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

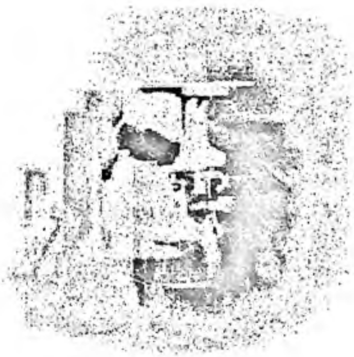
ANALITIK KIMYO SXEMA VA JADVALLARDA

O‘ZBEKISTON RESPUBLIKASI
OLIY 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: 74.200.526
A 95

M.R. Amonov, G'.Q. Shirinov
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:
M.S. Sharipov — t.f.nomzodi, dotsent (BuxDU Kimyo kafedrasi)
M.A. Tursunov — kimyo fanlari bo'yicha falsafa doktori (PhD)
V.N. Axmedov — t.f.nomzodi, dotsent (BMTI Tabiiy fanlar kafedrasi)

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

KIRISH

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

Har qanday fanni mukammal o'zlashtirishga yordam beruvchi omillardan biri o'qitishning ko'rgazmali bo'lishidir. Analitik kimyoni o'rganishda kimyoviy analizga tegishli turli hisoblash usullariga juda ko'p vaqt ajratiladi. Bu usullar, asosan, talabalarning mustaqil ishlari orqali o'rganiladi va turli ma'lumotnoma materiallarining bo'lishini talab etadi. Analitik kimyo bo'yicha o'zbek tilida yozilgan ma'lumotnomalar yo'q. Shuni inobatga olib, ushbu ma'lumotnoma yaratildi.

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 atamalarning qisqa lug'ati hamda analitik kimyoning rivojlanishiga o'z hissasini qo'shgan olimlar haqida ma'lumotlar keltirilgan.

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

SIFAT ANALIZI

1-jadval

ZAMONAVIY ANALITIK KIMYONING TUZILISHI

Analitik kimyo –
moddalarning kimoviy tarkibi va tuzilishini aniqlash uchun qo'llaniladigan analiz usullari va vositalari haqidagi fandir

Sifat analizi
Analiz qilinadigan ob'yekt qanday tarkibiy qismlardan iboratligi, tuzilishi, uning tarkibida qanday funksional guruhlar borligi kabi masalalarni yechadi

Miqdoriy analiz
Analiz qilinadigan ob'yekt tarkibiga kirgan barcha yoki ayrim komponentlarning miqdori to'g'risidagi masalalarni yechadi

Analiz turlari

1. Element analiz – namunaning element tarkibini aniqlash
2. Moddiy analiz – analiz qilinadigan komponentning bor yoki yo'qligini aniqlash
3. Funksional analiz – funksional guruhlarni aniqlash
4. Molekulyar analiz – kimyoviy birikmalarni aniqlash (masalan, gazlar aralashmasining analizi)
5. Fazali analiz – bir jinsli bo'lmagan obyektdagi (masalan, minerallarda) qo'shimchalar analizi
6. Izotop analizi – sun'iy elementlar tarkibidagi izotoplarni aniqlash

Analitik kimyo usullarining klassifikatsiyasi:

- Kimyoviy
- Fizikaviy
- Fizik-kimyoviy

2-jadval

ANALIZ QILINADIGAN MODDA MIQDORIGA KO'RA ANALIZ USULLARINING KLASSIFIKATSIYASI

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

3-jadval

SIFAT ANALIZINING TURLARI

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

4-jadval

ANALITIK REAKSIYALARNING BELGILARI

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

5-jadval

KATIONLARNI ANALITIK KLASSIFIKATSIYALASH USULLARI

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

5.1-jadval

KATIONLARNING VODOROD SULFIDLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

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

* Mg^{2+} dan tashqari

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

5.2-jadval

KATIONLARNING KISLOTA-ASOSLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

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

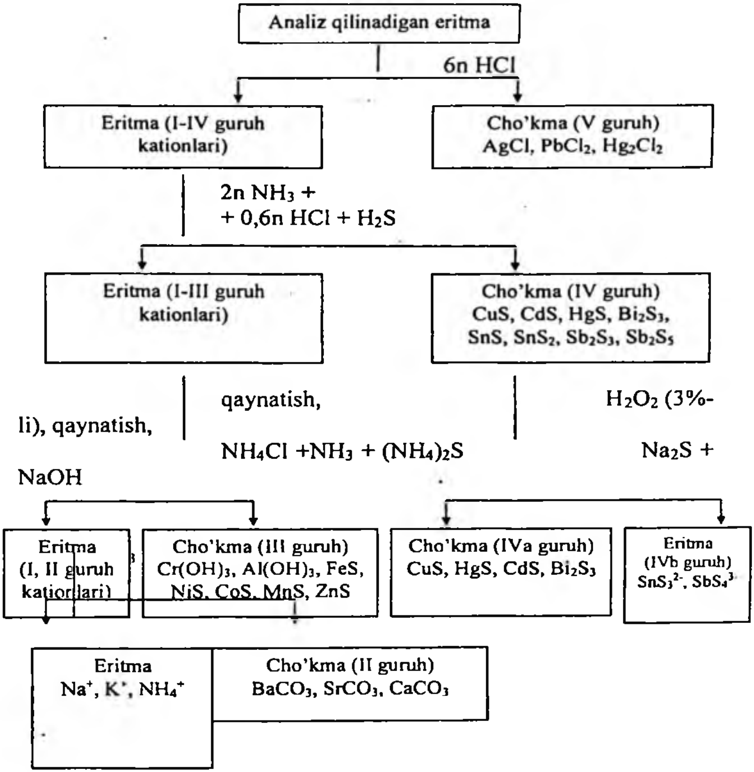
5.3-jadval

KATIONLARNING AMMIAK-FOSFATLI ANALIZ USULI BO'YICHA KLASSIFIKATSIYASI

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

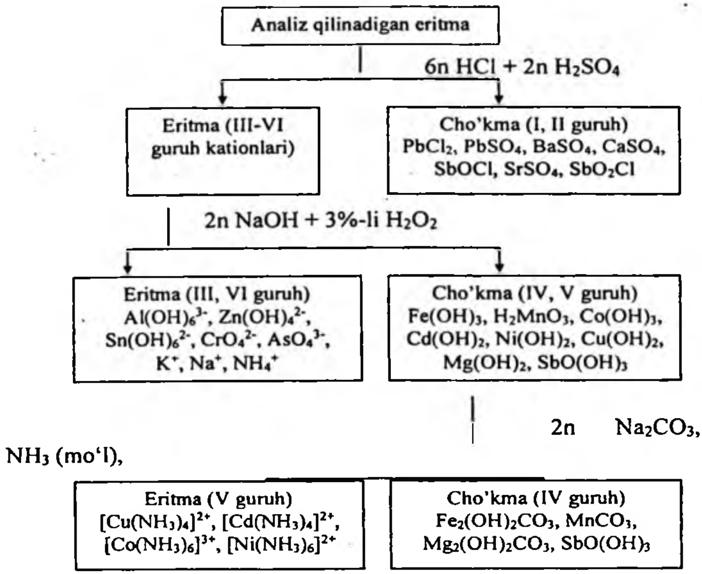
1-sxema

VODOROD SULFIDLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



2-sxema

KISLOTA-ASOSLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH



3-sxema

AMMAK-FOSFATLI ANALIZ USULI BO'YICHA KATIONLARNI GURUHLARGA AJRATISH

Analiz qilinadigan eritma

2n HCl

Eritma (II-V guruh kationlari)

Cho'kma (I guruh) $AgCl$, $PbCl_2$, Hg_2Cl_2

6n HNO_3

Eritma (III-V guruh kationlari)

Cho'kma (II guruh) H_2SnO_3, $HSbO_3$

NH_3(kons., mo'l) + $(NH_4)_2HPO_4$

Eritma (IV va V guruh kationlari)

Cho'kma (III guruh) $Ba_3(PO_4)_2$, $Ca_3(PO_4)_2$, $Sr_3(PO_4)_2$, $MgNH_4PO_4$, $MnNH_4PO_4$, $Fe_3(PO_4)_2$, $AlPO_4$, $FePO_4$, $CrPO_4$, $BiPO_4$

2n

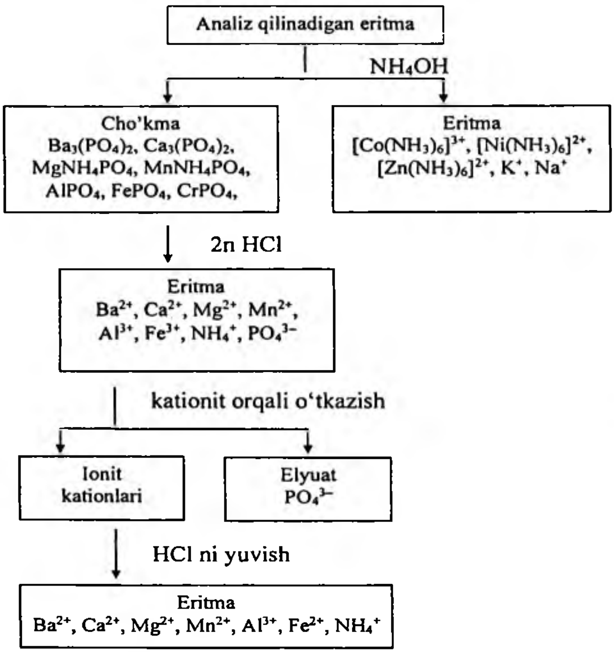
CH_3COOH

Eritma (IIIa guruh) Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, Mn^{2+}, Fe^{2+}

Cho'kma (IIIb guruh) $FePO_4$, $AlPO_4$, $CrPO_4$, $BiPO_4$

4-sxema

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



6-jadval

I ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

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

6-jadvalning davomi

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

7-jadval

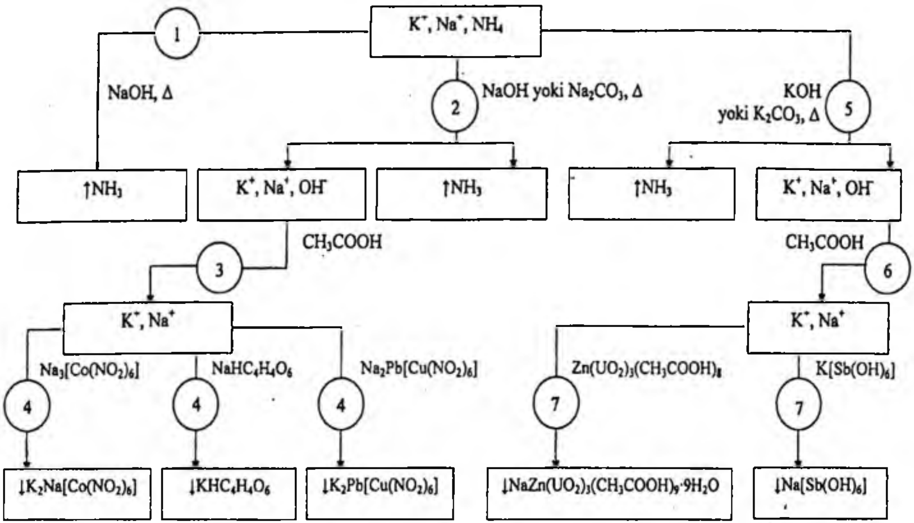
I. ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

K^+, Na^+, NH_4^+

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

5-sxema

I ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



8-jadval

II ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

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

8-jadvalning davomi

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

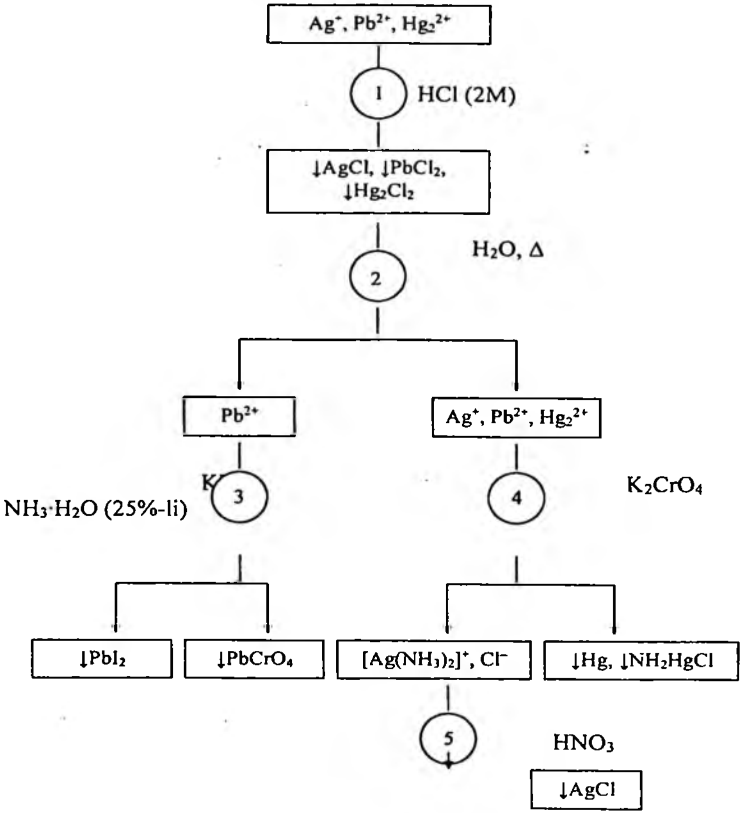
II. ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

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

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

6-sxema

II ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



10-jadval

III ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

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

10-jadvalning davomi

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

11-jadval

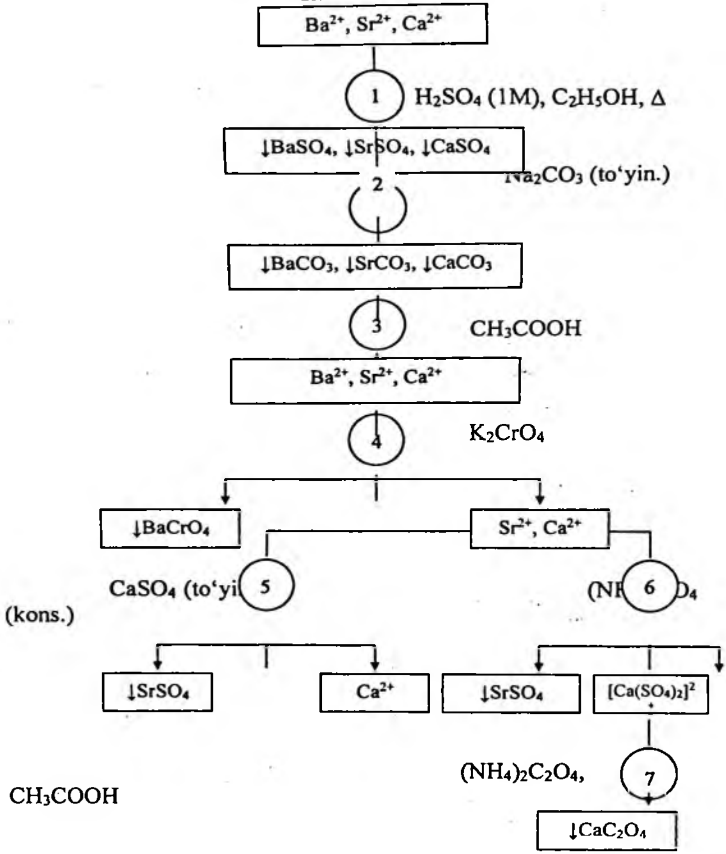
III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

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

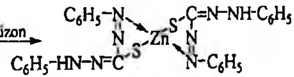
Bosqichning t/r	Analiz bosqichlari
1	C_6H_5OH ishtirokida qizdirib, 1,0 M H_2SO_4 ta'sir ettirib, III analitik guruh kationlarini cho'ktirish: $Ba^{2+} \xrightarrow{H_2SO_4,\Delta} BaSO_4\downarrow \quad EK_{BaSO_4} = 1{,}1\cdot 10^{-10}$ $Sr^{2+} \xrightarrow{H_2SO_4,\Delta} SrSO_4\downarrow \quad EK_{SrSO_4}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

7-sxema

III ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



12-jadvalning davomi

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

12-jadvalning davomi

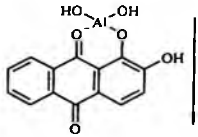
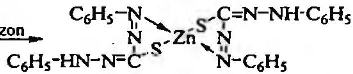
Sn^{2+}	$Bi(OH)_3$	$3Na_2SnO_2 + 2Bi(OH)_3\downarrow = 2Bi\downarrow + 3Na_2SnO_3 + 3H_2O$ $3SnO_2^{2-} + 2Bi(OH)_3 = 2Bi\downarrow + 3SnO_3^{2-} + 3H_2O$	Metall holdagi vismut ajralib chiqadi (bu reaksiyadan Bi ni topishda ham foydalaniladi)
Sn^{IV}	NaOH (KOH)	$SnCl_4 + 4NaOH = H_4SnO_4\downarrow +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

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

IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

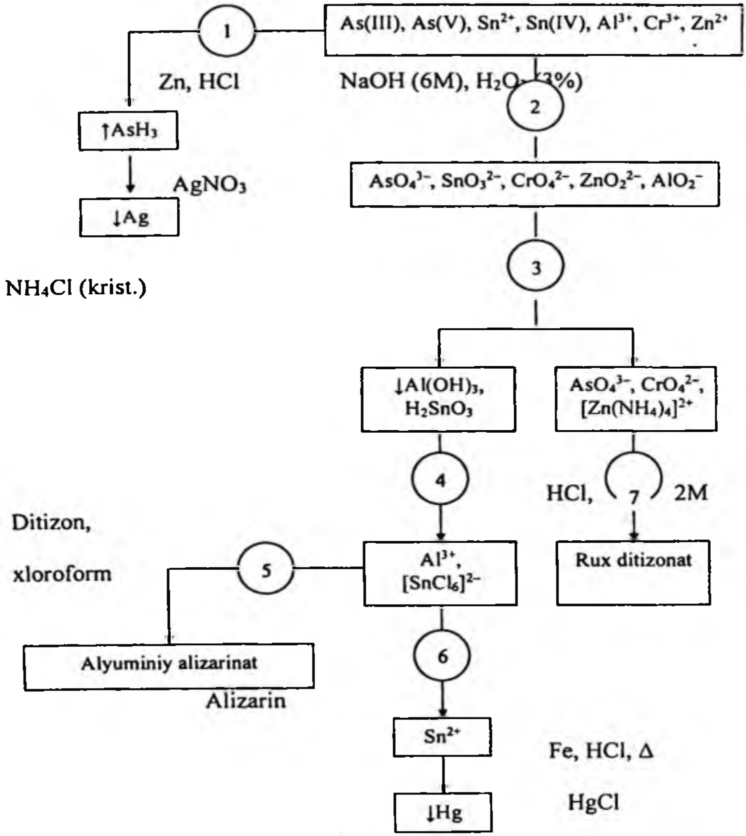
Al^{3+}, Zn^{2+}, Cr^{3+}, Sn^{2+}, Sn(IV), As(III), As(V)

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

	$[Sn(OH)_6]^{2-} \xrightarrow{NH_4Cl,\ \Delta} Sn(OH)_4\downarrow$
4	2M HCl ta'sirida 3 cho'kmani eritish: $Al(OH)_3\downarrow \xrightarrow{HCl} Al^{3+}$ $Sn(OH)_4\downarrow \xrightarrow{HCl} [SnCl_6]^{2-}$
5	5 ertimaga alizarin yoki natriy atsetat ta'sir ettirib, Al^{3+} ionlarini topish: $Al^{3+} \xrightarrow{alizarin,\ NaOH}$  $Al^{3+} \xrightarrow{CH_3COONa} Al(OH)_2CH_3COO\downarrow$
6	HCl muhitida temir qirindilari bilan qaynatilgan 4 eritmaga simob (II) tuzini ta'sir ettirib, Sn(IV) ionlarini aniqlash: $[SnCl_6]^{2-} \xrightarrow{Fe,\ HCl,\ \Delta} Sn^{2+} \xrightarrow{HgCl_2} Hg\downarrow$
7	3 sentrifugatga ditizon yoki $K_4[Fe(CN)_6]$ eritmasi ta'sir ettirib Zn^{2+} kationlarini topish: $[Zn(NH_3)_4]^{2+} \xrightarrow{ditizon}$  $[Zn(NH_3)_4]^{2+} \xrightarrow{K_4[Fe(CN)_6]} K_2Zn_3[Fe(CN)_6]_2\downarrow$

8-sxema

IV ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



14-jadval

V ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

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

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

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

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

15-jadval

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

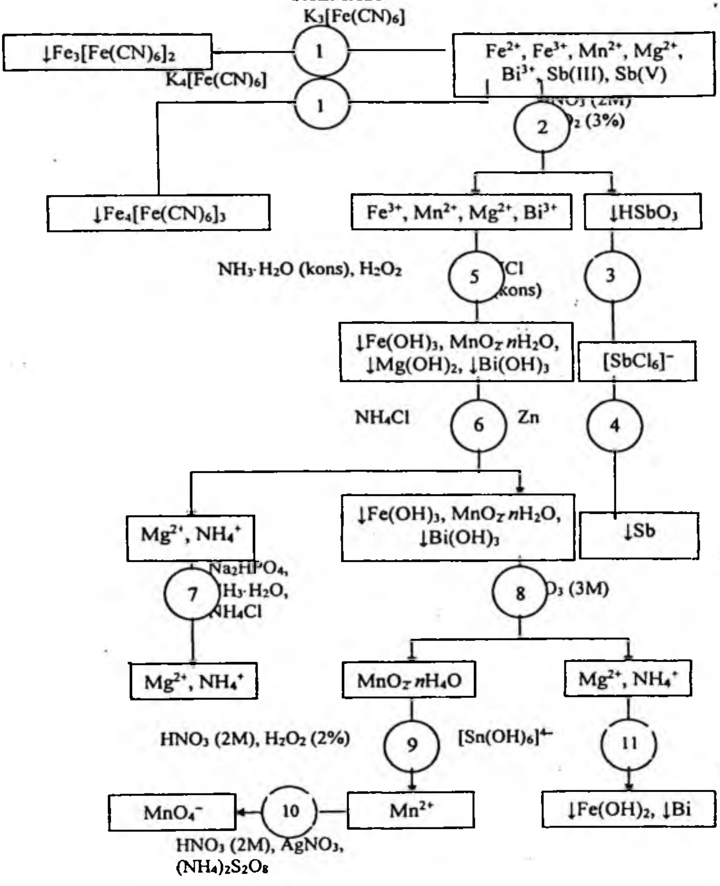
Mg^{2+}, Mn^{2+}, Fe^{2+}, Fe^{3+}, Bi^{3+}, Sb(III), Sb(V)

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

	6 cho‘kma tarkibi: $MnO_2 \cdot nH_2O\downarrow$, $BiONO_3\downarrow$, $Fe(OH)_3\downarrow$
7	6 sentrifugatga ammiakli bufer eritma ishtirokida $NaHPO_4$ ta'sir ettirib, Mg^{2+} kationlarini aniqlash: $$Mg^{2+} \xrightarrow{Na_2HPO_4,\ NH_3 \cdot H_2O + NH_4Cl} MgNH_4PO_4\downarrow$$
8	6 cho‘kmaga HNO_3 eritmasi ta’sir ettirib, Bi^{3+} va Fe^{3+} kationlarini ajratish: $$BiONO_3\downarrow \xrightarrow{HNO_3} Bi^{3+}$$ $$Fe(OH)_3\downarrow \xrightarrow{HNO_3} Fe^{3+}$$ cho‘kma $MnO_2 \cdot nH_2O\downarrow$
9	8-bosqich bo‘yicha olingan cho‘kmani H_2O_2 ishtirokida HNO_3 eritmasi ta’sir ettirib, eritish: $$MnO_2 \cdot nH_2O\downarrow \xrightarrow{HNO_3,\ H_2O_2} Mn^{2+}$$
10	9 eritmaga $(NH_4)_2S_2O_8$ ta’sir ettirib, Mn^{2+}kationlarini aniqlash: $$Mn^{2+} \xrightarrow{(NH_4)_2S_2O_8;\ HNO_3;\ AgNO_3} MnO_4^-$$
11	8 sentrifugatga yangi tayyorlangan $[Sn(OH)_6]^{4-}$ ta’sir ettirib, Bi^{3+} ionlarini topish: $$Bi^{3+} \xrightarrow{[Sn(OH)_6]^{4-}} Bi\downarrow$$

9-sxema

V ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



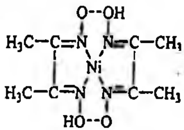
16-jadval

VI ANALITIK GURUH KATIONLARINING XUSUSIY REAKSIYALARI

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

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

16-jadvalning davomi

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

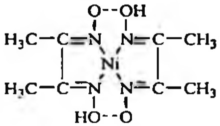
17-jadval

VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ BOSQICHLARI

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

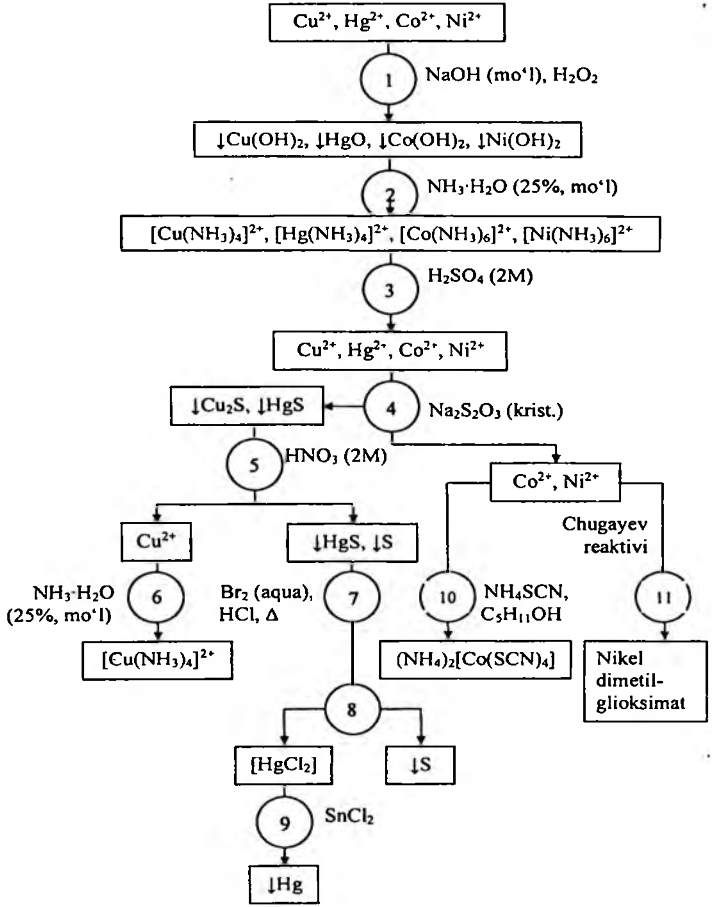
osqichning t/r	Analiz bosqichlari
1*	IV analitik guruh kationlarining guruh reagenti (mo'l $NH_3 \cdot H_2O$ bilan o'zaro ta'siri: $Cu^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$ $Hg^{2+} \xrightarrow{\text{mo'l } NH_3 \cdot H_2O} [Hg(NH_3)_4]^{2+}$ $Co^{2+} \xrightarrow{\text{mo'l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

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

7	Sentrifugalab S↓ dan $[HgCl_2]$ ni ajratish.
8	$SnCl_2$ ta'sirida 7 sentrifugatdan Hg^{2+} ionlarini topish $[HgCl_2] \xrightarrow{SnCl_2} Hg\downarrow$
9	Amil spirti ishtirokida NH_4SCN ta'sir ettirib, 3 sentrafugatdan Co ionlarini topish: $Co^{2+} \xrightarrow{NH_4SCN} (NH_4)_2[Co(SCN)_4]$
10	Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, sentrifugatdan Ni^{2} ionlarini topish Ni $\xrightarrow{dimetilglioksim}$ 

10-sxema

VI ANALITIK GURUH KATIONLARINING SISTEMATIK ANALIZ SXEMASI



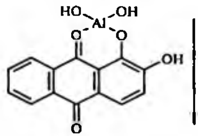
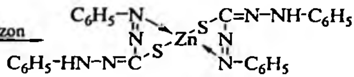
18-jadval

I – VI ANALITIK GURUH KATIONLARI ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

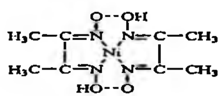
Bosqichning t/r	Analiz bosqichlari
1	Alohida namunadagi NH_4 ionlarini ishqor ta'sir ettirib, qizdirib topish: $NH_4^+ \xrightarrow{NaOH,\ \Delta} NH_3\uparrow$
2	Alohida namunaga $K_3[Fe(CN)_6]$ eritmasi ta'sir ettirib, temir(II) ionlarini topish: $Fe^{2+} \xrightarrow{K_3[Fe(CN)_6]} Fe_3[Fe(CN)_6]_2\downarrow$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

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

14	III analitik guruh kationlari aralashmasining sistematik analiz bosqichlari sxemasi bo'yicha 13 cho'kmani analiz qilish.
15	3 % li H_2O_2 ishtirokida mo'l 6M NaOH eritmasi ta'sir ettirib, IV guruh kationlarini V, VI analitik guruh kationlaridan ajratish: $Al^{3+} \xrightarrow{NaOH} Al(OH)_3\downarrow \xrightarrow{mo'l\ NaOH} [Al(OH)_6]^{3-}$ $Zn^{2+} \xrightarrow{NaOH} Zn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH} [Zn(OH)_4]^{2-}$ $Cr^{3+} \xrightarrow{NaOH} Cr(OH)_3\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} CrO_4^{2-}$ $Sn^{2+} \xrightarrow{NaOH} Sn(OH)_2\downarrow \xrightarrow{mo'l\ NaOH,\ H_2O_2,\ \Delta} [Sn(OH)_6]^{2-}$ $Sn(IV) \xrightarrow{NaOH} Sn(OH)_4\downarrow \xrightarrow{mo'l\ NaOH} [Sn(OH)_6]^{2-}$ $As(III) \xrightarrow{NaOH} AsO_3^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_4^{3-}$ $As(V) \xrightarrow{NaOH} AsO_4^{3-} \xrightarrow{H_2O_2,\ \Delta} AsO_4^{3-}$ Bunda V, VI analitik guruh kationlari cho'kmalar hosil qiladilar: $Fe(OH)_3$, $Mg(OH)_3$, $MnO_2 \cdot nH_2O$, BiOCl, SbO_2Cl, $Cu(OH)_2$, HgO, $Ni(OH)_2$, $Co(OH)_3$.
16	15 sentrufugatning alohida ulushiga HCl muhitida ruh metali ta'sir ettirib, As(V) ionlarini topish (topishga Sb(III), Sb(V) ionlari halaqit beradi): $As\ (III),\ (V) \xrightarrow{Zn;\ HCl} AsH_3\uparrow$ $AgNO_3$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ $Ag\downarrow$ (qora) (Gutsayt reaksiyasi) $[HgCl_2]$ bilan namlangan qog'oz $\xrightarrow{AsH_3\uparrow}$ (Zanger-Blek reaksiyasi) $AsH_2(HgCl)\downarrow$ $AsH(HgCl)_2\downarrow$ $As(HgCl)_3\downarrow$ $As_2Hg_3\downarrow$ (sarg'ish-qo'ng'ir)
17	Qizdirilganda NH_4Cl kristallari ta'sirida 15 sentrifugatdan $[Al(OH)_6]^{3-}$, $[Sn(OH)_6]^{2-}$ gidroksoanionlarni ajratish: $[Al(OH)_6]^{3-} \xrightarrow{NH_4Cl,\ \Delta} Al(OH)_3\downarrow$ $[Sn(OH)_6]^{2-} \xrightarrow{NH_4Cl,\ \Delta} Sn(OH)_4\downarrow$
18	2 M HCl ta'sirida 17 cho'kmani eritish:

