

M.R. Amonov, G'.Q. Shirinov

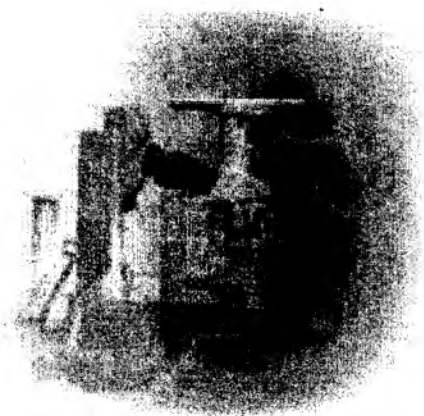
ANALITIK KIMYO SXEMA VA JADVALLARDA



**O'ZBEKISTON RESPUBLIKASI
OLIIY VA O'RTA MAXSUS TA'LIM VAZIRLIGI**

M. R. Amonov, G'. Q. Shirinov

**ANALITIK
KIMYO
SXEMA VA
JADVALLARDA
*O'QUV QO'LLANMA***



**Toshkent
“Innovatsiya-Ziyo”
2020**

UDK: 373.6

BBK: 24.200.526

A 95

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**Analitik kimyo sxema va jadvallarda /o'quv qo'llanma/. – Toshkent:
“Innovatsiya-Ziyo”, 2020, 300 bet.**

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, doktorantlar hamda o'qituvchilar ham foydalanishlari mumkin.

Taqrizchilar:

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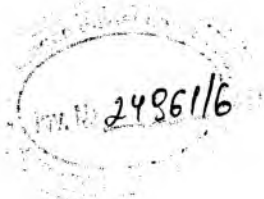
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**O'zbekiston Respublikasi Oliy va o'rta maxsus ta'lim vazirligi
universitetlar talabalari uchun qo'llanma sifatida tavsiya etgan**

ISBN 978-9943-7025-6-1

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KIRISH

Analitik kimyo oliy ma'lumotli biolog mutaxassislarini 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.

Ma'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.

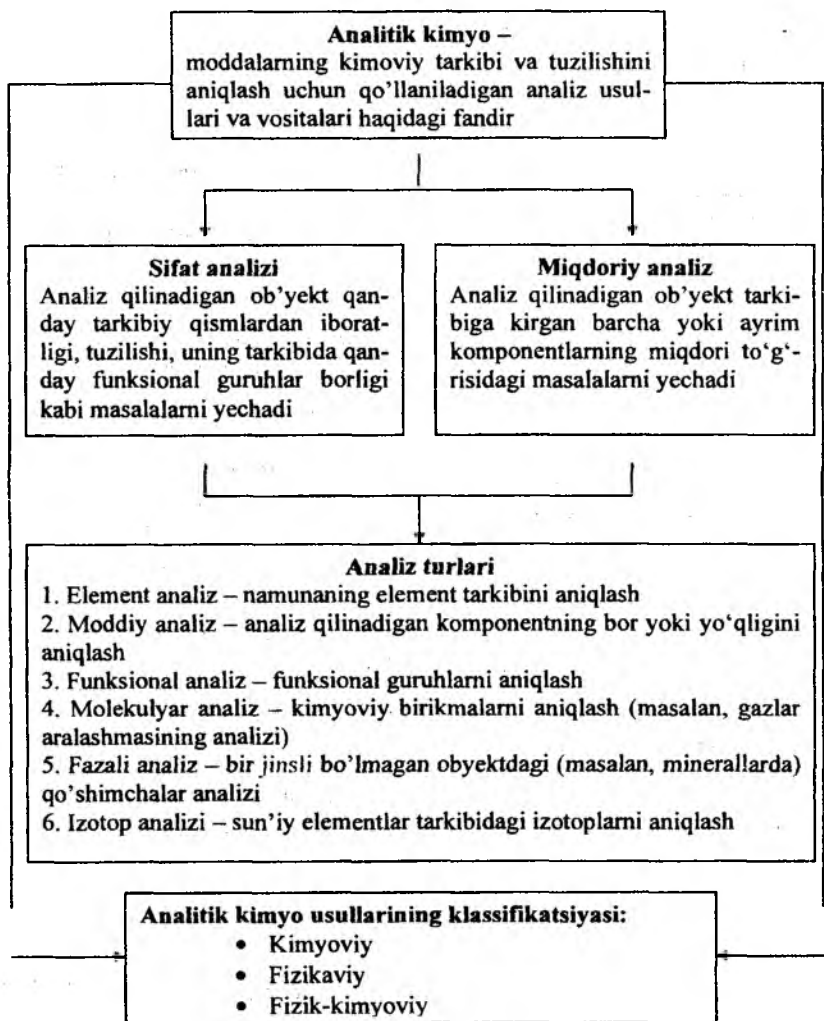
Ilovalar bo'limida kimyoviy-analitik aniqlashlarni o'tkazish uchun zarur bo'lgan amaliy materiallarni mujassamlashtirilgan jadvallar, analitik atamalarining qisqa lug'ati hamda analitik kimyoning rivojlanishiga o'z hissasini qo'shgan olimlar haqida ma'lumotlar keltirilgan.

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



**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}

SIFAT ANALIZINING TURLARI

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

ANALITIK REAKSIYALARNING BELGILARI

Analitik belgilar	Misol
1. Xarakterli cho'kma hosil bo'lishi	$3\text{Fe}^{2+} + 2[\text{Fe}(\text{CN})_6]^{3-} \leftrightarrow \text{Fe}_3[\text{Fe}(\text{CN})_6]_2\downarrow$
2. Eritma rangining o'zgarishi	$\text{Cu}^{2+} + 4\text{NH}_3 \leftrightarrow [\text{Cu}(\text{NH}_3)_4]^{2+}$ (havorang eritma)
3. Gaz ajralishi	$\text{FeS} + 2\text{H}^+ \leftrightarrow \text{Fe}^{2+} + \text{H}_2\text{S}\uparrow$ (xarakterli hid)
4. Issiqlik chiqishi yoki yutilishi	$\text{HCN} + \text{NaOH} \rightarrow \text{NaCN} + \text{H}_2\text{O}$ (issiqlik chiqishi bilan) $\text{CaSO}_4 + 2\text{H}_2\text{O} \rightarrow \text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ (issiqlik yutilishi bilan)

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 , $\text{NH}_3 \cdot \text{H}_2\text{O}$) ga turlicha munosabatiga
Ammiak-fosfatli analiz usuli (5.3.-jadval)	Kationlar fosfatlarining suvda va ammiak eritmasida turlicha eruvchanligiga

**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

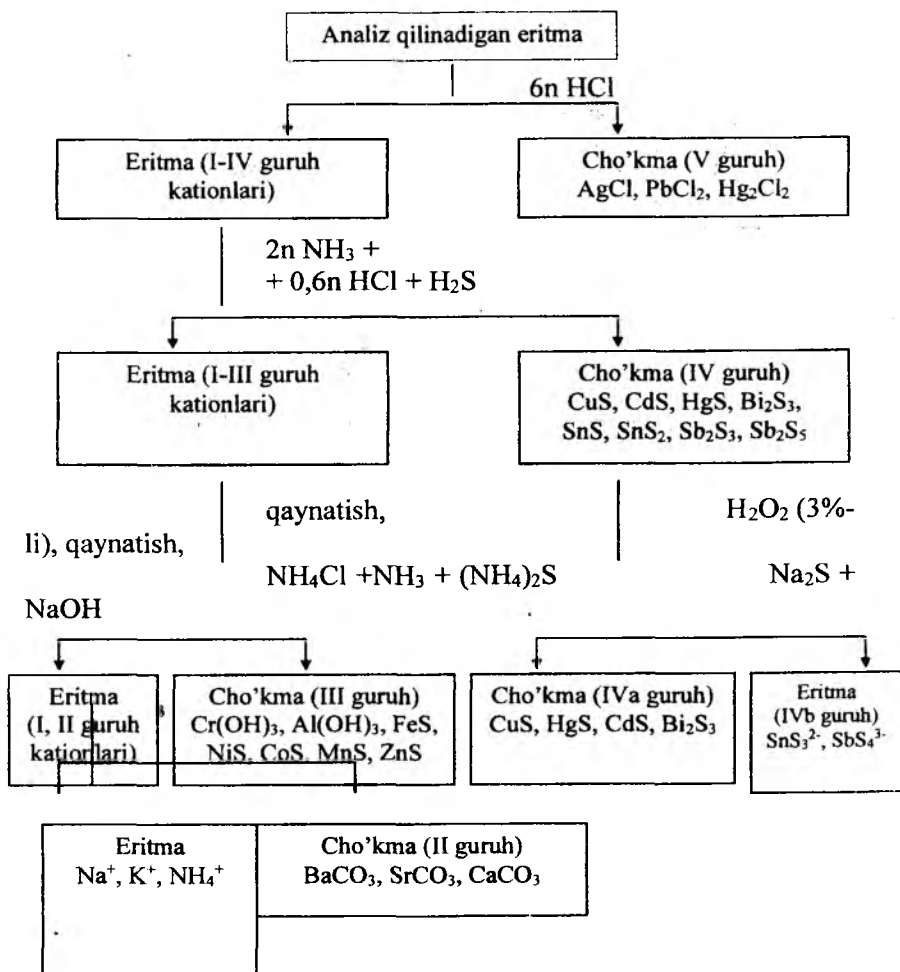
**KATIONLARNING KISLOTA-ASOSLI ANALIZ USULI BO'YICHA
KLASSIFIKATSIYASI**

Guruh	Kationlar	Guruh reagenti	Birikmalarning eruvchanligi
I	$\text{Na}^+, \text{K}^+, \text{NH}_4^+$	Mavjud emas	Xloridlar, sulfatlar va gidroksidlar suvda eriydi.
II	$\text{Ag}^+, \text{Pb}^{2+}, \text{Hg}_2^{2+}$	2M HCl eritmasi	Xloridlar suvda erimaydi
III	$\text{Ba}^{2+}, \text{Sr}^{2+}, \text{Ca}^{2+}$	1M H_2SO_4 eritmasi + $\text{C}_2\text{H}_5\text{OH}$	Sulfatlar suvda erimaydi.
IV	$\text{Al}^{3+}, \text{Zn}^{2+}, \text{Cr}^{3+}, \text{Sn(II)}, \text{Sn(IV)}, \text{As(III)}, \text{As(V)}$	mo'l 6M NaOH eritmasi + 3% H_2O_2	Gidroksidlar suvda erimaydi, lekin mo'l ishqor-da eriydi.
V	$\text{Fe}^{2+}, \text{Fe}^{3+}, \text{Mg}^{2+}, \text{Mn}^{2+}, \text{Bi}^{3+}, \text{Sb(III)}, \text{Sb(V)}$	mo'l kons. $\text{NH}_3 \cdot \text{H}_2\text{O}$	Gidroksidlar suvda, mo'l ishqorda va ammiakda erimaydi.
VI	$\text{Co}^{2+}, \text{Ni}^{2+}, \text{Cd}^{2+}, \text{Cu}^{2+}, \text{Hg}^{2+}$	mo'l kons. $\text{NH}_3 \cdot \text{H}_2\text{O}$	Gidroksidlar suvda mo'l ishqorda erimaydi, lekin mo'l ammiakda eriydi.

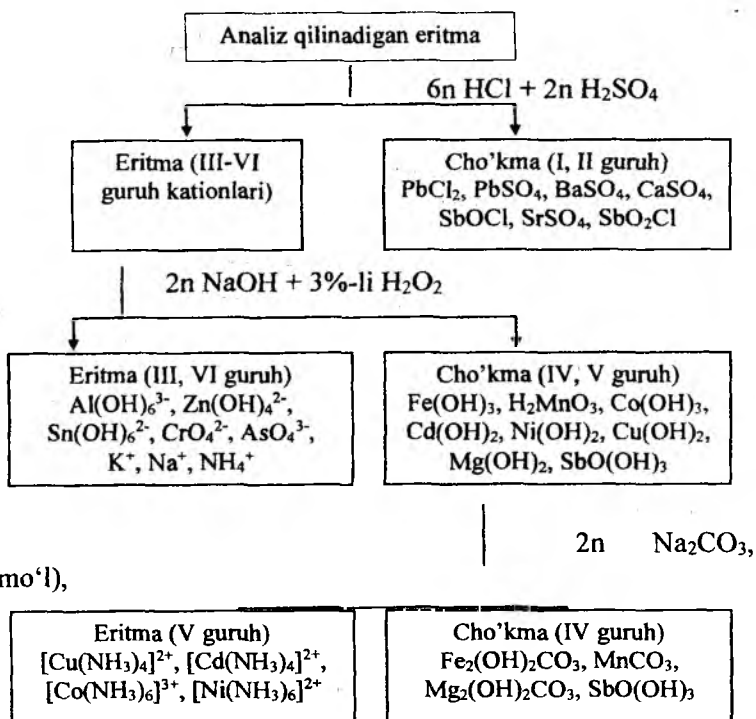
**KATIONLARNING AMMIK-FOSFATLI ANALIZ USULI BO'YICHA
KLASSIFIKATSIYASI**

Guruh	Kationlar	Guruh reagenti	Birikmalarning eruvchanligi
I	$\text{Ag}^+, \text{Pb}^{2+}, \text{Hg}_2^{2+}$	HCl	Xloridlar suvda erimaydi
II	$\text{Sn}^{2+}, \text{Sn(IV)}, \text{Sb(III)}, \text{Sb(V)}$	HNO_3	Metastibiat va metastanat kislotalar suvda erimaydi.
III	$\text{Ba}^{2+}, \text{Sr}^{2+}, \text{Ca}^{2+}, \text{Mg}^{2+}, \text{Mn}^{2+}, \text{Fe}^{3+}, \text{Al}^{3+}, \text{Cr}^{3+}, \text{Fe}^{3+}$	$(\text{NH}_4)_2\text{HPO}_4$, kons. $\text{NH}_3 \cdot \text{H}_2\text{O}$	Fosfatlar suvda va mo'l ammiak eritmasida erimaydi.
IV	$\text{Cu}^{2+}, \text{Cd}^{2+}, \text{Hg}^{2+}, \text{Co}^{2+}, \text{Ni}^{2+}, \text{Zn}^{2+}$	$(\text{NH}_4)_2\text{HPO}_4$, kons. $\text{NH}_3 \cdot \text{H}_2\text{O}$	Fosfatlar suvda erimaydi, lekin mo'l ammiak eritmasida eriydi.
V	$\text{Na}^+, \text{K}^+, \text{NH}_4^+$	Mavjud emas	Xloridlar, nitratlar va fosfatlar suvda eriydi.

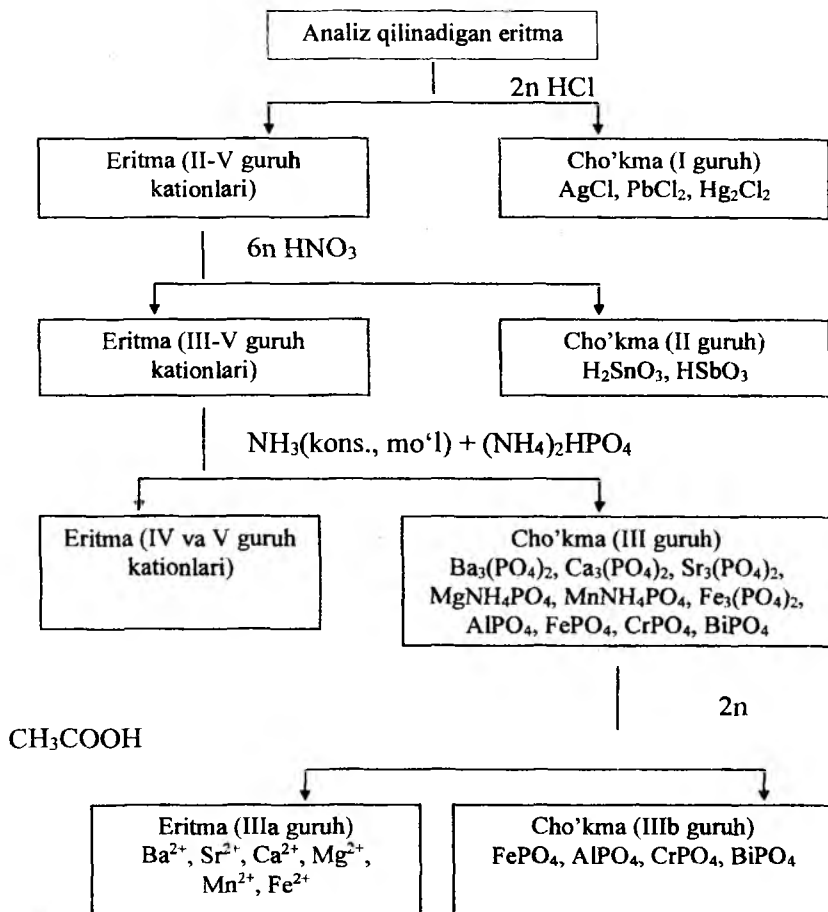
VODOROD SULFIDLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



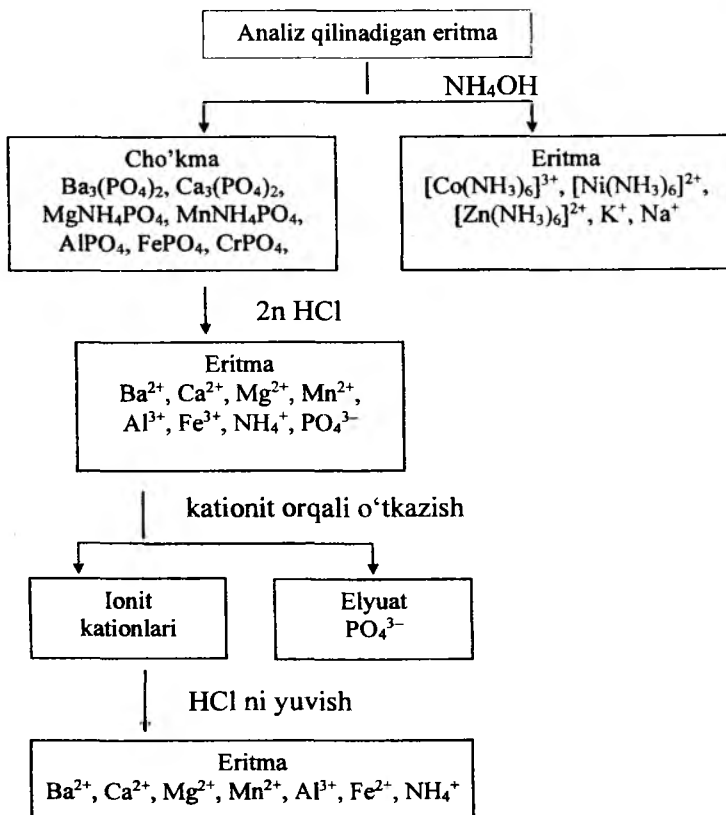
KISLOTA-ASOSLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



AMMAK-FOSFATLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



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



I ANALITIK GURUH KATIONLARNING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
NH_4^+	Nessler reaktivi	$\text{NH}_4\text{Cl} + 2\text{K}_2[\text{HgI}_4] + 4\text{KOH} = [\text{O}(\text{Hg})_2\text{NH}_2]\downarrow + 7\text{KI} + \text{KCl} + 3\text{H}_2\text{O}$ $\text{NH}_4^+ + 2[\text{HgI}_4]^{2-} + 4\text{OH}^- = [\text{O}(\text{Hg})_2\text{NH}_2]\downarrow + 7\text{I}^- + 3\text{H}_2\text{O}$	Sariq-qo'ng'ir cho'kma. Nessler reaktivi ortiqcha olinadi, chunki cho'kma ammoniy tuzlarida eriydi.
	NaOH (KOH)	$\text{NH}_4\text{Cl} + \text{NaOH} = \text{NaCl} + \text{NH}_4\text{OH}$ $\text{NH}_4^+ + \text{Cl}^- + \text{K}^+ + \text{OH}^- = \text{K}^+ + \text{Cl}^- + \text{NH}_4\text{OH}$ $\text{NH}_4\text{OH} \xrightarrow{t} \text{NH}_3\uparrow + \text{H}_2\text{O}$	$t^\circ\text{C}$ va $\text{pH} > 7$ ga teng bo'lganda ajralib chiqqan NH_3 ni hididan yoki namlangan indikator qog'oz rangining o'zgarishidan bilish mumkin.
K^+	$\text{NaHC}_4\text{H}_4\text{O}_6$ yoki vino kislotasi $[\text{H}_2\text{C}_4\text{H}_4\text{O}_6]^-$ CH_3COONa	$\text{KCl} + \text{NaHC}_4\text{H}_4\text{O}_6 = \text{KHC}_4\text{H}_4\text{O}_6\downarrow + \text{NaCl}$ $\text{K}^+ + \text{HC}_4\text{H}_4\text{O}_6^- = \text{KHC}_4\text{H}_4\text{O}_6\downarrow$	$\text{pH} = 7$, past haroratda probirka devori shisha tayyoqcha bilan ishqalanganda oq kristall cho'kma hosil bo'ladi.
	$\text{Na}_3[\text{Co}(\text{NO}_2)_6]$	$2\text{KCl} + \text{Na}_3[\text{Co}(\text{NO}_2)_6] = \text{K}_2\text{Na}[\text{Co}(\text{NO}_2)_6]\downarrow + 2\text{NaCl}$ $2\text{K}^+ + \text{Na}^+ + [\text{Co}(\text{NO}_2)_6]^{3-} = \text{K}_2\text{Na}[\text{Co}(\text{NO}_2)_6]\downarrow$	$\text{pH} = 7$, sariq cho'kma, kuchli kislotalarda eriydi.
	$\text{Na}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6]$	$2\text{KCl} + \text{Na}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6] = \text{K}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6]\downarrow + 2\text{NaCl}$ $2\text{K}^+ + \text{Pb}[\text{Cu}(\text{NO}_2)_6]^{2-} = \text{K}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6]\downarrow$	Qora yoki qo'ng'ir rangli kub shakldagi kristallar.
	Alangani bo'yashi		Och binafsha

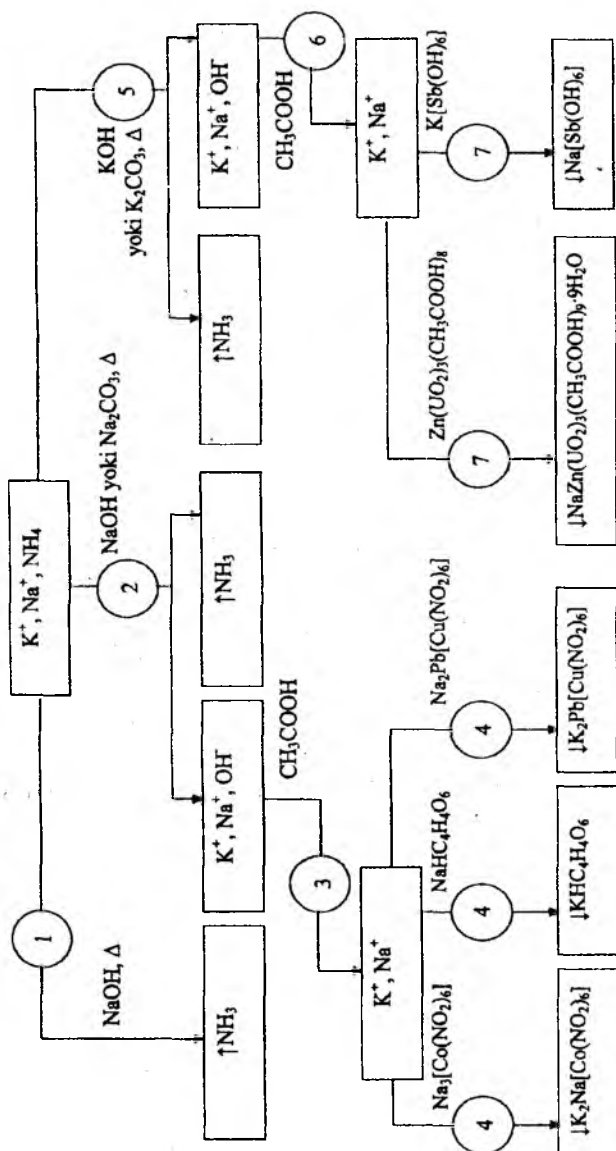
Na ⁺	K[Sb(OH) ₆]	$\text{NaCl} + \text{K}[\text{Sb}(\text{OH})_6] = \text{Na}[\text{Sb}(\text{OH})_6] + \text{KCl}$ $\text{Na}^+ + [\text{Sb}(\text{OH})_6]^- = \text{Na}[\text{Sb}(\text{OH})_6]$	Probirka devorlari shisha tayoq-cha bilan ishqalanganda oq kristall cho'kma paydo bo'ladi
	$\text{Zn}(\text{UO}_2)_2 \times$ $\times (\text{CH}_3\text{COO})_2$	$\text{Na}^+ + \text{Zn}(\text{UO}_2)_2(\text{CH}_3\text{COO})_2 + 9\text{H}_2\text{O} =$ $= \text{NaZn}(\text{UO}_2)_2(\text{CH}_3\text{COO})_2 \cdot 9\text{H}_2\text{O}$	Sarg'ish kristall cho'kma. Natriy uchun eng sezgir reagent
	Alangani bo'yashi		Natriyning uchuvchan tuzlari alangani to'q sariq rangga kiritadi

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: $Na^+ \xrightarrow{K[Sb(OH)_6]} Na[Sb(OH)_6] \downarrow$ $Na^+ \xrightarrow{Zn(UO_2)_3(CH_3COO)_8} NaZn(UO_2)_3(CH_3COO)_9 \cdot 9H_2O \downarrow$

I ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI

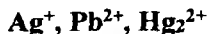


II ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Ag^+	HCl	$\text{AgNO}_3 + \text{HCl} = \text{AgCl}\downarrow + \text{HNO}_3$ $\text{Ag}^+ + \text{Cl}^- = \text{AgCl}\downarrow$	Oq cho'kma, oriqlacha ammiakda eriydi
	KI	$\text{AgNO}_3 + \text{KI} = \text{AgI}\downarrow + \text{HNO}_3$ $\text{Ag}^+ + \text{I}^- = \text{AgI}\downarrow$	Sariq cho'kma $\text{Na}_2\text{S}_2\text{O}_3$ da eriydi
	K_2CrO_4	$2\text{AgNO}_3 + \text{K}_2\text{CrO}_4 = \text{Ag}_2\text{CrO}_4\downarrow + 2\text{KNO}_3$ $2\text{Ag}^+ + \text{CrO}_4^{2-} = \text{Ag}_2\text{CrO}_4\downarrow$	$\text{pH} = 7$, qizil g'isht tusli cho'kma ammiakda va nitrat kislotada eriydi
	Na_2HPO_4	$3\text{AgNO}_3 + 2\text{Na}_2\text{HPO}_4 = \text{Ag}_3\text{PO}_4\downarrow + \text{NaH}_2\text{PO}_4 + 3\text{NaNO}_3$ $3\text{Ag}^+ + 2\text{HPO}_4^{2-} = \text{Ag}_3\text{PO}_4\downarrow + \text{H}_2\text{PO}_4^-$	Sariq cho'kma, ammiakda va nitrat kislotada eriydi
	HCl	$\text{Pb}(\text{NO}_3)_2 + 2\text{HCl} = \text{PbCl}_2\downarrow + 2\text{HNO}_3$ $\text{Pb}^{2+} + 2\text{Cl}^- = \text{PbCl}_2\downarrow$	Oq cho'kma, issiq suvda eriydi
Pb^{2+}	H_2SO_4	$\text{Pb}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 = \text{PbSO}_4\downarrow + 2\text{HNO}_3$ $\text{Pb}^{2+} + \text{SO}_4^{2-} = \text{PbSO}_4\downarrow$	Oq cho'kma, o'yuvchi ishqorlar bilan qizdirilganda eriydi
	KI	$\text{Pb}(\text{NO}_3)_2 + 2\text{KI} = \text{PbI}_2\downarrow + 2\text{KNO}_3$ $\text{Pb}^{2+} + 2\text{I}^- = \text{PbI}_2\downarrow$	Yaltiroq tilla rangli kristall cho'kma
	$\text{K}_2\text{Cr}_2\text{O}_7$	$2\text{Pb}(\text{NO}_3)_2 + \text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{O} = 2\text{PbCrO}_4\downarrow + 2\text{KNO}_3 + 2\text{HNO}_3$ $2\text{Pb}^{2+} + \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O} = 2\text{PbCrO}_4\downarrow + 2\text{H}^+$	Sariq cho'kma ishqorlarda eriydi

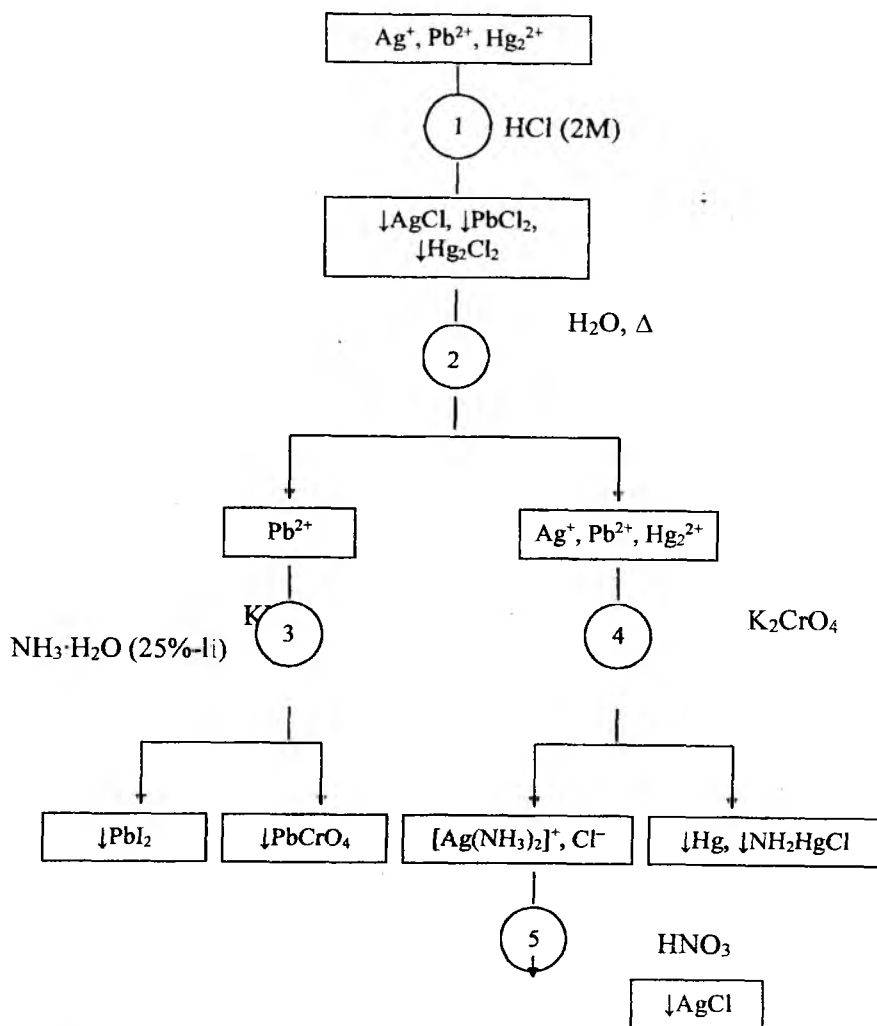
$[\text{Hg}_2]^{2+}$	HCl	$\text{Hg}_2(\text{NO}_3)_2 + 2\text{HCl} = \text{Hg}_2\text{Cl}_2 \downarrow + 2\text{HNO}_3$ $[\text{Hg}_2]^{2+} + 2\text{Cl}^- = \text{Hg}_2\text{Cl}_2 \downarrow$	Oq cho'kma
	K_2CrO_4	$\text{Hg}_2(\text{NO}_3)_2 + \text{K}_2\text{CrO}_4 = \text{Hg}_2\text{CrO}_4 \downarrow + 2\text{KNO}_3$ $[\text{Hg}_2]^{2+} + \text{CrO}_4^{2-} = \text{Hg}_2\text{CrO}_4 \downarrow$	Qizil cho'kma, ishqorlar va suyultirilgan nitrat kislotada erimaydi
	KI	$\text{Hg}_2(\text{NO}_3)_2 + 2\text{KI} = \text{Hg}_2\text{I}_2 \downarrow + 2\text{KNO}_3$ $[\text{Hg}_2]^{2+} + 2\text{I}^- = \text{Hg}_2\text{I}_2 \downarrow$	Yashil cho'kma
	NaOH yoki KOH	$\text{Hg}_2(\text{NO}_3)_2 + 2\text{NaOH} = \text{Hg}_2\text{O} \downarrow + 2\text{NaNO}_3 + \text{H}_2\text{O}$ $[\text{Hg}_2]^{2+} + 2\text{OH}^- = \text{Hg}_2\text{O} \downarrow + \text{H}_2\text{O}$	Qora cho'kma
	Qaytaruvchilar	$\text{Hg}_2(\text{NO}_3)_2 + \text{Cu} = 2\text{Hg} \downarrow + \text{Cu}(\text{NO}_3)_2$ $\text{Hg}_2^{2+} + \text{Cu} = \text{Cu}^{2+} + 2\text{Hg} \downarrow$	Mis plastinkada simobning kulrang dog'i paydo bo'ladi

II. ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI



Bosqichning t/r	Analiz bosqichlari
1	2M HCl ta'sir ettirib, II analitik guruh kationlarini cho'ktirish: $\text{Ag}^+ \xrightarrow{\text{HCl}} \text{AgCl} \downarrow \quad EK_{\text{AgCl}} = 1,78 \cdot 10^{-10}$ $\text{Pb}^{2+} \xrightarrow{\text{HCl}} \text{PbCl}_2 \downarrow \quad EK_{\text{PbCl}_2} = 1,6 \cdot 10^{-5}$ $\text{Hg}_2^{2+} \xrightarrow{\text{HCl}} \text{Hg}_2\text{Cl}_2 \downarrow \quad EK_{\text{Hg}_2\text{Cl}_2} = 1,3 \cdot 10^{-18}$ HCl saqlagan cho'kmani suv bilan yuvish
2	1 cho'kmani issiq suv bilan yuvib, qo'rg'oshin kationlarini ajratish: $\text{PbCl}_2 \downarrow \xrightarrow{\text{H}_2\text{O}, \Delta} \text{Pb}^{2+}$
3	K_2CrO_4 yoki KI eritmaları ta'sir ettirib, 2 sentrifugatdan Pb^{2+} kationlarini topish: $\text{Pb}^{2+} \xrightarrow{\text{K}_2\text{CrO}_4} \text{PbCrO}_4 \downarrow$ $\text{Pb}^{2+} \xrightarrow{\text{KI}} \text{PbI}_2 \downarrow$
4	1 cho'kmaga NH_3 eritmasi ta'sir ettirib, Ag^+ kationlarini ajratish va Hg_2^{2+} kationlarini topish: $\text{AgCl} \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Ag}(\text{NH}_3)_2]^+ + \text{Cl}^- \text{ (eritma)}$ $\text{Hg}_2\text{Cl}_2 \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{HgNH}_2]\text{Cl} \downarrow + \text{Hg} \downarrow$
5	4 eritmaga kons. HNO_3 ta'sir ettirib, Ag^+ kationlarini topish: $[\text{Ag}(\text{NH}_3)_2]^+ + \text{Cl}^- \xrightarrow{\text{kons. HNO}_3} \text{AgCl} \downarrow$

II ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



III ANALITIK GURUH KATIONLARNING 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'rtta 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
Ca^{2+}	Alangani bo'yashi		Rangsiz alangani sarg'ish-yashil rangga kiritadi
	$(NH_4)_2C_2O_4$	$CaCl_2 + (NH_4)_2C_2O_4 = CaC_2O_4 \downarrow + 2NH_4Cl$ $Ca^{2+} + C_2O_4^{2-} = CaC_2O_4 \downarrow$	Oq cho'kma, mineral kislotalarda eriydi

Ca^{2+}	$\text{K}_4[\text{Fe}(\text{CN})_6]$ ($\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$)	$\text{CaCl}_2 + \text{K}_4[\text{Fe}(\text{CN})_6] + 2\text{NH}_4\text{Cl} = \text{Ca}(\text{NH}_4)_2[\text{Fe}(\text{CN})_6]\downarrow + 4\text{KCl}$ $\text{Ca}^{2+} + [\text{Fe}(\text{CN})_6]^{4-} + 2\text{NH}_4^+ = \text{Ca}(\text{NH}_4)_2[\text{Fe}(\text{CN})_6]\downarrow$	Oq kristall cho'kma, sirka kislotada erimaydi
	Na_2HPO_4	$\text{CaCl}_2 + \text{Na}_2\text{HPO}_4 = \text{CaHPO}_4\downarrow + 2\text{NaCl}$ $\text{Ca}^{2+} + \text{HPO}_4^{2-} = \text{CaHPO}_4\downarrow$	Oq cho'kma, kislotalarda eriydi
	Alangani bo'yashi		Kalsiyning uchuvchan tuzlari rangsiz alangani qizil-g'isht rangiga kirtadi
	H_2SO_4	$\text{SrCl}_2 + \text{H}_2\text{SO}_4 = \text{SrSO}_4\downarrow + 2\text{HCl}$ $\text{Sr}^{2+} + \text{SO}_4^{2-} = \text{SrSO}_4\downarrow$	Oq cho'kma, kislotalarda amalda erimaydi
Sr^{2+}	Gipsli suv ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)	$\text{SrCl}_2 + \text{CaSO}_4 = \text{SrSO}_4\downarrow + \text{CaCl}_2$ $\text{Sr}^{2+} + \text{SO}_4^{2-} = \text{SrSO}_4\downarrow$	Eritma qizdirilganda oq loyqa hosil bo'ladi
	$(\text{NH}_4)_2\text{C}_2\text{O}_4$	$\text{SrCl}_2 + (\text{NH}_4)_2\text{C}_2\text{O}_4 = \text{SrC}_2\text{O}_4\downarrow + 2\text{NH}_4\text{Cl}$ $\text{Sr}^{2+} + \text{C}_2\text{O}_4^{2-} = \text{SrC}_2\text{O}_4\downarrow$	Oq cho'kma, mineral kislotalarda va qizdirilganda konsentrlangan CH_3COOH da ham eriydi
	Na_2HPO_4	$\text{SrCl}_2 + \text{Na}_2\text{HPO}_4 = \text{SrHPO}_4\downarrow + 2\text{NaCl}$ $\text{Sr}^{2+} + \text{HPO}_4^{2-} = \text{SrHPO}_4\downarrow$	Oq cho'kma, kislotalarda eriydi
	Alangani bo'yashi		Rangsiz alangani och-qizil rangiga kirtadi

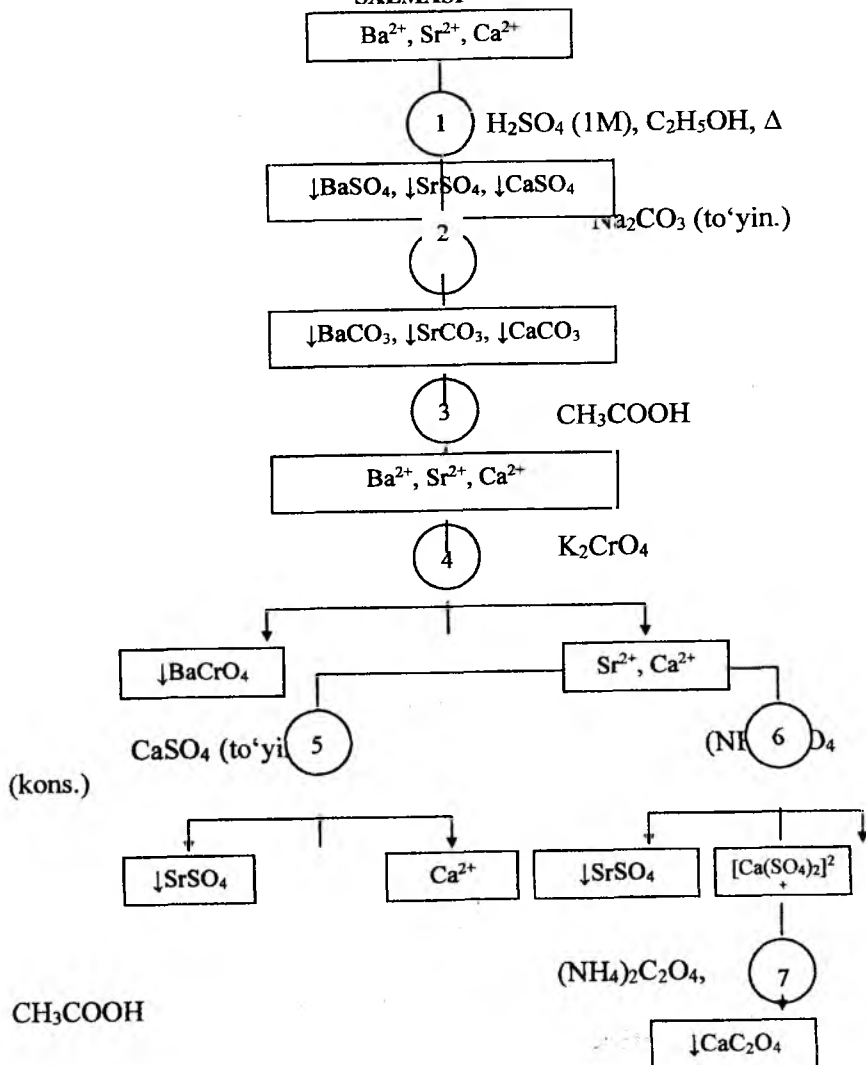
III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

Ba²⁺, Sr²⁺, Ca²⁺

Bosqich chinn g t/r	Analiz bosqichlari
1	C₆H₅OH ishtirokida qizdirib, 1,0 M H₂SO₄ ta'sir ettirib, III analitik guruh kationlarini cho'ktirish: $\text{Ba}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \Delta} \text{BaSO}_4 \downarrow \quad EK_{\text{BaSO}_4} = 1,1 \cdot 10^{-10}$ $\text{Sr}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \Delta} \text{SrSO}_4 \downarrow \quad EK_{\text{SrSO}_4} = 3,2 \cdot 10^{-7}$ $\text{Ca}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \text{C}_2\text{H}_5\text{OH}, \Delta} \text{CaSO}_4 \downarrow \quad EK_{\text{CaSO}_4} = 2,5 \cdot 10^{-5}$
2	III guruh analitik kationlari sulfatlarining cho'kmalariga qaynatib Na₂CO₃ to'yingan eritmasi ta'sir ettirib, qayta cho'ktirish: $\text{BaSO}_4 \downarrow \xrightarrow{\text{Na}_2\text{CO}_3, \Delta} \text{BaCO}_3 \downarrow \quad EK_{\text{BaCO}_3} = 4,0 \cdot 10^{-10}$ $\text{SrSO}_4 \downarrow \xrightarrow{\text{Na}_2\text{CO}_3, \Delta} \text{SrCO}_3 \downarrow \quad EK_{\text{SrCO}_3} = 1,1 \cdot 10^{-10}$ $\text{CaSO}_4 \downarrow \xrightarrow{\text{Na}_2\text{CO}_3, \Delta} \text{CaCO}_3 \downarrow \quad EK_{\text{CaCO}_3} = 3,8 \cdot 10^{-9}$
3	2 cho'kmani CH₃COOH eritmasi ta'sir ettirib eritish: $\text{BaCO}_3 \downarrow \xrightarrow{\text{CH}_3\text{COOH}} \text{Ba}^{2+}$ $\text{SrCO}_3 \downarrow \xrightarrow{\text{CH}_3\text{COOH}} \text{Sr}^{2+}$ $\text{CaCO}_3 \downarrow \xrightarrow{\text{CH}_3\text{COOH}} \text{Ca}^{2+}$
4	3 eritmaning alohida ulushiga K₂CrO₄ eritmasi ta'sir ettirib Ba²⁺ kationlarini topish: $\text{Ba}^{2+} \xrightarrow{\text{K}_2\text{CrO}_4} \text{BaCrO}_4 \downarrow$ Agar Ba²⁺ ishtiroki tasdiqlangan bo'lsa, unda u 3 eritmadan K₂CrO₄ eritmasi ta'sir ettirib ajratish.
5	4 sentrafugatning alohida ulushiga kalsiy sulfatning to'yingan eritmasi (gipsli suv) ta'sir ettirib Sr²⁺ kationlarini topish: $\text{Sr}^{2+} \xrightarrow{\text{CaSO}_4 \text{ to'yingan eritmasi}} \text{SrSO}_4 \downarrow$
6	(NH₄)₂SO₄ ning konsentrlangan eritmasining ta'sir ettirib, 4 sentrifugatdan Sr²⁺ kationlarini ajratish: $\text{Sr}^{2+} \xrightarrow{\text{kons. (NH}_4)_2\text{SO}_4} \text{SrSO}_4 \downarrow$ $\text{Ca}^{2+} \xrightarrow{\text{kons. (NH}_4)_2\text{SO}_4} [\text{Ca}(\text{SO}_4)_2]^{2-}$
7	6 sentrifugatga (NH₄)₂C₂O₄ eritmasi ta'sir ettirib, Ca²⁺ kationlarini topish: $\text{Ca}^{2+} \xrightarrow{(\text{NH}_4)_2\text{C}_2\text{O}_4, \text{CH}_3\text{COOH}} \text{CaC}_2\text{O}_4 \downarrow$

III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ

SXEMASI



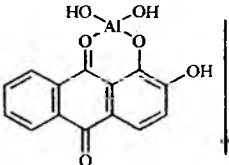
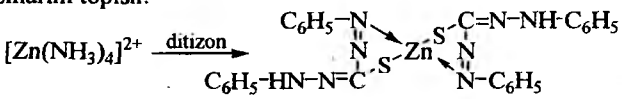
Sn^{2+}	$\text{Bi}(\text{OH})_3$	$3\text{Na}_2\text{SnO}_2 + 2\text{Bi}(\text{OH})_3 \downarrow = 2\text{Bi} \downarrow + 3\text{Na}_2\text{SnO}_3 + 3\text{H}_2\text{O}$ $3\text{SnO}_2 + 2\text{Bi}(\text{OH})_3 = 2\text{Bi} \downarrow + 3\text{SnO}_3^{2-} + 3\text{H}_2\text{O}$	Metall holdagi vismut ajralib chiqadi (bu reaksiyadan Bi ni topishda ham foydalaniladi)
	$\text{NaOH} (\text{KOH})$	$\text{SnCl}_4 + 4\text{NaOH} = \text{H}_2\text{SnO}_4 \downarrow + 4\text{NaCl}$ $\text{Sn}^{4+} + 4\text{OH}^- = \text{H}_4\text{SnO}_4 \downarrow$	Oq iviq cho'kma
Sn^{IV}	Qaytaruvchilar (Mg, Fe)	$\text{H}_2[\text{SnCl}_6] + \text{Mg} = \text{MgCl}_2 + \text{SnCl}_2 + 2\text{HCl}$ $[\text{SnCl}_6]^{2-} + \text{Mg} = \text{Mg}^{2+} + \text{Sn}^{2+} + 6\text{Cl}^-$	Agar eritmada kislotay yetishmay qolsa, Sn ning kulrang cho'kmasi hosil bo'ladi, HCl ta'sirida cho'kma erib ketadi
	$\text{RbCl} (\text{CsCl})$	$\text{H}_2[\text{SnCl}_6] + 2\text{RbCl} = \text{Rb}_2[\text{SnCl}_6] \downarrow + 2\text{HCl}$ $[\text{SnCl}_6]^{2-} + 2\text{Rb}^+ = \text{Rb}_2[\text{SnCl}_6] \downarrow$	Oq bulut shaklidagi kristall cho'kma
	AgNO_3	$\text{NaAsO}_2 + \text{H}_2\text{O} + 3\text{AgNO}_3 = \text{Ag}_3\text{AsO}_3 \downarrow + 2\text{HNO}_3 + \text{NaNO}_3$ $\text{AsO}_2^- + \text{H}_2\text{O} + 3\text{Ag}^+ = \text{Ag}_3\text{AsO}_3 \downarrow + 2\text{H}^+$	Sariq cho'kma, NH_4OH da eriydi
As^{III}	I_2 eritmasi	$\text{NaAsO}_2 + \text{I}_2 + 2\text{H}_2\text{O} = \text{NaH}_2\text{AsO}_4 + 2\text{HI}$ $\text{AsO}_2^- + \text{I}_2 + 2\text{H}_2\text{O} = \text{H}_2\text{AsO}_4^- + 2\text{H}^+ + 2\text{I}^-$	$\text{pH} \geq 7$, yod eritmasining qo'ng'ir rangi yo'qoladi
	Zn + AgNO_3 bilan hamlangan qog'oz	$\text{Na}_3\text{AsO}_3 + 3\text{Zn} + 9\text{HCl} = \text{AsH}_3 \uparrow + 3\text{ZnCl}_2 + 3\text{NaCl} + 3\text{H}_2\text{O}$ $\text{AsO}_3^{3-} + 3\text{Zn} + 9\text{H}^+ = \text{AsH}_3 \uparrow + 3\text{Zn}^{2+} + 3\text{H}_2\text{O}$ $\text{AsH}_3 \uparrow + 6\text{Ag}^+ + 3\text{H}_2\text{O} = 6\text{Ag} \downarrow + \text{H}_3\text{AsO}_3 + 6\text{H}^+$	Ajralib chiqayotgan AsH_3 gazni Ag^+ ionini kumush metaligacha qaytargani sababli qog'oz tezda qorayadi
As^V	AgNO_3	$\text{Na}_3\text{AsO}_4 + 3\text{AgNO}_3 = \text{Ag}_3\text{AsO}_4 \downarrow + 3\text{NaNO}_3$ $\text{AsO}_4^{3-} + 3\text{Ag}^+ = \text{Ag}_3\text{AsO}_4 \downarrow$	Qo'ng'ir cho'kma, ammiakda eriydi

As ^v	KI	$\text{Na}_3\text{AsO}_4 + 2\text{KI} + 4\text{HCl} = \text{NaAsO}_2 + \text{I}_2\downarrow + 2\text{NaCl} + 2\text{KCl} + 2\text{H}_2\text{O}$ $\text{AsO}_4^{3-} + 2\text{I}^- + 3\text{H}^+ = \text{AsO}_2^- + \text{I}_2\downarrow + 2\text{H}_2\text{O}$	pH < 7, erkin yodning ajralishi natijasida ertma qo'ng'ir rangga kiradi
	MoO ₃ + NH ₄ NO ₃	$\text{H}_3\text{AsO}_4 + 12\text{MoO}_3 + 3\text{NH}_4\text{NO}_3 = (\text{NH}_4)_3[\text{AsMo}_{12}\text{O}_{40}]\downarrow + 3\text{HNO}_3$ $\text{AsO}_4^{3-} + 12\text{MoO}_3 + 3\text{NH}_4\text{NO}_3 = (\text{NH}_4)_3[\text{AsMo}_{12}\text{O}_{40}]\downarrow + 3\text{NO}_3^-$	Sariq rangli kristall cho'kma
	Zn + AgNO ₃ bilan namlangan qog'oz	$\text{AsO}_4^{3-} + 7\text{H}^+ + 2\text{Zn} = \text{AsH}_3\uparrow + 2\text{Zn}^{2+} + 4\text{H}_2\text{O}$ $\text{AsH}_3\uparrow + 6\text{Ag}^+ + 3\text{H}_2\text{O} = 6\text{Ag}\downarrow + \text{H}_3\text{AsO}_3 + 6\text{H}^+$	Ag ⁺ ionining arsin ta'sirida metall holatdagi kumushgacha qaytarilishi sababli qog'oz qorayadi

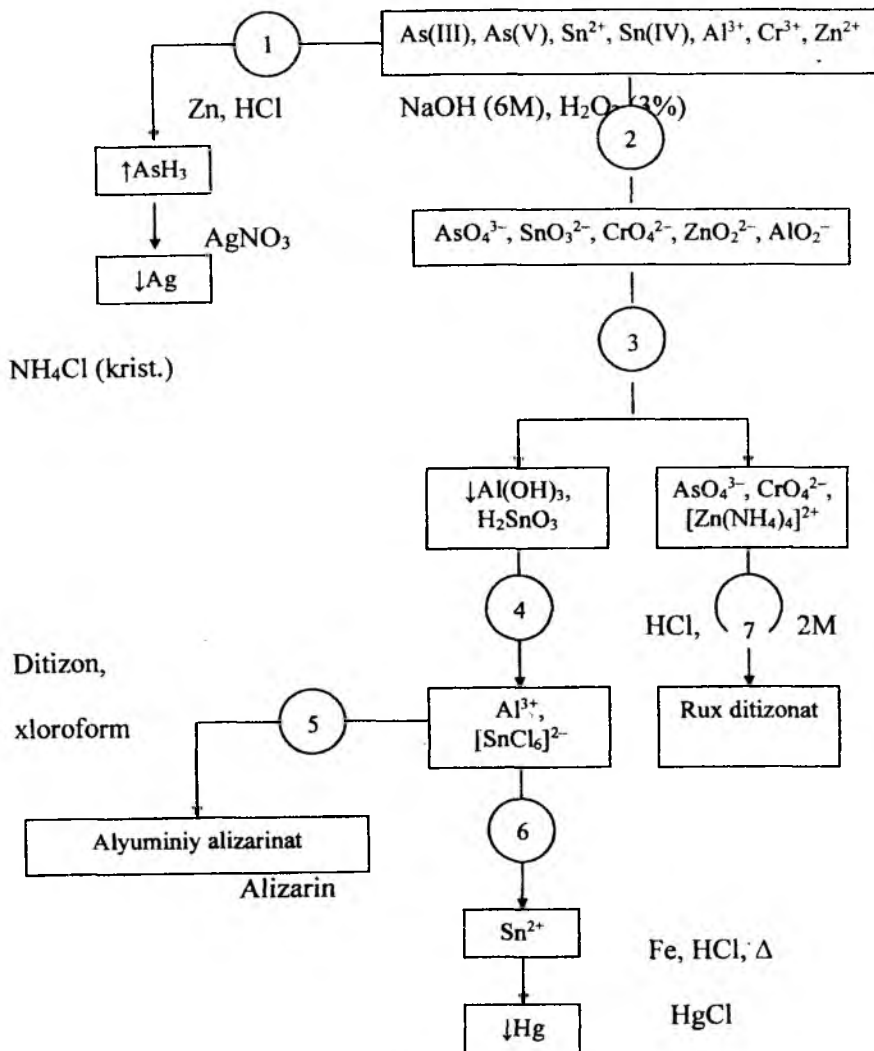
IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

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: $\text{As (III), (V)} \xrightarrow{\text{Zn, HCl}} \text{AsH}_3 \uparrow$ AgNO_3 bilan namlangan qog'oz $\xrightarrow{\text{AsH}_3 \uparrow} \text{Ag} \downarrow$ (Gutsayt reaksiyasi) (qora) $[\text{HgCl}_2]$ bilan namlangan qog'oz $\xrightarrow{\text{AsH}_3 \uparrow}$ $\text{AsH}_2(\text{HgCl}) \downarrow$ $\text{AsH}(\text{HgCl})_2 \downarrow$ $\text{As}(\text{HgCl})_3 \downarrow$ $\text{As}_2\text{Hg}_3 \downarrow$ (sarg'ish-qo'ng'ir)
2	Qizdirilganda IV analitik guruh kationlariga H_2O_2 ishtirokida mo'l 6M NaOH ta'sir ettirish: $\text{Al}^{3+} \xrightarrow{\text{NaOH}} \text{Al(OH)}_3 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Al(OH)}_6]^{3-}$ $\text{Zn}^{2+} \xrightarrow{\text{NaOH}} \text{Zn(OH)}_2 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Zn(OH)}_4]^{2-}$ $\text{Cr}^{3+} \xrightarrow{\text{NaOH}} \text{Cr(OH)}_3 \downarrow \xrightarrow{\text{mo'l NaOH, H}_2\text{O}_2, \Delta} \text{CrO}_4^{2-}$ $\text{Sn}^{2+} \xrightarrow{\text{NaOH}} \text{Sn(OH)}_2 \downarrow \xrightarrow{\text{mo'l NaOH, H}_2\text{O}_2, \Delta} [\text{Sn(OH)}_6]^{2-}$ $\text{Sn(IV)} \xrightarrow{\text{NaOH}} \text{Sn(OH)}_4 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Sn(OH)}_6]^{2-}$ $\text{As(III)} \xrightarrow{\text{NaOH}} \text{AsO}_3^{3-} \xrightarrow{\text{H}_2\text{O}_2, \Delta} \text{AsO}_4^{3-}$ $\text{As(V)} \xrightarrow{\text{NaOH}} \text{AsO}_4^{3-} \xrightarrow{\text{H}_2\text{O}_2, \Delta} \text{AsO}_3^{3-}$
3	2 eritmadan qizdirilganda NH_4Cl kristallari ta'sir ettirib, $[\text{Al(OH)}_6]^{3-}$ gidroksoanionlarni ajratish: $[\text{Al(OH)}_6]^{3-} \xrightarrow{\text{NH}_4\text{Cl}, \Delta} \text{Al(OH)}_3 \downarrow$

	$[\text{Sn}(\text{OH})_6]^{2-} \xrightarrow{\text{NH}_4\text{Cl}, \Delta} \text{Sn}(\text{OH})_4 \downarrow$
4	2M HCl ta'sirida 3 cho'kmani eritish: $\text{Al}(\text{OH})_3 \downarrow \xrightarrow{\text{HCl}} \text{Al}^{3+}$ $\text{Sn}(\text{OH})_4 \downarrow \xrightarrow{\text{HCl}} [\text{SnCl}_6]^{2-}$
5	5 ertimaga alizarin yoki natriy atsetat ta'sir ettirib, Al^{3+} ionlarini topish:  $\text{Al}^{3+} \xrightarrow{\text{alizarin, NaOH}}$ $\text{Al}^{3+} \xrightarrow{\text{CH}_3\text{COONa}} \text{Al}(\text{OH})_2\text{CH}_3\text{COO} \downarrow$
6	HCl muhitida temir qirindilari bilan qaynatilgan 4 eritmaga simob (II) tuzini ta'sir ettirib, $\text{Sn}(\text{IV})$ ionlarini aniqlash: $[\text{SnCl}_6]^{2-} \xrightarrow{\text{Fe, HCl}, \Delta} \text{Sn}^{2+} \xrightarrow{\text{HgCl}_2} \text{Hg} \downarrow$
7	3 sentrifugatga ditizon yoki $\text{K}_4[\text{Fe}(\text{CN})_6]$ eritmasi ta'sir ettirib Zn^{2+} kationlarini topish:  $[\text{Zn}(\text{NH}_3)_4]^{2+} \xrightarrow{\text{ditizon}}$ $[\text{Zn}(\text{NH}_3)_4]^{2+} \xrightarrow{\text{K}_4[\text{Fe}(\text{CN})_6]} \text{K}_2\text{Zn}_3[\text{Fe}(\text{CN})_6]_2 \downarrow$

IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



V ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Hova
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 $NH_4OH + NH_4Cl$	$MgCl_2 + Na_2HPO_4 + NH_4OH = MgNH_4PO_4 \downarrow + 2NaCl + H_2O$ $Mg^{2+} + HPO_4^{2-} + NH_4OH = MgNH_4PO_4 \downarrow + H_2O$	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
	NaOH	$MnSO_4 + 2NaOH = Mn(OH)_2 \downarrow + Na_2SO_4$ $Mn^{2+} + 2OH^- = Mn(OH)_2 \downarrow$	Oq cho'kma, kuchli kislotalarda eriydi
Mn^{2+}	$NaOH + H_2O_2$	$MnSO_4 + 2NaOH + H_2O_2 = MnO_2 \cdot nH_2O \downarrow + Na_2SO_4$ $Mn^{2+} + 2OH^- + H_2O_2 = MnO_2 \cdot nH_2O \downarrow$	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)

Fe^{2+}	NaOH (KOH)	$\text{FeSO}_4 + 2\text{NaOH} = \text{Fe(OH)}_2\downarrow + \text{Na}_2\text{SO}_4$ $\text{Fe}^{2+} + 2\text{OH}^- = \text{Fe(OH)}_2\downarrow$	Oq cho'kma, havoda qisman oksidlanishi tufayli xira-yashil tusga kiradi, kislotalarda eriydi
	$\text{K}_3[\text{Fe(CN)}_6]$	$3\text{FeCl}_2 + 2\text{K}_3[\text{Fe(CN)}_6] = \text{Fe}_3[\text{Fe(CN)}_6]_2\downarrow + 6\text{KCl}$ $3\text{Fe}^{2+} + 2[\text{Fe(CN)}_6]^{3-} = \text{Fe}_3[\text{Fe(CN)}_6]_2\downarrow$	"Turabul ko'ki" deb nomlanuvchi ko'k cho'kma, kislotalarda erimaydi, lekin ishqorlar ta'sirida parchalanadi
	$\text{NaOH (KOH, NH}_4\text{OH)}$	$\text{FeCl}_3 + 3\text{NaOH} = \text{Fe(OH)}_3\downarrow + 3\text{NaCl}$ $\text{Fe}^{3+} + \text{OH}^- = \text{Fe(OH)}_3\downarrow + 3\text{NaCl}$	Qizil-qo'ng'ir cho'kma, kislotalarda eriydi
Fe^{3+}	$\text{K}_4[\text{Fe(CN)}_6]$	$4\text{FeCl}_3 + 3\text{K}_4[\text{Fe(CN)}_6] = \text{Fe}_4[\text{Fe(CN)}_6]_3\downarrow + 12\text{KCl}$ $4\text{Fe}^{3+} + 3[\text{Fe(CN)}_6]^{4-} = \text{Fe}_4[\text{Fe(CN)}_6]_3\downarrow$	"Berlin lazuri" deb nomlanuvchi to'q-ko'k rangli cho'kma, ishqorlarda eriydi
	NH_4SCN	$\text{FeCl}_3 + 3\text{NH}_4\text{SCN} = [\text{Fe(SCN)}_3] + 3\text{NH}_4\text{Cl}$ $\text{Fe}^{3+} + 3\text{SCN}^- = [\text{Fe(SCN)}_3]$	Qizil rangli eritma
	Na_2HPO_4	$\text{FeCl}_3 + 2\text{Na}_2\text{HPO}_4 = \text{FePO}_4\downarrow + \text{NaH}_2\text{PO}_4 + 3\text{NaCl}$ $\text{Fe}^{3+} + 2\text{HPO}_4^{2-} = \text{FePO}_4\downarrow + \text{H}_2\text{PO}_4^{2-}$	Och-sariq cho'kma, kuchli kislotalarda eriydi
Bi^{3+}	NH_4OH	$\text{Bi(NO}_3)_3 + 2\text{NH}_4\text{OH} = \text{Bi(OH)}_3\downarrow + 2\text{NH}_4\text{NO}_3$ $\text{Bi}^{3+} + 2\text{NH}_4\text{OH} = \text{Bi(OH)}_3\downarrow + 2\text{NH}_4^+$ $\text{Bi(OH)}_3\downarrow + \text{H}_2\text{O} = \text{BiONO}_3\downarrow + \text{H}_2\text{O}$	Oq cho'kma, mineral kislotalarda eriydi
	NaOH (KOH)	$\text{Bi(NO}_3)_3 + 3\text{NaOH} = \text{Bi(OH)}_3\downarrow + 3\text{NaNO}_3$ $\text{Bi}^{3+} + 3\text{OH}^- = \text{Bi(OH)}_3\downarrow$	Oq rangli cho'kma, kislotalarda eriydi

