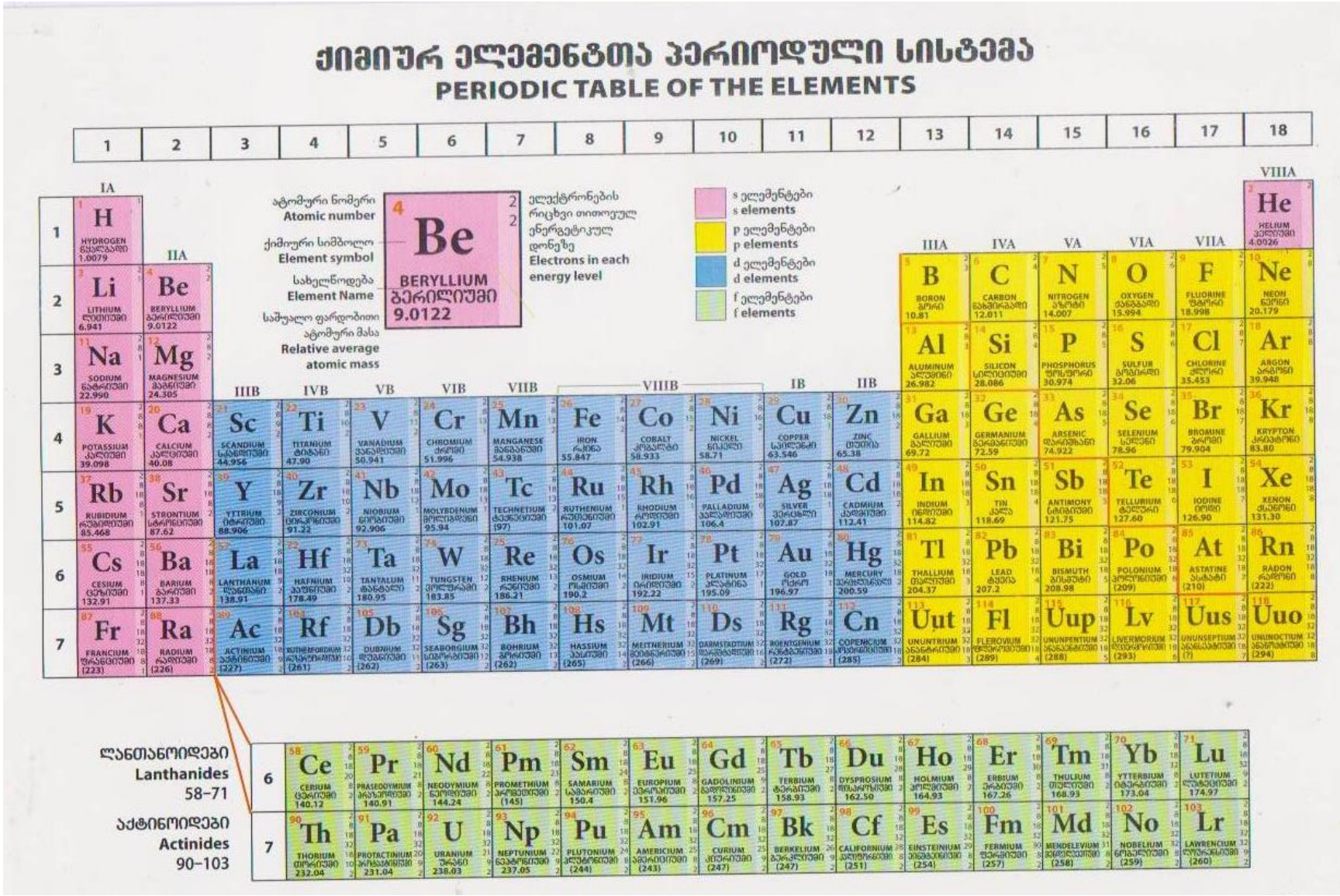
**Tengiz wivwivaZe**

**rezo kldiaSvili, nodar CigogiZe**

# araorganul naerTTa

# ZiriTadi klasebi

**,,teqnikuri universiteti”**


ქიმიურ ელემენტთა პერიოდული სისტემა
PERIODIC TABLE OF THE ELEMENTS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
IA IIA IIIB IVB VB VIB VIIB VIIIB IB IIB IIIA IVA VA VIA VIIA VIIIA
ატომური ნომერი Atomic number
ქიმიური სიმბოლო Element symbol
სახელწოდება Element Name
საშუალო ფარდობითი ატომური მასა Relative average atomic mass
ელექტრონების რიცხვი თითოეულ ენერგეტიკულ დონეზე Electrons in each energy level
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s ელემენტები s elements
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d ელემენტები d elements
f ელემენტები f elements
ლანთანოიდები Lanthanides 58–71
აქტინოიდები Actinides 90–103

saqarTvelos teqnikuri universiteti

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# araorganul naerTTa

# ZiriTadi klasebi

damtkicebulia saxelmZRvanelod

stu-is saredaqcio-sagamomcemlo

sabWos mier ..... oqmi # .....

2016

**Tbilisi**

winamdebare saxelmZRvanelo _ ,,araorganul naerTTa ZiriTadi klasebi” (am saxiT ibeWdeba pirvelad) Sedgenilia araorganuli qimiis Tanamedrove kursis programis Sesabamisad da srulad upasuxebs dRevandeli donis moTxovniT gaTvaliswinebul sakiTxebs.

saxelmZRvaneloSi srulyofili saxiT pirvelad gaecnobiT araorganul naerTTa oTx ZiriTad klass _ oqsidebs, mJavebs, fuZeebsa da marilebs, maTi miRebis TiTqmis yvela xerxs, fizikur-qimiur Tvisebebsa da gamoyenebis areals. aseTi midgoma aadvilebs informaciis (Teoriuli da praqtikuli nawili) aRqmas da gaTavisebas, calkeuli sakiTxebis ganxilva-daxasiaTebisas maTi msgavseba-gansxvavebis ukeT warmoCenas.

sabednierod qarTveli moswavle-axalgazrdebidan bevri iCens dainteresebas qimiis, rogorc mecnierebis, da misi miRwevebis praqtikuli gamoyenebis mimarT. swored aseTi axalgazrdebisaTvis pirvelad aris warmodgenili am saxelmZRvaneloSi bevri saintereso (Taviseburad unikaluri) masala saTauriT ,,meti rom vicodeT oqsidTa, mJavaTa, fuZeTa da marilTa Sesaxeb”.

mTlianad saxelmZRvanelos Sinaarsi ar scildeba ganaTlebisa da mecnierebis saministros mier damtkicebul qimiis programas.

saxelmZRvanelo ,,araorganul naerTTa ZiriTadi klasebi”, saintereso da sasargeblo iqneba umaRlesi saswavleblebisa (bakalavriati, magistratura, doqtorantura) da umaRlesi profesiuli ganaTlebis studentebisaTvis, igi aseve gamoadgebaT sajaro skolebis ufrosklaselebs, pedagogebsa da qimia-biologiiT dainteresebul pirebs.

redaqtori qimiis mecnierebaTa doqtori,
profesori SoTa sidamoniZe

recenzentebi: qimiis mecnierebaTa doqtori
profesori mixeil gverdwiTeli

qimiis mecnierebaTa doqtori,
profesori maia cincaZe

## Sesavali

zogadad, nivTiereba, Sedgenilobis mixedviT, arsebobs **martivi** (elementaruli) da **rTuli**.

martivi nivTiereba Sedgeba erTi elementisgan, rTuli nivTierebis SedgenilobaSi Sedis ori an meti elementi.

Tavis mxriv, martivi nivTierebebi iyofa metalebad da arametalebad (metaloidebad).

**metali** xasiaTdeba ,,metaluri“ bzinvarebiT, wevadobiT, iglineba furclebad, iWimeba mavTulad, kargi siTbo- da eleqtrogamtaria; oTaxis temperaturaze yvela metali (vercxliswylis garda) myar mdgomareobaSia.

**arametals (metaloids)** ar axasiaTebs metaluri bzinva, igi myifea, cudad atarebs siTbos da eleqtrobas. zogierTi arametali (metaloidi), Cveulebriv pirobebSi, airad mdgomareobaSia.

rTuli nivTierebebi iyofa organul da araorganul nivTierebebad: miRebulia, organuls ewodos naxSirbadis naerTebi (naxSirbadis umartivesi naerTebi _ $CO$, $CO_2$, $H_2CO_3$ da karbonatebi, $HCN$ da cianidebi, karbidebi da zogierTi sxv., Cveulebriv ganixileba araorganuli qimiis kursSi); yvela danarCen nivTierebas ewodeba araorganuli (zogjer mineraluri).

rTuli nivTierebebi iyofa klasebad an Sedgenilobis (elementiani, anu binaruli, naerTebi da mravalelementiani naerTebi; JangbadSemcveli, azotSemcveli da a.S.), an qimiuri Tvisebebis, e.i. funqciebis (fuZur-mJavuri, Jangva-aRdgeniTi da a.S.) mixedviT, romlebsac es nivTierebebi axorcielebs qimiur reaqciebSi, _ maTi funqciuri niSnis mixedviT.

mniSvnelovan binarul naerTebs miekuTvneba qimiur elementTa naerTebi JangbadTan (oqsidebi _ $Na_2O$, $CaO$, $Al_2O_3$, $CO_2$, $SiO_2$ da a.S.), halogenebTan (halogenidebi anu haloidebi _ $NaCl$, $KBr$, $CaF_2$, $MgI_2$, $FeCl_2$ da a.S.), azotTan (nitridebi _ $Li_3N$, $Na_3N$, $Mg_3N_2$, $Ca_3N_2$, $AlN$ da a.S.), naxSirbadTan (karbidebi _ $CaC_2$, $Fe_3C$, $Al_4C_3$, $Mn_3C$ da a.S.). wyalbadTan (hidridebi - $LiH$, $KH$, $MgH_2$, $CaH_2$, $AlH_3$ da a.S.). binaruli naerTebis formulebSi pirveli iwereba naklebeleqtrouaryofiTi elementis simbolo (am wesidan mniSvnelovani gamonaklisia azotis naerTebi wyalbadTan _ amiaki $NH_3$ da hidrazini $N_2H_4$, romlebSic miRebulia pirveli daiweros ufro eleqtrouaryofiTi azotis simbolo), magaliTad, $Ag_2O$ _ vercxlis oqsidi, $OF_2$ _ Jangbadis fToridi (fTori _ ufro eleqtrouaryofiTi elementia, vidre Jangbadi), $KBr$ _ kaliumis bromidi, $Mg_3N_2$ _ magniumis nitridi, $CaC_2$ _ kalciumis karbidi (magram saxelwodeba arametalis wyalbaduri naerTisa, romelic xasiaTdeba mJavuri TvisebebiT, warmoiqmneba imave wesiT, romelic miRebulia mJavebisTvis, _ ix. qvemoT).

Tu nakleb eleqtrouaryofiTi elementi iqneba gansxvavebul JangviT mdgomareobaSi, maSin misi saxelwodebis Semdeg frCxilebSi miuTiTeben mis Jangvis xarisxs romauli cifrebiT.[1] mag.,

[1] dReisaTvis miRebulia IUPAC-is (International Union of Pure and Applied Chemistry _ Teoriuli da gamoyenebiTi qimiis saerTaSoriso kavSiri) mier SemuSavebuli nomenklatura.

$Cu_2O$ _ spilenZ(I)-is oqsidi, $CuO$ _ spilenZ(II)-is oqsidi, $CO$ _ naxSirbad(II)-is oqsidi, $CO_2$ _ naxSirbad(IV)-is oqsidi, $SF_6$ _ gogird(VI)-is fToridi. SeiZleba, agreTve, Jangvis xarisxis nacvlad daiweros berZnuli TavsarTi _ mono, di, tri, tetra, penta, heqsa da a.S. ufro eleqtrouaryofiTi elementisa naerTis formulaSi: $CO$ _ naxSirbadis monoqsidi, $CO_2$ _ naxSirbadis dioqsidi, $SF_6$ _ gogirdis heqsafToridi.

qimiuri elementebis urTierTqmedebis Sedegad warmoiqmneba qimiuri naerTebi (rTul nivTierebebi). rTuli nivTierebebi, Tavis mxriv, iyofa araorganul da organul nivTierebebad. mocemul SemTxvevaSi ganvixilavT araorganul nivTierebebs.

nivTierebaTa klasifikacia aadvilebs maT Seswavlas. naerTTa klasebis TaviseburebaTa codnis safuZvelze SesaZlebelia maTi calkeuli warmomadgenlis daxasiaTeba.

araorganul naerTTa ZiriTadi klasebia: **oqsidebi, mJavebi, fuZeebi** da **marilebi.**

# I Tavi. oqsidi

**oqsidi aris naerTi, warmoqmnili ori elementis atomebisgan, romelTagan erT-erTi Jangbadia -2 Jangvis xarisxiT.** oqsids warmoqmnis yvela elementi sami inertuli airis _ heliumis ($He$), neonis ($Ne$) da argonis ($Ar$) garda.

oqsidebis umetesoba miiReba martivi nivTierebebis SeerTebiT, nawili ki _ arapirdapiri gziT.

oqsidebs miekuTvneba elementisa da Jangbadis yvela naerTi, magaliTad, $Na_2O$, $Fe_2O_3$, $P_2O_5$ ($P_4O_{10}$), garda JangbadSemcveli naerTisa, romelSic Jangbad-atomebi erTmaneTTan dakavSirebulia qimiuri bmebiT (peroqsidi, zeperoqsidi, ozonidi), magaliTad,

$Na_2O_2$ _ natriumis peroqsidi: $\overset{+1}{Na}-\overset{-1}{O}-\overset{-1}{O}-\overset{+1}{Na}$

$KO_2$ _ kaliumis zeperoqsidi: $K^+[O \overset{..}{=} O]^-$

$KO_3$ _ kaliumis ozonidi: $K^+[O \overset{..}{=} O \overset{..}{=} O]^-$

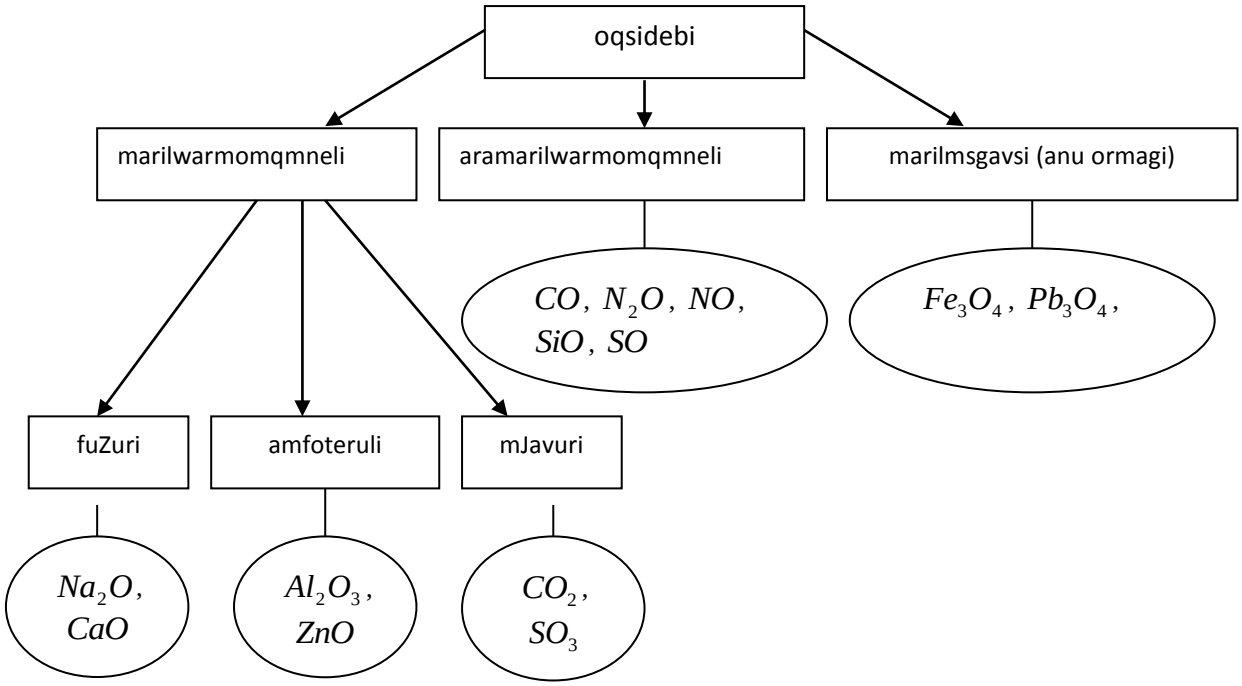
da JangbadTan fToris naerTebi ($OF_2, O_2F_2$), romlebsac ewodeba ara fToris oqsidebi, aramed Jangbadis fToridebi, radgan maTSi Jangbadis Jangvis xarisxi dadebiTia:

$\overset{+2-1}{OF_2}$ ; $\overset{+1}{O_2}\overset{-1}{F_2}$.

## 1.1. oqsidTa klasifikacia da qimiuri Tvisebebis cvlilebaTa kanonzomierebani

### 1.1.1. oqsidTa klasifikacia qimiuri TvisebebiT

qimiuri Tvisebebis mixedviT oqsidebi iyofa Semdeg tipebad:




**aramarilwarmomqmneli ewodeba oqsids, romelsac ar Seesabameba arc mJava da arc fuZe**, magaliTad, $CO$, $N_2O$, $NO$, $SiO$, $SO$ da sxv.

**marilmsgavsi oqsidi ewodeba ormag oqsids, romlis SedgenilobaSi, JangbadTan erTad, Sedis mxolod erTi metalis atomebi Jangvis sxvadasxva xarisxSi**.

metali, romelic naerTSi avlens Jangvis sxvadasxva xarisxs, warmoqmnis ormag anu marilmsgavs oqsids. magaliTad, $Pb_3O_4$, $Fe_3O_4$, $Mn_3O_4$ (am oqsidTa formulebi SeiZleba asec daiweros: $2PbO \cdot PbO_2$; $FeO \cdot Fe_2O_3$; $MnO \cdot Mn_2O_3$). $Fe_3O_4 \rightarrow FeO \cdot Fe_2O_3$ warmoadgens

fuZur oqsids, qimiurad dakavSirebuls amfoterul oqsidTan $Fe_2O_3$, romelic mocemul SemTxvevaSi avlens mJavuri oqsidis Tvisebebs. $Fe_3O_4$ formalurad SeiZleba ganvixiloT, rogorc marili, warmoqmnili $Fe(OH)_2$ fuZiT da $[HFeO_2]$ mJaviT, romelic ar arsebobs bunebaSi:

$$\overset{+2}{Fe}(OH)_2 + 2[\overset{+3}{H}FeO_2] = \underbrace{\overset{+2}{Fe}(\overset{+3}{Fe}O_2)_2}_{Fe_3O_4} + 2H_2O$$

tyvia (IV)-is oqsidis hidratidan $PbO_2 \cdot 2H_2O \equiv H_4PbO_4$, rogorc mJavadan, da $Pb(OH)_2$-dan, rogorc fuZidan, SeiZleba miviRoT ori ormagi oqsidi _ $Pb_2O_3$ da $Pb_3O_4$ (surinji), romlebic SeiZleba ganvixiloT, rogorc marilebi. pirveli warmoadgens **metatyviis mJavas** $(H_2PbO_3)$ tyviis marils, xolo meore _ **orTotyviis mJavas** $(H_4PbO_4)$ marils.

oqsidebs Soris, gansakuTrebiT $d$-elementebis oqsidebs Soris, bevria cvladi Sedgenilobis (**bertolidebi**) oqsidebi, romlebSic Jangbadis Semcveloba ar Seesabameba steqiometrul Sedgenilobas da icvleba sakmaod farTo sazRvrebSi, magaliTad, titan(II)-is oqsidis $TiO$ Sedgeniloba icvleba $TiO_{0,65} - TiO_{1,25}$ sazRvrebSi.

**marilwarmomqmneli oqsidi ewodeba oqsids, romelic warmoqmnis marils.**

am tipis oqsidebi iyofa sam klasad: **fuZuri, amfoteruli** da **mJavuri oqsidebi.**

**fuZuri oqsidi** ewodeba oqsids, romlis elementi marilis an fuZis warmoqmnis dros xdeba **kationi**, an kidev, **oqsids**, romelic urTierTqmedebs mJavasTan marilisa da wylis warmoqmniT, **fuZuri oqsidi**, ewodeba. aseTi saxelwodeba am tipis oqsidma miiRo imis gamo, rom TiToeul fuZur oqsids Seesabameba fuZe-hidratirebuli oqsidi (hidroqsidi):

$$K_2O - KOH$$

$$CaO - Ca(OH)_2$$

$$FeO - Fe(OH)_2 \text{ da a.S.}$$

fuZur oqsids ($Na_2O$, $K_2O$, $CaO$, $MgO$, $FeO$, $CuO$, $BaO$, $CrO$, $MnO$ da a.S.) warmoqmnis mxolod metali.

**mJavuri oqsidi** ewodeba oqsids, romlis elementi marilis an mJavas warmoqmnis dros Sedis **anionis** SedgenilobaSi. an kidev, oqsids, romelic urTierTqmedebs fuZesTan marilisa da wylis warmoqmniT, mJavuri oqsidi ewodeba. aseTi saxelwodeba am tipis oqsidma miiRo imis gamo, rom TiToeul mJavur oqsids Seesabameba mJava-hidroqsidi (Tumca es saxelwodeba mJavebis SemTxvevaSi ar ixmareba):

$$CO_2 \_ H_2CO_3$$

$$N_2O_5 \_ HNO_3$$

$SO_3$ _ $H_2SO_4$

$P_2O_5$ _ $H_3PO_4$ d a.S.

**amfoteruli oqsidi** ewodeba oqsids, romlis elements, reaqciis pirobebze damokidebulebiT, SeuZlia gamoavlinos rogorc **mJavuri oqsidis,** aseve **fuZuri oqsidis** Tvisebebi, e.i. aqvs ormagi (**amfoteruli**) buneba. am tipis oqsidebs miekuTvneba _ $BeO$, $ZnO$, $Al_2O_3$, $Cr_2O_3$, $Fe_2O_3$ da a.S.

marilebis warmoqmnisas oqsidwarmomqmneli elementebis Jangvis xarisxi **ar icvleba**, magaliTad,

$$\overset{+2}{Ca}O + \overset{+4}{C}O_2 = \overset{+2}{Ca}\overset{+4}{C}O_3$$

$$\overset{+2}{Mg}O + \overset{+6}{S}O_3 = \overset{+2}{Mg}\overset{+6}{S}O_4$$

Tu marilebis warmoqmnis dros xdeba oqsidwarmomqmnel elementTa Jangvis xarisxis cvlileba, maSin miRebuli marilebi unda miekuTvnos sxva mJavaTa an fuZeTa marilebs, magaliTad,

a) $2\overset{+2}{Fe}O + 4\overset{+6}{S}O_3 = \overset{+3}{Fe}_2(\overset{+6}{S}O_4)_3 + \overset{+4}{S}O_2$

$Fe_2(SO_4)_3$ warmoadgens gogirdmJavasa ($H_2SO_4$) da rkina(III)-is hidroqsidisgan _ $Fe(OH)_3$ warmoqmnil marils, romelsac Seesabameba $Fe_2O_3$ oqsidi.

b) $2KOH + 2\overset{+4}{N}O_2 = K\overset{+3}{N}O_2 + K\overset{+5}{N}O_3 + H_2O$

warmoqmnili marilebi aris azotovani mJavas ($\overset{+3}{HNO}_2$) da azotmJavas ($\overset{+5}{HNO}_3$) marilebi, romlebsac Seesabameba oqsidebi $\overset{+3}{N}_2O_3$ da $\overset{+5}{N}_2O_5$.

### 1.1.2. oqsidis Tvisebebis cvlilebis kanonzimierebani

elementis Jangvis xarisxis gazrda da misi radiusis Semcireba (am dros xdeba efeqturi uaryofiTi muxtis Semcireba Jangbadis atomze _ $\delta_O$) Sesabamis oqsids gadaaqcevs ufro mJavur oqsidad. es xsnis oqsidebis TvisebaTa cvlilebis kanonzomierebas _ fuZuri oqsididan amfoterulisken da Semdgom mJavuri oqsidisken.

**a) erT periodSi** elementTa atomuri nomris zrdas Seesabameba oqsidTa mJavuri Tvisebebis da maTi Sesabamisi mJavebis gaZliereba (cxr. 1).

| $Na_2O$ | $MgO$ | $Al_2O_3$ | $SiO_2$ | $P_4O_{10}$ | $SO_3$ | $Cl_2O_7$ |
|---|---|---|---|---|---|---|
| fuZuri oqsidi, Zlieri fuZis | fuZuri oqsidi, susti fuZis | amfoteruli oqsidi, amfoteruli hidroqsidis | mJavuri oqsidi, Zalian susti mJavis | mJavuri oqsidi, saSualo Zalis mJavis | mJavuri oqsidi, Zlieri mJavis | mJavuri oqsidi, Zlieri mJavis |

cxrili 1

**oqsidTa Tvisebebis fuZur-mJavuri damokidebuleba**
**Jangbadis atomis efeqtur muxtze**

| **Ooqsidi** | $Na_2O$ | $MgO$ | $Al_2O_3$ | $SiO_2$ | $P_4O_{10}$ | $SO_3$ | $Cl_2O_7$ |
|---|---|---|---|---|---|---|---|
| efeqturi muxti, $\delta_O$ | -0,81 | -0,42 | -0,31 | -0,23 | -0,13 | -0,06 | -0,01 |
| oqsidis fuZur-mJavuri Tvisebebi | fuZuri Tvisebebi | fuZuri Tvisebebi | amfoteruli Tvisebebi | mJavuri Tvisebebi | | | |

**b)** perioduli sistemis mTavar qvejgufebSi erTi elementidan meoreze zemodan qvemoT gadasvlis dros SeimCneva oqsidTa fuZuri Tvisebebis gaZliereba:

$BeO$ $MgO$ $CaO$ $SrO$ $BaO$ $RaO$

amfoteruli fuZuri fuZuri fuZuri fuZuri fuZuri

fuZuris Sesabamisi Tvisebebis gaZliereba

**g)** elementis Jangvis xarisxis gazrdasTan erTad oqsidis mJavuri Tvisebebi Zlierdeba da fuZuri Tvisebebi sustdeba (cxr. 2):

cxrili 2

**fuZur-mJavuri Tvisebebis damokidebuleba**
**metalebis Jangvis xarisxze**

| | | | | |
|---|---|---|---|---|
| $\overset{+2}{Cr}O$ fuZuri oqsidi | $\overset{+3}{Cr}_2O_3$ amfoteruli oqsidi | – | $\overset{+6}{Cr}O_3$ mJavuri oqsidi | – |
| $\overset{+2}{Fe}O$ fuZuri oqsidi | $\overset{+3}{Fe}_2O_3$ amfoteruli oqsidi | – | – | – |
| $\overset{+2}{Mn}O$ fuZuri oqsidi | $\overset{+3}{Mn}_2O_3$ amfoteruli oqsidi, fuZuri Tvisebebis metobiT | $\overset{+4}{Mn}O_2$ amfoteruli oqsidi, fuZuri Tvisebebis metobiT | $\overset{+6}{Mn}O_3$ mJavuri oqsidi | $\overset{+7}{Mn}_2O_7$ mJavuri oqsidi |

## 1.2. oqsidis miRebis xerxebi

oqsidis SeiZleba miviRoT sxvadasxva qimiuri reaqciis Sedegad.

1. martivi nivTierebisa (oqros, platinisa da inertuli airebis gamoklebiT), da Jangbadis urTierTqmedebiT:

$$S + O_2 = SO_2,$$

$$2Ca + O_2 = 2CaO,$$

$$4Li + O_2 = 2Li_2O.$$

sxva tute metalebis JangbadSi wvis dros warmoiqmneba peroqsidebi:

$$2Na + O_2 = Na_2O_2$$

an zeperoqsidebi:

$$K + O_2 = KO_2$$

am metalTa oqsidebi SeiZleba miviRoT peroqsidis (an zeperoqsidis) urTierTqmedebiT Sesabamis metalTan:

$$Na_2O_2 + 2Na = 2Na_2O$$

an maTi Termuli daSlis dros:

$$2BaO_2 \overset{t}{=} 2BaO + O_2$$

2. binaruli naerTebis JangbadSi wvis Sedegad:

a) qalkogenidebis gamowviT:

$$4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2 \uparrow$$

$$2CuSe + 3O_2 = 2CuO + 2SeO_2$$

$$4CuFeS_2 + 13O_2 = 4CuO + 2Fe_2O_3 + 8SO_2 \uparrow$$

b) fosfinis, gogirdnaxSirbadis da fosfidebis dawviT:

$$4PH_3 + 8O_2 = P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4 \uparrow$$

$$CS_2 + 3O_2 = CO_2 + 2SO_2$$

$$2Ca_3P_2 + 8O_2 = 6CaO + P_4O_{10}$$

3. marilebis Termuli daSliT:

a) karbonatebi:

$$CaCO_3 \overset{t}{=} CaO + CO_2 \uparrow$$

tute metalebis karbonatebi (liTiumis karbonatis gamoklebiT) **dneba** daSlis gareSe.

b) nitratebi:

$$2Cu(NO_3)_2 \overset{t}{=} 2CuO + 4NO_2 \uparrow + O_2 \uparrow$$

g) Tu marili warmoqmnilia metalis kationiT, romelic avlens Jangvis sxvadasxva xarisxs da mJavas anioniT, romelic xasiaTdeba mJangavi TvisebebiT, SeiZleba warmoiqmnas oqsidebi, elementebis sxva Jangvis xarisxiT, magaliTad:

$$4Fe(NO_3)_2 \overset{t}{=} 2Fe_2O_3 + 8NO_2 \uparrow + O_2 \uparrow,$$

$$2FeSO_4 \overset{t}{=} Fe_2O_3 + SO_2 \uparrow + SO_3 \uparrow,$$

$$(NH_4)_2Cr_2O_7 \overset{t}{=} N_2 \uparrow + 4H_2O + Cr_2O_3.$$

4. JangbadSemcveli mJavasa da fuZis Termuli daSla iwvevs oqsidisa da wylis warmoqmnas:

$$2H_3PO_4 \overset{t}{=} P_2O_5 + 3H_2O,$$

$$SiO_2 \cdot xH_2O \overset{t}{=} SiO_2 + xH_2O,$$

$$Ca(OH)_2 \overset{t}{=} CaO + H_2O.$$

tute metalebis hidroqsidebi dneba daSlis gareSe.

5. Tu qimiuri elementi Tavis naerTebSi avlens sxvadasxva Jangvis xarisxs da warmoqmnis ramdenime oqsids, maSin:

a) dabali oqsidis Jangvis dros SeiZleba miviRoT oqsidi, romelSic Sesabamis elements eqneba Jangvis ufro maRali xarisxi:

$$4FeO + O_2 = 2Fe_2O_3,$$

$$2NO + O_2 = 2NO_2,$$

$$2NO_2 + O_3 = N_2O_5 + O_2,$$

$$2SO_2 + O_2 \overset{t}{\underset{V_2O_5}{=}} 2SO_3.$$

b) da, analogiurad, maRali oqsidebis aRdgenis dros SeiZleba miviRoT dabali oqsidebi:

$$Fe_2O_3 + CO \overset{t}{=} 2FeO + CO_2 .$$

6. zogierT metals, romelic ZabvaTa mwkrivSi dgas wyalbadamde, SeuZlia, maRali temperaturis dros, wylidan gamoaZevos wyalbadi. am dros agreTve warmoiqmneba metalis oqsidi:

$$Fe + H_2O \overset{t}{\leftrightarrow} FeO + H_2 \ \ (t > 570^\circ C) .$$

7. marilis mJavur oqsidTan gaxurebis SemTxvevaSi reaqciis mimarTuleba damokidebulia oqsidis fardobiT aqroladobaze _ naklebaqroladi oqsidi gamoaZevebs marilidan ufro aqrolad oqsids:

$$Na_2CO_3 + SiO_2 \overset{t}{=} Na_2SiO_3 + CO_2 \uparrow ,$$

$$2Ca_3(PO_4)_2 + 6SiO_2 \overset{t}{=} 6CaSiO_3 + P_4O_{10} ,$$

$$2Na_2SO_4 + 2B_2O_3 \overset{t}{=} 4NaBO_2 + 2SO_2 \uparrow + O_2 \uparrow ,$$

$$4NaNO_3 + 2Al_2O_3 \overset{t}{=} 4NaAlO_2 + 4NO_2 \uparrow + O_2 \uparrow .$$

8. metalis urTierTqmedebisas mJangav-mJavebTan xdeba mJavawarmomqmneli elementis nawilobrivi aRdgena oqsidis warmoqmniT:

$$Cu + 2H_2SO_{4konc.} = CuSO_4 + SO_2 \uparrow + 2H_2O$$

$$Zn + 4HNO_{3konc.} = Zn(NO_3)_2 + 2NO_2 \uparrow + 2H_2O$$

9. wyalwamrTmevi nivTierebis moqmedebisas mJavasa an marilze:

$$4HNO_3 + P_4O_{10} = (HPO_3)_4 + 2N_2O_5 ,$$

$$2KMnO_4 + H_2SO_{4konc.} = K_2SO_4 + Mn_2O_7 + H_2O ,$$

$$2KClO_4 + H_2SO_{4konc.} = K_2SO_4 + Cl_2O_7 + H_2O .$$

10. susti aramdgradi mJavas marilis urTierTqmedebiT Zlieri mJavas xsnarTan:L

$$Na_2CO_3 + 2HCl = 2NaCl + CO_2 \uparrow + H_2O .$$

## 1.3. oqsidis fizikuri Tvisebebi

oqsidi arsebobs samive agregatul mdgomareobaSi:

airadi oqsidi _ $SO_2$, $CO_2$, $NO$, $N_2O$, $Cl_2O$ da sxv.,

Txevadi oqisdi _ $N_2O_3$, $SO_3$, $Cl_2O_7$, $Mn_2O_7$ da sxv.,

myari oqsidi _ $P_2O_3$, $P_2O_5$, $SiO_2$, $SeO_2$, $TeO_2$ da sxv.

zogi oqsidi uferoa, magaliTad, $CO$, $CO_2$, $NO$, $N_2O$ da a.S., zogi ki Seferili: $N_2O_3$ _ lurji, $Cr_2O_3$ _ mwvane, $NO_2$ _ mura wiTeli, $CuO$ _ Savi, $Fe_2O_3$ _ wiTeli, $Al_2O_3$ _ TeTri.

oqsidis duRilisa da dnobis temperaturebi icvleba farTo intervalSi. oTaxis temperaturaze oqsids, kristaluri mesris tipze damokidebulebiT, rogorc zemoT aRvniSneT, SeuZliaT yofna sxvadasxva agregatul mdgomareobaSi. es ganisazRvreba qimiuri bmis bunebiT, romelic SeiZleba iyos ionuri an kovalentur-polaruli.

oqsidi, romelic warmoqmnis molekulur kristalur mesers, oTaxis temperaturaze, imyofeba airad an Txevad mdgomareobebSi. molekulebis polarobis gazrdiT dnobisa da duRilis temperaturebi izrdeba (cxr. 3).

cxrili 1.

**zogierTi oqsidis dnobisa da duRilis temperaturebi**

| | $CO_2$ | $CO$ | $SO_2$ | $ClO_2$ | $SO_3$ | $Cl_2O_7$ | $H_2O$ |
|---|---|---|---|---|---|---|---|
| $T_{dn}$, $^\circ C$ | -78 ($T_{aqrolva}$) | -205 | -75,46 | -59 | 16,8 | -93,4 | 0 |
| $T_{duR}$, $^\circ C$ | | -191,5 | -10,1 | 9,7 | 44,8 | 87 | 100 |

oqsidi, romelic warmoqmnis ionur kristalur mesers, magaliTad, $CaO$, $BaO$ da sxv. myari nivTierebebia, dnobis maRali temperaturiT ($>1000^\circ C$).

zogierT oqsidSi bma kovalentur-polarulia. isini warmoqmnian kristalur mesrebs, sadac elementis atomebi SekavSirebulia Jangbadis ramdenime ,,xiduri“ atomiT da realizebulia usasrulo samganzomilebiani qseli, magaliTad, $Al_2O_3$, $SiO_2$, $TiO_2$, $BeO$, da am oqsidebs aqvT Zalian maRali dnobis temperatura.

## 1.4. oqsidis qimiuri Tvisebebi

### 1.4.1. fuZuri oqsidi

fuZur oqsids miekuTvneba:

- pirveli jgufis mTavari qvejgufis (tute metalebi $Li - Fr$),

- meore jgufis mTavari qvejgufis, dawyebuli magniumidan ( $Mg - Ra$ ),
- oqsidebi gardamavali metalebisa Jangvis dabali xarisxiT, magaliTad, $MnO$ , $FeO$ .

1. aqtiuri metalis (tute da tutemiwaTa metalebi, dawyebuli kalciumidan) oqsidi Cveulebriv pirobebSi uSualod urTierTqmedebs wyalTan, warmoqmnis hidroqsids, romelic warmoadgens Zlier, wyalSi xsnad fuZes _ tutes, magaliTad,

$$BaO + H_2O = Ba(OH)_2$$

$$Na_2O + H_2O = 2NaOH .$$

2. fuZuri oqsidi urTierTqmedebs mJavasTan da warmoqmnis marils:

$$CaO + 2HCl = CaCl_2 + H_2O$$

$$MgO + H_2SO_4 = MgSO_4 + H_2O$$

3. marili warmoiqmneba agreTve misi urTierTqmedebiT mJavur oqsidTan:

$$Na_2O_{my.} + CO_{2airi} = Na_2CO_3$$

$$CaO_{my.} + SO_{3Tx.} = CaSO_4$$

$$CaO_{my.} + SiO_{2my.} \overset{t}{=} CaSiO_3$$

### 1.4.2. mJavuri oqsidi

arametalis (metaloidis) mravali oqsidi aris mJavuri oqsidi ($CO_2$, $SO_3$, $P_4O_{10}$ da sxv.). gardamavali metalis (umaRlesi Jangvis xarisxiT) oqsidi umeteswilad avlens aseve mJavuri oqsidis Tvisebebs, magaliTad, $CrO_3$, $V_2O_5$, $Mn_2O_7$ da sxv.

1. mJavuri oqsidi reagirebs wyalTan Sesabamisi mJavas warmoqmniT:

$$SO_3 + H_2O = H_2SO_4$$

$$P_4O_{10} + 6H_2O = 4H_3PO_4$$

zogierTi oqsidi, magaliTad, $SiO_2$, $MoO_3$ da sxva uSualod wyalTan ar urTierTqmedebs da maTi Sesabamisi mJavebi miiReba arapirdapiri gziT:

$$(x-1)H_2O + Na_2SiO_3 + 2HCl = 2NaCl + SiO_2 \cdot xH_2O \downarrow$$

$$Na_2MoO_4 + 2HCl = 2NaCl + H_2MoO_4 \downarrow$$

2. mJavuri oqsidis urTierTqmedebiT fuZur oqsidTan warmoiqmneba marili:

$$SO_2 + Na_2O = Na_2SO_3$$

$$SiO_2 + CaO \overset{t}{=} CaSiO_3$$

3. marili warmoiqmneba agreTve mJavuri oqsidis fuZesTan reagirebiT:

$$Cl_2O + 2NaOH = 2NaClO + H_2O$$

$$SO_3 + Ba(OH)_2 = BaSO_4 \downarrow + H_2O$$

Tu mJavuri oqsidi aris mravalfuZiani mJavas anhidridi, maSin reaqciaSi monawile fuZisa da mJavuri oqsidis fardobaze damokidebulebiT, SeiZleba warmoiqmnas saSualo

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$

an mJavuri marili

$$CaCO_3 \downarrow + CO_2 \uparrow + H_2O = Ca(HCO_3)_{2xsnari}$$

4. naklebaqroladi oqsidi marilidan gamoaZevebs aqrolad oqsids. magaliTad,

$$Na_2CO_3 + SiO_2 \overset{t}{=} Na_2SiO_3 + CO_2 \uparrow .$$

### 1.4.3. amfoteruli oqsidi

amfoteruloba (berZ. amphoteros _ erTic da meorec) aris zogierTi qimiuri elementisa ($Be$, $Zn$, $Al$, $Cr$ da sxv.) da misi naerTis (oqsidebi, hidroqsidebi, aminomJavebi) unari gamoavlinos rogorc mJavuri, ise fuZuri Tvisebebi, reaqciaSi monawile meore reagentis Tvisebebze damokidebulebiT.

erTi da igive nivTiereba (mag., $ZnO$), Zlier mJavasTan an mJavur oqsidTan reagirebisas, avlens fuZuri oqsidis Tvisebebs. magaliTad,

$$ZnO + 2HCl = ZnCl_2 + H_2O$$

$$ZnO + SO_3 = ZnSO_4,$$

xolo Zlier fuZesTan an fuZur oqsidTan uerTierTqmedebis dros _ mJavuri oqsidis Tvisebebs. magaliTad,

$$ZnO + 2NaOH + H_2O = Na_2[Zn(OH)_4]$$ (wyalxsnarSi)

$$ZnO + CaO \overset{t}{=} CaZnO_2$$ (Sednobisas)

amfoterul oqsids SeuZlia marilidan gamoaZevos aqroladi oqsidi. magaliTad,

$$K_2CO_3 + ZnO \overset{t}{=} K_2ZnO_2 + CO_2 \uparrow .$$

### 1.5. oqsidis zogadqimiuri Tvisebebi

oqsids SeuZlia monawileoba miiRos Jangva-aRdgenis reaqciebSi, romlebic iwvevs mocemuli elementis Jangvis xarisxis cvlilebas.

**1. oqsidis aRdgena**. aRmdgenebi ($C$, $CO$, $H_2$, $CH_4$ da aqtiuri metalebi, iseTebi rogoricaa $Mg$, $Al$) gaxurebisas oqsididan aRadgens mraval elements martiv nivTierebamde. magaliTad,

$$ZnO + C \overset{t}{=} Zn + CO \uparrow ,$$

$$WO_3 + 3H_2 \overset{t}{=} W + 3H_2O \uparrow ,$$

$$3CuO + 2NH_3 \overset{t}{=} 3Cu + N_2 \uparrow + 3H_2O \uparrow ,$$

$$P_4O_{10} + 10C \overset{t}{=} P_4 + 10CO \uparrow ,$$

$$9CuO + 2CH_3NH_2 \overset{t}{=} 9Cu + N_2 \uparrow + 2CO_2 \uparrow + 5H_2O \uparrow ,$$

$$\underset{\text{xsnari krioliTSi}}{2Al_2O_3} \overset{\text{eleqtroliz gamdnar}}{=} \overset{\text{i}}{4Al + 3O_2 \uparrow} ,$$

$$CuO + CO \overset{t}{=} Cu + CO_2 \uparrow ,$$

$$Cr_2O_3 + 2Al \overset{t}{=} 2Cr + Al_2O_3 ,$$

$$SiO_2 + 2Mg \overset{t}{=} Si + 2MgO ,$$

$$2NO_2 + 4Cu \overset{t}{=} N_2 \uparrow + 4CuO ,$$

$$CO_2 + 2Mg \overset{t}{=} C + 2MgO .$$

**2. oqsidis Jangva.** cvalebadi Jangvis xarisxis mqone elementTa oqsidebi SeiZleba monawileobdnen iseT reaqciebSi, romlebic iwvevs mocemuli elementis Jangvis xarisxis amaRlebas. magaliTad,

$$\overset{+3}{Cr}_2O_3 + 4NaOH + 3NaNO_3 \underset{\text{Sednoba}}{\overset{t}{=}} 2Na_2\overset{+6}{Cr}O_4 + 3NaNO_2 + 2H_2O\uparrow,$$

$$3\overset{+2}{Pb}O + KClO_3 \underset{\text{Sednoba}}{\overset{t}{=}} 3\overset{+4}{Pb}O_2 + KCl$$

$$\overset{+3}{Fe}_2O_3 + 4KOH + 3KNO_3 \underset{\text{Sednoba}}{\overset{t}{=}} 3KNO_2 + 2\underset{\substack{\text{kaliumis}\\ \text{ferati}}}{K_2\overset{+6}{Fe}O_4} + 2H_2O\uparrow,$$

$$\overset{+3}{Fe}_2O_3 + 3Cl_2 + 10KOH_{\text{konc.}} \overset{t}{=} 2K_2\overset{+6}{Fe}O_4 + 6KCl + 5H_2O\uparrow,$$

$$2\overset{+2}{NO} + O_2 = 2\overset{+4}{NO}_2,$$

$$2\overset{+4}{NO}_2 + O_3 = \overset{+5}{N}_2O_5 + O_2.$$

**3. oqsidis pasivacia**. hidroqsidis Termuli daSla maRal temperaturaze ($>1000^\circ C$) iwvevs oqsidis warmoqmnas qimiurad naklebaqtiuri formiT:

$$2Al(OH)_3 \xrightarrow{t} Al_2O_3 + 3H_2O\uparrow,$$

$$2Cr(OH)_3 \xrightarrow{t} Cr_2O_3 + 3H_2O\uparrow.$$

am gziT miRebuli oqsidi ar ixsneba arc wyalSi, arc mJavaSi da arc tuteSi. maTi gadayvana xsnad formaSi SeiZleba mxolod SednobiT marilTan an tutesTan. magaliTad,

$$Al_2O_3 + Na_2CO_3 \xrightarrow{t} 2NaAlO_2 + CO_2\uparrow,$$

$$Al_2O_3 + 2NaOH \xrightarrow{t} 2NaAlO_2 + H_2O\uparrow.$$

## 1.6. meti rom vicodeT oqsidTa Sesaxeb

sayovelTaod cnobilia, rom qimiur elementis **oqsidi (Jangeuli)** farTo diapazonis fizikur-qimiuri procesebis dros warmoiqmneba. mravali maTgani Zvirfasi sasargeblo wiaRiseulia (magaliTad, rkinis, aluminis, manganumis, kalis da sxva madnebi). zogierTi bunebrivi oqsidi (rkinis, kalis da sxv.) ZiriTadi madneulia Sesabamisi metalis misaRebad.

elementTa periodul sistemaSi oqsidTa Tvisebebi (fizikuri, qimiuri da sxv.) jgufebsa da periodebSi garkveuli kanonzomierebebiT icvleba _ fuZuri oqsidebis Tvisebebidan, amfoterulis gavliT, mJavuri oqsidebis Tvisebebamde.

oqsidebi farTod gamoiyeneba Tanamedrove mrewvelobis sxvadasxva dargsa da yofacxovrebaSi.

**wyalbadis oqsidi (** $H_2O$ **, wyali)** _ wyalbadis JangbadTan umartivesi naerTi ( $H_2O$ -Si Jangbadi masiT 88,81% da wyalbadi 11,19%). wyals udidesi gamoyeneba aqvs, radgan igi sicocxlisTvis aucilebeli naerTia _ fiziologiuri da bioqimiuri procesebi organizmSi wylis garemoSi da misi monawileobiT mimdinareobs. arc erTi sasicocxlo procesi organizmSi wylis monawileobis gareSe ar warimarTeba. yinulis dnobis Sedegad miRebuli, e.w. **mdnari wyali biologiurad aqtiuria** (xasiaTdeba **biostimulatoruli** TvisebebiT), **vinaidan xels uwyobs cocxal organizmTa zrda-ganviTarebas, amcirebs qolesterinis dones sisxlSi, aumjobesebs nivTierebaTa cvlas organizmSi da sxv**.

distilirebuli wyali farmakologiuri preparatia (gamoiyeneba farmaciasa da medicinaSi), misi $pH 5{,}0 - 6{,}8$ farglebSia. mraval samkurnalo formas (xsnari, nayeni, naxarSi) distilirebul wyalze amzadeben, medicinaSi distilirebuli wyali gamoiyeneba sainieqciod, samkurnalod (dermatologia) da sxv.

**liTiumis oqsids (** $Li_2O$ **)**, romlis miReba SeiZleba misi wviT JangbadSi an mSral haerze, an misi karbonatis gaxurebisas ( $800^\circ C$ -mde), iyeneben liTiumis marilebisa ( $LiCl$ , $LiNO_3$ , $Li_2SO_4$ da sxv.) da hidroqsidis ( $LiOH$ , fuZis-tutis) misaRebad, agreTve maRali gardatexis koeficientis mqone minisa da keramikuli Wiquris dasamzadeblad.

**natriumis oqsidi (** $Na_2O$ **)**, miiReba arapirdapiri gziT, $Na_2O_2$ -is aRdgeniT ( $Na_2O_2 + 2Na = 2Na_2O$ ), aqtiurad urTierTqmedebs wyalTan tutis ( $NaOH$ ) warmoqmniT (am reaqcias praqtikuli mniSvneloba ar aqvs da iSviaTad iyeneben sufTa hidroqsidis misaRebad), xolo mJavur, amfoterul oqsidebTan da hidroqsidebTan urTierTqmedebs Sesabamisi marilebis gamoyofiT (am reaqciebs mniSvnelovani praqtikuli gamoyeneba aqvT).

**kaliumis oqsidis (** $K_2O$ **)** umniSvnelo raodenoba miiReba Tavad metaluri kaliumis wvis dros ( $4K + O_2 = 2K_2O$ ), umetesi raodenobiT miiReba zeperoqsidi ( $2K + 2O_2 = K_2O_4$ ), xolo mcire raodenobiT _ peroqsidi ( $2K + O_2 = K_2O_2$ ). kaliumis oqsidi energiulad urTierTqmedebs wyalTan Sesabamisi hidroqsidis (tutis) warmoqmniT. masze didi moTxovnilebis gamo, igi miiReba metaluri kaliumis moqmedebiT kaliumis hidroqsidze an nitritsa da nitratze ( $2K + 2KOH = 2K_2O + H_2$ , $6K + 2KNO_2 = 4K_2O + N_2$ , $10K + 2KNO_3 = 6K_2O + N_2$ ).

**beriliumis oqsidi (** $BeO$ **)** Zneldnobadobis ( $2530^{\circ}C$ ) gamo gamoiyeneba cecxlgamZle masalad da Termomedeg dieleqtrikad. igi ixmareba, agreTve neitronebis dasayovneblad birTvul reaqtorebSi. rogorc amfoteruli oqsidi Sednobis dros urTierTqmedebs fuZur da mJavur oqsidebsa da hidroqsidebTan Sesabamisi marilebis warmoqmniT, romlebsac farTod iyeneben mrewvelobis sxvadasxva dargSi _ kerZod, metalurgiaSi nakeTobebis elastikurobis, simtkicisa da mdgradobis misaRwevad.

**magniumis oqsidi (** $MgO$ , mwvari magnezia) dnobis maRali temperaturis gamo ( $2800^{\circ}C$ ) gamoiyeneba cecxlgamZle aguris, tigelisa da sxvaTa dasamzadeblad. magniumis oqsidisa da magniumis qloridis koncentrirebul xsnarTa narevi myardeba mkvriv masad, romelic cnobilia magneziuri cementis (sorelis cementis) saxelwodebiT, romlisganac amzadeben sales qvebsa da wisqvilis dolabebs, xolo magneziuri cementisa da xis naxerxisgan Sedgenili masa _ qsilolitis saxelwodebiT, gamoiyeneba samSeneblo saqmeSi.

**kalciumis oqsidis** ( $CaO$ **,** Caumqrali kiri) wyalTan urTierTqmedebisas ( $CaO + H_2O = Ca(OH)_2 + Q$ ) warmoiqmneba Camqrali kiri _ mniSvnelovani samSeneblo masala. kalciumis oqsidis gavarvarebiT koqsTan erTad eleqtroRumelebSi miiReba teqnikuri karbidi ( $CaC_2$ ), romlis wyalTan urTierTqmedebiT warmoiqmneba acetileni ( $C_2H_2$ ). JangbadSi acetilenis dawviT miiRweva Zalian maRali ( $2500-3000^{\circ}C$ ) temperatura, romelic gamoiyeneba metalebis Wrisa da SeduRebisTvis. kalciumis oqsidi aseve farTod ixmareba mWida masalebis, kerZod, gamoiyeneba cementis warmoebaSi, agreTve minis damzadebis dros, wylis sixistis Tavidan asacileblad da sxv.

**stronciumis oqsids (** $SrO$ **)** iyeneben minis mrewvelobaSi _ minisa da minanqris misaRebad, aseve samSeneblo saqmeSi. igi Sedis mravali katalizatoris SedgenilobaSi, mniSvnelovani gamoyeneba aqvs stronciumis naerTebis misaRebad. stronciumis oqsidi gamoiyeneba piroteqnikaSi.

**bariumis oqsidi (** $BaO$ **)** gamoiyeneba specialuri daniSnulebis minebis, minanqrebisa da Termoizolatorebis dasamzadeblad. cementSi, kalciumis oqsidis nacvlad, bariumis oqsidis gamoyenebiT miiReba wyalSi gansakuTrebiT mdgradi cementi, romelic Seicavs sulfat-ionebs ( $SO_4^{2-}$ ) mometebuli raodenobiT. bariumis oqsidi wyalSi gaxsnisas iZleva Zlier fuZes da misi wyalxsnari (,,baritis wyali") farTod gamoiyeneba qimia-biologiis laboratoriebSi _ rogorc iafi fuZe. bariumis oqsidi luminescirebs (civ naTebas iwyebs) ultraiisferi sxivebis zemoqmedebiT.

**boris oqsidi (** $B_2O_3$ mJavuri oqsidi, boris anhidridi) miiReba boris wvis Sedegad, magram ufro martivia misi miReba bormJavas ( $H_3BO_3$ ) gaxurebiT. eleqtroRumelSi boris oqsidis naxSirTan

gavarvarebiT ($2B_2O_3 + 7C = B_4C + 6CO$, $2500^\circ C$) miiReba teqnikaSi Zalian mniSvnelovani boris karbidi ($B_4C$) _ Zneldnobadi nivTiereba, romelic simagriT almass (yvelaze magar nivTierebas) uaxlovdeba, gamoiyeneba rogorc saabrazivo masala. boris anhidridi ixmareba bormJavas misaRebad. gamdnar boris oqsidSi, romelic warmoqmnis minisebr masas, ixsneba mravali metalis oqsidi da warmoiqmneba Seferili ,,minebi" ($3B_2O_3 + Cr_2O_3 = 2Cr(BO_2)_3$ _ mwvane mina, $B_2O_3 + CoO = Co(BO_2)_2$ _ lurji mina. minis masaSi $B_2O_3$-is SetaniT (3-12%) miiReba didi simtkicis mina, romelic medegia qimiuri zemoqmedebisa da temperaturis cvlilebis mimarT. misgan amzadeben maRali xarisxis qimiur WurWels.

**aluminis oqsidi ($Al_2O_3$, amfoteruli oqsidi),** romelic bunebaSi moipoveba mineral korundis saxiT da simagriT almass uaxlovdeba _ wiTlad Sefervisas es lalia, xolo cisfrad Sefervisas _ safironi. orive Zvirfasi qvaa da maT saiuveliro warmoebaSi iyeneben. igive korundi ($Al_2O_3$) ixmareba, rogorc saabrazivo masala saxexi qargolisa da zumfara qaRaldis dasamzadeblad. xelovnurad miRebuli korundis monokristalebi (kerZod, lali) didi simagris gamo gamoiyeneba zust meqanizmebSi, agreTve kvantur generatorebSi (lazerebi). aluminis oqsidSemcveli aluminsilikatebis, zogierTi saxeoba, magaliTad, ceoliTebi rogorc molekuluri sacrebi _ ixmareba naxSirwyalbadebis dasayofad, airisa da siTxis dasacileblad da sxv. aluminTermiis dros, aluminis oqsidis ($Al_2O_3$) warmoqmnisas, viTardeba eleqtrorkalis ($3000 - 3500^\circ C$) temperatura da xdeba sxva metalTa oqsidebidan metalebis aRdgena Tavisufal mdgomareobamde (25% $Al$ da 75% $Fe_2O_3$, e.w. Termiti, cecxlwamkidi-magniumis fxvnili da bariumis peroqsidis ($BaO_2$) narevi: $8Al + 3Fe_3O_4 = 9Fe + 4Al_2O_3$).

**galiumis oqsidi ($Ga_2O_3$)** gamoiyeneba optikuri minis warmoebaSi, naxevargamtarebis teqnikaSi, advildnobadi Senadnobebis misaRebad (Tavad metaluri galiumis dnobis temperaturaa $29{,}8^\circ C$).

**indiumis oqsidiT ($In_2O_3$)** minis zedapiris dafarvis SemTxvevaSi igi xdeba eleqtrogamtari da inarCunebs eleqtrogamtarobas, amitom indiumis oqsidi farTod gamoiyeneba eleqtroteqnikaSi, xelsawyoTmSeneblobasa da sxva warmoebebSi.

**Taliumis oqsidebi ($Tl_2O$ da $Tl_2O_3$)** higroskopiuli nivTierebebia. ixmareba metaluri Taliumis misaRebad _ naxSirbadis monooqsidi ($CO$) da wyalbadi advilad aRadgens maT Tavisufal metalamde. Talium(I)-is oqsidi energiulad moqmedebs minaze da iyeneben eleqtroteqnikaSi, agreTve Talium(III)-is oqsidis ($Tl_2O_3$) misaRebad. Taliumis oqsidebi SeaqvT gansakuTrebuli daniSnulebis optikur minebSi, romlebic gamoirCeva refraqciis maRali koeficientiT.

**naxSirbadis oqsidebi (** $CO$ **da** $CO_2$**). naxSirbad(II)-is oqsidi (** $CO$**,** monooqsidi) ufero, usuno, ugemo, haerze odnav msubuqi, wyalSi mcired xsnadi, Zlier **momwamlavi** airia. wvis didi siTburi efeqtis gamo $CO$-mniSvnelovani airadi sawvavia. igi kargi aRmdgenia _ gamoiyeneba metalurgiaSi metalebis aRsadgenad maTi oqsidebidan. naxSirbadis monooqsidi Jangbadze ufro mtkiced ukavSirdeba hemoglobinis SedgenilobaSi Semaval rkina(II)-is ions ( $Fe^{2+}$ ), ris gamoc sisxls veRar gadaaqvs Jangbadi adamianis organizmis qsovilTa ujredebSi da iwyeba ,,Jangbadovani SimSili" _ Zlieri mowamvlisas adamiani iRupeba, amitom $CO$-s uwodes ,,mxuTavi airi". naxSirbad(II)-is oqsidi xasiaTdeba qimiur reaqciebSi Sesvlis didi unariT, amitom **farTod gamoiyeneba organul sinTezSi. ixmareba agreTve samxedro saqmeSi** (gaaqtiurebuli naxSiris Tanaobisas an mzis sinaTleze ierTebs qlors _ warmoqmnis fosgens $CO+Cl_2=COCl_2$ Zlier momwamlav airs), **TuTia-qromis katalizatoris** ( $ZnO+Cr_2O_3$ narevi) Tanaobisas ( $250-300^\circ C$ da 100atm. wneva) $CO$ ierTebs wyalbads meTilis spirtis warmoqmniT ( $CO+2H_2=CH_3OH$ ), **romelsac didi raodenobiT moixmars qimiuri mrewveloba. wyalairis narevis** ( $CO+H_2$ ) **wvis dros izrdeba Tbounarianoba da mas iyeneben sawvavad _ Zlieri alis misaRebad, agreTve madnebis aRmdgenad, metalTa** (nikelisa da sxv.) **rafinirebisTvis**. aRsaniSnavia, rom $CO$**-sa da** $H_2$**-is narevze, saTanado katalizatoris moqmedebiT iReben xelovnur benzins, aldehidebs, ketonebs, meTilis spirts da mraval sxva naxSirwyalbads, romlebic gamoiyeneba qimiur mrewvelobasa da ZravebSi sawvavad**.

**naxSirbad(IV)-is oqsidi (** $CO_2$, naxSirbadis dioqsidi, naxSirorJangi) ufero airia, susti mJave suniT da gemoTi. $CO_2$ gamoyofisas grovdeba (radgan haerze mZimea) saTavsoebis fskerze (sardafebSi, WebSi, zogierT gamoqvabulSi da sxv.), amitom maTSi Sesvlisas didi sifrTxilea saWiro, radgan aZnelebs sunTqvas. $CO_2$-is wyalxsnars sasiamovno gemo aqvs, amitomac farTod iyeneben gamagrilebeli wylebisa da SuSxuna sasmelebis, ludisa da Saqris warmoebaSi. naxSirorJangi ( $CO_2$ ) naxSirTan ( $C$ ) maRal temperaturaze warmoqmnis $CO$-s ( $CO_2+C=2CO$, buduris reaqcia), romelsac arsebiTi mniSvneloba aqvs metalurgiaSi rkinis madnebis aRdgenis procesSi.

airadi naxSirbadis dioqsids 60atm. wnevis pirobebSi, gadadis ra igi Txevad mdgomareobaSi, inaxaven foladis balonebSi. Zlieri gacivebisas Txevadi $CO_2$ iyineba da warmoiqmneba e.w. ,,mSrali yinuli", romlis aorTqlebis temperaturaa - $79^\circ C$. ixmareba malfuWebadi produqtebis Sesanaxad da maTi transportirebisTvis. $CO_2$ gamoiyeneba qimiur mrewvelobaSi sodis, Sardovanas, oqsikarbomJavebis misaRebad, agreTve Tbogadamtanad grafitis reaqtorebSi,

xanZris Casaqrobad da cecxlsaSiSi nivTierebebis gadatanisas, sasaTbure meurneobebSi da sxv. myar $CO_2$ iyeneben afeTqebis Zalis gasadideblad _ afeTqebis dros gamoyofili siTbo myisve aaorTqlebs ,,mSral" yinuls, ris gamoc miiReba didi moculobis airi, romelic aZlierebs afeTqebis moqmedebas.

haerSi 3%-mde $CO_2$-is koncentracia adamianze mavned ar moqmedebs, magram misi meti Semcveloba ukve Zalian saziano xdeba, Tu $CO_2$-is koncentracia 10%-s aRwevs, adamiani kargavs grZnobas, rasac mohyveba sikvdili sunTqvis Sewyvetis gamo.

**siliciumis oqsidebi (**$SiO$ **da** $SiO_2$**).** silicium (II)-is oqsidi ($SiO$) bunebaSi ar moipoveba da xelovnurad miiReben silicium(IV)-is oqsidisa da siliciumis narevis gaxurebiT ($1250-1300^\circ C$ temperaturaze $SiO_2 + Si = 2SiO$). miRebuli siliciumis monooqsidi ($SiO$) airad mdgomareobaSia da misi swrafi gacivebiT warmoiqmneba fisisebri amorfuli nivTiereba. siliciumis monooqsids iyeneben eleqtrosaizolacio masalebis dasamzadeblad, radioteqnikuri da ultrabgeriTi xelsawyoebis warmoebaSi da sxv.

**siliciumis dioqsidi anu kaJmiwa** $SiO_2$ (siliciumis yvela naerTis amosavali nivTiereba), siliciumis naerTebidan yvelaze mdgradi _ bunebaSi moipoveba rogorc kristaluri, ise amorfuli saxiT. kristaluri $SiO_2$ Zalian magaria, ar ixsneba wyalSi, dneba daaxloebiT $1710^\circ C$-ze, romlis gacivebiT miiReba amorfuli $SiO_2$ gamWvirvale minisebri masa, romlis gafarToebis koeficienti Zalian mcirea, amitomac kvarcis WurWeli did gamoyenebas poulobs laboratoriul praqtikaSi (gavarvarebuli kvarcis WurWeli civ wyalSic ar ibzareba). $SiO_2$-is erT-erTi forma infuzoruli miwis (kizerguli) saxeliTaa cnobili, xasiaTdeba siTxis Sesrutvis didi unariT, amitom gamoiyeneba sxvadasxva miznisTvis (magaliTad, nitrogliceriniT gaJRenTiT mzaddeba dinamiti). kvarcma didi gamoyeneba pova ultrabgeris misaRebad, romlis moqmedebiT SeiZleba uamravi molekulis daSla, zogierTi qimiuri reaqciis aRZvra. ultrabgeriTma talRebma didi gamoyeneba pova agreTve teqnikaSi _ metalTa blokebis erTgvarovnebis dasadgenad.

siliciumis dioqsidi qviSis saxiT mniSvnelovani raodenobiT gamoiyeneba rogorc saSeni masala cementTan an kirTan erTad. wminda silicium(IV)-is oqsids iyeneben minisa da faifuris warmoebaSi. gamWvirvale mTis brolis (kvarcis erT-erTi saxeoba) kristalebisgan mzaddeba optikuri xelsawyoebi, prizmebi, linzebi, kvarcis naerTebi da sxv. siliciumis mJavasgan wylis warTmeviT miRebul myar, naxevrad gamWvirvale, amorful masas ($SiO_2$), romelic didi forianobiT xasiaTdeba _ silikagels uwodeben da rogorc karg adsorbents farTod iyeneben tenis mSTamnTqmelad.

**germaniumis oqsidebi (** $GeO$ **da** $GeO_2$ **).** $GeO$ amJRavnebs aRdgenis unars _ gamoiyeneba Jangva-aRdgeniT procesebSi. germanium(II)-is oqsidi avlens amfoterul Tvisebebs ixsneba mJavasa da tuteSi Sesabamisi marilebis warmoqmniT, romlebic Semdgom gamoiyeneba sxvadasxva mniSvnelovani naerTis misaRebad.

**germanium(IV)-is dioqsidi (** $GeO_2$ **)** ixmareba Zlier gamWvirvale da maRali Suqtexis koeficientis mqone kvarcis minis misaRebad, romelsac didi raodenobiT iyeneben optikuri minis warmoebaSi, agreTve tranzistorebis, mzis elementebis, zogierTi tipis fotoelementebis da sxva xelsawyoebis dasamzadeblad.

**kalis oqsidebi (** $SnO$ **da** $SnO_2$ _ kalaqva, kasiteriti). kala(II)-is oqsidi ( $SnO$ ) teqnikaSi farTo gamoyenebas poulobs rogorc aRmdgeni. kargad ixsneba mJavebSi, Zalian Znelad tuteebSi _ kalis Sesabamisi marilebis warmoqmniT. kala(II)-is naerTebs iyeneben samRebro saqmeSi, navTobis mrewvelobaSi da a.S.

**kala(IV)-is dioqsidi (** $SnO_2$ **)** _ kalaqva, kasiteriti aris kalis erTaderTi bunebrivi minerali, romelic gamoiyeneba metaluri kalis misaRebad ( $SnO_2 + 2C = Sn + 2CO$ , $1000^\circ C$ -ze). kalis orJangi ixmareba TeTri minanqrisa da Wiquris dasamzadeblad agreTve laboratoriul praqtikasa (metastanatebis miReba $SnO_2$ -ze tuteTa moqmedebiT $SnO_2 + 2NaOH = Na_2SnO_3 + H_2O$ ) da teqnikis sxvadasxva dargSi.

**tyviis oqsidebi (** $Pb_2O$ **,** $PbO$ **,** $PbO_2$ **da** $Pb_3O_4$ **).**

**tyvia(I)-is oqsidi (** $Pb_2O$ **)** Savis feris kristalebi an fxvnilia, romelic miiReba tyvia(II)-is oqsidis nawilobrivi aRdgeniT wyalbadis areSi an $CO$ -s nakadSi $2500^\circ C$ -ze: $2PbO + H_2 = Pb_2O + H_2O$ ; $2PbO + CO = Pb_2O + CO_2$ . tyvia(I)-is oqsidi gamoiyeneba metaluri tyviis misaRebad $Pb_2O = Pb + PbO$ ; tyvia(I)-is oqsidisa da organuli halogennawarmebis ( $C_2H_5Cl$ , $C_2H_5Br$ ) urTierTqmedebiT miiReba tyviis subhalogenidebi, romlebsac didi gamoyeneba aqvT inovaciuri naerTebis misaRebad.

**tyvia(II)-is oqsidi (** $PbO$ **)** cnobilia ori saxiT _ tyviis murdasangi (mowiTalo feri) da masikoti (yviTeli feri). tyvia(II)-is oqsidis SednobiT miiReba misi mowiTalo saxesxvaoba _ murdasangi, xolo _ masikoti tyviis karbonatis an nitratis frTxili gaxurebiT. ufro mdgradia mowiTalo modifikacia _ xangrZlivi duRilisas yviTeli oqsidi mowiTaloSi gadadis; tyvia(II)-is oqsidi gamoiyeneba tyviis minis (broli), Wiquris dasamzadeblad da laqsaRebavebis, olifis warmoebaSi (olifas amzadeben selis zeTis duRebiT tyviis oqsidTan erTad). tyvia organul mJavebTan warmoqmnis e.w. sikativebs, romlebsac iyeneben teqnikuri zeTebisa da saRebavebis gaSrobis

dasaCqareblad. tyviis oqsids amosaval nivTierebad iyeneben tyvia(II)-is marilebis dasamzadeblad.

**tyvia(IV)-is oqsidi (** $PbO_2$ **, dioqsidi)** muqi yavisferi fxvnili, romelic miiReba tyvia(II)-is naerTebze damJangavis moqmedebiT ( $PbCl_2 + Na_2O_2 = PbO_2 + 2NaCl$ ). igi amfoterulia, Tumca masSi Warbobs mJava Tvisebebi. gamoiyeneba metaplumbatebisa ( $CaPbO_3$ ) da orToplumbatebis ( $Na_4PbO_4$ ) misaRebad. bioqimiur laboratoriebSi tyviis dioqsids iyeneben rogorc Zlier mJangavs (magaliTad, $PbO_2 + 4HCl = PbCl_2 + Cl_2 + 2H_2O$ , $5PbO_2 + 2MnSO_4 + 6HNO_3 = 2PbSO_4 + 3Pb(NO_3)_2 + 2HMnO_4 + 2H_2O$ ). gogirdi da wiTeli fosfori tyviis dioqsidTan xaxunis dros aaldeba, amitomac tyviis dioqsidma gamoyeneba pova asanTis warmoebaSi.

**tyvia(II)-isa da (IV)-is Sereuli oqsidi (** $Pb_3O_4$ **, surinji)**, romelic miiReba wiTeli feris fxvnilis saxiT _ tyvia(II)-is oqsidis (masikotis) haerze gaxurebiT ( $400-500^\circ C$ -mde). surinji gamoiyeneba zeTis wiTeli saRebavis mosamzadeblad _ igi erT-erTi saukeTeso saRebavia gemebis wyalqveSa nawilebis, rkinis koWebisa da wyalsadeni milebis koroziisgan dasacavad. surinjis sagozavi (surinjis sqeli narevi carcTan da selis zeTTan) ixmareba rkinis pirapirebis asacxebad (maTi SeerTebis dros). mSrali surinji uwylo glicerinTan iZleva masas (coms), romelic advilad magrdeba, amitom gamoiyeneba minisa da metalis Sesakerad (akvariumebi). surinji aseve ixmareba brolis, Wiquris, minanqris, linoleumis warmoebaSi.

**azot(I, II, III, IV da V)-is oqsidebi.**

**azot(I)-is oqsidi (** $N_2O$ **)** ufero, sasiamovno sunis da motkbo gemos mqone airia. misi SesunTqva iwvevs SegrZnebis dakargvas, amitom mas iyeneben, rogorc narkozul nivTierebas qirurgiaSi. aRsaniSnavia, rom $N_2O$ mxolod maRal temperaturaze iSleba Jangbadis gamoyofiT ( $2N_2O = 2N_2 + O_2$ ), amitom igi aZnelebs sunTqvas _ sufTa $N_2O$ -s CasunTqviTYadamiani daixrCoboda Jangbadis uqonlobis gamo iseve, rogorc, magaliTad, wminda azotis areSi. haerTan an JangbadTan SesunTqvisas $N_2O$ amcirebs tkivilis SegrZnebas, amgzneb moqmedebas axdens adamianze, ris gamoc $N_2O$ -s ,,malxeni airi” ewoda.

**azot(II)-is oqsidi (** $NO$ **)** ufero airia, wyalSi mcired ixsneba _ masTan qimiur urTierTqmedebaSi ar Sedis. $NO$ endoTermuli naerTia, magram sakmaod mdgradia, arc Tu ise advilad iSleba Jangbadad da azotad, amitom mis areSi mbJutavi kvari qreba. qimiurad sakmaod aqtiuria _ haeris Jangbads uerTdeba oTaxis temperaturaze ( $2NO + O_2 = 2NO_2$ ). elWeqis dros, agreTve uranis, plutoniumisa da wyalbadis yumbarebis afeTqebisas aucileblad iJangeba

atmosferos azoti (maRal $2500-3000^{\circ}C$ temperaturaze warmoqnili $N_2+O_2 \Leftrightarrow 2NO-181$kj/moli, gacivebisas iJangeba $NO_2$-mde, saidanac miiReba misi dimeric _ $N_2O_4$). azot(II)-is oqsidi amiakis Jangvis ($4NH_3+5O_2=4NO+6H_2O$) mniSvnelovani naxevarproduqtia azotmJavis misaRebad.

