



CODE:

(to be filled in by the jury at the end of the test here and on the envelope)

REGIONAL CHEMISTRY COMPETITION

April 6, 2019

- 1) The tests are stapled with an envelope on the top. In the envelope there is piece of paper on which you should fill in the requested data: name and surname, school, supervisor etc. and then close and **seal the envelope!**
- 2) Do not put any signature, or a mark on the envelope and on the test (the code should be filled in by the jury). If any signature or mark is found on the test or envelope, the competitor will be disqualified.
- 3) You should write on the test using a **blue pen**, answers written with pencil will not be considered.
- 4) A calculator can be used for the numerical problems. It is not allowed to use textbooks, any other book, notebook, paper, the periodic table, cell phone etc. Cell phones should be left on the teacher's desk or out of the test room.
- 5) All necessary data are provided in the test.
- 6) Any conversation between the competitors is forbidden. If you have any question, then the teacher in the room should call the responsible teacher for the competition.
- 7) Read the test carefully and answer the questions following the instructions by: encircling, writing down the solution and answer in the designated space in the test. The jury **will evaluate only the answers written in the designated space for it**, and the procedures for solving the problems will be checked. The back of every page of the test, that is empty, can be used for free writing and it will not be checked and evaluated!
- 8) The maximal number of points is **50**. In the first part of the test with multiple choice questions, each correct answer brings 2 points (maximum 30). The correct answers to the problems in the second part brings maximum 20 points.
- 9) The competition lasts **90 minutes**. The tests that are handed after the given time will not be considered for scoring.

We wish you a successful work!

For the jury only

Part I: _____

Part II: _____

Total points: _____

Checked by (Name and Surname)



MULTIPLE CHOICE QUESTIONS TEST WITH ONE CORRECT ANSWER

(Select just one answer A, B, C or D)

- Which of the following combinations of quantum numbers **does not** correspond to an electron in a ground-state cobalt atom?
 - $n = 3, l = 0, m_l = 0$
 - $n = 4, l = 2, m_l = -2$
 - $n = 3, l = 1, m_l = -1$
 - $n = 4, l = 0, m_l = 0$
- Having in mind the following combination of elements C, Se, B, Sn and Cl, which of the following statements **is not** correct:
 - Sn atom has the largest atomic radius
 - Cl is the most electronegative
 - graphite is the best electrical conductor
 - only B can form binary compounds with hydrogen with empirical formula XH_3 .
- In the case of N_2O_5 molecule it is not true that:
 - it contains 6 σ bonds
 - it contains 2 π bonds
 - it does not contain N–N and O–O bonds
 - the molecule is not a resonant hybrid
- Which of the following statements, related to a polyelectronic atom, **is not** correct?
 - The effective nuclear charge depends on the number of electrons present in the atom
 - Electrons in an s-orbital are more effective than those in other orbitals at shielding other electrons from the nuclear charge because s-electrons can penetrate more to the nucleus of the atom.
 - Electrons having $l = 2$ are better at shielding than electrons having $l = 1$.
 - The effective nuclear charge for an electron in a p-orbital is lower than for an electron in an s-orbital in the same shell.
- In the case of which compound is the chemical bonding between nitrogen atoms stronger: N_2H_2 or N_2H_4 ?
 - N_2H_4
 - N_2H_2
 - there is no difference between the strength of mentioned chemical bonds in the case of two compounds
 - There is not enough information to give an answer.
- Prior 1961, the atomic mass unit was defined as 1/16 of the atomic mass of ^{16}O . What was the mass of a ^{12}C atom prior 1961 if the atomic (average) mass of oxygen on today's scale is 15,9994 u?
 - 32 u
 - 16 u
 - 12 u
 - 8 u
- Identify the correct answer:
 - Graphite, diamond, amorphous carbon and fullerenes are polymorphic modifications of carbon.
 - The fundamental building unit of graphite, diamond, amorphous carbon and fullerene is graphene.
 - The diamond is an electrical conductor.
 - Compared with diamond, graphite is thermodynamically more stable phase.
- Which is the number of the closest anions coordinating a cation and vice versa in the case of the structure of the most quoted ionic substance, NaCl?
 - 4, 6
 - 6, 6
 - 6, 4
 - 2, 4
- Four substances have been studied in a research laboratory: HCl, glucose ($C_6H_{12}O_6$), CH_3COOH and NH_3 . A technician prepared an aqueous solution of one of the compounds but forgot to label it and has gone home. In order to identify the solution, its colleague tested it with litmus paper and realized that the solution turns the litmus paper red. Using a conductivity meter, he found that the solution is weakly conducting. Identify the dissolved substance:
 - HCl
 - NH_3
 - CH_3COOH
 - $C_6H_{12}O_6$



