2SO_3	1/2	63,02
$Na_2S_2O_3$	1	158,10
$Na_2S_2O_3 \cdot 5H_2O$	1	248,18
Askorbin kislota	1/2	88,063
Rezorsin (bromatometrik)	1/6	18,35
Streptotsid (bromatometrik)	1/4	43,05
Streptotsid (nitritometrik)	1	172,21
Sulfamin kislota	1	97,09
Sulfanil kislota	1	209,24
Fenol (bromatometrik)	1/6	15,69
3. Cho'ktirish va kompleksimetriya usullari		
$AgNO_3$	1	169,873
HBr	1	80,912
HCN (Mor, Folgard, Fayans bo'yicha)	1	27,026
HCl	1	36,461
HI	1	127,9124
HNCS (Folgard bo'yicha)	1	59,09

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$Hg(NO_3)_2 \cdot H_2O$	1/2	171,31
$Hg_2(NO_3)_2 \cdot H_2O$	1/2	280,61
KBr	1	119,002
KCN (Mor, Folgard, Fayans bo'yicha)	1	65,116
KCl	1	74,551
K_2CrO_4	1	97,095
KNCS	1	97,18
KI	1	166,0027
NH_4Cl	1	53,491
NH_4NCS	1	76,12
NaBr	1	102,894
NaCl	1	58,443
NaI	1	149,8942
4. EDTA bilan titrlash usullari		
$BaCl_2$	1	208,24
$Ba(NO_3)_2$	1	261,34
$Bi(NO_3)_3$	1	394,995
$BiONO_3 \cdot H_2O$	1	305,000
$CaCO_3$	1	100,09
$CaCl_2$	1	110,99
$CaCl_2 \cdot 6H_2O$	1	219,08
$Ca(NO_3)_2$	1	164,09
CaO	1	56,08
$CuSO_4$	1	159,60
$Hg(NO_3)_2$	1	324,60
$MgCl_2$	1	95,211
$Mg(NO_3)_2$	1	148,314
$MgSO_4$	1	120,36
$Na_2H_2C_{10}H_{12}O_8N_2$ (EDTA)	1	336,209
$Na_2H_2C_{10}H_{12}O_8N_2 \cdot 2H_2O$ (EDTA-digidrat)	1	372,239
Zn	1	65,38
$ZnCl_2$	1	136,29
$Zn(NO_3)_2$	1	189,39
$Zn(NO_3)_2 \cdot 6H_2O$	1	297,48
ZnO	1	81,38
$ZnSO_4$	1	161,44
$ZnSO_4 \cdot 7H_2O$	1	287,54

11-*jadval*

KISLOTA-ASOSLI INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	**Suvli eritmalarda rang o’zgarishining pH oraliqlari**	**Rangining o’zgarishi**
Metil binafsha (1-o’tish)	0,13 – 0,5	sariq – yashil
Metil yashili	0,1 – 2,0	sariq – yashil
Metil binafsha (2-o’tish)	1,0 – 1,5	yashil – ko’k
Timol ko’ki (1-o’tish)	1,2 – 2,8	qizil – sariq
Tropeolin 00	1,4 – 3,2	qizil – sariq
Metil binafsha (3-o’tish)	2,0 – 3,0	ko’k – binafsha
β-Dinitrofenol	2,4 – 4,0	rangsiz – sariq
α-Dinitrofenol	2,8 – 4,4	rangsiz – sariq
Metiloranj	3,0 – 4,4	qizil – sariq
Bromfenol ko’ki	3,0 – 4,6	sariq – ko’k
Kongo qizili	3,0 – 5,2	ko’kimtir-binafsha – qizil
Alizarin qizil S (1-o’tish)	3,7 – 5,2	sariq – binafsha
γ-Dinitrofenol	4,0 – 5,4	rangsiz – sariq
Metil qizil	4,4 – 6,2	qizil – sariq
p-Nitrofenol	5,6 – 7,6	rangsiz – sariq
Bromtimol ko’ki	6,0 – 7,6	sariq – ko’k
Neytral qizil	6,8 – 8,0	qizil – sariq
Tropeolin 000	7,6 – 9,0	jigarrang-sariq – to’q-qizil
Timol ko’ki (2-o’tish)	8,0 – 9,6	sariq – ko’k
Fenolftalein	8,2 – 10,0	rangsiz – qizil
Timolftalein	9,4 – 10,5	rangsiz – ko’k
Tropeolin 0	11,0 – 13,0	sariq – zarg’aldoq
Indigokarmin	11,6 – 14,0	ko’k – sariq
1,3,5-Trinitrobenzol	12,2 – 14,0	rangsiz – zarg’aldoq

12-*jadval*

ADSORBSION INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	**Aniqlanadigan ion**	**Titrant**	**Rangining o'zgarishi**
Alizarin qizil (alizarinsulfokislota)	$[Fe(CN_6)]^{4-}$ SCN^-	Pb^{2+} Ag^+	sariq – pushti-qizil
Bromfenol ko'ki (tetrabromfenolsulfoftalein)	Tl^+ Hg^{2+} SCN^- I^-, Cl^- Br^-	I^- Cl^- Ag^+ Ag^+ Hg_2^{2+}	sariq – yashil och-binafsha – sariq binafsha – ko'kimtir-yashil
Difenilkarbazid	CN^- Cl^-, Br^-	Ag^+ Hg_2^{2+}	sarg'ish-yashil – ko'kimtir-ko'k rangsiz – binafsha
Difenilkarbazon	Cl^-, I^-, CN^- Cl^- Br^-, I^- SCN^-	Hg_2^{2+} Ag^+ Ag^+ Ag^+	qizil – binafsha sariq – yashil pushti – ko'k
2,7-Dixlorfluoressein	Cl^-, Br^-, I^-	Ag^+	sarg'ish-yashil – pushti-qizil
Rodamin 6J (dietilamino-*o*-karboksife-nil-ksantenilxloridning etil efiri)	Br^-	Ag^+	sarg'ish-qizil - binafsha
Kongo qizili (difenil-*bis*-(1-amino)-2-naftilazo-4-sulfokislota)	Cl^-, Br^-, I^-	Ag^+	qizil – ko'k
Fluoressein (rezorsinftalein)	Cl^-, Br^-, I^-, SCN^-	Ag^+	sarg'ish-yashil – pushti
Eozin (tribromo (R) fluoressein)	Br^-, I^-	Ag^+	zarg'aldoq – qizg'ish-binafsha
Eritrozin (diyodo (R) fluoressein)	I^- MoO_4^-	Ag^+ Pb^{2+}	zarg'aldoq – to'q-qizil

13-*jadval*

METALLOXROM INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	Ratsional nomlanishi	Aniqlanadigan element	pH oraliqlari	Rang o'zgarishi	
				kompleks	indikator
Alizarin (alizarin qizil, sulfo-alizarin)	1,2-dioksiantraxinon-3-sulfo-kislota	Th Sc Y	2,3 – 3,4 2 5	pushti qizil pushti	sariq yashil sariq
Arsenazo I (uranon)	2-(*o*-arsenofenilazo)-1,8-diok-sinaftalin-3,6-disulfokislota	U(IV), Th(IV) Ca, Mg	1,7 – 3,0 10	ko'k binafsha	pushti qizg'ish-zarg'aldoq
Arsenazo (III)	1,8-dioksinaftalin-3,6-disulfo-kislota-2,7-*bis*-(azo-1)-2-fe-nilarson kislota	U, Th, Zn	kuchli kislotali	ko'kimtir-yashil	qizil
Brompirogallol qizili	3',3"-dibromsulfogallein	Bi Pb Cd, Ni Mg, Mn	2 – 3 5 – 6 9,3 10	qizil ko'k ko'k ko'k	zarg'aldoq-sariq qizil qizil binafsha
Glitsinkrezol qizili	3,3'-*bis*-(N-karboksimetil)-aminometil-*o*-krezolsulfofta-lein (natriyli tuzi)	Cu(II)	5 – 6	qizil	sariq
Glitsintimol ko'ki	3,3'-*bis*-(N-karboksimetil)-aminometiltimolsulfoftalein	Cu(II)	5 – 5,5	ko'k	sariq yoki yashil-sariq

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Ditizon	2-fenilgidrazinfenilazotio-chumoli kislota	Pb, Zn, Cd Bi	4,7 – 5,4 2,5 – 5,0	qizil qizil	ko'k-qizil ko'k-qizil
Krezolftalekson	3,3'-*bis*-(N,N-dikarboksimetil) -aminometil-*o*-krezolftalein (natriyli tuzi)	Ca, Ba, Sr	10 – 11	qirmizi	pushti
Ksilenoloranj	3,3'-*bis*-(N,N-dikarboksimetil) -aminometiltimolsulfoftalein	Bi, Fe(III) Th Pb, Zn, Cd Hg(II), Co Mn, Mg, Ca	1 – 2 2,5 – 3,5 5 – 6 10	qizg'ish-binafsha qizg'ish-binafsha binafsha binafsha	sariq sariq sariq kulrang
Metiltimol ko'ki	3,3'-*bis*-(N,N-dikarboksimetil) -aminometiltimolsulfoftalein (natriyli tuzi)	Pb, Cd, Mn, Zn Hg(II), La, Sc Pb, Zn, Cd, Mg Cu, Ca, Ba, Sr	5 – 6,5 11,5 – 12,5	ko'k ko'k	sariq kulrang yoki kulrang-sariq
Morin	2',3,4',5,7-pentaoksiflavon	Ga, Th	4,5 – 6	yashil fluo-ressensiya	fluoressen-siya so'nadi
Mureksid	5,5'-nitrilodipurpir kislota (ammoniyli tuzi)	Mn, Ni Co(II), Zn, Cd, Ca	9 – 10 > 12	sariqdan-qizilgacha sariqdan-qizilgacha	binafsha binafsha

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Naftol binafsha	4-(4-nitrofenilazo)-2-*bis*-(karboksimetil)aminometil-1-naftol	Bi Cu(II), Zn, Cd, Co(II), Mg, Mn(II)	1 – 2 10 – 11	qizg'ish-binafsha qizg'ish-binafsha	qizg'ish- zarg'aldoq ko'k
PAN	1-(2-piridilazo)-2-naftol	Zn, Cd Ni Cu(II) Bi	5 – 7 4 < 2,5 1 – 3	pushti-qizil pushti-qizil pushti-qizil pushti-qizil	sariq sariq sariq sariq
PAR	4-(2-piridilazo)-rezorsin	Bi, Tl(III) Al Hg(II)	1 – 2 3 6 – 11	zarg'aldoq yoki qizil	yashil-sariq
Pirokatexin binafsha	3,3',4'-trifuksin-2"-sulfon kislota	Bi, Th, Ga Sn, Pb Fe, Cu(II) Zn, Mg, Cd, Co(II), Mn, Ni	2 – 3 4,5 – 5,5 5,5 – 6,5 9 – 11	ko'k ko'k ko'k ko'k	sariq sariq sariq qizg'ish-binafsha
Piragallol qizil	pirogallol-sulfoftalein	Bi Pb Ni, Co(II)	2 – 3 5 – 6 9	qizil binafsha ko'k	zarg'aldoq-sariq qizil qizil
Salitsil kislota	*o*-oksibenzoy kislota	Fe(III)	1,8 – 3	binafsha	sariq

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Timolftaleinkomplekson	3,3-*bis*-(N,N-dikarboksimetil) -aminometilftalein (natriyli tuzi)	Ca, Ba, Sr, Ag, Mn(II)	10 – 11	ko'k	rangsiz
Tiron	1,2-dioksibenzol-3,5-disulfo-kislota (natriyli tuzi)	Fe(III), Ti(IV)	2 – 3	ko'k	sariq
Fluorekson (fluoresseinkom-plekson, kalsein)	*bis*-(N,N-dikarboksimetil)-aminometilfluoressein (natriyli tuzi)	Ca, Ba, Sr Cu(II), Mn(II)	> 10 10 – 11	sarg'ish-ya-shil fluores-sensiya qizil yoki qizg'ish-binafsha	fluoressensiya so'nadi; eritma pushti sarg'ish-ya-shil fluores-sensiya
Xromazurol S	3"-sulfo-2",6"-dixlor-3,3'-dimetil-4-oksifukson-5,5'-dikarbon kislota	Fe(III), Th, Zr Al, Ca, La Cu(II) Ni Ca, Mg	2 – 3 4 – 5 6 – 6,5 7,5 10 – 11	qizg'ish-binafsha yoki binafsha-ko'k	sariq yoki sarg'ish-yashil
Erioxromsianin R	2"-sulfo-3,3'-dimetil-4-oksi-fukson-5,5'-dikarbon kislota	Zr Th, Fe(III) Al Mg, Cu(II) Ca	1,4 2 – 3 5 – 6 10 11,5	pushti qirmizi binafsha	sariq zarg'aldoq sariq

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Erioxrom qora T	1-(1-oksi-2-naftilazo)-6-nitro-2-naftol-4-sulfokislota	lantanidlar Pb, Zn, Mg Ca, Ba, Mn(II) Fe(III), Cd, Hg(II)	8 – 9 8 – 10	qizil	ko'k
SPADNS	2-(4-sulfofenilazo)-1,8-diok-sinaftalin-3,6-disulfokislota	Zr Th	1,5 – 2,5 2,5 – 3,5	qizg'ish-pushti ko'k-binafsha	sariq to'q-qizil

14-*jadval*

REDOKS INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	E_0^h **(pH = 0)**	**Rangining o'zgarishi**	
		oksidlanish	**qaytarilish**
Safranin T	0,24	qizil	rangsiz
Neytral qizil	0,24	qizil	rangsiz
Indigomonosulfon kislota	0,26	qizil	rangsiz
Indigotetrasulfon kislota	0,37	ko'k	rangsiz
Metilen ko'ki	0,53	yashil-ko'k	rangsiz
2,6-Dixlorfenolindofenol	0,64	ko'k	rangsiz
2,6-Dibrombenzolindofenol	0,67	ko'k	rangsiz
Difenilamin (difenilbenzidin)	0,76	binafsha	rangsiz
Difenilaminsulfon kislota	0,85	qizg'ish-binafsha	rangsiz
N-fenilantranil kislota	1,08	binafsha-qizil	rangsiz
1,10-Fenantrolin-Fe(II)-kompleksi	1,06	och-zangori	qizil
Nitro-*o*-fenantrolin-Fe(II)-kompleksi	1,25	och-zangori	binafsha-qizil

15-*jadval*

METALL IONLARINI ANIQLASHDA QO'LLANILADIGAN ORGANIK REAGENTLAR

Element	Reagent	Aniqlash usuli
Alyuminiy	Alizarin	Fotometrik
	Alizarinsulfokislotaning natriyli tuzi	-//-
	Alyuminon	-//-
	Alberon	-//-
	Gematoksilin	-//-
	Diazobenzolsulfokislota	-//-
	Erioxromsianin	-//-
	Kvarsetin	-//-
	Kupferon	-//-
	Morin	-//-
	8-Oksixinolin	Titrimetrik, tortma
	Piridin	Fotometrik
	Salitsilidenaminofenol	-//-
	Tannin	Tortma
	Xinalizarin	Fotometrik
	Xinaldin kislota	-//-
	Xromazurol S	-//-
Ammiak	Kalignost	Tortma, titrimetrik, fotometrik
Berilliy	Alberon	Fotometrik
	Berilon II IPEA	-//-
	Kurkumin	-//-
	4-*p*-Nitrofenilazoarsin	-//-
	Tannin	Tortma
	Xinalizarin	Fotometrik
Galliy	Alizarinsulfokislotaning natriyli tuzi	-//-
	Gallion IPEA	-//-
	Dibromoksixinolin	Tortma
	Kupferon	-//-
	Morin	Fotometrik
	8-Oksixinolin	Tortma, titrimetrik, fotometrik
	Rodamin V	Ekstraksion-fotometrik
	Tannin	Tortma
	Xinalizarin	Ekstraksion-fotometrik

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Gafniy	Arsenazo III Kupferon	Fotometrik Tortma, titrimetrik
Germaniy	Difenilkarbazon 8-Oksixinolin Fenilfluoron	Fotometrik Tortma Fotometrik
Indiy	Arsenazo 5,7-Dibrom-8-oksixinolin Ditizon 8-Oksixinolin	-//- -//- -//- Tortma, titrimetrik
Kadmiy	Antranil kislota Diantipirilmetan Ditizon Difenilkarbazid Na-dietilditiokarbamat Kadion Kristall binafsha Metil binafsha Merkaptobenztiazolon α-Naftoxinon 8-Oksixinolin	Tortma -//- Fotometrik -//- -//- -//- -//- -//- Tortma -//- Tortma, titrimetrik
Kaliy	Dipikrilamin Nitrozo-R-tuz Natriy tetrafenilborat	Tortma, titrimetrik, fotometrik Fotometrik Tortma, titrimetrik
Kalsiy	Azoazoksi Natriy naftalinoksamat Pikrolon kislota Xloranil kislota Oksalat kislota	Fotometrik -//- Tortma Fotometrik Tortma
Kobalt	Antranil kislota Diantipirilmetan Dimetilglioksim Ditizon 8-Merkaptoxinolin 8-Oksixinolin PAN Tiomochevina	-//- -//- Fotometrik -//- -//- Tortma, titrimetrik, fotometrik Fotometrik Tortma

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Kumush	*p*-Dimetilaminobenzilidenrodanin Ditizon Difenilkarbazon Natriy dietilditiokarbamat Merkaptobenztiazol Tiomochevina Xinaldin kislota	Titrimetrik, fotometrik Fotometrik -//- Ekstraksion-fotometrik Tortma -//- Titrimetrik
Litiy	8-Oksixinolin Toron	Tortma, titrimetrik, fotometrik Fotometrik
Magniy	*bis*-Salitsilidenetilendiamin Difenilkarbazid Magnezon IPEA 8-Oksixinolin Pikrolon kislota Sulfanil kislota Titan yashil	-//- -//- -//- Tortma, titrimetrik, fotometrik Tortma Fotometrik -//-
Magniy	Fenazon Xinalizarin	Fotometrik -//-
Marganes	Antranil kislota Natriy dietilditiokarbamat 8-Merkaptoxinolin Nioksim 8-Oksixinolin Tiomochevina Xinaldin kislota Sistein	Tortma Fotometrik -//- -//- Tortma, titrimetrik, fotometrik Tortma -//- -//-
Mis	Antranil kislota α-Benzoinoksim 1,2-Diaminoantraxinon-3-sulfokislota Dimetilglioksim 2,9-Dimetil-4,7-difenil-1,10-fenantro-lin Daksim	Tortma -//- Fotometrik -//- -//- Ekstraksion-fotometrik

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Mis	Ditizon	Fotometrik
	8,8-Dixinolildisulfid	-//-
	Kaliy ksantat	Ekstraksion-fotometrik
	Kuproin	Tortma
	Kupferon	Fotometrik
	Merkaptosirka kislota	Tortma, titrimetrik
	Merkaptobenztiazol	Ekstraksion-fotometrik
	Neokuproin	Fotometrik
	α-Nitrozo-β-naftol	Tortma, titrimetrik, fotometrik
	8-Oksixinolin	Tortma
	Salitsilaldoksim	Fotometrik
	Salitsil kislota	Ekstraksion-fotometrik
	Tenoiltriftoratseton	-//-
	Tiomochevina	-//-
	Tiosemikarbazid	Tortma
	Xinaldin kislota	
Mishyak	Erioxromsianin	Fotometrik
	Kaliy ksantat	-//-
	Tioatsetamid	Tortma
	Tiomochevina	-//-
	Tioanilid	Fotometrik
Molibden	α-Benzoinoksim	Tortma
	Ditiol	Fotometrik
	8-Merkaptoxinolin	-//-
	8-Oksixinolin	Tortma, titrimetrik fotometrik
Nikel	Antranil kislota	Tortma
	α-Benzildioksim	-//-
	Diallilditiokarbamoilgidrazin	-//-
	Dimetilglioksim	Tortma, titrimetrik, fotometrik
	Ditizon	Fotometrik
	Nioksim	-//-
	8-Oksixinolin	Tortma, titrimetrik, fotometrik
	Tiomochevina	Tortma
	α-Furildioksim	-//-
	Xinaldin kislota	-//-

15-*jadvalning davomi*

Niobiy	Kupferon Pirogallol Tannin Toron Fenilarson kislota	-//- Fotometrik Tortma Fotometrik Tortma
Oltin	*p*-Dimetilaminobenzilidenrodanin Ditizon Merkaptobenztiazol Rodamin B Tiomochevina Tiofenol *o*-Toluidin	Fotometrik -//- Tortma Fotometrik Tortma -//- Fotometrik
Osmiy	8-Merkaptoxinolin Tiomochevina Tionalid	-//- -//- -//-
Palladiy	Atsetilen *p*-Dimetilaminobenzilidenrodanin Dimetilglioksim 2,2'-Dipiridil Ditizon 8-Merkaptoxinolin α-Nitrozo-β-naftol 8-Oksixinolin Salitsilaldoksim Tiomochevina 1,10-Fenantrolin Fenilpiridilketoksim α-Furildioksim	-//- -//- Tortma, titrimetrik, fotometrik Tortma Ekstraksion-fotometrik Fotometrik -//- Tortma, titrimetrik, fotometrik Tortma -//- Fotometrik -//- Tortma, ekstraksion-fotometrik
Platina	2-Merkaptobenzotiazol α-Furildioksim	Tortma -//-
Qalay	Brilliant sariq Ditizon Ditiol Kristall binafsha Metil binafhsa	Fotometrik -//- -//- -//- -//-

15-*jadvalning davomi*

Qo’rg’oshin	Antarnil kislota Arsatsen Ditizon Difenilkarbazid Merkaptobenztiazol 8-Oksixinolin Salitsilaldoksim Sulfarsatsen Tioatsetamid Tionalid Ftal kislota Xinaldin kislota	Tortma Fotometrik -//- -//- Tortma Tortma, titrimetrik, fotometrik Tortma Titrimetrik Tortma -//- Fotometrik Tortma
Reniy	8-Merkaptoxinolin Nitron Rodamin 6J	Fotometrik Tortma Fotometrik
Rodiy	Tiobarbitur kislota Tiomochevina Tionalid	Tortma -//- -//-
Rubidiy	Dipikrilamin Natriy tetrafenilborat	Tortma, fotometrik Fotometrik, titrimetrik
Ruteniy	Antranil kislota 8-Merkaptoxinolin Tiomochevina Tionalid	Fotometrik -//- Tortma -//-
Rux	Antranil kislota Arsatsen Brilliant sariq Diallilditiokarbamoilgidrazon Ditizon Ksineloloranj Metil binafsha Natriy ditiokarbamat 8-Oksixinolin Rodamin B Sulfarsatsen	Tortma Fotometrik -//- Tortma Ekstraksion-fotometrik Fotometrik -//- -//- Tortma, titrimetrik, fotometrik Fotometrik Tortma, titrimetrik, fotometrik

15-*jadvalning davomi*

Seziy	Dipikrilamin Kalignost	Tortma, fotometrik Tortma, titrimetrik, fotometrik
Seriy	8-Oksixinolin Tenoiltriftoratseton	Ekstraksion-fotometrik -//-
Simob	Antranil kislota *p*-Dimetilaminobenzilidenrodanin Ditizon Difenilkarbazid Difenilkarbazon Kristall binafsha Metil binafsha Tetrafenilarsoniy xlorid Tioatsetamid Tiomochevina Tionalid	Tortma Fotometrik -//- -//- -//- -//- -//- -//- Tortma -//- -//-
Sirkoniy	Alizarin Arsenazo Arsenazo III Bodom kislota Ditizon Kupferon Morin 8-Oksixinolin	Fotometrik -//- -//- Tortma Fotometrik Tortma Fotometrik Tortma, titrimetrik, fotometrik
Stronsiy	Pikrolon kislota Xloranil kislota	Tortma Fotometrik
Surma	Pirogallol Pirrolidinditiokarbon kislota Tionalid	Tortma Fotometrik Tortma
Talliy	Brilliant sariq Ditizon Kristall binafsha Merkaptobenzotiazol 8-Merkaptoxinolin Metil binafsha Natriy tetrafenilborat	Fotometrik -//- -//- Tortma Fotometrik -//- Tortma, titrimetrik fotometrik