	$Al(OH)_3\downarrow \xrightarrow{HCl} Al^{3+}$ $Sn(OH)_4\downarrow \xrightarrow{HCl} [SnCl_6]^{2-}$
19	18 sentrfugatga alizarin yoki natriy atsetat eritmalari ta'sir ettirib, Al^{3+} ionlarini topish: $Al^{3+} \xrightarrow{\text{alizarin, NaOH}}$  $Al^{3+} \xrightarrow{CH_3COONa} Al(OH)_2CH_3COO\downarrow$
20	HCl muhitida temir qirindilari bilan qaynagan 18 eritmaga simob (II) tuzi eritmasi ta'sir ettirib, Sn(IV) ionlarini topish: $[SnCl_6]^{2-} \xrightarrow{Fe, HCl; \Delta} Sn^{2+} \xrightarrow{HgCl_2} Hg\downarrow$
21	17 sentrifugatga ditizon yoki $K_4[Fe(CN)_6]$ eritmasi ta'sir ettirib, Zn^{2+} kationlarini topish: $[Zn(NH_3)_4]^{2+} \xrightarrow{\text{ditizon}}$  $[Zn(NH_3)_4] \xrightarrow{K_4[Fe(CN)_6]} K_2Zn_3[Fe(CN)_6]_2\uparrow$
22	15 cho'kmaga H_2O_2 bilan HNO_3 ta'sir ettirib, Sb(V) ionlarini V, VI analitik guruhning boshqa kationlaridan ajratish: $SbO_2Cl \xrightarrow{HNO_3; H_2O_2} HSbO_3\downarrow$ Bunda V, VI guruh kationlarining erimaydigan birikmalari quyidagi kationlarining qaytarilishi bilan eriydi: $MnO_2 \cdot nH_2O\downarrow \xrightarrow{HNO_3; H_2O_2} Mn^{2+}$ $Co(OH)_2\downarrow \xrightarrow{HNO_3; H_2O_2} Co^{2+}$
23	22 cho'kmani HCl eritmasida eritish: $HSbO_3\downarrow \xrightarrow{HCl} [SbCl_6]^-$
24	23 eritmaga nikel plastinkasida rux metali ta'sir ettirib, Sb(V) ion-

	larini ajratish: $[SbCl_6]^- \xrightarrow{Zn} Sb\downarrow$
25	22 sentrifugatga konsetrlangan $NH_3 \cdot H_2O$ ta'sir ettirib, V analitik guruh kationlarini cho'ktirish: $Mg^{2+} \xrightarrow{NH_3 \cdot H_2O} Mg(OH)_2\downarrow$ $Mn^{2+} \xrightarrow{NH_3 \cdot H_2O} Mn(OH)_2\downarrow$ $Fe^{3+} \xrightarrow{NH_3 \cdot H_2O} Fe(OH)_3\downarrow$ $Bi^{3+} \xrightarrow{NH_3 \cdot H_2O} BiONO_3\downarrow$ Bunda VI analitik guruh kationlari ammiakatlar ko'rinishida eritmada qoladi: $Cu(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$ $HgO\downarrow \xrightarrow{NH_3 \cdot H_2O} [Hg(NH_3)_4]^{2+}$ $Co(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Co(NH_3)_6]^{2+}$ $Ni(OH)_2\downarrow \xrightarrow{NH_3 \cdot H_2O} [Ni(NH_3)_6]^{2+}$
26	25 cho'kmaga NH_4Cl+3% li H_2O_2 eritmasi ta'sir ettirib, Mg^{2+} kationlarini ajratish: $Mg(OH)_2\downarrow \xrightarrow{NH_4Cl} Mg^{2+}$ $Mn(OH)_2\downarrow \xrightarrow{3\%\ H_2O_2} MnO_2 \cdot nH_2O\downarrow$ Cho'kma tarkibi: $MnO_2 \cdot nH_2O\downarrow$, $BiONO_3\downarrow$, $Fe(OH)_3\downarrow$
27	27 sentrifugatga ammiakli bufer eritma ishtirokida Na_2HPO_4 ta'sir ettirib, Mg^{2+} ionlarini topish: $Mg^{2+} \xrightarrow{Na_2HPO_4,\ NH_3 \cdot H_2O + NH_4Cl} MgNH_4PO_4\downarrow$
28	26 cho'kmaga HNO_3 eritmasi ta'sir ettirib, Bi^{3+} kationlarini ajratish: $BiONO_3\downarrow \xrightarrow{HNO_3} Bi^{3+}$ $Fe(OH)_3\downarrow \xrightarrow{HNO_3} Fe^{3+}$ Cho'kmada: $MnO_2 \cdot nH_2O\downarrow$
29	28 bosqich bo'yicha olingan $MnO_2 \cdot nH_2O$ cho'kmani H_2O_2 ishtirokida HNO_3 eritmasi ta'sir ettirib eritish: $MnO_2 \cdot nH_2O\downarrow \xrightarrow{HNO_3;\ H_2O_2} Mn^{2+}$
30	29 eritmaga $(NH_4)_2S_2O_8$ ta'sir ettirib, Mn^{2+} ionlarini topish: $Mn^{2+} \xrightarrow{(NH_4)_2S_2O_8;\ HNO_3;\ AgNO_3} MnO_4^-$

31	28 sentrifugatga yangi tayyorlangan $Na_4[Sn(OH)_6]$ ta'sir ettirib, Bi^{3+} ionlarini topish: $Bi^{3+} \xrightarrow{Na_4[Sn(OH)_6]} Bi\downarrow$
32	2 M H_2SO_4 ta'sirida 25 eritmadagi ammiakatlarni parchalash
33	32 eritmaga $Na_2S_2O_3$ ta'sir ettirib, VI analitik guruhning boshqa kationlaridan Cu^{2+} va Hg^{2+} ionlarini ajratish: $Cu^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} Cu_2S\downarrow$ $Hg^{2+} \xrightarrow{Na_2S_2O_3,\ \Delta} HgS\downarrow$
34	Qizdirilganda suyultirilgan HNO_3 ta'sir ettirib, 33 cho'kmadan Cu_2S ni HgS dan ajratish: $Cu_2S\downarrow \xrightarrow{HNO_3;\ \Delta} Cu^{2+}$ Bu sharoitda $HgS\downarrow$ erimaydi.
35	34 sentrifugatga konsentrlangan $NH_3 \cdot H_2O$ ta'sir ettirib, Cu^{2+} ionlarini topish: $Cu^{2+} \xrightarrow{NH_3 \cdot H_2O} [Cu(NH_3)_4]^{2+}$
36	Qizdirilganda HCl ishtirokida bromli suv yoki zar suvi ta'sir ettirib, 34 cho'mani eritish: $HgS\downarrow \xrightarrow{Br_2;\ HCl} [HgCl_2] + S\downarrow$ $HgS\downarrow \xrightarrow{kons\ HNO_3;\ kons\ HCl} [HgCl_2]$
37	36 sentrifugatga $SnCl_2$ eritmasi ta'sir ettirib, Hg^{2+}ionlarini topish: $[HgCl_2] \xrightarrow{SnCl_2} Hg\downarrow$
38	33 sentrifugatga amil spirt ishtirokida NH_4SCN eritmasi ta'sir ettirib, Co^{2+} ionlarini topish: $Co^{2+} \xrightarrow{NH_4SCN} (NH_4)_2[Co(SCN)_4]$
39	33 sentrifugatga Chugayev reaktivi (dimetilglioksim) ta'sir ettirib, Ni^{2+} ionlarini topish: $Ni \xrightarrow{dimeulglioksim}$ 

11-*sxema*

I – VI ANALITIK GURUH KATIONLARI ARALASHMASINING SISTEMATIK ANALIZ SXEMASI

1. Alohida namunalardan NH_4^+, Fe^{2+}, Fe^{3+} kationlarini aniqlash
2. Alohida namunadan NH_4^+ ionlarini Na_2CO_3 yoki NaOH ta'-sirida yo'qotish va eritmadagi K^+ ionlarini aniqlash
3. Alohida namunadan NH_4^+ ionlarini K_2CO_3 yoki KOH ta'si-rida yo'qotish va eritmadagi Na^+ ionlarini aniqlash
4. 2M HCl eritmasi ta'sirida II analitik guruh kationlarini cho'ktirish va olingan cho'kmani tekshirish
5. II analitik guruhni ajratib olgandan so'ng, sentrifugatdan III analitik guruh kationlarini cho'ktirish
6. 5 cho'kmadan $PbSO_4$ ni ajratish va qolgan cho'kmani III analitik guruh kationlari uchun tekshirish
7. 3%-li H_2O_2 eritmasi ishtirokida, 6M NaOH ta'sirida IV guruh kationlarini V va VI guruh kationlaridan ajratish va hosil bo'lgan eritmada ularni aniqlash
8. Sb(V) ionlarini V va VI analitik guruhlarning boshqa kationlaridan ajratish
9. Konsentrlangan $NH_3 \cdot H_2O$ eritmasi ta'sirida V va VI guruhlarni ajratish (V guruh cho'kmada; VI guruh eritmada)
10. 9 cho'kmani V analitik guruh kationlari uchun tekshirish (Fe^{2+}, Fe^{3+} dan tashqari)
11. 10 eritmani VI analitik guruh kationlari uchun tekshirish

19-jadval

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

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

20-jadval

KUCHLI KISLOTALAR TA'SIRIDA GAZSIMON MAHSULOTLAR HOSIL QILADIGAN ANIONLAR

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

21-jadval

ANIONLARNING OKSIDLANISH-QAYTARILISH XOSSASI BO'YICHA KLASSIFIKATSIYASI

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

22-jadval

I ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

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

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

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

22-jadvalning davomi

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

22-jadvalning davomi

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

23-jadval

II ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI*

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

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

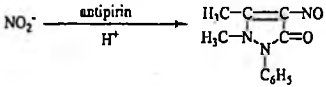
23-jadvalning davomi

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

24-jadval

III ANALITIK GURUH ANIONLARINING XUSUSIY REAKSIYALARI

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

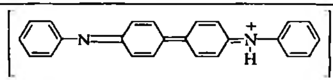
NO_3^-	$FeSO_4$ (kris.)	$6FeSO_4 + 2NaNO_2 + 4H_2SO_4 = 3Fe_2(SO_4)_3 + 2NO +$ $+ 2Na_2SO_4 + 4H_2O$ $6Fe^{2+} + 2NO_3^- + 8H^+ = 6Fe^{3+} + 2NO + 4H_2O$ $NO + Fe^{2+} + SO_4^{2-} = [Fe(NO)SO_4]$	Temir (II)-sulfat kristali atrofida qo'ng'ir xalqa vujudga keladi
NO_2^-	Kislotalar	$2NaNO_2 + 2H_2SO_4 =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

25-jadval

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

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

$C_2O_4^{2-}$	Ca^{2+}	$CaC_2O_4\downarrow$ (oq cho'kma, sirka kislotada eri-maydi)
	MnO_4^- (H_2SO_4 muhitida)	$CO_2\uparrow$ ($KMnO_4$ eritmasi rangsizlanadi)
AsO_4^{2-}	$MgCl_2$ + NH_4OH + NH_4Cl (magnezial aralashma)	$MgNH_4AsO_4\downarrow$ (oq cho'kma)
	Ag^+	$Ag_3AsO_4\downarrow$ (jigarrang, HNO_3 va NH_4OH da eriydi)
	I^- ($CHCl_3$ ishtirokida HCl muhitida)	$[I_3]^-$ – xloroformli qatlamning qizg'ish-bi-nafsha rangi
AsO_3^{2-}	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 HCl muhitida)	$[I_3]^-$ – 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 kis-lotalarda eriydi)
	H_2SO_4, ($SiO_2 \cdot H_2O$)	$H_2SiO_3\downarrow$ (gel)
Cl^-	Ag^+	$AgCl\downarrow$ (oq cho'kma, $(NH_4)_2CO_3$ va NH_4OH da eriydi)
Br^-	Ag^+	$AgBr\downarrow$ (sariq cho'kma, NH_4OH da qisman eriydi)
	Cl_2 ($CHCl_3$ ishtirokida kislotali muhitda)	Br_2 (xloroformli qatlam qo'ng'ir rangga bo'yaladi)

I^-	Ag^+	$AgI\downarrow$ (sariq cho‘kma, NH_4OH da eriydi)
	Cl_2 ($CHCl_3$ ishtirokida kislotali muhitda) mo‘l Cl_2	$[I_3]^-$ – xloroformli qatlam qizg‘ish-binafsha rangga bo‘yaladi. IO_3^- – xloroformli qatlam rangsizlanadi.
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^o	$N_2\uparrow$
CH_3COO^-	H^+	CH_3COOH (sirka hidi)
	C_2H_5OH; H_2SO_4	$CH_3COOC_2H_5$ (olma hidi)
	Fe(III)	$[(CH_3COO)_6Fe(OH)_2]^+$ (qizg‘ish-qo‘ng‘ir rang)

26-jadval

II – VI ANALITIK GURUH KATIONLARINING SODA ERITMASI BILAN REAKSIYALARI

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

27-jadval

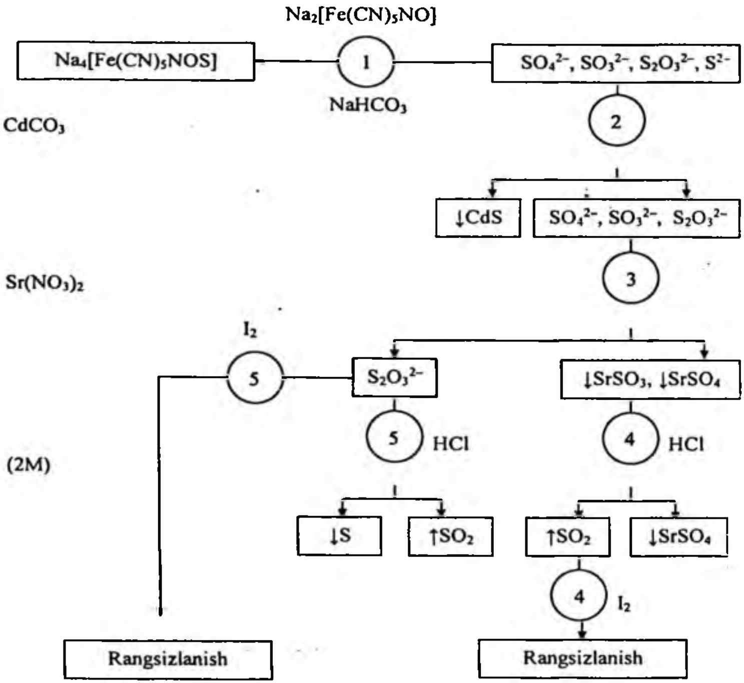
OLTINGUGURT SAQLAGAN ANIONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

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

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

12-sxema

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



28-jadval

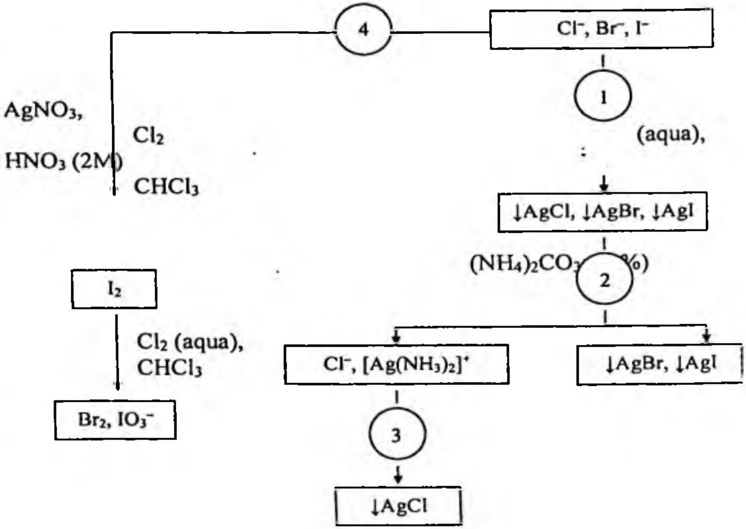
GALOGENID-IONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

Cl^-, Br^-, I^-

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

13-sxema

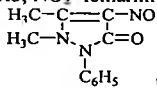
GALOGENID-IONLAR (Cl^-, Br^-, I^-) ARALASHMASINING ANALIZ SXEMASI



29-jadval

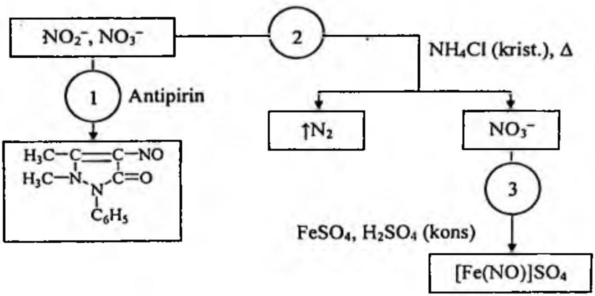
AZOT SAQLAGAN ANIONLAR ARALASHMASINING SISTEMATIK ANALIZ BOSQICHLARI

NO_2^-, NO_3^-

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

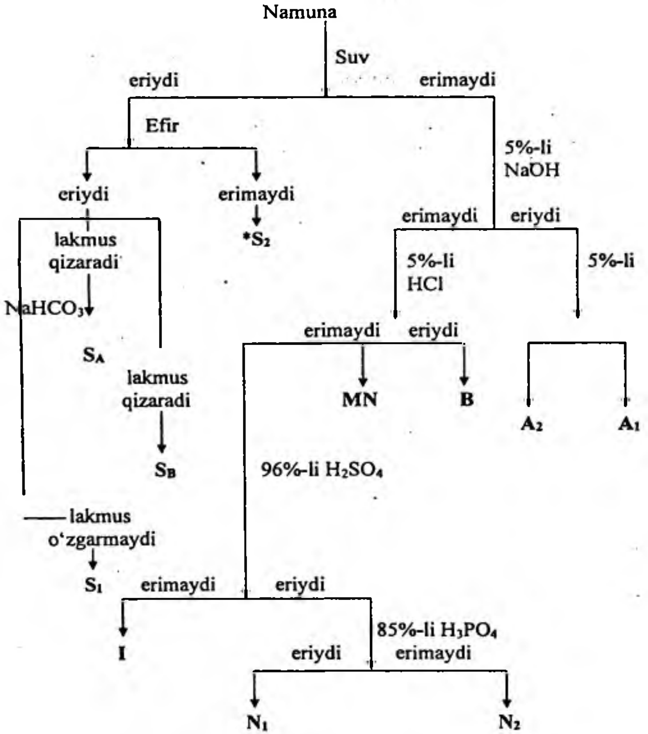
14-sxema

NO_2^-, NO_3^- ANIONLARI ARALASHMASINING ANALIZ SXEMASI



15-*sxema*

ERUVCHANLIKKA ASOSLANGAN ORGANIK BIRIKMALAR ARALASHMASINING AJRATILISHI



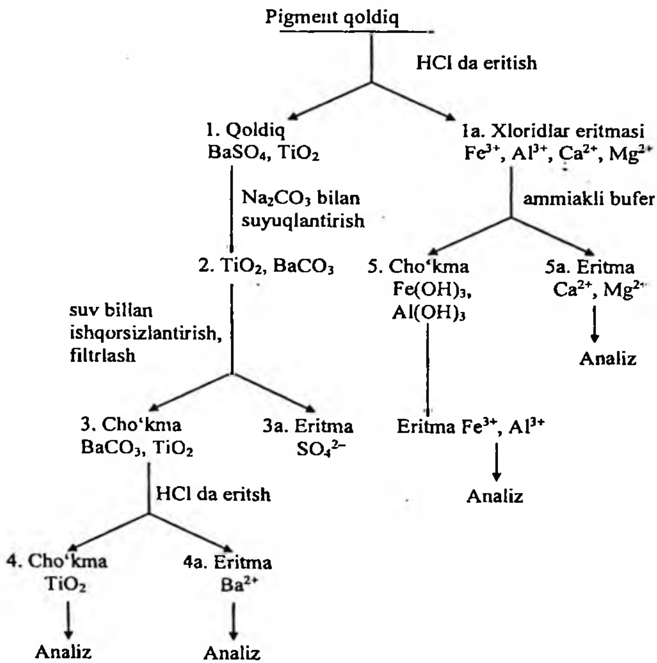
*S_2 – organik kislotalarning tuzlari ($RCOONa$, RSO_3Na), aminlar gidroxloridlari ($RNH{\cdot}HCl$), aminokislotalar ($R-CHCNH_3^+COO^-$), uglevodlar, polioksibirikmalar, ko'p asosli kislotalar; S_A – besh yoki undan kam C atomlarini saqlagan bir asosli karbon kislotalar, aromatik sul-fokislotalar; 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.

16-*sxema*

LAK-BO'YOQ MATERIALLAR ANALIZI

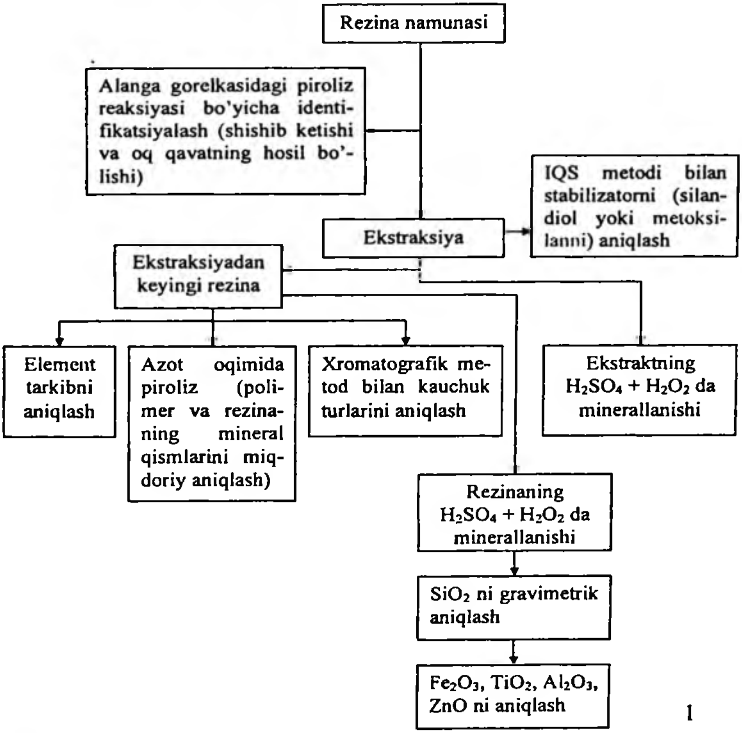
Pigment qoldiqning analizi



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

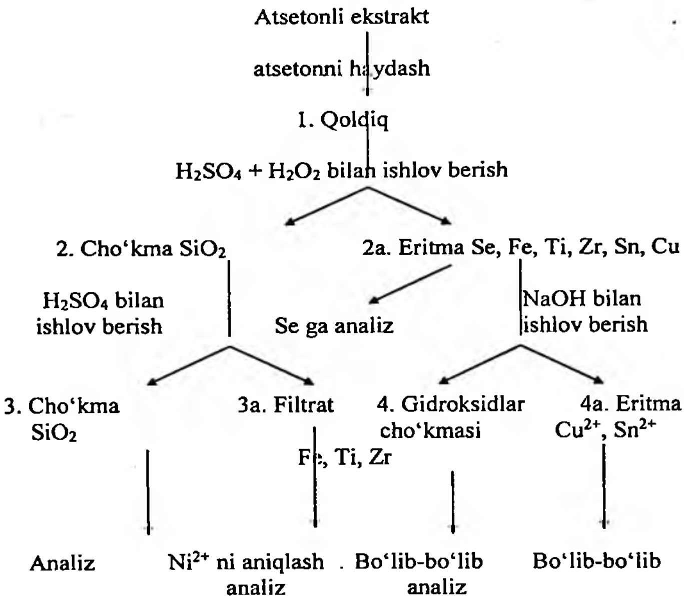
17-sxema

SILOKSAN KAUCHUKLAR ANALIZI



8-sxema

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,

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Kuchli konsentrlangan eritmalar uchun formula bir oz murakkablashadi:

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

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

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

Elektrolitlar eritmalarida kimyoviy muvozanat holati muvozanat konstantasi K bilan xarakterlanadi:

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

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

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

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

qisqartirilgan ko‘rinishda:

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

Bu reaksiyaning muvozanat konstantasi 25 ^{0}C haroratda

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

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

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

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

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

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 ifodalaniladi:

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

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

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

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

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

Umumiy holda bu jarayonlarni quyidagi tenglama bilan ifodalash mumkin:

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

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

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

yoki

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

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

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

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

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

Kuchsiz kislota eritmalarining muvozanat konstantasi K_a bilan ifodalanadi:

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

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

Kuchsiz asos eritmalarining muvozanat konstantasi K_b bilan ifodalanadi:

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

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

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

Shuning uchun:

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

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

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

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

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

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

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

bunda C – kuchsiz elektrolitning molyar konsentratsiyasi.

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

Kislota va asoslarning eritmalarida muvozanat

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

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

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

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

$$pH + pOH = 14 \text{ (25 °C da).}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Kuchsiz kislota va asoslar suvli eritmalarda qisman ionlanadi. Masalan:

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

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

Bunday kislota asoslarning eritmalardagi muvozanat tegishli muvozanat konstantalari bilan xarakterlanadi:

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

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

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

$$[H^+] = \sqrt{K_a \cdot C_a};$$
$$[OH^-] = \sqrt{K_b \cdot C_b}.$$

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

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

$$[H^+] = \alpha \cdot C_a;$$
$$[OH^-] = \alpha \cdot C_b.$$

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

$$[H^+] = K_a \cdot \frac{C_a}{C_{tuz}};$$
$$[OH^-] = K_b \cdot \frac{C_b}{C_{tuz}}.$$

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

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

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

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

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

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

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

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

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

Yechish. NaOH konsentratsiyasini mol/l da hisoblaymiz:

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

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

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

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

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

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

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

Mustaqil yechish uchun masalalar

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

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

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

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

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

Geterogen sistemalarda muvozanat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Bundan, $S = \sqrt[3]{\frac{EK_{PbI_2}}{4}} = \sqrt[3]{8 \cdot 10^{-9}/4} = 1{,}3 \cdot 10^{-3}$ 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:

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

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

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

Quyidagi proporsiyadan stronsiy fosfatning eruvchanligini g/l da hisoblaymiz:

0,25 litr eritma $2{,}80 \cdot 10^{-5}$ 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:

$$S_x = \frac{x}{M_{Sr_3(PO_4)_2}} = \frac{1{,}12 \cdot 10^{-4}}{452{,}803} = 2{,}5 \cdot 10^{-7} \text{ mol/l},$$

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

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

S ning qiymatini EK tenglamasiga qo'yamiz:

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

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 $[I^-] = 0{,}1$ mol/l.

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

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

Bundan, $x = \dfrac{EK_{PbI_2}}{(0{,}1)^2} = \dfrac{8 \cdot 10^{-9}}{0{,}01} = 8 \cdot 10^{-7}$ 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. $5 \cdot 10^{-3}$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 $2{,}5 \cdot 10^{-3}$ 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 g PbI_2 ni eritish uchun 2 litr suv talab etildi. Tuzning eruvchanlik ko'paytmasini hisoblang.

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

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

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

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

Gidrolizlanadigan tuzlar eritmalarida muvozanat

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

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

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

GIDROLIZ PARAMETRLARINI HISOBLASH JADVALI

Tuz	Gidroliz konstantasi, K_g	Gidroliz darajasi, h	$[H^+]$	$[OH^-]$
Kuchli kislota va kuchsiz asosdan ho-sil 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 ho-sil 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:

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

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

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

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

Tuzning konsentartsiyasini mol/l da hisoblaymiz:

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

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

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

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

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

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

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

Yechish. Ammoniy xlorid quyidagi tenglama bo'yicha dissotsialanadi:

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

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

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

Bunday turdagi tuzlarning gidroliz konstantasini hisoblashda quyidagi formuladan foydalaniladi:

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

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

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

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

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

Yechish. Ammoniy atsetat quyidagicha ionlanadi:

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

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

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

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

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

Gidroliz darajalarni masala shartida berilgan haroratlarda hisoblaymiz:

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

60°C $\quad h_{60°C} = \dfrac{\sqrt{\dfrac{10^{-13}}{1{,}74\cdot10^{-5}\cdot1{,}76\cdot10^{-5}}}}{1+\sqrt{\dfrac{10^{-13}}{1{,}74\cdot10^{-5}\cdot1{,}76\cdot10^{-5}}}} = 1{,}82\cdot10^{-2}.$

Binobarin, gidroliz darajasi $\dfrac{h_{60°C}}{h_{25°C}} = \dfrac{1{,}82\cdot10^{-2}}{5{,}74\cdot10^{-3}} = 3{,}17$ marta ortgan.

Mustaqil yechish uchun masalalar

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

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

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

Bufer eritmalarda muvozanat

Keng ma'noda bufer sistemalarga quyidagicha ta'rif berish mumkin: tarkib o'zgarganda qandaydir parametrlarni muayyan qiymatlarda saqlab turuvchi sistemalar. Bufer eritmalar kislota-asosli (eritmaga kislota yoki asos kiritilganda pH ning qiymatini doimiy saqlab turuvchi); oksidlanish-qaytarishli (oksidlovchi yoki 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 $NH_3{\cdot}H_2O$ va NH_4Cl; fosfatli bufer eritma NaH_2PO_4 va Na_2HPO_4 dan iborat aralashmalardir.

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

$$pH = pK_a - \lg\frac{C_{kislota}}{C_{tuz}}.$$

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 $\tilde{N}_{lA^-}$ – 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 F $CH_3COO^- + H^+$ (kuchsiz elektrolit; ionlanishi qaytar);

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$x = \frac{0{,}1\cdot 9}{10} = 0{,}09M\ NH_4Cl.$$

Quyidagi tenglama bo‘yicha bufer aralashmaning pH ini aniqlaymiz:

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

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

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

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

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

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

$$C_2(Na_2CO_3)=\frac{C_1(Na_2CO_3)\cdot V_1(Na_2CO_3)}{V_1(Na_2CO_3)+V_1(NaHCO_3)}=\frac{0{,}1\cdot 30}{30+15}=0{,}0667\approx 6{,}67\cdot 10^{-2}\ \text{M};$$

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

$$pK_2=-\lg K_{2(H_2CO_3)}=-\lg 4{,}69\cdot 10^{-11}=10{,}33.$$

Bufer eritmaning pH qiymatini topsak:

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

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.

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

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

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:

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

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

bunda C_{HA} va C_{A^-} – kislota-asosli juft komponentlarining konsentartsiyasi; C – eritmaning umumiy konsentratsiyasi (C = [HA] + [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 CH_3COOH hamda 0,205M CH_3COONa 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 $C = 0{,}337$ mol/l bo'lsa, uning bufer sig'imini hisoblang. $K_{NH_3} = 1{,}76 \cdot 10^{-5}$.

Yechish. Ammiak eritmasi suvda quyidagicha dissotsialanadi:

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

Ammoniy ionining dissotsilanish konstantasi:

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

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

Mustaqil yechish uchun masalalar

6-masala. 1 litrda 0,2M CH_3COONa va 0,2M CH_3COOH saqlagan bufer 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 C_6H_5COOH va 0,35 mol C_6H_5COONa saqlaydi. Bufer aralashmaning pH ini hisoblang.

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

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

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

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

Kompleks birikmalarning eritmalarida muvozanat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Barqarorlik va beqarorlik konstantalari orasida quyidagi nisbat mavjud:

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

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

Yechish. Tuzning dissotsilanishini quyidagi tenglamalar bilan ifodalash mumkin:

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

(1)

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

(2)

Ikkinchi qaytar jarayon uchun beqarorlik konstantasining ifodasini yozamiz:

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

Jadvaldan komplek ionning barqarorlik konstantasini topamiz: $\lg\beta = 7{,}23$; bi-nobarin, $\beta = 10^{7{,}23} = 1{,}7\cdot10^7$,

$$K_{beqar} = \frac{1}{\beta} = 5{,}9\cdot10^{-8}.$$

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

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

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

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

Bundan, $x = \sqrt[3]{\frac{K_{beqar.}\cdot C}{4}} = \sqrt[3]{\frac{5{,}9\cdot10^{-8}\cdot0{,}05}{4}} = 0{,}9\cdot10^{-3};$

$$[Ag^+] = x = 0{,}9\cdot10^{-3}\ \text{mol/l};$$

$$[NH_3] = 2x = 2\cdot0{,}9\cdot10^{-3} = 1{,}8\cdot10^{-3}\ \text{mol/l}.$$

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

Yechish. Kompleks ionning dissotsilanishi quyidagi tenglama asosida boradi:

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

Jadvaldan HgI_4^{2-} kompleksi uchun $\lg\beta_4 = 30{,}18$; $\beta_4 = 1{,}51\cdot10^{30}$ ekanligini aniqlaymiz. Bundan:

$$\beta_4 = \frac{[HgI_4^{2-}]}{[Hg^{2+}][I^-]^4} = 1{,}51\cdot10^{30}.$$

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 KJ ning umumiy konsentratsiyasiga teng deb hisoblasak, unda:

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

Mustaqil yechish uchun masalalar

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

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

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

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

Oksidlanish-qaytarilish jarayonlari

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

$$\begin{array}{c} Ox_1 + ne \rightarrow Red_1 \\ Red_2 - ne \rightarrow Ox_2 \\ \hline Ox_1 + Red_2 = Red_1 + Ox_2 \end{array}$$

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

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

Moddalarning 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 – potensiali bilan tavsiflash mumkin.

