

**Chemical properties of the
elements from IB group and from
the platinum family**

The plan of the lecture

- 1. Overall characteristic of elements from IB group*
- 2. Natural resources of elements from IB group*
- 3. Physical and chemical properties of copper, silver and gold*
- 4. Main compounds of copper, silver and gold.*
- 5. The usage of copper, silver and gold in medicine.*
- 6. Properties of metals from platinum family.*

PERIODIC TABLE OF THE ELEMENTS

<http://www.ktf-split.hr/periodni/en/>

PERIOD	GROUP	RELATIVE ATOMIC MASS (1)																18	
	1 IA	2 IIA	GROUP IUPAC										13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	VIIIA	
	1	2	3	4	5	6	7	8	9	10	11 IB	12 IIB	13	14	15	16	17	18	
	1.0079	6.941	9.0122	ATOMIC NUMBER										10.811	12.011	14.007	15.999	18.998	20.180
	H	Li	Be	SYMBOL										B	C	N	O	F	Ne
	HYDROGEN	LITHIUM	BERYLLIUM	ELEMENT NAME										BORON	CARBON	NITROGEN	OXYGEN	FLUORINE	NEON
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	H	Li	Be											B	C	N	O	F	Ne
2	Li	Be											B	C	N	O	F	Ne	
3	Na	Mg											Al	Si	P	S	Cl	Ar	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac-Lr	Rf	Db	Sg	Bh	Hs	Mt	Uuu	Uuu	Uub							

 Metal	 Semimetal	 Nonmetal
 1 Alkali metal	 2 Alkaline earth metal	 16 Chalcogens element
 Transition metals	 Lanthanide	 17 Halogens element
 Actinide	STANDARD STATE (25 °C; 101 kPa)	
	Ne - gas	Fe - solid
	Ga - liquid	Tc - synthetic

LANTHANIDE

57 138.91	58 140.12	59 140.91	60 144.24	61 (145)	62 150.36	63 151.96	64 157.25	65 158.93	66 162.50	67 164.93	68 167.26	69 168.93	70 173.04	71 174.97
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
LANTHANUM	CERIUM	PRASEODYMIUM	NEODYMIUM	PROMETHIUM	SAMARIUM	EUROPIUM	GADOLINIUM	TERBIUM	DYSPROSIUM	HOLMIUM	ERBIUM	THULIUM	YTTERIUM	LUTETIUM

ACTINIDE

89 (227)	90 232.04	91 231.04	92 238.03	93 (237)	94 (244)	95 (243)	96 (247)	97 (247)	98 (251)	99 (252)	100 (257)	101 (258)	102 (259)	103 (262)
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
ACTINIUM	THORIUM	PROTACTINIUM	URANIUM	NEPTUNIUM	PLUTONIUM	AMERICIUM	CURIUM	BERKELIUM	CALIFORNIUM	EINSTEINIUM	FERMIUM	MENDELEVIUM	NOBELIUM	LAWRENCIUM

(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)
 Relative atomic mass is shown with five significant figures. For elements having no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
 However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Old version of the periodic table