15-*jadvalning davomi*

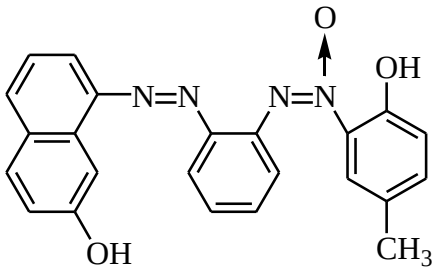
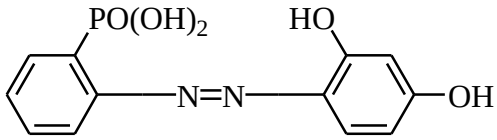
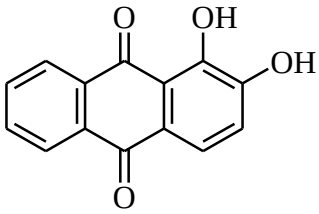
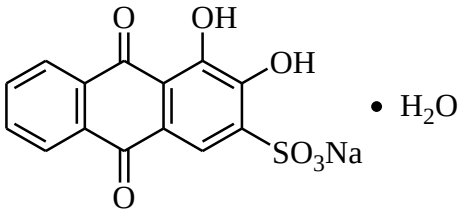
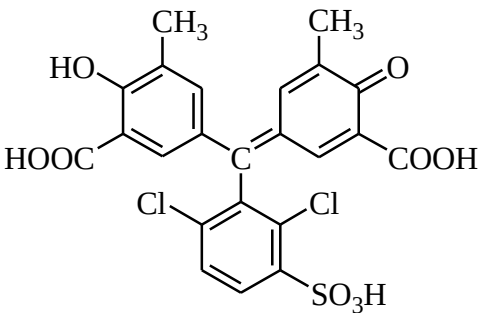
Tantal	*p*-Dimetilaminobenzilidenrodanin Kupferon Pirogallol Tannin Toron Fenilarson kislota Fenilfluoron	-//- Tortma Fotometrik Tortma Fotometrik Tortma Fotometrik
Titan	Kupferon 8-Oksixinolin Sulfosalitsil kislota Tayron	Tortma, fotometrik Tortma, titrimetrik, fotometrik Fotometrik -//-
Toriy	Alizarin Alizarinsulfokislota Arsenazo III Kupferon Morin 8-Oksixinolin Pikrolon kislota Toron	Fotometrik -//- -//- Tortma Fotometrik Tortma -//- Fotometrik
Uran	Arsenazo III Kupferon Merkaptosirka kislota Morin PAN Tenoiltriftoratseton Toron Xinaldin kislota	-//- Tortma Fotometrik -//- -//- Ekstraksion-fotometrik Fotometrik Tortma
Vanadiy	Kupferon 8-Merkaptoxinolin 8-Oksixinolin	Tortma Fotometrik Tortma, titrimetrik, fotometrik
Vismut	Diantipirilmetan Ditizon Ksilenoloranj Kupferon Merkaptobenztiazol Merkaptofeniltiodiazolin 8-Oksixinolin	Tortma Titrimetrik Fotometrik Tortma -//- Fotometrik Tortma, titrimetrik

15-*jadvalning davomi*

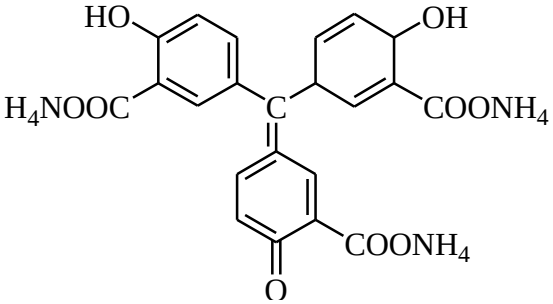
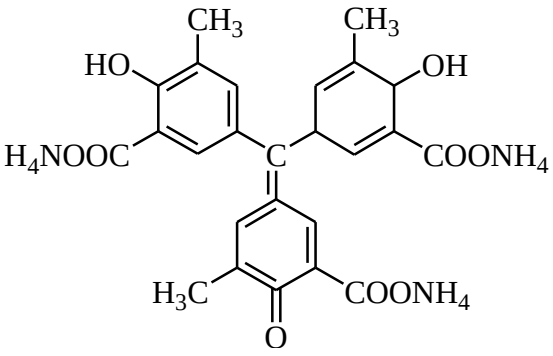
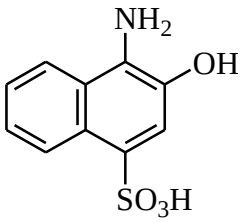
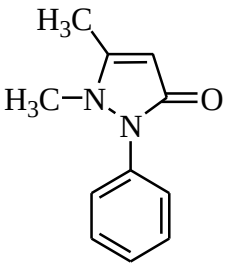
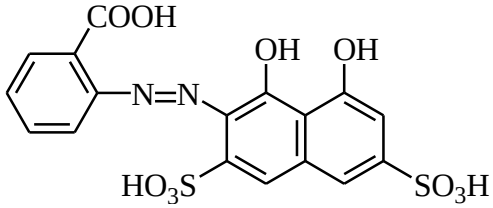
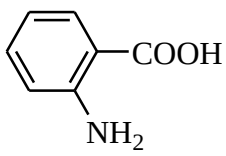
Vismut	Pikrin kislota Pirogallol Tioatsetamid Tionalid Tiomochevina Toron	Tortma -//- -//- Fotometrik Tortma Fotometrik
Volfram	Ditiol Merkaptosirka kislota 8-Oksixinolin Rodamin B	Fotometrik -//- Tortma, titrimetrik, fotometrik Fotometrik
Xrom (III)	Komplekson III 8-Oksixinolin Xinaldin kislota	Fotometrik Tortma, titrimetrik, fotometrik Tortma
Xrom (VI)	Difenilkarbazid Komplekson III Xromotrop kislota	Fotometrik -//- -//-

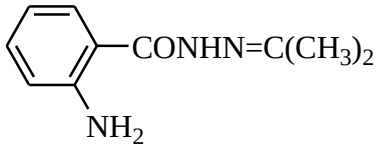
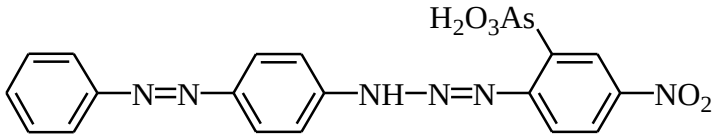
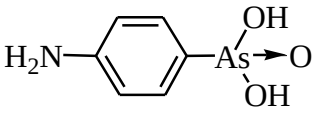
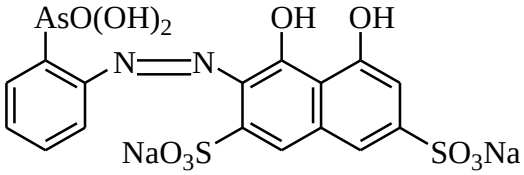
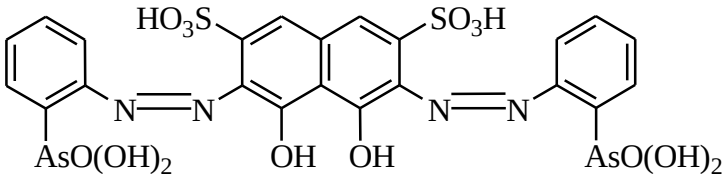
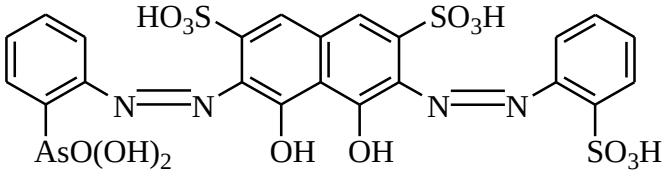
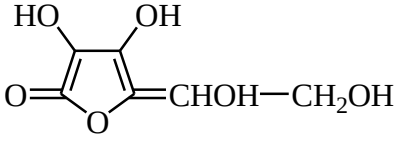
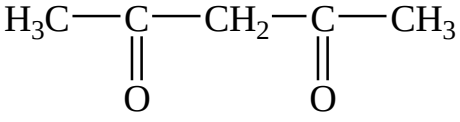
16-*jadval*.

NOORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN MUHIM ORGANIK REAGENTLAR

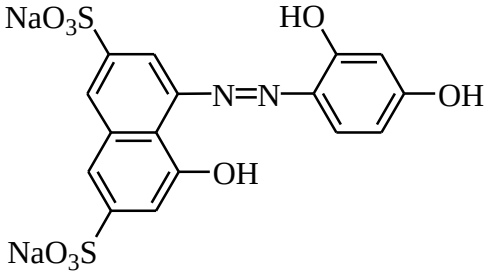
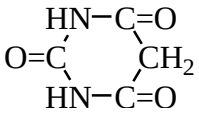
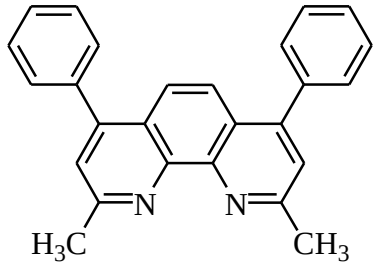
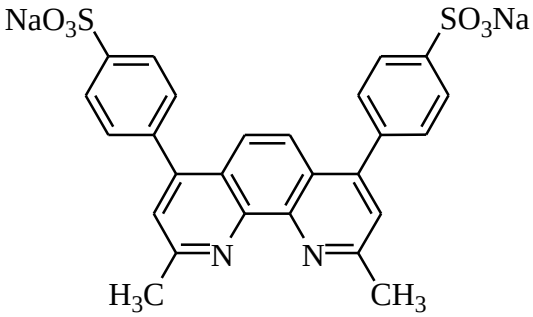
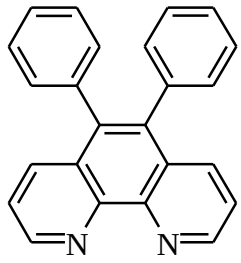
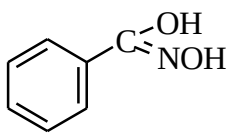
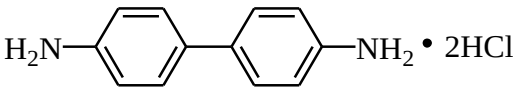
Reagent	Aniqlanadigan ionlar
1. Azo-azoksi BN 	M.m. 398,42 Ca^{2+}, Sr^{2+}
2. Azofosfon 	M.m. 294,20 Sc^{3+}
3. Alizarin (1,2-dioksiantraxinon) 	M.m. 240,21 Al^{3+}, Be^{2+}, F^{-}, In^{3+}, Th^{IV}, Zr^{IV}
4. Alizarin qizil C (S) (natriy gidroksiantraxinonsulfonat) 	M.m. 360,27 Al^{3+}, B^{III}, Ga^{3+}, La^{3+}, Th^{IV}, Zr^{IV}, U^{VI}, F^{-}
5. Alberon (xromazurol S) 	M.m. 539,34 Al^{3+}, Be^{2+}, In^{3+}, Ga^{3+}, Zr^{IV}, U^{VI}

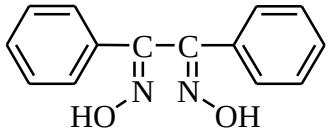
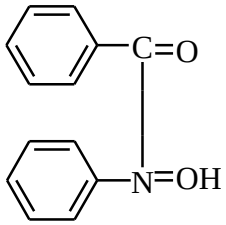
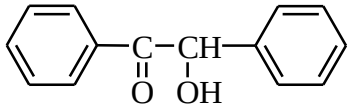
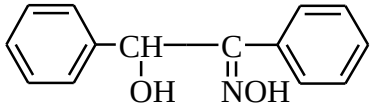
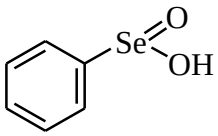
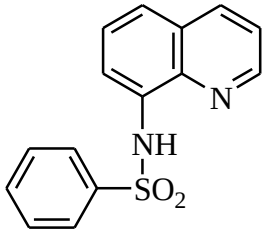
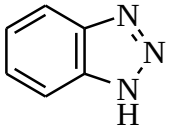
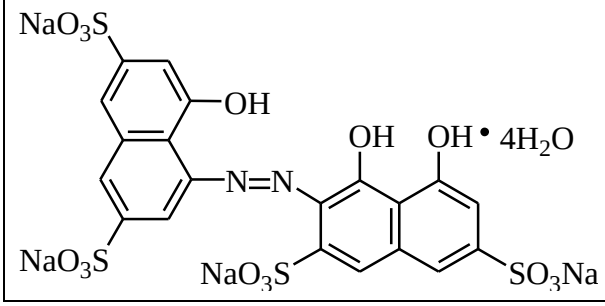
16-*jadvalning davomi*

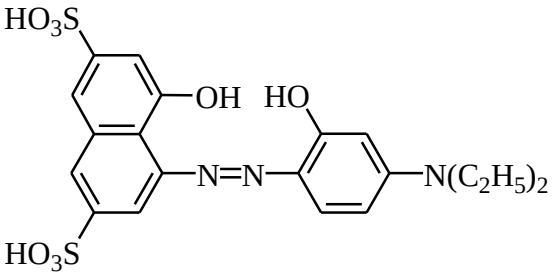
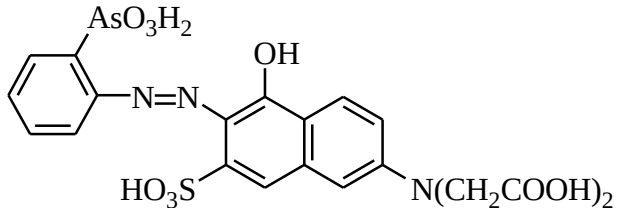
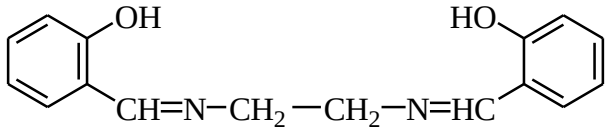
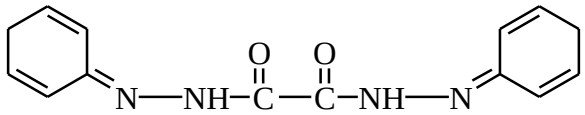
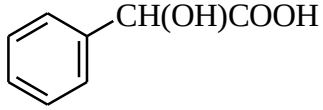
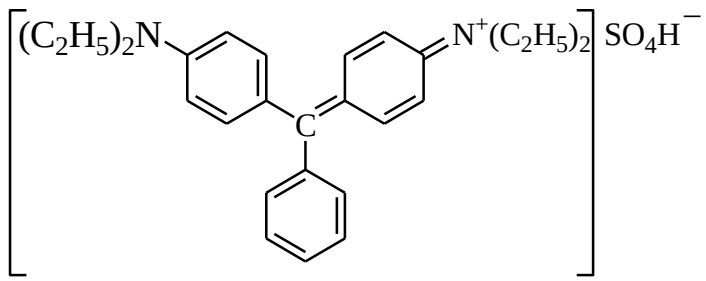
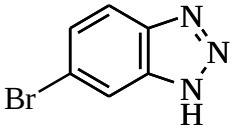
6. Alyuminon (aurintrikarbon kislotaning NH_4^+-li tuzi) 	M.m. 473,44 Al^{3+}, Be^{2+}, Zr^{IV}, V^{IV}, Ga^{3+}, Th^{IV}
7. Alyumokrezon (trimetilalyuminon) 	M.m. 515,52 Al^{3+}, Be^{2+}, Mg^{2+}, Ca^{2+}, Co^{2+}, Ni^{2+}
8. 1-Amino-2-naftol-4-sulfokislota (ext-kislota) 	M.m. 239,25 Pd^{2+}, NO_2^-, PO_4^{3-}
9. Antipirin 	M.m. 188,23 NO_2^-, $Co(SCN)_4^{2-}$, $HgCl_4^{2-}$, $Zn(SCN)_4^{2-}$, BiI_4^-, $AuCl_4^-$
10. Antrazoxrom (xromotrop 2S) 	M.m. 468,42 Al^{3+}, Be^{2+}, Mg^{2+}, Ca^{2+}, V^{IV}
11. Antranil kislota 	M.m. 137,14 Cd^{2+}, Co^{2+}, Cu^{2+}, Mn^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Th^{IV}, Zn^{2+} (MR_2 ko'rinishida)

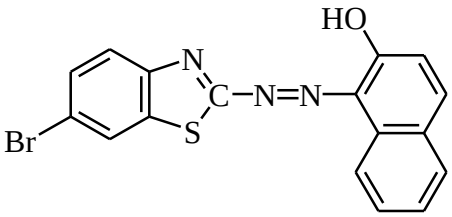
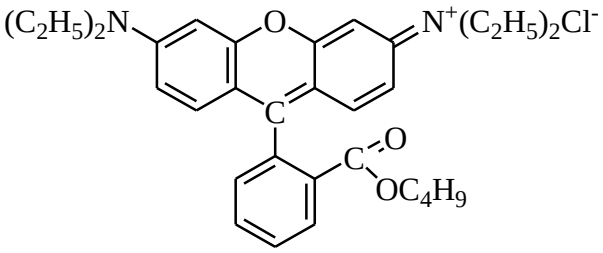
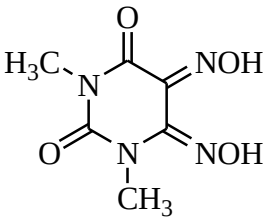
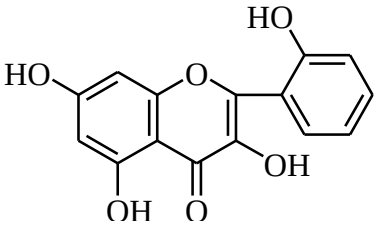
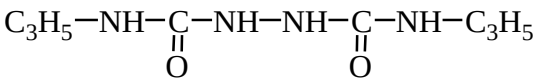
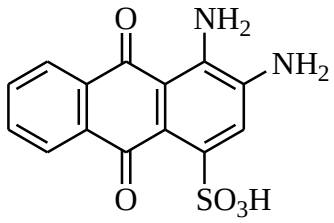
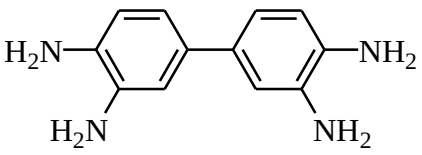
12. Antarnil kislotaning izopropilengidrazidi 	M.m. 191,23 V^{V}
13. Arsazen 	M.m. 470,28 Pb^{2+}, Zn^{2+}
14. Arsanil kislota (*p*-aminofenilarson kislota) 	M.m. 217,06 Ti^{IV}, Zr^{IV} (MR_2 ko'rinishida)
15. Arsenazo I (uranon I, toron, neotorin) 	M.m. 592,29 Al^{3+}, BF_4^-, Be^{2+}, Ca^{2+}, Co^{2+}, Cu^{2+}, Nb^{V}, Ni^{2+}, Ta^{V}, Th^{IV},Ti^{IV}, UO_2^{2+}, V^{IV}, Zr^{IV}, F^-
16. Arsenazo III 	M.m. 776,39 Th^{IV}, U^{IV}, Hf^{IV}, Zr^{IV}, Al^{3+}, Be^{2+}, Ca^{2+}, Cd^{2+}, Hg^{2+}, Mg^{2+}, Pb^{2+}, Ti^{IV}, Zn^{2+}, Y^{3+}
17. Arsenazo M 	M.m. 732,50 La^{III}, Al^{3+}, Ba^{2+}, Ca^{2+}, Cu^{2+}, Ga^{3+}, In^{3+}, Mg^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+}, Sr^{2+}, SO_4^{2-}
18. Askorbin kislota 	M.m. 176,13 Nb^{IV}, Ti^{IV}, U
19. Atsetilatseton (diatsetilmetan) 	M.m. 100,12 Be^{2+}, Cr^{3+}, Fe^{3+}, Mo^{VI}, V^{III}, V^{V}, Zr^{IV}

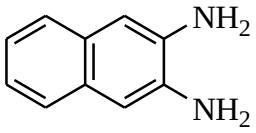
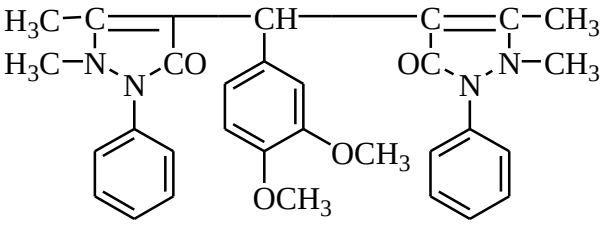
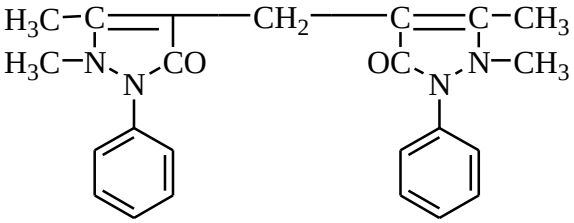
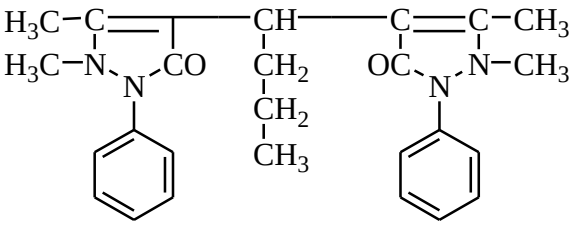
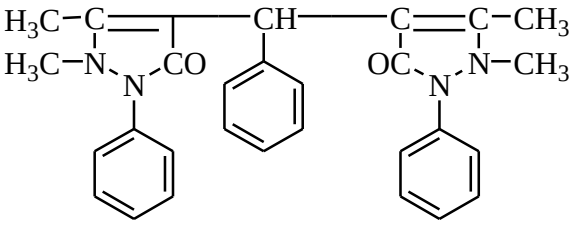
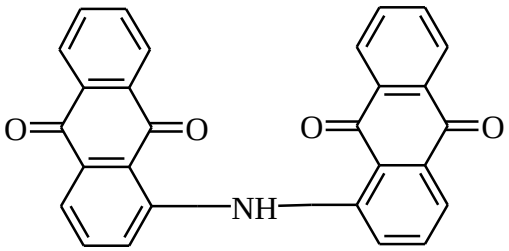
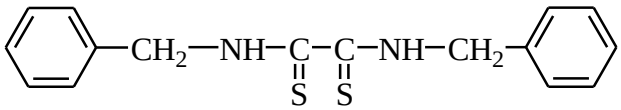
16-*jadvalning davomi*

20. Ash-rezorsin, dinatriyli tuzi  	M.m. 484,36 B^{III}
21. Barbiturat kislota  	M.m. 128,09 CN^-, SCN^-
22. Batokuproin (2,9-dimetil-4,7-difenil-1,10-fenantrolin)  	M.m. 360,46 Cu^I
23. Batokuproindisulfokislotaning natriyli tuzi  	M.m. 564,54 Cu^I
24. Batofenantrolin (4,7-difenil-1,10-fenantrolin)  	M.m. 332,40 Fe^{2+}
25. Benzgidroksam kislota  	M.m. 137,14 V^V, Mn^{2+}, U^{IV}, Ti^{IV}
26. Benzidin digidroxlorid  	M.m. 257,16 Ta^V, Ti^{IV}, Ce^{IV}, Ge^{IV}, V^V, W^{VI}

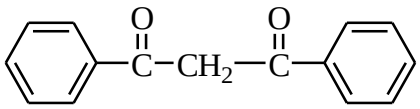
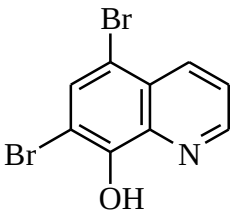
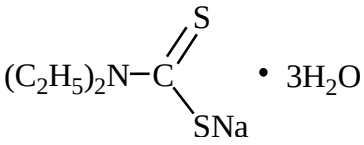
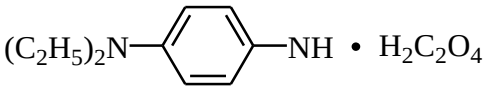
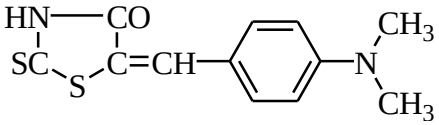
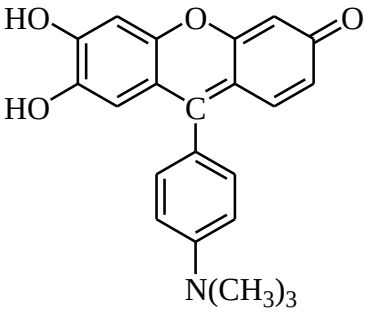
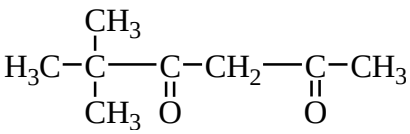
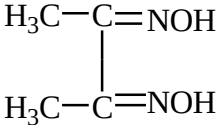
27. α-Benzildioksim (nikelon; α-difenildioksim) 	M.m. 240,26 Ni^{2+}, Pd^{2+}
28. N-Benzoil-fenil-N-fenilgidroksilamin (BFGA) 	M.m. 213,24 Al^{3+}, Be^{2+}, Fe^{3+}, V^{V}, Ta^{V}, Hg^{2+}, Ti^{IV}, W^{VI}, Zr^{IV}
29. Benzoin 	M.m. 212,25 B^{III}, Be^{2+}, Ge^{IV}, Sb^{III}, Zn^{2+}
30. α-Benzoinoksim (kupron) 	M.m. 227,26 Cu ($CuR{\cdot}2H_2O$ ko'rinishida), Mo^{VI} (MoO_2R_2 ko'rinishida), Cu^{2+}, V^{V}
31. Benzolselenat kislota 	M.m. 189,07 Sc^{3+} (ScR_3 ko'rinishida)
32. 8-(Benzolsulfanilamino)-xinolin 	M.m. 284,34 Cd^{2+}, Co^{2+}
33. Benzotriazol 	M.m. 119,13 Os, Cd^{2+}, Ni^{2+}, Ag^{+}, Zn^{2+}
34. Berillon II 	M.m. 810,56 Be^{2+}, B^{III}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cu^{2+}