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

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

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

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

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

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

$$+3e + MnO_4^- + 4H^+ \rightarrow MnO_2\downarrow + 2H_2O$$

(1)

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

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

(2)

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

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

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

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

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

$+2e + [I_3]^- \rightarrow 3I^-$ 1 $E°$ = 0,545 V

$AsO_2^- + [I_3]^- + 4OH^- \rightarrow AsO_4^{3-} + 3I^- + 2H_2O$

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

$+2e + H_3AsO_4 + 2H^+ \rightarrow HAsO_2 + 2H_2O$ 1 $E°$ = 0,56 V

$-2e + 3I^- \rightarrow [I_3]^-$ 1 $E°$ = 0,545 V

$AsO_2^- + [I_3]^- + 4OH^- \rightarrow AsO_4^{3-} + 3I^- + 2H_2O$

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

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

- reaksiyaning elektr yurituvchi kuchi (E.Yu.K) – o'zaro ta'sir etuvchi sistema potensiallarining farqi; odatda, E.Yu.K. 0,4 V dan katta bo'lgan reaksiyalar boradi.
- quyidagi tenglamalar bilan hisoblanadigan redoks reaksiyaning muvozanat konstantasi:

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

yoki

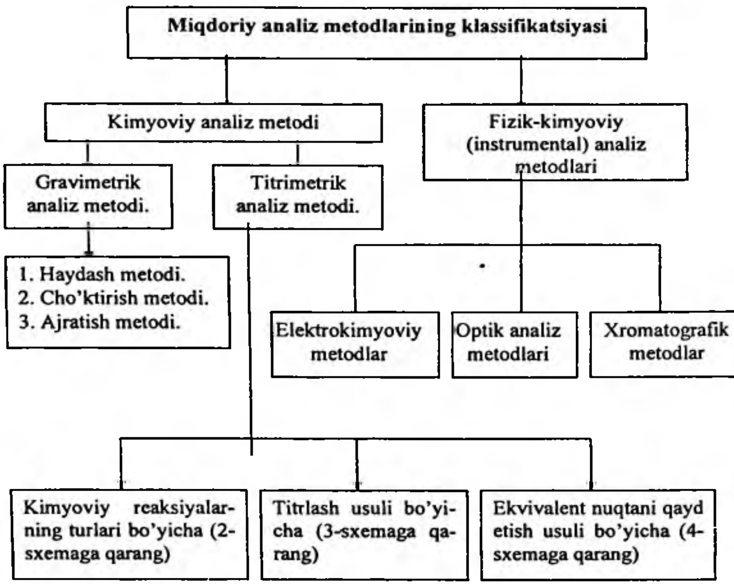
$$\lg K = \frac{n(E_1^\circ - E_2^\circ)}{0,059},$$

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

MIQDORIY ANALIZ

1-sxema

MIQDORIY ANALIZ USULLARINING KLASSIFIKATSIYASI



3-sxema

TITRLASH USULI BO'YICHA TITRIMETRIK ANALIZ METODLARINING KLASSIFIKATSIYASI

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

4-sxema

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

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

1-jadval

GRAVIMETRIK ANALIZ METODI

<table>
<tr><th colspan="3">Gravimetrik analiz metodi moddaning erkin yoki muayyan tarkibli birikma ko'rinishida ajratib olingan tarkibiy qismlari massasining aniq o'lchanishiga asoslangan</th></tr>
<tr><th rowspan="3">Cho'ktirish metodlari</th><th colspan="2">Haydash metodlari</th></tr>
<tr><th colspan="2">Haydash metodlarida aniqlanuvchi komponent uchuvchan birikma ko'rinishida miqdoriy haydaladi</th></tr>
<tr><th>Bevosita haydash metodlari</th><th>Bilvosita haydash metodlari</th></tr>
<tr>
<td>Cho'ktirish metodlarida aniqlanuvchi komponent muayyan tarkibli qiyin eruvchan kimyoviy birikma ko'rinishida miqdoriy cho'ktiriladi.
Masalan,
– SO_4^{2-} ni aniqlashda ular Ba^{2+} ionlari bilan cho'ktiriladi:
$Ba^{2+} + SO_4^{2-} \rightarrow \underset{\text{cho'ktirilgan shakl}}{BaSO_4\downarrow}$
– qizdirilgandan keyin:
$BaSO_4\downarrow \xrightarrow{\Delta} \underset{\text{gravimetrik shakl}}{BaSO_4}$
Bu holda cho'ktirilgan va gravimetrik shakllar mos tushadi.</td>
<td>Agar haydalgan mahsulot massasi bevosita o'lchansa, bunday usul bevosita haydash deb aytiladi.
Masalan, kalsiy karbonat tortimining parchalanishidan hosil bo'lgan CO_2 ni aniqlash:
$CaCO_3\downarrow + 2H^+ \xrightarrow{\Delta} CO_2\uparrow + Ca^{2+} + H_2O$
$CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$
CO_2 ning miqdori natron ohaki ($NaOH + CaO$) bilan to'ldirilgan yutivchi nay massasining ortishiga qarab hisoblanadi</td>
<td>Agar haydalgan mahsulot massasi haydashgacha va haydashdan keyingi namuna massasining farqiga qarab aniqlansa, bunday usul bilvosita haydash deb aytiladi.
Masalan, moddalarning namligini, kristallogidratlardagi kristallizatsion suvni aniqlash:
$BaCl_2 \cdot 2H_2O \xrightarrow{\Delta} BaCl_2 + H_2O\uparrow$</td>
</tr>
</table>

1-Jadvalning davomi

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

2-jadval

KISLOTA-ASOSLI TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
0,1M - 0,001M HCl, H_2SO_4 va bosh. kislotalarning eritmalari (atsidimetriya)	Kislota - asosli indikatorlar (masalan, metiloranj, fenolftalein)	Standart moddalar ($Na_2B_4O_7 \cdot 10H_2O$, Na_2CO_3, K_2CO_3). Standart eritmalar (NaOH, KOH, $Ba(OH)_2$)	Bu metod bilan quyidagilar aniqlanadi • kuchli kislota va asoslar; • kuchsiz kislota va asoslar, $K_1 \geq 5 \cdot 10^{-7}$; • kuchli kislota va kuchsiz asosdan ($K_b \leq 5 \cdot 10^{-7}$) yoki kuchli asos va kuchsiz kislotadan ($K_a \leq 5 \cdot 10^{-7}$) tarkib topgan tuzlar.	1. Reaksiya mahsulotlari yoki titrlash egri chiziqlari bo'yicha indikatorni to'g'ri tanlash. 2. Ekvivalent nuqtaga yaqinlashganda titrlashni sekin o'tkazish. 3. $t = 20 - 25°C$	$H^+ + OH^- \rightleftarrows HOH$ Masalan, to'g'ri titrlash: $Na_2CO_3 + HCl \xrightarrow{f.f.} NaHCO_3 + NaCl$ $Na_2CO_3 + 2HCl \xrightarrow{m.o.} NaCl + CO_2\uparrow + H_2O$ teskari titlash: $CH_3COOH + NaOH_{(mo'l)} \rightleftarrows CH_3COONa + H_2O$ $NaOH_{(qoldiq)} + HCl \rightleftarrows NaCl + H_2O$
0,1M - 0,001M KOH, NaOH va bosh. ishqorlarning eritmalari (alkalimetriya)		Standart moddalar ($H_2C_2O_4 \cdot 2H_2O$, $H_2C_2H_4O_6$). Standart eritmalar (HCl, H_2SO_4)			

3-jadval

CHO'KTIRISHGA ASOSLANGAN TITRLASH

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

3-jadvalning davomi

Fayans-Xodakov metodi bo'yicha argentometrik titrlash	0,1M yoki 0,05M $AgNO_3$ eritmasi	Adsorbsion indikatorlar: eozin, fluoressein va boshqalar	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^-, NCS^- aniqlanadi	Qo'llaniladigan indikatorga qarab titrlash pH ning muayyan qiymatlarida o'tkaziladi	$Ag^+ + I^- \rightarrow AgI\downarrow$
Merkurometrik metod	0,1M $Hg_2(NO_3)_2$ eritmasi	Temir (III)-rodanit $[Fe(NCS)_3]$, difenilkarbazon $NH - NH - C_6H_5$ | $C = O$ | $N = N - C_6H_5$	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^- aniqlanadi	Titrlash kislotali muhitda o'tkaziladi	$Hg_2^{2+} + 2Cl^- \rightarrow$ $\rightarrow Hg_2Cl_2\downarrow$

4-jadval

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 $Na_2[Fe(CN)_5NO]$, difenilkarbazid yoki difenilkarbazon eritmalari, I^- ni aniqlashda indikator qo'llanilmaydi	NaCl yoki KCl standart moddalar va ularning standart eritmalari	Cl^-, Br^-, I^-, NCS^-, CN^- aniqlanadi	Titrlash kislotali (HNO_3) muhitda o'tkaziladi	$Hg^{2+} + 2Cl^- \rightarrow$ $\rightarrow [HgCl_2]$ $Hg^{2+} + 2Br^- \rightarrow$ $\rightarrow [HgBr_2]$ $Hg^{2+} + 2NCS^- \rightarrow$ $\rightarrow [HgNCS_2]$ $Hg^{2+} + [Fe(CN)_5NO]^{2-}$ $\rightarrow Hg[Fe(CN)_5NO]\downarrow$ yoki Hg^{2+} ning difenilkarbazid yoki difenilkarbazon bilan rangli komplekslari $Hg^{2+} + 4I^- \rightarrow$ $\rightarrow [HgI_2]^{2-}$ $[HgI_2]^{2-} + Hg^{2+} \rightarrow$ $\rightarrow 2HgI_2\downarrow$

5-jadval

KOMPLEKSONOMETRIK TITRLASH

Titrant	Indikatorlar	Standart moddalar va standart eritmalar	Metodning imkoniyatlari	Titrlash shartlari	Reaksiya tenglamalari
To'g'ri titrlash: 0,05M-0,1M trilon B (Na_2H_2L) eritmasi	Metalloxrom indikatorlar: erioxrom qora T, mureksid va boshqalar	Standart moddalar: Zn, ZnO, $CaCO_3$. Standart eritmalar: $ZnSO_4$, $MgSO_4$	Cu^{2+}, Co^{2+}, Pb^{2+}, Ni^{2+}, Sr^{2+}, Fe^{3+}, Al^{3+}, Ba^{2+}, Zn^{2+}, Ca^{2+}, Mg^{2+} va bosh. aniqlanadi	Titrlash pH ning 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'zgargunicha titrlanadi.
Teskari tirlash: 1. 0,05M-0,1M trilon B eritmasi 2. 0,05M-0,1M $MgSO_4$ yoki $ZnSO_4$ eritmalari			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_2O_4, $MgNH_4PO_4$) dagi kationlar aniqlanadi	Titrlash pH ning muayyan qiymatlarida o'tkaziladi	$H_2L^{2-}_{(mo'l)} + Me^{2+} \rightarrow [MeL]^{2-} + H^+$ $H_2L^{2-}_{(qoldiq)} + Mg^{2+} \rightarrow [MgL]^{2-} + H^+$ Metall kationlarini saqlagan eritmaga mo'l miqdorda trilon B eritmasi qo'shiladi va uning ortiqchasi metallo-xrom indikatori ishtirokida magniy tuzlari eritmasi bilan titrlanadi

5-jadvalning davomi

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

5-sxema

OKSIDLANISH-QAYTARISHLI TITRLASH USULLARI

Oksidlanish-qaytarishli titrlash usullari

Oksidimetriya

Bu usul oksidlovchilarning standart eritmalari bilan titrlab qaytaruvchilarni aniqlashga asoslangan:

permanganatometriya

(titrant – $KMnO_4$),

bromatometriya

(titrant – $KBrO_3$),

dixromatometriya

(titrant – $K_2Cr_2O_7$),

yodometriya

(titrant – KI dagi I_2),

yodxlorimetriya

(titrant – ICl),

nitritometriya

(titrnat – $NaNO_2$),

serīmetriya

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

va boshqalar

Reduktometriya

Bu usul qaytaruvchilarning standart eritmalari bilan titrlab oksidlovchilarni aniqlashga asoslangan:

yodometriya

(titrant – $Na_2S_2O_3$),

nitritometriya

(titrant – $NaNO_2$),

gidrazinometriya

(titrant – $N_2H_4 \cdot H_2SO_4$),

askorbinometriya

(titrant – $C_6H_8O_6$),

ferrometriya

(titrant – $FeSO_4$) va boshqalar

6-jadval

PERMANGANATOMETRIK TITRLASH

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

7-jadval

YODOMETRIK TITRLASH

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

7-jadvalning davomi

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

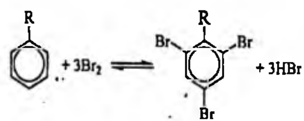
8-jadval

YODXLORIMETRIK TITRLASH

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

9-jadval

BROMATOMETRIK TITRLASH

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

10-jadval

NITRITOMETRIK TITRLASH

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

11-*jadval*

XROMATOMETRIK TITRLASH

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

12-*jadval*

SERIMETRIK TITRLASH

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

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 boyicha hisoblanadi:

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

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

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

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

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

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

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

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

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

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

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

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

2. Titrantning aniqlanuvchi modda titri bo'yicha:

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

$$\omega,\%=\frac{T_{(T/a)}\cdot K\cdot V\cdot 100}{m_t}\text{ (to‘g‘ri va bilvosita titrlash)},$$

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

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

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

Pipetkalash usuli

1. Ekvivalent molyar massa boyicha:

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

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

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3; V_k – modda tortimi eritilgan kolba hajmi, sm^3; V_p – eritmaning alikvot qismini o‘lchab olishga qo‘llaniladigan pipetka hajmi, sm^3.

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

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

bunda, V – titrlangan eritma hajmi, taxminan 20 sm^3; V_k – modda tortimi eritilgan kolbaning hajmi, sm^3; V_p – eritmaning alikvot qismini o‘lchab olishga qo‘llaniladigan pipetka hajmi, sm^3.

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

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

bunda, V – standart moddaning alikvot qismiga sarflanadigan titrlangan eritmaning hajmi, sm^3; V_k – modda tortimi eritilgan kolbaning hajmi, sm^3; V_p – eritmaning alikvot qismini o‘lchab olishga qo‘llaniladigan pipetka hajmi, sm^3.

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

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

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

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

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:

$$\omega,\% = \frac{T_{(T/a)} \cdot K \cdot V \cdot V_k \cdot 100}{m_t \cdot V_p} \text{ (to‘g‘ri va bilvosita titrlash),}$$

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

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 konsentartsiyasi, mol/dm^3; V_0 – konsentratsiyasi aniq bo‘lgan eritma hajmi, sm^3; V – konsentratsiyasi aniqlanadigan eritma hajmi, sm^3

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

Asosiy statistik xarakteristikalar

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Analizning ishonchlilik chegarasini hisoblash

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

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

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

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

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

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

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

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

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

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

Hisoblab topilgan Q kattalik uning jadval qiymatlari Q (p, n) bilan taqqoslanadi. Agar $Q > Q$ (p, n) bo'lsa, unda 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

2-jadval

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

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

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

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

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

3-jadval

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

f_2	f_1										
	1	2	3	4	5	6	8	10	12	16	20
1	4052	4999	5403	5625	5764	5859	5981	6056	6106	6169	6208
2	98,49	99,00	99,17	99,25	99,30	99,33	99,36	99,40	99,42	99,44	99,45
3	34,12	30,81	29,46	28,71	28,24	27,91	27,49	27,23	27,05	26,83	26,65
4	21,20	18,00	16,69	15,98	15,52	15,21	14,80	14,54	14,37	14,15	14,02
5	16,26	13,27	12,06	11,39	10,97	10,77	10,27	10,05	9,89	9,68	9,55
6	13,74	10,92	9,78	9,15	8,75	8,47	8,10	7,87	7,72	7,52	7,39
7	12,25	9,55	8,45	7,85	7,46	7,19	6,84	6,62	6,47	6,27	6,15
8	11,26	8,65	7,59	7,01	6,63	6,37	6,03	5,82	5,67	5,48	5,36

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

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

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

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

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

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

Har bir namuna uchun kvadratlar farqini, so'ng esa

$$S = \sqrt{\frac{\sum_{1}^{m}\sum_{1}^{n}(x_{ji} - x_j)^2}{n - m}}$$

formuladan xatolikni hisoblaymiz.

Kvadratlar farqining qiymatlari:

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

$f = 4 \cdot 5 - 5 = 15$ uchun o'rtacha 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. $Q = \dfrac{x_1 - x_2}{R}$ 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

Absorbsion usullar Modda tomonidan yorug'lik nurining yutilishini o'lchashga asoslangan	Kolorimetriya Fotokolorimetriya Spcktrofotometriya
Emmision usullar Modda tomonidan tarqatilgan nurning intensivligini o'lchashga asoslangan	Emmision spektral analiz Alanga fotometriyasi
Nurning eritma (suspenziya, emulsiya)dagi muallaq zarrachalar bilan ta'siridan keyin uning intensivligini o'lchashga asoslangan usullar	Fluorimetriya Turbidimetriya Nefelometriya
Yorug'lik nuri ta'siri ostida molekulalarning qutblanishiga asoslangan usullar	Refraktometriya Polyarimetriya

2-sxema

MOLEKULYAR-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'ysinmaydi. Spektr sohasi: 400-700 nm. O'lchash aniqligi ±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'ysinadi. Spektr sohasi: 300-700 nm. Asbob – fotoelektrokolorimetr. O'lchash aniqligi ±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 ±2%.

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

1-jadval

IQ- VA UB-SPEKTROSKOPIYANING ANALIZDA QO'LLANILISHI

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

2-jadval

KOLORIMETRIYA VA FOTOKOLORIMETRIYA METODLARINING TAVSIFLARI

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

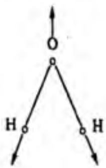
3-sxema

TEBRANMA IQ-SPEKTRLARNING KLASSIFIKATSIYASI

Normal tebranishlar
(faqat elektron dipol momentlari o'zgaradigan molekulalarda kuzatiladi, barcha atomlarning yadrolari bir xil chastota va faza bilan tebranadi)

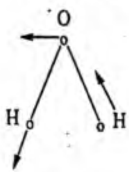
Valent tebranishlar ν
(molekula qo'zg'alganda bog'lar orasidagi burchak o'zgarmaydi, lekin bog' uzunligi o'zgaradi)

Simmetrik $\nu_{(S)}$



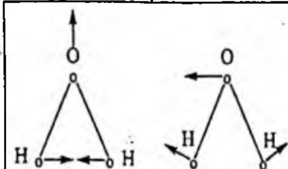
ν^{S} H_2O

Assimetrik $\nu_{(aS)}$



ν^{aS} H_2O

Deformatsion tebranishlar σ
(molekula qo'zg'alganda bog'lar orasidagi burchak o'zgaradi)



σ H_2O

SPEKTROSKOPIYA USULLARIDAGI ASOSIY TERMIN VA TUSHUNCHALAR

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

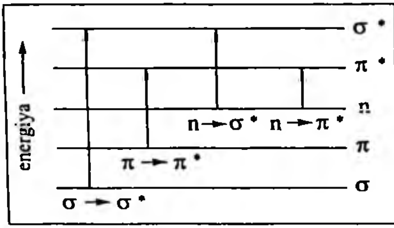
Spektr xarakteristikasi – maksimumlar (yutilish chiziqlari) soni; ularning to'lqin uzunligi (yoki chastotalar) shkalasidagi o'rni; maksimumlar (intensivlik) balandligi, yutilish chiziqlarining shakli.

Tebranma spektr (IQ-spektroskopiya) – 4000-400 sm^{-1} sohasidagi xarakterli maksimumlar (kimyoviy bog'lardagi atomli tebranishlar keltirib chiqaradi); energiyaning yutilishiga bog'liq.

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

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

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



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

Elektron pog'onalarning sxemasi va elektron o'tishlarning energiyasi

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

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

3-jadval

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

To'lqin soni, sm^{-1}	Tebranishlar turi va tegishli struktur element	Modda
3700...3600 (tor chiziq) 3500...3300 (keng chiziq)	Valent tebranish, – O – H (erkin, assitsilanmagan guruh) Valent tebranish, – O – H (bog'langan guruh)	Spirtlar, fenollar, kislotalar, oksiketonlar, oksikislota efirlari
3550...3350	Valent, – N – H (assitsilanmagan guruh)	Birlamchi va ikkilamchi aminlar va amidlar
3500...3100	Valent, – N – H (assitsilangan guruh)	
3300...3270	Valent, ≡ C – H	Atsetilenning mono-almashingan hosilalari
3350...3150 (keng chiziq)	Valent, – NH_3	Aminlar va aminokislotalar gidroxloridlari
3300...2500 (juda keng chiziq)	Valent, – O – H (assitsilangan guruh)	Karbon kislotalar, xelatlar
3100...3000	Valent, = C – H	Aromatik uglevodorodlar, olefinlar
3000...2800	Valent, – C – H	Parafinlar, sikloparafinlar
2962, 2872	Valent, – CH_3	Parafinlar
2962, 2853	Valent, – CH_2 –	Parafinlar
2900...2400	Valent, – O – D, – N – D	Spirtlar, aminlar
2820	Valent, – O – CH_3	Oddiy metil efirlar
2820...2730	Valent, N – CH_3	N-metilamin
2820...2720	Valent, OC – H	Aldegidlar

2600...2550	Valent, – S – H	Merkaptanlar, tiofenollar
2300...2100	Valent, – C ≡ X (X = C, N, O)	Atsetilen, nitrillar, uglerod oksidlari
2270...2000	Valent, – Y = C = X (Y = N, C; X = O, S)	Izotsianat va ketonlar
2260...2190	Valent, – C ≡ C –	Atsetilenning 1,2-dialmashingan hosilalari
2260	Valent, – N⁺ ≡ N	Diazoniy tuzlarining hosilalari
2245...2220	Valent, – C ≡ N	Nitrillar
2185...2120	Valent, – N = C –	Izonitrillar
2140...2100	Valent, – C ≡ C –	Monoalmashingan atsetilenlar
1900...1600	Valent, – C = O	Karbonil birikmalar
1850...1740	Valent, – C – O	Karbon kislotalarning galogenangidridlari
1840...1780 1780...1720	Valent, – C = O	Karbon kislotalarning angidridlari (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, $-C=N$	Azometinlar, oksi-ranlar
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 ikki-lamchi 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 nitrobirik-malar
1518	Valent, $-NO_2$	Aromatik nitrobirik-malar
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-dialmashingan hosilalar (*trans*-izomerlar)
995...985 915...905	Deformatsion, = C – H	Etilenning monoalmashingan hosilalari
900...860 810...750	Deformatsion, – C – H	Benzolning 1,3-dialmashingan hosilalari
725...680 885...855	Deformatsion, = C – H	Etilenning 1,1-dialmashingan hosilalari
860...800	Deformatsion, – C – H	Benzolning 1,4-dialmashingan hosilalari
780...500	Valent, – C – Hal	Aromatik va alifatik galogen hosilalar
770...735	Deformatsion, = C – H	Benzolning 1,2-dialmashingan hosilalari
770...730	Deformatsion, = C – H	Benzolning monoalmashingan hosilalari
710...690 780...720	Deformatsion, – C – H	To'rttadan ko'proq $-CH_2-$ guruhini saqlagan *n*-parafinlar
705...550	Valent, – C – S	Oltingugurt saqlagan organik birikmalar (merkaptanlar, 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‘likning to‘lqin uzunliklari	Yutiladigan nurning rangi	Qo‘shimcha rang (eritmada kuzatiladigan rangi)
400-435	Binafsha	Sarg‘ish-yashil
435-480	Ko‘k	Sariq
480-490	Yashil-ko‘k	Zarg‘aldoq
490-500	Ko‘kimtir-yashil	Qizil
500-560	Yashil	Qirmizi
560-580	Sarg‘ish-yashil	Binafsha
580-595	Sariq	Ko‘k
595-605	Zarg‘aldoq	Yashil-ko‘k
605-730	Qizil	Ko‘kimtir-yashil
730-760	Qirmizi	Yashil

5-jadval

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

5.1-jadval

Bir kattalikdan ikkinchi kattalikka o'tish		
Kattaliklar		Matematik amallar
σ, sm^{-1}	ν, Ghz	σ ni $3\cdot10^{10}$ ga ko'paytirish
λ, mkm	ν, Ghz	$3\cdot10^{14}$ ni λ ga bo'lish
λ, nm	ν, Ghz	$3\cdot10^{17}$ ni λ ga bo'lish
λ, mkm	σ, sm^{-1}	10^{14} ni λ ga bo'lish
ν, Ghz	λ, mkm	$3\cdot10^{14}$ ni ν ga bo'lish
ν, Ghz	σ, sm^{-1}	ν ni $3\cdot10^{10}$ ga bo'lish
σ, sm^{-1}	λ, mkm	10^{4} ni ν ga bo'lish

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

4-sxema

EMISSION ANALIZ METODLARI

Emmision analiz metodlari

Emission spektral analiz

Bu metod yuqori haroratli yorug'lik manbalarida (elektr yoyi, elektr uchqunida) qo'zg'algan atomlar nurlarining to'lqin uzunligi va quvvatini o'lchashga asoslangan.

Alanga fotometriyasi

Metod asosida aniqlanadigan elementlarning gaz alangasida qo'zg'algan atomlarining spektral nurlanishini qo'llash yotadi.

Fluorimetriya

Bu metod analiz qilinadigan moddalarning fluoressensiyalanish intensivligini o'lchashga asoslangan. Ba'zi moddalarga elektromagnit nurlarning ta'siridan vujudga keladigan nurlanish lyuminessensiya (sovuq nurlanish) deb aytiladi. Lyuminessensuya zarrachaning qo'zg'algan holatdan normal holatga qaytishi natijasida vujudga keladi, ya'ni modda molekulasi yutgan energiyani xususiy nurlanishga aylantiradi. Modda zarrachalari quyidagi ta'sirlar ostida qo'zg'algan holatga o'tishlari mumkin:

- yorug'lik – fluoressensiya;
- rentgen nurlari – rentgenolyuminessensiya
- kimyoviy reaksiya – xemilyuminessensiya

6-jadval

EMISSION SPEKTRAL ANALIZ

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

7-jadval

EMISSION ALANGALI FOTOMETRIYA

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

FLUORIMETRIYA

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

5-sxema

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

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

Turbidimetriya

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

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

bunda:

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

k – eritmaning loyqalanuvchanlik koeffitsiyenti;

l – qatlam qalinligi;

C – muallaq zarrachalar konsentratsiyasi.

Bu tenglama faqat juda suyultirilgan eritmalar uchun qo'llaniladi.

Nefelometriya

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

$$I_t = k \cdot C.$$

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

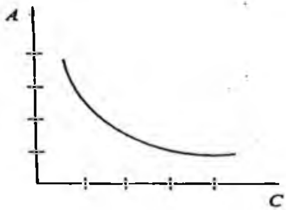
$$\frac{I_t^1}{I_t^2} = \frac{C_1}{C_2}; \; C_1 = \frac{I_t^1 \cdot C_2}{I_t^2}.$$

9-jadval

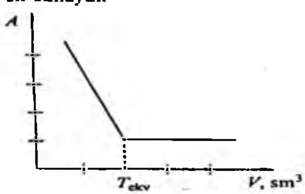
TURBIDIMETRIYA VA NEFELOMETRIYA USULLARIDA MIQDORIY ANIQLASH USULLARI

<table>
<tr><th>Turbidimetriya</th><th>Nefelometriya</th></tr>
<tr><td>

1. *Darajalangan grafik usuli*
Ma'lum konsentratsiyali standart eritmalarning turbidimetrik analiz natijalariga asosan $A = f(C)$ bog'liqlik grafigi tuziladi (bog'liqlik chiziqli emas).



2. *Turbidimetrik titrlash*
Bu usul titrantning aniqlanadigan 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.

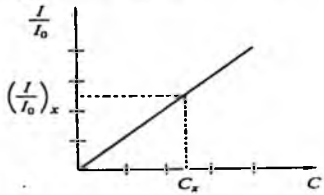


Turbidimetrik titrlash egri chizig'i

</td><td>

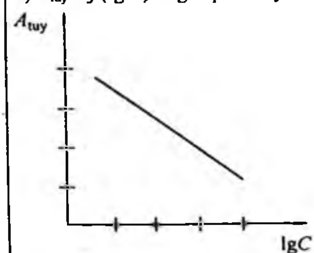
1. *Darajalangan grafik usuli*
Ma'lum konsentratsiyali standart eritmalarning nefelometrik analiz natijalariga asosan grafiklar tuziladi:

a) $\frac{I}{I_0} = f(C)$ bog'liqlik bo'yicha;



Konsentratsiya ortishi bilan tarqalgan yorug'likning intensivligi ham ortadi.

b) $A_{tuy} = f(\lg C)$ bog'liqlik bo'yicha;



Konsentratsiya ortishi bilan tuyulma optik zichlik (A_{tuy}) kamayib boradi.

</td></tr>
</table>

6-sxema

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

Yorug'lik ta'sirida molekulaning qutblanish hodisasiga asoslangan metodlar

Refraktometriya

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

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

bunda:

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

n ning qiymatlari quyidagi shartlarda hisoblanadi:

$t^o = 20°C$;

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

O'lchash uchun asbob – n-refraktometr.

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

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

Polyarimetriya

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

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

bunda:

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

α – graduslarda o'lchangan aylanish burchagi;

l – qatlam qalinligi, dm;

C – eritma konsentratsiyasi, g/100 ml.

α quyidagilarga bog'liq:

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

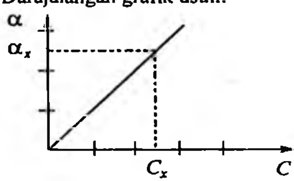
Shartlar: $t^o = 20°C$; $\lambda = 589{,}3$ nm $[\alpha]_D^{20}$

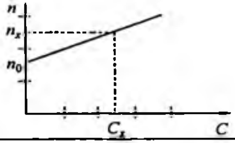
O'lchash uchun asbob – α-polyarimetr.

O'lchash aniqligi $\pm 0{,}02°$.

10-jadval

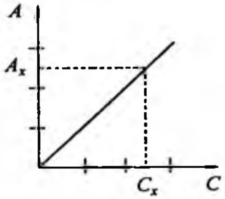
REFRAKTOMETRIYA VA POLYARIMETRIYA USULLARINING IMKONIYATLARI

Refraktometriya	Polyarimetriya
Sifat analizi	
1. n kattaligi bo'yicha moddalarni identifikatsiyalash. 2. Birikmalarning, shu jumladan, dorivor preparatlarning tozaligini aniqlash.	1. $[\alpha]_D^{20}$ kattalik bo'yicha optik faol moddalarni identifikatsiyalash. α ning qiymati o'lchanadi, formula bo'yicha $[\alpha]_D^{20}$ topiladi va ma'lumotnoma qiymatlari bilan solishtiriladi.
Miqdoriy analiz	
1. Eritmaning sindirish ko'rsatkichi n additiv kattalik ekanligini hisobga olgan holda, moddalarning konsentratsiyasi (C) quyidagi formulaga muvofiq aniqlanadi: $$C_x = \frac{n - n_0}{F},$$ bunda: n – aniqlanadigan moddaning sindirish ko'rsatkichi; n_0 – erituvchining sindirish ko'rsatkichi; F – muayyan konsentratsiya uchun refraktometrik faktor (const), u konsentratsiya 1% ga ko'payganda sindirish ko'rsatkichi necha marta ortishini ko'rsatadi. 2. Ikki va undan ortiq komponentli aralashmalardagi moddalarning konsentratsiyasi quyidagi formula bo'yicha hisoblanadi: $$C_2 = \frac{n - n_0 - F_1C_1}{F_2},$$ 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 komponenntning 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 eritmalarning optik zichligi A_{st} aniqlanadi, ε hisoblanadi va $\varepsilon_{o'rt}$ topiladi, A_x o'lchanadi va C_x formula bo'yicha topiladi.