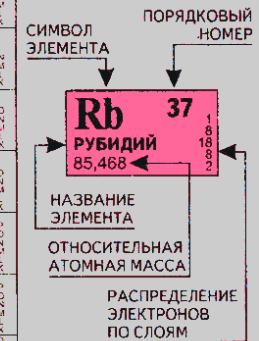
ПЕРИОДИЧЕСКАЯ СИСТЕМА ХИМИЧЕСКИХ ЭЛЕМЕНТОВ Д.И.МЕНДЕЛЕЕВА

Периоды	Ряды	ГРУППЫ ЭЛЕМЕНТОВ																Энергия ионизации			
		I		II		III		IV		V		VI		VII		VIII					
		a	б	a	б	a	б	a	б	a	б	a	б	a	б	б		a			
1	1	H ВОДОРОД 1,008																He ГЕЛИЙ 4,003	2		
2	2	Li ЛИТИЙ 6,941		Be БЕРИЛЛИЙ 9,0122		B БОР 10,811		C УГЛЕРОД 12,011		N АЗОТ 14,007		O КИСЛОРОД 15,999		F ФТОР 18,998				Ne НЕОН 20,179	10		
3	3	Na НАТРИЙ 22,99		Mg МАГНИЙ 24,312		Al АЛЮМИНИЙ 26,992		Si КРЕМНИЙ 28,086		P ФОСФОР 30,974		S СЕРА 32,064		Cl ХЛОР 35,453				Ar АРГОН 39,948	18		
4	4	K КАЛИЙ 39,102		Ca КАЛЬЦИЙ 40,08		Sc СКАНДИЙ 44,956		Ti ТИТАН 47,895		V ВАНАДИЙ 50,941		Cr ХРОМ 51,996		Mn МАРГАНЕЦ 54,838		Fe ЖЕЛЕЗО 55,849		Co КОБАЛЬТ 58,933		Ni НИКЕЛЬ 58,7	
	5	Cu МЕДЬ 63,546		Zn ЦИНК 65,37		Ga ГАЛЛИЙ 69,72		Ge ГЕРМАНИЙ 72,59		As МЫШЬЯК 74,922		Se СЕЛЕН 78,96		Br БРОМ 79,904				Kr КРИПТОН 83,8	36		
5	6	Rb РУБИДИЙ 85,468		Sr СТРОНЦИЙ 87,62		Y ИТРИЙ 88,906		Zr ЦИРКОНИЙ 91,22		Nb НИОБИЙ 92,906		Mo МОЛИБДЕН 95,94		Tc ТЕХНЕЦИЙ [98]		Ru РУТЕНИЙ 101,07		Rh РОДИЙ 102,906		Pd ПАЛЛАДИЙ 106,4	
	7	Ag СЕРЕБРО 107,868		Cd КАДМИЙ 112,41		In ИНДИЙ 114,82		Sn ОЛОВО 118,69		Sb СУРЬМА 121,75		Te ТЕЛЛУР 127,6		I ИОД 126,905				Xe КСЕНОН 131,3	54		
6	8	Cs ЦЕЗИЙ 132,905		Ba БАРИЙ 137,34		57-71 ЛАНТАНОИДЫ		Hf ГАФНИЙ 178,49		Ta ТАНТАЛ 180,948		W ВОЛЬФРАМ 193,85		Re РЕННИЙ 186,207		Os ОСМИЙ 190,2		Ir ИРИДИЙ 192,22		Pt ПЛАТИНА 195,09	
	9	Au ЗОЛОТО 196,967		Hg РУТУТЬ 200,59		81 ТАЛЛИЙ		Pb СВИНЕЦ 207,19		Bi ВИСМУТ 208,98		Po ПОЛОНИЙ [210]		At АСТАТ [210]		Os ОСМИЙ 190,2		Ir ИРИДИЙ 192,22		Pt ПЛАТИНА 195,09	
7	10	Fr ФРАНЦИЙ [223]		Ra РАДИЙ [226]		89-103 АКТИНОИДЫ		Rf РЕЗЕРФОРДИЙ [261]		Db ДУБНИЙ [262]		Sg СИБОРГИЙ [263]		Bh БОРИЙ [262]		Hn ХАНИЙ [265]		Mt МЕЙТТЕРИЙ [268]		Rn РАДОН [222]	86
ВЫСШИЕ ОКСИДЫ		R_2O	RO	R_2O_3	RO_2	R_2O_5	RO_3	R_2O_7	RO_4												
ЛЕТУЧИЕ ВОДОРОДНЫЕ СОЕДИНЕНИЯ					RH_4	RH_3	H_2R	HR													

www.calc.ru



Д.И. Менделеев
1834-1907



- s-элементы
- p-элементы
- d-элементы
- f-элементы

ЛАНТАНОИДЫ

57 La ЛАНТАН 138,906	58 Ce ЦЕРИЙ 140,12	59 Pr ПРАЗЕОДИМ 140,908	60 Nd НЕОДИМ 144,24	61 Pm ПРОМЕТИЙ [145]	62 Sm САМАРИЙ 150,4	63 Eu ЕВРОПИЙ 151,96	64 Gd ГАДОЛИНИЙ 157,25	65 Tb ТЕРБИЙ 158,926	66 Dy ДИСПРОЗИЙ 162,5	67 Ho ГОЛЬМИЙ 164,93	68 Er ЭРБИЙ 167,26	69 Tm ТУЛИЙ 168,934	70 Yb ИТТЕРБИЙ 173,04	71 Lu ЛЮТЕЦИЙ 174,97
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АКТИНОИДЫ

89 Ac АКТИНИЙ [227]	90 Th ТОРИЙ 232,038	91 Pa ПРОТАКТИНИЙ [231]	92 U УРАН 238,029	93 Np НЕПУТНИЙ [237]	94 Pu ПЛУТОНИЙ [244]	95 Am АМЕРИЦИЙ [243]	96 Cm КЮРИЙ [247]	97 Bk БЕРКЛИЙ [247]	98 Cf КАЛЬФОРНИЙ [251]	99 Es ЭЙНШТЕЙНИЙ [254]	100 Fm ФЕРМИЙ [257]	101 Md МЕНДЕЛЕВИЙ [258]	102 No НОБЕЛИЙ [259]	103 Lr ЛОУРЕНСИЙ [260]
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Overall characteristic of elements from IB group

- Electron configuration:
- Cu: [Ar] $4s^1$ $3d^{10}$
- Ag: [Kr] $5s^1$ $4d^{10}$
- Au: [Xe] $6s^1$ $4f^{14}$ $5d^{10}$
- Copper, silver and, especially, gold are very inert. Because of this reason they can be found as elements in nature.
- However, they are prone to form complexes.

2. Natural resources of elements from IB group

- **Gold** is thought to be the first metal mankind got familiar with. It happened about 5 000 years B.C.