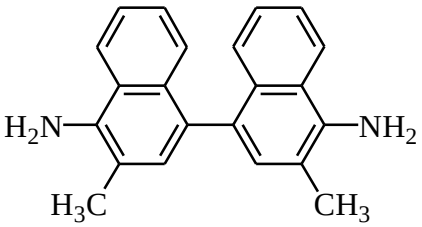
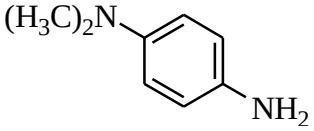
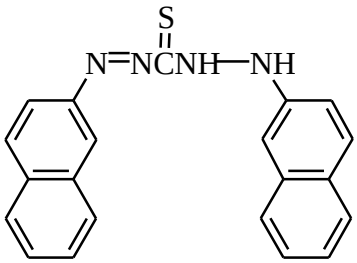
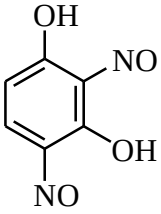
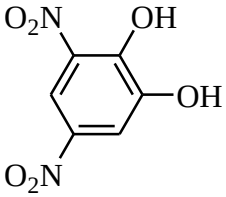
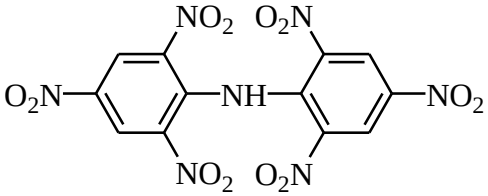
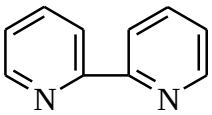
35. Berillon III  	M.m. 495,52 Be^{2+}, B^{III}
36. Berillon IV  	M.m. 583,36 Be^{2+}, B^{III}
37. Bis-salitsilal-etilendiamin  	M.m. 268,31 Mg^{2+}
38. Bis (siklogeksanoksalil) digidrazon (kuprizon)  	M.m. 268,27 Cu^{2+}
39. Bodom kislota (fenilglikol kislota)  	M.m. 125,15 Hf^{IV}, Zr^{IV}, Sc^{3+}
40. Brilliant yashili  	M.m. 482,64 BF_4^-, $SbCl_6^-$, ReO_4^-, $AuCl_4^-$, TaF_5^-, $HgBr_3^-$, $ZnCl_4^-$
41. 5-Brombenztriazol  	M.m. 198,02 Pd^{2+}

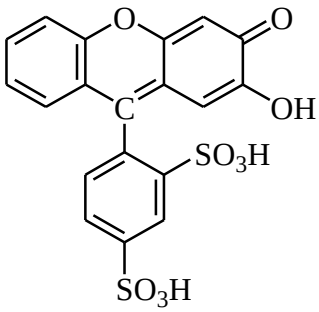
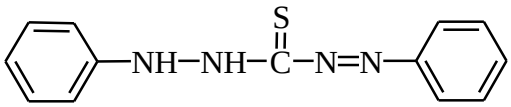
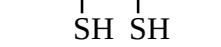
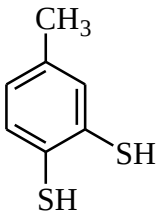
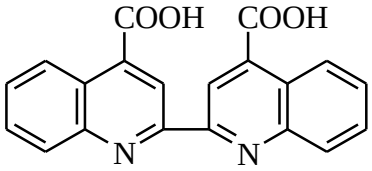
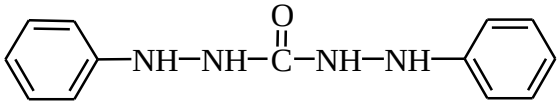
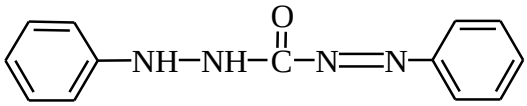
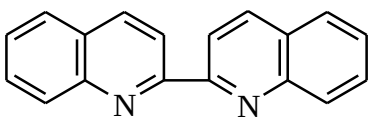
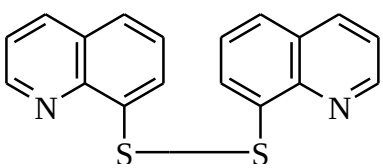
42. Brombenztiazo 	M.m. 384,25 Cd^{2+}
43. Butilrodamin S (butilrodamin V; rodamin S butil efiri) 	M.m. 535,12 As^{V}, $GaCl_4^-$, NbF_6^-, ReO_4^-, TaF_6^-, $TeBr_6^{2-}$
44. Daksim 	M.m. 184,15 Co^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, Pd^{2+}
45. Ditissin 	M.m. 286,24 Al^{3+}, Ga^{3+}, Th^{IV}, Zr^{IV}
46. Diallilditiokarbamidogidrazin (dalsin) 	M.m. 230,35 Ag^+, Cu^{2+}, Ni^{2+}, Pb^{2+},
47. Diaminoantraxinonsulfokislota 	M.m. 318,30 Cu^{2+}
48. 3,3'-Diamionbenzidin (tetraamionodifenil) 	M.m. 214,27 Se^{IV}, V^{V}, Cr^{VI}

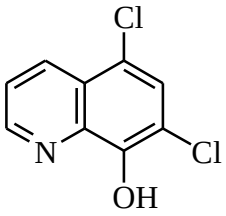
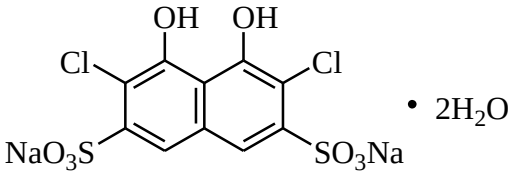
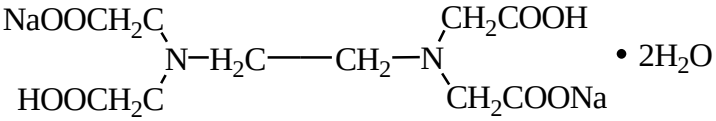
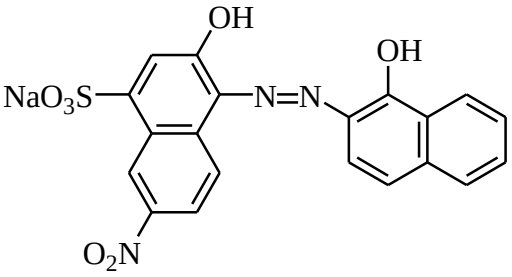
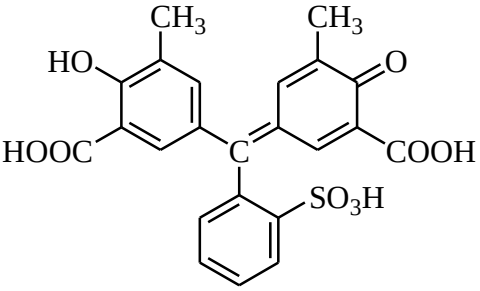
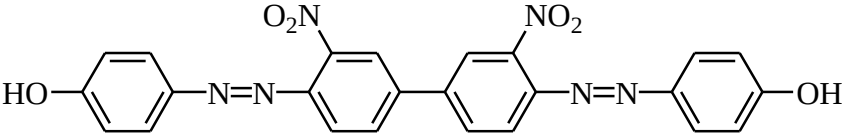
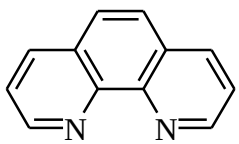
49. 2,3-Diaminonaftalin 	M.m. 158,20 Se^{IV}
50. Diantipiril-3,4-dimetoksifenilmetan 	M.m. 524,62 V^{V}
51. Diantipirilmetan 	M.m. 388,47 Ti^{IV}, Cd^{2+}, Fe, Bi^{III}, Co^{2+}, Au, Ce, Tl, Ir, Mo, Os, Pd,. Sb
52. Diantipirilpropilmetan 	M.m. 430,55 Ga^{3+}, Ir^{3+}, Te^{IV}, Tl^{III}, Os
53. Diantipirilfenilmetan 	M.m. 460,53 Ga^{3+}, Te^{IV}, V^{V}
54. 1,1'-Diantrimid (1,1'-diantraxinonilamin) 	M.m. 429,43 B^{III}, Ge^{IV}, Se^{IV}, Te^{IV}
55. N,N'-Dibenzilditiooksamid (N,N'-Dibenzilrodanid kislota; DBTA) 	M.m. 300,44 Pd, Pt

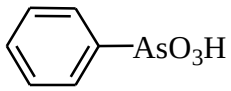
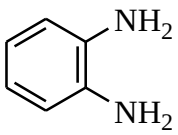
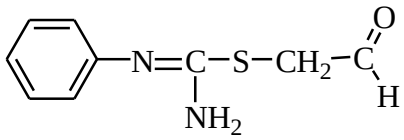
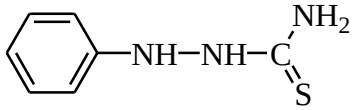
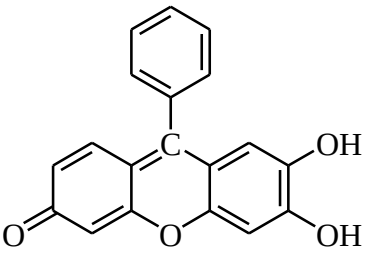
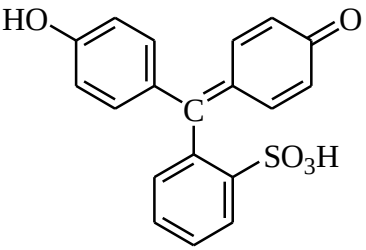
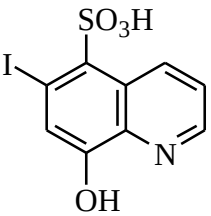
16-*jadvalning davomi*

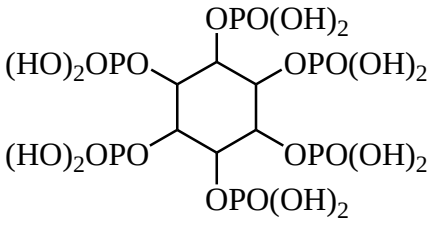
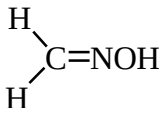
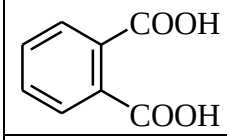
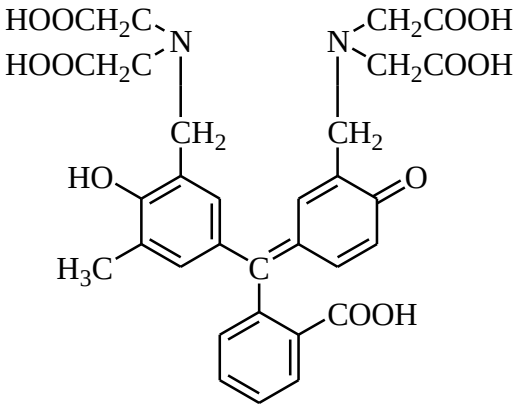
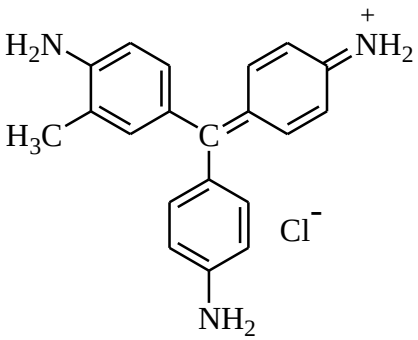
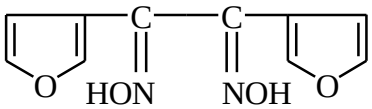
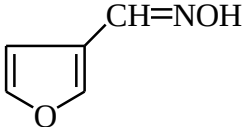
56. Dibenzoilmetan 	M.m. 224,26 UO_2^{2+}, Fe^{2+}
59. Dibromoksin (5,7-dibrom-8-gidroksixinolin) 	M.m. 302,95 Fe^{3+}, Ti^{IV}, Al^{3+}, Co^{2+}, Cu^{2+}, Ga^{3+}, Tl^{III}, V, Zr^{IV}, In^{3+}, Sc^{3+}, UO_2^{2+}
57. N,N'-Dietilditiokarbamat (kupral, DDTK) 	M.m. 225,34 Cu^{2+}, Ni^{2+}, UO_2^{2+}
58. N,N'-Dietil-*p*-fenilendiamin oksalat 	
60. *p*-Dimetilaminobenzilidenrodanin (rodanin, Faygl reaktivi) 	M.m. 264,36 Ag^{+}, Au^{3+}, Pd^{2+}, Pt, Hg^{2+}, CN^{-}
61. *p*-Dimetilaminofenilfluoron (dimetilfluoron) 	M.m. 363,37 Ta^{V}
62. 2,2'-Dimetilgeksandion-3,5 	M.m. 142,20 Be^{2+} (BeR_2 ko'rinishida)
63. Dimetilglioksim (diatsetilglioksim, Chugaev reaktivi) 	M.m. 116,12 Ni^{2+}, Pd^{2+} (MeR_2 ko'rinishida), Fe^{2+}, Co, Re

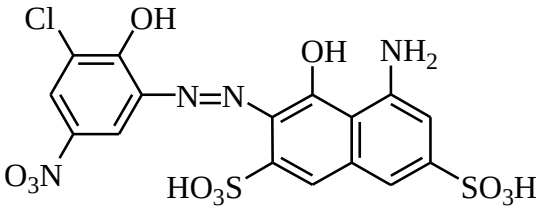
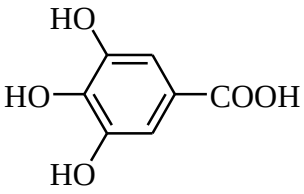
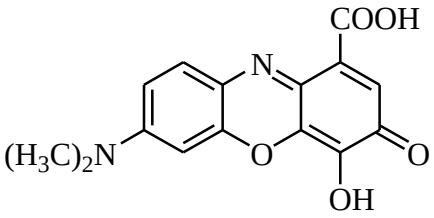
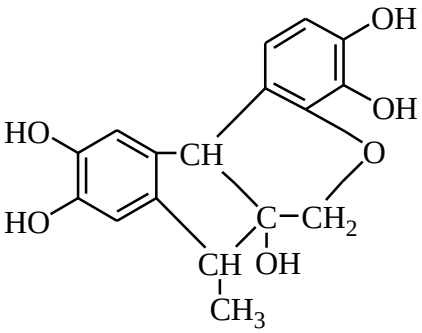
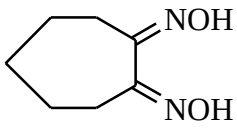
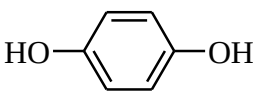
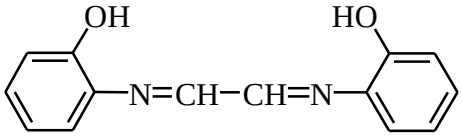
64. 3,3'-Dimetilnaftidin 	M.m. 312,41 Zn^{2+}, V^{V}
65. N,N'-Dimetil-*p*-fenilendiamin digidroxlorid (yoki oksalat) [*p*-amino-dimetilanilin]  • 2HCl	M.m. 209,12 H_2S, HS^-, S^{2-}, S
66. Di-2-naftiltiokarbazon (dinaftizon) 	M.m. 356,44 Ag^+, Au^{3+}, Bi^{3+}, Cd^{2+}, Cu^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Tl^+, Zn^{2+}, In^{3+}, Ga^{3+}
67. 2,4-Dinitrozorezorsin 	M.m. 168,11 Co^{2+}, Fe
68. 3,5-Dinitropirokatexin 	M.m. 200,11 Ge, W
69. Dipikrinamin 	M.m. 439,21 K^+, Cs^+, Rb^+
70. 2,2'-Dipiridil (2,2'-bipiridil) 	M.m. 156,19 Ni^{2+}, Co^{2+}, Zn^{2+}, Fe^{2+}, Cd^{2+}, Co^{2+}, Cu^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}, Zn^{2+}

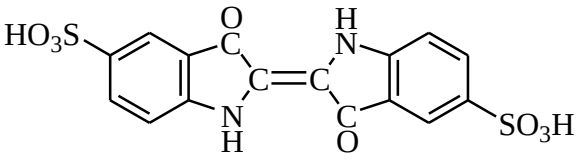
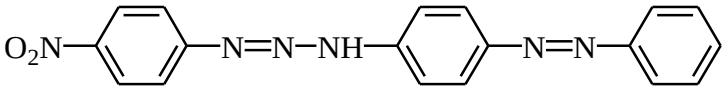
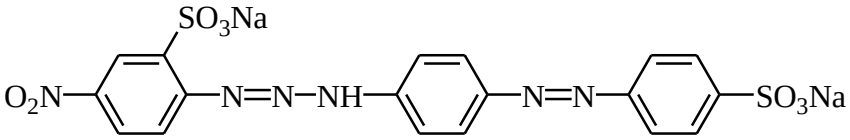
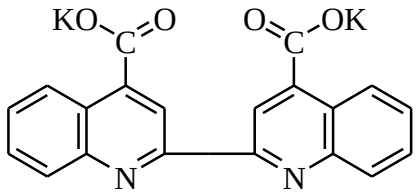
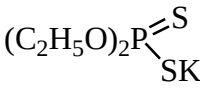
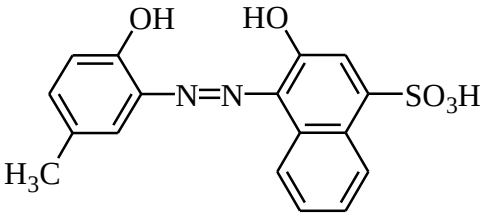
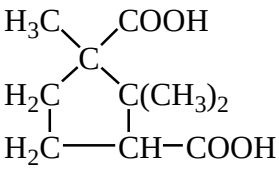
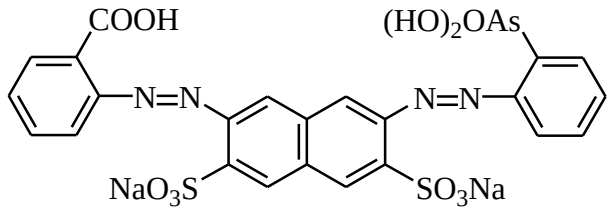
71. Disulfofenilfluoron 	M.m. 480,42 Ge^{IV}, In^{3+}, Ti^{IV}
72. Ditizon (difeniltiokarbazon) 	M.m. 256,32 Ag^{+}, Au^{III}, Bi^{3+}, Cd^{2+}, Co^{2+}, Cu^{2+}, Hg^{2+}, In^{3+}, Ni^{2+}, Pb^{2+}, Pd^{2+}, Pt^{2+},
73. Ditioksamid 	M.m. 120,19 Co^{2+}, Cu^{2+}, Ni^{2+}, Pt^{IV}, Ru^{IV}, Os, U
74. Ditiol 	M.m. 156,27 Sn^{2+}, W^{VI}, Mo^{VI}
75. Ditsinxonin kislota 	M.m. 469,17 Ti^{IV}, Mo^{VI}, U^{VI}, W^{VI}
76. Difenilkarbazid 	M.m. 242,28 Hg^{2+}, Cr^{VI}, Cu^{2+}, Re, Os
77. Difenilkarbazon 	M.m. 240,26 Cd^{2+}, Co^{2+}, Cu^{+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Hg_2^{2+}, Mn^{2+}, Ni^{2+}, Sn^{2+}, Pb^{2+}, Zn^{2+}
78. 2,2'-Dixinolil (bixinolin, kuproin) 	M.m. 256,31 Cu^{+}, Tl^{3+}
79. 8,8'-Dixinolilsulfid 	M.m. 320,44 Cu^{+}

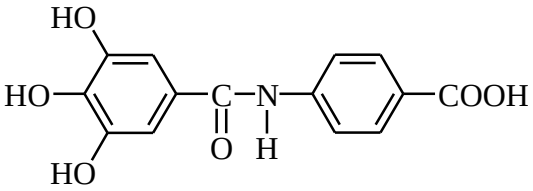
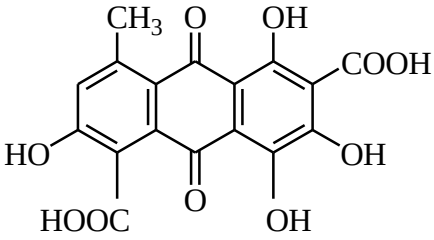
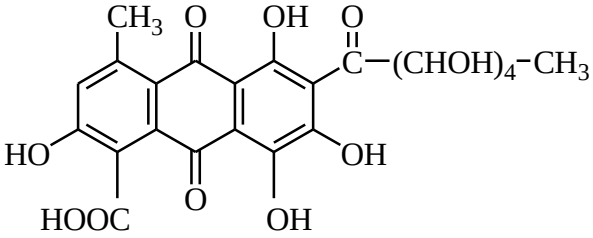
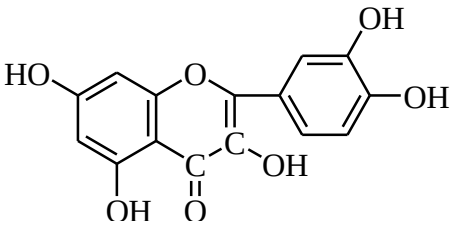
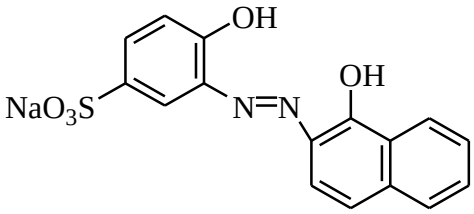
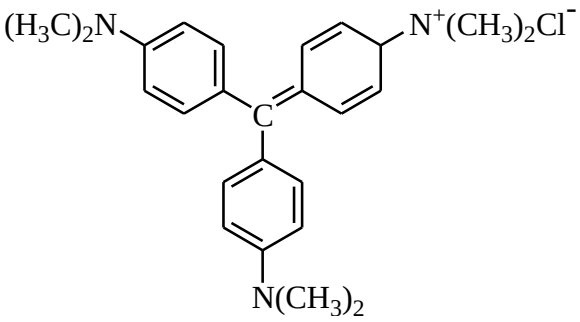
80. 5,7-Dixlor-8-oksixinolin (dixloroksin) 	M.m. 214,05 Ti^{IV}, Cu^{2+}, Fe^{3+}, Pb^{2+}, Al^{3+}, Co^{2+}, Ga^{3+}, In^{3+}, Sc^{3+} UO_2^{2+}
81. 2,7-Dixlorxromotrop kislota 	M.m. 469,17 Ti^{IV}, Mo^{VI}, U^{VI}, W^{VI}
82. EDTA (natriy etilendiamintetraatsetat, komplekson III, trilon B) 	M.m. 372,24 Bi^{III}, Co^{III}, Cu^{2+}, Fe^{3+}, Mg^{2+}, Mn^{III}, Ni^{2+}, Cr^{III}
83. Erioxrom qora T (xromogen qora maxsus ET-00) 	M.m. 461,39 Mg^{2+}, Th^{IV}, Ti^{IV}, Cd^{2+}, In^{3+}, Zn^{2+}
84. Erioxromsianin R 	M.m. 470,45 Al^{3+}, Be^{2+}, In^{3+}, Zr^{IV}
85. Fenazo 	M.m. 484,43 Mg^{2+}
86. Fenantrolin (ferroin) 	M.m. 198,22 Fe^{2+}, Cu^{2+}, Ru, Ni, Zn^{2+}, Mo, Hg, Mn

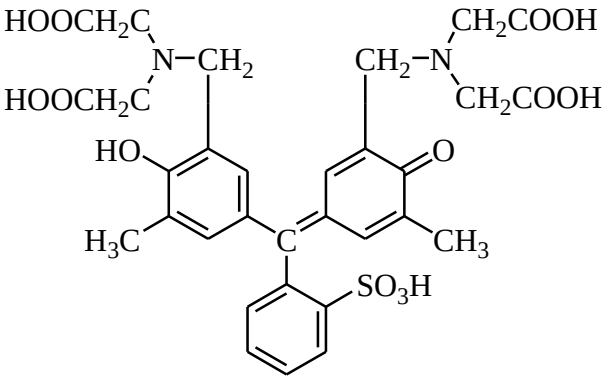
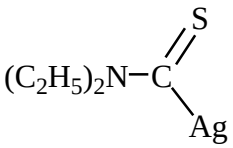
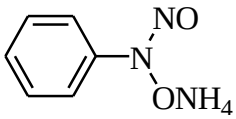
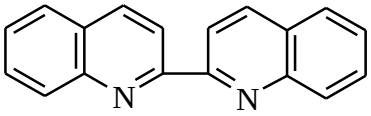
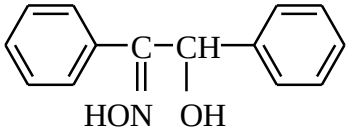
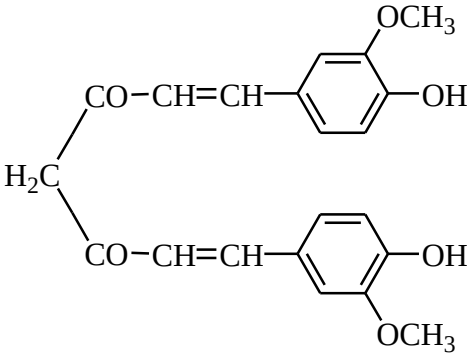
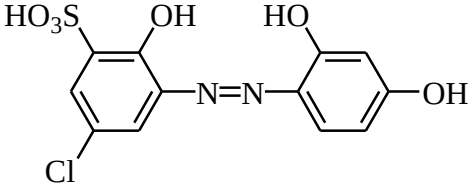
87. Fenilarson kislota 	M.m. 202,04 Hf^{IV}, Nb^{IV}, Sn^{IV}, Ta^{V}, Th^{IV}, Zr^{IV}
88. *o*-Fenilendiamin (1,2-fenilendiamin) 	M.m. 108,14 Se
89. Feniltiogidantion kislota 	M.m. 210,25 Cd^{2+}, Co^{2+}, Cu^{2+}, Bi^{3+}, Pb^{2+}, Sb^{3+}
90. Feniltiosemikarbazid 	M.m. 167,23 ReO_4^-
91. Fenilfluoron 	M.m. 320,30 Ga^{3+}, Ge^{IV}, In^{3+}, Mo^{VI}, Nb^{V}, Sb, Sn, Ta^{V}, U, Zr^{IV}
92. Fenol qizil (fenolsulfoftalein) 	M.m. 354,38 Br_2, Br^-
93. Ferron 	M.m. 351,12 Al^{3+}, Fe^{3+}, V