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

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

bunda:

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

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

bunda:

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

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

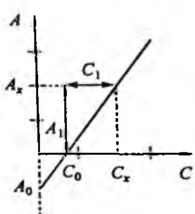
$$C_x = C_{st} \cdot \frac{A_x}{A_{x+st} - A_x}.$$

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

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

Hisoblash usullari:

I



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

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

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

bunda:

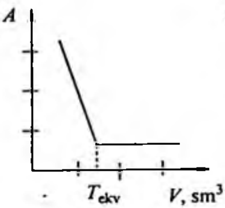
F – analitik faktor;

C_0 – taqqoslash eritmasidagi modda miqdori;

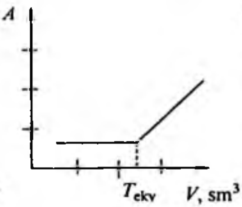
A_n – ma’lum konsentratsiyali bir qator eritmalarning yutishi;

A_x – tekshiriladigan eritmaning yutishi.

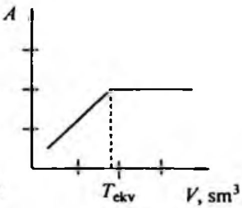
5. *Fotometrik titrlash usuli*
(ekvivalent nuqtani fotometrik aniqlash usuliga asoslangan, namunadagi ko‘p sonli moddalar analizida qo‘llaniladi).



Tekshiriladigan
eritmaning yutish



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

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

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

bunda:

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

11-jadval

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

Spirt konsentratsiyasi	Sindirish ko'rsatkichi (20°C da)	Har 1% spirt uchun tuzatish koeffitsiyenti	Harorat koeffitsiyenti
0	1,33300		$1{,}0\cdot10^{-4}$
1	1,33345	$4{,}5\cdot10^{-4}$	$1{,}0\cdot10^{-4}$
2	1,33400	$5{,}5\cdot10^{-4}$	$1{,}0\cdot10^{-4}$
3	1,33444	$4{,}4\cdot10^{-4}$	$1{,}1\cdot10^{-4}$
4	1,33493	$4{,}9\cdot10^{-4}$	$1{,}1\cdot10^{-4}$
5	1,33535	$4{,}2\cdot10^{-4}$	$1{,}2\cdot10^{-4}$
6	1,33587	$5{,}2\cdot10^{-4}$	$1{,}2\cdot10^{-4}$

7	1,33641	$5,4 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
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	$4,8 \cdot 10^{-4}$	$1,3 \cdot 10^{-4}$
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	$5,3 \cdot 10^{-4}$	$1,4 \cdot 10^{-4}$
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	$6,0 \cdot 10^{-4}$	$1,5 \cdot 10^{-4}$
21	1,34452	$6,2 \cdot 10^{-4}$	$1,6 \cdot 10^{-4}$
22	1,34512	$6,0 \cdot 10^{-4}$	$1,6 \cdot 10^{-4}$
23	1,34573	$6,1 \cdot 10^{-4}$	$1,7 \cdot 10^{-4}$
24	1,34635	$6.2 \cdot 10^{-4}$	$1,8 \cdot 10^{-4}$
25	1,34697	$6,2 \cdot 10^{-4}$	$1,9 \cdot 10^{-4}$
30	1,35000	$6,0 \cdot 10^{-4}$	$2,0 \cdot 10^{-4}$
35	1,35320	$6,4 \cdot 10^{-4}$	$2,0 \cdot 10^{-4}$
40	1,35500	$4,0 \cdot 10^{-4}$	$2,1 \cdot 10^{-4}$
45	1,35700	$4,0 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$
50	1,35900	$4,0 \cdot 10^{-4}$	$2,4 \cdot 10^{-4}$
55	1,36060	$3,2 \cdot 10^{-4}$	$2,6 \cdot 10^{-4}$
60	1,36180	$2,4 \cdot 10^{-4}$	$2,6 \cdot 10^{-4}$
65	1,36300	$2,4 \cdot 10^{-4}$	$3,4 \cdot 10^{-4}$
70	1,36380	$1,6 \cdot 10^{-4}$	$3,6 \cdot 10^{-4}$
75	1,36450	$1,4 \cdot 10^{-4}$	$3,8 \cdot 10^{-4}$
			$4,0 \cdot 10^{-4}$

12-jadval

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

Konsentratsiya, %	Eritmalarning sindirish ko'rsatkichlari faktorlari			
	Ammiak eritmasi	Analgin	Antipirin	Barbamil
1	1 – 5%-li konsentratsiyalari 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
Konsentratsiya, %	**Natriy barbital**	**Geksametilentetramin**	**Glyukoza, suvsiz**	**Glyukoza, nam miqdorli 10%**
1	Hamma konsentratsiyalar uchun 0,00182	0,00164	Hamma konsentratsiyalar uchun 0,00142	Hamma konsentratsiyalar 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		

Konsentratsiya, %	Izoniazid	Kaliy atsetat	Kaliy bromid	Kaliy yodid
1	0,00200	0,00130	0,00121	Hamma konsentratsiyalar 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	
Konsentratsiya, %	**Kaliy xlorid**	**Kalsiy glyukanat**	**Kalsiy xlorid·$6H_2O$**	**Aminokapron kislota**
1	0,00140	0,00164	0,00120	Hamma konsentratsiyalar 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	

Konsentratsiya, %	Askorbin kislota	Borat kislota	Nikotin kislota	Kodein fosfat
1	0,00160	Hamma konsentratsiyalar uchun 0,00067	Hamma konsentratsiyalar uchun 0,00210	Hamma konsentratsiyalar 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			
Konsentratsiya, %	**Natriy kofeinbenzoat**	**Magniy sulfat $\times 7H_2O$**	**Natriy benzoat**	**Natriy bromid**
1	Hamma konsentratsiyalar uchun 0,00192	Hamma konsentratsiyalar 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

Konsentratsiya, %	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

Konsentratsiya, %	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

ILOVALAR

1-jadval

TURLI HARORATLARDA SUVNING ION KO'PAYTMASI K_{H_2O}

t °C	K_{H_2O}	$aH^+ = aOH^-$	t °C	K_{H_2O}	$aH^+ = aOH^-$
0	$0{,}13 \cdot 10^{-14}$	$0{,}36 \cdot 10^{-7}$	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	$0{,}40 \cdot 10^{-11}$	$2{,}0 \cdot 10^{-6}$

2-jadval

BA'ZI KISLOTA VA ISHQOR ERITMALARINING ZICHLIGI VA KONSENTRATSIYASI

(t = 20 °C)

Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l	Zichlik, kg/m^3	Massa ulushi, %	Molyarlik, mol/l
Kislotalar:					
nitrat					
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			
sulfat					
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 l 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/m^3	**Massa ulushi, %**	**Molyarlik, mol/l**	**Zichlik, kg/m^3**	**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			

3-jadval

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)	NH_2CH_2COOH	$1{,}7 \cdot 10^{-10}$	9,77
Benzoy	C_6H_5COOH	$6{,}3 \cdot 10^{-5}$	4,20
Xlorbenzoy	ClC_6H_4COOH	$1{,}2 \cdot 10^{-3}$	2,92
Glikol	$CH_2(OH)COOH$	$1{,}5 \cdot 10^{-4}$	3,83
Glyukon	$CH_2OH(CHOH)_4COOH$	$1{,}4 \cdot 10^{-4}$	3,86
Kroton (β-metilakril)	$CH_3CH = COOH$	$2{,}0 \cdot 10^{-5}$	4,69
Laurin	$CH_3(CH_2)_{10}COOH$	$1{,}1 \cdot 10^{-5}$	4,95
Sut	$CH_3CHOHCOOH$	$1{,}38 \cdot 10^{-4}$	3,86
Chumoli	$HCOOH$	$1{,}78 \cdot 10^{-4}$	3,75
o-Nitrobenzoy	$O_2NC_6H_4COOH(1,2)$	$6{,}8 \cdot 10^{-3}$	2,17
Pikrin	$HOC_6H_2(NO_2)_3$	$4{,}2 \cdot 10^{-1}$	0,38
Propion	CH_3CH_2COOH	$1{,}35 \cdot 10^{-5}$	4,87
Moy	$CH_3(CH_2)_2COOH$	$1{,}5 \cdot 10^{-5}$	4,82
Sirka	CH_3COOH	$1{,}75 \cdot 10^{-5}$	4,75
Fenol	C_6H_5OH	$1{,}05 \cdot 10^{-10}$	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

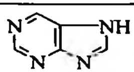
Ikki asosli			
Sulfit	H_2SO_3	$K_1 = 1,4 \cdot 10^{-2}$ $K_2 = 6,2 \cdot 10^{-8}$	1,85 7,20
Sulfid	H_2S	$K_1 = 1,0 \cdot 10^{-7}$ $K_2 = 2,5 \cdot 10^{-13}$	7,00 12,60
Karbonat	H_2CO_3	$K_1 = 4,5 \cdot 10^{-7}$ $K_2 = 5,0 \cdot 10^{-11}$	6,35 10,30
Xromat	H_2CrO_4	$K_1 = 2,1 \cdot 10^{-1}$ $K_2 = 3,2 \cdot 10^{-7}$	0,67 6,50
Vino	$H_2C_4H_4O_6$	$K_1 = 1,3 \cdot 10^{-3}$ $K_2 = 3,0 \cdot 10^{-5}$	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	$H_2C_2O_4$	$K_1 = 5,6 \cdot 10^{-2}$ $K_2 = 5,4 \cdot 10^{-5}$	1,25 4,27
Qahrabo	$H_2C_4H_4O_4$	$K = 6,17 \cdot 10^{-5}$ $K = 2,29 \cdot 10^{-6}$	4,21 5,64
Salitsil	$C_6H_4(OH)COOH$	$K_1 = 1,1 \cdot 10^{-3}$ $K_2 = 3,6 \cdot 10^{-14}$	2,97 13,59
Sulfosalitsil	$HSO_3C_6H_3(OH)COOH$	$K_2 = 3,1 \cdot 10^{-3}$ $K_3 = 2,0 \cdot 10^{-12}$	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
T o' r t a s o s l i			
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	$pK_b = -\lg K_b$
B i r k i s l o t a l i			
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
I k k i k i s l o t a l i			
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 kislota, 1M, ml**	**pH**	**Sirka kislota, 1M, ml**	**pH**	**Sirka kislota, 1M, ml**
3,8	421,5	4,67	100,0	5,5	57,4
3,9	345,1	4,7	96,8	5,6	55,9
4,0	284,4	4,8	87,2	5,7	54,7
4,1	136,2	4,9	79,5	5,8	53,7
4,2	197,9	5,0	73,4	5,9	53,0
4,3	167,4	5,1	68,6	6,0	52,3
4,4	143,3	5,2	64,8	6,1	51,9
4,5	124,1	5,3	61,7	6,2	51,5
4,6	108,9	5,4	59,3	6,3	51,2

Fosfatli bufer aralashma

a ml 1/15M Na_2HPO_4 va (100 – *a*) ml 1/15M KH_2PO_4 dan iborat aralashma

pH	***a***	**pH**	***a***
4,80	0,35	6,45	28,70
4,85	0,45	6,50	31,30
4,90	0,60	6,55	34,10
4,95	0,75	6,60	37,10
5,00	0,95	6,65	40,00

5,05	1,15	6,70	43,00
5,10	1,35	6,75	46,00
515	1,55	6,80	49,20
5,20	1,80	6,85	52,20
5,25	2,05	6,90	55,20
5,30	2,30	6,95	58,20
5,35	2,65	7,00	61,20
5,40	3,00	7,05	64,20
5,45	3,45	7,10	67,00
5,50	3,90	7,15	69,80
5,55	4,35	7,20	72,60
5,60	4,90	7,25	75,40
5,65	5,50	7,30	77,70
5,70	6,20	7,35	79,90
5,75	7,00	7,40	81,80
5,80	7,90	7,45	83,50
5,85	8,80	7,50	85,20
5,90	9,80	7,55	86,90
5,95	10,80	7,60	88,50
6,00	12,10	7,65	89,90
6,05	13,50	7,70	91,20
6,10	15,00	7,75	92,40
6,15	16,70	7,80	93,60
6,20	18,40	7,85	94,60
6,25	20,10	7,90	95,50
6,30	22,10	7,95	96,20
6,35	24,20	8,00	96,90
6,40	26,40		

Ayrim moddalarning bufer eritmalari

modda	pH
0,05M kaliy tetraoksalat digidrat eritmasi ($KH_3C_4H_4O_8 \cdot 2H_2O$; M.m. 254,19)	1,679 (25 °C)
Kaliy gidrotartratning to'yingan eritmasi (≈ 0,025M) ($KHC_4H_4O_6$; M.m. 188,178)	3,567 (25 °C)
0,05M kaliy digidrotsitrat	3,776 (25 °C)

($KH_2C_6H_5O_7$; M.m. 230,215)	
0,05M kaliy gidroftalat eritmasi ($KHC_8H_4O_4$; M.m. 204,223)	4,008 (25 °C)
Piperazinfosfatning to'yingan eritmasi* (≈ 0,065M) ($C_4H_{12}N_2HPO_4 \cdot H_2O$; M.m. 202,147)	6,36 (16 °C); 6,34 (18 °C)
0,05M natriy tetraborat eritmasi ($Na_2B_4O_7 \cdot 10H_2O$; M.m. 381,372)	9,18 (25 °C); 9,07 (38 °C)

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		$1,12 \cdot 10^{-20}$	$3,59 \cdot 10^{-6}$	$1,66 \cdot 10^{-4}$
$AlAsO_4$	$1,6 \cdot 10^{-16}$	$1,6 \cdot 10^{-16}$	$1,27 \cdot 10^{-8}$	$2,10 \cdot 10^{-7}$
$Ba_3(AsO_4)_2$		$7,76 \cdot 10^{-51}$	$3,73 \cdot 10^{-11}$	$2,57 \cdot 10^{-9}$
$BiAsO_4$		$4,37 \cdot 10^{-10}$	$2,09 \cdot 10^{-5}$	$7,27 \cdot 10^{-4}$
$Ca_3(AsO_4)_2$		$6,76 \cdot 10^{-19}$	$9,11 \cdot 10^{-5}$	$3,62 \cdot 10^{-3}$
$Co_3(AsO_4)_2$		$7,6 \cdot 10^{-29}$	$2,34 \cdot 10^{-6}$	$1,06 \cdot 10^{-4}$
$CrAsO_4$	$7,8 \cdot 10^{-21}$	$7,8 \cdot 10^{-21}$	$8,33 \cdot 10^{-11}$	$1,69 \cdot 10^{-9}$
$Cu_3(AsO_4)_2$	$7,6 \cdot 10^{-36}$	$7,6 \cdot 10^{-36}$	$9,32 \cdot 10^{-8}$	$4,37 \cdot 10^{-6}$
$FeAsO_4$	$5,8 \cdot 10^{-21}$	$5,8 \cdot 10^{-21}$	$7,61 \cdot 10^{-11}$	$1,48 \cdot 10^{-9}$
$Mg_3(AsO_4)_2$		$2,09 \cdot 10^{-20}$	$4,54 \cdot 10^{-5}$	$1,59 \cdot 10^{-3}$
$Mn_3(AsO_4)_2$	$1,9 \cdot 10^{-29}$	$1,9 \cdot 10^{-29}$	$7,07 \cdot 10^{-7}$	$3,13 \cdot 10^{-5}$
$Ni_3(AsO_4)_2$	$3,1 \cdot 10^{-26}$	$3,1 \cdot 10^{-26}$	$3,10 \cdot 10^{-6}$	$1,41 \cdot 10^{-4}$
$Pb_3(AsO_4)_2$	$4,1 \cdot 10^{-36}$	$4,1 \cdot 10^{-36}$	$3,28 \cdot 10^{-8}$	$2,95 \cdot 10^{-6}$
$Sr_3(AsO_4)_2$		$1,62 \cdot 10^{-18}$	$1,09 \cdot 10^{-4}$	$5,87 \cdot 10^{-3}$

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

$Zn_3(AsO_4)_2$	$1{,}07\cdot10^{-16}$	$1{,}07\cdot10^{-27}$	$1{,}58\cdot10^{-6}$	$7{,}50\cdot10^{-4}$
arsenitlar				
Ag_3AsO_3	$1{,}0\cdot10^{-17}$	$1{,}22\cdot10^{-17}$	$2{,}60\cdot10^{-5}$	$5{,}99\cdot10^{-4}$
bromidlar				
AgBr	$4{,}90\cdot10^{-13}$	$4{,}90\cdot10^{-13}$	$7{,}12\cdot10^{-7}$	$1{,}34\cdot10^{-5}$
CuBr	$5{,}25\cdot10^{-9}$	$5{,}25\cdot10^{-9}$	$7{,}24\cdot10^{-5}$	$1{,}04\cdot10^{-3}$
$HgBr_2$	$5{,}75\cdot10^{-23}$	$5{,}75\cdot10^{-23}$	$1{,}38\cdot10^{-6}$	$7{,}73\cdot10^{-5}$
$PbBr_2$	$9{,}12\cdot10^{-6}$	$2{,}76\cdot10^{-5}$	$2{,}73\cdot10^{-2}$	1,00
gidroksidlar				
AgOH	$1{,}60\cdot10^{-8}$	$1{,}63\cdot10^{-8}$	$1{,}61\cdot10^{-4}$	$2{,}01\cdot10^{-3}$
$Al(OH)_3$	$1{,}10\cdot10^{-33}$	$1{,}10\cdot10^{-33}$	$2{,}52\cdot10^{-9}$	$1{,}97\cdot10^{-8}$
$Bi(OH)_3$	$4{,}27\cdot10^{-31}$	$4{,}27\cdot10^{-31}$	$1{,}12\cdot10^{-8}$	$2{,}92\cdot10^{-7}$
$Ca(OH)_2$	$5{,}49\cdot10^{-6}$	$7{,}96\cdot10^{-6}$	$1{,}26\cdot10^{-2}$	$9{,}32\cdot10^{-2}$
$Cd(OH)_2$ passiv shakl	$3{,}98\cdot10^{-15}$	$3{,}98\cdot10^{-15}$	$1{,}07\cdot10^{-5}$	$1{,}57\cdot10^{-4}$
$Ce(OH)_2$	$6{,}32\cdot10^{-22}$	$6{,}32\cdot10^{-22}$	$2{,}21\cdot10^{-6}$	$4{,}20\cdot10^{-5}$
$Co(OH)_2$ havorang	$6{,}31\cdot10^{-15}$	$6{,}31\cdot10^{-15}$	$1{,}16\cdot10^{-5}$	$1{,}08\cdot10^{-4}$
$Co(OH)_2$	$1{,}59\cdot10^{-15}$	$1{,}59\cdot10^{-15}$	$7{,}35\cdot10^{-6}$	$6{,}83\cdot10^{-5}$
$Co(OH)_2$ pushti, yangi	$2{,}00\cdot10^{-16}$	$2{,}00\cdot10^{-16}$	$3{,}68\cdot10^{-6}$	$3{,}42\cdot10^{-5}$
$Co(OH)_3$ pushti, eskirgan	$1{,}00\cdot10^{-43}$	$1{,}00\cdot10^{-43}$	$7{,}80\cdot10^{-12}$	$8{,}58\cdot10^{-11}$
$Cr(OH)_3$	$6{,}31\cdot10^{-31}$	$6{,}31\cdot10^{-31}$	$1{,}24\cdot10^{-8}$	$1{,}27\cdot10^{-7}$
$Fe(OH)_2$	$7{,}94\cdot10^{-16}$	$7{,}94\cdot10^{-16}$	$1{,}05\cdot10^{-5}$	$9{,}45\cdot10^{-5}$
$Fe(OH)_3$	$3{,}72\cdot10^{-40}$	$3{,}72\cdot10^{-40}$	$1{,}80\cdot10^{-9}$	$1{,}93\cdot10^{-8}$
$Hg_2(OH)_2$ (Hg_2O)	$1{,}60\cdot10^{-23}$	$1{,}60\cdot10^{-23}$	$1{,}59\cdot10^{-8}$	$6{,}92\cdot10^{-7}$
$Hg(OH)_2$ (HgO)	$3{,}0\cdot10^{-26}$	$3{,}0\cdot10^{-26}$	$1{,}95\cdot10^{-8}$	$4{,}57\cdot10^{-7}$
LiOH	$4{,}0\cdot10^{-2}$	$6{,}25\cdot10^{-2}$	0,3425	0,8202
$Mg(OH)_2$ barq. shakli	$1{,}12\cdot10^{-11}$	$1{,}31\cdot10^{-11}$	$1{,}49\cdot10^{-4}$	$8{,}67\cdot10^{-4}$
$Mn(OH)_2$	$1{,}59\cdot10^{-13}$	$1{,}70\cdot10^{-13}$	$3{,}49\cdot10^{-5}$	$3{,}11\cdot10^{-4}$
$Ni(OH)_2$	$3{,}16\cdot10^{-16}$	$3{,}16\cdot10^{-16}$	$4{,}40\cdot10^{-6}$	$4{,}08\cdot10^{-5}$
$Ni(OH)_2$ eskirgan	$6{,}3\cdot10^{-18}$	$6{,}3\cdot10^{-18}$	$1{,}17\cdot10^{-6}$	$1{,}08\cdot10^{-5}$
$Pb(OH)_2 \leftrightarrow Pb^{2+} + 2OH^-$	$1{,}0\cdot10^{-20}$	$1{,}0\cdot10^{-20}$	$1{,}36\cdot10^{-7}$	$3{,}29\cdot10^{-6}$

$Pb(OH)_2 \leftrightarrow PbOH^+ + OH^-$	$8{,}7 \cdot 10^{-14}$	$8{,}7 \cdot 10^{-14}$	$2{,}96 \cdot 10^{-7}$	$7{,}13 \cdot 10^{-6}$
$Pt(OH)_2$	$1{,}0 \cdot 10^{-35}$	$1{,}0 \cdot 10^{-35}$	$1{,}23 \cdot 10^{-12}$	$2{,}82 \cdot 10^{-11}$
$Pt(OH)_4$ (PtO_2)	$1{,}6 \cdot 10^{-72}$	$1{,}6 \cdot 10^{-72}$	$1{,}44 \cdot 10^{-15}$	$3{,}79 \cdot 10^{-14}$
$Sb(OH)_3$	$3{,}99 \cdot 10^{-42}$	$3{,}99 \cdot 10^{-42}$	$2{,}0 \cdot 10^{-5}$	$3{,}45 \cdot 10^{-4}$
$Sn(OH)_2 \leftrightarrow Sn^{2+} + 2OH^-$	$1{,}41 \cdot 10^{-28}$	$1{,}41 \cdot 10^{-28}$	$1{,}39 \cdot 10^{-7}$	$2{,}12 \cdot 10^{-6}$
$Sn(OH)_2 \leftrightarrow SnOH^+ + 2OH^-$	$4{,}6 \cdot 10^{-15}$	$4{,}6 \cdot 10^{-15}$	$2{,}84 \cdot 10^{-6}$	$4{,}34 \cdot 10^{-5}$
$Sn(OH)_4$	$1{,}0 \cdot 10^{-57}$	$1{,}0 \cdot 10^{-57}$	$1{,}31 \cdot 10^{-12}$	$2{,}45 \cdot 10^{-11}$
yodatlar				
$AgIO_3$	$3{,}09 \cdot 10^{-8}$	$3{,}22 \cdot 10^{-8}$	$1{,}79 \cdot 10^{-4}$	$5{,}07 \cdot 10^{-3}$
$Ba(IO_3)_2$	$1{,}51 \cdot 10^{-9}$	$2{,}05 \cdot 10^{-9}$	$7{,}99 \cdot 10^{-4}$	$3{,}89 \cdot 10^{-2}$
$Ce(IO_3)_2$	$3{,}16 \cdot 10^{-10}$	$1{,}15 \cdot 10^{-9}$	$2{,}56 \cdot 10^{-3}$	$1{,}70 \cdot 10^{-1}$
$Pb(IO_3)_2$	$2{,}63 \cdot 10^{-13}$	$2{,}83 \cdot 10^{-13}$	$4{,}14 \cdot 10^{-5}$	$2{,}30 \cdot 10^{-3}$
yodidlar				
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	$8{,}71 \cdot 10^{-9}$	$8{,}71 \cdot 10^{-8}$	$1{,}51 \cdot 10^{-3}$	$6{,}96 \cdot 10^{-2}$
karbonatlar				
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	$8{,}91 \cdot 10^{-17}$	$8{,}91 \cdot 10^{-17}$	$2{,}81 \cdot 10^{-6}$	$1{,}30 \cdot 10^{-4}$
$MgCO_3 \cdot 3H_2O$	$1{,}00 \cdot 10^{-5}$	$3{,}08 \cdot 10^{-5}$	$5{,}55 \cdot 10^{-3}$	$7{,}68 \cdot 10^{-2}$
$MnCO_3$	$5{,}01 \cdot 10^{-10}$	$5{,}11 \cdot 10^{-10}$	$2{,}26 \cdot 10^{-5}$	$2{,}60 \cdot 10^{-4}$
$NiCO_3$	$1{,}35 \cdot 10^{-7}$	$1{,}63 \cdot 10^{-7}$	$4{,}03 \cdot 10^{-4}$	$4{,}79 \cdot 10^{-3}$
$PbCO_3$	$7{,}41 \cdot 10^{-14}$	$7{,}41 \cdot 10^{-14}$	$2{,}72 \cdot 10^{-7}$	$7{,}27 \cdot 10^{-6}$

$SrCO_3$	$1,10\cdot10^{-10}$	$1,10\cdot10^{-10}$	$1,05\cdot10^{-5}$	$1,55\cdot10^{-4}$
$ZnCO_3$	$1,45\cdot10^{-11}$	$1,45\cdot10^{-11}$	$3,80\cdot10^{-6}$	$4,77\cdot10^{-5}$
oksalatlar				
$Ag_2C_2O_4$	$3,57\cdot10^{-11}$	$4,10\cdot10^{-11}$	$2,27\cdot10^{-4}$	$6,89\cdot10^{-3}$
BaC_2O_4	$1,10\cdot10^{-7}$	$1,49\cdot10^{-7}$	$3,85\cdot10^{-4}$	$8,68\cdot10^{-3}$
CaC_2O_4	$2,29\cdot10^{-9}$	$2,60\cdot10^{-9}$	$4,86\cdot10^{-5}$	$6,22\cdot10^{-4}$
CdC_2O_4	$1,59\cdot10^{-8}$	$1,96\cdot10^{-8}$	$1,40\cdot10^{-4}$	$2,81\cdot10^{-3}$
CoC_2O_4	$6,31\cdot10^{-8}$	$8,53\cdot10^{-8}$	$2,92\cdot10^{-4}$	$4,29\cdot10^{-3}$
CuC_2O_4	$3,16\cdot10^{-8}$	$4,10\cdot10^{-8}$	$2,02\cdot10^{-4}$	$3,06\cdot10^{-3}$
FeC_2O_4	$2,00\cdot10^{-7}$	$3,05\cdot10^{-7}$	$5,52\cdot10^{-4}$	$7,94\cdot10^{-3}$
$Hg_2C_2O_4$	$1,00\cdot10^{-13}$	$1,00\cdot10^{-13}$	$3,16\cdot10^{-7}$	$1,55\cdot10^{-5}$
MgC_2O_4	$7,94\cdot10^{-5}$	$1,47\cdot10^{-4}$	$1,65\cdot10^{-2}$	0,1852
MnC_2O_4	$2,00\cdot10^{-6}$	$4,88\cdot10^{-6}$	$3,50\cdot10^{-3}$	$5,01\cdot10^{-2}$
NiC_2O_4	$3,98\cdot10^{-10}$	$4,42\cdot10^{-10}$	$2,11\cdot10^{-5}$	$3,10\cdot10^{-4}$
PbC_2O_4	$4,79\cdot10^{-10}$	$5,32\cdot10^{-10}$	$2,31\cdot10^{-5}$	$6,82\cdot10^{-4}$
SrC_2O_4	$5,63\cdot10^{-8}$	$7,61\cdot10^{-8}$	$2,41\cdot10^{-4}$	$4,23\cdot10^{-3}$
ZnC_2O_4	$1,59\cdot10^{-9}$	$1,77\cdot10^{-9}$	$2,64\cdot10^{-5}$	$4,05\cdot10^{-4}$
sulfatlar				
Ag_2SO_4	$1,455\cdot10^{-5}$	$5,02\cdot10^{-5}$	$2,32\cdot10^{-2}$	0,7244
$BaSO_4$	$1,05\cdot10^{-10}$	$1,05\cdot10^{-10}$	$1,02\cdot10^{-5}$	$2,39\cdot10^{-4}$
$CaSO_4$	$9,12\cdot10^{-6}$	$2,30\cdot10^{-5}$	$4,79\cdot10^{-3}$	$6,52\cdot10^{-2}$
Hg_2SO_4	$6,76\cdot10^{-7}$	$1,11\cdot10^{-6}$	$1,05\cdot10^{-3}$	$5,22\cdot10^{-2}$
$PbSO_4$	$1,59\cdot10^{-8}$	$1,96\cdot10^{-8}$	$1,40\cdot10^{-4}$	$4,24\cdot10^{-3}$
$SrSO_4$	$3,47\cdot10^{-7}$	$5,29\cdot10^{-7}$	$7,27\cdot10^{-4}$	$1,34\cdot10^{-2}$
sulfidlar				
Ag_2S	$6,31\cdot10^{-50}$	$6,31\cdot10^{-50}$	$2,51\cdot10^{-17}$	$6,22\cdot10^{-16}$
CdS	$7,94\cdot10^{-27}$	$7,94\cdot10^{-27}$	$8,91\cdot10^{-14}$	$1,15\cdot10^{-12}$
CoS_α	$3,98\cdot10^{-21}$	$3,98\cdot10^{-21}$	$6,31\cdot10^{-11}$	$5,74\cdot10^{-10}$
CoS_B	$2,00\cdot10^{-25}$	$2,00\cdot10^{-25}$	$4,47\cdot10^{-13}$	$4,06\cdot10^{-12}$
CuS	$6,31\cdot10^{-36}$	$6,31\cdot10^{-36}$	$2,51\cdot10^{-18}$	$2,40\cdot10^{-17}$