In nature gold exists as:

- Pure chemical element;
- Electrum (Au + 15 – 50% Ag);
- Sulfides, arsenides, tellurides.



«Philosopher's stone»

- There was a dream of ancient alchemists about a substance called “Philosopher's stone” that can turn metals to gold.
- In 1947 35 mcg of gold have been produced in a nucleic reaction from mercury.
- However, such a “transmutation” cannot be used in commerce. The price of that process is too expensive.

2. Natural resources of elements from IB group

- **Silver** is known for about 5 000 years B.C.
- In nature silver can be found as:
- Pure chemical element;
- Electrum (Au + 15 – 50% Ag);
- Argenite – Ag_2S ;
- Kerargirite – AgCl



2. Natural resources of elements from IB subgroup

- **Copper** is known since 3 000 years B.C. There were ancient mining camps on the island Cyprus.

Natural minerals are:

- Copper iron (II) sulfide CuFeS_2 ;
- Halkozine – Cu_2S ; covellite – CuS ;
- Copprite – Cu_2O ;
- Azurite – $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$ or $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$;
- Malachite – $\text{Cu}_2\text{CO}_3(\text{OH})_2$
or $(\text{CuOH})_2\text{CO}_3$
or $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$;
- Copper as a pure chemical element is rare in nature.



Physical and chemical properties of copper

- Copper is an orange-pink plastic metal. It is covered by a layer of copper (II) oxide on the open air. That layer changes the overall color of copper to yellow-red.
- With the course of time copper is covering up by a layer of green hydroxycarbonate:
- $2\text{Cu} + \text{H}_2\text{O} + \text{CO}_2 + \text{O}_2 \rightarrow (\text{CuOH})_2\text{CO}_3$



Physical and chemical properties of silver

- Pure silver is very plastic white metal (the coefficient of the reflection of light is close to 100 %). It is the best known conductor of electricity. With the course of time that metal is losing its reflecting ability because of the corrosion by hydrogen sulfide in the presence of oxygen. Silver sulfide has a black color.
- $4\text{Ag} + 2\text{H}_2\text{S} + \text{O}_2 \rightarrow 2\text{Ag}_2\text{S} + 2\text{H}_2\text{O}$



Physical and chemical properties of gold

- **Gold** is a soft and plastic yellow metal.
- In normal conditions it cannot react with the most of the acids, as well as with oxygen. Because of this reason gold is so expensive. Indeed, other metals can be easily destroyed by acids and bases.
- However, gold can easily react with reactants that can form a complex compound in the presence of oxygen. For example, gold can be dissolved in water solutions of cyanides in the presence of oxygen:
- $4\text{Au} + 8\text{KCN} + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 4\text{K}[\text{Au}(\text{CN})_2] + 4\text{KOH}$
- $2\text{K}[\text{Au}(\text{CN})_2] + \text{Zn} \rightarrow \text{K}_2[\text{Zn}(\text{CN})_4] + 2\text{Au} \downarrow$

Chemical properties of copper

- $2\text{Cu} + \text{O}_2 (400 - 500^\circ\text{C}) \rightarrow 2\text{CuO}$
- $4\text{Cu} + \text{O}_2 (> 800^\circ\text{C}) \rightarrow 2\text{Cu}_2\text{O}$

- $\text{Cu} + \text{S} (t_1^\circ) \rightarrow \text{CuS}$
- $2\text{Cu} + \text{S} (t_2^\circ > t_1^\circ) \rightarrow \text{Cu}_2\text{S}$

- $\text{Cu} + \text{Cl}_2 \rightarrow \text{CuCl}_2$



Reaction between copper and chlorine gas

Chemical properties of copper

- Dilute solutions of nonoxidizing acids and alkalis (in the absence of oxidizers) usually cannot react with copper.
- $\text{Cu} + 4\text{HNO}_3 (\text{conc.}) \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$
- $3\text{Cu} + 8\text{HNO}_3 (40\%) \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO} + 4\text{H}_2\text{O}$
- $\text{Cu} + 2\text{H}_2\text{SO}_4 (\text{conc.}) \rightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O}$
- $2\text{Cu} + 4\text{HCl}(\text{conc.}) \rightarrow 2\text{H}[\text{CuCl}_2] + \text{H}_2$
- $2\text{Cu} + 4\text{HCl}(\text{dilute}) + \text{O}_2 \rightarrow 2\text{CuCl}_2 + 2\text{H}_2\text{O}$
- $2\text{Cu} + \text{H}_2\text{S} \rightarrow \text{Cu}_2\text{S} + \text{H}_2$
- $2\text{Cu} + 8\text{NH}_4\text{OH} + \text{O}_2 \rightarrow 2[\text{Cu}(\text{NH}_3)_4](\text{OH})_2 + 6\text{H}_2\text{O}$
- $2\text{Cu} + \text{I}_2 \rightarrow 2\text{CuI} \quad ((\text{Cu}^{2+} + 4\text{I}^- \rightarrow 2\text{CuI} + \text{I}_2))$