	Na_2SnO_2	$3\text{Na}_2\text{SnO}_2 + 2\text{Bi}(\text{OH})_3 \downarrow = 2\text{Bi} \downarrow + 3\text{Na}_2\text{SnO}_3 + 3\text{H}_2\text{O}$ $3\text{SnO}_2^{2-} + 2\text{Bi}(\text{OH})_3 = 2\text{Bi} \downarrow + 3\text{SnO}_3^{2-} + 3\text{H}_2\text{O}$	Metall holdagi vismut ajralib chiqadi
Bi^{3+}	KI	$\text{Bi}(\text{NO}_3)_3 + 3\text{KI} = \text{BiI}_3 \downarrow + 3\text{KNO}_3$ $\text{Bi}^{3+} + 3\text{I}^- = \text{BiI}_3 \downarrow$ $\text{BiI}_3 + \text{KI} = \text{K[BiI}_4]$	Qora cho'kma, reagentning ortiqcha miqdorida to'q-sariq rangli kompleks birikma hosil qiladi
	$\text{K}_2\text{Cr}_2\text{O}_7$	$2\text{Bi}(\text{NO}_3)_3 + \text{K}_2\text{Cr}_2\text{O}_7 + 2\text{H}_2\text{O} = (\text{BiO})_2\text{Cr}_2\text{O}_7 \downarrow + 2\text{KNO}_3 + 4\text{HNO}_3$ $2\text{Bi}^{3+} + \text{Cr}_2\text{O}_7^{2-} + 2\text{H}_2\text{O} = (\text{BiO})_2\text{Cr}_2\text{O}_7 \downarrow + \text{H}^+$	Sariq cho'kma, sirka kislotada eriydi, ishqoriyda erimaydi
	Na_2HPO_4	$\text{Bi}(\text{NO}_3)_3 + 2\text{Na}_2\text{HPO}_4 = \text{BiPO}_4 \downarrow + \text{NaH}_2\text{PO}_4 + 3\text{NaNO}_3$ $\text{Bi}^{3+} + 2\text{HPO}_4^{2-} = \text{BiPO}_4 \downarrow + \text{H}_2\text{PO}_4^-$	Oq kukunsimon cho'kma, suyuqlashtirilgan HNO_3 da erimaydi
	H_2O (gidroliz)	$\text{Na}_3[\text{SbCl}_6] + \text{H}_2\text{O} = \text{SbOCl} \downarrow + 3\text{NaCl} + 2\text{HCl}$ $[\text{SbCl}_6]^{3-} + \text{H}_2\text{O} = \text{SbOCl} \downarrow + 5\text{Cl}^- + 2\text{H}^+$	Oq cho'kma, kislotalarda, jumladan tartirat kislotada ham eriydi
Sb^{III}	NaOH (KOH)	$\text{H}_3[\text{SbCl}_6] + 3\text{NaOH} = \text{HSbO}_2 \downarrow + 3\text{NaCl} + 3\text{HCl} + \text{H}_2\text{O}$ $[\text{SbCl}_6]^{3-} + 3\text{OH}^- = \text{HSbO}_2 \downarrow + 6\text{Cl}^- + \text{H}_2\text{O}$	Oq cho'kma, kislotada va ishqoriyda eriydi
	HNO_3	$\text{SbCl}_3 + 2\text{HNO}_3 + \text{H}_2\text{O} = \text{HSbO}_3 \downarrow + 4\text{HNO}_2 \downarrow + 3\text{HCl}$ $\text{Sb}^{3+} + 2\text{NO}_3^- + \text{H}_2\text{O} = \text{HSbO}_3 \downarrow + 4\text{HNO}_2 \downarrow + \text{H}^+$	Oq cho'kma
	$\text{Na}_2\text{S}_2\text{O}_3$	$2\text{SbCl}_3 + 2\text{Na}_2\text{S}_2\text{O}_3 + 3\text{H}_2\text{O} = \text{Sb}_2\text{OS}_2 \downarrow + 2\text{Na}_2\text{SO}_4 + 6\text{HCl}$ $2\text{Sb}^{3+} + 2\text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O} = \text{Sb}_2\text{OS}_2 \downarrow + 2\text{SO}_4^{2-} + 6\text{H}^+$	$\text{pH} \leq 7$, qizil cho'kma (surma kinovari), kislotalarda oson eriydi
	Qaytaruvchilar (Zn, Sn, Mg)	$2\text{H}_3[\text{SbCl}_6] + 3\text{Zn} \downarrow = 2\text{Sb} \downarrow + 3\text{ZnCl}_2 + 6\text{HCl}$ $2[\text{SbCl}_6]^{3-} + 3\text{Zn} \downarrow = 2\text{Sb} \downarrow + 3\text{Zn}^{2+} + 12\text{Cl}^-$	Qora cho'kma, HNO_3 da eriydi

Sb ^v	H ₂ O (gidroliz)	$\text{Na}[\text{SbCl}_6] + 2\text{H}_2\text{O} = \text{SbO}_2\text{Cl}\downarrow + \text{NaCl} + 4\text{HCl}$ $[\text{SbCl}_6]^- + 2\text{H}_2\text{O} = \text{SbOCl}\downarrow + 5\text{Cl}^- + 4\text{H}^+$	Oq cho'kma, qizdirilganda kislotalarda eriydi
	NaOH (KOH)	$\text{H}[\text{SbCl}_6] + 5\text{NaOH} = \text{HSbO}_3\downarrow + 5\text{NaCl} + \text{HCl} + 2\text{H}_2\text{O}$ $[\text{SbCl}_6]^- + 5\text{OH}^- = \text{HSbO}_3\downarrow + 6\text{Cl}^- + 2\text{H}_2\text{O}$	Oq cho'kma
	Qaytaruvchilar (Zn, Sn, Mg)	$2\text{H}[\text{SbCl}_6] + 5\text{Zn} = 2\text{Sb}\downarrow + 5\text{ZnCl}_2 + 2\text{HCl}$ $2[\text{SbCl}_6]^{3-} + 5\text{Zn} = 2\text{Sb}\downarrow + 5\text{Zn}^{2+} + 12\text{Cl}^-$	Qora cho'kma, HNO ₃ da eriydi

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

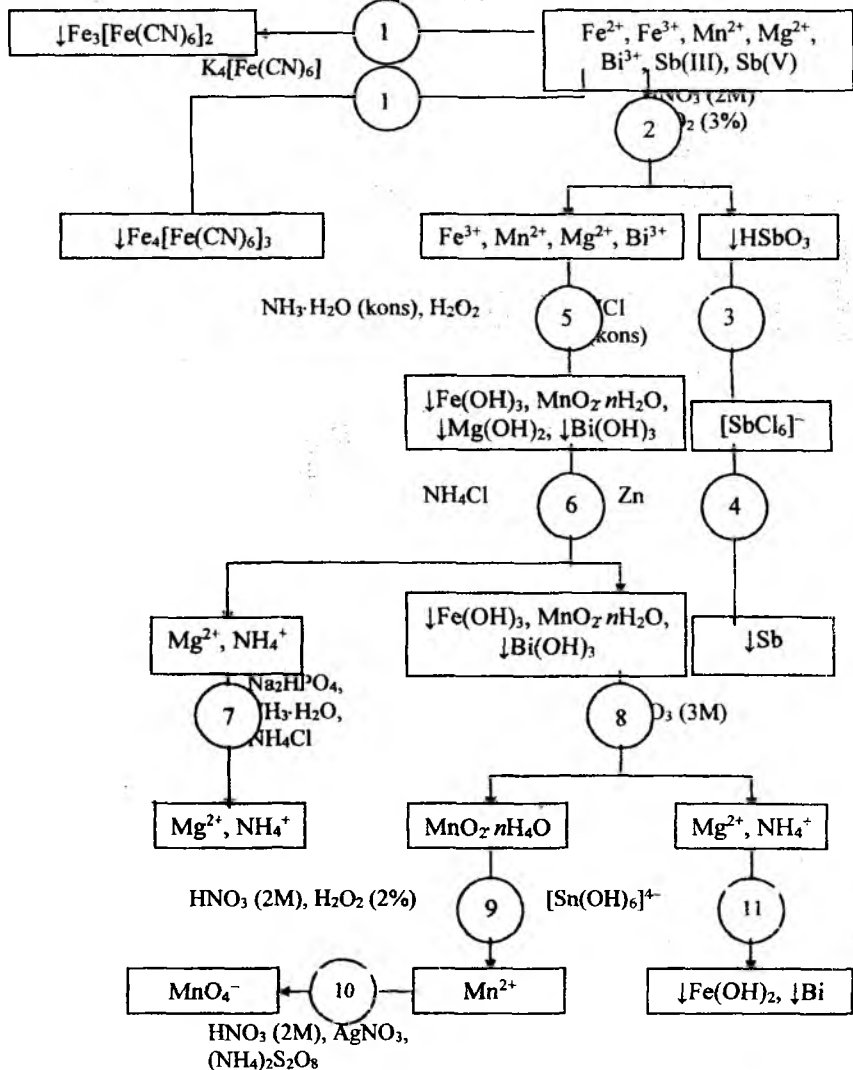
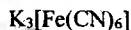
Mg²⁺, Mn²⁺, Fe²⁺, Fe³⁺, Bi³⁺, Sb(III), Sb(V)

Bosqichning t/r	Analiz bosqichlari
1	Alohida namunadagi Fe(II), Fe(III) ionlarini tegishli K₃[Fe(CN)₆] va K₄[Fe(CN)₆] reagentlari bilan aniqlash: $\text{Fe}^{2+} \xrightarrow{\text{K}_3[\text{Fe}(\text{CN})_6]} \text{Fe}_3[\text{Fe}(\text{CN})_6]_2 \downarrow$ $\text{Fe}^{3+} \xrightarrow{\text{K}_4[\text{Fe}(\text{CN})_6]} \text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \downarrow$
2	H₂O₂ bilan HNO₃ ta'sir ettirib, Sb(III) va Sb(V) ionlarini ajratish: $\text{Sb(III), Sb(V)} \xrightarrow{\text{HNO}_3} \text{HSbO}_3 \downarrow$ $\text{Fe}^{2+} \xrightarrow{\text{HNO}_3} \text{Fe}^{3+}$
3	2 cho'kmani HCl eritmasida eritish: $\text{HSbO}_3 \downarrow \xrightarrow{\text{HCl}} [\text{SbCl}_6]^-$
4	Nikel plastinkasida 3 eritmaga rux ta'sir ettirib, Sb(V) ionlarini aniqlash: $[\text{SbCl}_6]^- \xrightarrow{\text{Zn}} \text{Sb} \downarrow$
5	2 sentrifugatdan konsertlangan NH₃·H₂O ta'sir ettirib, V analitik guruh kationlarini cho'ktirish: $\text{Mg}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Mg}(\text{OH})_2 \downarrow$ $\text{Mn}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Mn}(\text{OH})_2 \downarrow$ $\text{Fe}^{3+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Fe}(\text{OH})_3 \downarrow$ $\text{Bi}^{3+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{BiONO}_3 \downarrow$
6	5 cho'kmaga NH₄Cl + 3%-li H₂O₂ eritmasi ta'sir ettirib, Mg²⁺ kationlarini ajratish: $\text{Mg}(\text{OH})_2 \downarrow \xrightarrow{\text{NH}_4\text{Cl}} \text{Mg}^{2+}$ $\text{Mn}(\text{OH})_2 \downarrow \xrightarrow{3\% \text{-li H}_2\text{O}_2} \text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$

	6 cho'kma tarkibi: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$, $\text{BiONO}_3 \downarrow$, $\text{Fe}(\text{OH})_3 \downarrow$
7	6 sentrifugatga ammiakli bufer eritma ishtirokida NaHPO_4 ta'sir ettirib, Mg^{2+} kationlarini aniqlash: $\text{Mg}^{2+} \xrightarrow{\text{Na}_2\text{HPO}_4, \text{NH}_3 \cdot \text{H}_2\text{O} + \text{NH}_4\text{Cl}} \text{MgNH}_4\text{PO}_4 \downarrow$
8	6 cho'kmaga HNO_3 eritmasi ta'sir ettirib, Bi^{3+} va Fe^{3+} kationlarini ajratish: $\text{BiONO}_3 \downarrow \xrightarrow{\text{HNO}_3} \text{Bi}^{3+}$ $\text{Fe}(\text{OH})_3 \downarrow \xrightarrow{\text{HNO}_3} \text{Fe}^{3+}$ cho'kma $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$
9	8-bosqich bo'yicha olingan cho'kmani H_2O_2 ishtirokida HNO_3 eritmasi ta'sir ettirib, eritish: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow \xrightarrow{\text{HNO}_3; \text{H}_2\text{O}_2} \text{Mn}^{2+}$
10	9 eritmaga $(\text{NH}_4)_2\text{S}_2\text{O}_8$ ta'sir ettirib, Mn^{2+} kationlarini aniqlash: $\text{Mn}^{2+} \xrightarrow{(\text{NH}_4)_2\text{S}_2\text{O}_8; \text{HNO}_3; \text{AgNO}_3} \text{MnO}_4^-$
11	8 sentrifugatga yangi tayyorlangan $[\text{Sn}(\text{OH})_6]^{4-}$ ta'sir ettirib, Bi^{3+} ionlarini topish: $\text{Bi}^{3+} \xrightarrow{[\text{Sn}(\text{OH})_6]^{4-}} \text{Bi} \downarrow$

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ

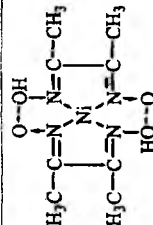
SXEMASI



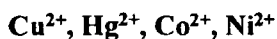
VI ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Havo
Cu^{2+}	NH_4OH	$2\text{CuSO}_4 + 2\text{NH}_4\text{OH} = (\text{CuOH})_2\text{SO}_4\downarrow + (\text{NH}_4)_2\text{SO}_4$ $(\text{CuOH})_2\text{SO}_4\downarrow + 10\text{NH}_4\text{OH} = 2[\text{Cu}(\text{NH}_3)_4](\text{OH})_2 +$ $+ (\text{NH}_4)_2\text{SO}_4 + 8\text{H}_2\text{O}$	Havo rang cho'kma, ortiqcha ammiakda eriydi, ko'k tusli kompleks
	$\text{Na}_2\text{S}_2\text{O}_3$	$2\text{CuSO}_4 + 2\text{Na}_2\text{S}_2\text{O}_3 + 2\text{H}_2\text{O} = 2\text{Na}_2\text{SO}_4 + \text{Cu}_2\text{S}\downarrow + \text{S}\downarrow +$ $+ 2\text{H}_2\text{SO}_4$ $2\text{Cu}^{2+} + 2\text{S}_2\text{O}_3^{2-} + \text{H}_2\text{O} = \text{Cu}_2\text{S}\downarrow + \text{S}\downarrow + 4\text{H}^+ + 2\text{SO}_4^{2-}$	$\text{pH} < 7$, to'q-qo'ng'ir cho'kma
	$\text{K}_4[\text{Fe}(\text{CN})_6]$	$2\text{CuSO}_4 + \text{K}_4[\text{Fe}(\text{CN})_6] = \text{Cu}_2[\text{Fe}(\text{CN})_6]\downarrow + 2\text{K}_2\text{SO}_4$ $2\text{Cu}^{2+} + \text{K}_4[\text{Fe}(\text{CN})_6]^{4-} = \text{Cu}_2[\text{Fe}(\text{CN})_6]\downarrow$	$\text{pH} < 7$ qizil-qo'ng'ir cho'kma
	Qaytaruvchilar (Fe, Al)	$\text{CuSO}_4 + \text{Fe}\downarrow = \text{FeSO}_4 + \text{Cu}\downarrow$ $\text{Cu}^{2+} + \text{Fe}\downarrow = \text{Fe}^{2+} + \text{Cu}\downarrow$	Qizil g'ovak massa ko'rinishida mis metalligacha qaytariladi
Hg^{2+}	NaOH (KOH)	$\text{Hg}(\text{NO}_3)_2 + 2\text{NaOH} = \text{Hg}(\text{OH})_2\downarrow$ $\text{Hg}^{2+} + 2\text{OH}^- = \text{Hg}(\text{OH})_2\downarrow$ $\text{Hg}(\text{OH})_2\downarrow + \text{H}_2\text{O}$	Sariq cho'kma, kislotalarda eriydi. $\text{Hg}(\text{OH})_2$ beqaror bo'lib, HgO va H_2O ga parchalanadi
	NH_4OH	$\text{HgCl}_2 + 2\text{NH}_4\text{OH} = [\text{NH}_2\text{HgCl}]\downarrow + \text{NH}_4\text{Cl} + 2\text{H}_2\text{O}$ $\text{HgCl}_2 + 2\text{NH}_4\text{OH} = [\text{NH}_2\text{HgCl}]\downarrow + \text{NH}_4^+ + \text{Cl}^- + 2\text{H}_2\text{O}$	Oq cho'kma, kislotalarda eriydi
	KI	$\text{Hg}(\text{NO}_3)_2 + \text{KI} = \text{HgI}_2\downarrow + 2\text{KNO}_3$ $\text{HgI}_2 + 2\text{I}^- = [\text{HgI}_4]^{2-}$	Sarg'ish-qizil cho'kma, kompleks ion hosil qilib eriydi

	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
Hg^{2+}	$SnCl_2$	$2HgCl_2 + SnCl_2 = Hg_2Cl_2 \downarrow + SnCl_4$ $2HgCl_2 + Sn^{2+} = Hg_2Cl_2 \downarrow + Sn^{4+} + 2Cl^{2-}$ $Hg_2Cl_2 \downarrow + SnCl_2 = 2Hg \downarrow + SnCl_4$ $Hg_2Cl_2 \downarrow + Sn^{2+} = 2Hg \downarrow + Sn^{4+} + 2Cl^-$	Avval oq cho'kma hosil bo'ladi, mo'l reaktiv ta'sirida kulrang tusga kiradi, ya'ni simob qaytariladi
	$NaOH (KOH)$	$CoCl_2 + 2NaOH = Co(OH) \downarrow + 2NaCl$ $CoOHCl \downarrow + NaOH = Co(OH)_2 \downarrow + NaCl$ $4Co(OH)_2 \downarrow + O_2 + 2H_2O = 4Co(OH)_3 \downarrow$	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
Co^{2+}	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 erydi
	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, kislotada, ammiak va ammoniy tuzlarida erydi

Ni^{2+}	NH_4OH	$\text{Ni}(\text{NO}_3)_2 + \text{NH}_4\text{OH} = \text{Ni}(\text{OH})(\text{NO}_3)\downarrow + \text{NH}_4\text{NO}_3$ $\text{Ni}(\text{OH})(\text{NO}_3)\downarrow + 7\text{NH}_4\text{OH} = (\text{NO}_3)_2[\text{Ni}(\text{NH}_3)_6] + \text{NH}_4\text{NO}_3 + 7\text{H}_2\text{O}$	Yashil rangli asosli tuz cho'kadi, ko'k qizil rangli kompleks
	Na_2HPO_4	$3\text{Ni}(\text{NO}_3)_2 + 4\text{Na}_2\text{HPO}_4 = \text{Ni}_3(\text{PO}_4)_2\downarrow + 2\text{NaH}_2\text{PO}_4 + 6\text{NaNO}_3$ $3\text{Ni}^{2+} + 4\text{HPO}_4^{2-} = \text{Ni}_3(\text{PO}_4)_2\downarrow + 2\text{H}_2\text{PO}_4^-$	Yashil cho'kma kislotalarda va ammiakda eriydi
	Dimetilglioksim (Chugayev reaktiv)	$\text{Ni} \xrightarrow{\text{dimetilglioksim}}$ 	Qizil rangli ichki kompleks tuz cho'kmasi

VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

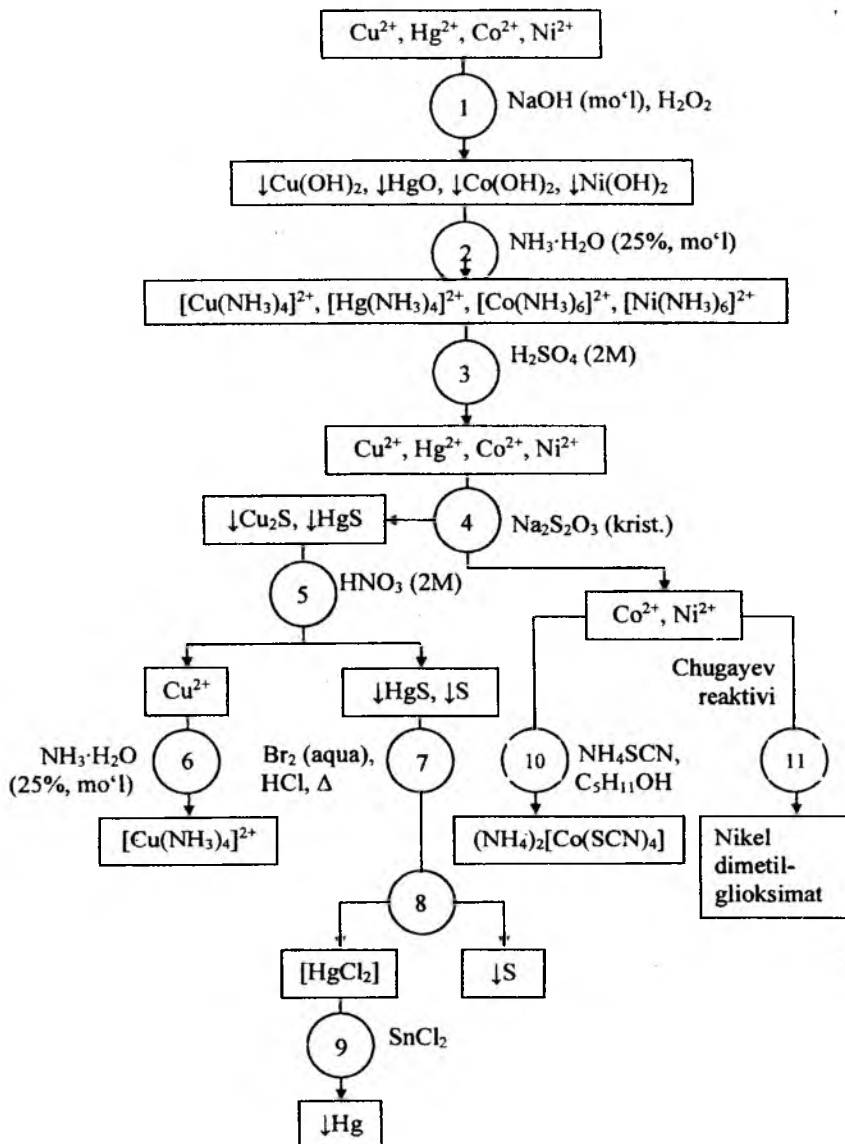


Bosqichning t/r	Analiz bosqichlari
1*	IV analitik guruh kationlarining guruh reagenti ($\text{mo'l NH}_3 \cdot \text{H}_2\text{O}$) bilan o'zaro ta'siri: $\text{Cu}^{2+} \xrightarrow{\text{mo'l NH}_3 \cdot \text{H}_2\text{O}} [\text{Cu}(\text{NH}_3)_4]^{2+}$ $\text{Hg}^{2+} \xrightarrow{\text{mo'l NH}_3 \cdot \text{H}_2\text{O}} [\text{Hg}(\text{NH}_3)_4]^{2+}$ $\text{Co}^{2+} \xrightarrow{\text{mo'l NH}_3 \cdot \text{H}_2\text{O}} [\text{Co}(\text{NH}_3)_6]^{2+}$ $\text{Ni}^{2+} \xrightarrow{\text{mo'l NH}_3 \cdot \text{H}_2\text{O}} [\text{Ni}(\text{NH}_3)_6]^{2+}$
2*	2 M H_2SO_4 ta'sirida ammiaklarni parchalash.
3*	2 eritmaga $\text{Na}_2\text{S}_2\text{O}_3$ ta'sir ettirib, Cu^{2+} va Hg^{2+} ionlarini IV analitik guruhining boshqa kationlardan ajratish: $\text{Cu}^{2+} \xrightarrow{\text{Na}_2\text{S}_2\text{O}_3, \Delta} \text{Cu}_2\text{S} \downarrow$ $\text{Hg}^{2+} \xrightarrow{\text{Na}_2\text{S}_2\text{O}_3, \Delta} \text{HgS} \downarrow$
4	Suyultirilgan HNO_3 da qizdirilganda 3 cho'kmani qisman eritib, Cu_2S ni HgS dan ajratish. $\text{Cu}_2\text{S} \downarrow \xrightarrow{\text{HNO}_3, \Delta} \text{Cu}^{2+}$
5	Konsentrlangan $\text{NH}_3 \cdot \text{H}_2\text{O}$ ta'sir ettirib 4 eritmadan Cu^{2+} ionlarni topish $\text{Cu}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Cu}(\text{NH}_3)_4]^{2+}$
6	HCl ishtirokida bromli suv yoki zar suvi ta'sir ettirib, 3 cho'kmani eritish: $\text{HgS} \downarrow \xrightarrow{\text{Br}_2; \text{HCl}} [\text{HgCl}_2] + \text{S} \downarrow$ $\text{HgS} \downarrow \xrightarrow{\text{kons HNO}_3; \text{kons HCl}} [\text{HgCl}_2]$

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

7	Sentrifugalab S↓ dan [HgCl ₂] ni ajratish.
8	SnCl₂ ta'sirida 7 sentrifugatdan Hg²⁺ ionlarini topish $[\text{HgCl}_2] \xrightarrow{\text{SnCl}_2} \text{Hg}\downarrow$
9	Amil spirti ishtirokida NH₄SCN ta'sir ettirib, 3 sentrafugatdan Co²⁺ ionlarini topish: $\text{Co}^{2+} \xrightarrow{\text{NH}_4\text{SCN}} (\text{NH}_4)_2[\text{Co}(\text{SCN})_4]$
10	Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, sentrifugatdan Ni²⁺ ionlarini topish $\text{Ni} \xrightarrow{\text{dimetilglioksim}}$

VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI

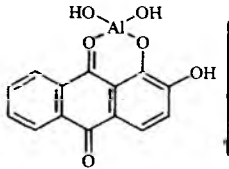
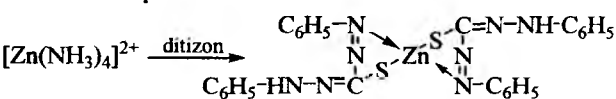


I – VI ANALITIK GURUH KATIONLARI ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

Bosqichning t/r	Analiz bosqichlari
1	Alohida namunadagi NH_4 ionlarini ishqor ta'sir ettirib, qizdirib topish: $\text{NH}_4^+ \xrightarrow{\text{NaOH}, \Delta} \text{NH}_3 \uparrow$
2	Alohida namunaga $\text{K}_3[\text{Fe}(\text{CN})_6]$ eritmasi ta'sir ettirib, temir(II) ionlarini topish: $\text{Fe}^{2+} \xrightarrow{\text{K}_3[\text{Fe}(\text{CN})_6]} \text{Fe}_3[\text{Fe}(\text{CN})_6]_2 \downarrow$
3	Alohida namunaga $\text{K}_4[\text{Fe}(\text{CN})_6]$ eritmasi ta'sir ettirib, temir(III) ionlarini topish: $\text{Fe}^{3+} \xrightarrow{\text{K}_4[\text{Fe}(\text{CN})_6]} \text{Fe}_4[\text{Fe}(\text{CN})_6]_3 \downarrow$
4	Alohida namunadagi Na_2CO_3 ta'sirida qizdirib, K^+ ionlarini topishdan oldin NH_4^{3+} ionlarini yo'qotish: $\text{NH}_4^+ \xrightarrow{\text{Na}_2\text{CO}_3, \Delta} \text{NH}_3 \uparrow$ $\text{Me}^{n+} \xrightarrow{\text{Na}_2\text{CO}_3, \Delta} \text{II, III, V, VI analitik guruh kationlarining oksidlari, gidroksidlari, karbonatlari va asosli tuzlari cho'kmasi.}$
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: $[\text{Me}(\text{OH})_6]^{6-n} \xrightarrow{\text{CH}_3\text{COOH}} \text{Me}(\text{OH})_n \downarrow$
6	$\text{HC}_4\text{H}_4\text{O}_6$, $\text{Na}_3[\text{Co}(\text{NO}_2)_6]$, $\text{Na}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6]$ reagentlari bilan 5 eritmadan K^+ ionlarini topish: $\text{K}^+ \xrightarrow{\text{NaHC}_4\text{H}_4\text{O}_6} \text{KHC}_4\text{H}_4\text{O}_6 \downarrow$ $\text{K}^+ \xrightarrow{\text{Na}[\text{Co}(\text{NO}_2)_6]} \text{K}_2\text{Na}[\text{Co}(\text{NO}_2)_6] \downarrow$ $\text{K}^+ \xrightarrow{\text{Na}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6]} \text{K}_2\text{Pb}[\text{Cu}(\text{NO}_2)_6] \downarrow$
7	Alohida namunadan K_2CO_3 ta'sirida qizdirib, Na^+ ionlarini topishdan oldin NH_4^+ ionlarini yo'qotish: $\text{NH}_4^+ \xrightarrow{\text{K}_2\text{CO}_3, \Delta} \text{NH}_3 \uparrow$ $\text{Me}^{n+} \xrightarrow{\text{K}_2\text{CO}_3, \Delta} \text{II, III, V, VI analitik guruh kationlarining}$

	oksidlari, gidroksidlari, karbonatlari va asosli tuzlari cho'kmasi.
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. $[\text{Me}(\text{OH})_6]^{6-n} \xrightarrow{\text{CH}_3\text{COOH}} \text{Me}(\text{OH})_n \downarrow$
9	$\text{K}[\text{Sb}(\text{OH})_6]$, $\text{Zn}(\text{UO}_2)_3(\text{CH}_3\text{COO})_8$ reagentlari bilan 8 eritmadan Na^+ ionlarini topish: $\text{Na}^+ \xrightarrow{\text{K}[\text{Sb}(\text{OH})_6]} \text{Na}[\text{Sb}(\text{OH})_6] \downarrow$ $\text{Na}^+ \xrightarrow{\text{Zn}(\text{UO}_2)_3(\text{CH}_3\text{COOH})_8} \text{NaZn}(\text{UO}_2)_3(\text{CH}_3\text{COOH})_9 \cdot 9\text{H}_2\text{O} \downarrow$
10	Boshlang'ich eritmadan 2 M HCl eritmasi ta'sir ettirib, II analitik guruh kationlarini ajratish. $\text{Ag}^+ \xrightarrow{\text{HCl}} \text{AgCl} \downarrow$ $\text{Pb}^{2+} \xrightarrow{\text{HCl}} \text{PbCl}_2 \downarrow$ $\text{Hg}_2^{2+} \xrightarrow{\text{HCl}} \text{Hg}_2\text{Cl}_2 \downarrow$ HCl saqlagan cho'kmani suv bilan yuvish.
11	II analitik guruh kationlari aralashmasining analiz bosqichlari sxemasi bo'yicha 10 cho'kmani analiz qilish.
12	$\text{C}_2\text{H}_5\text{OH}$ ishtirokida qizdirib, H_2SO_4 eritmasi ta'sir ettirib, III analitik guruh kationlarini va Pb^{2+} ionlarini cho'ktirish: $\text{Ba}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \Delta} \text{BaSO}_4 \downarrow$ $\text{Sr}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \Delta} \text{SrSO}_4 \downarrow$ $\text{Ca}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \text{C}_2\text{H}_5\text{OH}, \Delta} \text{CaSO}_4 \downarrow$ $\text{Pb}^{2+} \xrightarrow{\text{H}_2\text{SO}_4, \Delta} \text{PbSO}_4 \downarrow$ H_2SO_4 saqlagan cho'kmani suv bilan yuvish.
13	30 %-li $\text{NH}_4\text{CH}_3\text{COO}$ eritmasi ta'sir ettirib, so'ng sentrifugalab, 12 cho'kmadan $\text{PbSO}_4 \downarrow$ ni ajratish: $\text{PbSO}_4 \downarrow \xrightarrow{\text{NH}_4\text{CH}_3\text{COO}} [\text{PbSO}_4 \cdot \text{Pb}(\text{CH}_3\text{COO})_2]$ 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 bos- qichlari sxemasi bo'yicha 13 cho'kmani analiz qilish.
15	3 % li H_2O_2 ishtirokida mo'l 6M NaOH eritmasi ta'sir ettirib, IV guruh kationlarini V, VI analitik guruh kationlaridan ajratish: $\text{Al}^{3+} \xrightarrow{\text{NaOH}} \text{Al(OH)}_3 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Al(OH)}_6]^{3-}$ $\text{Zn}^{2+} \xrightarrow{\text{NaOH}} \text{Zn(OH)}_2 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Zn(OH)}_4]^{2-}$ $\text{Cr}^{3+} \xrightarrow{\text{NaOH}} \text{Cr(OH)}_3 \downarrow \xrightarrow{\text{mo'l NaOH, H}_2\text{O}_2, \Delta} \text{CrO}_4^{2-}$ $\text{Sn}^{2+} \xrightarrow{\text{NaOH}} \text{Sn(OH)}_2 \downarrow \xrightarrow{\text{mo'l NaOH, H}_2\text{O}_2, \Delta} [\text{Sn(OH)}_6]^{2-}$ $\text{Sn(IV)} \xrightarrow{\text{NaOH}} \text{Sn(OH)}_4 \downarrow \xrightarrow{\text{mo'l NaOH}} [\text{Sn(OH)}_6]^{2-}$ $\text{As(III)} \xrightarrow{\text{NaOH}} \text{AsO}_3^{3-} \xrightarrow{\text{H}_2\text{O}_2, \Delta} \text{AsO}_4^{3-}$ $\text{As(V)} \xrightarrow{\text{NaOH}} \text{AsO}_4^{3-} \xrightarrow{\text{H}_2\text{O}_2, \Delta} \text{AsO}_4^{3-}$ Bunda V, VI analitik guruh kationlari cho'kmalar hosil qiladilar: Fe(OH)_3, Mg(OH)_3, $\text{MnO}_2 \cdot n\text{H}_2\text{O}$, BiOCl, SbO_2Cl, Cu(OH)_2, HgO, Ni(OH)_2, Co(OH)_3.
16	15 sentrifugatning alohida ulushiga HCl muhitida ruh metali ta'sir ettirib, As(V) ionlarini topish (topishga Sb(III), Sb(V) ionlari halaqit beradi): $\text{As (III), (V)} \xrightarrow{\text{Zn, HCl}} \text{AsH}_3 \uparrow$ $\text{AgNO}_3 \text{ bilan namlangan qog'oz} \xrightarrow{\text{AsH}_3 \uparrow} \text{Ag} \downarrow \text{ (qora)}$ (Gutsayt reaksiyasi) $[\text{HgCl}_2] \text{ bilan namlangan qog'oz} \xrightarrow{\text{AsH}_3 \uparrow} \begin{cases} \text{AsH}_2(\text{HgCl}) \downarrow \\ \text{AsH}(\text{HgCl})_2 \downarrow \\ \text{As}(\text{HgCl})_3 \downarrow \\ \text{As}_2\text{Hg}_3 \downarrow \end{cases}$ (Zanger-Blek reaksiyasi) (sarg'ish-qo'ng'ir)
17	Qizdirilganda NH_4Cl kristallari ta'sirida 15 sentrifugatdan $[\text{Al(OH)}_6]^{3-}$, $[\text{Sn(OH)}_6]^{2-}$ gidroksoanionlarni ajratish: $[\text{Al(OH)}_6]^{3-} \xrightarrow{\text{NH}_4\text{Cl}, \Delta} \text{Al(OH)}_3 \downarrow$ $[\text{Sn(OH)}_6]^{2-} \xrightarrow{\text{NH}_4\text{Cl}, \Delta} \text{Sn(OH)}_4 \downarrow$
18	2 M HCl ta'sirida 17 cho'kmani eritish:

	$\text{Al(OH)}_3 \downarrow \xrightarrow{\text{HCl}} \text{Al}^{3+}$ $\text{Sn(OH)}_4 \downarrow \xrightarrow{\text{HCl}} [\text{SnCl}_6]^{2-}$
19	18 sentrifugatga alizarin yoki natriy atsetat eritmaları ta'sir ettirib, Al^{3+} ionlarini topish:  $\text{Al}^{3+} \xrightarrow{\text{alizarin, NaOH}}$ $\text{Al}^{3+} \xrightarrow{\text{CH}_3\text{COONa}} \text{Al(OH)}_2\text{CH}_3\text{COO} \downarrow$
20	HCl muhitida temir qirindilari bilan qaynagan 18 eritmaga simob (II) tuzi eritmasi ta'sir ettirib, Sn(IV) ionlarini topish: $[\text{SnCl}_6]^{2-} \xrightarrow{\text{Fe, HCl, } \Delta} \text{Sn}^{2+} \xrightarrow{\text{HgCl}_2} \text{Hg} \downarrow$
21	17 sentrifugatga ditizon yoki $\text{K}_4[\text{Fe(CN)}_6]$ eritmasi ta'sir ettirib, Zn^{2+} kationlarini topish:  $[\text{Zn(NH}_3)_4]^{2+} \xrightarrow{\text{ditizon}}$ $[\text{Zn(NH}_3)_4] \xrightarrow{\text{K}_4[\text{Fe(CN)}_6]} \text{K}_2\text{Zn}_3[\text{Fe(CN)}_6]_2 \uparrow$
22	15 cho'kmaga H_2O_2 bilan HNO_3 ta'sir ettirib, Sb(V) ionlarini V, VI analitik guruhning boshqa kationlaridan ajratish: $\text{SbO}_2\text{Cl} \xrightarrow{\text{HNO}_3; \text{H}_2\text{O}_2} \text{HSbO}_3 \downarrow$ Bunda V, VI guruh kationlarining erimaydigan birikmalari quyidagi kationlarining qaytarilishi bilan eriydi: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow \xrightarrow{\text{HNO}_3; \text{H}_2\text{O}_2} \text{Mn}^{2+}$ $\text{Co(OH)}_2 \downarrow \xrightarrow{\text{HNO}_3; \text{H}_2\text{O}_2} \text{Co}^{2+}$
23	22 cho'kmani HCl eritmasida eritish: $\text{HSbO}_3 \downarrow \xrightarrow{\text{HCl}} [\text{SbCl}_6]^-$
24	23 eritmaga nikel plastinkasida rux metali ta'sir ettirib, Sb(V) ion-

	larini ajratish: $[\text{SbCl}_6]^- \xrightarrow{\text{Zn}} \text{Sb} \downarrow$
25	22 sentrifugatga konsentrlangan $\text{NH}_3 \cdot \text{H}_2\text{O}$ ta'sir ettirib, V analitik guruh kationlarini cho'ktirish: $\text{Mg}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Mg}(\text{OH})_2 \downarrow$ $\text{Mn}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Mn}(\text{OH})_2 \downarrow$ $\text{Fe}^{3+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{Fe}(\text{OH})_3 \downarrow$ $\text{Bi}^{3+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} \text{BiONO}_3 \downarrow$ Bunda VI analitik guruh kationlari ammiakatlar ko'rinishida eritma-da qoladi: $\text{Cu}(\text{OH})_2 \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Cu}(\text{NH}_3)_4]^{2+}$ $\text{HgO} \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Hg}(\text{NH}_3)_4]^{2+}$ $\text{Co}(\text{OH})_2 \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Co}(\text{NH}_3)_6]^{2+}$ $\text{Ni}(\text{OH})_2 \downarrow \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Ni}(\text{NH}_3)_6]^{2+}$
26	25 cho'kmaga $\text{NH}_4\text{Cl} + 3\% \text{ li } \text{H}_2\text{O}_2$ eritmasi ta'sir ettirib, Mg^{2+} kationlarini ajratish: $\text{Mg}(\text{OH})_2 \downarrow \xrightarrow{\text{NH}_4\text{Cl}} \text{Mg}^{2+}$ $\text{Mn}(\text{OH})_2 \downarrow \xrightarrow{3\% \text{ H}_2\text{O}_2} \text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$ Cho'kma tarkibi: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$, $\text{BiONO}_3 \downarrow$, $\text{Fe}(\text{OH})_3 \downarrow$
27	27 sentrifugatga ammiakli bufer eritma ishtirokida Na_2HPO_4 ta'sir ettirib, Mg^{2+} ionlarini topish: $\text{Mg}^{2+} \xrightarrow{\text{Na}_2\text{HPO}_4, \text{NH}_3 \cdot \text{H}_2\text{O} + \text{NH}_4\text{Cl}} \text{MgNH}_4\text{PO}_4 \downarrow$
28	26 cho'kmaga HNO_3 eritmasi ta'sir ettirib, Bi^{3+} kationlarini ajratish: $\text{BiONO}_3 \downarrow \xrightarrow{\text{HNO}_3} \text{Bi}^{3+}$ $\text{Fe}(\text{OH})_3 \downarrow \xrightarrow{\text{HNO}_3} \text{Fe}^{3+}$ Cho'kmada: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow$
29	28 bosqich bo'yicha olingan $\text{MnO}_2 \cdot n\text{H}_2\text{O}$ cho'kmani H_2O_2 ishtirokida HNO_3 eritmasi ta'sir ettirib eritish: $\text{MnO}_2 \cdot n\text{H}_2\text{O} \downarrow \xrightarrow{\text{HNO}_3; \text{H}_2\text{O}_2} \text{Mn}^{2+}$
30	29 eritmaga $(\text{NH}_4)_2\text{S}_2\text{O}_8$ ta'sir ettirib, Mn^{2+} ionlarini topish: $\text{Mn}^{2+} \xrightarrow{(\text{NH}_4)_2\text{S}_2\text{O}_8; \text{HNO}_3; \text{AgNO}_3} \text{MnO}_4^-$

31	28 sentrifugatga yangi tayyorlangan $\text{Na}_4[\text{Sn}(\text{OH})_6]$ ta'sir ettirib, Bi^{3+} ionlarini topish: $\text{Bi}^{3+} \xrightarrow{\text{Na}_4[\text{Sn}(\text{OH})_6]} \text{Bi} \downarrow$
32	2 M H_2SO_4 ta'sirida 25 eritmadagi ammiakatlarni parchalash
33	32 eritmaga $\text{Na}_2\text{S}_2\text{O}_3$ ta'sir ettirib, VI analitik guruhning boshqa kationlaridan Cu^{2+} va Hg^{2+} ionlarini ajratish: $\text{Cu}^{2+} \xrightarrow{\text{Na}_2\text{S}_2\text{O}_3, \Delta} \text{Cu}_2\text{S} \downarrow$ $\text{Hg}^{2+} \xrightarrow{\text{Na}_2\text{S}_2\text{O}_3, \Delta} \text{HgS} \downarrow$
34	Qizdirilganda suyultirilgan HNO_3 ta'sir ettirib, 33 cho'kmadan Cu_2S ni HgS dan ajratish: $\text{Cu}_2\text{S} \downarrow \xrightarrow{\text{HNO}_3; \Delta} \text{Cu}^{2+}$ Bu sharoitda $\text{HgS} \downarrow$ erimaydi.
35	34 sentrifugatga konsentrlangan $\text{NH}_3 \cdot \text{H}_2\text{O}$ ta'sir ettirib, Cu^{2+} ionlarini topish: $\text{Cu}^{2+} \xrightarrow{\text{NH}_3 \cdot \text{H}_2\text{O}} [\text{Cu}(\text{NH}_3)_4]^{2+}$
36	Qizdirilganda HCl ishtirokida bromli suv yoki zar suvi ta'sir ettirib, 34 cho'mani eritish: $\text{HgS} \downarrow \xrightarrow{\text{Br}_2; \text{HCl}} [\text{HgCl}_2] + \text{S} \downarrow$ $\text{HgS} \downarrow \xrightarrow{\text{kons HNO}_3; \text{kons HCl}} [\text{HgCl}_2]$
37	36 sentrifugatga SnCl_2 eritmasi ta'sir ettirib, Hg^{2+} ionlarini topish: $[\text{HgCl}_2] \xrightarrow{\text{SnCl}_2} \text{Hg} \downarrow$
38	33 sentrifugatga amil spirt ishtirokida NH_4SCN eritmasi ta'sir ettirib, Co^{2+} ionlarini topish: $\text{Co}^{2+} \xrightarrow{\text{NH}_4\text{SCN}} (\text{NH}_4)_2[\text{Co}(\text{SCN})_4]$
39	33 sentrifugatga Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, Ni^{2+} ionlarini topish: $\text{Ni} \xrightarrow{\text{dimetilglioksim}}$

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 guruhlarining boshqa kationlaridan ajratish
- 9 — Konsentrlangan $\text{NH}_3 \cdot \text{H}_2\text{O}$ eritmasi ta'sirida V va VI guruhlarini 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

**Ba²⁺ va Ag⁺ TUZLARINING TURLICH A ERUVCHANLIGIGA
ASOSLANGAN ANIONLARNING ANALITIK KLASSIFIKATSIYASI**

Analitik guruh	Anionlar	Guruh reagenti	Cho'kmalarning xossalari
I	SO ₄ ²⁻ , SO ₃ ²⁻ , S ₂ O ₃ ²⁻ , CO ₃ ²⁻ , AsO ₄ ³⁻ , AsO ₃ ³⁻ , C ₂ O ₄ ²⁻ , CrO ₄ ²⁻ , (Cr ₂ O ₇ ²⁻), SiO ₃ ²⁻ , BO ₂ ⁻ (B ₄ O ₇ ²⁻), F ⁻ , IO ₃ ⁻ , IO ₄ ⁻ , PO ₄ ³⁻ , C ₄ H ₄ O 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 ₆ H ₅ COO ⁻ , S ²⁻	AgNO ₃ , HNO ₃ da	Kumush tuzlarining cho'kmalari suvda va nitrat kislotada erimaydi.
III	NO ₃ ⁻ , NO ₂ ⁻ , CH ₃ COO ⁻ , ClO ₄ ⁻ , BrO ₃ ⁻	Mavjud emas	Bariy va kumush tuzlarining cho'kmalari suvda eriydi.

**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 ₂ O ₃ ²⁻	SO ₂	Yongan oltingugurt hidi
NO ₂ ⁻	NO ₂	Qizg'ish-qo'ng'ir bug'lar
S ²⁻ ; SO ₃ ²⁻ ; S ₂ O ₃ ²⁻	H ₂ S	Palag'da tuxum hidi
CH ₃ COO ⁻	CH ₃ COOH	Sirka hidi
Br ⁻	Br	Qizg'ish-qo'ng'ir bug'lar
Cl ⁻	HCl	Bo'g'uvchi gaz, AgNO ₃ erit-masining loyqalanishi.

ANIONLARNING OKSIDLANISH-QAYTARILISH XOSSASI BO'YICHA KLASSIFIKATSIIYASI

Oksidlovchi-anionlar	Qaytaruvchi-anionlar
$\text{Cr}_2\text{O}_7^{2-}; \text{AsO}_4^{3-}; \text{NO}_3^-; \text{IO}_4^-; \text{IO}_3^-$	$\text{Br}^-; \text{I}^-; \text{S}^{2-}; \text{C}_2\text{O}_4^{2-}; \text{AsO}_3^{3-}; \text{SO}_3^{2-}; \text{S}_2\text{O}_3^{2-}; \text{NO}_2^-$
<i>Eritmada mavjudligini aniqlash</i>	
KI ta 'sirida I_2 rangi paydo bo'ladi	I_2 yoki KMnO_4 ta 'sirida eritma rangsizlanadi
<i>Misolalar</i>	
$+ 2e + \text{AsO}_4^{3-} + 2\text{H}^+ \rightleftharpoons \text{AsO}_3 + \text{H}_2\text{O}$ $- 2e + 3\text{I}^- \rightleftharpoons [\text{I}_3]^-$	$- 2e + \text{SO}_3^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{SO}_4^{2-} + 2\text{H}^+$ $+ 2e + [\text{I}_3]^- \rightleftharpoons 3\text{I}^-$
$\text{AsO}_4^{3-} + 2\text{H}^+ + 3\text{I}^- \rightleftharpoons \text{AsO}_3^{3-} + \text{H}_2\text{O} + [\text{I}_3]^-$ (kons. HCl muhitida) $+ 6e + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ $- 2e + 3\text{I}^- \rightleftharpoons [\text{I}_2]$	$\text{SO}_3^{3-} + \text{H}_2\text{O} + [\text{I}_3]^- \rightleftharpoons \text{SO}_4^{2-} + 2\text{H}^+ + 3\text{I}^-$ $- 2e + \text{C}_2\text{O}_4^{2-} \rightleftharpoons 2\text{CO}_2 \uparrow$ $+ 5e + \text{MnO}_4^- + 8\text{H}^+ \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 9\text{I}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O} + 3[\text{I}_3]^-$	$5\text{C}_2\text{O}_4^{2-} + 2\text{MnO}_4^- + 16\text{H}^+ \rightleftharpoons 10\text{CO}_2 \uparrow + 2\text{Mn}^{2+} + 8\text{H}_2\text{O}$ $- 2e + \text{AsO}_3^{3-} + 2\text{OH}^- \rightleftharpoons \text{AsO}_4^{3-} + \text{H}_2\text{O}$ $+ 2e + [\text{I}_3]^- \rightleftharpoons 3\text{I}^-$
	$\text{AsO}_3^{3-} + 2\text{OH}^- + [\text{I}_3]^- \rightleftharpoons \text{AsO}_4^{3-} + 3\text{I}^- + \text{H}_2\text{O}$ (NaHCO ₃ muhitida)
	Kons. H_2SO_4 ta 'sirida I_2 va Br_2 ajraladi. $- 2e + 2\text{I}^- \rightleftharpoons \text{I}_2$ $+ 8e + \text{SO}_4^{2-} + 10\text{H}^+ \rightleftharpoons \text{H}_2\text{S} + 4\text{H}_2\text{O}$
	$8\text{I}^- + \text{SO}_4^{2-} + 10\text{H}^+ \rightleftharpoons 4\text{I}_2 \uparrow + \text{H}_2\text{S} \uparrow + 4\text{H}_2\text{O}$
	$- 2e + 2\text{Br}^- \rightleftharpoons \text{Br}_2$ $+ 2e + \text{SO}_4^{2-} + 4\text{H}^+ \rightleftharpoons \text{SO}_2 + \text{H}_2\text{O}$
	$2\text{Br}^- + \text{SO}_4^{2-} + 4\text{H}^+ \rightleftharpoons \text{Br}_2 + \text{SO}_2 + \text{H}_2\text{O}$

I ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
SO_4^{2-}	$\text{Pb}(\text{NO}_3)_2$	$\text{Na}_2\text{SO}_4 + \text{Pb}(\text{NO}_3)_2 = \text{PbSO}_4\downarrow + 2\text{NaNO}_3$ $\text{SO}_4^{2-} + \text{Pb}^{2+} = \text{PbSO}_4\downarrow$	Oq cho'kma, ishqorlarda eriydi
	SrCl_2	$\text{Na}_2\text{SO}_4 + \text{SrCl}_2 = \text{SrSO}_4\downarrow + 2\text{NaCl}$ $\text{SO}_4^{2-} + \text{Sr}^{2+} = \text{SrSO}_4\downarrow$	Oq cho'kma (joyqa), kislotalarda deyarli erimaydi
	HCl	$\text{Na}_2\text{SO}_3 + 2\text{HCl} = 2\text{NaCl} + \text{SO}_2\uparrow + \text{H}_2\text{O}$ $\text{SO}_3^{2-} + 2\text{H}^+ = \text{SO}_2\uparrow + \text{H}_2\text{O}$	$\text{SO}_2\uparrow$ ajraladi
SO_3^{2-}	$\text{I}_2 + \text{H}_2\text{O}$	$\text{Na}_2\text{SO}_3 + \text{I}_2 + \text{H}_2\text{O} = \text{Na}_2\text{SO}_4 + 2\text{HI}$ $\text{SO}_3^{2-} + \text{I}_2 + \text{H}_2\text{O} = \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{I}^-$	Yodli suv eritmasi rangsizlanadi
	SrCl_2	$\text{Na}_2\text{SO}_3 + \text{SrCl}_2 = \text{SrSO}_3\downarrow + 2\text{NaCl}$ $\text{SO}_3^{2-} + \text{Sr}^{2+} = \text{SrSO}_3\downarrow$	Oq cho'kma, kislotalarda eriydi
$\text{S}_2\text{O}_3^{2-}$	HCl	$\text{Na}_2\text{S}_2\text{O}_3 + 2\text{HCl} = \text{H}_2\text{S}_2\text{O}_3 + 2\text{NaCl}$ $\text{H}_2\text{S}_2\text{O}_3 = \text{S}\downarrow + \text{SO}_2\uparrow + \text{H}_2\text{O}$	Reaksiya natijasida hosil bo'lgan S $\downarrow$ eritmani joyqalantiradi
	I_2	$2\text{Na}_2\text{S}_2\text{O}_3 + \text{I}_2 = 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$ $2\text{S}_2\text{O}_3^{2-} + \text{I}_2 = 2\text{I}^- + \text{S}_4\text{O}_6^{2-}$	I_2 eritmasi rangsizlanadi

* Guruh reagenti BaCl_2 (yoki $\text{Ba}(\text{NO}_3)_2$) ta'sirida birinchi analitik guruh anionlarining barchasi cho'kмага tushadi

$S_2O_3^{2-}$	$AgNO_3$	$Na_2S_2O_3 + 2AgNO_3 = Ag_2S_2O_3 \downarrow + 2NaNO_3$ $S_2O_3^{2-} + 2Ag^+ = Ag_2S_2O_3 \downarrow$ $Ag_2S_2O_3 + H_2O = Ag_2S \downarrow + 2H^+ + SO_4^{2-}$	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.
	$(NH_4)_2MoO_4$	$Na_3PO_4 + 3NH_4Cl + 12(NH_4)_2MoO_4 + 24HNO_3 =$ $= 12(NH_4)_3[PMo_{12}O_{40}] + 12H_2O + 24NH_4NO_3 + 3NaCl$ $PO_4^{3-} + 12MoO_4^{2-} + 24H^+ = (NH_4)_3[PMo_{12}O_{40}] \downarrow + 12H_2O$	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 kiribadi

F ⁻	CaCl ₂	$2\text{NaF} + \text{CaCl}_2 = \text{CaF}_2\downarrow + 2\text{NaCl}$ $2\text{F}^- + \text{Ca}^{2+} = \text{CaF}_2\downarrow$	Oq cho'kma, kislotalarda qiyin eriydi
	SiO ₂	$\text{SiO}_2 + 4\text{HF} = \text{SiF}_4\uparrow + 2\text{H}_2\text{O}$ $\text{SiF}_4 + 4\text{H}_2\text{O} = \text{H}_4\text{SiO}_4 + 4\text{HF}\uparrow$	Ortosilikat kislotalarining hosil bo'lishi sababli suv loyqalanadi
SiO ₃ ²⁻	AgNO ₃	$\text{Na}_2\text{SiO}_3 + 2\text{AgNO}_3 = \text{Ag}_2\text{SiO}_3\downarrow + 2\text{NaNO}_3$ $\text{SiO}_3^{2-} + 2\text{Ag}^+ = \text{Ag}_2\text{SiO}_3\downarrow$	Sariq cho'kma, nitrat kislotalarda eriydi
	Suyultirilgan kislotalar	$\text{SiO}_3^{2-} + \text{H}_2\text{SO}_4 + \text{H}_2\text{O} = m\text{SiO}_2 \cdot n\text{H}_2\text{O}\downarrow + \text{SO}_4^{2-}$	Silikat kislotalar oq iviq cho'kma (gel) holida cho'kadi
	Ammoniy tuzlari	$\text{SiO}_3^{2-} + 2\text{H}_2\text{O} + 2\text{NH}_4^+ = \text{H}_2\text{SiO}_3\downarrow + 2\text{NH}_4\text{OH}$	Qizdirilganda oq iviq cho'kma hosil bo'ladi
C ₂ O ₄ ²⁻	CaCl ₂	$\text{Na}_2\text{C}_2\text{O}_4 + \text{CaCl}_2 = \text{CaC}_2\text{O}_4\downarrow + 2\text{NaCl}$ $\text{C}_2\text{O}_4^{2-} + \text{Ca}^{2+} = \text{CaC}_2\text{O}_4\downarrow$	Oq cho'kma, mineral kislotalarda eriydi, lekin sirka kislotalarda erimaydi.
	AgNO ₃	$\text{Na}_2\text{C}_2\text{O}_4 + 2\text{AgNO}_3 = \text{Ag}_2\text{C}_2\text{O}_4\downarrow + 2\text{NaNO}_3$ $\text{C}_2\text{O}_4^{2-} + 2\text{Ag}^+ = \text{Ag}_2\text{C}_2\text{O}_4\downarrow$	Oq iviq cho'kma HNO ₃ va NH ₄ OH da eriydi
	KMnO ₄	$5\text{Na}_2\text{C}_2\text{O}_4 + 2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 = 2\text{MnSO}_4 + 5\text{Na}_2\text{SO}_4 + \text{K}_2\text{SO}_4 + 10\text{CO}_2 + 8\text{H}_2\text{O}$ $5\text{C}_2\text{O}_4^{2-} + 2\text{MnO}_4^- + 16\text{H}^+ = 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O}$	Eritma rangsizlanadi
	H ₂ SO ₄	$\text{H}_2\text{C}_2\text{O}_4 \xrightarrow{\text{kons. H}_2\text{SO}_4} \text{H}_2\text{O} + \text{CO}_2\uparrow + \text{CO}\uparrow$	CO yoqilganda ko'k alanga hosil qilib yonadi

CrO_4^{2-} $\text{Cr}_2\text{O}_7^{2-}$	$\text{Pb}(\text{NO}_3)_2$	$\text{K}_2\text{CrO}_4 + \text{Pb}(\text{NO}_3)_2 = \text{PbCrO}_4\downarrow + 2\text{KNO}_3$ $\text{CrO}_4^{2-} + \text{Pb}^{2+} = \text{PbCrO}_4\downarrow$	Sariq rangli cho'kma
	AgNO_3	$\text{K}_2\text{CrO}_4 + 2\text{AgNO}_3 = \text{Ag}_2\text{CrO}_4\downarrow + 2\text{KNO}_3$ $\text{CrO}_4^{2-} + 2\text{Ag}^+ = \text{Ag}_2\text{CrO}_4\downarrow$	Qizil-g'isht rangli cho'kma
	H_2O_2	$\text{K}_2\text{Cr}_2\text{O}_7 + 4\text{H}_2\text{O}_2 + \text{H}_2\text{SO}_4 = 2\text{H}_2\text{CrO}_4 + 3\text{H}_2\text{O} + \text{K}_2\text{SO}_4$ $\text{Cr}_2\text{O}_7^{2-} + 4\text{H}_2\text{O}_2 + 2\text{H}^+ = 2\text{H}_2\text{CrO}_4 + 3\text{H}_2\text{O}$	Ko'k rangli eritma, perxromat kislotaning parchalanishi sababli eritma tezda yashil rangga o'tadi
	Qaytaruvchilar $\text{Na}_2\text{SO}_3, \text{H}_2\text{S}$	$\text{K}_2\text{Cr}_2\text{O}_7 + 3\text{Na}_2\text{SO}_3 + 4\text{H}_2\text{SO}_4 = \text{Cr}_2(\text{SO}_4)_3 + 3\text{Na}_2\text{SO}_4 + \text{K}_2\text{SO}_4 + 4\text{H}_2\text{O}$ $\text{Cr}_2\text{O}_7^{2-} + 3\text{SO}_3^{2-} + 8\text{H}^+ = 2\text{Cr}^{3+} + 3\text{SO}_4^{2-} + 4\text{H}_2\text{O}$	Eritma rangsizlanadi

II ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Ilova
Cl ⁻	H ₂ SO ₄ (kons.)	$\text{NaCl} + \text{H}_2\text{SO}_4 = \text{NaHSO}_4 + \text{HCl} \uparrow$	Quruq holdagi xloridlardan gaz holatdagi HCl ajraladi, ho'llan-gan ko'k lakmus qizaradi
	KMnO ₄ (kris.)	$16\text{HCl} + 2\text{KMnO}_4 = 2\text{MnCl}_2 + 2\text{KCl} + 5\text{Cl}_2 \uparrow + 8\text{H}_2\text{O}$ $16\text{HCl} + 2\text{MnO}_4^{2-} = 2\text{Mn}^{2+} + 6\text{Cl}^- + 5\text{Cl}_2 \uparrow + 4\text{H}_2\text{O}$	Erkin xlor ajraladi, yodokratsmal qog'ozi ko'karadi
Br ⁻	H ₂ SO ₄ (kons.)	$\text{KBr} + \text{H}_2\text{SO}_4 = \text{KHSO}_4 + \text{HBr} \uparrow$	Quruq bromidlardan HBr gaz holatda ajralib chiqadi
	Oksidlovchilar (KMnO ₄ , PbO ₂ , KClO ₃)	$2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 + 10\text{KBr} = 6\text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{Br}_2 + 8\text{H}_2\text{O}$ $2\text{MnO}_4^{2-} + 8\text{H}^+ + 10\text{Br}^- = 2\text{Mn}^{2+} + 5\text{Br}_2 + 8\text{H}_2\text{O}$	Erkin Br ₂ ajralib chiqishi sababli eritma qo'ng'ir tusga kiradi
I ⁻	Pb(NO ₃) ₂	$2\text{KI} + \text{Pb}(\text{NO}_3)_2 = \text{PbI}_2 \downarrow + 2\text{KNO}_3$ $2\text{I}^- + \text{Pb}^{2+} = \text{PbI}_2 \downarrow$	Tillarang kristall cho'kma
	H ₂ SO ₄ (kons.)	$8\text{HI} + \text{H}_2\text{SO}_4 = \text{H}_2\text{S} \uparrow + 4\text{I}_2 \downarrow + 4\text{H}_2\text{O}$ $8\text{I}^- + \text{SO}_4^{2-} + 10\text{H}^+ = \text{H}_2\text{S} \uparrow + 4\text{I}_2 \downarrow + 4\text{H}_2\text{O}$	Hosil bo'lgan I ₂ eritmani qo'n-g'ir rangga bo'yaydi
S ²⁻	Kislotalar (H ₂ SO ₄ , HCl)	$\text{Na}_2\text{S} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + \text{H}_2\text{S} \uparrow$ $\text{FeS} + 2\text{HCl} = \text{FeCl}_2 + \text{H}_2\text{S} \uparrow$	Ajralib chiqayotgan H ₂ S ni bad-bo'y hididan bilish mumkin

* Guruh reagenti AgNO₃ ta'sirida ikkinchi anionlik guruh anionlarining barchasi cho'kmaga tushadi

	CdCl_2	$\text{CdCl}_2 + \text{H}_2\text{S} = \text{CdS} \downarrow + 2\text{HCl}$ $\text{Cd}^{2+} + \text{S}^{2-} = \text{CdS} \downarrow$	pH $\geq 0,5$; sariq cho'kma, kislotalarda eriydi
	Oksidlovchilar	$3\text{Na}_2\text{S} + \text{K}_2\text{Cr}_2\text{O}_7 + 7\text{H}_2\text{SO}_4 = 3\text{S} \downarrow + \text{Cr}_2(\text{SO}_4)_3 + \text{K}_2\text{SO}_4 + 3\text{Na}_2\text{SO}_4 + 7\text{H}_2\text{O}$ $3\text{S}^{2-} + \text{Cr}_2\text{O}_7^{2-} + 7\text{H}^+ = 3\text{S} \downarrow + 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	Oltinugurtning ajralishidan eritma loyqalanadi
	$\text{Hg}(\text{NO}_3)_2$	$2\text{NH}_4\text{SCN} + \text{Hg}(\text{NO}_3)_2 = \text{Hg}(\text{SCN})_2 + 2\text{NH}_4\text{NO}_3$ $2\text{SCN}^- + \text{Hg}^{2+} = \text{Hg}(\text{SCN})_2 \downarrow$ $\text{Hg}(\text{SCN})_2 \downarrow + 2\text{SCN}^- = [\text{Hg}(\text{SCN})_4]^{2-}$	Ortiqcha reagentda kompleks birlikma hosil qilib eriydigan oq cho'kma
SCN^-	FeCl_3	$3\text{NH}_4\text{SCN} + \text{FeCl}_3 = [\text{Fe}(\text{SCN})_3] + 3\text{NHCl}$ $3\text{SCN}^- + \text{Fe}^{3+} = [\text{Fe}(\text{SCN})_3]$	Reagentning konsentratsiyasiga qarab sarg'ishdan qizil-qo'ng'ir-gacha eritma hosil bo'ladi
	Oksidlovchilar (KMnO_4 , HNO_3)	$6\text{KMnO}_4 + 5\text{HSCN} + 4\text{H}_2\text{SO}_4 = 6\text{MnSO}_4 + 5\text{HCN} \uparrow + 3\text{K}_2\text{SO}_4 + 4\text{H}_2\text{O}$ $6\text{MnO}_4^- + 5\text{SCN}^- + 13\text{H}^+ = 6\text{Mn}^{2+} + 5\text{HCN} \uparrow + 5\text{SO}_4^{2-} + 4\text{H}_2\text{O}$	Permanganat eritmasi rangsizlanadi. Tajribani juda oz miqdordagi (1-2 tomchi) rodanid eritmasi bilan mo'rili shaklda olib borish kerak, chunki HCN bug'lari nihoyatda zaharli!
CN^-	ZnCl_2 , $\text{Pb}(\text{NO}_3)_2$	$\text{ZnCl}_2 + 2\text{KCN} = \text{Zn}(\text{CN})_2 \downarrow + 2\text{KCl}$ $\text{Zn}(\text{CN})_2 \downarrow + 2\text{KCN} = \text{K}_2[\text{Zn}(\text{CN})_4]$	Oq cho'kma, ortiqcha KCN da kompleks birlikma hosil qilib eriydi
	Suyultirilgan mineral kislotalar	$\text{KCN} + \text{H}_2\text{SO}_4 = \text{K}_2\text{SO}_4 + \text{HCN} \uparrow$	Mo'rili shaklda bajariladi!

III ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI

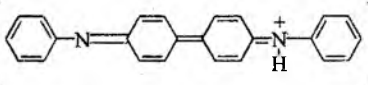
Ion	Reagent	Reaksiyalarning molekulyar va ionli tenglamalari	Illova
CH_3COO^-	H_2SO_4	$2\text{CH}_3\text{COONa} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{CH}_3\text{COOH}\uparrow$ $2\text{CH}_3\text{COO}^- + 2\text{H}^+ \rightarrow 2\text{CH}_3\text{COOH}\uparrow$	Eritma qizdirilganda CH_3COOH ajralib chiqadi, uni hididan bilish mumkin
	FeCl_3	$3\text{CH}_3\text{COONa} + \text{FeCl}_3 \rightarrow [(\text{CH}_3\text{COO})_3\text{Fe}]\downarrow + 3\text{NaCl}$ $[(\text{CH}_3\text{COO})_3\text{Fe}]\downarrow \xrightarrow{\text{H}_2\text{O}, \text{I}} [\text{Fe}_2(\text{CH}_3\text{COO})_6(\text{OH})_2]\text{OH}$	Qizil-qo'ng'ir cho'kma, suv bilan qizdirilganda asosli tuz cho'kmaga tushadi
	$\text{H}_2\text{SO}_4 + \text{C}_2\text{H}_5\text{OH}$	$2\text{CH}_3\text{COONa} + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{CH}_3\text{COOH}$ $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} = \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$	Xarakterli xushbo'y hidga ega bo'lgan etilatsetat hosil bo'ladi
NO_3^-	Difenilamin		NO_3^- ta'sirida difenilamin ko'k rangga kiradi
	Cu	$4\text{HNO}_3 + \text{Cu} = \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2\uparrow + 2\text{H}_2\text{O}$ $4\text{H}^+ + 2\text{NO}_3^- + \text{Cu} = \text{Cu}^{2+} + 2\text{NO}_2\uparrow + 2\text{H}_2\text{O}$	Qo'ng'ir gaz ajralib chiqadi, probirka oq qog'oz ustiga qo'yib qaralsa, gaz ajralgani oson seziladi
	$\text{Cu} + \text{H}_2\text{SO}_4$	$8\text{NaNO}_3 + 3\text{Cu} + 4\text{H}_2\text{SO}_4 = 2\text{NO}\uparrow + 3\text{Cu}(\text{NO}_3)_2 + 4\text{Na}_2\text{SO}_4 + 4\text{H}_2\text{O}$ $2\text{NO}_3^- + 3\text{Cu} + 8\text{H}^+ = 2\text{NO}\uparrow + 3\text{Cu}^{2+} + 4\text{H}_2\text{O}$ $2\text{NO}\uparrow + \text{O}_2 = 2\text{NO}_2\uparrow$	
	$\text{Al (Zn)} + \text{NaOH}$	$3\text{NaNO}_3 + 8\text{Al} + 5\text{NaOH} + 2\text{H}_2\text{O} = 8\text{NaAlO}_2 + 3\text{NH}_3\uparrow$ $3\text{NO}_3^- + 8\text{Al} + 5\text{OH}^- + 2\text{H}_2\text{O} = 8\text{AlO}_2^- + \text{NH}_3\uparrow$	Ajralib chiqayotgan NH_3 indikator qog'ozini ko'kurtiradi

NO_3^-	FeSO_4 (kris.)	$6\text{FeSO}_4 + 2\text{NaNO}_2 + 4\text{H}_2\text{SO}_4 = 3\text{Fe}_2(\text{SO}_4)_3 + 2\text{NO} + 2\text{Na}_2\text{SO}_4 + 4\text{H}_2\text{O}$ $6\text{Fe}^{2+} + 2\text{NO}_3^- + 8\text{H}^+ = 6\text{Fe}^{3+} + 2\text{NO} + 4\text{H}_2\text{O}$ $\text{NO} + \text{Fe}^{2+} + \text{SO}_4^{2-} = [\text{Fe}(\text{NO})\text{SO}_4]$	Temir (II)-sulfat kristali atrofida qo'ng'ir xalqa vujudga keladi
NO_2^-	Kislotalar	$2\text{NaNO}_2 + 2\text{H}_2\text{SO}_4 = 2\text{HNO}_2 + \text{Na}_2\text{SO}_4$ $2\text{HNO}_2 \rightarrow \text{NO}_2\uparrow + \text{NO}\uparrow + \text{H}_2\text{O}$	Qo'ng'ir rangli gazlar aralashmasi hosil bo'ladi
	KMnO_4	$5\text{NaNO}_2 + 2\text{KMnO}_4 + 3\text{H}_2\text{SO}_4 = \text{NaNO}_3 + 2\text{MnSO}_4 + \text{K}_2\text{SO}_4 + 3\text{H}_2\text{O}$ $5\text{NO}_2^- + 2\text{MnO}_4^- + 6\text{H}^+ = 5\text{NO}_3^- + 2\text{Mn}^{2+} + 3\text{H}_2\text{O}$	KMnO_4 eritmasi rangsizlanadi
	NH_4Cl (kris.), l°	$\text{NH}_4\text{Cl} + \text{NaNO}_2 = \text{N}_2\uparrow + \text{NaCl} + 2\text{H}_2\text{O}$	Erkin azot ajralib chiqadi
	Antipirin	$\text{NO}_2^- \xrightarrow[\text{H}^+]{\text{antipirin}} \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{NO} \\ \quad \quad \\ \text{H}_3\text{C}-\text{N} \quad \quad \text{C}=\text{O} \\ \quad \quad \quad \\ \quad \quad \quad \text{N} \\ \quad \quad \quad \\ \quad \quad \quad \text{C}_6\text{H}_5 \end{array}$	Yashil rangli azobo'yoq hosil bo'ladi

**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)	$\text{BaSO}_4\downarrow$ (oq cho‘kma, kislotalar va ishqor-larda erimaydi)
	Sr^{2+} (mineral kislotalar muhitida)	$\text{SrSO}_4\downarrow$ (oq cho‘kma, kislotalarda erimaydi)
SO_3^{2-}	H^+	$\text{SO}_2\uparrow$ (hid)
	$[\text{I}_3]^-$	I^- (yod eritmasi rangsizlanadi)
$\text{S}_2\text{O}_3^{2-}$	H^+	$\text{SO}_2\uparrow$ (hid) + $\text{S}\downarrow$ (oq cho‘kma)
	$[\text{I}_3]^-$	I^- (yod eritmasi rangsizlanadi)
	Ag^+ mo‘l	$\text{Ag}_2\text{S}_2\text{O}_3\downarrow$ (oq cho‘kma, parchalanganda qo-rayadi $\text{Ag}_2\text{S}\downarrow$)
CO_3^{2-}	H^+	$\text{CO}_2\uparrow$
	Mg^{2+}	$\text{MgCO}_3\downarrow$ (oq cho‘kma)
	Fenolftalein	Qizil
HCO_3^-	Mg^{2+} (qaynatilganda)	$\text{MgCO}_3\downarrow$ (oq cho‘kma) + $\text{CO}_2\uparrow$
	Fenolftalein	Ranglanmaydi
PO_4^{3-}	$\text{MgCl}_2 + \text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$ (magnezial alaralashma)	$\text{MgNH}_4\text{PO}_4\downarrow$ (oq cho‘kma)
	Ag^+	$\text{Ag}_3\text{PO}_4\downarrow$ (sariq cho‘kma, HNO_3 ; NH_4OH da eriydi)

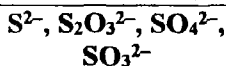
$C_2O_4^{2-}$	Ca^{2+}	$CaC_2O_4 \downarrow$ (oq cho'kma, sirka kis'lotada eri-maydi)
	MnO_4^- (H_2SO_4 muhitida)	$CO_2 \uparrow$ ($KMnO_4$ eritmasi rangsizlanadi)
AsO_4^{3-}	$MgCl_2 + NH_4OH + NH_4Cl$ (magnezial aralashma)	$MgNH_4AsO_4 \downarrow$ (oq cho'kma)
	Ag^+	$Ag_3AsO_4 \downarrow$ (jigarang, HNO_3 va NH_4OH da eriydi)
	I^- ($CHCl_3$ ishtirokida muhitida) HCl	$[I_3]^-$ – xloroformli qatlamning qizg'ish-bi-nafsha rangi
AsO_3^{3-}	S^{2-}	$As_2S_3 \downarrow$ (sariq cho'kma, kons HCl da eri-maydi, 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 muhitida) HCl	$[I_3]^-$ – xloroformli qatlamning qizg'ish-bi-nafsha 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'yay-di.
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 muhitida) kislotali	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.
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 mu-hitida)	$[Fe(NO)]SO_4$ (qo'ng'ir xalqa)
	Difenilamin	 $\cdot H_2SO_4$ (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)

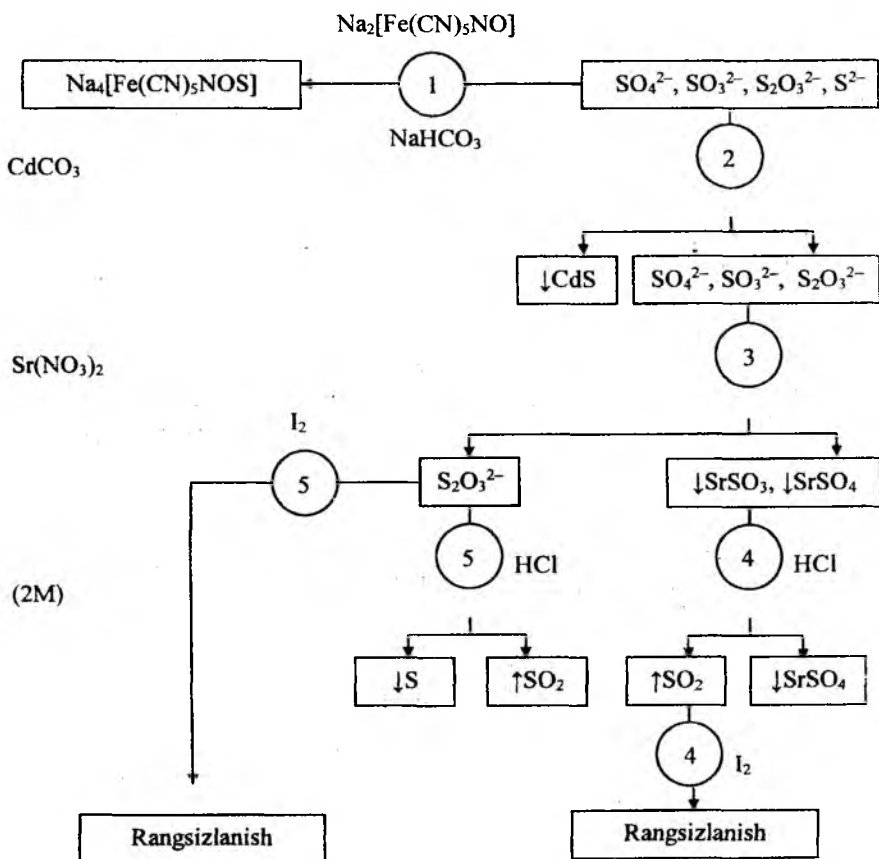
II – VI ANALITIK GURUH KATIONLARINING SODA ERITMASI BILAN REAKSIYALARI

Analitik guruh	Reaksiyalarning tenglamalari
II	$2\text{Ag}^+ + \text{CO}_3^{2-} \leftrightarrow \text{Ag}_2\text{CO}_3\downarrow \xrightarrow{\Delta} \text{Ag}_2\text{O}\downarrow + \text{CO}_2\uparrow$ $2\text{Pb}^{2+} + 2\text{CO}_3^{2-} + \text{H}_2\text{O} \rightarrow (\text{PbOH})_2\text{CO}_3\downarrow + \text{CO}_2\uparrow$ $\text{Hg}_2^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{Hg}_2\text{CO}_3\downarrow \leftrightarrow \text{HgO}\downarrow + \text{Hg}\downarrow + \text{CO}_2\uparrow$
III	$\text{Ba}^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{BaCO}_3\downarrow$ $\text{Sr}^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{SrCO}_3\downarrow$ $\text{Ca}^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{CaCO}_3\downarrow$
IV	$2\text{Al}^{3+} + 3\text{CO}_3^{2-} + 3\text{H}_2\text{O} \rightarrow 2\text{Al}(\text{OH})_3\downarrow + 3\text{CO}_2\uparrow$ $\text{Al}(\text{OH})_3\downarrow + 3\text{OH}^- \rightarrow [\text{Al}(\text{OH})_6]^{3-}$ $2\text{Cr}^{3+} + 3\text{CO}_3^{2-} + 3\text{H}_2\text{O} \leftrightarrow 2\text{Cr}(\text{OH})_3\downarrow + 3\text{CO}_2\uparrow$ $\text{Cr}(\text{OH})_3\downarrow + 3\text{OH}^- \rightarrow [\text{Cr}(\text{OH})_6]^{3-}$ $\text{Sn}^{2+} + \text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow \text{Sn}(\text{OH})_2\downarrow + \text{CO}_2\uparrow$ $\text{Sn}(\text{OH})_2\downarrow + 4\text{OH}^- \rightarrow [\text{Sn}(\text{OH})_6]^{4-}$ $[\text{SnCl}_6]^{2-} + \text{CO}_3^{2-} + 2\text{H}_2\text{O} \rightarrow \text{Sn}(\text{OH})_4\downarrow + 2\text{CO}_2\uparrow + 6\text{Cl}^-$ $\text{Sn}(\text{OH})_4\downarrow + 2\text{OH}^- \rightarrow [\text{Sn}(\text{OH})_6]^{2-}$ $\text{Zn}^{2+} + \text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow \text{Zn}(\text{OH})_2\downarrow + \text{CO}_2\uparrow$ $\text{Zn}(\text{OH})_2\downarrow + 2\text{OH}^- \rightarrow [\text{Zn}(\text{OH})_4]^{2-}$
V	$\text{Fe}^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{FeCO}_3\downarrow \text{ havoda tez qo'ng'irlashadi va quyi-dagi tenglama bo'yicha } \text{Fe}(\text{OH})_3 \text{ hosil bo'ladi:}$ $4\text{FeCO}_3\downarrow + 6\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{Fe}(\text{OH})_3\downarrow + 4\text{CO}_2\uparrow$ $2\text{Fe}^{3+} + 3\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow 2\text{Fe}(\text{OH})_3\downarrow + 3\text{CO}_2\uparrow$ $\text{Mn}^{2+} + \text{CO}_3^{2-} \leftrightarrow \text{MnCO}_3\downarrow$ $2\text{Mg}^{2+} + 2\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow (\text{MgOH})_2\text{CO}_3\downarrow + \text{CO}_2\uparrow$ $2\text{Bi}^{3+} + 3\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow 2\text{BiOHCO}_3\downarrow + \text{CO}_2\uparrow$ $2[\text{SbCl}_6]^{3-} + 3\text{CO}_3^{2-} + 3\text{H}_2\text{O} \leftrightarrow 2\text{Sb}(\text{OH})_3\downarrow + \text{CO}_2\uparrow + 12\text{Cl}^-$ $[\text{SbCl}_6]^- + 3\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow \text{HSbO}_3\downarrow + 2\text{CO}_2\uparrow + 6\text{Cl}^- + \text{HCO}_3^-$
VI	$2\text{Co}^{2+} + 2\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow (\text{CoOH})_2\text{CO}_3\downarrow + \text{CO}_2\uparrow$ $\text{Ni}^{2+} + \text{CO}_3^{2-} \rightarrow \text{NiCO}_3\downarrow$ $2\text{Cu}^{2+} + 2\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow (\text{CuOH})_2\text{CO}_3\downarrow + \text{CO}_2\uparrow$ $2\text{Hg}^{2+} + 2\text{CO}_3^{2-} + \text{H}_2\text{O} \leftrightarrow (\text{HgOH})_2\text{CO}_3\downarrow + \text{CO}_2\uparrow$ $(\text{HgOH})_2\text{CO}_3\downarrow \leftrightarrow 2\text{HgO}\downarrow + \text{CO}_2\uparrow + \text{H}_2\text{O}$

**OLTINGUGURT SAQLAGAN ANIONLAR ARALASHMASINING
SISTEMATIK ANALIZ BOSQICHLARI**



Bosqich n g t/r	Analiz bosqichlari
1	Boshlang'ich eritmaning alohida ulushiga kuchsiz ishqoriy muhitda $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$ ta'sir ettirib, S^{2-} ionlarini topish: $\text{S}^{2-} \xrightarrow{\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]} \text{Na}_2[\text{Fe}(\text{CN})_5\text{NOS}]^{4-}$ 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: $\text{S}^{2-} \xrightarrow{\text{CdCO}_3} \text{CdS} \downarrow$ $\text{CdS} \downarrow$ cho'kmasi sentrifugalab ajratiladi
3	2 sentrifugatga stronsiy tuzlarining eritmasini ta'sir ettirib $\text{S}_2\text{O}_3^{2-}$ va SO_3^{2-}, SO_4^{2-} ionlarini ajratish: $\text{SO}_3^{2-} \xrightarrow{\text{SrNO}_3} \text{SrSO}_3 \downarrow$ $\text{SO}_4^{2-} \xrightarrow{\text{SrNO}_3} \text{SrSO}_4 \downarrow$ 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: $\text{SrSO}_3 \downarrow \xrightarrow{\text{HCl}} \text{SO}_2 \uparrow$ Yod eritmasi ta'sir ettirib, SO_3^{2-} ionlarini aniqlash: $\text{SO}_2 \uparrow \xrightarrow{\text{I}_2; \text{HCl}} \text{SO}_4^{2-}$ 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, $\text{S}_2\text{O}_3^{2-}$ ionlarini topish: $\text{S}_2\text{O}_3^{2-} \xrightarrow{\text{HCl}} \text{S} \downarrow$ $\text{S}_2\text{O}_3^{2-} \xrightarrow{\text{I}_2; \text{HCl}} \text{yod eritmasi rangsizlanadi}$

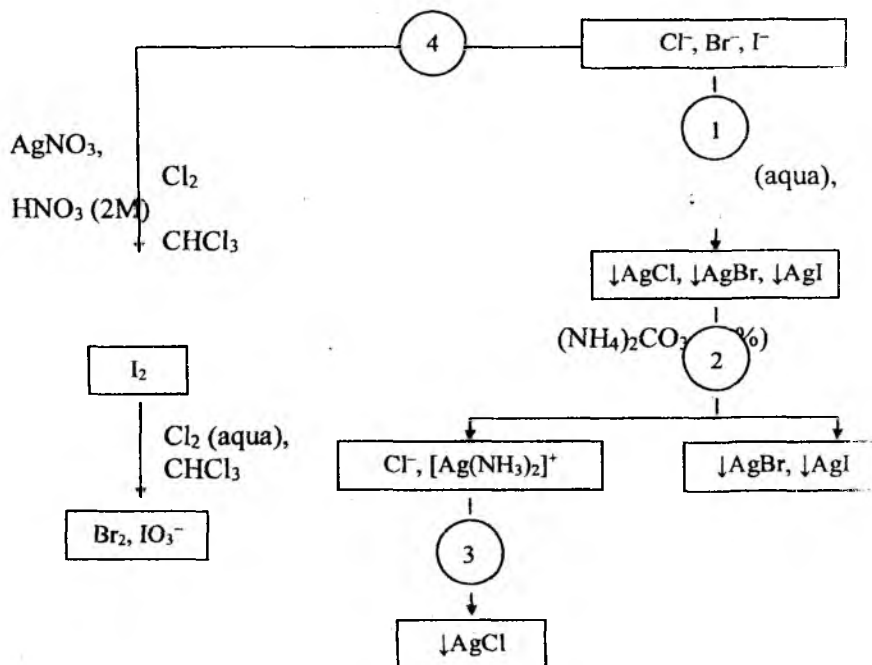
SO_4^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, S^{2-} ARALASHMASINING ANALIZ SXEMASI


**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'ktirish: $\text{Cl}^- \xrightarrow{\text{AgNO}_3, \text{HNO}_3} \text{AgCl} \downarrow$ $\text{Br}^- \xrightarrow{\text{AgNO}_3, \text{HNO}_3} \text{AgBr} \downarrow$ $\text{I}^- \xrightarrow{\text{AgNO}_3, \text{HNO}_3} \text{AgI} \downarrow$ Sentrifugalab cho'kma ajratiladi. Sentrifugat analiz qilinmaydi.
2	1 cho'kmaga 12% li $(\text{NH}_4)_2\text{CO}_3$ eritmasi ta'sir ettirib, Cl^- ionlarini ajratish: $\text{AgCl} \downarrow \xrightarrow{(\text{NH}_4)_2\text{CO}_3, 12\%} [\text{Ag}(\text{NH}_3)_2]^+, \text{Cl}^-$ Sentrifugalab AgBr, AgI cho'kma ajratiladi va analiz qilinmaydi.
3	2 sentrifugatga HNO_3 eritmasi ta'sir ettirib, Cl^- ionlarini topish: $[\text{Ag}(\text{NH}_3)_2]^+, \text{Cl}^- \xrightarrow{\text{HNO}_3} \text{AgCl} \downarrow$
4	Boshlang'ich eritmaning alohida ulushiga xloroform ishtirokida xlorli suv ta'sir ettirib, I^- va Br^- ionlarini topish: $\text{I}^- \xrightarrow{\text{Cl}_2} \text{I}_2 \text{ (xloroformli qatlam qizg'ish-binafsha rangga bo'yaladi)}$ $\text{Br}^- \xrightarrow{\text{Cl}_2} \text{Br}_2 \text{ (xloroformli qatlamning qizg'ish - binafsha rangi yo'qoladi va zarg'aldoq rang paydo bo'ladi)}$

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



29-jadval

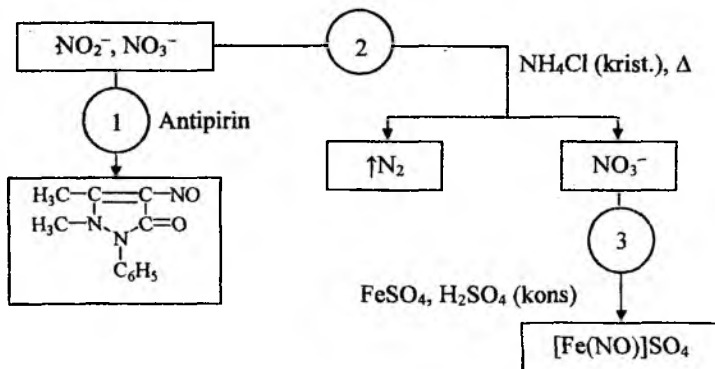
AZOT SAQLAGAN ANIONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI



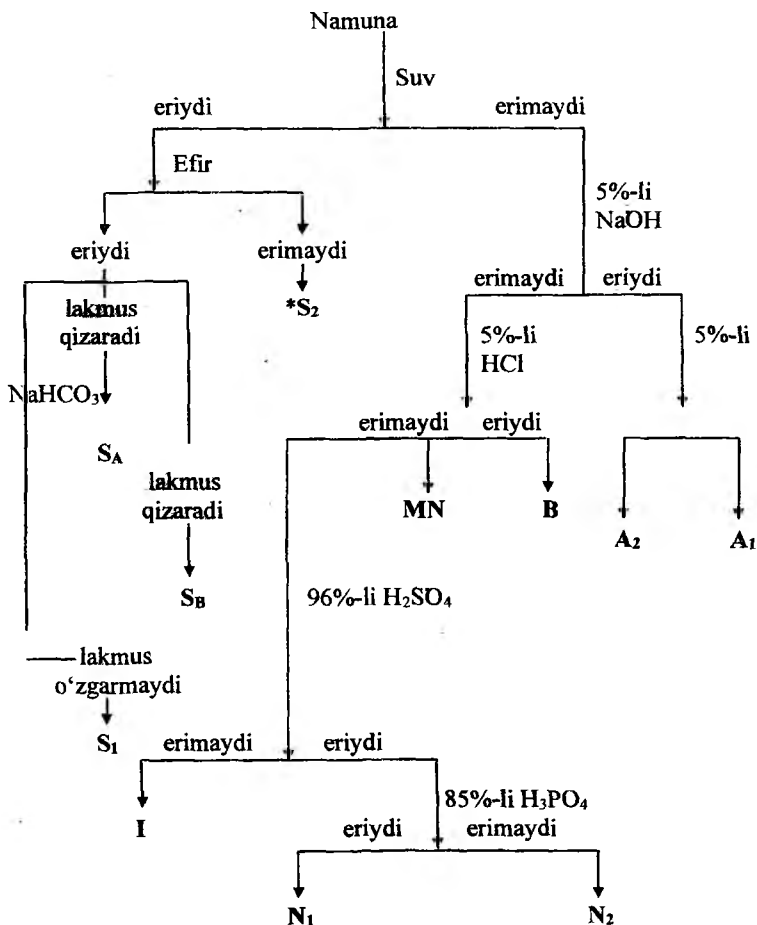
Bosqic hning t/r	Analiz bosqichlari
1	Nordonlashtirilgan boshlang'ich eritmaning alohida ulushidan kristall holdagi antipirin ta'sir ettirib, NO_2^- ionlarini topish: $\text{NO}_2^- \xrightarrow[\text{H}^+]{\text{antipirin}} \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{NO} \\ \qquad \qquad \\ \text{H}_3\text{C}-\text{N} \quad \text{N}-\text{C}=\text{O} \\ \\ \text{C}_6\text{H}_5 \end{array} \quad (\text{yashil rang})$
2	Boshlang'ich eritmaning alohida ulushidan kristall NH_4Cl ta'sirida qizdirib, NO_2^- ionlarini yo'qotish: $\text{NO}_2^- \xrightarrow[\Delta]{\text{NH}_4\text{Cl}} \text{N}_2\uparrow$
3	2 eritmadan konsentrlangan H_2SO_4 ishtirokida FeSO_4 ta'sir ettirib, NO_3^- ionlarini topish: $\text{NO}_3^- \xrightarrow{\text{FeSO}_4, \text{H}_2\text{SO}_4} [\text{Fe}(\text{NO})\text{SO}_4] \text{ (qo'ng'ir xalqa)}$ Agar eritmada Br^- yoki I^- ionlari bo'lsa, ular HCl eritmasi ishtirokida xlorli suv ta'sirida qizdirib yo'qotiladi: $\text{Br}^- \xrightarrow[\Delta]{\text{Cl}_2, \text{HCl}} \text{Br}_2\uparrow; \quad \text{I}^- \xrightarrow[\Delta]{\text{Cl}_2, \text{HCl}} \text{I}_2\uparrow$

14-sxema

NO₂⁻, NO₃⁻ ANIONLARI ARALASHMASINING ANALIZ SXEMASI



ERUVCHANLIKKA ASOSLANGAN ORGANIK BIRIKMALAR ARALASHMASINING
AJRATILISHI

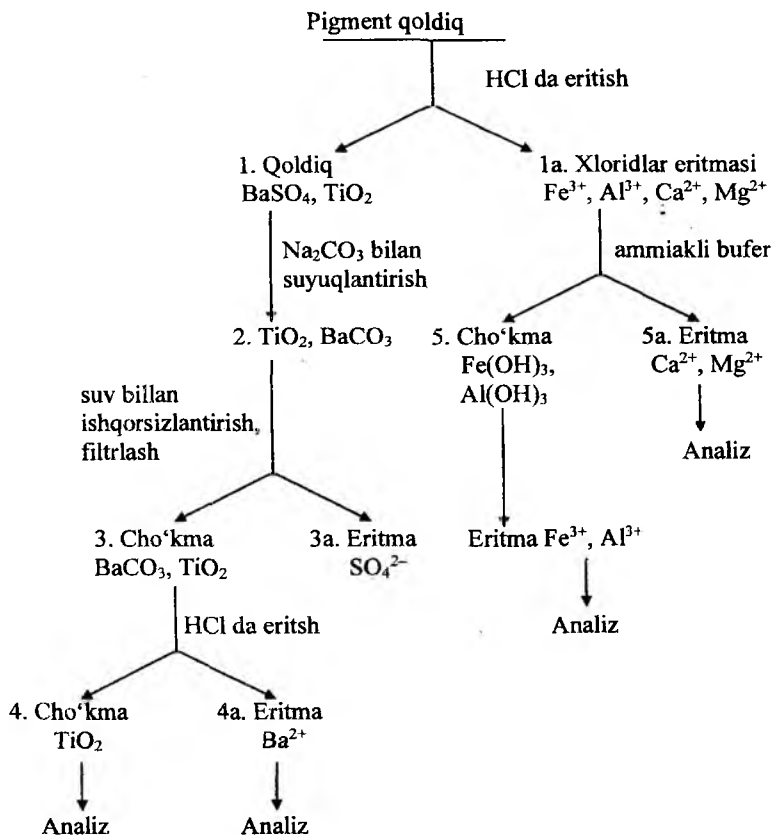


*S_2 – organik kislotalarning tuzlari (RCOONa , RSO_3Na), aminlar gidroksidlarlari ($\text{RNH}\cdot\text{HCl}$), aminokislotalar ($\text{R} - \text{CHCNH}_3^+\text{COO}^-$), uglevodlar, polioksibirikmalar, ko'p asosli kislotalar; S_A – besh yoki undan kam C atomlarini saqlagan bir asosli karbon kislotalar, aromatik sul-fokislotalar; S_B – olti yoki undan kam

C atomlarini saqlagan aminlar; **S**₁ – besh yoki undan kam C atomlarini saqlagan spirtlar, aldegidlar, ketonlar, murakkab efirlar, nitrillar va amidlar; **A**₁ – kuchli karbon kislotalar, *o*- va *p*- holatda o‘rinbosarlarni saqlagan fenollar, β -diketonlar; **A**₂ – 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); **N**₁ – spirtlar, aldegidlar, metilketonlar, siklik ketonlar, murakkab efirlar (5 – 9 C), oddiy efirlar (C atomlari 8 tadan kam), epoksidlar; **N**₂ – alkenlar, alkinlar, oddiy efirlar, ba‘zi aromatik birikmalar, ketonlar (**N**₁ ga kiritilganlardan tashqari); **I** – to‘yingan uglevodorodlar, alkilgalogenidlar, arilgalogenidlar, ba‘zi aromatik birikmalar.

LAK-BO'YOQ MATERIALLAR ANALIZI

Pigment qoldiqning analizi



1. Namuna.

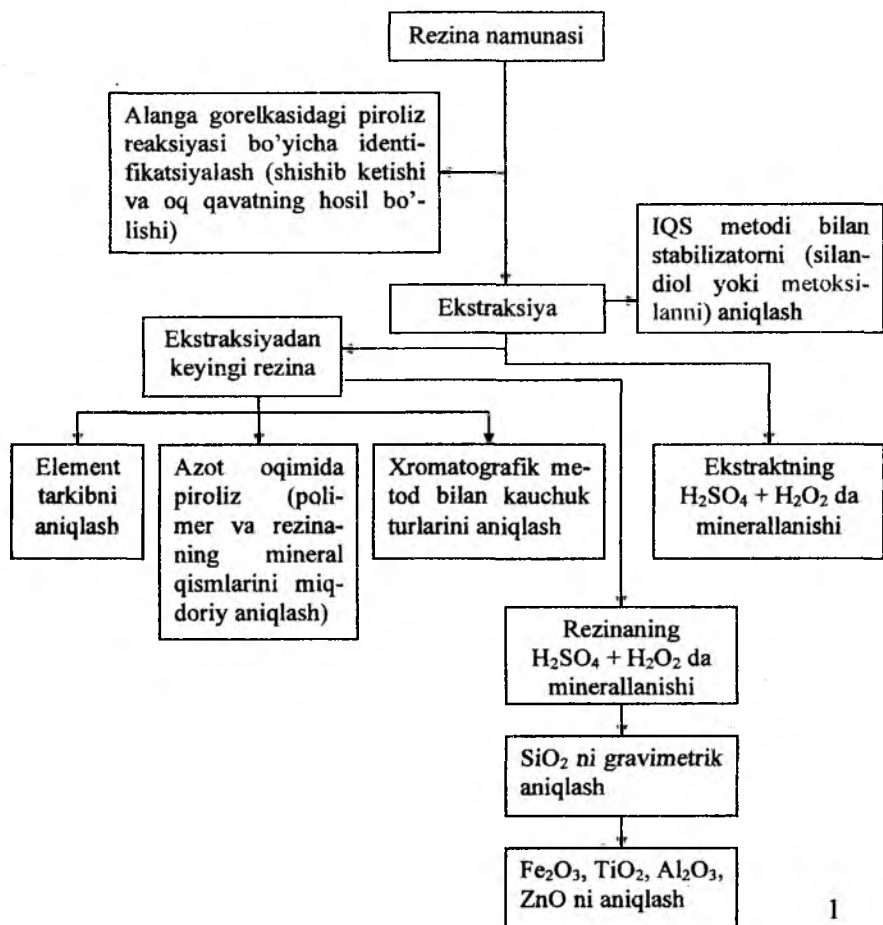
2. Erituvchini haydash→2a. Erituvchi analizi.

3. Plastifikatorni ajratish→3a. Plastifikator analizi.

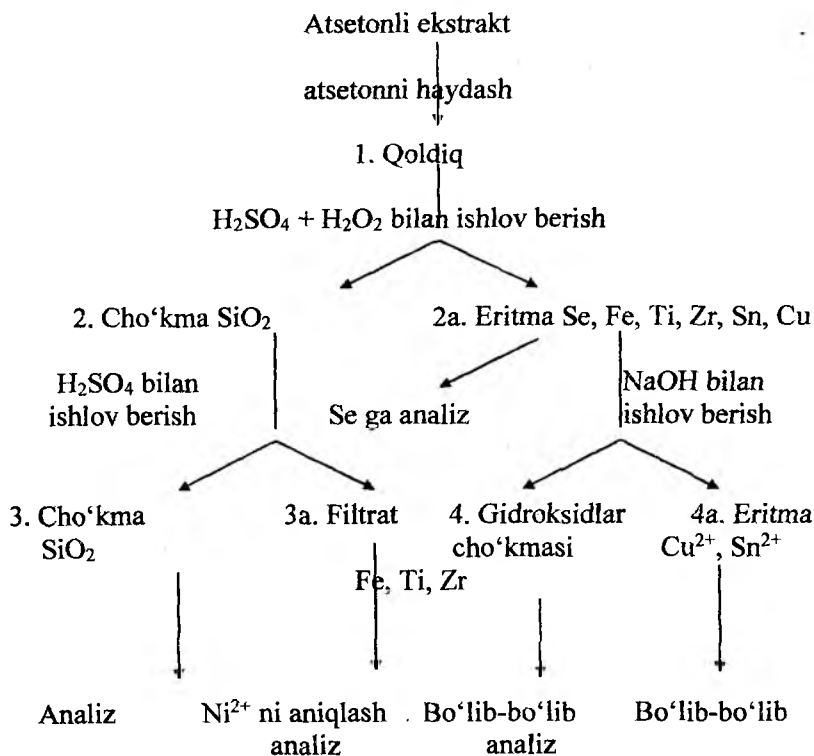
4. Plyonka hosil qiluvchini ajratish→4a. Plyonka hosil qiluvchining analizi.

5. Pigment qoldiq→5a. Pigment qoldiqning analizi.

SILOKSAN KAUCHUKLAR ANALIZI



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



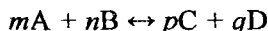
Massalar ta'siri qonuni – sifat analizining nazariy asosidir. U turli kimyoviy jarayonlarning muvozanatlarini – cho'kma hosil bo'lishi va erishi, bir qiyin eriydigan birikmani boshqasiga aylanishi, gidroliz jarayoni, amfoterlik va hokazolarni ilmiy asoslab beradi.

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,



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

$$v_1 = k_1[A]^m \cdot [B]^n$$

$$v_2 = k_2[C]^p \cdot [D]^q$$

bunda v_1 va v_2 – to'g'ri va teskari reaksiyalarning 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:

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

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

bu oxirgi tenglama kimyoning eng asosiy qonunlaridan biri bo'lgan *massalar ta'siri qonunining matematik ifodasi* bo'lib, u quyidagicha ta'riflanadi: *muvozanat vujudga kelganda reaksiya natijasida hosil*

bo'lgan moddalar konsentratsiyalari ko'payt-masining 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:

$$\mu = 1/2 (C_1 Z_1^2 + C_2 Z_2^2 + \dots C_n Z_n^2),$$

$$\mu = 1/2 \sum C_i Z_i^2$$

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

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

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

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 eritmalarida ($\sim 0,0001 M$) $f \approx 1$ va $a = C$ bo'ladi.

Elektrolitlar eritmalarida kimyoviy muvozanat holati muvozanat konstantasi K bilan xarakterlanadi:

$$B_m A_n \rightleftharpoons m B^{n+} + n A^{m-}$$

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

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



qisqartirilgan ko'rinishda:



Bu reaksiyaning muvozanat konstantasi 25 °C haroratda

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

Suvdagi eritmalarida suvning massasi ko'pchilik hollarda eritilgan moddaning massasi bilan taqqoslaganda juda yuqori, uning 1 l eritmada 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 °C haroratda

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

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 ifodalaniadi:

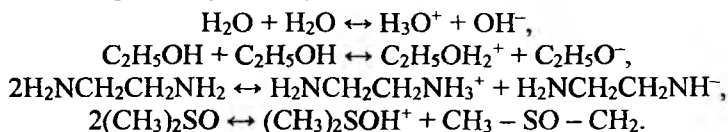
$$\begin{aligned}-\lg[H^+] &= \text{pH}; \\ -\lg[\text{OH}^-] &= \text{pOH}.\end{aligned}$$

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

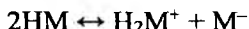
$$\text{pH} + \text{pOH} = \text{p}K_{\text{H}_2\text{O}} = 14.$$

Suvsiz eritmalar analitik kimyosida qo'llaniladigan ko'pgina erituvchilar suvga

o'xshash avtoprotolizga uchraydi, masalan:



Umumiy holda bu jarayonlarni quyidagi tenglama bilan ifodalash mumkin:



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:

$$K_s = \alpha_{\text{H}_2\text{M}^+} \cdot \alpha_{\text{M}^-} \quad (\text{termodinamik avtoprotoliz konstantasi})$$

yoki

$$K_s = [\text{H}_2\text{M}^+][\text{M}^-] \quad (\text{konsentratsion avtoprotoliz konstantasi}).$$

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 ($\text{p}K_s = -\lg K_s$) berilgan erituvchining kislotalik darajasini ifodalaydi (suv uchun – 14; etano-

uchun – 18,75; dimetilformamid uchun – 27,0; atsetonitril uchun 33,3 va hokazo).

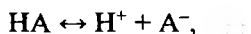
**ANALITIK KIMYODA QO‘LLANILADIGAN MUHIM SUVSIZ
ERITUVCHILARNING DIELEKTRIK O‘TKAZUVCHANLIKLARI (ϵ^*) VA
AVTOPROTOLIZ KONSTANTALARI (pK_s)**

Erituvchi	ϵ^* (25 °C)	pK_s
Spirtlar		
Metanol	32,6	17,31
Etanol	24,3	18,54
<i>n</i> -Propanol	20,1	19,46
<i>izo</i> -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 saqllovchi birikmalar		
Formamid	109,5	17,0
N,N-Dimetilformamid	36,71	23,10
Ammiak	22,7 (– 50 °C)	32,72
Oltingugurt saqllovchi 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 uchun pK_s ham shu tartibda o'zgarib boradi: $\text{CH}_3\text{COOC}_6\text{H}_{13} > \text{CH}_3\text{COOC}_5\text{H}_{11} > \text{CH}_3\text{COOC}_4\text{H}_9 > \text{CH}_3\text{COOC}_3\text{H}_7 > \text{CH}_3\text{COOC}_2\text{H}_5 > \text{CH}_3\text{COOCH}_3 > \text{CH}_3\text{COOH} > \text{HCOOH}$. Shu bilan birga ularning dielektrik o'tkazuvchanliklari (ϵ^*) ham shu tartibda ortib boradi (jad-valga qarang).

Kuchsiz kislota eritmalarining muvozanat konstantasi K_a bilan ifodalanadi:

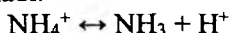


$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

Kuchsiz asos eritmalarining muvozanat konstantasi K_b bilan ifodalanadi:

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

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:



Shuning uchun:

$$K_a = \frac{[\text{H}^+][\text{NH}_3]}{[\text{NH}_4^+]}$$

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

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

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 ($\alpha < 5\%$) α ning qiymati juda kichik bo'ladi va $1 - \alpha$ ayirma birga teng deb olinadi. Shu sababli, tenglamani qisqartirilgan ko'rinish-da $K = C\alpha^2$ yozish mumkin.

Kislota va asoslarning eritmalarida muvozanat

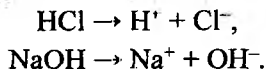
Suvli eritmalarining kislotaligini vodorod ionlarining konsentratsiyasi belgilaydi va pH kattaligi bilan xarakterlanadi:

$$\begin{aligned} \text{pH} &= -\lg[\text{H}^+], \\ \text{pOH} &= -\lg[\text{OH}^-]. \end{aligned}$$

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

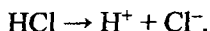
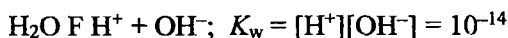
$$\text{pH} + \text{pOH} = 14 \text{ (25 } ^\circ\text{C da)}.$$

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



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

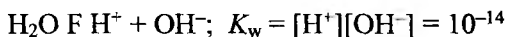
0,001M HCl eritmasida $[\text{H}^+]$ ionlarining konsentratsiyasini hisoblash:



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

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

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



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'rniqa pH ni qo'llash qulaydir. Yuqoridagi eritmalarining pH qiymatlarini hisoblaymiz:

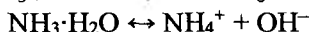
suv: $[H^+] = [OH^-] = 10^{-7}$ mol/l, unda $pH = 7$;

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:



Bunday kislota asoslarning eritmalaridagi 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:

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

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

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 $100\% - \alpha = 100 - 0,089 = 99,91\%$ 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, $\text{pH} = -\lg 8,9 \cdot 10^{-7} = 6,05$.

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/sm³; ω – eritma konsentratsiyasi, %; M – NaOH ning molyar massasi, g.

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

Unda, $\text{pOH} = -\lg 0,1 = 1,0$; $\text{pH} = 14 - \text{pOH} = 14 - 1 = 13$.

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

Yechish. pOH ni hisoblaymiz: $\text{pOH} = 14 - \text{pH} = 14 - 10,80 = 3,20$.

Bundan, $-\lg[\text{OH}^-] = 3,20$ yoki $\lg[\text{OH}^-] = -3,20$; $[\text{OH}^-] = 10^{-3,2}$,
Bundan, $[\text{OH}^-] = 6,31 \cdot 10^{-4} \text{ mol/l}$.

Mustaqil yechish uchun masalalar

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

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

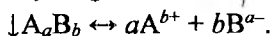
6-masala. Sirka kislota konsentratsiyasi 0,01M va ionlanish darajasi 4,2% bo'lgan eritmaning pH ini hisoblang.

7-masala. $\text{pH} = 7,36$ bo'lgan eritmaning vodorod ionlari konsentratsiyasi $\text{pH} = 7,53$ bo'lgan eritmaning vodorod ionlari konsentratsiyasidan necha marta ortiq?

8-masala. $\text{pH} = 4,8$ bo'lgan sirka kislota eritmasining konsentratsiyasini hisoblang.

Geterogen sistemalarda muvozanat

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



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:

$$C_{A^{b+}}^a \cdot C_{B^{a-}}^b > EK.$$

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

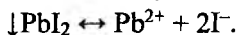
$$C_{A^{b+}}^a \cdot C_{B^{a-}}^b < EK.$$

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

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

1-masala. Qo'rg'oshin yodidning eruvchanlik ko'paytmasi 20 °C da $8,0 \cdot 10^{-9}$ 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:



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

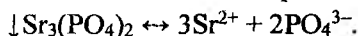
$$\text{Unda, } EK_{\text{PbI}_2} = [\text{Pb}^{2+}] \cdot [\text{I}^-]^2 = S \cdot (2S)^2 = 4S^3.$$

$$\text{Bundan, } S = \sqrt[3]{\frac{EK_{\text{PbI}_2}}{4}} = \sqrt[3]{8 \cdot 10^{-9} / 4} = 1,3 \cdot 10^{-3} \text{ mol/l}.$$

Qo'rg'oshin yodidning molyar massasi 461 g/mol ga teng. Unda cho'kmaning g/l da ifodalangan eruvchanligi $461 \cdot 1,3 \cdot 10^{-3} = 0,6$ ga teng bo'ladi.

2-masala. 250 ml to'yingan eritma $2,80 \cdot 10^{-5}$ g stronsiy fosfat saqlaydi. Tuzning eruvchanlik ko'paytmasini hisoblang.

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



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

$$EK_{\text{Sr}_3(\text{PO}_4)_2} = [\text{Sr}^{2+}]^3 \cdot [\text{PO}_4^{3-}]^2.$$

Quyidagi proporsiyadan stronsiy fosfatning eruvchanligini g/l da hisoblaymiz:

0,25 litr eritma $2,80 \cdot 10^{-5}$ g stronsiy fosfat saqlaydi

1 litr eritma x g stronsiy fosfat saqlaydi

$$x = \frac{2,80 \cdot 10^{-5} \cdot 1}{0,25} = 1,12 \cdot 10^{-4} \text{ g/l}.$$

Hosil bo'lgan konsentratsiyani mol/l da ifodalaymiz:

$$S_x = \frac{x}{M_{\text{Sr}_3(\text{PO}_4)_2}} = \frac{1,12 \cdot 10^{-4}}{452,803} = 2,5 \cdot 10^{-7} \text{ mol/l},$$

bunda $M_{\text{Sr}_3(\text{PO}_4)_2}$ – stronsiy fosfatning molyar massasi.

Stronsiy fosfatning muvozanat tenglamasidan ko'rinib turibdiki, S mol/l stronsiy fosfatdan $3S$ mol/l stronsiy ionlari va $2S$ mol/l fosfat-ionlar hosil bo'ladi. Unda $EK_{\text{Sr}_3(\text{PO}_4)_2} = (3S)^3(2S)^2 = 108S^5$.

S ning qiymatini EK tenglamasiga qo'yamiz:

$$EK = 108 \cdot (2,5 \cdot 10^{-7})^5 = 0,7 \cdot 10^{-31}.$$

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

Yechish. Qo'rg'oshin yodidning suvdagi eruvchanligi 1-masalada hisoblangan. Shu tuzning 0,1M kaliy yodid eritmasidagi eruvchanligini x bilan belgilab, uni hisoblaymiz. Unda tenglamaga muvofiq (1-masalaga qarang) qo'rg'oshin ionlarining konsentratsiyasi ham x ga teng bo'ladi, yodid-ionlarning konsentratsiyasi esa $2x + 0,1$

ni tashkil etadi. Faraz qilaylik, $2x \ll 0,1$, unda $2x$ kattalikni $0,1$ ga nisbatan inobatga olmasak ham bo'ladi va $[I^-] = 0,1 \text{ mol/l}$.

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

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

$$\text{Bundan, } x = \frac{EK_{PbI_2}}{(0,1)^2} = \frac{8 \cdot 10^{-9}}{0,01} = 8 \cdot 10^{-7} \text{ mol/l}.$$

Binobarin, kaliy yodid ishtirokida qo'rg'oshin yodidning eruvchanligi $1,3 \cdot 10^{-3} / 8 \cdot 10^{-7} = 1,6 \cdot 10^3$ marta kamayadi.

4-masala. $5 \cdot 10^{-3} \text{M}$ kalsiy xlorid va natriy sulfat eritmalarining teng hajmlari qo'shildi. Kalsiy sulfat cho'kmasi hosil bo'ladimi ($EK_{CaSO_4} = 2,5 \cdot 10^{-5}$)?

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 $2,5 \cdot 10^{-3} \text{ mol/l}$ ga teng bo'ladi. Unda $C_{Ca^{2+}} \cdot C_{SO_4^{2-}} = 2,5 \cdot 10^{-3} \cdot 2,5 \cdot 10^{-3} = 6,25 \cdot 10^{-6}$, ya'ni hosil bo'lgan qiymat EK_{CaSO_4} dan kichik, demak cho'kma hosil bo'lmaydi.

Mustaqil yechish uchun masalalar

5-masala. $1,16 \text{ g}$ 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 $0,1 \text{M}$ qo'rg'oshin nitrat eritmasiga teng hajmda $0,3 \text{M}$ natriy xlorid eritmasi qo'shilsa, qo'rg'oshin xlorid cho'kmasi hosil bo'ladimi?

8-masala. Kalsiy fluoridning $0,05 \text{M}$ kalsiy xlorid eritmasidagi eruvchanligi suvdagi eruvchanligiga nisbatan qanday o'zgaradi ($EK_{CaF_2} = 4 \cdot 10^{-11}$)?

9-masala. Magniy gidroksidning eruvchanlik ko'paytmasi $6 \cdot 10^{-10}$ ga teng. $1,6 \cdot 10^{-4} M$ 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).

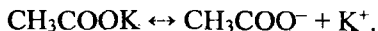
GIDROLIZ PARAMETRLARINI HISOBLASH JADVALI

Tuz	Gidroliz konstantasi, K_x	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	$\frac{K_w}{K_a \cdot K_b}$	$\frac{\sqrt{\frac{K_w}{K_a \cdot K_b}}}{1 + \sqrt{\frac{K_w}{K_a \cdot K_b}}}$	$\sqrt{\frac{K_w \cdot K_a}{K_b}}$	$\sqrt{\frac{K_w \cdot K_b}{K_a}}$

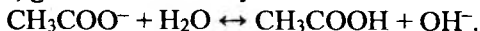
Izoh: K_w – suvning ion ko‘paytmasi,
 C_{BA} – tuzning konsentratsiyasi, mol/l.

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 dissotsialanadi:



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



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

Tuzning konsentratsiyasini mol/l da hisoblaymiz:

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

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

Kislotaning ionlanish konstantasini jadvaldan topamiz: $K_{\text{CH}_3\text{COOH}} = 1,74 \cdot 10^{-5}$. 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. De-mak, $[\text{OH}^-] = [\text{CH}_3\text{COO}^-] = h \cdot C_{\text{tuz}} = 7,6 \cdot 10^{-5} \cdot 0,1 = 7,6 \cdot 10^{-6} \text{ mol/l}$.

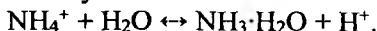
Bundan, $\text{pOH} = -\lg 7,6 \cdot 10^{-6} = 5,12$ va $\text{pH} = 14 - 5,12 = 8,88$.

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

Yechish. Ammoniy xlorid quyidagi tenglama bo‘yicha dissotsialanadi:



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



Bunday tuzdagi tuzlarning gidroliz konstantasini hisoblashda quyidagi formuladan foydalaniladi:

$$K_g = \frac{K_w}{K_{\text{NH}_3 \cdot \text{H}_2\text{O}}} = \frac{10^{-14}}{1,76 \cdot 10^{-5}} = 5,68 \cdot 10^{-10}.$$

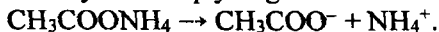
Ammoniy xlorid eritmasidagi $[\text{H}^+]$ ning konsentatsiyasini $[\text{H}^+] = \sqrt{K_g \cdot C_{\text{tuz}}}$ formula bo'yicha topamiz:

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

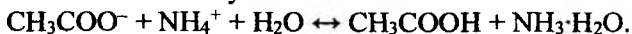
$$\text{pH} = -\lg 7,63 \cdot 10^{-6} = 5,12.$$

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:



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



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:

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

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

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

Buf eritmalarda muvozanat

Keng ma'noda bufer sistemalariga 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 qaytaruvchi 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 $\text{NH}_3 \cdot \text{H}_2\text{O}$ 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 quyi-dagi tenglama bo'yicha hisoblanadi:

$$\text{pH} = \text{p}K_a - \lg \frac{C_{\text{kislota}}}{C_{\text{tuz}}}.$$

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

$$pOH = pK_b + \lg \frac{C_{asos}}{C_{tuz}};$$

$$pH = 14 - pK_b + \lg \frac{C_{asos}}{C_{tuz}}.$$

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

$$pH = pK_{a_2} + \lg \frac{C_{A^{2-}}}{C_{HA^-}},$$

bunda $\tilde{N}_{A^{2-}}$ va $\tilde{N}_{HA^-}$ — B_2A va BHA tuzlarning konsentratsiyasi; pK_{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:

$$pH = pK_a + \lg \frac{C_{HA^{2-}}}{C_{H_2A^-}}.$$

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:

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

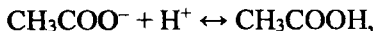
$CH_3COONa \rightarrow CH_3COO^- + Na^+$ (kuchli elektrolit; to'liq dissotsilanadi).

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 $[CH_3COOH] = C_{kislota}$.

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

$$\delta f = \delta K_a - \lg \frac{C_{kislota}}{C_{tuz}}; \quad pH = 4,76 - \lg \frac{0,2}{0,2} = 4,76.$$

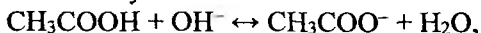
a) agar 0,01 mol HCl qo'shilsa, HCl va CH_3COONa orasida reaksiya boradi:



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

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

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



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

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

2-masala. Ammiak va ammoniy xloridning 0,1M eritmalaridan 1:9 nisbatda tayyorlangan bufer aralashmaning pH ini aniqlang. ($K_{\text{NH}_3 \cdot \text{H}_2\text{O}} = 1,8 \cdot 10^{-5}$; 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 konsentra-tsiyasini aniqlaymiz:

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

$$x = \frac{0,1 \cdot 9}{10} = 0,09\text{M NH}_4\text{Cl}.$$

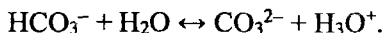
Quyidagi tenglama bo'yicha bufer aralashmaning pH ini aniqlaymiz:

$$\text{pH} = 14 - \text{p}K_{\text{NH}_3 \cdot \text{H}_2\text{O}} + \lg \frac{C_{\text{NH}_3 \cdot \text{H}_2\text{O}}}{C_{\text{NH}_4\text{Cl}}};$$

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

3-masala. 30 ml 0,1M Na_2CO_3 va 15 ml 0,1M NaHCO_3 eritmaları aralashtirilganda hosil bo'lgan eritmaning pH ini aniqlang. $K_{2(\text{H}_2\text{CO}_3)} = 4,69 \cdot 10^{-11}$

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



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

$$C_2(\text{Na}_2\text{CO}_3) = \frac{C_1(\text{Na}_2\text{CO}_3) \cdot V_1(\text{Na}_2\text{CO}_3)}{V_1(\text{Na}_2\text{CO}_3) + V_1(\text{NaHCO}_3)} = \frac{0,1 \cdot 30}{30 + 15} = 0,0667 \approx 6,67 \cdot 10^{-2}$$

M;

$$C_2(\text{NaHCO}_3) = \frac{C_1(\text{NaHCO}_3) \cdot V_1(\text{NaHCO}_3)}{V_1(\text{Na}_2\text{CO}_3) + V_1(\text{NaHCO}_3)} = \frac{0,1 \cdot 15}{30 + 15} = 0,0333 \approx 3,33 \cdot 10^{-2} \text{ M};$$

$$\text{p}K_2 = -\lg K_{2(\text{H}_2\text{CO}_3)} = -\lg 4,69 \cdot 10^{-11} = 10,33.$$

Bufer eritmaning pH qiymatini topsak:

$$\text{pH} = \text{p}K_{2(\text{H}_2\text{CO}_3)} + \lg \frac{C_{\text{CO}_3^{2-}}}{C_{\text{HCO}_3^-}} = 10,33 + \lg \frac{6,67 \cdot 10^{-2}}{3,33 \cdot 10^{-2}} = 10,33 + 0,3 = 10,63.$$

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.

$$\pi = \frac{\Delta C_b}{\Delta \text{pH}};$$

$$\pi = -\frac{\Delta C_a}{\Delta \text{pH}}.$$

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:

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

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

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

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

$$\pi = \frac{2,3 \cdot C \cdot K_b \cdot [H^+]}{(K_b + [H^+])^2}$$

4-masala. pH = 4 bo'lgan va 1,140M CH₃COOH hamda 0,205M CH₃COONa dan tarkib topgan eritmaning bufer sig'imini hisoblang. $K_{CH_3COOH} = 1,74 \cdot 10^{-5}$.

Yechish. Komponentlarning umumiy konsentratsiyasini topamiz:

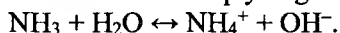
$$C = 1,140 + 0,205 = 1,345 \text{ mol/l.}$$

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

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

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

Yechish. Ammiak eritmasi suvda quyidagicha dissotsialanadi:



Ammoniy ionining dissotsilanish konstantasi:

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

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

Mustaqil yechish uchun masalalar

6-masala. 1 litrda 0,2M CH₃COONa va 0,2M CH₃COOH saqlagan bufer eritma-ning pH ini hisoblang. Bu eritmaga 0,01M HCl qo'shilganda pH qanday o'zgaradi?

7-masala. 1 litr benzoatli bufer aralashma 0,35 mol C₆H₅COOH va 0,35 mol C₆H₅COONa saqlaydi. Bufer aralashmaning pH ini hisoblang.

8-masala. 25 ml 0,1M CH₃COOH eritmasiga 25 ml 0,1M CH₃COONa 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 $\text{NH}_3 \cdot \text{H}_2\text{O}$ va 0,5 mol NH_4Cl saqlagan ammoniyli bufer eritmaning pH ini hisoblang. 0,2M NaOH qo'shilganda pH qanday o'zgaradi?

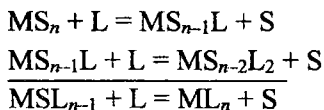
10-masala. 0,4M CH_3COOH va 0,15M CH_3COONa saqlagan bufer eritmada pH = 4,35. Bu eritmaning bufer sig'imini hisoblang.

11-masala. $\pi = 0,3$ 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

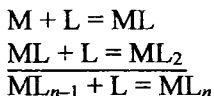
Komplekslar – bu markaziy atom (kompleks hosil qiluvchi) va ligandlar deb nomlanuvchi ionlardan (yoki neytral molekulalardan) tarkib topgan kimyoviy birikmalardir.

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:

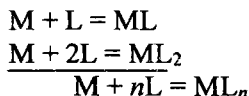


Suyiltirilgan eritmalarda erituvchining aktivligi amalda doimiy va ionlarni solvatlovchi erituvchi molekulalarining soni doim ma'lum bo'lgani uchun kompleks eritmalaridagi muvozanatni odatda quyidagi ko'rinishlarda ifodalash mumkin:

Bosqichli



Umumiy



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

$$K_1^0 = \frac{a_{\text{ML}}}{a_{\text{M}} \cdot a_{\text{L}}};$$

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

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

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

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

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

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

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.

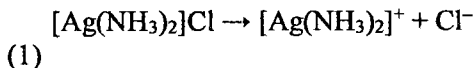
$$K_{\text{beqar.}} = \frac{[M][L]^n}{[ML_n]}$$

Barqarorlik va beqarorlik konstantalari orasida quyidagi nisbat mavjud:

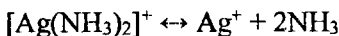
$$K_{\text{beqar.}} = \frac{1}{K_{\text{barqar.}}} = \frac{1}{\beta}$$

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

Yechish. Tuzning dissotsilanishini quyidagi tenglamalar bilan ifodalash mumkin:



(1)



(2)

Ikkinchi qaytar jarayon uchun beqarorlik konstantasining ifodasini yozamiz:

$$K_{\text{beqar.}} = \frac{[\text{Ag}^+][\text{NH}_3]^2}{[[\text{Ag}(\text{NH}_3)_2]^+]}$$

Jadvaldan kompleks ionning barqarorlik konstantasini topamiz:
 $\lg\beta = 7,23$; bi-nobarin, $\beta = 10^{7,23} = 1,7 \cdot 10^7$,

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

$[\text{Ag}^+]$ ni x mol/l bilan belgilaymiz, unda (2) tenglamaga muvofiq $[\text{NH}_3] = 2x$ mol/l, $[\text{Ag}(\text{NH}_3)_2]^+$ 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 konsentratsiyasini doimiy deb qabul qilishimiz mumkin:

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

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

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

$$[\text{NH}_3] = 2x = 2 \cdot 0,9 \cdot 10^{-3} = 1,8 \cdot 10^{-3} \text{ mol/l}.$$

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:



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

$$\beta_4 = \frac{[\text{HgI}_4^{2-}]}{[\text{Hg}^{2+}][\text{I}^-]^4} = 1,51 \cdot 10^{30}.$$

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

$$[\text{Hg}^{2+}] = \frac{[\text{HgI}_4^{2-}]}{\beta_4 [\text{I}^-]^4} = \frac{10^{-2}}{1,51 \cdot 10^{30} \cdot (0,5)^4} = 1,06 \cdot 10^{-31} \text{ M.}$$

Mustaqil yechish uchun masalalar

3-masala. 0,1M $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ eritmasida $[\text{Cu}^{2+}]$ va $[\text{NH}_3]$ ni hisoblang.