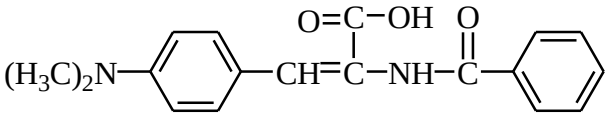
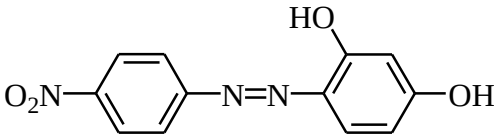
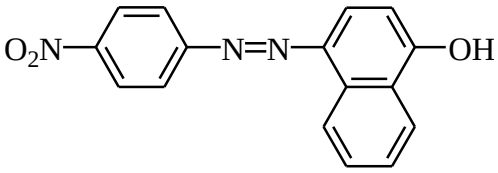
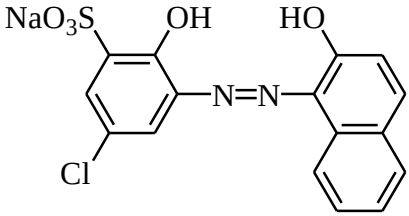
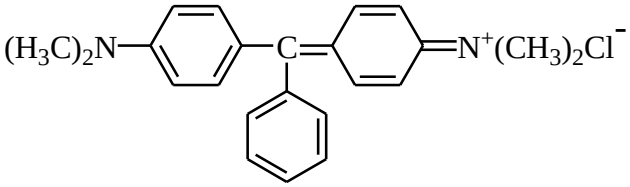
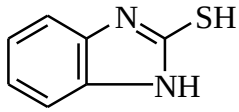
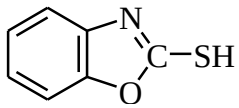
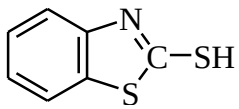
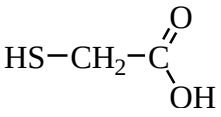
94. Fitin kislota 	M.m. 660,04 Th^{IV}, Nb^{V}, Zr^{IV}, Se^{III}
95. Formaldoksim 	M.m. 45,04 Fe^{2+}, Fe^{3+}, Mn^{2+}, Ni^{2+}, V, Ce
96. Ftal kislota 	M.m. 166,13 Pb^{2+}
97. Ftaleinkomplekson (*o*-krezolftaleinkomplekson) 	M.m. 636,61 Ba^{2+}, Ca^{2+}, Sr^{2+}
98. Fuksin asosi 	M.m. 337,85 Br_2, BF_4^-, ReO_4^-, S^{IV}
99. α-Furildioksim 	M.m. 238,20 Ni^{2+}, Co^{2+}, Pd^{2+}, Re
100. β-Furfuraldoksim (β-furfuraloksim) 	M.m. 111,10 Pd^{2+}

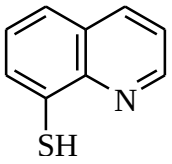
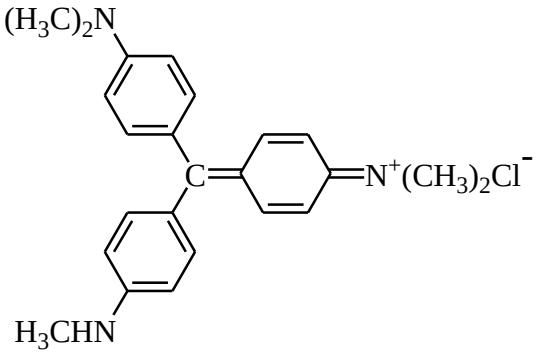
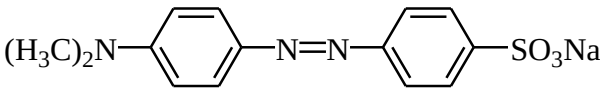
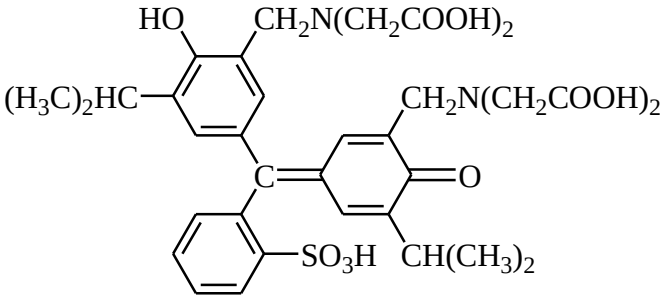
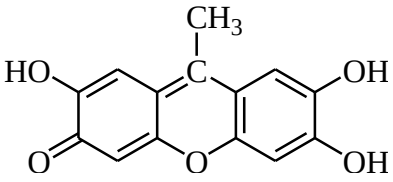
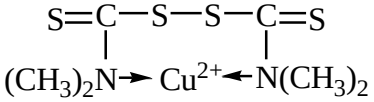
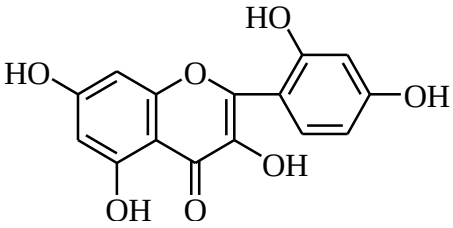
101. Gallion 	M.m. 536,87 Ga^{3+}, In^{3+}
102. Gallat kislota 	M.m. 170,12 V^{V}, Ta^{V}
103. Gallotsianin 	M.m. 300,27 Ga^{III}, Hg, Pb, Sb^{III}
104. Gematoksilin 	M.m. 302,28 Al^{3+}, B^{III}, In^{3+}, Fe^{2+}, Fe^{3+}, Nb^{V}, Sn^{IV}, Ta^{V}, V^{V}, Zn^{2+}
105. Geptoksim 	M.m. 156,18 Ni^{2+}, Pd^{2+}
106. Gidroxinon 	M.m. 110,11 Nb^{V}, Ta^{V}, W^{VI}, Au, Cr, Ir, Ru
107. Glioksal-bis (2-gidroksianil) 	M.m. 240,26 Ca^{2+}, Cd^{2+}, Sc^{3+}, U^{VI}, Mg^{2+}, Co^{2+}, Ni^{2+}, Ag, Au

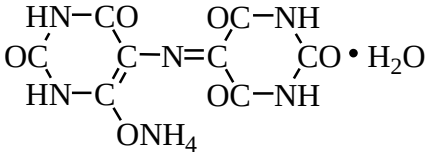
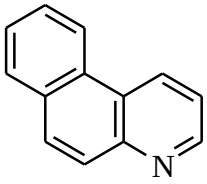
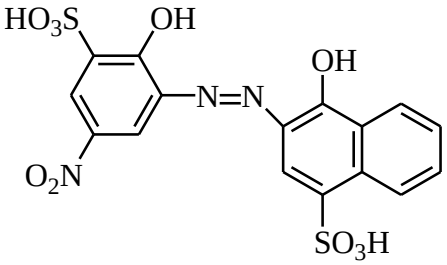
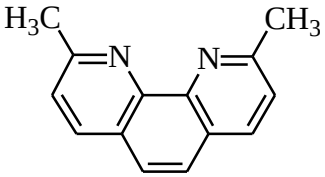
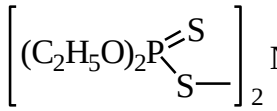
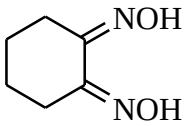
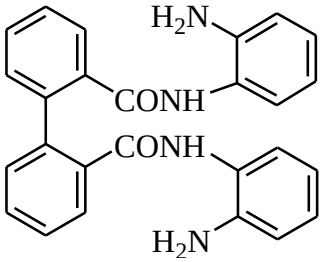
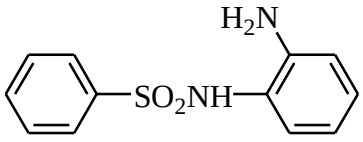
108. Indigokarmin 	M.m. 254,29 Cl_2, ClO^-, H_2S
109. Kadion 	M.m. 346,35 Cd^{2+}
110. Kadion S (S) (Kadion II) 	M.m. 550,43 Cd^{2+}
111. Kaliy 2-2'-bisinxoninat 	M.m. 420,51 Cu^{I}
112. Kaliy dietilditiofosfat 	M.m. 224,31 Cu^{2+}, Bi^{3+}, Ni^{2+}, Pb^{2+}, Pd^{2+}
113. Kalmagit 	M.m. 358,37 Ca^{2+}
114. *d*, ***l***-Kamfara kislota 	M.m. 200,23 Ga, In, Th
115. Karboksiarsenazo 	M.m. 770,41 Ba^{2+}, SO_4^{2-}

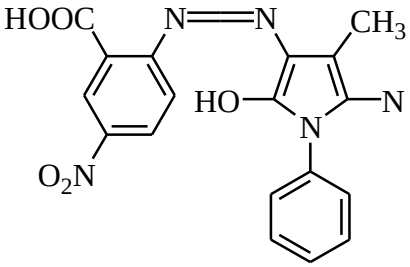
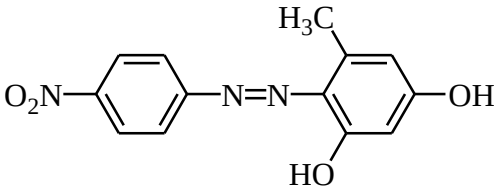
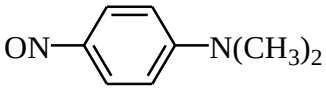
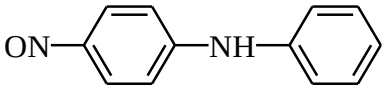
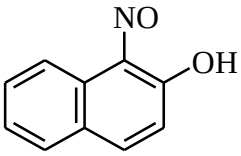
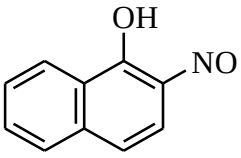
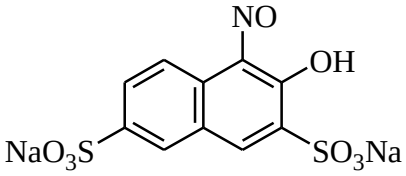
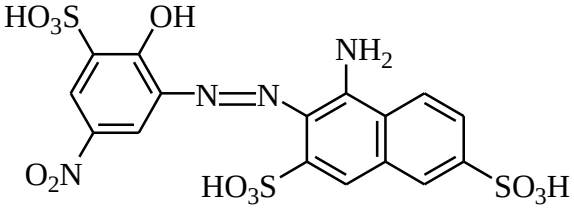
116. *p*-Karboksigallanilid 	M.m. 289,24 Ti^{IV}
117. Karmin 	M.m. 374,26 B^{III}, Th^{IV}, U^{VI}
118. Karmin kislota 	M.m. 492,40 B^{III}, Th^{IV}, U^{VI}
119. Kvertsetin 	M.m. 302,24 Cr^{III}, Al^{3+}, Fe^{3+}, Sn^{IV}, B^{III}, Ga^{3+}, Ge^{IV}, Hf^{IV}, In^{3+}, Th^{IV}, Zr^{IV}, Ta^{V}, U^{VI}
120. Kislotali xrom binafsha K (xromli binafsha K) 	M.m. 366,33 Nb^{V}
121. Kristall binafsha (kristallviolet) 	M.m. 407,99 Cd^{2+}, Sb^{V}, Ta^{V}, Ti^{3+}, Zn^{2+}, BF_4^-, ReO_4^-, ClO_4^-, SCN^-, $Pt(SCN)_6^{2-}$

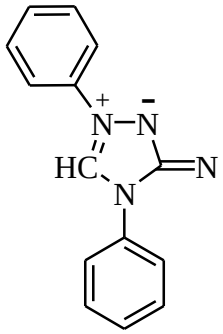
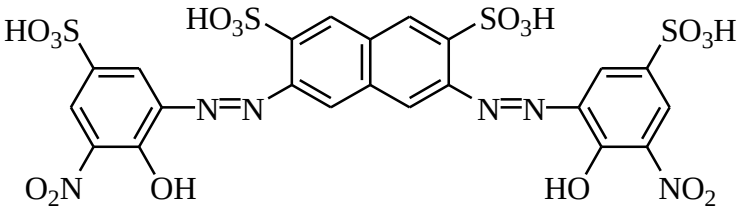
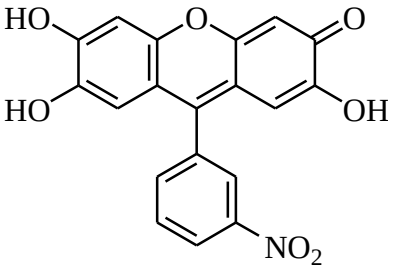
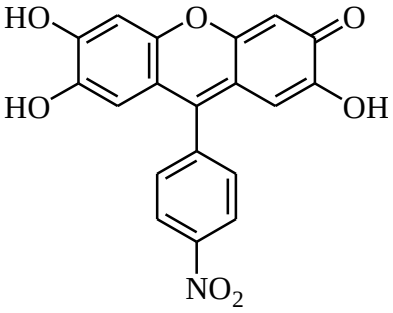
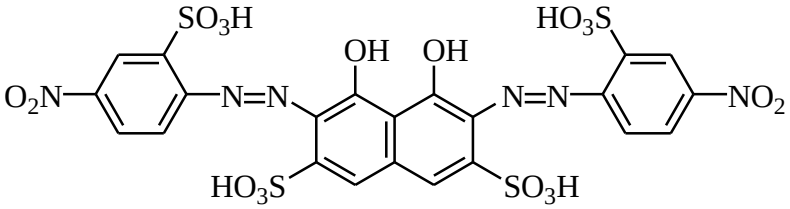
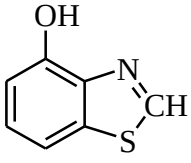
122. Ksilenoloranj 	M.m. 627,66 Al^{3+}, Bi^{3+}, Cu^{2+}, Ga^{3+}, In^{3+}, Hf^{IV}, Nb^{V}, Pd^{2+}, Pb^{2+}, Tl^{3+}, Ti^{IV}, Th^{IV}, V^{V}, Zn^{2+}, Zr^{IV}
123. Kumush N,N'-dietilditiokarbamat 	M.m. 256,13 As
124. Kupferon 	M.m. 155,16 Bi^{3+}, Cu^{2+}, Fe^{3+}, Ga^{3+}, Nb^{V}, Ta^{V}, U^{VI}, Ti^{IV}, Th^{IV}, Zr^{IV}, Hf^{IV}, V^{V}
125. Kuproin 	78 ga qarang
126. Kupron 	30 ga qarang
127. Kurkumin 	M.m. 368,39 B^{III}
128. Lyumogallion 	M.m. 344,73 Ga^{3+}, Nb^{V}, Mo^{VI}, Sc^{3+}, Sn^{IV}

129. Lyumokupferon 	M.m. 310,35 Cu^{2+}
130. Magnezon I 	M.m. 259,23 Mg^{2+}
131. Magnezon II 	M.m. 293,29 Mg^{2+}
132. Magnezon XS 	M.m. 400,77 Mg^{2+}, Zn^{2+}
133. Malaxit yashil B 	M.m. 364,92 $GaCl_4^-$, ReO_4^-, $SbCl_6^-$, TaF_6^-, $TiCl_4^-$
134. 2-Merkaptobenzimidazol 	M.m. 150,20 Rh^{3+}, Se
135. 2-Merkaptobenzoksazol 	M.m. 151,18 Rh^{3+}, Pd^{2+}, Ir^{IV}
136. 2-Merkaptobenztiazol (kaptaks) 	M.m. 167,24 Cu^{2+}, Bi^{3+}, Tl^+
137. Merkaptosirka kislota 	M.m. 92,11 Fe^{2+}, Al^{3+}, W^{VI}, Sn^{2+}

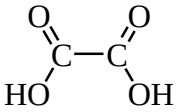
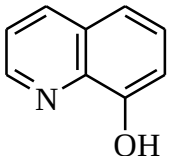
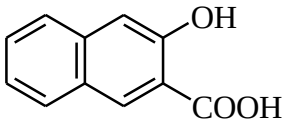
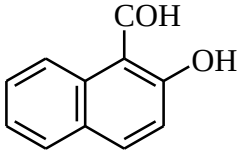
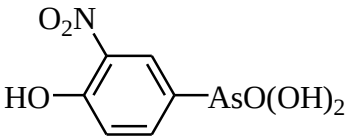
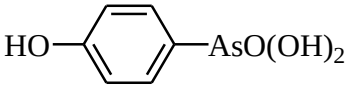
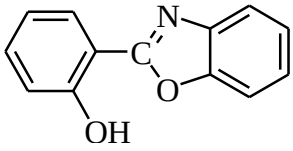
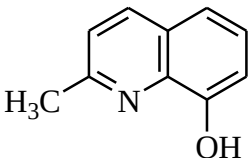
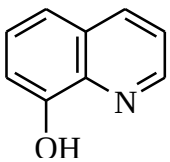
138. 8-Merkaptoxinolin (8-Tioksin, tiooksin) 	M.m. 161,23 Cu^{2+}, Fe^{3+}, In^{3+}, Ir^{3+}, Ga^{3+}, Mo^{VI}, Mn^{2+}, Os, Pd^{2+}, Pt^{IV}, Rh^{3+}, Tl^{+}, V
139. Metil binafsha 	$AuCl_4^-$, $GaCl_4^-$, ClO_4^-, ReO_4^-, BF_4^-, TaF_6^-, $SbCl_6^-$, $TlCl_4^-$, $ZnCl_4^{2-}$
140. Metiloranj 	M.m. 327,33 Cl_2, OCl^-, V^V
141. Metiltimol ko'ki 	M.m. 760,85 Mg^{2+}, Ca^{2+}, Co^{2+}, Zn^{2+}, Ga^{3+}, Hf^{IV}, Ti^{IV}, Th^{IV}, V^V, Zr^{IV}, Nb^V, Pd^{2+}
142. Metilfluoron 	M.m. 258,23 Ge^{IV}, Sb^{III}
143. Mis tnuramat (merkupral, dikupral, tetrametiltnuramid-sulfid) 	M.m. 303,96 Ag^+, Hg^{2+}
144. Morin 	M.m. 302,24 B^{III}, Be^{2+}, Al^{3+}, Ga^{3+}, In^{3+}, Ta^V, Th^{IV}, Zr^{IV}, U, W

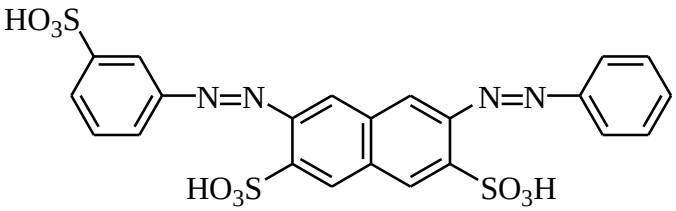
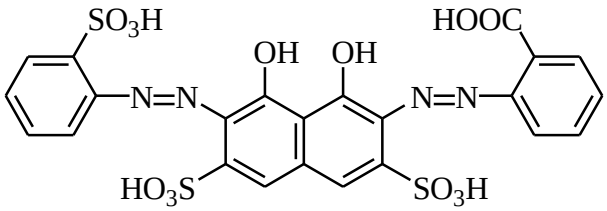
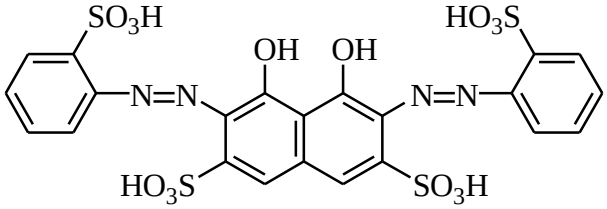
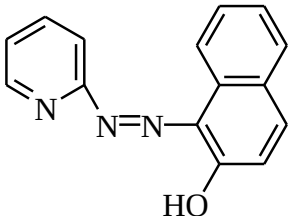
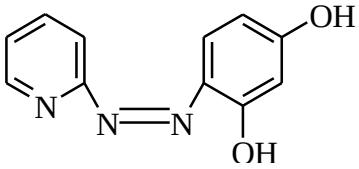
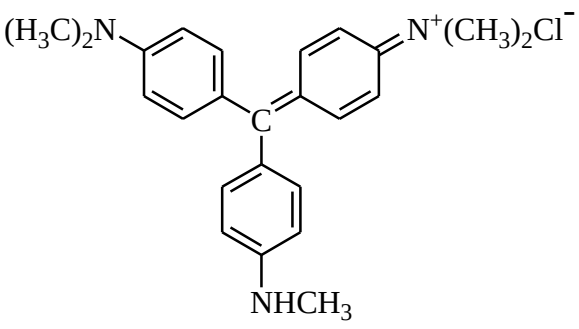
145. Mureksid (ammoniy purpurat) 	M.m. 302,20 Ca^{2+}, Sr^{2+}, Zn^{2+}, Ni^{2+}, Sc^{3+}
146. β-Naftoxinolin 	M.m. 179,22 Cd^{2+}
147. Nevazol NS 	M.m. 421,37 V^{V}
148. Neokuproin (2,9-dimetil-1,10-fenantrolin) 	M.m. 208,26 Cu^{2+}
149. Nikel dietilditiofosfat 	M.m. 429,13 Cd^{2+}
150. Nioksim (dioksim siklogeksandion-1,2) 	M.m. 142,16 Ni^{2+}, Pd^{2+}
151. Nitriton A 	M.m. 424,49 NO_2^-
152. Nitriton B 	M.m. 220,29 NO_2^-

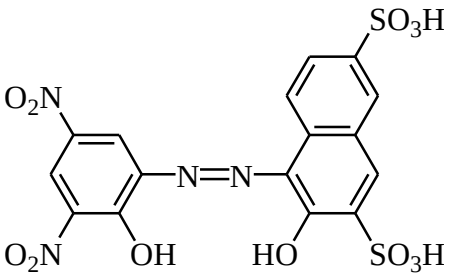
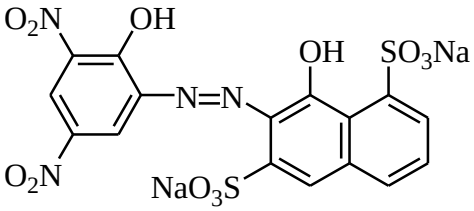
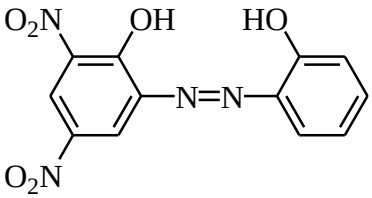
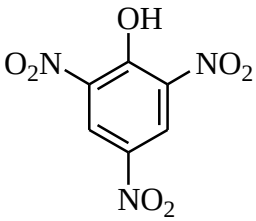
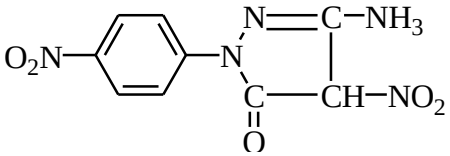
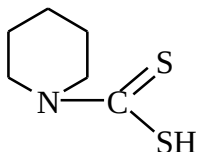
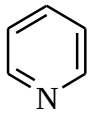
153. Nitroantranilazo 	M.m. 367,32 Li^+
154. 4-Nitrobenzolazoorsin 	M.m. 273,25 Be^{2+}
155. 4-Nitrozo-N,N'-dimetilalanin 	M.m. 150,18 Pd, Pt, Ir
156. *p*-Nitrozodifenilamin 	M.m. 198,22 Pd, Ir, Rh
157. 1-Nitrozo-2-naftol (α-nitrozo-β-naftol) 	M.m. 173,17 Co^{3+}, Fe^{3+}, Pd^{2+}, Ni^{2+}
158. 2-Nitrozo-1-naftol (β-nitrozo-α-naftol) 	M.m. 173,17 Co^{3+}, Ni^{2+}, Pd^{2+}, Rh
159. Nitrozo-R-tuz 	M.m. 377,25 Co^{2+}, Fe, Pd^{2+}, U, Zr, K
160. Nitroksaminazo 	M.m. 548,49 Co, Pd^{2+}