Copper (I) oxide and hydroxide

- $\text{Cu}_2\text{O} + 4\text{HCl} \rightarrow 2\text{H}[\text{CuCl}_2] + \text{H}_2\text{O}$
- $\text{CuOH} + \text{HCl} \rightarrow \text{CuCl}\downarrow + \text{H}_2\text{O}$
- $\text{Cu}_2\text{O} + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + \text{H}_2\text{O} + \text{Cu}\downarrow$
- $\text{Cu}_2\text{O} + 2\text{NaOH}(\text{conc.}) \rightarrow 2\text{Na}[\text{Cu}(\text{OH})_2]$
- $\text{CuOH} + \text{NaOH}(\text{conc.}) \rightarrow \text{Na}[\text{Cu}(\text{OH})_2]$
- $\text{Cu}_2\text{O} + 4\text{NH}_3 + \text{H}_2\text{O} \rightarrow 2[\text{Cu}(\text{NH}_3)_2]\text{OH}$
- $\text{CuOH} + 2\text{NH}_3(\text{aq.}) \rightarrow [\text{Cu}(\text{NH}_3)_2]\text{OH}$
- $4\text{CuOH} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Cu}(\text{OH})_2$

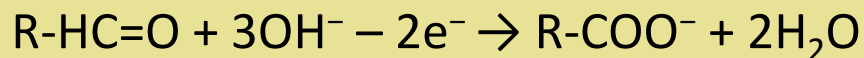
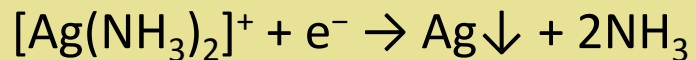
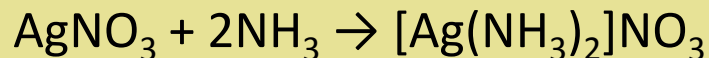
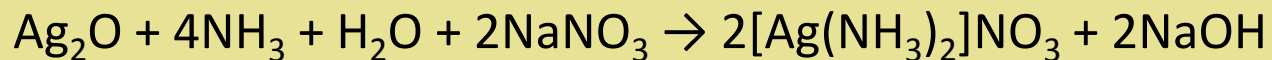
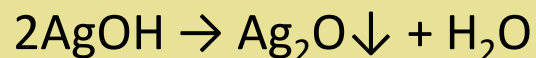
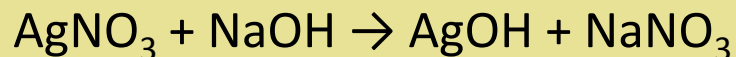
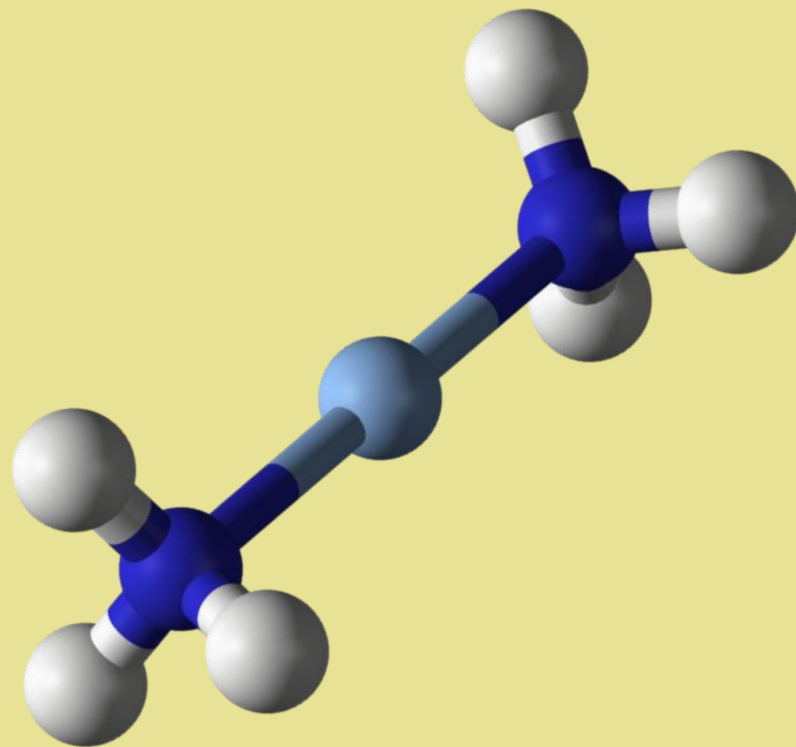
Salts of copper