**azot(III)-is oqsidi (**$N_2O_3$**,** azotovani oqsidi) muqi-cisferi siTxea, Cveulebriv temperaturaze aramdgradia da iSleba azotis monooqsidad da dioqsidad ($N_2O_3=NO+NO_2$). wyalSi ixsneba azotmJavas warmoqmniT ($N_2O_3+H_2O=2HNO_2$). tuteebTan urTierTqmedebs azotovanmJavas marilebis _ nitritebis warmoqmniT ($N_2O_3+2NaOH=2NaNO_2+H_2O$). praqtikuli gamoyeneba ar aqvs.

**azot(IV)-is oqsidi (**$NO_2$**, dioqsidi)** muqi-wiTeli feris airia. gacivebisas ($-11^{\circ}C$) azotis dioqsidi gardaiqmneba ufero kristalebad. romlebic ZiriTadad $N_2O_4$ molekulebisgan Sedgeba ($-11^{\circ}C$-dan $140^{\circ}C$-mde $NO_2$ da $N_2O_4$-is molekulebi wonasworobaSia $NO_2 \Leftrightarrow N_2O_4$). dioqsidi Zlieri mJangavia _ masSi iwvis kaliumi, fosfori, naxSirbadi da gogirdi. rogorc katalizatoris ($NO_2$) moqmedebiT gogirdis dioqsidi iJangeba trioqsidamde, romlis Semdgomi wyalSi gaxsniT miiReba gogirdmJava (aRniSnuli xerxi gamoiyeneba nitrozuli meTodiT gogirdmJavas warmoebaSi) ($NO_2+SO_2+H_2O=H_2SO_4+NO$). $NO_2$-is wyalSi gaxsnisas warmoiqmneba azotovanmJava da azotmJava ($2NO_2+H_2O=HNO_2+HNO_3$). amitom $NO_2$ ($N_2O_4$) SeiZleba CaiTvalos am mJavebis Sereul anhidridad. amasTan, dioqsidis tuteebSi gaxsnisas miiReba azotovanmJavas da azotmJavas Sesabamisi marilebis _ nitritebisa da nitratebis narevi ($2NO_2+2KOH=KNO_2+KNO_3+H_2O$). gansakuTrebiT didi teqnikuri mniSvneloba aqvs $NO_2$-is wyalsa da JangbadTan urTierTqmedebis reaqcias, radgan maszea agebuli azotmJavas Tanamedrove warmoeba ($4NO_2+2H_2O+O_2=4HNO_3$).

$NO_2$ gamoiyeneba zogierT metalTan urTierTqmedebisas Sesabamisi nitratis misaRebad, radgan aqtiuri metalebi aaldeba mis areSi ($2NO_2+K=KNO_3+NO$), aseve $NO_2$-is STanTqmisas metalebis oqsidebiT warmoiqmneba nitratebi da nitritebi ($4NO_2+2BaO=Ba(NO_3)_2+Ba(NO_2)_2$). gogirdmJavas warmoebaSi $NO_2$ gamoiyeneba rogorc Jangbadis gadamcemi. $NO_2$, iseve rogorc azotis sxva oqsidebi, sakmaod Zlieri momwamlavia, misi CasunTqva iwvevs gulis dazianebas da sasunTqi organoebis Zlier gaRizianebas.

**azot(V)-is oqsidi (** $N_2O_5$**,** azotis anhidridi) ufero, gamWvirvale, kristaluri nivTierebaa, qroldeba ($32^\circ C$-ze), aramdgradia, advilad iSleba oTaxis temperaturazec Jangbadis gamoyofiT ($2N_2O_5 = 4NO_2 + O_2$), amitom Zlieri mJangavia, mravali organuli naerTi masTan Sexebisas aaldeba. $N_2O_5$ Zneli misaRebia da mcire praqtikuli mniSvnelobac aqvs.

**fosfor(III)-isa da (V)-is (** $P_2O_3$ **da** $P_2O_5$**) oqsidebi.**

**fosfor(III)-is oqsidi (** $P_2O_3$**, anu** $P_4O_6$ **fosforovani anhidridi)** TeTri, cviliseburi, Zlieri momwamlavi, kristaluri nivTierebaa. arsebobs dimeris ($P_4O_6$-is) saxiT. wyalSi ixsneba fosforovanmJavas warmoqmniT ($P_4O_6 + 6H_2O = 4H_3PO_3$). fosforovani anhidridi gamoiyeneba fosforis anhidridis misaRebad ($P_2O_3 + O_2 = P_2O_5$) _ am reaqcias axlavs naTeba, romelic kargad Cans sibneleSi. qimiuri reaqciis dros, sinaTlis aseT gamosxivebas, romelsac ar axasiaTebs temperaturis SesamCnevi cvlileba, **qemiluminescencia** ewodeba (farTo masStabiT iyeneben Tanamedrove sareklamo teqnikaSi). fosforovani anhidridi (fosforis msgavsad) Zlieri sawamlavia.

**fosfor(V)-is oqsidi (** $P_2O_5$ **anu** $P_4O_{10}$**, fosforis anhidridi)** TeTri, Zlier higroskopiuli, myari nivTierebaa, energiulad uerTdeba wyals didi raodenobis siTbos gamoyofiT. fosfor(V)-is oqsidi maRal temperaturaze ($359^\circ C$-ze) aqroldeba _ orTqlSi misi formulaa $P_4O_{10}$. igi xarbad ierTebs wyals da gamoiyeneba efeqtur wyalwamrTmev saSualebad _ wyals arTmevs iseT Zlier mJavebsac ki, rogoricaa gogirdmJava, azotmJava, qlormJava ($P_2O_5 + 2HNO_3 = 2HPO_3 + N_2O_5$, $P_2O_5 + H_2SO_4 = 2HPO_3 + SO_3$, $P_2O_5 + 2HClO_4 = 2HPO_3 + Cl_2O_7$). am Tvisebis gamo fosforis anhidrids iyeneben airebis gasaSrobad, siTxeebis gasauwyloeblad da qimiuri naerTebidan wylis mosacileblad. fosfor(V)-is oqsids iyeneben sxvadasxva mniSvnelovani marilis misaRebad ($P_2O_5 + 3CaO = Ca_3(PO_4)_2$, $P_2O_5 + 2NH_3 + 3H_2O = 2NH_4H_2PO_4$).

**dariSxan(III)-is da (V)-is (** $As_2O_3$ **da** $As_2O_5$**) oqsidebi**.

**dariSxan(III)-is oqsidi (** $As_2O_3$**, TeTri dariSxani)** wyalSi mcired xsnadi, motkbo gemos nivTierebaa, xasiaTdeba amfoteruli TvisebebiT ($As_2O_3 + 6HCl = 2AsCl_3 + 3H_2O$, $As_2O_3 + 2KOH = 2KAsO_2 + H_2O$). dariSxan(III)-is oqsidi, iseve rogorc misi wyalxsnari, Zlieri Sxamia (0,1g $As_2O_3$ ukve sasikvdilod moqmedebs adamianze). dariSxanis oqsidi farTod ixmareba soflis meurneobis mavneblebis mosaspobad. garda amisa, mas didi samkurnalo mniSvneloba aqvs da gamoiyeneba medicinaSi, kerZod, mis safuZvelze damzadebul wamlebs

rekomendacias uweven _ sisxlnaklebobis, gamofitvis dros da sxv. iyeneben agreTve stomatologiur praqtikaSi.

**dariSxan(V)-is oqsidi (** $As_2O_5$ **, dariSxanis anhidridi)** ar miiReba dariSxanis an Tundac dariSxan(III)-is oqsidis JangbadTan uSualo urTierTqmedebiT, igi miiReba dariSxanmJavas hidratis gauwyloebiT ( $2H_3AsO_4 \cdot 4H_2O = As_2O_5 + 7H_2O$ ). dariSxanis anhidridi TeTri, minisebri nivTierebaa, advilad ganiTxeva tenian haerze. $As_2O_5$ ixmareba dariSxan(V)-is mJavas misaRebad ( $As_2O_5 + 3H_2O = 2H_3AsO_4$ ), agreTve misi Sesabamisi zogierTi marilis _ inseqticidebis ( $Na_3AsO_4$ , $Ca_3(AsO_4)_2$ da sxv.) sinTezisTvis, romlebsac iyeneben mcenareTa mavneblebis winaaRmdeg sabrZolvelad.

**stibium(III)-isa da (V)-is (** $Sb_2O_3$ **da** $Sb_2O_5$ **) oqsidebi**:

**stibium(III)-is oqsidi (** $Sb_2O_3$ **)** metaluri stibiumis wvis produqtia ( $4Sb + 3O_2 = 2Sb_2O_3$ ). ar ixsneba wyalSi, igi amfoteruli oqsidia _ gamoiyeneba stibium(III)-is qloridisa da sxva halogenidebis, agreTve stibitebis (natriumis, kaliumis da sxv.) misaRebad. $Sb_2O_3$ stibiumis oqsiqloridTan ( $SbOCl$ ) warmoqmnis ormag naerTs ( $Sb_2O_3 \cdot 3SbOCl$ ), romelsac ,,algarotis" fxvnili ewodeba da gamoiyeneba teqnikis sxvadasxva dargSi.

**stibium(V)-is oqsidi (** $Sb_2O_5$ **)** Cveulebriv pirobebSi aris myari nivTiereba, wyalSi Znelad ixsneba, magram svel lurj lakmusis qaRalds mainc wiTlad Rebavs, rac mowmobs mis mJavur xasiaTs. ixmareba stibiummJavas ( $H_3SbO_4$ ) marilebis (stibatebis-anTimonatebis) misaRebad (stibium(V)-is oqsidis SednobiT tuteebTan: $Sb_2O_5 + 6NaOH = 2Na_3SbO_4 + 3H_2O$ ). miRebulia da praqtikulad gamoiyeneba agreTve metastibatebi ( $NaSbO_3$ , $KSbO_3$ ) da pirostibatebi ( $Na_4Sb_2O_7$ , $K_4Sb_2O_7$ ) _ yvela es marili polimeria.

**bismut(III)-is oqsidi (** $Bi_2O_3$ **),** e.w. bismutis ,,oxra", yviTeli feris, myari nivTierebaa, gadnobisas igi yavisfer siTxed gadaiqceva. $Bi_2O_3$ advilad ixsneba mJavaSi, miRebuli marilebic (qloridi, nitrati da sxv.) wyalSi kargad xsnadia. maTi nawili ekvris minis zedapirs da amitom gamoiyeneba sarkis dasamzadeblad, minisa da metalis erTmaneTTan mirCilvis dros da sxv. bismutis oqsidma sxvadasxva gamoyeneba pova teqnikaSi _ ZiriTadad, saxanZro da sxva sasignalo aparaturaSi. bismutis oqsiduri naerTi gamoiyeneba didi Suqtexis koeficientis optikuri minisa da feradi Wiquris dasamzadeblad.

**gogird(IV)-isa da (VI)-is oqsidebi (** $SO_2$ **da** $SO_3$ **).**

**gogird(IV)-is oqsidi (** $SO_2$ **, dioqsidi, gogirdovani anhidridi, gogirdovani airi)** ufero, damaxasiaTebeli mkveTri sunis mqone airia. wyalSi kargad ixsneba (1 moculoba wyalSi 40 moculoba $SO_2$). gogirdis dioqsidis ZiriTadi momxmarebelia gogirdmJavas warmoeba ($2SO_2 + O_2 \Leftrightarrow 2SO_3$, $400-500^\circ C$, katalizatori $V_2O_5$; $SO_3 + H_2O = H_2SO_4$). igi aris antiseptikuri saSualeba. spobs mikroorganizmebs, amitom iyeneben bostneulis, xexilis SesaxrColeblad, xolo lpobis Tavidan acilebis mizniT mas agreTve iyeneben Rvinis kasrebSi obis mosaspobad. gogirdovani airi auferulebs mraval saRebars, radgan warmoqmnis maTTan ufero naerTebs. magram miRebuli naerTebi aramdgradebia, SeiZleba gacxelebiT an sinaTlis moqmedebiT advilad daiSalos da qsovilma aRidginos pirvandeli feri.

**gogird(VI)-is oqsidi (** $SO_3$ **, trioqsidi, gogirdis anhidridi)** haerze ,,bolavs" _ igi gogirdmJavas uwvrilesi wveTebia, romlebic warmoiqmneba oqsidis orTqlis SeerTebiT haerSi arsebul wylis orTqlTan. gogirdis trioqsidis nawili ixmareba gogirdmJavas misaRebad ($SO_3 + H_2O = H_2SO_4$), xolo danarCeni miewodeba mSTanTqmel koSkebs, sadac igi ixsneba koncentrirebul gogirdmJavaSi da warmoiqmneba sqeli zeTisebri siTxe _ pirogogirdmJavas xsnari ($SO_3 + H_2SO_4 = H_2S_2O_7$), romlis wyliT ganzavebiT mzaddeba sasurveli koncentraciis gogirdmJava ($H_2S_2O_7 + H_2O = 2H_2SO_4$).

**selenisa da teluris dioqsidebi (** $SeO_2$ **da** $TeO_2$ **)** maTi yvelaze mdgradi Jangbadiani naerTebia. orive dioqsidi myaria. $SeO_2$ nebismieri TanafardobiT ixsneba wyalSi, xolo $TeO_2$ umniSvnelod xsnadia (100g wyalSi ixsneba 0,0007g $TeO_2$). selenisa da teluris dioqsidebi mJavuri anhidridebia da gamoiyeneba Sesabamisad selenovanmJavas, telurovanmJavasa da maTi Sesabamisi marilebis misaRebad _ Semdgom maTi mizanmimarTulad moxmarebis mizniT.

**selenisa da teluris trioqsidebi (** $SeO_3$ **da** $TeO_3$ **)** maTi umaRlesi Jangbadiani naerTebia. $SeO_3$ TeTri, kristaluri nivTierebaa, wyalTan urTierTqmedebs Zalian energiulad da iyeneben selenmJavas da praqtikuli mniSvnelobis mqone Sesabamisi selenaturi marilebis ($Na_2SeO_4$, $CaSeO_4$ da sxv.) misaRebad, romlebic gamoiyeneba kauCukis vulkanizaciisaTvis, silikatur warmoebaSi minis gasauferuleblad, denis gammarTvelebsa da fotoelementebSi. mizanmimarTulad ixmareba samkurnalo preparatebis wamroebaSi. $TeO_3$ yviTeli feris, wyalSi uxsnadi fxvnilia, urTierTqmedebs tuteebTan Sesabamisi naerTebis warmoqmniT, romelTa mcire raodenobiT damateba zrdis tyviis meqanikur Tvisebebs, xasiaTdeba agreTve naxevargamtaruli TvisebebiT da gamoiyeneba eleqtroteqnikaSi. zogierTi maTgani ixmareba qimiur sinTezSi telurorganuli naerTebis misaRebad.

**qloris oqsidebi (**$Cl_2O$ **_ moyavisfro-yviTeli airi,** $ClO_2$ **_ momwvano-yviTeli airi,** $Cl_2O_6$ **_ muqi wiTeli aqroladi siTxe,** $Cl_2O_7$ **_ ufero zeTisebri siTxe)** wyalSi gaxsnisas warmoqmnis Jangbadian mJavebs, romlebSic qlori, iseve, rogorc yvela Jangbadian naerTSi, avlens dadebiT Jangvis xarisxs. qloris oqsidebi Zlieri mJangavia. qloris yvela oqsidi feTqebadia. qloris JangbadnaerTebi miiReba arapirdapiri gziT, radgan qlori Jangbads uSualod ar uerTdeba.

**qlor(I)-is oqsidi (**$Cl_2O$**, qveqlorovanmJavas anhidridi),** romelic miiReba qloris moqmedebiT vercxliswyal(II)-is oqsidze ($HgO + 2Cl_2 = Cl_2O + HgCl_2$) mZime airia, aRizianebs sasunTq organoebs, aramdgradi naerTia, advilad iSleba qlorad da Jangbadad ($2Cl_2O = 2Cl_2 + O_2$); kargad ixsneba wyalSi da gamoiyeneba qveqlorovanmJavas da misi Sesabamisi marilebis hipoqloritebis misaRebad.

**qlor(II)-is dioqsidi (**$ClO_2$ **anu** $Cl_2O_4$**, qlorovanmJavasa da qveqlormJavas anhidridi)** miiReba berToles marilze koncentrirebuli gogirdmJavas moqmedebiT ($3KClO_3 + 3H_2SO_4 = 2ClO_2 + HClO_4 + 3KHSO_4 + H_2O$). igi aris mxrColavi endoTermuli naerTi, ris gamoc mcire gaxurebiTac afeTqebiT iSleba. qloris dioqsidi Zlieri mJangavia. gamoiyeneba laboratoriul praqtikaSi qlorovanmJavas ($HClO_2$) da qveqlormJavas ($HClO_3$) misaRebad.

**qlor(VI)-is trioqsidi (**$ClO_3$ **anu** $Cl_2O_6$**, qveqlormJavas da qlormJavas anhidridi)** muqi wiTeli feris zeTisebri siTxea, Cveulebriv pirobebSi nela iSleba, wyalSi gaxsnis dros miiReba qveqlormJava ($HClO_3$) da qlormJava ($HClO_4$). ZiriTadad ixmareba zemoaRniSnuli mJavebisa ($2ClO_3 + H_2O = HClO_3 + HClO_4$) da maTi Sesabamisi marilebis ($KClO_3$ da sxv.) misaRebad. $KClO_3$ (berToles marili) didi gamoyeneba pova asanTis waroebaSi, piroteqnikasa da medicinaSi.

**qlor(VII)-is oqsidi (**$Cl_2O_7$**, qlormJavas anhidridi)** ufero zeTisebri siTxea, SedarebiT mdgradia, gaxurebisas ($120^\circ C$) iSleba afeTqebiT. iyeneben qlormJavas misaRebad ($Cl_2O_7 + H_2O = 2HClO_4$) da misi marilebis (tetraoqsoqloratebis _ perqloratebis) warmoebisTvis ($KClO_4$, $Ca(ClO_4)_2$ da sxv.), romlebsac didi gamoyeneba aqvT laboratoriul teqnikaSi (Jangva-aRdgeniT procesebSi), aseve ixmareba zogierTi feTqebadi nivTierebis dasamzadeblad.

**bromis oqsidebi (**$Br_2O$**,** $BrO_2$ **da** $BrO_3$**)** aramdgradi da Znelad misaRebi nivTierebebia. brom(I)-is oqsidi ($Br_2O$) yavisfer-wiTeli siTxea, wyalSi ixsneba qvebromovanmJavas warmoqmniT ($Br_2O + H_2O = 2HBrO$). gamoiyeneba qvebromovanmJavas da misi Sesabamisi

marilebis _ hipobromitebis ($NBrO$, $KBrO$ da sxv.) misaRebad. isini Zlieri mJangavebia da gamoiyeneba organul naerTTa sinTezSi.

**brom(IV)-isa da (VI)-is dioqsidi da trioqsidi (**$BrO_2$**,** $BrO_3$**)** miiReba bromisa da Jangbadis narevidan dabali temperaturis milakebSi eleqtruli ganmuxtvis pirobebSi. ixmareba qvebrommJavas da brommJavas, maTi Sesabamisi marilebis miRebisa da gamoyenebisas, agreTve laboratoriebSi rogorc Zlieri mJangavebi organul sinTezSi.

**iodis JangbadnaerTebidan aRsaniSnavia** $IO_2$ **(**$I_2O_4$**) da** $I_2O_5$**,** romelTagan ufro mniSvnelovania es ukanaskneli ($I_2O_5$). igi kristaluri nivTierebaa. miiReba qveiodmJavas gaxurebiT ($2HIO_3 = I_2O_5 + H_2O$). rogorc mJangavi gamoiyeneba sxvadasxva nivTierebasTan ($H_2S$, $HCl$ da sxv.) urTierTqmedebisTvis. qveiodmJavas anhidridi ($I_2O_5$) ixmareba rogorc reaqtivi $CO$-s gansazRvrisTvis (iodometruli meTodi) $I_2O_5 + 5CO = I_2 + 5CO_2$.

**spilenZ(I)-is oqsidi (**$Cu_2O$**)Q**agurisferi, wyalSi uxsnadi nivTiereba kargad ixsneba amiaksa da halogenwyalbadebSi Sesabamisi kompleqsnaerTebis warmoqmniT. maRal temperaturaze aRmdgenis moqmedebiT advilad aRdgeba Tavisufal metalamde ($Cu_2O + H_2 = 2Cu + H_2O$, $150^\circ C$; $CuO + CO = Cu + CO_2$, $200^\circ C$). ufro maRal temperaturaze ($1025^\circ C$) $Cu_2O$ gardaiqmneba $CuO$-d, xolo Semdeg _ iSleba ($2Cu_2O + O_2 = 4CuO$; $2Cu_2O = 4Cu + O_2$). minerali kupriti ($Cu_2O$) gamoiyeneba metaluri spilenZis misaRebad ($Cu_2O + C = 2Cu + CO$, aRdgena xdeba koqsiT).

**spilenZ(II)-is oqsidi (**$CuO$**)** Savi feris fxvnilia, wyalSi mcired ixsneba, xolo koncentrirebul mJavebsa da amoniumis iodidSi kargad xsnadia. spilenZ(II)-s oqsidi aseve ixsneba galRobil minaSi da aZlevs mas momwvano lurj fers, xolo koloiduri $CuO$ minas alisfrad Rebavs. aqedan gamomdinare, $CuO$ gamoiyeneba feradi minebis, keramikuli Wiqurisa da minanqris warmoebaSi.

**vercxl(I)-is oqsidi (**$Ag_2O$**)** moyavisfro Savi feris, wyalSi mcired xsnadi nivTierebaa. sinaTlis zegavleniT igi iSleba da gardaiqmneba $AgO$-d. gacxelebiT ($200^\circ C$-mde) ki aRdgeba metalur vercxlamde ($2Ag_2O = 4Ag + O_2$). vercxl(I)-is oqsidis amiakur xsnarze aRmdgenis (glukoza, formaldehidi) damatebisas gamoiyofa metaluri vercxli, romelic warmoqmnis mbrwyinav sarkisebr Sres ($Ag_2O + HCHO = 2Ag + HCOOH$). analogiuri reaqciebi gamoiyeneba sarkis, Termosisa da diuaris WurWlis dasamzadeblad.

**oqro(I)-isa da (II)-is oqsidebi (**$Au_2O$ **da** $Au_2O_3$**)** miiReba Sesabamisi qloridis urTierTqmedebiT tutesTan ($2AuCl + 2KOH = Au_2O + 2KCl + H_2O$). igi advilad

disproporcirdeba ($3Au_2O = 4Au + Au_2O_3$). $Au_2O$ iisferi, myari, xolo $Au_2O_3$ _ yavisferi, aramdgradi nivTierebaa. oqros oqsidebs wminda praqtikuli gamoyeneba TiTqmis ara aqvT. Tavad oqros Senadnobebi vercxlTan da spilenZTan gamoiyeneba eleqtroteqnikasa da stomatologiaSi, saiuveliro nakeTobebis dasamzadeblad, minis, faifuris, metalTa zedapirebis dasafaravad. koloidur oqros medicinaSi iyeneben rogorc antiseptikur nivTierebas. oqro aris Zalian bevri qveynis ZiriTadi savaluto metali.

**TuTiis oqsidi (**$ZnO$**)** TeTri feris kristaluri nivTierebaa, wyalSi cudad ixsneba, amfoterul bunebas amJRavnebs, ixsneba rogorc mJavebSi, ise tuteebSi saTanado marilebis warmoqmniT. $ZnO$-s didi praqtikuli gamoyeneba aqvs _ ixmareba TeTri saRebavis saxiT (TuTiis TeTra). TuTiis oqsids moixmars agreTve rezinisa da keramikis warmoeba. $ZnO$ Sedis im nivTierebaTa jgufSi (TuTiis sulfidi da sxv.), romlebsac aqvT luminescenciis (civi naTebis) unari, romelic farTod gamoiyeneba mecnierebasa da teqnikaSi.

$ZnO$ ixmareba zogierTi samkurnalo preparatis misaRebad, romelic gamoiyeneba medicinasa da kosmetologiaSi. TuTiis oqsids aseve iyeneben rogorc katalizators spirtebis sinTezSi.

**kadmiumis oqsidi (**$CdO$**)** moyviTalo-yavisferi fxvnilia, wyalSi cudad ixsneba. kargad ixsneba mJavebSi Sesabamisi marilebis warmoqmniT. gamoiyeneba saRebavebisa da feradi minebis warmoebaSi. $CdO$-s orTqli Zalian toqsikuria.

**vercxliswylis oqsidi (**$HgO$**)** wiTeli feris fxvnilia. igi miiReba vercxliswylis gaxurebiT ($350^\circ C$). vercxliswylis oqsidi advilad iSleba $500^\circ C$-ze maRal temperaturaze, $HgO$-s miRebisa da daSlis reaqciebi Seqcevadi procesebia: $Hg + 1/2O_2 \underset{500^\circ C}{\overset{350^\circ C}{\Leftrightarrow}} HgO$. vercxliswylis oqsidi mizanmimarTulad gamoiyeneba fungiciduri da baqtericiduli daniSnulebiT medicinasa da soflis meurneobaSi.

**skandium(III)-isa da itrium(III)-is oqsidebi (**$Sc_2O_3$ **da** $Y_2O_3$**)** ufero, higroskopuli da Zneldnobadebia, cudad ixsneba wyalsa da tuteSi, kargad mJavaSi Sesabamisi marilebis warmoqmniT. skandiumis oqsidis Semcvel zogierT ferits iyeneben eleqtrogamomTvlel manqanebSi, agreTve saaviacio da raketul tenikaSi. itriumis oqsidi gamoiyeneba radioeleqtronikasa da eleqtrogamomTvlel manqanebSi, agreTve rogorc konstruqciuli masalis komponenti birTvul teqnikaSi.

**lanTanisa da aqtiniumis oqsidebi (**$La_2O_3$ **da** $Ac_2O_3$**)** ufero kristalebia, ixsneba wyalSi didi raodenobiT siTbos gamoyofiT, aseve ixsneba mJavaSi Sesabamisi marilis warmoqmniT. lanTanis oqsidi gamoiyeneba rogorc katalizatori bioqimiur procesebSi. aseve iyeneben minis mrewvelobaSi, romelic minas aniWebs ultraiisferi sxivebis STanTqmis unars. aqtiniumis oqsidi

ixmareba iseTi mniSvnelovani marilebis misaRebad, rogoricaa qloridebi, sulfatebi, ftoridebi, ftorosilikatebi da sxv. aqtiniumis yvela naerTi, maT Soris, oqsidic momwamlavia da maTTan muSaoba saxifaTo (gansakuTrebiT imis gamo, rom igi $x$-gamosxivebis wyaroa).

**titan(II)-is, (III)-isa da (IV)-is oqsidebi (**$TiO$**,** $Ti_2O_3$**,** $TiO_2$ **_ titanis dioqsidi, titanis TeTra).** titan(II)-is oqsidi oqrosferi masis saxiT miiReba titanis dioqsidisa da metaluri titanis narevis vakuumSi gaxurebisas ($TiO_2 + Ti = 2TiO$, $1700^\circ C$). titan(III)-is oqsidi miiReba titan(IV)-is oqsidis aRdgeniT maRal temperaturaze ($2TiO_2 + C = Ti_2O_3 + CO$). igi iisferia, mcired ixsneba wyalSi, xolo kargad _ gogirdmJavaSi. titan(IV)-is oqsidi, dioqsidi ($TiO_2$) bunebaSi gavrcelebulia _ ruTilis, brukitisa da sxva saxiT, romlebic erTmaneTisgan gansxvavdeba simetriis RerZebiT, feriT, simkvriviT. miiReba titanis dawviT Jangbadis areSi ($Ti + O_2 = TiO_2$). igi TeTri fxvnilia, mcired ixsneba ganzavebul mJavebSi, tuteebsa da wyalSi. kargad ixsneba koncentrirebul gogirdmJavasa da natriumis tutis nadnobSi.

titanis oqsidebi, gansakuTrebiT titanis dioqsidi ($TiO_2$) gamoiyeneba Zneldnobadi minis, Wiquris, minanqrisa da zeTis TeTri saRebavebis dasamzadeblad.

**cirkonium(IV)-is dioqsidi (**$ZrO_2$**)** miiReba metaluri cirkoniumis gaxurebiT Jangbadis areSi ($Zr + O_2 = ZrO_2$). igi TeTri fxvnilia, Zneldnobadi, qimiuri reagentebis mimarT mdgradi naerTi.

cirkoniumis dioqsidi saukeTeso cecxlagmZle, maRalxarisxovani masalaa da gamoiyeneba tigelebis, Rumlebis amosagebad, agreTve cecxlgamZle da mJavagamZle aguris, faifurisa da minis (eleqtroizolatoris), minanqris, Wiqurisa da mdgradi saRebavebis dasamzadeblad.

hafnium(IV)-is dioqsidi ($HfO_2$) TeTri nivTierebaa, wyalSi mcired xsnadi, Zneldnobadi ($2790^\circ C$), qimiurad sakmaod inertulia _ civ ganzavebul mJavebsa da tuteebSi ar ixsneba, diamagnituria. haerze, Cveulebriv pirobebSi, metaluri hafniumi ifareba Sesabamisi dioqsidis ($HfO_2$) mtkice SriT da icavs mas Semdgomi koroziisgan.

hafniumis dioqsidi gamoiyeneba maRali gardatexis maCveneblis mqone optikuri minebis dasamzadeblad.

**vanadium(II)-is, (III)-is, (IV)-isa da vanadium(V)-is oqsidebi (**$VO$**,** $V_2O_3$**,** $VO_2$ **da** $V_2O_5$**).**

**vanadium(II)-is oqsidi (**$VO$**)** miiReba vanadiumis ufro maRali oqsidis metaloTermuli aRdgeniT ($2V_2O_3 + 4K = 4VO + K_2O_2$). igi monacrisfro-Savi kristalia, misi hidrati susti fuZea.

**vanadium(III)-is oqsids (**$V_2O_3$**)** iReben vanadium(V)-is oqsidis ($V_2O_5$) aRdgeniT _ wyalbadiT an $CO$-Ti maRal temperaturaze ($V_2O_5 + 2H_2 = V_2O_3 + 2H_2O$ an $V_2O_5 + 2CO = V_2O_3 + 2CO_2$). igi Savi feris, Zneldnobadi, paramagnituri kristalia, haerze nela

iJangeba. $V_2O_3$ gamoiyeneba feradi minebis misaRebad da agreTve pirveladi spirtebis daSlis katalizatorad.

**vanadium(IV)-is oqsidi (**$VO_2$**)** miiReba vanadium(III)-is oqsidis haerze neli JangviT ($2V_2O_3 + O_2 = 4VO_2$). igi myari kristaluri nivTierebaa, Zneldnobadia, cudad ixsneba wyalSi, rogorc amfoteruli nivTiereba ixsneba mJavasa da tuteSi Sesabamisi marilebis warmoqmniT. vanadiumis dioqsidi ixmareba qimiur mrewvelobaSi rogorc erT-erTi saukeTeso katalizatori gogirdmJavas warmoebaSi, agreTve minis, keramikisa da mrewvelobis sxva dargebSi.

**vanadium(V)-is oqsidi (**$V_2O_5$**, anhidridi)** yvelaze mniSvnelovania vanadiumis oqsidebs Soris praqtikuli gamoyenebis mxriv. vanadiumis anhidridi miiReba metaluri vanadiumis fxvnilis dawviT JangbadSi ($4V + 5O_2 = 2V_2O_5$). igi myari kristaluri nivTierebaa susti paramagnituri TvisebebiT, xasiaTdeba wyalSi SezRuduli xsnadobiT, cudad ixsneba spirtSi, kargad xsnadia tuteebSi (rogorc mJavuri oqsidi) Sesabamisi marilebis _ metavanadatis, pirovanadatisa da orTovanadatis warmoqmniT ($KVO_3$, $K_4V_2O_7$ da $K_3VO_4$). aqedan yvelaze mniSvnelovania amoniumis vanadati ($NH_4VO_3$), romelic sawyisi nivTierebaa vanadiumis sxva naerTebis misaRebad. maTi umravlesoba gamoiyeneba rogorc sasuqi soflis meurneobaSi da samkurnalwamlo saSualebebi _ medicinaSi. vanadiumis anhidridi ixmareba zogierTi organuli sinTezis dros.

**tantal(I)-is, (II)-is, (III)-is da (V)-is oqsidebi (**$Ta_2O$, $TaO$, $Ta_2O_3$ **da** $Ta_2O_5$**),** romelTagan mniSvnelobiT da gamoyenebis TvalTaxedviT gamorCeulia tantalis pentaoqsidi ($Ta_2O_5$). yvelaze xSirad igi miiReba metaluri tantalis gaxurebiT Jangbadis areSi ($1600^\circ C$, $4Ta + 5O_2 = 2Ta_2O_5$) an tantal(V)-is hidratirebuli oqsidis gauwyloebiT gaxurebisas ($Ta_2O_5 \cdot nH_2O = Ta_2O_5 + nH_2O$). tantalis pentaoqsidi aris TeTri myari nivTiereba, romelic ar ixsneba wyalsa da mJavebSi (mdnobi mJavas $HF$-is gamoklebiT). igi amfoteruli oqsidia. labisebri TeTri naleqi ($Ta_2O_5 \cdot nH_2O$) wylis cvalebadi SemcvelobiT amJRavnebs koloiduri xsnarebis warmoqmnis unars. $Ta_2O_5$ gamoiyeneba sinTezuri boWkos warmoebaSi, sinTezuri membranebis dasamzadeblad _ kvebis mrewvelobaSi, agreTve rogorc katalizatori grafitisgan xelovnuri almasis misaRebad.

**qrom(III)-isa da (VI)-is oqsidebi (**$Cr_2O_3$ **da** $CrO_3$**)** metaluri qromis yvelaze mniSvnelovani oqsidebia. qromis trioqsidi ($Cr_2O_3$) mwvane heqsagonaluri kristalebis fxvnilia, Zneldnobadi ($2265^\circ C$), qimiurad inertuli, wyalSi uxsnadia, mJavebsa da tuteebSi Znelad, magram mainc ixsneba. misi amfoteruli Tvisebebi mJRavndeba Sesabamis mJavebTan da

tuteebTan Sednobis procesSi ($Cr_2O_3 + 2KOH = 2KCrO_2 + H_2O$; $Cr_2O_3 + 3H_2SiO_3 = Cr_2(SiO_3)_3 + 3H_2O$), $Cr_2O_3$ intensiuri Seferilobisa da mdgradobis gamo mineralur saRebavs warmoadgens keramikisa da minisTvis da amitom mas farTod iyeneben silikatur warmoebaSi. qromis trioqsidi simagriT korunds uaxlovdeba _ gamoiyeneba abraziul masalad. aluminis oqsidTan mcire raodenobiT qromis trioqsidis Sednobisas miiReba xelovnuri lali (naxevrad Zvirfasi qva), romelsac iyeneben saiuveliro saqmesa da kvantur generatorebSi.

**qrom(VI)-is oqsidi ($CrO_3$, qromis anhidridi)** miiReba natriumis an kaliumis qromatze an dioqromatze Warbi koncentrirebuli gogirdmJavas moqmedebiT ($Na_2CrO_4 + H_2SO_4 = CrO_3 + Na_2SO_4 + H_2O$; $K_2Cr_2O_7 + H_2SO_4 = 2CrO_3 + K_2SO_4 + H_2O$). qrom(VI)-is oqsidi wiTeli kristaluri nivTierebaa. igi mJava oqsidia, Seesabameba ori mJava: qrommJava da diqrommJa ($CrO_3 + H_2O = H_2CrO_4$; $2CrO_3 + H_2O = H_2Cr_2O_7$). orive mJava arsebobs mxolod wyalxsnarSi da Tavisufal mdgomareobaSi gamoyofis procesSi iSleba qromis anhidridad ($CrO_3$) da wylad ($H_2O$), Tumca maTi marilebi sakmaod mtkicea.

**qromis trioqsids ($CrO_3$)** xSirad iyeneben organuli nivTierebebis dasaJangad, magaliTad, misi moqmedebiT eTilis spirti aaldeba ($C_2H_5OH + 4CrO_3 = 2Cr_2O_3 + 2CO_2 + 3H_2O$). mSrali qromis anhidridi gamoiyeneba amiakis dasaJangad azotad da wylad ($2CrO_3 + 2NH_3 = N_2 + 3H_2O + Cr_2O_3$).

**molibdenis oTxi oqsididan ($Mo_2O_3$, $MoO_2$, $Mo_2O_5$ da $MoO_3$)** yvelaze mdgradia molibdenis trioqsidi ($MoO_3$), romelic miiReba metaluri molibdenis gaxurebiT ($570^\circ C$) haerze ($2Mo + 3O_2 = 2MoO_3$). advilad miiReba agreTve molibdenis dioqsidi ($Mo + O_2 = MoO_2$). molibdenis danarCen oqsidebs praqtikuli gamoyeneba ar aqvT. molibdenis trioqsidi fxvnilia, gaTbobiT yviTel Seferilobas iZens, wyalSi Znelad ixsneba. advilad ixsneba tuteSi. Znelad ixsneba mdnob mJavasa ($HF$) da koncentrirebul gogirdmJavaSi. molibdenis dioqsidi iisferia, wyalSi uxsnadia, iCens sust fuZe Tvisebebs, Znelad ixsneba mJavebSi.

molibdenis trioqsidi amJRavnebs ra mJavur Tvisebebs, ixsneba tuteSi da gamoiyeneba molibdenmJavas marilebis _ molibdatebis misaRebad ($MoO_3 + 2NaOH = Na_2MoO_4 + H_2O$). molibdenis saRebavi farTod gamoiyeneba teqnikasa da yofacxovrebaSi _ xasiaTdeba maRali stabilurobiT, bzinvarebiT da kargi damfaravi TvisebebiT.

**volframis dioqsidi ($WO_2$) da trioqsidi ($WO_3$)** miiReba metaluri volframis gaxurebiT ($600^\circ C$) wylis orTqlTan ($W + 2H_2O = WO_2 + 2H_2$), xolo ufro maRal temperaturaze ($900^\circ C$)

gacxelebisas volframisa da Jangbadis urTierTqmedebiT ($2W + 3O_2 = 2WO_3$). volframis dioqsidi da trioqsidi ixmareba volframitebisa da volframatebis misaRebad ($Wo_2 + 2KOH = K_2WO_3 + H_2O$; $WO_3 + K_2O = K_2WO_4$), romlebic maRali eleqtrogamtarobisa da Termuli gafarToebis mcire koeficientis gamo gamoiyeneba minebTan SeduRebisTvis. aseve maTi gamoyeneba SeiZleba qimiuri reaqtivebis, katalizatorebis, zeTis saRebavebis da keramikis Semferadeblad, xis nakeTobebisa da qsovilebis gasaJRenTad cecxlisgan dacvis mizniT.

**manganum(II)-is, (III)-is, (IV)-is, (VII)-is martivi (** $MnO$ **,** $Mn_2O_3$ **,** $MnO_2$ **,** $Mn_2O_7$ **)** da erTi Sereuli ($Mn_3O_4$ **anu** $MnO \cdot Mn_2O_3$) oqsidebidan $MnO$-sa da $Mn_2O_3$-s aqvT fuZe Tvisebebi, $MnO_2$-s amfoteruli, xolo umaRlesi oqsidi $Mn_2O_7$ aris manganummJavas ($HMnO_4$) anhidridi. cnobilia, agreTve manganum(VI)-is warmoebulebi, magram misi Sesabamisi oqsidi ($MnO_3$) ar aris miRebuli. $MnO$ mwvane feris, Zneldnobadi ($1780^\circ C$) naxevargamtaruli Tvisebebis mqone naerTia. wyalSi ar ixsneba. Sesabamisi hidroqsidi miiReba arapirdapiri gziT _ manganum(II)-is xsnad marilze tutis moqmedebiT ($MnCl_2 + 2NaOH = Mn(OH)_2 + 2NaCl$). manganum(II)-is hidroqsidi TeTri naleqia, amJRavnebs mxolod fuZe Tvisebebs _ ixsneba mJavebSi ($Mn(OH)_2 + 2HNO_3 = Mn(NO_3)_2 + 2H_2O$), magram ar ixsneba tuteSi. haerze swrafad muqdeba, iJangeba manganum(IV)-is hidroqsidad ($2Mn(OH)_2 + O_2 + 2H_2O = 2Mn(OH)_4$). manganum(III)-is oqsidi ($Mn_2O_3$) Savi ferisaa, bunebaSi moipoveba mineral braunitis saxiT. Savi feris manganumis dioqsidi ($MnO_2$) manganumis yvelaze mdgradi naerTia (cnobilia mineral pirolizitis saxiT). igi amfoteruli oqsidia, magram masSi rogorc mJavuri, aseve fuZe Tvisebebi Zalian sustad aris gamosaxuli. manganumis dioqsidi Zlieri mJangavia da farTod gamoiyeneba teqnikasa da laboratoriul praqtikaSi. misgan mzaddeba katalizatori ,,gopkaliti", romelic oTaxis temperaturaze $CO$-s Jangavs $CO_2$-ad. $MnO_2$**-**ma gamoyeneba pova leklanSes elementSi, rogorc depolarizatorma. igi minis warmoebaSi ixmareba rogorc gamauferulebeli, gamoiyeneba agreTve asanTis warmoebaSi. $Mn_2O_7$ momwvano-mura feris zeTisebri siTxea, Zlieri damJangavia _ eTeri da spirti masTan Sexebisas aaldeba, rkina(II)-is marilebi gardaiqmneba rkina(III)-is marilebad, gogirdovanmJava-gogirdmJavad. igi miiReba kaliumis permanganatis koncentrirebuli gogirdmJavaTi damuSavebis dros ($2KMnO_4 + H_2SO_4 = Mn_2O_7 + K_2SO_4 + H_2O$). manganum(VII)-is oqsidi tipuri mJavuri oqsidia, advilad urTierTqmedebs wyalTan manganummJavas warmoqmniT ($Mn_2O_7 + H_2O = 2HMnO_4$).

**teqcenium(IV)-isa da (VII)-is oqsidebi (** $TcO_2$ **da** $Tc_2O_7$ **).**

**teqcenium(IV) oqsidi** miiReba amoniumis perteqnatis Termuli daSliT ($2NH_4TcO_4 = 2TcO_2 + N_2 + 4H_2O$). igi amfoteruli Tvisebebis, Savi feris fxvnilia. haerisa da Jangbadis moqmedebiT iJangeba $Tc_2O_7$-mde ($4Tc + 7O_2 = 2Tc_2O_7$). $Tc_2O_7$ higroskopuli yviTeli kristalebia, paramagnituri TvisebebiT; advilad ixsneba wyalSi teqneciummJavas ($HTcO_4$) warmoqmniT ($Tc_2O_7 + H_2O = 2HTcO_4$). teqcenium(VII)-is oqsidi aseve gamoiyeneba misi Sesabamisi marilebis – perteqnatebis misaRebad ($Tc_2O_7 + 2NH_3 + H_2O = 2NH_4TcO_4$), romlebic Zalian mniSvnelovani naerTebia, rogorc Teoriuli, aseve praqtikuli qimiis TvalsazrisiT, radgan isini xasiaTdebian Zlieri mJangavi TvisebebiT (atomur reaqtorebSi gamoyenebis perspeqtiviT).

**rkinis oqsidebi (** $FeO$**,** $Fe_2O_3$ **da** $Fe_3O_4$**)**

**rkina(II)-is oqsidi (** $FeO$**)** _ miiReba metaluri rkinis daJangviT ($2Fe + O_2 = 2FeO$), haeris SeuRwevlad rkinis oqsalatis Termuli daSliT ($FeC_2O_4 = FeO + CO + CO_2$), rkina(III)-is oqsidis naxSirbad(II)-is oqsidiT aRdgeniT ($Fe_2O_3 + CO = 2FeO + CO_2$, $500^\circ C$-ze), rkinis karbonatis Termuli daSliT ($FeCO_3 = FeO + CO_2$, $580^\circ C$-ze). rkinis monooqsidi aris Savi feris, aramdgradi, kristaluri fxvnili. igi wyalsa da tuteSi ar ixsneba, xolo mJavaSi ixsneba Sesabamisi marilis warmoqmniT ($FeO + 2HCl = FeCl_2 + H_2O$).

**rkina(III)-is oqsidi (** $Fe_2O_3$**)** _ miiReba metaluri rkinis daJangviT haerze ($4Fe + 3O_2 = 2Fe_2O_3$, $200^\circ C$ zeviT), rkinis hidroqsidis, nitratisa da piritis gavarvarebiT haerze ($2Fe(OH)_3 = Fe_2O_3 + 3H_2O$, $700^\circ C$; $4Fe(NO_3)_3 = 2Fe_2O_3 + 12NO_2 + 3O_2$, $800^\circ C$; $4FeS_2 + 11O_2 = 2Fe_2O_3 + 8SO_2$); igi aris wiTeli feris kristaluri fxvnili, ar ixsneba wyalSi, amJRavnebs sust amofoterul Tvisebebs _ urTierTqmedebs rogorc tutesTan (SednobiT), aseve mJavasTan ($Fe_2O_3 + 2KOH = 2KFeO_2 + H_2O$, $Fe_2O_3 + 3H_2SO_4 = Fe_2(SO_4)_3 + 3H_2O$).

**magnituri rkinaqva (** $Fe_3O_4$ **magnetiti), wiTeli rkinaqva (** $Fe_2O_3$ **hematiti), mura rkinaqva (** $Fe_2O_3 \cdot 3H_2O$ **limoniti)** da sxva rkinis oqsidebi miekuTvneba rkinis mniSvnelovan madnebs, romlebisganac naxSirbad(II)-is oqsidiT ($CO$), koqsiT ($C$), wyalbadiT ($H$) da aluminiT ($Al$) aRdgenisas miiReba kacobriobisTvis uZvelesi droidan cnobili da yvelaze mniSvnelovani metali rkina ($Fe_3O_4 + 4CO = 3Fe + 4CO_2$, $Fe_2O_3 + 3C = 2Fe + 3CO$, $Fe_2O_3 + 3H_2 = 2Fe + 3H_2O$, $3Fe_3O_4 + 8Al = 9Fe + 4Al_2O_3$).

rkina(II, III)-is oqsidi ($Fe_3O_4$, Sereuli oqsidi, rkinis xenji). bunebaSi moipoveba magnituri rkinaqvis saxiT. Sereuli oqsidia _ $FeO \cdot Fe_2O_3$. igi miiReba rkinis JangbadSi an gavarvarebul rkinaze wylis orTqlis moqmedebiT ($3Fe + 2O_2 = Fe_3O_4$; $3Fe + 4H_2O \Leftrightarrow Fe_3O_4 + 4H_2O$, $700^\circ C$-mde), xolo ufro maRal temperaturamde gacxelebisas ($1200^\circ C$-ze) rkina Jangad ($Fe_2O_3$) gadaiqceva. $Fe_3O_4$ Savi feris fxvnilia, wyalSi ar ixsneba, denis kargi gamtaria.

rkinis oqsids aqvs mniSvnelovani gamoyeneba, rogorc saRebavebis pigments, aseve rogorc mineralur saRebavsa da ZiriTad komponents melnis warmoebaSi. rkinis oqsidis ionebi monawileoben hemoglobinis mier Jangbadis gadatanis procesSi filtvebidan qsovilTa ujredebSi. rkinis oqsidebis monawileoba aucilebelia mcenareTa normaluri zrda-ganviTarebisTvis, radgan niadagSi rkinis ukmarisobis SemTxvevaSi mcenare avaddeba, mcirdeba qlorofilis sinTezis procesi, yovndeba maTi zrda da ganviTareba. rkinis zogierTi naerTi ixmareba rogorc koagulanti wylis gasufTavebis procesSi. $Fe_2O_3$-is urTierTqmedeba mJavebTan gamoyenebas poulobs rkina(III)-is marilebis sinTezSi.

rkinis xenjisa ($Fe_3O_4$) da ekvivalenturi raodenobiT aRebuli aluminis fxvnilis narevis (aseT narevs Termiti ewodeba, xolo process _ aluminTermia) anTebiT warimarTeba Zlieri ekzoTermuli reaqcia. am dros iseTi maRali temperatura ($3000^\circ C$) viTardeba, rom reaqciis ($3Fe_3O_4 + 8Al = 9Fe + 4Al_2O_3$) orive produqti dneba _ relsebisa da foladisgan Camosxmuli detalebis SeduReba xdeba.

**kobaltis oqsidebi (**$CoO$**,** $Co_2O_3$ **da** $Co_3O_4$**).**

**kobalt(II)-is oqsidi (**$CoO$**)** miiReba metalur kobaltze Jangbadis an wylis orTqlis moqmedebiT ($940^\circ C$-zeviT), agreTve kobalt(II)-is hidroqsidis gavarvarebiT haeris SeuRwevad ($2Co + O_2 = 2CoO$; $Co + H_2O = CoO + H_2$, $Co(OH)_2 = CoO + H_2O$). igi monacrisfro-mwvane kristaluri fxvnilia, Zalian mdgradi ($2860^\circ C$-mde), wyalSi uxsnadi nivTiereba. $CoO$ fuZe oqsidia da urTierTqmedebs Zlier mJavebTan Sesabamisi marilebis warmoqmniT ($CoO + 2HNO_3 = Co(NO_3)_2 + H_2O$; $CoO + H_2SO_4 = CoSO_4 + H_2O$). kobalt(II)-is oqsidis SednobiT Warb kaliumis an natriumis tutesTan miiReba lurji feris kaliumisa da natriumis kobalti ($CoO + 2NaOH = Na_2CoO_2 + H_2O$). kobalt(II)-is oqsidis Zlieri gaxurebisas ($800 - 1500^\circ C$) metalTa sxvadasxva oqsidTan ($Al_2O_3$, $Cr_2O_3$, $MnO_2$ da sxv.) warmoiqmneba zustad gansazRvruli Sedgenilobis naerTebi an myari xsnarebi, romelTa Seferiloba SeiZleba iyos lurji, mwvane an vardisferi. mRebav pigmentebs miekuTvneba tenaris lurji (safuZveli udevs $Co[Al_2O_4]$) an myari xsnari ($Co[Al_2O_4 \cdot Co_3O_4]$-Tan an $CoO$-Tan), laJvardovan-lurji stanati

($Co_2SnO_4$-is narevi $SnO_2$-sa da $SiO_2$-Tan), rinmanis mwvane $CoZnO_2$, vardisferi kobalti ($CoO$ da $MgO$ myari xsnari).

**kobalt(III)-is oqsidis ($Co_2O_3$)** miReba SeiZleba maRal temperaturaze ($\sim 300^\circ C$) gaxurebis procesSi ($4Co + 3O_2 = 2Co_2O_3$). kobaltis trioqsidi aseve kobalt(II)-is nitratis gaxurebiT ($180^\circ C$, $4Co(NO_3)_2 = 2Co_2O_3 + 8NO_2 + O_2$). igi Savi heqsagonaluri sistemis, wvrili formis kristalebia, gaxurebisas misgan warmoiqmneba $Co_3O_4$. kobalt(III)-is oqsidi Jangavs marilmJavas qloris gamoyofiT ($Co_2O_3 + 6HCl = 2CoCl_2 + Cl_2 + 3H_2O$). miuxedavad imisa, rom kobaltis trioqsidi SedarebiT mdgradi oqsidia, saerTod, unda iTqvas, rom kobalt(III)-is naerTebi gacilebiT aramdgradia, vidre rkina(III)-is analogiuri naerTebi da amJRavneben Zlier mJangav Tvisebebs.

**kobalt(II)-isa da (III)-is Sereuli oqsidi ($Co_3O_4$)** miiReba fxvnilisebri metaluri kobaltis haerze gavarvarebiT ($300-400^\circ C$, $3Co + 2O_2 = Co_3O_4$ anu $Co^{2+}[Co_2^{3+}O_4]$). igi Savi feris, oqtaedruli kristalebia, ixsneba mJavebSi, magaliTad, marilmJavaSi qloris gamoyofiT ($Co_3O_4 + 8HCl = 3CoCl_2 + Cl_2 + 4H_2O$), xolo gogirdmJavaSi _ Jangbadis gamoyofiT ($2Co_3O_4 + 6H_2SO_4 = 6CoSO_4 + O_2 + 6H_2O$).

kobaltis oqsidebs iyeneben imasTan dakavSirebiT, rom radgan madnebSi metaluri kobaltis Semcveloba umniSvneloa, amitom kobaltSemcveli madnebidan iReben kobaltis oqsidebs, xolo Semdeg oqsidebs aRadgenen wyalbadiT ($250-1100^\circ C$) da miiReba metaluri kobalti fxvnilis saxiT ($Co_2O_3 + 3H_2 = 2Co + 3H_2O$, $CoO + H_2 = Co + H_2O$). kobaltis oqsidebs iyeneben, agreTve Tavisufali kobaltis misaRebad aluminTermuli aRdgeniT ($2500-3300^\circ C$, $3Co_3O_4 + 8Al = 9Co + 4Al_2O_3$; $3CoO + 2Al = 3Co + Al_2O_3$). zesufTa metaluri kobalti miiReba kobaltis sulfatis ($CoSO_4 \cdot 7H_2O$ xsnaris eleqtroliziT ($50-60^\circ C$) da misi Semdgomi eleqtrolituri rafinirebiT.

kobaltis monooqsidi ($CoO$) gamoiyeneba kobalt(II)-is martivi marilebis umetesobis misaRebad. am mizniT aRniSnul oqsids amuSaveben sxvadasxva mJavas saSualebiT ($CoO + 2HCl = CoCl_2 + H_2O$; $CoO + H_2SO_4 = CoSO_4 + H_2O$ da sxv.). aseve kobalt(II)-is oqsidis SednobiT Warbi kaliumis an natriumis tuteebTan miiReba lurji feris kaliumisa da natriumis kobaltiti ($CoO + 2NaOH = Na_2CoO_2 + H_2O$).

kobaltis oqsidebs iyeneben feradi (lurji, mwvane, vardisferi) minanqris, faiansis, faifurisa da minis mrewvelobaSi, agreTve Jangvisa da daSlis reaqciebis katalizatorad. $Co_3O_4$ gamoiyeneba

iseTi minis dasamzadeblad, romelic STanTqavs ultraiisfer sxivebs agreTve rogorc amiakis mJangavi katalizatori.

**nikelis oqsidebi (** $NiO$ **,** $Ni_2O_3$ **)** _ nikeli warmoqmnis ori saxis oqsids da maT Sesabamis hidroqsidebs; magram cnobilia mxolod nikel(II)-is da ara $Ni$(III)-is marilebi, romelTa umravlesoba mwvane ferisaa.

**nikel(II)-is oqsidi (** $NiO$ **)** miiReba metaluri nikelis fxvnilis gaxurebiT ($500^\circ C$) JangbadTan ($2Ni + O_2 = 2NiO$) an nikel(II)-is karbonatis ($NiCO_3 = NiO + CO_2$) da aseve nitratisa da sulfatis gavarvarebiT ($1000 - 1100^\circ C$) temperaturamde. nikelis oqsidi _ $NiO$ gvxvdeba agreTve bunebaSi mineral bunzenitis saxiT _ igi aragamWvirvale, muqi mwvane oqtaedruli kristalebia maSin, rodesac Sesabamisi gadamuSavebiT (nikelis karbonatidan, sulfatidan da a.S.) miRebuli oqsidi ($NiO$) monacrisfro-mwvane kuburi kristalebia, wyalSi mcired xsnadi, kargad xsnadia mJavebSi _ warmoiqmneba nikel(II)-is marilebi. nikelis monooqsidis fuZe Tvisebebi vlindeba amoniumis marilebze moqmedebisas, saidanac igi aZevebs amiaks, reagirebs mJavur oqsidebTan ($WO_3$-sa da $MoO_3$-Tan), xels uwyobs $KMnO_4$-is daSlas ($100 - 105^\circ C$-ze), Jangavs amiaks.

nikelis monooqsidi gamoiyeneba katalizatorad, keramikul warmoebaSi mwvane pigmentad, minisa da minanqris dasamzadeblad da sxv.

**nikel(III)-is oqsidi (** $Ni_2O_3$ **)** miiReba nikel(II)-is nitratis gaxurebiT ($250 - 300^\circ C$) haerze ($4Ni(NO_3)_2 = 2Ni_2O_3 + 8NO_2 + O_2$). nikel(III)-is oqsidi ixsneba marilmJavaSi qloris, xolo Jangbadovan mJavebSi _ Jangbadis gamoyofiT ($Ni_2O_3 + 6HCl = 2NiCl_2 + Cl_2 + 3H_2O$ da $2Ni_2O_3 + 4H_2SO_4 = 4NiSO_4 + O_2 + 4H_2O$). nikel(III)-is naerTebi mcire raodenobiT arsebobs da aramdgradia, iCens Jangvis unars. nikelis trioqsidisTvis damaxasiaTebelia agreTve hidratirebuli oqsidis warmoqmnis unari ($Ni_2O_3 \cdot H_2O$) da misi ramdenime modifikaciis saxiT arseboba _ yvela maTgani aramdgradia. am proceszea agebuli edisonis tute akumulatoris moqmedeba ($Ni_2O_3 + H_2O + Fe + 2H_2O \underset{\text{damuxtva}}{\overset{\text{ganmuxtva}}{\Leftrightarrow}} 2Ni(OH)_2 + Fe(OH)_2$), romlebsac farTo gamoyeneba aqvT teqnikasa da yofacxovrebaSi, radgan tute akumulatorebi msubuqia, xolo muSaobis xangrZlivoba didi.

**ruTenium(IV)-isa da (VIII)-is oqsidebi (** $RuO_2$ **da** $RuO_4$ **).** ruTeniumis dioqsidi ($RuO_2$) miiReba ruTeniumis gaxurebisas ($600^\circ C$) Jangbadis atmosferoSi an sulfidis gamowviT ($Ru + O_2 = RuO_2$; $RuS_2 + 3O_2 = RuO_2 + 2SO_2$). ruTeniumis dioqsidi lurji, tetraedruli kristaluri

nivTierebaa, sakmaod mdgradia, wyalSi mcired xsnadia, wyalbadiT advilia misi aRdgena. ruTenium(IV)-is oqsidi gamoiyeneba Sesabamisi marilebis misaRebad ($RuO_2 + 4HCl = RuCl_4 + 2H_2O$).

**ruTenium(VIII)-is** oqsidi miiReba gaxurebul ($1000^\circ C$) ruTeniumze Jangbadis moqmedebisas ($Ru + 2O_2 = RuO_4$) an ruTeniumis fxvnilze tute metalTa hipoqloritebis moqmedebiT ($Ru + 4KOCl = RuO_4 + 4KCl$, oTaxis temperaturaze). $RuO_4$ oqrosferi kristalebia, gacxelebisas afeTqebiT iSleba martiv nivTierebebad. tuteebis moqmedebiT ruTeniumis tetraoqsidi gardaiqmneba ($RuO_4 + 2KOH = K_2RuO_4 + 1/2O_2 + H_2O$). $RuO_4$ Zlieri mJangavia, spirtTan urTierTqmedebs afeTqebiT, Jangavs $HCl$-s ($RuO_4 + 8HCl = RuCl_4 + 2Cl_2 + 4H_2O$). $RuO_4$ ixsneba wyalsa da $CCl_4$-Si.

ruTeniumis naerTebi gamoiyeneba ,,mudmivi kalmis“ wveris dasamzadeblad da saiuveliro nawarmebisTvis, eleqtrokontaqtorebis da xmis maregistrirebeli aparatebis nemsebis warmoebaSi.

**osmium(II)-is, (III)-is, (IV)-isa da (VIII)-is oqsidebi (**$OsO$**,** $Os_2O_3$**,** $OsO_2$ **da** $OsO_4$**).**

**osmium(II)-is oqsidi (**$OsO$**)** miiReba osmiumis fxvnilis, osmiumis sulfitis da natriumis karbonatis narevis gacxelebiT dabal wnevaze. igi monacrisfro-Savi fxvnilia, mcired ixsneba wyalsa da mJavaSi. osmium(III)-is oqsids iReben $OsO_4$-is aRdgeniT, risTvisac osmiumis tetraoqsids, osmiumis fxvnils da natriumis karbonats acxeleben $CO_2$-is areSi. igi muqi yavisferi fxvnilia, wyalSi mcired xsnadi. $OsO_2$-is naerTi miiReba osmiumis fxvnilze $OsO_4$-is orTqlis moqmedebisas. igi warmoadgens mowiTalo-yavisfer fxvnils, wyalSi mcired xsnadia, gaxurebisas iSleba.

**osmium(VIII)-is tetraoqsidi (**$OsO_4$**)** miiReba metaluri osmiumis an misi naerTebis Jangvis procesSi ($Os + 2O_2 = OsO_4$; $K_2OsO_4 + Cl_2 = OsO_4 + 2KCl$). igi yviTeli feris kristalia, dneba $42^\circ C$-ze, duRs $131^\circ C$-ze, aqvs mkveTri suni, ixsneba wyalSi, magram raime garkveul naerTs ar warmoqmnis, aseve ixsneba spirtSi, misi orTqli Zlier toqsikuria. $OsO_4$ mJavur Tvisebebs amJRavnebs, fuZovan naerTebTan urTierTqmedebisas ($OsO_4 + 2NaOH = Na_2[OsO_4(OH)_2]$). osmiumis tetraoqsidi aqtiuri mJangavia rogorc koncentrirebuli marilmJavas, aseve sxvadasxva organuli nivTierebis mimarT.

osmiumis tetraoqsidi gamoiyeneba histologiur preparatebSi cximovani ujredebis dasadgenad (cximebTan urTierTqmedebisas $OsO_4$ iSleba da mas lurj Seferilobas aZlevs). misi

fxvnili gamoiyeneba katalizatorad amiakis sinTezis, naxSirwyalbadis Jangvis, acetonis hidrirebisa da sxva reaqciebSi.

**rodiumis oqsidebi (** $RhO$ **,** $Rh_2O_3$ **da** $RhO_2$ **),** romelTagan **rodium(II)-is oqsidi (** $RhO$ **)** miiReba metaluri rodiumis gaxurebiT ( $700-800^\circ C$ ) haerze ( $2Rh+O_2=2RhO$ ). igi moSavo-yavisferi naerTia, ar ixsneba wyalsa da mJavebSi. **rodium(III)-is oqsidi (** $Rh_2O_3$ **)** miiReba fxvnilisebri metaluri rodiumi an misi nitratis an hidroqsidis haerze gaxurebiT ( $800^\circ C$ -mde, $4Rh(NO_3)_2=2Rh_2O_3+12NO_2+3O_2$ ; $2Rh(OH)_3=Rh_2O_3+3H_2O$ ). igi mwvane feris kristalebia, mcired ixsneba wyalsa da samefo wyalSi, gacxelebisas wyalbadi mas metalamde aRadgens. **rodium(IV)-is oqsidi (** $RhO_2$ **)** miiReba misi SednobiT natriumis nitratsa da hidrooqsidis narevTan, xolo rodiumis hidratirebuli dioqsidi ( $RhO_2\cdot nH_2O$ ) eleqtrolizuri daJangviT.

rodiumis naerTebi gamoiyeneba refleqtorebis dasamzadeblad, agreTve kontaqtorebisa da saiuveliro sagnebis warmoebaSi. rodiumis Sava (sevadi) farTod gamoiyeneba katalizatorisa da Savi pigmentis saxiT faifuris nakeTobaTa mosaxatavad.

**iridiumis oqsidebi (** $Ir_2O_3$ **,** $IrO_2$ **da** $IrO_3$ **).**

**iridium(III)-is oqsidi (** $Ir_2O_3$ **)** myari, muqlurji feris nivTiereba, wyalSi mcired xsnadia, kargad ixsneba gogirdmJavaSi. igi miiReba iridium(III)-is sulfidis gaxurebiT ( $2Ir_2S_3+9O_2=2Ir_2O_3+6SO_2$ ).

**iridium(IV)-is oqsidi (iridiumis dioqsidi,** $IrO_2$ **)** miiReba fxvnilisebri metaluri iridiumis gaxurebiT ( $Ir+O_2=IrO_2$ ). igi Savi feris kristaluri nivTierebaa, cudad ixsneba wyalSi, spirtsa da mJavebSi, gaxurebisas ( $1100^\circ C$ ) ganicdis Termul disociacias Semadgenel elementebad.

**iridium(VI)-is oqsidi (** $IrO_3$ **)** miiReba metaluri iridiumis Zlieri gaxurebiT ( $850-900^\circ C$ ) Jangbadis atmosferoSi ( $2Ir+3O_2=2IrO_3$ ).

iridiumis zogierTi naerTi ixmareba qimiis laboratoriuli WurWlisa da instrumentebis dasamzadeblad. maTi fxvnilisebri forma gamoiyeneba rogorc katalizatori, xolo Senadnobebisgan akeTeben kalmis wverebs, sazRvao kompasebis isrebisTvis sayrden RerZebs da sxv., agreTve iyeneben saiuveliro saqmeSi.

**paladiumis oqsidebi (** $PdO$ **,** $Pd_2O_3$ **da** $PdO_2$ **).**

**paladium(II)-is** oqsidi miiReba metaluri paladiumis Zlieri gaxurebiT JangbadSi ( $2Pd+O_2=2PdO$ ) da paladium(II)-is nitratis gavarvarebiT ( $2Pd(NO_3)_2=2PdO+4NO_2+O_2$ ). igi Savi feris fxvnilia, cudad ixsneba wyalsa da mJavebSi,

gaxurebisas ($850-900^{\circ}C$) iSleba martiv nivTierebebad. $PdO$ Zlieri mJangavia, Jangavs $CO$-s, wyalbads da sxv.

**paladium(III)-is oqsidi ($Pd_2O_3$)** miiReba paladium(II)-is nitratis wyalxsnaris ozoniT daJangvis dros. $Pd_2O_3$ muqi yavisferi fxvnilia, romelic feTqdeba gaxurebisas, cudad ixsneba azotmJavasa da gogirdmJavaSi, kargad ixsneba marilmJavaSi _ qloris gamoyofiT.

**paladium(IV)-is ($PdO_2$)** oqsidis miReba SeiZleba kaliumis heqsaqlorpaladatis(IV) tutiT damuSavebis Sedegad ($(K_2PdCl_6)+4KOH=PdO_2\cdot 2H_2O+6KCl$). igi muqi wiTeli feris myari nivTierebaa, ixsneba ganzavebul mJavebsa da koncentrirebul tuteTa xsnarebSi.

paladiumis zogierTi oqsidi gamoiyeneba naxSirbad(II)-is oqsidisa ($CO$) da wyalbadis dasaJangad, agreTve qimiur warmoebasa da laboratoriaSi, rogorc metad aqtiuri katalizatori (hidrogenizaciis reaqciebSi, $NH_3$-is daJangvisas, $CO$-s daJangvisas $CO_2$-mde oTaxis temperaturaze haeris JangbadiT da sxv.). paladiumis naerTebis garkeul nawils iyeneben medicinasa da saiuveliro saqmeSi.

**platina(II)-is (III)-is, (IV)-is (VI)-is oqsidebi ($PtO$, $Pt_2O_3$, $PtO_2$, $PtO_3$).**

platina _ TeTri, mbzinavi, Wedadi metalia, ar icvleba haerze Zlieri gavarvarebis drosac (calkeuli mJava masze ar moqmedebs). platina arapirdapiri gziT JangbadTan warmoqmnis oqsidebs ($PtO_2$ an $PtO$).

**platina(II)-is oqsidi ($PtO$)** aris kristaluri fxvnili, monacrisfro-Savi feris, wyalSi ar ixsneba, kargad ixsneba mJavebSi platina(II)-is marilebis warmoqmniT ($PtO+2HNO_3=Pt(NO_3)_2+H_2O$). gaxurebisas ($500^{\circ}C$) platinis oqsidi iSleba, miiReba metaluri platina da Jangbadi ($2PtO=2Pt+O_2$).

**platina(III)-is oqsidi (hidratirebuli, $Pt_2O_3\cdot H_2O$)** yavisferi naleqi, miiReba $PtCl_2$-ze tute metalebis karbonatTa moqmedebis dros.

**platina(IV)-is oqsidi (hidratirebuli, $PtO_2\cdot 3H_2O$)** miiReba platina(IV)-is qloridis ($PtCl_4$) wyalxsnaris duRiliT mwvave natriumTan ($PtCl_4+4NaOH+H_2O=PtO_2\cdot 3H_2O+4NaCl$). igi yviTeli fxvnilia, cudad ixsneba wyalSi, aqvs amfoteruli Tvisebebi. ixsneba marilmJavaSi $H_2[PtCl_6]\cdot 6H_2O$ warmoqmniT da tuteebSi $M_2^I[Pt(OH)_6]$-is (sadac $M_2^I=Na^+,K^+$) gamoyofiT.

**platina(IV)-is oqsidi (arahidratirebuli, $PtO_2$)** Savi fxvnilia, romelic cudad ixsneba wyalsa da mJavebSi, xolo Semadgenel elementebad iSleba maRal temperaturaze ($450^{\circ}C$) gaxurebis dros.

**platina(VI)-is oqsidi (hidratirebuli,** $3PtO_3 \cdot H_2O$**)** miiReba anodze $PtO_2 \cdot nH_2O$ civi xsnaris eleqtrolizis dros. $3PtO_3 \cdot H_2O$ ixsneba $HCl$-sa da $HNO_3$-Si, Zlieri mJangavia. $HCl$-Tan urTierTqmedebisas gamoyofs qlors. daSlisas miiReba $PtO_3$ da Jangbadi.

platina da misi naerTebi qimiuri mdgradobis, dnobis maRali temperaturisa da gansakuTrebuli katalizuri Tvisebebis gamo farTod gamoiyeneba mrewvelobasa da sxvadasxva teqnikur dargSi. maTgan mzaddeba laboratoriuli WurWeli _ tigelebi, jamebi, Spatelebi, sacrebi, filtrebi, eleqtrodebi, gamosaxdeli aparatura da sxv. am nivTierebebs iyeneben eleqtroRumlebis gamTbobi elementebisa da temperaturis gasazomi xelsawyoebis (winaRobis Termometrebi, Termowyvilebi) dasamzadeblad. maT didi raodenobiT moixmars saiuveliro nakeTobaTa sawarmoebi. gogirdmJavas misaRebad gamoiyeneba platinirebuli azbesti, xolo koloiduri platina _ hidrogenizaciis reaqciebis Casatareblad, spirtebis dehidrataciisTvis da sxv.