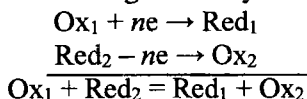
4-masala. 0,05M $\text{K}_3[\text{Fe}(\text{CN})_6]$ eritmasida $[\text{Fe}^{3+}]$, $[\text{CN}^-]$ va $[\text{K}^+]$ ni hisoblang.

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

6-masala. 0,1M $\text{K}_2[\text{Cd}(\text{CN})_4]$ va 0,1M $[\text{Cd}(\text{NH}_3)_4]\text{SO}_4$ eritmalarning qaysi birida $[\text{Cd}^{2+}]$ 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:



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

$$K = \frac{[\text{Ox}_2][\text{Red}_1]}{[\text{Ox}_1][\text{Red}_2]}$$

Moddalarning oksidlanish-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 – potentsiali bilan tavsiflash mumkin.

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

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

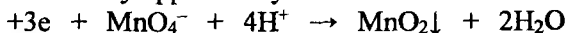
bunda E – sistemaning redoks potentsiali, V ; E° - sistemaning standart redoks potentsiali*, V ; T – harorat, K ; n – oksidlanish-qaytarilish reaksiyasida ishtirok etuvchi elek-tronlar; R – universal gaz doimiysi, $8,312 \text{ J}/(\text{mol}\cdot\text{K})$; F – Faradey doimiysi, 96500 Kl ; $[\text{Ox}]^n$, $[\text{Red}]^m$ – stexiometrik koeffitsiyentlarda olingan oksidlovchi va qaytaruvchining konsentratsiyasi.

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

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

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

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



(1)

$$E = E^\circ + \frac{0,059}{3} \lg [\text{MnO}_4^-] \cdot [\text{H}^+]^4 \quad (25^\circ\text{C da})$$



(2)

$$E = E^\circ + \frac{0,059}{3} \lg \frac{[\text{MnO}_4^-] \cdot [\text{H}^+]^8}{[\text{Mn}^{2+}]} \quad (25^\circ\text{C da})$$

E° kattaligi ko'p jihatdan kislotada konsentratsiyasiga bog'liq bo'ladi va konsentrlangan H_2SO_4 ishtirokida uning qiymati $+1,51 \text{ V}$ dan $+1,9 \text{ V}$ 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, arsenionlarning yod bilan reaksiyasi faqat natriy gidrokarbonat muhitida ($\text{pH} = 9$) borishi mumkin:

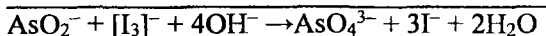


$$= -0,71 \text{ V}$$

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

$$+2e + [I_3]^- \rightarrow 3I^- \quad 1 \quad E^\circ$$

$$= 0,545 \text{ V}$$



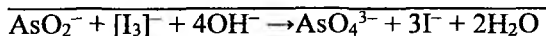
Kislotali muhitda esa bunday reaksiya bormaydi, chunki $E_{\text{H}_3\text{AsO}_4/\text{HAsO}_2}^\circ = 0,56 \text{ V}$ qiymat $E_{[I_3]^-/3I^-}^\circ = 0,545 \text{ V}$ dan katta va shuning uchun reaksiya yo'nalishi o'zgaradi:

$$+2e + \text{H}_3\text{AsO}_4 + 2\text{H}^+ \rightarrow \text{HAsO}_2 + 2\text{H}_2\text{O} \quad 1 \quad E^\circ$$

$$= 0,56 \text{ V}$$

$$-2e + 3I^- \rightarrow [I_3]^- \quad 1 \quad E^\circ$$

$$= 0,545 \text{ V}$$



Oksidlanish-qaytarilish reaksiyalarining tezligiga reagentlar konsentratsiyasi, eritma muhiti va harorattan tashqari katalizatorlar ham jiddiy ta'sir ko'rsatadi. Katalizator sifatida begona modda yoki reaksiya mahsulotlaridan biri xizmat qilishi mumkin. Masalan, permanganat-ionlarning oksalat kislotasi 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 potentsiallarining farqi; odatda, E.Yu.K. 0,4 V dan katta bo'lgan reaksiyalar boradi.

- quyidagi tenglamalar bilan hisoblanadigan redoks reaksiyaning muvozanat konstantasi:

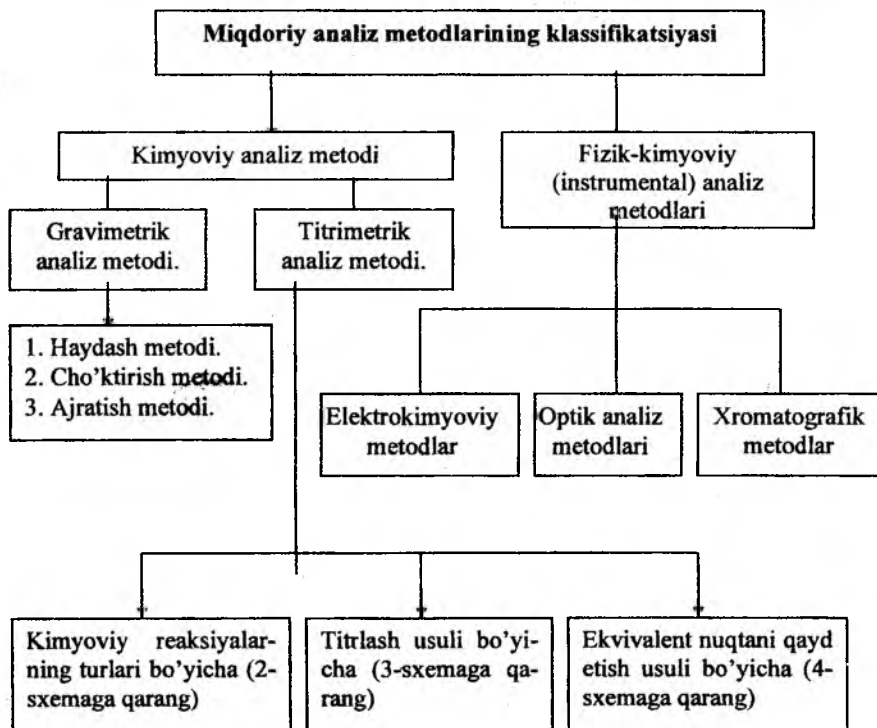
$$K = 10^a, \text{ bu yerda } a = \frac{n(E_1^\circ - E_2^\circ)}{0,059} \quad (25^\circ\text{C da})$$

yoki

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

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

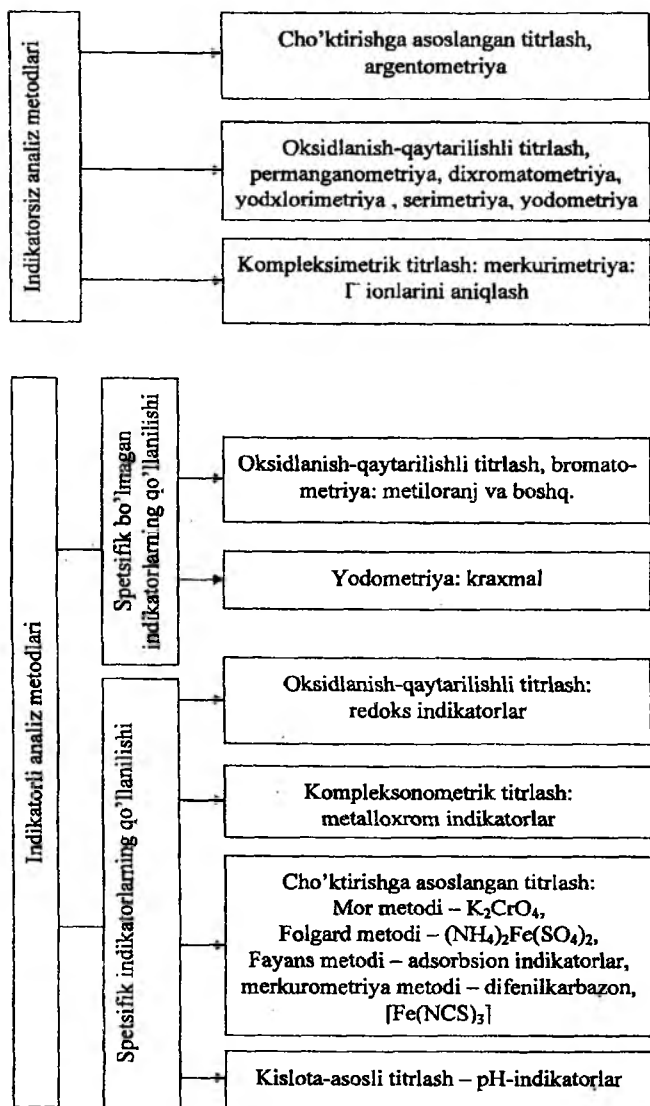
MIQDORIY ANALIZ USULLARINING KLASSIFIKATSIYASI



TITRLASH USULI BO'YICHA TITRIMETRIK ANALIZ
METODLARINING KLASSIFIKATSIYASI

To'g'ri titrlash	Teskari titrlash	Bilvosita titrlash
Aniqlanuvchi modda eritmasiga bevosita titrant eritmasi qo'shiladi. Misol: $\text{H}_2\text{C}_2\text{O}_4 + 2\text{NaOH} \rightleftharpoons \text{Na}_2\text{C}_2\text{O}_4 + 2\text{H}_2\text{O}$	Aniqlanuvchi modda eritmasiga aniq konsentratsiyali titrant eritmasidan mo'l miqdor qo'shiladi, uning ortiqcha miqdori ikkinchi titrant bilan titrlanadi. Misol: $\text{CH}_3\text{COOH} + \text{NaOH}(\text{mo'l}) \rightleftharpoons \text{CH}_3\text{COONa} + \text{H}_2\text{O}$ $\text{NaOH}(\text{qoldiq}) + \text{HCl} \rightleftharpoons \text{NaCl} + \text{H}_2\text{O}$	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: $+6e + \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$ $-2e + 3\text{I}^- \rightleftharpoons [\text{I}_3]^-$ $\text{C}_2\text{O}_7^{2-} + 14\text{H}^+ + 9\text{I}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O} + 3[\text{I}_3]^-$ $-2e + [\text{I}_3]^- \rightleftharpoons 3\text{I}^-$ $-2e + 2\text{S}_2\text{O}_3^{2-} \rightleftharpoons \text{S}_4\text{O}_6^{2-}$ $[\text{I}_3]^- + 2\text{S}_2\text{O}_3^{2-} \rightarrow 3\text{I}^- + \text{S}_4\text{O}_6^{2-}$

**EKVIVALENT NUQTANI QAYD ETISH USULI BO'YICHA
TITRIMETRIK ANALIZ METODLARINING KLASSIFIKATSIIYASI**



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	Bilvosita haydash metodlari
	Bevosita haydash metodlari	
Cho'ktirish metodlarida aniqlanuvchi komponent muayyan tarkibli qiyin eruvchan kimyoviy birikma ko'rinishida miqdoriy cho'ktiriladi. <i>Masalan,</i> SO_4^{2-} ni aniqlashda ular Ba^{2+} ionlari bilan cho'ktiriladi: $\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4 \downarrow$ cho'ktirilgan shakl – qizdirilgandan keyin: $\text{BaSO}_4 \xrightarrow{\Delta} \text{BaSO}_3$ gravimetrik shakl Bu holda cho'ktirilgan va gravimetrik shakllar mos tushadi.	Agar haydalgan mahsulot massasi bevosita o'lchansa, bunday usul bevosita haydash deb aytiladi. <i>Masalan,</i> kalsiy karbonat tortimining parchalanishidan hosil bo'lgan CO_2 ni aniqlash: $\text{CaCO}_3 \downarrow + 2\text{H}^+ \xrightarrow{\Delta} \text{CO}_2 \uparrow + \text{Ca}^{2+} + \text{H}_2\text{O}$ $\text{CO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$ CO_2 ning miqdori natron ohaki ($\text{NaOH} + \text{CaO}$) bilan to'ldirilgan yutuvchi nay massasining o'rlishiga qarab hisoblanadi	Agar haydalgan mahsulot massasi haydashgacha va haydashdan keyingi natijaga massasining farqiga qarab aniqlansa, bunday usul bilvosita haydash deb aytiladi. <i>Masalan,</i> moddalarning namligini, kristallogidratlardagi kristallizatsion suvni aniqlash: $\text{BaCl}_2 \cdot 2\text{H}_2\text{O} \xrightarrow{\Delta} \text{BaCl}_2 + \text{H}_2\text{O} \uparrow$

- Ca^{2+} ionlarini aniqlashda ular ammoniy oksalat bilan cho'ktiladi: $\text{Ca}^{2+} + \text{C}_2\text{O}_4^{2-} \rightarrow \text{CaC}_2\text{O}_4 \downarrow$ cho'ktilgan shakl - qizdirilganda keyin: $\text{CaC}_2\text{O}_4 \xrightarrow{\Delta} \text{CO}_2 \uparrow + \text{CO} \uparrow + \text{CaO}$ gravimetrik shakl Cho'ktilish metodi bo'yicha natijalarni hisoblash: $\omega, \% = \frac{m_{\text{gr.shakl}} \cdot F \cdot 100}{m_t},$	Revosita 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: $\omega, \% = \frac{(m_t - m_{\text{gr.shakl}}) \cdot 100}{m_t},$ 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;
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;		
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.		

KISLOTA-ASOSLI TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M - 0,001M HCl, H ₂ SO ₄ va bosh. kislotalarning eritmaları (atsidimetriya)	Kislota - asosli indikatorlar (masalan, metiloranj, fenolftalein)	Standart moddalar (Na ₂ B ₄ O ₇ ·10H ₂ O, Na ₂ CO ₃ , K ₂ CO ₃). Standart eritmalar (NaOH, KOH, Ba(OH) ₂)	Bu metod bilan quyidagilar aniqlanadi • kuchli kislota va asoslar; • kuchsiz kislota va asoslar, $K_1 \geq 5 \cdot 10^{-7}$; • kuchli kislota va kuchsiz asosdan ($K_6 \leq 5 \cdot 10^{-7}$) yoki kuchli asos va kuchsiz kislota ($K_6 \leq 5 \cdot 10^{-7}$) tarkib topgan tuzlar.	1. Reaksiya mahsulotlari yoki titrlash egri chiziqlari bo'yicha indikatorni to'g'ri tanlash. 2. Ekvivalent nuqtaga yaqinlashgan da titrlashni sekin o'tkazish. 3. $t = 20 - 25^\circ\text{C}$	$\text{H}^+ + \text{OH}^- \rightleftharpoons \text{HOH}$ Masalan, to'g'ri titrlash: $\text{Na}_2\text{CO}_3 + \text{HCl} \rightarrow \text{NaHCO}_3 + \text{NaCl}$ $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow \text{NaCl} + \text{CO}_2 \uparrow + \text{H}_2\text{O}$ teskari titrlash: $\text{CH}_3\text{COOH} + \text{NaOH}_{(\text{qo'ld})} \rightleftharpoons \text{CH}_3\text{COONa} + \text{H}_2\text{O}$ $\text{NaOH}_{(\text{qo'ld})} + \text{HCl} \rightleftharpoons \text{NaCl} + \text{H}_2\text{O}$
0,1M - 0,001M KOH, NaOH va bosh. ishqorlarning eritmaları (alkalimetriya)		Standart moddalar (H ₂ C ₂ O ₄ ·2H ₂ O, H ₂ C ₂ H ₃ O ₆). Standart eritmalar (HCl, H ₂ SO ₄)			

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 eritmalar	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'lmasi kerak (titrant yoki indikator bilan cho'lqama hosil qiladi)	$\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl} \downarrow$ $2\text{Ag}^+ + \text{CrO}_4^{2-} \rightarrow \text{Ag}_2\text{CrO}_4 \downarrow$
Folgard metodi bo'yicha argentometrik titrlash (rodanometriya)	To'g'ri titrlash: 0,05M yoki 0,1M NH_4NCS , KNCS yoki AgNO_3 eritmalar Teskari titrlash: yuqorida ko'rsatilgan titrantlar	$(\text{NH}_4)_2[\text{Fe}(\text{SO}_4)_2]$ ning to'yingan eritmasi	AgNO_3 , KCl va NaCl , KNCS larining standart eritmalar	To'g'ri titrlashda: Ag^+ , Hg_2^{2+} hamda KNCS titrant eritmasi bilan Br^- , I^- aniqlanadi; Teskari titrlashda: Cl^- , Br^- , I^- , S^{2-} , AsO_4^{3-} , CO_3^{2-} , $\text{C}_2\text{O}_4^{2-}$, NCS^- , CN^- , PO_4^{3-} , CrO_4^{2-} aniqlanadi	1. Titrlash kislotali muhitda o'tkaziladi; 2. $\text{Hg}(\text{I})$ tuzlari va F^- ionlari bo'lmasi 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: $\text{Ag}^+ + \text{NCS}^- \rightarrow \text{AgNCS} \downarrow$ $3\text{NCS}^- + \text{Fe}^{3+} \rightarrow [\text{Fe}(\text{NCS})_3] \downarrow$ Teskari titrlash: $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl} \downarrow$ $\text{Ag}^+ + \text{NCS}^- \rightarrow \text{AgNCS} \downarrow$ $3\text{NCS}^- + \text{Fe}^{3+} \rightarrow [\text{Fe}(\text{NCS})_3] \downarrow$

Fayans-Xodakov metodi bo'yicha argentometrik titrlash	0,1M yoki 0,05M AgNO_3 eritmasi	Adsorbsion indi- katorlar: eozin, fluorescein va boshqalar	NaCl yoki KCl standart moddalar va ularning stan- dard eritmaları	Cl^- , Br^- , I^- , NCS^- aniqlanadi	Qo'llaniladigan indikatorga qarab titrlash pH ning muayyan qiymat- larida o'tkaziladi	$\text{Ag}^+ + \text{I}^- \rightarrow \text{AgI} \downarrow$
Merkurometrik metod	0,1M $\text{Hg}_2(\text{NO}_3)_2$ eritmasi	Temir (III)-roda- nit $[\text{Fe}(\text{NCS})_3]$, difenilkarbazon $\text{NH} - \text{NH} - \text{C}_6\text{H}_5$ $\text{C} = \text{O}$ $\text{N} = \text{N} - \text{C}_6\text{H}_5$	NaCl yoki KCl standart moddalar va ularning stan- dard eritmaları	Cl^- , Br^- , I^- aniq- lanadi	Titrlash kislorati muhitida o'tkazi- ladi	$\text{Hg}_2^{2+} + 2\text{Cl}^- \rightarrow \text{Hg}_2\text{Cl}_2 \downarrow$

MERKURIMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar 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) ₅ NO], difenilkarbazid yoki difenilkarbazon eritmaları, I ⁻ ni aniqlashda indikator qo'llanilmaydi	NaCl yoki KCl standart moddalar va ularning standart eritmaları	Cl ⁻ , Br ⁻ , I ⁻ , NCS ⁻ , CN ⁻ aniqlanadi	Titrlash kislotali (HNO ₃) muhitda o'tkaziladi	$\text{Hg}^{2+} + 2\text{Cl}^- \rightarrow [\text{HgCl}_2]$ $\text{Hg}^{2+} + 2\text{Br}^- \rightarrow [\text{HgBr}_2]$ $\text{Hg}^{2+} + 2\text{NCS}^- \rightarrow [\text{HgNCS}_2]$ $\text{Hg}^{2+} + [\text{Fe}(\text{CN})_5\text{NO}]^{2-} \rightarrow \text{Hg}[\text{Fe}(\text{CN})_5\text{NO}] \downarrow$ yoki Hg²⁺ ning difenilkarbazid yoki difenilkarbazon bilan rangli komplekslari $\text{Hg}^{2+} + 4\text{I}^- \rightarrow [\text{HgI}_2]^{2-}$ $[\text{HgI}_2]^{2-} + \text{Hg}^{2+} \rightarrow 2\text{HgI}_2 \downarrow$

KOMPLEKSONOMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
To'g'ri titrlash: 0,05M-0,1M trilon B (Na ₂ H ₂ L) 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 muayyan qiymatlarida o'tkaziladi	$H_2L^{2-} + Me^{2+} \rightarrow [MeL]^{2-} + 2H^+$ Me ²⁺ kationlarini saqlagan eritmaga ammiakli bufer eritma, indikator qo'shiladi va trilon B ning standart eritmasi bilan rang o'zgar-gunicha titrlanadi.
Teskari titrlash: 1. 0,05M-0,1M trilon B eritmasi 2. 0,05M-0,1M MgSO ₄ yoki ZnSO ₄ eritmali			1. Maxsus indikatorlar mavjud emas. 2. Kationlar cho'kmasi bufer eritmada hosil bo'ladi. 3. Kompleks hosil bo'lishi sekin boradi. 4. Suvda erimaydigan cho'kmalar (CaC ₂ O ₄ , MgNH ₄ PO ₄) dagi kationlar aniqlanadi	Titrlash pH ning muayyan qiymatlarida o'tkaziladi	$H_2L^{2-} (mo'l) + Me^{2+} \rightarrow [MeL]^{2-} + H^+$ $H_2L^{2-} (goldag) + Mg^{2+} \rightarrow [MgL]^{2-} + H^+$ Metall kationlarini saqlagan eritmaga mo'l miqdorda trilon B eritmasi qo'shiladi va uning ortiqchasi metalloxrom indikator ishtirokida magniy tuzlari eritmasi bilan titrlanadi

5-jadvalning davomi

Bilvosita titrlash: 0,05M-0,1M trilon B eritmasi		Metallar aniqlanadi	--	$\text{Me}^{2+} + [\text{MgL}]^{2-} \rightarrow \text{Mg}^{2+} + [\text{MeL}]^{2-}$ $\text{H}_2\text{L}^{2-} + \text{Mg}^{2+} \rightarrow [\text{MgL}]^{2-} + \text{H}^+$ Eritmaga trilon B ning rux yoki magniy bilan kompleksidan mo'1 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		$\text{H}_2\text{L}^{2-} + \text{Me}^{2+} \rightarrow [\text{MeL}]^{2-} + 2\text{H}^+$ $2\text{H}^+ + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O}$

OKSIDLANISH-QAYTARISHLI TITRLASH USULLARI

Oksidlanish-qaytarishli titrlash usullari

Oksidimetriya

Bu usul oksidlovchilarning standart eritmalari bilan titrlab qaytaruvchilarni aniqlashga asoslangan:

permanganometriya

(titrant – KMnO_4),

bromometriya

(titrant – KBrO_3),

dixromometriya

(titrant – $\text{K}_2\text{Cr}_2\text{O}_7$),

yodometriya

(titrant – KI dagi I_2),

yodxlorimetriya

(titrant – ICl),

nitritometriya

(titrant – NaNO_2),

serimetriya

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

va boshqalar

Reduktometriya

Bu usul qaytaruvchilarning standart eritmalari bilan titrlab oksidlovchilarni aniqlashga asoslangan:

yodometriya

(titrant – $\text{Na}_2\text{S}_2\text{O}_3$),

nitritometriya

(titrant – NaNO_2),

gidrazinometriya

(titrant – $\text{N}_2\text{H}_4 \cdot \text{H}_2\text{SO}_4$),

askorbinometriya

(titrant – $\text{C}_6\text{H}_8\text{O}_6$),

ferrometriya

(titrant – FeSO_4) va boshqalar

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'shili- shidan 30 sekund davomida yo'qol- maydigan pushti rangning paydo bo'lishi; 2. Indikatorli: – redoksindikator- lar, masalan ferro- in	H ₂ C ₂ O ₄ ·2H ₂ O, Na ₂ C ₂ O ₄ , As ₂ O ₃ , Fe (met.), (NH ₄) ₂ Fe(SO ₄) ₂ · x6H ₂ O. Standart eritmalar H ₂ C ₂ O ₄ va NaAsO ₂	Quyidagilar aniqla- nadi: 1) qaytaruvchilar: to'g'ri titrlash bilan C ₂ O ₄ ²⁻ , Fe ²⁺ , H ₂ O ₂ , NO ₂ ⁻ ; tekshiruvchi bilvosita titrlash bi- lan – Ca ²⁺ . 2) oksidlovchilar: teskari titrlash bi- lan – MnO ₂ , PbO ₂ , K ₂ Cr ₂ O ₇ , S ₂ O ₈ ²⁻ (2- standart eritma – H ₂ C ₂ O ₄ , NaAsO ₂); bilvosita titrlash bi- lan Ca ²⁺ , Sr ²⁺ , Ba ²⁺ , Pb ²⁺ .	Titrlash a) kuchli kislotali muhitda (H ₂ SO ₄); b) qizdirilganda (t = 60-70°C) yoki xona haroratida o'tkazi- ladi. Titrlash seklin o't- kaziladi, har bir ke- yingi tomchi oldin- gisi rangsizlangan- dan keyin qo'shila- di.	+5e + MnO ₄ ⁻ + 8H ⁺ = Mn ²⁺ + 4H ₂ O E° = 1,51 V. Teskari titrlash metodi bilan Ca ²⁺ ni aniqlash 1. Ca ²⁺ + C ₂ O ₄ ²⁻ (met.) → CaC ₂ O ₄ ↓ + C ₂ O ₄ ²⁻ (goldaq) 2. -2e + C ₂ O ₄ ²⁻ → 2CO ₂ ↑ 5 +5e + MnO ₄ ⁻ + 8H ⁺ → Mn ²⁺ + 4H ₂ O 2 2MnO ₄ ⁻ + C ₂ O ₄ ²⁻ (goldaq) + 16H ⁺ → → 2Mn ²⁺ + 8H ₂ O + 10CO ₂ ↑ Bilvosita titrlash metodi bi- lan Ca ²⁺ ni aniqlash 1. Ca ²⁺ + C ₂ O ₄ ²⁻ → CaC ₂ O ₄ ↓ 2. CaC ₂ O ₄ ↓ + 2H ⁺ → H ₂ C ₂ O ₄ + Ca ²⁺ 3. -2e + H ₂ C ₂ O ₄ → 2CO ₂ ↑ + 2H ⁺ 5 +5e + MnO ₄ ⁻ + 8H ⁺ → Mn ²⁺ + 4H ₂ O 2 2MnO ₄ ⁻ + 5H ₂ C ₂ O ₄ + 16H ⁺ → 2Mn ²⁺ + 8H ₂ O + 10CO ₂ ↑

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 erit- dagi erit- masi 2. Na ₂ S ₂ O ₃ eritmasi	1. Indikatorsiz: titrantning (I ₂) oriqcha ton- chisi eritma rangini och-sa- riqqa kiritadi.	As ₂ O ₃ , N ₂ H ₄ ·H ₂ SO ₄ , BaS ₂ O ₃ . Standart erit- malar: Na ₂ S ₂ O ₃ , I ₂ ning KI dagi eritmasi	Quyidagilar aniq- landi: 1) Na ₂ S ₂ O ₃ eritma- si yordamida to'- g'ri titrlash bilan — oksidlovchilar (I ₂); 2) I ₂ ning KI dagi eritmasi yordami- da to'g'ri titrlash bilan — qaytaruv- chilar (Na ₂ S ₂ O ₃ , As ₂ O ₃); 3) bilvosita titr- lash bilan — kuchli oksidlovchilar Cl ₂ KBrO ₃ , H ₂ O ₂ ;	1. Titrlash sovuqda o'tkaziladi, chunki I ₂ uchuvchan va indi- kator — kraxmalning sezgirliги pasayadi. 2. Titrlash neytral, kuchsiz kislotali yo- ki kuchsiz ishqoriy muhitda o'tkaziladi. a) kuchli ishqoriy mu- hitda yod dispropor- siyalanadi I ₂ + 2OH ⁻ → IO ⁻ + I ⁻ + H ₂ O; b) kuchli kislotali mu- hitda qo'shimcha re- aksiyalar boradi 4I ⁻ + O ₂ + 4H ⁺ → — S ₂ O ₃ ²⁻ + 2H ⁺ → SO ₂ ↑ + S↓ + H ₂ O	1) + 2e + [I ₃] ⁻ → 3I ⁻ 1 - 2e + 2S ₂ O ₃ ²⁻ → S ₄ O ₆ ²⁻ 1 [I ₃] ⁻ + 2S ₂ O ₃ ²⁻ → S ₄ O ₆ ²⁻ + 3I ⁻ 2) - 2e + AsO ₃ ³⁻ + 2OH ⁻ → AsO ₄ ³⁻ + H ₂ O 1 + 2e + [I ₃] ⁻ → 3I ⁻ 1 AsO ₃ ³⁻ + [I ₃] ⁻ + 2OH ⁻ → AsO ₄ ³⁻ + 3I ⁻ + H ₂ O 3) + 6e + Cr ₂ O ₇ ²⁻ + 14H ⁺ → 2Cr ³⁺ + 7H ₂ O 3 - 2e + 3I ⁻ → [I ₃] ⁻ 3 Cr ₂ O ₇ ²⁻ + 14H ⁺ + 9I ⁻ → 2Cr ³⁺ + + 7H ₂ O + 3[I ₃] ⁻

1. 0,1M- 0,05M $\text{Na}_2\text{S}_2\text{O}_3$ eritmasi	2. Indikatorli: 0,5%-li krax- mal eritmasi	$\text{K}_2\text{Cr}_2\text{O}_7$, KBrO_3 , KIO_3 , $\text{K}_3[\text{Fe}(\text{CN})_6]$ va I_2 ning KI dagi, KMnO_4 standart eritmalar	4) to'g'ri titrlash bilan - kuchli kis- lotalar, teskari titrlash bilan - kuchsiz kislotalar; 5) aromatik va ge- terotsiklik birk- malar (fenol, dife- nol va aromatik aminlar); 6) to'yinmagan uglevodorodlar	3. Bilvosita titrlash metodi bilan kuchli oksidlovchilarni aniqlashda ajralib chiq- yotgan yodni eritish uchun KI eritmasidan qo'shib turish kerak: $\text{I}_2 + \text{I}^- \rightarrow [\text{I}_3]^-$; KI ni qo'shgandan keyin reaksiya ara- lashma 10-15 min qo- rong'i joyda saqlana- di	4) $+10\text{e} + 2\text{IO}_3^- + 12\text{H}^+ \rightarrow \text{I}_2 + 6\text{H}_2\text{O}$ 1 $-2\text{e} + 2\text{I}^- \rightarrow \text{I}_2$ 5 $\text{IO}_3^- + 6\text{I}^- + 5\text{I}^- \rightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$ $3\text{I}_2 + 3\text{I}^- \rightarrow 3[\text{I}_3]^-$ $\text{IO}_3^- + 6\text{H}^+ + 8\text{I}^- \rightarrow 3[\text{I}_3]^- + 3\text{H}_2\text{O}$
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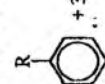
YODXORIMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M ICl eritmasi	1. Kraxmal eritmasi 2. Indikatorsiz: ajralib chiqqan yod eritmani och-sariq rangga bo'yaydi	As ₂ O ₃ , N ₂ H ₄ ·H ₂ SO ₄ , K ₄ [Fe(CN) ₆] va KI, Na ₂ S ₂ O ₃ standart eritmalar	Quyidagilar aniqlanadi: 1) to'g'ri titrlash bilan - Sn ²⁺ , NCS ⁻ , SO ₃ ²⁻ , anipirin, askorbin kislotasi; 2) teskari titrlash bilan - Hg ²⁺ , Fe ³⁺ ; 3) bilvosita titrlash bilan - KI	Titrlash kislotali (HCl) muhitda o'tkaziladi	Titrantni tayyorlash $-2e + \Gamma + \text{Cl}^- \rightarrow \text{ICl}$ $+4e + \text{IO}_3^- + 6\text{H}^+ + \text{Cl}^- \rightarrow \text{ICl} + 3\text{H}_2\text{O}$ $2\Gamma + \text{IO}_3^- + 6\text{H}^+ + 3\text{Cl}^- \rightarrow 3\text{ICl} + 3\text{H}_2\text{O}$ $+2e + \text{ICl} \rightarrow \Gamma + \text{Cl}^- \quad E^\circ = +0,795 \text{ V}$ $(E \leq 0,4 \text{ V da})$ $+2e + 2\text{ICl} \rightarrow \text{I}_2 + 2\text{Cl}^- \quad E^\circ = +1,06 \text{ V}$ $(E \leq 0,6 \text{ V da})$ $-2e + \text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ \quad $ $+2e + \text{ICl} \rightarrow \Gamma + \text{Cl}^- \quad $ $\text{SO}_3^{2-} + \text{H}_2\text{O} + \text{ICl} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + \text{Cl}^-$ $\text{ICl} + 2\Gamma \rightarrow [\text{I}_3]^- + \text{Cl}^-$

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: difenilamin, tropeolin-00, neytral qizil va uning metilen ko'k bilan aralashmasi	<i>p</i> -Aminobenzoy kislotasi, sulfanil kislotasi, gidrazin sulfat. Standart eritmalar: KMnO ₄ (tekshirish uchun), gidrazin sulfat	Quyidagilar aniqlanadi: a) oksidlovchilar: KMnO ₄ , Ce ^{IV} , Cl ₂ , H ₂ O ₂ ; b) qaytaruvchilar: sulfanil kislotasi, gidrazin sulfat, Sn ²⁺ , Fe ²⁺ , As ₂ O ₃ ; c) birlamchi va ikkilamchi aminlar (streptotsid, norsulfazol, sulfatsil va boshqalar)	1. Kislotali muhit (HCl ning mo'lmiqdori). 2. "Sovuqda" yoki $t = 20-25^{\circ}\text{C}$ da. 3. Sekin titrlanadi, ayniqsa titrlash oxirida. 4. Katalizator sifatida KBr qo'llaniladi.	a) Oksidlanish: $-2e + \text{HNO}_2 + \text{H}_2\text{O} \rightarrow \text{NO}_3^- + 3\text{H}^+$ $E^{\circ} = 0,94 \text{ V}$. b) Qaytarilish: $+6e + 2\text{HNO}_2 + 6\text{H}^+ \rightleftharpoons \text{N}_2\uparrow + 4\text{H}_2\text{O}$ $E^{\circ} = 1,44 \text{ V}$. c) Diazotirlash: $\text{R-NH}_2 + \text{NaNO}_2 + 2\text{HCl} \rightleftharpoons [\text{R-N}^+\equiv\text{N}]\text{Cl}^- + \text{NaCl} + 2\text{H}_2\text{O}$ d) Nitrozirlash: $\text{R-NH-R} + \text{NaNO}_2 + \text{HCl} \rightarrow \text{R-N(NO)R}' + \text{NaCl} + \text{H}_2\text{O}$

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, metiloran).	Standart modda As ₂ O ₃ . Standart eritma Na ₂ S ₂ O ₃	Quyidagilar aniqlanadi: a) bevosita oksidlash yo'li bilan Na ₂ H ₄ , H ₂ SO ₄ , Sb ^{III} , Sn ²⁺ , As ^{III} , As ₂ O ₃ kabi qaytaruvchilar; b) bromlash yo'li bilan fenol, rezorsin (teskari titrlash), salitsil kislotasi; c) aromatik aminlar, masalan streptotsid	Kislotali muhit	a) $+6e + \text{BrO}_3^- + \text{H}^+ \rightarrow \text{Br}^- + 3\text{H}_2\text{O} \quad 2$ $E^\circ = 1,45 \text{ V}$ $-4e + \text{AsO}_3^- + \text{H}_2\text{O} \rightarrow \text{AsO}_4^{3-} + 2\text{H}^+ \quad 1$ $E^\circ = 0,56 \text{ V}$ $\text{BrO}_3^- + 3\text{AsO}_3^{3-} \rightarrow \text{Br}^- + 3\text{AsO}_4^{2-}$ b) $-2e + 2\text{Br}^- \rightarrow \text{Br}_2 \quad 5$ $E^\circ = 1,087 \text{ V}$ $+10e + 2\text{BrO}_3^- + 12\text{H}^+ \rightarrow \text{Br}_2 + 3\text{H}_2\text{O} \quad 1$ $E^\circ = 1,52 \text{ V}$ $\text{BrO}_3^- + 5\text{Br}^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$  bunda R = -OH; -NH₂

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: $(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$. Standart eritma: $Na_2S_2O_3$ (yodometrik metod bilan standartlash-tiriladi)	Quyidagilar aniqlanadi: 1) teskari titrlash bilan - SO_3^{2-} , I^- , Fe^{2+} , Sn^{2+} , AsO_3^{3-} , $[Fe(CN)_6]^{4-}$, metanol, askorbin kislotasi; 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)	$E^\circ(Cr_2O_7^{2-}/Cr^{3+}) = +1,33 V$ 1) $-e + Fe^{2+} \rightarrow Fe^{3+}$ $+6e + Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$ 6 $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$ 2) $Ba^{2+} + CrO_4^{2-} \rightarrow BaCrO_4 \downarrow$ $2BaCrO_4 + 4H^+ \rightarrow 2Ba^{2+} + Cr_2O_7^{2-} + 2H_2O$ $Cr_2O_7^{2-}$ ionlari Fe^{2+} bilan titrlanadi 3) $3Fe^{2+} + NO_3^- + 4H^+ \rightarrow 3Fe^{3+} + NO \uparrow + 2H_2O$ $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+ \rightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$

SERIMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M, 0,01M $\text{Ce}(\text{SO}_4)_2 \times$ $\times 4\text{H}_2\text{O}$ eritmasi	1. Redoks indikatorlar: ferroin, di-o-fenantrolin, di-fenilamin. 2. Indikatorsiz - Ce^{4+} eritmalarini sariq rangga ega. 3. pH-indikatorlar (metiloranj, metil qizil) - qaytnas oksidlanish	$\text{Na}_2\text{C}_2\text{O}_4$, $(\text{NH}_4)_2\text{C}_2\text{O}_4$, Titrant yodometrik metod bilan standartlashtiriladi	As^{III} , Fe^{2+} , Sb^{III} , Sn^{2+} , $[\text{Fe}(\text{CN})_6]^{4-}$, H_2O_2 , $\text{C}_2\text{O}_4^{2-}$, NO_2^- , organik birlikmalar: fenollar, aminlar, aminokislotalar, organik kislotalar, uglevodlar aniqlanadi	Titrlash kislotali muhitda o'tkaziladi (HClO_4)	$\text{Ce}^{4+} + e \rightleftharpoons \text{Ce}^{3+}$ HClO_4 muhitida $E^\circ = +1,70 \text{ V}$. Seriya kompleks tuzlari redoks juftlarining oksidlanish-qaytarilish potentsiallari anionlar tabiatiga bog'liq: $E^\circ[\text{Ce}(\text{SO}_4)_3]^{2-}/\text{Ce}^{3+} = 1,44 \text{ V}$, $E^\circ[\text{Ce}(\text{SO}_4)_6]^{2-}/\text{Ce}^{3+} = 1,61 \text{ V}$, $E^\circ[\text{CeCl}_6]^{2-}/\text{Ce}^{3+} = 1,28 \text{ V}$. Masalan: $-2e + \text{H}_2\text{C}_2\text{O}_4 \rightarrow 2\text{CO}_2\uparrow + 2\text{H}^+$ $+e + \text{Ce}^{4+} \rightarrow \text{Ce}^{3+}$ $\text{H}_2\text{C}_2\text{O}_4 + 2\text{Ce}^{4+} \rightarrow 2\text{CO}_2\uparrow + 2\text{Ce}^{3+} + 2\text{H}^+$

TITRIMETRIK ANALIZDA HISOBLASH FORMULALARI

Ayrim tortimlar usuli

1. Ekvivalent molyar massa bo'yicha:

- titrantlarni standartlash uchun qo'llaniladigan kimyoviy toza moddalar tortimining massasi quyidagi formula bo'yicha 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:

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

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

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

2. Titrantning aniqlanuvchi modda titri bo'yicha:

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

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

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

bunda, $T_{(T/a)}$ – titrantning aniqlanuvchi modda bo'yicha titri, g/sm³; $T_{1(T/a)}$ – aniqlanadigan modda bilan bevosita ta'sir etadigan titrantning aniqlanuvchi modda bo'yicha titri, g/sm³; 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:

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

bunda, V – titrlangan eritma hajmi, taxminan 20 sm³; V_k – modda tortimi eritilgan kolba hajmi, sm³; V_p – eritmaning alikvot qismini o'lchab olishga qo'llaniladigan pipetka hajmi, sm³.

- aniqlanadigan modda tortimining massasi (m_t) quyidagi formula bo'yicha aniqlanadi:

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

bunda, V – titrlangan eritma hajmi, taxminan 20 sm³; V_k – modda tortimi eritilgan kolbaning hajmi, sm³; V_p – eritmaning alikvot qismini o'lchab olishga qo'llaniladigan pipetka hajmi, sm³.

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

$$C_M = \frac{m_t \cdot V_p \cdot 1000}{E_M \cdot V_k \cdot V},$$

bunda, V – standart moddaning alikvot qismiga sarflanadigan titrlangan eritmaning hajmi, sm³; V_k – modda tortimi eritilgan

kolbaning hajmi, sm^3 ; V_p – eritmaning alikvot qismini o'lishga qo'llaniladigan pipetka hajmi, sm^3 .

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

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

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

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

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:

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

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

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 konsentratsiyasi, 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 byuretk 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 mumkin. 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 $x_1, x_2, \dots, x_n$ lar a kattalikni n marta o'lchash natijalari bo'lsa, unda

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

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 $x_1, x_2, \dots, x_n$ 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:

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

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:

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

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:

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

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

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

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 ($x_1, x_{\max} - x_{\min}$). 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 qo'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

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:

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

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 namunalariidagi 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:

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

$$1. \bar{x} = \frac{0,31 + 0,30 + 0,29 + 0,32}{4} = 0,305.$$

$$2. \bar{x} = \frac{0,51 + 0,57 + 0,58 + 0,57}{4} = 0,578.$$

$$3. \bar{x} = \frac{0,71 + 0,69 + 0,71 + 0,71}{4} = 0,705.$$

$$4. \bar{x} = \frac{0,92 + 0,92 + 0,95 + 0,95}{4} = 0,935.$$

$$5. \bar{x} = \frac{1,18 + 1,17 + 1,21 + 1,19}{4} = 1,19.$$

Har bir namuna uchun kvadratlar farqini, so'ng esa

$$S = \sqrt{\frac{\sum_{j=1}^m \sum_{i=1}^n (x_{ji} - \bar{x}_j)^2}{n - m}}$$

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 xatolikni 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:

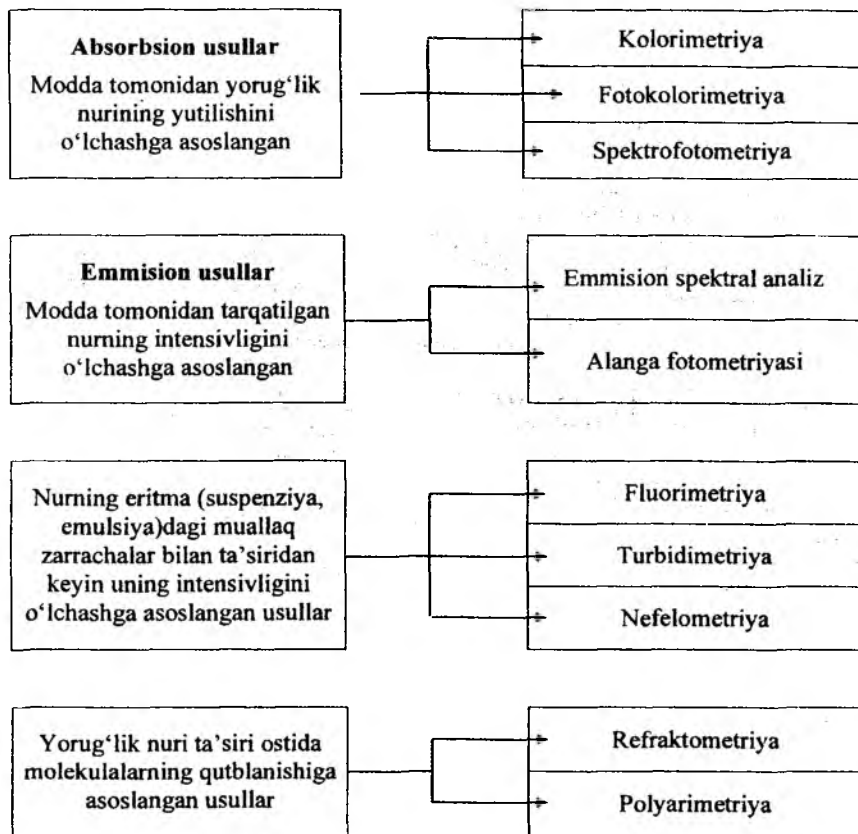
$$Q = \frac{2,99 - 2,91}{2,99 - 2,86} = 0,62.$$

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



MOLEKULAR-ABSORBSION ANALIZ USULLARI

Analiz spektrning ko'rinish, UB-, IQ-sohasida molekula yoki ionlar tomonidan elektromagnit nurlarning yutilishini o'lchashga asoslangan.

Kolorimetriya

Bu metod turli konsentratsiyali eritmalar rangining intensivligini taqqoslashga asoslangan. Yorug'lik monoxromatik emas. Yorug'likning yutilish qonuniga bo'y-sinmaydi. Spektr sohasi: 400-700 nm. O'lchash aniqligi $\pm 5-10\%$. Analiz uchun kolorimetrik probirkalar ishlatiladi.

Fotoelektrokolorimetriya

Bu metod spektrning ko'rinish sohasida aniqlanuvchi moddaning monoxromatik bo'lmagan yoki qisman monoxromatik nurlarni yutish darajasini o'lchashga asoslangan. Yorug'likning yutilish qonuniga bo'y-sinadi. Spektr sohasi: 300-700 nm. Asbob – fotoelektrokolorimetr. O'lchash aniqligi $\pm 3\%$.

Spektrning ko'rinish, UB- va IQ-sohalaridagi spektroskopiya

Bu metodlar modda tomonidan spektrning ko'rinish (360-760 nm), UB- (180-360 nm) va IQ- (760-1100 nm) sohalarida monoxromatik nurlarning yutilishini o'lchashga asoslangan.

Spektr sohasi – 180-760 nm.
Asbob – UB-spektrofotometr
O'lchash aniqligi $\pm 2\%$.

Spektr sohasi – 760-1100 nm.
Asbob – IQ-spektrofotometr
O'lchash aniqligi $\pm 2\%$.

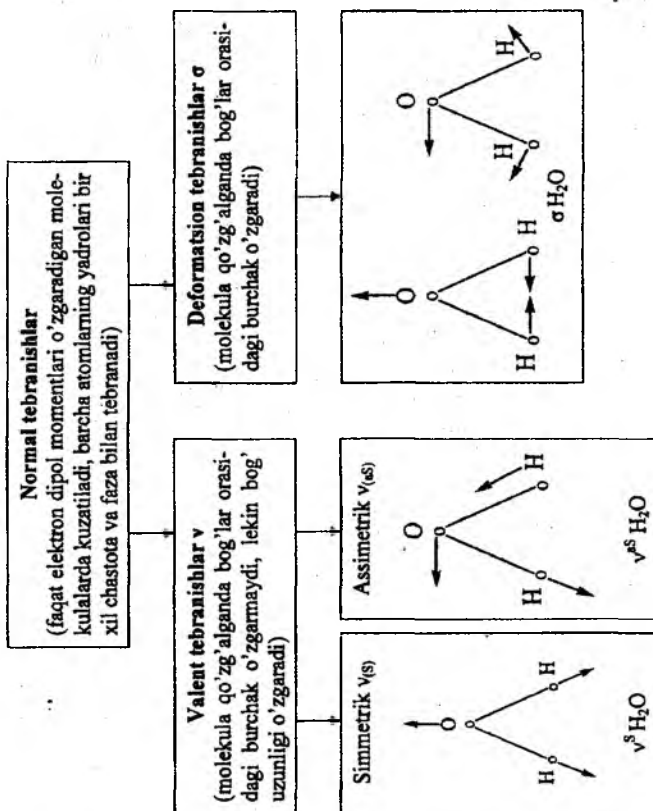
IQ- VA UB-SPEKTROSKOPIYANING ANALIZDA QO'LLANILISHI

IQ-spektroskopiya	UB-spektroskopiya
Sifat analizi	Sifat analizi
Bu metod yordamida: - tegishli xarakteristik chastotalardagi ($600-1500 \text{ sm}^{-1}$) 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) yutish (spektrdagi maksimum) bo'yicha organik va anorganik birliklarning strukturasini aniqlanadi.	Bu metod yordamida: - organik birliklarning strukturasini aniqlanadi (ayrim kimyoviy bog'lar uchun xarakterli bo'lgan yutish maksimumlari yoki minimumlarining to'liq uzunliklari bo'yicha hamda yutish intensivligi bo'yicha); - molekulararo ta'sir, zaryad ko'chishi bilan komplekslar (π-komplekslar) hosil bo'lish mexanizmlari o'rganiladi; - ma'lum konsentratsiyali eritmalarining maksimum nuqtasidagi ϵ kattalik va yutish chiziqlarining to'liq kattaliklari bo'yicha moddalar identifikatsiyalanadi; - organik birliklardagi elektronlarning energetik pog'onalari tavsiflanadi
Miqdoriy analiz	Miqdoriy analiz
Analiz asosida Buger-Lambert-Ber qonuni yotadi, biroq bu qiymchiliklarni tug'diradi, chunki / kattalik juda kichik (o'ltashlar tor quyvetada 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 yutuvtchi moddalar aralashmasi uchun ham o'tkazish mumkin.

KOLORIMETRIYA VA FOTOKOLORIMETRIYA METODLARINING TAYSIFLARI

Kolorimetriya	Fotokolorimetriya
Bu metod rangli eritmalarining konsentratsiyalarini taxminiy baholashda qo'llaniladi. Agar eritma rangsiz bo'lsa, rangli birlikka bosil bo'lishi bilan boradigan fotometrik reaksiya o'tkaziladi. Buger-Lambert-Ber qonuniga bo'yinishi talab etilmaydi. Miqdoriy aniqlashlar quyidagi metodlar bilan o'tkaziladi: 1. Taqqoslash metodi: tekshiriladigan va standart eritmalar qatlaminig 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 – tegishli standart va tekshiriladigan eritmalar qatlaminig qalinligi. 2. Standart seryalar 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 eritmalarining optik zichligi (A) yoki o'tkazishini (T) o'lchash yoli bilan rangli eritmalarining konsentratsiyasini aniqlashda qo'llaniladi. Buger-Lambert-Ber qonuniga bo'yinishi shart. $A = \lg \frac{I_0}{I}; \quad I = I_0 \cdot 10^{-\epsilon \cdot l}; \quad A = \epsilon \cdot C \cdot l;$ $T = \frac{I}{I_0}; \quad A = \lg \frac{1}{T}; \quad \epsilon = \frac{A \cdot l}{C \cdot l}; \quad E_{1\%}^{1\text{cm}} = \frac{A \cdot l}{C \cdot l}.$ 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; $E_{1\%}^{1\text{cm}}$ – yorug'lik yutilishining solishtirma koeffitsiyenti, qatlam qalinligi 1 sm va konsentratsiyasi $C = 1\%$ bo'lgan eritmaning optik zichligiga (A) teng. $\epsilon = E_{1\%}^{1\text{cm}} \cdot \frac{M}{10}, \quad \text{bunda } M - \text{moddaning molekulyar massasi.}$ Konsentratsiya quyidagi metodlar bilan aniqlanadi: 1. Darajalangan grafik metodi. 2. ϵ koeffitsiyentlarning o'rta qiyamatlari bo'yicha. 3. Qo'shimchalar metodi. 4. Differensial fotometriya metodi. 5. Ekstraksiyon-fotometrik metod.

TEBRANMA IQ-SPEKTRLARNING KLASSIFIKATSIYASI



SPEKTROSKOPIYA USULLARIDAGI ASOSIY TERMIN VA TUSHUNCHALAR

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

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

Tebranma spektr (IQ-spektroskopiya) – $4000-400\text{ sm}^{-1}$ 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'liqin uzunliklari hamda molekula strukturasi o'zgarganda ular kam o'zgaradi. ($2000-4000\text{ sm}^{-1}$ oraliq $C-H$; $O-H$; $N-H$ bog'larning valent tebranishlariga mos keladi; $1500-1950\text{ sm}^{-1}$ 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) – ($600-1500\text{ sm}^{-1}$) 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.

	$\sigma \rightarrow \sigma^*$	O'tish
	$\pi \rightarrow \pi^*$	Birikma
	$n \rightarrow \pi^*$	metan, etan, to'yinmagan uglevo-dorodlar
	$n \rightarrow \sigma^*$	spirtlar, efirlar, xlororganik birikmalar
	$\pi \rightarrow \pi^*$	aromatik birikmalar
	$n \rightarrow \pi^*$	

Elektron pog'onalarining 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}	Teburanishlar turi va tegishli struktur element	Modda
3700...3600 (tor chiziq)	Valent tebranish, $-\text{O}-\text{H}$ (erkin, assitsilanmagan guruh)	Spirtlar, fenollar, kislotalar, oksiketonlar, oksikislota efirlari
3500...3300 (keng chiziq)	Valent tebranish, $-\text{O}-\text{H}$ (bog‘langan guruh)	
3550...3350	Valent, $-\text{N}-\text{H}$ (assitsilanmagan guruh)	Birlamchi va ikki- lamchi aminlar va amidlar
3500...3100	Valent, $-\text{N}-\text{H}$ (assitsilangan guruh)	
3300...3270	Valent, $\equiv\text{C}-\text{H}$	Atsetilenning mono-almashingan hosilalari
3350...3150 (keng chiziq)	Valent, $-\text{NH}_2$	Aminlar va amino- kislotalar gidrokslo- ridlari
3300...2500 (juda keng chiziq)	Valent, $-\text{O}-\text{H}$ (assitsilangan guruh)	Karbon kislotalar, xelatlar
3100...3000	Valent, $=\text{C}-\text{H}$	Aromatik uglevodo- rodlar, olefinlar
3000...2800	Valent, $-\text{C}-\text{H}$	Parafinlar, sikloparafinlar
2962, 2872	Valent, $-\text{CH}_3$	Parafinlar
2962, 2853	Valent, $-\text{CH}_2-$	Parafinlar
2900...2400	Valent, $-\text{O}-\text{D}$, $-\text{N}-\text{D}$	Spirtlar, aminlar
2820	Valent, $-\text{O}-\text{CH}_3$	Oddiy metil efirlar
2820...2730	Valent, $\text{N}-\text{CH}_3$	N-metilamin
2820...2720	Valent, $\text{OC}-\text{H}$	Aldegidlar

2600...2550	Valent, $-S-H$	Merkaptanlar, tiofenollar
2300...2100	Valent, $-C \equiv X$ ($X = C, N, O$)	Atsetilen, nitrillar, uglerod oksidlari
2270...2000	Valent, $-Y = C = X$ ($Y = N, C; X = O, S$)	Izotsianat va ketonlar
2260...2190	Valent, $-C \equiv C-$	Atsetilenning 1,2-dialmashigan hosilalari
2260	Valent, $-N^+ \equiv N$	Diazoniyl tuzlarining hosilalari
2245...2220	Valent, $-C \equiv N$	Nitrillar
2185...2120	Valent, $-N = C-$	Izonitrillar
2140...2100	Valent, $-C \equiv C-$	Monoalmashigan atsetilenlar
1900...1600	Valent, $-C = O$	Karbonil birikmalar
1850...1740	Valent, $-C - O$	Karbon kislotalarining galogenangidridlari
1840...1780 1780...1720	Valent, $-C = O$	Karbon kislotalarining anhidridlari (2 ta chiziq)
1780...1750 1760...1700	Valent, $-C = O$ Valent, $-C = O$	Fenilkarbon kislotalar, karbon kislotalarning vinil efirlari
1750...1730	Valent, $-C - O$	To'yinmagan karbon kislotalarning alkil efirlari
1730...1710	Valent, $-C = O$	To'yinmagan aldegidlar 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, $-C \equiv N$	Azometinlar, oksiranlar
1690...1660	Valent, $-C = O$	α , β -to'yinmagan va aromatik ketonlar
1680...1630	Valent, $-C = O$	Karbon kislotalar birlamchi, ikkilamchi va uchlamchi amidlari
1660...1600	Valent, $-C = C -$	Aromatik birikmalar, olefinlar
1650...1620	Deformatsion, $-NH_2$	Karbon kislotalar-ning 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 kislotalar-ning 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, kar-bon 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
1050...1010	Valent, $-C-O-$	Birlamchi spirtlar
1070...1030	Valent, $-S=O$	Sulfoksidlar
970...960	Deformatsion, $=C-H$	Etilenning 1,2-dialmashigan hosilalar (<i>trans</i> -izomerlar)
995...985 915...905	Deformatsion, $=C-H$	Etilenning monoal-mashigan hosilari
900...860 810...750	Deformatsion, $-C-H$	Benzolning 1,3-dialmashigan hosilari
725...680 885...855	Deformatsion, $=C-H$	Etilenning 1,1-dialmashigan hosilari
860...800	Deformatsion, $-C-H$	Benzolning 1,4-dialmashigan hosilari
780...500	Valent, $-C-Hal$	Aromatik va alifatik galogen hosilalar
770...735	Deformatsion, $=C-H$	Benzolning 1,2-dialmashigan hosilari
770...730	Deformatsion, $=C-H$	Benzolning monoal-mashigan hosilari
710...690 780...720	Deformatsion, $-C-H$	To'rttadan ko'proq $-CH_2-$ guruhini saqlagan <i>n</i> -parafinlar
705...550	Valent, $-C-S$	Oltingugurt saqlagan organik birikmalar (merkaptanlar, tio-

		efirlar)
730...680	Deformatsion, – C – H	Etilenning 1,2-dial- mashingan 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

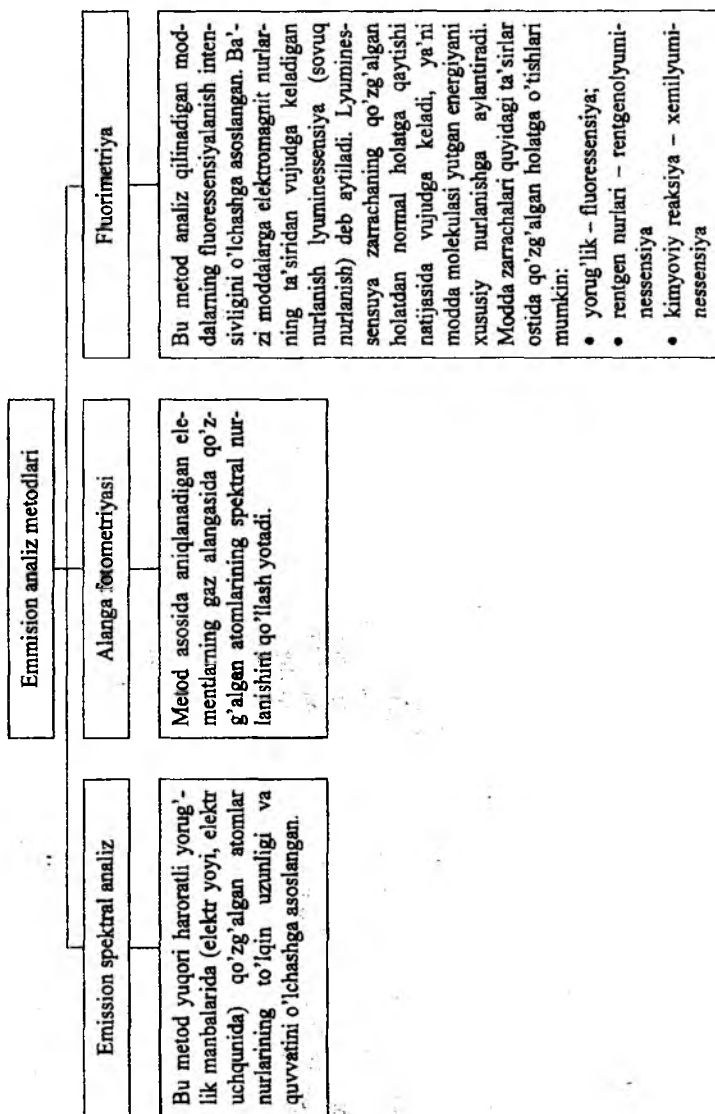
5-jadval

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

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'liq soni; ν – tebranish chastotasi; λ – to'liq uzunligi.

EMISSION ANALIZ METODLARI



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 chiziqlarning berilgan elementga tegishli ekanligi to'liq uzunligi va chiziqli intensivligi bo'yicha aniqlanadi. Aniqlash chegarasi $10^{-2} - 10^{-5}\%$.	Metod asosini spektral chiziqli intensivligi va element konsentratsiyasi orasidagi bog'liqlik tashkil etadi. Odatda alohida chiziqlarning intensivligi emas, balki turli elementlarga tegishli ikki spektral chiziqlarning nisbati qo'llaniladi. Aniqlanadigan komponentning analitik chiziqli intensivligi boshqa komponentning (ichki standartning) analitik chiziqli 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.

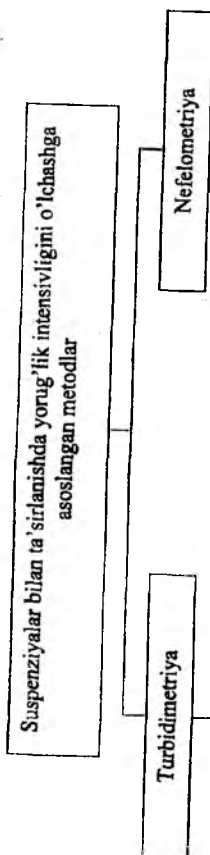
EMISSION ALANGALI FOTOMETRIYA

Sifat analizi	Miqdoriy analiz
Metod asosini analiz qilinadigan element atomlarining alanga spektrida qo'zg'alishi 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'liq uzunliklariga mos tushishi kerak. Analiz atomlarning alangada nurlanadigan spektrlari bo'yicha o'tkaziladi. Asosan ishqoriy va ishqoriy-yer elementlari, talyi aniqlanadi.	Elementning aniqlanishi spektral chiziq intensivligi (I) va elementning eritmada konsentratsiyasi (C) orasidagi funksional bog'liqlikka asoslangan. Asosiy tenglama: $\lg I = \lg a + b \cdot \lg C$, bunda: a — proporsionallik koeffitsiyenti (yorug'lik manbaining haroratiga bog'liq); b — qo'zg'alman atomlarning yorug'lik kvantini yutishini hisobga oluvchi koeffitsiyent. Miqdoriy aniqlash quyidagi metodlar bilan o'tkaziladi: - darajalangan grafik ($\lg I = f(\lg C)$ chiziqli bog'liqlik); - qo'shimchalar metodi; Aniqlashning o'rtacha chegarasi — $10^{-3} - 10^{-4} \%$.

