Dobeles novads

Grindex

Valsts izglītības satura centrs

NACIONĀLAIS ATTĪSTĪBAS PLĀNS 2020

EIROPAS SAVIENĪBA
Eiropas Sociālais fonds

atbalsts izcilībai

IEGULDĪJUMS TAVĀ NĀKOTNĒ

8.3.2.1./16/I/002

NACIONĀLA UN STARPTAUTISKA MĒROGA PASĀKUMU ĪSTENOŠANA IZGLĪTOJAMO TALANTU ATTĪSTĪBAI

BCho

29th Baltic Chemistry Olympiad
Dobele, Latvia, April 19-21, 2023

PRACTICAL EXAM

L	**V**	**A**	

Student code:

April 19th, 2023
Dobele, Latvia

Periodic table:

1 1.008 **H**																	2 4.003 **He**
3 6.94 **Li**	4 9.01 **Be**											5 10.81 **B**	6 12.01 **C**	7 14.01 **N**	8 16.00 **O**	9 19.00 **F**	10 20.18 **Ne**
11 22.99 **Na**	12 24.31 **Mg**											13 26.98 **Al**	14 28.09 **Si**	15 30.97 **P**	16 32.06 **S**	17 35.45 **Cl**	18 39.95 **Ar**
19 39.10 **K**	20 40.08 **Ca**	21 44.96 **Sc**	22 47.87 **Ti**	23 50.94 **V**	24 52.00 **Cr**	25 54.94 **Mn**	26 55.85 **Fe**	27 58.93 **Co**	28 58.69 **Ni**	29 63.55 **Cu**	30 65.38 **Zn**	31 69.72 **Ga**	32 72.61 **Ge**	33 74.92 **As**	34 78.97 **Se**	35 79.90 **Br**	36 83.80 **Kr**
37 85.47 **Rb**	38 87.62 **Sr**	39 88.91 **Y**	40 91.22 **Zr**	41 92.91 **Nb**	42 95.95 **Mo**	43 (98) **Tc**	44 101.07 **Ru**	45 102.91 **Rh**	46 106.42 **Pd**	47 107.87 **Ag**	48 112.41 **Cd**	49 114.82 **In**	50 118.71 **Sn**	51 121.76 **Sb**	52 127.60 **Te**	53 126.90 **I**	54 131.29 **Xe**
55 132.91 **Cs**	56 137.33 **Ba**	57-71 **La-Lu**	72 178.49 **Hf**	73 180.95 **Ta**	74 183.84 **W**	75 186.21 **Re**	76 190.23 **Os**	77 192.22 **Ir**	78 195.08 **Pt**	79 196.97 **Au**	80 200.59 **Hg**	81 204.38 **Tl**	82 207.2 **Pb**	83 208.98 **Bi**	84 (209) **Po**	85 (210) **At**	86 (212) **Rn**
87 (223) **Fr**	88 (226) **Ra**	89-103 **Ac-Lr**	104 (267) **Rf**	105 (268) **Db**	106 (269) **Sg**	107 (270) **Bh**	108 (270) **Hs**	109 (278) **Mt**	110 (281) **Ds**	111 (282) **Rg**	112 (285) **Cn**	113 (286) **Nh**	114 (289) **Fl**	115 (290) **Mc**	116 (293) **Lv**	117 (294) **Ts**	118 (294) **Og**

Atomic number

1 1.008 **H**

Atomic weight
Atomic symbol

57 138.91 **La**	58 140.12 **Ce**	59 140.91 **Pr**	60 144.24 **Nd**	61 (145) **Pm**	62 150.36 **Sm**	63 151.96 **Eu**	64 157.25 **Gd**	65 158.93 **Tb**	66 162.50 **Dy**	67 164.93 **Ho**	68 167.26 **Er**	69 168.93 **Tm**	70 173.05 **Yb**	71 174.97 **Lu**
89 (227) **Ac**	90 232.04 **Th**	91 231.04 **Pa**	92 238.03 **U**	93 (237) **Np**	94 (244) **Pu**	95 (243) **Am**	96 (247) **Cm**	97 (247) **Bk**	98 (251) **Cf**	99 (252) **Es**	100 (257) **Fm**	101 (258) **Md**	102 (259) **No**	103 (266) **Lr**