**lanTanoidebis oqsidebi**

lanTanoid(III)-is oqsidTa ($Ln_2O_3$, sadac $Ln$ _ lanTanoidia) umravlesoba miiReba maTi gaxurebiT haerze ($200^\circ C$ zeviT, $4Ln + 3O_2 = 2Ln_2O_3$), agreTve lanTanoidebis nitratebis, karbonatebis, oqsalatebisa da sulfatebis Termuli daSliT. lanTanoidTa oqsidebi Zneldnobadia (daaxloebiT $2000^\circ C$), xasiaTdeba fuZuri TvisebebiT. wyalSi praqtikulad ar ixsneba, magram urTierTqmedeben masTan Sesabamisi hidroqsidebis ($La(OH)_3$) warmoqmniTa da siTbos gamoyofiT. lanTanoidTa oqsidebi kargad ixsneba $HCl$-sa da $HNO_3$-Si ($La_2O_3 + 6HCl = 2LaCl_3 + 3H_2O$; $La_2O_3 + 6HNO_3 = 2La(NO_3)_3 + 3H_2O$), magram gavarvarebis SemTxvevaSi, iseve rogorc aluminis oqsidi ($Al_2O_3$), kargavs qimiur aqtiurobas.

lanTanoidTa oqsidebi tuteebTan ar urTierTqmedebs, rac mianiSnebs maT fuZur Tvisebebze.

zogierTi lanTanoidi ($Ce$-ceriumi, $\mathrm{Pr}$-prazeodimi, $Tb$-terbiumi, $Dy$-disproziumi) qimiur naerTebSi amJRavnebs +4-is tol Jangvis ricxvs. ceriumis dioqsidi ($CeO_2$) warmoiqmneba martivi nivTierebebis uSualo urTierTqmedebiT ($Ce + O_2 = CeO_2$). igi aris Zneldnobadi ($2500^\circ C$) nivTiereba, qimiurad sakmaod inertulia, ar urTierTqmedebs mJavebsa da tuteebTan.

lanTanoidebidan Jangvis ricxvi +2 yvelaze mkafiod mJRavndeba evropiumis ($Eu$), samariumisa ($Sm$) da iterbiumis ($Yb$) naerTebSi, romlebic emsgavseba kalciumis qvejgufis elementTa naerTebs.

amJamad, lanTanoidebs iReben samrewvelo masStabiT da farTod iyeneben teqnikaSi. lanTanoidebis oqsidebi ixmareba foladis, Tujisa da feradi metalebis warmoebaSi. maTi mcire raodenobiT damateba mniSvnelovnad aumjobesebs uJangavi, swrafmWreli, Termomdgradi

foladisa da Tujis xarisxs. ceriumis naerTi rkinasa da lanTanTan ixmareba sanTebelas warmoebaSi.

lanTanoidebi didi raodenobiT gamoiyeneba minis mrewvelobaSi. ceriumSemcveli mina ar mkrTaldeba radioaqtiuri sxivebis moqmedebiT da ixmareba atomur teqnikaSi. lanTanoidTa naerTebi Sedis optikuri minebis SedgenilobaSi.

lanTanoidTa oqsidebs iyeneben minis gasauferuleblad da misTvis sxvadasxva Seferilobis misacemad (neodim(III)-is oqsidi, $Nd_2O_3$, minas wiTlad, prazeodim(III)-is oqsidi, $\mathrm{Pr}_2O_3$, mwvaned aferadebs). lanTanoidTa oqsidebs iyeneben, agreTve faifuris, Wiqurisa da minanqris Sesaferadeblad (cecxlgamZle keramika).

neodimisa da prazeodimis oqsidebis Semcveli mina ar atarebs ultraiisfer sxivebs, amitomac gamoiyeneba ultraiisferi sxivebisgan damcavi saTvalis dasamzadeblad. speqtroskopuli da astronomiuli xelsawyoebisaTvis gamosadegi optikuri mina Seicavs neodimis oqsidebs. lanTanis oqsidis ($Ln_2O_3$) Semcveli mina did eleqtrogamtarobas iCens, xolo ceriumis oqsidis Semcveli _ sinaTlisadmi didi mgrZnobiarobiT xasiaTdeba.

**aqtinoidebis oqsidebi.** aqtinoidTa martivi nivTierebebi qimiurad aqtiuria. bevri maTgani haerze TandaTanobiT iJangeba. wvis dros warmoiqmneba aqtinoidTa mdgradi oqsidebi ($Th + O_2 = ThO_2$; $4Pa + 5O_2 = 2Pa_2O_5$; $3U + 3O_2 = U_3O_6$ (anu $UO_2 \cdot 2UO_2$). yvela aqtinoidi, ZiriTadad, amJRavnebs Jangvis ricxvs +3 ($Ac_2O_3$) da Sesabamisad warmoqmnis lanTanoidTa(III) msgavs naerTebs.

aqtinoidebisTvis(IV) cnobilia izomorfuli kristaluri dioqsidebi ($AcO_2$), romlebic wyalSi praqtikulad ar ixsnebian da masTan qimiurad ar urTierTqmedeben. isini praqtikulad ar ixsnebian arc ganzavebul mJavebSi, magram, rogorc Zlieri mJangavebi, Jangaven zogierT mJavas ($2AmO_2 + 8HCl = AmCl_3 + Cl_2 + 4H_2O$). aqtinoidTa aRdgena SeiZleba Zlieri aRmdgenebis moqmedebiT ($ThO_2 + 2H_2 = Th + 2H_2O$).

aqtinoidTa dioqsidebi tuteebTan ar urTierTqmedebs SednobiTac ki, radgan aqtinoidebi umeteswilad amJRavnebs fuZe Tvisebebs. protaqtinium(V)-is oqsidi praqtikulad ar avlens mJavur Tvisebebs da SesamCnevadac ki ixsneba cxel gogirdmJavaSi ($Pa_2O_3 + H_2SO_4 = (PaO_2)_2SO_4 + H_2O$).

**uran(IV)-is oqsidi** _ $UO_2$ wyalSi uxsnadi yavisferi fxvnilia. uranis marilebi (fToridebisa da fosfatebis garda) maRal temperaturaze ($500^\circ C$-ze zeviT) gaxurebisas advilad gardaiqmneba uranis Sereul oqsidad $U_3O_6$ ($2UO_2 \cdot UO_2$) _ muq mwvane naerTamde.

uran(VI)-is oqsidi, romelic miiReba uranis nitratis frTxili gavarvarebiT ($2UO_2(NO_3)_2 = 2UO_3 + 4NO_2 + O_2$) amJRavnebs amfoterul Tvisebebs _ mJavebTan warmoqmnis uranilis ($UO_2^{2+}$) marilebs, xolo fuZur oqsidebTan _ uranatebs ($UO_3 + 2HCl = UO_2Cl_2 + H_2O$; $UO_3 + K_2O = K_2UO_4$). kations $UO_2^{2+}$ _ uranili ewodeba; igi miiReba uranis trioqsidis mJavebSi gaxsnis procesSi.

aqtinoidebisa da maTi naerTebis (zogadad, oqsidebisac) gamoyeneba dakavSirebulia Sigaatomuri energiis moxmarebis problemasTan. zogierTi maTgani gamoiyeneba rogorc malegirebeli komponenti mraval SenadnobSi _ aseTi Senadnobebi gamoirCeva mcire simkvriviT, maRali simtkiciTa da qimiuri mdgradobiT maRal temperaturaze. zogierTi ki _ birTvul reaqtorebSi maRali energiebis wyarod, agreTve fluorescirebadi minis warmoebasa da fotografiaSi.

# II Tavi. mJava da fuZe

## 2.1. mJavasa da fuZis Teoriebi

cnebebi ,,mJava“ da ,,fuZe“ formulirebulia XVII saukuneSi. magram am terminebis Sinaarsi araerTxel iqna gadasinjuli da ganaxlebuli. arsebobs mJavasa da fuZis ramdenime Teoria. aq ganvixilavT mxolod sam Teorias, romlebic yvelaze xSirad gamoiyeneba qimiuri procesebis asaxsnelad.

### 2.1.1. eleqtrolituri Teoria

eleqtrolituri disociaciis Teoriis (1887w.) safuZvelze, romelic SemoTavazebulia Svedi fizikos-qimikosis svante areniusis (1859-1927ww.) mier, mJavas da fuZis gansazRvras SeiZleba mieces Semdegi interpretacia:

**mJava** _ eleqtrolitia, romelic wyalxsnarSi disocirebulia mxolod wyalbadis kationad ($H^+$) anu e.w. hidroqsoniumis ($H_3O^+$) kationad da mJavas naSTis anionad ($Cl^-$, $Br^-$, $S^{2-}$, $NO_3^-$, $SO_4^{2-}$ da sxv.).

magaliTad,

$$HNO_3 \overset{H_2O}{\leftrightarrow} H^+(H_3O^+) + NO_3^-$$

$$HCl \overset{H_2O}{\leftrightarrow} H^+(H_3O^+) + Cl^-$$

**fuZe** _ eleqtrolitia, romelic disociaciisas wyalxsnarSi anionis saxiT iZleva mxolod hidroqsilis anions ($OH^-$) da metalis ($M^+$) kations (gamonaklisia amoniumis kationi $NH_4^+$).

magaliTad,

$$KOH \leftrightarrow K^+ + OH^-,$$

$$Ca(OH)_2 \leftrightarrow Ca^{2-} + 2OH^-,$$

$$NH_4OH \leftrightarrow NH_4^+ + OH^-.$$

### 2.1.2. protolituri Teoria

danielma fizikos-qimikosma iohan brenstedma (1879-1047ww.) da ingliselma qimikosma Tomas lourma (1874-1936ww.) praqtikulad erTdroulad

(1928-1929ww.) SemogvTavazes mJavasa da fuZis protolituri Teoria, romlis Tanaxmad

**mJava** _ wyalbadis kationebis donoria:

$$HAn \leftrightarrow H^+ + An^-$$

mJava arsebobs:

a) molekuluri _ $HCl \leftrightarrow H^+ + Cl^-$,

b) kationuri _ $NH_4^+ \leftrightarrow NH_3 + H^+$,

g) anionuri _ $HCO_3^- \leftrightarrow CO_3^{2-} + H^+$.

**fuZe** _ wyalbadis kationis aqceptori.

fuZe arsebobs:

a) molekuluri _ $HN_3 + H^+ \leftrightarrow NH_4^+$,

b) anionuri _ $OH^- + H^+ \leftrightarrow H_2O$,

g) kationuri _ $(AlOH)^{2+} + H^+ \leftrightarrow Al^{3+} + H_2O$.

amfolituri naerTi (amfoliti) _ nivTierebaa, romelic aris protonis rogorc donori, ise aqceptori. igi SeiZleba iyos damuxtuli, magaliTad:

$$H_2PO_4^- \leftrightarrow H^+ + HPO_4^{2-}$$

$$H_2PO_4^- + H^+ \leftrightarrow H_3PO_4$$

da neitraluri:

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

$$H_2O + H^+ \leftrightarrow H_3O^+$$

mJava da fuZe arsebobs mxolod, rogorc SeuRlebuli wyvilebi:

$$\text{mJava} \leftrightarrow \text{fuZe} + \text{protoni}$$

SeuRlebuli mJavasa da fuZis mJavur-fuZuri procesi SeiZleba gamoisaxos saerTo sqemiT:

$$AH + B \leftrightarrow BH^+ + A^-,$$

sadac $AH$, $BH^+$ _ mJavebia, $B$, $A^-$ _ fuZeebi.

xsnarSi ar arsebobs Tavisufali protoni. wyalSi igi warmoqmnis hidroqsoniumis $H_3O^+$ kations.

mJavas cnebebi protolitur da eleqtrolitur TeoriebSi emTxveva erTmaneTs, magram cneba ,,fuZe” moicavs naerTebis ufro farTo wres: fuZe SeiZleba iyos nivTiereba, romelsac ar aqvs $OH^-$ anioni, magaliTad, $NH_3$, $(C_2H_5)_2O$.

### 2.1.3. eleqtronuli Teoria

amerikelma fizikos-qimikosma jilbert luisma (1875-1946ww.) SemogvTavaza mJavasa da fuZis eleqtronuli Teoria. misi Teoriis mixedviT **mJavebs** miekuTvneba nivTierebebi, romlebic aris eleqtronuli wyvilebis **aqceptorebi**, xolo **fuZeebs** _ eleqtronuli wyvilebis **donorebi** (cxr. 4).

am Teoriis ganmasxvavebeli niSania is, rom mJava da fuZe urTierTqmedebs donorul-aqceptoruli meqanizmiT bmis warmoqmniT:

$$A+ : B \leftrightarrow A : B$$

sadac $A$ _ mJavaa, $: B$ _ fuZe, $A : B$ _ mJavur-fuZuri kompleqsi (neitralizaciis produqti).

mJavur Tvisebebze pasuxismgebeli atomis mier SeZenili eleqtronuli wyvili xSirad amTavrebs Sesabamisi elementis eleqtronul konfiguracias. eleqtrolituri da protolituri Teoriebisgan gansxvavebiT, mJavebs miekuTvneba naerTebi, romlebic ar Seicavs wyalbads (aprotonuli mJavebi).

magaliTad,

$$: NH_3 + BF_3 \leftrightarrow NH_3BF_3$$

$BF_3$ aris mJava.

cxrili 4

**,,neitralizaciis reaqciis“ zogierTi magaliTi**

| **mJava** | **fuZe** | **fuZur-mJavuri kompleqsi** |
|---|---|---|
| $H^+$ | $OH^-$ | $H_2O$ |
| $CO_2$ | $H_2O$ | $H_2CO_3$ |
| $AlCl_3$ | $Cl^-$ | $[AlCl_4]^-$ |
| $Zn(OH)_2$ | $2OH^-$ | $[Zn(OH)_4]^{2-}$ |
| $BF_3$ | $NH_3$ | $BF_3 \cdot NH_3$ |
| $BF_3$ | $(C_2H_5)_2O$ | $(C_2H_5)_2O \cdot BF_3$ |
| $SbCl_5$ | $(C_2H_5)_2O$ | $SbCl_5 \cdot (C_2H_5)_2O$ |
| $Ag^+$ | $2CN$ | $[Ag(CN)_2]^+$ |

brenstedisa (protolituri Teoria) da luisis TeoriebSi fuZis cnebebi erTmaneTs emTxveva, magram eleqtronul TeoriaSi mJavas cneba protonis garda, moicavs nawilakebs, romlebsac unari aqvT moaxdinos eleqtronuli wyvilis aqceptoroba.

ionizebul gamxsnelSi (magaliTad, $H_2O$) iwvevs wyalbadis ionTa koncentraciis zrdas (hidroqsoniumis kationebi):

$$AlCl_3 + 2H_2O \leftrightarrow Al(OH)Cl_2 + H_3O^+ + Cl^-$$

$$SO_3 + 2H_2O \leftrightarrow H_3O^+ + HSO_4^-$$

wyalSi luisis fuZis gaxsna iwvevs $OH^-$ anionebis koncentraciis zrdas:

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

$$(CH_3)NH_2 + H_2O \leftrightarrow (CH_3)NH_3^+ + OH^-$$

orToborMJavas $H_3BO_3$ mJavuri Tvisebebi am naerTisTvis ganpirobebulia ara eleqtrolituri disociaciiT, aramed hidroqsoniumis ($H_3O^+$) kationis warmoqmnis Sedegad reaqciiT:

$$H_3BO_3 + 2H_2O \leftrightarrow [B(OH)_4]^- + H_3O^+$$

# 2.2. mJava

## 2.2.1. mJavebis klasifikacia

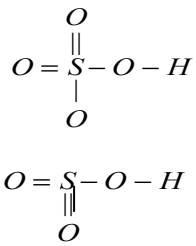
ganxilulia naerTebi, romlebic eleqtrolituri Teoriis poziciidan warmoadgens mJavebs. maTi klasificireba SeiZleba sxvadasxva niSnis mixedviT.

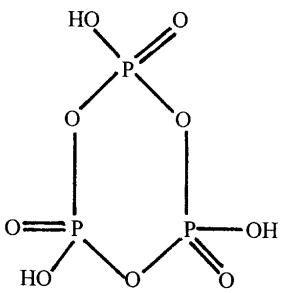
**1. araorganul mJavebad** ($HNO_3$, $H_2SO_4$ da sxv.) da **organul mJavebad** ($HCOOH$, $CH_3COOH$ da sxv.). Semdgom ganvixilavT mxolod araorganul mJavebs.

**2. Jangbadis SemcvelobiT mJavur naSTSi:**

a) uJangbado mJavebi _ $H_nX$, sadac $X$ aris halogeni, qalkogeni an $CN$, $NCS$ da sxva tipis araorganuli radikali. magaliTad, $HCl$, $H_2S$, $HCN$.

b) JangbadSemcveli (oqsomJavebi), zogadi formuliT $H_nEO_m$, sadac $E$ _ Jangbadwarmomqmneli elementia. zogierTi oqsomJava SeiZleba Seicavdes kompleqswarmomqmneli elementis ramdenime atoms, magaliTad, $H_4P_2O_7$, $H_2S_2O_7$. am dros erTtipuri fragmentebi dakavSirebulia Jangbadis atomiT: $E-O-E$. aseT SemTxvevaSi erTnairma fragmentebma SeiZleba warmoqmnas rogorc Ria jaWvi, magaliTad, $H_2S_2O_7$, ise cikluri struqtura, magaliTad, $(HPO_3)_n$:





pirogogirdmJava metafosformJava

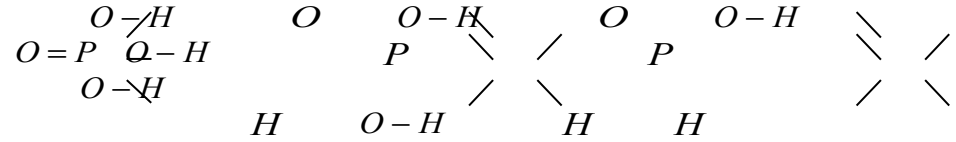
oqsomJavebi damaxasiaTebelia mravali qimiuri elementisTvis, gansakuTrebiT elementebisTvis, romelTa Jangvis xarisxi umaRlesia (+3 da meti).

**3. fuZianobiT**. mJavas fuZianoba _ im wyalbadis ionTa ricxvi, romlebic wydeba mJavas molekulidan misi disociaciis dros an Cainacvleba metalis kationiT mJavas urTierTqmedebisas fuZesTan an metalTan. fuZianobis mixedviT mJavebi arsebobs erTfuZiani ($HCl$, $HNO_3$), orfuZiani ($H_2SO_4$, $H_2CO_3$), samfuZiani ($H_3PO_4$, $H_3AsO_4$) da a.S. umetes SemTxvevaSi, oqsomJavebSi wyalbadis atomebi dakavSirebulia Jangbadis atomebTan da anionis centralur atomTan. swored, wyalbadis es atomebi wydeba wyalxsnarSi mJavas disociaciis dros, hidroqsoniumis ($H_3O^+$) kationis warmoqmniT da monawileobs neitralizaciis reaqciaSi, e.i. gansazRvravs mJavas fuZianobas.

araorganuli mJavebisTvis, rogorc wesi, molekulaSi wyalbadis atomTa saerTo ricxvi Seesabameba mJavas fuZianobas, magram es yovelTvis ase araa. zogierT mJavaSi aris wyalbadis atomebi, romlebic uSualod dakavSirebulia mJavas warmomqmneli elementis atomTan. wyalbadis aseTi atomebi ar Cainacvleba metalis ioniT, e.i. ar gansazRvravs mJavas fuZianobas.

$\overset{+5}{H_3PO_4}$ $\overset{+3}{H_3PO_3}$ $\overset{+1}{H_3PO_2}$

orTofosformJava fosforovani mJava qvefosforovani mJava



mJavas fuZianoba: 3 2 1

**organuli mJavebisTvis** molekulaSi wyalbadis atomTa saerTo ricxvi, umravles SemTxvevaSi, **ar Seesabameba mJavas fuZianobas**. organuli mJavebis fuZianoba ganisazRvreba karboqsilTa jgufebis ricxviT molekulaSi, magaliTad,

$OH$ $HO$ $OH$

Zmris erTfuZiani mJava mJaunas orfuZiani mJava

mravalfuZiani mJava disocirdeba safexurebad da SeiZleba warmoiqmnas marilTa ramdenime rigi, magaliTad, gogirdmJava _ orfuZiani mJava, disocirdeba or safexurad:

$$H_2SO_4 \leftrightarrow H^+ + HSO_4^- \leftrightarrow 2H^+ + SO_4^{2-}$$

marilTa ori rigis warmoqmniT:

sulfati ($SO_4^{2-}$), magaliTad, $Na_2SO_4$ _ natriumis sulfati,

hidrosulfati ($HSO_4^-$), magaliTad, $NaHSO_4$ _ natriumis hidrosulfati

an natriumis mJava sulfati.

**4. mJavas siZlieriT**. mJavas siZliere (iseve rogorc sxva eleqtrolitis) ganisazRvreba disociaciis ($\alpha$) xarisxiT, romelic mocemuli eleqtrolitis xsnarSi disocirebuli molekulebis raodenobis, molekulebis saerTo raodenobasTan fardobis tolia, e.i. disocirebuli molekulebis wilis, misi gamosaxva SeiZleba agreTve procentebiT:

$$\alpha = \frac{V_{\text{disoc.}}}{V_{\text{saerTo}}} \times 100\%$$

eleqtrolitis siZlieris dasaxasiaTeblad iyeneben agreTve disociaciis mudmivas (disociaciis reaqciis wonasworobis mudmiva):

$$HA_n + H_2O \leftrightarrow H_3O^+ + A_n^-$$

$$K = \frac{[H_3O^+][A_n^-]}{[HA_n][H_2O]},$$

radgan wyalxsnarSi wylis koncentracia SeiZleba miRebuli iqnes mudmiv sidided, misi Setana SeiZleba wonasworobis mudmivaSi:

$$K \cdot [H_2O] = K_\alpha = \frac{[H_3O^+][A_n^-]}{[HA_n]}.$$

$K_\alpha$ sidides ewodeba mJavas disociaciis mudmiva (indeqsi ,,$\alpha$" _ ingl. $acid$ _ mJava), mricxvelSi, Cveulebriv, gviCvenebs ara hidroqsoniumis kationebis, aramed wyalbadis ionebis koncentracias.

mJavas siZlieris raodenobrivi Sefaseba xdeba polingis wesiT: Tu oqsomJavas formulas warmovadgenT zogadi saxiT _ $H_nEO_m$, maSin ($m-n$)

sxvaobiT SeiZleba Sefasdes mJavas siZliere: romelic mJavasaTvisac iqneba es sxvaoba meti, is mJava iqneba meti siZlieris:

Tu $m-n=0$, mJava Zalian sustia ($HClO$).

Tu $m-n=1$, mJava sustia ($HClO_2$).

Tu $m-n=2$, mJava Zlieria ($HClO_3$).

Tu $m-n=3$, mJava Zalian Zlieria ($HClO_4$).

mravalfuZliani mJavebisTvis TiToeuli safexuris disociacia SeiZleba Caiweros Tavisi disociaciis mudmiviT, amasTan, rogorc wesi, yoveli Semdegi mudmiva mis winamdebareze ramdenime rigiT naklebia:

$$K_1 >> K_2 >> K_3 >> K_4 ...$$

(magaliTad, fosformJavasTvis $K_1 = 7 \cdot 10^{-3}$, $K_2 = 6 \cdot 10^{-8}$, $K_3 = 5 \cdot 10^{-13}$).

oqsomJavaSi Jangbadis erTi atomis Secvla fToris atomiT iwvevs siZlieris mkveTr zrdas. magaliTad SeiZleba gamodges fTorsulfomJava $HSO_3F$. aseTi mJavebis saxelwodebaa _ supermJava. mJavebis am klass miekuTvneba mJavebi kompleqsuri anioniT, magaliTad, $HSbF_6$.

**5. mdgradobiT.** zogierTi oqsomJava arsebobs mxolod wyalxsnaris saxiT da Termulad mdgradia. individualuri (Tavisufali) saxiT maTi miReba SeuZlebelia, magaliTad, $H_2CO_3$, $H_2SO_3$, $HClO$, $HClO_2$. amave dros aris gaxurebis mimarT (Termulad) mdgradi (medegi) mJavebi, magaliTad, $H_2SO_4$ ($t_{\text{duR.}} = 296{,}5^\circ C$), $H_2SiO_3$ ($t_{\text{duR.}} = 1619^\circ C$)

**6. wylisa da mJavuri oqsidis fardobiT.** am niSnis mixedviT mJavebi iyofa **orTo-, meta-, piro**-mJavebad da cvladi Sedgenilobis mJavebad.

**orTo-mJavebs** miekuTvneba mJava, romelSic wylisa da mJavur oqsidTa fardoba 1-s aRemateba. aseTia orTofosformJava $H_3PO_4[V(H_2O):V(P_2O_5)=3:1]$.

meta-mJavebSi es fardoba 1-is tolia, magaliTad, metafosformJava $HPO_3[V(H_2O):V(P_2O_5)=1:1]$. amave mJavebs miekuTvneba azotis, gogirdisa da sxva mravali mJava.

**piro-mJavebi** miiReba orTo-mJavebidan maTi gaxurebiT, wylis molekulebis mowyvetis Sedegad:

$$2H_3PO_4 \overset{t}{=} H_4P_2O_7 + H_2O\uparrow$$

an mJavuri oqsidis gaxsniT mJavaSi:

$$SO_3 + H_2SO_4 = H_2S_2O_7 .$$

saxelwodeba am mJavebma miiRes berZnuli sityvidan pyr _ cecxli.

zogierT mJavaSi wylisa da mJavuri oqsidis, fardoba damokidebulia maTi miRebis xerxze, magaliTad, $xSiO_2 \cdot yH_2O$; $xTiO_2 \cdot yH_2O$; $xSnO_2 \cdot yH_2O$. yvelaze xSirad isini gvxvdeba koloiduri xsnarebis saxiT.

**7. xsnadobiT**. mJavebi xsnadobis mixedviT arsebobs xsnadi, rogoricaa $HNO_3$, $H_3PO_4$, $HCl$, da wyalSi uxsnari _ $SiO_2 \cdot xH_2O$, $H_2MoO_4$ da sxv.

### 2.2.2. mJavas miRebis xerxebi

1. uJangbado mJava SeiZleba miviRoT:

a) martivi nivTierebis urTierTqmedebiT wyalbadTan: $S + H_2 \overset{t}{=} H_2S\uparrow$; wyalbadis wviT qloris atmosferoSi $Cl_2 + H_2 = 2HCl\uparrow$ da warmoqmnili airadi wyalbadnaerTebis wyalSi gaxsniT.

b) organuli halogenSemcveli naerTebis dawviT:

$$2CH_3Cl + 3O_2 \rightarrow 2HCl\uparrow + 2CO_2 + 2H_2O .$$

g) alkanebis halogenebTan urTierTqmedebis:

$$CH_4 + Cl_2 \xrightarrow{h\nu} HCl\uparrow + CH_3Cl .$$

d) arapirdapiri gziT _ Sesabamis marilze sxva mJavas moqmedebiT:

$$2NaCl + H_2SO_4 \overset{t}{\rightarrow} 2HCl\uparrow + Na_2SO_4 ,$$

$$FeS + 2HCl \rightarrow H_2S\uparrow + FeCl_2 .$$

e) Jangva-aRdgeniTi reaqciebiT

$$4Cl_2 + H_2S + 4H_2O \rightarrow 8HCl\uparrow + H_2SO_4 .$$

2. JangbadSemcveli mJavebi SeiZleba miviRoT:

a) mJavuri oqsidebis (mJavaTa anhidridebis) wyalTan (Tu isini wyalSi ixsneba) urTierTqmedebiT:

$$SO_3 + H_2O \rightarrow H_2SO_4 ,$$

$$N_2O_5 + H_2O \rightarrow 2HNO_3 ,$$

$$P_2O_5 + 3H_2O \rightarrow 2H_3PO_4 .$$

anu $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$.

Tu mJavuri oqsidis Sesabamisi mJava ar ixsneba wyalSi, maSin es xerxi ar gamoiyeneba, magaliTad,

$$SiO_2 + H_2O \neq$$

$$WO_3 + H_2O \neq$$

b) arapirdapiri gziT _ Sesabamis marilze sxva mJavas moqmedebiT:

$$Ca_3(PO_4)_2 + 3H_2SO_4 \rightarrow 2H_3PO_4 + 3CaSO_4\downarrow,$$

$$K_2SiO_3 + H_2SO_4 \rightarrow H_2SiO_3\downarrow + K_2SO_4,$$

$$NaNO_3 + H_2SO_4 \rightarrow HNO_3\uparrow + NaHSO_4.$$

### 2.2.3. nebismieri mJavas miRebis saerTo meTodebi

praqtikulad yvela mJava SeiZleba miviRoT qvemoT moyvanili erT-erTi meTodiT;

1. marilisa da mJavas urTierTqmedebiT axali mJavasa da axali fuZis warmoqmna, Tu maT Soris ar mimdinareobs Jangva-aRdgenis reaqciebi, magaliTad:

a) susti mJavas gamoZeveba Zlieri mJavaTi

$$NaCN + HCl \overset{t}{=} HCN\uparrow + NaCl;$$

b) aqroladi mJavas gamoZeveba misi marilebidan naklebad aqroladi mJavaTi. am mizniT, Cveulebriv, gamoiyeneba gogirdmJava, radgan amisaTvis mas gaaCnia mTeli rigi aucilebeli Tviseba:

_ Zlieri mJavaa,

_ Termulad mdgradia,

_ mcired aqroladia $[t_{\text{duR.}}(H_2SO_4) = 296{,}5^\circ C]$,

$$\underset{\text{myari}}{NaCl} + \underset{\text{konc.}}{H_2SO_4} = HCl\uparrow + NaHSO_4,$$

$$NaHSO_4 + NaCl \overset{t}{=} HCl\uparrow + Na_2SO_4.$$

gogirdmJavas SeuZlia marilidan gamoaZevos ufro Zlieri mJava, iseTic ki rogoricaa qlormJava _ Jangbvadovani mJavebidan yvelaze Zlieri:

$$KClO_4 + H_2SO_4 \underset{\text{vakuumi}}{\overset{t}{=}} HClO_4\uparrow + KHSO_4.$$

magram am mizniT gogirdmJavas gamoyenebisas aucilebelia gaviTvaliswinoT misi sxva Tvisebebic, romlebic ramdenadme zRudavs mis gamoyenebas. koncentrirebuli gogirdmJava aris sakmaod Zlieri damJangavi, amitom **ar SeiZleba misi gamoyeneba** iseTi mJavebis misaRebad rogoricaa $HBr$, $HI$, $H_2S$, radgan mJavawarmomqmneli elementebi SeuZlia gadaiyvanos sxva Jangvis xarisxSi, magaliTad:

$$8\overset{-1}{H}\underset{\text{myari}}{\overset{-1}{I}} + \underset{\text{konc.}}{H_2SO_4} = H_2S\uparrow + 4H_2O + 4\overset{0}{I}_2.$$

aseT SemTxvevaSi SeiZleba gamoviyenoT fosformJavaTi marilis gaxureba, romelic ar avlens damJangav Tvisebebs:

$$Na\bar{B}r + H_3PO_4 \overset{t}{=} H\bar{B}r\uparrow + NaH_2PO_4.$$

garda amisa, koncentrirebuli gogirdmJava xasiaTdeba sakmaod Zlieri wyalwamrTmevi TvisebiT, rac iwvevs mJavebis daSlas, wylis warTmevis gamo, centraluri atomis disproporcirebis xarjze:

$$3KClO_3 + 3H_2SO_4 = H_2O + 3KHSO_4 + 2ClO_2 + HClO_4$$

an xels uwyobs aramdgradi mJavuri oqsidis warmoqmnas, romelic SeiZleba daiSalos afeTqebiT:

$$2KMnO_4 + H_2SO_4 = Mn_2O_7\downarrow + K_2SO_4 + H_2O,$$

$$2Mn_2O_7 = 4MnO_2 + 3O_2.$$

g) erTi uxsnari produqtis warmoqmniT:

$$AgNO_3 + HCl = AgCl\downarrow + HNO_3,$$

$$Ba(H_2PO_4)_2 + H_2SO_4 = BaSO_4\downarrow + 2H_3PO_4,$$

$$Na_2SiO_3 + 2HCl + (x-1)H_2O = SiO_2\cdot xH_2O\downarrow + 2NaCl.$$

2. marilebis urTierTqmedebiT wyalTan, hidrolizi praqtikulad mimdinareobs bolomde:

$$Al_2S_3 + 6H_2O = 2Al(OH)_3\downarrow + 3H_2S\uparrow.$$

3. mJavaTa halogenhidridebis hidrolizi:

$$PBr_5 + H_2O = POBr_3 + 2HBr\uparrow,$$

$$PBr_3 + 3H_2O = H_3PO_3 + 3HBr\uparrow,$$

$$SOCl_2 + 2H_2O = H_2SO_3 + 2HCl\uparrow,$$

sulfurilis qloridi — cxeli wyali

$$SO_2Cl_2 + H_2O = SO_3\uparrow + 2HCl\uparrow,$$

Tionilis qloridi

$$COCl_2 + H_2O \overset{t}{=} CO_2\uparrow + 2HCl\uparrow.$$

fosgeni — cxeli wyali

4. arametalebis daJangviT azotmJavaTi:

$$3P + 5HNO_3 + 2H_2O = 3H_3PO_4 + 5NO\uparrow,$$

$$S + 2HNO_{3\text{konc.}} \overset{t}{=} H_2SO_4 + 2NO\uparrow.$$

5. mJavawarmomqmneli elementebis daJangviT Jangvis ufro maRal xarisxamde:

$$H_3PO_3 + H_2O_2 = H_3PO_4 + H_2O,$$

$$2H_2SO_4 + 5H_3PO_3 + 2KMnO_4 = 5H_3PO_4 + 2MnSO_4 + K_2SO_4 + 3H_2O,$$

$$H_2SO_3 + H_2O_2 = H_2SO_4 + H_2O,$$

$$HNO_2 + Br_2 + H_2O = HNO_3 + 2HBr.$$

### 2.2.4. mJavas fizikuri Tvisebebi

mJavaTa umravlesoba Cveulebriv pirobebSi siTxea ($HNO_3$, $H_2SO_4$, $HClO_4$ da sxv.), zogierTi maTgani ki _ myari nivTierebaa ($H_3PO_4$, $H_3PO_3$, $H_2SiO_3$ da sxv.). iSviaTi gamonaklisis garda (magaliTad, $H_2SiO_3$), mJava wyals Seereva nebismieri TanafardobiT. uJangbado mJava arametalis airadi wyalbadnaerTis wyalxsnaria. mJavas xsnars mJave gemo aqvs, mcenareuli da cxoveluri warmoSobis qsovilebs azianebs, moqmedebs indikatorebze _ lakmusis iisfer xsnars awiTlebs, meTilnarinjis narinjisfer xsnars vardisfrad feravs (fenolfTaleinis ufero xsnars fers ar ucvlis).

### 2.2.5. mJavas qimiuri Tvisebebi

mJavas iseTi Tvisebebi, rogoricaa sxvadasxva nivTierebasTan urTierTqmedeba, mJave gemo, indikatorebis feris Secvla da sxva ganpirobebulia maT wyalxsnarebSi wyalbadionTa arsebobiT.

1. ganvixiloT aramJangavi mJavas qimiuri Tvisebebi:

1.1. mimocvlis reaqciebi

a) fuZesTan urTierTqmedeba (rogorc xsnad, ise uxsnarTan) _ neitralizaciis reaqciebi

$$HCl + NaOH = H_2O + NaCl$$

$$H_2SO_4 + Ba(OH)_2 = 2H_2O + BaSO_4 \downarrow$$

b) marilebTan urTierTqmedeba

$$2HNO_3 + MgCl_2 = Mg(NO_3)_2 + 2HCl$$

$$2H_3PO_4 + 3CaSO_3 = Ca_3(PO_4)_2 \downarrow + 3SO_2 \uparrow + 3H_2O$$

mimocvlis reaqciis gantolebis Sedgenis dros aucilebelia gaviTvaliswinoT am reaqciis bolomde mimdinareobis pirobebi:

a) Tundac erTi uxsnari nivTierebis warmoqmna,

b) nivTierebis airad mdgomareobaSi gamoyofa,

g) susti eleqtrolitis (magaliTad, wylis) warmoqmna.

**1.2.** reaqciebi fuZur ( $FeO$ ) da amfoterul ( $ZnO$ ) oqsidebTan:

a) $H_2SO_4 + FeO = FeSO_4 + H_2O$

b) $2HNO_3 + ZnO = Zn(NO_3)_2 + H_2O$

1.3. eleqtroqimiur ZabvaTa mwkrivSi wyalbadamde mdgomi metalebi aZevebs wyalbads im mJavebidan, romlebic ar iTvleba Zlier mJangavebad ( $HCl$ , $H_2SO_{4\text{ganz.}}$):

$$Mg + 2HCl = MgCl_2 + H_2 \uparrow,$$

$$Zn + \underset{\text{ganz.}}{H_2SO_4} = ZnSO_4 + H_2 \uparrow.$$

Tu reaqciis Sedegad warmoiqmneba uxsnari marili an oqsidi, maSin metali pasiuri xdeba da ar ixsneba:

$$Pb + H_2SO_4 \neq$$

( $PbSO_4$ _ ar ixsneba wyalSi)

$$Al + HNO_{3(\text{konc.})} \neq$$

(metalis zedapiri ifareba oqsiduri afskiT)

**1.4.** Termulad aramdgradi mJavebi, magaliTad, naxSirmJava, gogirdovani mJava, iSleba oTaxis temperaturaze an mcire gaxurebis dros:

$$H_2CO_3 = CO_2 \uparrow + H_2O$$

$$H_2SO_3 \overset{t}{=} SO_2 \uparrow + H_2O \uparrow$$

$$SiO_2 \cdot xH_2O \overset{t}{=} SiO_2 + xH_2O \uparrow$$

1.5. mJavawarmomqmneli elementis Jangvis xarisxis cvlilebiT mimdinare reaqciebi:

$$4H\overset{-}{Cl} + MnO_2 = MnCl_2 + \overset{0}{Cl}_2 + 2H_2O,$$

$$H_3\overset{+3}{P}O_3 + H_2O_2 = H_3\overset{+5}{P}O_4 + H_2O,$$

$$2H_2\overset{+6}{S}O_{4(\text{konc.})} + Cu = CuSO_4 + \overset{+4}{S}O_2 + 2H_2O,$$

$$2H_2\overset{-2}{S} + H_2\overset{+4}{S}O_3 = 3\overset{0}{S}\downarrow + 3H_2O.$$

am principis mixedviT mJava arsebobs mJangavi da aRmdgeni.

### 2.2.6. mJangavi mJavas Tvisebebi

**2.1.** mimocvlis reaqciebi. mJangavi mJava reagirebs oqsidTan, hidroqsidTan da marilTan, romelTa SedgenilobaSi Semavali metalis kationi ar avlens Jangvis cvlad xarisxs, da aseve mJavasTan, romelic ar iTvleba mJangavad.

**2.2.** reaqcia hidroqsidTan, oqsidTan da marilTan.

a) Tu fuZis warmomqmneli metals SeiZleba hqondes ramdenime Jangvis xarisxi, xolo mJava avlens mJangav Tvisebebs, maSin es reaqciebi SeiZleba warimarTos elementTa Jangvis xarisxis cvlilebiT, magaliTad,

$$Fe(OH)_2 + 4HNO_{3(\text{konc.})} = Fe(NO_3)_3 + NO_2 \uparrow + 3H_2O.$$

b) analogiurad iqceva reaqciebSi mJava-mJangavebi da metalTa oqsidebi, romlebic avlenen Jangvis cvlad xarisxs:

$$2FeO + 4H_2SO_{4(\text{konc.})} = Fe_2(SO_4)_3 + SO_2 \uparrow + 4H_2O.$$

g) mJangavi mJavas reaqciisas marilebTan, romlebic Seicaven aRmdgeni Tvisebebis mqone anionebs, mimdinareobs misi Jangva:

$$3Na_2S + 8HNO_{3(\text{ganz.})} = 6NaNO_3 + 3S\downarrow + 2NO\uparrow + 4H_2O,$$

$$8NaI + 5H_2SO_{4(\text{konc.})} = 4I_2\downarrow + H_2S\uparrow + 4Na_2SO_4 + 4H_2O.$$

### 2.2.7. mJangavi mJavas metalebTan urTierTqmedeba

azotisa da gogirdis koncentrirebuli mJavebi iTvleba Zlier mJangavebad da SeuZliaT urTierTqmedeba metalebTan, romlebic ZabvaTa mwkrivSi dganan, rogorc wyalbadamde, ise mis Semdeg, magram wyalbadis gamoZeveba ar xdeba, warmoiqmneba azotis da gogirdis aRdgenis produqtebi, amasTan, produqtTa Sedgeniloba damokidebulia metalis aqtivobaze, mJavas koncentraciasa da temperaturaze:

$$Cu + 4HNO_{3(\text{konc.})} = Cu(NO_3)_2 + 2NO_2 \uparrow + 2H_2O ,$$

$$3Cu + 8HNO_{3(\text{ganz.})} = 3Cu(NO_3)_2 + 2NO \uparrow + 4H_2O ,$$

$$5C_O + 12HNO_{3(\text{Zlier ganz.})} = 5C_O(NO_3)_2 + N_2 \uparrow + 6H_2O ,$$

$$4Zn + 10HNO_{3(\text{Zlier ganz.})} = 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O .$$

spilenZi ar urTierTqmedebs ganzavebul gogirdmJavasTan, magram reagirebs koncentrirebulTan, Tumca am dros wyalbadi ar gamoiyofa:

$$Cu + 2H_2SO_{4(\text{konc.})} = CuSO_4 + SO_2 \uparrow + 2H_2O .$$

zogierTi metali, romelic ZabvaTa mwkrivSi wyalbadamde dgas, magaliTad, $Fe$, $Al$, $Cr$, ar urTierTqmedebs azotmJavasTan da koncentrirebul gogirdmJavasTan, radgan am metalTa zedapirze es mJavebi pasiurdeba oqsiduri afskis warmoqmnis gamo, romelic Cveulebriv pirobebSi ar ixsneba koncentrirebul mJavaSi.

koncentrirebuli azotisa da gogirdis mJavebi urTierTqmedebs arametalebTan _ gogirdTan, fosforTan, naxSirbadTan:

$$S + 2HNO_{3(\text{konc.})} \overset{t}{=} H_2SO_4 + 2NO \uparrow ,$$

$$S + 2H_2SO_{4(\text{konc.})} \overset{t}{=} 3SO_2 \uparrow + 2H_2O \uparrow ,$$

$$3P + 5HNO_{3(\text{konc.})} + 2H_2O \overset{t}{=} 3H_3PO_4 + 5NO \uparrow ,$$

$$C + 2H_2SO_{4(\text{konc.})} \overset{t}{=} CO_2 \uparrow + 2SO_2 \uparrow + 2H_2O .$$

mJavebi, warmoqmnili umaRlesi Jangvis xarisxis mqone gardamavali metalebiT, magaliTad, qromis $[H_2CrO_4]$, manganumis $[HMnO_4]$ Zlieri mJangavebia:

$$2H_2CrO_4 + 3SO_2 = Cr_2(SO_4)_3 + 2H_2O ,$$

$$2HMnO_4 + 5H_2SO_3 = 2MnSO_4 + 3H_2SO_4 + 3H_2O.$$

mJavebs, romlebSic mJavawarmomqmneli elementi imyofeba Sualedur Jangvis xarisxSi, SeuZliaT gamoavlinon rogorc mJangavi, ise aRmdgeni Tvisebebi:

$H_2SO_3 + 2H_2S = 3S\downarrow + 3H_2O$ ( $H_2SO_3$ _ mJangavi)

$H_2SO_3 + NO_2 = NO\uparrow + H_2SO_4$ ( $H_2SO_3$ _ aRmdgeni)

## 2.3. meti rom vicodeT mJavaTa Sesaxeb

sayovelTaod cnobilia, rom mJavaTa umravlesoba Cveulebriv pirobebSi, Txevadia ( $HNO_3$ - azotmJava, $H_2SO_4$ - gogirdmJava, $HClO_4$ - qlormJava da sxv.), zogierTi maTgani ki – myari nivTierebaa ( $H_3PO_3$ - fosforovanmJava, $H_3PO_4$ - fosformJava, $H_2SiO_3$ - siliciummJava da sxv.). iSviaTi gamonaklisis garda (magaliTad, $H_2SiO_3$ ), mJava wyals ereva nebismieri TanafardobiT. uJangbado mJava arametalis (metaloidis) airadi wyalbadnaerTis wyalxsnaria ( $HCl$ - marilmJava anu qlorwyalbadmJava, $HBr$ - bromwyalbadmJava, $H_2S$ - gogirdwyalbadmJava da sxv.).

mJava mcenareuli da cxoveluri warmoSobis qsovilebs azianebs (amoWams), moqmedebs indikatorebze – lakmusis iisfer xsnars awiTlebs, meTilnarinjis narinjisfer xsnars vardisfrad feravs, fenolftaleinis ufero xsnars fers ar ucvlis da sxv.

**fTorwyalbadmJava ( $HF$ , mdnobi mJava)** – saSualo siZlieris erTfuZiani mJavaa. sxva halogenwyalbadmJavebTan ( $HF, HCl, HBr, HI$ ) SedarebiT sustia. maTi siZliere izrdeba mwkrivSi ( $HF, HCl, HBr, HI$ ), rac aixsneba - $H-Hal$ ( $Hal$ _ halogeni) bmis energiis SemcirebiT. iodwyalbadmJava ( $HI$ ) am mwkrivSi yvelaze Zlieri mJavaa (igi sxva uJangbado mJavebs Sorisac yvelaze Zlieri mJavaa). fTorwyalbadmJava energiulad Sedis qimiur reaqciebSi TiTqmis yvela metalTan, oqrosa ( $Au$ ) da platinis ( $Pt$ ) garda, Sesabamisi marilis – fToridis warmoqmniT. $HF$ wyalxsnarSic asocirebulia molekulebis saxiT – wyalbaduri bmebis gamo. 0,1 $N$ xsnarSi fTorwyalbadmJavas ionebad disociaciis xarisxi Seadgens 8%-s maSin, rodesac imave koncentraciis

danarCeni halogenwyalbadmJavebis disociaciis xarisxi 92-95%-is intervalSia. fTorwyalbadmJavas mniSvnelovan Tvisebas warmoadgens silicium(IV)-is oqsidTan urTierTqmedeba ($4HF + SiO_2 = SiF_4 + 2H_2O$). igi Slis minas, radgan urTierTqmedebs masSi Semaval $SiO_2$-Tan, amazea agebuli minis zedapirze gavireba.

qlorwyalbadmJava ($HCl$, marilmJava) – Zlieri erTfuZiani mJavaa, romelsac marilmJava ewodeba. misi koncentrirebuli xsnari Seesabameba 37% $HCl$-is Semcvelobas (simkvrive 1,19g/sm$^3$). marilmJavaSi ixsneba yvela metali ($2HCl + Fe = FeCl_2 + H_2$, $2HCl + Zn = ZnCl_2 + H_2$ da sxv.), romelic metalTa aqtiurobis mwkrivSi wyalbadamdea moTavsebuli (sxva mJavebTan erTad, romlebic iCenen Jangvis unars, danarCen metalebsac xsnis: $Au + 4HCl + HNO_3 = HAuCl_4 + NO + 2H_2O$). haerze qlorwyalbadmJava bolavs, radgan wylis orTqlTan urTierTqmedebisas warmoqmnis nisls, romelic $HCl$-is xsnaris mcire zomis wveTebisgan Sedgeba.

marilmJavas didi gamoyeneba aqvs medicinaSi (marilmJava adamianis kuWis wvenis erT-erTi ZiriTadi komponentia - monawileobs sakvebis monelebasa da aTvisebaSi, monawileobs zogierTi hormonis warmoqmnaSi, uvnebels xdis garemodan kuWSi moxvedril mikrobebs. amitom kuWis wvenis dabali mJavianobis dros iyeneben marilmJavas ganzavebul 8,2-8,4%-ian xsnars), qimiur warmoebaSi, metalurgiaSi, saRebavebis damzadebaSi, qloris warmoebasa da bevri metalis qloridis mosamzadeblad. metalTa zedapiris dasamuSaveblad monikelebis, moqromvis, moTuTiebis win. marilmJavas mniSvnelovan raodenobas iyeneben agreTve laboratoriul praqtikaSi.

**bromwyalbadmJava ($HBr$)** – Zlieri erTfuZiani mJavaa. masSi mravali metali ixsneba – bromidebis warmoqmniT, romelTa umravlesoba wyalSi xsnadia. bromwyalbadmJava sinaTleze, haerTan Sexebis dros, swrafad muqdeba Tavisufali bromis gamoyofis gamo ($4HBr + O_2 = 2Br_2 + 2H_2O$). bromwyalbadmJavas wyalxsnari advilad miiReba, Tu am halogens gogirdovani airiT aRadgenen wyalxsnarSi ($Br_2 + SO_2 + 2H_2O = 2HBr + H_2SO_4$). miRebuli narevis gacxelebiT gamoixdeba bromwyalbadmJavas wyalxsnari, gogirdmJava, rogorc Znelad aqroladi, naleqSi darCeba. bromidebis xsnadoba axlosaa Sesabamisi qloridebis xsnadobasTan. $HBr$-is mTavari gansxvaveba $HCl$-gan isaa, rom bromwyalbadmJava nela iJangeba molekuluri JangbadiT

(sinaTle aCqarebs am reaqcias). bromwyalbadmJavas marilebidan mniSvnelovania tute metalebis ( $NaBr$ , $KBr$ da sxv.) bromidebi.

sinaTlisadmi didi grZnobierebis gamo, fotografiul qimiaSi farTod iyeneben bromis naerTebs, maTze didi moTxovnilebaa organul sinTezSi, laboratoriul teqnikaSi.

**iodwyalbadmJava ( $HI$ )** – erTfuZiani Zlieri mJavaa. mis marilebs iodidebi ewodeba. yvela maTgani, garda vercxlis iodidisa ( $AgI$ ), wyalSi xsnadia. molekuluri Jangbadi TandaTan Jangavs iodwyalbadmJavas, oTaxis temperaturaze (sinaTlis moqmedebiT reaqcia Cqardeba $4HI + O_2 = I_2 + 2H_2O$ ) maSin, rodesac bromwyalbadmJava gacilebiT nela urTierTqmedebs JangbadTan, xolo qlorwyalbadmJava, Cveulebriv pirobebSi, saerTod ar urTierTqmedebs JangbadTan. iodwyalbadmJavas aRmdgeni Tvisebebi kidev ufro mkafiod mJRavndeba koncentrirebul gogirdmJavasTan urTierTqmedebis procesSi ( $8HI + H_2SO_4 = 4I_2 + H_2S + 4H_2O$ ). amitom iodwyalbadmJava praqtikulad ar miiReba iodidebze gogirdmJavas moqmedebiT.

iodwyalbadmJavas naerTebidan didi gamoyeneba aqvs natriumisa da kaliumis iodidebs analizuri miznebisTvis, medicinaSi (sadezinfeqciod da samkurnalod). maT iyeneben agreTve fotografiasa da saRebavebis warmoebaSi.

**qveqlorovani mJava ( $HClO$ )** – miiReba qlor(I)-is oqsidis ( $Cl_2O$ ) gaxsniT wyalSi ( $Cl_2O + H_2O = 2HClO$ ), agreTve qloris wyalSi gaxsniT (hidroliziT, $Cl_2 + H_2O = HClO + HCl$ ). igi Zalian susti mJavaa – misi marilebia hipoqloritebi ( $NaClO$ , $KClO$ da sxv.). qveqlorovani mJava da misi marilebi (hipoqloritebi) Zlieri mJangavebia, radgan maTi daSlis dros gamoyofili atomuri Jangbadi ( $HClO = HCl + O$ , $NaClO = NaCl + O$ ) Zlieri mJangavia.

**qlorovanmJava ( $HClO_2$ )** – warmoiqmneba qloris dioqsidis wyalSi gaxsniT ( $2ClO_2 + H_2O = HClO_2 + HClO_3$ ). qlorovanmJavas wyalxsnari aseve miiReba bariumis qloritze $(Ba(ClO_2)_2)$ ganzavebuli gogirdmJavas moqmedebiT $(Ba(ClO_2)_2) + H_2SO_4 = 2HClO_2 + BaSO_{4\downarrow})$ . misi wyalxsnarebi aramdgradia. qlorovanmJava avtoredoqsidacias ganicdis. TviTJangva – aRdgenisas qlorovanmJavasagan miiReba qveqlorovanmJavas da qveqlormJavas narevi $(2HClO_2 = HClO + HClO_3)$ . qlorovanmJava susti mJavaa da igi Tavisufali saxiT dRemde ar aris miRebuli. bevrad ufro mdgradia

qlorovanmJavas marilebi – qloritebi, risTvisac qloris dioqsidiT moqmedeben natriumis peroqsidze ($2ClO_2 + Na_2O_2 = 2NaClO_2 + O_2$).

qloritebi gamoiyeneba rogorc Zlieri mJangavebi da maTeTrebeli nivTiereba. mZime metalebis myari qloritebi gaxurebiT da dartymiT afeTqebiT iSleba.

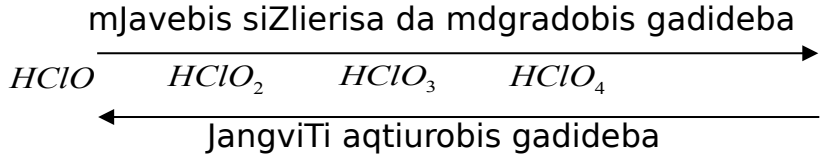
**qveqlormJava ($HClO_3$)** – miiReba qloratebze ganzavebuli mJavebis moqmedebisas ($Ba(ClO_3)_2 + H_2SO_4 = 2HClO_3 + BaSO_4\downarrow$). bariumsulfatis gamoleqvis Semdeg siTxes gadmoasxamen da vakuumSi aaorTqleben 40%-iani $HClO_3$-is xsnaris miRebamde. Semdgomi koncentrirebisas $HClO_3$ iwyebs daSlas.

qveqlormJava Zlieri erTfuZiani mJavaa – amasTanave igi Zlieri mJangavia. misi wyalxsnarebi, romlebSic $HClO_3$-is Semcveloba 40%-ze naklebia, sakmaod mdgradia. qveqlormJavas marilebi – qloratebi advilad miiReba qloris gatarebiT tuteTa cxel xsnarebSi ($3Cl_2 + 6KOH = KClO_3 + 5KCl + 3H_2O$). kaliumis qlorati (romelic misi pirvelad mimRebis pativsacemad berToles marilis saxelwodebiTaa cnobili) miiReba agreTve cxel kirxsnarSi qloris gatarebiT da Semdgom kaliumqloridis damatebiT $(6Cl_2 + 6Ca(OH)_2 = Ca(ClO_3)_2 + 5CaCl_2 + 6H_2O;\ Ca(ClO_3)_2 + 2KCl = 2KClO_3 + CaCl_2$.

qveqlormJavas kaliumqlorati Zlieri mJangavia – wvis unaris mqone nivTierebebTan advilad feTqdeba, amitom foierverkebis damzadebisas Semadgenel nawilebs cal-calke dafxvnian da mxolod amis Semdeg frTxilad Seureven erTmaneTs. mas didi raodenobiT iyeneben asanTis warmoebaSi, piroteqnikasa da medicinaSi.

**qlormJava ($HClO_4$)** – miiReba misi Sesabamisi anhidridis wyalSi gaxsniT ($Cl_2O_7 + H_2O = 2HClO_4$). igi qloris Jangbadovani mJavebidan yvelaze mdgradi mJavaa. $HClO_4$ yvelaze Zlieri erTfuZiani mJavaa. qlormJava Tavisufal mdgomareobaSi arsebobs. igi feTqebadia. misi erTi wveTi ki iwvevs qaRaldis, bambis, xis aalebas. wyalTan warmoqmnis hidratebs, romelgan monohidrati $HClO_4 \cdot H_2O$ xasiaTdeba dnobis maRali temperaturiT (+50°C). gacxelebisas qlormJava advilad feTqdeba, rac aixsneba imiT, rom $HClO_4$-is gaTbobisas miRebuli $Cl_2O_7$ iSleba ($2Cl_2O_7 = 4ClO_2 + 3O_2$). qlormJava xSirad feTqdeba uZrav mdgomareobaSic ki, amitom mas dabal temperaturaze gamoxdian. misi wyalxsnarebi bevrad ufro mdgradia.

qlormJavas marilebi – perqloratebi ($KClO_4$, $Ca(ClO_4)_2$ da sxv.), qloris Jangbadovani naerTebidan yvelaze mdgradia. maT iyeneben zogierTi feTqebadi nivTierebis dasamzadeblad. qloris naerTebi gamoiyeneba kvebis mrewvelobasa da medicinaSi, sasuqebis warmoebasa da fotografiaSi.




amrigad, SeiZleba iTqvas, rom qloris Jangvis ricxvis zrdasTan erTad izrdeba Jangbadovani mJavebis siZliere da mdgradoba, magram maTi JangviTi aqtiuroba mcirdeba.

**qvebromovanmJava ($HBrO$)** miiReba brom(I)-is oqsidis wyalSi gaxsniT ($Br_2O + H_2O = 2HBrO$). igi miiReba agreTve bromis gatarebiT civ wyalSi ($Br_2 + H_2O = HBrO + HBr$). qvebromovanmJava arsebobs mxolod wyalxsnarSi. sinaTleze da gaxurebis dros ($HBrO$) iSleba bromwyalbadmJavas da Jangbadis gamoyofiT ($2HBrO = 2HBr + O_2$) – Sigamolekuluri Jangva-aRdgenis Sedegad.

qvebromovanmJavas marilebs hipobromitebi ($NaBrO$, $Ca(BrO)_2$ da sxv.) ewodeba da maTi miReba SeiZleba bromis gatarebiT tuteTa civ xsnarebSi ($Br_2 + 2NaOH = NaBrO + NaBr + H_2O$). $HBrO$ ufro sustia, vidre $HClO$, amitom misi marilebi (hipobromitebi) ufro Zlieri mJangavebia, vidre hipoqloritebi.

**bromovanmJava ($HBrO_2$)** warmoiqmneba brom(III)-is fToridis hidroliziT ($BrF_3 + 2H_2O = HBrO_2 + 3HF$), romelsac Tan axlavs disproporcireba ($3HBrO_2 = 2HBrO_3 + HBr$) da qvebrommJavas ($HBrO_3$) warmoqmna. bromovanmJavas marilebs bromitebi ($NaBrO_2$, $KBrO_2$ da sxv.) ewodeba.

**qvebrommJava ($HBrO_3$)** miiReba bromis wyalxsnarSi Zlieri mJangavis (qloris) gatarebiT ($Br_2 + 6H_2O + 5Cl_2 = 2HBrO_3 + 10HCl$). mdgradia mxolod misi wyalxsnari. misi xsnari uferoa. $HBrO_3$-is Sesabamisi marilebi – bromitebi miiReba bromis gatarebiT tuteTa cxel xsnarebSi ($3Br_2 + 6KOH = KBrO_3 + 5KBr + 3H_2O$). koncentrirebul xsnarebSi $HBrO_3$ iSleba. misi Sesabamisi anhidridi ar aris cnobili. Tavisi TvisebebiT $HBrO_3$ Zalian hgavs $HClO_3$-s. qvebromJava agreTve miiReba bariumis bromatis

ganzavebuli gogirdmJavaTi daSlisas ($Ba(BrO_3)_2 + H_2SO_4 = 2HBrO_3 + BaSO_4\downarrow$). qvebrommJavas marilebi ($M[BrO_3]$, sadac $M = Na,\ K,\ Ca$ da sxv.) SedarebiT mdgradi naerTebia. bromatebi, qloratebis msgavsad, Zlieri mJangavebia.

qvebrommJavasa da mis naerTebs iyeneben organul sinTezSi, laboratoriul teqnikaSi, kvebis mrewvelobaSi (kaliumis bromati - $KBrO_3$) da sxv.

**brommJava ($HBrO_4$)** SeiZleba miRebul iqnes qvebrommJavas wyalxsnarSi qsenonis difToridis ($XeF_2$) gatarebiT ($HBrO_3 + XeF_2 + H_2O = HBrO_4 + Xe + 2HF$). brommJava arsebobs mxolod wyalxsnaris saxiT. SedarebiT mdgradia misi marilebi – tetraoqsobromatebi ($NaBrO_4$, $KBrO_4$ da sxv.). brommJavasa da misi marilebis _ perbromatebis Sesaxeb cnobebi jerjerobiT TiTqmis ar moipoveba.

bromis nawarmebi farTod gamoiyeneba meurneobis sxvadasxva dargSi – zogierTi specifikuri saxis pesticidebisa da saRebavebis dasamzadeblad. maT iyeneben agreTve farmacevtul mrewvelobaSi – samkurnalo preparatebis misaRebad.

**qveiodovanmJava ($HIO$)** – miiReba iodis urTierTqmedebiT wyalTan ($I_2 + H_2O = HIO + HI$). qveiodovanmJava mxolod ganzavebuli xsnaris saxiT arsebobs. mwkrivSi $HClO - HBrO - HIO$ mJavebis mdgradoba da JangviTi aqtiuroba mcirdeba. qveiodovani mJava ($HIO$) amfoteruli naerTia, romelSic fuZuri Tvisebebi sWarbobs mJavur Tvisebebs. qveiodovanmJava advilad ganicdis TviTJangva-aRdgeniT gardaqmnas (miiReba qveiodovanmJava da iodwyalbadmJava $3HOI = HIO_3 + 2HI$). qveiodovanmJavas marilebi – hipoioditebi miiReba iodis gaxsniT tutis civ xsnarSi ($I_2 + 2KOH = KIO + KI + H_2O$). hipoioditebi advilad iSleba, xdeba iodionis disproporcireba ($3KIO = KIO_3 + 2KI$).

**qveiodmJavas ($HIO_3$)** miReba SeiZleba iodis JangviT azotmJavaSi ($3I_2 + 10HNO_3 = 6HIO_3 + 10NO + 2H_2O$). igi ufero kristaluri nivTierebaa, arsebobs Tavisufali saxiT, kargad ixsneba wyalSi, oTaxis temperaturaze mdgradia. 200ºC-mde gacxelebisas $HIO_3$-sagan miiReba qveiodmJavas anhidridi ($I_2O_5$), romelic wyalTan isev qveiodmJavas warmoqmnis ($I_2O_5 + H_2O = 2HIO_3$). qveiodmJava da misi marilebi (iodatebi - $NaIO_3$, $KIO_3$ da sxv.) ufro susti mJangavebia, vidre qveqlor- da qvebrommJavebi da maTi Sesabamisi

marilebi. qveiodmJavasTvis damaxasiaTebelia iodatebTan erTad gamokristaleba (cnobilia naerTebi _ $KIO_3 \cdot 2HIO_3$, $NaIO_3 \cdot 2HIO_3$ da sxv.).

**iodmJava ($HIO_4$)** – miiReba iodis qlormJavaTi daJangvis dros ($I_2 + 2HClO_4 = 2HIO_4 + Cl_2$). igi Zlieri mJangavia. aRsaniSnavia, rom iodmJavasTan Sebmuli wylis molekulebis wyalbadebic iCens metaliT Canacvlebis unars. igi rTuli mJavaa, romelsac SeiZleba mieweros $(HIO_4)_x(H_2O)_y$ formula, magaliTad, $H_5IO_6$ xuTfuZiani susti mJavaa, romelSic wyalbadis xuTive atomi Cainacvleba metaliT. orToiodmJavas ($H_5IO_6$) marilebs ($Ag_5IO_6$, $Na_5IO_6$ da sxv.) **orToperiodatebi** ewodeba. perqloratebisgan ($KClO_4$ da sxv.) gansxvavebiT, TiTqmis yvela periodati mcired ixsneba wyalSi.

iodi da misi naerTebi didi raodenobiT gamoiyeneba medicinaSi. misi 10%-iani spirtxsnari ixmareba Wrilobebis sadezinfeqciod da samkurnalod. gamoiyeneba agreTve aTerosklerozis sawinaaRmdegod. iodis naerTebs iyeneben fotografiasa da saRebavebis warmoebaSi, organul sinTezSi da sxv., agreTve ixmareba analizur qimiaSi (iodometria da sxv.).

**gogirdwyalbadmJava ($H_2S$)** - gogirdwyalbadis wyalxsnari susti orfuZiani mJavaa; miiReba gogirdis wyalbadTan urTierTqmedebiT $S + H_2 = H_2S$ (maRal temperaturaze) da misi wyalSi gaxsniT. disocirdeba or safexurad, ZiriTadad pirveli safexuris mixedviT ($H_2S \Leftrightarrow H^+ + HS^-$, $K_1 = 9 \cdot 10^{-8}(I)$; $HS^- \Leftrightarrow H^+ + S^{2-}$, $K_2 = 4 \cdot 10^{-12}(II)$. me-2 safexuris disociacia imdenad mcirea, rom igi ver axdens arsebiT gavlenas gogirdwyalbadmJavas eleqtrogamtarobaze. $H_2S$**-**is wyalxsnarSi wyalbad-ionTa koncentracia sakmarisia imisaTvis, rom man lurji lakmusis feri wiTlad Secvalos, magram arasakmarisia yviTeli meTiloraJi wiTlad Sesaferad. gogirdwyalbadmJava warmoqmnis srul ($Na_2S$, $CaS$ da sxv.) da mJava ($NaHS$, $KHS$ da sxv.) marilebs – hidrosulfidebs. vercxlisa da spilenZis sagnebi Savdeba $H_2S$-is Semcvel haersa da wyalSi ($4Ag + 2H_2S + O_2 = 2Ag_2S + 2H_2O$; $2Cu + 2H_2S + O_2 = 2CuS + 2H_2O$), rac gamowveulia imiT, rom vercxlisa da spilenZis zedapiri ifareba Sesabamisi sulfidebis feniT ($Ag_2S$ da $CuS$ Savi ferisaa). igi kargi aRmdgenia ($H_2S + Cl_2 = S + 2HCl$; $5H_2S + 2KMnO_4 + 3H_2SO_4 = 5S + K_2SO_4 + 2MnSO_4 + 8H_2O$ da sxv.). sulfidebis

sxvadasxva xsnadobasa da Seferilobazea damyarebuli laboratoriul praqtikaSi mZime metalTa ionebis TvisebiT da raodenobiT analizSi $H_2S$ -is gamoyeneba.

**gogirdovanmJava ($H_2SO_3$)** – saSualo siZlieris orfuZiani mJavaa. miiReba gogirdovani airis ($SO_2$) wyalTan urTierTqmedebiT ($SO_2 + H_2O \Leftrightarrow H_2SO_3$), romelic mxolod wyalxsnaris saxiT arsebobs. xsnars gogirdovani airis suni aqvs, misgan am ukanasknelis ($SO_2$) aqrolebis gamo. gogirdovani mJava warmoqmnis ori rigis marilebs – saSualo marilebs (sulfitebs, $Na_2SO_3$, $CaSO_3$ da sxv.) da mJava marilebs (hidrosulfitebs, $NaHSO_3$, $KHSO_3$ da sxv.). yvela hidrosulfiti wyalSi xsnadia, sulfitebidan xsnadia mxolod tute metalTa da amoniumis marilebi, xolo danarCeni uxsnari an mcired xsnadia. reaqciebSi gogirdovani mJava gamoiyeneba rogorc aRmdgeni ($H_2SO_3 + Cl_2 + H_2O = H_2SO_4 + 2HCl$; $2K_2SO_3 + O_2 = 2K_2SO_4$ da sxv.) da rogorc mJangavi($H_2SO_3 + 2H_2S = 3S + 3H_2O$ da sxv.).

gogirdovani mJava, gogirdovani airis analogiurad, gamauferebeli moqmedebiT xasiaTdeba, rac mis gamoyenebas ganapirobebs. $H_2SO_3$-iT aTeTreben Sals, abreSums, qaRalds, romlebic qloris moqmedebiT iSlebian.

**gogirdmJava ($H_2SO_4$)** – ufero, araaqroladi, blanti siTxea. igi Zlieri, orfuZiani mJavaa, Zlieri eleqtroliti. wyalxsnarebSi or safexurad disocirdeba ($H_2SO_4 \rightarrow H^+ + HSO_4^-(I)$, $HSO_4^- \Leftrightarrow H^+ + SO_4^{2-}(II)$). pirvel safexurze disociacia srulad mimdinareobs. gogirdmJavas mJavas yvela Tviseba axasiaTebs – moqmedebs fuZur oqsidebTan, fuZeebTan, marilebTan ($H_2SO_4 + BaO = BaSO_4\downarrow + H_2O$, $H_2SO_4 + Mg(OH)_2 = MgSO_4 + 2H_2O$, $H_2SO_4 + Cu(NO_3)_2 = CuSO_4 + 2HNO_3$). metalebTan urTierTqmedebisas aRsaniSnavia, rom ganzavebuli gogirdmJavas SemTxvevaSi mJangavia wyalbdis dadebiTi ioni ($H^+$), amitom igi urTierTqmedebs mxolod im metalebTan, romlebic aqtiurobis mwkrivSi moTavsebulia wyalbadamde ($Mg + H_2SO_4 = Mg^{+2}SO_4 + H_2$), xolo koncentrirebuli gogirdmJavas dros mJangavia gogirdis ($S^{6+}$) ioni, romelic Jangavs metalTa aqtiurobis mwkrivSi vercxlamde moTavsebul yvela metals – pirobebisa (mJavas koncentracia, temperatura) da metalis aqtiurobis mixedviT miiReba sxvadasxva nivTiereba ($Cu^\circ + 2H_2\overset{2+}{S}O_4 = \overset{2+}{C}uSO_4 + \overset{4+}{S}O_2 + 2H_2O$,

$3Z_n^{\circ} + 4H_2\overset{6+}{S}O_4 = 3Z_n^{2+}SO_4 + S^{\circ} + 4H_2O, \quad 4Z_n^{\circ} + 5H_2\overset{6+}{S}O_4 = 4Z_n^{2+}SO_4 + H_2\overset{2-}{S} + 4H_2O$ ). koncentrirebuli gogirdmJava Jangavs zogierT arametalsac (mag. gogirds, $2H_2\overset{6+}{S}O_4 + \overset{\circ}{S} = 3\overset{4+}{S}O_2 + 2H_2O;$ naxSirbads, $2H_2\overset{6+}{S}O_4 + \overset{\circ}{C} = 2\overset{4+}{S}O_2 + \overset{4+}{C}O_2 + 2H_2O$ ). gogirdmJava warmoqmnis ori rigis marilebs: srul marilebs – sulfatebs ( $CaCo_3 + H_2SO_4 = CaSO_4 + CO_2 + H_2O$ ) da mJava marilebs – hidrosulfatebs ( $NH_4OH + H_2SO_4 = NH_4HSO_4 + H_2O$ ).

gogirdmJava qimiuri mrewvelobis erT-erTi mniSvnelovani produqtia – mas iyeneben navTobgamwmend warmoebaSi, organul sinTezSi da mineraluri sasuqebis misaRebad. gogirdmJavas saSualebiT miiReba sxvadasxva mJava da marili. igi farTod gamoiyeneba saRebrebis, feTqebadi nivTierebebis, sinTezuri gamrecxi saSualebebis warmoebaSi. metaldasamuSavebel warmoebaSi igi gamoiyeneba metalis zedapiris oqsidebisagan gasasufTaveblad – monikelebis, moqromvis an sxva msgavsi operaciebis win. gogirdmJavas higroskopiuloba, wylisadmi didi swrafva ganapirobebs mis gamoyenebas airebis gasaSrobad.

**selenwyalbadmJava ( $H_2Se$ )** – miiReba selenis uSualo SeerTebiT (400°C) wyalbadTan ( $Se + H_2 \Leftrightarrow H_2Se$ ) da Semdgom wyalSi gaxsniT. misi wyalxsnari xasiaTdeba susti mJavas TvisebebiT. igi orfuZiani, nakleb mdgradi mJavaa, vidre gogirdwyalbadmJava, magram wyalSi masze kargad ixsneba (0,1 moluri koncentraciis xsnarSi $H_2Se$ -is ionebad disociaciis xarisxi 4%-ia). misi pirveli disociaciis mudmiva ( $K_1 = 1{,}88 \cdot 10^{-4}$ ) sakmaod mcirea. selenwyalbadmJavas marilebs selenidebi ewodeba. selenwyalbadmJava marilebis or rigs warmoqmnis – mJava selenidebs ( $M^{/}HSe$ , sadac $M^{/} = Na, K$ da a.S.) da srul selenidebs ( $M_2^{/}Se$ ). $H_2Se$ - kargi aRmdgenia ( $H_2Se + Cl_2 = Se + 2HCl$ ). selenwyalbadmJavas naerTebs aRmoaCndaT naxevargamtaris Tvisebebi da farTod gamoiyeneba eleqtroteqnikaSi.

**telurwyalbadmJava ( $H_2Te$ ).** teluri wyalbads uSualod ar uerTdeba. misi wyalbadnaerTis miReba SeiZleba eleqtroliziT – wyalbadis teluris kaTodze gamoyofiT. garda amisa, metalebis teluridebze (magaliTad, $Al_2Te_3$ -ze) mJavebis moqmedebiT miiReba dabali koncentraciis telurwyalbadi ( $Al_2Te_3 + 6HCl = 3H_2Te + 2AlCl_3$ ). wyalSi telurwyalbadi SedarebiT kargad ixsneba

da miiReba telurwyalbadmJava (haerTan Sexebisas swrafad iSleba, amitom masTan muSaoba SeiZleba uhaero garemoSi). igi susti orfuZiani mJavaa. telurwyalbadmJavas marilebs teluridebi ewodeba. igi warmoqmnis mJava marilebs ($NaHTe,\ KHTe$) da srul marilebs ($Na_2Te$ da sxv.). telurwyalbadmJavas marilebidan wyalSi kargad ixsneba tute metalebis marilebi, xolo mZime metalebis teluridebi wyalSi ar ixsneba. telurwyalbadmJava kargi aRmdgenia ($H_2T_e^{2-} + Cl_2^\circ = T_e^\circ + 2HCl^-$).

teluri da misi warmoebulebi gamoiyeneba naxevargamtarebis teqnikaSi. metalebze damateba zrdis maT meqanikur mdgradobas. teluris naerTebs iyeneben agreTve qimiur sinTezSi telurorganuli nivTierebebis misaRebad.