FLUORIMETRIYA

Sifat analizi	Miqdoriy analiz
Bu metod aniqlanadigan moddaning tegishli sharoitlarda lyuminessensiyalanishiga asoslangan. Organik birikmalar fluorensensiyaning xarakteristik spektral chiziqlari yoki fluorensentli nurlanishning rangi bo'yicha identifikatsiyalanadi. Anorganik ionlar uchun lyuminessensiyani 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'liq uzunlikdagi lyuminessensiyani ajratuvchi yorug'lik filtrlari qo'llaniladi.	Miqdoriy analiz asosini eritma fluorensensiyasi intensivligining fluorensensiyalanadigan moddalar konsentratsiyasiga bo'lgan bog'liqligi tashkil etadi. $10^{-7} - 10^{-4}$ mol/dm³ konsentratsiyali suyultirilgan eritmalarining fluorensensiya intensivligi quyidagi formula bo'yicha topiladi: $F = I_0 \cdot 2,3 \cdot \epsilon \cdot C \cdot b \cdot \varphi$ bunda: F – fluorensensiya intensivligi, kvant·c⁻¹; I_0 – ta'sir etuvchi nurning intensivligi, kvant·c⁻¹; ϵ – yutilishning molyar koeffitsiyenti; b – fluorensensiyalanadigan qatlarning qalinligi; φ – fluorensensiya umumiy (modda tabiatiga bog'liq). Aniqlash chegarasi 10^{-7} mol/dm³. Analizlar halqit beruvchi begona qo'shimchalarni saqlagan moddalar analizida <i>ekstraksiya-lyuminessentli miqdoriy analiz</i> qo'llaniladi. Tekshiriladigan modda organik erituvchi bilan ekstraksiyalanadi va yuqorida bayon etilgan usul bilan aniqlanadi.

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



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.

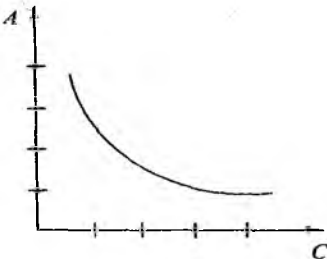
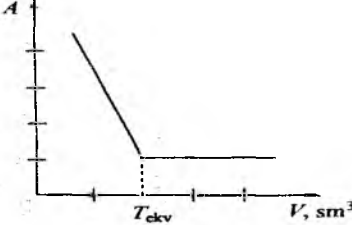
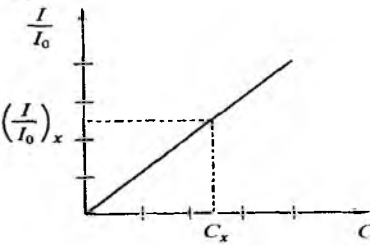
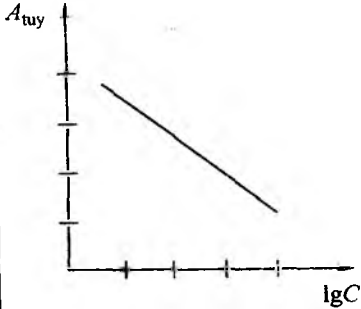
Konsentratsiyani aniqlash metodi muallaq zarrachalar tomonidan tarqatilgan va ularning konsentratsiyasiga proporsional bo'lgan yorug'lik intensivligini I_1 o'lchashga asoslangan.

$$I_1 = k \cdot C.$$

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

$$\frac{I_1^1}{I_1^2} = \frac{C_1}{C_2}; C_1 = \frac{I_1^1 \cdot C_2}{I_1^2}.$$

**TURBIDIMETRIYA VA NEFELOMETRIYA USULLARIDA
MIQDORIY ANIQLASH USULLARI**

Turbidimetriya	Nefelometriya
1. <i>Darajalangan grafik usuli</i> Ma'lum konsentratsiyali standart eritmalarining turbidimetrik analiz natijalariga asosan $A = f(C)$ bog'liqlik grafigi tuziladi (bog'liqlik chiziqli emas).  2. <i>Turbidimetrik titrlash</i> Bu usul titrantning aniqlanadigan modda 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. <i>Darajalangan grafik usuli</i> Ma'lum konsentratsiyali standart eritmalarining 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.

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

Yorug'lik ta'sirida molekulaning qutblanish hodisiga asoslangan metodlar

Refraktometriya

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

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

bunda:

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

n ning qiymatlari quyidagi shartlarda hisoblanadi:

$$t^\circ = 20^\circ\text{C};$$

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

O'lchash uchun asbob – n -refraktometr.

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

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

Polarimetriya

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);

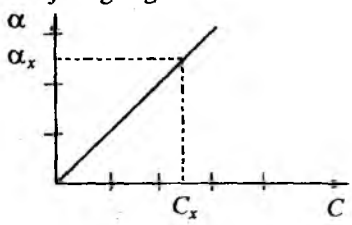
- optik faol modda qatlamining qalinligi (l).

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

O'lchash uchun asbob – α -polarimetr.

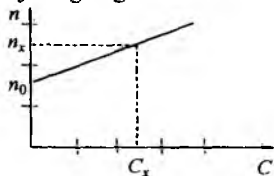
O'lchash aniqligi $\pm 0,02^\circ$.

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	1. Optik faol moddalarning konsentratsiyasi quyidagi formulaga muvofiq topiladi: $C = \frac{\alpha \cdot 100}{[\alpha]_D^{20} \cdot l}.$ 2. Darajalangan grafik usuli: 

bilan aniqlangan moddaning refraktometrik faktori;
 F_2 — tekshiriladigan modda tarkibidagi ikkinchi komponentning refraktometrik faktori.

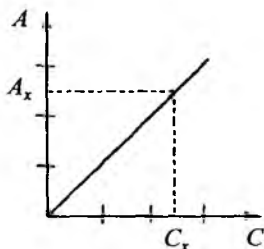
3. Darajalangan grafik usuli:



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 eritmalarining optik zichligi A_{st} aniqlanadi, ε hisoblanadi va $\varepsilon \cdot l$ 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.

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

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

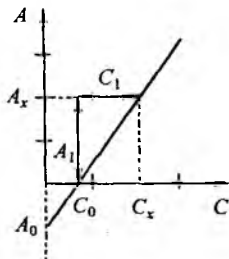
Qo'shimchalar usulida C_x ni, shuningdek $A_x = f(C_{st})$ koordinatalaridagi grafik bo'yicha ham topish mumkin.

4. Differensial fotometriya usuli

(rangli eritmalar analizida qo'llaniladi).

Hisoblash usullari:

I



$$C_x = C_0 + C_1$$

$$A_x = A_0 + A_1$$

Differensial fotometriyaning darajalangan grafigi

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

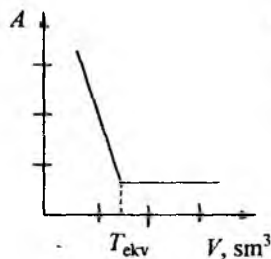
$$F = \frac{(C_x - C_0)}{A_n}; \quad C_x = C_0 + A_x \cdot F_{\text{taq}},$$

bunda:

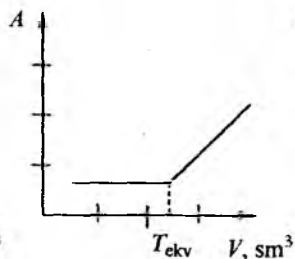
- F – analitik faktor;
- C_0 – taqqoslash eritmasidagi modda miqdori;
- A_n – ma’lum konsentratsiyali bir qator eritmalarining yutishi;
- A_x – tekshiriladigan eritmaning yutishi.

5. Fotometrik titrlash usuli

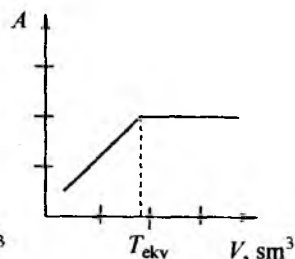
(ekvivalent nuqtani fotometrik aniqlash usuliga asoslangan, namunadagi ko‘p sonli moddalar analizida qo‘llaniladi).



Tekshiriladigan
eritmaning yutish



Titrantning yutish
kattaligi bo‘yicha



Reaksiya
mahsulotining yutish

kattaligi bo'yicha
fotometrik titrlash
egri chizig'i

fotometrik titrlash egri
chizig'i

kattaligi bo'yicha
fotometrik titrlash egri
chizig'i

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

$$C_1 = \frac{A^{\lambda_1} \cdot \epsilon_2^{\lambda_2} - A^{\lambda_2} \cdot \epsilon_1^{\lambda_1}}{\epsilon_1^{\lambda_1} \cdot \epsilon_2^{\lambda_2} - \epsilon_1^{\lambda_2} \cdot \epsilon_2^{\lambda_1}};$$

$$C_2 = \frac{A^{\lambda_2} \cdot \epsilon_1^{\lambda_1} - A^{\lambda_1} \cdot \epsilon_2^{\lambda_2}}{\epsilon_1^{\lambda_1} \cdot \epsilon_2^{\lambda_2} - \epsilon_1^{\lambda_2} \cdot \epsilon_2^{\lambda_1}},$$

bunda:

λ_1 – birinchi analitik to'liqin uzunligi;

λ_2 – ikkinchi analitik to'liqin uzunligi;

A^{λ_1} – λ_1 to'liqin uzunlikdagi aralashmaning optik zichligi;

A^{λ_2} – λ_2 to'liqin uzunlikdagi aralashmaning optik zichligi;

C_1 – 1-komponentning konsentratsiyasi;

C_2 – 2-komponentning konsentratsiyasi;

$\epsilon_1^{\lambda_1}; \epsilon_2^{\lambda_2}; \epsilon_1^{\lambda_2}; \epsilon_2^{\lambda_1}$ – tegishli λ_1 va λ_2 to'liqin uzunliklaridagi 1- va 2-komponentlarning molyar yutilish koeffitsiyentlari.

11-jadval

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

Spiri konsentratsiyasi	Sindirish ko'rsatkichi (20°C da)	Har 1% spirt uchun tuzatish koeffitsiyenti	Harorat koeffitsiyenti
0	1,33300		$1,0 \cdot 10^{-4}$
1	1,33345	$4,5 \cdot 10^{-4}$	$1,0 \cdot 10^{-4}$
2	1,33400	$5,5 \cdot 10^{-4}$	$1,0 \cdot 10^{-4}$
3	1,33444	$4,4 \cdot 10^{-4}$	$1,1 \cdot 10^{-4}$
4	1,33493	$4,9 \cdot 10^{-4}$	$1,1 \cdot 10^{-4}$
5	1,33535	$4,2 \cdot 10^{-4}$	$1,2 \cdot 10^{-4}$
6	1,33587	$5,2 \cdot 10^{-4}$	$1,2 \cdot 10^{-4}$

7	1,33641	$5,4 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
8	1,33700	$5,9 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
9	1,33760	$6,0 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
10	1,33808	$4,8 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
11	1,33870	$6,2 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
12	1,33924	$5,4 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
13	1,33977	$5,3 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
14	1,34043	$6,6 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
15	1,34096	$5,3 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
16	1,34158	$6,2 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
17	1,34209	$5,1 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
18	1,34270	$6,1 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
19	1,34330	$6,0 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
20	1,34390	$6,0 \cdot 10^{-4}$	$1,6 \cdot 10^{-4}$
21	1,34452	$6,2 \cdot 10^{-4}$	$1,6 \cdot 10^{-4}$
22	1,34512	$6,0 \cdot 10^{-4}$	$1,7 \cdot 10^{-4}$
23	1,34573	$6,1 \cdot 10^{-4}$	$1,8 \cdot 10^{-4}$
24	1,34635	$6,2 \cdot 10^{-4}$	$1,9 \cdot 10^{-4}$
25	1,34697	$6,2 \cdot 10^{-4}$	$2,0 \cdot 10^{-4}$
30	1,35000	$6,0 \cdot 10^{-4}$	$2,0 \cdot 10^{-4}$
35	1,35320	$6,4 \cdot 10^{-4}$	$2,1 \cdot 10^{-4}$
40	1,35500	$4,0 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$
45	1,35700	$4,0 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$
50	1,35900	$4,0 \cdot 10^{-4}$	$2,6 \cdot 10^{-4}$
55	1,36060	$3,2 \cdot 10^{-4}$	$2,6 \cdot 10^{-4}$
60	1,36180	$2,4 \cdot 10^{-4}$	$3,4 \cdot 10^{-4}$
65	1,36300	$2,4 \cdot 10^{-4}$	$3,6 \cdot 10^{-4}$
70	1,36380	$1,6 \cdot 10^{-4}$	$3,8 \cdot 10^{-4}$
75	1,36450	$1,4 \cdot 10^{-4}$	$4,0 \cdot 10^{-4}$

**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- tsiyalar 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 miqdori 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		

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·6H₂O	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	

Konsentra-tsiya, %	Askorbin kislota	Borat kislota	Nikotin kislota	Kodein fosfat
1	0,00160	Hamma konsentrat-siyalar uchun 0,00067	Hamma konsentrat-siyalar uchun 0,00210	Hamma konsentrat-siyalar 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			
Konsentrat-siya, %	Natriy kofeinbenzoat	Magniy sulfat $\times 7H_2O$	Natriy benzoat	Natriy bromid
1	Hamma konsentrat-siyalar uchun 0,00192	Hamma konsentrat-siyalar 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

Konsentra- tsiya, %	Natriy gidrokarbonat	Natriy yodid	Natriy salitsilat	Natriy tetraborat
1	Hamma konsentrat- siyalar uchun 0,00125	Hamma konsentrat- siyalar 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

Konsentra- tsiya, %	Novokain	Novokain- amid	Natriy norsulfazol, suvsiz	Pilokarpin gidroxlorid
1	0,00221	Hamma konsentrat- siyalar 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 konsentrat- siyalar 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

TURLI HARORATLARDa SUVNING ION KO'PAYTMASI KH_2O

$t^{\circ}C$	KH_2O	$\frac{aH^+}{aOH^-}$	$t^{\circ}C$	KH_2O	$\frac{aH^+}{aOH^-}$
0	$0,13 \cdot 10^{-14}$	$0,36 \cdot 10^{-7}$	28	$1,62 \cdot 10^{-14}$	$1,27 \cdot 10^{-7}$
5	$0,21 \cdot 10^{-14}$	$0,46 \cdot 10^{-7}$	29	$1,76 \cdot 10^{-14}$	$1,33 \cdot 10^{-7}$
10	$0,36 \cdot 10^{-14}$	$0,59 \cdot 10^{-7}$	30	$1,89 \cdot 10^{-14}$	$1,37 \cdot 10^{-7}$
15	$0,58 \cdot 10^{-14}$	$0,76 \cdot 10^{-7}$	35	$0,27 \cdot 10^{-13}$	$1,65 \cdot 10^{-7}$
16	$0,63 \cdot 10^{-14}$	$0,79 \cdot 10^{-7}$	40	$0,38 \cdot 10^{-13}$	$1,95 \cdot 10^{-7}$
17	$0,68 \cdot 10^{-14}$	$0,82 \cdot 10^{-7}$	50	$0,56 \cdot 10^{-13}$	$2,4 \cdot 10^{-7}$
18	$0,74 \cdot 10^{-14}$	$0,86 \cdot 10^{-7}$	60	$1,26 \cdot 10^{-13}$	$3,55 \cdot 10^{-7}$
19	$0,79 \cdot 10^{-14}$	$0,89 \cdot 10^{-7}$	70	$2,10 \cdot 10^{-13}$	$0,49 \cdot 10^{-6}$
20	$0,86 \cdot 10^{-14}$	$0,93 \cdot 10^{-7}$	80	$3,40 \cdot 10^{-13}$	$0,58 \cdot 10^{-6}$
21	$0,93 \cdot 10^{-14}$	$0,96 \cdot 10^{-7}$	90	$0,52 \cdot 10^{-12}$	$0,72 \cdot 10^{-6}$
22	$1,00 \cdot 10^{-14}$	$1,00 \cdot 10^{-7}$	100	$0,74 \cdot 10^{-12}$	$0,86 \cdot 10^{-6}$
23	$1,10 \cdot 10^{-14}$	$1,05 \cdot 10^{-7}$	120	$1,25 \cdot 10^{-12}$	$1,12 \cdot 10^{-6}$
24	$1,19 \cdot 10^{-14}$	$1,09 \cdot 10^{-7}$	140	$1,80 \cdot 10^{-12}$	$1,34 \cdot 10^{-6}$
25	$1,27 \cdot 10^{-14}$	$1,13 \cdot 10^{-7}$	160	$2,50 \cdot 10^{-12}$	$1,58 \cdot 10^{-6}$
26	$1,38 \cdot 10^{-14}$	$1,17 \cdot 10^{-7}$	180	$3,20 \cdot 10^{-12}$	$1,80 \cdot 10^{-6}$
27	$1,50 \cdot 10^{-14}$	$1,23 \cdot 10^{-7}$	200	$0,40 \cdot 10^{-11}$	$2,0 \cdot 10^{-6}$

**BA'ZI KISLOTA VA ISHQOR ERITMALARINING ZICHLIGI VA
KONSENTRATSIYASI
($t = 20\text{ }^{\circ}\text{C}$)**

Zichlik, kg/m³	Massa ulushi, %	Molyarlik, mol/l	Zichlik, kg/m³	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
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
Zichlik, kg/m³	Massa ulushi, %	Molyarlik, mol/l	Zichlik, kg/m³	Massa ulushi, %	Molyarlik, mol/l

Ishqorlar:

ammiak eritmasi

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			

kaliy gidroksid (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

natriy gidroksid (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			

**KISLOTALARNING IONLANISH KONSTANTALARI
(KISLOTALILIK KONSTANTALARI)**

Kislota nomi	Formulasi	K_a	$pK_a = -\lg K_a$
Bir asosli			
Nitrit	HNO_2	$6,9 \cdot 10^{-4}$	3,16
Azid	HN_3	$2,0 \cdot 10^{-5}$	4,70
Vodorod peroksid	H_2O_2	$2,6 \cdot 10^{-12}$	11,58
Rodanid	HSCN	$1,4 \cdot 10^{-1}$	0,85
Ftorid	HF	$6,2 \cdot 10^{-4}$	3,21
Xlorit	HClO_2	$1,1 \cdot 10^{-2}$	1,97
Gipoxlorit	HClO	$2,95 \cdot 10^{-8}$	7,53
Sianat	HCNO	$2,7 \cdot 10^{-4}$	3,57
Sianid	HCN	$5,0 \cdot 10^{-10}$	9,30
Aminosirka (glisin)	$\text{NH}_2\text{CH}_2\text{COOH}$	$1,7 \cdot 10^{-10}$	9,77
Benzoy	$\text{C}_6\text{H}_5\text{COOH}$	$6,3 \cdot 10^{-5}$	4,20
Xlorbenzoy	$\text{ClC}_6\text{H}_4\text{COOH}$	$1,2 \cdot 10^{-3}$	2,92
Glikol	$\text{CH}_2(\text{OH})\text{COOH}$	$1,5 \cdot 10^{-4}$	3,83
Glyukon	$\text{CH}_2\text{OH}(\text{CHOH})_4\text{COOH}$	$1,4 \cdot 10^{-4}$	3,86
Kroton (β -metilakril)	$\text{CH}_3\text{CH} = \text{COOH}$	$2,0 \cdot 10^{-5}$	4,69
Laurin	$\text{CH}_3(\text{CH}_2)_{10}\text{COOH}$	$1,1 \cdot 10^{-5}$	4,95
Sut	$\text{CH}_3\text{CHOHCOOH}$	$1,38 \cdot 10^{-4}$	3,86
Chumoli	HCOOH	$1,78 \cdot 10^{-4}$	3,75
<i>o</i> -Nitrobenzoy	$\text{O}_2\text{NC}_6\text{H}_4\text{COOH}(1,2)$	$6,8 \cdot 10^{-3}$	2,17
Pikrin	$\text{HOC}_6\text{H}_2(\text{NO}_2)_3$	$4,2 \cdot 10^{-1}$	0,38
Propion	$\text{CH}_3\text{CH}_2\text{COOH}$	$1,35 \cdot 10^{-5}$	4,87
Moy	$\text{CH}_3(\text{CH}_2)_2\text{COOH}$	$1,5 \cdot 10^{-5}$	4,82
Sirka	CH_3COOH	$1,75 \cdot 10^{-5}$	4,75
Fenol	$\text{C}_6\text{H}_5\text{OH}$	$1,05 \cdot 10^{-10}$	9,98
Monoxlorsirka	CH_2ClCOOH	$1,41 \cdot 10^{-3}$	2,85
Dixlorsirka	CHCl_2COOH	$5,0 \cdot 10^{-2}$	1,30
Trixlorsirka	CCl_3COOH	$2,0 \cdot 10^{-1}$	0,70
Monoyodsirka	CH_2ICOOH	$6,7 \cdot 10^{-4}$	3,17

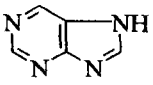
Ikki asosli			
Sulfit	H_2SO_3	$K_1 = 1,4 \cdot 10^{-2}$ $K_2 = 6,2 \cdot 10^{-8}$	1,85 7,20
Sulfid	H_2S	$K_1 = 1,0 \cdot 10^{-7}$ $K_2 = 2,5 \cdot 10^{-13}$	7,00 12,60
Karbonat	H_2CO_3	$K_1 = 4,5 \cdot 10^{-7}$ $K_2 = 5,0 \cdot 10^{-11}$	6,35 10,30
Xromat	H_2CrO_4	$K_1 = 2,1 \cdot 10^{-1}$ $K_2 = 3,2 \cdot 10^{-7}$	0,67 6,50
Vino	$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$	$K_1 = 1,3 \cdot 10^{-3}$ $K_2 = 3,0 \cdot 10^{-5}$	2,89 4,52
Selenat	H_2SeO_3	$K_1 = 1,8 \cdot 10^{-3}$ $K_2 = 3,2 \cdot 10^{-9}$	2,75 8,5
Tellurit	H_2TeO_3	$K_1 = 2,7 \cdot 10^{-3}$ $K_2 = 1,8 \cdot 10^{-8}$	2,57 7,74
Oksalat	$\text{H}_2\text{C}_2\text{O}_4$	$K_1 = 5,6 \cdot 10^{-2}$ $K_2 = 5,4 \cdot 10^{-5}$	1,25 4,27
Qahrabo	$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$	$K = 6,17 \cdot 10^{-5}$ $K = 2,29 \cdot 10^{-6}$	4,21 5,64
Salitsil	$\text{C}_6\text{H}_4(\text{OH})\text{COOH}$	$K_1 = 1,1 \cdot 10^{-3}$ $K_2 = 3,6 \cdot 10^{-14}$	2,97 13,59
Sulfosalitsil	$\text{HSO}_3\text{C}_6\text{H}_3(\text{OH})\text{COOH}$	$K_2 = 3,1 \cdot 10^{-3}$ $K_3 = 2,0 \cdot 10^{-12}$	2,51 11,70
Uch asosli			
Borat	H_3BO_3	$K_1 = 7,1 \cdot 10^{-10}$ $K_2 = 1,8 \cdot 10^{-13}$ $K_3 = 1,6 \cdot 10^{-14}$	9,15 12,74 13,80
Arsenat	H_3AsO_4	$K_1 = 5,6 \cdot 10^{-3}$ $K_2 = 1,7 \cdot 10^{-7}$ $K_3 = 2,95 \cdot 10^{-12}$	2,25 6,77 11,53
Ortofosfat	H_3PO_4	$K_1 = 7,1 \cdot 10^{-3}$	2,15

		$K_2 = 6,2 \cdot 10^{-8}$ $K_3 = 5,0 \cdot 10^{-13}$	7,21 12,3
Fosfit	H_3PO_3	$K_1 = 2,5 \cdot 10^{-2}$ $K_2 = 2,0 \cdot 10^{-7}$	1,6 6,7
To'rt asosli			
Etilendiamin-tetrasirka	$(CH_2)_2N_2(CH_2COOH)_4(H_4Y)$	$K_1 = 1,0 \cdot 10^{-2}$ $K_2 = 2,1 \cdot 10^{-3}$ $K_3 = 6,9 \cdot 10^{-7}$ $K_4 = 5,5 \cdot 10^{-11}$	2,00 2,67 6,16 10,26
Ortosilikat	H_4SiO_4	$K_1 = 1,3 \cdot 10^{-10}$ $K_2 = 1,6 \cdot 10^{-12}$ $K_3 = 2,0 \cdot 10^{-14}$	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	$NH_3 \cdot H_2O$	$1,76 \cdot 10^{-5}$	4,76
Litiy gidroksid	$LiOH$	$6,8 \cdot 10^{-1}$	0,17
Anilin	$C_6H_5NH_2$	$3,31 \cdot 10^{-10}$	9,48
Butilamin	$CH_3(CH_2)_2CH_2NH_2 + H_2O$	$6,0 \cdot 10^{-4}$	3,22
Dimetilamin	$(CH_3)_2NH$	$7,24 \cdot 10^{-4}$	3,14
Dimetilanilin	$C_6H_5N(CH_3)_2$	$2,4 \cdot 10^{-10}$	9,62
Dietilamin	$(C_2H_5)_2NH$	$9,55 \cdot 10^{-4}$	3,02
Metilamin	CH_3NH_2	$5,37 \cdot 10^{-4}$	3,27
Piridin	C_5H_5N	$1,51 \cdot 10^{-9}$	8,82
Trietilamin	$(C_2H_5)_3N + H_2O$	$1,0 \cdot 10^{-3}$	2,99

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

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
5,15	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		

Ayrim moddalarining bufer eritmalari

modda	pH
0,05M kaliy tetraoksalat digidrat eritmasi ($\text{KH}_3\text{C}_4\text{H}_4\text{O}_8 \cdot 2\text{H}_2\text{O}$; M.m. 254,19)	1,679 (25 °C)
Kaliy gidrotartratning to'yingan eritmasi ($\approx 0,025\text{M}$) ($\text{KHC}_4\text{H}_4\text{O}_6$; M.m. 188,178)	3,567 (25 °C)
0,05M kaliy digidrotsitrat	3,776 (25 °C)

($\text{KH}_2\text{C}_6\text{H}_5\text{O}_7$; M.m. 230,215)	
0,05M kaliy gidroftalat eritmasi ($\text{KHC}_8\text{H}_4\text{O}_4$; M.m. 204,223)	4,008 (25 °C)
Piperazinfosfatning to'yingan eritmasi* ($\approx 0,065\text{M}$) ($\text{C}_4\text{H}_{12}\text{N}_2\text{HPO}_4 \cdot \text{H}_2\text{O}$; M.m. 202,147)	6,36 (16 °C); 6,34 (18 °C)
0,05M natriy tetraborat eritmasi ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$; M.m. 381,372)	9,18 (25 °C); 9,07 (38 °C)

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
arsenatlar				
Ag_3AsO_4		$1,12 \cdot 10^{-20}$	$3,59 \cdot 10^{-6}$	$1,66 \cdot 10^{-4}$
AlAsO_4	$1,6 \cdot 10^{-16}$	$1,6 \cdot 10^{-16}$	$1,27 \cdot 10^{-8}$	$2,10 \cdot 10^{-7}$
$\text{Ba}_3(\text{AsO}_4)_2$		$7,76 \cdot 10^{-51}$	$3,73 \cdot 10^{-11}$	$2,57 \cdot 10^{-9}$
BiAsO_4		$4,37 \cdot 10^{-10}$	$2,09 \cdot 10^{-5}$	$7,27 \cdot 10^{-4}$
$\text{Ca}_3(\text{AsO}_4)_2$		$6,76 \cdot 10^{-19}$	$9,11 \cdot 10^{-5}$	$3,62 \cdot 10^{-3}$
$\text{Co}_3(\text{AsO}_4)_2$		$7,6 \cdot 10^{-29}$	$2,34 \cdot 10^{-6}$	$1,06 \cdot 10^{-4}$
CrAsO_4	$7,8 \cdot 10^{-21}$	$7,8 \cdot 10^{-21}$	$8,33 \cdot 10^{-11}$	$1,69 \cdot 10^{-9}$
$\text{Cu}_3(\text{AsO}_4)_2$	$7,6 \cdot 10^{-36}$	$7,6 \cdot 10^{-36}$	$9,32 \cdot 10^{-8}$	$4,37 \cdot 10^{-6}$
FeAsO_4	$5,8 \cdot 10^{-21}$	$5,8 \cdot 10^{-21}$	$7,61 \cdot 10^{-11}$	$1,48 \cdot 10^{-9}$
$\text{Mg}_3(\text{AsO}_4)_2$		$2,09 \cdot 10^{-20}$	$4,54 \cdot 10^{-5}$	$1,59 \cdot 10^{-3}$
$\text{Mn}_3(\text{AsO}_4)_2$	$1,9 \cdot 10^{-29}$	$1,9 \cdot 10^{-29}$	$7,07 \cdot 10^{-7}$	$3,13 \cdot 10^{-5}$
$\text{Ni}_3(\text{AsO}_4)_2$	$3,1 \cdot 10^{-26}$	$3,1 \cdot 10^{-26}$	$3,10 \cdot 10^{-6}$	$1,41 \cdot 10^{-4}$
$\text{Pb}_3(\text{AsO}_4)_2$	$4,1 \cdot 10^{-36}$	$4,1 \cdot 10^{-36}$	$3,28 \cdot 10^{-8}$	$2,95 \cdot 10^{-6}$
$\text{Sr}_3(\text{AsO}_4)_2$		$1,62 \cdot 10^{-18}$	$1,09 \cdot 10^{-4}$	$5,87 \cdot 10^{-3}$

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

$Zn_3(AsO_4)_2$	$1,07 \cdot 10^{-16}$	$1,07 \cdot 10^{-27}$	$1,58 \cdot 10^{-6}$	$7,50 \cdot 10^{-4}$
arsenitlar				
Ag_3AsO_3	$1,0 \cdot 10^{-17}$	$1,22 \cdot 10^{-17}$	$2,60 \cdot 10^{-5}$	$5,99 \cdot 10^{-4}$
bromidlar				
$AgBr$	$4,90 \cdot 10^{-13}$	$4,90 \cdot 10^{-13}$	$7,12 \cdot 10^{-7}$	$1,34 \cdot 10^{-5}$
$CuBr$	$5,25 \cdot 10^{-9}$	$5,25 \cdot 10^{-9}$	$7,24 \cdot 10^{-5}$	$1,04 \cdot 10^{-3}$
$HgBr_2$	$5,75 \cdot 10^{-23}$	$5,75 \cdot 10^{-23}$	$1,38 \cdot 10^{-6}$	$7,73 \cdot 10^{-5}$
$PbBr_2$	$9,12 \cdot 10^{-6}$	$2,76 \cdot 10^{-5}$	$2,73 \cdot 10^{-2}$	1,00
gidroksidlar				
$AgOH$	$1,60 \cdot 10^{-8}$	$1,63 \cdot 10^{-8}$	$1,61 \cdot 10^{-4}$	$2,01 \cdot 10^{-3}$
$Al(OH)_3$	$1,10 \cdot 10^{-33}$	$1,10 \cdot 10^{-33}$	$2,52 \cdot 10^{-9}$	$1,97 \cdot 10^{-8}$
$Bi(OH)_3$	$4,27 \cdot 10^{-31}$	$4,27 \cdot 10^{-31}$	$1,12 \cdot 10^{-8}$	$2,92 \cdot 10^{-7}$
$Ca(OH)_2$	$5,49 \cdot 10^{-6}$	$7,96 \cdot 10^{-6}$	$1,26 \cdot 10^{-2}$	$9,32 \cdot 10^{-2}$
$Cd(OH)_2$ passiv shakl	$3,98 \cdot 10^{-15}$	$3,98 \cdot 10^{-15}$	$1,07 \cdot 10^{-5}$	$1,57 \cdot 10^{-4}$
$Ce(OH)_2$	$6,32 \cdot 10^{-22}$	$6,32 \cdot 10^{-22}$	$2,21 \cdot 10^{-6}$	$4,20 \cdot 10^{-5}$
$Co(OH)_2$ havorang	$6,31 \cdot 10^{-15}$	$6,31 \cdot 10^{-15}$	$1,16 \cdot 10^{-5}$	$1,08 \cdot 10^{-4}$
$Co(OH)_2$	$1,59 \cdot 10^{-15}$	$1,59 \cdot 10^{-15}$	$7,35 \cdot 10^{-6}$	$6,83 \cdot 10^{-5}$
$Co(OH)_2$ pushti, yangi	$2,00 \cdot 10^{-16}$	$2,00 \cdot 10^{-16}$	$3,68 \cdot 10^{-6}$	$3,42 \cdot 10^{-5}$
$Co(OH)_3$ pushti, eskirgan	$1,00 \cdot 10^{-43}$	$1,00 \cdot 10^{-43}$	$7,80 \cdot 10^{-12}$	$8,58 \cdot 10^{-11}$
$Cr(OH)_3$	$6,31 \cdot 10^{-31}$	$6,31 \cdot 10^{-31}$	$1,24 \cdot 10^{-8}$	$1,27 \cdot 10^{-7}$
$Fe(OH)_2$	$7,94 \cdot 10^{-16}$	$7,94 \cdot 10^{-16}$	$1,05 \cdot 10^{-5}$	$9,45 \cdot 10^{-5}$
$Fe(OH)_3$	$3,72 \cdot 10^{-40}$	$3,72 \cdot 10^{-40}$	$1,80 \cdot 10^{-9}$	$1,93 \cdot 10^{-8}$
$Hg_2(OH)_2$ (Hg_2O)	$1,60 \cdot 10^{-23}$	$1,60 \cdot 10^{-23}$	$1,59 \cdot 10^{-8}$	$6,92 \cdot 10^{-7}$
$Hg(OH)_2$ (HgO)	$3,0 \cdot 10^{-26}$	$3,0 \cdot 10^{-26}$	$1,95 \cdot 10^{-8}$	$4,57 \cdot 10^{-7}$
$LiOH$	$4,0 \cdot 10^{-2}$	$6,25 \cdot 10^{-2}$	0,3425	0,8202
$Mg(OH)_2$ barq. shakli	$1,12 \cdot 10^{-11}$	$1,31 \cdot 10^{-11}$	$1,49 \cdot 10^{-4}$	$8,67 \cdot 10^{-4}$
$Mn(OH)_2$	$1,59 \cdot 10^{-13}$	$1,70 \cdot 10^{-13}$	$3,49 \cdot 10^{-5}$	$3,11 \cdot 10^{-4}$
$Ni(OH)_2$	$3,16 \cdot 10^{-16}$	$3,16 \cdot 10^{-16}$	$4,40 \cdot 10^{-6}$	$4,08 \cdot 10^{-5}$
$Ni(OH)_2$ eskirgan	$6,3 \cdot 10^{-18}$	$6,3 \cdot 10^{-18}$	$1,17 \cdot 10^{-6}$	$1,08 \cdot 10^{-5}$
$Pb(OH)_2 \leftrightarrow Pb^{2+} + 2OH^-$	$1,0 \cdot 10^{-20}$	$1,0 \cdot 10^{-20}$	$1,36 \cdot 10^{-7}$	$3,29 \cdot 10^{-6}$

$\text{Pb(OH)}_2 \leftrightarrow \text{PbOH}^+ + \text{OH}^-$	$8,7 \cdot 10^{-14}$	$8,7 \cdot 10^{-14}$	$2,96 \cdot 10^{-7}$	$7,13 \cdot 10^{-6}$
Pt(OH)_2	$1,0 \cdot 10^{-35}$	$1,0 \cdot 10^{-35}$	$1,23 \cdot 10^{-12}$	$2,82 \cdot 10^{-11}$
$\text{Pt(OH)}_4 (\text{PtO}_2)$	$1,6 \cdot 10^{-72}$	$1,6 \cdot 10^{-72}$	$1,44 \cdot 10^{-15}$	$3,79 \cdot 10^{-14}$
Sb(OH)_3	$3,99 \cdot 10^{-42}$	$3,99 \cdot 10^{-42}$	$2,0 \cdot 10^{-5}$	$3,45 \cdot 10^{-4}$
$\text{Sn(OH)}_2 \leftrightarrow \text{Sn}^{2+} + 2\text{OH}^-$	$1,41 \cdot 10^{-28}$	$1,41 \cdot 10^{-28}$	$1,39 \cdot 10^{-7}$	$2,12 \cdot 10^{-6}$
$\text{Sn(OH)}_2 \leftrightarrow \text{SnOH}^+ + 2\text{OH}^-$	$4,6 \cdot 10^{-15}$	$4,6 \cdot 10^{-15}$	$2,84 \cdot 10^{-6}$	$4,34 \cdot 10^{-5}$
Sn(OH)_4	$1,0 \cdot 10^{-57}$	$1,0 \cdot 10^{-57}$	$1,31 \cdot 10^{-12}$	$2,45 \cdot 10^{-11}$
y o d a t l a r				
AgIO_3	$3,09 \cdot 10^{-8}$	$3,22 \cdot 10^{-8}$	$1,79 \cdot 10^{-4}$	$5,07 \cdot 10^{-3}$
$\text{Ba(IO}_3)_2$	$1,51 \cdot 10^{-9}$	$2,05 \cdot 10^{-9}$	$7,99 \cdot 10^{-4}$	$3,89 \cdot 10^{-2}$
$\text{Ce(IO}_3)_2$	$3,16 \cdot 10^{-10}$	$1,15 \cdot 10^{-9}$	$2,56 \cdot 10^{-3}$	$1,70 \cdot 10^{-1}$
$\text{Pb(IO}_3)_2$	$2,63 \cdot 10^{-13}$	$2,83 \cdot 10^{-13}$	$4,14 \cdot 10^{-5}$	$2,30 \cdot 10^{-3}$
y o d i d l a r				
AgI	$9,98 \cdot 10^{-17}$	$9,98 \cdot 10^{-17}$	$1,03 \cdot 10^{-8}$	$2,41 \cdot 10^{-7}$
CuI	$1,10 \cdot 10^{-12}$	$1,10 \cdot 10^{-12}$	$1,05 \cdot 10^{-6}$	$2,00 \cdot 10^{-5}$
Hg_2I_2	$4,47 \cdot 10^{-29}$	$4,47 \cdot 10^{-29}$	$2,24 \cdot 10^{-10}$	$1,46 \cdot 10^{-8}$
PbI_2	$8,71 \cdot 10^{-9}$	$8,71 \cdot 10^{-8}$	$1,51 \cdot 10^{-3}$	$6,96 \cdot 10^{-2}$
k a r b o n a t l a r				
Ag_2CO_3	$8,13 \cdot 10^{-12}$	$9,49 \cdot 10^{-12}$	$1,33 \cdot 10^{-4}$	$3,68 \cdot 10^{-3}$
BaCO_3	$5,13 \cdot 10^{-9}$	$5,93 \cdot 10^{-9}$	$7,70 \cdot 10^{-5}$	$1,52 \cdot 10^{-3}$
CaCO_3	$2,88 \cdot 10^{-9}$	$3,26 \cdot 10^{-9}$	$5,71 \cdot 10^{-5}$	$5,72 \cdot 10^{-4}$
CdCO_3	$5,25 \cdot 10^{-12}$	$5,25 \cdot 10^{-9}$	$2,29 \cdot 10^{-6}$	$3,95 \cdot 10^{-5}$
CoCO_3	$1,45 \cdot 10^{-13}$	$1,45 \cdot 10^{-13}$	$3,80 \cdot 10^{-7}$	$3,94 \cdot 10^{-6}$
CuCO_3	$2,34 \cdot 10^{-10}$	$2,34 \cdot 10^{-10}$	$1,37 \cdot 10^{-5}$	$1,69 \cdot 10^{-4}$
FeCO_3	$2,09 \cdot 10^{-11}$	$2,09 \cdot 10^{-11}$	$4,57 \cdot 10^{-6}$	$5,30 \cdot 10^{-5}$
Hg_2CO_3	$8,91 \cdot 10^{-17}$	$8,91 \cdot 10^{-17}$	$2,81 \cdot 10^{-6}$	$1,30 \cdot 10^{-4}$
$\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$	$1,00 \cdot 10^{-5}$	$3,08 \cdot 10^{-5}$	$5,55 \cdot 10^{-3}$	$7,68 \cdot 10^{-2}$
MnCO_3	$5,01 \cdot 10^{-10}$	$5,11 \cdot 10^{-10}$	$2,26 \cdot 10^{-5}$	$2,60 \cdot 10^{-4}$
NiCO_3	$1,35 \cdot 10^{-7}$	$1,63 \cdot 10^{-7}$	$4,03 \cdot 10^{-4}$	$4,79 \cdot 10^{-3}$
PbCO_3	$7,41 \cdot 10^{-14}$	$7,41 \cdot 10^{-14}$	$2,72 \cdot 10^{-7}$	$7,27 \cdot 10^{-6}$

SrCO_3	$1,10 \cdot 10^{-10}$	$1,10 \cdot 10^{-10}$	$1,05 \cdot 10^{-5}$	$1,55 \cdot 10^{-4}$
ZnCO_3	$1,45 \cdot 10^{-11}$	$1,45 \cdot 10^{-11}$	$3,80 \cdot 10^{-6}$	$4,77 \cdot 10^{-5}$
oksalatlar				
$\text{Ag}_2\text{C}_2\text{O}_4$	$3,57 \cdot 10^{-11}$	$4,10 \cdot 10^{-11}$	$2,27 \cdot 10^{-4}$	$6,89 \cdot 10^{-3}$
BaC_2O_4	$1,10 \cdot 10^{-7}$	$1,49 \cdot 10^{-7}$	$3,85 \cdot 10^{-4}$	$8,68 \cdot 10^{-3}$
CaC_2O_4	$2,29 \cdot 10^{-9}$	$2,60 \cdot 10^{-9}$	$4,86 \cdot 10^{-5}$	$6,22 \cdot 10^{-4}$
CdC_2O_4	$1,59 \cdot 10^{-8}$	$1,96 \cdot 10^{-8}$	$1,40 \cdot 10^{-4}$	$2,81 \cdot 10^{-3}$
CoC_2O_4	$6,31 \cdot 10^{-8}$	$8,53 \cdot 10^{-8}$	$2,92 \cdot 10^{-4}$	$4,29 \cdot 10^{-3}$
CuC_2O_4	$3,16 \cdot 10^{-8}$	$4,10 \cdot 10^{-8}$	$2,02 \cdot 10^{-4}$	$3,06 \cdot 10^{-3}$
FeC_2O_4	$2,00 \cdot 10^{-7}$	$3,05 \cdot 10^{-7}$	$5,52 \cdot 10^{-4}$	$7,94 \cdot 10^{-3}$
$\text{Hg}_2\text{C}_2\text{O}_4$	$1,00 \cdot 10^{-13}$	$1,00 \cdot 10^{-13}$	$3,16 \cdot 10^{-7}$	$1,55 \cdot 10^{-5}$
MgC_2O_4	$7,94 \cdot 10^{-5}$	$1,47 \cdot 10^{-4}$	$1,65 \cdot 10^{-2}$	0,1852
MnC_2O_4	$2,00 \cdot 10^{-6}$	$4,88 \cdot 10^{-6}$	$3,50 \cdot 10^{-3}$	$5,01 \cdot 10^{-2}$
NiC_2O_4	$3,98 \cdot 10^{-10}$	$4,42 \cdot 10^{-10}$	$2,11 \cdot 10^{-5}$	$3,10 \cdot 10^{-4}$
PbC_2O_4	$4,79 \cdot 10^{-10}$	$5,32 \cdot 10^{-10}$	$2,31 \cdot 10^{-5}$	$6,82 \cdot 10^{-4}$
SrC_2O_4	$5,63 \cdot 10^{-8}$	$7,61 \cdot 10^{-8}$	$2,41 \cdot 10^{-4}$	$4,23 \cdot 10^{-3}$
ZnC_2O_4	$1,59 \cdot 10^{-9}$	$1,77 \cdot 10^{-9}$	$2,64 \cdot 10^{-5}$	$4,05 \cdot 10^{-4}$
sulfatlar				
Ag_2SO_4	$1,455 \cdot 10^{-5}$	$5,02 \cdot 10^{-5}$	$2,32 \cdot 10^{-2}$	0,7244
BaSO_4	$1,05 \cdot 10^{-10}$	$1,05 \cdot 10^{-10}$	$1,02 \cdot 10^{-5}$	$2,39 \cdot 10^{-4}$
CaSO_4	$9,12 \cdot 10^{-6}$	$2,30 \cdot 10^{-5}$	$4,79 \cdot 10^{-3}$	$6,52 \cdot 10^{-2}$
Hg_2SO_4	$6,76 \cdot 10^{-7}$	$1,11 \cdot 10^{-6}$	$1,05 \cdot 10^{-3}$	$5,22 \cdot 10^{-2}$
PbSO_4	$1,59 \cdot 10^{-8}$	$1,96 \cdot 10^{-8}$	$1,40 \cdot 10^{-4}$	$4,24 \cdot 10^{-3}$
SrSO_4	$3,47 \cdot 10^{-7}$	$5,29 \cdot 10^{-7}$	$7,27 \cdot 10^{-4}$	$1,34 \cdot 10^{-2}$
sulfidlar				
Ag_2S	$6,31 \cdot 10^{-50}$	$6,31 \cdot 10^{-50}$	$2,51 \cdot 10^{-17}$	$6,22 \cdot 10^{-16}$
CdS	$7,94 \cdot 10^{-27}$	$7,94 \cdot 10^{-27}$	$8,91 \cdot 10^{-14}$	$1,15 \cdot 10^{-12}$
CoS_a	$3,98 \cdot 10^{-21}$	$3,98 \cdot 10^{-21}$	$6,31 \cdot 10^{-11}$	$5,74 \cdot 10^{-10}$
CoS_b	$2,00 \cdot 10^{-25}$	$2,00 \cdot 10^{-25}$	$4,47 \cdot 10^{-13}$	$4,06 \cdot 10^{-12}$
CuS	$6,31 \cdot 10^{-36}$	$6,31 \cdot 10^{-36}$	$2,51 \cdot 10^{-18}$	$2,40 \cdot 10^{-17}$

Cu ₂ S	$2,51 \cdot 10^{-48}$	$2,51 \cdot 10^{-48}$	$8,56 \cdot 10^{-17}$	$1,36 \cdot 10^{-15}$
FeS	$5,13 \cdot 10^{-18}$	$5,13 \cdot 10^{-18}$	$2,27 \cdot 10^{-9}$	$1,99 \cdot 10^{-8}$
HgS qora	$(1,59 \cdot 10^{-52})$	$(1,59 \cdot 10^{-52})$		
HgS qizil	$(3,98 \cdot 10^{-53})$	$(3,98 \cdot 10^{-53})$		
MnS pushti	$2,51 \cdot 10^{-10}$	$2,51 \cdot 10^{-10}$	$1,59 \cdot 10^{-5}$	$1,38 \cdot 10^{-4}$
MnS yashil	$2,51 \cdot 10^{-13}$	$2,51 \cdot 10^{-13}$	$5,01 \cdot 10^{-7}$	$4,36 \cdot 10^{-6}$
NiS _a	$3,16 \cdot 10^{-19}$	$3,16 \cdot 10^{-19}$	$5,62 \cdot 10^{-10}$	$5,10 \cdot 10^{-9}$
NiS _b	$1,00 \cdot 10^{-24}$	$1,00 \cdot 10^{-24}$	$1,00 \cdot 10^{-12}$	$9,08 \cdot 10^{-12}$
NiS _γ	$2,00 \cdot 10^{-26}$	$2,00 \cdot 10^{-26}$	$1,41 \cdot 10^{-13}$	$1,28 \cdot 10^{-12}$
PbS	$2,51 \cdot 10^{-27}$	$2,51 \cdot 10^{-27}$	$5,04 \cdot 10^{-14}$	$1,20 \cdot 10^{-12}$
SnS	$1,00 \cdot 10^{-25}$	$1,00 \cdot 10^{-25}$	$3,16 \cdot 10^{-13}$	$4,77 \cdot 10^{-12}$
ZnS _a	$1,59 \cdot 10^{-24}$	$1,59 \cdot 10^{-24}$	$1,26 \cdot 10^{-12}$	$1,23 \cdot 10^{-11}$
ZnS _b	$2,51 \cdot 10^{-22}$	$2,51 \cdot 10^{-22}$	$1,59 \cdot 10^{-11}$	$1,54 \cdot 10^{-10}$

sulfitlar

Ag ₂ SO ₃	$1,51 \cdot 10^{-14}$	$1,51 \cdot 10^{-14}$	$1,56 \cdot 10^{-5}$	$4,61 \cdot 10^{-4}$
BaSO ₃	$7,94 \cdot 10^{-7}$	$1,31 \cdot 10^{-6}$	$1,14 \cdot 10^{-3}$	$2,48 \cdot 10^{-2}$
CaSO ₃	$1,29 \cdot 10^{-8}$	$1,59 \cdot 10^{-8}$	$1,26 \cdot 10^{-4}$	$1,51 \cdot 10^{-3}$
Hg ₂ SO ₃	$1,00 \cdot 10^{-27}$	$1,00 \cdot 10^{-27}$	$3,16 \cdot 10^{-14}$	$1,52 \cdot 10^{-12}$
MgSO ₃	$3,16 \cdot 10^{-3}$	$1,88 \cdot 10^{-2}$	0,14	1,43
SrSO ₃	$3,98 \cdot 10^{-8}$	$5,14 \cdot 10^{-8}$	$2,27 \cdot 10^{-4}$	$3,81 \cdot 10^{-3}$

fosfatlar

Ag ₃ PO ₄	$1,29 \cdot 10^{-20}$	$1,29 \cdot 10^{-20}$	$4,67 \cdot 10^{-6}$	$1,96 \cdot 10^{-4}$
AlPO ₄	$5,75 \cdot 10^{-19}$	$5,75 \cdot 10^{-19}$	$6,61 \cdot 10^{-10}$	$8,06 \cdot 10^{-9}$
BaHPO ₄		$9,12 \cdot 10^{-8}$	$3,02 \cdot 10^{-4}$	$7,05 \cdot 10^{-3}$
Ba ₃ (PO ₄) ₂		$3,39 \cdot 10^{-23}$	$1,26 \cdot 10^{-5}$	$7,57 \cdot 10^{-4}$
BiPO ₄	$1,29 \cdot 10^{-23}$	$1,29 \cdot 10^{-23}$	$3,59 \cdot 10^{-12}$	$1,09 \cdot 10^{-10}$
CaHPO ₄	$2,75 \cdot 10^{-7}$	$4,20 \cdot 10^{-7}$	$8,58 \cdot 10^{-4}$	$1,17 \cdot 10^{-2}$
Ca ₃ (PO ₄) ₂		$1,00 \cdot 10^{-26}$	$2,47 \cdot 10^{-6}$	$7,67 \cdot 10^{-4}$
Cd ₃ (PO ₄) ₂	$2,51 \cdot 10^{-33}$	$2,51 \cdot 10^{-33}$	$1,18 \cdot 10^{-7}$	$6,24 \cdot 10^{-6}$

CoHPO ₄	$2,00 \cdot 10^{-7}$	$7,03 \cdot 10^{-7}$	$6,73 \cdot 10^{-4}$	$1,04 \cdot 10^{-2}$
Co ₃ (PO ₄) ₂	$2,00 \cdot 10^{-35}$	$2,00 \cdot 10^{-35}$	$4,50 \cdot 10^{-8}$	$1,65 \cdot 10^{-6}$
CrPO ₄ yashil		$2,40 \cdot 10^{-23}$	$4,90 \cdot 10^{-12}$	$7,20 \cdot 10^{-11}$
CrPO ₄ binafsha		$1,00 \cdot 10^{-17}$	$3,16 \cdot 10^{-9}$	$4,65 \cdot 10^{-8}$
Cu ₃ (PO ₄) ₂	$1,26 \cdot 10^{-37}$	$1,26 \cdot 10^{-37}$	$1,63 \cdot 10^{-8}$	$6,22 \cdot 10^{-7}$
FePO ₄	$1,29 \cdot 10^{-22}$	$1,29 \cdot 10^{-22}$	$1,14 \cdot 10^{-11}$	$1,71 \cdot 10^{-10}$
MgNH ₄ PO ₄		$2,51 \cdot 10^{-13}$	$6,31 \cdot 10^{-5}$	$8,66 \cdot 10^{-4}$
Ni ₃ (PO ₄) ₂	$5,01 \cdot 10^{-31}$	$5,01 \cdot 10^{-31}$	$3,41 \cdot 10^{-7}$	$1,25 \cdot 10^{-5}$
PbHPO ₄		$1,41 \cdot 10^{-10}$	$1,19 \cdot 10^{-5}$	$3,60 \cdot 10^{-4}$
Pb ₃ (PO ₄) ₂	$7,94 \cdot 10^{-43}$	$7,94 \cdot 10^{-43}$	$1,49 \cdot 10^{-9}$	$1,21 \cdot 10^{-7}$
SrHPO ₄		$5,75 \cdot 10^{-7}$	$7,59 \cdot 10^{-4}$	$1,39 \cdot 10^{-2}$
Sr ₃ (PO ₄) ₂		$4,07 \cdot 10^{-23}$	$1,30 \cdot 10^{-6}$	$2,82 \cdot 10^{-5}$
Zn ₃ (PO ₄) ₂	$9,12 \cdot 10^{-33}$	$9,12 \cdot 10^{-33}$	$1,53 \cdot 10^{-7}$	$5,92 \cdot 10^{-6}$
ftoridlar				
BaF ₂	$1,05 \cdot 10^{-26}$	$2,43 \cdot 10^{-6}$	$8,47 \cdot 10^{-3}$	$1,48 \cdot 10^{-1}$
CaF ₂	$3,98 \cdot 10^{-11}$	$4,70 \cdot 10^{-11}$	$2,27 \cdot 10^{-4}$	$1,78 \cdot 10^{-3}$
SrF ₂	$2,46 \cdot 10^{-9}$	$3,37 \cdot 10^{-9}$	$9,44 \cdot 10^{-4}$	$1,19 \cdot 10^{-2}$
xloridlar				
AgCl	$1,78 \cdot 10^{-10}$	$1,78 \cdot 10^{-10}$	$1,35 \cdot 10^{-5}$	$1,93 \cdot 10^{-4}$
Hg ₂ Cl ₂	$1,32 \cdot 10^{-18}$	$1,32 \cdot 10^{-18}$	$6,91 \cdot 10^{-7}$	$3,25 \cdot 10^{-5}$
PbCl ₂	$1,74 \cdot 10^{-5}$	$6,02 \cdot 10^{-5}$	$4,13 \cdot 10^{-2}$	1,15
xromatlar				
Ag ₂ CrO ₄	$1,29 \cdot 10^{-12}$	$1,44 \cdot 10^{-12}$	$7,12 \cdot 10^{-5}$	$2,36 \cdot 10^{-3}$
BaCrO ₄	$1,18 \cdot 10^{-10}$	$1,18 \cdot 10^{-10}$	$1,08 \cdot 10^{-5}$	$2,75 \cdot 10^{-4}$
CaCrO ₄	$7,10 \cdot 10^{-4}$	$3,67 \cdot 10^{-3}$	$6,06 \cdot 10^{-2}$	$9,45 \cdot 10^{-1}$
Hg ₂ CrO ₄	$5,00 \cdot 10^{-9}$	$1,13 \cdot 10^{-8}$	$1,06 \cdot 10^{-4}$	$5,50 \cdot 10^{-3}$
PbCrO ₄	$1,18 \cdot 10^{-14}$	$1,18 \cdot 10^{-14}$	$1,33 \cdot 10^{-7}$	$4,31 \cdot 10^{-6}$
SrCrO ₄		$2,24 \cdot 10^{-5}$	$4,73 \cdot 10^{-3}$	$9,63 \cdot 10^{-2}$

**VODOROD ELEKTRODGA NISBATAN SUVLI ERITMALARDAGI
STANDART OKSIDLANISH-QAYTARILISH POTENSIALLARI (E°)**
(jadvaldagi potentsiallar qiymatlari $\mu = 0$ va $t = 25^\circ\text{C}$ uchun
keltirilgan)

Element	Yarim reaksiyalar tenglamalari	E° , V
Ag	$\text{Ag}^+ + e \leftrightarrow \text{Ag}_{(q)}$	+0,799
	$\text{Ag}^{2+} + e \leftrightarrow \text{Ag}^+$	+1,998
	$\text{AgO}^+ + 2\text{H}^+ + e \leftrightarrow \text{Ag}^{2+} + \text{H}_2\text{O}$	+2,016
	$2\text{AgO}_{(q)} + 2\text{H}^+ + 2e \leftrightarrow \text{Ag}_2\text{O} + \text{H}_2\text{O}$	+1,41
	$2\text{AgO}_{(q)} + \text{H}_2\text{O} + 2e \leftrightarrow \text{Ag}_2\text{O} + \text{OH}^-$	+0,599
	$\text{Ag}_2\text{O}_{(q)} + 2\text{H}^+ + 2e \leftrightarrow 2\text{Ag}_{(q)} + \text{H}_2\text{O}$	+1,173
	$\text{Ag}_2\text{O}_{(q)} + \text{H}_2\text{O} + 2e \leftrightarrow 2\text{Ag}_{(q)} + 2\text{OH}^-$	+0,342
	$\text{Ag}_2\text{CrO}_{4(q)} + 2e \leftrightarrow 2\text{Ag}_{(q)} + \text{CrO}_4^{2-}$	+0,447
	$\text{Ag}_2\text{S}_{(q)} + 2\text{H}^+ + 2e \leftrightarrow 2\text{Ag}_{(q)} + \text{H}_2\text{S}_{(g)}$	-0,036
	$\text{Ag}_2\text{S}_{(q)} + 2e \leftrightarrow \text{Ag}_{(q)} + \text{S}^{2-}$	-0,712
	$\text{AgCl}_{(q)} + e \leftrightarrow \text{Ag}_{(q)} + \text{Cl}^-$	+0,222
	$\text{AgBr}_{(q)} + e \leftrightarrow \text{Ag}_{(q)} + \text{Br}^-$	+0,071
	$\text{AgI}_{(q)} + e \leftrightarrow \text{Ag}_{(q)} + \text{I}^-$	-0,152
Al	$\text{Al}^{3+} + 3e \leftrightarrow \text{Al}_{(q)}$	-1,66
	$\text{Al}^{3+} + 2e \leftrightarrow \text{Al}^+$	-2,76
	$\text{Al}^{3+} + e \leftrightarrow \text{Al}_{(q)q}$	-0,55
	$\text{AlO}_2^- + 4\text{H}^+ + 3e \leftrightarrow \text{Al}_{(q)} + 2\text{H}_2\text{O}$	-1,262
	$\text{Al}(\text{OH})_{3(q)} + 3e \leftrightarrow \text{Al}_{(q)} + 3\text{OH}^-$	-2,31
	$[\text{AlF}_6]^{3-} + 3e \leftrightarrow \text{Al}_{(q)} + 6\text{F}^-$	-2,07
As	$\text{H}_3\text{AsO}_4 + 3\text{H}^+ + 2e \leftrightarrow \text{AsO}^+ + 3\text{H}_2\text{O}$	+0,55
	$\text{H}_3\text{AsO}_4 + 2\text{H}^+ + 2e \leftrightarrow \text{HAsO}_2 + 2\text{H}_2\text{O}$	+0,559
	$\text{H}_2\text{AsO}_4^- + 3\text{H}^+ + 2e \leftrightarrow \text{HAsO}_2 + 2\text{H}_2\text{O}$	+0,666
	$\text{HASO}_4^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{HAsO}_2 + 2\text{H}_2\text{O}$	+0,881
	$\text{HASO}_4^{2-} + 3\text{H}^+ + 2e \leftrightarrow \text{AsO}_2^- + 2\text{H}_2\text{O}$	+0,609
	$\text{AsO}_4^{3-} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{AsO}_2^- + 4\text{OH}^-$	-0,67
	$2\text{H}_3\text{AsO}_4 + 4\text{H}^+ + 4e \leftrightarrow \text{As}_2\text{O}_{3(q)} + 5\text{H}_2\text{O}$	+0,58

	$2\text{H}_2\text{AsO}_4^- + 6\text{H}^+ + 4e \leftrightarrow \text{As}_2\text{O}_{3(\text{q})} + 5\text{H}_2\text{O}$	+0,687
	$2\text{HASO}_4^{2-} + 8\text{H}^+ + 4e \leftrightarrow \text{As}_2\text{O}_{3(\text{q})} + 5\text{H}_2\text{O}$	+0,901
	$2\text{AsO}_4^{3-} + 10\text{H}^+ + 4e \leftrightarrow \text{As}_2\text{O}_{3(\text{q})} + 5\text{H}_2\text{O}$	+1,27
	$\text{AsO}_4^{3-} + 8\text{H}^+ + 5e \leftrightarrow \text{As}_{(\text{q})} + 4\text{H}_2\text{O}$	+0,648
	$\text{As}_2\text{O}_{3(\text{q})} + 6\text{H}^+ + 6e \leftrightarrow 2\text{As}_{(\text{q})} + 3\text{H}_2\text{O}$	+0,234
As	$\text{AsO}^+ + 2\text{H}^+ + 3e \leftrightarrow \text{As}_{(\text{q})} + \text{H}_2\text{O}$	+0,254
	$\text{HASO}_2 + 3\text{H}^+ + 3e \leftrightarrow \text{As}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,248
	$\text{AsO}_2^- + 4\text{H}^+ + 3e \leftrightarrow \text{As}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,429
	$\text{AsO}_2^- + 2\text{H}_2\text{O} + 3e \leftrightarrow \text{As}_{(\text{q})} + 4\text{OH}^-$	-0,68
	$\text{As}_{(\text{q})} + 3\text{H}^+ + 3e \leftrightarrow \text{AsH}_{3(\text{g})}$	-0,608
Au	$\text{Au}^{3+} + 2e \leftrightarrow \text{Au}^+$	+1,41
	$\text{Au}^{3+} + 3e \leftrightarrow \text{Au}_{\text{q}}$	+1,50
	$\text{Au}^+ + e \leftrightarrow \text{Au}_{(\text{q})}$	+1,68
	$\text{AuCl}_4^- + 2e \leftrightarrow \text{AuCl}_2^- + 2\text{Cl}^-$	+0,926
	$\text{AuBr}_4^- + 2e \leftrightarrow \text{AuBr}_2^- + 2\text{Br}^-$	+0,805
	$\text{AuCl}_4^- + 3e \leftrightarrow \text{Au}_{(\text{q})} + 4\text{Cl}^-$	+1,002
	$\text{AuBr}_4^- + 3e \leftrightarrow \text{Au}_{(\text{q})} + 4\text{Br}^-$	+0,858
	$\text{AuCl}_2^- + e \leftrightarrow \text{Au}_{(\text{q})} + 2\text{Cl}^-$	+1,154
B	$\text{AuBr}_2^- + e \leftrightarrow \text{Au}_{(\text{q})} + 2\text{Br}^-$	+0,963
	$\text{H}_3\text{BO}_3 + 3\text{H}^+ + 3e \leftrightarrow \text{B}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,869
	$\text{H}_2\text{BO}_3^- + 4\text{H}^+ + 3e \leftrightarrow \text{B}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,687
	$\text{HBO}_3^{2-} + 5\text{H}^+ + 3e \leftrightarrow \text{B}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,437
	$\text{BO}_3^{3-} + 6\text{H}^+ + 3e \leftrightarrow \text{B}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,165
	$\text{B}(\text{OH})_3 + 3\text{H}^+ + 3e \leftrightarrow \text{B}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,87
	$[\text{BF}_4]^- + 3e \leftrightarrow \text{B}_{(\text{q})} + 4\text{F}^-$	-1,04
	$\text{H}_2\text{B}_4\text{O}_7 + 12\text{H}^+ + 12e \leftrightarrow 4\text{B}_{(\text{q})} + 7\text{H}_2\text{O}$	-0,836
Ba	$\text{B}_4\text{O}_7^{2-} + 14\text{H}^+ + 12e \leftrightarrow 4\text{B}_{(\text{q})} + 7\text{H}_2\text{O}$	-0,792
	$\text{Ba}^{2+} + 2e \leftrightarrow \text{Ba}_{(\text{q})}$	-2,905
Be	$\text{BaO} + 2\text{H}^+ + 2e \leftrightarrow \text{Ba}_{(\text{q})} + \text{H}_2\text{O}$	-2,166
	$\text{Be}^{2+} + 2e \leftrightarrow \text{Be}_{(\text{q})}$	-1,85
Bi	$\text{Be}_2\text{O}_3^{2-} + 3\text{H}_2\text{O} + 4e \leftrightarrow 2\text{Be}_{(\text{q})} + 6\text{OH}^-$	-2,62
	$\text{Bi}^{3+} + 3e \leftrightarrow \text{Bi}_{(\text{q})}$	+0,215
	$\text{BiOH}^{2+} + \text{H}^+ + 3e \leftrightarrow \text{Bi}_{(\text{q})} + \text{H}_2\text{O}$	+0,254