- $4\text{CuCl} + \text{O}_2 + 4\text{HCl} \rightarrow 4\text{CuCl}_2 + 2\text{H}_2\text{O}$
- $2\text{CuCl} (\text{t}^\circ) \rightarrow 2\text{Cu} + \text{CuCl}_2$
- $\text{CuSO}_4 (\text{t}^\circ) \rightarrow \text{Cu} + \text{CuSO}_4$
- $\text{CuCl} + \text{Cl}_2 \rightarrow \text{CuCl}_2$
- $\text{CuCl}_2 + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{NH}_3)_4]\text{Cl}_2$
- $\text{CuCl}_2 + 2\text{NaCl}(\text{conc.}) \rightarrow \text{Na}_2[\text{CuCl}_4]$
- $2\text{CuSO}_4 + 4\text{KI} \rightarrow 2\text{K}_2\text{SO}_4 + 2\text{CuI} + \text{I}_2$

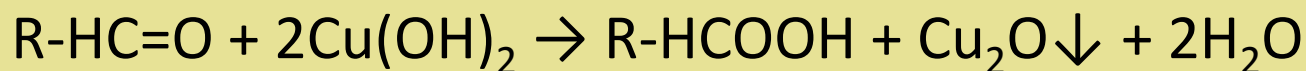
Chemical properties of silver

- $2\text{Ag} + \text{H}_2\text{S} (\text{t}^\circ) \rightarrow \text{Ag}_2\text{S} + \text{H}_2 \uparrow$
- $2\text{Ag} + \text{S} (\text{t}^\circ) \rightarrow \text{Ag}_2\text{S}$
- $2\text{Ag} + 2\text{HI}(\text{aq}) (\text{t}^\circ) \rightarrow 2\text{AgI} + \text{H}_2 \uparrow$
- $2\text{Ag} + 2\text{HCl}(\text{g}) (\text{t}^\circ) \rightarrow 2\text{AgCl} + \text{H}_2 \uparrow$
- $2\text{Ag} + 2\text{H}_2\text{SO}_4 (\text{conc.}) \rightarrow \text{Ag}_2\text{SO}_4 + \text{SO}_2 \uparrow + 2\text{H}_2\text{O}$
- $\text{Ag} + 2\text{HNO}_3 (\text{conc.}) \rightarrow \text{AgNO}_3 + \text{NO}_2 \uparrow + \text{H}_2\text{O}$
- $3\text{Ag} + 4\text{HNO}_3 (\text{dilute}) \rightarrow 3\text{AgNO}_3 + \text{NO} \uparrow + 2\text{H}_2\text{O}$

Tollens' reactant



Test reactions for polyatomic alcohols and aldehydes with the fresh $\text{Cu}(\text{OH})_2$



AgNO_3 as a reactant to reveal the presence of chlorides, bromides and iodides in water solutions

Chemical properties of gold

- Gold can be dissolved in ***selenic acid*** (but it cannot be dissolved in any other individual acid) at 200 °C:
- $2\text{Au} + 6\text{H}_2\text{SeO}_4 \rightarrow \text{Au}_2(\text{SeO}_4)_3 + 3\text{H}_2\text{SeO}_3 + 3\text{H}_2\text{O}$
- $2\text{Au} + 3\text{Cl}_2 (200^\circ\text{C}) \rightarrow 2\text{AuCl}_3$
- $2\text{Au} + 3\text{Br}_2 \rightarrow 2\text{AuBr}_3$
- $2\text{Au} + \text{I}_2 + 2\text{KI} \rightarrow 2\text{K}[\text{AuI}_2]$
- $\text{Au} + \text{Cs} \rightarrow \text{CsAu}$
- $2\text{Au} + 2\text{HCl} + 3\text{Cl}_2 \rightarrow 2\text{H}[\text{AuCl}_4]$

“Tsar’s vodka”

Tsar’s vodka (*Aqua Regia*, *Aqua Regis*, *A.R.*) — is the mixture of concentrated nitric HNO_3 (65-68 % by mass) and hydrochloric HCl (32-35 % by mass) acids, taken in the proportion of 1:3 by volume (mass ratio per pure acids is about 1:2)



“Tsar’s vodka”

- A mixture of numerous products forms when HCl reacts with HNO₃. Some of them are free radicals like atomic chlorine and NO.
- $3\text{HCl} + \text{HNO}_3 \rightarrow 2\text{Cl}\cdot + \text{NOCl} + 2\text{H}_2\text{O}$
- $\text{NOCl} \rightarrow \text{NO} + \text{Cl}\cdot$
- $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$
- This mixture must be fresh to keep its oxidizing properties. One of the end products of the reactions in Tsar’s vodka is nitrogen dioxide that has a brown color.