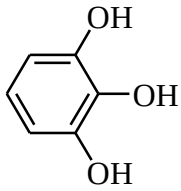
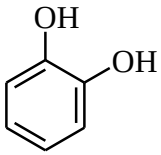
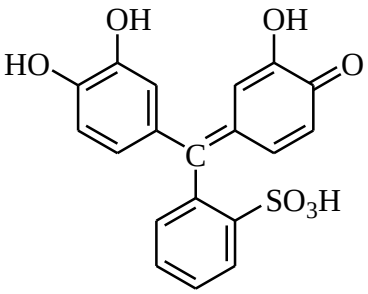
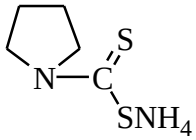
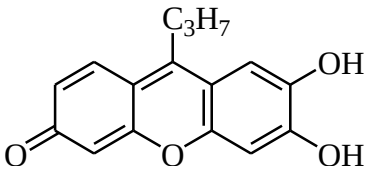
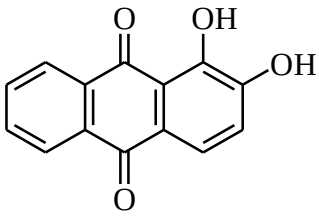
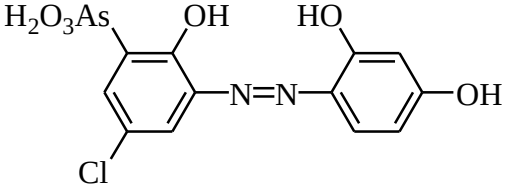
161. Nitron 	M.m. 312,37 NO_3^-, ClO_3^-, ClO_4^-, ReO_4^-, BF_4^-
162. Nitrosulfofenol S 	M.m. 810,62 Nb^{IV}, Zr^{IV}
163. *o*-Nitrofenilfluoron 	M.m. 365,30 Zr^{IV}, Nb^{V}
164. *p*-Nitrofenilfluoron 	M.m. 365,30 Sn^{IV}
165. Nitxromazo (nitroortanil C) 	M.m. 778,62 Ba^{2+}, Sr^{2+}, SO_4^{2-}, S
166. 4-Oksibenztiazol 	M.m. 151,18 Cu^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}

16-*jadvalning davomi*

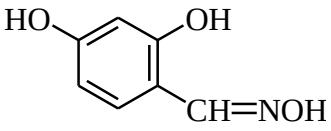
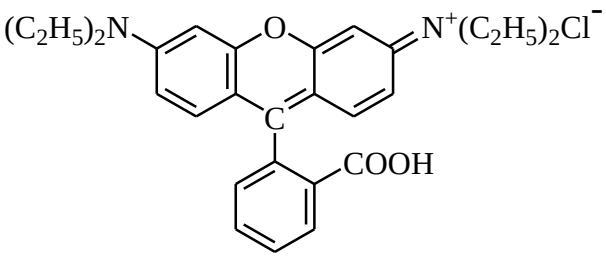
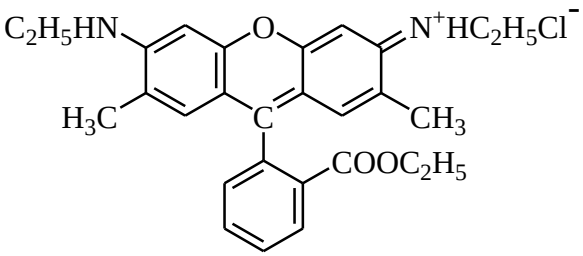
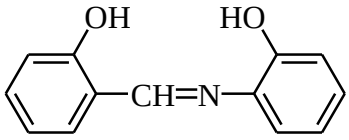
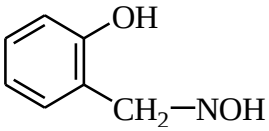
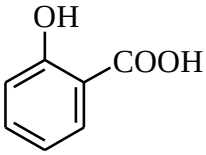
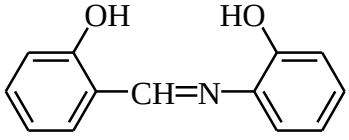
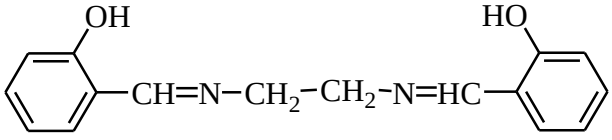
167. Oksalat kislota 	M.m. 90,04 Ca^{2+}, La^{3+}, Th
168. Oksin 	175 ga qarang
169. 2-Oksi-3-naftoy kislota 	M.m. 188,18 Al^{3+}, Be^{2+}
170. 2-Oksinaftalinkarbaldegid-1 	M.m. 172,18 Be^{2+}, Mg^{2+} (MR_2 ko'rinishida)
171. 4-Oksi-3-nitrofenilarson kislota 	M.m. Cd^{2+}
172. *p*-Oksifenilarson kislota 	M.m. 218,04 Sn^{IV}, Ti^{IV}, Zr^{IV}
173. 2-(2-Oksifenil)benzoksazol 	M.m. 211,22 Cu^{2+}, Cd^{2+}
174. 8-Oksixinaldin 	M.m. 159,17 Zn^{2+}, Mg^{2+}
175. 8-Oksixinolin (oksin, *o*-oksixinolin) 	M.m. 145,16 Al^{3+}, Be^{2+}, Bi^{3+}, Cd^{2+}, Co^{3+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, Ga^{3+}, In^{3+}, Mg^{2+}, Mn^{2+}, Mo^{VI}, Nb^{V}, Ni^{2+}, Pb^{2+}, Sn^{IV}, Sc^{3+}, Ti^{IV}, Th^{IV}, Tl^{3+}, U^{VI}, V, W^{VI}

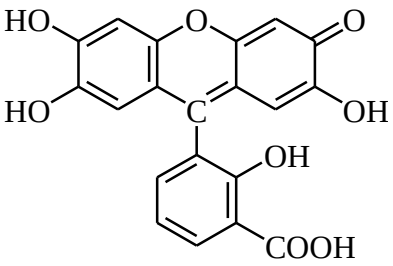
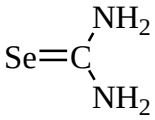
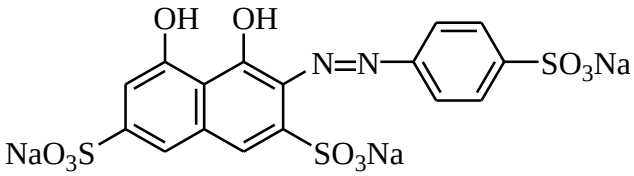
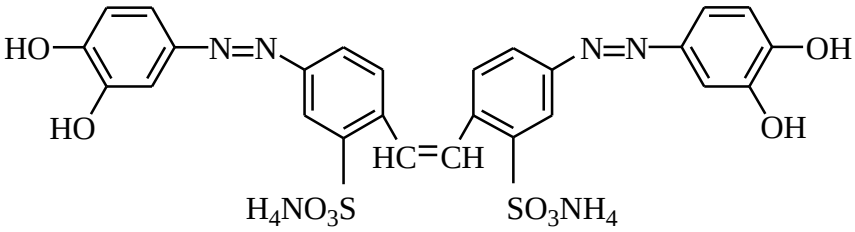
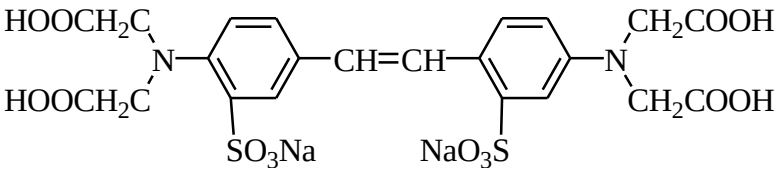
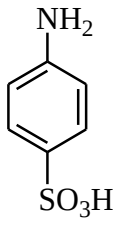
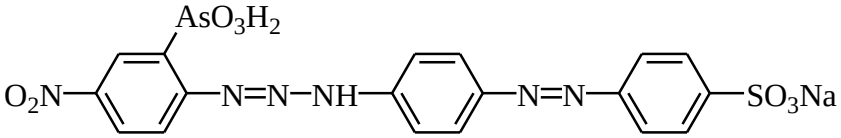
176. Ortanil B 	M.m. 608,57 Ba^{2+}, SO_4^{2-}
177. Ortanil K 	M.m. 652,69 Ba^{2+}, SO_4^{2-}
178. Ortanil S (sulfonazo III) 	M.m. 688,65 Ba^{2+}, SO_4^{2-}, Sr^{2+}
179. PAN [1-(2-piridilazo)naftol-2] 	M.m. 249,27 Cd^{2+}, Co^{2+}, Co^{3+}, Cu^{2+}, Fe^{3+}, Ga^{3+}, In^{3+}, Mn^{2+}, Ni^{2+}, Os^{VIII}, Pd^{2+}, U^{VI}, V^{V}, Zn^{2+}
180. PAR [4-(2-piridilazo)rezorsin] 	M.m. 215,21 Co^{2+}, Cu^{2+}, Ga^{3+}, In^{3+}, Nb^{V}, Pd^{2+}, Pb^{2+}, Os^{VIII}, Ta^{V}, Ti^{IV}, Tl^{3+}, U^{VI}, Zn^{2+}, Zr^{IV}
181. Pentametil binafsha 	Sb^{V}, Zn^{2+}, Cd^{2+}, Tl^{3+}, Hg^{2+}

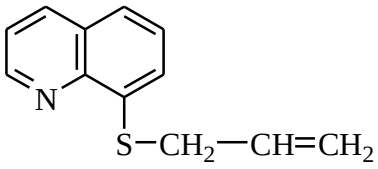
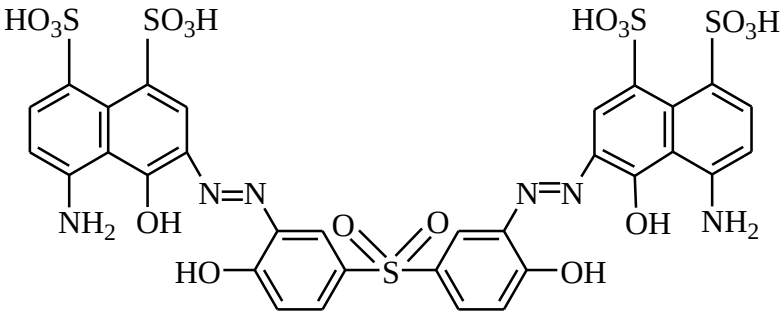
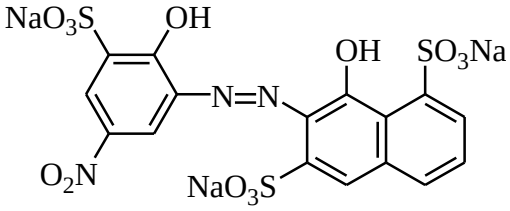
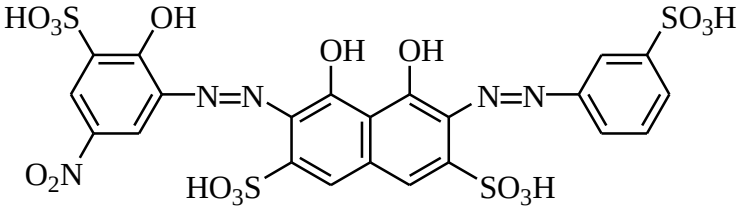
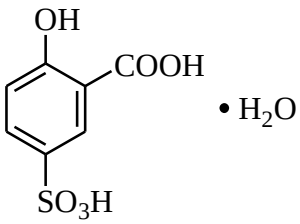
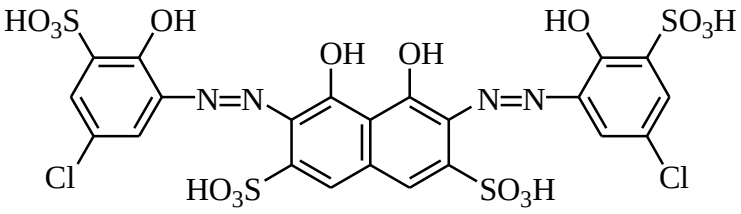
182. Pikramin R 	M.m. 514,39 Nb^{V}, Zr^{IV}
183. Pikramin-epsilon 	M.m. 558,36 Cu^{2+}, Hf^{IV}, Nb^{V}, Zr^{IV}
184. Pikraminazofenol 	M.m. 304,22 Ca^{2+}, Mg^{2+}
185. Pikrin kislota 	M.m. 299,11 Bi^{3+}
186. Pikrolon kislota 	M.m. 264,20 Pb^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Th^{IV} (MR_n ko'rinishida; n – metall valentligi)
187. Piperidin-N-ditiokarbon kislota 	M.m. 161,29 Co, Ni, Cu, Rh, Mg^{2+}
188. Piridin (+ SCN^{-}) 	Co^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}

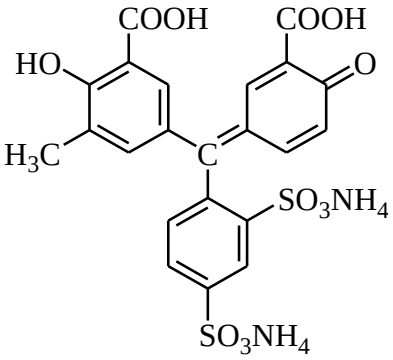
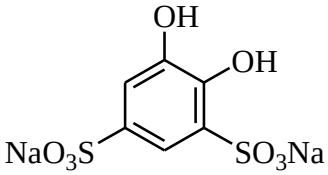
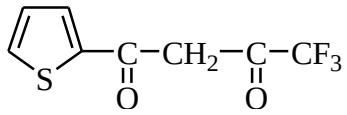
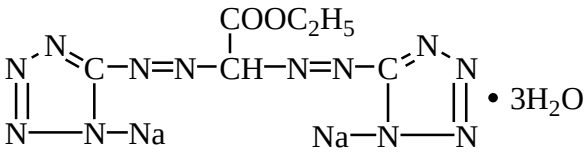
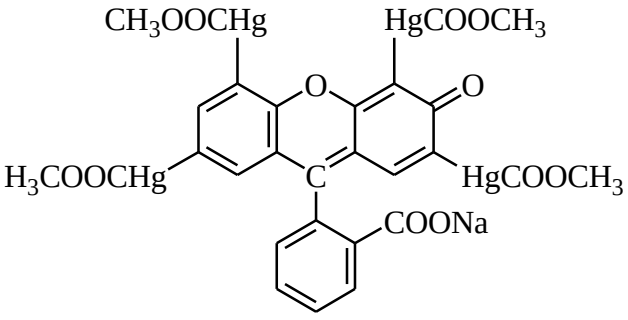
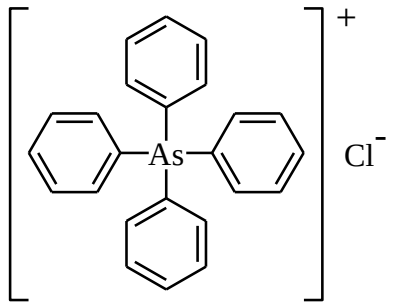
189. Pirogallol 	M.m. 126,11 Nb, Ta, Ti, Zr, Sb, Bi, O_2
190. Pirokatexin 	M.m. 110,11 Ti, Mo, V, Nb, Ta, Ge
191. Pirokatexin binafsha (pirokatexinsulfoftalein) 	M.m. 386,38 B^{III}, Bi^{3+}, In^{3+}, Ge^{IV}, Sc^{3+}, Sn^{2+}, Ta^{V}, Zr^{IV}, Th^{IV}
192. N-Pirrolidinilditiokarbon kislotaning NH_4-li tuzi 	M.m. 164,30 Nb^{V}, Bi^{3+}, Sb^{3+}, Co, Ni
193. Propilfluoron 	M.m. 286,28 Sc^{3+}, Te^{IV}
194. Purpurin 	M.m. 256,21 Zr^{IV}, F^{-}
195. Rezarson 	M.m. 388,60 Ge^{IV}, Mo^{VI}, Ga, Th

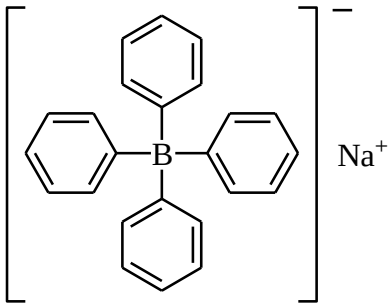
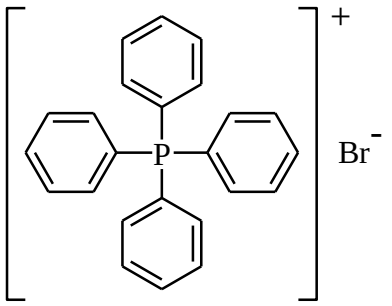
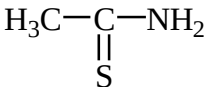
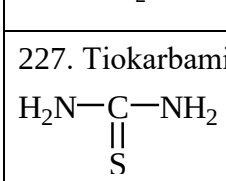
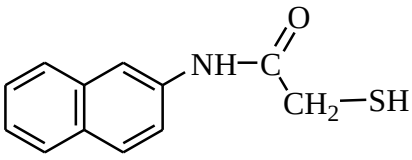
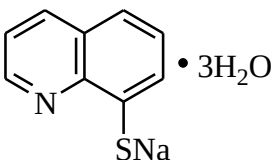
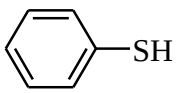
16-*jadvalning davomi*

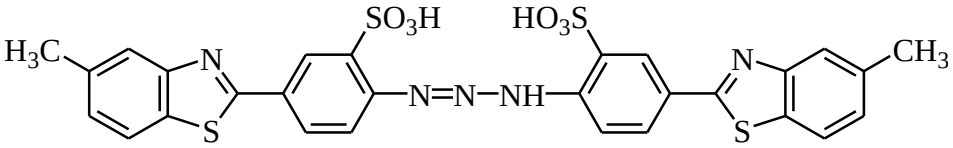
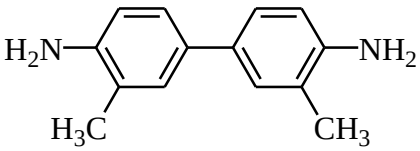
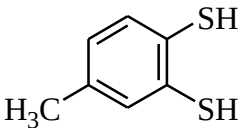
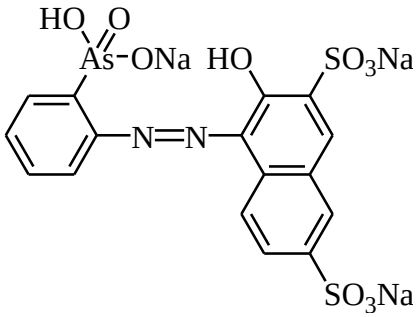
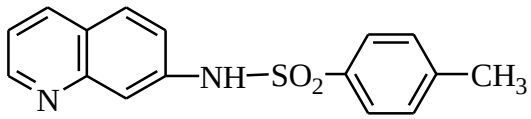
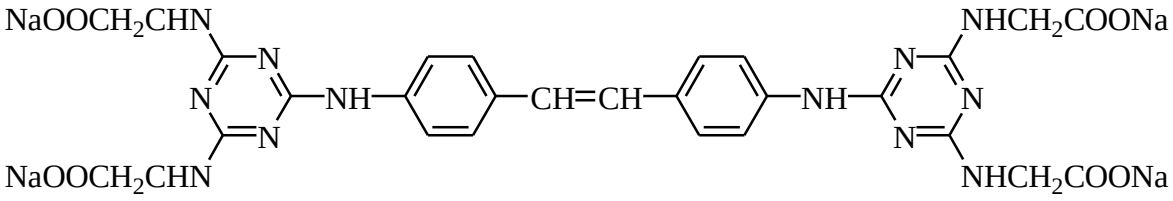
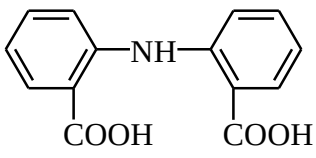
196. Rezorsilaldoksim  	M.m. 153,13 Fe^{3+}
197. Rodamin V (rodamin S)  	M.m. 479,02 $AuCl_4^-$, CdI_4^{2-}, $GaCl_4^-$, $InBr_4^-$, ReO_4^-, WO_4^{2-}, $Zn(SCN)_4^{2-}$
198. Rodamin 6J  	M.m. 479,02 Ta^V, $Zn(SCN)_4^{2-}$, In^{3+}, ReO_4^-, $TlCl_4^-$, $GaCl_4^-$
199. Salitsilal-*o*-aminofenol  	M.m. 213,24 Mn^{2+}, Al^{3+}, Ga^{3+}
200. Salitsilaldoksim  	M.m. 137,14 Cu^{2+}, Ti^{IV}, U^{VI}, Zn^{2+}, Pb^{2+}, Fe^{3+}, Ni^{2+}
201. Salitsil kislota  	M.m. 138,12 Fe^{3+}, Cu^{2+}, Ti^{IV}, U^{VI}
202. Salitsilidenaminofenol  	M.m. 213,24 Al^{3+}
203. Salitsilidenetilendiamin  	M.m. 268,32 Mg^{2+}

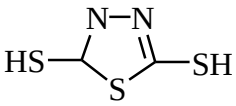
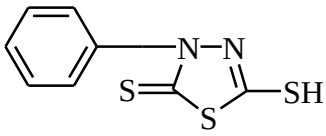
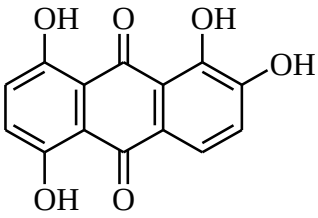
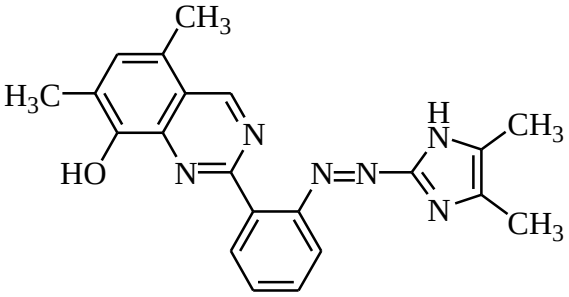
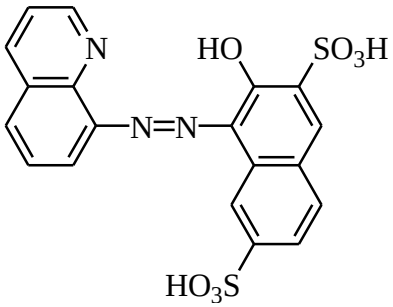
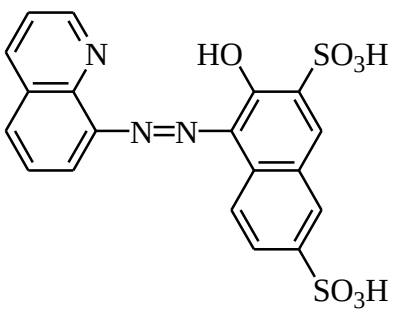
204. Salitsilfluoron 	M.m. 380,30 In^{3+}, Th^{IV}, W^{VI}, SO_4^{2-}
205. Selenokarbamid 	M.m. 123,02 Os^{VI}, Ru^{IV}
206. SPADNS 	M.m. 570,40 Hf^{IV}, Th^{IV}, Zr^{IV}, F^-
207. Stilbazo 	M.m. 646,65 Al^{3+}, B^{III}, Ga^{3+}, In^{3+}, Mo^{VI}, Sn^{2+}, Sc^{3+}, Zn^{2+}, Zr^{IV}
208. Stilbekson 	M.m. 646,50 Fe^{III}
209. Sulfanil kislota 	M.m. 173,18 Al^{3+}, Mg^{2+}
210. Sulfarsazen (plyumbon) 	M.m. 572,32 Pb^{2+}, Zn^{2+}, Hg^{2+}

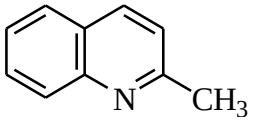
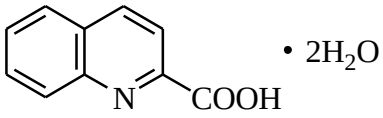
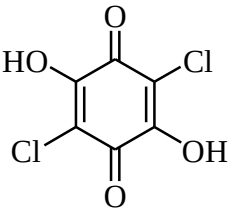
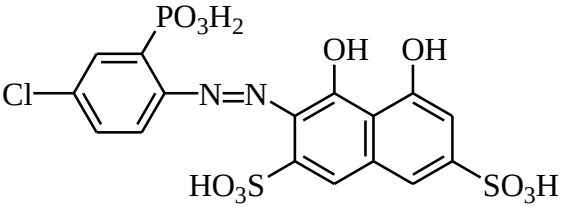
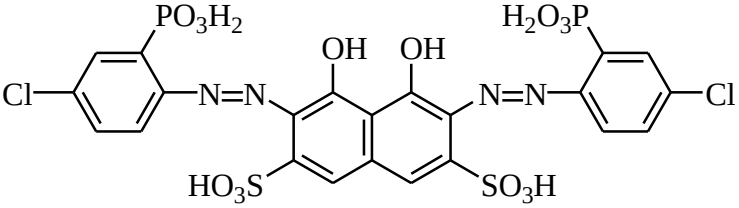
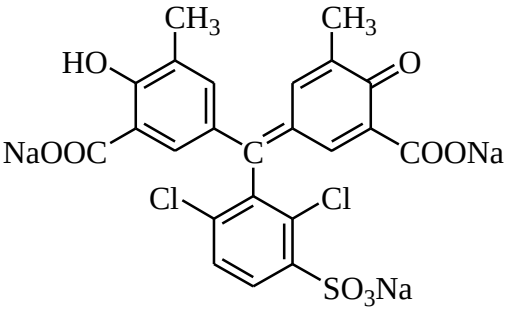
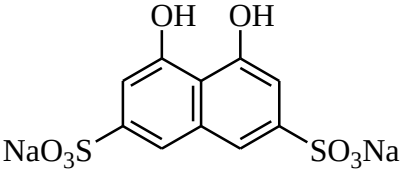
211. Sulfoalltioks 	M.m. 281,34 Rh
212. Sulfonazo 	976,90 Sc^{3+}, In^{3+}, Ga^{3+}
213. Sulfonitrazo E 	M.m. 615,40 Ga^{3+}, Sc^{3+}, Mo, V
214. Sulfonitrofenol M 	M.m. 749,62 Pd^{2+}, Zr^{IV}
215. Sulfosalitsil kislota 	M.m. 245,21 Fe, Ti^{IV}
216. Sulfoxlorfenol S 	M.m. 789,52 Nb^{V}, Mo^{VI}