	$\text{BiO}^+ + 2\text{H}^+ + 3e \leftrightarrow \text{Bi}_{(q)} + \text{H}_2\text{O}$	+0,320
	$\text{BiOCl}_{(q)} + 2\text{H}^+ + 3e \leftrightarrow \text{Bi}_{(q)} + \text{H}_2\text{O} + \text{Cl}^-$	+0,160
	$\text{Bi}_2\text{O}_{3(q)} + 3\text{H}_2\text{O} + 6e \leftrightarrow 2\text{Bi}_{(q)} + 6\text{OH}^-$	-0,46
	$\text{Bi}_2\text{O}_{5(q)} + 10\text{H}^+ + 4e \leftrightarrow 2\text{Bi}^{3+} + 5\text{H}_2\text{O}$	+1,759
	$\text{Bi}_2\text{O}_{5(q)} + 8\text{H}^+ + 4e \leftrightarrow 2\text{BiOH}^{2+} + 3\text{H}_2\text{O}$	+1,700
Bi	$\text{Bi}_2\text{O}_{5(q)} + 6\text{H}^+ + 4e \leftrightarrow 2\text{BiO}^+ + 3\text{H}_2\text{O}$	+1,605
	$\text{NaBiO}_{3(q)} + 4\text{H}^+ + 2e \leftrightarrow \text{BiO}^+ + \text{Na}^+ + \text{H}_2\text{O}$	> +1,8
	$\text{Bi}_{(q)} + 3\text{H}^+ + 3e \leftrightarrow \text{BiH}_{3(g)}$	-0,800
Br	$\text{Br}_{2(s)} + 2e \leftrightarrow 2\text{Br}^-$	+1,09
	$[\text{Br}_3]^- + 2e \leftrightarrow 3\text{Br}^-$	+1,05
	$\text{HBrO}_3 + 5\text{H}^+ + 6e \leftrightarrow \text{Br}^- + 3\text{H}_2\text{O}$	+1,42
	$3\text{HBrO}_3 + 15\text{H}^+ + 16e \leftrightarrow [\text{Br}_3]^- + 9\text{H}_2\text{O}$	+1,462
	$\text{BrO}_3^- + 3\text{H}_2\text{O} + 6e \leftrightarrow \text{Br}^- + 6\text{OH}^-$	+0,61
	$2\text{HBrO}_3 + 10\text{H}^+ + 10e \leftrightarrow \text{Br}_{2(s)} + 6\text{H}_2\text{O}$	+1,48
	$\text{HBrO}_3 + 4\text{H}^+ + 4e \leftrightarrow \text{HBrO} + 2\text{H}_2\text{O}$	+1,46
	$\text{HBrO}_3 + 3\text{H}^+ + 4e \leftrightarrow \text{BrO}^- + 2\text{H}_2\text{O}$	+1,33
	$2\text{HBrO} + 2\text{H}^+ + 2e \leftrightarrow \text{Br}_{2(s)} + 2\text{H}_2\text{O}$	+1,59
	$2\text{BrO}^- + 4\text{H}^+ + 2e \leftrightarrow \text{Br}_{2(s)} + 2\text{H}_2\text{O}$	+2,09
	$2\text{BrO}^- + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{Br}_{2(s)} + 4\text{OH}^-$	+0,45
	$\text{BrO}^- + \text{H}_2\text{O} + 2e \leftrightarrow \text{Br}^- + 2\text{OH}^-$	+0,76
C	$\text{CO}_{2(g)} + 2\text{H}^+ + 2e \leftrightarrow \text{CO}_{2(g)} + \text{H}_2\text{O}$	-0,12
	$2\text{CO}_{2(g)} + 2\text{H}^+ + 2e \leftrightarrow \text{H}_2\text{C}_2\text{O}_4$	-0,49
	$\text{CO}_{2(g)} + 2\text{H}^+ + 2e \leftrightarrow \text{HCOOH}$	-0,20
	$\text{CNO} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{CN}^- + 2\text{OH}^-$	-0,97
	$2\text{HCNO} + 2\text{H}^+ + 2e \leftrightarrow 2\text{H}_2\text{O} + (\text{CN})_{2(g)}$	+0,33
	$(\text{CN})_{2(g)} + 2\text{H}^+ + 2e \leftrightarrow 2\text{HCN}$	+0,37
Ca	$\text{Ca}^{2+} + 2e \leftrightarrow \text{Ca}_{(q)}$	-2,87
	$\text{CaO}_{\text{gidr}} + 2\text{H}^+ + 2e \leftrightarrow \text{Ca}_{(q)} + \text{H}_2\text{O}$	-2,19
	$\text{CaO}_{(q)} + 2\text{H}^+ + 2e \leftrightarrow \text{Ca}_{(q)} + \text{H}_2\text{O}$	-1,90
	$\text{Ca}(\text{OH})_{2(q)} + 2e \leftrightarrow \text{Ca}_{(q)} + 2\text{OH}^-$	-3,03
Cd	$\text{Cd}^{2+} + 2e \leftrightarrow \text{Cd}_{(q)}$	-0,40
	$\text{Cd}(\text{CN})_4^{2-} + 2e \leftrightarrow \text{Cd}_{(q)} + 4\text{CN}^-$	-1,09
	$[\text{Cd}(\text{NH}_3)_4]^{2+} + 2e \leftrightarrow \text{Cd}_{(q)} + 4\text{NH}_3$	-0,61

	$\text{Cd}(\text{OH})_{2(\text{q})} + 2e \leftrightarrow \text{Cd}_{(\text{q})} + 2\text{OH}^-$	-0,81
	$\text{CdS}_{(\text{q})} + 2e \leftrightarrow \text{Cd}_{(\text{q})} + \text{S}^{2-}$	-1,17
Ce	$\text{Ce}^{3+} + 3e \leftrightarrow \text{Ce}$	-2,48
	$[\text{Ce}(\text{OH})_2]^{2+} + 2\text{H}^+ + e \leftrightarrow \text{Ce}^{3+} + 2\text{H}_2\text{O}$	+1,73
	$[\text{Ce}(\text{OH})]^{2+} + \text{H}^+ + e \leftrightarrow \text{Ce}^{3+} + \text{H}_2\text{O}$	+1,71
	$[\text{Ce}(\text{ClO}_4)_6]^{2-} + e \leftrightarrow \text{Ce}^{3+} + 6\text{ClO}_4^-$	+1,70
Ce	$[\text{Ce}(\text{NO}_3)_6]^{2-} + e \leftrightarrow \text{Ce}^{3+} + 6\text{NO}_3^-$	+1,60
	$[\text{Ce}(\text{SO}_4)_3]^{2-} + e \leftrightarrow \text{Ce}^{3+} + 3\text{SO}_4^{2-}$	+1,44
Cl	$\text{Cl}_{2(\text{g})} + 2e \leftrightarrow 2\text{Cl}^-$	+1,35
	$\text{Cl}_{2(\text{aqua})} + 2e \leftrightarrow 2\text{Cl}^-$	+1,39
	$\text{ClO}_4^- + 2\text{H}^+ + 2e \leftrightarrow \text{ClO}_3^- + \text{H}_2\text{O}$	+1,19
	$\text{ClO}_4^- + \text{H}_2\text{O} + 2e \leftrightarrow \text{ClO}_3^- + 2\text{OH}^-$	+0,36
	$2\text{ClO}_4 + 16\text{H}^+ + 14e \leftrightarrow \text{Cl}_{2(\text{g})} + 8\text{H}_2\text{O}$	+1,39
	$\text{ClO}_3^- + 3\text{H}^+ + 2e \leftrightarrow \text{HClO}_2 + \text{H}_2\text{O}$	+1,21
	$\text{ClO}_3^- + \text{H}_2\text{O} + 2e \leftrightarrow \text{ClO}_2^- + 2\text{OH}^-$	+0,33
	$\text{ClO}_2^- + \text{H}_2\text{O} + 2e \leftrightarrow \text{ClO}^- + 2\text{OH}^-$	+0,66
	$2\text{HClO} + 2\text{H}^+ + 2e \leftrightarrow \text{Cl}_{2(\text{g})} + \text{H}_2\text{O}$	+1,63
	$2\text{ClO}^- + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{ClO}_{2(\text{g})} + 4\text{OH}^-$	+0,40
Co	$\text{Co}^{3+} + e \leftrightarrow \text{Co}^{2+}$	+1,81
	$\text{Co}^{3+} + 3e \leftrightarrow \text{Co}_{(\text{q})}$	+0,46
	$\text{Co}^{2+} + 2e \leftrightarrow \text{Co}_{(\text{q})}$	-0,28
	$\text{Co}_3\text{O}_{4(\text{q})} + 8\text{H}^+ + 2e \leftrightarrow 3\text{Co}^{2+} + 4\text{H}_2\text{O}$	+2,11
	$\text{Co}_2\text{O}_{3(\text{q})} + 6\text{H}^+ + 2e \leftrightarrow 2\text{Co}^{2+} + 3\text{H}_2\text{O}$	+1,75
	$\text{Co}(\text{OH})_{2(\text{q})} + 2e \leftrightarrow \text{Co}_{(\text{q})} + 2\text{OH}^-$	-0,73
	$[\text{Co}(\text{NH}_3)_6]^{3+} + e \leftrightarrow [\text{Co}(\text{NH}_3)_6]^{2+}$	+0,1
	$\text{CoO}(\text{OH})_{(\text{q})} + \text{H}_2\text{O} + e \leftrightarrow \text{Co}(\text{OH})_{2(\text{q})} + \text{OH}^-$	+0,17
Cr	$\text{Cr}^{3+} + e \leftrightarrow \text{Cr}^{2+}$	-0,41
	$\text{Cr}^{3+} + 3e \leftrightarrow \text{Cr}_{\text{q}}$	-0,74
	$\text{Cr}^{2+} + 2e \leftrightarrow \text{Cr}_{\text{q}}$	-0,91
	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e \leftrightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
	$\text{Cr}_2\text{O}_7^{2-} + 12\text{H}^+ + 6e \leftrightarrow 2\text{Cr}^{2+} + 5\text{H}_2\text{O}$	+1,26
	$\text{Cr}_2\text{O}_7^{2-} + 10\text{H}^+ + 6e \leftrightarrow 2[\text{Cr}(\text{OH})_2]^+ + 3\text{H}_2\text{O}$	+1,14
	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 12e \leftrightarrow 2\text{Cr}_{(\text{q})} + 7\text{H}_2\text{O}$	+0,29

	$\text{HCrO}_4^- + 7\text{H}^+ + 3e \leftrightarrow \text{Cr}^{3+} + 4\text{H}_2\text{O}$	+1,20
	$\text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3e \leftrightarrow \text{Cr}(\text{OH})_{3(\text{q})} + 5\text{OH}^-$	-0,13
	$\text{HCrO}_4^- + 6\text{H}^+ + 3e \leftrightarrow [\text{CrOH}]^{2+} + 3\text{H}_2\text{O}$	+1,28
	$\text{CrO}_4^{2-} + 7\text{H}^+ + 3e \leftrightarrow [\text{CrOH}]^{2+} + 3\text{H}_2\text{O}$	+1,40
	$\text{CrO}_4^{2-} + 6\text{H}^+ + 3e \leftrightarrow \text{Cr}(\text{OH})_2 + 2\text{H}_2\text{O}$	+1,28
	$\text{CrO}_4^{2-} + 4\text{H}^+ + 3e \leftrightarrow \text{CrO}_2^- + 2\text{H}_2\text{O}$	+0,95
	$\text{CrO}_4^{2-} + 2\text{H}^+ + 3e \leftrightarrow \text{CrO}_3^{3-} + \text{H}_2\text{O}$	+0,36
Cu	$\text{Cu}^{2+} + e \leftrightarrow \text{Cu}^+$	+0,16
	$\text{Cu}^{2+} + 2e \leftrightarrow \text{Cu}_{(\text{q})}$	+0,34
	$\text{Cu}^+ + e \leftrightarrow \text{Cu}_{(\text{q})}$	+0,52
	$\text{HCuO}_2^- + 3\text{H}^+ + e \leftrightarrow \text{Cu}^+ + 2\text{H}_2\text{O}$	+1,73
	$\text{CuO}_2^{2-} + 4\text{H}^+ + e \leftrightarrow \text{Cu}^+ + 2\text{H}_2\text{O}$	+2,51
	$\text{HCuO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Cu}_{(\text{q})} + 2\text{H}_2\text{O}$	+1,13
	$\text{CuO}_2^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{Cu}_{(\text{q})} + 2\text{H}_2\text{O}$	+1,52
	$2\text{Cu}^{2+} + \text{H}_2\text{O} + 2e \leftrightarrow \text{Cu}_2\text{O}_{(\text{q})} + 2\text{H}^+$	+0,20
	$2\text{HCuO}_2^- + 4\text{H}^+ + 2e \leftrightarrow \text{Cu}_2\text{O}_{(\text{q})} + 3\text{H}_2\text{O}$	+1,78
	$2\text{CuO}_2^{2-} + 6\text{H}^+ + 2e \leftrightarrow \text{Cu}_2\text{O}_{(\text{q})} + 3\text{H}_2\text{O}$	+2,56
	$\text{CuO} + 2\text{H}^+ + e \leftrightarrow \text{Cu}^+ + \text{H}_2\text{O}$	+0,62
	$\text{Cu}^{2+} + \text{Br}^- + e \leftrightarrow \text{CuBr}_{(\text{q})}$	+0,64
	$\text{Cu}^{2+} + \text{Cl}^- + e \leftrightarrow \text{CuCl}_{(\text{q})}$	+0,54
	$\text{Cu}^{2+} + \text{I}^- + e \leftrightarrow \text{CuI}_{(\text{q})}$	+0,86
	$[\text{Cu}(\text{NH}_3)_4]^{2+} + e \leftrightarrow [\text{Cu}(\text{NH}_3)_2]^+ + 2\text{NH}_3$	-0,01
	$[\text{Cu}(\text{NH}_3)_2]^+ + e \leftrightarrow \text{Cu}_{(\text{q})} + 2\text{NH}_3$	-0,12
	$[\text{Cu}(\text{NH}_3)_4]^{2+} + 2e \leftrightarrow \text{Cu}_{(\text{q})} + 4\text{NH}_3$	-0,07
F	$\text{F}_{2(\text{g})} + 2\text{H}^+ + 2e \leftrightarrow 2\text{HF}$	+2,81
	$\text{F}_{2(\text{g})} + 2e \leftrightarrow 2\text{F}^-$	+2,87
	$\text{F}_2\text{O} + 2\text{H}^+ + 4e \leftrightarrow 2\text{HF} + \text{H}_2\text{O}$	+2,12
	$\text{F}_2\text{O} + 2\text{H}^+ + 4e \leftrightarrow 2\text{F}^- + \text{H}_2\text{O}$	+2,15
	$\text{F}_2\text{O} + 2\text{H}^+ + 2e \leftrightarrow \text{F}_{2(\text{g})} + \text{H}_2\text{O}$	+1,44
Fe	$\text{Fe}^{3+} + e \leftrightarrow \text{Fe}^{2+}$	+0,77
	$\text{Fe}^{3+} + 3e \leftrightarrow \text{Fe}_{(\text{q})}$	-0,04
	$\text{Fe}^{2+} + 2e \leftrightarrow \text{Fe}_{(\text{q})}$	-0,44
	$\text{Fe}(\text{OH})^{2+} + \text{H}^+ + e \leftrightarrow \text{Fe}^{2+} + \text{H}_2\text{O}$	+0,91

	$\text{Fe}(\text{OH})_2^+ + 2\text{H}^+ + e \leftrightarrow \text{Fe}^{2+} + 2\text{H}_2\text{O}$	+1,19
	$\text{FeO}_4^{2-} + 8\text{H}^+ + 3e \leftrightarrow \text{Fe}^{3+} + 4\text{H}_2\text{O}$	+1,70
	$\text{FeO}_4^{2-} + 7\text{H}^+ + 3e \leftrightarrow \text{Fe}(\text{OH})_2^+ + 3\text{H}_2\text{O}$	+1,65
	$\text{FeO}_4^{2-} + 3\text{H}^+ + 3e \leftrightarrow \text{Fe}(\text{OH})_2^+ + 2\text{H}_2\text{O}$	+1,56
	$\text{FeO}_4^{2-} + 5\text{H}^+ + 3e \leftrightarrow \text{HFeO}_2 + 2\text{H}_2\text{O}$	+1,00
	$\text{HFeO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Fe}_{(q)} + 2\text{H}_2\text{O}$	+0,49
	$[\text{Fe}(\text{CN}_6)]^{3-} + e \leftrightarrow [\text{Fe}(\text{CN}_6)]^{4-}$	+0,36
	$\text{Fe}(\text{C}_{12}\text{H}_8\text{N}_2)_3^{3+} + e \leftrightarrow \text{Fe}(\text{C}_{12}\text{H}_8\text{N}_2)_3^{2+}$	+1,06
H	$2\text{H}^+ + 2e \leftrightarrow \text{H}_{2(g)}$	$\pm 0,0000$
	$2\text{H}^+ (10^{-7} \text{ M}) + 2e \leftrightarrow \text{H}_{2(g)}$	-0,41
	$\text{H}_{2(g)} + 2e \leftrightarrow 2\text{H}^+$	-2,25
	$2\text{H}_2\text{O} + 2e \leftrightarrow \text{H}_{2(g)} + 2\text{OH}^-$	-0,83
	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e \leftrightarrow 2\text{H}_2\text{O}$	+1,77
	$\text{HO}_2^- + \text{H}_2\text{O} + 2e \leftrightarrow 3\text{OH}^-$	+0,88
Hg	$2\text{Hg}^{2+} + 2e \leftrightarrow \text{Hg}_2^{2+}$	+0,91
	$\text{Hg}_2^{2+} + 2e \leftrightarrow 2\text{Hg}_{(s)}$	+0,79
	$\text{HgO}_{(q)} + \text{H}_2\text{O} + 2e \leftrightarrow \text{Hg}_{(s)} + 2\text{OH}^-$	+0,10
	$\text{HgO}_{(q)} + 2\text{H}^+ + 2e \leftrightarrow \text{Hg}_{(s)} + \text{H}_2\text{O}$	+0,93
	$2\text{Hg}(\text{OH})_{2(q)} + 4\text{H}^+ + 2e \leftrightarrow \text{Hg}_2^{2+} + 4\text{H}_2\text{O}$	+1,28
	$\text{Hg}_2\text{Cl}_{2(q)} + 2e \leftrightarrow 2\text{Hg}_{(s)} + 2\text{Cl}^-$	+0,27
	$\text{Hg}_2\text{Br}_{2(q)} + 2e \leftrightarrow 2\text{Hg}_{(s)} + 2\text{Br}^-$	+0,14
	$\text{Hg}_2\text{I}_{2(q)} + 2e \leftrightarrow 2\text{Hg}_{(s)} + 2\text{I}^-$	-0,04
	$\text{Hg}_2\text{C}_2\text{O}_{4(q)} + 2e \leftrightarrow 2\text{Hg}_{(s)} + 2\text{C}_2\text{O}_4^{2-}$	+0,42
	$\text{HgS}_{(q, \text{ qora})} + 2e \leftrightarrow \text{Hg}_{(s)} + \text{S}^{2-}$	-0,67
	$\text{HgS}_{(q, \text{ qizil})} + 2e \leftrightarrow \text{Hg}_{(s)} + \text{S}^{2-}$	-0,70
	$[\text{Hg}(\text{CN})_4]^{2-} + 2e \leftrightarrow \text{Hg}_{(s)} + 4\text{CN}^-$	-0,37
I	$[\text{I}_3]^- + 2e \leftrightarrow 3\text{I}^-$	-0,536
	$\text{I}_{2(aqua)} + 2e \leftrightarrow 2\text{I}^-$	+0,621
	$3\text{I}_2 + 2e \leftrightarrow 2[\text{I}_3]^-$	+0,789
	$\text{H}_5\text{IO}_6 + \text{H}^+ + 2e \leftrightarrow \text{IO}_3^- + 3\text{H}_2\text{O}$	+1,6
	$\text{HIO}_5^{2-} + 3\text{H}^+ + 2e \leftrightarrow \text{IO}_3^- + 2\text{H}_2\text{O}$	+1,898
	$\text{HIO}_5^{2-} + 8\text{H}^+ + 6e \leftrightarrow \text{HIO} + 4\text{H}_2\text{O}$	+1,389
	$2\text{HIO}_5^{2-} + 18\text{H}^+ + 14e \leftrightarrow \text{I}_{2(q)} + 10\text{H}_2\text{O}$	+1,384

	$3\text{HIO}_5^{2-} + 27\text{H}^+ + 22e \leftrightarrow [\text{I}_3]^- + 15\text{H}_2\text{O}$	+1,357
	$\text{HIO}_5^{2-} + 9\text{H}^+ + 8e \leftrightarrow \text{I}^- + 5\text{H}_2\text{O}$	+1,288
	$\text{HIO}_4 + 2\text{H}^+ + 2e \leftrightarrow \text{HIO}_3 + \text{H}_2\text{O}$	+1,626
	$\text{IO}_4^- + 2\text{H}^+ + 2e \leftrightarrow \text{IO}_3^- + \text{H}_2\text{O}$	+1,653
	$\text{HIO}_4 + 6\text{H}^+ + 6e \leftrightarrow \text{HIO} + 3\text{H}_2\text{O}$	+1,290
	$\text{IO}_4^- + 7\text{H}^+ + 6e \leftrightarrow \text{HIO} + 3\text{H}_2\text{O}$	+1,235
	$2\text{HIO}_4 + 14\text{H}^+ + 14e \leftrightarrow \text{I}_{2(\text{q})} + 8\text{H}_2\text{O}$	+1,300
	$3\text{HIO}_4 + 21\text{H}^+ + 22e \leftrightarrow [\text{I}_3]^- + 12\text{H}_2\text{O}$	+1,276
	$\text{HIO}_4 + 7\text{H}^+ + 8e \leftrightarrow \text{I}^- + 4\text{H}_2\text{O}$	+1,215
I	$\text{IO}_3^- + 6\text{H}^+ + 4e \leftrightarrow \text{I}^- + 3\text{H}_2\text{O}$	+1,155
	$\text{IO}_3^- + 4\text{H}^+ + 4e \leftrightarrow \text{IO}^- + 2\text{H}_2\text{O}$	+0,972
	$2\text{HIO}_3 + 10\text{H}^+ + 10e \leftrightarrow \text{I}_2 + 6\text{H}_2\text{O}$	+1,169
	$3\text{HIO}_3 + 15\text{H}^+ + 16e \leftrightarrow [\text{I}_3]^- + 9\text{H}_2\text{O}$	+1,145
	$\text{HIO}_3 + 5\text{H}^+ + 6e \leftrightarrow \text{I}^- + 3\text{H}_2\text{O}$	+1,0777
	$2\text{HIO} + 2\text{H}^+ + 2e \leftrightarrow \text{I}_{2(\text{q})} + 2\text{H}_2\text{O}$	+1,354
	$2\text{IO}^- + 4\text{H}^+ + 2e \leftrightarrow \text{I}_{2(\text{q})} + 2\text{H}_2\text{O}$	+2,005
	$3\text{HIO} + 3\text{H}^+ + 4e \leftrightarrow [\text{I}_3]^- + 3\text{H}_2\text{O}$	+1,213
	$3\text{IO}^- + 6\text{H}^+ + 4e \leftrightarrow [\text{I}_3]^- + 3\text{H}_2\text{O}$	+1,701
	$\text{IO}^- + 2\text{H}^+ + 2e \leftrightarrow \text{I}^- + \text{H}_2\text{O}$	+1,313
	$\text{HIO} + \text{H}^+ + 2e \leftrightarrow \text{I}^- + \text{H}_2\text{O}$	+0,987
	$2\text{ICl}_{3(\text{q})} + 6e \leftrightarrow \text{I}_{2(\text{q})} + 6\text{Cl}^-$	+1,28
	$\text{ICl}_{(\text{q})} + 2e \leftrightarrow \text{I}_{2(\text{q})} + 2\text{Cl}^-$	+1,22
	$\text{ICl} + 2e \leftrightarrow \text{I}_{2(\text{q})} + 2\text{Cl}^-$	+1,19
	$2\text{IBr}_{(\text{s})} + 2e \leftrightarrow \text{I}_{2(\text{q})} + 2\text{Br}^-$	+1,02
K	$\text{K}^+ + e \leftrightarrow \text{K}_{(\text{q})}$	-2,925
Li	$\text{Li}^+ + e \leftrightarrow \text{Li}_{(\text{q})}$	-3,03
Mg	$\text{Mg}^{2+} + 2e \leftrightarrow \text{Mg}_{(\text{q})}$	-2,37
	$\text{Mg}(\text{OH})_{(\text{q})} + 2e \leftrightarrow \text{Mg}_{(\text{q})} + 2\text{OH}^-$	-2,69
	$\text{MgO}_{(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{Mg}_{(\text{q})} + \text{H}_2\text{O}$	-1,869
	$\text{MgO}_{(\text{q suvsiz})} + 2\text{H}^+ + 2e \leftrightarrow \text{Mg}_{(\text{q})} + \text{H}_2\text{O}$	-1,722
Mn	$\text{Mn}^{2+} + 2e \leftrightarrow \text{Mn}_{(\text{q})}$	-1,18
	$\text{Mn}^{\text{IV}} + e \leftrightarrow \text{Mn}^{\text{III}} (3,5\text{M H}_2\text{SO}_4)$	+1,65
	$\text{Mn}^{\text{III}} + e \leftrightarrow \text{Mn}^{\text{II}} (3,5\text{M H}_2\text{SO}_4)$	+1,59

	$\text{MnO}_4^- + e \leftrightarrow \text{MnO}_4^{2-}$	+0,576
	$\text{MnO}_4^- + 2\text{H}_2\text{O} + 3e \leftrightarrow \text{MnO}_{2(\text{q})} + 4\text{OH}^-$	+0,588
	$\text{MnO}_4^- + 4\text{H}^+ + 3e \leftrightarrow \text{MnO}_{2(\alpha, \text{q})} + 2\text{H}_2\text{O}$	+1,695
	$\text{MnO}_4^- + 4\text{H}^+ + 3e \leftrightarrow \text{MnO}_{2(\beta, \text{q})} + 2\text{H}_2\text{O}$	+1,679
	$\text{MnO}_4^- + 8\text{H}^+ + 4e \leftrightarrow \text{Mn}^{3+} + 4\text{H}_2\text{O}$	+1,506
	$\text{MnO}_4^- + 8\text{H}^+ + 5e \leftrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,507
	$\text{MnO}_4^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{MnO}_{2(\text{q})} + 2\text{H}_2\text{O}$	+2,257
	$\text{MnO}_4^{2-} + 5\text{H}^+ + 4e \leftrightarrow \text{HMnO}_2^- + 2\text{H}_2\text{O}$	+1,234
	$\text{MnO}_4^{2-} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{MnO}_{2(\text{q})} + 4\text{OH}^-$	+0,51
	$\text{MnO}_{2(\text{q})} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{Mn}(\text{OH})_2 + 2\text{OH}^-$	-0,05
Mn	$\text{MnO}_{2(\text{q})} + 4\text{H}^+ + 2e \leftrightarrow \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
	$\text{MnO}_{2(\text{q})} + 4\text{H}^+ + 2e \leftrightarrow \text{Mn}^{3+} + 2\text{H}_2\text{O}$	+0,948
	$\text{Mn}(\text{OH})_{3(\text{q})} + e \leftrightarrow \text{Mn}(\text{OH})_{2(\text{q})} + \text{OH}^-$	+0,1
	$\text{Mn}^{2+} + 2e \leftrightarrow \text{Mn}_{(\text{q})}$	-1,18
	$\text{Mn}(\text{OH})_{2(\text{q})} + 2e \leftrightarrow \text{Mn}_{(\text{q})} + 2\text{OH}^-$	-1,55
	$\text{HMnO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Mn}_{(\text{q})} + 2\text{H}_2\text{O}$	-0,163
N	$\text{NO}_3^- + 2\text{H}^+ + e \leftrightarrow \text{NO}_{2(\text{g})} + \text{H}_2\text{O}$	+0,775
	$2\text{NO}_3^- + 4\text{H}^+ + 2e \leftrightarrow \text{N}_2\text{O}_{4(\text{g})} + 2\text{H}_2\text{O}$	+0,80
	$\text{NO}_3^- + 3\text{H}^+ + 2e \leftrightarrow \text{HNO}_2 + \text{H}_2\text{O}$	+0,94
	$\text{NO}_3^- + 2\text{H}^+ + 2e \leftrightarrow \text{NO}_2^- + \text{H}_2\text{O}$	+0,835
	$\text{NO}_3^- + 4\text{H}^+ + 3e \leftrightarrow \text{NO}_2^- + 2\text{H}_2\text{O}$	+0,96
	$\text{NO}_{2(\text{g})} + e \leftrightarrow \text{NO}_2^-$	+0,893
	$\text{NO}_{2(\text{g})} + \text{H}^+ + e \leftrightarrow \text{HNO}_2$	+1,093
	$\text{NO}_{2(\text{g})} + 2\text{H}^+ + 2e \leftrightarrow \text{NO}_{(\text{g})} + \text{H}_2\text{O}$	+1,049
	$2\text{NO}_{2(\text{g})} + 6\text{H}^+ + 6e \leftrightarrow \text{N}_2\text{O}_{(\text{g})} + 3\text{H}_2\text{O}$	+1,229
	$2\text{NO}_{2(\text{g})} + 8\text{H}^+ + 8e \leftrightarrow \text{N}_{2(\text{g})} + 4\text{H}_2\text{O}$	+1,363
	$\text{NO}_2^- + 2\text{H}^+ + e \leftrightarrow \text{NO}_{(\text{g})} + \text{H}_2\text{O}$	+1,202
	$\text{HNO}_2 + \text{H}^+ + e \leftrightarrow \text{NO}_{(\text{g})} + \text{H}_2\text{O}$	+1,004
	$2\text{NO}_2^- + 6\text{H}^+ + 4e \leftrightarrow \text{N}_2\text{O}_{(\text{g})} + 3\text{H}_2\text{O}$	+1,396
	$2\text{HNO}_2 + 4\text{H}^+ + 4e \leftrightarrow \text{N}_2\text{O}_{(\text{g})} + 3\text{H}_2\text{O}$	+1,297
	$2\text{NO}_2^- + 8\text{H}^+ + 6e \leftrightarrow \text{N}_{2(\text{g})} + 4\text{H}_2\text{O}$	+1,520
	$2\text{HNO}_2 + 6\text{H}^+ + 6e \leftrightarrow \text{N}_{2(\text{g})} + 4\text{H}_2\text{O}$	+1,454
	$\text{NO}_2^- + 7\text{H}^+ + 6e \leftrightarrow \text{NH}_{3(\text{g})} + 2\text{H}_2\text{O}$	+0,789

	$\text{HNO}_2 + 7\text{H}^+ + 6e \leftrightarrow \text{NH}_4^+ + 2\text{H}_2\text{O}$	+0,864
	$\text{N}_{2(\text{g})} + 6\text{H}^+ + 6e \leftrightarrow 2\text{NH}_{3(\text{g})}$	+0,057
	$\text{N}_{2(\text{g})} + 2\text{H}_2\text{O} + 6\text{H}^+ + 6e \leftrightarrow 2\text{NH} \cdot \text{H}_2\text{O}$	+0,92
	$\text{N}_{2(\text{g})} + 8\text{H}^+ + 6e \leftrightarrow 2\text{NH}_4^+$	+0,275
Na	$\text{Na}^+ + e \leftrightarrow \text{Na}_{(\text{q})}$	-2,713
Ni	$\text{Ni}^{2+} + 2e \leftrightarrow \text{Ni}_{(\text{q})}$	-0,250
	$\text{NiO}_{2(\text{q})} + 4\text{H}^+ + 2e \leftrightarrow \text{Ni}^{2+} + 2\text{H}_2\text{O}$	+1,593
	$\text{NiO}_{2(\text{q})} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{Ni}(\text{OH})_{2(\text{q})} + 2\text{OH}^-$	+0,49
	$\text{Ni}_2\text{O}_{3(\text{q})} + 6\text{H}^+ + 2e \leftrightarrow 2\text{Ni}^{2+} + 3\text{H}_2\text{O}$	+1,753
	$\text{Ni}_3\text{O}_{4(\text{q})} + 2\text{H}_2\text{O} + 2e \leftrightarrow 3\text{HNiO}_2^- + \text{H}^+$	-0,718
	$\text{Ni}_3\text{O}_{4(\text{q})} + 8\text{H}^+ + 2e \leftrightarrow 3\text{Ni}^{2+} + 4\text{H}_2\text{O}$	+1,977
Ni	$\text{HNiO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Ni}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,648
	$[\text{Ni}(\text{NH}_3)_6]^{2+} + 2e \leftrightarrow \text{Ni}_{(\text{q})} + 6\text{NH}_3$	-0,49
O	$\text{O}_{2(\text{g})} + 4\text{H}^+ + 4e \leftrightarrow 2\text{H}_2\text{O}$	+1,229
	$\text{O}_{2(\text{g})} + 2\text{H}_2\text{O} + 4e \leftrightarrow 4\text{OH}^-$	+0,401
	$\text{O}_{3(\text{g})} + 2\text{H}^+ + 2e \leftrightarrow \text{O}_{2(\text{g})} + \text{H}_2\text{O}$	+2,076
	$\text{O}_{3(\text{g})} + 6\text{H}^+ + 6e \leftrightarrow 3\text{H}_2\text{O}$	+1,501
	$\text{O}_{3(\text{g})} + \text{H}_2\text{O} + 3e \leftrightarrow \text{O}_{2(\text{g})} + 2\text{OH}^-$	+1,24
	$\text{O}_{2(\text{g})} + 2\text{H}^+ + 2e \leftrightarrow \text{H}_2\text{O}_2$	+0,69
	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e \leftrightarrow 2\text{H}_2\text{O}$	+1,776
P	$\text{P}_{(\text{qizil})} + 3\text{H}^+ + 3e \leftrightarrow \text{PH}_{3(\text{g})}$	-0,111
	$\text{P}_{(\text{oq})} + 3\text{H}^+ + 3e \leftrightarrow \text{PH}_{3(\text{g})}$	-0,063
	$\text{PO}_4^{3-} + 3\text{H}^+ + 2e \leftrightarrow \text{HPO}_3^{2-} + \text{H}_2\text{O}$	+0,121
	$\text{HPO}_4^{2-} + 2\text{H}^+ + 2e \leftrightarrow \text{HPO}_3^{2-} + \text{H}_2\text{O}$	-0,234
	$\text{H}_2\text{PO}_4^- + \text{H}^+ + 2e \leftrightarrow \text{HPO}_3^{2-} + \text{H}_2\text{O}$	-0,447
	$\text{H}_2\text{PO}_4^- + 2\text{H}^+ + 2e \leftrightarrow \text{H}_2\text{PO}_3^- + \text{H}_2\text{O}$	-0,260
	$\text{H}_3\text{PO}_4 + \text{H}^+ + 2e \leftrightarrow \text{H}_2\text{PO}_3^- + \text{H}_2\text{O}$	-0,329
	$\text{H}_3\text{PO}_4 + 2\text{H}^+ + 2e \leftrightarrow \text{H}_3\text{PO}_3 + \text{H}_2\text{O}$	-0,276
	$\text{PO}_4^{3-} + 8\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{qizil})} + 4\text{H}_2\text{O}$	-0,128
	$\text{PO}_4^{3-} + 8\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{oq})} + 4\text{H}_2\text{O}$	-0,156
	$\text{HPO}_4^{2-} + 7\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{qizil})} + 4\text{H}_2\text{O}$	-0,288
	$\text{HPO}_4^{2-} + 7\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{oq})} + 4\text{H}_2\text{O}$	-0,316
	$\text{H}_2\text{PO}_4^- + 6\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{qizil})} + 4\text{H}_2\text{O}$	-0,358

	$\text{H}_2\text{PO}_4^- + 6\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{aq})} + 4\text{H}_2\text{O}$	-0,386
	$\text{H}_3\text{PO}_4 + 5\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{qizil})} + 4\text{H}_2\text{O}$	-0,383
	$\text{H}_3\text{PO}_4 + 5\text{H}^+ + 5e \leftrightarrow \text{P}_{(\text{aq})} + 4\text{H}_2\text{O}$	-0,411
	$\text{H}_3\text{PO}_3 + 2\text{H}^+ + 2e \leftrightarrow \text{H}_3\text{PO}_2 + \text{H}_2\text{O}$	-0,499
	$\text{HPO}_3^{2-} + 5\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{qizil})} + 3\text{H}_2\text{O}$	-0,298
	$\text{HPO}_3^{2-} + 5\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{aq})} + 3\text{H}_2\text{O}$	-0,346
	$\text{H}_2\text{PO}_3^- + 4\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{qizil})} + 3\text{H}_2\text{O}$	-0,419
	$\text{H}_2\text{PO}_3^- + 4\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{aq})} + 3\text{H}_2\text{O}$	-0,467
	$\text{H}_3\text{PO}_3 + 3\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{qizil})} + 3\text{H}_2\text{O}$	-0,454
	$\text{H}_3\text{PO}_3 + 3\text{H}^+ + 3e \leftrightarrow \text{P}_{(\text{aq})} + 3\text{H}_2\text{O}$	-0,502
	$\text{H}_4\text{P}_2\text{O}_6 + 2\text{H}^+ + 2e \leftrightarrow 2\text{H}_3\text{PO}_3$	+0,38
	$2\text{H}_3\text{PO}_4 + 2\text{H}^+ + 2e \leftrightarrow \text{H}_4\text{P}_2\text{O}_6 + 2\text{H}_2\text{O}$	-0,94
Pb	$\text{Pb}^{2+} + 2e \leftrightarrow \text{Pb}_{(\text{q})}$	-0,126
	$\text{Pb}^{4+} + 2e \leftrightarrow \text{Pb}^{2+}$	+1,694
	$\text{PbO}_{2(\text{q})} + 4\text{H}^+ + 2e \leftrightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$	+1,455
	$\text{PbO}_{2(\text{q})} + 4\text{H}^+ + \text{SO}_4^{2-} + 2e \leftrightarrow \text{PbSO}_{4(\text{q})} + 2\text{H}_2\text{O}$	+1,685
	$\text{PbO}_{2(\text{q})} + \text{H}^+ + 2e \leftrightarrow \text{HPbO}_2$	+0,621
	$3\text{PbO}_3^{2-} + 10\text{H}^+ + 4e \leftrightarrow \text{HPb}_3\text{O}_{4(\text{q})} + 5\text{H}_2\text{O}$	+2,515
	$\text{PbO}_3^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{PbO}_{(\text{q})} + 2\text{H}_2\text{O}$	+2,001
	$\text{PbO}_3^{2-} + 3\text{H}^+ + e \leftrightarrow \text{HPbO}_2^- + \text{H}_2\text{O}$	+1,547
	$\text{PbO}_3^{2-} + 6\text{H}^+ + 2e \leftrightarrow \text{Pb}^{2+} + 3\text{H}_2\text{O}$	+2,375
	$\text{Pb}_3\text{O}_{4(\text{q})} + \text{H}_2\text{O} + 2e \leftrightarrow 2\text{PbO}_{(\text{q})} + 2\text{OH}^-$	+0,249
	$\text{Pb}_3\text{O}_{4(\text{q})} + 8\text{H}^+ + 2e \leftrightarrow 3\text{Pb}^{2+} + 3\text{H}_2\text{O}$	+2,094
	$\text{Pb}_3\text{O}_{4(\text{q})} + 2\text{H}_2\text{O} + 2e \leftrightarrow 3\text{HPbO}_2 + \text{H}^+$	+0,390
	$\text{PbO}_{(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{Pb}_{(\text{q})} + \text{H}_2\text{O}$	+0,249
	$\text{PbSO}_{4(\text{q})} + 2e \leftrightarrow \text{Pb}_{(\text{q})} + \text{SO}_4^{2-}$	-0,335
	$\text{HPbSO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Pb}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,702
	$\text{Pb}_{(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{PbH}_2$	-1,507
Pt	$\text{Pt}^{2+} + 2e \leftrightarrow \text{Pt}_{(\text{q})}$	+1,2
	$\text{PtO}_{2(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{Pt}(\text{OH})_{2(\text{q})}$	+1,1
	$\text{Pt}(\text{OH})_{2(\text{q})} + 2e \leftrightarrow \text{Pt}_{(\text{q})} + 2\text{OH}^-$	+0,15
	$\text{Pt}(\text{OH})_{2(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{Pt}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,98
S	$\text{SO}_4^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{H}_2\text{SO}_3 + \text{H}_2\text{O}$	+0,17

	$\text{SO}_4^{2-} + 4\text{H}_2\text{O} + 2e \leftrightarrow \text{SO}_3^{2-} + 2\text{OH}^-$	-0,93
	$\text{SO}_4^{2-} + 8\text{H}^+ + 6e \leftrightarrow \text{S}_{(\text{q})} + 4\text{H}_2\text{O}$	+0,357
	$\text{HSO}_4^- + 7\text{H}^+ + 6e \leftrightarrow \text{S}_{(\text{q})} + 4\text{H}_2\text{O}$	+0,339
	$\text{SO}_4^{2-} + 8\text{H}^+ + 8e \leftrightarrow \text{S}^{2-} + 4\text{H}_2\text{O}$	+0,149
	$\text{SO}_4^{2-} + 9\text{H}^+ + 8e \leftrightarrow \text{HS}^- + 4\text{H}_2\text{O}$	+0,252
	$\text{SO}_4^{2-} + 10\text{H}^+ + 8e \leftrightarrow \text{H}_2\text{S}_{(\text{g})} + 4\text{H}_2\text{O}$	+0,303
	$\text{HSO}_4^- + 9\text{H}^+ + 8e \leftrightarrow \text{H}_2\text{S}_{(\text{g})} + 4\text{H}_2\text{O}$	+0,289
	$\text{S}_2\text{O}_8^{2-} + 2e \leftrightarrow 2\text{SO}_4^{2-}$	+2,010
	$\text{S}_2\text{O}_8^{2-} + 2\text{H}^+ + 2e \leftrightarrow 2\text{HSO}_4^-$	+2,123
	$\text{S}_4\text{O}_6^{2-} + 2e \leftrightarrow 2\text{S}_2\text{O}_3^{2-}$	+0,219
	$\text{S}_4\text{O}_6^{2-} + 12\text{H}^+ + 10e \leftrightarrow 4\text{S}_{(\text{q})} + 6\text{H}_2\text{O}$	+0,416
	$\text{S}_2\text{O}_6^{2-} + 2e \leftrightarrow 2\text{SO}_3^{2-}$	+0,026
	$\text{SO}_{2(\text{g})} + 4\text{H}^+ + 4e \leftrightarrow \text{S}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,451
	$\text{H}_2\text{SO}_3 + 4\text{H}^+ + 4e \leftrightarrow \text{S}_{(\text{q})} + 3\text{H}_2\text{O}$	+0,449
	$2\text{SO}_3^{2-} + 6\text{H}^+ + 4e \leftrightarrow \text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O}$	+0,705
S	$2\text{HSO}_3^- + 4\text{H}^+ + 4e \leftrightarrow \text{S}_2\text{O}_3^{2-} + 3\text{H}_2\text{O}$	+0,491
	$4\text{HSO}_3^- + 8\text{H}^+ + 6e \leftrightarrow \text{S}_4\text{O}_6^{2-} + 6\text{H}_2\text{O}$	+0,581
	$\text{SO}_3^{2-} + 6\text{H}^+ + 6e \leftrightarrow \text{S}^{2-} + 3\text{H}_2\text{O}$	+0,231
	$\text{S}_{(\text{q})} + 2e \leftrightarrow \text{S}^{2-}$	-0,476
	$\text{S}_{(\text{q})} + \text{H}^+ + 2e \leftrightarrow \text{HS}^-$	-0,065
	$\text{S}_{(\text{q})} + 2\text{H}^+ + 2e \leftrightarrow \text{H}_2\text{S}_{(\text{g})}$	+0,142
	$\text{S}_2^{2-} + 2\text{H}^+ + 2e \leftrightarrow 2\text{HS}^-$	+0,298
	$\text{S}_2^{2-} + 2e \leftrightarrow 2\text{S}^{2-}$	-0,524
	$\text{S}_3^{2-} + 3\text{H}^+ + 4e \leftrightarrow 3\text{HS}^-$	+0,097
	$\text{S}_4^{2-} + 4\text{H}^+ + 6e \leftrightarrow 4\text{HS}^-$	+0,033
Sb	$\text{Sb}^{\text{V}} + 2e \leftrightarrow \text{Sb}^{\text{III}} (6\text{M HCl})$	+0,818
	$\text{Sb}^{\text{V}} + 2e \leftrightarrow \text{Sb}^{\text{III}} (3,5\text{M HCl})$	+0,746
	$\text{Sb}_2\text{O}_{5(\text{q})} + 6\text{H}^+ + 4e \leftrightarrow 2\text{SbO}^+$	+0,581
	$\text{SbO}^+ + 2\text{H}^+ + 3e \leftrightarrow \text{Sb}_{(\text{q})} + \text{H}_2\text{O}$	+0,212
	$\text{SbO}_3^- + 2\text{H}^+ + 2e \leftrightarrow \text{SbO}_2^- + \text{H}_2\text{O}$	+0,353
	$\text{SbO}_3^- + 3\text{H}^+ + 2e \leftrightarrow \text{HSbO}_2 + \text{H}_2\text{O}$	+0,678
	$\text{SbO}_3^- + 4\text{H}^+ + 2e \leftrightarrow \text{SbO}^+ + 2\text{H}_2\text{O}$	+0,704

	$\text{SbO}_2^+ + 2\text{H}^+ + 2e \leftrightarrow \text{SbO}^- + \text{H}_2\text{O}$	+0,720
	$2\text{SbO}_3^- + 6\text{H}^+ + 4e \leftrightarrow \text{Sb}_2\text{O}_{3(\text{q})} + 3\text{H}_2\text{O}$	+0,772
	$\text{SbO}_2^- + 4\text{H}^+ + 3e \leftrightarrow \text{Sb}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,446
	$\text{HSbO}_2 + 3\text{H}^+ + 3e \leftrightarrow \text{Sb}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,230
	$\text{Sb}_2\text{O}_{5(\text{q})} + 4\text{H}^+ + 4e \leftrightarrow \text{Sb}_2\text{O}_{3(\text{q})} + 2\text{H}_2\text{O}$	+0,692
	$\text{Sb}_2\text{O}_{3(\text{q})} + 6\text{H}^+ + 6e \leftrightarrow 2\text{Sb}_{(\text{q})} + 3\text{H}_2\text{O}$	+0,152
	$\text{Sb}_{(\text{q})} + 3\text{H}^+ + 3e \leftrightarrow \text{SbH}_{3(\text{g})}$	-0,510
Si	$\text{SiO}_{2(\text{q})} + 4\text{H}^+ + 4e \leftrightarrow \text{Si}_{(\text{q})} + 2\text{H}_2\text{O}$	-0,86
	$\text{SiO}_3^{2-} + 6\text{H}^+ + 4e \leftrightarrow \text{Si}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,455
	$\text{HSiO}_3^- + 5\text{H}^+ + 4e \leftrightarrow \text{Si}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,632
	$\text{H}_2\text{SiO}_3 + 4\text{H}^+ + 4e \leftrightarrow \text{Si}_{(\text{q})} + 3\text{H}_2\text{O}$	-0,780
	$\text{SiO}_{2(\text{q})} + 8\text{H}^+ + 8e \leftrightarrow \text{SiH}_{4(\text{g})} + 2\text{H}_2\text{O}$	-0,377
	$\text{SiO}_3^{2-} + 10\text{H}^+ + 8e \leftrightarrow \text{SiH}_{4(\text{g})} + 3\text{H}_2\text{O}$	-0,176
	$\text{HSiO}_3^- + 9\text{H}^+ + 8e \leftrightarrow \text{SiH}_{4(\text{g})} + 3\text{H}_2\text{O}$	-0,265
Si	$\text{H}_2\text{SiO}_3 + 8\text{H}^+ + 8e \leftrightarrow \text{SiH}_{4(\text{g})} + 3\text{H}_2\text{O}$	-0,339
	$\text{Si}_{(\text{q})} + 4\text{H}^+ + 4e \leftrightarrow \text{SiH}_{4(\text{g})}$	+0,102
	$\text{SiF}_6^{2-} + 4e \leftrightarrow \text{Si}_{(\text{q})} + 6\text{F}^-$	-1,2
Sn	$\text{Sn}^{\text{IV}} + 2e \leftrightarrow \text{Sn}^{\text{II}}$	+0,154
	$\text{Sn}^{\text{IV}} + 4e \leftrightarrow \text{Sn}_{(\text{q})}$	+0,01
	$\text{Sn}^{\text{II}} + 2e \leftrightarrow \text{Sn}_{(\text{q})}$	-0,136
	$\text{SnO}_3^{2-} + 3\text{H}^+ + 2e \leftrightarrow \text{HSnO}_2^- + \text{H}_2\text{O}$	+0,374
	$\text{SnO}_3^{2-} + 6\text{H}^+ + 2e \leftrightarrow \text{Sn}^{2+} + 3\text{H}_2\text{O}$	+0,844
	$\text{HSnO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Sn}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,33
	$\text{Sn}_{(\text{q})} + 4\text{H}^+ + 4e \leftrightarrow \text{SnH}_{4(\text{g})}$	-1,074
Sr	$\text{Sr}^{2+} + 2e \leftrightarrow \text{Sr}_{(\text{q})}$	-2,89
Zn	$\text{Zn}^{2+} + 2e \leftrightarrow \text{Zn}_{(\text{q})}$	-0,763
	$\text{ZnO}_2^{2-} + 4\text{H}^+ + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 2\text{H}_2\text{O}$	+0,441
	$\text{HZnO}_2^- + 3\text{H}^+ + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 2\text{H}_2\text{O}$	-0,054
	$\text{ZnO}_2^{2-} + 2\text{H}_2\text{O} + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 4\text{OH}^-$	-1,216
	$\text{Zn}(\text{OH})_{2(\text{q})} + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 2\text{OH}^-$	-1,245
	$\text{ZnS}_{(\text{q})} + 2e \leftrightarrow \text{Zn}_{(\text{q})} + \text{S}^{2-}$	-1,40
	$[\text{Zn}(\text{NH}_3)_4]^{2+} + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 4\text{NH}_3$	-1,04
	$[\text{Zn}(\text{CN})_4]^{2+} + 2e \leftrightarrow \text{Zn}_{(\text{q})} + 4\text{CN}^-$	-1,26

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	$\lg \beta_6$
Amniakli												
$[\text{Ag}(\text{NH}_3)_2]^+$	$2,09 \cdot 10^3$	3,32	$1,62 \cdot 10^7$	7,21								
$[\text{Cd}(\text{NH}_3)_4]^{2+}$	$3,24 \cdot 10^2$	2,51	$2,95 \cdot 10^4$	4,47	$5,89 \cdot 10^5$	5,77	$3,63 \cdot 10^6$	6,56				
$[\text{Co}(\text{NH}_3)_6]^{3+}$	97,7	1,99	$3,16 \cdot 10^3$	3,50	$2,69 \cdot 10^4$	4,43	$1,18 \cdot 10^5$	5,07	$1,35 \cdot 10^{30}$	5,13	$2,45 \cdot 10^4$	4,39
$[\text{Co}(\text{NH}_3)_6]^{3+}$	$2,00 \cdot 10^7$	7,3	$1,00 \cdot 10^{14}$	14	$1,26 \cdot 10^{20}$	20,1	$5,01 \cdot 10^{25}$	25,7	$6,31 \cdot 10^{30}$	30,8	$4,57 \cdot 10^{33}$	33,66
$[\text{Cu}(\text{NH}_3)_2]^+$	$8,51 \cdot 10^5$	5,93	$5,50 \cdot 10^8$	8,74								
$[\text{Cu}(\text{NH}_3)_4]^{2+}$	$9,77 \cdot 10^3$	3,99	$2,14 \cdot 10^7$	7,33	$1,15 \cdot 10^{10}$	10,06	$1,07 \cdot 10^{12}$	12,03				
$[\text{Fe}(\text{NH}_3)_4]^{2+}$	25,1	1,4	$1,59 \cdot 10^2$	2,2			$5,01 \cdot 10^3$	3,7				
$[\text{Hg}(\text{NH}_3)_4]^{2+}$	$6,31 \cdot 10^8$	8,8	$3,16 \cdot 10^{17}$	17,5	$3,16 \cdot 10^{18}$	18,5	$1,82 \cdot 10^{19}$	19,26				
$[\text{Ni}(\text{NH}_3)_6]^{2+}$	$4,68 \cdot 10^2$	2,67	$4,17 \cdot 10^4$	4,62	$2,51 \cdot 10^6$	6,40	$2,09 \cdot 10^7$	7,32	$1,26 \cdot 10^8$	8,10	$1,02 \cdot 10^8$	8,01
$[\text{Zn}(\text{NH}_3)_4]^{2+}$	$1,51 \cdot 10^2$	2,18	$2,69 \cdot 10^4$	4,43	$5,50 \cdot 10^6$	6,74	$2,51 \cdot 10^9$	9,40				
Bromidli												
$[\text{AgBr}_2]^-$	$2,40 \cdot 10^4$	4,38	$2,19 \cdot 10^7$	7,34	$7,08 \cdot 10^8$	8,85	$5,01 \cdot 10^8$	8,70	$2,00 \cdot 10^9$	9,30		
$[\text{BiBr}_6]^{3-}$	$1,82 \cdot 10^2$	2,26	$2,82 \cdot 10^4$	4,45	$2,14 \cdot 10^6$	6,33	$6,61 \cdot 10^7$	7,82	$2,63 \cdot 10^9$	9,42	$5,01 \cdot 10^9$	9,70
$[\text{CdBr}_4]^{2-}$	$1,70 \cdot 10^2$	2,23	$6,31 \cdot 10^2$	2,80	$3,98 \cdot 10^3$	3,60	$5,01 \cdot 10^3$	3,70				
$[\text{HgBr}_4]^{2-}$	$1,12 \cdot 10^6$	9,05	$2,14 \cdot 10^{17}$	17,33	$5,50 \cdot 10^{19}$	19,74	$4,37 \cdot 10^{21}$	21,64				
$[\text{PbBr}_4]^{2-}$	$1,70 \cdot 10^2$	2,23	$3,02 \cdot 10^2$	2,48	$1,82 \cdot 10^3$	3,26	$2,00 \cdot 10^3$	3,30				
$[\text{SnBr}_3]^-$	5,37	0,73	13,8	1,14	22,39	1,35						

Gidrokso-									
$[\text{Ag}(\text{OH})_2]^{2-}$	$2,00 \cdot 10^2$	2,30	$1,00 \cdot 10^4$	4,0	$1,59 \cdot 10^5$	5,2			
$[\text{Al}(\text{OH})_4]^-$	$1,10 \cdot 10^9$	9,04					$1,00 \cdot 10^{23}$	33,0	
$[\text{Bi}(\text{OH})_4]^-$	$2,51 \cdot 10^{12}$	12,4	$6,31 \cdot 10^{15}$	15,8			$1,59 \cdot 10^{35}$	35,2	
$[\text{Cd}(\text{OH})_4]^{2-}$	$1,48 \cdot 10^4$	4,17	$2,14 \cdot 10^8$	8,33	$1,05 \cdot 10^9$	9,02	$3,98 \cdot 10^8$	8,6	
$[\text{Co}(\text{OH})_2]^-$	$2,51 \cdot 10^4$	4,4	$3,98 \cdot 10^4$	4,6	$3,16 \cdot 10^{10}$	10,5			
$[\text{Cr}(\text{OH})_4]^-$	$1,26 \cdot 10^{10}$	10,1	$6,31 \cdot 10^{17}$	17,8			$7,94 \cdot 10^{29}$	29,9	
$[\text{Cu}(\text{OH})_4]^{2-}$	$1,00 \cdot 10^7$	7,0	$4,79 \cdot 10^{13}$	13,68	$13,68 \cdot 10^{17}$	17,0	$3,16 \cdot 10^{18}$	18,5	
$[\text{Fe}(\text{OH})_4]^{2-}$	$3,63 \cdot 10^5$	5,56	$5,89 \cdot 10^9$	9,77	$9,77 \cdot 10^9$	9,67	$3,63 \cdot 10^8$	8,56	
$[\text{Fe}(\text{OH})_3]$	$7,41 \cdot 10^{11}$	101,87	$1,48 \cdot 10^{21}$	21,17	$21,17 \cdot 10^{30}$	30,67			
$[\text{Hg}(\text{OH})_2]^-$	$2,00 \cdot 10^{10}$	10,30	$5,01 \cdot 10^{21}$	21,70	$21,70 \cdot 10^{21}$	21,20			
$[\text{Ni}(\text{OH})_3]^-$	$9,33 \cdot 10^4$	4,97	$3,55 \cdot 10^8$	8,55	$8,55 \cdot 10^{11}$	11,33			
$[\text{Pb}(\text{OH})_2]^-$	$7,94 \cdot 10^6$	6,9	$6,31 \cdot 10^{10}$	10,08	$10,08 \cdot 10^{11}$	11,3			
$[\text{Sb}(\text{OH})_4]^-$			$2,00 \cdot 10^{24}$	24,3	$24,3 \cdot 10^{36}$	36,7	$2,00 \cdot 10^{38}$	38,3	
$[\text{Sn}(\text{OH})_2]^-$	$7,24 \cdot 10^{11}$	11,86	$4,37 \cdot 10^{20}$	20,64	$20,64 \cdot 10^{25}$	25,13			
$[\text{Zn}(\text{OH})_4]^{2-}$	$2,51 \cdot 10^4$	4,40	$2,00 \cdot 10^{11}$	11,30	$11,30 \cdot 10^{13}$	13,14	$4,57 \cdot 10^{14}$	14,64	
$[\text{Zr}(\text{OH})_4]$	$2,09 \cdot 10^{14}$	14,32	$1,82 \cdot 10^{28}$	28,26	$28,26 \cdot 10^{41}$	41,91	$1,86 \cdot 10^{55}$	55,27	
Yodidli									
$[\text{Ag}(\text{IO}_3)_2]^-$	4,27	0,63	79,4	1,90					
Yodidli									
$[\text{Ag}_4]^{3-}$	$3,80 \cdot 10^6$	6,58	$5,50 \cdot 10^{11}$	11,74	$4,79 \cdot 10^{13}$	13,68	$1,00 \cdot 10^{14}$	14,00	

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

Sulfidli									
$[\text{Ag}(\text{SO}_3)_3]^{5-}$	$3,98 \cdot 10^5$	5,60	$4,79 \cdot 10^8$	8,68	$1,01 \cdot 10^9$	9,00			
$[\text{Cu}(\text{SO}_3)_3]^{5-}$	$7,08 \cdot 10^7$	7,85	$5,01 \cdot 10^8$	8,70	$2,29 \cdot 10^9$	9,36			
$[\text{Hg}(\text{SO}_3)_3]^{4-}$			$1,18 \cdot 10^{24}$	24,07	$9,12 \cdot 10^{24}$	24,96			
Tiosulfatli									
$[\text{Ag}(\text{S}_2\text{O}_3)_3]^{5-}$	$6,61 \cdot 10^8$	8,82	$2,88 \cdot 10^{13}$	13,46	$1,41 \cdot 10^{14}$	14,15			
$[\text{Cd}(\text{S}_2\text{O}_3)_3]^{4-}$	$8,71 \cdot 10^3$	3,94	$3,02 \cdot 10^6$	6,48	$1,59 \cdot 10^8$	8,20			
$[\text{Cu}(\text{S}_2\text{O}_3)_3]^{5-}$	$1,86 \cdot 10^{10}$	10,27	$1,66 \cdot 10^{12}$	12,22	$6,92 \cdot 10^{13}$	13,84			
$[\text{Hg}(\text{S}_2\text{O}_3)_3]^{6-}$			$7,24 \cdot 10^{29}$	29,86	$1,82 \cdot 10^{32}$	32,26	$4,07 \cdot 10^{33}$	33,61	
$[\text{Pb}(\text{S}_2\text{O}_3)_3]^{6-}$	$5,01 \cdot 10^2$	2,7	$1,35 \cdot 10^5$	5,13	$2,24 \cdot 10^6$	6,35	$1,59 \cdot 10^7$	77,20	
$[\text{Zn}(\text{S}_2\text{O}_3)_3]^{4-}$	$1,95 \cdot 10^2$	2,29	$3,89 \cdot 10^4$	4,59			4,0	0,6	
Fosfatli									
$[\text{Al}(\text{H}_2\text{PO}_4)_3]$	10^3	3	$2,00 \cdot 10^5$	5,3	$3,98 \cdot 10^7$	7,6			
$[\text{Fe}(\text{H}_2\text{PO}_4)_3]^-$	$3,16 \cdot 10^3$	3,5					$1,41 \cdot 10^9$	9,15	
Ftoridli									
$[\text{AgF}]$	2,29	0,36							
$[\text{AlF}_6]^{3-}$	$1,26 \cdot 10^7$	7,10	$9,55 \cdot 10^{11}$	11,98	$6,76 \cdot 10^{15}$	15,83	$3,39 \cdot 10^{18}$	$18,53$	$1,59 \cdot 10^{20}$
$[\text{CrF}_3]$	$1,59 \cdot 10^5$	5,20	$3,47 \cdot 10^8$	8,54	$1,05 \cdot 10^{11}$	11,02			
$[\text{FeF}_3]^{2-}$	$1,1 \cdot 10^6$	6,04	$5,50 \cdot 10^{10}$	10,74	$5,5 \cdot 10^{13}$	13,74	$5,5 \cdot 10^{15}$	$15,74$	$1,26 \cdot 10^{16}$