“Tsar’s vodka”

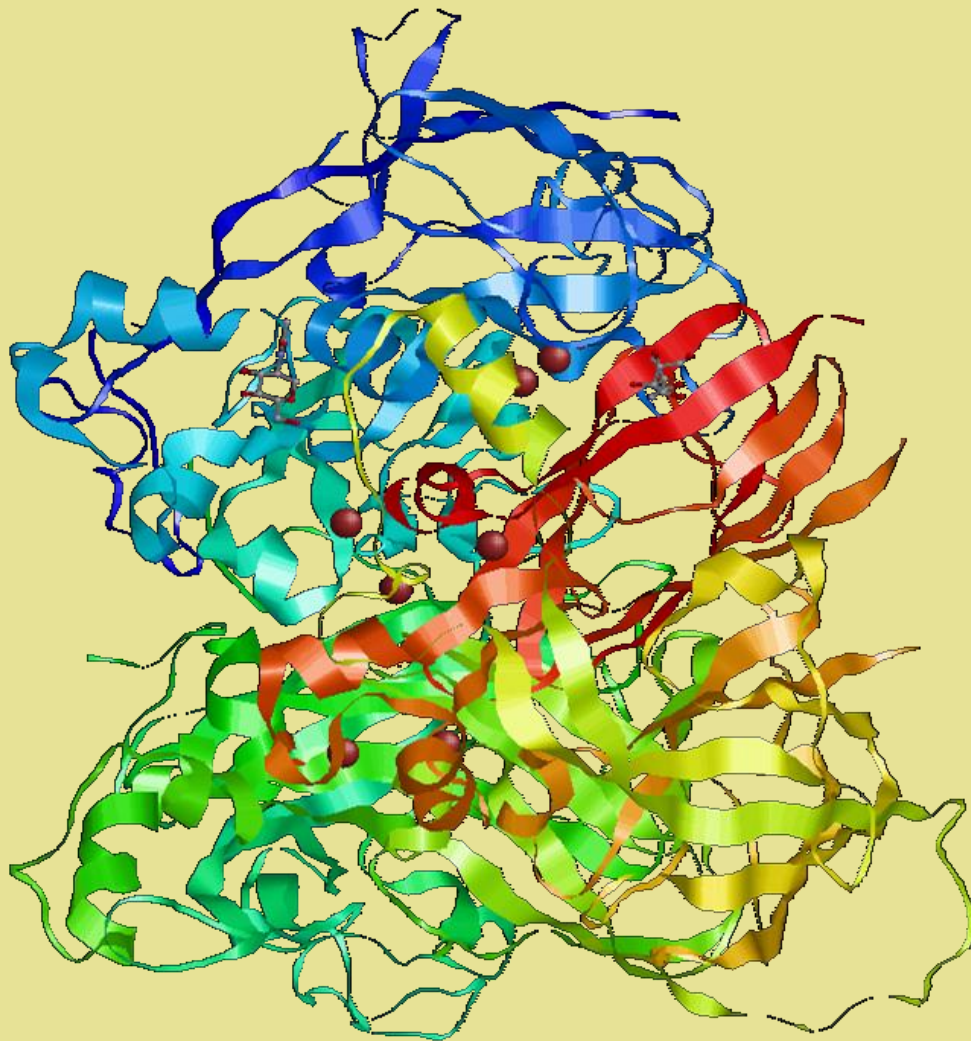
- $\text{Au} + 4\text{HCl} + \text{HNO}_3 \rightarrow \text{H}[\text{AuCl}_4] + \text{NO}\uparrow + 2\text{H}_2\text{O}$
- Silver cannot be dissolved in Tsar’s vodka because of the passivation by insoluble AgCl .
- $2[\text{AuCl}_4]^- + 3\text{Fe}^{2+} \rightarrow 3\text{Fe}^{3+} + 8\text{Cl}^- + 2\text{Au}\downarrow$
- $4[\text{AuCl}_4]^- + 3\text{N}_2\text{H}_4 \rightarrow 3\text{N}_2 + 12\text{H}^+ + 16\text{Cl}^- + 4\text{Au}\downarrow$