General instructions:

- Follow safety rules. No eating or drinking in the lab during the practical exam.
- During the Practical exam, some of the glassware and plastics are expected to be used several times. Clean it carefully.
- You can start writing when the command Start has been given.
- You have 5 hours to complete the practical exam.
- Practical examination consists of 2 Problems.
- For draft and calculation purposes, you can use separate sheets or the other sides of the theoretical exam booklet.
- It is strictly forbidden to communicate between students during the exam.
- Raise your hand if you require to go to the bathroom.
- Write your student code on each page.
- The official English version of the exam is available on request for clarification.

Good luck!

List of chemicals (Problem 1):

Labels	Content
1, 2, 3, 4	Solids in labelled vials
I, II, III, IV, V	Solutions in labelled vials
A, B, C	Solutions in labelled vials
PE	Petroleum ether (hexanes) in a stoppered test tube

List of chemicals (Problem 2):

1, 2, 3, 4, 5	Solutions in labelled vials
CH-1, CH-2, CH-3	Solutions in labelled vials
D, E	Solutions in labelled vials
NH_3	Diluted aqueous ammonia in a stoppered test tube

List of chemicals (both Problems):

H_2O	Distilled water in a plastic bottle
H_2SO_4	Diluted sulfuric acid in a stoppered test tube
Zn	Zinc dust in a stoppered test tube
	Plastic pipettes
	Test tubes

Practical Problem No.1 (20% of total)

Part A.

Switzerland is a globally known centre of the pharmaceutical industry. Many pharmaceutical companies are located here, including very big corporations, such as Novartis and Hoffmann-La Roche in the Basel area. Chemicals are taking leading positions among export products of the country. Switzerland is also the home of the World Health Organization (WHO), which is a specialized agency of the United Nations with the headquarter in Geneva.

In 1977 WHO published an Essential Medicines List (EML), which is updated every 2 years. Currently, it contains almost 500 medications, which are considered to be the most effective and safe to cover the principal needs of the health system. In this task, you will have to determine the compounds from this list and learn, for which properties they were included in the EML.

*1.1. In each of the vials **1–4** there is only one solid from the list: $BaSO_4$, $FeSO_4 \cdot 7H_2O$, $[Ag(NH_3)_2]F$, $KMnO_4$, $Fe_4[Fe(CN)_6]_3$, C, As_2O_3, I_2, $Na_2[Fe(CN)_5(NO)] \cdot 2H_2O$. **Fill in** the table with the formulas of corresponding medications.*

Formula	Trade name (example)	Medical use
	CharcoAid	Poisonings (non-specific antidote)
	Radiogardase	Thallium and radioactive caesium poisonings
	Trisenox	Cancer
	Feosol	Iron deficiency
	Nipride	Hypertensive crisis (high blood pressure)
	Permitabs	Dermatological infections
	Varibar	X-ray imaging (radiocontrast agent)
	Iodosorb	Iodine deficiency, antiseptic
	Saforide	Dental caries prevention, antimicrobial

*1.2. **Identify** the compounds in vials **1–4** by analyzing their appearance, solubility in water and petroleum ether, as well the colours of formed solutions. Mark the solubility and colours as* "+" or "-".

Vial	Compound	Soluble in water?	Solution coloured?	Soluble in hexane?	Solution coloured?
1					
2					
3					
4					

*1.3. **Find** which two compounds from **1**–**4** can react with each other in an aqueous solution. Perform this reaction without and with the addition of acid (H_2SO_4). Write down the equations of the reactions. Use "↓" for precipitates and "↑" for gas evolution.*

Conditions	Reaction equation
Without H_2SO_4	
With H_2SO_4	

Part B.

In vials **I**–**V** there are five solutions of sodium salts also from EML: fluoride, hypochlorite, nitrite, hydrogen carbonate and thiosulfate.