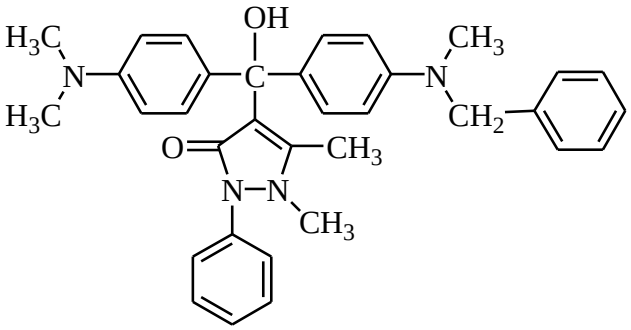
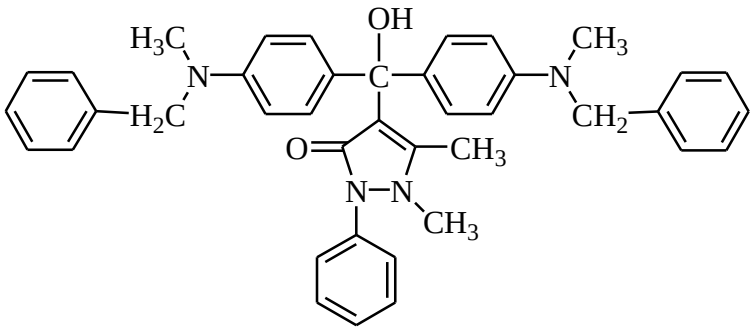
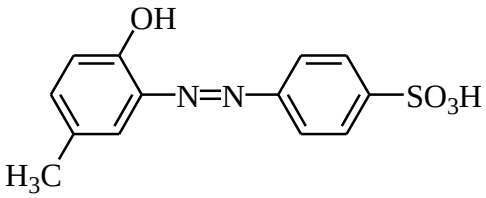
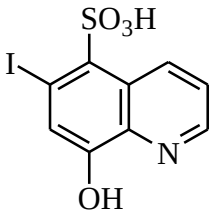
217. Sulfoxrom 	M.m.584,57 Al^{3+}, F^{-}, Be^{2+}, Ga^{III}
218. Tayron (tiron) 	M.m. 314,19 Fe^{3+}, Ti^{IV}, Nb^{V}, Mo^{VI}, Ce^{IV}, Os
219. 2-Tenoiltriftoratseton (TTFA, TTA) 	M.m. 222,18 Al^{3+}, Ba^{2+}, Be^{2+}, Bi^{3+}, Cd^{2+}, Ce^{2+}, Co^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, In^{3+}, Nb^{V}, Ni^{2+}, Th^{IV}, Tl^{3+}, Ti^{IV}
220. Tetra 	M.m. 378,22 Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, Pd^{2+}, Cu^{2+}, Zn^{2+}
221. Tetrasimobatsetatfluoressein, Na-li tuzi 	M.m. 1372,80 S^{2-}
222. Tetrafenilarsoniy xlorid 	M.m. 418,80 ReO_4^{-}, Os^{VI}, Cd^{2+}, Mn^{2+}, Hg^{2+}, Sn^{2+}, Zn^{2+}

223. Tetrafenilboratning natriyli tuzi (kalignost) 	M.m. 342,22 K^+, Cs^{2+}, Rb^+, NH_4^+, Tl^+
224. Tetrafenilfosfoniy bromid 	M.m. 419,30 Os^{VI}, ReO_4^-
225. Tioatsetamid 	M.m. 75,13 Cd^{2+}, Cu^{2+}, As, Sb, Bi^{3+}, Mo^{VI}, Pb^{2+}, Pd^{2+}
226. Tioglikol kislota $HS - CH_2 - COOH$	M.m. 92,11 U, Fe, Co^{2+}, Ni^{2+}, Mo, Pd^{2+}, Cr^{3+}, Se, Ta
227. Tiokarbamid 	M.m. 76,12 Ir, Rh, Ru, Bi^{3+}, Os^{VI}, Te^{IV}, Se^{IV}, Pd^{2+}, NO_2^-
228. Tionalid 	M.m. 217,29 Ag^+, As^{III}, Sb^{III}, Sn^{2+}, Cu^{2+}, Hg^{2+}, Pd^{2+}, Bi^{3+}, Rh^{III}, Ru, Mn^{2+}, Tl^+, Pb^{2+}
229. Tiooksin (8-merkaptooksixinolin) 	M.m. 237,25 Pd^{2+}, Cu^{2+}, ReO_4^-, In^{3+}, Mn^{2+}, V^V, Co^{2+}, Os, Tl^+
230. Tiofenol 	M.m. 110,17 Au^{3+}, Pd^{2+}, Pt^{IV}

231. Titan sariq 	M.m. 695,71 Mg^{2+}, Cd^{2+}
233. *o*-Tolidin 	M.m. 212,29 Cl_2, Br_2, I_2, ClO^-, Au, Ce^{IV}
234. Toluol-3,4-ditiol (1,2-dimerkapto-4-metilbenzol) 	M.m. 156,27 Sn^{2+}, Mo^{VI}, W^{VI}
235. Toron I (toron, APANS) 	M.m. 598,27 Th^{IV}, U, Li^+, Be^{2+}, Bi^{3+}, Zr^{IV}, Hf^{IV}
236. 8-*p*-Tosilaminoxinolin [8-(*p*-toluolsulfanilamino)-xinolin] 	M.m. 298,37 Cd^{2+}, Zn^{2+}
237. Triazinilstilbekson, Na-li tuzi 	M.m. 952,61; Mg^{2+}
238. Vanadoks (2,2'-dikarboksidifenilamin) 	M.m. 257,25 V^V

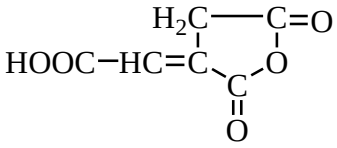
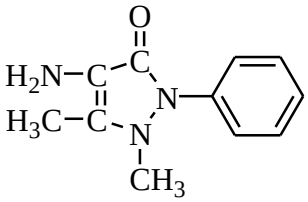
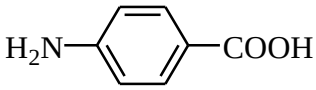
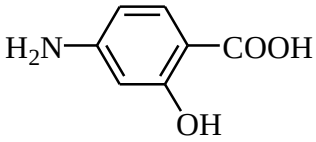
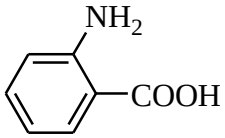
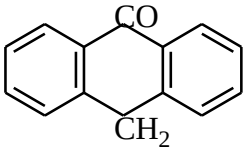
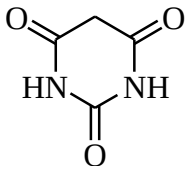
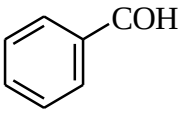
239. Vismutol I (vismutiol I) 	M.m. 150,23 Bi^{III}, Pd^{2+}
240. Vismutol II (vismutiol II, merkaptofeniltiotiodiazolon) 	M.m. 226,33 Bi^{III}, Pd^{2+}, Te
241. Xinazolinazo 	M.m. 386,46 Li^{+}
242. Xinalizarin 	M.m. 272,21 Mg^{2+}, Be^{2+}, Al^{3+}, Ga^{3+}, In^{3+}, Th^{IV}, U^{VI}, Zn^{2+}, Zr^{IV}
243. Xinolinazo E 	M.m. 395,33 Co^{2+}
244. Xinolinazo R 	M.m. 395,33 Co^{2+}

245. Xinaldin 	M.m. 143,19 Pd, W, Ti^{IV}, Os^{VIII}, Ru^{IV}, Rh^{IV}, Pt^{IV}
246. Xinaldin kislota 	M.m. 209,20 Cu^{2+}, Zn^{2+}, Pb^{2+}, Ag^{+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Fe^{2+}, Cd^{2+}, UO_2^{2+}
247. Xloranil kislota 	Al^{3+}, Ca^{2+}, Mo^{VI}, Pb^{2+}, Sr^{2+}
248. Xlorfosfonazo I 	M.m. 538,82 U^{VI}
249. Xlorfosfonazo III 	M.m. 757,36 U^{VI}, Se^{3+}, Ba^{2+}, Sr^{2+}, Mg^{2+}, Th^{IV}
250. Xromazurol S 	5 ga qarang
251. Xromotrop kislotaning dinatriyli tuzi 	M.m. 364,25 Cr^{VI}, Ti^{IV}, Nb^{V}, Ta^{V}

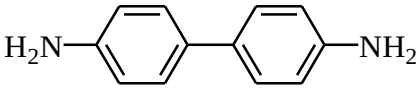
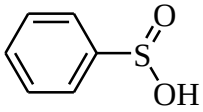
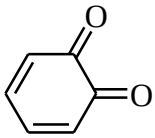
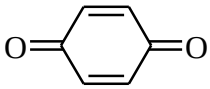
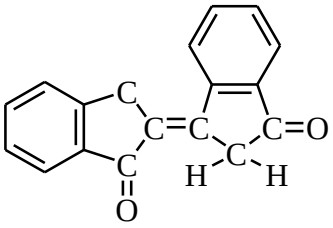
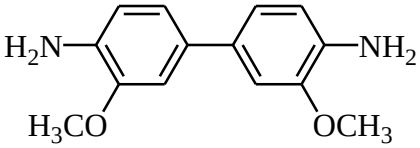
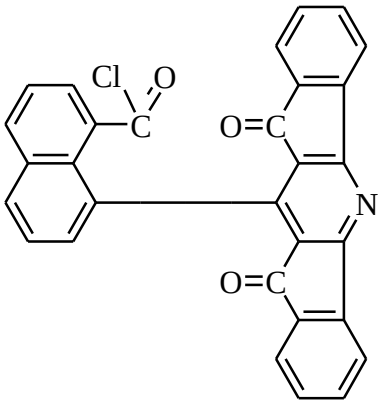
252. Xrompirazol I 	M.m. 532,68 P, As, Mo, BF_4^-, $TlCl_4^-$, $AuCl_4^-$, $SbCl_6^-$, BiI_4^-, ReO_4^-, Zn^{2+}
253. Xrompirazol II 	M.m. 608,78 P, As, Mo, BF_4^-, $TlCl_4^-$, $AuCl_4^-$, $SbCl_6^-$, BiI_4^-, ReO_4^-, Zn^{2+}
254. X-Sirkonon (sirkonon) 	M.m. 292,31 Zr^{IV}
255. 7-Yod-8-oksixinolin-5-sulfokislota (ferron) 	M.m. 351,11 Fe, F

17-*jadval*

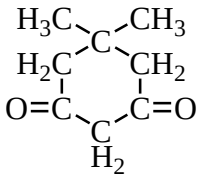
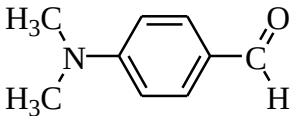
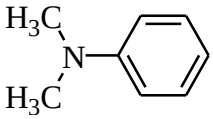
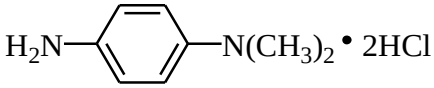
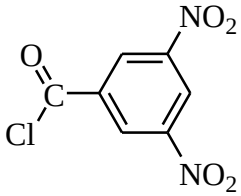
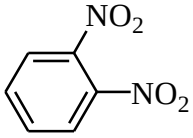
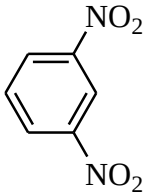
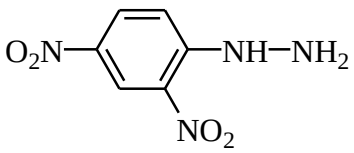
ORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN MUHIM ORGANIK REAGENTLAR

Reagent	Aniqlanadigan moddalar
1. Akonit angidrid 	Uchlamchi aminlar
2. 4-Aminoantipirin ($K_4[Fe(CN)_6]$ yoki $(NH_4)_2S_2O_8$ bilan birga) 	Fenollar, xlorfenollar, naftollar, aromatik aldegidlar
3. 4-Aminobenzoy kislota (PAB) 	Flavinlar, timol, metiletilketon
4. 4-Aminosalitsil kislota (PASK) 	Aldozalar
5. Antranil kislota 	Aldegidlar, ketonlar, birlamchi spirtlar
6. Antron 	Aldegidlar, uglevodlar
7. Barbiturat kislota 	Nikotin kislota va uning hosilalari, furfurol va pentozalar
8. Benzaldegid 	Atseton, yuqori spirtlar, inden, aminlar

17-*jadvalning davomi*

9. Benzidin 	Nikotin, aminonitrillar
10. Benzolsulfin kislota 	Xinonlar
11. 1,2-Benzoxinon 	1,2-Diaminlar
12. 1,4-Benzoxinon 	Indol, pirrol va ularning hosilalari, aminlar, siklopentadiyen
13. Bindon 	Birlamchi va ikkilamchi aromatik aminlar
14. Bromtimol ko'ki	To'trlamchi aminlar
15. Bromfenol ko'ki	To'rtlamchi aminlar
16. *n*-Butilamin $CH_3 – (CH_2)_3 – NH_3$	Benzoxinon
17. 1,2-Dianizidin 	Fenollar, aldegidlar
18. Dibepin 	Birlamchi alkil- va aralkilaminlar

17-*jadvalning davomi*

19. Dimedon 	Aldegidlar
20. 4-Dimetilaminobenzaldegid 	Birlamchi aromatik aminlar, sulfanilamidlar, to'yinmagan uglevodorodlar
21. N,N-Dimetilanilin 	1,3-Dinitrozobirikmalar, polinitrobirikmalar, 4-nitrobenzoy kislota efirlari
22. N,N-Dimetil-*p*-fenilendiamin gidroxlorid 	Merkaptanlar, disulfidlar
23. 3,5-Dinitrobenzoilxlorid 	Ikkilamchi aromatik aminlar, gidrazin hosilalari
24. 1,2-Dinitrobenzol 	Fluoren va uning hosilalari
25. 1,3-Dinitrobenzol 	Aldegidlar, ketonlar
26. 1,4-Dinitrobenzol 	Fluoren va uning hosilalari, siklopentadiyen
27. 2,4-Dinitrofenilgidrazin 	Aldegidlar, ketonlar, aldozalar

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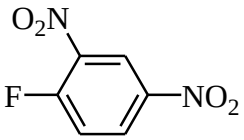
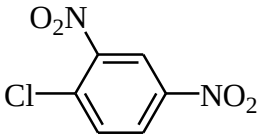
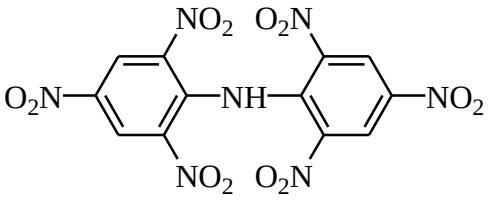
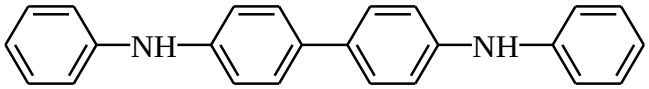
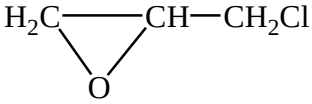
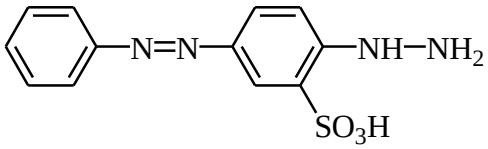
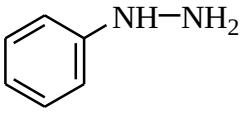
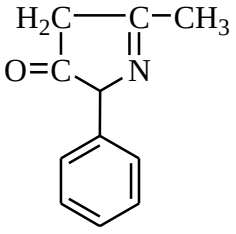
28. 2,4-Dinitroftorbenzol 	Tiollar, birlamchi va ikkilamchi aminlar
29. 2,4-Dinitroxlorbenzol 	Birlamchi alifatik va aromatik aminlar, piridin va uning hosilalari
30. Dipikrilamin (geksanitrodifenilamin) 	Siklopentadiyen va hosilalari
31. Difenilbenzidin 	Xinonlar, nitrozobirikmalar, organik peroksidlar, xloraminlar
32. Epixlorgidrin 	Piridin va uning hosilalari
33. Etilendiamin $H_2N - CH_2 - CH_2 - NH_2$	Xinonlar va xinon hosil qiluvchi moddalar
34. 2-(4-Fenilazo)-fenilgidrazinsulfokislota 	Atsetaldegid
35. Fenilgidrazin 	Aldegidlar, monozalar
36. 1,4-Fenilendiamin + oksidlovchilar 	Fenollar, birlamchi aromatik aminlar, diolefinlar, izopren, xloropren
37. 1-Fenil-3-metil-pirazolon-5 	Diazobirikmalar

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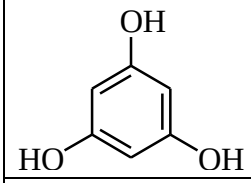
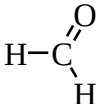
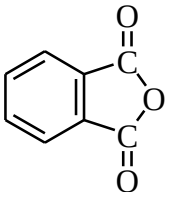
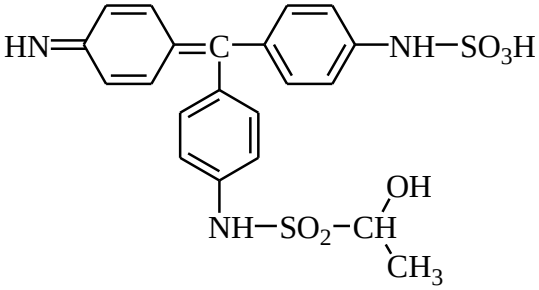
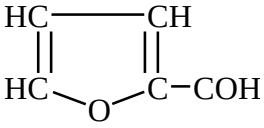
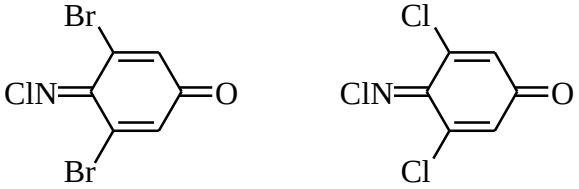
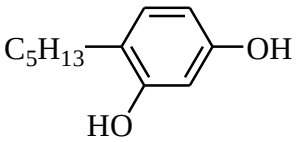
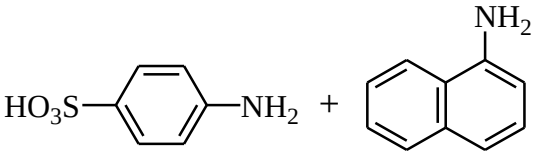
38. Floroglyutsin 	Furfurol, vanilin, 1,4-benzoxinon, gidroxinon
39. Formaldegid (+ H_2SO_4) 	Aromatik uglevodorodlar, indol va hosilalari, polifenillar, xlorbenzol
40. Ftal angidrid 	Alifatik spirtlar
41. Fuksinsulfat kislota (Shiff reaktivi) 	Aldegidlar, alanin, albumin, aminosirka kislota, meteonin
42. Furfurol 	Atseton, izopropanol, borneol, metilketon, terpenlar
43. Gibbs reaktivi (2,6-dibromxinonxlorimin yoki 2,6-dixlorxinonxlorimin) 	*p*-Holati bo'sh bo'lgan fenollar, xlorlangan fenollar, tiollar, kumarin
44. 4-Geksilrezorsin 	Akrolein
45. Griss reaktivi (sulfanil kislota + 1-naftilamin) 	Nitrat kislota efirlari, nitrozobirikmalar, nitrobirikmalar

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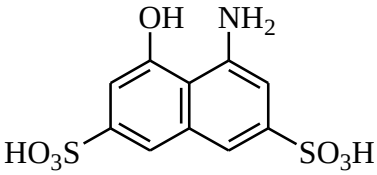
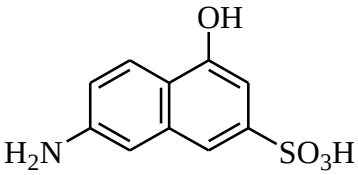
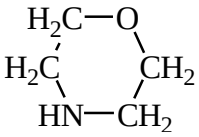
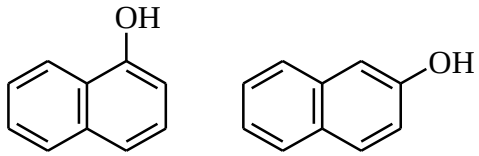
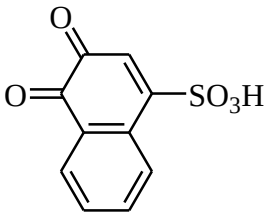
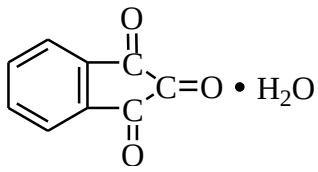
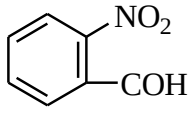
46. H-kislota (ash-kislota, 1-amino-8-naftol-3,6-disulfokislota) 	Anilin va hosilalari, toluidinlar, ketonlar
47. I-kislota (6-amino-1-naftol-3-sulfokislota) 	Formaldegid, glioksal, piperonal, urotropin
48. Metil binafsha (16-jadvaldan 139 ga qarang)	Aldegidlar, nitrofenollar
49. Morfolin 	Kislota angidridlar, xinonlar
50. 1-Naftol va 2-naftol 	Aromatik aminlar, ularning hosilalari, sulfanilamidlar, aminobenzoy kislota, aminokislotalar
51. 1,2-Naftoxinon-4-sulfokislota (Erlix-Gerter reaktivi) 	Birlamchi va ikkilamchi aminlar, gidrazidlar, sulfanilaminlar, aminokislotalar, rezorsin
52. Ningidrin 	Aminokislotalar, aminofenollar, birlamchi aminlar, kislota gidrazidlari
53. 4-Nitroanilin 	Fenollar, naftollar, aromatik aminlar, diolefinlar, aminofenollar
54. 2-Nitrobenzaldegid 	Ketonlar

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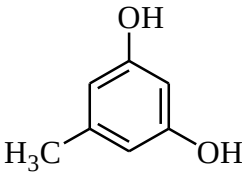
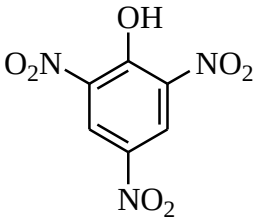
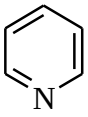
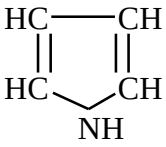
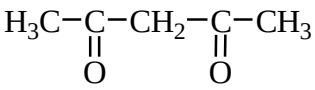
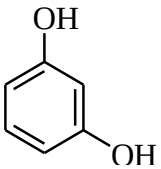
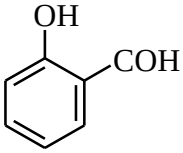
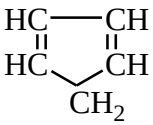
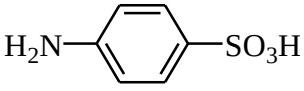
55. Orsin 	Pentozalar, pentozanlar, furfurol
56. Pikrin kislota 	Alifatik aminlar, alkaloidlar
57. Piridin 	Dinitroxlorbenzol, xlorbenzol, poligalogenidli birikmalar
58. Pirrol 	Aldegidlar
59. 2,4-Pentadion 	Birlamchi aminlar
60. Rezorsin (+ H_2SO_4) 	Benzaldegid, salitsil aldegid, furfurol, fruktoza
61. Salitsil aldegid 	Birlamchi alifatik aminlar, ketonlar, sulfanilamidlar, yuqori spirtlar
62. Siklopentadiyen 	Ketonlar
63. Sulfanil kislota 	Aromatik aminlar, fenollar
64. Tetrafenilboratning natriyli tuzi (16-jadvaldan 223 ga qarang)	Ikkilamchi aminlar

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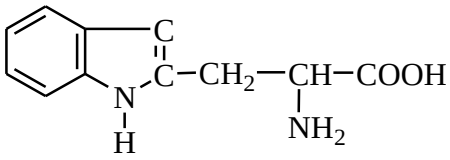
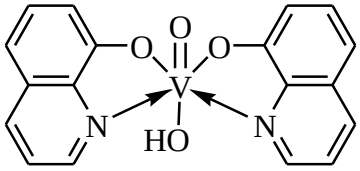
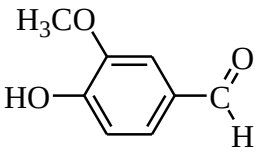
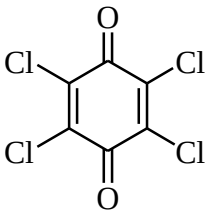
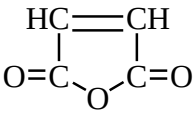
65. Triptofan (+ oksidlovchilar) 	Aldegidlar
66. Vanadiy oksixinolyat 	Birlamchi, ikkilamchi va uchlamchi spirtlar
67. Vanilin 	Ketonlar, pirrol, indol, skatol
68. Xloranil 	Birlamchi aromatik aminlar, aminobenzoy kislotalar, uchlamchi aminlar
69. Xlormaleinangidrid 	Tutash qo’shbog’lar
70. Xromotrop kislota, dinatriyli tuzi (16-jadvaldan 251 ga qarang)	Formaldegid

18-*jadval*

ORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN BA'ZI NOORGANIK REAGENTLAR

Reagent	**Aniqlanadigan moddalar**
1. Gidroksilamin gidroxlorid ($FeCl_3$ bilan birga) $NH_2OH \cdot HCl$ (M.m. 69,49)	Xinonlar, angidridlar, kislota amidlari, imidlar, murakkab efirlar
2. Denije reaktivi $HgSO_4 \cdot H_2SO_4$	Tiofen
3. Dragendorf reaktivi $KBiI_4$ (M.m. 755,70)	Alkaloidlar, ionogen bo'lmagan SAM
4. Ilosvay reaktivi $Cu(NO_3)_2$ (yoki $CuCl_2$) + $NH_2OH \cdot HCl$ + NH_4OH + jelatina	Atsetilen va uning hosilalari
5. Millon reaktivi $Hg_2(NO_3)_2 + Hg(NO_3)_2 + HNO_2$	Fenollar
6. Natriy nitroprussid (Legal reaktivi) $Na_2[Fe(CN)_5NO] \cdot H_2O$ (M.m. 279,95)	Ketonlar, ikkilamchi va alifatik aminlar, aldegidlar, indol va uning gomologlari
7. Natriy pentatsianoferrat (II) [natriy nitroprussid + ammiak] $Na_3[Fe(CN)_5NH_3]$	Nitrozobirikmalar, tiokarbamid, izonikotin kislota, to'yinmagan va aromatik aldegidlar
8. Reyneke tuzi $NH_4[Cr(SCN)_4(NH_3)_2] \cdot 2H_2O$ (M.m. 372,44)	Organik asoslar: atropin, xolin, rezerpin, brutsin, xinin, strixnin
9. Tollens reaktivi $Ag(NH_3)_2OH$	Organik qaytaruvchilar
10. Feling reaktivi $NaKC_4H_4O_6 + CuSO_4 + NaOH$	Qaytaruvchi saxaridlar
11. Folin reaktivi (fosforomolibdat va fosforovolframat kislotalarning aralashmasi)	Organik qaytaruvchilar
12. Fred reaktivi $Na_2MoO_4 + H_2SO_4$	Asos guruhini yonaki zanjirda saqlovchi siklik aminlar

ANALITIK TERMINLARNING QISQA LUG'ATI

Adsorbsiya – qattiq modda yoki suyuqlik yuzasida erigan yoki gazsimon moddalarning yutilishi

Aktivlik – ionlarning effektiv, tajribada aniqlanadigan konsentratsiyasi bo'lib, u umumiy konsentratsiya bilan aktivlik koeffitsiyentining ko'paytmasiga teng

Akseptor – elektronlarni qabul qilib, erkin orbital va donorning juftlashmagan elektronlari hisobiga kimyoviy bog'lanishni hosil qiluvchi atom (ion yoki atomlar guruhi)

Alkalimetriya – titrant sifatida kuchli asoslarning standart eritmalari qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usullari

Amalda topilgan qiymat – haqiqiy qiymatga yaqin bo'lgan aniqlanadigan miqdorning tajribada olingan yoki hisoblab topilgan qiymati.