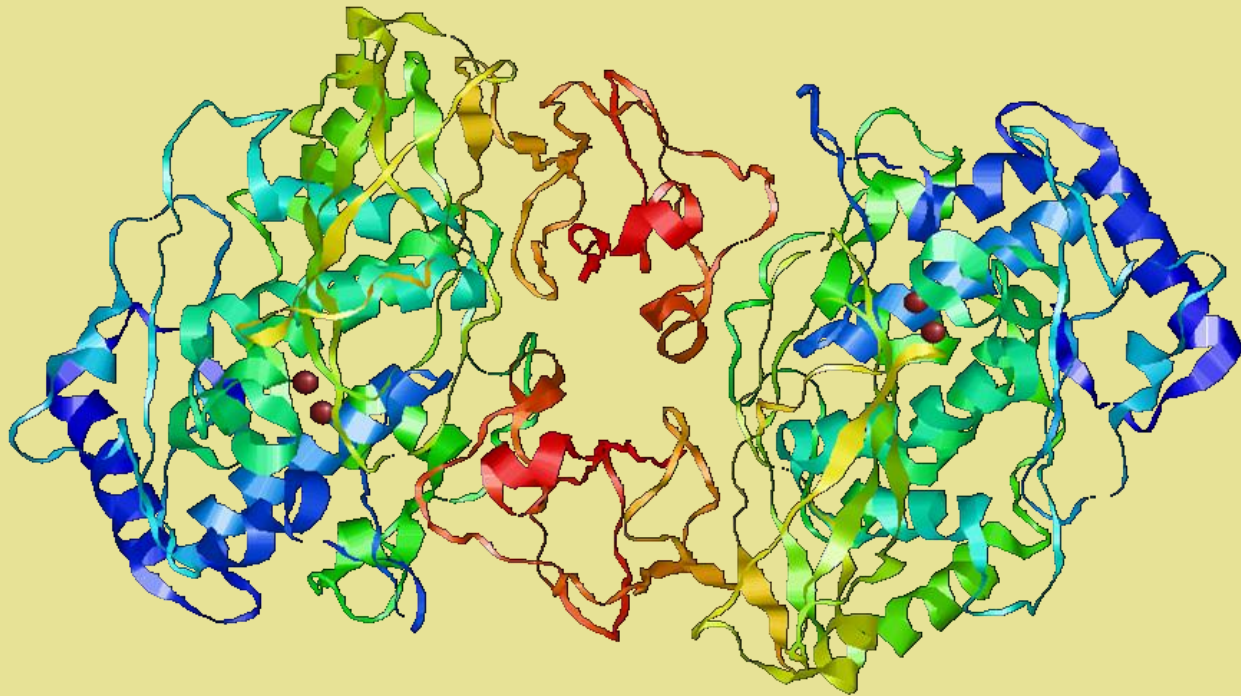
Biological roles of copper

- Copper is an essential element for all plants and animals. Copper is transported in blood by a specific protein that is called ceruloplasmin.
- Copper ions are co-factors for numerous enzymes including cytochrome c oxidase and superoxide dismutase.
- In blood of some mollusks and arthropoda oxygen is transported by hemocyanine. In that protein there are no porfirine rings, copper ions are coordinated by nitrogen atoms from histidines.

Ceruloplasmin



Hemocyanine



The usage of copper and its compounds in medicine

- In 2008 the fact of the existence of bactericide surface of copper has been officially confirmed in USA.
- Staphylococcus aureus with the resistance to multiple drugs (MRSA) is sensitive to copper and its alloys.
- Also copper can deactivate Influenza virus.

The usage of copper and its compounds in medicine

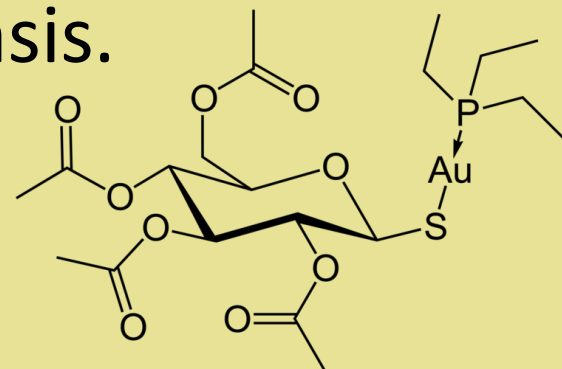
- $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ – is an antiseptic (it can be found in eye drops, gastric lavage solutions)
- CuSO_4 – is a frequent component of vitamin and mineral complexes

The usage of silver and its compounds in medicine

- **Silver proteinate – collargol, protargol – colloid silver** – is the result of chemical reaction between silver oxide and proteins, such as BSA or casein. Silver ions are released slowly from these proteinates.

The usage of compounds of gold in medicine

- Organic compounds of gold (**cryzanol** and **auranofine**) are used in medicine with the aim to treat autoimmune diseases (including rheumatoid arthritis) and amebiasis.



- Compounds of gold are toxic, while pure gold is inert and cannot demonstrate its toxic properties.

The usage of gold in medicine

- Tooth crowns can be made from gold.
- «**Gold for drinking**» — is a colloid solution with a red color. It is still popular, even though it is inert. Ancient Chinese alchemists started to drink colloid gold solutions about 1 000 years B.C.



The chemistry of elements from the platinum family

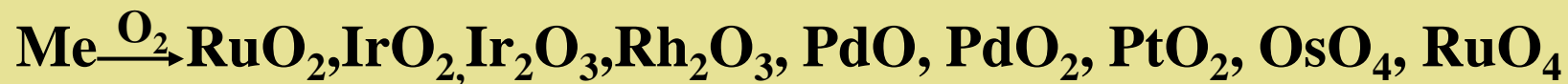
1. Physical and chemical properties

These metals are shiny gray. **Pd** and **Pt** are soft; **Ir** is hard and durable; **Os** and **Ru** are fragile.

Pt – metals are inert.

These metals are resistant to corrosion in normal conditions. They can dissolve hydrogen.

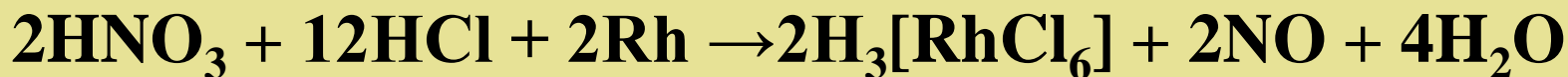
Pd and Pt are frequently used as catalysts.