Cu_2S	$2,51\cdot10^{-48}$	$2,51\cdot10^{-48}$	$8,56\cdot10^{-17}$	$1,36\cdot10^{-15}$
FeS	$5,13\cdot10^{-18}$	$5,13\cdot10^{-18}$	$2,27\cdot10^{-9}$	$1,99\cdot10^{-8}$
HgS qora	$(1,59\cdot10^{-52})$	$(1,59\cdot10^{-52})$		
HgS qizil	$(3,98\cdot10^{-53})$	$(3,98\cdot10^{-53})$		
MnS pushti	$2,51\cdot10^{-10}$	$2,51\cdot10^{-10}$	$1,59\cdot10^{-5}$	$1,38\cdot10^{-4}$
MnS yashil	$2,51\cdot10^{-13}$	$2,51\cdot10^{-13}$	$5,01\cdot10^{-7}$	$4,36\cdot10^{-6}$
NiS_α	$3,16\cdot10^{-19}$	$3,16\cdot10^{-19}$	$5,62\cdot10^{-10}$	$5,10\cdot10^{-9}$
NiS_β	$1,00\cdot10^{-24}$	$1,00\cdot10^{-24}$	$1,00\cdot10^{-12}$	$9,08\cdot10^{-12}$
NiS_γ	$2,00\cdot10^{-26}$	$2,00\cdot10^{-26}$	$1,41\cdot10^{-13}$	$1,28\cdot10^{-12}$
PbS	$2,51\cdot10^{-27}$	$2,51\cdot10^{-27}$	$5,04\cdot10^{-14}$	$1,20\cdot10^{-12}$
SnS	$1,00\cdot10^{-25}$	$1,00\cdot10^{-25}$	$3,16\cdot10^{-13}$	$4,77\cdot10^{-12}$
ZnS_α	$1,59\cdot10^{-24}$	$1,59\cdot10^{-24}$	$1,26\cdot10^{-12}$	$1,23\cdot10^{-11}$
ZnS_β	$2,51\cdot10^{-22}$	$2,51\cdot10^{-22}$	$1,59\cdot10^{-11}$	$1,54\cdot10^{-10}$
sulfitlar				
Ag_2SO_3	$1,51\cdot10^{-14}$	$1,51\cdot10^{-14}$	$1,56\cdot10^{-5}$	$4,61\cdot10^{-4}$
$BaSO_3$	$7,94\cdot10^{-7}$	$1,31\cdot10^{-6}$	$1,14\cdot10^{-3}$	$2,48\cdot10^{-2}$
$CaSO_3$	$1,29\cdot10^{-8}$	$1,59\cdot10^{-8}$	$1,26\cdot10^{-4}$	$1,51\cdot10^{-3}$
Hg_2SO_3	$1,00\cdot10^{-27}$	$1,00\cdot10^{-27}$	$3,16\cdot10^{-14}$	$1,52\cdot10^{-12}$
$MgSO_3$	$3,16\cdot10^{-3}$	$1,88\cdot10^{-2}$	0,14	1,43
$SrSO_3$	$3,98\cdot10^{-8}$	$5,14\cdot10^{-8}$	$2,27\cdot10^{-4}$	$3,81\cdot10^{-3}$
fosfatlar				
Ag_3PO_4	$1,29\cdot10^{-20}$	$1,29\cdot10^{-20}$	$4,67\cdot10^{-6}$	$1,96\cdot10^{-4}$
$AlPO_4$	$5,75\cdot10^{-19}$	$5,75\cdot10^{-19}$	$6,61\cdot10^{-10}$	$8,06\cdot10^{-9}$
$BaHPO_4$		$9,12\cdot10^{-8}$	$3,02\cdot10^{-4}$	$7,05\cdot10^{-3}$
$Ba_3(PO_4)_2$		$3,39\cdot10^{-23}$	$1,26\cdot10^{-5}$	$7,57\cdot10^{-4}$
$BiPO_4$	$1,29\cdot10^{-23}$	$1,29\cdot10^{-23}$	$3,59\cdot10^{-12}$	$1,09\cdot10^{-10}$
$CaHPO_4$	$2,75\cdot10^{-7}$	$4,20\cdot10^{-7}$	$8,58\cdot10^{-4}$	$1,17\cdot10^{-2}$
$Ca_3(PO_4)_2$		$1,00\cdot10^{-26}$	$2,47\cdot10^{-6}$	$7,67\cdot10^{-4}$
$Cd_3(PO_4)_2$	$2,51\cdot10^{-33}$	$2,51\cdot10^{-33}$	$1,18\cdot10^{-7}$	$6,24\cdot10^{-6}$

$CoHPO_4$	$2{,}00 \cdot 10^{-7}$	$7{,}03 \cdot 10^{-7}$	$6{,}73 \cdot 10^{-4}$	$1{,}04 \cdot 10^{-2}$
$Co_3(PO_4)_2$	$2{,}00 \cdot 10^{-35}$	$2{,}00 \cdot 10^{-35}$	$4{,}50 \cdot 10^{-8}$	$1{,}65 \cdot 10^{-6}$
$CrPO_4$ yashil		$2{,}40 \cdot 10^{-23}$	$4{,}90 \cdot 10^{-12}$	$7{,}20 \cdot 10^{-11}$
$CrPO_4$ binafsha		$1{,}00 \cdot 10^{-17}$	$3{,}16 \cdot 10^{-9}$	$4{,}65 \cdot 10^{-8}$
$Cu_3(PO_4)_2$	$1{,}26 \cdot 10^{-37}$	$1{,}26 \cdot 10^{-37}$	$1{,}63 \cdot 10^{-8}$	$6{,}22 \cdot 10^{-7}$
$FePO_4$	$1{,}29 \cdot 10^{-22}$	$1{,}29 \cdot 10^{-22}$	$1{,}14 \cdot 10^{-11}$	$1{,}71 \cdot 10^{-10}$
$MgNH_4PO_4$		$2{,}51 \cdot 10^{-13}$	$6{,}31 \cdot 10^{-5}$	$8{,}66 \cdot 10^{-4}$
$Ni_3(PO_4)_2$	$5{,}01 \cdot 10^{-31}$	$5{,}01 \cdot 10^{-31}$	$3{,}41 \cdot 10^{-7}$	$1{,}25 \cdot 10^{-5}$
$PbHPO_4$		$1{,}41 \cdot 10^{-10}$	$1{,}19 \cdot 10^{-5}$	$3{,}60 \cdot 10^{-4}$
$Pb_3(PO_4)_2$	$7{,}94 \cdot 10^{-43}$	$7{,}94 \cdot 10^{-43}$	$1{,}49 \cdot 10^{-9}$	$1{,}21 \cdot 10^{-7}$
$SrHPO_4$		$5{,}75 \cdot 10^{-7}$	$7{,}59 \cdot 10^{-4}$	$1{,}39 \cdot 10^{-2}$
$Sr_3(PO_4)_2$		$4{,}07 \cdot 10^{-23}$	$1{,}30 \cdot 10^{-6}$	$2{,}82 \cdot 10^{-5}$
$Zn_3(PO_4)_2$	$9{,}12 \cdot 10^{-33}$	$9{,}12 \cdot 10^{-33}$	$1{,}53 \cdot 10^{-7}$	$5{,}92 \cdot 10^{-6}$
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_2Cl_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_2CrO_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_2CrO_4	$5{,}00 \cdot 10^{-9}$	$1{,}13 \cdot 10^{-8}$	$1{,}06 \cdot 10^{-4}$	$5{,}50 \cdot 10^{-3}$
$PbCrO_4$	$1{,}18 \cdot 10^{-14}$	$1{,}18 \cdot 10^{-14}$	$1{,}33 \cdot 10^{-7}$	$4{,}31 \cdot 10^{-6}$
$SrCrO_4$		$2{,}24 \cdot 10^{-5}$	$4{,}73 \cdot 10^{-3}$	$9{,}63 \cdot 10^{-2}$

7-jadval

VODOROD ELEKTRODGA NISBATAN SUVLI ERITMALARDAGI STANDART OKSIDLANISH-QAYTARILISH POTENSIALLARI (E^o)
(jadvaldagi potensiallar qiymatlari $\mu = 0$ va $t = 25°C$ uchun keltirilgan)

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

	$2H_2AsO_4^- + 6H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+0,687
	$2HAsO_4^{2-} + 8H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+0,901
	$2AsO_4^{3-} + 10H^+ + 4e \leftrightarrow As_2O_{3(q)} + 5H_2O$	+1,27
	$AsO_4^{3-} + 8H^+ + 5e \leftrightarrow As_{(q)} + 4H_2O$	+0,648
As	$As_2O_{3(q)} + 6H^+ + 6e \leftrightarrow 2As_{(q)} + 3H_2O$	+0,234
	$AsO^+ + 2H^+ + 3e \leftrightarrow As_{(q)} + H_2O$	+0,254
	$HAsO_2 + 3H^+ + 3e \leftrightarrow As_{(q)} + 2H_2O$	+0,248
	$AsO_2^- + 4H^+ + 3e \leftrightarrow As_{(q)} + 2H_2O$	+0,429
	$AsO_2^- + 2H_2O + 3e \leftrightarrow As_{(q)} + 4OH^-$	–0,68
	$As_{(q)} + 3H^+ + 3e \leftrightarrow AsH_{3(g)}$	–0,608
Au	$Au^{3+} + 2e \leftrightarrow Au^+$	+1,41
	$Au^{3+} + 3e \leftrightarrow Au_q$	+1,50
	$Au^+ + e \leftrightarrow Au_{(q)}$	+1,68
	$AuCl_4^- + 2e \leftrightarrow AuCl_2^- + 2Cl^-$	+0,926
	$AuBr_4^- + 2e \leftrightarrow AuBr_2^- + 2Br^-$	+0,805
	$AuCl_4^- + 3e \leftrightarrow Au_{(q)} + 4Cl^-$	+1,002
	$AuBr_4^- + 3e \leftrightarrow Au_{(q)} + 4Br^-$	+0,858
	$AuCl_2^- + e \leftrightarrow Au_{(q)} + 2Cl^-$	+1,154
	$AuBr_2^- + e \leftrightarrow Au_{(q)} + 2Br^-$	+0,963
B	$H_3BO_3 + 3H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,869
	$H_2BO_3^- + 4H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,687
	$HBO_3^{2-} + 5H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,437
	$BO_3^{3-} + 6H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,165
	$B(OH)_3 + 3H^+ + 3e \leftrightarrow B_{(q)} + 3H_2O$	–0,87
	$[BF_4]^- + 3e \leftrightarrow B_{(q)} + 4F^-$	–1,04
	$H_2B_4O_7 + 12H^+ + 12e \leftrightarrow 4B_{(q)} + 7H_2O$	–0,836
	$B_4O_7^{2-} + 14H^+ + 12e \leftrightarrow 4B_{(q)} + 7H_2O$	–0,792
Ba	$Ba^{2+} + 2e \leftrightarrow Ba_{(q)}$	–2,905
	$BaO + 2H^+ + 2e \leftrightarrow Ba_{(q)} + H_2O$	–2,166
Be	$Be^{2+} + 2e \leftrightarrow Be_{(q)}$	–1,85
	$Be_2O_3^{2-} + 3H_2O + 4e \leftrightarrow 2Be_{(q)} + 6OH^-$	–2,62
Bi	$Bi^{3+} + 3e \leftrightarrow Bi_{(q)}$	+0,215
	$BiOH^{2+} + H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O$	+0,254

	$BiO^+ + 2H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O$	+0,320
	$BiOCl_{(q)} + 2H^+ + 3e \leftrightarrow Bi_{(q)} + H_2O + Cl^-$	+0,160
	$Bi_2O_{3(q)} + 3H_2O + 6e \leftrightarrow 2Bi_{(q)} + 6OH^-$	–0,46
	$Bi_2O_{5(q)} + 10H^+ + 4e \leftrightarrow 2Bi^{3+} + 5H_2O$	+1,759
	$Bi_2O_{5(q)} + 8H^+ + 4e \leftrightarrow 2BiOH^{2+} + 3H_2O$	+1,700
Bi	$Bi_2O_{5(q)} + 6H^+ + 4e \leftrightarrow 2BiO^+ + 3H_2O$	+1,605
	$NaBiO_{3(q)} + 4H^+ + 2e \leftrightarrow BiO^+ + Na^+ + H_2O$	> +1,8
	$Bi_{(q)} + 3H^+ + 3e \leftrightarrow BiH_{3(g)}$	–0,800
Br	$Br_{2(s)} + 2e \leftrightarrow 2Br^-$	+1,09
	$[Br_3]^- + 2e \leftrightarrow 3Br^-$	+1,05
	$HBrO_3 + 5H^+ + 6e \leftrightarrow Br^- + 3H_2O$	+1,42
	$3HBrO_3 + 15H^+ + 16e \leftrightarrow [Br_3]^- + 9H_2O$	+1,462
	$BrO_3^- + 3H_2O + 6e \leftrightarrow Br^- + 6OH^-$	+0,61
	$2HBrO_3 + 10H^+ + 10e \leftrightarrow Br_{2(s)} + 6H_2O$	+1,48
	$HBrO_3 + 4H^+ + 4e \leftrightarrow HBrO + 2H_2O$	+1,46
	$HBrO_3 + 3H^+ + 4e \leftrightarrow BrO^- + 2H_2O$	+1,33
	$2HBrO + 2H^+ + 2e \leftrightarrow Br_{2(s)} + 2H_2O$	+1,59
	$2BrO^- + 4H^+ + 2e \leftrightarrow Br_{2(s)} + 2H_2O$	+2,09
	$2BrO^- + 2H_2O + 2e \leftrightarrow Br_{2(s)} + 4OH^-$	+0,45
	$BrO^- + H_2O + 2e \leftrightarrow Br^- + 2OH^-$	+0,76
C	$CO_{2(g)} + 2H^+ + 2e \leftrightarrow CO_{2(g)} + H_2O$	–0,12
	$2CO_{2(g)} + 2H^+ + 2e \leftrightarrow H_2C_2O_4$	–0,49
	$CO_{2(g)} + 2H^+ + 2e \leftrightarrow HCOOH$	–0,20
	$CNO + 2H_2O + 2e \leftrightarrow CN^- + 2OH^-$	–0,97
	$2HCNO + 2H^+ + 2e \leftrightarrow 2H_2O + (CN)_{2(g)}$	+0,33
	$(CN)_{2(g)} + 2H^+ + 2e \leftrightarrow 2HCN$	+0,37
Ca	$Ca^{2+} + 2e \leftrightarrow Ca_{(q)}$	–2,87
	$CaO_{gidr} + 2H^+ + 2e \leftrightarrow Ca_{(q)} + H_2O$	–2,19
	$CaO_{(q)} + 2H^+ + 2e \leftrightarrow Ca_{(q)} + H_2O$	–1,90
	$Ca(OH)_{2(q)} + 2e \leftrightarrow Ca_{(q)} + 2OH^-$	–3,03
Cd	$Cd^{2+} + 2e \leftrightarrow Cd_{(q)}$	–0,40
	$Cd(CN)_4^{2-} + 2e \leftrightarrow Cd_{(q)} + 4CN^-$	–1,09
	$[Cd(NH_3)_4]^{2+} + 2e \leftrightarrow Cd_{(q)} + 4NH_3$	–0,61

	$Cd(OH)_{2(q)} + 2e \leftrightarrow Cd_{(q)} + 2OH^-$	–0,81
	$CdS_{(q)} + 2e \leftrightarrow Cd_{(q)} + S^{2-}$	–1,17
Ce	$Ce^{3+} + 3e \leftrightarrow Ce$	–2,48
	$[Ce(OH)_2]^{2+} + 2H^+ + e \leftrightarrow Ce^{3+} + 2H_2O$	+1,73
	$[Ce(OH)]^{2+} + H^+ + e \leftrightarrow Ce^{3+} + H_2O$	+1,71
	$[Ce(ClO_4)_6]^{2-} + e \leftrightarrow Ce^{3+} + 6ClO_4^-$	+1,70
Ce	$[Ce(NO_3)_6]^{2-} + e \leftrightarrow Ce^{3+} + 6NO_3^-$	+1,60
	$[Ce(SO_4)_3]^{2-} + e \leftrightarrow Ce^{3+} + 3SO_4^{2-}$	+1,44
Cl	$Cl_{2(g)} + 2e \leftrightarrow 2Cl^-$	+1,35
	$Cl_{2(aqua)} + 2e \leftrightarrow 2Cl^-$	+1,39
	$ClO_4^- + 2H^+ + 2e \leftrightarrow ClO_3^- + H_2O$	+1,19
	$ClO_4^- + H_2O + 2e \leftrightarrow ClO_3^- + 2OH^-$	+0,36
	$2ClO_4 + 16H^+ + 14e \leftrightarrow Cl_{2(g)} + 8H_2O$	+1,39
	$ClO_3^- + 3H^+ + 2e \leftrightarrow HClO_2 + H_2O$	+1,21
	$ClO_3^- + H_2O + 2e \leftrightarrow ClO_2^- + 2OH^-$	+0,33
	$ClO_2^- + H_2O + 2e \leftrightarrow ClO^- + 2OH^-$	+0,66
	$2HClO + 2H^+ + 2e \leftrightarrow Cl_{2(g)} + H_2O$	+1,63
	$2ClO^- + 2H_2O + 2e \leftrightarrow ClO_{2(g)} + 4OH^-$	+0,40
Co	$Co^{3+} + e \leftrightarrow Co^{2+}$	+1,81
	$Co^{3+} + 3e \leftrightarrow Co_{(q)}$	+0,46
	$Co^{2+} + 2e \leftrightarrow Co_{(q)}$	–0,28
	$Co_3O_{4(q)} + 8H^+ + 2e \leftrightarrow 3Co^{2+} + 4H_2O$	+2,11
	$Co_2O_{3(q)} + 6H^+ + 2e \leftrightarrow 2Co^{2+} + 3H_2O$	+1,75
	$Co(OH)_{2(q)} + 2e \leftrightarrow Co_{(q)} + 2OH^-$	–0,73
	$[Co(NH_3)_6]^{3+} + e \leftrightarrow [Co(NH_3)_6]^{2+}$	+0,1
	$CoO(OH)_{(q)} + H_2O + e \leftrightarrow Co(OH)_{2(q)} + OH^-$	+0,17
Cr	$Cr^{3+} + e \leftrightarrow Cr^{2+}$	–0,41
	$Cr^{3+} + 3e \leftrightarrow Cr_q$	–0,74
	$Cr^{2+} + 2e \leftrightarrow Cr_q$	–0,91
	$Cr_2O_7^{2-} + 14H^+ + 6e \leftrightarrow 2Cr^{3+} + 7H_2O$	+1,33
	$Cr_2O_7^{2-} + 12H^+ + 6e \leftrightarrow 2Cr^{2+} + 5H_2O$	+1,26
	$Cr_2O_7^{2-} + 10H^+ + 6e \leftrightarrow 2[Cr(OH)_2]^+ + 3H_2O$	+1,14
	$Cr_2O_7^{2-} + 14H^+ + 12e \leftrightarrow 2Cr_{(q)} + 7H_2O$	+0,29

	$HCrO_4^- + 7H^+ + 3e \leftrightarrow Cr^{3+} + 4H_2O$	+1,20
	$CrO_4^{2-} + 4H_2O + 3e \leftrightarrow Cr(OH)_{3(q)} + 5OH^-$	–0,13
	$HCrO_4^- + 6H^+ + 3e \leftrightarrow [CrOH]^{2+} + 3H_2O$	+1,28
	$CrO_4^{2-} + 7H^+ + 3e \leftrightarrow [CrOH]^{2+} + 3H_2O$	+1,40
	$CrO_4^{2-} + 6H^+ + 3e \leftrightarrow Cr(OH)_2 + 2H_2O$	+1,28
	$CrO_4^{2-} + 4H^+ + 3e \leftrightarrow CrO_2^- + 2H_2O$	+0,95
	$CrO_4^{2-} + 2H^+ + 3e \leftrightarrow CrO_3^{3-} + H_2O$	+0,36
Cu	$Cu^{2+} + e \leftrightarrow Cu^+$	+0,16
	$Cu^{2+} + 2e \leftrightarrow Cu_{(q)}$	+0,34
	$Cu^+ + e \leftrightarrow Cu_{(q)}$	+0,52
	$HCuO_2^- + 3H^+ + e \leftrightarrow Cu^+ + 2H_2O$	+1,73
	$CuO_2^{2-} + 4H^+ + e \leftrightarrow Cu^+ + 2H_2O$	+2,51
	$HCuO_2^- + 3H^+ + 2e \leftrightarrow Cu_{(q)} + 2H_2O$	+1,13
	$CuO_2^{2-} + 4H^+ + 2e \leftrightarrow Cu_{(q)} + 2H_2O$	+1,52
	$2Cu^{2+} + H_2O + 2e \leftrightarrow Cu_2O_{(q)} + 2H^+$	+0,20
	$2HCuO_2^- + 4H^+ + 2e \leftrightarrow Cu_2O_{(q)} + 3H_2O$	+1,78
	$2CuO_2^{2-} + 6H^+ + 2e \leftrightarrow Cu_2O_{(q)} + 3H_2O$	+2,56
	$CuO + 2H^+ + e \leftrightarrow Cu^+ + H_2O$	+0,62
	$Cu^{2+} + Br^- + e \leftrightarrow CuBr_{(q)}$	+0,64
	$Cu^{2+} + Cl^- + e \leftrightarrow CuCl_{(q)}$	+0,54
	$Cu^{2+} + I^- + e \leftrightarrow CuI_{(q)}$	+0,86
	$[Cu(NH_3)_4]^{2+} + e \leftrightarrow [Cu(NH_3)_2]^+ + 2NH_3$	–0,01
	$[Cu(NH_3)_2]^+ + e \leftrightarrow Cu_{(q)} + 2NH_3$	–0,12
	$[Cu(NH_3)_4]^{2+} + 2e \leftrightarrow Cu_{(q)} + 4NH_3$	–0,07
F	$F_{2(g)} + 2H^+ + 2e \leftrightarrow 2HF$	+2,81
	$F_{2(g)} + 2e \leftrightarrow 2F^-$	+2,87
	$F_2O + 2H^+ + 4e \leftrightarrow 2HF + H_2O$	+2,12
	$F_2O + 2H^+ + 4e \leftrightarrow 2F^- + H_2O$	+2,15
	$F_2O + 2H^+ + 2e \leftrightarrow F_{2(g)} + H_2O$	+1,44
Fe	$Fe^{3+} + e \leftrightarrow Fe^{2+}$	+0,77
	$Fe^{3+} + 3e \leftrightarrow Fe_{(q)}$	–0,04
	$Fe^{2+} + 2e \leftrightarrow Fe_{(q)}$	–0,44
	$Fe(OH)^{2+} + H^+ + e \leftrightarrow Fe^{2+} + H_2O$	+0,91

	$Fe(OH)_2^+ + 2H^+ + e \leftrightarrow Fe^{2+} + 2H_2O$	+1,19
	$FeO_4^{2-} + 8H^+ + 3e \leftrightarrow Fe^{3+} + 4H_2O$	+1,70
	$FeO_4^{2-} + 7H^+ + 3e \leftrightarrow Fe(OH)^{2+} + 3H_2O$	+1,65
	$FeO_4^{2-} + 3H^+ + 3e \leftrightarrow Fe(OH)_2^+ + 2H_2O$	+1,56
	$FeO_4^{2-} + 5H^+ + 3e \leftrightarrow HFeO_2 + 2H_2O$	+1,00
	$HFeO_2^- + 3H^+ + 2e \leftrightarrow Fe_{(q)} + 2H_2O$	+0,49
	$[Fe(CN_6)]^{3-} + e \leftrightarrow [Fe(CN_6)]^{4-}$	+0,36
	$Fe(C_{12}H_8N_2)_3^{3+} + e \leftrightarrow Fe(C_{12}H_8N_2)_3^{2+}$	+1,06
H	$2H^+ + 2e \leftrightarrow H_{2(g)}$	±0,0000
	$2H^+(10^{-7}M) + 2e \leftrightarrow H_{2(g)}$	–0,41
	$H_{2(g)} + 2e \leftrightarrow 2H^+$	–2,25
	$2H_2O + 2e \leftrightarrow H_{2(g)} + 2OH^-$	–0,83
	$H_2O_2 + 2H^+ + 2e \leftrightarrow 2H_2O$	+1,77
	$HO_2^- + H_2O + 2e \leftrightarrow 3OH^-$	+0,88
Hg	$2Hg^{2+} + 2e \leftrightarrow Hg_2^{2+}$	+0,91
	$Hg_2^{2+} + 2e \leftrightarrow 2Hg_{(s)}$	+0,79
	$HgO_{(q)} + H_2O + 2e \leftrightarrow Hg_{(s)} + 2OH^-$	+0,10
	$HgO_{(q)} + 2H^+ + 2e \leftrightarrow Hg_{(s)} + H_2O$	+0,93
	$2Hg(OH)_{2(q)} + 4H^+ + 2e \leftrightarrow Hg_2^{2+} + 4H_2O$	+1,28
	$Hg_2Cl_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2Cl^-$	+0,27
	$Hg_2Br_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2Br^-$	+0,14
	$Hg_2I_{2(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2I^-$	–0,04
	$Hg_2C_2O_{4(q)} + 2e \leftrightarrow 2Hg_{(s)} + 2C_2O_4^{2-}$	+0,42
	$HgS_{(q\text{ , qora})} + 2e \leftrightarrow Hg_{(s)} + S^{2-}$	–0,67
	$HgS_{(q\text{ , qizil})} + 2e \leftrightarrow Hg_{(s)} + S^{2-}$	–0,70
	$[Hg(CN)_4]^{2-} + 2e \leftrightarrow Hg_{(s)} + 4CN^-$	–0,37
I	$[I_3]^- + 2e \leftrightarrow 3I^-$	–0,536
	$I_{2(aqua)} + 2e \leftrightarrow 2I^-$	+0,621
	$3I_2 + 2e \leftrightarrow 2[I_3]^-$	+0,789
	$H_5IO_6 + H^+ + 2e \leftrightarrow IO_3^- + 3H_2O$	+1,6
	$HIO_5^{2-} + 3H^+ + 2e \leftrightarrow IO_3^- + 2H_2O$	+1,898
	$HIO_5^{2-} + 8H^+ + 6e \leftrightarrow HIO + 4H_2O$	+1,389
	$2HIO_5^{2-} + 18H^+ + 14e \leftrightarrow I_{2(q)} + 10H_2O$	+1,384

	$3HIO_5^{2-} + 27H^+ + 22e \leftrightarrow [I_3]^- + 15H_2O$	+1,357
	$HIO_5^{2-} + 9H^+ + 8e \leftrightarrow I^- + 5H_2O$	+1,288
	$HIO_4 + 2H^+ + 2e \leftrightarrow HIO_3 + H_2O$	+1,626
	$IO_4^- + 2H^+ + 2e \leftrightarrow IO_3^- + H_2O$	+1,653
	$HIO_4 + 6H^+ + 6e \leftrightarrow HIO + 3H_2O$	+1,290
	$IO_4^- + 7H^+ + 6e \leftrightarrow HIO + 3H_2O$	+1,235
	$2HIO_4 + 14H^+ + 14e \leftrightarrow I_{2(q)} + 8H_2O$	+1,300
	$3HIO_4 + 21H^+ + 22e \leftrightarrow [I_3]^- + 12H_2O$	+1,276
	$HIO_4 + 7H^+ + 8e \leftrightarrow I^- + 4H_2O$	+1,215
I	$IO_3^- + 6H^+ + 4e \leftrightarrow I^+ + 3H_2O$	+1,155
	$IO_3^- + 4H^+ + 4e \leftrightarrow IO^- + 2H_2O$	+0,972
	$2HIO_3 + 10H^+ + 10e \leftrightarrow I_2 + 6H_2O$	+1,169
	$3HIO_3 + 15H^+ + 16e \leftrightarrow [I_3]^- + 9H_2O$	+1,145
	$HIO_3 + 5H^+ + 6e \leftrightarrow I^- + 3H_2O$	+1,0777
	$2HIO + 2H^+ + 2e \leftrightarrow I_{2(q)} + 2H_2O$	+1,354
	$2IO^- + 4H^+ + 2e \leftrightarrow I_{2(q)} + 2H_2O$	+2,005
	$3HIO + 3H^+ + 4e \leftrightarrow [I_3]^- + 3H_2O$	+1,213
	$3IO^- + 6H^+ + 4e \leftrightarrow [I_3]^- + 3H_2O$	+1,701
	$IO^- + 2H^+ + 2e \leftrightarrow I^- + H_2O$	+1,313
	$HIO + H^+ + 2e \leftrightarrow I^- + H_2O$	+0,987
	$2ICl_{3(q)} + 6e \leftrightarrow I_{2(q)} + 6Cl^-$	+1,28
	$ICl_{(q)} + 2e \leftrightarrow I_{2(q)} + 2Cl^-$	+1,22
	$ICl + 2e \leftrightarrow I_{2(q)} + 2Cl^-$	+1,19
	$2IBr_{(s)} + 2e \leftrightarrow I_{2(q)} + 2Br^-$	+1,02
K	$K^+ + e \leftrightarrow K_{(q)}$	–2,925
Li	$Li^+ + e \leftrightarrow Li_{(q)}$	–3,03
Mg	$Mg^{2+} + 2e \leftrightarrow Mg_{(q)}$	–2,37
	$Mg(OH)_{(q)} + 2e \leftrightarrow Mg_{(q)} + 2OH^-$	–2,69
	$MgO_{(q)} + 2H^+ + 2e \leftrightarrow Mg_{(q)} + H_2O$	–1,869
	$MgO_{(q\ suvsiz)} + 2H^+ + 2e \leftrightarrow Mg_{(q)} + H_2O$	–1,722
Mn	$Mn^{2+} + 2e \leftrightarrow Mn_{(q)}$	–1,18
	$Mn^{IV} + e \leftrightarrow Mn^{III}$ (3,5M H_2SO_4)	+1,65
	$Mn^{III} + e \leftrightarrow Mn^{II}$ (3,5M H_2SO_4)	+1,59

	$MnO_4^- + e \leftrightarrow MnO_4^{2-}$	+0.576
	$MnO_4^- + 2H_2O + 3e \leftrightarrow MnO_{2(q)} + 4OH^-$	+0,588
	$MnO_4^- + 4H^+ + 3e \leftrightarrow MnO_{2(\alpha,\ q)} + 2H_2O$	+1,695
	$MnO_4^- + 4H^+ + 3e \leftrightarrow MnO_{2(\beta,\ q)} + 2H_2O$	+1,679
	$MnO_4^- + 8H^+ + 4e \leftrightarrow Mn^{3+} + 4H_2O$	+1,506
	$MnO_4^- + 8H^+ + 5e \leftrightarrow Mn^{2+} + 4H_2O$	+1,507
	$MnO_4^{2-} + 4H^+ + 2e \leftrightarrow MnO_{2(q)} + 2H_2O$	+2,257
	$MnO_4^{2-} + 5H^+ + 4e \leftrightarrow HMnO_2^- + 2H_2O$	+1,234
	$MnO_4^{2-} + 2H_2O + 2e \leftrightarrow MnO_{2(q)} + 4OH^-$	+0,51
	$MnO_{2(q)} + 2H_2O + 2e \leftrightarrow Mn(OH)_2 + 2OH^-$	–0,05
Mn	$MnO_{2(q)} + 4H^+ + 2e \leftrightarrow Mn^{2+} + 2H_2O$	+1,23
	$MnO_{2(q)} + 4H^+ + 2e \leftrightarrow Mn^{3+} + 2H_2O$	+0,948
	$Mn(OH)_{3(q)} + e \leftrightarrow Mn(OH)_{2(q)} + OH^-$	+0,1
	$Mn^{2+} + 2e \leftrightarrow Mn_{(q)}$	–1,18
	$Mn(OH)_{2(q)} + 2e \leftrightarrow Mn_{(q)} + 2OH^-$	–1,55
	$HMnO_2^- + 3H^+ + 2e \leftrightarrow Mn_{(q)} + 2H_2O$	–0,163
N	$NO_3^- + 2H^+ + e \leftrightarrow NO_{2(g)} + H_2O$	+0,775
	$2NO_3^- + 4H^+ + 2e \leftrightarrow N_2O_{4(g)} + 2H_2O$	+0,80
	$NO_3^- + 3H^+ + 2e \leftrightarrow HNO_2 + H_2O$	+0,94
	$NO_3^- + 2H^+ + 2e \leftrightarrow NO_2^- + H_2O$	+0,835
	$NO_3^- + 4H^+ + 3e \leftrightarrow NO_2^- + 2H_2O$	+0,96
	$NO_{2(g)} + e \leftrightarrow NO_2^-$	+0,893
	$NO_{2(g)} + H^+ + e \leftrightarrow HNO_2$	+1,093
	$NO_{2(g)} + 2H^+ + 2e \leftrightarrow NO_{(g)} + H_2O$	+1,049
	$2NO_{2(g)} + 6H^+ + 6e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,229
	$2NO_{2(g)} + 8H^+ + 8e \leftrightarrow N_{2(g)} + 4H_2O$	+1,363
	$NO_2^- + 2H^+ + e \leftrightarrow NO_{(g)} + H_2O$	+1,202
	$HNO_2 + H^+ + e \leftrightarrow NO_{(g)} + H_2O$	+1,004
	$2NO_2^- + 6H^+ + 4e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,396
	$2HNO_2 + 4H^+ + 4e \leftrightarrow N_2O_{(g)} + 3H_2O$	+1,297
	$2NO_2^- + 8H^+ + 6e \leftrightarrow N_{2(g)} + 4H_2O$	+1,520
	$2HNO_2 + 6H^+ + 6e \leftrightarrow N_{2(g)} + 4H_2O$	+1,454
	$NO_2^- + 7H^+ + 6e \leftrightarrow NH_{3(g)} + 2H_2O$	+0,789