Analitik guruh – bir yoki bir nechta umumiy kimyoviy xossalarga ega bo'lgan kimyoviy birikmalar majmui

Analitik kimyo – moddaning kimyoviy tarkibini aniqlash usullari haqidagi fan

Analitik reagentlar – kimyoviy analiz uchun mo'ljallangan va tozalik darajasi bo'yicha farq qiladigan kimyoviy preparatlar

Analitik reaksiyalarning sezgirligi – *Topilish minimumi*ga qarang

Analitik signal – aniqlanadigan komponentlar miqdori bilan funksional bog'langan aniqlashlarning o'rtacha (matematik) natijalari. Sifat analizida – kimyoviy reaksiya natijasida moddaning tashqi ko'rinishi yoki agregat holatining o'zgarishi

Analiz aniqligi – barcha (ham sistematik, ham tasodifiy) xatoliklarning nolga yaqinligini ifodalovchi sifat xarakteristikasi

Analiz usuli – modda analizining asosini tashkil etgan prinsiplarning qisqa tavsifi

Analiz usulikasi – analizning aniqligini va to'g'riligini ta'minlaydigan bar-cha sharoitlar va jarayonlarning batafsil bayonnomasi

Analiz usulining sezgirlik koeffitsiyenti – darajalangan xarakteristikaning birinchi hosilaviy qiymati

Analiz natijalarining to'g'riligi – sistematik xatoning nolga yaqinligini ifodalovchi analiz sifati

Analiz natijasi – parallel aniqlashlar natijalarining o'rtacha qiymati

Aniqlanadigan modda bo'yicha titr (g/sm^3, g/ml) – 1 sm^3 (1 ml) eritmadagi titrantning massasiga ekvivalent bo'lgan aniqlanadigan modda massasi

Argentometriya – titrant sifatida kumush nitrat eritmasi qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Atom massa (nisbiy) – modda atom massasining uglerod-12 atom massasi 1/12 qismiga nisbati

Atsidimetriya – titrant sifatida kuchli kislotalarning standart eritmalari qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usullari

Birgalikda cho'ktirish – asosiy moddaning (komponentning) begona moddalar (qo'shimchalar) bilan birga cho'kishi

Bromatometriya – BrO_3^- + Br^- aralashmasi qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Bufer eritmalar – pH ning muayyan qiymati, oksidlanish-qaytarilish potensiali, metall ionlarining konsentratsiyasi va muhitning boshqa xarakteristikalarini doimiy saqlab turadigan eritmalar. pH-buferlar – kislota-asos jufti HA va A^- yoki MH^+ va M^+ komponentlarini saqlagan aralashma; pM-buferlar – ML va M^{n+} aralashmasi

Bufer sig'imi – eritma pH ini bir birlikka o'zgartirish uchun unga qo'shiladigan kuchli asos yoki kuchli kislota miqdori

Bo'lib-bo'lib cho'ktirish – moddalar aralashmasini ajratish usuli bo'lib, izlanadigan ionlarni spetsifik reaksiyalardan foydalanib tekshirilayotgan eritmaning alohida ulushlaridan bevosita cho'ktirish

Darajalangan xarakteristika – formula, jadval yoki grafik ko'rinishida ifodalangan va tajriba yoki hisoblashlar yo'li bilan aniqlangan komponent miqdorining analitik signalga bog'liqligi

Diapazon – berilgan usulika bo'yicha belgilangan miqdorlar qiymatlarining oraliqlari

Dispersiya – tasodifiy kattaliklarning o'rtacha qiymatiga nisbatan tarqalishi

Donor – o'zining juftlashmagan elektronlari va aktseptorning bo'sh orbitalini to'ldirishi hisobiga kimyoviy bog'lanishni hosil qiluvchi atom yoki atomlar guruhi

Donor-aktseptor (koordinatsion) bog'lanish – bir element atomining (donorning) juftlashmagan elektronlari va boshqa element atomining (aktseptorning) bo'sh orbitali orasida vujudga keladigan kimyoviy bog'lanish

Ekvivalent – kislota-asosli reaksiyada bitta vodorod (gidroksoniy) yoki OH^- ioniga yoki oksidlanish-qaytarilish reaksiyasida bitta elektronga ekvivalent bo'lgan moddaning real yoki shartli zarrachasi

Ekvivalent molyar massa – moddaning molyar massasi bilan ekvivalentlik faktorining ko'paytmasiga teng bo'lgan 1 mol ekvivalent modda massasi

Ekvivalent nuqta – qo'shilgan titrant miqdorining titrlanadigan modda miqdoriga ekvivalent bo'lgan titrlash egri chizig'idagi nuqta

Ekvivalentlik faktori f_{ekv}(X) – kislota-asosli reaksiyada bitta vodorod (gidroksoniy) yoki OH^- ioniga yoki oksidlanish-qaytarilish reaksiyasida bitta elektronga modda zarrachasining qaysi ulushi ekvivalent bo'lishini ko'rsatuvchi son

Ekstraksiya – tanlab ta'sir etuvchi erituvchilar yordamida suyuq yoki qattiq moddalar aralashmasini ajratish usuli; aralashma komponentlarining erituvchilarda turlicha erishiga asoslangan

Elektrolitik dissotsilanish – erituvchi molekulalari ta'sirida elektrolit molekulalarining ionlarga parchalanishi

Elektrolitlar – molekulalari ionlarga dissotsilanadigan kislota, asos va tuzlar eritmalari hamda eritilgan va suyuqlantirilgan holda elektr tokini o'tkazuvchi moddalar

Elektronga moyillik – elektronning atom, molekula yoki radikalga qo'shilishida ajralib chiqadigan energiya

Element organik analiz – organik birikmalardagi elementlarni miqdoriy aniqlashda qo'llaniladigan analitik usullar majmui

Eritmaning ion kuchi – ionlar zaryadi va konsentratsiyasiga bog'liq bo'lgan eritmadagi shu ionlarning o'zaro ta'sir kuchini ifodalovchi kattalik

Erituvchilar – turli moddalarni eritish xossasiga ega bo'lgan kimyoviy birikmalar yoki aralashmalar

Eruvchanlik – moddaning boshqa moddalar bilan bir jinsli sistemalar – eritmalar hosil qilish xususiyati; erigan modda konsentratsiyasi bilan ifodalanadi

Fiksanal – shisha ampulalarga joylashtirilgan va standart eritmalar tayyorlash uchun xizmat qiladigan moddaning aniq miqdori (odatda 0,1 mol)

Funksional analiz – organik birikmalar va plastmassalardagi reaksion faol guruhlarni (funksional guruhlarni) aniqlashda qo'llaniladigan fizikaviy va kimyoviy analiz usullarining majmui

Gidroliz – erigan modda ionlari bilan suv ionlarining o'zaro ta'siri natijasida eritma muhitining o'zgarishi

Gravimetrik faktor – aniqlanadigan namudagi komponent miqdorini ifodalaydigan koeffitsiyent bo'lib, aniqlanadigan komponent bilan gravimetrik shakl molyar massalarining nisbatini ko'rsatadi

Gravimetriya (tortma analiz) – ma'lum tarkibli birikma sifatida ajratilgan namuna komponentining massasini aniq o'lchashga asoslangan kimyoviy analizning miqdoriy usuli

Guruh reagenti – ko'p sonli noorganik ionlar yoki organik birikmalarning muayyan sinflari bilan xarakterli mahsulotlar (cho'kma, gaz, rangli eritmalar) hosil qiladigan reaktiv

Hajmiy analiz – *Titrimetrik analiz*ga qarang

Identifikatsiya – fizikaviy, fizik-kimyoviy va kimyoviy xossalarni taqqoslab, noma'lum birikmani boshqa ma'lum birikmaga o'xshashligini aniqlash

Indikatorlar – muhit sharoitiga (gidroksoniy, metall ionlarining konsentratsiyasi, moddalarning oksidlangan va qaytarilgan shakllarining nisbati va boshqalarga) bog'liq holda rangini o'zgartiruvchi organik va noorganik moddalar

Ionitlar – o'zining ionlarini eritma ionlariga almashtira oladigan qattiq qiyin eruvchan moddalar

Ionlanish – neytral atomlar yoki molekulalardan ionlarning hosil bo'lishi

Ishonchlilik chegarasi – o'rtacha qiymatni saqlash ehtimolligi mavjud bo'lgan oraliq

Ichki kompleks birikmalar – tuz hosil qiluvchi va kompleks hosil qiluvchi guruhlarni saqlagan organik reagentlarning metall ionlari bilan hosil qilgan siklik kompleks birikmalari bo'lib, markaziy atom shu sikllarning birida yoki bir nechtasida joylahsadi

Kompleksonometriya – metall ionlarining etilendiamintetrasirka kislota bilan kompleks birikmalar hosil qilish reaksiyalariga asoslangan miqdoriy analizning titrimetrik usuli

Konsentratsiya – eritmadagi berilgan komponentning nisbiy miqdorini ifodalovchi kattalik; hisoblashlarda asosan molyar, normal, foiz va molyal konsentratsiyalar ishlatiladi

Konsentrlash – aniqlanadigan komponent miqdorini (konsentratsiyasini) oshirish usulu

Koordinatsion son – kompleks birikmada markaziy atom bilan bog'langan neytral molekulalar yoki ionlarning umumiy soni

Ligandlar – kompleks birikmada markaziy atom bilan bog'langan molekulalar yoki ionlar

Makrokomponentlar – aniqlanadigan komponentda massa ulushi 10 – 100% bo'lgan moddalar

Massalar ta'siri qonuni – muvozanatda turgan kimyoviy reaksiyalardagi ta'sir etuvchi moddalar orasidagi nisbatlarni o'rnatuvchi qonun

Merkurimetriya – titrant sifatida simob (II) tuzlarining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Mikrokomponentlar – aniqlanadigan komponentda massa ulushi 10^{-3}% dan kam bo'lgan moddalar

Mikrokristalloskopiya – analiz qilinadigan eritma tomchisiga reaktivning ta'siridan o'ziga xos shakldagi kristallarning hosil bo'lishiga asoslangan sifat analizining usuli

Minimal hajm – aniqlanadigan ionning topilish minimumini saqlagan eritma hajmi

Miqdor – ob'yektning aniqligi bo'lib, shu asosida uni bir jinsli tarkibiy qismlarga ajratish mumkin

Miqdoriy analiz – aniqlanadigan namunadagi kimyoviy elementlar (birikmalar) yoki ular shakllarining konsentratsiyasini (miqdorini) eksperimental aniqlash (o'lchash)

Mol – 0,012 kg uglerod-12 izotopida nechta atom bo'lsa, shuncha shartli zarrachalarni saqlagan modda miqdorining birligi

Molekulyar massa (nisbiy) – modda molekula massasining uglerod-12 atom massasi 1/12 qismiga nisbati

Molyar konsentratsiya (mol/dm^3, mol/l) – 1 dm^3 (yoki 1 litr) eritmadagi erigan moddaning mol miqdori

Molyar massa – 1 mol moddaning massasi (g/mol)

Molyar ulush – berilgan sistemada komponent miqdorining moddalar umumiy miqdoriga bo'lgan nisbati. Birning ulushlari, foiz, promille (mingdan bir ulush $‰$) va million ulushlarda (mln^{-1}) ifodalanadi

Namuna – kimyoviy tarkibni aks ettiruvchi tekshiriladigan materialning bir qismi

Nazorat (xolis) tajriba – o'xshash shroitda (bir xil reagent, asboblar va boshqalar), lekin aniqlanadigan moddasiz kimyoviy analiz jarayonlarini takrorlash. Analiz natijalarini tuzatish maqsadida bajariladi

Niqoblash – halaqit beruvchi ionlarni kam dissotsilanuvchi, asosan kompleks birikmalar ko'rinishda bog'lash yoki ularni boshqa shaklga (masalan, oksidlanish darajasini o'zgartirib) o'tkazish

Nisbiy standart chetlanish – standart chetlanishning o'rtacha qiymatga nisbati

Normal konsentratsiya – 1 dm^3 (yoki 1 litr) eritmada eritilgan moddaning g·ekv miqdori

Oksidimetriya – oksidlovchilarning standart eritmalari qo'llaniladigan miqdoriy analizning titrimetrik usullar majmui

Oksidlanish-qaytarilish potensiali – oksidlanish-qaytarilish juftini saqlagan eritmaga inert (platina yoki oltin) elektrod tushirilganda yuzaga keladigan potensial. Nernst tenglamasi bilan ifodalanadi

Oksredmetriya – oksidlanish-qaytarilish reaksiyalariga asoslangan miqdoriy analizning titrimetrik usullar majmui

Parallel aniqlashlar – bir xil sharoitda bitta namuna uchun olingan ko'p sonli natijalar

Permanganatometriya – titrant sifatida kaliy permanganat eritmasining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Protoliz – kuchsiz elektrolitlar yoki kam eriuvchan moddalar hosil bo'lishi bilan boradigan moddalarning suv bilan o'zaro ta'siri

Qo'shimchalar – analiz qilinadigan namunada miqdori 10% dan kam bo'lgan moddalar

Real zarrachalar – kimyoviy reaksiyalarda bevosita ishtirok etuvchi atomlar, ionlar, molekulalar, radikallar, elektronlar va hokazo

Reduktometriya – qaytaruvchilarning standart eritmalari qo'llaniladigan miqdoriy analizning titrimetrik usullar majmui

Selektiv reagentlar – muayyan sharoitlarda faqat kamroq sondagi ionlar bilan o'xshash reaksiyalar beradigan analitik reagentlar

Sentrifugalash – markazdan qochma kuchlar ta'sirida aralashmalarni qattiq va suyuq fazalarga ajratish

Serimetriya – titrant sifatida seriy tuzlarining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Sistematik xatolar – aniqlanadigan komponent miqdorining haqiqiy va o'rtacha qiymatlari orasidagi statistik farq

Sifat – moddiy ob'yektning (predmet, hodisa, jarayonning) muayyan aniqligi bo'lib, shu asosida u berilgan ob'yekt deb hisoblanadi va boshqa ob'yektlardan farq qiladi

Sifat analiz – aniqlanadigan namuna komponentlarini topish va identifikatsiyalash

Solvatlanish – erigan modda zarrachalarining erituvchi zarrachalari bilan o'zaro ta'siri natijasida molekulayr agregatlar – solvatlarning hosil bo'lishi

Solvoliz – erigan modda va erituvchi orasida boradigan va muayyan tarkibli yangi kimyoviy birikmalarning hosil bo'lishiga olib keladigan almashinish reaksiyalari

Spetsifik reaksiyalar – muayyan sharoitda faqat bitta moddani (ionni) topishga (aniqlashga) imkon beradigan analitik reaksiyalar

Standart elektrod potensial – 25°C va atmosfera bosimida elektrod potensialni belgilovchi ionlarning aktivligi 1 ga teng bo'lgan eritmadagi elektrodning potensiali

Standart (titrlangan) eritmalar – miqdoriy analizning titrimetrik usullarida qo'llaniladigan aniq konsentratsiyali eritmalar

Standart namunalar – turli kimyoviy analiz usullari uchun qo'llaniladigan aniq kimyoviy tarkibli etalonlar

Standart chetlanish (o'rtacha kvadratik chetlanish) – xatoliklar xarakteristikasi bo'lib, dispersiyadan olingan kvadrat ildizning musbat qiymatini ifodalaydi

Suyultirish chegarasi – 1 g aniqlanadigan ionni saqlagan eritmaning millilitr miqdori

Titr (g/sm^3, g/ml) – 1 sm^3 yoki 1 ml eritmadagi moddaning massasi

Titrimetrik analiz (hajmiy analiz) – aniqlanadigan eritma bilan reaksiyasiga sarflanadigan ma'lum konsentratsiyali reagent eritmasining hajmini o'lchashga asoslangan miqdoriy analiz usullarining majmui

Titrlangan eritmalar – *Standart eritmalar*ga qarang

Titrlash – titrimetrik analizning asosiy usuli bo'lib, unda ma'lum konsentratsiyali reagent eritmasi byuretkadan aniqlanadigan eritmaga ekvivalent nuqtaga yetguncha qo'shiladi

Titrlash egri chiziqlari – titrlash jarayonining grafik ko'rinishi. Egri chiziqlar titrant hajmi (*V*) – ionlar konsentratsiyasi (*C*) koordinatalarida tuziladi

Titrlash sakramasi – titrlash egri chizig'ining keskin o'zgarishi. Titrantning 99,9 – 100,1% oraliqdagi qo'shilishida kuzatiladi

Tomchi analiz – filtr qog'oz, shisha plastinka ustida eritmalarning tomchilari orasida boradigan reaksiyalarga asoslangan sifat yoki yarimsifat analizning usuli

Topilish minimumi – ma'lum sharoitda modda yoki ionning ayni reaksiya yordamida topilishi mumkin bo'lgan eng kam miqdori; analitik reaksiyaning sezgirligini xarakterlaydi

Tortim – analitik aniqlashlarni o'tkazish uchun olingan namunaning muayyan qismi

Tortma analiz – *Gravimetriya*ga qarang

Vodorod ko'rsatkich pH – eritmdagi gidroksoniy ionlarining konsentratsiyasini (aktivligini) xarakterlovchi kattalik bo'lib, u H_3O^+ molyar konsentratsiyasining manfiy logarifmiga teng

Xelatlar – *Ichki kompleks birikmalar*ga qarang

Xossa – ob'yektning sifat ko'rsatkichi bo'lib, uning boshqa ob'yekt bilan o'xsahshligini yoki farqini ifodalaydi va u bilan ta'sirlashganda namoyon bo'ladi

Xromatografiya – muayyan sorbentda aniqlanadigan aralashma komponentlarining turlicha sorbsiyalanishiga asoslangan aralashmalarni ajratish va analiz qilish usullarining majmui

Xromatometriya – titrant sifatida kaliy dixromat eritmasining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Xromoforlar – tashqi ta'sirlar ostida moddaning ranglanishini keltirib chiqaradigan atomlar guruhi

Yodometriya – $I_3^-/3I^-$ ($I_2/2I^-$) juftining oksidlanish-qaytarilish xossalariga asoslangan miqdoriy analizning titrimetrik usuli

O'ziga xos reaksiyalar – faqat berilgan modda uchun xos bo'lgan reaksiyalar

Chegara (quyi yoki yuqori) – aniqlanadigan komponentning eng kam yoki eng ko'p miqdori

Cho'ktirish – bir yoki bir nechta ionlar yoki moddalarni kam eruvchan moddalar ko'rinishida ajratish

АНАЛИТИК КИМЁНИНГ РИВОЖЛАНИШИГА ЎЗ ҲИССАСИНИ ҚЎШГАН ОЛИМЛАР

Абу Райҳон Мухаммад ибн Ахмад ал-Беруний – Ўрта Осиёнинг буюк мутаффакири, энциклопедист олими. Математика ва астрономия, география, топография, физика, фармакология ва тиббиёт, геология ва минералогия, тарихга оид кўп сонли асарлар муаллифи. Ернинг Қуёш атрофида айланишини биринчи марта аниқлаган олим

Алимарин Иван Павлович (1903 – 1989) – кимёгар-аналитик. Асосий ишлари миқдорий микро- ва ультрамикроанализга бағишланган. Ярим ўтказгичлардаги қўшимчаларни аниқлашда нейтрон-активацион усулни таклиф этди

Алкемаде (Alkemade) Корнелис (1923 – 1989) – даниялик шифокор. Аланга фотометрияси усулини ишлаб чиқди

Ангстрем (Angström) Андерс Йонас (1814 – 1874) – швед физики ва астрономи, спектрал анализнинг асосчиларидан бири

Аррениус (Arrhenius) Сванте Август (1859 – 1927) – швед физкимёгари. Электролитик диссоциланиш назариясининг асосчиси. Кимёвий кинетикага оид ишларнинг муаллифи (Аррениус тенгламаси). Нобель мукофоти совриндори

Афцелиус (Afzelius) Иоган (1753 – 1837) – швед кимёгари, Упсаль университетининг кимё, металлургия ва фармация профессори, Берцелиус устози

Балар (Balard) Антуан Жером (1802 – 1876) – француз кимёгари. Бромни кашф этди

Бекман (Beckman) Эрнст Отто (1853 – 1923) – немис кимёгари. Эриган модданинг молекуляр массасини аниқлаш усулини ишлаб чиқди, спектрал анализ соҳасида ишлар олиб борди

Бер (Beer) Август (1825 – 1863) – немис шифокори. Оптикага оид тадқиқотлар олиб борди, нурнинг ютилиш қонунини кашф этди

Бергман (Bergman) Торберн Улаф (1735 – 1784) – швед кимёгари ва минералоги. Аналитик кимё асосчиларидан бири. Сифат ва миқдорий анализ усулларини ишлаб чиқди

Бертолле (Berthollet) Клод Луи (1748 – 1822) – француз кимёгари, кимёвий мувозанат таълимотининг асосчиси. Ж. Прустдан фарқли равишда кимёвий бирикмаларнинг таркиби ўзгарувчан деб таъкидлайди. Хлор билан оқартириш усулини ишлаб чиқди, бертолле тузини кашф этди

Берцелиус (Berzelius) Йёнс Якоб (1779 – 1848) – швед кимёгари ва минералоги. Церий, селен ва торийни кашф этди. Электрокимёвий дуализм назариясини асослади ва унинг асосида элементлар, бирикмалар ва минераллар классификациясини яратди. Элементларнинг атом оғирликлар жадвалини тузди, замонавий кимёвий белгиларни киритди

Бётгер (Böttger) Вильгельм (1871 – 1949) – немис кимёгари. Миқдорий анализ усулларини ишлаб чиқди

Бойль (Boyle) Роберт (1627 – 1691) – инглиз физики ва кимёгари, Лондон қироллик жамиятининг асосчиларидан бири. Кимёвий элемент тушунчасини биринчи марта ил-мий асослаб берди, экспериментал усулларни кимёга киритди, кимёвий анализга асос солди, кимёнинг фан сифатида шаклланишига ҳиссасини қўшди. Газ қонунларининг бирини яратди (Бойль – Мариотт қонуни)