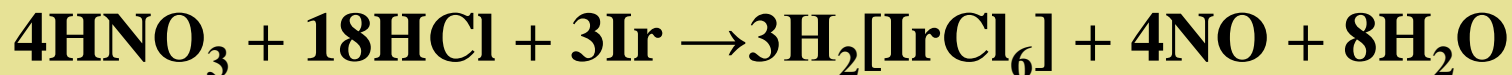
Pt metals cannot react with HCl and diluted H₂SO₄ and HNO₃.



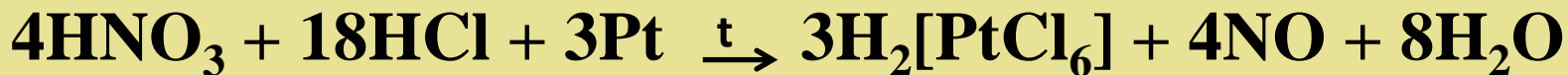
Tsar's vodka reacts with those metals



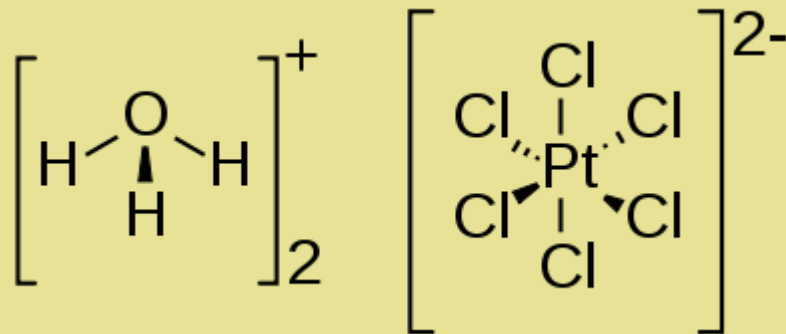
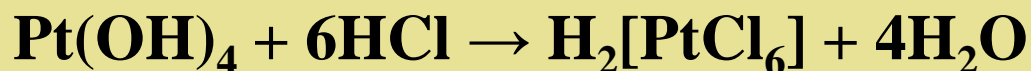
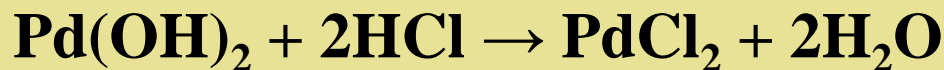
Fractioned state



Fractioned state



Hydroxides of platinum metals (Me(OH)₂, Me(OH)₃, Me(OH)₄) demonstrate weak basic or amphoteric properties.



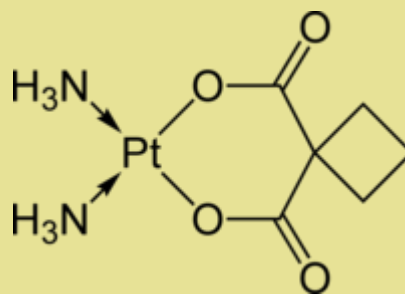
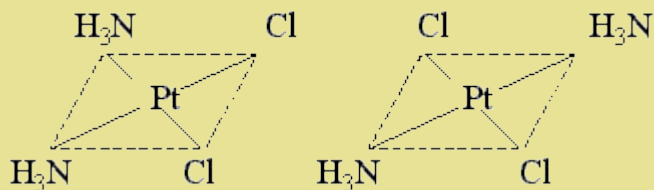
THE USAGE OF COMPOUNDS OF PLATINUM FAMILY ELEMENTS

Pt metals are not essential for human body
Their usage in medicine is limited.

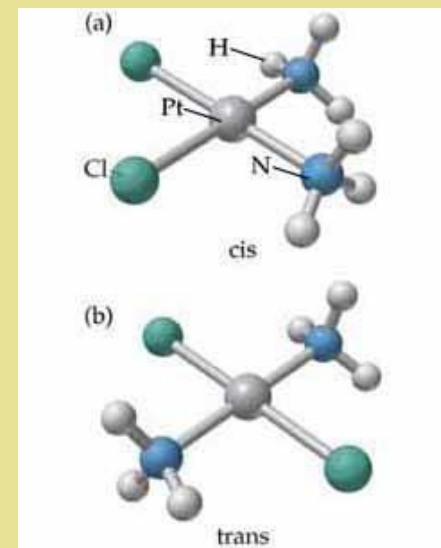
OsO₄ – is used in histology, but it is very toxic

Pd – is used in dentistry

Cis-[Pt(NH₃)₂Cl₂] – cisplatin – is used to treat tumors (oncologic diseases) by the way of replication block caused by the formation of covalent bonds with guanines.



carboplatin



What's the price of gold?



What's the price of platinum?



What's the price of silver?



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Thank you for listening!!!