**selenovanmJava ($H_2SeO_3$)** – miiReba selenis dioqsidis ($SeO_2$) wyalSi gaxsniT ($SeO_2 + H_2O = H_2SeO_3$). igi aris susti orfuZiani mJava. gogirdovanmJavasgan ($H_2SO_3$) gansxvavebiT, selenovanmJava gamoyofilia Tavisufal mdgomareobaSi da myari nivTierebaa, romelic advilad kargavs wyals gaxurebis (70ºC) dros ($H_2SeO_3 = SeO_2 + H_2O$). gogirdovanmJavasgan gansxvavebiT, selenovanmJava mxolod simetriul formiT $\begin{pmatrix} H-O \\ H-O \end{pmatrix} Se=O$ arsebobs. selenovanmJavas miReba aseve SeiZleba, magaliTad, elementarul selenze ganzavebuli azotmJavas moqmedebiT ($3Se + 4HNO_3 + H_2O = 3H_2SeO_3 + 4NO$). igi mdgradia 70ºC temperaturaze dabla. selenovanmJavas marilebs selenitebi ewodeba ($Na_2SeO_3,\ K_2SeO_3$). maTi miReba SeiZleba selenovanmJavas ganeitralebiT ($H_2SeO_3 + 2NaOH = Na_2SeO_3 + 2H_2O,\ H_2SeO_3 + Ca(OH)_2 = CaSeO_3 + 2H_2O$). selenitebi Tavis xsnadobiT axlos aris sulfitebTan.

selenovanmJavas iyeneben selenis mJavas ($H_2SeO_4$) misaRebad ($H_2SeO_3 + Cl_2 + H_2O = H_2SeO_4 + 2HCl$).

**selenmJava ($H_2SeO_4$)** – SeiZleba miRebuli iqnes selenis trioqsidis energiuli urTierTqmedebiT wyalTan ($SeO_3 + H_2O = H_2SeO_4$). igi orfuZiani, Zlieri mJavaa. mis marilebs selenatebi ewodeba. maTi miReba SeiZleba selenmJavas urTierTqmedebiT tute da tutemiwa oqsidebTan (

($H_2SeO_4 + Na_2O = Na_2SeO_4 + H_2O$) da hidroqsidebTan ($H_2SeO_4 + Ca(OH)_2 = CaSeO_4 + 2H_2O$).

selenmJava Zlier disocirebulia ionebad. Tavisi siZlieriT selenmJava gogirdmJavas msgavsia. koncentrirebuli selenmJava, gogirdmJavas msgavsad, organuli naerTebis danaxSirebas iwvevs. selenmJava advilad aRdgeba, radgan igi Zlieri mJangavia – marilmJavas qlors Jangavs da Tavad selenovanmJavamde aRdgeba ($H_2SeO_4 + 2HCl = H_2SeO_3 + Cl_2 + H_2O$). amitomac, samefo wylis msgavsad, selenmJavasa da marilmJavas narevSi oqro ixsneba, platina ki ara. gaxurebisas (270°C) selenmJava Jangbads gamoyofs da miiReba selenovanmJava ($2H_2SeO_4 = 2H_2SeO_3 + O_2$).

seleni da misi naerTebi gamoiyeneba denis gammarTvelebsa da fotoelementebSi. maT iyeneben, agreTve kauCukis vulkanizaciisaTvis da silikatur warmoebaSi minis gasauferuleblad. selenis warmoebulebis didi momxmarebelia eleqtroteqnikuri sawarmoebi.

**telurovanmJava ($H_2TeO_3$)** – miiReba teluris mJavuri anhidridis ($TeO_2$) wyalSi gaxsniT ($TeO_2 + H_2O = H_2TeO_3$). telurovanmJava mxolod simetriul formiT $\begin{pmatrix} H-O \\ H-O \end{pmatrix} \quad Te=O$ arsebobs (gogirdmJavas sapirispirod). telurovanmJava naxSirmJavaze ($H_2CO_3$) ufro, susti, orfuZiani mJavaa. igi xsnaridan Tavisufali saxiT miRebisas nawilobriv kargavs wyals, ris Sedegadac misi Sedgeniloba SeiZleba gamoisaxos $xTeO_2 \cdot yH_2O$ formuliT. susti gaTbobis drosac ki es hidrati mTlianad kargavs wyals. telurovanmJavas marilebis (teluritebis) misaRebad saWiroa $TeO_2$-is gaxsna Sesabamis tuteSi ($TeO_2 + 2NaOH = Na_2TeO_3 + H_2O$; $TeO_2 + Ca(OH)_2 = CaTeO_3 + H_2O$). teluritebis xsnadoba wyalSi SedarebiT SezRudulia (selenitebTan SedarebiT) – kargad ixsneba mxolod natriumisa ($Na_2TeO_3$) da kaliumis ($K_2TeO_3$) teluritebi.

telurovanmJavas polimerizaciisadmi midrekileba aqvs da amitom teluritebze mJavebis moqmedebiT gamoiyofa cvladi Sedgenilobis $TeO_2 \cdot nH_2O$ naleqi. telurovanmJavas axasiaTebs mJangav-aRmdgenis Tvisebebi, magram analogiuri mJavebisagan ($H_2SO_3$, $H_2SeO_3$) gansxvavebiT, telurovanmJavasTvis ufro damaxasiaTebelia Jangvis unari (

$H_2\overset{4+}{T}eO_3 + 4HI^- = T_e^\circ + 2I_2^\circ + 3H_2O$) da piriqiT, $TeO_2$-is Jangva $TeO_3$-ad imdenad Znelad mimdinareobs, rom saWiroa Zlieri mJangavis gamoyeneba ( $3\overset{4+}{T}eO_2 + H\overset{5+}{Cl}O_3 = 3\overset{6+}{Te}O_3 + HCl$).

**telurmJava (**$H_2TeO_4$ **anu orTotelurmJava** $H_6TeO_6$**)** – miiReba telurovanmJavas JangviT ($H_2TeO_3 + Cl_2 + 3H_2O = H_6TeO_6 + 2HCl$), misi Jangva eleqtroliziTac SeiZleba

($5TeO_2 + 2KMnO_4 + 6HNO_3 + 12H_2O = 5H_6TeO_6 + 2KNO_3 + 2Mn(NO_3)_2$

an $(5Te + 6HClO_3 + 12H_2O = 5H_6TeO_6 + 3Cl_2)$. misi wyalxsnaris aorTqlebisas miiReba orTotelurmJava ($H_6TeO_6$), romelic eqvsfuZian mJavas warmoadgens. misi wyalSi xsnadoba didia. telurmJava Zalian susti mJavaa. misi disociaciis mudmiva ($K_1 = 2\cdot10^{-8}$ da $K_2 = 5\cdot10^{-11}$) Zalian mcirea. telurmJava imdenad sustia, rom xSirad ver xerxdeba misi yvela wyalbadis metaliT Canacvleba (magaliTad, $Na_2H_4TeO_6$ da $K_2H_4TeO_6$).

$H_6TeO_6$ gaxurebiT ($H_6TeO_6 \xrightarrow{t} H_2TeO_4 + 2H_2O$) gardaiqmneba $H_2TeO_4$-ad, magram es forma misTvis araa damaxasiaTebeli. orTotelurmJava TeTri, kristaluri nivTierebaa, kargad ixsneba wyalSi. cnobilia misi marilebi – orToteluratebi ($Ag_6TeO_6$ da $Hg_3TeO_6$).

teluri da misi naerTebi gamoiyeneba teqnikis sxvadasxva dargSi, kerZod, naxevargamtarebis warmoebaSi, zrdis naerTebis meqanikur mdgradobas, iyeneben agreTve qimiur sinTezSi telurorganuli nivTierebebis misaRebad.

**azotovanmJava (**$HNO_2$**)** – miiReba azot(III)-is oqsidze wylis moqmedebiT ($N_2O_3 + H_2O \Leftrightarrow 2HNO_2$), agreTve romelime misi marilisa da ganzavebuli gogirdmJavas urTierTqmedebiT ($2KNO_2 + H_2SO_4 = 2HNO_2 + K_2SO_4$). azotovani mJava arsebobs mxolod Zlier ganzavebuli wyalxsnarebis saxiT (Tavisufali saxiT ar aris miRebuli). igi susti erTfuZiani, aramdgradi mJavaa da iSleba ($2HNO_2 = NO_2 + NO + H_2O$). azotovanmJava SeiZleba iyos rogorc mJangavi ($2HNO_2 + 2KI + H_2SO_4 = 2NO + I_2 + K_2SO_4 + 2H_2O$), ise aRmdgeni ($5HNO_2 + 2KMnO_4 + 3H_2SO_4 = 5HNO_3 + 2MnSO_4 + K_2SO_4 + 3H_2O$). azotovanmJavas marilebs ($NaNO_2$, $KNO_2$, $Ca(NO_2)_2$ da sxv.) nitritebi ewodeba. isini sakmaod mdgradia. azotovanmJava ufro Zlieri mJangavia, vidre azotmJava.

azotmJava ($HNO_3$) – amJamad azotis fiqsaciis (e.i. azotis qimiuri naerTis miReba) da, kerZod, azotmJavas miRebis ekonomikurad yvelaze gamarTlebuli meTodia amiakis sinTezi ($N_2$ da $H_2$-dan) da sinTezuri amiakis katalizuri Jangva azotis Jangamde $4NH_3+5O_2=4NO+6H_2O$, $4NH_3+7O_2=4NO_2+6H_2O$ ($NO$ haeris JangbadiT $NO_2$-mde iJangeba da wyalSi gaxsniT $NO_2$ gardaiqmneba $HNO_3$-ad). es aris azotmJavas miRebis ZiriTadi meTodi. azotmJava (wylisa da azotis oqsidebisgan Tavisufali) ufero siTxea; sinaTlis moqmedebiT TandaTanobiT daSlis gamo ($4HNO_3 \Leftrightarrow 4NO_2+O_2+2H_2O$) 98-99%-iani azotmJava yovelTvis Seferilia yviTlad azotis dioqsidis $NO_2$-is Semcvelobis gamo (sufTa azotmJavas miReba ver xerxdeba). gamoTqma ,,koncentrirebuli azotmJava", Cveulebriv, gulisxmobs 69,2%-ian azotmJavas, romelic azeotropuli narevis saxiT gamoixdeba.

azotmJava erTfuZiani Zlieri mJava da Zlieri eleqtrolitia, misi wyalxsnari srulad disocirdeba ionebad ($HNO_3 \Leftrightarrow H^+ + NO_3^-$), axasiaTebs mkveTrad gamoxatuli Jangvis unari. koncentrirebuli azotmJavaTi advilad iJangeba mravali arametali Sesabamisi mJavas ($2HNO_3+S=2NO+H_2SO_4$, $5HNO_3+3P=5NO+H_2O+3HPO_3$) warmoqmniT.

azotmJava moqmedebs TiTqmis yvela metalze (oqros, platinis, tantalis, rodiumisa da iridiumis gamoklebiT) da gardaqmnis maT nitratebad da oqsidebad ($\underset{\text{ganz.}}{8HNO_3}+3Cu=3Cu(NO_3)_2+2NO+4H_2O$; $\underset{\text{konc.}}{4HNO_3}+Cu=Cu(NO_3)_2+2NO_2+2H_2O$) – ase warimarTeba reaqciebi dadebiTi potencialis mqone metalebTan. uaryofiTi potencialis mqone metalebze azotmJavas moqmedebisas azoti aRdgeba sxvadasxva JangviT ricxvamde, rac damokidebulia metalis aqtiurobasa da azotmJavas ganzavebis xarisxze ($\underset{\text{ganz.}}{10HNO_3}+4Zn=4Zn(NO_3)_2+NH_4NO_3+3H_2O$, $\underset{\text{ganz}}{10HNO_3}+4Zn=4Zn(NO_3)_2+N_2O+5H_2O$, $\underset{\text{ganz.}}{4HNO_3}+Fe=Fe(NO_3)_3+NO+2H_2O$), xolo koncentrirebul azotmJavaSi rkina ar ixsneba, radgan igi pasiuri xdeba.

metalebze azotmJavas urTierTqmedebis dros wyalbadi, rogorc wesi, ar gamoiyofa (gamonaklisia mxolod erTaderTi SemTxveva – magniumiT azotmJavadan wyalbadis gamoZeveba, isic mxolod dasawyisSi), radgan

azotmJavaSi azotis ( $N^{5+}$ ) ioni +5 Jangvis ricxviT ufro Zlieri mJangavia, vidre wyalbad-ioni ( $H^+$ anu hidroqsoniumis ( $H_3O$ )+ ioni).

narevs, romelic Sedgeba 1 moculoba azotmJavas da 3 moculoba koncentrirebuli marilmJavasagan samefo wyali ewodeba (cnobilia Tezafis saxelwodebiTac), radgan masSi ixsneba TviT ,,metalTa mefec" – oqro (aseve ixsneba platinac) $Au + HNO_3 + 3HCl = AuCl_3 + NO + 2H_2O$ (am ukanasknelis Zlieri JangviTi unari ganpirobebulia imiT, rom azotmJava Jangavs $HCl$ -s atomuri qloris gamoyofiT, romelic metad aqtiuria metalebTan reaqciaSi). $HCl$ -is siWarbis SemTxvevaSi miiReba kompleqsuri mJava ( $Au + HNO_3 + 4HCl = H[AuCl_4] + NO + 2H_2O$ ).

azotmJavas marilebs ( $NaNO_3$, $KNO_3$, $Ca(NO_3)_2$ ) nitratebi ewodeba.

azotmJava qimiuri mrewvelobis mniSvnelovani produqtia. didi raodenobiT gamoiyeneba azotovani sasuqebis, feTqebadi nivTierebebis, samkurnalo preparatebis, saRebrebis, xelovnuri boWkos, plastmasebisa da sxv. dasamzadeblad. iyeneben agreTve medicinaSi meWeWebis mosawvavad, cilebis raodenobiTi gansazRvrisaTvis klinikur laboratoriebSi. Tezafi ixmareba antimikrobul saSualebad.

**qvefosforovani mJava ( $H_3PO_2$ )** miiReba fosforovanmJavas da fosformJavas narevSi wyalbadis gatarebiT ( $H_3PO_3 + H_3PO_4 + 3H_2 = 2H_3PO_2 + 3H_2O$ ) an warmoiqmneba marilis saxiT _ fosforze tutis moqmedebiT ( $8P + 3Ba(OH)_2 + 6H_2O = 3Ba(H_2PO_2)_2 + 2PH_3$ ). igi erTfuZiani mJavaa, amitomac marilebis erT mwkrivs warmoqmnis ( $NaH_2PO_2$ da sxv.). bariumis marilis dakristalebis Semdeg masze moqmedeben gogirdmJavaTi. gamoleqili $BaSO_4$ -is mocilebis Semdeg xsnars aorTqleben Sesqelebamde. gacivebisas xsnaridan gamoiyofa qvefosforovanmJava ufero kristalebis saxiT – gamoyofis momentSi wyalbadi advilad aRadgens mJavas fosfinamde ( $PH_3$ ). TviT mJavac Zlieri aRmdgenia, Sesabamisi marilebidan leqavs vercxlsa da oqros da sxva metalebs, xolo Tavad fosformJavamde ( $H_3PO_4$ ) iJangeba ( $3H_3PO_2 + 4BiCl_3 + 6H_2O = 3H_3PO_4 + 4Bi + 12HCl$ ). aseTi reaqciebis meSveobiT SeiZleba metaliT daifaros aragamtari sagnebi – mina, keramika, plastmasa. am gziT SeiZleba aragamtaris zedapirze Seiqmnas metalis mkvrivi safari, bunebrvia, rom am meTodma didi praqtikuli gamoyeneba pova sxvadasxva miznisaTvis.

qvefosforovanmJava mJangavis Tvisebebsac avlens ( $H_3PO_2 + 2Zn + 2H_2SO_4 = 2ZnSO_4 + 2H_2O + PH_3$ ). igi wyalxsnarSi nela ixsneba, ris Sedegadac miiReba fosforovanmJava ( $H_3PO_3$ ), fosformJava ( $H_3PO_4$ ) da wyalbadi ( $H_2$ ): $2H_3PO_2 + 3H_2O = H_3PO_3 + H_3PO_4 + 3H_2$ .

**fosforovanmJava ( $H_3PO_3$ )** – warmoiqmneba fosfor(III)-is oqsidis ( $P_2O_3$ an misi dimeris - $P_4O_6$ ) wyalSi gaxsniT ( $P_2O_3 + 3H_2O = 2H_3PO_3$ an $P_4O_6 + 6H_2O = 4H_3PO_3$ ). igi ufero, wyalSi kargad xsnadi myari nivTierebaa. fosforovanmJava aris saSualo siZlieris orfuZiani mJava. masSi ( $H_3PO_3$ -Si) wyalbadis sami atomidan ori dakavSirebulia fosforis atomTan Jangbadis meSveobiT, mesame wyalbadi ki uSualod fosforTan da amitom mas ar aqvs metalis atomiT Canacvlebis unari.

fosforovanmJava, garda fosfor(III)-is oqsidis wyalSi gaxsnisa, miiReba $PCl_3$ -is hidroliziTac ( $PCl_3 + 3H_2O = H_3PO_3 + 3HCl$ ). mis marilebs fosfitebi ( $Na_2HPO_3$, $CaHPO_3$ ), xolo mJava marilebs ( $NaH_2PO_3$, $Ca(H_2PO_3)_2$, $NH_4H_2PO_3$ ) – hidrofosfitebi ewodeba.

**fosformJava anu orTofosformJava ( $H_3PO_4$ )** – miiReba fosfor(V)-is oqsidis energiuli urTierTqmedebiT wyalTan ( $P_2O_5 + 3H_2O = 2H_3PO_4$ ). igi ufero, gamWvirvale, rombuli kristalebia. advilad ganiTxeva haerze. wyals yovelgvari TanafardobiT ereva (gasayidi fosformJava sqeli siTxea, Seicavs 80-98% $H_3PO_4$ ). orTofosformJava saSualo siZlieris mJavaa. misi disociacia safexurebad mimdinareobs ( $H_3PO_4 \Leftrightarrow H^+ + H_2PO_4^{2-}$ $K_1 = 8{,}1 \cdot 10^{-3}$; $H_2PO_4^- \Leftrightarrow H^+ + HPO_4^{2-}$ $K_2 = 6{,}0 \cdot 10^{-8}$; $HPO_4^{2-} \Leftrightarrow H^+ + PO_4^{3-}$ $K_3 = 1{,}8 \cdot 10^{-12}$ ), saidanac Cans, rom pirvel safexurze disociaciis xarisxi ufro metia, vidre meoreze da kidev ufro meti – vidre mesameze.

laboratoriaSi fosformJava miiReba wiTel fosforze 30%-iani cxeli azotmJavas moqmedebiT ( $3P + 5HNO_3 + 2H_2O = 3H_3PO_4 + 5NO$ ). teqnikuri miznebisTvis fosformJava miiReba kalciumis fosfatze ganzavebuli gogirdmJavas moqmedebiT ( $Ca_3(PO_4)_2 + 3H_2SO_4 = 2H_3PO_4 + 3CaSO_4$ ).

fosformJava iZleva sami tipis marils – fosfatebs ( $Na_3PO_4$ , $Ca_3(PO_4)_2$ ), hidrofosfatebs ( $Na_2HPO_4$, $CaHPO_4$ ) da dihidrofosfatebs ( $NaH_2PO_4$, $Ca(H_2PO_4)_2$ ).

fosformJava xSirad gamoiyeneba gamagrilebeli wylebis dasamzadeblad, samRebro saqmeSi da sxv. fosfatebma didi gamoyeneba pova sasuqis, minanqrisa da mqrqali minis warmoebaSi.

**metafosformJava ($HPO_3$) da pirofosformJava ($H_4P_2O_7$).** metafosformJava miiReba fosfor(V)-is oqsidze mcire raodenobis civi wylis moqmedebiT ($P_2O_5 + H_2O = 2HPO_3$, metafosformJava); formula $HPO_3$ pirobiTia, sinamdvileSi igi arsebobs polimeruli formiT – $(HPO_3)n$ (sadac $n = 3-8$). metafosformJava myari, gamWvirvale, ufero nivTierebaa, kargad ixsneba wyalSi, Zlier toqsikuria. wyalTan duRilis dros an dayovnebisas ierTebs wyals da warmoqmnis orTofosformJavas ($HPO_3 + H_2O = H_3PO_4$). metafosformJavas marilebs metafosfatebi ewodeba ($NaPO_3$, $Ca(PO_3)_2$).

pirofosformJavas ($H_4P_2O_7$) miReba SeiZleba fosfor(V)-is oqsidze (daaxloebiT 2-jer) meti raodenobis wylis damatebiT, vidre metafosformJavas SemTxvevaSi, magaliTad, $P_2O_5 + 2H_2O = H_4P_2O_7$. misi miReba SeiZleba agreTve orTofosformJavas gacxelebisas (200ºC-mde): $2H_3PO_4 = H_4P_2O_7 + H_2O$. igi 4-fuZiani mJavaa, magram warmoqmnis marilTa or rigs – orCanacvlebuls ($K_2H_2P_4O_7$, $CaH_2P_4O_7$) da oTxCanacvlebuls ($K_4P_2O_7$, $Ca_2P_2O_7$). pirofosformJavas marilebs 2- da 4- Canacvlebuli pirofosfatebi ewodeba. mZime metalebis fosfatebs damaxasiaTebeli feri aqvT, amitom isini gamoiyeneba analizuri miznebisTvis. pirofosformJava toqsikuria.

**dariSxanovanmJava ($H_3AsO_3$) da dariSxanmJava ($H_3AsO_4$).** dariSxanovanmJava miiReba dariSxan(III)-is oqsidis wyalTan urTierTqmedebiT ($As_2O_3 + 3H_2O = 2H_3AsO_3$). igi disocirebs rogorc mJavad ($H_3AsO_3 \Leftrightarrow 3H^+ + AsO_3^{3-}$), ise fuZed ($H_3AsO_3 \equiv As(OH)_3 \Leftrightarrow \overset{3+}{A}s + 3OH^-$), magram masSi mainc Warbobs mJavuri Tvisebebi. $H_3AsO_3$-is amfoteroba mowmobs dariSxanis metaloiduri Tvisebebis Sesustebas (fosforTan SedarebiT). dariSxanovanmJava Tavisufal mdgomareobaSi miRebuli ar aris da cnobilia mxolod wyalxsnaris saxiT, sadac damyarebulia wonasworoba ($H_3AsO_3 \Leftrightarrow HAsO_2 + H_2O$), romelic mniSvnelovnad gadaadgilebulia marjvniv – metadariSxanovanmJavas ($HAsO_2$) warmoqmnis mimarTulebiT. rogorc mJava, dariSxanovanmJava Zalian sustia, rogorc fuZe – kidev ufro susti. dariSxanovanmJavas marilebi – arsenitebi warmoadgenen

hipotezuri orTodariSxovanmJavas ($H_3AsO_3$) anu dariSxovanmJavas nawarmebs ($As_2O_3 + 6KOH = 2K_3AsO_3 + 3H_2O$ - kaliumis orToarseniti anu kaliumis arseniti), xolo metadariSxanovanmJavas ($HAsO_2$) nawarmebi – metaarsenitebs ($As_2O_3 + 2NaOH = 2NaAsO_2 + H_2O$ - natriumis metaarseniti).

dariSxan(V)-is oqsidze (dariSxanis anhidridi) $As_2O_5$-ze wylis moqmedebiT miiReba dariSxanmJava ($As_2O_5 + 3H_2O = 2H_3AsO_4$). aseve dariSxanmJava warmoiqmneba dariSxanis an dariSxanovananhidridis mduRare azotmJavaTi daJangvisas ($3As + 5HNO_3 + 2H_2O = 3H_3AsO_4 + 5NO$, $3As_2O_3 + 4HNO_3 + 7H_2O = 6H_3AsO_4 + 4NO$). igi samfuZiani mJavaa, myari, wyalSi advilad xsnadi nivTiereba. warmoqmnis marilebs – arsenatebs ($Na_3AsO_4$, $Ca_3(AsO_4)_2$ da sxv.). mJava areSi dariSxanmJava Zlieri mJangavia ($2HI + H_3AsO_4 = H_3AsO_3 + H_2O + I_2$). am reaqciaze agebuli iyo misi gamoyeneba organuli saRebarebis misaRebad. garda amisa, dariSxanmJavam didi gamoyeneba pova samkurnalo preparatebis damzadebis saqmeSi.

cnobilia agreTve **metadariSxanmJava (**$HAsO_3$**)** da misi marilebi _ metaarsenatebi ($NaAsO_3$, $Ca(AsO_3)_2$ da sxv.).

**stibiumovanmJava (**$H_3SbO_3$ **anu stibiumorTohidroqsidi (**$Sb(OH)_3$**)** _ TiTqmis uxsnari, TeTri fifqisebri nivTierebaa. igi wyalSive kargavs wyals da warmoqmnis stibiumis metahidroqsids ($H_3SbO_3 \equiv Sb(OH)_3 \Leftrightarrow SbO(OH)$ an $HSbO_2) + H_2O$), romelsac disociaciis tipis mixedviT SeiZleba ewodos metastibiumovanmJava ($HSbO_2$). stibium(III)-is oqsidis tutiT damuSavebisas warmoiqmneba metastibiumovanmJavas marili _ stibiti ($Sb_2O_3 + 2KOH = 2KSbO_2 + H_2O$). stibiumovanmJava, rogorc amfoteruli eleqtroliti, ganicdis disociacias ($Sb^{3+} + 3OH^- \Leftrightarrow Sb(OH)_3 \equiv H_3SbO_3 \Leftrightarrow 3H^+ + SbO_3^{3-}$), romlis drosac mJavebis moqmedebiTYwonasworoba gadaixreba marcxniv, e.i. miiReba marilebi $Sb^{3+}$ kationiT, tuteebis moqmedebiT ki _ marjvniv, rac stibitebis, e.i. $SbO_3^{3-}$ an $SbO_2^-$ anionebis warmoqmnasTanaa dakavSirebuli.

**stibiummJava (**$H[Sb(OH)_6]$ anu $Sb_2O_5 \cdot nH_2O$**)** _ cnobilia mxolod xsnaris saxiT. erT SemTxvevaSi misi Sedgeniloba SeiZleba warmodgenil iqnes heqsahidroqsomJavas $H[Sb(OH)_6]$ formulis saxiT, xolo sxva SemTxvevaSi _ $Sb_2O_5 \cdot nH_2O$ SedgenilobiT. pirveli formulis mixedviT,

heqsahidroqsostibiummJava erTfuZian mJavas warmoadgens. wyalSi cudad ixsneba da advilad gadadis koloidur mdgomareobaSi. misi natriumis stibatis Sedgeniloba zustad upasuxebs $Na[Sb(OH)_6]$ formulas. praqtikuli mniSvneloba aqvs kaliumis heqsahidroqsostibiums $K[Sb(OH)_6]$, romelic $Na^+$ -is aRmosaCenad gamoiyeneba. monostibiummJavas marilis garda, cnobilia polimJavebis marilebi [tri- da tetrastibatebi]. meore formulis mixedviT, arsebobs stibiummJavas marilebi _ stibatebi (anTimonatebi), romlebic miiReba stibium(V)-is oqsidis tutesTan SednobiT ( $Sb_2O_5 + 6NaOH = 2Na_3SbO_4 + 3H_2O$ ). cnobilia, agreTve metastibatebi ( $NaSbO_3$, $KSbO_3$ ) da pirostibatebi ( $Na_4Sb_2O_7$, $K_4Sb_2O_7$ ). rentgenostruqturuli analiziT dadgenilia, rom zemoaRniSnuli marilebi polimerebia.

**bismutmJava ( $HBiO_3$ )** _ miiReba bismutis urTierTqmedebiT koncentrirebul azotmJavasTan ( $Bi + 5HNO_3 = HBiO_3 + 5NO_2 + 2H_2O$ ). bismutmJava Tavisufal mdgomareobaSi ar aris gamoyofili. bismutis hidroqsidis ( $Bi(OH)_3$ ) JangviT (qloriT, permanganatiT da sxv.) miiReba bismutmJavas ( $HBiO_3$ -is) marilebi _ bismutatebi: $NaBiO_3$ _ yviTeli feris natriumis metamarili, $KBiO_3$ _ mowiTalo iisferi, orTobismutmJavas yavisferi marili _ $Na_3BiO_4$. es ukanaskneli advilad miiReba bismutis oqsidisa da natriumis peroqsidis SelRobiT an masze qloris moqmedebiT:

$2Bi_2O_3 + 6Na_2O_2 = 4Na_3BiO_4 + O_2$ an $Bi(OH)_3 + NaOH + Cl_2 = NaBiO_3 + 2HCl + H_2O$.

bismutatebi Zlieri mJangavebia:

$$2MnCl_2 + 5KBiO_3 + 16HCl = 2HMnO_4 + 5BiCl_3 + 5KCl + 7H_2O$$ .

bismutis naerTebi gamoiyeneba didi Suqtexis koeficientis optikuri minebisa da feradi Wiqurebis warmoebaSi. maT aseve iyeneben samedicino preparatebis dasamzadeblad.

**naxSirmJava ( $H_2CO_3$ )** _ miiReba naxSirbad(IV)-is oqsidis (dioqsidis, $CO_2$ ) wyalSi gaxsniT ( $CO_2 + H_2O \Leftrightarrow H_2CO_3$ ); igi sufTa saxiT ar miiReba da arsebobs mxolod wyalxsnaris saxiT. Cveulebriv pirobebSi wonasworoba Zlier aris gadaxrili marcxniv (gaxsnili $CO_2$ -is mxolod 1% warmoqmnis mJavas). oqsidis ZiriTadi nawili polihidratis ( $CO_2 \cdot nH_2O$ ) saxiTaa. naxSirmJava saSualo siZlieris mJava unda iyos, magram, radgan misi ( $H_2CO_3$ -is) Semcveloba

Zalian mcirea, amitom igi susti mJavaa (miuxedavad amisa, lakmus Seferavs wiTlad).

naxSirmJava orfuZiani mJavaa da disocirdeba safexurebad: 1) $H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$ ($K_1 = 4{,}01 \cdot 10^{-7}$); 2) $HCO_3^- \Leftrightarrow H^+ + CO_3^{2-}$ ($K_2 = 5{,}2 \cdot 10^{-11}$). disociacia pirvel safexurzec ki umniSvneloa, xolo meore safexuri mxolod Zlieri ganzavebisas xorcieldeba. xsnaris gaTbobisas gamoiyofa $CO_2$ (misi xsnadobis Semcirebis gamo) da wonasworoba ise dairRveva, rom zemoT aRwerili procesebi Sebrundeba. amitomac gaTbobisas naxSirmJava daiSleba $CO_2$-ad da $H_2O$-od. Sejamebuli procesi gamoisaxeba gantolebiT: $CO_2 + H_2O \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^- \Leftrightarrow 2H^+ + CO_3^{2-}$ (gaTbobisas procesi marjvnidan marcxniv warimarTeba). naxSirmJava warmoqmnis ori rigis marilebs _ saSualo marilebs _ karbonatebs ($H_2CO_3 + 2NaOH = Na_2CO_3 + 2H_2O$, $H_2CO_3 + Ca(OH)_2 = CaCO_3 + 2H_2O$) da mJava marilebs _ hidrokarbonatebs ($H_2CO_3 + KOH = KHCO_3 + H_2O$, $H_2CO_3 + NH_4OH = NH_4HCO_3 + H_2O$ da sxv.).

aRsaniSnavia, rom naxSirmJavas ($H_2CO_3$) formis garda, romelsac metanaxSirmJava ewodeba, cnobilia orTonaxSirmJava ($H_4CO_4$) organuli nawarmebis saxiT. es mJava arc Tavisufali mJavas da arc marilebis saxiT ar aris cnobili.

naxSirmJavas nawarmebidan yvelaze gavrcelebuli da gamoyenebadia kalciumis karbonati ($CaCO_3$), romelic carcis, kirqvisa da marmarilos ZiriTadi Semadgeneli nawilia. didi sameurneo mniSvneloba aqvs natriumis karbonats, romelic cnobilia sodis ($Na_2CO_3$) saxelwodebiT da iyeneben sapnis, minis warmoebaSi, yofacxovrebaSi _ sarecx saSualebad, wylis sixistis asacileblad. natriumis hidrokarbonati ($NaHCO_3$), romlis teqnikuri saxelwodebaa sasmeli soda _ gamoiyeneba medicinaSi Sinagan saSualebad kuWis wvis dros, rac kuWis wvenSi mJavas siWarbiTaa gamowveuli. sasmel sodas, rogorc $CO_2$-is wyaros, iyeneben sakonditro saqmeSi, puris cxobisas da cecxlsaqrobebSi. kaliumis karbonati ($K_2CO_3$) gamoiyeneba qimiuri minis, Txevadi sapnis warmoebaSi, fotografiasa da soflis meurneobaSi (sasuqad).

**siliciummJava ($H_2SiO_3$, metasiliciummJava)** _ miiReba arapirdapiri gziT _ misi marilis xsnarze mJavas moqmedebiT (

$Na_2SiO_3 + 2HCl = H_2SiO_3 \downarrow + 2NaCl$ ). mJavas da marilis koncentraciaze damokidebulebiT siliciummJava gamoiyofa labisebri masis an koloiduri xsnaris saxiT. igi upasuxebs ara marto ( $H_2SiO_3$ ) formulas, aramed _ saerTo formulas $xSiO_2 \cdot yH_2O$ , sadac $x$ da $y$ -is mniSvnelobebi damokidebulia siliciummJavas gamoleqvis pirobebze, roca $x = 1$ iqneba siliciummJava, Tu $x > 1$ _ polisiliciummJavebi. mTlianobaSi, $SiO_3^{2-}$ anionebis Semcvel naerTebs metasilikatebi ewodeba, xolo $SiO_4^{4-}$ anionebis Semcvels _ orTosilikatebi.

siliciummJava Zlier susti da aramdgradi mJavaa; misi disociaciis mudmiva mcirea, metad mcirea misi xsnadobac wyalSi. amitomac silikatebis xsnarebidan wyalbad-ionTa umniSvnelo koncentracia ukve sakmarisi xdeba mis gamosaleqavad. amiT aixsneba, rom Zlier susti mJavebic ki ganapirobebs siliciummJavas gamoZevebas silikatebidan.

**orTosiliciummJava (** $H_4SiO_4$ **)** warmoiqmneba $SiCl_4$ hidrolizis Sedegad ( $SiCl_4 + 4H_2O = H_4SiO_4 + 4HCl$ ). orTosiliciummJava kargavs erT molekula wyals da miiReba metasiliciummJava ( $H_4SiO_4 = H_2SiO_3 + H_2O$ ), xolo Semdgomis gaxurebiT TandaTanobiT iSleba siliciumis dioqsidad ( $SiO_2$ ) da ( $H_2O$ ) wylad ( $H_2SiO_3 = SiO_2 + H_2O$ ).

siliciummJavasgan wylis warTmeviT miiReba naxevrad gamWvirvale, amorfuli masa, romelic didi forianobiT xasiaTdeba. mas silikageli ewodeba. igi kargi adsorbentia da tenis mSTamnTqmelad gamoiyeneba. siliciummJavas natriumisa da kaliumis silikatebs xsnadi minebi ewodeba, xolo maT koncentrirebul xsnarebs _ Txevadi mina. igi Sedis cecxlgamZle sagozavis SedgenilobaSi, romelic gamoiyeneba minis, faifuris da qvis nakeTobebis Sesawebeblad. xsnadi miniT gaJRenTili qsovilebi da xis masalebi cecxlmedegia. silikatebi da aluminsilikatebi (siliciummJavas marilebi) ZiriTadi nedleulia minis, faifuris, qaSanuris, cementis, betonis, agurisa da sxva nakeTobebis warmoebaSi.

**bormJava (** $H_3BO_3$ **)** _ miiReba bor(III)-is oqsidis (anhidridis) wyalSi gaxsniT ( $B_2O_3 + 3H_2O = 2H_3BO_3$ ). bormJavas miReba SeiZleba agreTve borze koncentrirebuli gogirdmJavas an azotmJavas moqmedebiT ( $2B + 3H_2SO_4 = 2H_3BO_3 + 3SO_2$ ; $B + 3HNO_3 = H_3BO_3 + 3NO_2$ ). igi TeTri, qerclisebri, gamWvirvale eqvskuTxa kristalebia. bormJava aris susti, erTfuZiani mJava. yvela misi xsnadi marili Zlier hidrolizdeba fuZe ares warmoqmniT. gaxurebiT

bormJava kargavs wyals da gardaiqmneba metabormJavad ($HBO_2$) ($H_3BO_3 = HBO_2 + H_2O$), xolo Semdgomi gaxurebiT tetrabormJavad ($4HBO_2 = H_2B_4O_7 + H_2O$).

metabormJavas ($HBO_2$) marilebs ($NaBO_2$, $KBO_2$ da sxv.) metaboratebi ewodeba, xolo tetrabormJavas ($H_2B_4O_7$) marilebs ($Na_2B_4O_7$, $Ca_2B_4O_7$ da sxv.) tetraboratebi. orTobormJavas ($H_3BO_3$) tipis marilebi _ orToboratebi ar aris miRebuli, radgan igi imdenad susti mJavaa, rom misi marilebi srul hidrolizs ganicdian. meta- da tetraboratebis hidrolizis xarisxi ki ufro mcirea.

bormJavas ganeitralebis Sedegad warmoiqmneba metaboratebi ($H_3BO_3 + NaOH = NaBO_2 + 2H_2O$ da sxv.) da tetraboratebi ($4H_3BO_3 + 2NaOH = Na_2B_4O_7 + 7H_2O$). bormJava kargad ixsneba cxel wyalSi, amitom cxeli xsnaris gacivebiT misi gamokristaleba advilia. bormJava kargad ixsneba agreTve spirtebsa da glicerinSi.

bormJavas Seicavs zogierTi mineraluri wyali, xili, mcenareTa foTlebi da sxv. bormJava didi raodenobiT xmardeba boraqsis momzadebas. mas iyeneben agreTve sxvadasxva saxis minanqris misaRebad. radgan bormJava kargi sadezinfeqcio saSualebaa, amitom igi didi xania gamoiyeneba medicinaSi. igi aseve ixmareba rogorc makonservebeli preparati. aseve gamoiyeneba tyavis Trimvlisa da mineraluri saRebavebis dasamzadeblad. boris mJavas ZiriTadi momxmarebelia Wiquris, optikuri da feradi minis nakeTobaTa warmoebebi.

**manganummJava (**$HMnO_4$**)** _ miiReba manganum(II)-is sulfatis Jangvis dros tyviis dioqsidisa da azotmJavas erTdrouli moqmedebiT (krumis reaqcia, $2MnSO_4 + 5PbO_2 + 6HNO_3 = 2HMnO_4 + 2PbSO_4 + 3Pb(NO_3)_2 + 2H_2O$). es reaqcia gamoiyeneba manganumis aRmosaCenad da ara manganummJavas ($HMnO_4$ -is) misaRebad. praqtikulad manganummJava miiReba Semdegi reaqciebis meSveobiT ($Ba(MnO_4)_2 + H_2SO_4 = 2HMnO_4 + BaSO_4\downarrow$; $Mn_2O_7 + H_2O = 2HMnO_4$). manganummJavas koncentraciis gazrda wyalSi SeiZleba 20%-mde. ufro koncentrirebul xsnarebSi manganummJava iSleba ($4HMnO_4 = 4MnO_2 + 3O_2 + 2H_2O$) manganumis dioqsidad ($MnO_2$), Jangbadad ($O_2$) da wylad ($H_2O$). manganummJava erTfuZiani, Zlieri mJavaa, Tavisi siZlieriT igi $HCl$ -isa da $HNO_3$ -is Sesadaria.

manganummJava, rogorc Zlieri mJangavi farTod gamoiyeneba teqnkasa da laboratoriul praqtikaSi, ixmareba rogorc gamauferulebeli minis warmoebaSi, iyeneben katalizatorad da depolarizatorad galvanur elementebSi. aseve ixmareba samedicino praqtikaSi.

**qrommJava (** $H_2CrO_4$ **) da orqrommJava (** $H_2Cr_2O_7$ **)** _ orive mJava miiReba mJavuri oqsidis _ qrom(VI)-is oqsidis wyalSi gaxsniT ( $CrO_3 + H_2O = H_2CrO_4$ , $2CrO_3 + H_2O = H_2Cr_2O_7$ ) da mxolod wyalxsnaris saxiT arseboben (Tavisufal mdgomareobaSi gamoyofis mcdelobis procesSi iSlebian qromis anhidridad ( $CrO_3$ ) da ( $H_2O$ -d). qrommJavas marilebs ( $Na_2CrO_4$ , $CaCrO_4$ da sxv.) qromatebi, xolo orqrommJavas marilebs ( $K_2Cr_2O_7$ , $MgCr_2O_7$ da sxv.) diqromatebi ewodeba. qromatebs da maT wyalxsnarebs yviTeli Seferiloba aqvs, xolo diqromatebs da maT wyalxsnarebs _ narinjisferwiTeli. qromat-ionis ( $CrO_4^{2-}$ ) aRmomCenia bariumis ( $Ba^{2+}$ ) ioni ( $Ba^{2+} + CrO_4^{2-} = BaCrO_4$ ). qromatebi mJava areSi gardaiqmnebian diqromatebad ( $2Na_2CrO_4 + H_2SO_4 = Na_2Cr_2O_7 + Na_2SO_4 + H_2O$ ), xolo diqromatebi tute areSi _ qromatebad ( $Na_2Cr_2O_7 + 2NaOH = 2Na_2CrO_4 + H_2O$ ). maSasadame, xsnarSi am mJavebis ionTa Soris arsebobs wonasworoba _ mJava areSi ( $2CrO_4^{2-} + 2H^+ \Leftrightarrow Cr_2O_7^{2-} + H_2O$ , yviTeli feris xsnari gaxdeba narinjisferi), xolo tute areSi ( $Cr_2O_7^{2-} + 2OH^- \Leftrightarrow 2CrO_4 + H_2O$ , narinjisferi xsnari _ yviTeli).

## 2.4. fuZe

### 2.4.1. fuZeTa klasifikacia

fuZeTa klasifikacia SeiZleba Semdegi Tvisebebis mixedviT:

**1. fuZis mJavuroba** - $OH^-$ jgufebis ricxvi, romlebsac mJavas naSTze mimocvlis unari aqvs. magaliTad, $NaOH$ - erTmJavuri fuZe, $Ca(OH)_2$ - ormJavuri fuZe, $Fe(OH)_3$ - sammJavuri fuZe da a.S. am niSnis mixedviT fuZeebi SeiZleba iyos erT-, or-, sam- da a.S. mJavuri.

mravalmJavuri fuZe disocirdeba safexurebad da SeiZleba warmoiqmnas marilTa ramdenime mwkrivi, magaliTad, $(CaOH)_2CO_3$ - kalciumis hidroqsokarbonati; $CaCO_3$ - kalciumis karbonati.

**2. xsnadoba** – tute metalTa hidroqsidebi, meore jgufis mTavari jgufis metalebi, dawyebuli kalciumidan da damTavrebuli radiumiT, agreTve Talium(I)-is $[TlOH]$ da amoniumis hidroqsidebi $[NH_4OH]$ xsnadia wyalSi. sxva metalebis hidroqsidebi praqtikulad wyalSi uxsnaria.

**3. fuZis siZliere,** iseve rogorc sxva eleqtrolitebisa, ganisazRvreba disociaciis xarisxiT (an disociaciis mudmivaTi). Zlieri fuZeebia tute da tutemiwaTa metalebis hidrosidebi, Zlier, wyalSi xsnad fuZes tute ewodeba.

**4. fuZis Termuli mdgradoba.** gaxurebisas mravali fuZe iSleba metalis oqsidad da wylad. mdgradia tute metalTa hidroqsidebi, natriumidan dawyebuli, yvela maTgani dneba daSlis gareSe. liTiumis, stronciumis, bariumisa da radiumis hidroqsidebi iSleba dnobis temperaturaze ramdenadme ufro maRal temperaturaze. danarCeni metalebis hidroqsidebi iSleba dnobamde.

**5. mJavasa da tutesTan urTierTqmedebis mixedviT** metalTa hidroqsidebi SeiZleba daiyos fuZe da amfoterul hidroqsidebad. fuZe hidroqsidebs miekuTvneba hidroqsidi, romelic ixsneba mxolod mJavaSi da ar reagirebs tutesTan, xolo amfoteruls – hidroqsidi, romelic ixsneba rogorc mJavaSi, ise tuteSi.

fuZeebia tute da tutemiwaTa metalebis hidroqsidebi, agreTve magniumis hidroqsidi da dabali Jangvis xarisxis mqone gardamavali metalebis hidroqsidebi, magaliTad, $Cr(OH)_2$, $Mn(OH)_2$ da sxv.

amfoterulia hidroqsidebi $Be(OH)_2$, $Zn(OH)_2$, $Al(OH)_3$, $Sn(OH)_2$, agreTve Sualeduri Jangvis xarisxis mqone gardamavali metalebis hidroqsidebi, magaliTad, $Cr(OH)_3$, $Fe(OH)_3$ da sxv.

### 2.4.2. fuZis miRebis xerxebi

fuZis miRebis ramdenime xerxi arsebobs:

1. tute- da tutemiwa metalebis wyalTan urTierTqmedeba

$$2Li + 2H_2O = 2LiOH + H_2\uparrow,$$

$$Sr + 2H_2O = Sr(OH)_2 + H_2 \uparrow .$$

amave meTodiT SeiZleba amoniumis hidroqsidis miReba

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

wina magaliTebisagan gansxvavebiT es reaqcia mimdinareobs Jangvis xarisxis cvlilebis gareSe.

wyalTan reagireba yvela im metalsac SeuZlia, romelic eleqtronul potencialTa mwkrivSi wyalbadamde dgas, magram es reaqciebi warimarTeba maRal temperaturaze da Seqcevadia. am dros warmoiqmneba metalTa ara hidroqsidebi, aramed oqsidebi, radgan hidroqsidebi am temperaturaze Termulad aramdgradia. magaliTad,

$$Fe + H_2O \leftrightarrow FeO + H_2 \uparrow \quad (t > 570^\circ C \text{ dros }) .$$

2. tute- da tutemiwa metalebis oqsidebis da peroqsidebis wyalSi gaxsna:

$$CaO + H_2O = Ca(OH)_2 ,$$

$$Na_2O_2 + 2H_2O = 2NaOH + H_2O_2 .$$

sxva metalTa oqsidebi ar urTierTqmedebs wyalTan.

3. bolomde mimdinare marilTa hidrolizi:

$$Al_2S_3 + 6H_2O = 2Al(OH)_3 \downarrow + 3H_2S \uparrow$$

4. urTierTmaZlierebeli hidrolizis unaris mqone marilTa wyalxsnarebis Sereva:

$$2AlCl_3 + 3Na_2CO_3 + 3H_2O = 2Al(OH)_3 \downarrow + 6NaCl + 3CO_2 \uparrow .$$

5. metal-arametalis (metaloidis) zogierTi binaruli naerTis (hidridebi, nitridebi, fosfidebi da sxv.) wyliT daSla. magaliTad:

$$Li_3N + 3H_2O = 3LiOH + NH_3 \uparrow ,$$

$$NaH + H_2O = NaOH + H_2 \uparrow ,$$

$$Ca_3P_2 + 6H_2O = 3Ca(OH)_2 + 2PH_3 \uparrow ,$$

$$Mg_2Si + 4H_2O = 2Mg(OH)_2 \downarrow + SiH_4 \uparrow .$$

6. tute- da tutemiwa metalebis wyalxsnarebis eleqtrolizi:

$$2NaCl + 2H_2O \overset{\text{eleqtroliz i}}{\underset{\text{diafragma}}{=}} 2NaOH + Cl_2 \uparrow + H_2 \uparrow .$$

am meTodiT hidroqsidebis misaRebad aucilebelia kaToduri da anoduri sivrceebis gamoyofa, sxva SemTxvevaSi xdeba qloris urTierTqmedeba tutesTan sxva produqtebis warmoqmniT:

7. susti, wyalSi uxsnari fuZeebis miRebis mniSvnelovani meTodia marilTa xsnarebidan maTi gamoleqva tuteebiT an amiakis xsnariT:

$$MgSO_4 + 2KOH = Mg(OH)_2 \downarrow + K_2SO_4$$

$$AlCl_3 + 3NH_4OH = Al(OH)_3 \downarrow + 3NH_4Cl$$ .

tutiT amfoteruli hidroqsidis daleqvis dros sruli gamoleqvis miRweva SeiZleba mxolod marilisa da tutis mkacrad ekvimoluri raodenobebis SereviT. amitom amfoteruli hidroqsidebis dasaleqad gamoiyeneba amiakis wyalxsnari. amiakiT ar SeiZleba im metalis hidroqsidis daleqva, romelic masTan warmoqmnis kompleqsur kations.

aseTi xerxiT amoniumis hidroqsidis miReba ar SeiZleba, radgan $OH^-$ anionebis koncentraciis zrda iwvevs amiakis wyalSi xsnadobis Semcirebas da mis gamoyofas xsnaridan airis saxiT:

$$NH_4Cl + NaOH = NH_3 \uparrow + H_2O + NaCl$$ .

am xerxis gamoyeneba SeiZleba wyalSi xsnadi fuZeebis misaRebadac:

$Ca(OH)_2 + Na_2CO_3 \leftrightarrow 2NaOH + CaCO_3 \downarrow$ (sodis kaustizacia).

wonasworobis gadanacvleba $NaOH$-is warmoqmnis mxares miiRweva $CaCO_3$-is warmoqmnis xarjze, romelic nakleb xsnadia, vidre $Ca(OH)_2$.

tute metalis hidroqsidis warmoqmnis mxares wonasworobis mniSvnelovani wanacvlebisaTvis gamoiyeneba bariumis hidroqsidi da Sesabamisi tute metalis sulfati:

$$Ba(OH)_2 + Cs_2SO_4 = BaSO_4 \downarrow + 2CsOH$$ .

### 2.4.3. fuZis fizikuri Tvisebebi

fuZe ionuri kristaluri struqturis nivTierebaa. maTi umetesoba Seferilia, magaliTad, $NaOH, KOH, Ca(OH)_2, Ba(OH)_2$, $Fe(OH)_2$ - TeTria, $Cu(OH)_2$ - cisferi, $Fe(OH)_3$ - mura wiTeli, $Co(OH)_2$ - vardisferi, $Ni(OH)_2$ da $Cr(OH)_3$ - mwvane, $Cr(OH)_2$ - moyviTalo-yavisferi da a.S.

Sexebisas tutisaTvis damaxasiaTebelia sapnisebri SegrZneba, indikatoris feris cvlileba – lakmusis iisferi xsnaris galurjeba, fenolfTaleinis ufero xsnaris Jolosfrad Seferva, meTilnarinjis xsnaris gayviTleba.

### 2.4.4. fuZis qimiuri Tvisebebi

fuZe urTierTqmedebs:

1. mJavasTan (a), mJavur (b) da amfoterul (g) oqsidebTan:

a) $NaOH + HCl = H_2O + NaCl$ ,

$Cu(OH)_2 + H_2SO_4 = 2H_2O + CuSO_4$ .

b) $2NaOH + SiO_2 \overset{t}{=} Na_2SiO_3 + H_2O$ ,

$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$ .

g) $Al_2O_3 + 2NaOH \overset{t}{=} 2NaAlO_2 + H_2O$ ,

$2NaOH + ZnO + H_2O = Na_2[Zu(OH)_4]$ .

2. marilebTan (wyalSi xsnadi fuZeebisTvis):

$$2NaOH + FeCl_2 = Fe(OH)_2 \downarrow + 2NaCl$$

$$Ca(OH)_2 + Mg(NO_3)_2 = Mg(OH)_2 \downarrow + Ca(NO_3)_2.$$

3. zogierT arametalTan (aseT SemTxvevaSi, rogorc wesi, mimdinareobs disproporcionirebis reaqciebi):

$$6NaOH + 3Cl_2 = 5NaCl + NaClO_3 + 3H_2O ,$$

$$6NaOH + 3S \overset{t}{=} 2Na_2S + Na_2SO_3 + 3H_2O ,$$

$$3KOH + 4P + 3H_2O \overset{t}{=} PH_3 \uparrow + 3KH_2PO_2.$$

tuteebis xsnarebTan siliciumis urTierTqmedeba unda warimarTos fosforis reaqciis msgavsad tuteSi, magram am dros warmoqmnili silani ($SiH_4$) urTierTqmedebs wyalTan wyalbadisa da siliciumis mJavas gamoyofiT, romelic ixsneba tuteSi:

$$2NaOH + Si + H_2O = Na_2SiO_3 + 2H_2 \uparrow .$$

4. zogierT metalTan, romelTa hidroqsidebi amfoterulia:

$$2NaOH + Zn + 2H_2O = Na_2[ZnOH)_4] + H_2 \uparrow$$

$$2NaOH + 2Al + 10H_2O = 2Na[Al(OH)_4(H_2O)_2] + 3H_2 \uparrow .$$

5. sxvadasxva nivTierebasTan da warmoiqmneba kompleqsuri naerTebi:

a) kationuri tipis: $Cu(OH)_2 + 4NH_4OH = [Cu(NH_3)_4](OH)_2 + 4H_2O.$

b) anionuri tipis: $Cu(OH)_2 + 4HCN = H_2[Cu(CN)_4] + 2H_2O.$

## 2.5. meti rom vicodeT fuZeTa Sesaxeb

fuZeTa (tuteTa) molekulebi, rogorc zemoT aRiniSna, Sedgeba metalTa atomebisa (gamonaklisia amoniumis tute, romelic Seicavs amoniumis $NH_4^+$-ions) da maTTan SeerTebuli hidroqsilis _ $OH^+$ erTi an ramdenime jgufisagan. metalTa Jangvis ricxvi gansazRvravs hidroqsilis jgufTa raodenobas. Tavis mxriv, hidroqsil-ionTa raodenoba gansazRvravs fuZeTa mJavurobas, e.i. fuZis unars gaaneitralos erTi molekula erTfuZiani mJava. Tu fuZis molekula Seicavs erT hidroqsil-ions ($OH^-$), fuZes ewodeba erTmJavuri, magaliTad, $NaOH$, $KOH$; or hidroqsil-ionis Semcvels _ ormJavuri, magaliTad, $Ca(OH)_2$, $Sr(OH)_2$ da a.S.

fuZis saxelwodeba warmoiqmneba metalisa da hidroqsilis saxelwodebisagan, magaliTad, $KOH$ _ kaliumis hidroqsidi, $Ca(OH)_2$ _ kalciumis hidroqsidi. Tu metali warmoqmnis ramdenime fuZes, maSin saxelwodebaSi miuTiTeben metalis Jangvis ricxvs: $Fe(OH)_2$ _ rkina(II)-is hidroqsidi, $Fe(OH)_3$ _ rkina(III)-is hidroqsidi. am saxelwodebis garda, zogierTi fuZisTvis gamoiyeneba sxva saxelwodebac: $NaOH$ _ mwvave natri, $KOH$ _ mwvave kali, $Ca(OH)_2$ _ Camqrali kiri.

wyalSi xsnadobis mixedviT fuZeebi iyofa or jgufad: erTs, fuZeTa mcire jgufs, romlebic ixsneba wyalSi ($NaOH$, $KOH$, $Ca(OH)_2$ da sxv.) tuteebi ewodeba _ maT miekuTvneba tute da tutemiwaTa metalebis fuZeebi magniumisa da beriliumis garda, xolo meores, fuZeTa mravalricxovan jgufs, romlebic ar ixsneba wyalSi ($Cu(OH)_2$, $Mg(OH)_2$, $Fe(OH)_2$ da sxv.) ewodeba uxsnari fuZeebi.

tute _ wyalSi xsnadi, TeTri feris, myari nivTierebebaa (gamonaklisia $NH_4OH$, romelic amiakis wyalxsnars $NH_3 \cdot H_2O$-s warmoadgens). isini ionuri kristaluri struqturis mqone naerTebia. xasiaTdeba zogierTi saerTo TvisebiT, romlebic yvelaze mkafiod vlindeba mwvave natriumsa da kaliumSi. tuteTa wyalxsnarebi erTnairad ucvlian fers indikatorebs: iisfer lakmuss _ lurjad, xolo ufero fenolfTaleins _ Jolosfrad. mwvave tuteebi ($NaOH$, $KOH$) ewodeba imis gamo, rom isini Zlier azianeben cocxali organizmebis kansa da qsovilebs.

eleqtrolituri disociaciis Teoriis Tanaxmad _ tuteebi eleqtrolitebia, romelTa disociaciis Sedegad anionebis saxiT mxolod hidroqsid-ionebi warmoiqmneba. tuteebi Zlieri eleqtrolitebia da maTi disociacia erT safexurad mimdinareobs: $KOH \rightarrow K^+ + OH^-$, $Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$. gamonaklisia

amoniumis tute, romelic sust eleqtrolitebs miekuTvneba ( $NH_3 \cdot H_2O \Leftrightarrow NH_4^+ + OH^-$ ).

**liTiumis hidroqsidi ( $LiOH$ _ tute)**, danarCeni tute metalebisagan gansxvavebiT miiReba, metaluri liTiumis mier wylis neli daSliT, Sesabamisi hidroqsidisa da wyalbadis gamoyofiT ( $2Li + 2H_2O = 2LiOH + H_2$ ). liTiumis hidroqsidi aseve miiReba wylis energiuli moqmedebiT Sesabamis hidridze ( $LiH + H_2O = LiOH + H_2$ ) da oqsidze ( $Li_2O + H_2O = 2LiOH$ ) agreTve Sesabamis marilze metalTa hidroqsidebis urTierTqmedebiT ( $Li_2SO_4 + Ba(OH)_2 = 2LiOH + BaSO_4$ ).

liTiumis hidroqsidi TeTri, kristaluri nivTierebaa, romelic xasiaTdeba ufro dabali xsnadobiT, vidre danarCeni tute metalebis hidroqsidebi ( $NaOH$ , $KOH$ da sxv.). gaxurebiT ( $500^\circ C$ ) liTiumis hidroqsidi iSleba Sesabamis oqsidad da wylad ( $2LiOH = Li_2O + H_2O$ ). liTiumis wyalxsnarebidan SeiZleba gamoiyos Sesabamisi kristalhidratebi ( $LiOH \cdot 2H_2O$ da $LiOH \cdot 3H_2O$ ).

liTiumis hidroqsidi gamoiyeneba, rogorc eleqtroliti didi tevadobis akumulatorebSi, romelic 2-3-jer axangrZlivebs tute akumulatorebis muSaobis xangrZlivobas.

**natriumisa ( $NaOH$ , tute, mwvave natri, kaustikuri soda) da kaliumis ( $KOH$ , tute, mwvave kali) hidroqsidebi** TeTri, kristaluri, Zlier higroskopuli nivTierebebia, romlebic miiReba metaluri natriumisa da kaliumis aqtiuri urTierTqmedebiT wyalTan ( $2Na + 2H_2O = 2NaOH + H_2$ , $2K + 2H_2O = 2KOH + H_2$ ). maTi miReba SeiZleba agreTve Sesabamisi oqsidebis wyalSi gaxsniT ( $Na_2O + H_2O = 2NaOH$ , $K_2O + H_2O = 2KOH$ ) da aramdgradi natriumisa da kaliumis hidridebis wyalTan urTierTqmedebiT ( $NaH + H_2O = NaOH + H_2$ , $KH + H_2O = KOH + H_2$ ). am reaqciebs praqtikuli mniSvneloba ar aqvs da iSviaTad iyeneben sufTa hidroqsidebis misaRebad.

natriumisa da kaliumis hidroqsidebis samrewvelo miRebis ZiriTadi meTodia maTi qloridebis wyalxsnarTa eleqtrolizi:

( $2NaCl + 2H_2O \xrightarrow{\text{eleqtroliz i}} 2NaOH + H_2 + Cl_2$ ; $2KCl + 2H_2O \xrightarrow{\text{eleqtroliz i}} 2KOH + H_2 + Cl_2$ ).

kaustifikaciis reaqcia _ sodis xsnaris Camqral kirTan duReba $Na_2CO_3 + Ca(OH)_2 = 2NaOH + CaCO_{3\downarrow}$ (amitom uwodeben natriumis tutes kaustikur sodas teqnikaSi) $NaOH$ -is miRebis Zveli meTodia. xsnaris

aorTqlebisas miiReba myari $NaOH$. am meTods amJamad naklebad iyeneben.

natriumisa da kaliumis tuteebi dneba SedarebiT dabal temperaturaze (318 da $360^\circ C$ Sesabamisad). gavarvarebisas ($\sim 1400^\circ C$) duRs da aqroldeba daSlis gareSe. wyalSi kargad ixsnebian, didi raodenobis siTbos gamoyofiT _ hidratebis warmoqmnis gamo.

natriumis hidroqsidi ZiriTadi qimiuri mrewvelobis erT-erTi mniSvnelovani produqtia. didi raodenobiT ixmareba navTobproduqtebis gasawmendad, sapnis, qaRaldis, tyavis, agreTve farmacevtul mrewvelobaSi, qimiuri boWkos misaRebad da sxv. kaliumis hidroqsids iyeneben sapnis, Sampunebis warmoebaSi. $KOH$ -is ufro farTod gamoyeneba siZviris gamo SezRudulia.

**amoniumis hidroqsidi ($NH_4OH$, amoniumis fuZe, tute, amiakis wyalxsnari)** miiReba amiakis wyalTan urTierTqmedebiT, am dros warmoiqmneba ara mxolod amiakis hidrati, aramed nawilobriv amoniumisa ($NH_4^+$) da hidroqsilis ($OH^-$) ionebic ($NH_3 + H_2O \Leftrightarrow NH_3 \cdot H_2O \Leftrightarrow NH_4^+ + OH^-$). amiakis wyalxsnarSi arsebuli $OH^-$ ionebi ganapirobebs xsnaris tute reaqcias _ iisferi lakmusi lurj, xolo fenolfTaleini Jolosfer Seferilobas iRebs.

amoniumis hidroqsidi (amiakis wyalxsnari) gamoiyeneba sayofacxovrebo qimiaSi saojaxo daniSnulebis sagnebis gasasufTaveblad, sarecx da laqebis amomyvan saSualebebad. amiakis 9,5-10%-iani xsnari, niSaduris spirtis saxelwodebiT, gamoiyeneba medicinaSi. amiakis wyalxsnaris mJavebiT ganeitralebas iyeneben amoniumis axali marilebis misaRebad da sxv.

**beriliumis hidroqsidi ($Be(OH)_2$)** miiReba mis romelime marilze tuteebis moqmedebiT ($BeCl_2 + 2NaOH = Be(OH)_2 + 2NaCl$). igi polimeruli naerTia, wyalSi ar ixsneba. Tavis qvejgufSi $Be(OH)_2$ erTaderTi fuZea, romelic amfoterul Tvisebebs iCens. beriliumis hidroqsidi labis msgavsi TeTri feris nivTierebaa, advilad ixsneba mJavebisa ($Be(OH)_2 + 2HNO_3 = Be(NO_3)_2 + 2H_2O$) da tuteebis ($Be(OH)_2 + 2NaOH = Na_2[Be(OH)_4]$ nalRobsa an wyalxsnarSi gacxelebisas, xolo oTaxis temperaturaze wyalxsnarSi $Be(OH)_2 + NaOH = Na[Be(OH)_3]$). rogorc tutesTan reaqciidan Cans beriliumi aris rTuli anionis $[Be(OH)_4]^{2-}$ an $[Be(OH)_3]^{-1}$ saxiT, romlebic dehidrataciis (gauwyloebis) SemTxvevaSi gadadis meta-formaSi $BeO_2^{2-}$, mag., (

$Na_2[Be(OH)_4] = Na_2BeO_2 + 2H_2O$). $Na_2BeO_2$-is msgavs marilebs, rogorc cnobilia, berilatebi ewodeba.

beriliumis hidroqsidi mizanmimarTulad gamoiyeneba axali marilebis misaRebad, agreTve mas iyeneben beriliumis iseTi mniSvnelovani naerTis misaRebad, rogoricaa beriliumis oqsidi ($BeO$), , romelic Zneldnobadobis ($2530^\circ C$) gamo gamoiyeneba cecxlgamZle masalad da Termomdgrad dieleqtrikad.

**magnumis hidroqsidi ($Mg(OH)_2$, fuZe)** _ miiReba TeTri labisebri naleqis saxiT, mis Sesabamis xsnad marilebze tuteebis moqmedebiT ($MgCl_2 + 2KOH = Mg(OH)_2 + 2KCl$, $MgCl_2 + 2NH_4OH = Mg(OH)_2 + 2NH_4Cl$). igi aris myari kristaluri nivTiereba, cudad ixsneba wyalSi, saSualo siZlieris fuZea, eleqtrobis cudi gamtaria da gaxurebisas xdeba misi gauwyloeba ($Mg(OH)_2 = MgO + H_2O$). magniumis hidroqsidi kargad ixsneba mJavasa ($Mg(OH)_2 + H_2SO_4 = MgSO_4 + 2H_2O$) da amoniumis xsnad marilSi ($Mg(OH)_2 + 2NH_4Cl = MgCl_2 + 2NH_3 + 2H_2O$). beriliumis hidroqsidisgan gansxvavebiT (zemoT vaCveneT), mas mxolod fuZe Tvisebebi aqvs. magniumis hidroqsidisa da oqsidis narevi wyalSi ixsneba, medicinaSi gamoiyeneba, rogorc antiseptikuri nivTiereba, aseve Sedis qlorofilis SedgenilobaSi da monawileobs fotosinTezSi, riTac dasturdeba misi didi biologiuri mniSvneloba.

**kalciumis hidroqsidis ($Ca(OH)_2$,** fuZe, tute, Camqrali kiri) miRebis ZiriTadi meTodia kiris Caqroba ($CaO + H_2O = Ca(OH)_2$). kalciumis hidroqsidi yvelaze xelmisawvdomi, iafi da amave dros Zlieri fuZea, tutea. igi miiReba sxva reaqciebiTac ($Ca + 2H_2O = Ca(OH)_2 + H_2$, $CaH_2 + 2H_2O = Ca(OH)_2 + 2H_2$, $Ca_3P_2 + 6H_2O = 3Ca(OH)_2 + 2PH_3$, $CaCl_2 + 2H_2O \xrightarrow{\text{eleqtroliz i}} Ca(OH)_2 + Cl_2 + H_2$), magram am reaqciebs praqtikuli gamoyeneba ar aqvT. Camqrali kiri TeTri feris, fxvniliseburi, wyalSi mcired xsnadi, myari nivTerebaa. mis najer wyalxsnars kiriani wyali ewodeba. masSi kalciumis hidroqsidi mTlianad disocirebulia ionebad ($Ca(OH)_2 = Ca^{2+} + 2OH^-$). Tu wyalSi met hidroqsids SevitanT, vidre SeiZleba gaixsnas, miiReba kirian wyalSi kalciumis hidroqsidis nawilakTa TeTri suspenzia _ kirrZe. kalciumis hidroqsidi reagirebs mJavebTan, mJava oqsidebTan, marilebTan. qloris gatarebiT kirian wyalSi miiReba e.w. qloriani

kiri ($Ca(OH)_2 + Cl_2 = Ca(OCl)Cl + H_2O$). igi gamoiyeneba rogorc maTeTrebel, ise sadezinfeqcio saSualebad, radgan masze atmosferuli $CO_2$-isa da wylis moqmedebiT gamoiyofa atomuri Jangbadi, romelic spobs mikroorganizmebs. kirian wyals iyeneben naxSirbadis dioqsidis ($CO_2$) aRmosaCenad. masSi dioqsidis gatarebisas gamWvirvale xsnari imRvreva uxsnari kalciumis karbonatis ($CaCO_3$) gamoyofis gamo ($Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$). $CO_2$-is Semdgomi gatarebisas xsnari isev gamWvirvale gaxdeba, radgan uxsnari karbonati xsnad hidrokarbonatad gardaiqmneba ($CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$), romelic gacxelebiT kvlav aimRvreva ($Ca(HCO_3)_2 \xrightarrow{t} CaCO_3 + H_2O + CO_2$). Camqral kirTan naxevarwyliani TabaSiris narevs ($CaSO_4 \cdot 0{,}5H_2O$) iyeneben samSeneblo saqmeSi _ kedlebis Sesalesad.

kalciumis karbonatisa da hidrokarbonatis urTierTgardaqmnas adgili aqvs bunebaSi. es reaqciebi iwvevs dedamiwis kirqviani qanebis fenebSi gamoqvabulebis warmoqmnas da masSi saocari stalaqtitebisa da stalagmitebis gaCenas, rac bunebis erT-erT saocrebadaa miCneuli.

**stronciumis hidroqsidi ($Sr(OH)_2$ fuZe, tute)** miiReba metaluri stronciumis wyalSi gaxsniT ($Sr + 2H_2O = Sr(OH)_2 + H_2$) an stronciumis oqsidze wylis moqmedebiT ($SrO + H_2O = Sr(OH)_2$). igi TeTri kristalebia, gacxelebisas advilad kargavs wyals ($Sr(OH)_2 = SrO + H_2O$). stronciumis hidroqsidi Zlieri fuZea (tute). advilad Sedis reaqciaSi mJavasTan ($Sr(OH)_2 + H_2SO_4 = SrSO_4 + 2H_2O$), naxSirbadis dioqsidTan warmoqmnis Sesabamis karbonats ($Sr(OH)_2 + CO_2 = SrCO_3 + H_2O$).

stronciumis hidroqsidi gamoiyeneba Warxlis Saqris rafinirebisa Tvis da agreTve zeTis saRebavebis sikativuri Tvisebebis gasaumjobeseblad. stronciumis naerTebi ixmareba kanis daavadebaTa TerapiaSi. aseve iyeneben minis mrewvelobaSi minanqris misaRebad da piroteqnkaSi.

**bariumis hidroqsidi ($Ba(OH)_2$ fuZe, tute)**, miiReba Sesabamisi oqsidis wyalSi gaxsniT ($BaO + H_2O = Ba(OH)_2$). misi miReba aseve advilad SeiZleba metaluri bariumis urTierTqmedebiT wyalTan ($Ba + 2H_2O = Ba(OH)_2 + H_2$). warmoebaSi bariumis fuZe miiReba Sesabamis sulfidze gadaxurebuli wylis orTqlis moqmedebiT ($BaS + 2H_2O = Ba(OH)_2 + H_2S$).

misi miReba aseve SeiZleba Sesabamis silikatze natriumis tutis moqmedebiT ($BaSiO_3 + 2NaOH = Ba(OH)_2 + Na_2SiO_3$).

$Ba(OH)_2$ TeTri, wyalSi kargad xsnadi nivTierebaa. baritis wyalxsnari Zlieri fuZea, advilad STanTqavs $CO_2$-s uxsnari karbonatis warmoqmniT ($Ba(OH)_2 + CO_2 = BaCO_{3\downarrow} + H_2O$). amitom baritis wyali gamoiyeneba $CO_2$-is aRmomCen reaqtivad. bariumis hidroqsidi energiulad reagirebs mJavebTan Sesabamisi marilebis warmoqmniT ($Ba(OH)_2 + 2HCl = BaCl_2 + 2H_2O$, $Ba(OH)_2 + H_2SO_4 = BaSO_{4\downarrow} + 2H_2O$). $Ba(OH)_2$ farTod ixmareba laboratoriaSi rogorc iafi xsnadi fuZe.