	$HNO_2 + 7H^+ + 6e \leftrightarrow NH_4^+ + 2H_2O$	+0,864
	$N_{2(g)} + 6H^+ + 6e \leftrightarrow 2NH_{3(g)}$	+0,057
	$N_{2(g)} + 2H_2O + 6H^+ + 6e \leftrightarrow 2NH \cdot H_2O$	+0,92
	$N_{2(g)} + 8H^+ + 6e \leftrightarrow 2NH_4^+$	+0,275
Na	$Na^+ + e \leftrightarrow Na_{(q)}$	–2,713
Ni	$Ni^{2+} + 2e \leftrightarrow Ni_{(q)}$	–0,250
	$NiO_{2(q)} + 4H^+ + 2e \leftrightarrow Ni^{2+} + 2H_2O$	+1,593
	$NiO_{2(q)} + 2H_2O + 2e \leftrightarrow Ni(OH)_{2(q)} + 2OH^-$	+0,49
	$Ni_2O_{3(q)} + 6H^+ + 2e \leftrightarrow 2Ni^{2+} + 3H_2O$	+1,753
	$Ni_3O_{4(q)} + 2H_2O + 2e \leftrightarrow 3HNiO_2^- + H^+$	–0,718
	$Ni_3O_{4(q)} + 8H^+ + 2e \leftrightarrow 3Ni^{2+} + 4H_2O$	+1,977
Ni	$HNiO_2^- + 3H^+ + 2e \leftrightarrow Ni_{(q)} + 2H_2O$	+0,648
	$[Ni(NH_3)_6]^{2+} + 2e \leftrightarrow Ni_{(q)} + 6NH_3$	–0,49
O	$O_{2(g)} + 4H^+ + 4e \leftrightarrow 2H_2O$	+1,229
	$O_{2(g)} + 2H_2O + 4e \leftrightarrow 4OH^-$	+0,401
	$O_{3(g)} + 2H^+ + 2e \leftrightarrow O_{2(g)} + H_2O$	+2,076
	$O_{3(g)} + 6H^+ + 6e \leftrightarrow 3H_2O$	+1,501
	$O_{3(g)} + H_2O + 3e \leftrightarrow O_{2(g)} + 2OH^-$	+1,24
	$O_{2(g)} + 2H^+ + 2e \leftrightarrow H_2O_2$	+0,69
	$H_2O_2 + 2H^+ + 2e \leftrightarrow 2H_2O$	+1,776
P	$P_{(qizil)} + 3H^+ + 3e \leftrightarrow PH_{3(g)}$	–0,111
	$P_{(oq)} + 3H^+ + 3e \leftrightarrow PH_{3(g)}$	–0,063
	$PO_4^{3-} + 3H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	+0,121
	$HPO_4^{2-} + 2H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	–0,234
	$H_2PO_4^- + H^+ + 2e \leftrightarrow HPO_3^{2-} + H_2O$	–0,447
	$H_2PO_4^- + 2H^+ + 2e \leftrightarrow H_2PO_3^- + H_2O$	–0,260
	$H_3PO_4 + H^+ + 2e \leftrightarrow H_2PO_3^- + H_2O$	–0,329
	$H_3PO_4 + 2H^+ + 2e \leftrightarrow H_3PO_3 + H_2O$	–0,276
	$PO_4^{3-} + 8H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,128
	$PO_4^{3-} + 8H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,156
	$HPO_4^{2-} + 7H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,288
	$HPO_4^{2-} + 7H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,316
	$H_2PO_4^- + 6H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,358

	$H_2PO_4^- + 6H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,386
	$H_3PO_4 + 5H^+ + 5e \leftrightarrow P_{(qizil)} + 4H_2O$	–0,383
	$H_3PO_4 + 5H^+ + 5e \leftrightarrow P_{(oq)} + 4H_2O$	–0,411
	$H_3PO_3 + 2H^+ + 2e \leftrightarrow H_3PO_2 + H_2O$	–0,499
	$HPO_3^{2-} + 5H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,298
	$HPO_3^{2-} + 5H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,346
	$H_2PO_3^- + 4H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,419
	$H_2PO_3^- + 4H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,467
	$H_3PO_3 + 3H^+ + 3e \leftrightarrow P_{(qizil)} + 3H_2O$	–0,454
	$H_3PO_3 + 3H^+ + 3e \leftrightarrow P_{(oq)} + 3H_2O$	–0,502
	$H_4P_2O_6 + 2H^+ + 2e \leftrightarrow 2H_3PO_3$	+0,38
	$2H_3PO_4 + 2H^+ + 2e \leftrightarrow H_4P_2O_6 + 2H_2O$	–0,94
Pb	$Pb^{2+} + 2e \leftrightarrow Pb_{(q)}$	–0,126
	$Pb^{4+} + 2e \leftrightarrow Pb^{2+}$	+1,694
	$PbO_{2(q)} + 4H^+ + 2e \leftrightarrow Pb^{2+} + 2H_2O$	+1,455
	$PbO_{2(q)} + 4H^+ + SO_4^{2-} + 2e \leftrightarrow PbSO_{4(q)} + 2H_2O$	+1,685
	$PbO_{2(q)} + H^+ + 2e \leftrightarrow HPbO_2$	+0,621
	$3PbO_3^{2-} + 10H^+ + 4e \leftrightarrow HPb_3O_{4(q)} + 5H_2O$	+2,515
	$PbO_3^{2-} + 4H^+ + 2e \leftrightarrow PbO_{(q)} + 2H_2O$	+2,001
	$PbO_3^{2-} + 3H^+ + e \leftrightarrow HPbO_2^- + H_2O$	+1,547
	$PbO_3^{2-} + 6H^+ + 2e \leftrightarrow Pb^{2+} + 3H_2O$	+2,375
	$Pb_3O_{4(q)} + H_2O + 2e \leftrightarrow 2PbO_{(q)} + 2OH^-$	+0,249
	$Pb_3O_{4(q)} + 8H^+ + 2e \leftrightarrow 3Pb^{2+} + 3H_2O$	+2,094
	$Pb_3O_{4(q)} + 2H_2O + 2e \leftrightarrow 3HPbO_2 + H^+$	+0,390
	$PbO_{(q)} + 2H^+ + 2e \leftrightarrow Pb_{(q)} + H_2O$	+0,249
	$PbSO_{4(q)} + 2e \leftrightarrow Pb_{(q)} + SO_4^{2-}$	–0,335
	$HPbSO_2^- + 3H^+ + 2e \leftrightarrow Pb_{(q)} + 2H_2O$	+0,702
	$Pb_{(q)} + 2H^+ + 2e \leftrightarrow PbH_2$	–1,507
Pt	$Pt^{2+} + 2e \leftrightarrow Pt_{(q)}$	+1,2
	$PtO_{2(q)} + 2H^+ + 2e \leftrightarrow Pt(OH)_{2(q)}$	+1,1
	$Pt(OH)_{2(q)} + 2e \leftrightarrow Pt_{(q)} + 2OH^-$	+0,15
	$Pt(OH)_{2(q)} + 2H^+ + 2e \leftrightarrow Pt_{(q)} + 2H_2O$	+0,98
S	$SO_4^{2-} + 4H^+ + 2e \leftrightarrow H_2SO_3 + H_2O$	+0,17

	$SO_4^{2-} + 4H_2O + 2e \leftrightarrow SO_3^{2-} + 2OH^-$	–0,93
	$SO_4^{2-} + 8H^+ + 6e \leftrightarrow S_{(q)} + 4H_2O$	+0,357
	$HSO_4^- + 7H^+ + 6e \leftrightarrow S_{(q)} + 4H_2O$	+0,339
	$SO_4^{2-} + 8H^+ + 8e \leftrightarrow S^{2-} + 4H_2O$	+0,149
	$SO_4^{2-} + 9H^+ + 8e \leftrightarrow HS^- + 4H_2O$	+0,252
	$SO_4^{2-} + 10H^+ + 8e \leftrightarrow H_2S_{(g)} + 4H_2O$	+0,303
	$HSO_4^- + 9H^+ + 8e \leftrightarrow H_2S_{(g)} + 4H_2O$	+0,289
	$S_2O_8^{2-} + 2e \leftrightarrow 2SO_4^{2-}$	+2,010
	$S_2O_8^{2-} + 2H^+ + 2e \leftrightarrow 2HSO_4^-$	+2,123
	$S_4O_6^{2-} + 2e \leftrightarrow 2S_2O_3^{2-}$	+0,219
	$S_4O_6^{2-} + 12H^+ + 10e \leftrightarrow 4S_{(q)} + 6H_2O$	+0,416
	$S_2O_6^{2-} + 2e \leftrightarrow 2SO_3^{2-}$	+0,026
	$SO_{2(g)} + 4H^+ + 4e \leftrightarrow S_{(q)} + 2H_2O$	+0,451
S	$H_2SO_3 + 4H^+ + 4e \leftrightarrow S_{(q)} + 3H_2O$	+0,449
	$2SO_3^{2-} + 6H^+ + 4e \leftrightarrow S_2O_3^{2-} + 3H_2O$	+0,705
	$2HSO_3^- + 4H^+ + 4e \leftrightarrow S_2O_3^{2-} + 3H_2O$	+0,491
	$4HSO_3^- + 8H^+ + 6e \leftrightarrow S_4O_6^{2-} + 6H_2O$	+0,581
	$SO_3^{2-} + 6H^+ + 6e \leftrightarrow S^{2-} + 3H_2O$	+0,231
	$S_{(q)} + 2e \leftrightarrow S^{2-}$	–0,476
	$S_{(q)} + H^+ + 2e \leftrightarrow HS^-$	–0,065
	$S_{(q)} + 2H^+ + 2e \leftrightarrow H_2S_{(g)}$	+0,142
	$S_2^{2-} + 2H^+ + 2e \leftrightarrow 2HS^-$	+0,298
	$S_2^{2-} + 2e \leftrightarrow 2S^{2-}$	–0,524
	$S_3^{2-} + 3H^+ + 4e \leftrightarrow 3HS^-$	+0,097
	$S_4^{2-} + 4H^+ + 6e \leftrightarrow 4HS^-$	+0,033
	$S_5^{2-} + 5H^+ + 8e \leftrightarrow 5HS^-$	+0,003
Sb	$Sb^V + 2e \leftrightarrow Sb^{III}$ (6M HCl)	+0,818
	$Sb^V + 2e \leftrightarrow Sb^{III}$ (3,5M HCl)	+0,746
	$Sb_2O_{5(q)} + 6H^+ + 4e \leftrightarrow 2SbO^+$	+0,581
	$SbO^+ + 2H^+ + 3e \leftrightarrow Sb_{(q)} + H_2O$	+0,212
	$SbO_3^- + 2H^+ + 2e \leftrightarrow SbO_2^- + H_2O$	+0,353
	$SbO_3^- + 3H^+ + 2e \leftrightarrow HSbO_2 + H_2O$	+0,678
	$SbO_3^- + 4H^+ + 2e \leftrightarrow SbO^+ + 2H_2O$	+0,704

	$SbO_2^+ + 2H^+ + 2e \leftrightarrow SbO^- + H_2O$	+0,720
	$2SbO_3^- + 6H^+ + 4e \leftrightarrow Sb_2O_{3(q)} + 3H_2O$	+0,772
	$SbO_2^- + 4H^+ + 3e \leftrightarrow Sb_{(q)} + 2H_2O$	+0,446
	$HSbO_2 + 3H^+ + 3e \leftrightarrow Sb_{(q)} + 2H_2O$	+0,230
	$Sb_2O_{5(q)} + 4H^+ + 4e \leftrightarrow Sb_2O_{3(q)} + 2H_2O$	+0,692
	$Sb_2O_{3(q)} + 6H^+ + 6e \leftrightarrow 2Sb_{(q)} + 3H_2O$	+0,152
	$Sb_{(q)} + 3H^+ + 3e \leftrightarrow SbH_{3(g)}$	–0,510
Si	$SiO_{2(q)} + 4H^+ + 4e \leftrightarrow Si_{(q)} + 2H_2O$	–0,86
	$SiO_3^{2-} + 6H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,455
	$HSiO_3^- + 5H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,632
	$H_2SiO_3 + 4H^+ + 4e \leftrightarrow Si_{(q)} + 3H_2O$	–0,780
	$SiO_{2(q)} + 8H^+ + 8e \leftrightarrow SiH_{4(g)} + 2H_2O$	–0,377
	$SiO_3^{2-} + 10H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,176
	$HSiO_3^- + 9H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,265
Si	$H_2SiO_3 + 8H^+ + 8e \leftrightarrow SiH_{4(g)} + 3H_2O$	–0,339
	$Si_{(q)} + 4H^+ + 4e \leftrightarrow SiH_{4(g)}$	+0,102
	$SiF_6^{2-} + 4e \leftrightarrow Si_{(q)} + 6F^-$	–1,2
Sn	$Sn^{IV} + 2e \leftrightarrow Sn^{II}$	+0,154
	$Sn^{IV} + 4e \leftrightarrow Sn_{(q)}$	+0,01
	$Sn^{II} + 2e \leftrightarrow Sn_{(q)}$	–0,136
	$SnO_3^{2-} + 3H^+ + 2e \leftrightarrow HSnO_2^- + H_2O$	+0,374
	$SnO_3^{2-} + 6H^+ + 2e \leftrightarrow Sn^{2+} + 3H_2O$	+0,844
	$HSnO_2^- + 3H^+ + 2e \leftrightarrow Sn_{(q)} + 2H_2O$	+0,33
	$Sn_{(q)} + 4H^+ + 4e \leftrightarrow SnH_{4(g)}$	–1,074
Sr	$Sr^{2+} + 2e \leftrightarrow Sr_{(q)}$	–2,89
Zn	$Zn^{2+} + 2e \leftrightarrow Zn_{(q)}$	–0,763
	$ZnO_2^{2-} + 4H^+ + 2e \leftrightarrow Zn_{(q)} + 2H_2O$	+0,441
	$HZnO_2^- + 3H^+ + 2e \leftrightarrow Zn_{(q)} + 2H_2O$	–0,054
	$ZnO_2^{2-} + 2H_2O + 2e \leftrightarrow Zn_{(q)} + 4OH^-$	–1,216
	$Zn(OH)_{2(q)} + 2e \leftrightarrow Zn_{(q)} + 2OH^-$	–1,245
	$ZnS_{(q)} + 2e \leftrightarrow Zn_{(q)} + S^{2-}$	–1,40
	$[Zn(NH_3)_4]^{2+} + 2e \leftrightarrow Zn_{(q)} + 4NH_3$	–1,04
	$[Zn(CN)_4]^{2+} + 2e \leftrightarrow Zn_{(q)} + 4CN^-$	–1,26

8-jadval

NOORGANIK LIGANDLI KOMPLEKSLAR VA ULARNING BARQARORLIK KONSTANTALARI (β)

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

8-jadvalning davomi

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

8-jadvalning davomi

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

8-jadvalning davomi

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

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

9-jadval

ORGANIK LIGANDLI KOMPLEKSLAR VA ULARNING BARQARORLIK KONSTANTALARI (β)

Kompleks ion	β_1	$lg\beta_1$	β_2	$lg\beta_2$	β_3	$lg\beta_3$	β_4	$lg\beta_4$	β_5	$lg\beta_5$	β_6	$lg\beta_6$
Atsetatli ($L - CH_3COO^-$)												
$[AgL_2]^-$	5,37	0,73	4,37	0,64								
$[CdL_4]^{2-}$	20,0	1,30	$1,91\cdot10^2$	2,28	$2,63\cdot10^2$	2,42	$1,0\cdot10^2$	2,00				
$[CoL_2]$			85,10	1,93								
$[CuL_2]$	$1,74\cdot10^2$	2,24	$2,00\cdot10^3$	3,30								
$[FeL_2]^-$	$1,59\cdot10^3$	3,2	$1,26\cdot10^6$	6,1	$2,0\cdot10^8$	8,3						
$[HgL_2]$			$2,62\cdot10^8$	8,43								
$[NiL_2]$	13,2	1,12	64,57	1,81								
Oksalatli ($L - C_2O_4^{2-}$)												
$[AlL_3]^{3-}$	$2,0\cdot10^7$	7,3	$1,00\cdot10^{13}$	13,0	$2,0\cdot10^{16}$	16,3						
$[CdL_2]^{2-}$	$1,00\cdot10^4$	4,0	$4,57\cdot10^5$	5,66								
$[CoL_3]^{4-}$	$5,01\cdot10^4$	4,7	$5,01\cdot10^6$	6,7	$5,01\cdot10^9$	9,7						
$[CuL_2]^{2-}$	$5,01\cdot10^6$	6,7	$2,51\cdot10^9$	9,4								
$[FeL_3]^{4-}$	$5,01\cdot10^4$	4,7			$1,66\cdot10^5$	5,22						
$[FeL_3]^{3-}$	$2,51\cdot10^9$	9,4	$1,59\cdot10^{16}$	16,2	$3,98\cdot10^{19}$	19,6						
$[MgL_2]^{2-}$	$3,55\cdot10^2$	2,55	$2,40\cdot10^4$	4,38								
$[MnL_2]^{2-}$	$6,61\cdot10^3$	3,82	$1,78\cdot10^5$	5,25								
$[NiL_3]^{4-}$	$\sim2\cdot10^5$	~5,3	$\sim3\cdot10^6$	6,5	$\sim10\cdot10^{14}$	~14						

9-jadvalning davomi

$[PbL_2]^{2-}$			$3,47\cdot10^6$	6,54								
$[ZnL_3]^{4-}$	$1,0\cdot10^5$	5,0	$2,29\cdot10^7$	7,36	$1,41\cdot10^8$	8,15						
Salitsilatli (L – $C_6H_4(COO)O^{2-}$)												
$[CuL_2]^{2-}$	$2,0\cdot10^7$	7,3	$1,00\cdot10^{13}$	13,0								
$[FeL_2]^{2-}$	$1,00\cdot10^4$	4,0	$4,57\cdot10^5$	5,66								
$[FeL_3]^{3-}$	$3,02\cdot10^{16}$	16,48	$1,44\cdot10^{28}$	25,16	$6,92\cdot10^{36}$	36,84						
$[NiL_2]^{2-}$	$8,91\cdot10^6$	6,95	$5,62\cdot10^{11}$	11,75								
Sulfosalitsilatli (L – $C_6H_3(COO)(SO_3)^{3-}$)												
$[AlL_3]^{6-}$	$1,59\cdot10^{13}$	13,20	$6,76\cdot10^{22}$	22,83	$7,76\cdot10^{28}$	28,89						
$[CuL_2]^{4-}$	$3,31\cdot10^9$	9,52	$2,82\cdot10^{16}$	16,45								
$[FeL_2]^{4-}$	$7,94\cdot10^5$	5,90	$7,94\cdot10^9$	9,90								
$[FeL_3]^{6-}$	$1,05\cdot10^{15}$	15,02	$5,75\cdot10^{25}$	25,76	$3,98\cdot10^{32}$	32,60						
$[MnL_2]^{4-}$	$1,74\cdot10^5$	5,24	$1,74\cdot10^8$	8,24								
Tartratli (L – $(CHOH)_2(COO)_2^{2-}$)												
$[AlL_2]^-$			$3,98\cdot10^8$	9,6								
$[BaL]^-$	$3,47\cdot10^2$	2,54										
$[BiL_2]^-$			$2,00\cdot10^{11}$	11,3								
$[CaL_2]^{2-}$	$9,55\cdot10^2$	2,98	$1,02\cdot10^9$	9,01								
$[CdL]$	$5,01\cdot10^2$	2,7										
$[CoL]$	$6,31\cdot10^2$	2,8										
$[CuL_4]^{6-}$	$1,00\cdot10^3$	3,0	$1,29\cdot10^5$	5,11	$5,75\cdot10^5$	5,76	$1,59\cdot10^6$	6,20				

9-jadvalning davomi

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

10-jadval

TITRIMETRIK ANALIZ NATIJALARINI HISOBLASH

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

$FeSO_4 \cdot 7H_2O$	1	278,01
$H_2C_2O_4$ (oksalat)	1/2	45,018
$H_2C_2O_4 \cdot 2H_2O$	1/2	63,033
H_2O_2	1/2	17,0073
H_2S (yodometrik)	1/2	17,04
I_2	1/2	126,9045
ICl	1/2	81,1785
$KBrO_3$	1/6	27,833
$KClO_3$	1/6	20,425
K_2CrO_4	1/3	64,730
$K_2Cr_2O_7$	1/6	49,031
$K_3Fe(CN)_6$	1	329,25
$K_4Fe(CN)_6$	1	368,35
$K_4Fe(CN)_6 \cdot 3H_2O$	1	422,40
KIO_3	1/6	35,6668
$KMnO_4$	1/5	31,6068
KNO_2	1/2	42,552
$NaAsO_2$	1/2	69,955
Na_2HAsO_3	1/2	84,954
$Na_2C_2O_4$	1/2	67,000
$NaNO_2$	1/2	34,4977
Na_2S ($S^{2-} \rightarrow S^0$)	1/2	39,02
Na_2SO_3	1/2	63,02
$Na_2S_2O_3$	1	158,10
$Na_2S_2O_3 \cdot 5H_2O$	1	248,18
Askorbin kislota	1/2	88,063
Rezorsin (bromatometrik)	1/6	18,35
Streptotsid (bromatometrik)	1/4	43,05
Streptotsid (nitritometrik)	1	172,21
Sulfamin kislota	1	97,09
Sulfanil kislota	1	209.24
Fenol (bromatometrik)	1/6	15,69
3. Cho'ktirish va kompleksimetriya usullari		
$AgNO_3$	1	169,873
HBr	1	80,912
HCN (Mor, Folgard, Fayans bo'yicha)	1	27,026

HCl	1	36,461
HI	1	127,9124
HNCS (Folgard bo‘yicha)	1	59,09
$Hg(NO_3)_2 \cdot H_2O$	1/2	171,31
$Hg_2(NO_3)_2 \cdot H_2O$	1/2	280,61
KBr	1	119,002
KCN (Mor, Folgard, Fayans bo‘yicha)	1	65,116
KCl	1	74,551
K_2CrO_4	1	97,095
KNCS	1	97,18
KI	1	166,0027
NH_4Cl	1	53,491
NH_4NCS	1	76,12
NaBr	1	102,894
NaCl	1	58,443
NaI	1	149,8942
4. EDTA bilan titrlash usullari		
$BaCl_2$	1	208,24
$Ba(NO_3)_2$	1	261,34
$Bi(NO_3)_3$	1	394,995
$BiONO_3 \cdot H_2O$	1	305,000
$CaCO_3$	1	100,09
$CaCl_2$	1	110,99
$CaCl_2 \cdot 6H_2O$	1	219,08
$Ca(NO_3)_2$	1	164,09
CaO	1	56,08
$CuSO_4$	1	159,60
$Hg(NO_3)_2$	1	324,60
$MgCl_2$	1	95,211
$Mg(NO_3)_2$	1	148,314
$MgSO_4$	1	120,36
$Na_2H_2C_{10}H_{12}O_8N_2$ (EDTA)	1	336,209
$Na_2H_2C_{10}H_{12}O_8N_2 \cdot 2H_2O$ (EDTA-digidrat)	1	372,239
Zn	1	65,38
$ZnCl_2$	1	136,29

$Zn(NO_3)_2$	1	189,39
$Zn(NO_3)_2 \cdot 6H_2O$	1	297,48
ZnO	1	81,38
$ZnSO_4$	1	161,44
$ZnSO_4 \cdot 7H_2O$	1	287,54

11-jadval

KISLOTA-ASOSLI INDIKATORLARNING XARAKTERISTIKALARI

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

Fenolftalein	8,2 – 10,0	rangsiz – qizil
Timolftalein	9,4 – 10,5	rangsiz – ko‘k
Tropeolin 0	11,0 – 13,0	sariq – zarg‘aldoq
Indigokarmin	11,6 – 14,0	ko‘k – sariq
1,3,5-Trinitrobenzol	12,2 – 14,0	rangsiz – zarg‘aldoq

12-jadval

ADSORBSION INDIKATORLARNING XARAKTERISTIKALARI

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

13-jadval

METALLOXROM INDIKATORLARNING XARAKTERISTIKALARI

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

13-jadvalning davomi

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

13-jadvalning davomi

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

13-jadvalning davomi

Timolftaleinkomplekson	3,3-*bis*-(N,N-dikarboksimetil)-aminometilftalein (natriyli tuzi)	Ca, Ba, Sr, Ag, Mn(II)	10 – 11	ko'k	rangsiz
Tiron	1,2-dioksibenzol-3,5-disulfokislota (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-yashil fluoressensiya qizil yoki qizg'ish-binafsha	fluoressensiya so'nadi; eritma pushti sarg'ish-yashil fluoressensiya
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	pushti qirmizi binafsha	sariq zarg'aldoq sariq

13-jadvalning davomi

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

14-jadval

REDOKS INDIKATORLARNING XARAKTERISTIKALARI

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

15-jadval

METALL IONLARINI ANIQLASHDA QO'LLANILADIGAN ORGANIK REAGENTLAR

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

	4-*p*-Nitrofenilazoarsin Tannin Xinalizarin	-//- Tortma Fotometrik
Galliy	Alizarinsulfokislotaning 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 Merkaptobenztiazolon 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	*p*-Dimetilamino	Titrimetrik,

	benzilidenrodanin Ditizon Difenilkarbazon Natriy dietilditiokarbamat Merkaptobenztiazol 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

15-jadvalning davomi

Mis	Ditizon 8,8-Dixinolildisulfid Kaliy ksantat Kuproin Kupferon Merkaptosirka kislota Merkaptobenztiazol Neokuproin α-Nitrozo-β-naftol 8-Oksixinolin Salitsilaldoksim Salitsil kislota Tenoiltriftoratseton 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	*p*-Dimetilamino benzilidenrodanin Ditizon	Fotometrik -//- Tortma

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

15-jadvalning davomi

Qo‘rg‘oshin	Antarnil kislota	Tortma
	Arsatsen	Fotometrik
	Ditizon	-//-
	Difenilkarbazid	-//-
	Merkaptobenztiazol	Tortma
	8-Oksixinolin	Tortma, titrimetrik, fotometrik
	Salitsilaldoksim	Tortma
	Sulfarsatsen	Titrimetrik
	Tioatsetamid	Tortma
	Tionalid	-//-
	Ftal kislota	Fotometrik
	Xinaldin kislota	Tortma
Reniy	8-Merkaptoxinolin	Fotometrik
	Nitron	Tortma
	Rodamin 6J	Fotometrik
Rodiy	Tiobarbitur kislota	Tortma
	Tiomochevina	-//-
	Tionalid	-//-
Rubidiy	Dipikrilamin	Tortma, fotometrik
	Natriy tetrafenilborat	Fotometrik, titrimetrik
Ruteniy	Antranil kislota	Fotometrik
	8-Merkaptoxinolin	-//-
	Tiomochevina	Tortma
	Tionalid	-//-
Rux	Antranil kislota	Tortma
	Arsatsen	Fotometrik

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

15-jadvalning davomi

Seziy	Dipikrilamin Kalignost	Tortma, fotometrik Tortma, titrimetrik, fotometrik
Seriy	8-Oksixinolin Tenoiltriftoratseton	Ekstraksion- fotometrik -//-
Simob	Antranil kislota *p*-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	*p*-Dimetilaminobenzilidenrodanin Kupferon Pirogallol Tannin	-//- Tortma Fotometrik Tortma Fotometrik

	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 Tenoiltriftoratseton Toron Xinaldin kislota	-//- Tortma Fotometrik -//- -//- Ekstraksion- fotometrik Fotometrik Tortma
Vanadiy	Kupferon 8-Merkaptoxinolin 8-Oksixinolin	Tortma Fotometrik Tortma, titrimetrik, fotometrik
Vismut	Diantipirilmetan Ditizon Ksilenoloranj	Tortma Titrimetrik Fotometrik

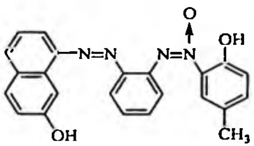
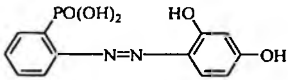
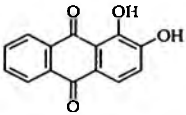
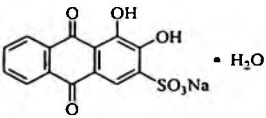
	Kupferon Merkaptobenztiazol Merkaptofeniltiodiazolin 8-Oksixinolin	Tortma -//- Fotometrik Tortma, titrimetrik

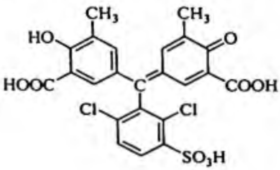
15-jadvalning davomi

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

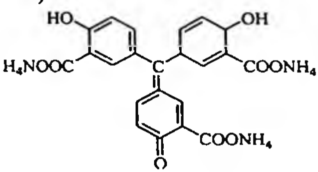
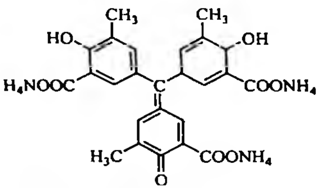
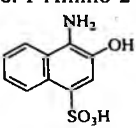
16-jadval

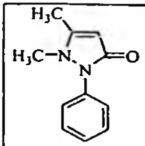
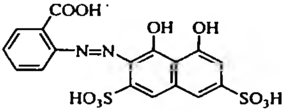
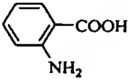
NOORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN MUHIM ORGANIK REAGENTLARNING FORMULALARI

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^-

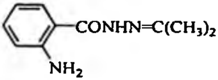
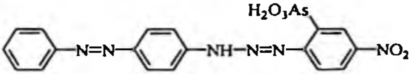
5. Alberon (xromazurol S) 	M.m. 539,34 Al^{3+}, Be^{2+}, In^{3+}, Ga^{3+}, Zr^{IV}, U^{VI}.