Xloridli											
$[\text{AgCl}_4]^{2-}$	$1,10 \cdot 10^3$	3,04	$1,74 \cdot 10^5$	5,24	$1,10 \cdot 10^5$	5,04	$1,38 \cdot 10^6$	6,14			
$[\text{BiCl}_6]^{3-}$	$2,69 \cdot 10^2$	2,43	$5,01 \cdot 10^4$	4,7	$1,00 \cdot 10^5$	5,0	$3,98 \cdot 10^5$	5,6	$1,26 \cdot 10^6$	6,1	$2,63 \cdot 10^6$
$[\text{CdCl}_4]^{2-}$	$1,12 \cdot 10^2$	2,05	$3,98 \cdot 10^2$	2,60	$2,51 \cdot 10^{32}$	2,40	$7,94 \cdot 10^2$	2,90			6,42
$[\text{FeCl}_2]$	2,29	0,36	2,51	0,40							
$[\text{FeCl}_3]$	28,18	1,45	$1,26 \cdot 10^2$	2,10	12,6	1,10					
$[\text{HgCl}_4]^{2-}$	$5,50 \cdot 10^6$	6,74	$1,66 \cdot 10^{13}$	13,22	$1,18 \cdot 10^{14}$	14,07	$1,66 \cdot 10^{16}$	16,22			
$[\text{PbCl}_4]^{2-}$	41,70	1,62	$2,75 \cdot 10^2$	2,44	$1,10 \cdot 10^2$		10,0	1,00			
$[\text{SnCl}_4]^{2-}$	32,4	1,51	$1,74 \cdot 10^2$	2,24	$1,07 \cdot 10^2$		30,20	1,48			
$[\text{SnCl}_6]^{3-}$										6,61	0,82
$[\text{SbCl}_6]^{3-}$			$3,09 \cdot 10^3$	3,49	$1,57 \cdot 10^4$	4,18	$5,25 \cdot 10^2$	4,72	$5,25 \cdot 10^4$	4,72	$1,29 \cdot 10^4$
											4,11
Sianidli											
$[\text{Ag}(\text{CN})_4]^{3-}$			$7,08 \cdot 10^{19}$	19,85	$3,55 \cdot 10^{20}$	20,55	$2,63 \cdot 10^{19}$	19,42			
$[\text{Cd}(\text{CN})_4]^{2-}$	$1,51 \cdot 10^3$	5,18	$3,98 \cdot 10^9$	9,60	$8,32 \cdot 10^{13}$	13,92	$1,29 \cdot 10^{17}$	17,11			
$[\text{Co}(\text{CN})_6]^{4-}$										$1,23 \cdot 10^{19}$	19,09
$[\text{Co}(\text{CN})_6]^{3-}$										$1,00 \cdot 10^{64}$	64
$[\text{Cu}(\text{CN})_4]^{3-}$			$1,00 \cdot 10^{24}$	24,0	$3,98 \cdot 10^{28}$	28,6	$2,00 \cdot 10^{30}$	30,3			
$[\text{Fe}(\text{CN})_6]^{4-}$										$1,00 \cdot 10^{24}$	24,0
$[\text{Fe}(\text{CN})_6]^{3-}$										$1,00 \cdot 10^{31}$	31,0
$[\text{Hg}(\text{CN})_4]^{2-}$	$1,00 \cdot 10^{18}$	18,00	$5,01 \cdot 10^{34}$	34,70	$3,16 \cdot 10^{38}$	38,53	$3,24 \cdot 10^{41}$	41,51			

ORGANIK LIGANDLI KOMPLEKSLAR VA ULARNING BARQARORLIK KONSTANTALARI (β)

Kompleks ion	Atsetatli ($L - CH_3COO^-$)									
	β_1	$\lg \beta_1$	β_2	$\lg \beta_2$	β_3	$\lg \beta_3$	β_4	$\lg \beta_4$	β_5	$\lg \beta_5$
$[AgL_2]^-$	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	$2,0 \cdot 10^4$	8,3				
$[HgL_2]$			$2,62 \cdot 10^4$	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				
$[CaL_2]^{2-}$	$1,00 \cdot 10^4$	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	$1,78 \cdot 10^3$	5,25						
$[NiL_3]^{4-}$	$\sim 2 \cdot 10^5$	$\sim 5,3$	$\sim 3 \cdot 10^6$	6,5	$\sim 10 \cdot 10^{14}$	~ 14				

$[PbL_2]^{2-}$			$3,47 \cdot 10^6$	6,54					
$[ZnL_3]^{4-}$	$1,0 \cdot 10^3$	5,0	$2,29 \cdot 10^7$	7,36	$1,41 \cdot 10^8$	8,15			
Salitsilatlari ($L - C_6H_4(COO)O^{2-}$)									
$[CuL_2]^{2-}$	$2,0 \cdot 10^7$	7,3	$1,00 \cdot 10^{13}$	13,0					
$[FeL_2]^{2-}$	$1,00 \cdot 10^4$	4,0	$4,57 \cdot 10^3$	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					
Sulfosalitsilatlari ($L - C_6H_3(COO)(SO_3)^{3-}$)									
$[AlL_3]^{6-}$	$1,59 \cdot 10^{13}$	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					
$[FeL_2]^{4-}$	$7,94 \cdot 10^3$	5,90	$7,94 \cdot 10^8$	9,90					
$[FeL_3]^{6-}$	$1,05 \cdot 10^{13}$	15,02	$5,75 \cdot 10^{23}$	25,76	$3,98 \cdot 10^{32}$	32,60			
$[MnL_2]^{4-}$	$1,74 \cdot 10^3$	5,24	$1,74 \cdot 10^8$	8,24					
Tartratlari ($L - (CHOH)_2(COO)_2^{2-}$)									
$[AlL_2]^-$			$3,98 \cdot 10^8$	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	$5,75 \cdot 10^3$	5,76	$1,59 \cdot 10^6$	6,20	

TITRIMETRIK ANALIZ NATIJALARINI HISOBLASH

Aniqlanadigan modda	Ekvivalentlik faktori	Ekvivalent molyar massa, g/mol
1. Kislota-asosli titrlash		
Ba(OH)_2	1/2	85,67
$\text{Ba(OH)}_2 \cdot 8\text{H}_2\text{O}$	1/2	157,73
HCOOH (chumoli)	1	46,026
CH_3COOH (sirka)	1	60,052
$\text{H}_2\text{C}_4\text{H}_4\text{O}_4$ (qahrabo)	1/2	59,045
$\text{H}_2\text{C}_4\text{H}_4\text{O}_6$ (vino)	1/2	75,044
$\text{H}_2\text{C}_2\text{O}_4$ (oksalat)	1/2	45,018
$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	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
$\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$	1/2	190,68
Na_2CO_3 (fenolftalein bilan)	1	105,989
Na_2CO_3 (metiloranj bilan)	1/2	52,9942
$\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$	1/2	143,070
NaHCO_3	1	84,007
NaOH	1	39,9971
2. Oksidlanish-qaytarilish usullari		
As_2O_3	1/4	49,4604
$\text{BaS}_2\text{O}_3 \cdot \text{H}_2\text{O}$	1	267,48
$\text{Ce(NH}_4)_4(\text{SO}_4)_4 \cdot 2\text{H}_2\text{O}$	1	632,53
$\text{Ce(SO}_4)_2 \cdot 4\text{H}_2\text{O}$	1	404,30
$\text{Fe (Fe}^{3+} \text{ f } \text{Fe}^{2+})$	1	55,847
$\text{Fe(NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$	1	392,13
FeSO_4	1	151,90

$\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$	1	278,01
$\text{H}_2\text{C}_2\text{O}_4$ (oksalat)	1/2	45,018
$\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$	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
$\text{K}_2\text{Cr}_2\text{O}_7$	1/6	49,031
$\text{K}_3\text{Fe}(\text{CN})_6$	1	329,25
$\text{K}_4\text{Fe}(\text{CN})_6$	1	368,35
$\text{K}_4\text{Fe}(\text{CN})_6 \cdot 3\text{H}_2\text{O}$	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
$\text{Na}_2\text{C}_2\text{O}_4$	1/2	67,000
NaNO_2	1/2	34,4977
$\text{Na}_2\text{S} (\text{S}^{2-} \rightarrow \text{S}^0)$	1/2	39,02
Na_2SO_3	1/2	63,02
$\text{Na}_2\text{S}_2\text{O}_3$	1	158,10
$\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$	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
Hg(NO ₃) ₂ · H ₂ O	1/2	171,31
Hg ₂ (NO ₃) ₂ · H ₂ O	1/2	280,61
KBr	1	119,002
KCN (Mor, Folgard, Fayans bo'yicha)	1	65,116
KCl	1	74,551
K ₂ CrO ₄	1	97,095
KNCS	1	97,18
KI	1	166,0027
NH ₄ Cl	1	53,491
NH ₄ NCS	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 · H ₂ O	1	305,000
CaCO ₃	1	100,09
CaCl ₂	1	110,99
CaCl ₂ · 6H ₂ O	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 ₂ H ₂ C ₁₀ H ₁₂ O ₈ N ₂ (EDTA)	1	336,209
Na ₂ H ₂ C ₁₀ H ₁₂ O ₈ N ₂ · 2H ₂ O (EDTA-digidrat)	1	372,239
Zn	1	65,38
ZnCl ₂	1	136,29

$\text{Zn}(\text{NO}_3)_2$	1	189,39
$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	1	297,48
ZnO	1	81,38
ZnSO_4	1	161,44
$\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$	1	287,54

11-jadval

KISLOTA-ASOSLI INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	Suvli eritmalarida 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 O	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)	$[\text{Fe}(\text{CN}_6)]^+$ SCN^-	Pb^{2+} Ag^+	sariq – pushti-qizil
Bromfenol ko'ki (tetrabromfenolsulfoftalein)	Ti^+ 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-karboksifenil-ksantenilxloridning etil efiri)	Br^-	Ag^+	sarg'ish-qizil – binafsha
Kongo qizili (difenil-bis-(1-amino)-2-	Cl^- , Br^- , I^-	Ag^+	qizil – ko'k

naftilazo-4-sulfokislota)			
Fluoressein (rezorsinfalein)	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

METALLOXROM INDIKATORLARNING XARAKTERISTIKALARI

Indikatorning nomi	Ratsional nomlanishi	Aniqlanadigan element	pH oralig'lar	Rang o'zgarishi	
				kompleks	indikator
Alizarin (alizarin qizil, sulfonalizarin)	1,2-dioksiantraxinon-3-sulfokislota	Th Sc Y	2,3 - 3,4 2 5	pushti qizil pushti	sariq yashil sariq
Arsenazo I (uranon)	2-(o-arsenofenilazo)-1,8-dioksinaftalin-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-disulfokislota-2,7-bis-(azo-1)-2-fenilarsen kislota	U, Th, Zn	kuchli kislotali	ko'kimitir- 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-krezolsulfogallein (natriyli tuzi)	Cu(II)	5 - 6	qizil	sariq
Glitsintimol ko'ki	3,3'-bis-(N-karboksimetil)-aminometilimolsulfogallein	Cu(II)	5 - 5,5	ko'k	sariq yoki yashil-sariq

Ditizon	2-fenilgidrazinifenilazotio- chumoli kisloata	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
Ksilenokoranj	3,3'-bis-(N,N-dikarboksimetil)- aminometilumolsulfoftalein	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
Metilhimol ko'ki	3,3'-bis-(N,N-dikarboksimetil)- aminometilumolsulfoftalein (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- resensiya	fluoresen- siya so'nadi
Mureksid	5,5'-nitritodipurpir kisloata (ammomiyli tuzi)	Mn, Ni Co(II), Zn, Cd, Ca	9 – 10 > 12	sariqdan- qizilgacha sariqdan- qizilgacha	binafsha binafsha

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, TM(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-sulfofalein	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

Timolftaleinkomplekson	3,3-bis-(N,N-dikarboksimetil)-aminometilftalein (natriyli tuzi)	Ca, Ba, Sr, Ag, Mn(II)	10 - 11	ko'k	rangsiz
Tiron	1,2-dioksi-benzol-3,5-disulfo-kislota (natriyli tuzi)	Fe(III), Ti(IV)	2 - 3	ko'k	sariq
Fluorekson (fluoresseinkomplekson, kalsein)	bis-(N,N-dikarboksimetil)-aminometilfluoressein (natriyli tuzi)	Ca, Ba, Sr Cu(II), Mn(II)	> 10 10 - 11	sarg'ish-ya-shil fluore-sensiya qizil yoki qizg'ish-binafsha	fluoresensiya so'nadi; eritma pushiti sarg'ish-ya-shil fluore-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-oksifukson-5,5'-dikarbon kislota	Zr Th, Fe(III) Al Mg, Cu(II) Ca	1,4 2 - 3 5 - 6 10 11,5	pushiti qirmizi binafsha	sariq zarg'aldoq sariq

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-dioxinaftalin-3,6-disulfokislota	Zr Th	1,5-2,5 2,5-3,5	qizg'ish- pushti ko'k-binafsha	sariq to'q-qizil

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- <i>o</i> -fenantrolin-Fe(II)-kompleksi	1,25	och-zangori	binafsha-qizil

**METALL IONLARINI ANIQLASHDA QO‘LLANILADIGAN ORGANIK
REAGENTLAR**

Element	Reagent	Aniqlash usuli
Alyuminiy	Alizarin	Fotometrik
	Alizarinsulfokislota	-//-
	natriyli tuzi	-//-
	Alyuminon	-//-
	Alberon	-//-
	Gematoksilin	-//-
	Diazobenzolsulfokislota	-//-
	Erioxromsianin	-//-
	Kvarsetin	-//-
	Kupferon	-//-
	Morin	Titrimetrik,
	8-Oksixinolin	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- <i>p</i> -Nitrofenilazoarsin Tannin Xinalizarin	--/ Tortma Fotometrik
Galliy	Alizarinsulfokislolaning natriyli tuzi Gallion IPEA Dibromoksixinolin Kupferon Morin 8-Oksixinolin Rodamin V Tannin Xinalizarin	--/ --/ Tortma --/ Fotometrik Tortma, titrimetrik, fotometrik Ekstraksion- fotometrik Tortma Ekstraksion- fotometrik

15-jadvalning davomi

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	Tortma --/ Fotometrik

	Difenilkarbazid Nadietilditiokarbamat Kadion Kristall binafsha Metil binafsha Merkaptobenzthiazolon α -Naftoxinon 8-Oksixinolin	-//- -//- -//- -//- -//- 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

15-jadvalning davomi

Kumush	<i>p</i> -Dimetilamino	Titrimetrik,
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	benzilidenrodanin Ditizon Difenilkarbazon Natriy dietilditiokarbamat Merkaptobenziazol Tiomochevina Xinaldin kislota	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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15-jadvalning davomi

Mis	Ditizon 8,8-Dixinolildisulfid Kaliy ksantat Kuproin Kupferon Merkaptosirka kislota Merkaptobenziazol Neokuproin α -Nitrozo- β -naftol 8-Oksixinolin Salitsilaldoksim Salitsil kislota Tenoiltrifloratseton Tiomochevina Tiosemikarbazid Xinaldin kislota	Fotometrik -//- Ekstraksion-fotometrik Tortma Fotometrik Tortma, titrimetrik Ekstraksion-fotometrik Fotometrik Tortma, titrimetrik, fotometrik Tortma Fotometrik Ekstraksion-fotometrik -//- -//- Tortma
Mishyak	Erioxromsianin Kaliy ksantat	Fotometrik -//-

	Tioatsetamid Tiomochevina Tioanilid	Tortma -//- Fotometrik
Molibden	α -Benzoinoksim Ditiol 8-Merkaptoxinolin 8-Oksixinolin	Tortma Fotometrik -//- Tortma, titrimetrik fotometrik
Nikel	Antranil kislota α -Benzildioksim Diallilditio karbamoilgidrazin Dimetilglioksim Ditizon Nioksim 8-Oksixinolin Tiomochevina α -Furildioksim Xinaldin kislota	Tortma -//- -//- Tortma, titrimetrik, fotometrik Fotometrik -//- Tortma, titrimetrik, fotometrik Tortma -//- -//-

15-jadvalning davomi

Niobiy	Kupferon Pirogallol Tannin Toron Fenilarson kislota	-//- Fotometrik Tortma Fotometrik Tortma
Oltin	<i>p</i> -Dimetilamino benzilidenrodanin Ditizon	Fotometrik -//- Tortma

	Merkaptobenzotiazol Rodamin B Tiomochevina Tiofenol <i>o</i> -Toluidin	Fotometrik Tortma -//- Fotometrik
Osmiy	8-Merkaptoxinolin Tiomochevina Tionalid	-//- -//- -//-
Palladiy	Atsetilen <i>p</i> - 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 binafsha	Fotometrik -//- -//- -//- -//-

Qo'rg'oshin	Antarnil kislota Arsatsen Ditizon Difenilkarbazid Merkaptobenztiazol 8-Oksixinolin	Tortma Fotometrik -//- -//- Tortma Tortma, titrimetrik, fotometrik
	Salitsilaldoksim Sulfarsatsen Tioatsetamid Tionalid Ftal kislota Xinaldin kislota	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	Tortma Fotometrik

	Brilliant sariq Diallilditiokarbamoilgidrazon Ditizon	-//- Tortma Ekstraksion- fotometrik Fotometrik
	Ksineloloranj Metil binafsha Natriy ditiokarbamat 8-Oksixinolin	-//- -//- Tortma, titrimetrik, fotometrik Fotometrik
	Rodamin B Sulfarsatsen	Tortma, titrimetrik, fotometrik

15-jadvalning davomi

Seziy	Dipikrilamin Kalignost	Tortma, fotometrik Tortma, titrimetrik, fotometrik
Seriy	8-Oksixinolin Tenoiltrifloratseton	Ekstraksion- fotometrik -//-
Simob	Antranil kislota <i>p</i> -Dimetilamino benzilidenrodanin Ditizon Difenilkarbazid Difenilkarbazon Kristall binafsha Metil binafsha Tetrafenilarsoniy xlorid Tioatsetamid	Tortma Fotometrik -//- -//- -//- -//- -//- -//- Tortma -//-

	Tiomochevina Tionalid	-//-
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	<i>p</i> - Dimetilaminobenzilidenrodanin Kupferon Pirogallol Tannin	-//- Tortma Fotometrik Tortma Fotometrik
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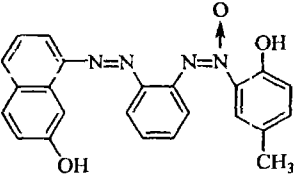
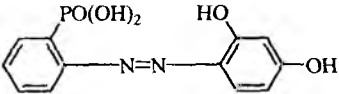
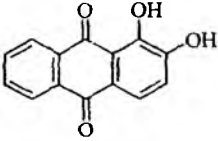
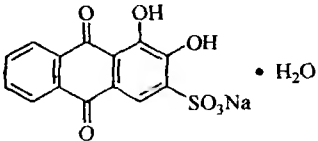
	Toron Fenilarson kislota Fenilfluoron	Tortma Fotometrik
Titan	Kupferon 8-Oksixinolin Sulfosalitsil kislota Tayron	Tortma, fotometrik Tortma, titrimetrik, fotometrik Fotometrik -//-
Toriy	Alizarin Alizarinsulfokislota Arsenazo III Kupferon Morin 8-Oksixinolin Pikrolon kislota Toron	Fotometrik -//- -//- Tortma Fotometrik Tortma -//- Fotometrik
Uran	Arsenazo III Kupferon Merkaptosirka kislota Morin PAN Tenoiltrifloratseton Toron Xinaldin kislota	-//- Tortma Fotometrik -//- -//- Ekstraksion- fotometrik Fotometrik Tortma
Vanadiy	Kupferon 8-Merkaptoxinolin 8-Oksixinolin	Tortma Fotometrik Tortma, titrimetrik, fotometrik
Vismut	Diantipirilmetan Ditizon Ksilenoloranj	Tortma Titrimetrik Fotometrik

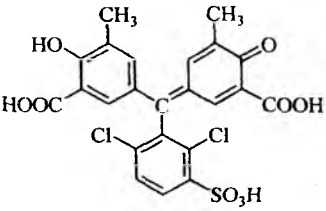
	Kupferon Merkaptobenzthiazol Merkaptofeniltiodiazolin 8-Oksixinolin	Tortma -//- Fotometrik Tortma, titrimetrik
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15-jadvalning davomi

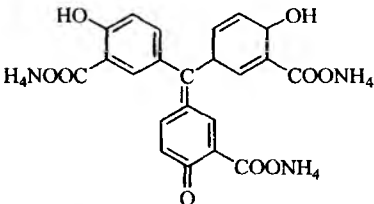
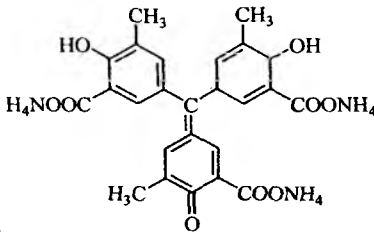
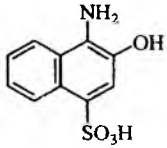
Vismut	Pikrin kislota Pirogallol Tioatsetamid Tionalid Tiomochevina Toron	Tortma -//- -//- Fotometrik Tortma Fotometrik
Volfram	Ditiol Merkaptosirka kislota 8-Oksixinolin Rodamin B	Fotometrik -//- Tortma, titrimetrik, fotometrik Fotometrik
Xrom (III)	Komplekson III 8-Oksixinolin Xinaldin kislota	Fotometrik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

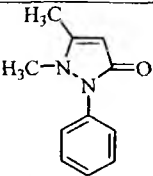
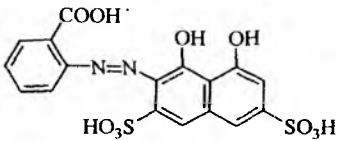
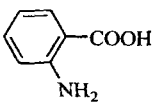
**NOORGANIK MODDALARNI ANIQLASHDA QO‘LLANILADIGAN
MUHIM ORGANIK REAGENTLARNING FORMULALARI**

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 monogidrat) 	M.m. 360,27 Al^{3+}, B^{III}, Ga^{3+}, La^{3+}, Th^{IV}, Zr^{IV}, U^{VI}, F^-

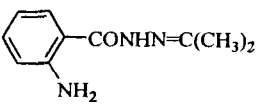
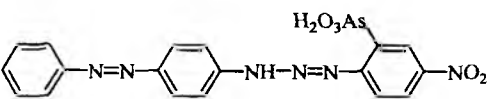
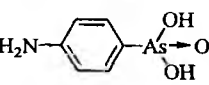
5. Alberon (xromazurol S) 	M.m. 539,34 Al^{3+}, Be^{2+}, In^{3+}, Ga^{3+}, Zr^{IV}, U^{VI}.
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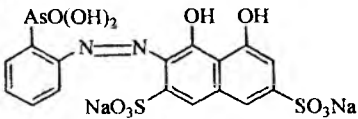
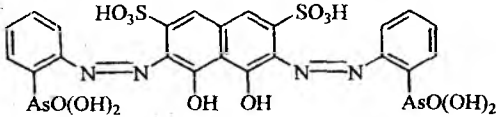
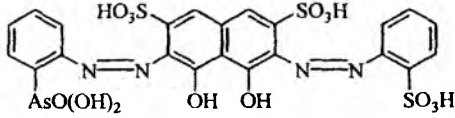
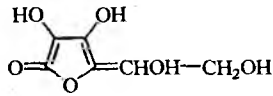
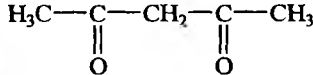
16-jadvalning davomi

6. Alyuminon (aurintrikarbon kislolaning 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

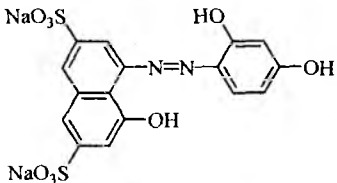
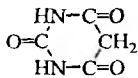
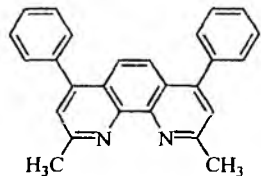
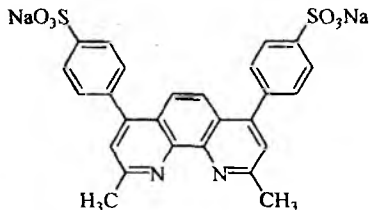
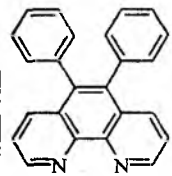
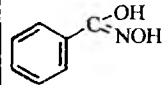
	NO_2^- , Co(SCN)_4^{2-} , HgCl_4^{2-} , Zn(SCN)_4^{2-} , BiI_4^- , AuCl_4^-
10. Antrazoxrom (xromotrop 2S) 	M.m. 468,42 Al^{3+} , Be^{2+} , Mg^{2+} , Ca^{2+} , V^{IV}
11. Antranil kislota 	M.m. 137,14 Cd^{2+} , Co^{2+} , Cu^{2+} , Mn^{2+} , Hg^{2+} , Ni^{2+} , Pb^{2+} , Th^{IV} , Zn^{2+} (MR_2 ko'rinishi-da)

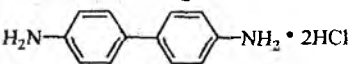
16-jadvalning davomi

12. Antarnil kislota 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'rini-shida)
15. Arsenazo I (uranon I, toron, neotorin)	M.m. 592,29 Al^{3+} , BF_4^- ,

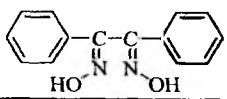
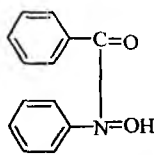
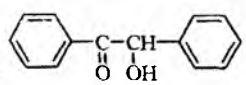
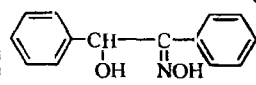
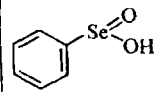
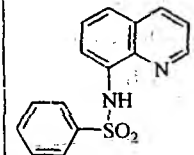
	$\text{Be}^{2+}, \text{Ca}^{2+}, \text{Co}^{2+}, \text{Cu}^{2+}, \text{Nb}^{\text{V}}, \text{Ni}^{2+}, \text{Ta}^{\text{V}}, \text{Th}^{\text{IV}}, \text{Ti}^{\text{IV}}, \text{UO}_2^{2+}, \text{V}^{\text{IV}}, \text{Zr}^{\text{IV}}, \text{F}^-$
16. Arsenazo III 	M.m. 776,39 $\text{Th}^{\text{IV}}, \text{U}^{\text{IV}}, \text{Hf}^{\text{IV}}, \text{Zr}^{\text{IV}}, \text{Al}^{3+}, \text{Be}^{2+}, \text{Ca}^{2+}, \text{Cd}^{2+}, \text{Hg}^{2+}, \text{Mg}^{2+}, \text{Pb}^{2+}, \text{Ti}^{\text{IV}}, \text{Zn}^{2+}, \text{Y}^{3+}$
17. Arsenazo M 	M.m. 732,50 $\text{La}^{\text{III}}, \text{Al}^{3+}, \text{Ba}^{2+}, \text{Ca}^{2+}, \text{Cu}^{2+}, \text{Ga}^{3+}, \text{In}^{3+}, \text{Mg}^{2+}, \text{Mn}^{2+}, \text{Ni}^{2+}, \text{Pb}^{2+}, \text{Sr}^{2+}, \text{Sr}^{2+}, \text{SO}_4^{2-}$
18. Askorbin kislota 	M.m. 176,13 $\text{Nb}^{\text{IV}}, \text{Ti}^{\text{IV}}, \text{U}$
19. Atsetilatseton (diatsetilmetan) 	M.m. 100,12 $\text{Be}^{2+}, \text{Cr}^{3+}, \text{Fe}^{3+}, \text{Mo}^{\text{VI}}, \text{V}^{\text{III}}, \text{V}^{\text{V}}, \text{Zr}^{\text{IV}}$

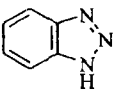
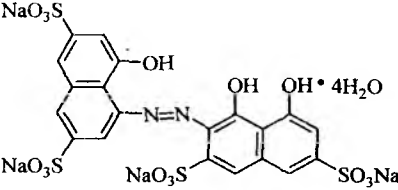
16-jadvalning davomi

20. Ashrezorsin, 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. Batokuproindi sulfokislotaning natriyli tuzi 	M.m. 564,54 Cu^I
24. Batofenantrolin (4,7-difenil-1,10-fenantrolin) 	M.m. 332,40 Fe²⁺
25. Benzgidroksam kislota 	M.m. 137,14 V^V, Mn²⁺, U^{IV}, Ti^{IV}

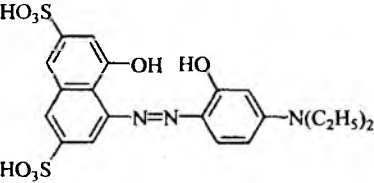
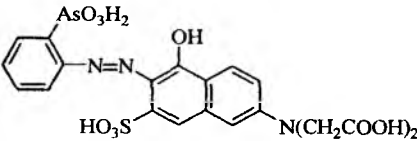
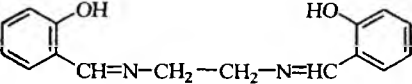
26. Benzidin digidroxlorid 	M.m. 257,16 Ta ^V , Ti ^{IV} , Ce ^{IV} , Ge ^{IV} , V ^V , W ^{VI}
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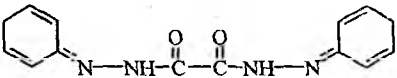
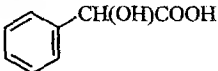
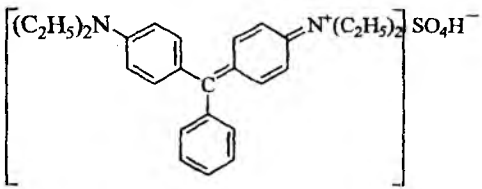
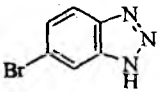
16-jadvalning davomi

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·2H2O ko'rini-shida), Mo ^{VI} (MoO2R2 ko'rinishida), Cu ²⁺ , V ^V
31. Benzolselenat kislota 	M.m. 189,07 Sc ³⁺ (ScR3 ko'rinishida)
32. 8-(Benzolsulfanilamino)-xinolin 	M.m. 284,34 Cd ²⁺ , Co ²⁺

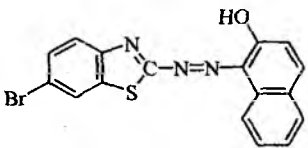
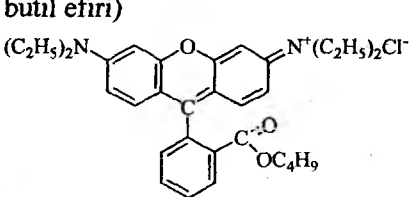
33. Benzotriazol 	M.m. 119,13 Os, Cd^{2+} , Ni^{2+} , Ag^+ , Zn^{2+}
34. Berillon II 	M.m. 810,56 Be^{2+} , B^{III} , Mg^{2+} , Al^{3+} , Mn^{2+} , Cu^{2+}

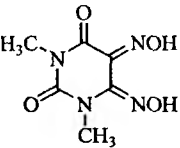
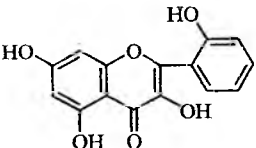
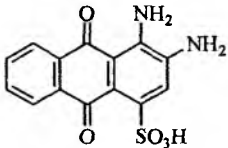
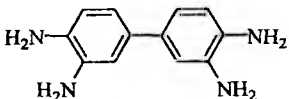
16-jadvalning davomi

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 (Siklogeksanoksaliil) digidrazon (kuprizon)	M.m. 268,27 Cu^{2+}

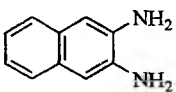
	
39. Bodom kislota (fenilglikol kislota) 	M.m. 125,15 Hf^{IV}, Zr^{IV}, Sc³⁺
40. Brilliant yashili 	M.m. 482,64 BF₄⁻, SbCl₆⁻, ReO₄⁻, AuCl₄⁻, TaF₅⁻, HgBr₃⁻, ZnCl₄⁻
41. 5-Brombenztriazol 	M.m. 198,02 Pd²⁺

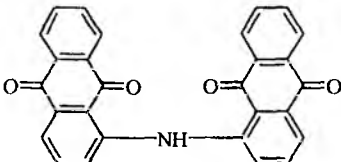
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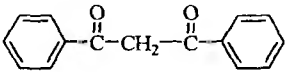
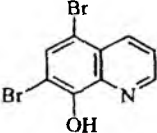
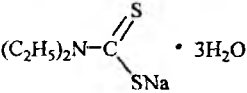
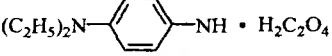
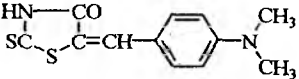
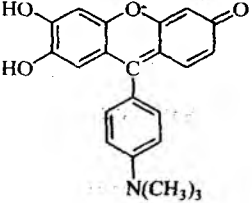
42. Brombenztriazol 	M.m. 384,25 Cd²⁺
43. Butilrodamin S (butilrodamin V; rodamin S butil efiri) 	M.m. 535,12 As^V, GaCl₄⁻, NbF₆⁻, ReO₄⁻, TaF₆⁻, TeBr₆²⁻

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) $\text{C}_3\text{H}_5\text{—NH—C(=O)—NH—NH—C(=O)—NH—C}_3\text{H}_5$	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}

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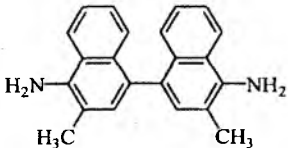
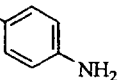
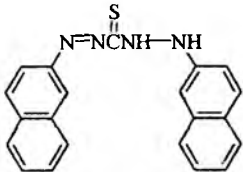
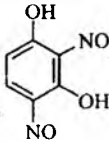
49. 2,3-Diaminonaftalin 	M.m. 158,20 Se^{IV}
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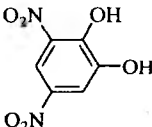
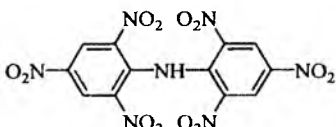
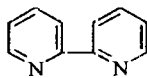
50. Diantipiril-3,4-dimetoksifenilmetan $ \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{CH}-\text{C}=\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \\ \text{H}_3\text{C}-\text{N}-\text{N}-\text{CO} \quad \quad \text{CH} \quad \quad \text{OC}-\text{N}-\text{N}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \\ \text{C}_6\text{H}_5 \quad \quad \quad \text{C}_6\text{H}_3(\text{OCH}_3)_2 \quad \quad \quad \text{C}_6\text{H}_5 \end{array} $	M.m. 524,62 V^V
51. Diantipirilmetan $ \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{CH}_2-\text{C}=\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \\ \text{H}_3\text{C}-\text{N}-\text{N}-\text{CO} \quad \quad \quad \text{OC}-\text{N}-\text{N}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \\ \text{C}_6\text{H}_5 \quad \quad \quad \text{C}_6\text{H}_5 \end{array} $	M.m. 388,47 Ti^{IV}, Cd²⁺, Fe, Bi^{III}, Co²⁺, Au, Ce, Tl, Ir, Mo, Os, Pd, Sb
52. Diantipirilpropilmetan $ \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{CH}-\text{C}=\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \\ \text{H}_3\text{C}-\text{N}-\text{N}-\text{CO} \quad \quad \text{CH}_2 \quad \quad \text{OC}-\text{N}-\text{N}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \quad \quad \\ \text{C}_6\text{H}_5 \quad \quad \quad \text{CH}_2 \quad \quad \quad \text{C}_6\text{H}_5 \\ \quad \quad \quad \quad \\ \quad \quad \quad \quad \text{CH}_3 \end{array} $	M.m. 430,55 Ga³⁺, Ir³⁺, Te^{IV}, Tl^{III}, Os
53. Diantipirilfenilmetan $ \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{C}-\text{CH}-\text{C}=\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \\ \text{H}_3\text{C}-\text{N}-\text{N}-\text{CO} \quad \quad \text{CH} \quad \quad \text{OC}-\text{N}-\text{N}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \quad \quad \quad \\ \text{C}_6\text{H}_5 \quad \quad \quad \text{C}_6\text{H}_5 \quad \quad \quad \text{C}_6\text{H}_5 \end{array} $	M.m. 460,53 Ga³⁺, 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'-Dibenzilditioooksamid Dibenzilrodanid kislota; DBTA) $ \text{C}_6\text{H}_5-\text{CH}_2-\text{NH}-\text{C}(=\text{S})-\text{C}(=\text{S})-\text{NH}-\text{CH}_2-\text{C}_6\text{H}_5 $	(N,N'- M.m. 300,44 Pd, Pt

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+}, Ti^{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-Dimetilamino benzilidenrodanin (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)

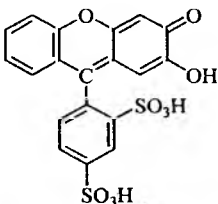
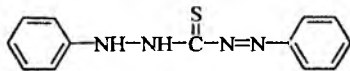
$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_3\text{C}-\text{C}-\text{C}-\text{CH}_2-\text{C}-\text{CH}_3 \\ \quad \quad \quad \quad \quad \\ \text{CH}_3 \quad \quad \text{O} \quad \quad \quad \text{O} \end{array}$	ko'rinishi-da)
63. Dimetilgliksim (diatsetilgliksim, Chugaev reaktivi) $\begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{NOH} \\ \\ \text{H}_3\text{C}-\text{C}=\text{NOH} \end{array}$	M.m. 116,12 Ni^{2+} , Pd^{2+} (MeR_2 ko'ri-nishida), Fe^{2+} , Co, Re

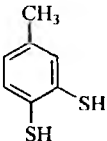
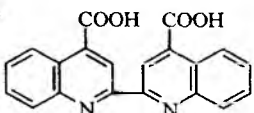
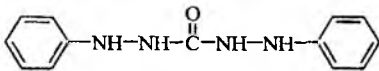
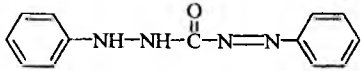
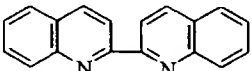
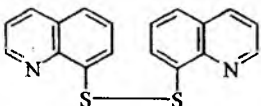
16-jadvalning davomi

64. 3,3'-Dimetilnaftidin 	M.m. 312,41 Zn^{2+} , V^{V}
65. N,N'-Dimetil-<i>p</i>-fenilendiamin digidroxlorid (yoki oksalat) [<i>p</i>-amino-dimetilanilin] $(\text{H}_3\text{C})_2\text{N}-\text{C}_6\text{H}_4-\text{NH}_2 \cdot 2\text{HCl}$ 	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-Dinitropiropokatehin 	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⁺

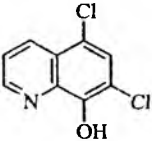
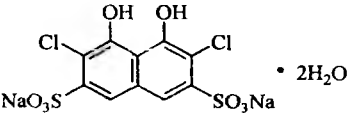
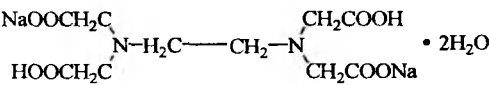
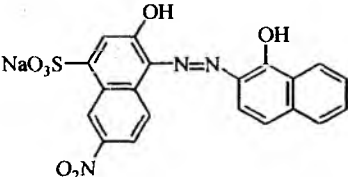
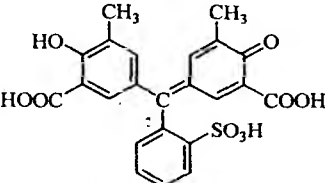
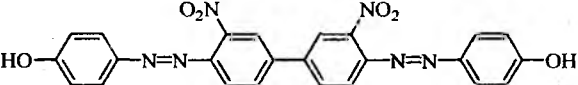
16-jadvalning davomi

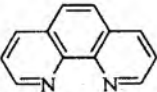
71. Disulfofenilfluoron 	M.m. 480,42 Ge ^{IV} , In ³⁺ , Ti ^{IV}
72. Ditzon (difeniltiokarbazon) 	M.m. 256,32 Ag ⁺ , Au ^{III} , Bi ³⁺ , Cd ²⁺ , Co ²⁺ , Cu ²⁺ , Hg ²⁺ , In ³⁺ , Ni ²⁺ , Pb ²⁺ , Pd ²⁺ , Pt ²⁺ ,
73. Ditioksamid $\begin{array}{c} \text{HN}=\text{C}-\text{C}=\text{NH} \\ \quad \\ \text{SH} \quad \text{SH} \end{array}$	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^+, Ti^{3+}
79. 8,8'-Dixinolilsulfid 	M.m. 320,44 Cu^+

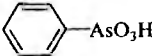
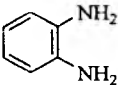
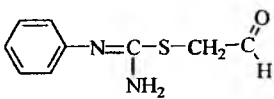
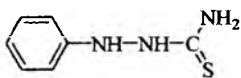
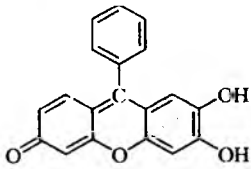
16-jadvalning davomi

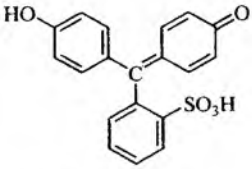
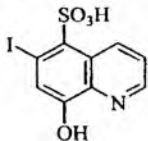
80. 5,7-Dixlor-8-oksixinolin (dixloroksin)	M.m. 214,05 Ti^{IV}, Cu^{2+}, Fe^{3+}, Pb^{2+}, Al^{3+}, Co^{2+},
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	$\text{Ga}^{3+}, \text{In}^{3+}, \text{Sc}^{3+}$ UO_2^{2+}
81. 2,7-Dixlorxromotrop kislota 	M.m. 469,17 $\text{Ti}^{\text{IV}}, \text{Mo}^{\text{VI}},$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

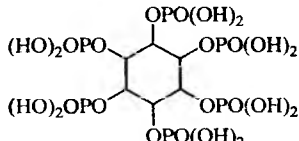
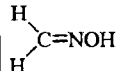
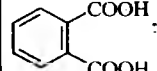
	Fe^{2+} , Cu^{2+} , Ru, Ni, Zn^{2+} , Mo, Hg, Mn
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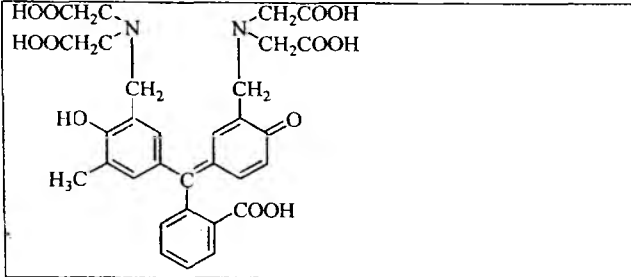
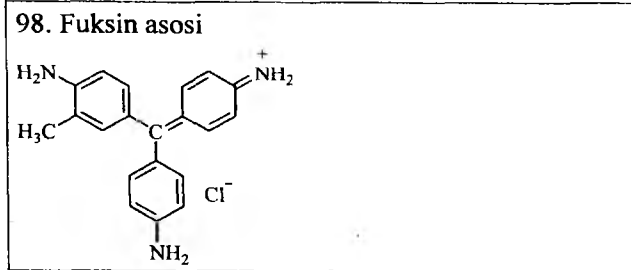
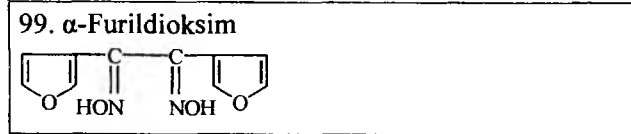
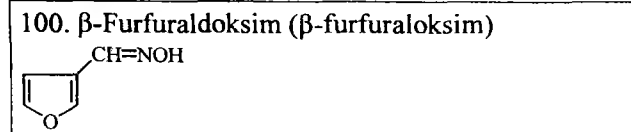
16-jadvalning davomi

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^-

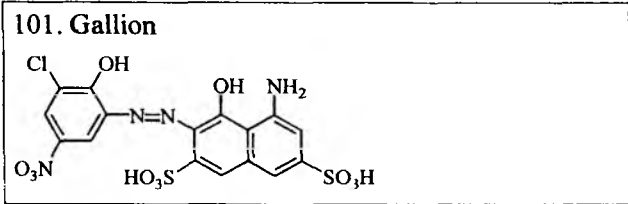
	
93. Ferron 	M.m. 351,12 Al³⁺, Fe³⁺, V

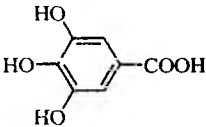
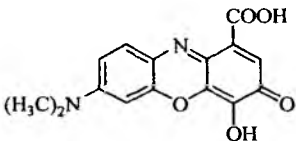
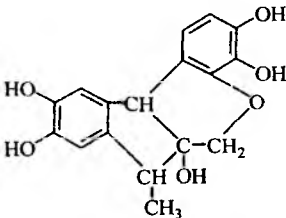
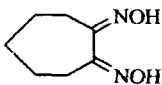
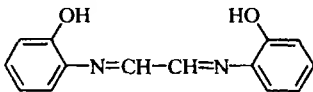
16-jadvalning davomi

94. Fitin kislota 	M.m. 660,04 Th^{IV}, Nb^V, Zr^{IV}, Se^{III}
95. Formaldoksim 	M.m. 45,04 Fe²⁺, Fe³⁺, Mn²⁺, Ni²⁺, V, Ce
96. Ftal kislota 	M.m. 166,13 Pb²⁺
97. Ftaleinkomplekson (<i>o</i>-krezolftaleinkomplekson)	M.m. 636,61 Ba²⁺, Ca²⁺, Sr²⁺

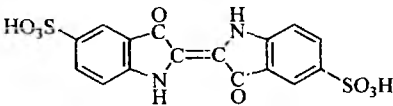
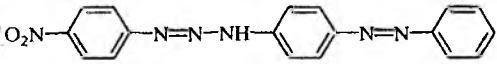
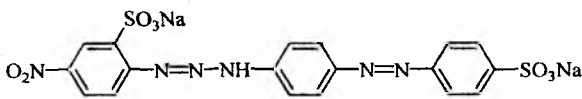
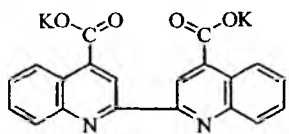
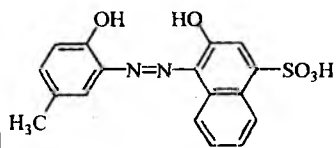
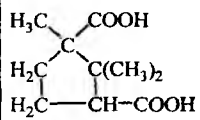
	
98. Fuksin asosi 	M.m. 337,85 Br₂, BF₄⁻, ReO₄⁻, S^{IV}
99. α-Furildioksim 	M.m. 238,20 Ni²⁺, Co²⁺, Pd²⁺, Re
100. β-Furfuraldoksim (β-furfuraloksim) 	M.m. 111,10 Pd²⁺

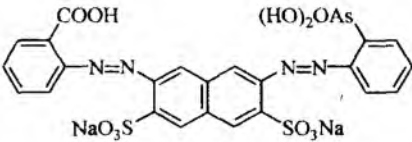
16-jadvalning davomi

101. Gallion 	M.m. 536,87 Ga³⁺, In³⁺
102. Gallat kislota	M.m. 170,12

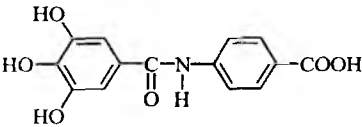
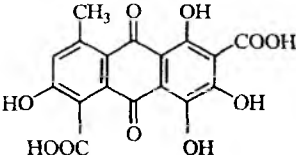
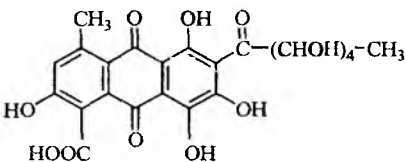
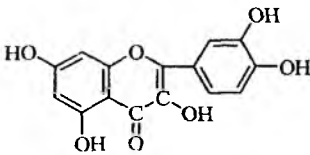
	V^V, Ta^V
103. Gallotsianin 	M.m. 300,27 $Ga^{III}, Hg, Pb, Sb^{III}$
104. Gematoksilin 	M.m. 302,28 $Al^{3+}, B^{III}, In^{3+}, Fe^{2+}, Fe^{3+}, Nb^V, Sn^{IV}, Ta^V, V^V, Zn^{2+}$
105. Geptoksim 	M.m. 156,18 Ni^{2+}, Pd^{2+}
106. Gidroxinon 	M.m. 110,11 $Nb^V, Ta^V, W^{VI}, Au, Cr, Ir, Ru$
107. Glioksal-bis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

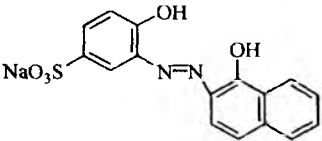
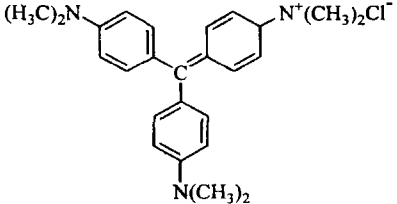
16-jadvalning davomi

108. Indigokarmin 	M.m. 254,29 Cl ₂ , ClO ⁻ , H ₂ S
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 $(C_2H_5O)_2P(=S)SK$	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

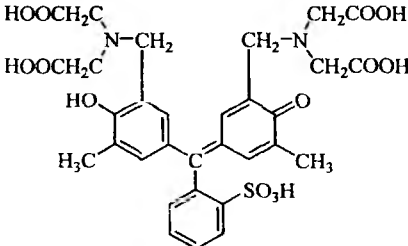
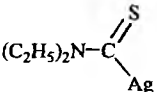
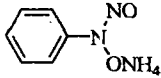
	$\text{Ba}^{2+}, \text{SO}_4^{2-}$
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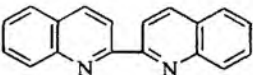
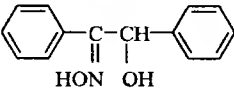
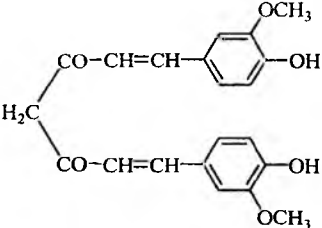
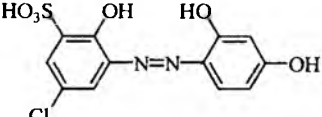
16-jadvalning davomi

116. <i>p</i>-Karboksigallanilid 	M.m. 289,24 Ti^{IV}
117. Karmin 	M.m. 374,26 $\text{B}^{\text{III}}, \text{Th}^{\text{IV}}, \text{U}^{\text{VI}}$
118. Karmin kislota 	M.m. 492,40 $\text{B}^{\text{III}}, \text{Th}^{\text{IV}}, \text{U}^{\text{VI}}$
119. Kvertsetin 	M.m. 302,24 $\text{Cr}^{\text{III}}, \text{Al}^{3+}, \text{Fe}^{3+},$ $\text{Sn}^{\text{IV}}, \text{B}^{\text{III}}, \text{Ga}^{3+},$ $\text{Ge}^{\text{IV}}, \text{Hf}^{\text{IV}}, \text{In}^{3+},$ $\text{Th}^{\text{IV}}, \text{Zr}^{\text{IV}}, \text{Ta}^{\text{V}},$ U^{VI}
120. Kislotali xrom binafsha K (xromli binafsha K)	M.m. 366,33 Nb^{V}

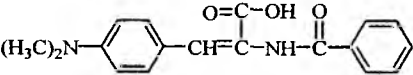
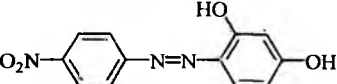
	
121. Kristall binafsha (kristallviolet) 	M.m. 407,99 Cd^{2+}, Sb^{V}, Ta^{V}, Ti^{3+}, Zn^{2+}, BF_4^-, ReO_4^-, ClO_4^-, SCN^-, $\text{Pt}(\text{SCN})_6^{2-}$

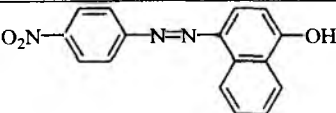
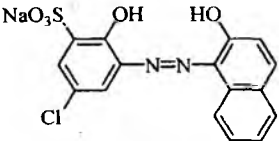
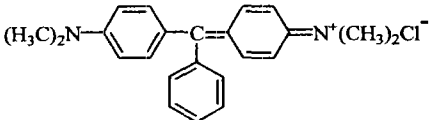
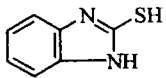
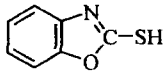
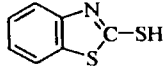
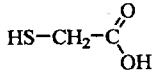
16-jadvalning davomi

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^{V}, 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}

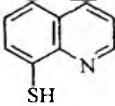
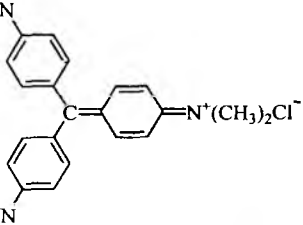
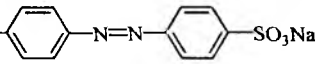
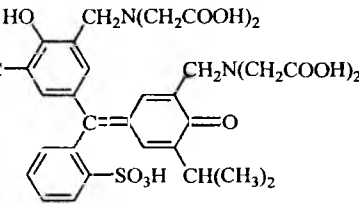
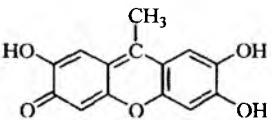
16-jadvalning davomi

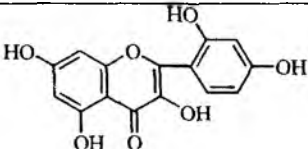
129. Lyumokupferon 	M.m. 310,35 Cu ²⁺
130. Magnezon I 	M.m. 259,23 Mg ²⁺
131. Magnezon II	M.m. 293,29

	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-Merkaptobenzthiazol (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+}

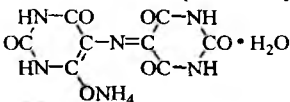
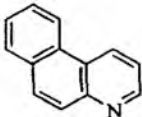
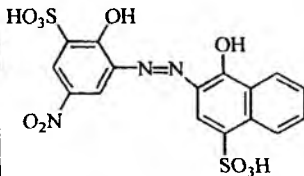
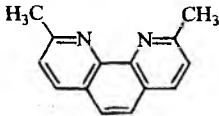
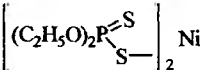
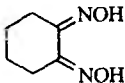
16-jadvalning davomi

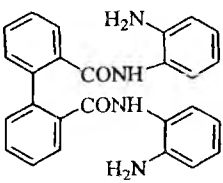
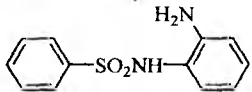
138. 8-Merkaptoxinolin (8-Tioksin, tioksin)	M.m. 161,23 Cu^{2+}, Fe^{3+}, In^{3+},
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	$\text{Ir}^{3+}, \text{Ga}^{3+}, \text{Mo}^{\text{VI}}, \text{Mn}^{2+}, \text{Os}, \text{Pd}^{2+}, \text{Pt}^{\text{IV}}, \text{Rh}^{3+}, \text{Tl}^{+}, \text{V}$
139. Metil binafsha $(\text{H}_3\text{C})_2\text{N}$  H_3CHN	$\text{AuCl}_4^-, \text{GaCl}_4^-, \text{ClO}_4^-, \text{ReO}_4^-, \text{BF}_4^-, \text{TaF}_6^-, \text{SbCl}_6^-, \text{TiCl}_4^-, \text{ZnCl}_4^{2-}$
140. Metiloranj $(\text{H}_3\text{C})_2\text{N}$  SO_3Na	M.m. 327,33 $\text{Cl}_2, \text{OCl}^-, \text{V}^{\text{V}}$
141. Metiltimol ko'ki 	M.m. 760,85 $\text{Mg}^{2+}, \text{Ca}^{2+}, \text{Co}^{2+}, \text{Zn}^{2+}, \text{Ga}^{3+}, \text{Hf}^{\text{IV}}, \text{Ti}^{\text{IV}}, \text{Th}^{\text{IV}}, \text{V}^{\text{V}}, \text{Zr}^{\text{IV}}, \text{Nb}^{\text{V}}, \text{Pd}^{2+}$
142. Metilfluoron 	M.m. 258,23 $\text{Ge}^{\text{IV}}, \text{Sb}^{\text{III}}$
143. Mis tnuramat (merkupral, dikupral, tetrametilturamid-sulfid) $\text{S}=\text{C}-\text{S}-\text{S}-\text{C}=\text{S}$ $(\text{CH}_3)_2\text{N} \rightarrow \text{Cu}^{2+} \leftarrow \text{N}(\text{CH}_3)_2$	M.m. 303,96 $\text{Ag}^+, \text{Hg}^{2+}$
144. Morin	M.m. 302,24 $\text{B}^{\text{III}}, \text{Be}^{2+}, \text{Al}^{3+}, \text{Ga}^{3+}, \text{In}^{3+}, \text{Ta}^{\text{V}},$

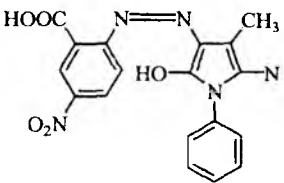
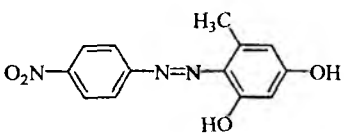
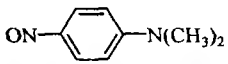
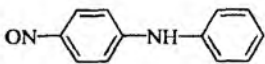
	$\text{Th}^{\text{IV}}, \text{Zr}^{\text{IV}}, \text{U}, \text{W}$
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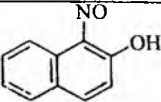
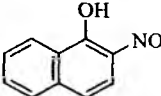
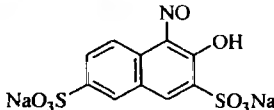
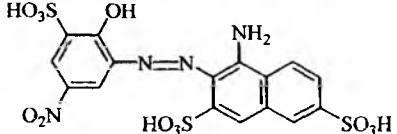
16-jadvalning davomi

145. Mureksid (ammoniy purpurat) 	M.m. 302,20 $\text{Ca}^{2+}, \text{Sr}^{2+}, \text{Zn}^{2+},$ $\text{Ni}^{2+}, \text{Sc}^{3+}$
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 $\text{Ni}^{2+}, \text{Pd}^{2+}$

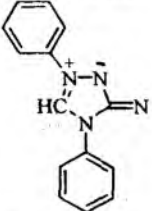
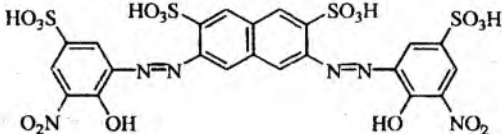
151. Nitriton A 	M.m. 424,49 NO_2^-
152. Nitriton B 	M.m. 220,29 NO_2^-

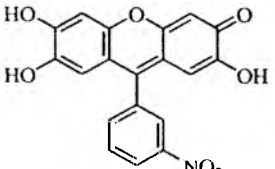
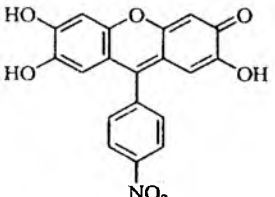
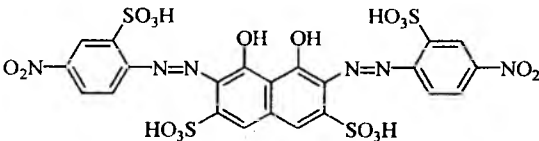
16-jadvalning davomi

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+} ,

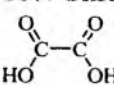
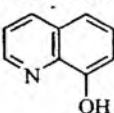
	Ni^{2+}
158. 2-Nitrozo-1-naftol (β-nitrozo-α-naftol) 	M.m. 173,17 Co^{3+}, Ni^{2+}, Pd^{2+}, Rh
159. Nitrozo-R-tuz 	M.m. 377,25 Co^{2+}, Fe, Pd^{2+}, U, Zr, K
160. Nitroksaminazo 	M.m. 548,49 Co, Pd^{2+}

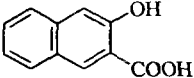
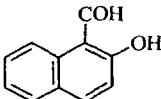
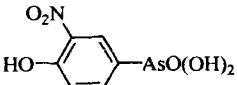
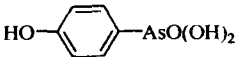
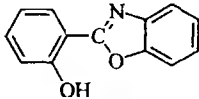
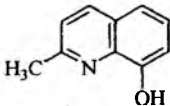
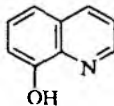
16-jadvalning davomi

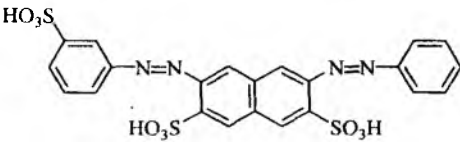
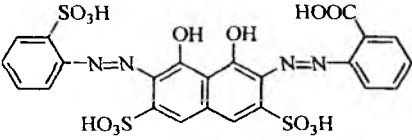
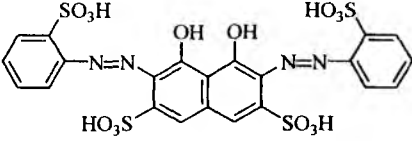
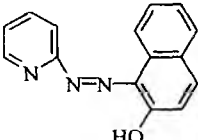
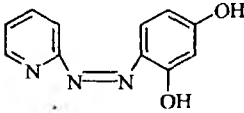
161. Nitron 	M.m. 312,37 NO_3^-, ClO_3^-, ClO_4^-, ReO_4^-, BF_4^-
162. Nitrosulfofenol S 	M.m. 810,62 Nb^{IV}, Zr^{IV}

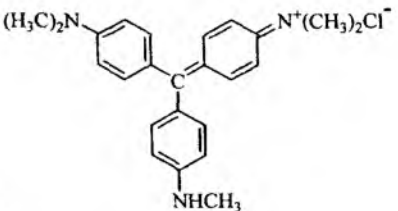
163. <i>o</i>-Nitrofenilfluoron 	M.m. 365,30 Zr^{IV}, Nb^V
164. <i>p</i>-Nitrofenilfluoron 	M.m. 365,30 Sn^{IV}
165. Nitxromazo (nitroortanil C) 	M.m. 778,62 Ba²⁺, Sr²⁺, SO₄²⁻, S
166. 4-Oksibenzotiazol 	M.m. 151,18 Cu²⁺, Ni²⁺, Zn²⁺, Cd²⁺

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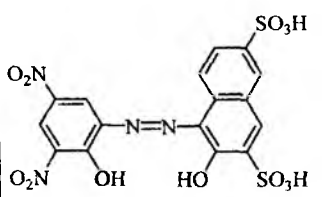
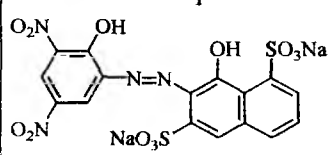
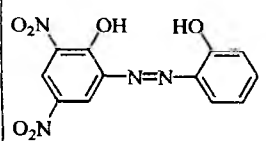
167. Oksalat kislota 	M.m. 90,04 Ca²⁺, La³⁺, Th
168. Oksin 	175 ga qarang