**aluminis hidroqsidi ($Al(OH)_3$)** miiReba arapirdapiri gziT _ aluminis xsnad marilze amoniumis tutis moqmedebiT ($Al_2(SO_4)_3 + 6NH_4OH = 2Al(OH)_3 + 3(NH_4)_2SO_4$). igi wyalSi uxsnari, TeTri, myari nivTierebaa. aluminis hidroqsidi tipuri amfoteruli naerTia _ urTierTqmedebs rogorc mJavebTan ($Al(OH)_3 + 3HCl = AlCl_3 + 3H_2O$), ise tuteebTan ($Al(OH)_3 + NaOH + 2H_2O = Na[Al(OH)_4(H_2O)_2]$). aluminis marilis xsnarze tutis damatebisas am ukanasknelis Warbi raodenoba iwvevs gamoleqili aluminis hidroqsidis gaxsnas. amitom $Al(OH)_3$-is misaRebad, rogorc zemoT aRvniSneT, mizanSewonilia aluminis marilis xsnarze vimoqmedoT amoniumis hidroqsidiT ($NH_4OH$), romlis Warb raodenobaSi ar ixsneba $Al(OH)_3$. koncentrirebuli da mduRare tuteebis moqmedebiT $Al(OH)_3$ warmoqmnis uwylo aluminatebs ($Al(OH)_3 + KOH = KAlO_2 + 2H_2O$).

aluminis hidroqsidi gamoiyeneba misi sxvadasxva marilis dasamzadeblad, xolo misi gauwyloebiT miiReba aluminis oqsidi, romlidanac eleqtroliziT miiReba metaluri alumini, romelsac udidesi gamoyeneba aqvs Tanamedrove teqnikasa da yofa-cxovrebaSi. aluminis naerTebi gamoiyeneba qaRaldis warmoebaSi, tyavis TrimlvisaTvis da qsovilebis Rebvis dros, rogorc fermWeri. aluminis hidroqsidis eTilis xsnari ganicdis koagulacias daleqvis procesSi da rogorc labismsgavsi naleqi Tan waritacebs wyalSi Sewonil nawilakebs, ris Sedegadac xdeba wylis gawmenda.

**galium(III)-is ($Ga(OH)_3$), indium(III)-is ($In(OH)_3$), Talium(I)-isa da Talium(III)-is ($TlOH$ da $Tl(OH)_3$) hidroqsidebi**.

**galium(III)-is hidroqsidi (** $Ga(OH)_3$ **)** miiReba mxolod arapirdapiri gziT, radgan misi oqsidi ( $Ga_2O_3$ ) wyalSi ar ixsneba, marilis wyalxsnarze unda vimoqmedoT tutis xsnariT ( $GaCl_3 + 3KOH = Ga(OH)_3 + 3KCl$ ). galium(III)-is hidroqsidi amfoterulia _ ixsneba tutesa ( $Ga(OH)_3 + NaOH = NaGaO_2 + 2H_2O$ ) da mJavaSi ( $Ga(OH)_3 + 3HCl = GaCl_3 + 3H_2O$ ). aluminis hidroqsidisgan ( $Al(OH)_3$ ) gansxvavebiT, galiumis hidroqsidi ( $Ga(OH)_3$ ) amiakis koncentrirebul xsnarSi ukeT ixsneba ( $Ga(OH)_3 + NH_4OH = NH_4GaO_2 + 2H_2O$ ). galiumis hidroqsidisa da tutis urTierTqmedebiT miRebul marilebs _ galatebi ewodeba, magaliTad amoniumis galati ( $NH_4GaO_2$ ), kalciumis galati ( $Ca(GaO_2)_2$ ) da sxva.

galiumis naerTebi farTod gamoiyeneba Tanamedrove teqnikasa da mrewvelobis sxvadasxva dargSi _ optikuri minis warmoebaSi, naxevargamtarebis teqnikaSi, advildnobadi Senadnobebis misaRebad, kargi Tbogadamtania birTvul reaqciebSi da sxv. galiumis zogierTi naerTi gamoiyeneba medicinaSi.

**indium(III)-is hidroqsidi (** $In(OH)_3$ **)** miiReba indium(III)-is marilis tutiT damuSavebis procesSi ( $InCl_3 + 3KOH = In(OH)_3 + 3KCl$ ). indiumis hidroqsidi, aluminisa da galiumis hidroqsidebis msgavsad, amfoteruli naerTia ( $In(OH)_3 + 3HCl = InCl_3 + 3H_2O$ , $In(OH)_3 + NaOH = NaInO_2 + 2H_2O$ ), magram, amasTan $Ga(OH)_3$ ufro mJavur Tvisebebs amJRavnebs, vidre $In(OH)_3$ , romelSic ufro fuZe Tvisebebi Warbobs. indiumis hidroqsidis tutesTan urTierTqmedebisas miiReba Sesabamisi marili _ indati, magaliTad, kalciumis indati ( $2In(OH)_3 + Ca(OH)_2 = Ca(InO_2)_2 + 4H_2O$ ).

indiumis hidroqsidi gamoiyeneba Sesabamisi marilebis misaRebad; misi zogierTi naerTi ixmareba metalebisa da Senadnobebis meqanikuri da qimiuri Tvisebebis gaumjobesebis mizniT, xolo minis zedapiris dafarvis SemTxvevaSi igi xdeba eleqtrogamtari da inarCunebs gamWvirvalobas.

**Talium(I)-isa da (III)-is hidroqsidebi (** $TlOH$ **da** $Tl(OH)_3$ **)** _ Sesabamisad miiReba Talium(I)-is oqsidis wyalSi gaxsniT ( $Tl_2O + H_2O = 2TlOH$ ) da Talium(III)-is marilze tutis wyalxsnaris moqmedebiT ( $Tl_2(SO_4)_3 + 6KOH = 2Tl(OH)_3 + 3K_2SO_4$ ). Talium(I)-is hidroqsidi ( $TlOH$ ) yviTeli feris, myari nivTierebaa, kargad ixsneba wyalSi da xasiaTdeba Zlieri tute TvisebebiT, garkveulad emsgavseba tute metalTa ( $NaOH$ , $KOH$ da sxv.)

hidroqsidebs. Talium(I)-is hidroqsidis xsnarze $CO_2$-is moqmedebiT miRebuli karbonati ($Tl_2CO_3$) kargad ixsneba wyalSi _ xsnars Zlieri tute reaqcia aqvs.

Talium(III)-is mowiTalo-yavisfer hidroqsids ($Tl(OH)_3$) aqvs fuZuri Tvisebebi _ praqtikulad ar ixsneba tuteSi, magram kargad xsnadia mJavebSi ($Tl(OH)_3 + 3HNO_3 = Tl(NO_3)_3 + 3H_2O$). Taliumis hidroqsidis ($Tl(OH)_3$) gaxurebiT miiReba Talium(III)-is oqsidi ($Tl_2O_3$), romelic Semdgomi gaxurebiT iSleba $Tl_2O$ da $O_2$-ad. danawevrebuli oqsidi ($Tl_2O$) $100^\circ C$-ze iSleba metalur Taliumad da Jangbadad ($2Tl_2O = 4Tl + O_2$).

Taliumis naerTebi gamoirCeva naxevargamtaruli TvisebebiT da gamoiyeneba fotoelementebsa da fotografiaSi, agreTve samedicino kvlevebSi. zogierTi misi naerTi (mag., sulfati) momwamlavi nivTierebaa da ixmareba mRrRnelebis mosaspobad. Taliumis karbonati, bromidi da iodidi SeaqvT gansakuTrebuli daniSnulebis optikur minebSi, romlebic gamoirCeva refraqciis maRali koeficientiT.

**germanium(II)-is hidroqsidi (**$Ge(OH)_2$**)** miiReba Sesabamisi marilis xsnarze tutis moqmedebiT ($GeCl_2 + 2NaOH = Ge(OH)_2 + 2NaCl$). germanium(II)-is hidroqsidi wyalSi praqtikulad uxsnari, amfoteruli Tvisebebis mqone nivTierebaa, masSi Warbobs mJava Tvisebebi ($Ge(OH)_2 + 2KOH = K_2GeO_2 + 2H_2O$, $Ge(OH)_2 + H_2SO_4 = GeSO_4 + 2H_2O$).

germanium(II)-is hidroqsidi gamoiyeneba Sesabamisi marilebis misaRebad; germaniumi da misi naerTebi ZiriTadad gamoiyeneba naxevargamtarebis teqnikaSi, agreTve Zlier gamWvirvale da maRali Suqtexis koeficientis mqone kvarcis minisa da, saerTod, optikuri minebis warmoebaSi.

**kala(II)-is hidroqsidi (**$Sn(OH)_2$**)** miiReba Sesabamisi marilis xsnarze tutis xsnaris moqmedebiT ($SnCl_2 + 2KOH = Sn(OH)_2 + 2KCl$). kalis hidroqsidi ($Sn(OH)_2$) amfoteruli naerTia, romelic advilad ixsneba rogorc mJavaSi ($Sn(OH)_2 + 2HNO_3 = Sn(NO_3)_2 + 2H_2O$), aseve tuteSi ($Sn(OH)_2 + 2NaOH = Na_2[Sn(OH)_4]$) _ tetrahidroqsostanitis warmoqmniT.

**kala(IV)-is hidroqsids (**$Sn(OH)_4$**) kalamJava ewodeba**; igi cnobilia ori modifikaciis saxiT: $\alpha$-kalamJava da $\beta$-kalamJava.

$\alpha$-kalamJava miiReba amiakis wyalxsnaris moqmedebiT kala(IV)-is qloridis xsnarze ($SnCl_4 + 4NH_4OH = H_2SnO_3 + 4NH_4Cl + H_2O$). gamoyofili

kalamJava gaSrobis dros TandaTanobiT kargavs wyals da gardaiqmneba kalas dioqsidad ($H_2SnO_3 = SnO_2 + H_2O$).

$\alpha$-kalamJava advilad ixsneba tuteSi hidroqsostanatis warmoqmniT ($H_2SnO_3 + 2KOH + H_2O = K_2[Sn(OH)_6]$). $\alpha$-kalamJava ixsneba agreTve mJavaSi kala(IV)-is marilebis warmoqmniT ($H_2SnO_3 + 4HCl = SnCl_4 + 3H_2O$).

$\beta$-kalamJava miiReba TeTri fxvnilis saxiT kalaze koncentrirebuli azotmJavas moqmedebiT($Sn + 4HNO_3 = H_2SnO_3 + 4NO_2 + H_2O$). $\alpha$-kalamJavasgan gansxvavebiT, $\beta$-kalamJava ar ixsneba mJavasa da tutis xsnarebSi. magram tutesTan Sednobis gziT SeiZleba misi gadayvana xsnarSi stanatis saxiT. $\alpha$-kalamJava xsnarSi Senaxvis SemTxvevaSi, TandaTanobiT gardaiqmneba $\beta$-kalamJavad.

kala da misi naerTebi gamoiyeneba kvebis mrewvelobis sxvadasxva dargSi. kalas dioqsidi ixmareba TeTri minanqrisa da Wiquris dasamzadeblad, xolo nawili naerTebisa _ xisa da TabaSiris nakeTobaTa mosavarayeblad (oqrosfer-yviTeli Seferiloba), agreTve samRebro saqmeSi, abreSumis dasamZimeblad, navTobis mrewvelobaSi da sxv.

**tyviis(II) hidroqsidi ($Pb(OH)_2$)** miiReba Sesabamis marilze tutis moqmedebiT ($PbCl_2 + 2NaOH = Pb(OH)_2 + 2NaCl$). tyviis hidroqsidis TeTri labisebri naleqi ($Pb(OH)_2$) ixsneba mJavasa ($Pb(OH)_2 + 2HNO_3 = Pb(NO_3)_2 + 2H_2O$) da tuteSi ($Pb(OH)_2 + 2KOH = K_2[Pb(OH)_4]$). magram myar tutesTan tyviis(II) hidroqsidis Sednobis dros miiReba arahidratirebuli plumbiti ($Pb(OH)_2 + 2NaOH = Na_2PbO_2 + 2H_2O$).

tyvia da misi mravalricxovani naerTi did gamoyenebas poulobs Tanamedrove teqnikisa da mrewvelobis sxvadasxva dargSi _ ixmareba mravali Senadnobis misaRebad, rentgenoteqnikaSi rogorc damcavi saSualeba, akumulatoris firfitebis dasamzadeblad, koroziamedegi masalebis misaRebad. surinjs ($Pb_3O_4$) iyeneben brolis, Wiquris, minanqris, linoleumis warmoebaSi, agreTve rogorc erT-erTi saukeTeso saRebavi koroziisgan dasacavad. tyviis acetati ixmareba samrebro saqmeSi da sxv.

**stibium(III)-is hidroqsidi ($Sb(OH)_3$)** miiReba arapirdapiri gziT _ stibiumis xsnad marilze tutis moqmedebiT ($SbCl_3 + 3KOH = Sb(OH)_3 + 3KCl$). $Sb(OH)_3$ wyalSi praqtikulad ar ixsneba. stibium(III)-is hidroqsidi amfoteruli

bunebisaa, masSi Warbobs fuZe Tvisebebi ( $2Sb(OH)_3 + 3H_2SO_4 = Sb_2(SO_4)_3 + 6H_2O$ , $Sb(OH)_3 + KOH = KSbO_2 + 2H_2O$ ).

stibiumi da misi naerTebi mniSvnelovnad amagrebs Senadnobebs, gamokristalebisas misi zogierTi Senadnobi farTovdeba da amitom maT iyeneben sastambo Sriftebis dasamzadeblad. ixmareba, agreTve germaniumis danamatad, romelic aumjobesebs germaniumis naxevargamtarul Tvisebebs.

**bismut(III)-is hidroqsidi ( $Bi(OH)_3$ )** miiReba mis xsnad marilze tutis moqmedebiT ( $BiCl_3 + 3NaOH = Bi(OH)_3 + 3NaCl$ ). igi Zalian susti fuZea, amitom $Bi$ (III)-is marilebi wyalxsnarebSi advilad hidrolizdeba fuZe marilebis ( $BiONO_3$ )-is warmoqmniT.

bismutis hidroqsidi ( $Bi(OH)_3$ ) gamoiyeneba specialuri daniSnulebis naerTebis dasamzadeblad da sxv.

**spilenZ(II)-is hidroqsidi ( $Cu(OH)_2$ )** miiReba spilenZis marilze tutis moqmedebisas, labisebri lurji naleqis saxiT ( $CuSO_4 + 2KOH = Cu(OH)_2 + K_2SO_4$ ). gaxurebisas spilenZ(II)-is hidroqsidi iSleba Savi feris $CuO$ warmoqmniT ( $Cu(OH)_2 = CuO + H_2O$ ). $Cu(OH)_2$ amfoterulia, ixsneba mJavaSi ( $Cu(OH)_2 + 2HNO_3 = Cu(NO_3)_2 + 2H_2O$ ), xolo gacxelebisas _ Warb tuteSic (koncentrirebul tuteSi gacxelebis gareSec, $Cu(OH)_2 + 2NaOH = Na_2[Cu(OH)_4]$ ). miRebul tute metalTa kupritebs ( $Na_2[Cu(OH)_4]$ , $K_2[Cu(OH)_4]$ ) aqvT lurji Seferiloba. spilenZ(II)-is hidroqsidi advilad ixsneba amiakis wyalxsnarSi, ris Sedegadac miiReba muqi lurji Seferilobis kompleqsuri naerTi ( $Cu(OH)_2 + 4NH_3 = [Cu(NH_3)_4](OH)_2$ ).

spilenZ(II)-is hidroqsidsa da mis Sesabamis warmoebulebs aqvT farTo praqtikuli gamoyeneba. spilenZis zogierTi naerTi, mag., bordos siTxe ( $CuSO_4 \cdot 5H_2O$ ) _ Sabiamnisa da kirxsnaris narevi ixmareba rogorc fungicidi.

**vercxl(I)-is hidroqsidis ( $AgOH$ )** miReba problematuria, radgan fuZeTa miRebis zogadi wesis mixedviT _ Sesabamis marilze tutis moqmedebiT _ ar xdeba vercxlis hidroqsidis miReba, yovelTvis gamoiyofa vercxl(I)-is oqsidi ( $Ag_2O$ ): $2AgNO_3 + 2KOH = Ag_2O + 2KNO_3 + H_2O$ . magram miRebuli xsnari, rogorc Cans, Seicavs mcire raodenobiT vercxl(I)-is hidroqsidsac, radgan mas aqvs tute reaqcia da sxva tutis msgavsad leqavs zogierTi metalis hidroqsids misi marilis xsnaridan.

zemoaRniSnulis safuZvelze SeiZleba iTqvas, rom $AgOH$ warmoadgens aramdgrad TeTri feris naleqs, romelic virtualurad miiReba $AgNO_3$-ze kaliumis tutis spirtxsnaris moqmedebiT ($AgNO_3 + KOH = AgOH + KNO_3$). vercxlis hidroqsidi sakmaod Zlieri fuZea, rac imiT mtkicdeba, rom vercxlis marilebi ar hidrolizdeba. vercxli da misi naerTebi gamoiyeneba saiuveliro da saojaxo nakeTobebis dasamzadeblad, sxvadasxva metalis zedapiris dasafaravad. didi raodenobiT gamoiyeneba radioeleqtroteqnikaSi, agreTve fotomasalebis (firfita, firi, qaRaldi da sxv.) dasamzadeblad.

**oqro(I)-is hidroqsidis ($AuOH$)** miRebac, vercxl(I)-is hidroqsidis msgavsad, ramdenadme albaTuria, radgan oqro(I)-is qloridze tutis moqmedebiT miiReba ara Sesabamisi hidroqsidi, aramed oqro(I)-is oqsidi ($2AuCl + 2KOH = Au_2O + 2KCl + H_2O$).

**oqro(III)-is hidroqsidi ($Au(OH)_3$)** miiReba Sesabamis qloridze ($AuCl_3$) tutis moqmedebiT ($AuCl_3 + 3KOH = Au(OH)_3 + 3KCl$). oqro(III)-is hidroqsidi wiTel-yavisferi fxvnilia. mas amfoteruli Tvisebebi axasiaTebs _ ixsneba mJavasa da tuteSi ($Au(OH)_3 + 4HNO_3 = H[Au(NO_3)_4] + 3H_2O$, $Au(OH)_3 + NaOH = Na[Au(OH)_4]$). miRebul naerTebs auratebi ewodeba.

oqro da misi zogierTi naerTi gamoiyeneba eleqtroteqnikaSi, stomatologiasa da siuveliro nakeTobaTa warmoebaSi. aseve iyeneben minis, faifuris an liTonTa zedapirebis dasafaravad. gamoiyeneba agreTve mikroeleqtronikaSi. koloiduri saxiT iyeneben rogorc antiseptikur saSualebas medicinaSi.

**TuTiis hidroqsidi ($Zn(OH)_2$)** miiReba Sesabamis xsnad marilze tutis moqmedebiT ($ZnSO_4 + 2KOH = Zn(OH)_2 + K_2SO_4$). TuTiis hidroqsidi TeTri, amfoteruli nivTierebaa, wyalSi ixsneba umniSvnelo raodenobiT, kargad ixsneba mJavasa da tuteSi ($Zn(OH)_2 + 2HCl = ZnCl_2 + 2H_2O$, $Zn(OH)_2 + Ba(OH)_2 = BaZnO_2 + 2H_2O$). TuTiis hidroqsidi ixsneba agreTve amiakis wyalxsnarSi, am dros miiReba kompleqsuri naerTi _ TuTiis heqsaminhidroqsidi ($Zn(OH)_2 + 6NH_3 = [Zn(NH_3)_6](OH)_2$). $Zn(OH)_2$ susti eleqtrolitia, amitom misi yvela marili, maT Soris cinkatebic ($Na_2ZnO_2$, $K_2ZnO_2$) wyalxsnarSi hidrolizdeba.

TuTiasa da mis mravalricxovan naerTs farTod iyeneben teqnikasa da yofa-cxovrebaSi koroziisagan metalTa zedapirebis dasacavad. warmoqmnis

mniSvnelovan Senadnobs _ TiTbers. TuTiis oqsidi ixmareba zeTis saRebavebis dasamzadeblad, zogierTi preparatis misaRebad, romelic gamoiyeneba medicinasa da kosmetikur saSualebebSi agreTve, rogorc katalizatori, spirtebis sinTezSi.

**kadmiumis hidroqsidi (**$Cd(OH)_2$**)** miiReba kadmiumis marilis xsnaris tutiT damuSavebiT ($CdCl_2 + 2KOH = Cd(OH)_2 + 2KCl$). gaxurebisas ($300^\circ C$) kadmiumis hidroqsidi iSleba Sesabamisi oqsidis warmoqmniT ($Cd(OH)_2 = CdO + H_2O$). kadmiumis hidroqsidSi mJavuri Tvisebebi ufro sustad aris gamoxatuli, vidre TuTiis hidroqsidSi, Tumca igi mJavaSic ixsneba ($Cd(OH)_2 + 2HCl = CdCl_2 + 2H_2O$) da tuteSic ($Cd(OH)_2 + 2NaOH = Na_2[Cd(OH)_4]$).

kadmiumis hidroqsidi gamoiyeneba yviTeli saRebavebisa da feradi minebis dasamzadeblad. kadmiumis zogierTi naerTiT faraven rkinis nakeTobebs, rac icavs maT koroziisagan.

**vercxliswylis (**$Hg$**)** erT-erTi Tavisebureba aris is, rom ar arsebobs misi hidroqsidi, im SemTxvevaSic ki, rodesac mosalodnelia vercxliswylis hidroqsidis warmoqmna, sinamdvileSi miiReba formalurad +1 Jangvis ricxvis mqone vercxliswylis oqsidi $Hg_2O$, grafikuli formula $\overset{Hg}{\underset{Hg}{|}}O$, mag., $Hg_2Cl_2 + 2NaOH = Hg_2O + 2NaCl + H_2O$. aseve vercxliswylis(II) marilze tutis moqmedebiT, Sesabamisi hidroqsidis $Hg(OH)_2$-is nacvlad, warmoiqmneba isev uwylo vercxliswylis(II) oqsidi: $HgCl_2 + 2KOH = HgO + 2KCl + H_2O$**.**

**skandiumis hidroqsidi (**$Sc(OH)_3$**)** miiReba Sesabamisi marilis tutesTan urTierTqmedebiT ($Sc(NO_3)_3 + 3NaOH = Sc(OH)_3 + 3NaNO_3$). igi labisebri TeTri naleqia, Znelad ixsneba wyalSi. skandiumis hidroqsidi amJRavnebs amfoterulobis niSnebs, advilad ixsneba ganzavebul mJavaSi ($Sc(OH)_3 + 3HNO_3 = Sc(NO_3)_3 + 3H_2O$).

skandiumi da misi hidroqsiduri naerTebi gamoiyeneba eleqtrovakuumur teqnikaSi, rogorc airebis STamnTqmeli; maT aseve STamnTqmelad iyeneben eleqtroteqnikaSi, kerZod, eleqtrogamomTvlel manqanebSi, saaviacio da raketul teqnikaSi.

**itriumis hidroqsidi (**$Y(OH)_3$**)** gamoiyofa mis xsnad marilze tutis moqmedebisas ($Y(NO_3)_3 + 3KOH = Y(OH)_3 + 3KNO_3$). igi TeTri, labisebri

nivTierebaa. misi fuZuri Tvisebebi Tavs iCens amoniumis marilidan amiakis gamoZevebisas ($Y(OH)_3 + 3NH_4NO_3 = Y(NO_3)_3 + 3NH_3 + 3H_2O$) da haeridan $CO_2$-is mierTebisas ($2Y(OH)_3 + 3CO_2 = Y_2(CO_3)_3 + 3H_2O$). itriumis hidroqsidi, rogorc aRvniSneT, ZiriTadad fuZovania, urTierTqmedebs mJavebTan Sesabamisi marilebis warmoqmniT ($Y(OH)_3 + 3H_2SO_4 = Y_2(SO_4)_3 + 6H_2O$). aluminis hidroqsidTan ($Al(OH)_3$) SedarebiT, itriumis hidroqsidi ufro metad amJRavnebs fuZe Tvisebebs.

itriumi da misi hidroqsiduri naerTebi gamoiyeneba rogorc konstruqciuli masalis komponenti birTvul teqnikaSi. zogierTi maTgani ixmareba radioeleqtronikasa da eleqtrogamomTvlel manqanebSi, xolo radioaqtiuri izotopi gamoiyeneba medicinaSi _ simsivneTa samkurnalod.

**lanTanis hidroqsidis (**$La(OH)_3$**)** miReba SeiZleba rogorc misi oqsidis wyalSi gaxsniT ($La_2O_3 + 3H_2O = 2La(OH)_3$), ise arapirdapiri gziT _ Sesabamis marilze tutis moqmedebiT ($La(NO_3)_3 + 3NaOH = La(OH)_3 + 3NaNO_3$). lanTanis hidroqsidi, iSviaTmiwaTa metalebis hidroqsidTa mwkrivSi yvelaze Zlieri fuZea, ixsneba mxolod mJavaSi ($2La(NO_3)_3 + 3H_2SO_4 = La_2(SO_4)_3 + 6H_2O$) da STanTqavs naxSirbadis dioqsids ($2La(OH)_3 + 3CO_2 = La_2(CO_3)_3 + 3H_2O$) Sesabamisi marilebis warmoqmniT. lanTanis marilebi ufero, advilad hidrolizebadia, amJRavneben kompleqsuri da ormagi marilebis warmoqmnis unars ($La_2(CO_3)_3 + Na_2CO_3 = 2Na[La(CO_3)_2]$).

lanTansa da mis hidroqsidur naerTebs iyeneben teqnikisa da mrewvelobis sxvadasxva dargSi meqanikuri, fizikur-qimiuri da sxva Tvisebebis gasaumjobeseblad. zogierTi maTgani ixmareba minis warmoebaSi _ minas aniWeben ultraiisferi sxivebis STanTqmis unars. lanTanis hidroqsidi gamoiyeneba rogorc katalizatori qimiur mrewvelobaSi.

**aqtiniumis hidroqsidi (**$Ac(OH)_3$**)** miiReba rogorc Sesabamisi oqsidis wyalSi gaxsniT ($Ac_2O_3 + 3H_2O = 2Ac(OH)_3$), ise arapirdapiri gziT _ aqtiniumis marilze tutis moqmedebiT ($AcCl_3 + 3KOH = Ac(OH)_3 + 3KCl$).

hidroqsidTa mwkrivSi $Sc(OH)_3$_$Y(OH)_3$_$La(OH)_3$_$Ac(OH)_3$ Zlierdeba fuZe Tvisebebi da izrdeba maTi xsnadoba wyalSi. Cveulebriv pirobebSi aqtiniumis fuZe urTierTqmedebs mxolod mJasTan

Sesabamisi marilebis warmoqmniT $Ac(OH)_3 + 3HF = AcF_3 + 3H_2O$, $2Ac(OH)_3 + 3H_2SO_4 = Ac_2(SO_4)_3 + 6H_2O$).

aqtiniumis yvela naerTi momwamlavia da maTTan muSaoba saSiSia, gansakuTrebiT imis gamo, rom igi $\alpha$-gamosxivebis wyaroa.

**titan(II)-is ($Ti(OH)_2$), titan(III)-isa ($Ti(OH)_3$) da titan(IV)-is ($Ti(OH)_4$) hidroqsidebi.**

**titan(II)-is hidroqsidi ($Ti(OH)_2$)** miiReba misi halidebis tutiT damuSavebis procesSi ($TiCl_2 + 2KOH = Ti(OH)_2 + 2KCl$). titan(II)-is hidroqsidi aqtiuri aRmdgenia, igi advilad iJangeba wyalTan Tanaobisas ($Ti(OH)_2 + H_2O = Ti(OH)_3 + 1/2H_2$, $Ti(OH)_2 + 2H_2O = H_4TiO_4 + H_2$).

**titan(III)-is hidroqsidi ($Ti(OH)_3$)** miiReba titan(III)-is marilze tutis moqmedebiT ($TiCl_3 + 3NaOH = Ti(OH)_3 + 3NaCl$). titan(III)-is hidroqsids aqvs mxolod fuZe Tvisebebi da amitom ar ixsneba tuteSi. igi Zalian advilad iJangeba haeris JangbadiT, ris Sedegadac warmoiqmneba orTotitanmJava ($2Ti(OH)_3 + H_2O + 1/2O_2 = 2H_4TiO_4$).

**titan(IV)-is hidroqsidi ($Ti(OH)_4$)** miiReba titanze mduRare wylis moqmedebiT ($Ti + 4H_2O = Ti(OH)_4 + 2H_2$). miRebuli hidroqsiduri Sre titans icavs Semdgomi Jangvisagan, magram wylis orTqli ($600 - 700^\circ C$) titanTan urTierTqmedebiT warmoqmnis dioqsids ($Ti + 2H_2O = TiO_2 + 2H_2$).

titanis hidroqsiduri naerTebi gamoiyeneba Zneldnobadi minis, Wiquris, minanqrisa da zeTis TeTri saRebavebis dasamzadeblad. maTi gamoyenebiT dafaruli metaluri nakeTobebi gamoirCeva didi zedapiruli simtkiciT.

**hafnium(IV)-is hidroqsidi ($Hf(OH)_4$)** anu hidratirebuli hafnium(IV)-is oqsidi ($HfO_2 \cdot 2H_2O$) miiReba hafnium(IV)-is marilis Rrma hidroliziT gaxurebis procesSi, agreTve hafnium(IV)-is marilis tutiT damuSavebisas ($HfCl_4 + 4H_2O = Hf(OH)_4 + 4HCl$, $Hf(SO_4)_2 + 4NaOH = Hf(OH)_4 + 2Na_2SO_4$). hafnium(IV)-is hidroqsidi gamoiyofa TeTri naleqis saxiT, ixsneba tuteSi ($Hf(OH)_4 + 2KOH = K_2[Hf(OH)_6]$).

hafniumis hidroqsiduri naerTebi gamoiyeneba maRali gardatexis maCveneblis mqone optikuri minebis dasamzadeblad.

**vanadium(II)-is hidroqsidi ($V(OH)_2$) da vanadium(III)-is hidroqsidi ($V(OH)_3$).**

vanadium(II)-is hidroqsidis miReba SeiZleba misi marilis wyalxsnaris tutiT damuSavebis dros ($VCl_2 + 2KOH = V(OH)_2 + 2KCl$). radgan vanadium(II)-is hidroqsidi Zalian susti fuZea, aramdgradia da advilad iJangeba haerze ($4V(OH)_2 + O_2 + 2H_2O = 4V(OH)_3$).

**vanadium(III)is hidroqsidi ($V(OH)_3$)** miiReba vanadium(III)-is Sesabamisi marilis damuSavebisas tute xsnariT, haeris SeuRwevad ($V(NO_3)_3 + 3KOH = V(OH)_3 + 3KNO_3$). igi advilad iJangeba haerze, aqvs susti fuZe Tvisebebi da haeris SeuRwevad mJavaSi gaxsnis dros warmoqmnis Sesabamis marils ($2V(OH)_3 + 3H_2SO_4 = V_2(SO_4)_3 + 6H_2O$).

vanadiumis hidroqsiduri naerTebi ixmareba qimiur mrewvelobaSi, rogorc erT-erTi saukeTeso katalizatori gogirdmJavas ($H_2SO_4$) warmoebaSi, agreTve minisa da keramikis warmoebaSi. vanadiumis zogierTi naerTi ixmareba, rogorc sasuqi, soflis meurneobaSi, xolo vanadiumis naerTebis Semcveli preparatebi, rogorc samkurnalo saSualebebi _ medicinaSi.

**tantal(III)-is hidroqsidi ($Ta(OH)_3$)** gamoiyofa tantalis triqloridis xsnaris natriumis an kaliumis tutiT damuSavebis dros ($TaCl_3 + 3NaOH = Ta(OH)_3 + 3NaCl$). tantal(III)-is hidroqsidi labisebri, Zalian advilad Jangvadi naleqia amfoteruli TvisebebiT ($Ta(OH)_3 + 3HF = TaF_3 + 3H_2O$, $Ta(OH)_3 + KOH = K[Ta(OH)_4]$).

tantali da tantalis hidroqsiduri naerTebi gamoiyeneba Tanamedrove teqnikisa da mrewvelobis sxvadasxva dargSi maRali koroziuli mdgradobis, mniSvnelovani meqanikuri simtkicis, dnobis maRali temperaturis, orTqlis dabali wnevis, Termuli gafarToebis mcire koeficientis, airebis Sekavebis unaris da sxva Tvisebebis gamo. maTgan damzadebuli sadistilacio aparatura, maduRrebi, eleqtrodebi da sxva ixmareba qimiur warmoebebsa da laboratoriebSi. didi moTxovnilebaa maT kafsulebze, tigelebze, sacrebsa da sawonebze analizuri xelsawyoebisaTvis.

**qrom(II)-is ($Cr(OH)_2$) da qrom(III)-is ($Cr(OH)_3$) hidroqsidebi**.

**qrom(II)-is hidroqsidi ($Cr(OH)_2$)** miiReba Sesabamis marilze tutis moqmedebiT ($CrCl_2 + 2NaOH = Cr(OH)_2 + 2NaCl$). qrom(II)-is hidroqsidi yviTeli feris naleqis saxiT gamoiyofa, wyalSi ar ixsneba, ixsneba mJavaSi ($Cr(OH)_2 + 2HCl = CrCl_2 + 2H_2O$, $Cr(OH)_2 + H_2SO_4 = CrSO_4 + 2H_2O$), magram rogorc mxolod fuZovani naerTi ar ixsneba tuteSi. qrom(II)-is hidroqsidi aRmdgenia,

advilad iJangeba mwvane feris qrom(III)-is hidroqsidad ( $4Cr(OH)_2 + O_2 + 2H_2O = 4Cr(OH)_3$ ). uJangbado areSi qrom(III)-is hidroqsidi iSleba qrom(II)-is oqsidis ( $Cr(OH)_2 = CrO + H_2O$ ), xolo haerze gaxurebisas _ qrom(III)-is oqsidis warmoqmniT ( $4Cr(OH)_2 + O_2 = 2Cr_2O_3 + 4H_2O$ ).

**qrom(III)-is hidroqsidi ( $Cr(OH)_3$ )** gamoileqeba tutis moqmedebiT qrom(III)-is marilze ( $CrCl_3 + 3NaOH = Cr(OH)_3 + 3NaCl$ ). igi amfoteruli TvisebebiT xasiaTdeba. axalmiRebuli qrom(III)-is hidroqsidi ixsneba mJavasa ( $2Cr(OH)_3 + 3H_2SO_4 = Cr_2(SO_4)_3 + 6H_2O$ ) da tutis ( $Cr(OH)_3 + 3KOH = K_3[Cr(OH)_6]$ ) xsnarebSi. $Cr^{+3}$-is ioni wyalxsnarSi mxolod hidratirebuli saxiT arsebobs. $[Cr(H_2O)_6]^{3+}$-is ions iisferi Seferiloba aqvs (minarevebis arsebobis gamo xsnari momwvanoa).

qromi da misi hidroqsiduri naerTebi gamoiyeneba sxvadasxva nakeTobis dasafaravad _ lamazi garegnuli saxis misacemad da koroziamedegobisaTvis. aseve gamoiyeneba tyavis TrimlvisaTvis, asanTis, saRebrebis, asafeTqebeli nivTierebebis warmoebaSi. ixmareba medicinaSi sisxlis daavadebisa da diagnostikisaTvis, agreTve iyeneben, rogorc fungicids.

**molibden(III)-is hidroqsidi ( $Mo(OH)_3$ )** SeiZleba miviRoT misi Sesabamisi naerTis tutiT damuSavebis dros ( $MoCl_3 + 3KOH = Mo(OH)_3 + 3KCl$ ). molibden(III)-is hidroqsidi amfoteruli naerTia ( $Mo(OH)_3 + 3HCl = MoCl_3 + 3H_2O$ , $Mo(OH)_3 + NaOH = Na[Mo(OH)_4]$ ), e.i. ixsneba rogorc mJavaSi, ise tutis wyalxsnarSi Sesabamisi naerTebis warmoqmniT. molibden(III)-is hidroqsidis daSliT miiReba molibden(III)-is oqsidi ( $2Mo(OH)_3 = Mo_2O_3 + 3H_2O$ ), Savi feris myari nivTiereba, ar ixsneba wyalSi.

molibdeni da misi hidroqsiduri naerTebi gamoiyeneba metalur nakeTobaTa meqanikuri simtkicis, koroziuli mdgradobis, drekadobis, simagris, Termomdgradobisa da wrTobis unaris gadidebis mizniT maRal temperaturaze. maT rogorc katalizators iyeneben Jangvis, hidrogenizaciis, izomerizaciis, polimerizaciisa da kondensaciis procesebSi. Sesabamisi saRebavebi xasiaTdeba maRali stabilurobiT, bzinvarebiT da kargi damfaravi TvisebebiT.

**manganum(II)-is ( $Mn(OH)_2$ ) da manganum(IV)-is ( $Mn(OH)_4$ ) hidroqsidebi.**

**manganum(II)-is hidroqsidi (** $Mn(OH)_2$ **)** miiReba arapirdapiri gziT _ manganum(II)-is xsnad marilze tutis moqmedebiT ( $MnCl_2 + 2NaOH = Mn(OH)_2 + 2NaCl$ , $MnSO_4 + 2KOH = Mn(OH)_2 + K_2SO_4$ ). manganum (II)-is hidroqsidi TeTri ferisaa da mxolod fuZe bunebisa, mJavebTan Sesabamis marilebs warmoqmnis ( $Mn(OH)_2 + 2HNO_3 = Mn(NO_3)_2 + 2H_2O$ ), magram ar ixsneba tuteSi. haerze manganum(II)-is hidroqsidi swrafad muqdeba, iJangeba manganum(IV)-is hidroqsidad.

manganum(IV)-is hidroqsidi, romelic miiReba manganum(II)-is haerze daJangviT ( $2Mn(OH)_2 + O_2 + 2H_2O = 2Mn(OH)_4$ ) xasiaTdeba didi aqtiurobiT, ris gamoc mrewvelobaSi gamoiyeneba rogorc Zlieri mJangavi.

manganumi da misi hidroqsiduri naerTebi did gamoyenebas poulobs teqnikisa da mrewvelobis TiTqmis yvela dargSi. feromanganumis saxiT ixmareba foladidan Jangbadisa da gogirdis mosacileblad, aseve Senadnobebis legirebisaTvis _ folads, alumins, magniums aniWebs simtkices, koroziamedegobas. iyeneben agreTve feradi minebis warmoebaSi. manganumis naerTebis nakleboba iwvevs mis deficits organizmSi, rasac Tan axlavs qlorofilis nakleboba (qlorozi). zogierTi niadagi Raribia manganumis naerTebiT, ris gamoc saWiroebs maT Semcvel sasuqebs. manganumSemcveli fermentebis gareSe SeuZlebelia warimarTos specifikuri metaboluri procesebi (cximovani, cilovani, naxSirwylovani cvla organizmSi). gamoiyeneba agreTve asanTis warmoebaSi, rogorc katalizatori qimiur sawarmoebSi, depolarizatorad galvanur elementebsa da medicinaSi _ anemiis sawinaaRmdegod, aTerosklerozis samkurnalod, sisxldenis SemaCerebel saSualebad, WrilobaTa mosabanad, mowamvlisas kuWis amosarecxad.

**rkina(II)-isa (** $Fe(OH)_2$ **) da rkina(III)-is (** $Fe(OH)_3$ **) hidroqsidebi.**

**rkina(II)-is hidroqsidi (** $Fe(OH)_2$ **)** gamoiyofa Sesabamisi marilis xsnarze tutis damatebisas _ TeTri fifqiseburi naleqis saxiT ( $FeCl_2 + 2NaOH = Fe(OH)_2 + 2NaCl$ ), romelic haerze maSinve mwvandeba, xolo Semdeg wiTel-murafers iZens rkina(III)-is hidroqsidad ( $Fe(OH)_3$ ) daJangvis gamo ( $4Fe(OH)_2 + O_2 + 2H_2O = 4Fe(OH)_3$ ). $Fe(OH)_2$ da $Fe(OH)_3$ wyalSi praqtikulad ar ixsneba. rkina(II)-is hidroqsidi fuZuri bunebis naerTia, ixsneba mJavaSi rkina(II)-is marilebis warmoqmniT ( $Fe(OH)_2 + 2HCl = FeCl_2 + 2H_2O$ ). sxvadasxva mJangaviT rkina(II)-is marilebi advilad iJangeba da warmoqmnis

rkina (III)-is marilebs, ris gamoc maT xSirad iyeneben aRmdgenad ( $3FeCl_2 + HNO_3 + 3HCl = 3FeCl_3 + NO + 2H_2O$ ,

$10FeSO_4 + 2KMnO_4 + 8H_2SO_4 = 5Fe_2(SO_4)_3 + K_2SO_4 + 2MnSO_4 + 8H_2O$ ).

**rkina(III)-is hidroqsidi ( $Fe(OH)_3$ )** wiTeli-muraferis naleqis saxiT gamoiyofa rkina(III)-is marilis xsnarze tutis moqmedebisas ( $Fe_2(SO_4)_3 + 6NaOH = 2Fe(OH)_3 + 3Na_2SO_4$ ). igi advilad warmoqmnis koloidur xsnarebs, amasTan, amfoteruli xasiaTis susti fuZea, radgan ixsneba ganzavebul mJavasa da tutis Tbil koncentrirebul xsnarSi Sesabamisi marilebis warmoqmniT ( $Fe(OH)_3 + 3HNO_3 = Fe(NO_3)_3 + 3H_2O$ , $Fe(OH)_3 + 3KOH = K_3[Fe(OH)_6]$ ).

$Fe(OH)_3$ ufro susti fuZea, vidre $Fe(OH)_2$ , rac imiT aixsneba, rom $Fe^{2+}$ -Tan SedarebiT $Fe^{3+}$ -is muxti ufro didia, xolo radiusi _ mcire, ris gamoc $Fe^{3+}$ ufro Zlierad ikavebs hidroqsid-ionebs. fuZuri bunebis Sesusteba imiTac gamoixateba, rom rkina(III)-is marilebi xsnarSi ufro Zlier hidrolizdeba, vidre rkina(II)-is marilebi.

rkina da misi hidroqsiduri naerTebi gamoiyeneba mrewvelobasa da teqnikis TiTqmis yvela dargSi kargi meqanikuri, biologiuri, fizikur-qimiuri Tvisebebis gamo: SenadnobebSi rkina da misi hidroqsiduri naerTebi ixmareba rogorc danamati simtkicis, plastikurobis, simagris, Wedadobis, antifriqciuli Tvisebebis modifikaciisaTvis da sxv. rkinis hidroqsidur naerTebs didi praqtikuli gamoyeneba aqvs mcenareTa mavneblebis winaaRmdeg, agreTve mineraluri saRebavebisa da melnis warmoebaSi, qsovilebis RebvaSi, rogorc koagulanti wylis gasufTavebis procesSi. rkinis naerTebs didi biologiuri mniSvneloba aqvs cocxali organizmebisaTvis _ rogorc sisxlis hemoglobinis ZiriTadi Semadgeneli nawili _ monawileobs hemoglobinis mier Jangbadis gadatanis procesSi. rkinis naerTebi aucilebelia mcenareebisTvisac _ monawileobs Jangva-aRdgenis procesebSi, Jangbadis mimocvlaSi.

**kobalt(II)-is hidroqsidi ( $Co(OH)_2$ )** miiReba kobalt(II)-is xsnad marilze tutis moqmedebiT ( $CoCl_2 + 2KOH = Co(OH)_2 + 2KCl$ ). misi $\alpha$ -modifikacia metastabiluria. $\alpha$ - $Co(OH)_2$ lurji naleqis saxiT miiReba Tu kobalt(II)-is marilis xsnarze tutis civi xsnariT vimoqmedebT. mdgradia $\beta$ - $Co(OH)_2$ saxesxvaoba, romelic miReba kobalt(II)-is marilis Tbil xsnarze tutis

moqmedebiT, ris Sedegadac gamoileqeba vardisferi naleqi. igive miiReba Tu gavaTbobT $\alpha$-$Co(OH)_2$. $\beta$-$Co(OH)_2$ rombuli sistemis, vardisferi kristalebia. kobalt(II)-is hidroqsidis orive saxesxvaoba wyalSi mcired ixsneba, xolo tutis Tbil koncentrirebul xsnarebsa da mineralur mJavaSi _ kargad.

**kobalt(III)-is hidroqsidi ($Co(OH)_3$)** miiReba kobalt(II)-is hidroqsidze haeris Jangbadisa da wylis moqmedebiT ($4Co(OH)_2 + O_2 + 2H_2O = 4Co(OH)_3$). kobalt(III)-is hidroqsidi muqi-vardisferia. aRniSnuli procesi gansakuTrebiT swrafad mimdinareobs Zlieri mJangavebis Tanaobis dros ($2Co(OH)_2 + NaClO + H_2O = 2Co(OH)_3 + NaCl$). kobalt(III)-Tvis marili ar aris damaxasiaTebeli _ kobalt(III)-is hidroqsidze JangbadSemcveli mJavas moqmedebiT kobalt(III)-is marili ki ar warmoiqmneba, aramed gamoiyofa kobalt(II)-is marili da Jangbadi ($4Co(OH)_3 + 4H_2SO_4 = 4CoSO_4 + O_2 + 10H_2O$), xolo marilmJavas SemTxvevaSi kobalt(II)-is marilTan erTad gamoiyofa qlori ($2Co(OH)_3 + 6HCl = 2CoCl_2 + Cl_2 + 6H_2O$).

kobalt(II da III)-is hidroqsiduri naerTebi gamoiyeneba feradi (lurji, mwvane, vardisferi) minanqris, keramikisa da minis mrewvelobaSi. maTi fxvnilebi ixmareba hidro- da dehidrogenizaciis reaqciebSi, navTobis damuSavebis procesSi da sxv. kobalti da misi naerTebi monawileobs sisxlis hemoglobinis sinTezSi, Sedis antianemiuri vitaminis ($B_{12}$) SedgenilobaSi. erT-erTi radioaqtiuri izotopi ($^{60}_{27}Co$), romelic $\gamma$-gamosxivebis wyaroa, gamoiyeneba avTvisebian simsivneTa samkurnalod.

**nikel(II)-isa ($Ni(OH)_2$) da nikel(III)-is ($Ni(OH)_3$) hidroqsidebi.**

**nikel(II)-is hidroqsidi ($Ni(OH)_2$)** miiReba nikel(II)-is xsnad marilze tutis moqmedebiT ($NiCl_2 + 2KOH = Ni(OH)_2 + 2KCl$). igi didi moculobis mwvane naleqis saxiT gamoiyofa. naleqis gaTbobisas an xsnaris didi xnis ganmavlobaSi Senaxvisas amorfuli naleqidan gamoiyofa ($Ni(OH)_2$)-is mwvane kristalebi. nikel(II)-is hidroqsidi xasiaTdeba fuZe TvisebebiT, ixsneba mJavaSi nikel(II)-is Sesabamisi marilis warmoqmniT ($Ni(OH)_2 + 2HCl = NiCl_2 + 2H_2O$) agreTve amoniumis tuteSi ($Ni(OH)_2 + 6NH_4OH = [Ni(NH_3)_6](OH)_2 + 6H_2O$).

**nikel(III)-is hidroqsidi ($Ni(OH)_3$)** miReba SeiZleba $Ni$(II) hidroqsidze (radgan $Fe(OH)_2$-isa da $Co(OH)_2$-isagan gansxvavebiT, $Ni$(II)-is hidroqsidi

mdgradia haerze) Zlieri mJangavis moqmedebiT, tutis Tanaobisas ($2Ni(OH)_2 + Cl_2 + 2NaOH = 2Ni(OH)_3 + 2NaCl$). nikel(III)-is hidroqsidi susti fuZea amfoterul TvisebaTa niSnebiT. mwkrivSi $Fe(OH)_3$_$Co(OH)_3$_ $Ni(OH)_3$ amfoteruli Tvisebebi TandaTanobiT qreba. nikel(III)-is hidroqsidze mJavas moqmedebiT mimdinare procesi Cveulebrivi reaqcia ki ar aris, aramed Jangva-aRdgeniTi procesia nikel(II)-is marilis warmoqmniT ($4Ni(OH)_3 + 8HNO_3 = 4Ni(NO_3)_2 + O_2 + 10H_2O$).

nikeli da misi hidroqsiduri naerTebi gamoiyeneba koroziamdgradi nakeTobebis, fizikur-qimiuri gazomvebisaTvis saWiro aparaturis, manqanaTa nawilebis dasamzadeblad da sxv. aseve iyeneben rkinis, foladis, spilenZisa da sxva masalebis zedapirTa dasafaravad. maTi garkveuli nawili ixmareba tute akumulatorebisaTvis, qimiur mrewvelobaSi katalizatorad, rogorc pigmenti antikoroziul saRebavebsa da keramikul masalebSi.

**platina(II)-is hidroqsidi (**$Pt(OH)_2$**)** miiReba $K_2[PtCl_4]$ xsnaris kaliumis tutiT damuSavebisas airadi $CO_2$-is atmosferoSi ($K_2[PtCl_4] + 2KOH = Pt(OH)_2 + 4KCl$). platina(II)-is hidroqsidi Savi fxvnilia, ar ixsneba wyalSi, ixsneba koncentrirebul mJavaSi ($Pt(OH)_2 + 4HCl = H_2[PtCl_4] + 2H_2O$).

**platina(IV)-is hidratirebuli oqsidi** $PtO_2 \cdot 3H_2O$ miiReba $PtCl_4$-is wyalxsnaris duRiliT mwvave natriumTan ($PtCl_4 + 4NaOH + H_2O = PtO_2 \cdot 3H_2O + 4NaCl$). naerTi $PtO_2 \cdot 3H_2O$ yviTeli fxvnilia, cudad ixsneba wyalSi, aqvs amfoteruli Tvisebebi, ixsneba mJavasa da tuteSi.

platinisa da hidroqsiduri naerTebisgan mzaddeba laboratoriuli WurWeli _ tigelebi, jamebi, Spatelebi, sacrebi, filtrebi, eleqtrodebi, gamosaxdeli aparatura da sxv. maTi Senadnobisgan damzadebuli eleqtrokontaqtorebi, sxvadasxva xelsawyos damcvelebi, rentgenis milakebis kaTodebi da antikaTodebi gamoiyeneba eleqtroteqnikur mrewvelobaSi. platinis hidroqsiduri naerTebi ixmareba axali kompleqsuri naerTebis misaRebad.

**ruTenium(II)-is hidroqsidi (**$Ru(OH)_2$**)** miiReba ruTenium(II)-is qloridis xsnaris tutiT damuSavebisas ($RuCl_2 + 2NaOH = Ru(OH)_2 + 2NaCl$). ruTenium(II)-is hidroqsidi yavisferi aramdgradi naleqia, advilad iJangeba da gardaiqmneba **ruTenium(III)-is hidroqsidad** ($4Ru(OH)_2 + O_2 + 2H_2O = 4Ru(OH)_3$).

**ruTenium(III)-is hidroqsidis (** $Ru(OH)_3$ **)** miReba SeiZleba, agreTve ruTenium(III)-is xsnadi marilis tutiT damuSavebis dros ( $RuCl_3 + 3KOH = Ru(OH)_3 + 3KCl$ ). cnobilia, aseve **ruTenium(IV) hidroqsidi (** $Ru(OH)_4$ **)** anu $RuO_4 \cdot 2H_2O$, romelic wyalSi uxsnari Savi feris fxvnilia, ixsneba mJavaSi.

ruTeniumi da ruTeniumis hidroqsiduri naerTebi gamoiyeneba mxolod Senadnobis saxiT _ samkaulebis, ,,mudmivi" kalmis wverebis, eleqtrokontaqtorebisa da xmis maregistrirebeli aparatebis nemsebis dasamzadeblad.

**rodium(III)-is hidroqsidi (** $Rh(OH)_3$ **)** miiReba rodium(III)-is marilis tutiT damuSavebis procesSi ( $Rh_2(SO_4)_3 + 6KOH = 2Rh(OH)_3 + 3K_2SO_4$ ). rodium(III)-is hidroqsidi yviTeli labisebri naleqia, romelic ixsneba mJavasa da Warb tuteSi ( $Rh(OH)_3 + 3HCl = RhCl_3 + 3H_2O$ , $Rh(OH)_3 + 3NaOH = Na_3[Rh(OH)_6]$ ).

rodiumi da misi hidroqsiduri naerTi arekvlis didi unaris gamo gamoiyeneba refleqtoris zedapiris dasafaravad. es nivTierebebi gamoiyeneba agreTve katalizatorisa da Savi pigmentis saxiT faifuris nakeTobaTa mosaxatavad. maTi zogierTi Senadnobi ki _ rogorc specifikuri katalizatori sinTezuri boWkos warmoebaSi, saiuveliro saqmeSi, Termowyvilebisa da avtokalmis wverebis dasamzadeblad, agreTve Termoelementebis warmoebaSi.

**iridium(III)-is hidroqsidis (** $Ir(OH)_3$ **)** miReba SeiZleba natriumis heqsaqloriridium(III)-is xsnarze tutis moqmedebiT ( $Na_3[IrCl_6] + 3NaOH = Ir(OH)_3 + 6NaCl$ ).

**iridium (IV)-is hidroqsidi (** $Ir(OH)_4$ **)** miiReba iridium(III)-is hidroqsidis haerze daJangviT ( $4Ir(OH)_3 + O_2 + 2H_2O = 4Ir(OH)_4$ ). misi miReba aseve SeiZleba iridiumis tetraqloridis cxeli tutiT damuSavebis dros _ warmoiqmneba iridium(IV)-is hidroqsidi lurji naleqis saxiT ( $IrCl_4 + 4KOH = Ir(OH)_4 + 4KCl$ ). igi ixsneba marilmJavasa da bromwyalbadmJavaSi iridium(IV)-is Sesabamisi kompleqsuri mJavebis warmoqmniT ( $Ir(OH)_4 + 6HCl = H_2[IrCl_6] + 4H_2O$ , $Ir(OH)_4 + 6HBr = H_2[IrBr_6] + 4H_2O$ ).

iridiumisa da misi hidroqsiduri naerTebisgan amzadeben kaTodebs, kontaqtorebs, Sigawvis Zravebis sanTlebis gamtarebs, laboratoriul WurWelsa

da instrumentebs. zogierTi maTi naerTi gamoiyeneba rogorc katalizatori, xolo Senadnobebi _ Termoelementebis, qimiuri aparaturisa da sazomi etalonebis dasamzadeblad agreTve saiuveliro saqmeSi.

**paladium(II)-is hidroqsidi (** $Pd(OH)_2$ **)** SeiZleba miviRoT paladium(II)-is marilis xsnaris tutesTan duRilis dros ( $PdCl_2 + 2NaOH = Pd(OH)_2 + 2NaCl$ ). paladium(II)-is hidroqsidi aris yavisfer-wiTeli, cudad ixsneba wyalSi, xolo kargad _ mJavaSi ( $Pd(OH)_2 + H_2SO_4 = PdSO_4 + 2H_2O$ ).

**paladium(IV)-is hidroqsidi (** $Pd(OH)_4$ **)** miiReba kaliumis heqsaqlorpaladium(IV)-is damuSavebisas tutiT ( $K_2[PdCl_6] + 4KOH = Pd(OH)_4$ anu $PdO_2 \cdot 2H_2O$ (paladiumis hidratirebuli dioqsidi) $+ 6KCl$ ). igi gamoileqeba wiTeli naleqis saxiT, ixsneba ganzavebul mJavasa ( $Pd(OH)_4 + 2H_2SO_4 = Pd(SO_4)_2 + 4H_2O$ ) da tutis koncentrirebul xsnarSi ( $Pd(OH)_4 + 4NaOH = Na_4[Pd(OH)_8]$ ).

paladiumi da misi hidroqsidnaerTebi gamoiyeneba spilenZisa da vercxlis nakeTobebis dacvisa da dekoratiuli dafarvisaTvis. qimiur laboratoriebSi iyeneben mravali reaqciis katalizatorad. maTi Senadnobebi oqrosTan, vercxlTan, spilenZsa da iridiumTan gamoiyeneba stomatologiaSi, saiuveliro saqmeSi da a.S.

**lanTanoid(III)-is hidroqsidebi (** $Ln(OH)_3$ **, sadac** $Ln = Ce, \mathrm{Pr}, Nd$ **da a.S.)** miiReba lanTanoid(III)-is Sesabamis marilebsa da tuteebs Soris mimocvlis reaqciebiT ( $LnCl_3 + 3KOH = La(OH)_3 + 3KCl$ ). mwkrivSi $Ce^{3+} \ldots Lu^{3+}$ radiusTa Semcirebis Sesabamisad ramdenadme sustdeba hidroqsidTa fuZuri xasiaTi, mcirdeba maTi Termuli mdgradoba da xsnadoba, mag., iterbiumisa ( $Yb$ ) da luteciumis ( $Lu$ ) hidroqsidebi amfoterulia, ixsneba tuteebSi Sesabamisi tetrahidroqsokompleqsebis warmoqmniT ( $Yb(OH)_3 + KOH = K[Yb(OH)_4]$ da $Lu(OH)_3 + NaOH = Na[Lu(OH)_4]$ ). lanTanoid(III)-is hidroqsidebis mJavaSi gaxsniT miiReba marili ( $2Ln(OH)_3 + 3H_2SO_4 = La_2(SO_4)_3 + 6H_2O$ ).

**cerium(IV)-is hidroqsidi (** $Ce(OH)_4$ **)** miiReba cerium(III)-is hidroqsidis haerze daJangviT an cerium(IV)-is marilze tutis moqmedebiT ( $4Ce(OH)_3 + O_2 + 2H_2O = 4Ce(OH)_4$ , $CeCl_4 + 4KOH = Ce(OH)_4 + 4KCl$ ). cerium(IV)-is hidroqsidi, cerium(III)-isgan gansxvavebiT, amJRavnebs amfoterul

Tvisebebs, urTierTqmedebs rogorc mJavasTan ( $Ce(OH)_4 + 2H_2SO_4 = Ce(SO_4)_2 + 4H_2O$ ), ise tuteebTan ( $Ce(OH)_4 + 2NaOH = Na_2[Ce(OH)_6]$ ) Sesabamisi naerTebis warmoqmniT. cerium(IV)-is naerTebi, zogierTis gamoklebiT, aramdgradi da Zlieri mJangavia ( $2Ce(OH)_4 + 8HCl = 2CeCl_2 + 2Cl_2 + 8H_2O$ ). kidev ufro naklebmdgradi da Zlieri mJangavebia prazeodim(IV)-isa da terbium(IV)-is naerTebi.

lanTanoidebi da maTi hidroqsidebi didi raodenobiT gamoiyeneba minis mrewvelobaSi. ceriumSemcveli mina ar mkrTaldeba radioaqtiuri sxivebis moqmedebiT da gamoiyeneba atomur teqnikaSi. lanTanoidebi Sedis optikuri minebis SedgenilobaSi. lanTanoidebis oqsidebs iyeneben minebis gasauferuleblad da maTTvis sxvadasxva Seferilobis misacemad. lanTanoidTa hidroqsidebsa da oqsidebs didi gamoyeneba aqvT faifuris, Wiqurisa da minanqris nawarmis Sesaferadeblad.

**aqtinoid(III)-is hidroqsidebi ( $Ac(OH)_3$ , sadac $Ac = Th, Pa, U$ da sxv.)**, lanTanoidTa hidroqsidebis msgavsad, sustad ixsneba wyalSi da amJRavnebs mkafiod gamosaxul fuZovan Tvisebebs _ advilad urTierTqmedeben mJavebTan, Sesabamisi naerTebis warmoqmniT ( $Ac(OH)_3 + 3HCl = AcCl_3 + 3H_2O$ , $Ac(OH)_3 + 3HNO_3 = Ac(NO_3)_3 + 3H_2O$ ).

**aqtinoid(IV)-is hidroqsidebisaTvis ( $Ac(OH)_4$ )** damaxasiaTebelia sakmaod susti fuZuri Tvisebebi da isini urTierTqmedeben mxolod Zlier mJavebTan Sesabamisi naerTebis warmoqmniT ( $Ac(OH)_4 + 4HCl = AcCl_4 + 4H_2O$ , $Ac(OH)_4 + 2H_2SO_4 = Ac(SO_4)_2 + 4H_2O$ ). aqtionid(IV)-is naerTebidan wyalSi kargad xsnadia nitratebi, zomierad _ sulfatebi, xolo cudad _ fosfatebi, karbonatebi, iodatebi da sxv. aqtinoid(IV)-is marilebi ganicdis Zlier hidrolizs.

uran(VI)-is hidroqsidSi fuZuri Tvisebebi sWarbobs mJavurs da qimiuri qcevis mixedviT igi SeiZleba ganvixiloT rogorc $UO_2(OH)_2$ tipis fuZe, romelic advilad urTierTqmedebs mJavasTan uranilis kationis $UO_2^{2+}$ warmoebulis warmoqmniT ( $UO_2(OH)_2 + 2HNO_3 = UO_2(NO_3)_2 + 2H_2O$ ). uranilis $UO_2^{2+}$ warmoebulebis hidrolizi Seqcevadi procesia ( $UO_2(NO_3)_2 + 2H_2O = UO_2(OH)_2 + 2HNO_3$ ). uran(VI)-is hidroqsidi mJavur Tvisebebs amJRavnebs mxolod tutesTan Sednobis dros ( $H_2UO_4 + 2NaOH = Na_2UO_4 + 2H_2O$ ).

aqtinoidebisa da maTi naerTebis gamoyeneba dakavSirebulia Sigaatomuri energiis gamoyenebis problemasTan. Toriumis bunebriv izotopze ($^{232}_{90}Th$) neitronebis moqmedebiT warmoqmnili uranis izotopi ($^{233}_{92}U$) gamoiyeneba birTvul sawvavad atomur reaqtorebSi. Tavad Toriumi ixmareba, agreTve, rogorc malegirebeli komponenti bevr SenadnobSi, romlebic gamoirCevian mcire simkvriviT, maRali simtkiciTa da qimiuri mdgradobiT maRal temperaturaze.

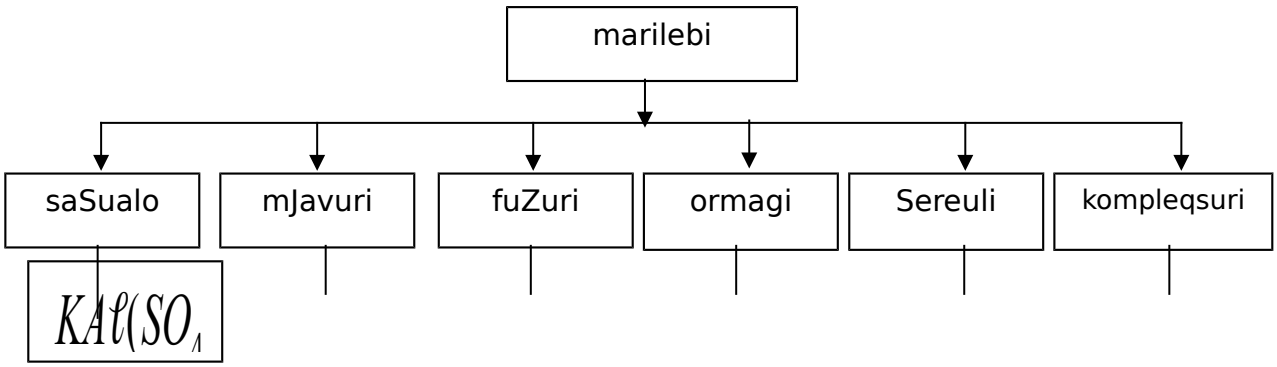
uranis zogierT naerTs iyeneben fluorescirebadi minis warmoebasa da fotografiaSi.

# III Tavi. marili

eleqtrolituri Teoriis TvalsazrisiT naerTTa am klasis warmomadgenels _ marils _ SeiZleba mieces aseTi gansazRvra: marili aris eleqtroliti, romelic wyalSi gasxnisas an dnobisas disociirdeba metalis an sxva, ufro rTul kationebad (magaliTad $NH_4^+$, $UO_2^{2+}$, $[Cu(NH_3)_4]^{2+}$) da mJavas naSTis anionebad ($Cl^-$, $S^{2-}$, $NO_3^-$, $SO_4^{2-}$ da a.S.).

## 3.1. marilTa klasifikacia

eleqtrolituri Teoriis TvalsazrisiT marili arsebobs eqvsi sxvadasxva tipis:




**1. saSualo marili** – marili, romelic warmoiqmneba fuZiT mJavis sruli ganeitralebis (wyalbadis yvela kationis metalis kationiT Canacvlebis) Sedegad:

$$2NaOH + H_2SO_4 = 2H_2O + Na_2SO_4 .$$

**2. mJavuri marili** – marili, romelic warmoiqmneba fuZiT mJavas arasruli ganeitralebis (ar xdeba wyalbadis yvela kationis Canacvleba metalis kationiT) Sedegad:

$$NaOH + H_2SO_4 = H_2O + NaHSO_4$$

aseTi tipis marilebi SeiZleba warmoiqmnas mxolod mravalfuZiani mJavaTi. $H_2SO_4$ mravalfuZiani mJavaa, romlis sruli ganeitralebis dros warmoiqmneba saSualo marili $Na_2SO_4$, xolo metaliT wyalbadis erTi kationis Canacvlebisas _ **mJavuri marili** $NaHSO_4$.

$H_3PO_4$ – samfuZiani mJavaa, romelSic SesaZlebelia Tanmimdevrobi T wyalbadis erTi, ori an samive kationis Canacvleba metaliT. am mJavas fuZiT

ganeitralebis Sedegad warmoiqmneba marilTa sami mwkrivi: $NaH_2PO_4$, $Na_2HPO_4$ da $Na_3PO_4$.

saerTod, mJavur marilebs miekuTvneba iseTi marilebi, romlebSic mJavur oqsidTa moluri Semcveloba metia fuZuri oqsidis molur Semcvelobaze, magaliTad, $Na_2B_4O_7$, $Na_2Cr_2O_7$, $Na_2S_2O_7$, $Na_4P_2O_7$. fuZur oqsidebTan da hidroqsidebTan reaqciis dros es marilebi gardaiqmneba saSualo marilebad:

$$MgO + Na_2B_4O_7 = Mg(BO_2)_2 + 2NaBO_2$$

$$2NaOH + Na_2Cr_2O_7 = 2Na_2CrO_4 + H_2O$$

**3. fuZuri marili** – marili, romelic warmoadgens mJaviT mravalmJavuri fuZis arasruli ganeitralebis produqts:

$$HCl + Ba(OH)_2 = Ba(OH)Cl + H_2O$$

**4. ormagi marili** – marili, romlis SedgenilobaSi Sedis mxolod erTi saxis anioni da sxvadasxva kationi, magaliTad, $KAl(SO_4)_2 \cdot 12H_2O$.

**5. Sereuli marili** – marili, romlis SedgenlobaSi Sedis erTi saxis kationi da sxvadasxva mJavas anionebi, magaliTad, qloriani kiri $CaCl(OCl)$.

**6. kompleqsuri marili** – marili, romelsac aqvs rTuli kationebi da anionebi da romelSic bma warmoqmnilia donorul-aqceptoruli meqanizmiT. aseTi marilis molekuluri formulis dawerisas kompleqsuri kationi an anioni Caismeba kvadratul frCxilebSi, magaliTad, $K_3[Fe(CN)_6]$, $K[BF_4]$, $Na[Al(OH)_4(H_2O)_2]$, $[Ag(NH_3)_2]OH$, $[Cu(NH_3)_4](OH)_2$.

## 3.2. marilis miRebis xerxebi

marili SeiZleba miviRoT qvemoT warmodgenili xerxebiT.

1. metalis urTierTqmedebiT _

a) mJavasTan:

$$Cr + 2HCl = CrCl_2 + H_2\uparrow$$ (haeris SeuRwevlad)

$$Cu + 4HNO_{3\text{konc.}} = Cu(NO_3)_2 + 2NO_2\uparrow + 2H_2O,$$

b) tutesTan:

$$2Al + 2NaOH + 10H_2O = 2Na[Al(OH)_4(H_2O)_2] + 3H_2\uparrow$$

2. metalis gaxurebiT arametalTan inertul atmosferoSi

$$2Fe + 3Cl_2 \overset{t}{=} 2FeCl_3,$$

$$Zn + S \overset{t}{=} ZnS\text{'}$$

$$2Li + H_2 \overset{t}{=} 2LiH\text{'}$$

$$6Mg + 2N_2 \overset{t}{=} 2Mg_3N_2\text{.}$$

3. marilidan metalis gamoZeveba sxva metaliT, romelic ZabvaTa mwkrivSi mdebareobs marilis SedgenilobaSi Semaval metalamde:

$$Fe + CuSO_4 = Cu + FeSO_4\text{.}$$

amasTan, gasaTvaliswinebelia is garemoeba, rom, Tu marilis SedgenilobaSi Semavali metali avlens cvalebadi Jangvis xarisxs, maSin igi SeiZleba aRdgenil iqnes misgan marjvniv mdebare, ufro dabali Jangvis xarisxis mqone metaliT:

$$2FeCl_3 + Cu = 2FeCl_2 + CuCl_2$$

am reaqciam gamoyeneba pova eleqtromrewvelobaSi sabeWdi danadgarebis platebis dasamzadeblad.

$$2FeCl_3 + Hg = 2FeCl_2 + HgCl_2\text{.}$$

amazea damokidebuli SenobaTa saTavsoebis gasufTaveba daRvrili vercxliswylisgan.

4. arametalis urTierTqmedebiT tutesTan:

$$3Cl_2 + 6KOH = 5KCl + KClO_3 + 3H_2O\text{,}$$

$$3S + 6NaOH \overset{t}{=} 2Na_2S + Na_2SO_3 + 3H_2O\text{.}$$

5. aqtiuri arametaliT naklebad araaqtiuri arametalis marilidan gamoZevebiT:

$$Cl_2 + 2NaBr = Br_2 + 2NaCl$$

am SemTxvevaSi ufro eleqtrouaryofiTi arametali (qlori) gamoaZevebs naklebad eleqtrouaryofiTs (broms).

6. ori sxvadasxvagvari oqsidis urTierTqmedebiT:

$$\underset{\text{fuZuri oqsidi}}{K_2O} + \underset{\text{mJavuri oqsidi}}{SO_2} = K_2SO_3\text{,}$$

$$\underset{\text{fuZuri oqsidi}}{Na_2O} + \underset{\text{amfoteruli oqsidi}}{Al_2O_3} \xrightarrow{t} 2NaAlO_2.$$

$$\underset{\text{amfoteruli oqsidi}}{ZnO} + \underset{\text{mJavuri oqsidi}}{SO_3} \xrightarrow{t} ZnSO_4.$$

7. fuZiT (an amfoteruli hidroqsidiT) mJavas neitralizacia:

$$KOH + HNO_3 = H_2O + KNO_3,$$

$$Zn(OH)_2 + H_2SO_4 = 2H_2O + ZnSO_4.$$

mravalfuZiani (an mravalmJavuri fuZis) SemTxvevaSi SesaZlebelia mJavuri (an fuZuri) marilis warmoqmna, reaqciaSi Sesuli, mJavas an fuZis fardobiT raodenobaze damokidebulebiT:

$$H_3PO_4 + NaOH = NaH_2PO_4 + H_2O,$$

$$NaH_2PO_4 + NaOH = Na_2HPO_4 + H_2O,$$

$$NaHPO_4 + NaOH = Na_3PO_4 + H_2O.$$

8. mJavuri an amfoteruli oqsidis fuZeSi gaxsniT an masTan SednobiT:

$$CO_2 + 2KOH = K_2CO_3 + 2H_2O,$$

$$SiO_2 + 2NaOH \xrightarrow{t} Na_2SiO_3 + H_2O'$$

$$ZnO + 2NaOH + H_2O = Na_2[Zn(OH)_4],$$

$$Al_2O_3 + 2NaOH \xrightarrow{t} 2NaAlO_2 + H_2O.$$

9. fuZuri an amfoteruli oqsidis mJavasTan urTierTqmedebiT:

$$MgO + 2HCl = MgCl_2 + H_2O,$$

$$ZnO + 2HNO_3 = Zn(NO_3)_2 + H_2O.$$

amasTan aucilebelia gaTvaliswinebul iqnes warmoqmnili oqsidis kationis Jangva, ufro maRal Jangvis xarisxamde:

$$FeO + 4HNO_{3\text{konc.}} = Fe(NO_3)_3 + NO_2\uparrow + 2H_2O$$

10. peroqsidis, zeperoqsidis da ozonidis urTierTqmedebiT mJavur oqsidTan:

$$2Na_2O_2 + 2CO_2 = 2Na_2CO_3 + O_2 \uparrow,$$

$$4KO_2 + 2CO_2 = 2K_2CO_3 + 30_2 \uparrow.$$

$$4KO_3 + 2CO_2 = 2K_2CO_3 + 50_2 \uparrow.$$

es reaqciebi safuZvlad udevs haeris regeneracias daxSul sivrceebSi (wyalqveSa navebi, kosmosuri xomaldebi, izolirebuli airwinaRebi).