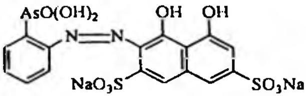
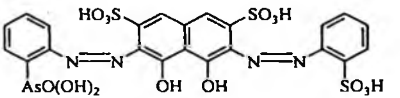
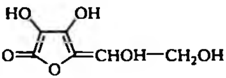
16-jadvalning davomi

6. Alyuminon (aurintrikarbon kislotaning NH_4^+-li tuzi) 	M.m. 473,44 Al^{3+}, Be^{2+}, Zr^{IV}, V^{IV}, Ga^{3+}, Th^{IV}
7. Alyumokrezon (trimetilalyuminon) 	M.m. 515,52 Al^{3+}, Be^{2+}, Mg^{2+}, Ca^{2+}, Co^{2+}, Ni^{2+}
8. 1-Amino-2-naftol-4-sulfokislota (ext-kislota) 	M.m. 239,25 Pd^{2+}, NO_2^-, PO_4^{3-}
9. Antipirin	M.m. 188,23

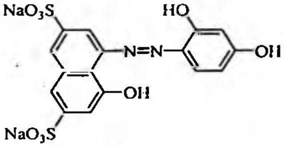
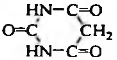
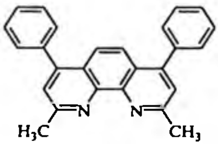
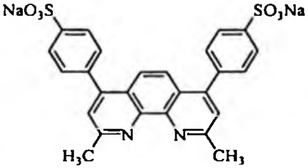
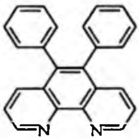
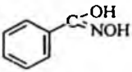
	NO_2^-, $Co(SCN)_4^{2-}$, $HgCl_4^{2-}$, $Zn(SCN)_4^{2-}$, BiI_4^-, $AuCl_4^-$
10. Antrazoxrom (xromotrop 2S) 	M.m. 468,42 Al^{3+}, Be^{2+}, Mg^{2+}, Ca^{2+}, V^{IV}
11. Antranil kislota 	M.m. 137,14 Cd^{2+}, Co^{2+}, Cu^{2+}, Mn^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Th^{IV}, Zn^{2+} (MR_2 ko‘rinishi-da)

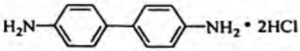
16-jadvalning davomi

12. Antarnil kislotaning izopropilengidrazidi 	M.m. 191,23 V^{V}
13. Arsazen 	M.m. 470,28 Pb^{2+}, Zn^{2+}
14. Arsanil kislota (*p*-aminofenilarson kislota) 	M.m. 217,06 Ti^{IV}, Zr^{IV} (MR_2 ko‘rini-shida)
15. Arsenazo I (uranon I, toron, neotorin)	M.m. 592,29 Al^{3+}, BF_4^-,

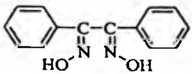
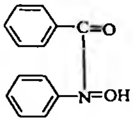
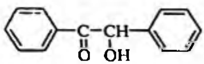
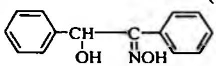
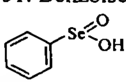
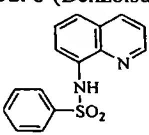
	Be^{2+}, Ca^{2+}, Co^{2+}, Cu^{2+}, Nb^{V}, Ni^{2+}, Ta^{V}, Th^{IV},Ti^{IV}, UO_2^{2+}, V^{IV}, Zr^{IV}, F^-
16. Arsenazo III 	M.m. 776,39 Th^{IV}, U^{IV}, Hf^{IV}, Zr^{IV}, Al^{3+}, Be^{2+}, Ca^{2+}, Cd^{2+}, Hg^{2+}, Mg^{2+}, Pb^{2+}, Ti^{IV}, Zn^{2+}, Y^{3+}
17. Arsenazo M 	M.m. 732,50 La^{III}, Al^{3+}, Ba^{2+}, Ca^{2+}, Cu^{2+}, Ga^{3+}, In^{3+}, Mg^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+}, Sr^{2+}, SO_4^{2-}
18. Askorbin kislota 	M.m. 176,13 Nb^{IV}, Ti^{IV}, U
19. Atsetilatseton (diatsetilmetan) $H_3C-\underset{\underset{O}{\Vert}}{C}-CH_2-\underset{\underset{O}{\Vert}}{C}-CH_3$	M.m. 100,12 Be^{2+}, Cr^{3+}, Fe^{3+}, Mo^{VI}, V^{III}, V^{V}, Zr^{IV}

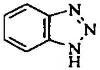
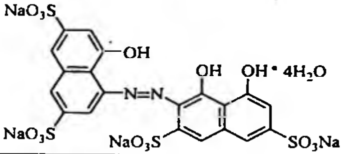
16-jadvalning davomi

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 Fe^{2+}
25. Benzgidroksam kislota 	M.m. 137,14 V^V, Mn^{2+}, U^{IV}, Ti^{IV}

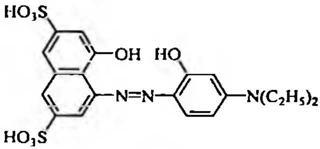
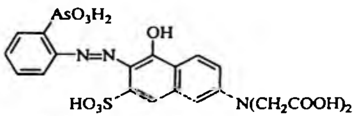
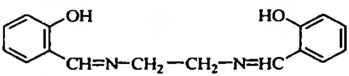
26. Benzidin digidroxlorid 	M.m. 257,16 Ta^{V}, Ti^{IV}, Ce^{IV}, Ge^{IV}, V^{V}, W^{VI}

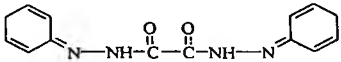
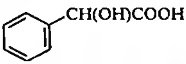
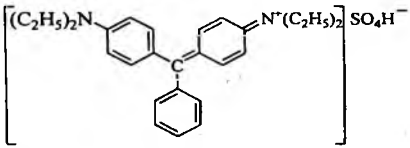
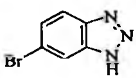
16-jadvalning davomi

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 ($CuR \cdot 2H_2O$ ko'rini-shida), Mo^{VI} (MoO_2R_2 ko'rinishida), Cu^{2+}, V^{V}
31. Benzolselenat kislota 	M.m. 189,07 Sc^{3+} (ScR_3 ko'rinishida)
32. 8-(Benzolsulfanilamino)-xinolin 	M.m. 284,34 Cd^{2+}, Co^{2+}

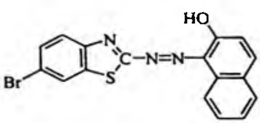
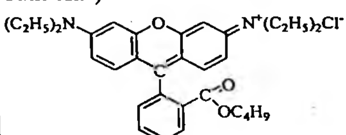
33. Benzotriazol 	M.m. 119,13 Os, Cd^{2+}, Ni^{2+}, Ag^{+}, Zn^{2+}
34. Berillon II 	M.m. 810,56 Be^{2+}, B^{III}, Mg^{2+}, Al^{3+}, Mn^{2+}, Cu^{2+}

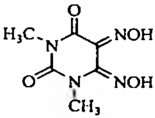
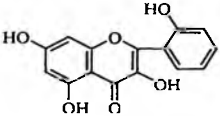
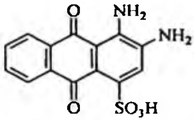
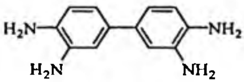
16-jadvalning davomi

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

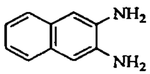
	
39. Bodom kislota (fenilglikol kislota) 	M.m. 125,15 Hf^{IV}, Zr^{IV}, Sc^{3+}
40. Brilliant yashili 	M.m. 482,64 BF_4^-, $SbCl_6^-$, ReO_4^-, $AuCl_4^-$, TaF_5^-, $HgBr_3^-$, $ZnCl_4^-$
41. 5-Brombenztriazol 	M.m. 198,02 Pd^{2+}

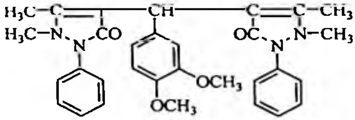
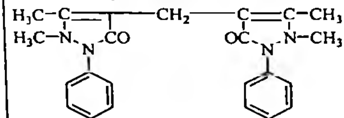
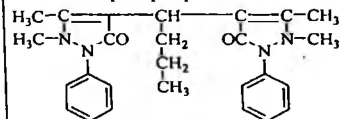
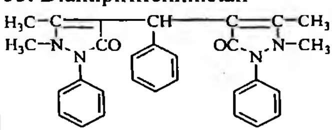
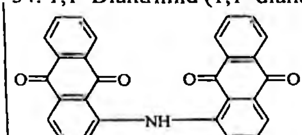
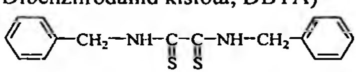
16-jadvalning davomi

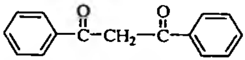
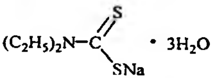
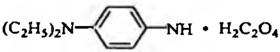
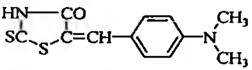
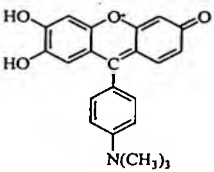
42. Brombenztiazo 	M.m. 384,25 Cd^{2+}
43. Butilrodamin S (butilrodamin V; rodamin S butil efiri) 	M.m. 535,12 As^V, $GaCl_4^-$, NbF_6^-, ReO_4^-, TaF_6^-, $TeBr_6^{2-}$

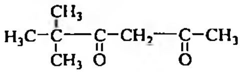
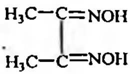
44. Daksim 	M.m. 184,15 Co^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, Pd^{2+}
45. Ditissin 	M.m. 286,24 Al^{3+}, Ga^{3+}, Th^{IV}, Zr^{IV}
46. Diallilditiokarbamidogidrazin (dalsin) $C_3H_5-NH-\underset{O}{\underset{\parallel}{C}}-NH-NH-\underset{O}{\underset{\parallel}{C}}-NH-C_3H_5$	M.m. 230,35 Ag^{+}, Cu^{2+}, 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}

16-jadvalning davomi

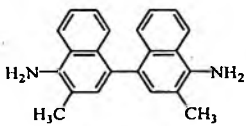
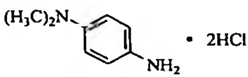
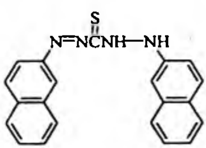
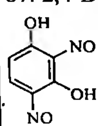
49. 2,3-Diaminonaftalin 	M.m. 158,20 Se^{IV}

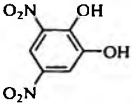
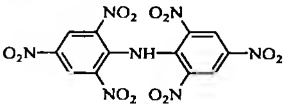
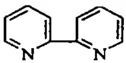
50. Diantipiril-3,4-dimetoksifenilmetan 	M.m. 524,62 V^{V}
51. Diantipirilmetan 	M.m. 388,47 Ti^{IV}, Cd^{2+}, Fe, Bi^{III}, Co^{2+}, Au, Ce, Tl, Ir, Mo, Os, Pd,. Sb
52. Diantipirilpropilmetan 	M.m. 430,55 Ga^{3+}, Ir^{3+}, Te^{IV}, Tl^{III}, Os
53. Diantipirilfenilmetan 	M.m. 460,53 Ga^{3+}, Te^{IV},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

56. Dibenzoilmetan 	M.m. 224,26 UO_2^{2+}, Fe^{2+}
59. Dibromoksin (5,7-dibrom-8-gidroksixinolin) 	M.m. 302,95 Fe^{3+}, Ti^{IV}, Al^{3+}, Co^{2+}, Cu^{2+}, Ga^{3+}, Tl^{III}, V, Zr^{IV}, In^{3+}, Sc^{3+}, UO_2^{2+}
57. N,N'- Dietilditiokarbamat (kupral, DDTK) 	M.m. 225,34 Cu^{2+}, Ni^{2+}, UO_2^{2+}
58. N,N'- Dietil - *p* - fenilendiamin oksalat 	
60. *p*-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

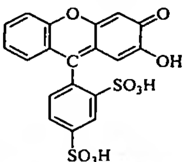
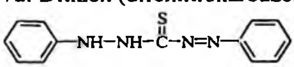
	ko'rinishi-da)
63. Dimetilglioksim (diatsetilglioksim, Chugaev reaktivi) 	M.m. 116,12 Ni^{2+}, Pd^{2+} (MeR_2 ko'ri-nishida), Fe^{2+}, Co, Re

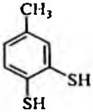
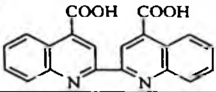
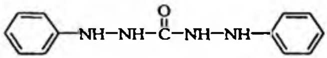
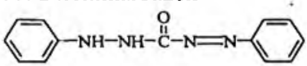
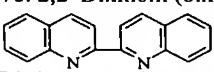
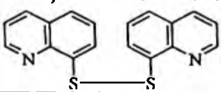
16-jadvalning davomi

64. 3,3'-Dimetilnaftidin 	M.m. 312,41 Zn^{2+}, V^{V}
65. N,N'-Dimetil-*p*-fenilendiamin digidroxlorid (yoki oksalat) [*p*-amino-dimetilanilin] 	M.m. 209,12 H_2S, HS^-, S^{2-}, S
66. Di-2-naftiltiokarbazon (dinaftizon) 	M.m. 356,44 Ag^+, Au^{3+}, Bi^{3+}, Cd^{2+}, Cu^{2+}, Hg^{2+}, Ni^{2+}, Pb^{2+}, Tl^+, Zn^{2+}, In^{3+}, Ga^{3+}
67. 2,4-Dinitrozorezorsin 	M.m. 168,11 Co^{2+}, Fe

68. 3,5-Dinitropirokatexin 	M.m. 200,11 Ge, W
69. Dipikrinamin 	M.m. 439,21 K^+, Cs^+, Rb^+
70. 2,2'-Dipiridil (2,2'-bipiridil) 	M.m. 156,19 Ni^{2+}, Co^{2+}, Zn^{2+}, Fe^{2+}, Cd^{2+}, Co^{2+}, Cu^{2+}, Mn^{2+}, Ni^{2+}, Pb^{2+}, Zn^{2+}

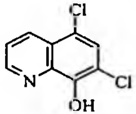
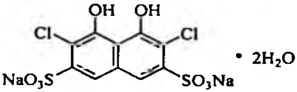
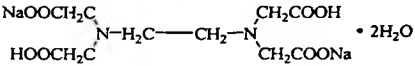
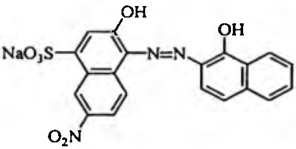
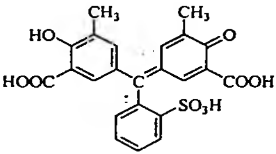
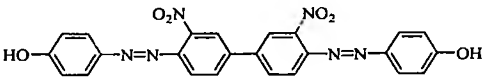
16-jadvalning davomi

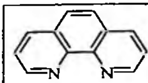
71. Disulfofenilfluoron 	M.m. 480,42 Ge^{IV}, In^{3+}, Ti^{IV}
72. Ditizon (difeniltiokarbazon) 	M.m. 256,32 Ag^+, Au^{III}, Bi^{3+}, Cd^{2+}, Co^{2+}, Cu^{2+}, Hg^{2+}, In^{3+}, Ni^{2+}, Pb^{2+}, Pd^{2+}, Pt^{2+},
73. Ditioksamid HN=C—C=NH SH SH	M.m. 120,19 Co^{2+}, Cu^{2+}, Ni^{2+}, Pt^{IV}, Ru^{IV}, Os, U

74. Ditiol 	M.m. 156,27 Sn^{2+}, W^{VI}, Mo^{VI}
75. Ditsinxonin kislota 	M.m. 469,17 Ti^{IV}, Mo^{VI}, U^{VI}, W^{VI}
76. Difenilkarbazid 	M.m. 242,28 Hg^{2+}, Cr^{VI}, Cu^{2+}, Re, Os
77. Difenilkarbazon 	M.m. 240,26 Cd^{2+}, Co^{2+}, Cu^{+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Hg_2^{2+}, Mn^{2+}, Ni^{2+}, Sn^{2+}, Pb^{2+}, Zn^{2+}
78. 2,2'-Dixinolil (bixinolin, kuproin) 	M.m. 256,31 Cu^{+}, Tl^{3+}
79. 8,8'-Dixinolilsulfid 	M.m. 320,44 Cu^{+}

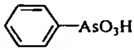
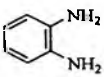
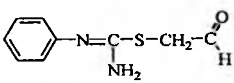
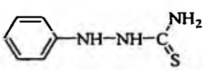
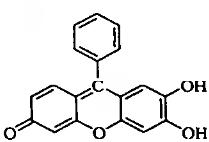
16-jadvalning davomi

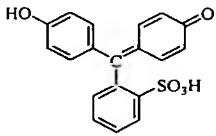
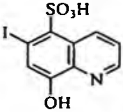
80. 5,7-Dixlor-8-oksixinolin (dixloroksin)	M.m. 214,05 Ti^{IV}, Cu^{2+}, Fe^{3+}, Pb^{2+}, Al^{3+}, Co^{2+},

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

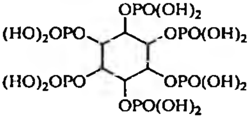
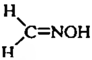
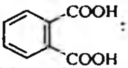
	Fe^{2+}, Cu^{2+}, Ru, Ni, Zn^{2+}, Mo, Hg, Mn

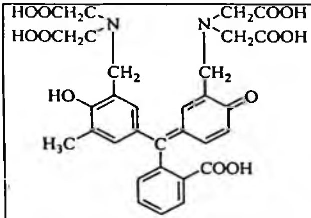
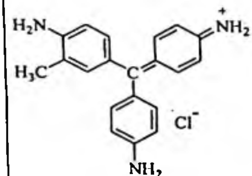
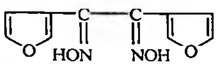
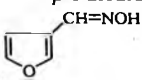
16-jadvalning davomi

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^-

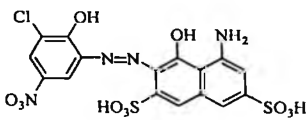
	
93. Ferron 	M.m. 351,12 Al^{3+}, Fe^{3+}, V

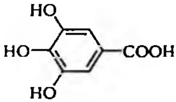
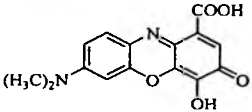
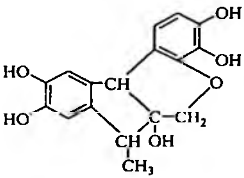
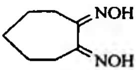
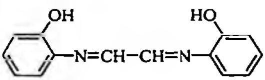
16-jadvalning davomi

94. Fitin kislota 	M.m. 660,04 Th^{IV}, Nb^{V}, Zr^{IV}, Se^{III}
95. Formaldoksim 	M.m. 45,04 Fe^{2+}, Fe^{3+}, Mn^{2+}, Ni^{2+}, V, Ce
96. Ftal kislota 	M.m. 166,13 Pb^{2+}
97. Ftaleinkomplekson (*o*-krezolftaleinkomplekson)	M.m. 636,61 Ba^{2+}, Ca^{2+}, Sr^{2+}

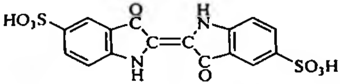
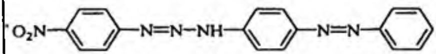
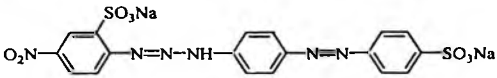
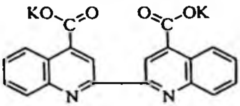
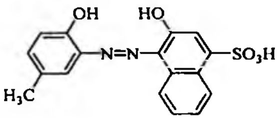
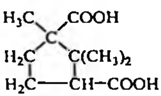
	
98. Fuksin asosi 	M.m. 337,85 Br_2, BF_4^-, ReO_4^-, S^{IV}
99. α-Furildioksim 	M.m. 238,20 Ni^{2+}, Co^{2+}, Pd^{2+}, Re
100. β-Furfuraldoksim (β-furfuraloksim) 	M.m. 111,10 Pd^{2+}

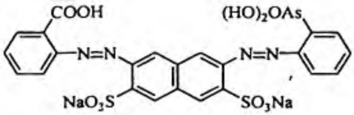
16-jadvalning davomi

101. Gallion 	M.m. 536,87 Ga^{3+}, In^{3+}
102. Gallat kislota	M.m. 170,12

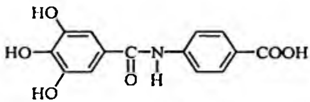
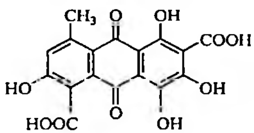
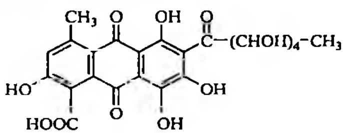
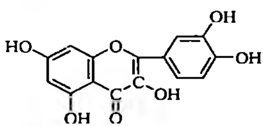
	V^{V}, Ta^{V}
103. Gallotsianin 	M.m. 300,27 Ga^{III}, Hg, Pb, Sb^{III}
104. Gematoksilin 	M.m. 302,28 Al^{3+}, B^{III}, In^{3+}, Fe^{2+}, Fe^{3+}, Nb^{V}, Sn^{IV}, Ta^{V}, V^{V}, Zn^{2+}
105. Geptoksim 	M.m. 156,18 Ni^{2+}, Pd^{2+}
106. Gidroxinon 	M.m. 110,11 Nb^{V}, Ta^{V}, W^{VI}, Au, Cr, Ir, Ru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

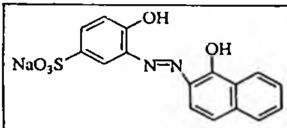
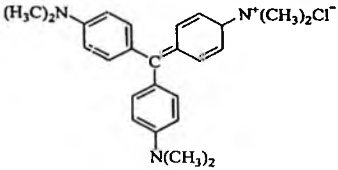
16-jadvalning davomi

108. Indigokarmin 	M.m. 254,29 Cl_2, ClO^-, H_2S
109. Kadion 	M.m. 346,35 Cd^{2+}
110. Kadion S (S) (Kadion II) 	M.m. 550,43 Cd^{2+}
111. Kaliy 2-2'-bisinxoninat 	M.m. 420,51 Cu^{I}
112. Kaliy dietilditiofosfat $(C_2H_5O)_2P(=S)SK$	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

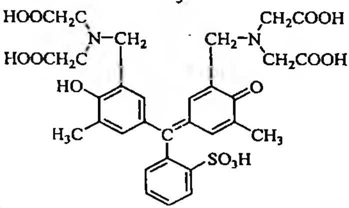
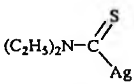
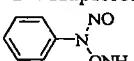
	Ba^{2+}, SO_4^{2-}

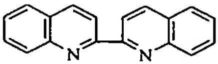
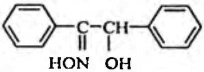
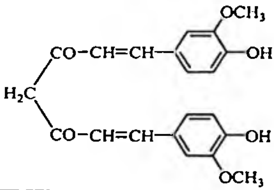
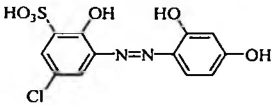
16-jadvalning davomi

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

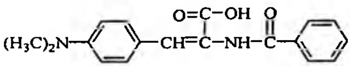
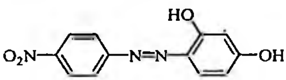
	
121. Kristall binafsha (kristallviolet) 	M.m. 407,99 Cd^{2+}, Sb^{V}, Ta^{V}, Ti^{3+}, Zn^{2+}, BF_4^-, ReO_4^-, ClO_4^-, SCN^-, $Pt(SCN)_6^{2-}$

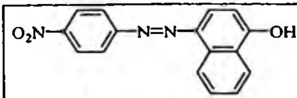
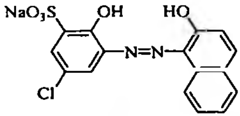
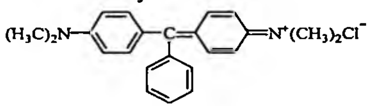
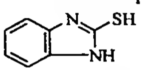
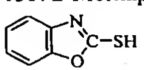
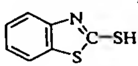
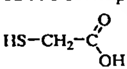
16-jadvalning davomi

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^{IV}, V^{V}

125. Kuproin 	78 ga qarang
126. Kupron 	30 ga qarang
127. Kurkumin 	M.m. 368,39 B^{III}
128. Lyumogallion 	M.m. 344,73 Ga^{3+}, Nb^{V}, Mo^{VI}, Sc^{3+}, Sn^{IV}

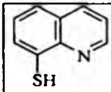
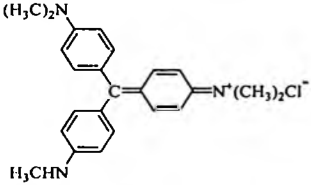
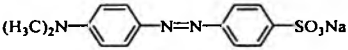
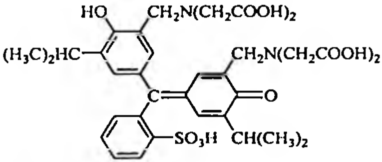
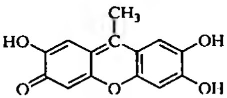
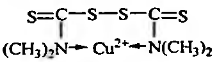
16-jadvalning davomi

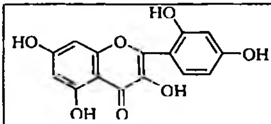
129. Lyumokupferon 	M.m. 310,35 Cu^{2+}
130. Magnezon I 	M.m. 259,23 Mg^{2+}
131. Magnezon II	M.m. 293,29

	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-Merkaptobenztiazol (kaptaks) 	M.m. 167,24 Cu^{2+}, Bi^{3+}, Tl^{+}
137. Merkaptosirka kislota 	M.m. 92,11 Fe^{2+}, Al^{3+}, W^{VI}, Sn^{2+}

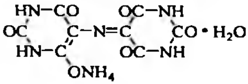
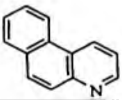
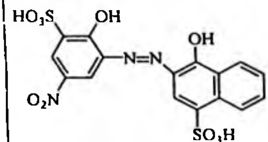
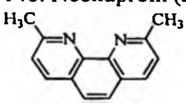
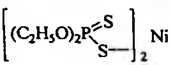
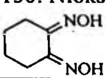
16-jadvalning davomi

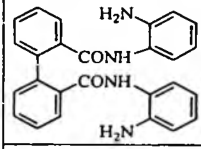
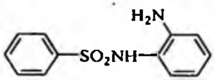
138. 8-Merkaptoxinolin (8-Tioksin, tiooksin)	M.m. 161,23 Cu^{2+}, Fe^{3+}, In^{3+},

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

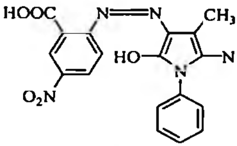
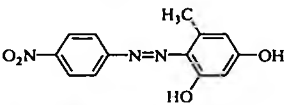
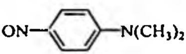
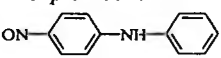
	Th^{IV}, Zr^{IV}, U, W

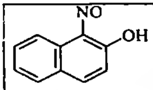
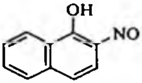
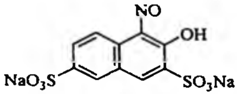
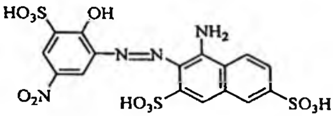
16-jadvalning davomi

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

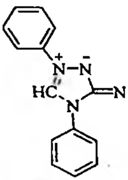
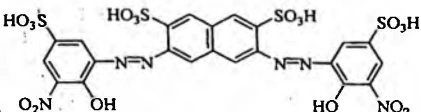
151. Nitriton A 	M.m. 424,49 NO_2^-
152. Nitriton B 	M.m. 220,29 NO_2^-

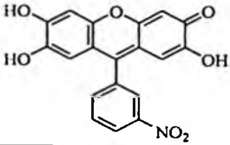
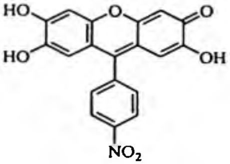
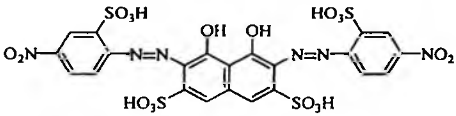
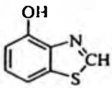
16-jadvalning davomi

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+},

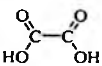
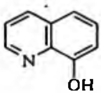
	Ni^{2+}
158. 2-Nitrozo-1-naftol (β-nitrozo-α-naftol) 	M.m. 173,17 Co^{3+}, Ni^{2+}, Pd^{2+}, Rh
159. Nitrozo-R-tuz 	M.m. 377,25 Co^{2+}, Fe, Pd^{2+}, U, Zr, K
160. Nitroksaminazo 	M.m. 548,49 Co, Pd^{2+}

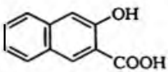
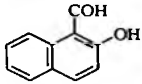
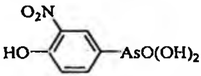
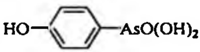
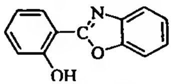
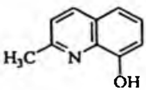
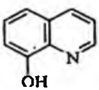
16-jadvalning davomi

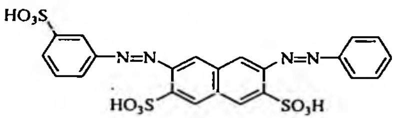
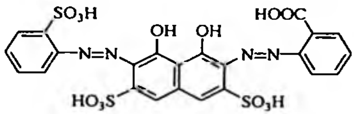
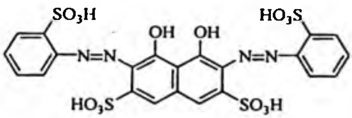
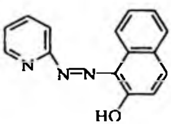
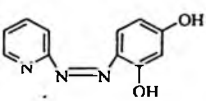
161. Nitron 	M.m. 312,37 NO_3^-, ClO_3^-, ClO_4^-, ReO_4^-, BF_4^-
162. Nitrosulfofenol S 	M.m. 810,62 Nb^{IV}, Zr^{IV}

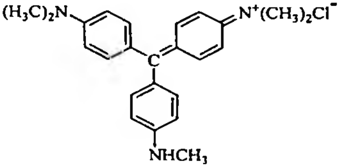
163. *o*-Nitrofenilfluoron 	M.m. 365,30 Zr^{IV}, Nb^{V}
164. *p*-Nitrofenilfluoron 	M.m. 365,30 Sn^{IV}
165. Nitxromazo (nitroortanil C) 	M.m. 778,62 Ba^{2+}, Sr^{2+}, SO_4^{2-}, S
166. 4-Oksibenztiazol 	M.m. 151,18 Cu^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}

16-jadvalning davomi

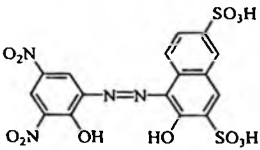
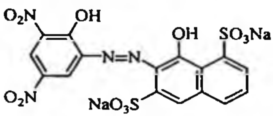
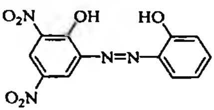
167. Oksalat kislota 	M.m. 90,04 Ca^{2+}, La^{3+}, Th
168. Oksin 	175 ga qarang

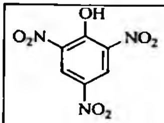
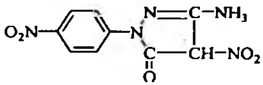
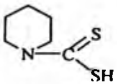
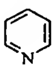
169. 2-Oksi-3-naftoy kislota 	M.m. 188,18 Al^{3+}, Be^{2+}
170. 2-Oksinaftalinkarbaldegid-1 	M.m. 172,18 Be^{2+}, Mg^{2+} (MR_2 ko'ri-nishida)
171. 4-Oksi-3-nitrofenilarson kislota 	M.m. Cd^{2+}
172. *p*-Oksifenilarson kislota 	M.m. 218,04 Sn^{IV}, Ti^{IV}, Zr^{IV}
173. 2-(2-Oksifenil)benzoksazol 	M.m.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

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

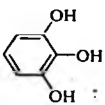
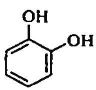
181. Pentametil binafsha 	Sb^{V}, Zn^{2+}, Cd^{2+}, Tl^{3+}, Hg^{2+}

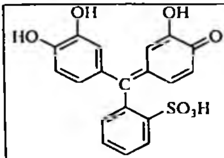
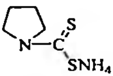
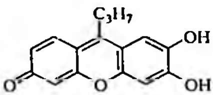
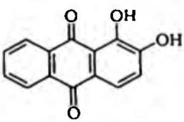
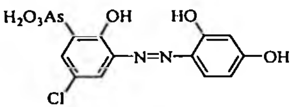
16-jadvalning davomi

182. Pikramin R 	M.m. 514,39 Nb^{V}, Zr^{IV}
183. Pikramin-epsilon 	M.m. 558,36 Cu^{2+}, Hf^{IV}, Nb^{V}, Zr^{IV}
184. Pikraminazofenol 	M.m. 304,22 Ca^{2+}, Mg^{2+}
185. Pikrin kislota	M.m. 299,11 Bi^{3+}

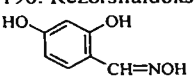
	
186. Pikrolon kislota 	M.m. 264,20 Pb^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, Th^{IV} (MR_n ko‘rinishida; n – metall valentligi)
187. Piperidin-N-ditiokarbon kislota 	M.m. 161,29 Co, Ni, Cu, Rh, Mg^{2+}
188. Piridin (+ SCN^-) 	Co^{2+}, Ni^{2+}, Zn^{2+}, Cd^{2+}

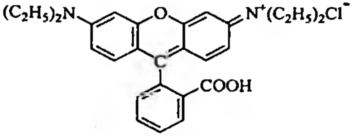
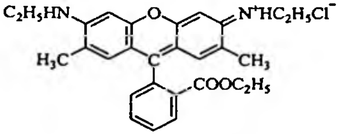
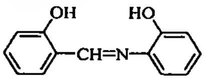
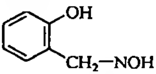
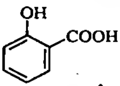
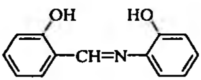
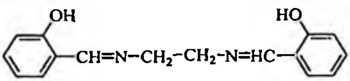
16-jadvalning davomi

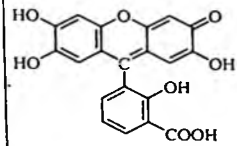
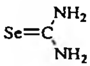
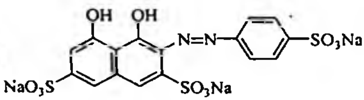
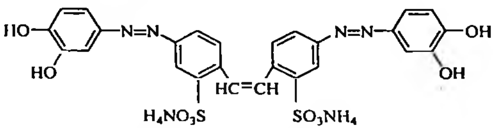
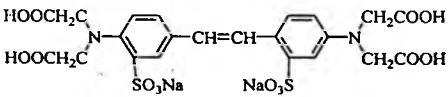
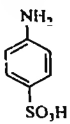
189. Pirogallol 	M.m. 126,11 Nb, Ta, Ti, Zr, Sb, Bi, O_2
190. Pirokatexin 	M.m. 110,11 Ti, Mo, V, Nb, Ta, Ge
191. Pirokatexin binafsha (pirokatexinsulfoftalein)	M.m. 386,38 B^{III}, Bi^{3+}, In^{3+},