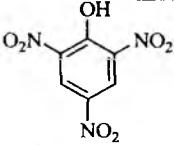
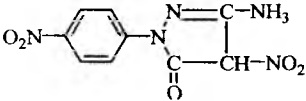
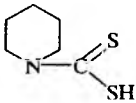
169. 2-Oksi-3-naftoy kislota 	M.m. 188,18 Al^{3+}, Be^{2+}
170. 2-Oksinaftalinkarbaldegid-1 	M.m. 172,18 Be^{2+}, Mg^{2+} (MR₂ ko'ri-nishida)
171. 4-Oksi-3-nitrofenilarson kislota 	M.m. Cd^{2+}
172. <i>p</i>-Oksifenilarson kislota 	M.m. 218,04 Sn^{IV}, Ti^{IV}, Zr^{IV}
173. 2-(2-Oksifenil)benzoksazol 	M.m. 211,22 Cu^{2+}, Cd^{2+}
174. 8-Oksixinaldin 	M.m. 159,17 Zn^{2+}, Mg^{2+}
175. 8-Oksixinolin (oksin, <i>o</i>-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 Ba²⁺, SO₄²⁻
177. Ortanil K 	M.m. 652,69 Ba²⁺, SO₄²⁻
178. Ortanil S (sulfonazo III) 	M.m. 688,65 Ba²⁺, SO₄²⁻, Sr²⁺
179. PAN [1-(2-piridilazo)naftol-2] 	M.m. 249,27 Cd²⁺, Co²⁺, Co³⁺, Cu²⁺, Fe³⁺, Ga³⁺, In³⁺, Mn²⁺, Ni²⁺, Os^{VIII}, Pd²⁺, U^{VI}, V^V, Zn²⁺
180. PAR [4-(2-piridilazo)rezorsin] 	M.m. 215,21 Co²⁺, Cu²⁺, Ga³⁺, In³⁺, Nb^V, Pd²⁺, Pb²⁺, Os^{VIII}, Ta^V, Ti^{IV}, Tl³⁺, U^{VI}, Zn²⁺, Zr^{IV}

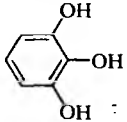
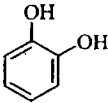
181. Pentametil binafsha 	$\text{Sb}^{\text{V}}, \text{Zn}^{2+}, \text{Cd}^{2+},$ $\text{Tl}^{3+}, \text{Hg}^{2+}$
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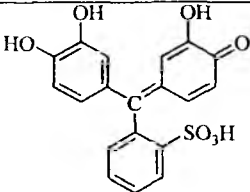
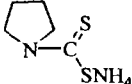
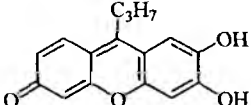
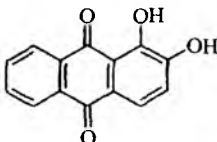
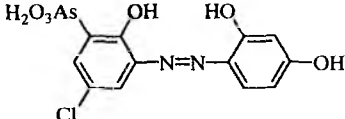
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182. Pikramin R 	M.m. 514,39 $\text{Nb}^{\text{V}}, \text{Zr}^{\text{IV}}$
183. Pikramin-epsilon 	M.m. 558,36 $\text{Cu}^{2+}, \text{Hf}^{\text{IV}}, \text{Nb}^{\text{V}},$ Zr^{IV}
184. Pikraminazofenol 	M.m. 304,22 $\text{Ca}^{2+}, \text{Mg}^{2+}$
185. Pikrin kislota	M.m. 299,11 Bi^{3+}

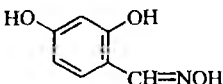
	
186. Pikrolon kislota 	M.m. 264,20 Pb^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Th^{IV} (MR_n ko'rinishida; n – metall valentligi)
187. Piperidin-N-ditiokarbon kislota 	M.m. 161,29 Co, Ni, Cu, Rh, Mg^{2+}
188. Piridin (+ SCN^-) 	Co^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}

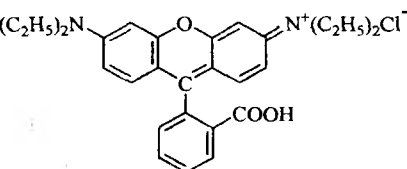
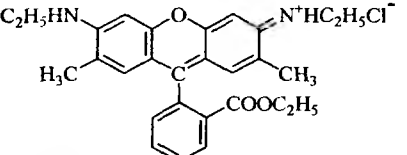
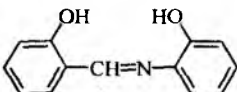
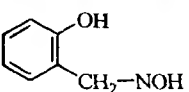
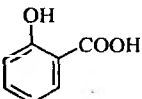
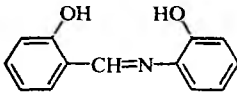
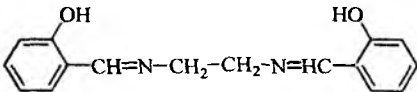
16-jadvalning davomi

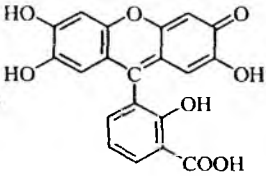
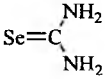
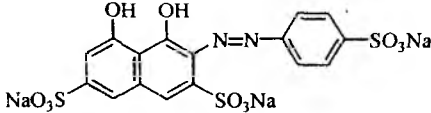
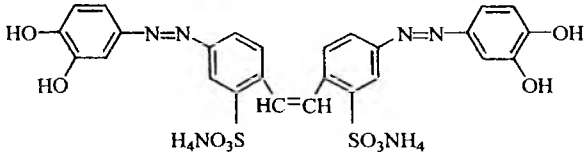
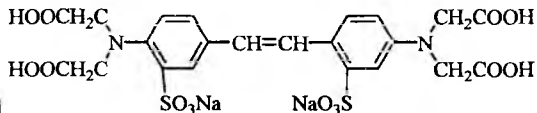
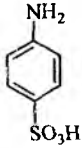
189. Pirogallol 	M.m. 126,11 Nb, Ta, Ti, Zr, Sb, Bi, O_2
190. Pirokatexin 	M.m. 110,11 Ti, Mo, V, Nb, Ta, Ge
191. Pirokatexin binafsha (pirokatexinsulfoftalein)	M.m. 386,38 B^{III}, Bi^{3+}, In^{3+},

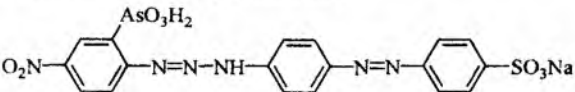
	$\text{Ge}^{\text{IV}}, \text{Sc}^{3+}, \text{Sn}^{2+},$ $\text{Ta}^{\text{V}}, \text{Zr}^{\text{IV}}, \text{Th}^{\text{IV}}$
192. N-Pirrolidinilditiokarbon kislotaning NH_4-li tuzi 	M.m. 164,30 $\text{Nb}^{\text{V}}, \text{Bi}^{3+}, \text{Sb}^{3+},$ Co, Ni
193. Propilfluoron 	M.m. 286,28 $\text{Sc}^{3+}, \text{Te}^{\text{IV}}$
194. Purpurin 	M.m. 256,21 $\text{Zr}^{\text{IV}}, \text{F}^-$
195. Rezarson 	M.m. 388,60 $\text{Ge}^{\text{IV}}, \text{Mo}^{\text{VI}}, \text{Ga},$ Th

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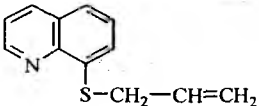
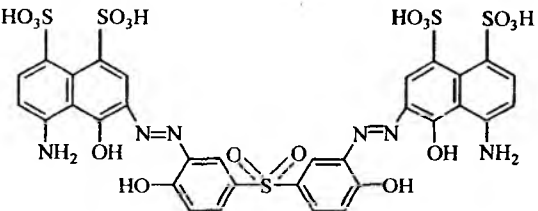
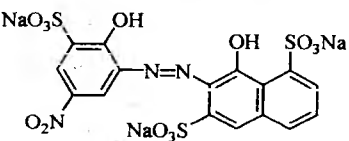
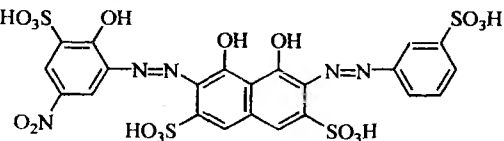
196. Rezorsilaldoksim 	M.m. 153,13 Fe^{3+}
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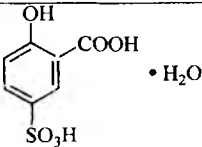
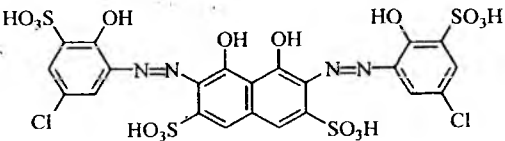
197. Rodamin V (rodamin S) 	M.m. 479,02 AuCl₄⁻, CdI₄²⁻, GaCl₄⁻, InBr₄⁻, ReO₄⁻, WO₄²⁻, Zn(SCN)₄²⁻
198. Rodamin 6J 	M.m. 479,02 Ta^V, Zn(SCN)₄²⁻, In³⁺, ReO₄⁻, TiCl₄⁻, GaCl₄⁻
199. Salitsilal-<i>o</i>-aminofenol 	M.m. 213,24 Mn²⁺, Al³⁺, Ga³⁺
200. Salitsilaldoksim 	M.m. 137,14 Cu²⁺, Ti^{IV}, U^{VI}, Zn²⁺, Pb²⁺, Fe³⁺, Ni²⁺
201. Salitsil kislota 	M.m. 138,12 Fe³⁺, Cu²⁺, Ti^{IV}, U^{VI}
202. Salitsilidenaminofenol 	M.m. 213,24 Al³⁺
203. Salitsilidenetilendiamin 	M.m. 268,32 Mg²⁺

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+}

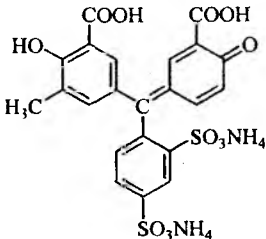
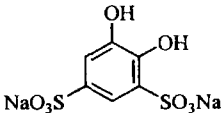
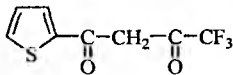
210. Sulfarsazen (plyumbon) 	M.m. 572,32 Pb²⁺, Zn²⁺, Hg²⁺
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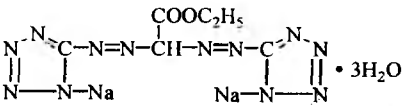
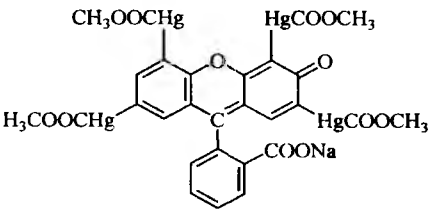
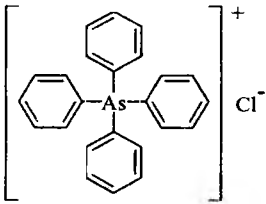
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211. Sulfoalltioks 	M.m. 281,34 Rh
212. Sulfonazo 	976,90 Sc³⁺, In³⁺, Ga³⁺
213. Sulfonitrazo E 	M.m. 615,40 Ga³⁺, Sc³⁺, Mo, V
214. Sulfonitrofenol M 	M.m. 749,62 Pd²⁺, Zr^{IV}
215. Sulfosalitsil kislota	M.m. 245,21

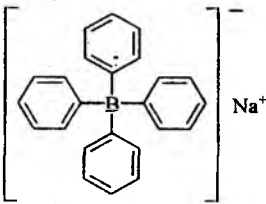
	Fe, Ti ^{IV}
216. Sulfoxlorfenol S 	M.m. 789,52 Nb ^V , Mo ^{VI}

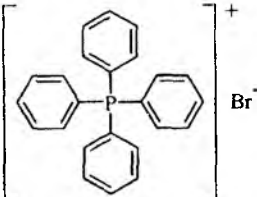
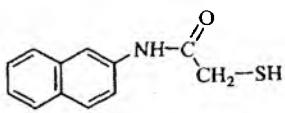
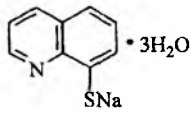
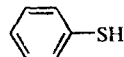
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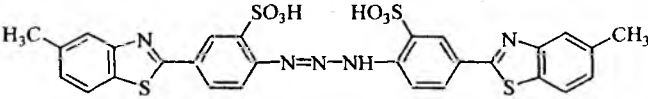
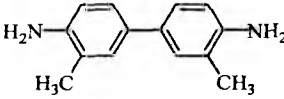
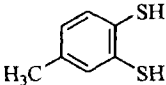
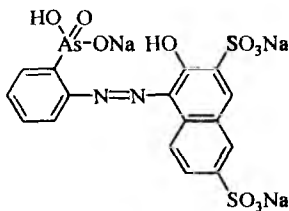
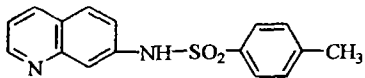
217. Sulfoxrom 	M.m. 584,57 Al ³⁺ , F ⁻ , Be ²⁺ , Ga ^{III}
218. Tayron (tiron) 	M.m. 314,19 Fe ³⁺ , Ti ^{IV} , Nb ^V , Mo ^{VI} , Ce ^{IV} , Os
219. 2-Tenoiltrifloratseton (TTFA, TTA) 	M.m. 222,18 Al ³⁺ , Ba ²⁺ , Be ²⁺ , Bi ³⁺ , Cd ²⁺ , Ce ²⁺ , Co ²⁺ , Cr ³⁺ , Cu ²⁺ , Fe ³⁺ , In ³⁺ , Nb ^V , Ni ²⁺ , Th ^{IV} , Ti ³⁺ , Ti ^{IV}

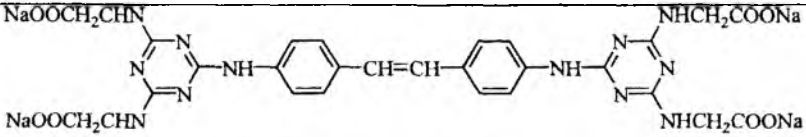
220. Tetra 	M.m. 378,22 Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, Pd^{2+}, Cu^{2+}, Zn^{2+}
221. Tetrasimobatsetatfluoressein, Nali tuzi 	M.m. 1372,80 S^{2-}
222. Tetrafenilarsoniy xlorid 	M.m. 418,80 ReO_4^-, Os^{VI}, Cd^{2+}, Mn^{2+}, Hg^{2+}, Sn^{2+}, Zn^{2+}

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223. Tetrafenilboratning natriyli tuzi (kalignost) 	M.m. 342,22 K^+, Cs^{2+}, Rb^+, NH_4^+, Ti^+
224. Tetrafenilfosfoniyl bromid	M.m. 419,30 Os^{VI}, ReO_4^-

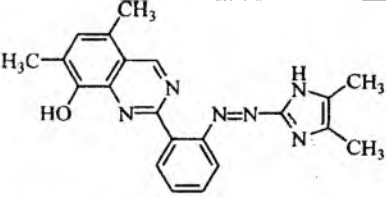
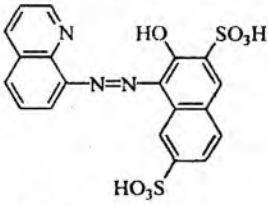
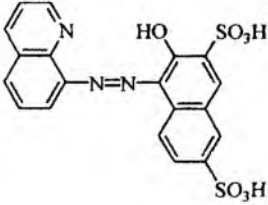
	
225. Tioatsetamid $\text{H}_3\text{C}-\underset{\text{S}}{\underset{\parallel}{\text{C}}}-\text{NH}_2$	M.m. 75,13 Cd^{2+}, Cu^{2+}, As, Sb, Bi^{3+}, Mo^{VI}, Pb^{2+}, Pd^{2+}
226. Tioglikol kislota $\text{HS}-\text{CH}_2-\text{COOH}$	M.m. 92,11 U, Fe, Co^{2+}, Ni^{2+}, Mo, Pd^{2+}, Cr^{3+}, Se, Ta
227. Tiokarbamid $\text{H}_2\text{N}-\underset{\text{S}}{\underset{\parallel}{\text{C}}}-\text{NH}_2$	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 Mg²⁺, Cd²⁺
233. <i>o</i>-Tolidin 	M.m. 212,29 Cl₂, Br₂, I₂, ClO⁻, Au, Ce^{IV}
234. Toluol-3,4-ditiol (1,2-dimerkapto-4-metilbenzol) 	M.m. 156,27 Sn²⁺, Mo^{VI}, W^{VI}
235. Toron I (toron, APANS) 	M.m. 598,27 Th^{IV}, U, Li⁺, Be²⁺, Bi³⁺, Zr^{IV}, Hf^{IV}
236. 8-<i>p</i>-Tosilaminoxinolin toluolsulfanilamino)-xinolin] 	[8-(<i>p</i>- M.m. 298,37 Cd²⁺, Zn²⁺
237. Triazinilstilbekson, M.m. 952,61; Mg²⁺	Na-li tuzi

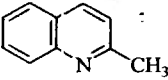
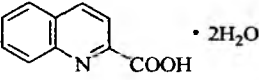
	
238. Vanadoks (2,2'-dikarboksidifenilamin)	M.m. 257,25 V ^V

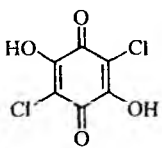
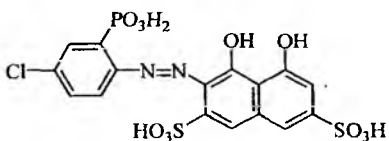
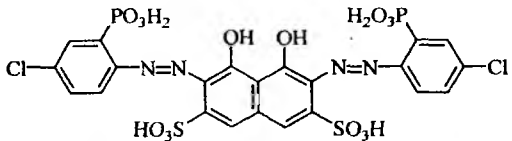
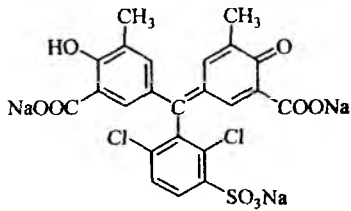
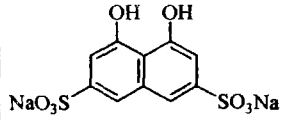
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239. Vismutol I (vismutiol I)	M.m. 150,23 Bi ^{III} , Pd ²⁺
240. Vismutol II (vismutiol II, merkaptofeniltiotiodiazolon)	M.m. 226,33 Bi ^{III} , Pd ²⁺ , Te
241. Xinazolinazo	M.m. 386,46 Li ⁺
242. Xinalizarin	M.m. 272,21 Mg ²⁺ , Be ²⁺ , Al ³⁺ , Ga ³⁺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

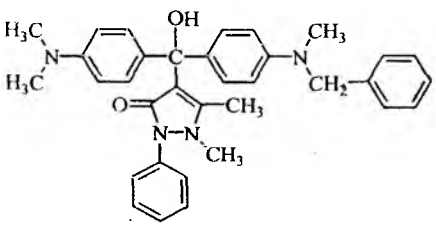
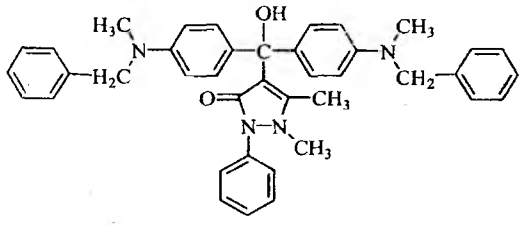
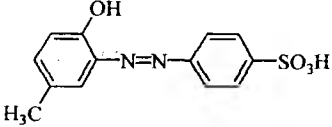
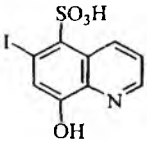
	Zr^{IV}
243. Xinolinazo E 	M.m. 395,33 Co^{2+}
244. Xinolinazo R 	M.m. 395,33 Co^{2+}

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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+},

	$\text{Cd}^{2+}, \text{UO}_2^{2+}$
247. Xloranil kislota 	$\text{Al}^{3+}, \text{Ca}^{2+}, \text{Mo}^{\text{VI}}, \text{Pb}^{2+}, \text{Sr}^{2+}$
248. Xlorfosfonazo I 	M.m. 538,82 U^{VI}
249. Xlorfosfonazo III 	M.m. 757,36 $\text{U}^{\text{VI}}, \text{Se}^{3+}, \text{Ba}^{2+}, \text{Sr}^{2+}, \text{Mg}^{2+}, \text{Th}^{\text{IV}}$
250. Xromazurol S 	5 ga qarang
251. Xromotrop kislota dinatriyli tuzi 	M.m. 364,25 $\text{Cr}^{\text{VI}}, \text{Ti}^{\text{IV}}, \text{Nb}^{\text{V}}, \text{Ta}^{\text{V}}$

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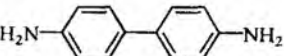
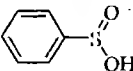
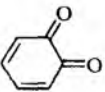
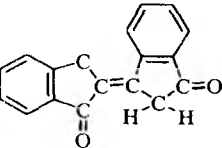
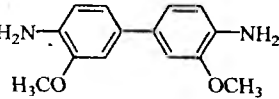
252. Xrompirazol I 	M.m. 532,68 P, As, Mo, BF_4^-, TiCl_4^-, AuCl_4^-, SbCl_6^-, BiI_4^-, ReO_4^-, Zn^{2+}
253. Xrompirazol II 	M.m. 608,78 P, As, Mo, BF_4^-, TiCl_4^-, AuCl_4^-, SbCl_6^-, BiI_4^-, ReO_4^-, Zn^{2+}
254. X-Sirkonon (sirkonon) 	M.m. 292,31 Zr^{IV}
255. 7-Yod-8-oksixinolin-5-sulfokislota (ferron) 	M.m. 351,11 Fe, F

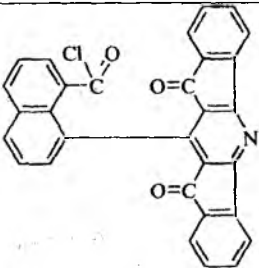
17-jadval

**ORGANIK MODDALARNI ANIQLASHDA QO‘LLANILADIGAN MUHIM
ORGANIK REAGENTLAR**

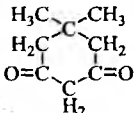
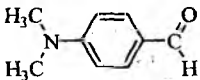
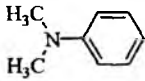
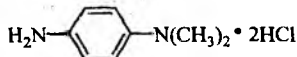
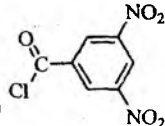
Reagent	Aniqlanadigan moddalar
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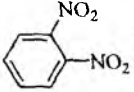
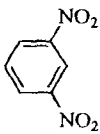
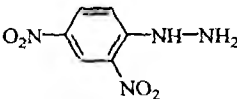
1. Akonit angidrid $\begin{array}{c} \text{H}_2\text{C}-\text{C}=\text{O} \\ \quad \quad \\ \text{HOOC}-\text{HC}=\text{C}-\text{O} \\ \quad \quad \quad \\ \quad \quad \quad \text{O} \end{array}$	Uchlamchi aminlar
2. 4-Aminoantipirin ($(\text{NH}_4)_2\text{S}_2\text{O}_8$ bilan birga) $\begin{array}{c} \text{O} \\ \\ \text{H}_2\text{N}-\text{C}-\text{C} \\ \quad \quad \\ \text{H}_3\text{C}-\text{C}=\text{N}-\text{N}-\text{C}_6\text{H}_5 \\ \\ \text{CH}_3 \end{array}$	Fenollar, xlorfenollar, naftollar, aromatik aldegidlar
3. 4-Aminobenzoy kislota (PAB) $\text{H}_2\text{N}-\text{C}_6\text{H}_4-\text{COOH}$	Flavinlar, timol, metiletilketon
4. 4-Aminosalitsil kislota (PASK) $\begin{array}{c} \text{H}_2\text{N}-\text{C}_6\text{H}_3(\text{OH})-\text{COOH} \end{array}$	Aldozalar
5. Antranil kislota $\begin{array}{c} \text{NH}_2 \\ \\ \text{C}_6\text{H}_4-\text{COOH} \end{array}$	Aldegidlar, ketonlar, birlamchi spirtlar
6. Antron $\begin{array}{c} \text{CO} \\ \\ \text{C}_{10}\text{H}_6 \\ \\ \text{CH}_2 \end{array}$	Aldegidlar, uglevodlar
7. Barbiturat kislota $\begin{array}{c} \text{O} \quad \quad \text{O} \\ \quad \quad \\ \text{HN} \quad \quad \text{NH} \\ \quad \quad \\ \text{C}=\text{O} \end{array}$	Nikotin kislota va uning hosilalari, furfurol va pentozalar
8. Benzaldegid $\text{C}_6\text{H}_5-\text{COH}$	Atseton, yuqori spirtlar, inden, aminlar

9. Benzidin 	Nikotin, aminonitrillar
10. Benzolsulfon kislota 	Xinonlar
11. 1,2-Benzoxinon 	1,2-Diaminlar
12. 1,4-Benzoxinon 	Indol, pirrol va ularning hosilalari, aminlar, sik- lopentadiyen
13. Bindon 	Birlamchi va ikkilamchi aromatik aminlar
14. Bromtimol ko'ki	To'rtlamchi aminlar
15. Bromfenol ko'ki	To'rtlamchi aminlar
16. <i>n</i> -Butilamin $\text{CH}_3 - (\text{CH}_2)_3 - \text{NH}_3$	Benzoxinon
17. 1,2-Dianizidin 	Fenollar, aldegidlar
18. Dibepin	Birlamchi alkil

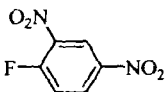
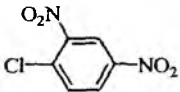
	va aralkilaminlar
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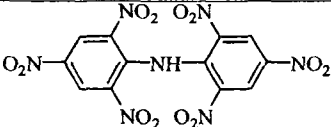
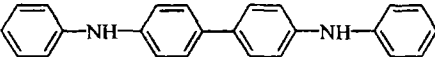
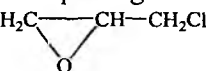
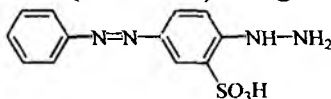
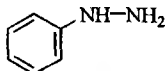
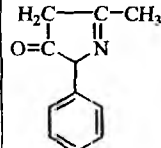
17-jadvalning davomi

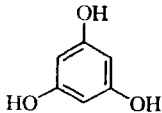
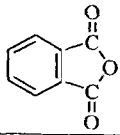
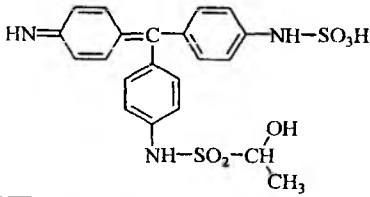
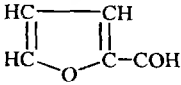
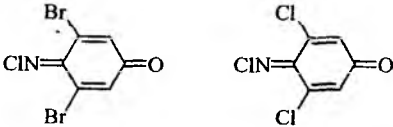
19. Dimedon 	Aldegidlar
20. 4-Dimetilaminobenzaldegid 	Birlamchi aromatik aminlar, sulfanilamidlar, to'yinmagan uglevodorodlar
21. N,N-Dimetilanilin 	1,3-Dinitrozobirikmalar, polinitrobirikmalar, 4-nitrobenzoy kislota efirlari
22. N,N-Dimetil-p-fenilendiamin gidroxlid 	Merkaptanlar, disulfidlar
23. 3,5-Dinitrobenzoilxlorid 	Ikkilamchi aromatik aminlar, gidrazin hosilalari

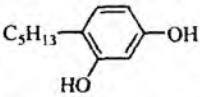
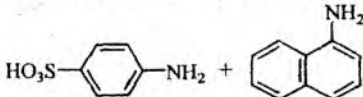
24. 1,2-Dinitrobenzol 	Fluoren va uning hosilalari
25. 1,3-Dinitrobenzol 	Aldegidlar, ketonlar
26. 1,4-Dinitrobenzol 	Fluoren va uning hosilalari, siklopentadiyen
27. 2,4-Dinitrofenilgidrazin 	Aldegidlar, ketonlar, aldozalar

17-jadvalning davomi

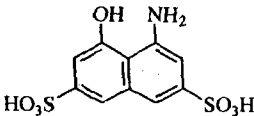
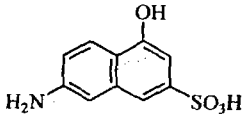
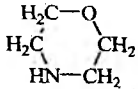
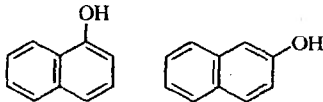
28. 2,4-Dinitroftorbenzol 	Tiollar, birlamchi va ikkilamchi aminlar
29. 2,4-Dinitroxlорbenzol 	Birlamchi alifatik va aromatik aminlar, piridin va uning hosilalari
30. Dipikrilamin (geksanitrodifenilamin) 	Siklopentadiyen va hosilalari

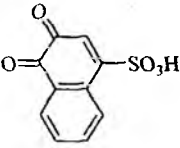
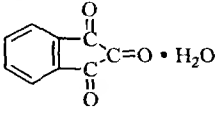
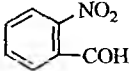
	
31. Difenilbenzidin 	Xinonlar, nitrozo birikmalar, organik peroksidlar, xloraminlar
32. Epixlorgidrin 	Piridin va uning hosilari
33. Etilendiamin $\text{H}_2\text{N} - \text{CH}_2 - \text{CH}_2 - \text{NH}_2$	Xinonlar va xinon hosil qiluvchi moddalar
34. 2-(4-Fenilazo)-fenilgidrazinsulfokislota 	Atsetaldegid
35. Fenilgidrazin 	Aldegidlar, monoazalar
36. 1,4-Fenilendiamin + oksidlovchilar 	Fenollar, birlamchi aromatik aminlar, diolefinlar, izopren, xloropren
37. 1-Fenil-3-metil-pirazolon-5 	Diazobirikmalar

38. Floroglyutsin 	Furfurol, vanilin, 1,4-benzoxinon, gidroksinon
39. Formaldegid (+ H₂SO₄) 	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-dibromxinxlorimin yoki 2,6-dixlorxinxlor-imin) 	<i>p</i>-Holati bo'sh bo'lgan fenollar, xlorlangan fe- nollar, tiollar, kumarin

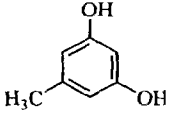
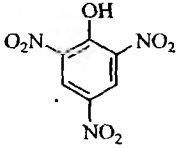
44. 4-Geksilrezorsin 	Akrolein
45. Griss reaktivi (sulfanil kislota + 1-naftilamin) 	Nitrat kislota efirlari, nitrozobirikmalar, nitrobirikmalar

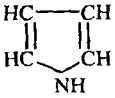
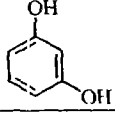
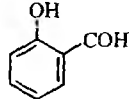
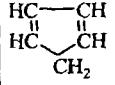
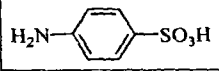
17-jadvalning davomi

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

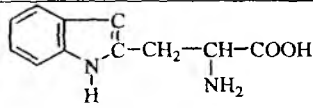
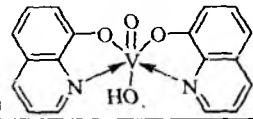
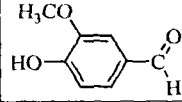
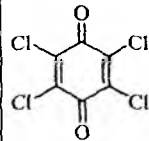
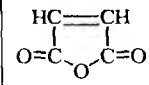
17-jadvalning davomi

55. Orsin 	Pentozalar, pentozanlar, furfurol
56. Pikrin kislota 	Alifatik aminlar, alkaloidlar
57. Piridin	Dinitroxlorbenzol,

	xlor-benzol, poligalogenidli birikmalar
58. Pirrol 	Aldegidlar
59. 2,4-Pentadion $\text{H}_3\text{C}-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{CH}_2-\overset{\text{O}}{\underset{\text{O}}{\text{C}}}-\text{CH}_3$	Birlamchi aminlar
60. Rezorsin (+ H ₂ SO ₄) 	Benzaldegid, salitsil aldegid, furfurol, fruktoza
61. Salitsil aldegid 	Birlamchi alifatik aminlar, ketonlar, sulfanil-amidlar, yuqori spirtlar
62. Siklopentadiyen 	Ketonlar
63. Sulfanil kislota 	Aromatik aminlar, fenollar
64. Tetrafenilboratning natriyli tuzi (16-jadvaldan 223 ga qarang)	Ikkilamchi aminlar

17-jadvalning davomi

65. Triptofan (+ oksidlovchilar)	Aldegidlar
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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. Gidrosilamin gidroxlorid (FeCl_3 bilan birga) $\text{NH}_2\text{OH} \cdot \text{HCl}$ (M.m. 69,49)	Xinonlar, angidridlar, kislota amidlari, imidlar,

	murakkab efirlar
2. Denije reaktivi $\text{HgSO}_4 \cdot \text{H}_2\text{SO}_4$	Tiofen
3. Dragendorf reaktivi KBiI_4 (M.m. 755,70)	Alkaloidlar, noionogen SFM
4. Ilosvay reaktivi $\text{Cu}(\text{NO}_3)_2$ (yoki CuCl_2) + $\text{NH}_2\text{OH} \cdot \text{HCl}$ + NH_4OH + jelatina	Atsetilen va uning hosilalari
5. Millon reaktivi $\text{Hg}_2(\text{NO}_3)_2 + \text{Hg}(\text{NO}_3)_2 + \text{HNO}_2$	Fenollar
6. Natriy nitoprussid (Legal reaktivi) $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}] \cdot \text{H}_2\text{O}$ (M.m. 279,95)	Ketonlar, ikkilamchi va alifatik aminlar, aldegidlar, indol va uning gomologlari
7. Natriy pentatsianoferrat (II) [natriy nitoprussid + ammiak] $\text{Na}_3[\text{Fe}(\text{CN})_5\text{NH}_3]$	Nitrozobirikmalar, tiokarbamid, izonikotin kislota, to'yinmagan va aromatik aldegidlar
8. Reyneke tuzi $\text{NH}_4[\text{Cr}(\text{SCN})_4(\text{NH}_3)_2] \cdot 2\text{H}_2\text{O}$ (M.m. 372,44)	Organik asoslar: atropin, xolin, rezerpin, brutsin, xinin, strixinin
9. Tollens reaktivi $\text{Ag}(\text{NH}_3)_2\text{OH}$	Organik qaytaruvchilar
10. Feling reaktivi $\text{NaKC}_4\text{H}_4\text{O}_6 + \text{CuSO}_4 + \text{NaOH}$	Qaytaruvchi saxaridlar
11. Folin reaktivi (fosforomolibdat va fosforovolfamat kislotalarning aralashmasi)	Organik qaytaruvchilar
12. Fred reaktivi $\text{Na}_2\text{MoO}_4 + \text{H}_2\text{SO}_4$	Asos guruhini yonaki zanjirda saqllovchi siklik aminlar

ANALITIK TERMINLARNING QISQA LUG'ATI

Adsorbtsiya – 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 eritmaları 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 sezgirliigi – *Topilish minimumiga* 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 barcha 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 eritmaları qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usullari

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

Bromatometriya – $\text{BrO}_3^- + \text{Br}^-$ aralashmasi qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Bufer eritmalar – pH ning muayyan qiymati, oksidlanish-qaytarilish potentsiali, 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 $f_{\text{ekv}}(\text{X})$ – 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 molekulari ta‘sirida elektrolit molekularining ionlarga parchalanishi

Elektrolitlar – molekulari 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 reaksiya 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 analizga* 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 oralik

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 joylashadi

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 usuli

Koordinatsion son – kompleks birikmada markaziy atom bilan bog'langan neytral molekular yoki ionlarning umumiy soni

Ligandlar – kompleks birikmada markaziy atom bilan bog'langan molekular 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 – obyektning 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 sharoitda (bir xil reagent, asboblardan boshqalar), lekin aniqlanadigan moddasiz kimyoviy analiz jarayonlarini takrorlash. Analiz natijalarini tuzatish maqsadida bajariladi

Niqoblash – xalaqit 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 eritmalarini qo'llaniladigan miqdoriy analizning titrimetrik usullar majmui

Oksidlanish-qaytarilish potentsiali – 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

Permanganometriya – titrant sifatida kaliy permanganat eritmasining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Protoliz – kuchsiz elektrolitlar yoki kam eruvchan 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, molekularlar, radikallar, elektronlar va hokazo

Reduktometriya – qaytaruvchilarning standart eritmaları 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 obyektning (predmet, hodisa, jarayonning) muayyan aniqligi bo'lib, shu asosida u berilgan obyekt deb hisoblanadi va boshqa obyektlardan farq qiladi

Sifat analiz – aniqlanadigan namuna komponentlarini topish va identifikatsiyalash

Solvatlanish – erigan modda zarrachalarining erituvchi zarrachalari bilan o'zaro ta'siri natijasida molekulyar agregatlar – solvatlarning hosil bo'lishi

Solvolyz – 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 potentsiali

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

Titir (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 eritmalarga* 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 eritmalarining 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 – *Gravimetriyaga* qarang

Vodorod ko'rsatkich pH – eritmadagi gidroksoniy ionlarining konsentratsiyasini (aktivligini) xarakterlovchi kattalik bo'lib, u H_3O^+ molyar konsentratsiyasining manfiy logarifmiga teng

Xelatlar – *Ichki kompleks birikmalarga* qarang

Xossa – obyektning sifat ko'rsatkichi bo'lib, uning boshqa obyekt bilan o'xshashligini 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 xossalari 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

ANALITIK KIMYONING RIVOJLANISHIGA O'Z HISSANI QO'SHGAN OLIMLAR

- Abu Rayhon ibn Axmud al-Beruniy – O'rta Osiyoning buyuk mutafakkiri, ensiklopedist olimi. Moddalarning solishtirma og'irliklarini katta aniqlik bilan o'lchadi
- Alimarin Ivan Pavlovich (1903 – 1989) – kimyogar-analitik. Asosiy ishlari miqdoriy mikro va ultramikroanalizga bag'ishlangan. Yarim o'tkazgichlardagi qo'shimchalarni aniqlashda neytron-aktivatsion usulni taklif etdi
- Alkemade Kornelis (1923 – 1989) – daniyal shifokor. Alanga fotometriyasi usulini ishlab chiqdi
- Angstrom Anders Yonas (1814 – 1874) – shved fiziki va astronomi, spectral analizning asoschilaridan biri
- Arrenius Svante Avgust (1859 – 1927) – shved fizikimyogari. Elektrolitik dissotsilanish nazariyasining asoschisi. Kimyoviy kinetikaga oid ishlarning muallifi (Arrenius tenglamasi). Nobel mukofoti sovrindori
- Afselius Iogan (1753 – 1837) – shved kimyogari, Upsala universitetining kimyo, metallurgiya va farmatsiya professori, Berselius ustози
- Balar Antuan Jerom (1802 – 1876) – fransuz kimyogari. Bromni kashf etdi
- Bekman Ernst Otto (1853 – 1923) – nemis kimyogari. Erigan moddaning molekulyar massasini aniqlash usulini ishlab chiqdi, spektral analiz sohasida ishlar olib bordi
- Ber Avgust (1825 – 1863) – nemis shifokori. Optikaga oid tadqiqotlar olib bordi,urning yutilish qonunini kashf etdi
- Bergman Torbern Ulaf (1735 – 1784) – shved kimyogari va mineralogi. Analitik kimyoning asoschilaridan biri. Sifat va miqdoriy analiz usullarini ishlab chiqdi
- Bertolle Klod Lui (1748 – 1822) – fransuz kimyogari, kimyoviy muvozanat ta'limotining asoschisi. Xlor bilan oqartirish usulini ishlab chiqdi, o'zining nomi bilan ataladigan tuzni kashf etdi
- Berselius Yyons Yakob (1779 – 1848) – shved kimyogari va mineralogi. Seriy, selen va toriyni kashf etdi. Elektokimyoviy

- dualizm nazariyasini asosladi va uning asosida elementlar, birikmalar va minerallar klassifikatsiyasini yaratdi. Element-larning atom og'irliklari jadvalini tuzdi, zamonaviy kimyoviy belgilarni kiritdi
- Byotger Vilgelm (1871 – 1949) – nemis kimyogari. Miqdoriy analiz usullarini ishlab chiqdi
- Boyl Robert (1627 – 1691) – ingliz fiziki va kimyogari. Kimyoviy element tushunchasini birinchi marta ilmiy asoslab berdi, eksperimental usullarni kimyoga kiritdi, kimyoviy analizga asos soldi. Gaz qonunlarining birini yaratdi (Boyl-Mariott qonuni)
- Brensted Yoxanes Nikolaus (1879 – 1947) – daniyalik kimyogar. Reaksiyalar kinetikasi, eritmalar termodinamikasi bilan shug'ullandi. Kislota va asoslar nazariyasini ishlab chiqdi
- Bryuster Deyvid (1781 – 1868) – shotlandiyalik fizik, nurning qutblanishini o'rgandi. Uning nomi bilan ataladigan qonunni kashf etdi, aylanma qutblanishni ochdi
- Buger Pyer (1698 – 1758) – fransuz olimi, fotometriyaning asoschilarida biri. Yorug'lik kuchini o'lchash usullarini ishlab chiqdi. Yorug'likning so'nish qonunini yaratdi (Buger-Lambert Ber qonuni)
- Bunzen Robert Vilgelm (1811 – 1899) – nemis kimyogari. G. Kirxgof bilan hamkorlikda spektral analizga asos soldi. Seziy, rubidiyni kash etdi
- Byerrum Nils (1879 – 1958) – daniyalik kimyogar. Kislota va asos nazariyasining asoschilaridan biri. Vodorod ionlari konsentratsiyasini aniqlash, amfoter elektrolitlar va boshqalarni o'rgandi
- Vaage Peter (1833 – 1900) – norvegiyalik matematik. K. Guldberg bilan birgalikda massalar ta'siri qonunini asoslab berdi
- Valden Paul (1863 – 1957) – kimyogar, Peterburg FA akademiki. Eritmalar elektrokimyosi, optik izomeriyani o'rgandi
- Vant-Goff Yakob Xendrik (1852 – 1911) – gollandiyalik fizikimyogar, kimyo bo'yicha birinchi Nobel mukofoti sovrindori. Stereokimyo, eritmalar va kimyoviy kinetika ta'limotining asoschilaridan biri. Eritmalardagi osmotik bosim qonunini kashf qildi
- Veybel Stig Erik (1898 –) – daniyalik kimyogar. Organik birikmalar analizini ishlab chiqdi

- Vensel Karl Fridrix (1740 – 1793) – Freybergdagi metal quyish zavodining boshqaruvchisi. Ekvivalentlar qonunining kashfiyotchisi Rixterdan oldin kislota va asoslar doimiy nisbatlarda birikishini aniqladi
- Vollaston Uilyam (1767 – 1828) – ingliz kimyogari va fiziki, fanga birinchi marta ekvivalent tushunchasini kiritdi
- Volta Alessandro (1745 – 1827) – italiyalik fizik. Elektr ta'limotining asoschilaridan biri. Birinchi galvanik elementni va birinchi galvanik elementlar batareyasini yaratdi
- Galvani Luidji (1737 – 1798) – italiyalik anatom va fiziolog, elektr ta'limoti va eksperimental elektrofiziologiyaning asoschilaridan biri. Metallning elektrolit bilan ta'sirlanishidan potentsiallar farqi yuzaga kelishini aniqladi
- Ganch Artur Rudolf (1857 – 1935) – organik-kimyogar, organik birikmalarni analiz qilishda birinchi marta fizik-kimyoviy usullarni qo'lladi
- Geyger Xans Vilgelm (1882 – 1945) – nemis fiziki. Zaryadlangan zarrachalarni qayd etish asbobini ixtiro qildi
- Gey-Lyussak Jozaf Lui (1778 – 1850) – fransuz kimyogari va fiziki. Gaz qonunlarini kashf qildi. Xlor, yod, kaliy va natriy – kimyoviy elementlar ekanligini isbotladi. Eruvchanlik diagrammalarini birinchi bo'lib tuzdi. Hajmiy analiz usullarini mukammallashtirdi
- Geyrovskiy Yaroslav (1890 – 1967) – chexiyalik fizikimyogar. Polyarografik analiz usulining asoschilaridan biri
- van Gelmont Yan Baptist (1574 – 1644) – gollandiyalik tabiatshunos, yadrokimyoning ko'zga ko'ringan namoyandalaridan biri. "Gaz" atamasining muallifi
- Gibbs Jozayya Uillarda (1839 – 1903) – amerikalik fizik, termodinamika va statistik mexanikaning asoschilaridan biri. Termodinamik qator tenglamalarni chiqardi
- Goppelsryoder potentsiallar nazariyasini ishlab chiqdi, fazalar qoidasini kashf etdi
- Kristof Frederik (1837 – 1919) – shveysariyalik kimyogar. Kapillyar analizga oid ko'p sonli ishlar muallifi
- Gofman (Hoffman) Avgust Vilgelm (1818 – 1892) – nemis kimyogari, Yu.Libix shogirdi. Asosan azot va fluor saqllovchi organik birikmalar va alkaloidlar ustida tadqiqotlar olib bordi

- Gofman Fridrix (1660 – 1743) – gollandiyalik shifokor. Analitik va farmasevtik kimyo bo'yicha turli tadqiqotlar muallifi. Tabiiy suvlar analizini o'tkazdi
- Grotgus Kristian Iogann Ditrix fon (1785 – 1822) – fizik va kimyogar olim. Elektroliz nazariyasini ishlab chiqdi va fotokimyo qonunini kashf qildi (Grotgus-Dreyper qonuni)
- Juldberg K. Maksimilian (1836 – 1902) – skandinaviyalik matematik. P. Vaage bilan birgalikda massalar ta'siri qonunini ta'rifladi
- Dalton Jon (1766 - 1844) – ingliz kimyogari va fiziki, kimyoviy atomizm ta'limotining asoschisi. Karrali nisbatlar qonunini kashf etdi, "atom og'irligi" tushunchasini fanga kiritdi, bir qator elementlarning atom massalarini aniqladi
- Dekruazil Fransua Antuan Anri (1751 – 1825) – fransuz kimyogarmuxandisi. Kislota va ishqorlarning hajmiy analiz usullarini ishlab chiqdi
- Devi Gemfri (1778 – 1829) – ingliz kimyogari va fiziki. Elektrokimyoning asoschilaridan biri, elektroliz yordamida bir qator elementlarni ajratib oldi
- Dyubosk Jyul (1817 – 1886) – fransuz olimi. Spektroskopni mukammallashtirdi
- Dyulong Pyer Lui – fransuz fiziki va kimyogari. A. Pti bilan birgalikda issiqlik sig'imi qonunini kashf etdi, katerometrni ixtiro qildi
- Dyuma Jan Batist (1800 – 1884) – fransuz kimyogari, organik kimyo asoschilaridan biri. Azot bug'lari va organik birikmalar zichligini aniqlash usullarini taklif etdi
- Jeyms A. – gaz-suyuqlik taqsimlanish xromatografiyasini ichlab chiqdi
- Jobir ibn Xayyon (taxminan 721 – 815) – arab alkimyogari. Ko'psonli kimyoviy jarayonla tavsiflangan alkimyoga oid asarlar muallifi
- Joffrua Klod Jozef (1685 – 1752) – fransuz kimyogari. Turli tabiiy birikmalar analizini o'tkazdi, novshdil tarkibini aniqladi
- Kavendish Genri (1731 – 1810) – ingliz fiziki va kimyogari. Ko'pgina gazlarning xossalarini o'rgandi, vodorodni kashf etdi, havo tarkibini va suvning kimyoviy tarkibini aniqladi

- Kannitssaro Stanislao (1826 – 1910) – italiyalik kimyogar. Atom-molekulyar nazariyaning asoschilaridan biri. “Atom”, “ekvivalent” va “molekula” tushunchalarini asoslab berdi
- Kekule Fridrix Avgust (1829 – 1896) – nemis kimyogari. Organik birikmalar tuzilishi nazariyasiga oid asarlar muallifi. Organik birikmalarda uglerod to‘rt valentli bo‘lishini ko‘rsatdi va benzolning xalqasimon formulasini taklif qildi
- Kirxgof Gustav Robert (1824 – 1887) – nemis kimyogari. R. Bunzen bilan hamkorlikda spektral analiz usuliga asos soldi. Nurlanish qonunini asoslab berdi va absolyut qora jism tushunchasini kiritdi
- Klassen Aleksandr (1843 – 1934) – nemis analitik-kimyogari
- Koltgof Isaak (1894 –) – amerikalik kimyogar-analitik. Konduktometrik va potensiomertik titrlash, indikatorlar nazariyasi, hajmiy analiz bo‘yicha bir qator ishlar muallifi
- Kruks Uilyam (1832 – 1919) – ingliz fiziki va kimyogari. Gazlardagi elektr razryadlar va katod nurlarini tadqiq qildi. Sintillyatsiya hodisasini ochdi, spintariskopni yaratdi
- Kun Rixard (1900 – 1967) – nemis biokimyogari. O‘simlik pigmentlari (karatinoidlar) va vitaminlar kimyosi bo‘yicha fundamental tadqiqotlar muallifi. Nobel mukofoti sovrindori
- Kyeldal Iogann Gustav (1849 – 1900) – daniyalik kimyogar. Uning nomi bilan ataladigan azotni aniqlash usulini yaratdi
- Lavuazye Antuan Loran (1743 – 1794) – fransuz kimyogari. zamonaviy kimyoning asoschilaridan biri. Kimyoviy birikmalarning ratsional nomenklaturasini ishlab chiqdi. Termokimyoga asos soldi
- Lambert Iogann Genrix (1728 – 1777) – nemis olimi, fotometriyaning asoschilaridan biri
- Levenguk Antoni van (1632 – 1729) – gollandiyalik tabiatshunos. ilmiy mikroskopiyaning asoschilaridan biri, 300 marta kattalashtiruvchi linzalarni yaratdi
- Libix Yustus (1803 – 1873) – nemis kimyogari. Bir qator organik birikmalarni sintez qildi, izomeriyani kashf etdi
- Lovits Tovi Yegorovich (1757 – 1804) – rus kimyogari. Yog‘och ko‘mirida erigan moddalarning adsorбилanishini kashf etdi. Spirt va suv aralashmasining solishtirma og‘irliklarini aniqladi. O‘ta to‘yingan eritmalar tushunchasini fanga kiritdi

- Lokyer Jozef Norman (1836 – 1920) – ingliz astronomi. Astrospektroskopiyaning asoschilaridan biri. Quyosh spektrlarini oʻrganish davrida geliyni kashf qildi
- Lomonosov Mixail Vasilyevich (1711 – 1865) – rus olimi. Tabiiy fanlar, tarix, metallurgiya va boshqa sohalarida faoliyat koʻrsatdi. Atom-molekulyar taʼlimot asoschisi va massalar saqlanish qonunining kashfiyotchisi
- Marggraf Andreas Sigizmund (1709 – 1782) – nemis kimyogari. Mikroskop yordamida tuzlar va minerallar tarkibini tadqiq etdi. Shaker kristallarini olishga erishdi
- Martin Archer Jon Porter (1910 –) – ingliz biokimyogari va fizikimyogari. Taqsimlanish xromatografiyasi: qogʻozda (R. Sing bilan hamkorlikda) va gaz-suyuqlik (N. Jeyms bilan hamkorlikda) usullarini ishlab chiqdi. Nobel mukofoti sovrindori
- Marsh Jeyms (1794 – 1846) – ingliz kimyogari, mishiyni aniqlash usulini ishlab chiqdi
- Mitcherlix Elxard (1794 – 1863) – nemis kimyogari. Izomorfizm va dimorfizm hodisalarini kash etdi
- Monye Lyudvig (1879 –) – nemis analitik-kimyogari
- Mor Karl Fridrix (1806 – 1879) – nemis kimyogari. Analizning bir qator usullarini ishlab chiqdi; analitik ishlar uchun bir nechta asboblarni yaratdi
- Nernst Valter (1864 – 1941) – nemis fizikimyogari, zamonaviy fizik kimyoning asoschilaridan biri. Elektrod potentsiallar qiymatini aniqlash tenglamasini yaratdi. Nobel mukofoti sovrindori
- Nessler Yulius (1827 – 1905) – nemis kimyogari. Bir nechta analitik usullarni ishlab chiqdi. Uning nomi bilan ataladigan reagentni oldi
- Ostvald Vilgelm Fridrix (1853 – 1932) – nemis fizikimyogari va faylasufi. Elektrolitlar nazariyasi, kimyoviy kinetika va katalizga oid fundamental asarlar muallifi. Nobel mukofoti sovrindori
- Panet Fridrix Adolf (1887 – 1958) – nemis kimyogari. Meteoritlar tadqiqotchisi, ulardagi geliy miqdorini aniqlash usullarini ishlab chiqdi. Fayans-panet qoidasining mualliflaridan biri
- Regl Frits (1869 – 1930) – avstriyalik kimyogar. Organik birikmalarning miqdoriy mikroanalizi usuliga asos soldi. Nobel mukofoti sovrindori

- Pungor (Pungor) erne (1923 –) – vengriyalik kimyogar. Analizning instrumental usullari va ion-selektiv membranali elektrod(larga oid bir qator ishlar muallifi; ossillometrik, fotometrik, polyarografik va potensiomertik analizning yangi usullarini ishlab chiqdi
- Pfaff (Pfaff) Kristian Genrix (1773 – 1852) – nemis fiziki va kimyogari. Ikki tomli «Analitik kimyo darsligi»ning muallifi
- Pfeffer (Pfeffer) Vilgelm (1845 – 1920) – nemis fiziologi. Kosmos hodisalari va ularning o‘simliklar fiziologiyasidagi ahamiyatini o‘rgandi
- Raul (Raoult) Fransua Mari (1830 – 1901) – fransuz fizigi va kimyogari. Eritmalarning fizik-kimyoviy xossalari(ni tadqiq etdi, uning nomi bilan ataladigan qonunlarni kashf etdi
- Rixter (Richter) Ieremiya Veniamin (1762 – 1807) – nemis kimyogari. Ekvivalentlar qonunini kashf etdi, «stexiometriya» tushunchasini kiritdi
- Roze (Rose) Genri (1795 – 1864) – nemis kimyogari. Sifat analizning vodorod sulfidli usulini va miqdoriy analizning bir qator usullarini ishlab chiqdi, niobiyni kashf etdi
- Roze (Rose) Gustav (1798 – 1873) – nemis mineralogi va kristallografi. Minerallarning kristallokimyoviy klassifikatsiyasini taklif etdi
- Rosko (Roscoe) Genri enfield (1833 – 1915) – ingliz kimyogari. R. Bunzen bilan birga fotokimyo qonunlaridan birini kashf etdi (Rosko – Bunzen qonuni). Vanadiyni kashf etdi
- Runge (Runge) Fridlib Ferdinand (1795 – 1867) – nemis kimyogari. Qog‘oz xromatografiyasining asoschisi hisoblanadi
- Reley (Rayleigh) (1842 – 1919) – ingliz fizigi, London qirollik jamiyatining a‘zosi va uning prezidenti. Nurning molekulyar tarqalish, akustika, tebranish nazariyalarining muallifi. U. Ramzay bilan hamkorlikda argonni kashf etdi. Nobel mukofoti sovrindori
- Sabadvari (Szabadvary) Ferenc – vengriyalik kimyo tarixi mutaxassisi
- Syorensen (Sørensen) Syoren Peter Lauri (1868 – 1939) – daniyalik fizikimyogar va biokimyogar. Aminokislotalar sintezining umumiy usuli va aminlardagi azotni miqdoriy aniqlash usulini ishlab chiqdi; vodorod ko‘rsatkich (rN) tushunchasini kiritdi
- Sing (Synge) Richard Lorens Milington (1914 –) – ingliz biokimyogari. Taqsimlanish xromatografiyasi usulini ishlab chiqdi

- (A. Martin bilan birgalikda). Oqsillar analitik kimyosiga oid asarlar muallifi. Nobel mukofoti sovrindori
- Svet Mixail Semyonovich (1872 – 1919) – rus fiziologi va botaniki, xromatografiyaning asoschisi. Yashil barglarning pigmentlariga oid tadqiqot ishlarini o‘tkazdi
- Seyze (Zeise) Vilyam Xristofer (1789 – 1847) – nemis farmasevti. Organik bisulfidlar olish usullaridan birini ishlab chiqdi, merkaptanlarni kashf etdi
- Tenar (Thenard) Lui Jak (1777 – 1887) – fransuz kimyogari. Natriy, kaliy va xlor – elementlar ekanligini isbotladi. Vodorod peroksidni olishga erishdi Gey-Lyussak bilan birga borni kashf etdi
- Tennant (Tennant) Smitson (1761 – 1815) – ingliz kimyogari. Osmiy, iridiyni kashf etdi, olmos – bu toza uglerod ekanligini isbotladi, oqartirish usulini ishlab chiqdi
- Turneyser (Thurneysser) Leonard (1530 – 1596) – alkimyogar. Achchiqtoshlar va selitra olish usulini o‘zgartirdi; oltingugurt, tuzlar, simob, sut shakarini tayyorlash usullarini tavsifladi; suvning taxminiy analizini o‘tkazdi
- Uillar (Willard) Gobard Gerd (1881 –) – amerikalik kimyogar-analitik
- Faradey (Faraday) Maykl (1791 – 1867) – ingliz fiziki, elektromagnit maydon ta’limotining asoschisi. elektr tokining kimyoviy ta’sirini tadqiq etdi, elektr va magnetizm, magnetizm va yorug‘lik orasidagi bog‘liklarni ochdi. Elektromagnit induksiyani kashf etdi. elektroliz qonunlarini o‘rnatdi. elektromagnit to‘lqinlar mavjudligini oldindan bashorat qildi
- Fayans (Fajans) Kazimir – amerikalik fizikimyogar. Radiokimyo, eritmalar nazariyasi, adsorbsiyaga oid asarlar muallifi. Fayans – Panet qoidasini o‘rnatdi
- Fisher (Fischer) emil German (1881 – 1945) – nemis organik-kimyogari, tabiiy birikmalar kimyosining asoschisi. Purin hosilalarini sintezladi va ularning tuzilishini tadqiq etdi. Nomenklaturani fanga kiritdi, rasional klassifikatsiyani tuzdi va ko‘pgina uglevodorodlarni sintezladi. Oqsillar kimyosiga oid fundamental tadqiqotlarni o‘tkazdi. Nobel mukofoti sovrindori

- Folin (Folin) Otto (1867 – 1934) – amerikalik biokimyogar. Endogen va ekzogen metabolizm nazariyasining muallifi; mochevina va azotni aniqlashning yangi mikro usullarini amaliyotga kiritdi
- Fontana (Fontana) Feliche (1720 – 1805) – italiyalik tabiatshunos. Gazlar hajmini o'ldirish uchun maxsus apparatlarni qo'lladi; suv gazini kashf etdi
- Fraunhofer (Fraunhofer) Yozef (1787 – 1826) – nemis fiziki. Linzalar, difraksiya panjaralarni tayyorlash usullarini takomillashtirdi. Uning nomi bilan ataluvchi spektr chiziqlarini kashf etdi
- Frezenius (Fresenius) Karl Remigius (1818 – 1897) – nemis kimyogar-analitik; Visbadendagi analitik laboratoriyani tashkil etdi, bevosita analitik kimyoga bag'ishlangan birinchi ilmiy jurnalga asos soldi. Kationlarni analitik guruhlariga ajratishni amalga oshirdi
- Fuks (Fuchs) Iogann (1774 – 1856) – nemis kimyogari va mineralogi. Natriy silikat (eruvchan shisha), fuksitni kashf etdi; sement, seolitlarni tadqiq etdi; «amorf» va «qotuvchi suyuqliklar» tushunchalarini kiritdi
- Xassel (Hassel) Odd (1897 – 1981) – norvegiyalik kimyogar, koformatsion analiz asoschilaridan biri. Rentgenografiya va elektronografiya usullari yordamida siklogeksan va uning hosilalari tuzilishini tadqiq etdi. Nobel mukofoti sovrindori
- Xeveshi (Hevesy) Derd (Georg) (1885 – 1966) – vengriyalik radiokimyogar. Kimyoviy va biokimyoviy jarayonlarni o'rganishda birinchi marta izotoplarni qo'lladi. Hamkasblari bilan birgalikda gafniyni kashf etdi. Nobel mukofoti sovrindori
- Xempel (Hempel) Valter (1851 – 1916) – nemis kimyogar-analitik
- Chugaev Lev Aleksandrovich (1873 – 1922) – rus kimyogari, kompleks birikmalar kimyosi bo'yicha ilmiy maktab asoschisi. Nikelni aniqlash uchun reagentni kashf etdi (CHugaev reaktivi). Uglevodorodlar sintezining usulini ishlab chiqdi (CHugaev reaksiyasi). Terpenlar kimyosiga oid asarlar muallifi
- Sheele (Scheele) Karl Vilgelm (1742 – 1786) – shved kimyogari. Ko'pgina anorganik va organik moddalar, jumladan, xlor, kaliy permanganat, glitserin, sianid kislota, bir qator organik kislotalarni olishga erishi. Havoning murakkab tarkibini isbotladi.

Shenbayn (Schönbein) Xristian Fridrix (1799 – 1868) – nemis kimyogari. Ozonni kashf etdi, piroksilinni sintezladi

Shtaudinger (Staudinger) German (1881 – 1965) – nemis kimyogari, yuqori molekulyar birikmalar kimyosining asoschilaridan biri, Polimerlar katta molekulalardan tarkib topishini isbotladi. «Makromolekula» atamasini fanga kiritdi, polimer tuzilishi nazariyasini ishlab chiqdi. Ko'pgina tabiiy va sintetik polimerlarni tadqiq etdi. Nobel mukofoti sovrindori

Yung (Young) Tomas (1773 – 1829) – ingliz olimi. Yorug'likning to'liq nazariyasini asoslab berdi. Interferensiya prinsipini ifodaladi, gazlarning akkomodatsiyasini tushuntirdi, modulini kiritdi (YUng moduli). Akustika, astronomiyaga oid asarlar muallifi

Yander (Jander) Gerxard (1862 – 1961) – nemis kimyogari. Suvsiz erituvchilar tadqiqotchisi

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M. R. Amonov, G'. Q. Shirinov

**ANALITIK
KIMYO
SXEMA VA JADVALLARDA
O'QUV QO'LLANMA**

Toshkent - "Innovatsiya-Ziyo" - 2020

Muharrir: F. Xolsaidov

Texnik muharrir: Q. Mamiraliyev

Nashriyot litsenziyasi AI №023, 27.10.2018.

Bosishga 30.11.2020. da ruxsat etildi. Bichimi 60x84.

"Times New Roman" garniturasini.

Ofset bosma usulida bosildi.

Shartli bosma tabog'i 18. Nashr bosma tabog'i 17,8

Adadi 300 nusxa.

"Innovatsiya-Ziyo" MCHJ matbaa bo'limida chop etildi.

Manzil: Toshkent shahri, Farhod ko'chasi, 6-uy.

ISBN 978-9943-7025-6-1



9 789943 702561