11. mJavas xsnaris warmoqmniT wyalSi uxsnari marilis daleqviT:

$$AgNO_3 + HCl = AgCl \downarrow + HNO_3,$$

$$Ca_3(PO_4)_2 + 3H_2SO_4 = 3CaSO_4 \downarrow + 2H_3PO_4.$$

miRebuli marili ar unda gaixsnas warmoqmnil mJavaSi.

12. mJavuri oqsidis urTierTqmedebiT marilTan:

$$SO_2 + Na_2CO_3 = Na_2SO_3 + CO_2 \uparrow,$$

$$6SiO_2 + 2Ca_3(PO_4)_2 \overset{t}{=} 6CaSiO_3 + P_4O_{10} \uparrow.$$

13. marilidan xsnadi tutiT uxsnari hidroqsidis gamoleqviT:

$$FeSO_4 + 2NaOH = Fe(OH)_{2\downarrow} + Na_2SO_4.$$

14. erTi uxsnari marilis, rogorc marilebs Soris mimocvlis reaqciis Sedegis warmoqmniT:

$$BaCl_2 + Na_2SO_4 = BaSO_{4\downarrow} + 2NaCl.$$

15. marilis Termuli daSliT:

marilis daSlis xarisxi ganisazRvreba kationis muxtis ($n^+$) fardobiT mis radiusTan. rac meti iqneba es fardoba, miT ufro ,,Rrma” iqneba daSlis xarisxi.

$$2LiNO_3 \overset{t}{=} 2LiNO_2 + O_2,$$

$$2KClO_3 \overset{t}{\underset{MnO_2}{=}} 2KCl + 30_2.$$

zogierT SemTxvevaSi marilis daSlaSi ganmsazRvrel rols asrulebs metalis kationis Sevsebuli 18-eleqtroniani qvedonec:

$$2Cu(NO_3)_2 \overset{t}{=} 2CuO + 4NO_2 + O_2,$$

$$2AgNO_3 \overset{t}{=} 2Ag + 2NO_2 + O_2.$$

16. marilis anionis SedgenilobaSi Semavali, marilwarmomqmneli elementis JangviT an aRdgeniT:

$$Na_2SO_3 + H_2O_2 = Na_2SO_4 + H_2O$$

$$Na_2SO_4 + 4C \overset{t}{=} Na_2S + 4CO.$$

## 3.3. marilis fizikuri Tvisebebi

marili arsebobs mravalgvari _ sxvadasxva simagrisa da simkvrivis, wyalxsnarisa da nadnobis gansxvavebuli eleqtrogamtarobis, myari kristaluri nivTierebis, SedarebiT maRali dnobisa da duRilis temperaturiT. wyalSi xsnadobis mixedviT _ kargad xsnadi, mcired xsnadi da praqtikulad uxsnari marili. unda gvaxsovdes, rom:

1. natriumisa da kaliumis yvela marili xsnadia;
2. yvela nitriti da nitrati xsnadia;
3. amoniumis ( $NH_4^+$ ) yvela marili xsnadia;
4. yvela qloridi xsnadia (garda $AgCl, Hg_2Cl_2, CuCl$ , xolo $PbCl_2$ mcired xsnadia);
5. yvela sulfati xsnadia (garda $BaO_4, PbSO_4$ ), xolo $CaSO_4$ da $Ag_2SO_4$ _ mcired xsnadi;
6. yvela sulfidi uxsnaria, garda tute metalebisa da amoniumis sulfidebisa;
7. yvela sulfiti, fosfati, karbonati uxsnaria, garda natriumisa da kaliumis Sesabamisi marilebisa;
8. yvela acetati xsnadia.

## 3.4. marilis qimiuri Tvisebebi

marils SeuZliaT urTierTqmedeba:

1. mJavasTan an mJavur oqsidTan (Zlieri an naklebaqroladi mJava gamoaZevebs sust an naklebaqrolads, aramdgradi mJavas marilebidan):

$$KCN + HCl = KCl + HCN ,$$

$$\underset{\text{myari}}{KClO_4} + \underset{\text{konc.}}{H_2SO_4} \overset{t}{=}\underset{\text{vakuumi}}{} KHSO_4 + HClO_4 ,$$

$$Na_2CO_3 + SiO_2 \overset{t}{=} Na_2SiO_3 + CO_2 \uparrow .$$

2. fuZesTan (Zlieri an naklebaqroladi fuZe aZevebs sust an ufro aqrolad fuZes marilidan):

$$FeSO_4 + 2NaOH = Fe(OH)_2 \downarrow + Na_2SO_4 ,$$

$$NH_4Cl + KOH = NH_3 \uparrow + H_2O + KCl .$$

3. marilTan:

$$AgNO_3 + NaCl = AgCl \downarrow + NaNO_3 .$$

eleqtrolitebs Soris mimocvlis reaqciis gantolebis Sedgenisas, aucilebelia bolomde gaviTvaliswinoT reaqciis mimdinareobis pirobebi da gamoviyenoT fuZeebis, mJavebis da marilebis xsnadobis cxrili (ix. danarTi, gv. 198).

4. metalTan, romelic ZabvaTa eleqtroqimiur mwkrivSi dgas metalamde, romlis kationi Sedis marilis SedgenilobaSi:

$$2AgNO_3 + Cu = 2Ag \downarrow + Cu(NO_3)_2 .$$

msgavsi reaqciebis gantolebaTa Sedgenisas ar unda gamoviyenoT metali, romelic dgas eleqtroqimiur ZabvaTa mwkrivSi magniumamde, radgan es metali, upirveles yovlisa, urTierTqmedebaSi Seva wyalTan, ris Sedegadac warmoiqmneba hidroqsidi, romelic reagirebs marilTan, (magaliTad, xsnari $CuSO_4 + Na$ ):

$$2Na + 2H_2O = 2NaOH + H_2 \uparrow ,$$

$$2NaOH + CuSO_4 = Cu(OH)_2 \downarrow + Na_2SO_4 .$$

5. JangbadSemcveli mJavas marili iSleba gaxurebis dros:

$$2Cu(NO_3)_2 \overset{t}{=} 2CuO + 4NO_2 \uparrow + O_2 \uparrow ,$$

$$CaCO_3 \overset{t}{=} CaO + CO_2 \uparrow (t > 900^\circ C \text{ dros }).$$

6. Tu mJavawarmomqmnel elements aqvs ramdenime Jangvis xarisxi, maSin saTanado mJangavis an aRmdgenis gamoyenebiT SeiZleba gadasvla erTi mJavas marilidan meore mJavas marilze, romlebSic erTi da igive mJavawarmomqmneli elementi imyofeba Jangvis sxva xarisxSi.

$$Na_2\overset{+4}{S}O_3 + H_2O_2 = Na_2\overset{+6}{S}O_4 + H_2O\cdot$$

analogiurad, Tu metali, romelic Sedis marilis SedgenilobaSi avlens sxvadasxva Jangvis xarisxs, maSin SeiZleba gadasvla erTi marilidan meoreze, romelSic metali iqneba Jangvis sxva xarisxSi:

$$3\overset{+2}{Fe}(NO_3)_2 + 4HNO_3 = 3\overset{+3}{Fe}(NO_3)_3 + NO\uparrow + 2H_2O$$

$$2\overset{+3}{Fe}Cl_3 + Cu = 2\overset{+2}{Fe}Cl_2 + CuCl_2.$$

# IV Tavi. marilis hidrolizi

neitralizaciis reaqciiT marilis miRebisas mosalodneli iyo, rom saSualo marilis wyalxsnars neitraluri reaqcia eqneboda. magram gairkva, rom mravali saSualo marilis wyalxsnars aqvs tute ($pH > 7$) an mJava ($pH < 7$) reaqcia, Tumca maT SedgenilobaSi ar Sedis arc wyalbadis ($H^+$) da arc hidroqsilis ($OH^-$) ionebi. amasTan, aRsaniSnavia, rom wyali umniSvnelod disocirdeba Semadgenel wyalbad- da hidroqsil- ionebad, magram miuxedavad amisa, swored wylis disociaciiT SeiZleba aixsnas iseTi mniSvnelovani movlena, rogoricaa nivTierebaTa **hidrolizi** (berZn. hidroz – wyali, lysis - daSla).

hidrolizis movlenas **s.areniusis Teoria** xsnis wylis disociaciiT miRebuli ionebis ($H^+$ da $OH^-$) urTierTqmedebiT gaxsnili nivTierebis ionebTan. miuxedavad imisa, rom wyalSi $H^+$ da $OH^-$ ionebis koncentracia Zalian mcirea, isini wonasworobaSi imyofeba wylis uamrav aradisocirebul molekulasTan. gaxsnili nivTierebis ionebTan wylis romelime ionis ($H^+$ an $OH^-$) dakavSireba arRvevs wonasworobas, rac iwvevs wylis axal-axali molekulebis disociacias. Sesabamisad, xsnarSi mniSvnelovani raodenobiT grovdeba wylis wyalbad ($H^+$)- an hidroqsil ($OH^-$)- ioni, ris gamoc xsnari mJava an tute reaqcias avlens.

amrigad, hidrolizi aris nivTierebis daSla wyliT. mocemul SemTxvevaSi gvainteresebs marilTa hidrolizi.

**gaxsnil marilis ionebis $M^{n+}$ da $A^{n-}$** (sadac $M^{n+}$ aris metalis, xolo $A_n^n$ - mJavas naSTis ioni, Sesabamisi dadebiTi da uaryofiTi $n$ - muxtebiT) **urTierTqmedebas wylis** ($H^+$ da $OH^-$) **ionebTan, ris Sedegadac**

**warmoiqmneba susti eleqtroliti** (susti mJava, susti fuZe an orive erTad), **marilis hidrolizi ewodeba**.

marilis hidrolizis procesi umravles SemTxvevaSi Seqcevadia.

imis mixedviT, Tu ra siZlieris fuZisa da mJavasgan aris warmoqmnili marili misi hidrolizi gansxvavebulad warimarTeba:

**1. Zlieri fuZisa da Zlieri mJavasgan warmoqmnili marili** ($KNO_3$, $NaCl$, $Na_2SO_4$) ar hidrolizdeba, radgan misi ionebis wyalTan urTierTqmedebiT susti eleqtroliti ar miiReba, xolo wylis disociaciis Sedegad wyalbadisa da hidroqsilis ionebis koncentracia umniSvneloa (wylis disociaciis xarisxi, oTaxis temperaturaze, $10^{-9}$-is tolia, e.i. wylis yoveli miliardi molekulidan mxolod erTi molekula disocirdeba $H^+$ da $OH^-$ ionebad), amitom wylis disociaciis wonasworoba ar irRveva da aseTi marilis xsnars aqvs neitraluri reaqcia:

$$NaCl + H_2O \Leftrightarrow NaOH + HCl$$

an ionur-molekuluri formiT:

$$Na^+ + Cl^- + H_2O \Leftrightarrow Na^+ + OH^- + H^+ + Cl^-$$

reaqciis gantolebis marcxena da marjvena nawilSi erTnairi ionebis Sekvecis Semdeg darCeba wylis disociaciis gantoleba:

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

aqedan gamomdinare, xsnarSi ar aris Warbi wyalbadisa ($H^+$) da hidroqsilis ($OH^-$) ionebi; amaT garda, wyalSi araviTari sxva sustad disocirebadi an Znelad xsnadi naerTebi ar warmoiqmneba da amis gamo wylis disociaciis wonasworobac ar dairRveva.

amrigad, **Zlieri fuZisa da Zlieri mJavas urTierTqmedebis Sedegad warmoqmnil marilis xsnarSi are praqtikulad neitraluri** ($pH \approx 7.0$) **rCeba, e.i. aseTi marili hidrolizs ar ganicdis.**

**2. Zlieri fuZisa da susti mJavasagan warmoqmnili marilis hidrolizi.** Zlieri fuZisa da susti mJavas mier warmoqmnili marilis ($Na_2CO_3$, $KNO_2$ da sxv.) hidrolizs ewodeba, agreTve, hidrolizi anionis mixedviT. ganvixiloT natriumis acetatis wyalxsnarSi mimdinare procesi. natriumis acetati ($CH_3COONa$) Zlieri eleqtrolitia, wyalSi gaxsnisas mTlianad disocirdeba ionebad:

$$CH_3COONa \rightarrow Na^+ + CH_3COO^-,$$

wyali Zlier umniSvnelod, magram mainc disocirdeba:

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

marilis disociaciis Sedegad miRebuli $Na^+$ da $CH_3COO^-$ ionebidan, natriumis kationi $Na^+$ ver boWavs xsnarSi arsebul hidroqsilis $OH^-$ anions da ver warmoqmnis natriumis hidroqsids ($NaOH$), radgan es ukanaskneli Zlieri eleqtrolitia da xsnarSi mxolod ionebis ($Na^+$ da $OH^-$) saxiT arsebobs. rac Seexeba susti ZmarmJavas anions – acetations - $CH_3COO^-$, igi uerTdeba $H^+$ ions da warmoqmnis susti eleqtrolitis – ZmarmJavas ($CH_3COOH$) molekulas. wyalbadionTa SeboWva arRvevs wylis disociaciis wonasworobas, ris gamoc wylis axali molekulebi iSleba ionebad. es procesi grZeldeba wonasworobis damyarebamde:

$$CH_3COO^- + H^+ \Leftrightarrow CH_3COOH \qquad H_2O \Leftrightarrow H^+ + OH^-$$

am gantolebaTa SejamebiT miiReba:

$$CH_3COO^- + H_2O \Leftrightarrow CH_3COOH + OH^-$$

$$CH_3COONa + H_2O \Leftrightarrow CH_3COOH + Na^+ + OH^-$$

amrigad, susti eleqtrolitis ($CH_3COOH$) warmoqmnis gamo wylis disociaciis ionuri wonasworoba gadaixreba marjvniv da warmoiqmneba hidroqsil-ionebis ($OH^-$) siWarbe, ris Sedegadac natriumis acetatis ($CH_3COONa$) wyalxsnars tute reaqcia eqneba. Sesabamisad, marilTa xsnarebs, romlebic warmoqmnilia Zlieri fuZiT da susti mJavaTi, aqvs fuZe reaqcia ($pH > 7$).

mravalfuZiani (or-, sammuxtiani anionebis dros da a.S.) susti mJavasa da Zlieri fuZisgan miRebuli marilis hidrolizi safexurebad – mJava marilebisa da bolos susti mJavas – susti eleqtrolitis warmoqmniT, mimdinareobs:

$$Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$$

I safexuri: $CO_3^{2-} + H_2O \Leftrightarrow HCO_3^- + OH^-$

$$2Na^+ + CO_3^{2-} + H_2O \Leftrightarrow 2Na^+ + HCO_3^- + OH^-$$

$$Na_2CO_3 + H_2O \Leftrightarrow NaHCO_3 + Na^+ + OH^-$$

II safexuri: $HCO_3^- + H_2O \Leftrightarrow H_2CO_3 + OH^-$

$$Na^+ + HCO_3^- + H_2O \Leftrightarrow Na^+ + H_2CO_3 + OH^-$$

$$NaHCO_3 + H_2O \Leftrightarrow H_2CO_3 + Na^+ + OH^-$$

aRsaniSnavia, rom Cveulebriv pirobebSi marilTa hidrolizis pirveli safexuri mimdinareobs ufro Zlierad, vidre meore da a.S. safexuri, radgan xsnarSi hidroqsil-ionebis ($OH^-$) koncentraciis zrda marcxniv gadaxris wonasworobas.

**3. Zlieri mJavasa da susti fuZisagan warmoqmnili marili. Zlieri mJavaTi da susti fuZiT miRebuli marilis** ($CuCl_2$, $FeCl_3$ da sxv.) **hidrolizs ewodeba, agreTve hidrolizi kationis mixedviT**. ganvixiloT amoniumis qloridis ($NH_4Cl$) wyalxsnarSi mimdinare procesi. igi Zlieri eleqtrolitia da wyalSi mTlianad disocirdeba Semadgenel ionebad:

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

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

qloris ioni ($Cl^-$) ar monawileobs hidrolizis reaqciaSi, radgan ar SeuZlia SeboWos wyalbadis ($H^+$) ioni, radgan marilmJava ($HCl$) Zlieri eleqtrolitia da wyalSi mTlianad disocirebulia ionebad.

$$NH_4^+ + H_2O \Leftrightarrow NH_3 \cdot H_2O + H^+,$$

$$NH_4^+ + Cl^- + H_2O \Leftrightarrow NH_3 \cdot H_2O + Cl^- + H^+,$$

$$NH_4Cl + H_2O \Leftrightarrow NH_3 \cdot H_2O + H^+ + Cl^-.$$

amrigad, $NH_4Cl$ hidrolizis Sedegad xsnarSi dagrovdeba wyalbadis ionebi ($H^+$), ufro sworad hidroqsoniumis ($H^+ + H_2O = H_3^+O$) ionebi, ris Sedegadac xsnars eqneba mJava are ($pH < 7$).

mravalfuZuri (mravalmuxtiani kationis Semcveli) susti fuZisa da Zlieri mJavasgan miRebuli marilis hidrolizi safexurebad mimdinareobs fuZe marilis warmoqmniT. magaliTad, spilenZ(II)-is qloridi or safexurad hidrolizdeba:

$$CuCl_2 \rightarrow Cu^{2+} + 2Cl^-$$

I safexuri: $Cu^{2+} + H_2O \Leftrightarrow Cu(OH)^+ + H^+$,

$$Cu^{2+} + 2Cl^- + H_2O \Leftrightarrow Cu(OH)^+ + 2Cl^- + H^+,$$

$$CuCl_2 + H_2O \Leftrightarrow Cu(OH)Cl + H^+ + Cl^-.$$

II safexuri: $Cu(OH)^+ + H_2O \Leftrightarrow Cu(OH)_2 + H^+$,

$$Cu(OH)^+ + Cl^- + H_2O \Leftrightarrow Cu(OH)_2 + Cl^- + H^+,$$

$$Cu(OH)Cl + H_2O \Leftrightarrow Cu(OH)_2 + H^+ + Cl^-.$$

Cveulebriv pirobebSi, hidrolizis II safexuri TiTqmis ar mimdinareobs, rac gamowveulia xsnarSi $H^+$ ionebis koncentraciis zrdiT da wonasworobis marcxniv gadaxriT. ganvixiloT kidev erTi magaliTi:

$$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$$

I safexuri: $Cu^{2+} + SO_4^{2-} + H_2O \Leftrightarrow Cu(OH)^+ + SO_4^{2-} + H^+$

$$Cu^{2+} + H_2O \Leftrightarrow Cu(OH)^+ + H^+$$

radgan $CuSO_4$ xsnarSi, $H^+$ da $Cu(OH)^+$ dadebiTad damuxtul ionebTan erTad, arsebobs $SO_4^{2-}$ uaryofiTi ionebi da molekuluri formiT, hidrolizis gantoleba iqneba:

$$2CuSO_4 + 2H_2O \Leftrightarrow (CuOH)_2SO_4 + 2H^+ + SO_4^{2-}.$$

amitom praqtikulad hidrolizi Cerdeba pirvel safexurze. Sesabamisad, marilis xsnars, romelic warmoqmnilia Zlieri mJavaTi da susti fuZiT, aqvs mJava reaqcia ($pH < 7$).

**4. susti fuZisa da susti mJavasgan warmoqmnili marilis hidrolizi. susti fuZiTa da susti mJavaTi warmoqmnili marilis (** $NH_4CN$, $NH_4NO_2$ **da sxv.) hidrolizs ewodeba hidrolizi kationisa da anionis mixedviT**.

fuZisa da mJavas, romlisganac warmoqmnilia konkretuli marili, siZliereze damokidebulebiT SesaZlebelia hidrolizis sami SemTxveva:

a) sxvadasxva siZlieris – susti mJavasa da susti fuZis urTierTqmedebiT warmoqmnili amoniumis cianidis ($NH_4CN$) hidrolizi, romlis $K_{NH_4OH} > K_{HCN}$ (sadac $K$ aris Sesabamisi naerTis disociaciis mudmiva), gamoisaxeba Semdegnairad:

$$NH_4^+ + H_2O \Leftrightarrow NH_3 \cdot H_2O + H^+ \ , \qquad CN^- + H_2O \Leftrightarrow HCN + OH^- .$$

gantolebaTa SejamebiT miiReba:

$$NH_4^+ + CN^- + H_2O \Leftrightarrow NH_3 \cdot H_2O + HCN \ ,$$

$$NH_4CN + H_2O \Leftrightarrow NH_3 \cdot H_2O + HCN \ .$$

radgan hidrolizs ganicdis rogorc kationi ($NH_4^+$), aseve anioni ($CN^-$), da amave dros disociaciis mudmiva susti amoniumis tutisa SedarebiT metia, vidre susti cianmJavasi, e.i. $K_{NH_4OH} > K_{HCN}$, amitom wonasworoba ufro SesamCnevad marjvniv wainacvlebs, vidre amoniumis qloridisa ($NH_4Cl$) da natriumis cianidis ($NaCN$) marilTa hidrolizis SemTxvevaSi.

amoniumis cianidis ($NH_4CN$) hidrolizis dros kationebi ($NH_4^+$) boWavs hidroqsid-ionebs, xolo anionebi ($CN^-$) – wyalbadis ionebs, e.i. kationis hidrolizi xels uwyobs anionis hidrolizs. $K_{NH_4OH} > K_{HCN}$ niSnavs, rom $CN^-$ - ionebi ufro mtkiced ikavSirebs wyalbad-ionebs, vidre $NH_4^+$ - ionebi hidroqsilis ionebs; aqedan gamomdinare, xsnarSi Tavisufal $OH^-$ - ionebis koncentracia SedarebiT maRali iqneba, vidre $H^+$- ionebis koncentracia da Sesabamisad xsnars eqneba susti tute are.

b) erTnairi siZlieris – susti mJavasa da susti fuZis mier warmoqmnili amoniumis acetatis SemTxvevaSi:

$$CH_3COONH_4 + H_2O \Leftrightarrow NH_4OH + CH_3COOH$$

amoniumis hidroqsidisa ($NH_4OH$) da ZmarmJavas ($CH_3COOH$) disociaciebis mudmivebi ($K_{NH_4OH}$ da $K_{CH_3COOH}$) praqtikulad erTnairia da $1{,}8\cdot10^{-5}$ tolia. radgan xsnarSi acetat-ionebisa ($CH_3COO^-$) da amoniumis ionebis ($NH_4^+$) koncentraciebi erTnairia, xolo Sesabamisi mJava da fuZe ZaliT erTmaneTis tolia, amitom xsnars eqneba **neitraluri are** ($pH = 7$).

g) **susti mravalfuZiani mJavasa** da **susti mravalmJavuri fuZis** urTierTqmedebis Sedegad miRebuli marilebi – aluminis ($Al$), qrom(III)-isa da rkina(III)-is sulfidebi, sulfatebi da karbonatebi mTlianad da Seuqcevad hidrolizdeba wyalSi – uxsnari fuZeebisa da aqroladi naerTebis saxiT:

$$Al_2S_3 + 6H_2O \rightarrow 2Al(OH)_3\downarrow + 3H_2S\uparrow,$$

$$Cr_2S_3 + 6H_2O \rightarrow 2Cr(OH)_3\downarrow + 3H_2S\uparrow.$$

hidrolizis gamo, aRniSnuli marilebi wyalxsnarebSi ver miiReba mimocvlis reaqciiT:

$$Fe_2(SO_4)_3 + 3Na_2CO_3 + 3H_2O \Leftrightarrow 2Fe(OH)_3\downarrow + 3Na_2SO_4 + 3CO_2\uparrow,$$

$$2Fe^{3+} + 3CO_3^{2-} + 3H_2O \Leftrightarrow 2Fe(OH)_3\downarrow + 3CO_2\uparrow.$$

## 4.1. hidrolizis xarisxi da hidrolizis mudmiva

**marilTa hidrolizi raodenobiTad xasiaTdeba hidrolizis xarisxiT ($\alpha_h$) – hidrolizebuli marilis molekulebis ricxvis ($n$) fardobiT gaxsnili marilis molekulaTa saerTo rixvTan** ($N$):

$$\alpha_{\text{h}} = \frac{n}{N} \cdot 100\%$$

marilTa hidrolizis procesi, umravles SemTxvevaSi, Seqcevadia. amitom misTvis marTebulia **masaTa qmedebis kanoni**. aqedan gamomdinare, SeiZleba vipovoT hidrolizis mudmivas maTematikuri gamosaxuleba.

zogadi saxiT $KA$ marilisTvis (sadac $K$ - kationia, xolo $A$ - anioni) hidrolizis reaqcia iqneba:

$$KA + H_2O \Leftrightarrow KOH + HA$$

am reaqciis wonasworobis mudmiva:

$$K = \frac{[KOH][HA]}{[KA][H_2O]}.$$

radgan $[H_2O]$ ganzavebul xsnarSi SeiZleba CaiTvalos mudmiv sidided, amitom $K[H_2O]$ namravli mudmivi iqneba da mas hidrolizis mudmiva ewodeba. amrigad,

$$K_{\text{h}} = \frac{[KOH][HA]}{[KA]}.$$

rogorc wonasworobis gantolebidan Cans, xsnarSi wylis koncentraciis gadidebiT (an marilis koncentraciis SemcirebiT) wonasworoba gadainacvlebs marcxnidan marjvniv. amitom ganzavebul xsnarebSi marilebi hidrolizdeba ukeTesad da swrafad, vidre koncentrirebulSi da, Sesabamisad hidrolizis xarisxi izrdeba xsnaris ganzavebis dros. magaliTad, kaliumis cianidis hidrolizis SemTxvevaSi:

$$KCN + H_2O \Leftrightarrow KOH + HCN$$

$$K_{\text{h}} = \frac{[KOH][HCN]}{[KCN]}$$

xsnaris 10-jer ganzavebis SemTxvevaSi Tavdapirvelad yvela nivTierebis - $KCN,\ HCN,\ KOH$, koncentracia 10-jer Semcirdeba. aqedan gamomdinare, hidrolizis mudmivas gantolebis marjvena nawilSi mricxveli Semcirdeba 100-jer, xolo mniSvneli mxolod 10-jer. magram hidrolizis mudmiva, rogorc wonasworobis yovelgvari mudmiva, ar aris damokidebuli nivTierebis koncentraciaze. amitom xsnarSi wonasworoba dairRveva. imisaTvis, rom wonasworoba xelaxla damyardes, kidev unda moxdes marilis garkveuli raodenobis hidrolizi, ris Sedegadac gaizrdeba kaliumis tutis da cianwyalbadmJavas koncentraciebi, xolo kaliumcianidis koncentracia Semcirdeba. amrigad, marilis hidrolizis xarisxi gaizrdeba.

laboratoriul praqtikaSi xSirad xels gviSlis hidrolizi, radgan misi mimdinareobis dros zogjer warmoiqmneba naleqi. le Satelies principis Tanaxmad SeiZleba wonasworobaze gavlenis moxdena Tu sistemaSi, romelSic damyarebulia wonasworoba SevitanT romelime warmoqmnil produqts, moxdeba hidrolizis CaxSoba. hidrolizis xarisxi mkveTrad Semcirdeba. am meTods xSirad iyeneben advilad hidrolizebad marilTa xsnarebis Sesanaxad. magaliTad, Tu movamzadebT rkina(III)-is qloridis wyalxsnars, maSin hidrolizis gamo xsnarSi male gaCndeba fuZe marilis naleqi ($FeOHCl_2$). am xsnaris $HCN$-iT SemJavebis dros masSi Warbi raodenobiT Seitaneba $H^+$- ionebi, romelic hidrolizis erT-erTi produqtia. amis gamo, upiratesad reaqcia warimarTeba marjvnidan marcxniv. aseT SemTxvevaSi xsnari SeiZleba SevinaxoT xangrZlivi drois ganmavlobaSi.

hidrolizis wonasworobis wanacvleba SeiZleba moxdes hidrolizis gaZlierebis mimarTulebiT, e.i. le Satelies principis Tanaxmad, hidrolizis erT-erTi produqtis SeboWviT hidrolizi gaZlierdeba da igi SeiZleba gaxdes sruli.

wylis molekulis eleqtrolituri disociacia temperaturis zrdiT mkveTrad izrdeba, e.i. izrdeba $H^+$ da $OH^-$ - ionebis raodenoba, rac zrdis imis SesaZleblobas, rom warmoiqmnas susti mJavasa da susti fuZis mcired disocirebuli molekulebi. amasTan dakavSirebiT, Zlierdeba marilis hidrolizi. magaliTad, natriumis acetatis ($CH_3COONa$) xsnarze (oTaxis temperaturaze) indikatori fenolftaleinis ramdenime wveTis damatebiT mis koncentrirebul xsnarSi gaCndeba mxolod susti vardisferi Seferiloba. magram sakmarisia xsnaris gacxeleba, rom igi Seiferos Jolosfrad, rac miuTiTebs hidroqsil-ionebis siWarbeze. xsnaris gacivebis dros Jolosferi Seferiloba Zlier sustdeba, e.i. procesi Seqcevadia.

hidrolizze temperaturis gavlenis Tvalyuris midevneba SeiZleba $FaC\ell_3$ xsnaris gamoyenebiT, sadac gaTbobis dros Cndeba rkinis fuZe marilisa da rkinis hidroqsidis naleqi, rac mowmobs marilis hidrolizis gaZlierebas.

amrigad, zemoTqmulis safuZvelze SeiZleba davaskvnaT, rom:

1) Zlieri fuZisa da Zlieri mJavasgan warmoqmnili marilis hidrolizis xarisxi praqtikulad nulis tolia;
2) susti fuZisa da Zlieri mJavasgan an Zlieri fuZisa da susti mJavasgan warmoqmnili marilis hidrolizis xarisxi daaxloebiT 1%-ia;

3) susti fuZisa da susti mJavasgan warmoqmnili marilis hidrolizis xarisxi sakmaod maRalia da zogjer 100%-s uaxlovdeba;
4) xsnaris ganzavebiT izrdeba wylis koncentracia da wonasworoba marjvniv gadaixreba – hidrolizis xarisxi gaizrdeba;
5) hidrolizis, rogorc neitralizaciis (ekzoTermuli reaqcia) Sebrunebuli procesis (endoTermuli reaqcia), mimdinareobisas temperaturis gazrda iwvevs wonasworobis gadaxras (le Satelies principi) hidrolizis gaZlierebis mimarTulebiT (am gziT SesaZlebelia hidrolizis bolomde miyvana);
6) hidrolizis Sedegad nivTierebis – airis an naleqis saxiT gamoyofis SemTxvevaSi hidrolizi praqtikulad Seuqcevadia.

## 4.2. hidrolizi zogadad

marilis hidrolizi nivTierebis hidrolizis kerZo SemTxvevaa. zogadad hidrolizi farTo gagebiT – es aris sxvadasxva nivTierebasa da wyals Soris mimocvliT daSlis reaqcia. aseTi gansazRvra moicavs organuli naerTebis – rTuli eTerebis, naxSirwylebis, cilebis, cximebis hidrolizs da araorganuli nivTierebebis – marilebis, halogenebis agreTve arametalTa halogenidebis hidrolizsac. magaliTad,

$$CH_3COOC_2H_5 + H_2O \Leftrightarrow CH_3COOH + C_2H_5OH\,,$$

$$CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2\uparrow,$$

$$Cl_2 + H_2O \Leftrightarrow HCl + HClO\,,$$

$$PI_3 + 3H_2O \rightarrow H_3PO_3 + 3HI\,.$$

qimiuri mrewvelobis mravali dargi hidrolizur process eyrdnoba (saxameblis da celulozis hidrolizi, cximebidan sapnis miReba da sxv.). cocxal organizmebSi, rogorc zemoT iTqva, mudmivad mimdinareobs naxSirwylebis, cximebis, cilebis da sxva organul naerTTa hidrolizi. amitom mtkiceba imisa, rom hidrolizi – es aris neitralizaciis Sebrunebuli reaqcia, marTebulia mxolod kerZo SemTxvevisaTvis, e.i. marilTa hidrolizisaTvis.

## 4.3. meti rom vicodeT marilTa Sesaxeb

**marili rTuli nivTierebaa, romlis SedgenilobaSi Sedis mJavur naSTTan SeerTebuli metalis (** $Na$ **,** $Mg$ **,** $Al$ **da sxv.) atomebi an amoniumis (** $NH_4$ **) jgufi**.

eleqtrolituri disociaciis Teoriis Tanaxmad _ marili iseTi eleqtrolitia, romlis disociaciis Sedegad warmoiqmneba metalis kationi ( $K^+$ , $Ca^{2+}$ , $Fe^{2+}$ da sxv.) an amoniumis ioni ( $NH_4^+$ ) da mJavuri naSTis anionebi ( $Cl^-$ , $NO_3^-$ , $SO_4^{-2}$ da sxv.).

$$NaCl \to Na^+ + Cl^- ,$$

$$NH_4NO_3 \to NH_4^+ + NO_3^- .$$

Sedgenilobis mixedviT ganasxvaveben **saSualo** ( $NaCl$ , $KNO_3$, $CaCO_3$ da a.S.), **fuZur** ( $Fe(OH)Cl_2$ , $Al(OH)(NO_3)_2$ , $Cr(OH)SO_4$ da a.S.), **ormag** ( $NaAl(SO_4)_2$ , $KCr(SO_4)_2$ , $LiFePO_4$ da a.S.), **Sereul** ( $CaOCl_2$ , $MgClNO_3$ , $FeNO_3SO_4$ da a.S.) da **kompleqsur** ( $K_3[Fe(CN)_6]$ , $K_4[Fe(CN)_6]$, $[Pt(NH_3)_2Cl_4]$, $[Cr(H_2O)_6]\cdot Cl_3$ da a.S.) marilebs.

nebismieri marili SeiZleba ganxilul iqnas, rogorc fuZisa da mJavas urTierTqmedebis, e.i. neitralizaciis reaqciis produqti. saSualo marili miiReba sruli neitralizaciis Sedegad ( $2KOH + H_2SO_4 = 2H_2O + K_2SO_4$ ). Tu fuZe aRebulia naklebi raodenobiT, vidre saWiroa mJavas sruli ganeitralebisaTvis warmoiqmneba mJavuri marili ( $Ca(OH)_2 + H_3PO_4 = CaHPO_4 + 2H_2O$ ). amrigad, rodesac mJavas molekulaSi metalis atomebiT Canacvlebis unaris mqone wyalbad-atomebis mxolod nawilia Canacvlebuli metalis atomebiT, miiReba mJavuri marili _ metalisa da mJavuri naSTis garda, igi Seicavs wyalbadis atomebsac ( $KH_2PO_4$ , $Mg(H_2PO_4)_2$ , $NaHCO_3$ ). aseTi marilebis disociacia gamoisaxeba gantolebiT:

$$KHSO_4 \to K^+ + HSO_4^- ,$$

$$KH_2PO_4 \to K^+ + H_2PO_4^- .$$

mJavuri marilis anionebi, rogorc susti eleqtroliti, ganicdis Semdgom disociacias:

$$HSO_4^- \Leftrightarrow H^+ + SO_4^{2-} ,$$

$$H_2PO_4^- \Leftrightarrow H^+ + HPO_4^{2-},$$

$$HPO_4^{2-} \Leftrightarrow H^+ + PO_4^{3-}.$$

zemoaRniSnulidan naTelia, rom mJavuri marili disocirdeba safexurebad _ jer xdeba metalis ionis mocileba, xolo Semdeg _ wyalbad-ionisa (umniSvnelod). mJavur marils warmoqmnis mravalfuZiani mJava.

fuZuri marili metalisa da mJavuri naSTis garda, Seicavs hidroqsilis ($OH^-$) jgufebs ($Fe(OH)Cl_2$, $Al(OH)(NO_3)_2$, $Cr(OH)SO_4$). es marili miiReba arasruli neitralizaciis reaqciiT, roca mJava aRebulia naklebi raodenobiT, vidre saWiroa fuZis sruli ganeitralebisaTvis ($Ca(OH)_2 + HNO_3 = Ca(OH)NO_3 + H_2O$). e.i. Tu fuZis hidroqsid-ionebis mxolod nawilia gacvlili mJavuri naSTis ionze miiReba fuZuri marili. aseT marils warmoqmnis mravalmJavuri fuZe. fuZuri marilis disociacia gamoisaxeba gantolebiT:

$$Ca(OH)NO_3 \rightarrow Ca(OH)^+ + NO_3^-$$

fuZuri marilis kationi Zlier umniSvnelo xarisxiT ganicdis Semdgom disociacias:

$$Ca(OH)^+ \Leftrightarrow Ca^{2+} + OH^-$$

ormagi marili Sedgeba ori sxvadasxva metalis kationisa da erTi mJavuri naSTis anionisgan ($NaAl(SO_4)_2$, $KCr(SO_4)_2$, $LiFePO_4$). aseTi marilis disociacia gamoisaxeba gantolebiT:

$$NaAl(SO_4)_2 \rightarrow Na^+ + Al^{3+} + 2SO_4^{2-}$$

Sereuli marili Sedgeba metalis erTi kationisa da ori sxvadasxva mJavas anionisagan ($CaOCl_2$ anu $Ca(ClO)Cl$). igi disocirdeba Semdegi gantolebiT:

$$Ca(ClO)Cl \rightarrow Ca^{2+} + ClO^- + Cl^-$$

kompleqsuri marilis SedgenilobaSi Sedis rTuli kompleqsuri ioni (formulaSi isini kvadratul frCxilebSia Casmuli): $K_3[Fe(CN)_6]$, $K_4[Fe(CN)_6]$, $[Cr(H_2O)_6]Cl_3$ da a.S. kompleqsur marils SeiZleba mivakuTvnoT kristalhidratebic _ Sabiamnis formula ($CuSO_4 \cdot 5H_2O$) SeiZleba ase daiweros: $[Cu(H_2O)_4]SO_4 \cdot H_2O$. kompleqsuri marilebis disociacia gamoisaxeba gantolebiT:

$$K_3[Fe(CN)_6] \rightarrow 3K^+ + [Fe(CN)_6]^{3-},$$

$$[Cr(H_2O)_6]Cl_3 \rightarrow [Cr(H_2O)_6]^{3+} + 3Cl^-.$$

marilis dasaxelebisaTvis gamoiyeneba mJavas naSTis metaluri saxelwodebebi _ jer asaxeleben metals, xolo Semdeg mJavur naSTs. uJangbado mJavas marilSi arametalis saxelwodebas emateba sufiqsi ,,di”, xolo Jangbadiani mJavas SemTxvevaSi saxelwodebis laTinur fuZes emateba sufiqsi ,,ati” (arametalis umaRlesi Jangvis xarisxis SemTxvevaSi), an ,,iti” (arametalis dabali Jangvis xarisxis SemTxvevaSi). Tu arametali naerTSi avlens ramdenime Jangvis xarisxs, maSin umciresi Jangvis xarisxis SemTxvevaSi Sesabamisi marilis dasaxelebisas iyeneben prefiqss ,,hipo”, xolo umaRlesi Jangvis xarisxis SemTxvevaSi _ prefiqs ,,per”.

qvemoT moyvanilia zogierTi marilis metaluri saxelwodeba:

$MeCl$ _ qloridebi
$MeF$ _ fToridebi
$MeBr$ _ bromidebi
$MeI$ _ iodidebi
$Me_2SO_4$ _ sulfatebi
$Me_2SO_3$ _ sulfitebi
$Me_2S$ _ sulfidebi
$Me_3PO_4$ _ fosfatebi
$Me_3PO_3$ _ fosfitebi
$Me_4P_2O_7$ _ difosfatebi
$Me_2CrO_4$ _ qromatebi
$Me_2Cr_2O_7$ _ diqromatebi

$Me_2SiO_3$ _ silikatebi
$Me_2CO_3$ _ karbonatebi
$MeNO_3$ _ nitratebi
$MeNO_2$ _ nitritebi
$Me_3N$ _ nitridebi
$MeMnO_4$ _ permanganatebi
$Me_2MnO_4$ _ manganatebi
$MeClO$ _ hipoqloritebi
$MeClO_2$ _ qloritebi
$MeClO_3$ _ qloratebi
$MeClO_4$ _ perqloratebi

Tu metali avlens cvladi Jangvis xarisxs, maSin marilis saxelwodebas emateba am metalis Jangvis xarisxis mniSvnelobis aRmniSvneli romauli cifri (frCxilebSi): $FeSO_4$ _ rkina(II)-is sulfati, $Fe_2(SO_4)_3$ _ rkina(III)-is sulfati.

mJavuri marilis dasaxelebisaTvis marilis saxelwodebas emateba prefiqsi ,,hidro“ an ,,dihidro“ imisda mixedviT, Tu ramdeni wyalbadis atomia mJavuri naSTis SedgenilobaSi:

$KHSO_4$ _ kaliumis hidrosulfati
$CaHPO_4$ _ kalciumis hidrofosfati
$Ca(H_2PO_4)_2$ _ kalciumis dihidrofosfati
$Na_2H_2P_2O_7$ _ natriumis dihidropirofosfati

fuZuri marilebis SemTxvevaSi mJavuri naSTis laTinur saxelwodebas emateba prefiqsi ,,hidroqso” an dihidroqso”:

$Al(OH)SO_4$ _ aluminis hidroqsosulfati

$Fe(OH)_2Cl$ _ rkinis dihidroqsoqloridi

SedarebiT rTulia kompleqsuri saxelwodebebi. mag., $K_4[Fe(CN)_6]$ _ kaliumis heqsacianoferati(II), $[Ag(NH_3)_2]Cl$ _ diaminvercxl(I)-is qloridi, $Na[Al(OH)_4(H_2O)_2]$ _ natriumis tetrahidroqsodiakvaaluminati (sityva ,,akva“ laTinurad niSnavs wyals).

saerTaSoriso nomenklaturiT marils, mJavas analogiurad, asaxeleben. qvemoT moyvanilia zogierTi Jangbadiani mJavas marilis saxelwodeba:

$Na_2SO_4$ _ natriumis tetraoqsosulfati(VI)

$K_2CO_3$ _ kaliumis trioqsokarbonati(IV)

$KClO$ _ kaliumis oqsoqlorati(I)

$KMnO_4$ _ kaliumis tetraoqsomanganati(VII)

$Na_2Cr_2O_7$ _ natriumis heptaoqsodiqromati(VI)

$(CuOH)_2CO_3$ _ hidroqsospilenZ(II)-is trioqsokarbonati(IV)

$Fe(OH)NO_3$ _ hidroqsorkina(II)-is trioqsonitrati(V)

$KAl(SO_4)_2$ _ kalium-aluminis tetraoqsosulfati(VI)

saerTaSoriso nomenklaturiT uJangbado mJavas saxelwodeba misi tradiciuli saxelwodebis analogiuria.

oqsidisa da fuZis msgavsad marilisTvisac xSirad iyeneben specifikur saxelwodebas. magaliTad, $Na_2CO_3$ _ sarecxi soda, $NaHCO_3$ _ sasmeli soda, $Na_2SO_4 \cdot 10H_2O$ _ glauberis marili, $(CuOH)_2CO_3$ _ malaqiti, $CaSO_4 \cdot 2H_2O$ _ TabaSiri da sxv.

**liTiumis binaruli naerTi** ufero kristaluri nivTierebaa da warmoadgens marils (an marilmsgavs naerTebs) _ qimiuri bunebis, xsnadobisa da hidrolizis xasiaTis mixedviT igi hgavs kalciumisa da magniumis Sesabamis naerTebs. binaruli naerTis da marilebis garkveuli nawili ( $LiF$ , $Li_2CO_3$ , $Li_3PO_4$ da sxv.) cudad xsnadia.

liTiumis haliduri ( $LiF$ , $LiCl$ , $LiBr$ , $LiI$ ) marilebi miiReba Sesabamisi martivi elementebis uSualo SeerTebiT, gaxurebis procesSi ( $2Li + Cl_2 = 2LiCl$ , $2Li + Br_2 = 2LiBr$ da sxv.) agreTve liTiumis Sesabamis naerTebze

halogenwyalbadmJavebis moqmedebiT ($LiNO_3 + HF = LiF + HNO_3$, $Li_2SO_4 + 2HI = 2LiI + H_2SO_4$).

**liTiumis qloridi (**$LiCl$**)** Zlier higroskopiuli nivTierebaa, advilad ganiTxeva tenian haerze, ierTebs amiaks da warmoqmnis naerTebs ($LiCl \cdot NH_3$, $LiCl \cdot 2NH_3$ da sxv.). liTiumis qloridi advilad STanTqavs naxSirbad(II)-is oqsids ($CO$) _ amitom igi gamoiyeneba wyalqveSa navebsa da kosmosur xomaldebSi haeris regeneraciisaTvis.

**liTiumis nitrati (**$LiNO_3$**)** advilad miiReba mis oqsidze azotmJavas moqmedebiT ($Li_2O + 2HNO_3 = 2LiNO_3 + H_2O$). liTiumis nitrati TeTri kristaluri nivTierebaa, kargad ixsneba wyalSi, spirtSi, Txevad amiakSi. gacxelebisas ($600^\circ C$) iSleba ($2LiNO_3 = Li_2O + 2NO_2 + 1/2O_2$).

**liTiumis karbonati (**$Li_2CO_3$**)** advilad miiReba mis marilis xsnarze karbonatis xsnaris moqmedebiT ($2LiCl + Na_2CO_3 = Li_2CO_3 + 2NaCl$). igi wyalSi mcired xsnadia. hidrokarbonati ($LiHCO_3$) kargad ixsneba wyalSi _ am niSniT igi arsebiTad gansxvavdeba danarCeni tute metalebisagan (maTi hidrokarbonatebi mcired xsnadia wyalSi), magram xsnadobis mixedviT hgavs tutemiwaTa metalebs.

liTiumis karbonati gamoiyeneba liTiumis sxva marilebis misaRebad. misi zogierTi marili gamoiyeneba medicinaSi specialuri malamoebis dasamzadeblad, agreTve msubuq mrewvelobaSi imisaTvis, rom qsovilebi gaauferulon da SesZinon maT wyalgaumtarobis Tviseba.

**natriumis qloridi (**$NaCl$**, halidi, sufris marili),** natriumis yvelaze metad gavrcelebuli naerTia. natriumi advilad Sedis urTierTqmedebaSi halogenebTan, kerZod, qlorTan ($2Na + Cl_2 = 2NaCl$). qimiurad sufTa natriumis qloridis misaRebad mis najer xsnarSi gaatareben airad qlorwyalbads ($HCl$), radgan am dros izrdeba qlor-ionebis koncentracia, Semcirdeba natriumis qloridis xsnadoba. gamokristalebul $NaCl$-s gaalRoben platinis jamSi. amgvarad miRebuli $NaCl$ gamoiyeneba titriani xsnaris mosamzadebladac.

**natriumis karbonati (**$Na_2CO_3$**, uwylo anu kalcinirebuli soda**) TeTri fxvnilia, advilad ixsneba wyalSi. hidratebis warmoqmnis gamo didi raodenobiT gamoyofs siTbos. kristalhidratebidan yvelaze mniSvnelovania $Na_2CO_3 \cdot 10H_2O$. soda mrewvelobaSi, ZiriTadad, solveis meTodiT miiReba _ natriumqloridis wyalxsnarSi wneviT atareben amiaksa da naxSirbadis

dioqsids (Warbad): $NH_3 + CO_2 + H_2O = NH_4HCO_3$, $NaCl + NH_4HCO_3 \Leftrightarrow NaHCO_3 + NH_4Cl$. am oTx marilTagan gamoileqeba yvelaze naklebad xsnadi _ natriumis hidrokarbonati ($NaHCO_3$) _ sasmeli soda. gafiltvris Semdeg naleqs axureben da miiReben uwylo sodas ($2NaHCO_3 = Na_2CO_3 + CO_2 \uparrow + H_2O$). amoniumis qloridze Camqrali kiris moqmedebiT iReben amiaks ($2NH_4Cl + Ca(OH)_2 = CaCl_2 + 2NH_3 \uparrow + 2H_2O$). naxSirbadis dioqsidi ($CO_2$) da amiaki ($NH_3$) warmoebas ubrundeba.

soda SeiZleba miviRoT agreTve natriumis sulfatis ($Na_2SO_4$), naxSirisa ($C$) da kalciumis karbonatis maRal temperaturaze erToblivi urTierTqmedebis Sedegad ($Na_2SO_4 + 2C + CaCO_3 = Na_2CO_3 + CaS + 2CO_2$, am reaqciis endoTermulobis gamo aucilebelia misi gaxureba).

**natriumis nitratis ($NaNO_3$, Ciles gvarjila)** miReba mravali gziT SeiZleba ($NaOH + HNO_3 = NaNO_3 + H_2O$, $2Na_2CO_3 + 4NO_2 + O_2 = 4NaNO_3 + 2CO_2$, $2NaOH + NO_2 + NO + O_2 = 2NaNO_3 + H_2O$). igi bunebaSic gvxvdeba natriumis iodatTan, sulfatTan da qloridTan erTad. natriumis nitrati TeTri, wyalSi advilad xsnadi kristaluri nivTierebaa. higroskopiulobis gamo denTis dasamzadeblad ar gamoiyeneba. mas iyeneben kvebis mrewvelobaSi, ZiriTadad ki soflis meurneobaSi niadagis gasanoyiereblad _ natriumis gvarjila sakmaod gavrcelebuli azotovani sasuqia.

natriumis qloridi ($NaCl$) ZiriTadi nedleulia metaluri natriumis ($Na$), natriumis tutis ($NaOH$), sodis ($Na_2CO_3$), sasmeli sodis ($NaHCO_3$), qloris ($Cl$) misaRebad da sxv. natriumis marilebi aucilebelia cocxali organizmebisaTvis, radgan natriumi qloridis saxiT Sedis sisxlis plazmis SedgenilobaSi. yovelwliurad adamiani sakvebTan erTad moixmars 5-10 kg $NaCl$.

rogorc zemoT aRiniSna, kristaluri natriumis karbonati ($Na_2CO_3 \cdot 10H_2O$) anu kristaluri soda gamoiyofa rogorc sodiani tbebidan, ise mas sinTezuri gziT amzadeben qarxnebSi. soda didi raodenobiT gamoiyeneba sapnis, minis, qsovilis, qaRaldisa da navTobis mrewvelobaSi.

**natriumis silikati (,,xsnadi mina”) $Na_2SiO_3$,** romelic miiReba wvrilad danawilebuli $SiO_2$-is gaxurebisas Sesabamisi tutis xsnarSi ($SiO_2 + 2NaOH = Na_2SiO_3 + H_2O$), agreTve $SiO_2$-is SednobiT ($1500^\circ C$) metalis karbonatTan ($SiO_2 + Na_2CO_3 = Na_2SiO_3 + CO_2$) gamoiyeneba rogorc Semkvreli

nivTiereba, metalis nakeTobebis formebisa da SesaduRi eleqtrodebis damzadebis dros. igi Sedis agreTve hermetizaciisaTvis saWiro sagozavebis SedgenilobaSi da aris silikaturi webos ZiriTadi Semadgeneli nawili.

**kaliumi gacxelebisas energiulad urTierTqmedebs halogenebTan** ( $2K + F_2 = 2KF$ **,** $2K + Cl_2 = 2KCl$ **,** $2K + Br_2 = 2KBr$ **,** $2K + I_2 = 2KI$ ), gogirdTan ( $2K + S = K_2S$ ), fosforTan ( $3K + P = K_3P$ ), azotTan ( $6K + N_2 = 2K_3N$ ), naxSirbadTan (koqsTan, $2K + 2C = K_2C_2$ ) **Sesabamisad halidebis, sulfidis, fosfidis, nitridisa da karbidis warmoqmniT**. $KCl$ erT-erTi yvelaze ufro koncentrirebuli kaliumis sasuqia. metalur kaliumze airadi amiakis moqmedebisas miiReba **kaliumis amidi** ( $2K + 2NH_3 = 2KNH_2 + H_2$ ), romelic gamoiyeneba **kaliumis cianidis** misaRebad ( $KNH_2 + C = KCN + H_2$ ). kaliumis tute naxSirbadis dioqsidis mierTebiT ganicdis **karbonizacias** ( $2KOH + CO_2 = K_2CO_3 + H_2O$ ) da miiReba **kaliumis karbonati (** $K_2CO_3$ **_ potaSi).** igi TeTri, wyalSi kargad xsnadi nivTierebaa. misi erT-erTi gamoyenebaa Zneldnobadi minebis warmoeba. kaliumis karbonati amosavali nivTierebaa kaliumis sxvadasxva marilis dasamzadeblad. civi kaliumis tute urTierTqmedebs qlorTan ( $2KOH + Cl_2 = KCl + KClO + H_2O$ ) **kaliumis qloridisa** ( $KCl$ ) da **kaliumis hipoqloritis** warmoqmniT, xolo cxel tutesTan urTierTqmedebisas miiReba Sesabamisi **qloridi** ( $KCl$ ) da **qlorati** ( $KClO_3$ , **berToles marili**, $6KOH + 3Cl_2 = 5KCl + KClO_3 + 3H_2O$ ). kaliumis qlorati dneba $336^\circ C$ -ze; katalizatorebis ( $MnO_2$ , $Cr_2O_3$ , $CaO$ ) monawileobiT berToles marili gacxelebisas iSleba ( $2KClO_3 \xrightarrow[\text{katal.}]{200^\circ C} 2KCl + 3O_2$ ). berToles marili gacxelebisas ukatalizatorodac iSleba, oRond sxva mimarTulebiT ( $2KClO_3 \xrightarrow{400^\circ C} KClO_4 + KCl + O_2$ , $4KClO_3 \xrightarrow{500^\circ C} 4KCl + 6O_2$ ). kaliumis qlorati gamoiyeneba rogorc mJangavi, didi raodenobiT moixmars mas asanTis warmoeba, gamoiyeneba agreTve piroteqnikaSi da feTqebadi nivTierebebis dasamzadeblad.

**kaliumis nitrati (** $KNO_3$ **, gvarjila)** miiReba kaliumis qloridiT vercxlis nitratis damuSavebis procesSi ( $KCl + AgNO_3 = KNO_3 + AgCl\downarrow$ ). ufro xSirad nitrati miiReba azotmJavas urTierTqmedebiT kaliumis tutesa ( $HNO_3 + KOH = KNO_3 + H_2O$ ) da karbonatis xsnarebTan ( $2HNO_3 + K_2CO_3 = 2KNO_3 + CO_2 + H_2O$ ). kaliumis nitratis Termuli daSliT miiReba

Sesabamisi **nitriti** da Jangbadi ($2KNO_3 \rightarrow 2KNO_2 + O_2$). kaliumis nitrati (gvarjila) Seicavs mcenareTa kvebisaTvis aucilebel kaliumsa da azots. nitratul sasuqebs ekuTvnis gvarjilebi: natriumis nitrati ($NaNO_3$, Ciles gvarjila), kaliumis nitrati ($KNO_3$, indoeTis gvarjila) kalciumis nitrati ($Ca(NO_3)_2$, norvegiis gvarjila) da amoniumis gvarjila ($NH_4NO_3$), romlebic Seicaven 15-20%-mde azots da maT didi gamoyeneba aqvT soflis meurneobaSi. kaliumis marilebi, samkurnalo preparatebis saxiT, farTod gamoiyeneba medicinaSi.

**kaliumis sulfati ($K_2SO_4$)** miiReba Sesabamisi tutiT gogirdmJavas sruli neitralizaciis Sedegad ($2KOH + H_2SO_4 = K_2SO_4 + 2H_2O$). mas axasiaTebs marilis yvela Tviseba. aRsaniSnavia, rom myari sulfatebi gavarvarebisas sxvadasxva gardaqmnas ganicdis, gamonaklisia tute metalTa sulfatebi ($K_2SO_4$, $Na_2SO_4$ da sxv.), romlebic gaxurebisas (~1400℃) dauSlelad dneba. kaliumis sulfati gamoiyeneba kaliumis sasuqad soflis meurneobaSi.

**kalium-aluminis Sabi ($KAl(SO_4)_2 \cdot 12H_2O$)** gamoiyeneba qaRaldis, saRebavisa da tyavis warmoebaSi; igi ixmareba aseve medicinaSi _ anTebis sawinaaRmdego da sisxlis SemaCerebel saSualebad.

**rubidiumis zogierTi marili (halidebi, nitratebi, karbonatebi, sulfatebi, fosfatebi da sxv.)** ixmareba rogorc samkurnalo preparatebi TerapiaSi, xolo rubidiumis ormagi da sammagi marilebi gamoiyeneba mikroqimiuri analizis dros zogierTi metalis gansazRvravad.

**ceziumis naerTebi** ixmareba raodenobriv mikroanalizSi zogierTi metalis raodenobis gansasazRvravad, xolo misi **marilebi** samkurnalo preparatebis saxiT gamoiyeneba medicinaSi.

**magniumis qloridi ($MgCl_2$)** metad gavrcelebulia bunebaSi, mas Seicavs zogierTi mineraluri wyali. $MgCl_2$-s didi raodenobiT Seicavs zRvis wyalic, rac mas mware gemos aZlevs. magniumis qloridi Zlieri higroskopuli nivTierebaa. magniumis oqsidis ($MgO$), magniumis qloridis koncentrirebul xsnarSi azeliT miiReba narevi, romelic ramdenime xnis Semdeg magrdeba da iqceva TeTr Semkvrel masad ($MgO + MgCl_2 + H_2O = 2MgOHCl$). mas sorelis cementi ewodeba _ gamoiyeneba teqnikuri mizniT. xolo magneziuri cementisa ($Mg_2CO_3Cl(OH) \cdot 3H_2O$) da xis naxerxisagan Sedgenili masa _ qsilolitis saxelwodebiT, ixmareba samSeneblo saqmeSi, agreTve salesi qvebisa da wisqvilis dolabebis dasamzadeblad.

**magniumis sulfati (**$MgSO_4$**)** miiReba Sesabamisi hidroqsidisa da gogirdmJavas urTierTqmedebiT ($Mg(OH)_2 + H_2SO_4 = MgSO_4 + 2H_2O$). mas Seicavs mware mineraluri wylebi da zRvis wylebic. tutemiwaTa metalebis sulfatebisagan ($CaSO_4$, $SrSO_4$, $BaSO_4$ da sxv.) gansxvavebiT, igi advilad ixsneba wyalSi. magniumis sulfatis kristalhidrati ($MgSO_4 \cdot 7H_2O$ mware marili, inglisuri marili) gamoiyeneba medicinaSi, agreTve safeiqro mrewvelobaSi, qaRaldis warmoebaSi da a.S. magniumis sulfatis spirtxsnarebze amiakis moqmedebiT miiReba kompleqsuri marilebi ($[Mg(NH_3)_2(H_2O)_4]SO_4$, $[Mg(NH_3)_3(H_2O)_3]SO_4$ da sxv.). cnobilia misi ormagi marilebic ($Na_2SO_4 \cdot MgSO_4 \cdot 2H_2O$, $K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$ da sxv.). aseTi marilebi sasuqebad ixmareba.

**kalciumis halidebi (**$CaF_2$**,** $CaCl_2$**,** $CaBr_2$**,** $CaI_2$**)**

**kalciumis fToridi (**$CaF_2$**, mlRobi Spati, fluoriti)** miiReba Sesabamis metalze fToris gatarebiT ($Ca + F_2 = CaF_2$). igi bunebaSi gavrcelebulia mineralebis _ mlRobi Spatis anu fluoritis saxiT. sinaTlis STanTqmis Sedegad fluorescirebs (cota xans anaTebs), ultraiisfer sxivebs Tavisuflad atarebs. kalciumis fToridi gamoiyeneba rogorc inseqtofungicidi soflis meurneobaSi. igi ixmareba agreTve metalurgiul mrewvelobaSi dnobis temperaturis dasawevad da minanqris damzadebaSi.

**kalciumis qloridis (**$CaCl_2$**)** misaRebad sufTa airad qlorwyalbads ($HCl$) gaatareben maRal temperaturaze kalciumis oqsidze an kalciumis karbonatze ($CaO + 2HCl = CaCl_2 + H_2O$, $CaCO_3 + 2HCl = CaCl_2 + H_2O + CO_2$). $CaCl_2$ gauwyloebuli TeTri higroskopiuli masaa, ixmareba rogorc airis saSrobi saSualeba. misi heqsahidratis ($CaCl_2 \cdot 6H_2O$) wyalSi gaxsna dakavSirebulia siTbos mniSvnelovan STanTqmasTan, amitom mas xSirad xmaroben macivebeli narevebis dasamzadeblad (Tu $CaCl_2 \cdot 6H_2O$ da yinuls aviRebT 1,44:1 woniTi SefardebiT, miiReba $-54{,}9^\circ C$ temperaturis narevi). kalciumis qloridi kargad ixsneba wyalsa da spirtSi.

$CaCl_2$**-**iT xis merqnisa da qsovilebis gaJRenTis Sedegad, orive cecxlgamZle gaxdeba. gamoiyeneba zogierTi sinTezuri fisis gasamyareblad da agreTve rZis asaWrelad.

**kalciumis karbonati (**$CaCO_3$**, kirqva, carci, marmarilo _ mineral kalcitis yvelaze ufro gavrcelebuli formebi**). kalciumis marilebia

mcenareul da cxovelur organizmebSi (daaxloebiT 80%). igi aris agreTve bunebriv wylebsa da niadagSi. kalciumis karbonati advilad miiReba Tu mis marilze vimoqmedebT tute marilis an amoniumis karbonatis xsnariT ($CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$, $CaCl_2 + CO_2 + 2NH_3 = CaCO_3 + 2NH_4Cl$ da sxv.). kalciumis karbonati wyalSi mcired xsnadia, SuSxuniT ixsneba mJavaSi ($CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$). civ wyalSi naxSirbad(IV)-is oqsidTan warmoqmnis hidrokarbonats ($CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2$), romelic kargad ixsneba wyalSi. misi xsnari daaxloebiT $70^\circ C$-mde gaTbobisas iSleba _ gamoileqeba karbonati ($Ca(HCO_3)_2 = CaCO_3 + CO_2 + H_2O$).

kalciumis karbonati kirqvis, carcisa da marmarilos saxiT mravalgvar gamoyenebas poulobs: kirqvebi gamoiyeneba Caumqrali kirisa da cementis misaRebad, minis warmoebaSi; carcs iyeneben rezinisa da saRebrebis dasamzadeblad, xolo marmarilos _ mSeneblobaSi, mosapirkeTebel masalad. kirqvas, kirs iyeneben agreTve soflis meurneobaSi mJava niadagebis mosakirianeblad _ maTi mJavianobis Semcirebis mizniT da struqturis gasaumjobeseblad.

**kalciumis sulfati orwyliani ($CaSO_4 \cdot 2H_2O$, TabaSiri)** gaxurebisas ($150-180^\circ C$) kargavs kristalizaciuri wylis 3/4-s da miiReba alebastri _ naxevarwyliani TabaSiris TeTri fxvnili ($CaSO_4 \cdot 2H_2O = CaSO_4 \cdot 0{,}5H_2O + 1{,}5H_2O$). wyalTan aseTi fxvnilis Serevisas midminareobs sapirispiro reaqcia ($CaSO_4 \cdot 0{,}5H_2O + 1{,}5H_2 = CaSO_4 \cdot 2H_2O$) da narevi swrafad magrdeba. am Tvisebas praqtikaSi iyeneben naZerwi samkaulebis, aslebis dasamzadeblad, travmatologiaSi _ TabaSiris artaSanis dasadebad, stomatologiaSi. Camqral kirTan ($Ca(OH)_2$) naxevarwyliani TabaSiris ($CaSO_4 \cdot 0{,}5H_2O$) narevs iyeneben samSeneblo saqmeSi (kedlebis Sesalesad).

**wylis sixiste**. wyals, romelic mniSvnelovani raodenobiT Seicavs **kalciumis** $Ca(HCO_3)_2$, $CaCl_2$, $CaSO_4$ an **magniumis** $Mg(HCO_3)_2$, $MgCl_2$, $MgSO_4$ marilebs **xisti wyali** ewodeba, **rbili wylisagan gansxvavebiT**, romelic mcire raodenobiT Seicavs an sruliad ar Seicavs zemoaRniSnul marilebs. sixiste orgvaria: karbonatuli (droebiTi, gardamavali) da arakarbonatuli (mudmivi). karbonatuli sixiste ganpirobebulia wyalSi kalciumisa da magniumis hidrokarbonatebis arsebobiT, arakarbonatuli _ Zlieri mJavebis marilebis, kalciumisa da magniumis sulfatebisa da qloridebis

arsebobiT. saerTo sixiste ganisazRvreba karbonatuli da arakarbonatuli sixisteebis jamiT. wylis sixistes sxvadasxva qveyanaSi sxvadasxvanairad afaseben. CvenTan miRebulia wylis sixistis gamosaxva _ 1l wyalSi arsebuli $Ca^{2+}$ da $Mg^{2+}$ ionebis milimoli ekvivalentebis ricxviT: sixiste = $\frac{[Ca^{2+}]}{20,04}+\frac{[Mg^{2+}]}{12,16}$, sadac $[Ca^{2+}]$ da $[Mg^{2+}]$ _ am ionebis koncentraciaa mg/l-Si, xolo 20,04 da 12,16 _ kalciumisa da magniumis miliekvivalentebis moluri masebi. Tu sixiste, gansazRvruli mmoli ekv/l-obiT, 1,5-mdea _ wyali Zlian rbilia, Tu 1,5-4 farglebSia _ rbilia, 4-8 saSualo sixistisaa, 8-12 xistia, zemoT ki wyali Zalian xistia. gansakuTrebiT xistia zRvisa da okeanis wyali. Savi zRvis wylis sixistea 65,5 mmoli ekv/l, okeanis wylis saSualo sixiste _ 130,5 mmoli ekv/l. sasmeli wylis sixiste ar unda aRematebodes 7 mmoli ekv/l-s.

sixiste bunebriv wylebs specifikur Tvisebebs SesZens. xist wyalSi didxans ixarSeba sakvebi produqti, cudad qafdeba saponi da ar iCens recxvis unars. saponi umaRles cximovanmJavaTa (palmitinmJavas $C_{17}H_{35}COOH$ da stearinmJavas $C_{15}H_{33}COOH$) natriumis an kaliumis marilia, maTi anionebi, $Ca^{2+}$ an $Mg^{2+}$ kationTan warmoqmnis uxsnar marils ( $2C_{17}H_{31}COO^{-}+Ca^{2+}=(C_{17}H_{31}COO)_2Ca\downarrow$, $2C_{17}H_{35}COO^{-}+Mg^{2+}=(C_{17}H_{35}COO)_2Mg\downarrow$) da moklebulia aqafebis unars. saponi qafdeba mxolod $Ca^{2+}$ da $Mg^{2+}$ ionebis mTlianad SeboWvis (gamoleqvis) Semdeg. es ar exeba sinTezur gamrecx saSualebebs, romlebic recxvis unars xist wyalSic inarCuneben.

wylis sixistis Sesamcireblad iyeneben fizikur da qimiur meTodebs. karbonatuli sixistis Tavidan acileba xdeba wylis aduRebiT. am dros hidrokarbonatebi iSleba uxsnari kalciumis karbonatisa da magniumis karbonatis warmoqmniT ($Ca(HCO_3)_2=CaCO_3\downarrow+CO_2+H_2O$, $Mg(HCO_3)_2=MgCO_3\downarrow+CO_2+H_2O$). arakarbonatul sixistes acileben sodis saSualebiT:

($CaSO_4+Na_2CO_3=CaCO_3\downarrow+Na_2SO_4$,

$CaCl_2+Na_2CO_3=CaCO_3\downarrow+2NaCl$).

sodis saSualebiT ispoba karbonatuli sixistec:

($Ca(HCO_3)_2+Na_2CO_3=CaCO_3\downarrow+2NaHCO_3$,

$Mg(HCO_3)_2+Na_2CO_3=MgCO_3\downarrow+2NaHCO_3$),

e.i. soda iwvevs saerTo sixistis mocilebas.

xisti wyali SeiZleba **ionitis** meSveobiTac ,,darbildes". ioniti _ bunebrivi an sinTezurad miRebuli maRalmolekuluri naerTia, romelic Seicaven xsnarSi arsebul ionebTan mimocvlis unaris mqone moZrav ionebs. Tu ioniti moZrav kations Seicavs, ewodeba **kationiti** (kationitad gamoiyeneba alumosilikatebi, magaliTad, ceoliti), Tu anions _ **anioniti**. xist wyals gaatareben kationitSi, romelic kalciumisa da magniumis ionebs daiWers da natriumis ionebs gascems ekvivalenturi raodenobiT. Tixa **permutiti** kalciumis ionebis mimocvlis Sedegad iZleva $2NaAlSiO_4 + Ca^{2+} = Ca(AlSiO_4)_2 + 2Na^+$. maSasadame, $Ca^{2+}$ da $Mg^{2+}$ ionebi xsnaridan gadadian kationSi, xolo kationitis ionebi (magaliTad, $Na^+$ ioni) _ xsnarSi. Sedegad wyali **darbildeba**.

xisti wyali ufro sasiamovno dasalevia, vidre rbili. orTqlis qvabebisTvis xisti wyali sazianoa, radgan wylis duRilisa da aorTqlebis dros qvabis kedlebze Cndeba kalciumisa da magniumis karbonatebis, sulfatebis, qloridebisa da sxva marilebis minaduRi, romelic qvabis zedapirze aZnelebs siTbos gadacemas, iwvevs saTbobis gadaxarjvas da azianebs qvabis kedlebs. amitom orTqlis qvabebisTvis saWiro wyals ionitebis svetSi gaatareben dasarbileblad (sixistis mosacileblad). mxolod aseTi damuSavebis Semdeg iyeneben wyals rogorc orTqlis qvabebis, ise sxva teqnikuri miznebisaTvis.

**kalciumis fosforiti ($Ca_3(PO_4)_2$) da apatiti ($Ca_5(PO_4)_3(F, Cl, OH)$)** mniSvnelovani **mineralebia**. apatiti da fosforiti gamoiyeneba xelovnuri sasuqebis dasamzadeblad. maTgan mzaddeba Termomdgradi faifuri, fosformJava da fosfatebi. erTCanacvlebuli fosfatebi ($Ca(H_2PO_4)_2$ da sxv.) wyalSi xsnadia, xolo or ($Na_2HPO_4$, $K_2HPO_4$, $(NH_4)_2HPO_4$) da samCanacvlebuli ($Na_3PO_4$, $K_3PO_4$, $(NH_4)_3PO_4$) fosfatebidan wyalSi ixsneba mxolod zemoT dasaxelebuli _ tute metalebisa da amoniumis marilebi. yvelaze mniSvnelovani fosforis sasuqebia _ martivi superfosfati ($Ca(H_2PO_4)_2 + 2CaSO_4$), ormagi superfosfati ($Ca(H_2PO_4)_2$), romelic Seicavs 40-45% $P_2O_5$-s (daaxloebiT 2-jer mets, vidre martivi superfosfati) da precipitati ($CaHPO_4 \cdot 2H_2O$) $P_2O_5$-is SemcvelobiT 30-35%.

**stronciumis karbonatis ($SrCO_3$, minerali stroncianiti)** miReba SeiZleba $CO_2$-is moqmedebiT Sesabamis oqsidsa ($SrO + CO_2 = SrCO_3$) an

hidroqsidze ($Sr(OH)_2 + CO_2 = SrCO_3 + H_2O$) an mimocvlis reaqciebiT ($SrCl_2 + (NH_4)_2CO_3 = SrCO_3 + 2NH_4Cl$). stronciumis karbonati warmoqmnis ormag ($SrCO_3 \cdot Na_2CO_3$) da sammag ($SrCO_3 \cdot CaCO_3 \cdot Na_2CO_3$) marilebs. stronciumis karbonati gamoiyeneba minanqris dasamzadeblad da katalizatoris sarCulad.