1.4. Assign the medical use of the compounds with the letter of corresponding medical use:

***A** – Severe metabolic acidosis, **B** – Dental caries prevention, **C** – Cyanide poisoning, **D** – Cyanide poisoning and fungal skin infections, **E** – Disinfectant*

Formula	Letter
$NaNO_2$	
$NaHCO_3$	
$Na_2S_2O_3$	
NaF	
NaClO	

*1.5. **Identify** the compounds **I**–**V**. You can use the solution of H_2SO_4 and the compounds **1**-**4**. For each compound, write at least one chemical reaction, which helped you explicitly identify the compounds. Use "↓" for precipitates and "↑" for gas evolution.*

Compound	Formula	Reaction(s) equation(s)
I		
II		
III		
IV		
V		

Part C.

In vials **A**–**C** there are 3 solutions of mixtures of 2 compounds from the list: Li_2CO_3, $ZnSO_4$, KI, CH_3COOH, $MgSO_4$, $CaCl_2$. All these compounds are also listed as important medicines in EML. Each of them is used to prepare a mixture and is used only once.

*1.6. **Find** the only possible compositions of the 3 mixtures. **Arrange** them with the medical use of the compounds.*

	Compound	Medical use
Mixture 1		Bipolar disorders
		Hyperthyroidism, radiation accidents, fungal infections
Mixture 2		Anticonvulsant
		Diarrhoea
Mixture 3		Corresponding metal supplement
		Infections of the ear canal

*1.7. **Perform** the cross-reactions between mixtures **A**–**C** and fill in the following table of observations with the symbols: "↓" – precipitate, "↑" – gas, "–" if there are no visible observations. Be aware that the result of some reactions can depend on the ratio of reagents used.*

Mixtures	A	B	C
A			
B			
C			

*1.8. Based on the observations, **determine** the composition of each mixture. **Write down** the ionic equations of performed reactions. Use "↓" for precipitates and "↑" for gases.*

Mixture A		

Mixture B		
Mixture C		
Combination	**Ionic equation(s)**	
A+B		
A+C		
B+C		

Practical Problem No.2 (20% of total)

Part A.

Switzerland, or officially the Swiss Confederation, is a federal republic consisting of 26 cantons. Interestingly, it does not have an official capital, although the parliament sits in Bern. Despite being a "federal city", it is not the most populated in Switzerland, the first place belongs to Zurich.

Switzerland has a code **CH**, abbreviated from the Roman name of the region *Confœderatio Helvetica*. You can find ".ch" as a top-level domain for Swiss websites. Also, each of the cantons has a two-letter abbreviation, listed below. They are used, for example, on car license plates.

CODE	Name	CODE	Name
ZH	Zurich	**SH**	Schaffhausen
BE	Bern	**AR**	Appenzell Ausserrhoden
LU	Lucerne	**AI**	Appenzell Innerhoden
UR	Uri	**SG**	St. Gallen
SZ	Schwyz	**GR**	Graubünden
OW	Obwalden	**AG**	Aargau
NW	Nidwalden	**TG**	Thurgau
GL	Glarus	**TI**	Ticino
ZG	Zug	**VD**	Vaud
FR	Fribourg	**VS**	Valais
SO	Solothurn	**NE**	Neuchâtel
BS	Basel-Stadt	**GE**	Geneva
BL	Basel-Landschaft	**JU**	Jura

In vials **1**–**5** there are five colourless solutions of individual ionic compounds. Each compound corresponds to one of Switzerland's cantons by its code: the first letter of the code is the starting letter for the metal cation formula and the second letter of the code is the starting letter for the anion formula. For example, **SH** (Schaffhausen) can correspond to **S**r**H**PO_4 and **BS** (Basel-Stadt) to **B**a**S**O_3. The solutions **1**–**5** contain the compounds with the following anions: formate (**H**COO^-), hydroxide (**O**H^-), iodide (**I**$^-$), sulphide (**S**$^{2-}$) and tungstate (**W**O_4^{2-}).

*2.1. For each anion from compounds **1**–**5**, **specify** possible canton codes(s) and water-soluble compounds that could correspond to them. Note that some canton code(s) may have*

no examples of water-soluble compounds. Do not consider the compounds of f-block elements.