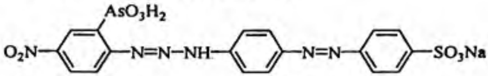
	Ge^{IV}, Sc^{3+}, Sn^{2+}, Ta^{V}, Zr^{IV}, Th^{IV}
192. N-Pirrolidinilditiokarbon kislotaning NH_4-li tuzi 	M.m. 164,30 Nb^{V}, Bi^{3+}, Sb^{3+}, Co, Ni
193. Propilfluoron 	M.m. 286,28 Sc^{3+}, Te^{IV}
194. Purpurin 	M.m. 256,21 Zr^{IV}, F^{-}
195. Rezarson 	M.m. 388,60 Ge^{IV}, Mo^{VI}, Ga, Th

16-jadvalning davomi

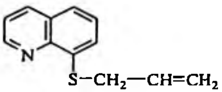
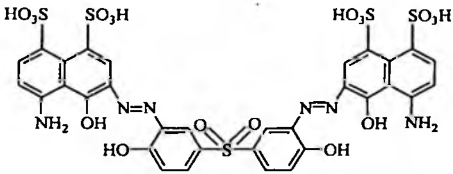
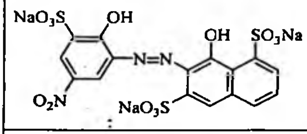
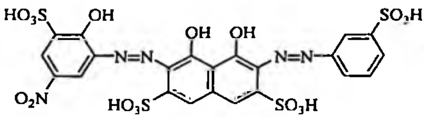
196. Rezorsilaldoksim 	M.m. 153,13 Fe^{3+}

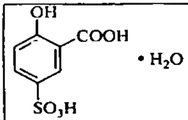
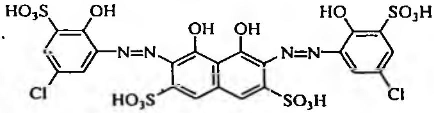
197. Rodamin V (rodamin S) 	M.m. 479,02 $AuCl_4^-$, CdI_4^{2-}, $GaCl_4^-$, $InBr_4^-$, ReO_4^-, WO_4^{2-}, $Zn(SCN)_4^{2-}$
198. Rodamin 6J 	M.m. 479,02 Ta^V, $Zn(SCN)_4^{2-}$, In^{3+}, ReO_4^-, $TlCl_4^-$, $GaCl_4^-$
199. Salitsilal-*o*-aminofenol 	M.m. 213,24 Mn^{2+}, Al^{3+}, Ga^{3+}
200. Salitsilaldoksim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

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

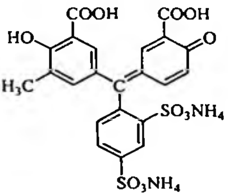
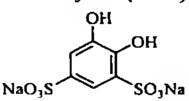
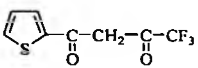
210. Sulfarsazen (plyumbon) 	M.m. 572,32 Pb^{2+}, Zn^{2+}, Hg^{2+}

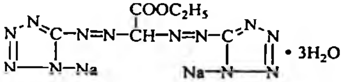
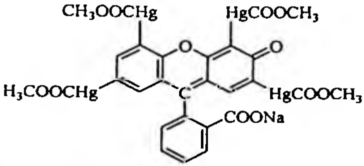
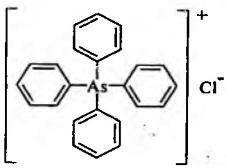
16-jadvalning davomi

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

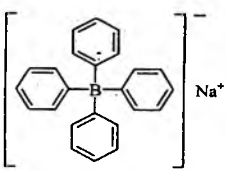
	Fe, Ti^{IV}
216. Sulfoxlorfenol S 	M.m. 789,52 Nb^{V}, Mo^{VI}

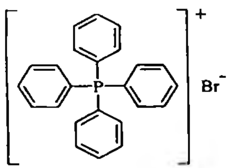
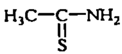
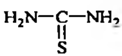
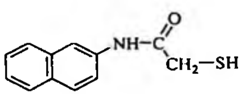
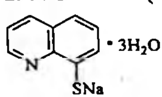
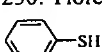
16-jadvalning davomi

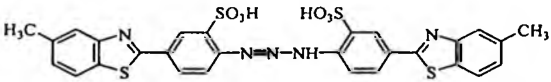
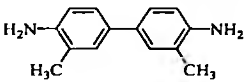
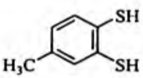
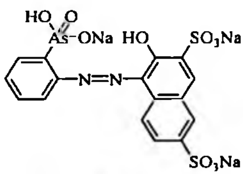
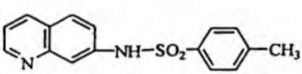
217. Sulfoxrom 	M.m.584,57 Al^{3+}, F^{-}, Be^{2+}, Ga^{III}
218. Tayron (tiron) 	M.m. 314,19 Fe^{3+}, Ti^{IV}, Nb^{V}, Mo^{VI}, Ce^{IV}, Os
219. 2-Tenoiltriftoratseton (TTFA, TTA) 	M.m. 222,18 Al^{3+}, Ba^{2+}, Be^{2+}, Bi^{3+}, Cd^{2+}, Ce^{2+}, Co^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, In^{3+}, Nb^{V},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

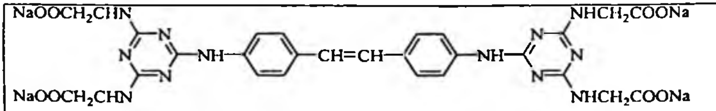
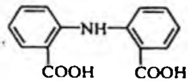
220. Tetra 	M.m. 378,22 Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, Pd^{2+}, Cu^{2+}, Zn^{2+}
221. Tetrasimobatsetatfluoressein, Nali tuzi 	M.m. 1372,80 S^{2-}
222. Tetrafenilarsoniy xlorid 	M.m. 418,80 ReO_4^-, Os^{VI}, Cd^{2+}, Mn^{2+}, Hg^{2+}, Sn^{2+}, Zn^{2+}

16-jadvalning davomi

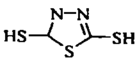
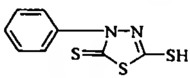
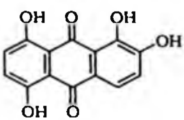
223. Tetrafenilboratning natriyli tuzi (kalignost) 	M.m. 342,22 K^+, Cs^{2+}, Rb^+, NH_4^+, Tl^+
224. Tetrafenilfosfoniy bromid	M.m. 419,30 Os^{VI}, ReO_4^-

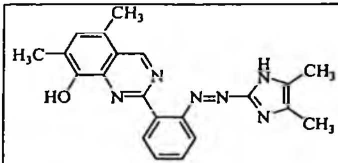
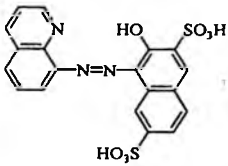
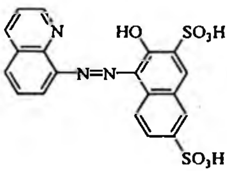
	
225. Tioatsetamid 	M.m. 75,13 Cd^{2+}, Cu^{2+}, As, Sb, Bi^{3+}, Mo^{VI}, Pb^{2+}, Pd^{2+}
226. Tioglikol kislota HS – CH_2 – COOH	M.m. 92,11 U, Fe, Co^{2+}, Ni^{2+}, Mo, Pd^{2+}, Cr^{3+}, Se, Ta
227. Tiokarbamid 	M.m. 76,12 Ir, Rh, Ru, Bi^{3+}, Os^{VI}, Te^{IV}, Se^{IV}, Pd^{2+}, NO_2^-
228. Tionalid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

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

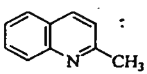
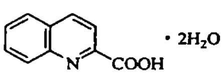
	
238. Vanadoks (2,2'-dikarboksidifenilamin) 	M.m. 257,25 V^{V}

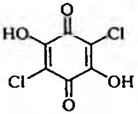
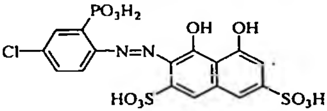
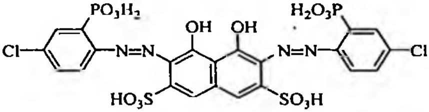
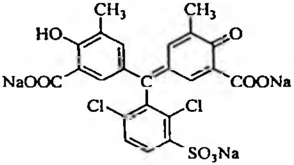
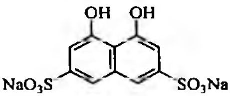
16-jadvalning davomi

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+},

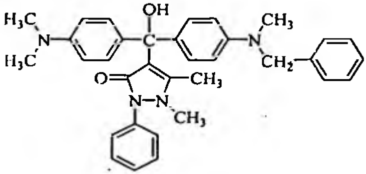
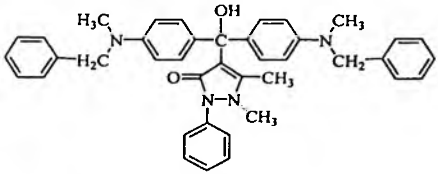
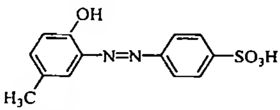
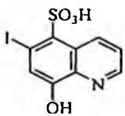
	Zr^{IV}
243. Xinolinazo E 	M.m. 395,33 Co^{2+}
244. Xinolinazo R 	M.m. 395,33 Co^{2+}

16-jadvalning davomi

245. Xinaldin 	M.m. 143,19 Pd, W, Ti^{IV}, Os^{VIII}, Ru^{IV}, Rh^{IV}, Pt^{IV}
246. Xinaldin kislota 	M.m. 209,20 Cu^{2+}, Zn^{2+}, Pb^{2+}, Ag^{+}, Mn^{2+}, Ni^{2+}, Co^{2+}, Fe^{2+},

	Cd^{2+}, UO_2^{2+}
247. Xloranil kislota 	Al^{3+}, Ca^{2+}, Mo^{VI}, Pb^{2+}, Sr^{2+}
248. Xlorfosfonazo I 	M.m. 538,82 U^{VI}
249. Xlorfosfonazo III 	M.m. 757,36 U^{VI}, Se^{3+}, Ba^{2+}, Sr^{2+}, Mg^{2+}, Th^{IV}
250. Xromazurol S 	5 ga qarang
251. Xromotrop kislotaning dinatriyli tuzi 	M.m. 364,25 Cr^{VI}, Ti^{IV}, Nb^{V}, Ta^{V}

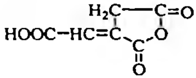
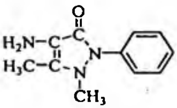
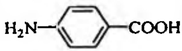
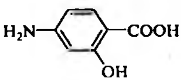
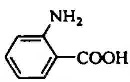
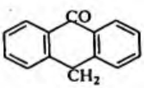
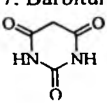
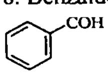
16-jadvalning davomi

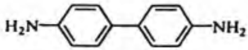
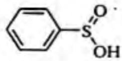
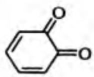
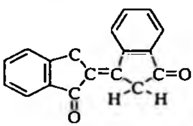
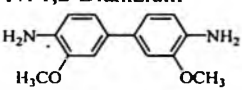
252. Xrompirazol I 	M.m. 532,68 P, As, Mo, BF_4^-, $TlCl_4^-$, $AuCl_4^-$, $SbCl_6^-$, BiI_4^-, ReO_4^-, Zn^{2+}
253. Xrompirazol II 	M.m. 608,78 P, As, Mo, BF_4^-, $TlCl_4^-$, $AuCl_4^-$, $SbCl_6^-$, BiI_4^-, ReO_4^-, Zn^{2+}
254. X-Sirkonon (sirkonon) 	M.m. 292,31 Zr^{IV}
255. 7-Yod-8-oksixinolin-5-sulfokislota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

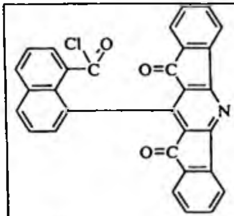
17-jadval

ORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN MUHIM ORGANIK REAGENTLAR

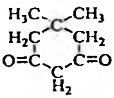
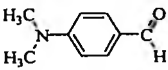
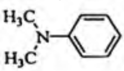
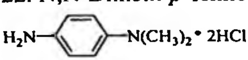
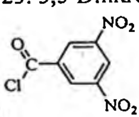
Reagent	Aniqlanadigan moddalar

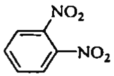
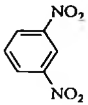
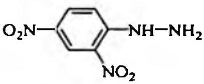
1. Akonit angidrid 	Uchlamchi aminlar
2. 4-Aminoantipirin ($K_4[Fe(CN)_6]$ yoki $(NH_4)_2S_2O_8$ bilan birga) 	Fenollar, xlorfenollar, naftollar, aromatik aldegidlar
3. 4-Aminobenzoy kislota (PAB) 	Flavinlar, timol, metiletilketon
4. 4-Aminosalitsil kislota (PASK) 	Aldozalar
5. Antranil kislota 	Aldegidlar,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

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

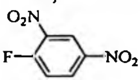
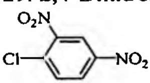
	va aralkilaminlar

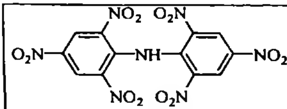
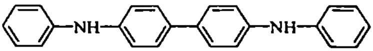
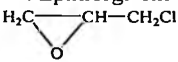
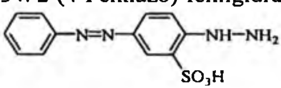
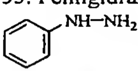
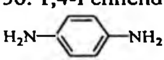
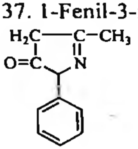
17-jadvalning davomi

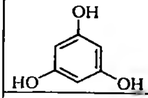
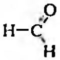
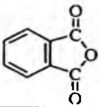
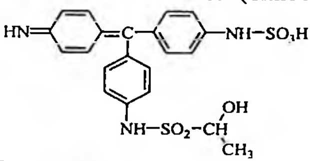
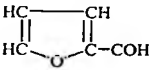
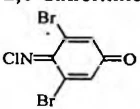
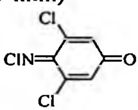
19. Dimedon 	Aldegidlar
20. 4-Dimetilaminobenzaldegid 	Birlamchi aromatik aminlar, sulfanilamidlar, to'yinmagan uglevodorodlar
21. N,N-Dimetilanilin 	1,3-Dinitrozobirikmalar, polinitrobirikmalar, 4-nitrobenzoy kislota efirlari
22. N,N-Dimetil-*p*-fenilendiamin gidroxlorid 	Merkaptanlar, disulfidlar
23.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

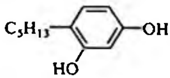
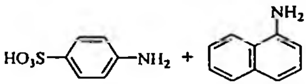
24. 1,2-Dinitrobenzol 	Fluoren va uning hosilalari
25. 1,3-Dinitrobenzol 	Aldegidlar, ketonlar
26. 1,4-Dinitrobenzol 	Fluoren va uning hosilalari, siklopentadiyen
27. 2,4-Dinitrofenilgidrazin 	Aldegidlar, ketonlar, aldozalar

17-jadvalning davomi

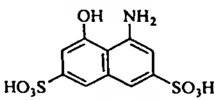
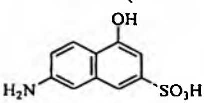
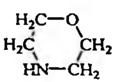
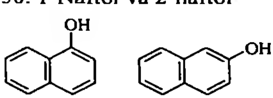
28. 2,4-Dinitroftorbenzol 	Tiollar, birlamchi va ikkilamchi aminlar
29. 2,4-Dinitroxlorbenzol 	Birlamchi alifatik va aromatik aminlar, piridin va uning hosilalari
30. Dipikrilamin (geksanitrodifenilamin)	Siklopentadiyen va hosilalari

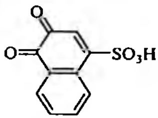
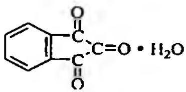
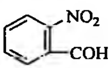
	
31. Difenilbenzidin 	Xinonlar, nitrozo birikmalar, organik peroksidlar, xloraminlar
32. Epixlorgidrin 	Piridin va uning hosilalari
33. Etilendiamin $H_2N-CH_2-CH_2-NH_2$	Xinonlar va xinon hosil qiluvchi moddalar
34. 2-(4-Fenilazo)-fenilgidrazinsulfokislota 	Atsetaldegid
35. Fenilgidrazin 	Aldegidlar, monozalar
36. 1,4-Fenilendiamin + oksidlovchilar 	Fenollar, birlamchi aromatik aminlar, diolefinlar, izopren, xloropren
37. 1-Fenil-3-metil-pirazolon-5 	Diazobirikmalar

38. Floroglyutsin 	Furfurol, vanilin, 1,4-benzoxinon, gidroxinon
39. Formaldegid (+ H_2SO_4) 	Aromatik uglevodorodlar, indol va hosilalari, polifenillar, xlorbenzol
40. Ftal angidrid 	Alifatik spirtlar
41. Fuksinsulfat kislota (Shiff reaktivi) 	Aldegidlar, alanin, albumin, aminosirka kislota, meteonin
42. Furfurol 	Atseton, izopropanol, borneol, metilketon, terpenlar
43. Gibbs reaktivi (2,6-dibromxinonxlorimin yoki 2,6-dixlorxinonxlor-imin)  	*p*-Holati bo'sh bo'lgan fenollar, xlorlangan fe-nollar, tiollar, kumarin

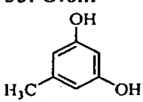
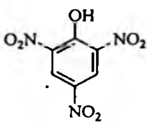
44. 4-Geksilrezorsin 	Akrolein
45. Griss reaktivi (sulfanil kislota + 1-naftilamin) 	Nitrat kislota efirlari, nitrozobirikmalar, nitrobirikmalar

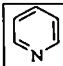
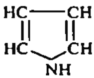
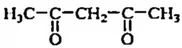
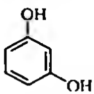
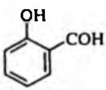
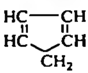
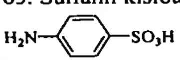
17-jadvalning davomi

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

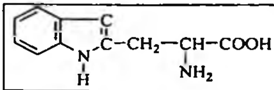
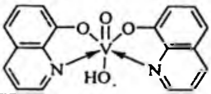
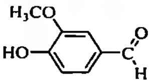
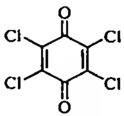
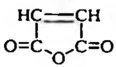
17-jadvalning davomi

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 	Birlamchi aminlar
60. Rezorsin (+ H_2SO_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

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

18-jadval

ORGANIK MODDALARNI ANIQLASHDA QO'LLANILADIGAN BA'ZI NOORGANIK REAGENTLAR

Reagent	Aniqlanadigan moddalar
1. Gidroksilamin gidroxlorid ($FeCl_3$ bilan birga) $NH_2OH{\cdot}HCl$ (M.m. 69,49)	Xinonlar, angidridlar, kislota amidlari, imidlar,

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

ANALITIK TERMINLARNING QISQA LUG'ATI

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

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

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

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

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

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

Analitik kimyo – moddaning kimyoviy tarkibini aniqlash usullari haqidagi fan

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

Analitik reaksiyalarning sezgirligi – *Topilish minimumi*ga qarang

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

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

Analiz usuli – modda analizining asosini tashkil etgan prinsiplarning qisqa tavsifi

Analiz usulikasi – analizning aniqligini va to'g'riligini ta'minlaydigan 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 eritmalari qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usullari

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

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

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

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

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

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

Diapazon – berilgan usulika bo'yicha belgilangan miqdorlar qiymatlarining oraliqlari

Dispersiya – tasodifiy kattaliklarning o'rtacha qiymatiga nisbatan tarqalishi

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Gravimetrik faktor – aniqlanadigan namudagi komponent miqdorini ifodalaydigan koeffitsiyent bo'lib, aniqlanadigan komponent bilan gravimetrik shakl molyar massalarining nisbatini ko'rsatadi

Gravimetriya (tortma analiz) – ma'lum tarkibli birikma sifatida ajratilgan namuna komponentining massasini aniq o'lchashga asoslangan kimyoviy analizning miqdoriy usuli

Guruh reagenti – ko'p sonli noorganik ionlar yoki organik birikmalarning muayyan sinflari bilan xarakterli mahsulotlar (cho'kma, gaz, rangli eritmalar) hosil qiladigan reaktiv

Hajmiy analiz – *Titrimetrik analiz*ga qarang

Identifikatsiya – fizikaviy, fizik-kimyoviy va kimyoviy xossalarni taqqoslab, noma'lum birikmani boshqa ma'lum birikmaga o'xshashligini aniqlash

Indikatorlar – muhit sharoitiga (gidroksoniy, metall ionlarining konsentratsiyasi, moddalarning oksidlangan va qaytarilgan shakllarining nisbati va boshqalarga) bog'liq holda rangini o'zgartiruvchi organik va noorganik moddalar

Ionitlar – o'zining ionlarini eritma ionlariga almashtira oladigan qattiq qiyin eruvchan moddalar

Ionlanish – neytral atomlar yoki molekulalardan ionlarning hosil bo'lishi

Ishonchlilik chegarasi – o'rtacha qiymatni saqlash ehtimolligi mavjud bo'lgan oraliq

Ichki kompleks birikmalar – tuz hosil qiluvchi va kompleks hosil qiluvchi guruhlarni saqlagan organik reagentlarning metall ionlari bilan hosil qilgan siklik kompleks birikmalari bo'lib, markaziy atom shu sikllarning birida yoki bir nechtasida 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 molekulalar yoki ionlarning umumiy soni

Ligandlar – kompleks birikmada markaziy atom bilan bog'langan molekulalar yoki ionlar

Makrokomponentlar – aniqlanadigan komponentda massa ulushi 10 – 100% bo'lgan moddalar

Massalar ta'siri qonuni – muvozanatda turgan kimyoviy reaksiyalardagi ta'sir etuvchi moddalar orasidagi nisbatlarni o'rnatuvchi qonun

Merkurimetriya – titrant sifatida simob (II) tuzlarining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Mikrokomponentlar – aniqlanadigan komponentda massa ulushi 10^{-3}% dan kam bo'lgan moddalar

Mikrokristalloskopiya – analiz qilinadigan eritma tomchisiga reaktivning ta'siridan o'ziga xos shakldagi kristallarning hosil bo'lishiga asoslangan sifat analizining usuli

Minimal hajm – aniqlanadigan ionning topilish minimumini saqlagan eritma hajmi

Miqdor – 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, asboblar va 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 eritmalari qo‘llaniladigan miqdoriy analizning titrimetrik usullar majmui

Oksidlanish-qaytarilish potensiali – oksidlanish-qaytarilish juftini saqlagan eritmaga inert (platina yoki oltin) elektrod tushirilganda yuzaga keladigan potensial. Nernst tenglamasi bilan ifodalanadi

Oksredmetriya – oksidlanish-qaytarilish reaksiyalariga asoslangan miqdoriy analizning titrimetrik usullar majmui

Parallel aniqlashlar – bir xil sharoitda bitta namuna uchun olingan ko‘p sonli natijalar

Permanganatometriya – titrant sifatida kaliy permanganat eritmasining qo‘llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Protoliz – kuchsiz elektrolitlar yoki kam 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, molekulalar, radikallar, elektronlar va hokazo

Reduktometriya – qaytaruvchilarning standart eritmalari qo'llaniladigan miqdoriy analizning titrimetrik usullar majmui

Selektiv reagentlar – muayyan sharoitlarda faqat kamroq sondagi ionlar bilan o'xshash reaksiyalar beradigan analitik reagentlar

Sentrifugalash – markazdan qochma kuchlar ta'sirida aralashmalarni qattiq va suyuq fazalarga ajratish

Serimetriya – titrant sifatida seriy tuzlarining qo'llanilishiga asoslangan miqdoriy analizning titrimetrik usuli

Sistematik xatolar – aniqlanadigan komponent miqdorining haqiqiy va o'rtacha qiymatlari orasidagi statistik farq

Sifat – moddiy 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

Solvoliz – erigan modda va erituvchi orasida boradigan va muayyan tarkibli yangi kimyoviy birikmalarning hosil bo'lishiga olib keladigan almashinish reaksiyalari

Spetsifik reaksiyalar – muayyan sharoitda faqat bitta moddani (ionni) topishga (aniqlashga) imkon beradigan analitik reaksiyalar

Standart elektrod potensial – 25°C va atmosfera bosimida elektrod potensialni belgilovchi ionlarning aktivligi 1 ga teng bo'lgan eritmadagi elektrodning potensiali

Standart (titrlangan) eritmalar – miqdoriy analizning titrimetrik usullarida qo'llaniladigan aniq konsentratsiyali eritmalar

Standart namunalar – turli kimyoviy analiz usullari uchun qo'llaniladigan aniq kimyoviy tarkibli etalonlar

Standart chetlanish (o'rtacha kvadratik chetlanish) – xatoliklar xarakteristikasi bo'lib, dispersiyadan olingan kvadrat ildizning musbat qiymatini ifodalaydi

Suyultirish chegarasi – 1 g aniqlanadigan ionni saqlagan eritmaning millilitr miqdori

Titr (g/sm^3, g/ml) – 1 sm^3 yoki 1 ml eritmadagi moddaning massasi

Titrimetrik analiz (hajmiy analiz) – aniqlanadigan eritma bilan reaksiyasiga sarflanadigan ma'lum konsentratsiyali reagent eritmasining hajmini o'lchashga asoslangan miqdoriy analiz usullarining majmui

Titrlangan eritmalar – *Standart eritmalar*ga qarang

Titrlash – titrimetrik analizning asosiy usuli bo'lib, unda ma'lum konsentratsiyali reagent eritmasi byuretkadan aniqlanadigan eritmaga ekvivalent nuqtaga yetguncha qo'shiladi

Titrlash egri chiziqlari – titrlash jarayonining grafik ko'rinishi. Egri chiziqlar titrant hajmi (V) – ionlar konsentratsiyasi (C) koordinatalarida tuziladi

Titrlash sakramasi – titrlash egri chizig'ining keskin o'zgarishi. Titrantning 99,9 – 100,1% oraliqdagi qo'shilishida kuzatiladi

Tomchi analiz – filtr qog'oz, shisha plastinka ustida eritmalarning tomchilari orasida boradigan reaksiyalarga asoslangan sifat yoki yarimsifat analizning usuli

Topilish minimumi – ma'lum sharoitda modda yoki ionning ayni reaksiya yordamida topilishi mumkin bo'lgan eng kam miqdori; analitik reaksiyaning sezgirligini xarakterlaydi

Tortim – analitik aniqlashlarni o'tkazish uchun olingan namunaning muayyan qismi

Tortma analiz – *Gravimetriya*ga qarang

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

Xelatlar – *Ichki kompleks birikmalar*ga 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 xossalariga asoslangan miqdoriy analizning titrimetrik usuli

O'ziga xos reaksiyalar – faqat berilgan modda uchun xos bo'lgan reaksiyalar

Chegara (quyi yoki yuqori) – aniqlanadigan komponentning eng kam yoki eng ko'p miqdori

Cho'ktirish – bir yoki bir nechta ionlar yoki moddalarni kam eruvchan moddalar ko'rinishida ajratish

ANALITIK KIMYONING RIVOJLANISHIGA O'Z HISSANI QO'SHGAN OLIMLAR

Abu Rayhon ibn Axmad 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) – daniyali shifokor. Alanga fotometriyasi usulini ishlab chiqdi

Angstrem Anders Yonas (1814 – 1874) – shved fiziki va astronomi, spectral analizning asoschilaridan biri

Arrenius Svante Avgust (1859 – 1927) – shved fizkimyogari. 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 ustozi

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, nurning 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 fizkimyogar,. 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 ichlab 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 potensiallar 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 fizkimyogar. 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 potensiallar 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 ftor saqlovchi 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)

Guldberg 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 kimyogar-muxandisi. 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'p sonli 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 potensiometrik 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 Toviy Yegorovich (1757 – 1804) – rus kimyogari. Yog'och ko'mirida erigan moddalarning adsorbilanishini 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 o'rganish davrida geliyni kashf qildi

Lomonosov Mixail Vasilyevich (1711 – 1865) – rus olimi. Tabiiy fanlar, tarix, metallurgiya va boshqa sohalarda faoliyat ko'rsatdi. Atom-molekulyar ta'limot 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 fizkimyogari. Taqsimlanish xromatografiyasi: qog'ozda (R. Sing bilan hamkorlikda) va gaz-suyuqlik (N. Jeyms bilan hamkorlikda) usullarini ishlab chiqdi. Nobel mukofoti sovrindori

Marsh Jeyms (1794 – 1846) – ingliz kimyogari, mishyakni 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 fizkimyogari, zamonaviy fizik kimyoning asoschilaridan biri. Elektrod potensiallar 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 fizkimyogari 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

Pregl 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 elektrodlarga oid bir qator ishlar muallifi; ossillometrik, fotometrik, polyarografik va potensiometrik 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 xossalarini 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 analizining 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 klassifikasiyasini taklif etdi

Rosko (Roscoe) Genri enfild (1833 – 1915) – ingliz kimyogari. R. Bunzen bilan birga fotokimyo qonunlaridan birini kashf etdi (Rosko – Bunzen qoununi). 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) Ferenц – vengriyalik kimyo tarixi mutaxassisi

Syorensen (Sørensen) Syoren Peter Lauriц (1868 – 1939) – daniyalik fizkimyogar 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 fizkimyogar. 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'lchash uchun maxsus apparatlarni qo'lladi; suv gazini kashf etdi

Fraungofer (Fraunhofer) Yozef (1787 – 1826) – nemis fiziki. Linzalar, difraktsion panjaralarni tayyorlash usullarini takomillashtirdi. Uning nomi bilan ataluvchi spektr chiziqlarini kashf etdi

Frezenius (Fresenius) Karl Remigius (1818 – 1897) – nemis kimyogar-analitiki; Visbadendagi analitik laboratoriyani tashkil etdi, bevosita analitik kimyoga bag'ishlangan birinchi ilmiy jurnalga asos soldi. Kationlarni analitik guruhlarga 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-analitiki

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'lqin 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

ADABIYOTLAR

1. Файзуллаев О. Аналитик кимё асослари. – Тошкент: Абдулла Қодирий номидаги халқ мероси, 2003.
2. Основы аналитической химии. В 2 кн. Учеб. для вузов / Золотов Ю.А., Дорохова Е.Н., Фадеева В.И. и др. Под ред. Ю.А. Золотова. – М.: Высш. шк., 1999.
3. Васильев В.П. Аналитическая химия. В 2 кн. – М.: Дрофа, 2002.
4. Аналитическая химия. Проблемы и подходы: В 2 т: Пер. с англ./Под ред. Р.Кельнера, Ж.-М. Мерме, М. Отто, Г.М. Видмера. – М.: «Аст», 2004.
5. Мусакин А.П. Таблицы и схемы аналитической химии. – Л.: Химия, 1979.
6. Крешков А.П. Основы аналитической химии. В 3 кн. – М.: Химия, 1977.
7. Алексеев В.Н. Ярим микрометод билан қилинадиган химиявий анализ курси. – Тошкент. Ўқитувчи, 1975.
8. Скуг Д., Уэст Д. Основы аналитической химии/ Пер. с англ. Под ред. Ю.А. Золотова. – М.: Мир, 1979.
9. Бусев А.И., Ефимов И.П. Определения, понятия, термины в химии. – М.: Просвещение, 1981.
10. Лурье Ю.Ю. Справочник по аналитической химии. 6-изд., перераб. и доп. – М.: Химия, 1989.
11. Янсон Э.Ю., Путнинь Я.К. Теоретические основы аналитической химии. – М.: Высшая школа, 1980.
12. Лайтинен Г.А., Харрис В.Е. Химический анализ./Пер. с англ. Под ред. Ю.А. Клячко. – М.: Химия, 1979.
13. Бончев П.Р. Введение в аналитическую химию./Пер. с болг. Под ред. Б.И. Лобова. – М.: Химия, 1978.
14. Фритц Дж. Шенк Г. Количественный анализ./Пер. с англ. Под ред. Ю.А. Золотова. – М.: Мир, 1978.
15. Петерс Д., Хайес Дж., Хифтье Г. Химическое разделение и измерение./Пер. с англ. Под ред. П.К. Агасяна. – М.: Химия, 1978.
16. Пятницкий И.В. Теоретические основы аналитической химии. Киев: Вища школа, 1978.

17. Миркомилова М. Аналитик кимё. – Тошкент: Ўзбекистон, 2002.
18. Джонсон К. Численные методы в химии. – М.: Мир, 1983.
19. Булатов М.И. Расчеты равновесий в аналитической химии. – Л.: Химия, 1984.
20. Данцер К., Тан Э., Мольх Д. Аналитика. Систематический обзор / Под ред. Ю.А. Клячко. – М.: Химия, 1981.

MUNDARIJA

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" garniturasi.
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