**stronciumis sulfati ($SrSO_4$, minerali celestini)** miiReba stronciumis oqsidze, hidroqsidsa da karbonatze ganzavebuli gogirdmJavas moqmedebiT ($SrO + H_2SO_4 = SrSO_4 + H_2O$, $Sr(OH)_2 + H_2SO_4 = SrSO_4 + 2H_2O$, $SrCO_3 + H_2SO_4 = SrSO_4 + CO_2 + H_2O$) an stronciumis oqsidis gacxelebisas magniumis sulfatTan erTad ($SrO + MgSO_4 = SrSO_4 + MgO$). stronciumis sulfati wyalSi mcired xsnadia. cnobilia stronciumis mravali ormagi sulfati ($3Na_2SO_4 \cdot SrSO_4$, $K_2SO_4 \cdot 2SrSO_4$ da sxv.).

celestini ($SrSO_4$) stronciumis yvelaze mniSvnelovani nedleulia, saidanac, Cveulebriv, miiReba metaluri stronciumi.

**bariumis fToridi ($BaF_2$)** miiReba fTorwyalbadis ($HF$) gatarebiT bariumis oqsidze ($BaO$) an hidroqsidze ($Ba(OH)_2$) an pirdapiri gziT ($2HF + BaO = BaF_2 + H_2O$, $2HF + Ba(OH)_2 = BaF_2 + 2H_2O$, $Ba + F_2 = BaF_2$). bariumis fToridi wyalSi mcired xsnadia, kargad ixsneba azotmJavaSi, marimlJavasa da mlRob mJavebSi. ixmareba optikuri minebisa da minanqris dasamzadeblad.

**bariumis qloridis ($BaCl_2$)** miReba SeiZleba pirdapiri sinTeziT ($Ba + Cl_2 = BaCl_2$), agreTve bariumis oqsidze, karbonatsa an hidroqsidze marilmJavas moqmedebisas ($BaO + 2HCl = BaCl_2 + H_2O$, $BaCO_3 + 2HCl = BaCl_2 + CO_2 + H_2O$, $Ba(OH)_2 + 2HCl = BaCl_2 + 2H_2O$). cnobilia bariumis qloridis amiakatebi ($BaCl_2 \cdot 4NH_3$, $BaCl_2 \cdot 2NH_4OH \cdot 2H_2O$). bariumis qloridi ixmareba misi marilebis (sulfatis, nitratis, fosfatisa da sxv.) misaRebad.

**bariumis sulfati ($BaSO_4$, minerali bariti)** misi erT-erTi yvelaze mniSvnelovani marili miiReba Sesabamisi marilis gogirdmJavaTi an tutemetalTa sulfatebis xsnariT damuSavebisas ($BaCl_2 + H_2SO_4 = BaSO_4\downarrow + 2HCl$, $Ba(NO_3)_2 + K_2SO_4 = BaSO_4\downarrow + 2KNO_3$). bariumis sulfati ufero kristaluri nivTierebaa. igi wyalSi uxsnaria, aseve ar ixsneba mJavasa da tuteSi. igi ixsneba qlorian wyalSi, bromwyalbadmJavasa da iodwyalbadmJavaSi da mcire raodenobiT koncentrirebul gogirdmJavaSi, ris Sedegadac miiReba

$H_2[Ba(SO_4)_2]$. bariumis ioni ($Ba^{2+}$) sulfat-ionis aRmomCen reaqtivad gamoiyeneba. am reaqciiT ganisazRvreba sulfatis raodenoba.

bariumis sulfati rentgenis sxivebis Zlieri STanTqmis unaris gamo gamoiyeneba kuW-nawlavis traqtis rentgenoskopiaSi. bariumis sulfati maRali dispersiuli fxvnilis saxiT gamoiyeneba qaRaldis warmoebaSi danamatis saxiT, qaRaldis sigluvisaTvis. igi ixmareba agreTve TeTri pigmentis saxiT zeTis saRebavebSi, linoleumis warmoebaSi. bariumis sulfatisa da TuTiis sulfidis narevi ($BaSO_4 \cdot ZnS$) cnobilia TeTri saRebavis _ liTofonis saxelwodebiT.

ramdenadac bariumis sulfati uxsnaria, amdenad igi uvnebelia. bariumis xsnadi marili ki gulze Zlier mavne zemoqmedebas axdens.

**bariumis nitrati ($Ba(NO_3)_2$)** miiReba bariumis oqsidze ($BaO + 2NH_4NO_3 = Ba(NO_3)_2 + 2NH_3 + H_2O$), hidroqsidze ($Ba(OH)_2 + 2NaNO_3 = Ba(NO_3)_2 + 2NaOH$) an qloridze ($BaCl_2 + 2NH_4NO_3 = Ba(NO_3)_2 + 2NH_4Cl$) amoniumis an natriumis nitratis xsnaris moqmedebiT. $Ba(NO_3)_2$ marili kargad xsnadia wyalSi. cnobilia misi kristalhidratebi ($Ba(NO_3)_2 \cdot 2H_2O$, $Ba(NO_3)_2 \cdot 4H_2O$). bariumis nitrati gadnobisas iSleba ($Ba(NO_3)_2 = 2BaO + 4NO_2 + O_2$).

**bariumis karbonati ($BaCO_3$, minerali viteriti)** advilad miiReba bariumis oqsidze an mis xsnad marilebze $CO_2$-is, amoniumis karbonatis an sodis xsnaris moqmedebiT ($BaO + CO_2 = BaCO_3$, $BaCl_2 + (NH_4)_2CO_3 = BaCO_3 + 2NH_4Cl$, $Ba(NO_3)_2 + Na_2CO_3 = BaCO_3 + 2NaNO_3$). bariumis karbonati wyalSi mcired xsnadia. igi tute metalebis karbonatebTan mravalricxovan kompleqsur naerTs warmoqmnis.

**aluminis qloridis ($AlCl_3$)** miReba SeiZleba aluminisa da qloris uSualo urTierTqmedebiT, Cveulebriv pirobebSi ($2Al + 3Cl_2 = 2AlCl_3$). igi miiReba agreTve gaxurebisas _ aluminis an misi oqsidis urTierTqmedebisas marilmJavasTan ($2Al + 6HCl = 2AlCl_3 + 3H_2\uparrow$, $Al_2O_3 + 6HCl = 2AlCl_3 + 3H_2O$). aluminis qloridi TeTri, kristaluri, advilad aqroladi nivTierebaa. gaxurebisas ($183^\circ C$-ze) xdeba misi sublimacia (gadadis orTqlis fazaSi). orTqlisebr mdgomareobaSi aluminis qloridis molekulis Sedgenilobas Seesabameba formula $Al_2Cl_6$. igi ixsneba TiTqmis yvela organul gamxsnelSi. Zlier higroskopiulia, advilad izidavs haeridan tens, ganicdis hidrolizs (

$AlCl_3 + 3H_2O = Al(OH)_3 + 3HCl$). aluminis qloridi hermetulad dacobil WurWelSi inaxeba (radgan igi haerze ganiTxeva da bolavs).

aluminqloridi farTod gamoiyeneba organul qimiaSi bevri katalizuri reaqciis, navTobis krekingis Casatareblad da sxv.

**aluminis bromidi (** $AlBr_3$ **)** miiReba Txevadi bromisa da aluminis cxeli fxvnilis urTierTqmedebiT ($2Al + 3Br_2 = 2AlBr_3$). alumini bromTan reagirebs Cveulebriv pirobebSic Sesabamisi bromidis ($AlBr_3$) warmoqmniT. aluminis uwylo bromidi miiReba agreTve daxurul WurWelSi aluminis burbuSelaze bromis orTqlis gavatarebT an fxvnilisebri aluminis an misi wvrili mavTulis bromis orTqlis areSi dawviT. $AlBr_3$ ixsneba mraval organul gamxsnelsa da wyalSi. orTqlisebr mdgomareobaSi aluminis bromidi Sedgeba dimeruli ($Al_2Cl_6$) kovalenturi molekulebisagan (dens ar atarebs).

aluminis bromidi gamoiyeneba rogorc mabromirebeli saSualeba da agreTve rogorc zogierTi reaqciis katalizatori.

**aluminis nitrati (** $Al(NO_3)_3$ **)** miiReba aluminis hidroqsidis azotmJavaSi gaxsniT ($Al(OH)_3 + 3HNO_3 = Al(NO_3)_3 + 3H_2O$). Cveulebriv pirobebSi alumini ar urTierTqmedebs koncentrirebul da Zlier ganzavebul azotmJavasTan damcveli oqsiduri afskis warmoqmnis gamo. cxeli koncentrirebuli azotmJava ki Jangavs mas ($Al + 6HNO_3 = Al(NO_3)_3 + 3NO_2 + 3H_2O$). amitom koncentrirebul $HNO_3$ inaxeba da gadaaqvT aluminis cisternebiT.

aluminis nitrati ($Al(NO_3)_3$) gamoiyeneba rogorc fermWeri qsovilebis Rebvis dros.

**aluminis acetati (** $Al(CH_3COO)_3$ **)** miiReba aluminis hidroqsidze ZmarmJavas moqmedebiT ($Al(OH)_3 + 3CH_3COOH = Al(CH_3COO)_3 + 3H_2O$). wyalxsnarSi Zlier hidrolizs ganicdis ($Al(CH_3COO)_3 + 3H_2O \Leftrightarrow Al(OH)_3 + 3CH_3COOH$). ZmarmJava aluminis xsnaris duRlisas ZmarmJava orTqldeba da rCeba fuZe marili. aluminis acetati ($Al(CH_3COO)_3$, burovis xsnari) Semkvreli, gamoiyeneba sadezinfeqcio saSualebad medicinaSi.

**aluminis sulfati (** $Al_2(SO_4)_3$ **)** miiReba aluminis gacxelebisas ganzavebul gogirdmJavasTan erTad Sesabamisi marilis warmoqmniT ($2Al + 3H_2SO_4 = Al_2(SO_4)_3 + 3H_2\uparrow$). cxeli koncentrirebuli gogirdmJava ki alumins

Jangavs ($2Al + 6H_2SO_4 = Al_2(SO_4)_3 + 3SO_2 + 6H_2O$). aluminis sulfatis kristalhidrati ($Al_2(SO_4)_3 \cdot 18H_2O$) gamWvirvale uferuli kristalebia, romlis gauwyloebiT miiReba $Al_2(SO_4)_3$ TeTri fxvnilis saxiT. aluminis sulfati ($Al_2(SO_4)_3$) kargad ixsneba wyalSi _ temperaturis gazrdisas misi xsnadoba mniSvnelovnad izrdeba. nawilobriv hidrolizis gamo mis wyalxsnars mJavuri reaqcia axasiaTebs ($Al_2(SO_4)_3 + 6H_2O \Leftrightarrow 2Al(OH)_3 + 3H_2SO_4$).

aluminis sulfati gamoiyeneba mRvrie wylis dasawmendad. $Al_2(SO_4)_3$ mimocvlis reaqciaSi Sedis gaxsnil kalciumis hidrokarbonatTan ($Al_2(SO_4)_3 + 3Ca(HCO_3)_2 = 2Al(HCO_3)_3 + 3CaSO_4$). aluminis hidrokarbonati, rogorc susti fuZisa da susti mJavasagan warmoqmnili marili, srul hidrolizs ganicdis ($Al(HCO_3)_3 + 3H_2O = Al(OH)_3 + 3H_2CO_3$). hidrolizis Sedegad warmoqmnili aluminis hidroqsidis ($Al(OH)_3$) koloiduri xsnari ganicdis koagulacias. daleqvis procesSi ki es labisebri naleqi Tan waritacebs wyalSi Sewonil nawilakebs, ris Sedegadac xdeba wylis dawmenda. aluminis sulfati, qlornatriumTan erTad, narevis saxiT gamoiyeneba qaRaldis warmoebaSi, radgan mimocvlis Sedegad warmoqmnili qloriani alumini Seawebebs qaRaldis boWkoebs erTmaneTTan. aluminis sulfatma farTo gamoyeneba pova agreTve tyavis TrimvlisaTvis da qsovilebis Rebvis dros rogorc fermWerma. gamoiyeneba agreTve medicinaSi (mcire koncentraciiT igi aaqtiurebs ferment amilazas, xolo maRali koncentraciiT _ iwvevs mis inaqtivacias).

tute metalis sulfatTan aluminis sulfati advilad warmoqmnis $M^1_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ tipis ormag marils, romelsac **Sabi** ewodeba. Cveulebrivi Sabi aris kalium-aluminis sulfati $K_2SO_4$**.** $Al_2(SO_4)_3 \cdot 24H_2O$ anu $KAl(SO_4)_2 \cdot 12H_2O$. aqvs momJavo gemo, gacxelebisas Sabi kargavs Tavis sakristalizacio wyals da miiReba gamomwvari (uwylo) Sabi. wyalSi Sabis xsnadoba SedarebiT mcirea.

Sabi gamoiyeneba warmoebaSi iseve rogorc aluminis sulfati, e.i. rogorc fermWeri, tyavis warmoebaSi _ rogorc mTrimlavi da medicinaSi _ rogorc Semkvreli, sisxlis aRmdgeni, anTebis sawinaaRmdego saSualeba.

**galium(III)-is qloridi (**$GaCl_3$**)** miiReba metaluri galiumis gacxelebisas qloris an qlorwyalbadis nakadSi ($2Ga + 3Cl_2 = 2GaCl_3$, $2Ga + 6HCl = 2GaCl_3 + 3H_2$). galium(III)-is qloridi advilad aqroladia, amitom Zneli ar aris misi gawmenda

sublimaciiT. tenian haerSi galium(III)-is qloridi ganiTxeva. wyalSi gaxsnisas igi ganicdis hidrolizs, ris gamoc misi xsnari Zlier mJavur reaqcias avlens.

galium(III)-is qloridi organuli sinTezisaTvis samqlorian aluminze ($AlCl_3$) ufro aqtiur katalizators warmoadgens da farTod gamoiyeneba axali naerTebis misaRebad.

**galium(III)-is sulfatis (**$Ga_2(SO_4)_3 \cdot 18H_2O$**)** kristalhidrati gamWvirvale uferuli kristalebia, romlis gauwyloebiT miiReba uwylo $Ga_2(SO_4)_3$ TeTri fxvnilis saxiT. kargad ixsneba wyalSi. galiumis sulfati amoniumis sulfatTan warmoqmnis Sabs _ $(NH_4)_2SO_4 \cdot Ga_2(SO_4)_3 \cdot 24H_2O$ anu $NH_4Ga(SO_4)_2 \cdot 12H_2O$. gamoiyeneba medicinaSi zogierTi daavadebis samkurnalod.

**indium(III)-is qloridi (**$InCl_3$**)** advilad miiReba indiumis dawvis dros qloris atmosferoSi ($2In+3Cl_2=2InCl_3$) an metaluri indiumis gaxsniT marilmJavaSi ($2In+6HCl=2InCl_3+3H_2$). indium(III)-is qloridi waylSi gaxsnisas ganicdis Zlier hidrolizs ($InCl_3+3H_2O \Leftrightarrow In(OH)_3+3HCl$). tute metalisa da amoniumis qloridTan indium(III)-is qloridi warmoqmnis ormag marils ($K_3InCl_6$, $(NH_4)_2InCl_5$). indiumis yvela halidi da maT Soris qloridic kargad ixsneba wyalSi siTbos didi raodenobis gamoyofiT.

indium(III)-is qloridi gamoiyeneba organul naerTTa sinTezSi da axali teqnologiuri masalebis warmoebaSi.

**indium(III)-is sulfati (**$In_2(SO_4)_3$**)** gogirdmJavas najeri xsnaridan gamokristalebisas miiReba mJavuri kristalhidratis saxiT ($InH(SO_4)_2 \cdot 3H_2O$), ganzavebuli xsnaridan ki miiReba saSualo marili ($In_2(SO_4)_3 \cdot nH_2O$, sadac $n=6-12$, temperaturaze damokidebulebiT). indiumis sulfati tute metalis sulfatTan warmoqmnis Sabebs ($Rb_2SO_4 \cdot In_2(SO_4)_3 \cdot 24H_2O$, $Cs_2SO_4 \cdot In_2(SO_4)_3 \cdot 2H_2O$), natriumTan da kaliumTan ki indiumis sulfati warmoqmnis Spinelebs ($Na_2SO_4 \cdot In_2(SO_4)_3 \cdot 8H_2O$ da $K_2SO_4 \cdot In_2(SO_4)_3 \cdot 8H_2O$).

indiumis sulfatis gavarvarebiT miiReba indium(III)-is oqsidi ($In_2(SO_4)_3=In_2O_3+3SO_3$), romelic farTod gamoiyeneba minis zedapiris dasafaravad, ris Semdegac mina xdeba eleqtrogamtari da inarCunebs gamWvirvalobas.

**Talium(I)-is sulfati (**$Tl_2SO_4$**)** miiReba Talium(I)-is oqsidis gaxsniT mJavaSi Sesabamisi marilis warmoqmniT ($Tl_2O+H_2SO_4=Tl_2SO_4+H_2O$).

**Talium(I)-is halidebi (** $TlF$ **,** $TlCl$ **,** $TlBr$ **,** $TlI$ **)** miiReba Talium(I)-is oqsidis, hidroqsidis, sulfidis an karbonatis halogenwyalbadmJavebiT damuSavebisas ($Tl_2O + 2HF = 2TlF + H_2O$, $TlOH + HCl = TlCl + H_2O$, $Tl_2S + 2HBr = 2TlBr + H_2S$, $Tl_2CO_3 + 2HI = 2TlI + CO_2 + H_2O$). Taliumis fToridi wyalSi kargad xsnadi, xolo qloridi, bromidi, iodidi wyalSi Znelad xsnadi naerTebia.

aRsaniSnavia, rom $Tl^+$-is ionuri radiusi, $K^+$-is, $Rb^+$-is, $Cs^+$-is ionebis radiusebis Tanazomieria, amitomac Taliumis am rigis naerTebis Tvisebebi hgavs tute metalebis naerTebis Tvisebebs.

**Talium(III)-is qloridi (** $TlCl_3$ **)** miiReba Talium(I)-is xsnarze qloriani wylis moqmedebiT ($TlCl + Cl_2 = TlCl_3$). igi wyalxsnaridan kristalhidratis ($TlCl_3 \cdot 4H_2O$) saxiT miiReba, romelic advilad kargavs wyals vakuumSi. $TlCl_3$-is wyalxsnars Zlieri mJavuri reaqcia aqvs.

**Talium(III)-is tribromidi (** $TlBr_3$ **) da triiodidi (** $TlI_3$ **)** miiReba Talium(III)-is oqsidis gaxsniT Sesabamis mJavaSi ($Tl_2O_3 + 6HBr = 2TlBr_3 + 3H_2O$, $Tl_2O_3 + 6HI = 2TlI_3 + 3H_2O$). isini ufro nakleb mdgradobas iCens, vidre msgavsi qloridi.

**Talium(III)-is nitrati (** $Tl(NO_3)_3$ **)** miiReba Talium(III)-is hidroqsidis urTierTqmedebiT azotmJavasTan ($Tl(OH)_3 + 3HNO_3 = Tl(NO_3)_3 + 3H_2O$). Talium(III)-is nitrati xsnaridan kristaldeba kristalhidratis saxiT ($Tl(NO_3)_3 + 3H_2O$). tute metalis an Talium(I)-is nitratTan igi warmoqmnis ormag nitrats $M_2[Tl(NO_3)_5]$, magaliTad $Tl_2[Tl(NO_3)_5]$.

Taliumis halidebi gamoiyeneba samedicino kvlevebsa da fotografiaSi. Taliumis sulfidi naxevargamtaria, ixmareba fotoelementebSi. Taliumis sulfati momwamlavi nivTierebaa da iyeneben mRrRnelebis winaaRmdeg. Taliumis karbonati, bromidi da iodidi SeaqvT gansakuTrebuli daniSnulebis optikur minebSi, romlebic gamoirCevian refraqciis maRali koeficientiT.

**germanitebi (** $Na_2GeO_2$ **) da germanatebi (** $Na_2GeO_3$ **).**

**germaniti (magaliTad,** $Na_2GeO_2$ **)** miiReba germaniumis myar tutesTan SednobiT ($Ge + 2NaOH = Na_2GeO_2 + H_2$). igi warmoadgens qvegermaniummJavas ($H_2GeO_2$)-is marils.

**germanatis** miReba SeiZleba germaniumis urTierTqmedebiT tutesTan, romelime mJangavis TanxlebiT ($Ge + 2NaOH + 2H_2O_2 = Na_2GeO_3 + 3H_2O$), an

germaniumis dioqsidis tuteSi gaxsniT ($GeO_2 + 2NaOH = Na_2GeO_3 + H_2O$). natriumgermanati ($Na_2GeO_3$) metagermaniummJavas ($H_2GeO_3$) marilia. cnobilia orTogermaniummJavas ($H_4GeO_4$) marilebi, romlebic miiReba $GeO_2$-is SednobiT tutesTan an karbonatTan ($GeO_2 + 2Na_2CO_3 = Na_4GeO_4 + 2CO_2$).

germaniumi da misi marilebi gamoiyeneba naxevargamtarTa teqnikaSi da Zlier gamWvirvale, maRali Suqtexis koeficientis mqone kvarcis minis warmoebaSi. didi raodenobiT moixmareba agreTve optikuri minis dasamzadeblad da araorganuli naerTebis sinTezSi.

**kala(II)-isa ($SnCl_2$) da kala(IV)-is qloridebi**

**kala(II)-is qloridi ($SnCl_2$)** miiReba misi gaxsniT koncentrirebul marilmJavaSi ($Sn + 2HCl = SnCl_2 + H_2$) an kala(II)-is hidroqsidisa da marilmJavas urTierTqmedebiT ($Sn(OH)_2 + 2HCl = SnCl_2 + 2H_2O$). kalis diqloridis xsnari ganzavebisas imRvreva hidrolizis Sedegad gamoyofili fuZuri marilis gamo ($SnCl_2 + H_2O = Sn(OH)Cl + HCl$). kalis diqloridi Zlieri aRmdgenia _ $Fe^{3+}$ ionebs igi $Fe^{2+}$ ionebad aRadgens ($SnCl_2 + 2FeCl_3 = SnCl_4 + 2FeCl_2$), $Hg^{2+}$-is ionebs metalur vercxliswylad aRadgens ($SnCl_2 + HgCl_2 = SnCl_4 + Hg$) da sxv.

**kala(IV)-is qloridi ($SnCl_4$)** miiReba sinTezuri gziT _ metalur kalaze Tavisufali qloris moqmedebiT ($300^\circ C$-ze: $Sn + 2Cl_2 = SnCl_4$). kalis tetraqloridi ($SnCl_4$) haerze mbolavi uferuli diamagnituri siTxea _ wyalSi $SnCl_4$ kargad ixsneba siTbos didi raodenobis gamoyofiT. mcire koncentraciis dros kalis tetraqloridi ganicdis hidrolizs, ris Sedegadac xsnari imRvreva ($SnCl_4 + 2H_2O = SnO_2 + 4HCl$). am reaqciis dros gamoyofili kalis orJangi ($SnO_2$) xsnarSi koloidur mdgomareobaSi rCeba.

kalis diqloridi ($SnCl_2$) ixmareba rogorc aRmdgeni qimiur sinTezSi, fermWerad samRebro saqmeSi, rogorc katalizatori navTobis mrewvelobaSi da sxv.

kalis tetraqloridi ($SnCl_4$) gamoiyeneba rogorc fermWeri samRebro saqmeSi, rogorc katalizatori diqlorirebis reaqciebSi da rogorc kondesaciis reaqciebis damCqarebeli organul qimiaSi.

**kala(IV)-is disulfidi ($SnS_2$).** oTxvalentiani kalis marilis xsnaridan, masSi gogirdwyalbadis gatarebisas, gamoileqeba yviTeli feris disulfidi (

$SnCl_4 + 2H_2S = SnS_2 + 4HCl$). imave Sedgenilobis naerTi miiReba kalis naxerxis, gogirdis da niSaduris narevis gaxurebiT. am gziT miRebul disulfids ($SnS_2$) oqrosferi qerclis saxe aqvs, ris gamo mas ,,mozaikuri oqro" ewodeba. igi gamoiyeneba brinjaosferi saRebavebis dasamzadeblad da sxv.

**tyvia(II)-is qloridi ($PbCl_2$)** miiReba tyviis marilis xsnaris marilmJavaTi ($Pb(NO_3)_2 + 2HCl = PbCl_2 + 2HNO_3$) damuSavebiT. $PbCl_2$ diamagnituria, civ wyalSi mcire raodenobiT ixsneba, xolo cxel wyalSi, koncentrirebul marilmJavasa da tute metalis qloridis xsnarSi _ kargad ($PbCl_2 + 2HCl = H_2[PbCl_4]$ da $PbCl_2 + 2KCl = K_2[PbCl_4]$). tyviis qloridi wyalxsnarSi ganicdis hidrolizs. cnobilia tyviis oqsiqloridebi _ TeTri $Pb_2OCl_2$ da yviTeli $Pb_2O_2Cl_2$, romlebic gamoiyeneba zeTis saRebavebis dasamzadeblad.

**tyvia(II)-is bromidi ($PbBr_2$)** gamoileqeba tyviis xsnad marilze bromidis moqmedebisas ($Pb(NO_3)_2 + 2KBr = PbBr_2 + 2KNO_3$, $Pb(CH_3COO)_2 + 2HBr = PbBr_2 + 2CH_3COOH$) an tyviisa da bromis urTierTqmedebiT ($Pb + Br_2 = PbBr_2$). igi ufero kristalebia, civ wyalSi mcired ixsneba, cxelSi _ kargad.

**tyvia(II)-is iodidi ($PbI_2$)** yviTeli naleqis saxiT gamoiyofa tyviis marilis xsnarze iod-ionebis moqmedebiT ($PbCl_2 + 2KI = PbI_2 + 2KCl$) da sxv. cxeli wylidan gamokristalebiT miiReba oqrosferi lamazi kristalebi. wyalSi mcired ixsneba. misi wyalxsnari uferulia.

**tyvia(II)-is acetati ($Pb(CH_3COO)_2$)** kargad xsnadia, ris gamoc farTod gamoiyeneba laboratoriul praqtikaSi ($PbCl_2 + 2CH_3COONa = Pb(CH_3COO)_2 + 2NaCl$). misi miReba SeiZleba agreTve tyviis Jangze ZmarmJavas moqmedebiT ($PbO + 2CH_3COOH = Pb(CH_3COO)_2 + H_2O$). misi wyalxsnaris aorTqlebisas gamokristaldeba trihidrati $(CH_3COO)_2Pb \cdot 3H_2O$, romelsac tkbili gemos gamo ,,tyviis Saqari" ewoda (sawamlavia).

tyviis acetati gamoiyeneba samRebro saqmeSi rogorc fermWeri. amave marilidan advilad mzaddeba tyviis sxva marilebi.

**tyvia(II)-is nitrati ($Pb(NO_3)_2$)** miiReba tyviis oqsidis, tyviis TeTras an damarcvluli metaluri tyviis gaxsniT cxel ganzavebul azotmJavaSi da SemJavebuli xsnaridan misi Semdgomi dakristalebiT:

$PbO + 2HNO_3 = Pb(NO_3)_2 + H_2O$, $Pb_3(OH)_2(CO_3)_2 + 6HNO_3 = 3Pb(NO_3)_2 + 2CO_2 + 4H_2O$.

tyviis nitrati wyalxsnarSi ganicdis hidrolizs:

$$Pb(NO_3)_2 + 2H_2O \Leftrightarrow Pb(OH)_2 + 2HNO_3.$$

tyviis nitrati gamoiyeneba asanTis warmoebaSi.

**tyvia(II)-is karbonati (** $PbCO_3$ **)** bunebaSi gvxvdeba TeTri tyviis madnis _ cerusitis saxiT. miiReba tyviis acetatSi ( $Pb(CH_3COO)_2$ **)** qloris ( $Cl_2$ ) gatarebiT an tyviis acetatis xsnarze amoniumis karbonatis damatebiT ( $Pb(CH_3COO)_2 + (NH_4)_2CO_3 = PbCO_3 + 2CH_3COONH_4$). tute metalis karbonatis moqmedebiT tyviis acetatis xsnaridan ileqeba tyviis fuZe karbonati ( $Pb(OH)_2 \cdot 2PbCO_3$). mas zeTis TeTri saRebavis dasamzadeblad xmaroben, ris gamoc **tyviis TeTras** uwodeben.

tyviis TeTras saRebavi maRali xarisxisaa _ kargad faravs zedapirs, magram haerze, Tu igi gogirdwyalbadis Tundac sul mcire raodenobas Seicavs droTa ganmavlobaSi **Savdeba** tyviis sulfidis ( $PbS$ ) warmoqmnis gamo.

**tyvia(II)-is qromati (** $PbCrO_4$ **)** miiReba tyviis acetatze biqromatis moqmedebiT:

( $2Pb(CH_3COO)_2 + K_2Cr_2O_7 + H_2O = 2PbCrO_4 + 2CH_3COOK + 2CH_3COOH$ ).

tyviis qromati Ria yviTeli feris Znelad xsnadi marilia. igi advilad ixsneba azotmJavasa da tuteSi. tyviis fuZe qromati ( $2PbO \cdot PbCrO_4$ ) bunebaSi moipoveba mineral **melanqromitis** saxiT.

tyviis qromati teqnikurad mniSvnelovani naerTia, gamoiyeneba yviTeli feris zeTis saRebavis dasamzadeblad.

**tyvia(II)-is sulfati (** $PbSO_4$ **)** tyviis marilebis xsnarebidan TeTri naleqis saxiT gamoiyofa gogirdmJavas moqmedebisas. tyviis sulfati Znelad xsnadi marilia, ukeT ixsneba koncentrirebul gogirdmJavaSi, marilmJavasa da azotmJavaSi. masze tutis moqmedebiT miiReba hidroqsiplumbitebi ( $PbSO_4 + 3NaOH = Na[Pb(OH)_3] + Na_2SO_4$).

bunebaSi tyviis sulfati gvxvdeba mqone mineral anglezitis rombuli kristalebis saxiT. misi sufTa kristalebi broliviT gamWvirvalea.

**tyviis tetrahalogenidebi**. koncentrirebul marilmJavaSi tyviis dioqsidis gaxsniT miiReba tyviis tetraqloridi ( $4HCl + PbO_2 = PbCl_4 + 2H_2O$ ), romelic advilad iSleba qloris gamoyofiT ( $PbCl_4 \Leftrightarrow PbCl_2 + Cl_2$ ). meore reaqcia Seqcevadia. tyviis tetraqloridis xsnaridan gamoyofa sakmaod Znelia. $PbCl_4$

gamoyofilia yviTeli feris siTxis saxiT koncentrirebul gogirdmJavaSi, romelSic igi ar ixsneba.

bevrad ufro mdgradia tyviis tetraqloridis nawarmi _ qlorplumbati ( $M_2^1[PbCl_6]$ ), romlis urTierTqmedebiT bromidTan da iodidTan miRebulia bromplumbati ( $M_2^1[PbBr_6]$ ) da iodplumbati ( $M_2[PbI_6]$ ).

**tyvia(IV)-is sulfati (** $Pb(SO_4)_2$ **)** miiReba 80% gogirdmJavas eleqtroliziT tyviis eleqtrodebs Soris. tyviis disulfati ufro Zlieri mJangavia, vidre tyviis orJangi ( $PbO_2$ ).

tyviis naerTi Zlieri sawamlavia.

**dariSxan(III)-is qloridi (** $AsCl_3$ **), metaarseniti (** $NaAsO_2$ **) da orToarseniti (** $Na_3AsO_3$ **)** miiReba marilmJavas moqmedebiT dariSxan(III)-is oqsidze ( $6HCl + As_2O_3 = 2AsCl_3 + 3H_2O$ ), $AsCl_3$ warmoadgens ufero siTxes, romelic tenian haerze bolavs. samqloriani dariSxanis orTqli Zlieri Sxamia. $As_2O_3$ -ze tutis moqmedebiT warmoiqmneba metadariSxanovanmJavas marili, **metaarseniti** ( $2NaOH + As_2O_3 = 2NaAsO_2 + H_2O$ ). tute metalis metaarseniti kargad ixsneba wyalSi, ufro mcired tute miwaTa metaarsenitebi, xolo mZime metalis metaarseniti wyalSi uxsnaria. orTodariSxanovanmJavas ( $H_3AsO_3$ ) Sesabamisi marili _ **orToarseniti** ( $Na_3AsO_3$ da sxv.) miiReba dariSxan(III)-is oqsidze tutis moqmedebiT ( $As_2O_3 + 6KOH = 2K_3AsO_3 + 3H_2O$ ).

**dariSxan(V)-is marilebi _ arsenati (** $Na_3AsO_4$ **), hidroarsenati (** $Na_2HAsO_4$ **) da dihidroarsenati (** $NaH_2AsO_4$ **).**

dariSxan(V)-is marili **arsenati**, magaliTad natriumis arsenati ( $Na_3AsO_4$ ) miiReba dariSxanmJavaze ( $H_3AsO_4$ ) Sesabamisi tutis moqmedebiT ( $H_3AsO_4 + 3NaOH = Na_3AsO_4 + 3H_2O$ ). hidroarsenati miiReba reaqciiT $H_3AsO_4 + 2NaOH = Na_2HAsO_4 + 2H_2O$ , xolo dihidroarsenati _ reaqciiT $H_3AsO_4 + NaOH = NaH_2AsO_4 + H_2O$ . mJavur garemoSi dariSxanmJavas marili _ arsenati asrulebs mJangavis rols, magaliTad, $Na_3\overset{5+}{As}O_4 + 2HI = Na_3\overset{3+}{As}O_3 + I_2 + H_2O$ (**natriumis arsenati** gardaiqmneba **natriumis arsenitad**). agreTve cnobilia, metadariSxanmJavas ( $HAsO_3$ ) Sesabamisi marilebi _ **metaarsenatebi** (magaliTad, $NaAsO_3$ , $Ca(AsO_3)_2$ da sxv.).

dariSxanis Semcveli preparatebi ixmareba sisxlnaklebobis, dauZlurebis SemTxvevaSi, agreTve stomatologiur praqtikaSi. dariSxanis marilebi ( $Na_3AsO_4$ , $Ca_3(AsO_4)_2$ , $Ca(AsO_2)_2$ ) rogorc **inseqticidebi** gamoiyeneba mcenareTa mavneblebis winaaRmdeg brZolaSi da sxv.

**stibium(III)-isa da (V)-is halogenidebi** ( $SbHal_3$ **da** $SbHal_5$ , sadac $Hal = F$ , $Cl$ , $Br$ da $I$ ) miiReba stibiumisa da halogenis uSualo urTierTqmedebiT ( $2Sb + 3F_2 = 2SbF_3$ , $2Sb + 3I_2 = 2SbI_3$ , $4Sb + 5F_2 = 2Sb_2F_5$ , $4Sb + 5Cl_2 = 2Sb_2Cl_5$ da sxv.). stibiumis halogenidebi, rogorc susti fuZis marilebi, wyalxsnarSi ganicdis Zlier hidrolizs, ris Sedegadac miiReba fuZuri marili (magaliTad, $SbCl_3 + 2H_2O = Sb(OH)_2Cl + 2HCl$ ). stibiumis hidroqsoqloridi ( $Sb(OH)_2Cl$ ) advilad kargavs wyals da miiReba oqsiqloridi ( $Sb(OH)_2Cl = SbOCl + H_2O$ ). marilSi ( $SbOCl$ ) jgufi $(SbO)^+$ asrulebs erTvalentovani metalis rols da mas **anTimonils** uwodeben. Sesabamisad, $SbOCl$ anTimonilis qloridi an stibiumis oqsiqloridi ewodeba.

stibiumis halogenidebi Tavisi TvisebebiT arsebiTad gansxvavdeba tipuri marilisagan _ magaliTad, isini hidrolizurad ufro Zlier iSleba, vidre eleqtrolizurad; maTi aqroladoba Zlieria, disociacia ki _ saerTod susti.

**stibium(III)-isa da (V)-is JangbadSemcveli marilebi** (**stibiti**, magaliTad, $NaSbO_2$ da **stibati**, magaliTad, $Na_3SbO_4$ ), romelTa miReba SeiZleba Sesabamisad $Sb_2O_3 + 2NaOH = 2NaSbO_2 + H_2O$ da $Sb_2O_5 + 6NaOH = 2Na_3SbO_4 + 3H_2O$ (stibium(V)-is oqsidis SednobiT tutesTan).

cnobilia, agreTve metastibatebi ( $NaSbO_3$ , $KSbO_3$ ) da pirostibatebi ( $Na_4Sb_2O_7$ , $K_4Sb_2O_7$ ). rentgenostruqturuli analiziT dadasturebulia, rom aRniSnuli marilebi polimerulia.

stibiumi da misi naerTebi gamokristalebisas farTovdeba, amitom maT farTo gamoyeneba poves sastambo Sriftebis damzadebaSi. maT iyeneben agreTve germaniumis danamatad, radgan mniSvnelovnad aumjobesebs mis naxevargamtarul Tvisebebs.

**bismut(III)-isa da (V)-is marilebi.**

**bismut(III)-is da (V)-is halidebi** miiReba martivi nivTirebebis _ bismutisa da halogenebis uSualo urTierTqmedebiT ( $2Bi + 3Cl_2 = 2BiCl_3$ , $2Bi + 5F_2 = 2BiF_5$ ). bismut(III)-is qloridi aseve miiReba misi gaxsnisas samefo

wyalSi ($HNO_3 + 3HCl$) da Semdgomi gamoxdiT ($Bi + HNO_3 + 3HCl = BiCl_3 + NO + 2H_2O$). bismut(III)-is qloridi TeTri kristaluri nivTierebaa. wyalSi gaxsnisas, hidrolizis Sedegad, warmoiqmneba bismutis uxsnari hidroqsiqloridi ($BiCl_3 + H_2O = Bi(OH)Cl_2 + HCl$) _ da oqsiqloridi ($BiCl_3 + H_2O = BiOCl + 2HCl$), romlebic TeTri naleqis saxiT gamoiyofa. bismut(III)-is oqsiqloridi ($BiOCl$) sinaTlis moqmedebiT muqdeba, sibneleSi ki isev TeTrdeba. SeiZleba iTqvas, rom bismut(III)-is marili wyalxsnarSi advilad hidrolizdeba fuZuri marilis warmoqmniT. zogadad ki bismutis halidebis hidrolizi mimdinareobs im tipis marilis hidrolizis mixedviT, romelic warmoqmnilia susti fuZiTa da Zlieri mJavaTi. magaliTad, $Bi(NO_3)_3 + H_2O \Leftrightarrow BiONO_3 + 2HNO_3$**.** radikali $(BiO)^+$ _ **bismutili** asrulebs erTvalentovani metalis rols.

**bismut(III)-is nitrati (**$Bi(NO_3)_3$**)** miiReba bismutis hidroqsidze Sesabamisi mJavas moqmedebiT ($Bi(OH)_3 + 3HNO_3 = Bi(NO_3)_3 + 3H_2O$). misi miReba aseve SeiZleba bismutisa da ganzavebul azotmJavas uSualo urTierTqmedebiT ($Bi + 4HNO_3 = Bi(NO_3)_3 + NO + 2H_2O$). igi uferoa, wyalSi kargad ixsneba. miRebuli xsnari gamWvirvalea, Tu igi mJavas Warbad Seicavs. sufTa wyalxsnarSi bismutis nitrati hidrolizurad iSleba da gamoileqeba uxsnari hidroqsi- da oqsimarilebi:

($Bi(NO_3)_3 + H_2O \Leftrightarrow Bi(OH)(NO_3)_2 + HNO_3$,

$Bi(NO_3)_3 + H_2O \Leftrightarrow BiONO_3 + 2HNO_3$).

bismutis fuZuri nitrati ixmareba gamowvis dros mooqruli faifuris zedapiris fiqsaciisaTvis, xolo bismutilnitrati _ medicinaSi, samkurnalo preparatebis dasamzadeblad.

**bismut(III)-is sulfati (**$Bi_2(SO_4)_3$**)** miiReba bismut(III)-is oqsidze ($Bi_3O_3$) an Tavad bismutze koncentrirebuli gogirdmJavas moqmedebiT ($Bi_2O_3 + 3H_2SO_4 = Bi_2(SO_4)_3 + 3H_2O$, $2Bi + 6H_2SO_4 = Bi_2(SO_4)_3 + 3SO_2 + 6H_2O$). bismut(III)-is sulfati TeTri, higroskopiuli nivTierebaa.

bismuti da misi zogierTi naerTi advilad ekvris minas da ixmareba sarkeebis dasamzadeblad, minisa da metalis erTmaneTTan misarCilavad da sxv.

**spilenZ(II)-is halidebi (**$CuF_2$**,** $CuCl_2$**,** $CuBr_2$**,** $CuI_2$**)** advilad miiReba maTi uSualo urTierTqmedebiT, magaliTad, tenian qlorTan gacxelebisas

warmoiqmneba spilenZ(II)-is qloridi ($Cu+Cl_2=CuCl_2$). misi miReba aseve SeiZleba spilenZ(II)-is hidroqsidis Sesabamis mJavaSi ($HCl$) gaxsniT $[Cu(OH)_2+2HCl=CuCl_2+2H_2O]$ gaxurebiT koncentrirebuli halogenwyalbadmJava reagirebs metalur spilenZTan haerze an Jangbadis areSi (spilenZi standartul eleqtrodul potencialTa rigSi aris wyalbadis Semdeg, amitom igi mJavebidan wyalbads ver aZevebs): $2Cu+4HCl+O_2=2CuCl_2+2H_2O$ .

**spilenZ(II)-is sulfati ($CuSO_4$)** miiReba spilenZis gaxsniT cxel koncentrirebul gogirdmJavaSi ($Cu+2H_2SO_4=CuSO_4+SO_2+2H_2O$). es reaqcia SeiZleba Semdeg safexurebad davSaloT. Tavdapirvelad, spilenZi iJangeba gogirdmJavas moqmedebiT, am dros gogirdmJava aRdgeba (gogirdovanmJavamde): $Cu+H_2SO_4=CuO+H_2SO_3$. gogirdovanmJava aramdgradobis gamo TavisiT iSleba: $H_2SO_3=SO_2+H_2O$. spilenZis oqsidi ixsneba Warb gogirdmJavaSi ($CuO+H_2SO_4=CuSO_4+H_2O$). spilenZis sulfati miiReba agreTve spilenZ(II)-is hidroqsidis gogirdmJavasTan urTierTqmedebiT ($Cu(OH)_2+H_2SO_4=CuSO_4+2H_2O$).

spilenZis sulfati (Sabiamani) $CuSO_4\cdot 5H_2O$, spilenZis ajaspi (ajaspi metalis _ $Fe$, $Cu$, $Zn$, $Co$, $Ni$ sulfatebis kristalhidratebis teqnikuri saxelwodebaa) gamoiyeneba mcenareTa mavneblebTan sabrZolvelad. medicinaSi _ antiseptikur, Semkvrel da mosawvav saSualebad, Tvalis TerapiaSi, anemiis sawinaaRmdegod, Ciyvis profilaqtikisa da mkurnalobisaTvis (iodTan erTad) da sxv. bordos siTxe (Sabiamnisa da kirxsnaris narevi) gamoiyeneba rogorc fungicidi.

**spilenZ(II)-is nitratis ($Cu(NO_3)_2$)** miReba SeiZleba spilenZis gaxsniT koncentrirebul azotmJavaSi:

($Cu+4HNO_3=Cu(NO_3)_2+2NO_2+2H_2O$).

igi aseve miiReba spilenZis urTierTqmedebiT ganzavebul azotmJavasTan ($3Cu+8HNO_3=3Cu(NO_3)_2+2NO+4H_2O$). spilenZis nitratis miRebis yvelaze xelmisawvdomi xerxia spilenZ(II)-is hidroqsidze azotmJavas moqmedeba ($Cu(OH)_2+2HNO_3=Cu(NO_3)_2+2H_2O$).

marilSi $NO_3^-$-is ionis arseboba advilad dadgindeba koncentrirebul gogirdmJavasa da spilenZTan marilis gaxurebiT (

$Cu + 2H_2SO_4 + 2NaNO_3 = CuSO_4 + Na_2SO_4 + 2NO_2 + 2H_2O$). am reaqciis mimdinareobis damaxasiaTebel niSans warmoadgens mura feris airis ($NO_2$) gamoyofa da xsnaris cisfrad Seferva (spilenZis hidratirebuli ionebis Seferiloba).

nitratebis mier Jangbadis advilad gacemas emyareba maTi gamoyeneba piroteqnikaSi _ feTqebadi nivTierebebis dasamzadeblad ($2Cu(NO_3)_2 = 2CuO + 4NO_2 + O_2$). spilenZis mraval sxva marils farTo praqtikuli gamoyeneba aqvs teqnikasa da yofa-cxovrebaSi.

**vercxlis halogennaerTebi (**$AgF$**,** $AgCl$**,** $AgBr$**,** $AgI$**)** miiReba halogenebis ($F$, $Cl$, $Br$, $I$) uSualo urTierTqmedebiT (tenisa da sinaTlis pirobebSi) metalur vercxlTan ($2Ag + Cl_2 = 2AgCl$, $2Ag + Br_2 = 2AgBr$). vercxlis fToridi kargad ixsneba wyalSi, xolo qloridi, bromidi da iodidi wyalSi uxsnaria. magram vercxlis yvela halidi ixsneba amiaksa ($AgCl + 2NH_4OH = [Ag(NH_3)_2]Cl + 2H_2O$) da cianidebSi ($AgBr + 2KCN = K[Ag(CN)_2] + KBr$).

vercxlis halidebs Soris farTod gamoiyeneba mieca vercxlis qloridi ($AgCl$) da bromidi ($AgBr$), romlebic fotomgrZnobiarobiT xasiaTdeba _ sinaTlis gavleniT $AgCl$ aRdgeba ($AgCl \xrightarrow{h\nu} Ag + 1/2Cl_2$). aseve gardaiqmneba vercxlis bromidi. $AgCl$-gan mzaddeba linzebi infrawiTeli gamosxivebisaTvis da radarebis ekranebi. $AgI$-ic gamoiyeneba sinaTlisadmi mgrZnobiare afskebis misaRebad.

vercxlis nitrati ($AgNO_3$) miiReba metaluri vercxlis gaxsniT koncentrirebul azotmJavaSi ($Ag + 2HNO_3 = AgNO_3 + NO_2 + H_2O$). misi miReba SeiZleba agreTve vercxlis fToridis wyalxsnarze azotmJavas moqmedebiT ($AgF + HNO_3 = AgNO_3 + HF$).

vercxlis marilebidan didi gamoyeneba aqvs nitrats, romelic kargad ixsneba wyalSi, spirtsa da acetonSi. $AgNO_3$-is wyalxsnarebidan, aRmdgenlebis moqmedebiT, miiReba metaluri vercxli $AgNO_3 + \underset{\text{formaldehi di}}{HCHO} = Ag + NO_2 + HCOOH$. am gziT mzaddeba sarkeebi, Termosebi, diuaris WurWeli da sxv.

**oqro(III)-is qloridi (**$AuCl_3$**)** miiReba oqros fxvnilze Warbi qloris moqmedebiT ($200^\circ C$): $2Au + 3Cl_2 = 2AuCl_3$. oqro(III)-is qloridi aris ZiriTadi

sawyisi nivTiereba oqros sxva naerTebis misaRebad: $AuCl_3 + 3HNO_3 = Au(NO_3)_3 + 3HCl$, $AuCl_3 + 3NaOH = Au(OH)_3 + 3NaCl$ da sxv. oqro(III)-is hidroqsidi advilad ixsneba tuteSi hidroqsoauratis warmoqmniT: $Au(OH)_3 + NaOH = Na(Au(OH)_4$. oqro(III)-is hidroqsidis mJavaSi gaxsnac anionuri kompleqsebis warmoqmnis xarjze xdeba: $Au(OH)_3 + 4HNO_3 = H[Au(NO_3)_4] + 3H_2O$.

oqro(III)-is naerTebi (qloridi, nitrati da sxv.) xasiaTdeba garkveuli mdgradobiT da advilad warmoqmnian koordinaciul naerTebs:

$$4Au + O_2 + 8KCN + 2H_2O = 4K[Au(CN)_2] + 4KOH,$$

$$Au + HNO_3 + 4HCl = H[AuCl_4] + NO + 2H_2O.$$

oqrosa da mis marilebs iyeneben eleqtroteqnikaSi, stomatologiaSi, saiuveliro nakeTobebis dasamzadeblad. oqros iyeneben agreTve minis, faifuris an metalTa zedapiris dasafaravad. koloiduri oqro gamoiyeneba rogorc antiseptikuri saSualeba medicinaSi. saiuveliro nawarmSi oqros ureven spilenZsa da vercxls _ maTSi oqro Sedis 37,5; 58,3; 75,0 da 91,6% odenobiT.

**TuTiis halidebi (halogenidebi _ $ZnF_2$, $ZnCl_2$, $ZnBr_2$, $ZnI_2$)** miiReba uSaulo urTierTqmedebiT (maRal temperaturaze, xolo nestian pirobebSi oTaxis temperaturazec) halogenebTan ($Zn + F_2 = ZnF_2$, $Zn + Cl_2 = ZnCl_2$ da sxv.). TuTiis halidebidan wyalSi uxsnaria mxolod TuTiis fToridi ($ZnF_2$). yvela maTgani TeTri feris, myari kristaluri nivTierebaa. Tavad TuTia ar aris toqsikuri metali, magram misi zogierTi naerTi, magaliTad, TuTiis qloridis ($ZnCl_2$) didi raodenobiT SesunTqva _ uaRresad saxifaToa janmrTelobisaTvis (es garemoeba mxedvelobaSi unda iqnes miRebuli rCilvis dros _ TuTiis gamoyenebisas).

TuTiis halidebidan gamoyeneba aqvs TuTiis qlorids _ advilad warmoqmnis rTuli Sedgenilobis kompleqsur naerTebs, romlebzec didi moTxovnilebaa bioqimiur teqnologiebSi axali masalebis warmoebisaTvis. TuTiis qloridi agreTve ixmareba xis warmoebaSi _ TuTiis qloridiT iJRenTeba xe-tye, rac icavs mas lpobisagan, gamoiyeneba aseve pergamentis dasamzadeblad da rCilvis win metalis zedapirebis gasasufTaveblad. TuTiis qlorids iyeneben medicinaSi samkurnalo preparatebis dasamzadeblad.

**TuTiis sulfatis ($ZnSO_4$)** miReba SeiZleba misi gaxsniT ganzavebul gogirdmJavaSi ($Zn + H_2SO_4 = ZnSO_4 + H_2\uparrow$), igi moqmedebs rogorc aRmdgenic

koncentrirebul gogirdmJavaSi ($Zn + 2H_2SO_4 = ZnSO_4 + SO_2 + 2H_2O$). igi aris TeTri feris kristaluri nivTiereba, kargad xsnadia wyalsa da organul gamxsnelSi.

TuTiis sulfati erT-erTi mniSvnelovani naerTia, romlisganac miiReba TuTiis danarCen nivTierebebi. TuTiis sulfatisa da bariumis sulfidis urTierTqmedebiT miiReba TeTri pigmenti _ liTofoni ($ZnSO_4 + BaS = ZnS + BaSO_4$), romelic ixsneba zeTSi da aseTi saxiT ixmareba saRebavis dasamzadeblad. igi erT-erT saukeTeso saRebavad aris miCneuli. zedmiwevniT sufTa TuTia miiReba TuTiis sulfatis ($ZnSO_4$) wyalxsnaris eleqtroliziT, romelzec didi moTxovnilebaa.

**TuTiis nitrati ($Zn(NO_3)_2$)** miiReba TuTiis hidroqsidis gaxsniT azotmJavaSi ($Zn(OH)_2 + 2HNO_3 = Zn(NO_3)_2 + 2H_2O$) an metaluri TuTiis uSualo urTierTqmedebiT azotmJavasTan ($4Zn + 10HNO_3 = 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$). igi TeTri feris, wyalSi kargad xsnadi marilia.

TuTiis nitrati gamoiyeneba araorganuli da organuli naerTebis sinTezSi axali maRalteqnologiuri masalebis mizanmimarTuli warmoebisaTvis.

**kadmiumis halidebis ($CdF_2$, $CdCl_2$, $CdBr_2$, $CdI_2$)** miReba SeiZleba halogenebis urTierTqmedebiT gavarvarebul ($500^\circ C$) kadmiumze ($Cd + F_2 = CdF_2$, $Cd + Cl_2 = CdCl_2$), an airadi halogenwyalbadebis gatarebiT gaxurebul kadmiumis oqsidze ($CdO + 2HBr = CdBr_2 + H_2O$, $CdO + 2HI = CdI_2 + H_2O$). kadmiumis halidebi TeTri, myari kristaluri nivTierebebia, kadmiumis fToridis ($CdF_2$) gamoklebiT, yvela danarCeni kargad ixsneba wyalSi, spirtsa da sxva organul gamxsnelebSi.

kadmiumis halidebi gamoiyeneba araorganuli da organuli naerTebis sinTezSi.

**kadmiumis sulfidi ($CdS$)** miiReba kadmiumze uSualod gogirdis ($S$) an gogirdwyalbadis ($H_2S$) moqmedebiT ($Cd + S = CdS$, $Cd + H_2S = CdS + H_2$), reaqciis Sedegad gamoiyofa intensiuri yviTeli feris kristaluri nivTierebebi. kadmiumis sulfidi gaxurebiT ixsneba koncentrirebul marilmJavaSi ($CdS + 4HCl = H_2[CdCl_4] + H_2S$), ganzavebul marilmJavasa ($3CdS + 8HNO_3 = 3Cd(NO_3)_2 + 2NO + 3S + 4H_2O$) da tute metalTa cianidebis xsnarSi ($CdS + 4KCN = K_2[Cd(CN)_4] + K_2S$).

kadmiumis sulfidi gamoiyeneba yviTeli feris zeTis saRebavebisa da feradi minebis dasamzadeblad. kadmiumis orTqli yviTeli ferisaa da metad

toqsikuria. saerTod, kadmiumis naerTebTan muSaobisas, misi maRali toqsikurobis gamo, didi sifrTxilea saWiro.

**vercxliswylis halidebi (** $Hg_2Cl_2$ **da** $HgCl_2$ **)** miiReba oTaxis temperaturaze vercxliswylis urTierTqmedebiT halogenebTan (fTori, qlori, bromi, iodi) _ reaqciebis Sedegad warmoiqmneba $Hg_2Cl_2$ da $HgCl_2$**.** vercxliswylis erT-erT qlorids, kerZod, $Hg_2Cl_2$ _ kalomeli ewodeba. igi TeTri feris kristaluri nivTierebaa. amoniumis tutiT ( $NH_4OH$ ) Sesvelebisas, igi intensiur Sav fers iRebs. kalomelSi ( $Hg_2Cl_2$ ) vercxliswylis Jangvis ricxvi formalurad +1-is tolia, magaliTad, vercxliswyali SeiZleba arsebobdes kationis $(Hg-Hg)^{2+}$ an $Hg_2^{2+}$ da agreTve Cveulebrivi kationis $Hg^{2+}$ _ saxiT. orive saxis kationsa da metalur vercxliswyals Soris arsebobs wonasworoba: $(Hg-Hg)^{2+} \Leftrightarrow Hg^{2+} + Hg^0$, romelic Cveulebriv temperaturaze da wyalxsnarebSi gadanacvlebulia marcxniv, xolo gaxurebis an sinaTlisa da qimiuri reaqtivebis moqmedebiT _ marjvniv.

vercxliswylis(I) yvela naerTSi misi atomebi erTmaneTTan SeerTebulia kovalenturi bmebiT _ $Hg-$ an $-Hg-Hg-$. Sesabamisad am naerTebSic vercxliswyali orvalentovania, magram $Hg$ -is TiToeuli atomis valentobis erTeuli ixarjeba $Hg$ -is meore atomTan bmaze, magaliTad, $Hg_2Cl_2$ anu $Cl-Hg-Hg-Cl$ .

**vercxliswyal(I)-is qloridis (** $Hg_2Cl_2$ **)** anu kalomelis miReba SeiZleba $HgCl_2$ -isa da $Hg$ -is narevis gaxurebiT ( $HgCl_2 + Hg = Hg_2Cl_2$ ). kalomeli ( $Hg_2Cl_2$ ) gamoiyeneba medicinaSi. misgan aseve amzadeben eleqtrodebs.

**vercxliswyal(II)-is qloridi (** $HgCl_2$ **)** anu sulema miiReba vercxliswylis uSualo urTierTqmedebiT qlorTan ( $Hg + Cl_2 = HgCl_2$ ). Cveulebriv sulema miiReba $Hg$ (II)-is sulfatis gaxurebiT natriumis qloridTan ( $HgSO_4 + 2NaCl = HgCl_2 + Na_2SO_4$ ).

sulema ( $HgCl_2$ ) Zlieri sawamlavia, xasiaTdeba fungiciduri da baqtericiduri TvisebebiT.

vercxliswyalTan muSaobis dros saWiroa didi sifrTxile _ vercxliswylis aqroladobisa da misi orTqlis toqsikurobis gamo.

**lanTanis halidebi (** $LaF_3$ **,** $LaCl_3$ **,** $LaBr_3$ **,** $LaI_3$ **)** miiReba lanTanis uSualo urTierTqmedebiT halogenebTan ( $2La + 3F_2 = 2LaF_3$ , $2La + 3Cl_2 = 2LaCl_3$ da sxv.).

lanTanis halidebi aseve miiReba lanTanis gaxsniT ganzavebul mJavaSi ( $2La + 6HCl = 2LaCl_3 + 3H_2$ ) an lanTanis qlorze bromwyalbadis moqmedebiT ( $LaCl_3 + 3HBr = LaBr_3 + 3HCl$ ).

**lanTanis sulfatis (** $La_2(SO_4)_3$ **)** miReba SeiZleba lanTanis hidroqsidis ( $La(OH)_3$ ) gaxsniT gogirdmJavaSi ( $2La(OH)_3 + 3H_2SO_4 = La_2(SO_4)_3 + 6H_2O$ ). misi miReba aseve SeiZleba misi, rogorc aqtiuri metalis, gaxsniT Sesabamis mJavaSi ( $2La + 3H_2SO_4 = La_2(SO_4)_3 + 3H_2O$ ).

**lanTanis nitrati (** $La(NO_3)_3$ **)** miiReba lanTanis hidroqsidze azotmJavas moqmedebiT ( $LaCl_3 + 3HNO_3 = La(NO_3)_3 + 3HCl$ , $La_2O_3 + 6HNO_3 = 2La(NO_3)_3 + 3H_2O$ ).

lanTanis marilebi uferoa, kargad ixsnebian wyalSi (magaliTad, qloridebi, bromidebi, sulfatebi, nitratebi da acetatebi), xolo mcired xsnadia _ fToridebi, fosfatebi, karbonatebi da oqsalatebi. lanTanis yvela marili advilad hidrolizebadia, amJRavnebs kompleqsuri da ormagi marilebis warmoqmnis unars.

lanTanis marilebi ixmareba minis mrewvelobaSi _ isini minas aniWeben ultraiisferi sxivebis STanTqmis unars. lanTanis halidebi gamoiyeneba, rogorc katalizatorebi. lanTanis zogierTi naerTi ixmareba agreTve radioteqnikaSi.

**aqtiniumis halidebi (** $AcF_3$ **,** $AcCl_3$ **,** $AcBr_3$ **,** $AcI_3$ **)** miiReba aqtiniumis hidroqsidze ( $Ac(OH)_3$ ) tetrahalogenmeTanis ( $CHal_4$ ) moqmedebiT ( $4Ac(OH) + 3CCl_4 = 4AcCl_3 + 3CO_2 + 6H_2O$ , $4Ac(OH)_3 + 3CBr_4 = 4AcBr_3 + 3CO_2 + 6H_2O$ da sxv.). maTi miReba aseve SeiZleba Cveulebriv pirobebSi, aqtiniumis fuZis urTierTqmedebiT halogenwyalbadmJavebTan ( $Ac(OH)_3 + 3HF = AcF_3 + 3H_2O$ , $Ac(OH) + 3HCl = AcCl_3 + 3H_2O$ ). aqtiniumis marilebidan wyalSi kargad xsnadia qloridi, bromidi, iodidi, xolo naklebxsnadia fToridi. aqtiniumis halidebi uferoa, gamonaklisia mxolod Savi feris aqtiniumis sulfidi ( $Ac_2S_3$ ). lanTanis marilebisgan gansxvavebiT, aqtiniumis marilebi Znelad ganicdian hidrolizs, radgan maT xasiaTdeba Zlieri fuZuri Tvisebebi aqvT.

**aqtiniumis sulfatis (** $Ac_2(SO_4)_3$ **)** miReba SeiZleba aqtiniumis oqsidis ( $Ac_2S_3$ ) gaxsniT Sesabamis mJavaSi:

( $Ac_2O_3 + 3H_2SO_4 = Ac_2(SO_4)_3 + 3H_2O$ ).

misi miReba SeiZleba agreTve aqtiniumis fuZis urTierTqmedebiT gogirdmJavasTan ( $2Ac(OH)_3 + 3H_2SO_4 = Ac_2(SO_4)_3 + 6H_2O$ ). aqtiniumis sulfati uferoa, wyalSi kargad xsnadia maSin, rodesac Znelad xsnadia aqtiniumis ormagi sulfati ( $K[Ac(SO_4)_2]$ ).

**aqtiniumis nitratis (** $Ac(NO_3)_3$ **)** miReba SeiZleba metaluri aqtiniumis gaxsniT ganzavebul azotmJavaSi, amasTan igi $HNO_3$ aRadgens amoniumis nitratamde ( $8Ac + 30HNO_3 = 8Ac(NO_3)_3 + 3NH_4NO_3 + 9H_2O$ ). igi miiReba agreTve aqtiniumis fuZis azotmJavasTan urTierTqmedebiT ( $Ac(OH)_3 + 3HNO_3 = Ac(NO_3)_3 + 3H_2O$ ). igi uferoa, kargad xsnadia wyalSi. lanTanis Sesabamis marilTan SedarebiT, aqtiniumis nitrati Znelad ganicdis hidrolizs, radgan mas aqvs Zlieri fuZe Tvisebebi. aqtiniumis zogierTi marili lanTanis Sesabamisi marilis izomorfulia.

aqtiniumis zogierTi halidi, agreTve nitrati, sulfati, acetati da sxva gamoiyeneba uaxles teqnologiebsa da medicinaSi samkurnalwamlo preparatebis dasamzadeblad.

**titan(II)-is qloridi, bromidi da iodidi (** $TiCl_2$ **,** $TiBr_2$ **da** $TiI_2$ **)**

**titanis diqloridi (** $TiCl_2$ **)** miiReba titanis triqloridis disproporcionirebiT ( $2TiCl_3 \Leftrightarrow TiCl_2 + TiCl_4$ ). miRebuli titanis diqloridi da tetraqloridi sxvadasxva temperaturaze gamoixdeba. aseTive gziT miiReba **titanis dibromidi da diodidi** ( $2TiBr_3 \Leftrightarrow TiBr_2 + TiBr_4$ , $2TiI_3 \Leftrightarrow TiI_2 + TiI_4$ ). es naerTebi Savi feris fxvnilebia, gaxurebisas iSleba.

**titan(III)-is fToridis (** $TiF_3$ **, trifToridi)** miReba SeiZleba titanis gaxsniT Sesabamis halogenwyalbadmJavaSi, kerZod, fTorwyalbadmJavaSi ( $2Ti + 6HF = 2TiF_3 + 3H_2$ ).

**titan(III)-is qloridi (** $TiCl_3$ **, triqloridi)** miiReba titan(II)-is oqsidis gaxsniT ganzavebul marilmJavaSi ( $2TiO + 6HCl = 2TiCl_3 + 2H_2O + H_2$ ). titanis triqloridi aseve miiReba misi tetraqloridis aRdgeniT wyalbadiT ( $2TiCl_4 + H_2 = 2TiCl_3 + 2HCl$ ). igi iisferi kristalia.

**titan(IV)-is qloridis (** $TiCl_4$ **, titanis tetraqloridi)** miReba SeiZleba titanis dioqsidis ( $TiO_2$ ) gaxsniT marilmJavaSi ( $TiO_2 + 4HCl = TiCl_4 + 2H_2O$ ). igi uferoa, Zlier hidrolizdeba wyalxsnarSi ( $TiCl_4 + 2H_2O = TiO_2 + 4HCl$ ). wylis

naklebobis SemTxvevaSi miiReba titanilqloridi ($TiOCl_2$). titanis tetraqloridisTvis damaxasiaTebelia agreTve mierTebis reaqciebi, ris Sedegadac miiReba koordinaciuli naerTebi ($(NH_4)_2[TiCl_6]\cdot 2H_2O$) da sxv.

**titan(IV)-is bromidis ($TiBr_4$, titanis tetrabromidi) da iodidis ($TiI_4$, titanis tetraiodidi)** miReba SeiZleba martivi nivTierebebis sinTeziT ($Ti+2Br_2=TiBr_4$, $Ti+2I_2=TiI_4$). titanis tetrabromidi yviTeli feris kristaluri nivTierebaa, xolo tetraiodidi _ wiTeli feris.

**titan(III)-is sulfati ($Ti_2(SO_4)_3$)** miiReba titan(II)-is oqsidis gaxsniT ganzavebul gogirdmJavaSi ($2TiO+3H_2SO_4=Ti_2(SO_4)_3+2H_2O+H_2$). igi, Cveulebriv, iisferia, kargad xsnadia wyalSi.

**titan(IV)-is sulfatis ($Ti(SO_4)_2$)** miReba SeiZleba titanis dioqsidis gaxsniT koncentrirebul gogirdmJavaSi ($TiO_2+2H_2SO_4=Ti(SO_4)_2+2H_2O$). titanis disulfati TeTri fxvnilia, ixsneba civ wyalSi.

titani da misi naerTebi koroziuli medegobisa da sxva unikaluri Tvisebebis gamo farTod gamoiyeneba axali teqnikis masalebis, qimiuri aparaturis, Zneldnobadi minis, Wiquris, minanqrisa da zeTis TeTri saRebavebis dasamzadeblad da sxv.

**cirkonium(II)-is qloridi ($ZrCl_2$)** miiReba misi triqloridis disproporcionirebiT vakuumSi gacxelebisas ($2ZrCl_3\Leftrightarrow ZrCl_2+ZrCl_4$) _ Sedegad miiReba Savi feris diqloridi da TeTri tetraqloridi. cirkoniumis miReba SeiZleba agreTve mis tetraqloridze metaluri cirkoniumis moqmedebiT maRal temperaturaze ($ZrCl_4+Zr=2ZrCl_2$).

**cirkonium(II)-is bromidi ($ZrBr_2$) da iodidi ($ZrI_2$)** miiReba Sesabamisad maTi triqloridebis vakuumSi disproporcionirebiT ($2ZrBr_3\Leftrightarrow ZrBr_2+ZrBr_4$, $2ZrI_3\Leftrightarrow ZrI_2+ZrI_4$). cirkoniumis tetrabromidsa da tetraiodidze moqmedeben metaluri cirkoniumiT maRal temperaturaze da miiReba Sesabamisad dibromidi ($ZrBr_4+Zr=2ZrBr_2$) da iodidi ($ZrI_4+Zr=2ZrI_2$). cirkoniumis dibromidi aramdgradi naerTia, gacxelebisas disproporcirdeba ($2ZrBr_2=ZrBr_4+Zr$) da miiReba cirkoniumis tetrabromidi ($ZrBr_4$) da metaluri cirkoniumi ($Zr$).

**cirkonium(IV)-is fToridi ($ZrF_4$, cirkoniumis tetrafToridi)** miiReba cirkoniumis dioqsidze fTorwyalbadmJavas moqmedebiT (

$ZrO_2 + 4HF = ZrF_4 + 2H_2O$). igi aseve miiReba metalur cirkoniumze fToris moqmedebisas ($Zr + 2F_2 = ZrF_4$) an fxvnilisebr cirkoniumze mlRobi mJavas moqmedebis dros ($Zr + 4HF = ZrF_4 + 2H_2$).

**cirkonium(IV)-is qloridi ($ZrCl_4$, cirkoniumis tetraqloridi)** miiReba metaluri cirkoniumis gacxelebisas airadi qloris moqmedebiT ($Zr + 2Cl_2 = ZrCl_4$). cirkoniumis tetraqloridi wyalTan hidrolizs ganicdis. igi ixsneba spirtSi, marilmJavaSi, tute metalTa qloridebis xsnarebSi.

**cirkonium(IV)-is bromidi ($ZrBr_4$, cirkoniumis tetrabromidi)** miiReba fxvnilisebri cirkoniumis gacxelebisas masze bromis moqmedebiT ($Zr + 2Br_2 = ZrBr_4$). cirkoniumis tetrabromidi ufero mikrokristaluri fxvnilia, wylis moqmedebiT iSleba da miiReba cirkonilis ($ZnO^{+2}$) dibromidi $ZrOBr_2$ da $HBr$ ($ZrBr_4 + H_2O = ZrOBr_2 + 2HBr$).

**cirkonium(IV)-is sulfati ($Zr(SO_4)_2$, disulfati)** miiReba cirkoniumis tetraqloridze koncentrirebuli gogirdmJavas moqmedebiT ($ZrCl_4 + 2H_2SO_4 = Zr(SO_4)_2 + 4HCl$). cirkoniumis sulfatis wyalxsnaris eleqtrolizis dros kaTodze gamoiyofa wyalbadi, anodisaken ki miemarTeba cirkoniumi da masTan mibmuli sulfat-ioni. aqedan daskvna _ xsnarSi cirkoniumis sulfatis formula unda iyo $H_2[ZrO(SO_4)_2]$ da mas **cirkonilgogirdmJava** ewodeba.

**cirkoniumis azotmJava marili ($Zr(NO_3)_4$)** ufero higroskopiuli kristalebia, wyalSi kargad ixsneba.

**cirkoniumis acetati ($Zr(CH_3COO)_4$)** miiReba cirkoniumis tetraqloridze ZmarmJavas moqmedebiT. aRniSnulis garda, cirkoniumi warmoqmnis xelatur naerTebs.

cirkoniumi da misi naerTebis masalebi gamoiyeneba aparatebis, kondesatorebis, saorTqleblebis, milebis, tumboebis, mJavamedegi sarqvelebis da sxva nakeTobaTa dasamzadeblad. maT iyeneben foladis warmoebaSi Jangbadis, azotisa da gogirdis mosacileblad. cirkoniumis naerTebis nawili ixmareba tigelebis, cecxlgamZle da mJavagamZle aguris, faifurisa da minis (eleqtroizolatoris), minanqris, Wiqurisa da mdgradi saRebavebis dasamzadeblad.

**hafnium(IV)-is fToridi (** $HfF_4$ **)** miiReba misi gaxsniT koncentrirebul fTorwyalbadmJavaSi ( $Hf + 4HF = HfF_4 + 2H_2$ ), agreTve metaluri hafniumisa da fToris urTierTqmedebiT gaxurebisas ( $Hf + 2F_2 = HfF_4$ ).

**hafnium(IV)-is qloridis (** $HfCl_4$ **)** miReba SeiZleba hafniumis gaxsniT ,,samefo wyalSi" ( $3Hf + 4HNO_3 + 12HCl = 3HfCl_4 + 4NO + 8H_2O$ ), agreTve maRal temperaturaze metaluri hafniumisa da qloris urTierTqmedebiT ( $Hf + 2Cl_2 = HfCl_4$ ). analogiurad miiReba hafnium(IV)-is bromidi da iodidi.

hafnium(IV)-is halidebi aqroladi, myari kristaluri nivTierebebia. hafniumisaTvis damaxasiaTebelia ormagi marilebis warmoqmnis unari, magaliTad, $(NH_4)_2[HfF_6]$ da sxv.

hafniumi da misi zogierTi naerTi rogorc axali teqnikuri masalebi farTod gamoiyeneba turboreaqtiul ZravebSi, xelovnur TanamgzavrebSi da sxv., agreTve maRalvakuumur teqnikaSi airebis Zlier STanTqmis unaris gamo. am nivTierebebs iyeneben agreTve maRali gardatexis maCveneblis mqone optikuri minebis dasamzadeblad.

**vanadium(II)-is fToridi (** $VF_2$ **)** miiReba vanadium(III)-is disproporcirebiT an vanadium(IV)-is fToridebis wyalbadiT aRdgenis Sedegad ( $2VF_3 = VF_2 + VF_4$ an $VF_4 + H_2 = VF_2 + 2HF$ ). igi ( $VF_2$ ) iisferi kristalia.