Бренстед (Brönsted) Иоханес Николаус (1879 – 1947) – даниялик кимёгар. Реакциялар кинетикаси, эритмалар термодинамикаси билан шуғулланди. Кислота ва асослар назариясини ишлаб чиқди

Брюстер (Brewster) Дейвид (1781 – 1868) – шотландиялик физик, нурнинг қутбланишини ўрганди. Унинг номи билан аталадиган қонунни кашф этди, айланма қутбланишни очди

Бугер (Bougeur) Пьер (1698 – 1758) – француз олими, фотометриянинг асосчиларидан бири. Ёруғлик кучини ўлчаш усулларини ишлаб чиқди. Ёруғликнинг сўниш қонунини яратди (Бугер-Ламберт-Бер қонуни)

Бунзен (Bunsen) Роберт Вильгельм (1811 – 1899) – немис кимёгари. Г.Р. Кирхгоф билан ҳамкорликда спектрал анализга асос солди. Цезий, рубидийни кашф этди

Бьеррум (Bjerrum) Нильс (1879 – 1958) – даниялик кимёгар. Электрокимё, кислота ва асос назарияси, водород ионлари концентрациясини аниқлаш, амфотер электролитлар ва бошқаларни ўрганиш билан шуғулланди

Вааге (Waage) Петер (1833 – 1900) – норвегиялик математик. К.М. Гульдберг билан биргаликда массалар таъсири қонунини асослаб берди

Вальден (Walden) Пауль (1863 – 1957) – кимёгар, Петербург ФА нинг академики, 1919 йилдан бошлаб Германияда ишлади. Эритмалар электрокимёси, оптик изомерияни ўрганди; кимё тарихига оид асарларнинг муаллифи

Вант-Гофф (vant-Hoff) Якоб Хендрик (1852 – 1911) – голландиялик физкимёгар, кимё бўйича биринчи Нобель мукофоти совриндори. Стереокимё, эритмалар ва кимёвий кинетика таълимотининг асосчиларидан бири. Эритмалардаги осмотик босим қонунини кашф этди

Вейбель (Veibel) Стиг Эрик (1898 –) – даниялик кимёгар. Органик бирикмалар анализини ишлаб чиқди

Венцель (Wenzel) Карл Фридрих (1740 – 1793) – Фрейбергдаги металл қуйиш заводнинг бошқарувчиси. Эквивалентлар қонунининг кашфиётчиси Рихтердан олдин кислота ва асослар доимий нисбатларда бирикишини аниқлади

Вёлер (Wöhler) Фридрих (1800 – 1882) – немис кимёгари. Анорганик моддалардан биринчи марта органик бирикмани синтезлади. Ю. Либих билан биргаликда бензоил радикалининг мавжудлигини исботлади

Воклен (Vauquelin) Луи Никола (1763 – 1829) – француз кимёгари. Хром ва бериллийни кашф этди

Волластон (Wollaston) Уильям (1767 – 1828) – инглиз кимёгари ва физики

Вольта (Volta) Алессандро (1745 – 1827) – италиялик физик ва физиолог. Электр токи таълимотининг асосчиларидан бири. Биринчи гальваник элементни ва биринчи гальваник элементлар батареясини яратди

Гадолин (Gadolin) Юхан (1760 – 1852) – финляндиялик кимёгар, Т. Бергман шогирди, Або университетининг профессори. Иттербида топилган минерални ўрганиш давомида янги сийрак-ер элементини кашф этди

Гальвани (Galvani) Луиджи (1737 – 1798) – италиялик анатом ва физиолог, электр таълимотининг асосчиларидан бири, экспериментал электрофизиология асосчиси. Металлнинг электролит билан таъсирланишидан потенциаллар фарқи юзага келишини аниқлади

Ганч (Hantzsch) Артур Рудольф (1857 – 1935) – органик-кимёгар, органик бирикмаларнинг анализ қилишда биринчи марта физик-кимёвий усулларни қўллади

Гейгер (Geiger) Ханс Вильгельм (1882 – 1945) – немис физики. Зарядланган заррачаларни қайд этиш асбобини ихтиро қилди

Гей-Люссак (Gay-Lussac) Жозеф Луи (1778 – 1850) – француз кимёгари ва физики. Газ қонунларини кашф этди. Хлор, йод, калий ва натрий – кимёвий элементлар эканлигини исботлади. Эрувчанлик диаграммаларини биринчи бўлиб тузди. Ҳажмий анализ усулларини мукамаллаштирди

Гейровский (Heyrovsky) Ярослав (1890 – 1967) – чехиялик физкимёгар

ван Гельмонт (van Helmont) Ян Баптист (1574 – 1644) – голландиялик табиатшунос, ятрокимёнинг кўзга кўринган намояндаларидан бири. «Газ» атамасининг муаллифи

Гиббс (Gibbs) Жозайя Уиллард (1839 – 1903) – америкалик физик, термодинамика ва статистик механиканинг асосчиларидан бири. Термодинамик потенциаллар назари-сини ишлаб чиқди, гетероген системалардаги мувозанатнинг умумий шарти – фазалар қоидасини кашф этди, қатор тенгламаларни (Гиббс – Гельмгольц, Гиббс – Дюгема) чиқарди

Гоппельсрёдер (Goppelsroeder) Кристоф Фредерик (1837 – 1919) – швейцариялик кимёгар. Капилляр анализга оид кўп сонли ишлар муаллифи

Гофман (Hoffman) Август Вильгельм (1818 – 1892) – немис кимёгари, Ю. Либих шогирди. Асосан азот ва фтор сақловчи органик бирикмалар ва алкалоидлар устида тадқиқотлар олиб борди

Гофман (Hoffman) Фридрих (1660 – 1743) – голландиялик шифокор. Аналитик ва фармацевтик кимё бўйича турли тадқиқотлар муаллифи. Кўп сонли табиий минерал сувларни текшириб, уларда карбонат ангидрид, кальций ва магний тузлари борлигини аниқлади

Гротгус (Grotthus) Кристиан Иоганн Дитрих фон (1785 – 1822) – физик ва кимёгар олим. Электролиз назарияси ва фотокимё қонунини (Гротгус – Дрейпер қонуни) кашф этди

Гульдберг (Guldberg) К. Максимилиан (1836 – 1902) – скандинавиялик математик. П. Вааге билан биргаликда массалар таъсири қонунини таърифлади

Дальтон (Dalton) Жон (1766 - 1844) – инглиз кимёгари ва физики, кимёвий атомизм таълимотининг асосчиси. Каррали нисбатлар қонунини кашф этди, «атом оғирлик» тушунчасини киритди, бир қатор элементларнинг атом массаларини аниқлади. Инсонларда ранг ажратиш хусусиятининг бузилишини (дальтонизм) таърифлаб берди

Декруазиль (Descroizille) Франсуа Антуан Анри (1751 – 1825) – француз кимёгар-технологи. Кислота ва ишқорларни ҳажмий анализ қилиш усулларини ишлаб чиқди

Дэви (Davy) Гемфри (1778 – 1829) – ингилз кимёгари ва физики. Электрокимё асосчила-ридан бири, Лондон қироллик жамиятининг аъзоси ва кейинчалик унинг президенти. Электролиз ёрдамида калий ва натрий, кальций, стронций, барий, магнийни олишга эришди

Дюбоск (Duboscq) Жюль (1817 – 1886) – француз олими. Спектроскопни мукаммаллаштирди

Дюлонг (Dulong) Пьер Луи – француз физики ва кимёгари. Биринчи бўлиб азот хлорид ва фосфит кислотани олди. А. Пти билан биргаликда иссиқлик сиғими қонунини кашф этди, катерометрни ихтиро қилди

Дюма (Dumas) Жан Батист (1800 – 1884) – француз кимёгари, органик кимё асосчилари-дан бири. Азот буғлари ва органик бирикмалар зичлигини аниқлаш усулларини таклиф этди

Жеймс (James) А. – газ-суюқлик тақсимланиш хроматографиясини ишлаб чиқди

Жобир ибн Хайён (тахминан 721 – 815) – араб алкимёгари. Кўп сонли кимёвий жараёнлари тавсифланган алкимёга оид асарлар муаллифи

Жоффруа (Geoffroy) Клод Жозеф (1685 – 1752) – француз кимёгари. Турли табиий бирикмалар анализини ўтказди, новшадил таркибини аниқлади

Ильинский Михаил Александрович (1856 – 1941) – рус органик-кимёгари, анилин бўёқлар саноатининг асосчиси

Кавендиш (Cavendish) Генри (1731 – 1810) – инглиз физики ва кимёгари. Кўпгина газлар-нинг хоссаларини ўрганди, водородни кашф этди, ҳаво таркибини ва сувнинг кимёвий таркибини аниқлади. Ернинг гравитацион доимийлиги, массаси ва ўртача зичлигини ўлчади

Канниццаро (Cannizzaro) Станислао (1826 – 1910) – италиялик кимёгар, атом-молекуляр назариянинг асосчиларидан бири. «Атом», «эквивалент» ва «молекула» тушунчаларини асослаб берди

Кекуле (Kekulé) Фридрих Август (1829 – 1896) – немис кимёгари. Органик бирикмалар тузилиши назариясига оид асарлар муаллифи. Углероднинг 4 валентли эканлигини кўрсатди ва бензолнинг циклик формуласини таклиф этди

Кирхгоф (Kirchhof) Густав Роберт (1824 – 1887) – немис кимёгари. Р. Бунзен билан ҳамкорликда спектрал анализ усулига асос солди, цезий ва рубидийни кашф этди. Нурланиш қонунини асослаб берди ва абсолют қора жисм тушунчасини киритди

Клапрот (Klaproth) Мартин Генрих (1743 – 1817) – немис кимёгари. Анорганик кимё ва минералогия билан шуғулланди. Уран, цирконий, титан ва церийни кашф этди

Классен (Classen) Александр (1843 – 1934) – немис аналитик-кимёгари

Клеве (Cleve) Пер Теодор (1840 – 1905) – швед кимёгари ва геологи, Упсаль университе-тининг профессори. Тулий ва гольмийни кашф этди, платина ва аммиакнинг комплекс бирикмаларини ўрганди. С. Аррениус назариясига қарши чиқди

Кольтгоф (Kolthhoff) Исаак (1894 –) – америкалик кимёгар-аналитик. Кондуктометрик ва потенциометрик титрлаш, индикаторлар назарияси, ҳажмий анализ бўйича бир қа-тор ишлар муаллифи

Крукс (Crookes) Уильям (1832 – 1919) – инглиз физики ва кимёгари, Лондон қироллик жамиятининг аъзоси ва унинг президенти. Газлардаги электр разрядлар ва катод нурларини тадқиқ этди. Сцинтилляция ҳодисасини очди, спинтарископни яратди. Таллийни кашф этди

Кун (Kuhn) Рихард (1900 – 1967) – немис кимёгари ва биокимёгари. Ўсимлик пигментлари (каротиноидлар) ва витаминлар кимёси бўйича фундаментал тадқиқотлар муаллифи. Нобель мукофоти совриндори

Кьельдаль (Kjeldahl) Иоганн Густав (1849 – 1900) – даниялик кимёгар. Кьельдаль методи деб номланган азотни аниқлаш усулини ишлаб чиқди

Лавуазье (Lavoisier) Антуан Лоран (1743 – 1794) – француз кимёгари, замонавий кимёнинг асосчиларидан бири. Ёниш жараёни, металларни куйдириш ва нафас олишда кисло-роднинг аҳамиятини аниқлаб, флогистон назариясини рад этди. Кимёвий бирикмаларнинг рационал номенкла-турасини ишлаб чиқди. Термокимёга асос солди. Машҳур «Кимё дарслиги»нинг муаллифи

Ламберт (Lambert) Иоганн Генрих (1728 – 1777) – немис олими, фотометриянинг асосчиларидан бири. Алгебра, тригонометрияга оид асарлар муаллифи, кометалар орбитаси ва Коинот тузилишини тадқиқ этди

Левенгук (Leeuwenhook) Антони ван (1632 – 1729) – голландиялик табиатшунос, илмий микроскопиянинг асосчиларидан бири. 300 марта катталаштирувчи линзаларни яратди, биринчи марта бактериялар, эритроцитлар ва уларнинг капиллярлардаги ҳаракатини кузатд

Либих (Liebig) Юстус (1803 – 1873) – немис кимёгари, агрокимёнинг асосчиларидан бири. Бир қатор органик бирикмаларни синтезлади ва изомерияни кашф этди. Радикаллар назариясини яратди. Ўсимликларнинг минерал озиқланиши ҳамда бижғиш ва чиришнинг кимёвий назариялари муаллифи

Ловиц Товий Егорович (1757 – 1804) – рус кимёгари ва фармацевти. Ёғоч кўмирида эриган моддаларнинг адсорбцияланишини кашф этди. Биринчи марта муздек сирка кислота ва бошқа бирикмаларни олди. Спирт ва сув аралашмасининг солиштирма оғирликларини аниқлади. Ўта тўйинган эритмалар тушунчасини киритди

Локьер (Lockyer) Жозеф Норман (1836 – 1920) – инглиз астрономи. Астроспектроскопиянинг асосчиларидан бири. Қуёш спектрларини ўрганди, номаълум элементга тегишли чизиқларни кашф этиб, уни гелий деб номлади

Ломоносов Михаил Васильевич (1711 – 1865) – рус олими. Табиий фанлар, тарих, метал-лургия, шеърият ва бошқа соҳаларда фаолият кўрсатди. Петербург ФА нинг биринчи академики. Унинг тадбири билан Москва университети барпо этилди. Атом-молекуляр таълимот асосчиси ва массалар сақланиш қонунининг кашфиётчиси. Физик кимё пойдеворига асос солди

Льюис (Lewis) Уильям (1708 – 1781) – инглиз кимёгари

Маргграф (Marggraf) Андреас Сигизмунд (1709 – 1782) – немис кимёгари. Микроскоп ёрдамида тузлар ва минераллар таркибини тадқиқ этди. Шакар кристалларини олишга эришди

Мартин (Martin) Арчер Жон Портер (1910 –) – инглиз биокимёгари ва физкимёгари. Тақсимланиш хроматографияси: қоғозда (Р. Синг билан ҳамкорликда) ва газ-суюқлик (Н. Жеймс билан ҳамкорликда) усулларини ишлаб чиқди. Нобель мукофоти совриндори (Р. Синг билан биргаликда) 100

Марш (Marsh) Жеймс (1794 – 1846) – ингилз кимёгари, мишьякни аниқлаш усулини ишлаб чиқди

Маршалл (Marshall) Фредерик Жозеф (1920 –) – америкалик кимёгар. С-14 углероди билан нишонланган доривор моддалар олиш усулини ишлаб чиқди

Митчерлих (Мичерлих) (Mitsherlich) Эльхард (1794 – 1863) – немис кимёгари. Изоморфизм ва диморфизм ҳодисаларини кашф этди

Монье (Monnier) Людвиг (1879 –) – немис аналитик-кимёгари

Мор (Mohr) Карл Фридрих (1806 – 1879) – немис кимёгари. Анализнинг бир қатор усулларини ишлаб чиқди; аналитик ишлар учун бир нечта асбобларни яратди

Нернст (Nernst) Вальтер (1864 – 1941) – немис физкимёгари, замонавий физик кимёнинг асосчиларидан бири. Термодинамиканинг учинчи қонунини асослаб берди (Нернст теоремаси), термомегнит ҳодисалардан бирини кашф этди (Нернст – Эттингсхаузен эффекти). Эритмалар назариси, электрокимё, кинетика ва катализга оид асарлар муал-лифи. Нобель мукофоти совриндори

Несслер (Nessler) Юлиус (1827 – 1905) – немис агрокимёгари. Бир қатор аналитик усулларни ишлаб чиқди. Несслер реактиви деб номланувчи реагентни олди

Оствальд (Ostwald) Вильгельм Фридрик (1853 – 1932) – немис физкимёгари ва файласуфи. Электролитлар эритмалари назарияси, кимёвий кинетика ва катализга оид фундаментал асарлар муаллифи. Фалсафий йўналишлардан бири – «энергитизм»нинг асосчиси. Нобель мукофоти совриндори

Панет (Paneth) Фридрих Адольф (1887 – 1958) – немис кимёгари. Метеоритлар тадқиқотчиси, улардаги гелий миқдорини аниқлаш усулларини ишлаб чиқди. Фаянс – Панет қоидасининг муаллифларидан бири

Парацельс (Paracelsus) (1493 – 1514) – шифокор ва табиатшунос, ятрокимёнинг асосчиларидан бири

Прегль (Pregl) Фриц (1869 – 1930) – австриялик кимёгар. Органик бирикмаларнинг миқдорий микроанализ усулига асос солди. Нобель мукофоти совриндори

Пунгор (Pungor) Эрне (1923 –) – венгриялик кимёгар. Анализнинг инструментал усуллари ва ион-селектив мембранали электродларга оид бир қатор ишлар муаллифи; осциллометрик, фотометрик, полярографик ва потенциометрик анализнинг янги усул-ларини ишлаб чиқди

Пфафф (Pfaff) Кристиан Генрих (1773 – 1852) – немис физики ва кимёгари. Икки томли «Аналитик кимё дарслиги»нинг муаллифи

Пфеффер (Pfeffer) Вильгельм (1845 – 1920) – немис физиологи. Осмос ҳодисалари ва уларнинг ўсимликлар физиологиясидаги аҳамиятини ўрганди

Рауль (Raoult) Франсуа Мари (1830 – 1901) – француз физики ва кимёгари. Эритмалар-нинг физик-кимёвий хоссаларини тадқиқ этди, унинг номи билан аталадиган қонун-ларни кашф этди

Рихтер (Richter) Иеремия Вениамин (1762 – 1807) – немис кимёгари. Эквивалентлар қону-нини кашф этди, «стехиометрия» тушунчасини киритди

Розе (Rose) Генри (1795 – 1864) – немис кимёгари. Сифат анализининг водород сульфидли усулини ва миқдорий анализнинг бир қатор усулларини ишлаб чиқди, ниобийни кашф этди

Розе (Rose) Густав (1798 – 1873) – немис минералоги ва кристаллографи. Минералларнинг кристаллокимёвий классификациясини таклиф этди

Роско (Roscoe) Генри Энфильд (1833 – 1915) – инглиз кимёгари. Р. Бунзен билан бирга фотокимё қонунларидан бирини кашф этди (Роско – Бунзен қоунуни). Ванадийни кашф этди

Рунге (Runge) Фридлиб Фердинанд (1795 – 1867) – немис кимёгари. Қоғоз хроматографиясининг асосчиси ҳисобланади

Рэлей (Rayleigh) (1842 – 1919) – ингилз физики, Лондон қироллик жамиятининг аъзоси ва унинг президенти. Нурнинг молекуляр тарқалиш, акустика, тебраниш назарияларининг муаллифи. У. Рамзай билан ҳамкорликда аргонни кашф этди. Нобель мукофоти совриндори

Сабадвари (Szabadvary) Ференц – венгриялик кимё тарихи мутахассиси

Сёренсен (Sørensen) Сёрен Петер Лауриц (1868 – 1939) – даниялик физкимёгар ва биокимёгар. Аминокислоталар синтезининг умумий усули ва аминлардаги азотни миқдорий аниқлаш усулини ишлаб чиқди; водород кўрсаткич (pH) тушунчасини киритди

Синг (Synge) Ричард Лоренс Милингтон (1914 –) – ингилз биокимёгари. Тақсимланиш хроматографияси усулини ишлшаб чиқди (А. Мартин билан биргаликда). Оқсиллар аналитик кимёсига оид асарлар муаллифи. Нобель мукофоти совриндори

Тенар (Thenard) Луи Жак (1777 – 1887) – француз кимёгари. Натрий, калий ва хлор – элементлар эканлигини исботлади. Водород пероксидни олишга эришди Гей-Люссак билан бирга борни кашф этди

Теннант (Tennant) Смитсон (1761 – 1815) – инглиз кимёгари. Осмий, иридийни кашф этди, олмос – бу тоза углерод эканлигини исботлади, оқартириш усулини ишлаб чиқди

Турнейсер (Thurneysser) Леонард (1530 – 1596) – алкимёгар. Аччиқтошлар ва селитра олиш усулини ўзгартирди; олтингугурт, тузлар, симоб, сут шакарини тайёрлаш усул-ларини тавсифлади; сувнинг тахминий анализини ўтказди

Уиллар (Willard) Гобард Герд (1881 –) – америкалик кимёгар-аналитик

Фарадей (Faraday) Майкл (1791 – 1867) – инглиз физики, электромагнит майдон таълимотининг асосчиси. Электр токининг кимёвий таъсирини тадқиқ этди, электр ва магнетизм, магнетизм ва ёруғлик орасидаги боғликларни очди. Электромагнит индукцияни кашф этди. Электролиз қонунларини ўрнатди. Электромагнит тўлқинлар мавжудлигини олдиндан башорат қилди

Фаянс (Fajans) Казимир – америкалик физкимёгар. Радиокимё, эритмалар назарияси, ад-сорбцияга оид асарлар муаллифи. Фаянс – Панет қоидасини ўрнатди

Фишер (Fischer) Эмиль Герман (1881 – 1945) – немис органик-кимёгари, табиий бирик-малар кимёсининг асосчиси. Пурин ҳосилаларини синтезлади ва уларнинг тузилишини тадқиқ этди. Номенклатурани фанга киритди, рационал классификацияни тузди ва кўпгина углеводородларни синтезлади. Оқсиллар кимёсига оид фундаментал тадқиқотларни ўтказди. Нобель мукофоти совриндори

Фолин (Folin) Отто (1867 – 1934) – америкалик биокимёгар. Эндоген ва экзоген метаболизм назариясининг муаллифи; мочевина ва азотни аниқлашнинг янги микро-усулларини амалиётга киритди

Фонтана (Fontana) Феличе (1720 – 1805) – италиялик табиатшунос. Газлар ҳажмини ўлчаш учун махсус аппаратларни қўллади; сув газини кашф этди

Фраунгофер (Fraunhofer) Йозеф (1787 – 1826) – немис физики. Линзалар, дифракцион панжараларни тайёрлаш усулларини такомиллаштирди. Унинг номи билан аталувчи спектр чизиқларини кашф этди

Фрезениус (Fresenius) Карл Ремигиус (1818 – 1897) – немис кимёгар-аналитики; Висбадендаги аналитик лабораторияни ташкил этди, бевосита аналитик кимёга бағишланган биринчи илмий журналга асос солди. Катионларни аналитик гуруҳларга ажратишни амалга оширди

Фукс (Fuchs) Иоганн (1774 – 1856) – немис кимёгари ва минералоги. Натрий силикат (эрувчан шиша), фукситни кашф этди; цемент, цеолитларни тадқиқ этди; «аморф» ва «қотувчи суюқликлар» тушунчаларини киритди

Хассель (Hassel) Одд (1897 – 1981) – норвегиялик кимёгар, коформацион анализ асос-чиларидан бири. Рентгенография ва электронография усуллари ёрдамида циклогексан ва унинг ҳосилалари тузилишини тадқиқ этди. Нобель мукофоти совриндори

Хевеши (Hevesy) Дьердь (Георг) (1885 – 1966) – венгриялик радиокимёгар. Кимёвий ва биокимёвий жараёнларни ўрганишда биринчи марта

изотопларни қўллади. Ҳамкасблари билан биргаликда гафнийни кашф этди. Нобель мукофоти совриндори

Хемпел (Hempel) Вальтер (1851 – 1916) – немис кимёгар-аналитики

Цвет Михаил Семёнович (1872 – 1919) – рус физиологи ва ботаники, хроматографиянинг асосчиси. Яшил баргларнинг пигментларига оид тадқиқот ишларини ўтказди

Цейзе (Zeise) Вильям Христофер (1789 – 1847) – немис фармацевти. Органик бисульфидлар олиш усулларидан бирини ишлаб чиқди, меркаптанларни кашф этди

Чугаев Лев Александрович (1873 – 1922) – рус кимёгари, комплекс бирикмалар кимёси бўйича илмий мактаб асосчиси. Никельни аниқлаш учун реагентни кашф этди (Чугаев реактиви). Углеводородлар синтезининг усулини ишлаб чиқди (Чугаев реакцияси). Терпенлар кимёсига оид асарлар муаллифи

Шеле (Scheele) Карл Вильгельм (1742 – 1786) – швед кимёгари. Кўпгина анорганик ва органик моддалар, жумладан хлор, калий перманганат, глицерин, цианид кислота, бир қатор органик кислоталарни олишга эриши. Ҳавонинг мураккаб таркибини исботлади.

Шенбайн (Schönbein) Христиан Фридрих (1799 – 1868) – немис кимёгари. Озонни кашф этди, пироксилинни синтезлади

Штаудингер (Staudinger) Герман (1881 – 1965) – немис кимёгари, юқори молекуляр бирик-малар кимёсининг асосчиларидан бири. Полимерлар катта молекулалардан таркиб топишини исботлади. «Макромолекула» атамасини фанга киритди, полимер тузилиши назариясини ишлаб чиқди. Кўпгина табиий ва синтетик полимерларни тадқиқ этди. Нобель мукофоти совриндори

Юнг (Young) Томас (1773 – 1829) – инглиз олими. Ёруғликнинг тўлқин назариясини асослаб берди. Интерференция принципини ифодалади, газларнинг аккомодациясини тушунтирди, модулини киритди (Юнг модули). Акустика, астрономияга оид асарлар муаллифи

Яндер (Jander) Герхард (1862 – 1961) – немис кимёгари. Сувсиз эритувчилар тадқиқотчиси

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