10. The compounds of calcium are essential building materials in living organisms (for example $\text{Ca}_3(\text{PO}_4)_2$ in the bones) and civil engineering on account of the rigidity of their structures which is due to the:
- weak electrostatic interactions between large Ca^{2+} ions and relevant anions in the structure, and this results in stable crystal lattice.
 - strong electrostatic interactions between small Ca^{2+} ions and relevant anions in the structure, and this results in stable crystal lattice.
 - metallic character of chemical bonding
 - covalent character of chemical bonding
11. White phosphorous, P_4 , burns in air forming a compound X with mass percent of phosphorous of 43,64 %, and the rest is oxygen. The molar mass of X is 283,9 g/mol. Which is the molecular formula of X?
- P_2O_5
 - P_4O_{10}
 - P_2O_3
 - P_4O_6
12. The reaction between the compound X from question 11 and unlimited quantity of water leads to compound Y:
- pyrophosphoric acid
 - metaphosphoric acid
 - phosphoric acid
 - phosphorous acid
13. Which of the following acids can not form a normal salt:
- Carbonic acid
 - Silicic acid
 - phosphorous acid
 - selenic acid
14. What is correct?
- $154 \text{ pm} < 7,70 \cdot 10^{-9} \text{ cm}$
 - $1,86 \cdot 10^{11} \mu\text{m} > 2,02 \cdot 10^2 \text{ km}$
 - $2,7 \text{ g/cm}^3 > 2,5 \cdot 10^3 \text{ kg/m}^3$
 - $6,022 \cdot 10^{23} \text{ mol}^{-1} > 8,300 \cdot 10^{26} \text{ kmol}^{-1}$
15. Which M^{3+} ion (where M is a metal) has the following electron configuration $[\text{Ar}]3d^6$:
- In^{3+}
 - Cr^{3+}
 - Co^{3+}
 - Fe^{3+}

PROBLEMS:

((Put the calculations and the answer to the problem at the designated place!
The Periodic table with the needed data is given on the last page of the test.))

1. An unidentified metal (M) reacts with an unidentified halogen gas to form a compound MX_2 . When heated, the compound decomposes by the reaction:



If 1,12 g MX_2 is heated, 0,720 g of MX is obtained, along with 56,0 mL of halogen gas under standard conditions. Identify:

- the metal
- the halogen element

SOLUTION:



Problem 1. ANSWER: a) _____ б) _____

2. The compound, Si_2H_x , is analyzed and found to contain 90,28 % silicon (by mass). What is the value of x ?

SOLUTION:

Problem 2. ANSWER: _____

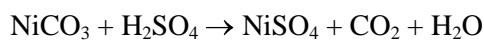


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3. A sample, with mass of 25,12 g, contains $6,022 \cdot 10^{23}$ particles. If 25,00 % of the total number of particles are argon atoms and 75,00 % are another element, what is the chemical identity of the other constituent?

SOLUTION:

Problem 3. ANSWER: _____

4. Nickel(II) sulfate, used for nickel plating, is prepared by treatment of nickel(II) carbonate with sulfuric acid:



- a) How many grams of H_2SO_4 are needed to react with 14,5 g of NiCO_3 ?
b) How many grams of NiSO_4 are obtained if the reaction yield is 78,9 %?

SOLUTION:

Problem 4. ANSWER: a) _____ b) _____



1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Uuu (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)			

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)