**vanadium(II)-is qloridis (** $VCl_2$ **)** miReba SeiZleba $VCl_3$ -is disproporcirebiT ( $2VCl_3 = VCl_2 + VCl_4$ ) an $VCl_4$ -is wyalbadiT aRdgenisas ( $VCl_4 + H_2 = VCl_2 + 2HCl$ ). vanadiumis diqloridi myaria, xolo vanadiumis tetraqloridi ( $VCl_4$ ), romelic miiReba fxvnilisebri vanadiumis gaxurebisas qloris areSi ( $V + 2Cl_2 = VCl_4$ ), muqi wiTeli feris siTxea, ixsneba organul gamxsnelSi, wyalSi ganicdis hidrolizs ( $VCl_4 + H_2O = VOCl_2 + 2HCl$ ), $VOCl_2$ _ vanadilis diqloridis da $HCl$ -is warmoqmniT.

**vanadium(II)-is bromidisa da iodidis** miReba SeiZleba Sesabamisad $VBr_3$ -is da $VI_3$ -is gaxurebiT vakuumSi ( $2VBr_3 = 2VBr_2 + Br_2$ , $2VI_3 = 2VI_2 + I_2$ ).

**vanadium(V)-is halidebidan** cnobilia mxolod vanadiumis pentafToridi ( $VF_5$ ), ufero, wyalSi kargad xsnadi marilis saxiT.

vanadiumisa da misi naerTebis gamoyeneba teqnikaSi mravalmxrivia, kerZod, isini ixmareba, rogorc erT-erTi saukeTeso katalizatori gogirmJavas, minisa da keramikis warmoebebSi. zogierTi maTgani gamoiyeneba rogorc

sasuqi soflis meurneobaSi, xolo maTi Semcveli preparatebi (samkurnalwamlo saSualebebi) _ medicinaSi.

**niobium(II)-is fToridi ( $NbF_2$ ) da qloridi ( $NbCl_2$ )** miiReba niobium(II)-is oqsidis gaxsniT mdnob mJavasa ( $HF$ ) da marilmJavaSi ( $HCl$ ): $NbO + 2HF = NbF_2 + H_2O$ da $NbO + 2HCl = NbCl_2 + H_2O$.

**niobium(III)-is qloridi ( $NbCl_3$ )** miiReba metalur niobiumze qloris moqmedebiT ( $450^\circ C$ ): $2Nb + 3Cl = 2NbCl_3$**.** niobiumis triqloridis miReba aseve SeiZleba misi pentaqloridis aRdgeniT ( $NbCl_5 + H_2 = NbCl_3 + 2HCl$ ). igi mcired aqroladi myari nivTierebaa, ar urTierTqmedebs wyalTan. amave gziT miiReba **niobiumis tribromidi ( $NbBr_3$ ):** $NbBr_5 + H_2 = NbBr_3 + 2HBr$ . bromis es naerTi wyalSi hidrolizis produqtebs warmoqmnis ( $5NbBr_3 = 3NbBr_5 + 2Nb$ ).

**niobium(IV)-is qloridi ( $NbCl_4$ ),** niobiumis tetraqloridi) wyalSi kargad ixsneba; gacxelebisas disproporcionirebis Sedegad miiReba $NbCl_3$ da $NbCl_5$ ( $2NbCl_4 = NbCl_3 + NbCl_5$ ). niobiumis tetraqloridis koncentrirebuli wyalxsnari lurjia.

**niobium(V)-is fToridi ( $NbF_5$ , niobiumis pentafToridi) da qloridi ( $NbCl_5$ , niobiumis pentaqloridi)** miiReba Sesabamisi elementebis pirdapiri urTierTqmedebiT ( $180 - 250^\circ C$ ): $2Nb + 5F_2 = 2NbF_5$ ; $2Nb + 5Cl_2 = 2NbCl_5$ . $NbF_5$ -is miReba aseve SeiZleba mlRobi mJavas moqmedebiT metalur niobiumze.

**niobium(V)-is iodidi ( $NbI_5$ )** miiReba niobiumze iodis orTqlis moqmedebisas maRal temperaturaze ( $300^\circ C$ ): $2Nb + 5I_2 = 2NbI_5$ . niobiumis pentafToridi ( $NbI_5$ ) gamoiyeneba sufTa niobiumis misaRebad.

niobiumi da misi naerTebi didi raodenobiT gamoiyeneba vakuumur teqnikaSi, eleqtroteqnikasa da rentgenis aparaturaSi. maTi mniSvnelovani nawili gamoiyeneba Zneldnobadi, mJavamedegi da zemagari Senadnobebis dasamzadeblad, agreTve qimiuri laboratoriebisaTvis tigelebis, ampulebis, sadistilacio xelsawyoebis dasamzadeblad.

**tantalis diqloridi ( $TaCl_2$ )** miiReba metalur tantalze airadi qlorwyalbadis moqmedebiT ( $600 - 700^\circ C$ ): $Ta + 2HCl = TaCl_2 + H_2$ . igi aseve miiReba tantalis pentaqloridis aluminiT aRdgenisas ( $TaCl_5 + Al = TaCl_2 + AlCl_3$ ).

**tantalis trifToridi ( $TaF_3$ )** miiReba fTorwyalbadisa da wyalbadis narevis moqmedebisas metalur tantalze ( $2Ta + 6HF = 2TaF_3 + 3H_2$ ).

**tantal(III)-is qloridi (** $TaCl_3$ **)** miiReba tantal(V)-is qloridze aluminis moqmedebisas ($3TaCl_5 + 2Al = 3TaCl_3 + 2AlCl_3$). tantalis triqloridi mwvane kristaluri nivTierebaa, wyalSi gaxsnisas ganicdis hidrolizs.

**tantalis tribromidi (** $TaBr_3$ **)** miiReba airad bromwyalbadis urTierTqmedebiT metalur tantalze ($550^\circ C$): $2Ta + 3Br_2 = 2TaBr_3$.

**tantal(IV)-is qloridi (** $TaCl_4$ **, tantalis tetraqloridi)** miiReba tantalis pentaqloridisa da triqloridis urTierTqmedebiT ($TaCl_3 + TaCl_5 = 2TaCl_4$). tantalis tetraqloridi mwvane feris nivTierebaa, wyalSi gaxsnisas ganicdis qimiur gardaqmnas.

**tantal(V)-is fToridi (** $TaF_5$ **, tantalis pentafToridi)**, miiReba pentaqloridze Txevadi mdnobi mJavas moqmedebiT ($TaCl_5 + 5HF = TaF_5 + 5HCl$). igi agreTve miiReba gaxurebisas tantalis fToriT Jangvis dros ($2Ta + 5F_2 = 2TaF_5$ ).

**tantal(V)-is qloridi (** $TaCl_5$ **, tantalis pentaqloridi)** miiReba metalur tantalze airadi qlorwyalbadis moqmedebiT ($410^\circ C$): $2Ta + 10HCl = 2TaCl_5 + 5H_2$.

**tantal(V)-is bromidi (** $TaBr_5$ **)** miiReba ($550^\circ C$) airad bromwyalbadTan metaluri tantalis urierTqmedebiT ($2Ta + 10HBr = 2TaBr_5 + 5H_2$).

tantali da misi naerTebi gamoiyeneba qimiur mrewvelobaSi sadistilacio aparaturis, milgayvanilobis, maduRrebis, eleqtrodebis agreTve qimiuri laboratoriebisaTvis kapsulebis, tigelebis, sacrebis, sawonebis, analizuri sasworebisaTvis da sxvaTa dasamxzadeblad. gamoiyeneba agreTve qirurgiaSi sisxlZarRvebisa da kapilarebis Sesakeri Zafebic am nivTierebebisganaa damzadebuli, SedarebiT msxvili Zafi da firfitebi ixmareba travmatologiaSi. aseve iyeneben maT sinTezuri boWkos warmoebasa da kvebis mrewvelobaSi, rogorc katalizatori farTod gamoiyeneba qimiur sawarmoebSi.

**qromis halidebi**

**qromis difToridi (** $CrF_2$ **)** miiReba gavarvarebul qromze mdnobi mJavas moqmedebiT ($Cr + 2HF = CrF_2 + H_2$) an Cveulebriv temperaturaze ($20 - 25^\circ C$) qromis diqloridze fTorwyalbadmJavas moqmedebiT ($CrCl_2 + 2HF = CrF_2 + 2HCl$). qromis difToridi mwvane feris kristalebia, wyalSi ixsneba SezRuduli

raodenobiT, tenian haerze advilad iJangeba da miiReba qromis trioqsidi ( $Cr_2O_3$ ).

**qromis diqloridi (** $CrCl_2$ **anu misi dimeri** $Cr_2Cl_4$ **)** miiReba wiTel varvarebamde gaxurebul qromze airadi qlorwyalbadis moqmedebisas ( $Cr + 2HCl = CrCl_2 + H_2$ ) an gauwyloebul triqloridze ( $400 - 450^\circ C$ ) wyalbadis nakadis gatarebiT ( $2CrCl_3 + H_2 = 2CrCl_2 + 2HCl$ ). qromis diqloridis dimeri ( $Cr_2Cl_4$ ) higroskopiuli TeTri kristalebia, wyalxsnari lurji ferisaa, romelic gacxelebisas mwvane fers iRebs. qromis diqloridis xsnari advilad STanTqavs Jangbads, gardaiqmneba $Cr_2OCl_4$ -ad, amitom gamoiyeneba airebis analizisaTvis. $CrCl_2$ -is xsnari advilad STanTqavs amiaksac, Sedegad temperaturis mixedviT miiReba lurji $[Cr(NH_3)_6]Cl_2$ , iisferi $CrCl_2 \cdot 5NH_3$ , iasamnis feri $CrCl_2 \cdot 2NH_3$ an momwvano feris $CrCl_2 \cdot NH_3$ -is naerTebi.

**qromis dibromidi (** $CrBr_2$ **)** miiReba wiTel varvarebamde gaxurebul qromze bromwyalbadis moqmedebisas ( $Cr + 2HBr = CrBr_2 + H_2$ ). igi moyviTalo feris kristaluri nivTierebaa, mdgradia mSral haerze, tenian haerze iJangeba _ miiReba mwvane feris oqsidi ( $Cr_2O_3$ ).

**qrom(II)-is sulfati (** $CrSO_4$ **)** miiReba qrom(III)-is sulfatis aRdgeniT. am mizniT mas emateba ganzavebuli gogirdmJava da TuTia an qroms gaxsnian ganzavebul gogirdmJavaSi ( $Cr_2(SO_4)_3 + H_2SO_4 + 2Zn = 2CrSO_4 + 2ZnSO_4$ , $Cr + H_2SO_4 = CrSO_4 + H_2$ ). qromis hidratirebuli sulfati ( $CrSO_4 \cdot H_2O$ ) uferoa, pentahidrati ( $CrSO_4 \cdot 5H_2O$ ) lurjia da Tavisi struqturiT Sabiamnis msgavsia. cxeli koncentrirebuli xsnaridan miiReba heptahidrati _ $CrSO_4 \cdot 7H_2O$ lurji feris kristalebi, romelic $FeSO_4 \cdot 7H_2O$ izomorfulia.

**qromis triqloridi (** $CrCl_3$ **)** miiReba mSrali qloris gatarebiT gavarvarebuli qromis zedapirze ( $2Cr + 3Cl_2 = 2CrCl_3$ ) an gaxurebuli qrom(III)-is oqsidis urTierTqmedebiT qlorTan da naxSirTan ( $Cr_2O_3 + 3Cl_2 + 3C = 2CrCl_3 + 3CO$ ) an kidev qrom(III)-is oqsidisa da oTxqlornaxSirbadis urTierTqmedebiT maRal temperaturaze ( $Cr_2O_3 + 3CCl_4 = 2CrCl_3 + 3COCl_2$ ). uwylo qromqloridi moyviTalo-iisferi kristaluri nivTierebaa, gaxurebisas ganicdis disociacias ( $2CrCl_3 = 2CrCl_2 + Cl_2$ ). civ wyalSi qloriani qromi ar ixsneba, gacxelebiT ki nela ixsneba, magram aRmdgenebis monawileobiT.

fTorTan da bromTan qromi msgavs naerTebs warmoqmnis ($CrF_3$ _ **qromis trifToridi** da $CrBr_3$ _ **qromis tribromidi).** iodTan qromi iZleva muqi wiTeli feris qromis triodidsa ($CrI_3$) da Sav iisfer hidrats ($CrI_3 \cdot 9H_2O$).

**qrom(III)-is nitrati ($Cr(NO_3)_3$)** miiReba qrom(III)-is hidroqsidis gaxsniT azotmJavaSi ($Cr(OH)_3 + 3HNO_3 = Cr(NO_3)_3 + 3H_2O$). igi ixmareba qsovilebis SeRebvisas rogorc fermWeri.

**qrom(III)-is sulfati ($Cr_2(SO_4)_3$)** miiReba qrom(III)-is hidroqsidis gaxsniT Sesabamis mJavaSi ($H_2SO_4$): $2Cr(OH)_3 + 3H_2SO_4 = Cr_2(SO_4)_3 + 6H_2O$. uwylo sulfatis ($Cr_2(SO_4)_3$) garda, cnobilia wyalSemcveli iisferi sulfati ($Cr_2(SO_4)_3 \cdot 12H_2O$) da ramdenime mwvane sulfati.

iisferi qromsulfatisa da kaliumsulfatis xsnarebis narevidan gamokristaldeba ormagi marili ($KCr(SO_4)_2 \cdot 12H_2O$ **anu** $K_2SO_4 \cdot Cr_2(SO_4)_3 \cdot 24H_2O$), romelic qromis Sabs warmoadgens. igi kristaldeba muqi mowiTalo-iisferi nivTierebis saxiT. qromis Sabi ($KCr(SO_4)_2 \cdot 12H_2O$) farTod gamoiyeneba tyavis Trimlvis saqmeSi (qromiani tyavi).

**qrommJavas marilebi _ qromatebi ($Na_2CrO_4$) da diqromatebi ($Na_2Cr_2O_7$)**

**natriumis qromati ($Na_2CrO_4$)** miiReba qrom(VI)-is oqsidis Sesabamis tuteSi gaxsniT ($CrO_3 + 2NaOH = Na_2CrO_4 + H_2O$). igi, iseve rogorc sxva qromatebi ($K_2CrO_4$, $CaCrO_4$) da maTi wyalxsnarebi yviTeli Seferilobisaa. natriumis qromati kristaldeba hidratis saxiT ($Na_2CrO_4 \cdot 10H_2O$), romelic ganiTxeva haerze _ tute metalebisa da amoniumis qromatebi kargad ixsneba wyalSi.

**natriumis diqromati ($Na_2Cr_2O_7$)** miiReba orqrom(VI)-is oqsidis ($2CrO_3$) gaxsniT Sesabamis tuteSi ($2CrO_3 + 2NaOH = Na_2Cr_2O_7 + H_2O$). igi, iseve rogroc yvela diqromati da maTi wyalxsnari, narinjisferia. natriumis diqromatis wyalSi xsnadoba didia. xsnarebidan gamoiyofa kristalhidratis ($Na_2Cr_2O_7 \cdot 2H_2O$) saxiT. igi advilad ganiTxeva haerze, ris gamoc misi gamoyeneba mouxerxebelia, amitom ormagi mimocvliT amzadeben kaliumis diqromats ($Na_2Cr_2O_7 + 2KCl = K_2Cr_2O_7 + 2NaCl$). kaliumis diqromati ($K_2Cr_2O_7$) ar ganiTxeva haerze.

tute areSi diqromati qromatad gardaiqmneba ( $K_2Cr_2O_7 + 2KOH = 2K_2CrO_4 + H_2O$ ) da narinjisferi xsnari gaxdeba yviTeli, xolo mJava areSi qromati _ diqromatad ( $2K_2CrO_4 + 2HCl = K_2Cr_2O_7 + 2KCl + H_2O$ ) da yviTeli xsnari gaxdeba narinjisferi. Zlieri gaxurebiT diqromatebi iSleba ( $2Na_2Cr_2O_7 = 2Na_2CrO_4 + Cr_2O_3 + 1{,}5O_2$ ). iseve rogorc qromatebi, diqromatebic Zlieri mJangavebia gansakuTrebiT maSin, rodesac reaqcia mimdinareobs mJavur areSi ( $Na_2Cr_2O_7 + 14HCl = 2CrCl_3 + 3Cl_2 + 2NaCl + 7H_2O$ ).

qromi da misi naerTebi gamoiyeneba azotmJavas warmoebaSi katalizatorad amiakis Jangvis dros. agreTve Termowyvilebis dasamzadeblad da aseve stomatologiasa da qirurgiaSi. maRali antikoroziuli unaris gamo gamoiyeneba metalTa zedapirebis dasacavad. natriumis, kaliumis, amoniumis diqromatebi farTod ixmareba tyavis TrimlvisaTvis, asanTis, saRebrebis, asafeTqebeli nivTierebebis warmoebaSi; tyviisa da stronciumis qromatebi _ saRebrebis dasamzadeblad, xolo qromkaliumis Sabi _ qsovilebis SesaRebad da sxv.

medicinaSi gamoiyeneba natriumis qromati (niSandebuli $^{51}_{24}Cr$ izotopiT) sisxlis sxvadasxva daavadebisa da kuWnawlavidan sisxldenis amosacnobad.

kaliumis diqromatis najeri xsnarisa da koncentrirebuli gogirdmJavas toli moculobebis narevi, e.w. ,,qromis narevi” xSirad ixmareba qimiuri WurWlis gasarecxad laboratoriebSi.

**manganumis halidebi**

**manganum(III)-isa da (IV)-is fToridebi.** manganumis fTorTan urTierTqmedebisas warmoiqmneba manganumis trifToridi ( $2Mn + 3F_2 = 2MnF_3$ ) da tetrafToridi ( $Mn + 2F_2 = MnF_4$ ).

fTormanganiti $K_2[MnF_6]$ miiReba kalciumis permanganatisa da kaliumfToridis SetaniT Zlier gacivebul 40%-ian ftorwyalbadmJavaSi ( $Ca[MnO_4] + 16HF + 4KF = 2K_2[MnF_6] + CaF_2 + 3F_2 + 8H_2O$ ).

**manganum(II)-is qloridi ( $MnCl_2$ )** miiReba manganumis dioqsidis urTierTqmedebiT koncentrirebul marilmJavasTan ( $MnO_2 + 4HCl = MnCl_2 + Cl_2 + 2H_2O$ ). manganumis diqloridis miReba aseve SeiZleba misi urTierTqmedebiT marilmJavasTan ( $Mn + 2HCl = MnCl_2 + H_2$ ). halogenebTan uSualo urTierTqmedebiT aseve miiReba manganumis diqloridi ( $Mn + Cl_2 = MnCl_2$ ). qloriani manganumis kargad xsnadi marilia, Zlier

higroskopiuli, ris gamo advilad ganiTxeva haerze. wyalxsnarebidan kristaldeba oTxi molekula wyliT ($MnCl_2 \cdot 4H_2O$) vardisferi kristalebis saxiT. igi ixmareba rogorc saRebavis fermWeri.

**manganum(III)-is qloridi ($MnCl_3$)** miiReba koncentrirebuli marilmJavas moqmedebiT manganumis dioqsidze ($8HCl + 2MnO_2 = 2MnCl_3 + Cl_2 + 4H_2O$). manganumis triqloridi arsebobs xsnaris saxiT. Tavisufali $MnCl_3$-is miReba ver xerxdeba. misi kompleqsuri marilebi _ qlormanganatebi, advilad miiReba kristalebis saxiT, risTvisac $MnCl_3$-is xsnarSi gajerebamde gaxsnian qlorwyalbads da daumateben tute metalis qlorids. xsnaris gacivebisas gamoiyofa wiTeli kristalebi, romelTa Sedgeniloba upasuxebs formulas $M_2^1[MnCl_5]$.

**manganum(IV)-is qloridi ($MnCl_4$)** miiReba manganumis dioqsidis gaxsniT koncentrirebul marilmJavaSi ($MnO_2 + 4HCl = MnCl_4 + 2H_2O$). aramdgradobis gamo igi male iSleba da amitom misi Tavisufali saxiT gamoyofa ver xerxdeba. $MnCl_4$-is daSlis Sedegad, rogorc zemoT aRiniSna, warmoiqmneba manganumis diqloridi da Tavisufali qlori ($MnCl_4 = MnCl_2 + Cl_2$). SedarebiT ufro mdgradia qlormanganitebi, romlebic miiReba tute metalis qloridisa da manganum(IV)-is qloridis urTierTqmedebiT. aseTia, magaliTad, wiTeli feris $K_2[MnCl_6]$, romelic miiReba kalciumis permanganatisa da kaliumis qloridis SetaniT Zlier gacivebul 40%-ian marilmJavaSi ($Ca(MnO_4)_2 + 16HCl + 4KCl = 2K_2[MnCl_6] + CaCl_2 + 3Cl_2 + 8H_2O$).

**manganum(II)-is sulfati ($MnSO_4$)** miiReba manganumis nebismieri naerTis gacxelebiT gogirdmJavasTan ($Mn(NO_3)_2 + H_2SO_4 = MnSO_4 + 2HNO_3$). manganum(II)-is sulfati warmoadgens manganumis erT-erT mdgrad naerTs. wyalxsnaridan gamokristaldeba mkrTali vardisferi kristalhidratis saxiT ($MnSO_4 \cdot 7H_2O$, $MnSO_4 \cdot 5H_2O$, $MnSO_4 \cdot 4H_2O$, $MnSO_4 \cdot H_2O$). kristalhidratis Sedgeniloba damokidebulia gamokristalebis temperaturaze.

teqnikuri miznebisTvis manganumsulfati miiReba piroluzitze ($MnO_2$) gogirdmJavas moqmedebiT ($MnO_2 + H_2SO_4 = MnSO_4 + H_2O + 1/2O_2$) an piroluzitis rkinis ajaspTan ($FeSO_4$) gaxurebiT ($2MnO_2 + 2FeSO_4 = 2MnSO_4 + Fe_2O_3 + 1/2O_2$). tute metalis marilTan $MnSO_4$ ormag marils warmoqmnis, romlis Sedgeniloba

gamoisaxeba $M_2^1SO_4 \cdot MnSO_4$ formuliT. es marilebi miiReba kristalhidratebis saxiT 2, 4 da 6 molekula wyalTan da uwylo mdgomareobaSic.

**manganum(III)-is sulfati ($Mn_2(SO_4)_3$)** miiReba manganum(III)-is oqsidis an hidroqsidis gaxsniT zomierad koncentrirebul gogirdmJavaSi ($Mn_2O_3 + 3H_2SO_4 = Mn_2(SO_4)_3 + 3H_2O$, $2Mn(OH)_3 + 3H_2SO_4 = Mn_2(SO_4)_3 + 6H_2O$) an koncentrirebul gogirdmJavas moqmedebiT kaliumis permanganatze ($2KMnO_4 + 5H_2SO_4 = Mn_2(SO_4)_3 \cdot H_2SO_4 \cdot 4H_2O + K_2SO_4 + 2O_2$). miRebuli wiTeli xsnaridan gamokristaldeba naerTi $Mn_2(SO_4)_3 \cdot H_2SO_4 \cdot 4H_2O$. Zlieri gacxelebiT manganum(III)-is wiTeli sulfati manganumis mwvane sulfatad gardaiqmneba.

tute metalebis sulfatebTan manganum(III)-is sulfati warmoqmnis ormagi marilebis or mwkrivs _ Sabebs, romelTagan yvelaze mdgradia cezium-manganumis Sabi ($Cs_2SO_4 \cdot Mn_2(SO_4)_3 \cdot 24H_2O$) broweulis feris kristalebi da disulfatmanganatebi ($M_2^1SO_4 \cdot Mn_2(SO_4)_3$), romlebic uwylod kristaldeba.

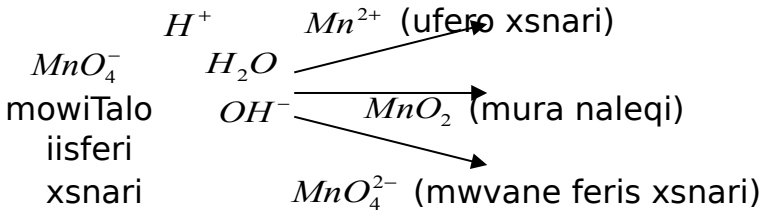
**manganum(IV)-is sulfati ($Mn(SO_4)_2$)** miiReba manganum(II)-is sulfatis kaliumis permanganatiT daJangvisas gogirdmJavas areSi ($3MnSO_4 + 2KMnO_4 + 8H_2SO_4 = 5Mn(SO_4)_2 + K_2SO_4 + 8H_2O$). reaqciis Sedegad gamoiyofa Savi feris ($Mn(SO_4)_2$) kristalebi. miRebuli naerTi wyalSi gaxsnisas hidrolizs ganicdis, ris Sedegadac gamoiyofa manganumis dioqsidis hidrati da gogirdmJava ($Mn(SO_4)_2 + 3H_2O \Leftrightarrow MnO_2 \cdot H_2O + 2H_2SO_4$).

manganum(IV)-is sulfati gamoiyeneba rogorc mJangavi.

**manganum(VI)-is naerTebi (manganatebi)** miiReba manganumis dioqsidis SednobiT tuteebTan, tute metalebis karbonatebTan an gvarjilebTan ($MnO_2 + 2KOH + 1/2O_2 = K_2MnO_4 + H_2O$, $MnO_2 + K_2CO_3 + 1/2O_2 = K_2MnO_4 + CO_2$, $MnO_2 + KNO_3 + 2KOH = K_2MnO_4 + KNO_2 + H_2O$). sufTa saxiT dRemde mxolod tute metalebis manganatebia miRebuli ($Na_2MnO_4 \cdot 6H_2O$, $Na_2MnO_4 \cdot 10H_2O$, $K_2MnO_4$ da a.S.), romlebsac muqi mwvane an TiTqmis Savi feri aqvT. wyalSi gaxsnisas manganatebi Jangva-aRdgenis Sedegad iSleba manganumis dioqsidad da permanganatad ($3K_2MnO_4 + 2H_2O = 2KMnO_4 + MnO_2 + 4KOH$). amave gziT iSleba manganatebi mJavur areSic ($3K_2MnO_4 + 2H_2SO_4 = 2KMnO_4 + MnO_2 \cdot 2H_2O + 2K_2SO_4$). amgvar daSlas uTuod Tavisufali qvemanganummJavas ($H_2MnO_4$) aramdgradoba ganapirobebs. $500^\circ C$-ze zeviTYgaxurebisas manganati Termul disociacias ganicdis (

$2K_2MnO_4 = 2K_2MnO_3 + O_2$). ZiriTadad ki procesi mimdinareobs kaliumis hipomanganatisa da dioqsidis warmoqmniT ($3K_2MnO_4 = 2K_3MnO_4 + MnO_2 + O_2$). teqnikuri bariummanganati ($BaMnO_4$) lamazi mwvane feris gamo saRebrad ixmareba (wyalSi uxsnaria).

**manganum(VII)-is naerTebi (permanganatebi)** miiReba manganatis xsnarze Zlieri mJangavis moqmedebiT ($2K_2MnO_4 + Cl_2 = 2KMnO_4 + 2KCl$). maTi miReba aseve SeiZleba manganatis wyalxsnaridan, sadac manganati TviTneburad gardaiqmneba manganummJavas marilad _ permanganatad ($3K_2MnO_4 + 2H_2O = 2KMnO_4 + MnO_2 + 4KOH$). $KMnO_4$ wyalSi xsnadi, muqi iisferi kristaluri nivTierebaa. igi Zlieri mJangavia:




permanganatebidan yvelaze meti mniSvneloba aqvs kaliumis permanganats ($KMnO_4$). kaliumis permanganatis xsnari gamoiyeneba sisxldenis SemaCerebel saSualebad, Wrilobebis mosabanad, mowamvlisas kuWis amosarecxad. natriumis permanganati ($NaMnO_4 \cdot 3H_2O$) didi xsnadobis gamo Zneli gamosakristalebelia xsnaridan da higroskopiulobis gamo advilad ganiTxeva haerze. kalciumis permanganati ($Ca(MnO_4)_2 \cdot 5H_2O$) gamoiyeneba wylis dezinfeqciisaTvis. danarCen permanganatebs praqtikuli gamoyeneba ar moupovebiaT. yvela permanganati ixsneba wyalSi Seferili xsnarebis warmoqmniT.

kaliumis permanganati ($KMnO_4$) dResdReobiT umTavresad kaliumis manganatis eleqtroliziT miiReba, romlis drosac manganat-ioni anodze kargavs eleqtrons ($MnO_4^{2-} - \bar{e}$), e.i. iJangeba (gardaiqmneba permanganat-ionad ($MnO_4^{1-}$)), xolo kaTodze wyalbad-ioni iZens eleqtrons ($H^+ + \bar{e}$) da aRdgeba wyalbadamde ($H^0$).

**rkina(II)-is difToridi (** $FeF_2$ **)** miiReba airadi fTorwyalbadis moqmedebiT rkinaze ($2HF + Fe = FeF_2 + H_2$) an $FeCl_2$-ze ($2HF + FeCl_2 = FeF_2 + 2HCl$). rkinis

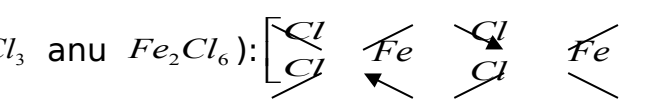
difToridi ufero nivTierebaa, advilad xsnadia wyalSi. cnobilia misi marilebi: $K[FeCl_3)$, $K_2[FeCl_4)$, $NH_4[FeF_3]\cdot 2H_2O$ da sxv.

**rkina(III)-is trifToridi (** $FeF_3$ **anu dimeri** $Fe_2F_6$ **):**

miiReba fToris moqmedebiT fxvnilisebr rkinaze ($3F_2+2Fe=2FeF_3$). igi mwvane feris kristaluri nivTierebaa, wyalSi gaxsnisas ganicdis hidrolizs.

**rkina(II)-is diqloridi (** $FeCl_2$ **)** miiReba rkinis burbuSelaze airadi qlrowyalbadis moqmedebiT ($500^\circ C$-ze, $Fe+2HCl=FeCl_2+H_2$) an rkinis uSualo gaxsniT marilmJavaSi ($2HCl+Fe=FeCl_2+H_2$). cnobilia kristalhidratebi ( $FeCl_2\cdot nH_2O$, sadac $n=1,2,4$ an 6). igi warmoqmnis ormag marilebs _ tetraqlorferatebs $M_2^1[FeCl_4]$. gacxelebisas $FeCl_2$ reaqciaSi Sedis wyalbadTan ($FeCl_2+H_2 \overset{\sim 1000^\circ C}{\Leftrightarrow} Fe+2HCl$). uwylo $FeCl_2$ energiulad ierTebs amiaks oTaxis teperaturaze ($FeCl_2+6NH_3=[Fe(NH_3)_6]Cl_2$). cnobilia misi kordinaciuli naerTebi organul ligandebTan.

**rkina(III)-is triqloridi (** $FeCl_3$ **anu** $Fe_2Cl_6$ **_ dimeri)** miiReba maRal temperaturaze ($400-500^\circ C$) qloris moqmedebisas fxvnilisebr rkinaze ( $2Fe+3Cl_2=2FeCl_3$ anu $Fe_2Cl_6$):



an piritze qloris moqmedebiT ($2FeS_2+5Cl_2=Fe_2Cl_6+2S_2Cl_2$).

Cveulebriv pirobebSi rkinis trioqsidi dimers warmoadgens _ orTqlis simkvrivis mixedviT $450^\circ C$-mde mas Seesabameba formula $Fe_2Cl_6$, xolo $750^\circ C$-ze $FeCl_3$. wyalxsnarSi hidrolizurad iSleba. Zlieri gacxelebisas gamoyofs qlors da miiReba: $Fe_2Cl_6=2FeCl_2+Cl_2$. airad amiakTan warmoqmnis heqsamins $[Fe(NH_3)_6]Cl_3$ _ wyalSi gaxsnisas iSleba. $Fe_2Cl_6$ mJangavia ( $Fe_2Cl_6+2KI=2FeCl_2+2KCl+I_2$).

$Fe_2Cl_6$ sisxldenis SesaCerebeli saSualebaa. gamoiyeneba koloidebis koagulaciisaTvis.

**rkina(II)-is dibromidi (** $FeBr_2$ **)** miiReba $Fe_2Br_6$ gacxelebiT ($400-500^\circ C$-ze): $Fe_2Br_6=2FeBr_2+Br_2$. **rkinis tribromis dimeri (** $Fe_2Br_6$ **)** ki warmoiqmneba rkinis burbuSelaze Txevadi bromis moqmedebiTY(

$2Fe+3Br_2=Fe_2Br_6$). rkina(II)-is bromidi ($FeBr_2$) yviTeli feris wyalsa da organul gamxsnelebSi xsnadi nivTierebaa, haerze advilad iSleba.

**rkina(II)-is iodidi ($FeI_2$)** mowiTalo-yavisferi, wyalSi xsnadi naerTia, gacxelebisas iSleba.

**rkina(II)-is sulfati ($FeSO_4\cdot 7H_2O$, rkinis ajaspi)** miiReba Semdegi reaqciebiT ($FeS_2+3O_2=FeSO_4+SO_2$, $FeS_2+CuO+3/2O_2=FeSO_4+CuS$, $PbSO_4+Fe=FeSO_4+Pb$ da sxv.). haerze advilad iJangeba. rkina(II)-is sulfati ixmareba mcenareTa mavneblebis winaaRmdeg, agreTve mineraluri saRebavebisa da Savi melnis dasamzadeblad. rkina(II)-isa da amoniumis ormagi sulfati (boris marili) $(NH_4)_2SO_4\cdot FeSO_4\cdot 6H_2O$ haerze mdgradi, Ria mwvane feris kristaluri nivTierebaa.

**rkina(II)-is nitrati ($Fe(NO_3)_2\cdot 6H_2O$)** wyalSi kargad xsnadi marilia. advilad warmoqmnis unikaluri tipis $M^IM^{II}[Fe(NO_3)_6]$ koordinaciul naerTebs.

**rkina(II)-is karbonati ($FeCO_3$)** gvxvdeba **mineral sideritis** anu **rkinis Spatis** saxiT. wyalSi uxsnaria, ixsneba $CO_2$-is Semcvel wyalSi ($FeCO_3+H_2CO_3=Fe(HCO_3)_2$). aseTi Sedgenilobis marili gvxvdeba zogierT mineralur wyalSi.

**rkina(II)-is cianidi ($Fe(CN)_2$, ferocianidi)** miiReba mis marilebze kaliumis cianidis moqmedebiT ($FeCl_2+2KCN=Fe(CN)_2+2KCl$). igi moyviTalo-yavisferi nivTierebaa. masze $KCN$-is moqmedebisas miiReba koordinaciuli naerTi _ kaliumis **heqsacianoferati(II)** anu kaliumis **heqsaferocianidi**, romelic cnobilia **sisxlis yviTeli marilis** saxelwodebiT ($Fe(CN)_2+4KCN=K_4[Fe(CN)_6]$). sxvadasxva metalis ferocianidebi Seferilia yviTlad, wiTlad da sxv. tute metalebis **ferocianidebi** wyalSi xsnadi, mdgradi da uvnebi naerTebia.

**rkina(III)-is cianidi ($Fe(CN)_3$, fericianidi)** miiReba rkina(III)-is hidroqsidze ($Fe(OH)_3$) kaliumis cianidis ($KCN$)-is moqmedebiT ($Fe(OH)_3+6KCN=K_3[Fe(CN)_6]+3KOH$). igi wiTeli feris koordinaciuli naerTia _ Seferilobis gamo mas **sisxlis wiTeli marili** ewodeba. wyalSi kargad ixsneba tute metalebis **fericianidebi**.

sisxlis wiTeli marili $[K_3[Fe(CN)_6]$ naklebmdgradia, vidre sisxlis yviTeli marili $(K_4[Fe(CN)_6]$, amitom igi momwamvlelia. es marilebi xsnarebidan

gamoleqaven Sesabamisad $\overset{2+}{Fe}$-isa da $\overset{3+}{Fe}$-is ionebs **turnbulis lurjisa** $Fe_3[Fe(CN)_6]_2$ da berlinis laJvardisferi $Fe_4[Fe(CN)_6]_3$ naerTis saxiT: $3FeSO_4 + 2K_3[Fe(CN)_6] = \underset{\text{turnbulis}}{Fe_3[Fe(CN)_6]_2} + 3K_2SO_4$ da $4FeCl_3 + 3K_4[Fe(CN)_6] = \underset{\text{berlinis}}{Fe_4[Fe(CN)_6]_3} + 12KCl$. rkinis sakoordinacio ricxvi am kompleqsur naerTebSi 6-is tolia. sisxlis wiTeli da yviTeli marilebi gamoiyeneba rkina(II)-isa ($\overset{2+}{Fe}$) da rkina(III)-is ($\overset{3+}{Fe}$) ionebis aRmomCen reaqtivebad. turnbulis lurjisa da berlinis laJvardis safuZvelze Seqmnilia mravali saRebavi.

**rkina(III)-is sulfati (**$Fe_2(SO_4)_3$**)** miiReba rkina(III)-is oqsidisa da gogirdmJavas urTierTqmedebiT ($2Fe(OH)_3 + 3H_2SO_4 = Fe_2(SO_4)_3 + 6H_2O$). misi miReba aseve SeiZleba rkina(II)-is Sesabamisi marilis rkina(III)-is marilad gardaqmniT sxvadasxva mJangavis moqmedebiT:

($6FeSO_4 + 2HNO_3 + 3H_2SO_4 = 3Fe_2(SO_4)_3 + 2NO + 4H_2O$,

$10FeSO_4 + 2KMnO_4 + 8H_2SO_4 = 5Fe_2(SO_4)_3 + 2MnSO_4 + K_2SO_4 + 8H_2O$).

rkina(III)-is sulfati wyalSi kargad xsnadi nivTierebaa, misi wyalxsnari hidrolizis gamo yviTeli, wiTeli an yavisferia. amoniumisa da kaliumis sulfatTan warmoqmnis ormag marils _ Sabs ($(NH_4)_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$, $K_2SO_4 \cdot Fe_2(SO_4)_3 \cdot 24H_2O$). Sabis misaRebad rkinis ajasps Jangaven wyalxsnarSi azotmJavaTi da gamoakristaleben amoniumis an kaliumis sulfatebis damatebis Semdeg. magniumis marilis minarevis gamo, rkinis Sabi iisfradaa Seferili, xolo qimiurad sufTa Sabi uferoa.

rkina-amoniumisa da rkina-kaliumis Sabebi fermWerad gamoiyeneba samRebro saqmeSi. isini gamoiyeneba agreTve mRvrie wylis dasawmendad, mJangavad da sxvadasxva reaqciis katalizatorad.

**rkina(VI)-is naerTi _ kaliumis ferati (**$K_2FeO_4$**)** miiReba rkina(III)-is oqsidis SednobiT kaliumis gvarjilasa ($KNO_3$) da tutesTan ($KOH$): $Fe_2O_3 + 3KNO_3 + 4KOH = 2K_2FeO_4 + 3KNO_2 + 2H_2O$ an rkina(III) hidroqsidze Zlieri mJangavisa (magaliTad, $Cl_2$) da kaliumis tutis moqmedebiT: $2Fe(OH)_3 + 3Cl_2 + 10KOH = 2K_2FeO_4 + 6KCl + 8H_2O$. anioni ($FeO_4^{2-}$) wiTeli ferisaa _ miRebuli kaliumis feratis wyalSi gaxsniT miiReba iisfer-wiTeli xsnari, romelzedac $BaCl_2$-is moqmedebiT gamoileqeba Znelad xsnadi bariumis

ferati: $K_2FeO_4 + BaCl_2 = BaFeO_4 + 2KCl$. yvela ferati Zalian Zlieri mJangavia, am TvisebiT isini permanganatebsac ki uswreben.

**kobalt(II)-is difToridi ($CoF_2$)** miiReba kobalt(II)-is oqsidis fTorwyalbadiT ($500^\circ C$-ze) damuSavebisas ($Co + 2HF = CoF_2 + H_2$). misi miReba SeiZleba agreTve kobalt(III)-is fToridis maRal temperaturamde gaxurebiT ($300^\circ C$-mde): $2CoF_3 = 2CoF_2 + F_2$ da kobalt(III)-is fToridis aRdgeniT wyalbadis areSi: $2CoF_3 + H_2 = 2CoF_2 + 2HF$. cnobilia kobalt(II)-is fToridis kompleqsuri naerTebi: aminebi $[Co(NH_3)_6]F_2$, $[Co(NH_3)_5 \cdot H_2O]F_2$, fTormarilebi $Na[CoF_3] \cdot H_2O$, $K[CoF_3] \cdot H_2O$, $K_2[CoF_4]$, fuZuri marili $CoF_2 \cdot CoO \cdot H_2O$, mJavuri marili $CoF_2 \cdot 5HF \cdot 6H_2O$ da a.S.

**kobalt(III)-is fToridi ($CoF_3$)** miiReba metaluri kobaltisa da fToris uSualo urTierTqmedebiT ($150-180^\circ C$-ze): $2Co + 3F_2 = 2CoF_3$. igi yavisferi kristaluri nivTierebaa. gacxelebisas an wylis moqmedebisas iSleba, wyalbadis areSi aRdgeba (ix. zeviT). tute metalebTan urTierTqmedebisas aRdgeba metaluri kobalti: $CoF_3 + 3K = Co + 3KF$. kobaltis trifToridi gamoiyeneba organuli naerTebis fToridebis reaqciebis Casatareblad.

**kobalt(II)-is qloridi ($CoCl_2$)** miiReba kobaltis dawviT qloris areSi ($Co + Cl_2 = CoCl_2$). igi Ria cisferi fxvnilia, wyalSi kargad ixsneba, misi wyalxsnari vardisferia. kobaltis diqloridi aseve kargad ixsneba spirtSi, acetonsa da sxva organul gamxsnelebSi. misi kristalhidratis feri damokidebulia wylis Semcvelobaze ($CoCl_2 \cdot 6H_2O$ vardisferia, $CoCl_2 \cdot 2H_2O$ movardisfro-iisferia, $CoCl_2 \cdot H_2O$ molurjo-iisferia). am mariliT gaJRenTili da gamomSrali filtris qaRaldi haeris tenianobis indikatorad SeiZleba iqnes gamoyenebuli, radgan tenianobis mixedviT misi feri, dehidrataciis gamo, vardisferidan lurj feramde icvleba.

**kobalt(III)-is qloridi ($CoCl_3$ anu $Co_2Cl_6$ _ dimeri)** miiReba kobaltis diqloridis ($CoCl_2$) spirtxsnarSi qloris gatarebiT _ ($60^\circ C$-ze): $2CoCl_2 + Cl_2 = 2CoCl_3$ (anu $Co_2Cl_6$). gauwyloebul eTerSi igi moSavo-mwvane feris fxvnilia, qimiurad aramdgradi, Zlieri mJangavia: $Co_2Cl_6 + 2KI = 2CoCl_2 + 2KCl + I_2$. iSleba gaTbobisas: $Co_2Cl_6 = 2CoCl_2 + Cl_2$. gamoiyeneba rogorc mJangavi rogorc araorganuli, ise organuli naerTebis mizanmimarTul sinTezSi.

**kobalt(II)-is sulfati (**$CoSO_4$**)** miiReba gogirdmJavas moqmedebiT kobalt(II)-is oqsidze ($CoO+H_2SO_4=CoSO_4+H_2O$) an hidroqsidze ($Co(OH)_2+H_2SO_4=CoSO_4+2H_2O$). kobalt(II)-is sulfati (ajaspi) vardisferi kristaluri nivTierebaa, wyalSi kargad ixsneba. amoniumis sulfatis Semcveli xsnarebidan kobaltis sulfati ormagi marilis saxiT kristaldeba: $(NH_4)_2SO_4\cdot CoSO_4\cdot 6H_2O$ wiTeli feris nivTiereba da sxv. cnobilia agreTve kobaltis fuZuri sulfatebi: lurji $CoSO_4\cdot 3Co(OH)_2$, iisferi $2CoSO_4\cdot Co(OH)_2\cdot 5H_2O$.

**kobalt(III)-is sulfati (**$Co_2(SO_4)_3$**)** miiReba anodze $CoSO_4$-is xsnaris 40%-ian gogirdmJavaSi eleqtrolizis dros. naerTi $Co_2(SO_4)_3\cdot 18H_2O$ momwvano-lurji ferisaa, qimiurad aramdgradi, Zlieri mJangavi. amoniumisa da tute metalebis sulfatebTan warmoqmnis Sabebs $M_2^1SO_4\cdot Co_2(SO_4)_3\cdot 24H_2O$ da sxv., romlebic wyalSi mcired xsnadi lurji feris kristaluri nivTierebebia.

kobaltis naerTebi gamoiyeneba feradi (lurji, mwvane, vardisferi) keramikis, minanqrisa da minis dasamzadeblad, romelic STanTqavs ultraiisfer sxivebs da rogorc amiakis mJangavi katalizatorebi agreTve navTobis gadamuSavebis procesSi, rogorc erT-erTi mniSvnelovani komponenti.

**nikel(II)-is halidebis (**$NiF_2$**,** $NiCl_2$**,** $NiBr_2$**,** $NiI_2$**)** miReba SeiZleba metaluri nikelis fxvnilze fToris, qloris, bromis an iodis nakadis gatarebiT ($500-600^\circ C$): $Ni+F_2=NiF_2$, $Ni+Cl_2=NiCl_2$ da a.S. nikelis difToridi cudad ixsneba wyalSi, spirtsa da eTerSi, xolo nikelis diqloridi, dibromidi da diodidi kargad ixsneba wyalsa da organul gamxsnelebSi (spirtSi, eTerSi da sxv.).

Txevad amiakSi gaxsnili tute metalis moqmedebiT nikelis bromididan miiReba maRaldispersiuli metaluri nikeli. nikelis dibromidi tute metalebis bromidebTan kompleqsur marilebs warmoqmnis: $M^1[NiBr_3]$, $M_2^1[NiBr_4]$ da sxv., aseve cnobilia nikelis iodidis kompleqsuri marilebi: $[Ni(H_2O)_6]I_2$, $[Ni(NH_3)_4]I_2$ da sxv.

**nikel(II)-is Tiocianati (rodanidi)** $Ni(SCN)_2\cdot nH_2O$ gamoileqeba nikel(II)-is sulfatisa da bariumis Tiocianatis xsnarebis Serevisas: $NiSO_4+Ba(SCN)_2=Ni(SCN)_2+BaSO_4\downarrow$. uwylo nikelis Tiocianiti muqi yavisferia. nikelis Tiocianati tute metalebis TiocianatebTan warmoqmnis $M_2^1[Ni(SCN)_4]\cdot H_2O$ da $M_4^1[Ni(SCN)_6]\cdot nH_2O$ Sedgenilobis marilebs. natriumis

Sesabamisi kompleqsnaerTi mwvanea, kaliumisa da amoniumis marilebi ki _ lurji.

**nikel(II)-is cianidi (** $Ni(CN)_2$ **anu** $Ni[Ni(CN)_4$ **)** yavisferi, wyalSi uxsnari nivTierebaa. misi miReba SeiZleba nikel(II)-is marilebze kaliumis cianidis xsnaris moqmedebiT ( $NiCl_2 + 2KCN = Ni(CN)_2 + 2KCl$ ). xsnaridan gamoleqili hidratirebuli nikelis cianidi ( $Ni(CN)_2 \cdot nH_2O$ ) mwvane ferisaa. Warbad aRebul kaliumis cianidis xsnarSi ixsneba $Ni(CN)_2 \cdot nH_2O$ . miiReba yviTeli feris $K_2[Ni(CN)_4] \cdot nH_2O$ -s xsnari, romlis aorTqlebiT SeiZleba gamoiyos $K_2[Ni(CN)_4] \cdot H_2O$ an $K_2[Ni(CN)_4] \cdot 3H_2O$ narinjisferi kristalebi.

**nikel(II)-is sulfati (** $NiSO_4$ **)** miiReba nikelze an nikelis oqsidze an nikelis sxva marilze koncentrirebuli gogirdmJavas moqmedebiT ( $Ni + H_2SO_4 = NiSO_4 + H_2$ , $NiO + H_2SO_4 = NiSO_4 + H_2O$ da $NiCO_3 + H_2SO_4 = NiSO_4 + CO_2 + H_2O$ ). nikelis uwylo sulfati ( $NiSO_4$ ) yviTeli kristaluri nivTierebaa, kargad ixsneba wyalSi, gaxurebiT iSleba, advilad aRdgeba wyalbadiT. cnobilia misi kristalhidratebi ( $NiSO_4 \cdot nH_2O$ , sadac $n = 2, 4, 5, 6$ an 7). cnobilia ormagi sulfatebic ( $M_2^1SO_4 \cdot NiSO_4 \cdot 6H_2O$ , sadac $M^1 = Rb^+, Cs^+, NH_4^+$ da sxv.).

**nikel(II)-is karbonati (** $NiCO_3$ **)** Ria mwvane feris, wyalSi mcired xsnadi naerTia. nikelis xsnad marilebze tute metalebis bikarbonatebis moqmedebisas gamoileqeba kristalhidratis saxiT ( $Ni(NO_3)_2 + 2NaHCO_3 = NiCO_3 + 2NaNO_3 + CO_2 + H_2O$ ). cnobilia misi kristalhidratebi ( $NiCO_3 \cdot 6H_2O$ da $NiCO_3 \cdot 3H_2O$ ). nikelis karbonati advilad ixsneba mJavaSi.

nikelis karbonati ixmareba, rogorc pigmenti keramikul mrewvelobaSi.

**metaluri platinis gaxurebisas fToris, qloris an iodidis orTqlSi warmoiqmneba Sesabamisi halidebi (** $PtF_3$ **,** $PtF_4$ **,** $PtCl_2$ **,** $PtCl_4$ **,** $PtBr_2$ **,** $PtBr_4$ **,** $PtI_2$ **,** $PtI_4$ **).**

**platina(II)-is fToridi da qloridi** miiReba misi gaxurebiTY( $500 - 600^\circ C$ ) airadi fTorisa da qloris nakadSi ( $Pt + F_2 = PtF_2$ , $Pt + Cl_2 = PtCl_2$ ), xolo platina(II)-is bromidi miiReba $H_2[PtBr_6]$ -is an $PtBr_4$ -is gaxurebiT ( $180^\circ C$ zeviT): $PtBr_4 = PtBr_2 + Br_2$ . platina(II)-is iodidis miReba SeiZleba $PtCl_2$ -ze $KI$ -is moqmedebiT ( $PtCl_2 + 2KI = PtI_2 + 2KCl$ ) an $Pt$ -is gaxurebisas iodis nakadSi ( $Pt + I_2 = PtI_2$ ).

platina(II)-is halidebi cudad ixsneba wyalSi da iSleba Semadgenel elementebad maRal temperaturamde ($580-600^{\circ}C$) gaxurebis procesSi.

**platina(IV)-is fToridi da qloridi (**$PtF_4$ **da** $PtCl_4$**)** warmoiqmneba gavarvarebul $750-800^{\circ}C$ platinaze fToris an qloris nakadis gatarebiT ($Pt+2F_2=PtF_4$, $Pt+2Cl_2=PtCl_4$) $PtCl_4$-is xsnari gamoiyeneba eleqtrolizuri moplatinebisaTvis. **platina(IV)-is bromidi** miiReba $H_2[PtBr_6]$-is gaxurebiT ($180^{\circ}C$-mde): $H_2[PtCl_6]+4KI=PtI_4+4KCl+2HCl$). platinis tetraiodidi muqi yavisferi fxvnilia, romelic gaxurebiT iSleba Semadgenel elementebad da ixsneba $HI$-Si heqsaiodplatinmJavas $H_2[PtI_6]$ warmoqmniT ($2HI+PtI_4=H_2[PtI_6]$).

**platina(IV)-is sulfati (**$Pt(SO_4)_2$**)** warmoqmnis yviTel kristalur nivTierebas, romelic ixsneba wyalSi, spirtSi, eTersa da mJavaSi. igi miiReba platinis tetraqloridze tyviis disulfatis moqmedebiT ($PtCl_4+Pb(SO_4)_2=Pt(SO_4)_2+PbCl_4$).

**platina(VI)-is fToridi (**$PtF_6$**)** miiReba maRal temperaturaze ($900-950^{\circ}C$) metaluri platinis fxvnilze fToris nakadis gatarebiT ($Pt+3F_2=PtF_6$). $PtF_6$ muqi wiTeli feris kristaluri nivTierebaa, wyalSi gaxsnisas ganicdis hidrolizs.

platina da misi naerTebi didi raodenobiT gamoiyeneba qimiur sinTezSi maRal teqnologiuri masalebis misaRebad. maTi mniSvnelovani nawilis realizeba xdeba eleqtroteqnikaSi da saiuveliro nakeTobebis dasamzadeblad. gansakuTrebuli qimiuri mdgradobis, dnobis maRali temperaturis, saukeTeso meqanikuri da katalizuri Tvisebebis gamo farTod gamoiyeneba uaxlesi teqnikisa da mrewvelobis sxvadasxva dargSi.

**ruTenium(II)-isa da (III)-is qloridebi (**$RuCl_2$ **da** $RuCl_3$**)** miiReba metalur ruTeniumis fxvnilze qloris gatarebiT maRal temperaturaze ($250-450^{\circ}C$): $Ru+Cl_2=RuCl_2$ da $2Ru+3Cl_2=2RuCl_3$. ruTeniumis diqloridi ($RuCl_2$) da triqloridi ($RuCl_3$) cudad ixsneba wyalsa da mJavaSi. ruTeniumis qloridebi kovalenturi naerTebia. tute metalebis qloridebTan warmoqmnis $M_2^1[RuCl_5)$-is tipis marilebs.

**ruTenium(III)-is bromidi (**$RuBr_3$**)** miiReba cxel ruTeniumze bromis moqmedebiT ($2Ru+3Br_2=2RuBr_3$). ruTeniumis tribromidic ($RuBr_3$) kovalenturi naerTia.

**ruTenium(III)-is iodidi (** $RuI_3$ **)** miiReba maRal temperaturaze gaxurebul metalur ruTeniumze iodis moqmedebiT ( $2Ru+3I_2=2RuI_3$ ). ruTeniumis triodidic agreTve kovalenturi naerTia, gacxelebisas advilad iSleba martiv nivTierebebad.

**ruTenium(IV)-is fToridi (** $RuF_4$ **)** miiReba Zalian reaqciisunariani ruTeniumis heqsafToridis ( $RuF_6$ ) daSliT ( $RuF_6=RuF_4+F_2$ ) ruTenium(IV)-is dabal fToridad ( $RuF_4$ ) da fTorad ( $F_2$ ).

**ruTenium(IV)-is qloridi (** $RuCl_4$ **)** miReba SeiZleba ruTenium(VIII)-is oqsidze marilmJavas moqmedebisas ( $RuO_4+6HCl=H_2[RuO_2Cl_4]+Cl_2+2H_2O$ I stadia da $H_2[RuO_2Cl_4]+2HCl=RuCl_4+Cl_2+2H_2O$ II stadia. jamurad $RuO_4+8HCl=RuCl_4+2Cl_2+4H_2O$ ). ruTeniumis tetraqloridi ( $RuCl_4$ ) kovalenturi naerTia. wylis moqmedebiT misgan miiReba $RuO_2$ . gaxurebisas wyalbadis Wavli aRadgens metalur ruTeniums. $RuCl_4$ -ze tute metalis qloridis moqmedebisas miiReba heqsaqlorruTenatebi(IV) $M_2^1[RuCl_6]$ .

ruTeniumis naerTebi gamoiyeneba samkaulebis, ,,mudmivi" kalmis wverebis, eleqtrokontaqtorebisa da xmis maregistrirebeli aparatebis nemsebis dasamzadeblad da sxv.

**osmium(II)-is qloridis (** $OsCl_2$ **)** miReba SeiZleba osmium(III)-is qloridis gaxurebiT dabal wnevaze ( $2OsCl_3=2OsCl_2+Cl_2$ ). osmiumis diqloridi ( $OsCl_2$ ) wyalSi mcired ixsneba, kargad ixsneba spirtSi, eTersa da azotmJavaSi.

**osmium(IV)-is fToridis (** $OsF_4$ **)** miReba SeiZleba gaxurebul ( $280^\circ C$ ) metalur osmiumze fToris gatarebiT ( $Os+2F_2=OsF_4$ ). osmiumis tetrafToridi yavisferi fxvnilia, romelic wylis moqmedebiT ganicdis hidrolizur daSlas.

**osmium(IV)-is qloridi (** $OsCl_4$ **)** miiReba osmiumis tetraoqsidis koncentrirebuli marilmJavaTi damuSavebisas ( $OsO_4+8HCl=OsCl_4+2Cl_2+4H_2O$ ) an qloris gatarebiT gaxurebul ( $650-700^\circ C$ ) metalur osmiumze ( $Os+2Cl_2=OsCl_4$ ). osmiumis tetraqloridi ( $OsCl_4$ ) moyavisfro-wiTeli nemsisebri kristalebia, wylis moqmedebiT TandaTanobiT gardaiqmneba osmiumis dioqsidad ( $3OsCl_4+2H_2O=OsO_2+2H_2[OsCl_6]$ ).

**osmium(IV)-is bromidi (** $OsBr_4$ **) da iodidi (** $OsI_4$ **)** iseve miiReba, rogorc osmiumis tetraqloridi _ osmiumis(VIII) oqsidze bromwyalbadmJavasa da

iodwyalbadmJavas koncentrirebuli wyalxsnarebis moqmedebiT ( $OsO_4 + 8HBr = OsBr_4 + 2Br_2 + 4H_2O$ da $OsO_4 + 8HI = OsI_4 + 2I_2 + 4H_2O$ ).

**osmium(VIII)-is fToridi ( $OsF_8$ )** warmoiqmneba fToris gatarebiT gaxurebul ( $250^\circ C$ ) metalur osmiumze ( $Os + 4F_2 = OsF_8$ ). osmiumis oqtafToridi ( $OsF_8$ ) yviTeli kristaluri nivTierebaa, xasiaTdeba mJangavi TvisebebiT, kanze moxvedrisas iwvevs sidamwvres, urTierTqmedebs wyalTan ( $OsF_8 + 4H_2O = OsO_4 + 8HF$ ).

osmiumi da misi naerTebi gamoiyeneba platinis, paladiumis, iridiumisa da ruTeniumis malegirebel elementad, agreTve ixmareba avtokalmebisa da eleqtrokontaqtorebis dasamzadeblad. maTi fxvnili gamoiyeneba katalizatorad amiakis sinTezis, naxSirwyalbadis Jangvis, acetonis hidrirebisa da sxva reaqciebSi.

**rodium(II)-is halidebi ( $RhF_2$ , $RhCl_2$ , $RhBr_2$ , $RhI_2$ )** miiReba rodium(III)-is fToridis, qloridis, bromidisa da iodidis gaxurebiT ( $950-1000^\circ C$ ): $2RhF_3 = 2RhF_2 + F_2$ , $2RhCl_3 = 2RhCl_2 + Cl_2$ da a.S. isini fxvnilisebri nivTierebebia, damaxasiaTebelia sxvadasxva Seferiloba. muqi yavisfridan iisfer-wiTlamde.

**rodium(III)-is fToridis ( $RhF_3$ )** miReba SeiZleba gacxelebul ( $500-600^\circ C$ ) rodiumze fToris moqmedebisas ( $2Rh + 3F_2 = 2RhF_3$ ). igi ( $RhF_3$ ) rombuli wiTeli kristalebia, mcired ixsneba wyalSi.

**rodium(III)-is qloridi ( $RhCl_3$ )** miiReba fxvnilisebr rodiumze qloris moqmedebisas ( $250-360^\circ C$ ) $2Rh + 3Cl_2 = 2RhCl_3$ . rodiumis triqloridi ( $RhCl_3$ ) mowiTalo-yavisferi kristaluri nivTierebaa, wyalsa da mJavaSi mcired ixsneba, hidratirebuli rodiumis triqloridi ki ( $RhCl_3 \cdot 4H_2O$ ) wyalSi kargad xsnadia.

**rodium(III)-is bromidis ( $RhBr_3$ )** miReba SeiZleba Sesabamisi martivi nivTierebebis urTierTqmedebiT ( $250^\circ C$ ) ( $2Rh + 3Br_2 = 2RhBr_3$ ). rodiumis tribromidi yavisferi fxvnilia, romelic gaxurebisas ( $527^\circ C$ ) iSleba Semadgenel elementebad. cnobilia $RhBr_3$ -is kompleqsuri aminebi.

**rodium(III)-is iodidis ( $RhI_3$ )** miReba SeiZleba kaliumis iodidis moqmedebisas rodium(III)-is marilis xsnarebze ( $Rh_2(SO_4)_3 + 6KI = 2RhI_3 + 3K_2SO_4$ ). rodiumis triodidi Savi, wyalSi mcired xsnadi nivTierebaa, gaxurebisas ( $327^\circ C$ ) iSleba.

**rodium(IV)-is fToridi (** $RhF_4$ **)** miiReba gamTbar ( $50^\circ C$ -mde) rodiumze elementuri fToris moqmedebiT ( $Rh + 2F_2 = RhF_4$ ). rodiumis tetrafToridis sublimaciiT SeiZleba misi sufTa saxiT miReba. igi wyalSi mcired xsnadi mowiTalo-yavisferi nivTierebaa.

rodiumi da misi naerTebi gamoiyeneba saiuveliro sawarmoSi, radgan sxvadasxva nakeTobaze eleqtrolizurad daleqili rodiumi iZleva mbzinav zedapirs. ixmareba, agreTve katalizatorisa da Savi pigmentis saxiT faifuris nakeTobaTa mosaxatavad. sinTezuri boWkos warmoebaSi gamoiyeneba, rogorc katalizatorebi.

**iridium(II)-is halidebi (** $IrCl_2$ **,** $IrBr_2$ **,** $IrI_2$ **)**

**iridium(II)-is qloridis (** $IrCl_2$ **)** miReba SeiZleba iridiumis gaxurebisas qloris WavlSi ( $Ir + Cl_2 = IrCl_2$ ). iridiumis diqloridi mwvane feris kristaluri nivTierebaa, mcire raodenobiT ixsneba tuteSi, xolo gaxurebisas ( $800^\circ C$ ) martiv nivTierebebad iSleba.

**iridium(III)-is qloridi (** $IrCl_3$ **)** warmoiqmneba gaxurebul ( $600^\circ C$ -mde) fxvnilisebr iridiumze qloris moqmedebiT ( $2Ir + 3Cl_2 = 2IrCl_3$ ). iridiumis triqloridi muqi mwvane feris nivTierebaa, aqroladia, wyalsa da mJavaSi mcire raodenobiT ixsneba.

**iridium(III)-is bromidi (** $IrBr_3$ **)** miiReba iridium(III)-is oqsidze ( $Ir_2O_3$ ) bromwyalbadmJavas moqmedebis Sedegad ( $Ir_2O_3 + 6HBr = 2IrBr_3 + 3H_2O$ ). iridiumis tribromidi Zlieri gaxurebisas iSleba Semadgenel elementebad.

**iridium(III)-is iodidi (** $IrI_3$ **)** miiReba Sesabamisi elementebis SeerTebisas (zomieri gaxurebisas, $2Ir + 3I_2 = 2IrI_3$ ) mwvane feris myari nivTierebaa, mcire raodenobiT ixsneba wyalSi, gaxurebis ( $400^\circ C$ ) dros iSleba.

**iridium(IV)-is fToridi (** $IrF_4$ **)** miiReba $Ir_2F_6$ -isa da iridiumis fxvnilis narevis gaxurebisas. wyalSi gaxsnisas igi hidrolizurad iSleba ( $IrF_4 + 4H_2O = Ir(OH)_4 + 4HF$ ).

**iridium(IV)-is qloridi (** $IrCl_4$ **)** warmoiqmneba ( $600^\circ C$ -ze) iridiumze qloriT moqmedebisas, maRali wnevis dros ( $Ir + 2Cl_2 = IrCl_4$ ). $NaCl$ an $KCl$ -Tan, qloris atmosferoSi, iridiumis gaxurebisas miiReba $Na_2[IrCl_6]$ an $K_2[IrCl_6]$ : $Ir + 2M^1Cl + 2Cl_2 = M^1_2[IrCl_6]$ .

**iridium(IV)-is bromidis ( $IrBr_4$ )** miReba SeiZleba iridium(IV)-is oqsidze ( $IrO_2$ ) bromwyalbadmJavas moqmedebisas ( $IrO_2 + 4HBr = IrBr_4 + 2H_2O$ ). iridiumis tetrabromidi lurji feris naerTia, hidrolizurad iSleba wyalSi gaxsnisas.

**iridium(VI)-is fToridis ( $IrF_6$ )** miReba SeiZleba Tu fxvnilisebr iridiums gavacxelebT, fToris atmosferoSi, fluoritis milSi ( $Ir + 3F_2 = IrF_6$ ). iridiumis heqsafToridi ( $IrF_6$ ) yviTeli, kristaluri nivTierebaa. Tavisi qimiuri xasiaTiT mJangavia ( $2IrF_6 + 8H_2O = 2IrO_3 \cdot 2H_2O + 12HF + O_2$ ).

**iridium(III)-is sulfidi ( $Ir_2S_3$ )** miiReba iridiumis triqloridis SemJavebul xsnarSi gogirdwyalbadis gatarebiT ( $2IrCl_3 + 3H_2S = Ir_2S_3 + 6HCl$ ). iridium(III)-is sulfidi myari, yavisferi naerTia, $1000^\circ C$ -mde gacxelebisas martiv nivTierebebad iSleba. wyalSi mcire raodenobiT ixsneba. kargad xsnadia azotmJavasa da kaliumis sulfidis xsnarSi.

iridiumi da misi naerTebi gamoiyeneba, rogorc katalizatori qimiur mrewvelobaSi. isini ixmareba kalmis wverebis, sazRvao kompasis isrebis agreTve zoma-wonis zust etalonebis da sxvaTa dasamzadeblad.

**paladium(II)-is halidebis ( $PdF_2$ , $PdCl_2$ , $PdBr_2$ , $PdI_2$ )** miReba SeiZleba gaxurebisas ( $550^\circ C$ -mde da ufro meti) paladiumis urTierTqmedebiT halogenebTan ( $Pd + F_2 = PdF_2$ , $Pd + Cl_2 = PdCl_2$ da a.S.). **paladiumis difToridi ( $PdF_2$ )** yavisferi kristaluri nivTierebaa, cudad ixsneba wyalSi, kargad _ mdnob mJavaSi _ tetrafTorpaladiummJavas $H_2[PdF_4]$ -is warmoqmniT ( $PdF_2 + 2HF = H_2[PdF_4]$ ). paladiumis diqloridi wiTeli kristaluri nivTierebaa, kargad ixsneba wyalSi. masze gogirdwyalbadis moqmedebiT warmoiqmneba Sesabamisi sulfidi ( $PdCl_2 + H_2S = PdS + 2HCl$ ). metalur paladiumze marilmJavas moqmedebiT qloris Tanaobisas miiReba tetraqlorpaladiummJava ( $H_2[PdCl_4]$ ): $Pd + Cl_2 + 2HCl = H_2[PdCl_4]$ . paladium(II)-is qloridis wyalxsnaris Warbi amiakiT damuSavebisas miiReba tetraminpaladium(II)-is qloridi ( $PdCl_2 + 4NH_4OH = [Pd(NH_3)_4Cl_2 + 4H_2O$ ).

**paladium(II)-is bromidi ( $PdBr_2$ )** yavisfer-wiTeli nivTierebaa, cudad ixsneba wyalSi, kargad bromwyalbadmJavasa da tute metalTa bromidebis wyalxsnarebSi _ tetrabrompaladiummJavasa ( $H_2[PdBr_4]$ ) da tetrabrompaladatis $M_2^+[PdBr_4]$ warmoqmniT $PdBr_2 + 2HBr = H_2[PdBr_4]$ ,

$PdBr_2 + 2KBr = K_2[PdBr_4]$. cnobilia, agreTve tetraaminpaladium(II)-is bromidi $[Pd(NH_3)_4]Br_2$ da misi stereoizomeri $[Pd(NH_3)_2Br_2]$.

**paladium(II)-is iodidis ($PdI_2$)** muqi wiTeli feris fxvnilia, cudad ixsneba wyalSi, urTierTqmedebs iodwyalbadmJavasa da tute metalTa iodidebis wyalxsnarebTan tetraiodopaladiummJavas ($H_2[PdI_4]$) da tetraiodopaladatis(II) ($M_2^+[PdI_4]$) warmoqmniT ($PdI_2 + 2HI = H_2[PdI_4]$ da $PdI_2 + 2NaI = Na_2[PdI_4]$). miRebulia agreTve tetraaminpaladium(II)-is iodidi ($[Pd(NH_3)_4]I_2$) da misi stereoizomeruli naerTi ($[Pd(NH_3)_2I_2]$).

**paladium(II)-is sulfati ($PdSO_4 \cdot 2H_2O$)** warmoiqmneba paladium(II)-is hidroqsidze gogirdmJavas moqmedebiT ($Pd(OH)_2 + H_2SO_4 = PdSO_4 + 2H_2O$) an metaluri paladiumis urTierTqmedebiT koncentrirebul gogirdmJavasTan ($Pd + 2H_2SO_4 = PdSO_4 \cdot 2H_2O + SO_2$).

**paladium(III)-is fToridi ($PdF_3$)** miiReba fToris moqmedebiT metalur paladiumze ($2Pd + 3F_2 = 2PdF_3$) an $PdF_2$-ze ($200^\circ C$): $2PdF_2 + F_2 = 2PdF_3$. paladiumis trifToridi higroskopiuli, paramagnituri, Savi feris kristaluri nivTierebaa, gaxurebisas iSleba Semadgenel elementebad, ixsneba mdnob mJavaSi, xasiaTdeba mJangavi TvisebebiT.

**paladium(IV)-is sulfidi ($PdS_2$)** miiReba paladiumis tetraqloridi SelRobiT gogirdTan ($400-500^\circ C$) $PdCl_4 + 2S = PdS_2 + 2Cl_2$. igi muqi yavisferi myari nivTierebaa, romelic gaxurebiT ($600^\circ C$ zeviT) gardaiqmneba paladium(II)-is sulfidad ($PdS_2 = PdS + S$).

paladiumi da misi naerTebi ixmareba vercxlisa da vercxlis nakeTobebis dacvisa da dekoratiuli dafarvisaTvis. qimiur mrewvelobaSi gamoiyeneba mravali qimiuri reaqciis katalizatorad.

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დანართი:

## მარილების, მჟავების და ფუძეების ხსნადობა წყალში

| იონები | $H^+$ | $NH_4^+$ | $K^+$ | $Na^+$ | $Ag^+$ | $Ba^{2+}$ | $Ca^{2+}$ | $Mg^{2+}$ | $Zn^{2+}$ | $Cu^{2+}$ | $Hg^{2+}$ | $Pb^{2+}$ | $Fe^{2+}$ | $Fe^{3+}$ | $Al^{3+}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $OH^-$ | | ხს | ხს | ხს | – | ხს | მხ | უ | უ | უ | – | უ | უ | უ | უ |
| $NO_3^-$ | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს |
| $Cl^-$ | ხს | ხს | ხს | ხს | უ | ხს | ხს | ხს | ხს | ხს | ხს | მხ | ხს | ხს | ხს |
| $S^{2-}$ | ხს | ხს | ხს | ხს | უ | – | – | – | უ | უ | უ | უ | უ | უ | – |
| $SO_3^{2-}$ | ხს | ხს | ხს | ხს | მხ | მხ | მხ | მხ | მხ | – | - | უ | მხ | – | – |
| $SO_4^{2-}$ | ხს | ხს | ხს | ხს | მხ | უ | მხ | ხს | ხს | ხს | ხს | უ | ხს | ხხ | ხს |
| $CO_3^{2-}$ | ხს | ხს | ხს | ხს | უ | უ | უ | უ | უ | – | – | უ | უ | – | – |
| $SiO_3^{2-}$ | უ | – | ხს | ხს | უ | უ | უ | უ | უ | – | – | უ | უ | – | – |
| $PO_4^{3-}$ | ხს | ხს | ხს | ხს | უ | უ | უ | უ | უ | უ | უ | უ | უ | უ | უ |
| $CH^3COO^-$ | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს | ხს |

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## ელექტროქიმიური ძაბვის მწკრივი



**Sinaarsi**