Anion	Canton code(s)	Example of the compound
Formate (**H**COO$^-$)		
Hydroxide (**O**H$^-$)		
Iodide (**I**$^-$)		
Sulphide (**S**$^{2-}$)		
Tungstate (**W**O$_4^{2-}$)		

*2.2. **Perform** the cross-reactions between solutions **1–5** as well as reactions with NH_3 and H_2SO_4 solutions and fill in the following table of observations with the symbols: "↓" for precipitation, "↑" for gas evolution, and "–" if there are no visible observations. Note the colours of precipitates.*

Solution	1	2	3	4	5
1					
2					
3					
4					
5					
NH_3					
H_2SO_4					

*2.3. Based on the observations and above-mentioned information, **identify** the compounds **1–5**.*

1	2	3	4	5

*2.4. **Write down** the ionic equations of the performed reactions. Use "↓" for precipitates and "↑" for gases.*

Combination	Ionic equation(s)
1+2	
1+3	
1+4	
1+5	
2+3	
2+4	
2+5	
3+4	
3+5	
4+5	
1+NH_3	
1+H_2SO_4	
2+NH_3	
2+H_2SO_4	
3+NH_3	
3+H_2SO_4	
4+NH_3	
4+H_2SO_4	
5+NH_3	
5+H_2SO_4	

Part B.

In vials **CH-1**, **CH-2** and **CH-3** there are three colourless solutions of different formates ($HCOO^-$), which correspond to the code for Switzerland **CH** according to the rule described before.

*2.5. **Provide** 3 examples of each of the formates that form colourless and coloured solutions. Do not consider the compounds of f-block elements.*

Colourless			
Coloured			

*2.6. **Identify** the compounds in test tubes **CH-1**, **CH-2** and **CH-3** by conducting reactions with NH_3 and H_2SO_4. **Write down** the ionic equations and **specify** the observations: formation of precipitate (↓) and its colour, gas evolution (↑). Use "–" if there are no visible observations.*

Vial	Compound	Ionic equation(s) with observations
CH-1		
CH-2		
CH-3		

*2.7. **Specify** the combination of two anions from compounds **1**–**5**, which could also be used to identify the cations in **CH-1**, **CH-2** and **CH-3**. **Check** your suggestion, if possible, by performing the reactions with chosen anion. **Write down** the corresponding ionic equations and **specify** the observations: formation of precipitate (↓) and its colour, gas evolution (↑) or other effects. Use "–" if there are no visible observations.*

Chosen anions		
Vial	**Ionic equation(s) with observations**	
CH-1		
CH-2		
CH-3		

Part C.

In vials **D** and **E** there are two solutions of salts of different shades of blue. Following the rule described above, the formula of each salt corresponds either to the code for Switzerland or cantons.

*2.8. **Perform** the reactions of **D** and **E** with: a) variable quantities of NH_3 solution; b) Zn with the addition of H_2SO_4 solution. Based on observations, **identify** the cations of given salts and **specify** possible associated code(s) of cantons or Switzerland. **Write down** the ionic equations of conducted reactions, indicating precipitates (↓), gas evolution (↑), or other effects, including colour changes.*

	Vial	Cation	Associated code(s)
	D		
	E		

Combination	Ionic equation(s)
D+NH_3	
D+Zn(H^+)	
E+NH_3	
E+Zn(H^+)	

*2.9. **Suggest** the anions in **D** and **E**. **Check** your suggestion by performing the reaction(s) with any reagent or encoded solution. **Write down** the corresponding chemical equations and specify the observations: formation of precipitate (↓) and its colour, gas evolution (↑), or other effects.*

Vial	Anion	Reaction equation(s) with observation(s)
D		
E		

*2.10. The complex formed by one of the salts in the excess of ammonia is called Schweizer's reagent. It is named after the Swiss chemist Matthias Eduard Schweizer (1818–1860), who discovered its property to dissolve a common substance. **Choose** the name of this substance:*

- ☐ polyethylene
- ☐ proteins
- ☐ fats
- ☐ starch
- ☐ cellulose