KÉMIA
ANGOL NYELVEN
CHEMISTRY
2007. május 15. 8:00
KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA
MEDIUM LEVEL
WRITTEN EXAMINATION

Az írásbeli vizsga időtartama: 120 perc
Duration of the written examination: 120 minutes

<table>
<thead>
<tr>
<th>Pótlapok száma/Number of supplementary sheets</th>
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OKTATÁSI ÉS KULTURÁLIS
MINISZTÉRIUM
MINISTRY OF EDUCATION
AND CULTURE
Important informations

- The examination test should be solved within 120 minutes, after 120 minutes the work should be finished.
- The sequence of answering the questions is free.
- For the solution of the problems calculators without text-storage capability and four-place logarithm tables can be used. Use of other electronic or written help is forbidden.
- Read the introductory text of the questions carefully and keep its instructions.
- Write the answers in ink. If you cancel an answer or part of an answer, the canceled work can not be evaluated.
- For the calculations, you can get maximum number of points only if the main steps of the calculation are indicated, too.
- Please, don’t write anything into the gray squares.
Read the following text carefully and answer the questions.

AMINO ACIDS FROM THE SPACE

Two European international research groups succeeded in creating amino acids in a laboratory simulating space conditions. These experiments confirm the assumption that comets and interplanetary dust might have played an important role in the birth of life on Earth.

An aluminium block was cooled down to -261 °C in a Leiden vacuum apparatus. In the equipment, steam, carbon dioxide, ammonia and methanol were injected in such a – 2:1:1:1 – molar ratio as they are present in the interstellar space. The thin ice layer formed on the cooling block was exposed to ultraviolet radiation for several hours. In this way, sunshine was imitated whose energy is breaking molecules and creating new ones. By analysing the ice layer, researchers found 16 different amino acids, six of them having even a biological role.

The European space mission Rosetta will provide an opportunity for researchers to control the result of their experiments on the spot, too. The spacecraft will transport an analytical instrument onto the surface of the comet Virtanen in 2011 to study the composition of the ice there. Before that, the space mission Stardust will collect dust originating from comets and take it to the Earth in 2006 in order to analyse it. Examination of the Australian Murchison meteorite also verified that amino acids might have got to Earth from space: more than seventy amino acids were identified in it.

(After The World of Nature, vol. 133. no. 10.)

a) List the names of the substances injected into the aluminium block and give their structural formula.

b) At the analysis of the ice layer on the cooling block amino acids were found. How many percent of them have a biological role?
c) Calculate the mass percent composition of the initial "ice layer". (Suppose that all injected substance will be frozen.)

d) Which one has the simplest structure among the amino acids commonly found in proteins? Give its constitutional formula and name.

e) Why was ultraviolet radiation used during the study of ice layer formed on the cooling block? What was the role of radiation?
2. Simple choice

*Write the only correct letter mark into the empty cell on the right-hand side of the answers.*

1. Consider the following equilibrium process: \( \text{N}_2 + 3 \text{H}_2 \rightleftharpoons 2 \text{NH}_3 \ \Delta H = -92 \text{kJ/mol} \)
   Which method can shift the equilibrium into the direction of the formation of the product?

   A) Decreasing the pressure.
   B) Decreasing the temperature.
   C) Adding ammonia.
   D) Decreasing the applied concentration of nitrogen.
   E) Employing a catalyst.

2. Choose the only *incorrect* statement.

   A) Simple anions are formed from atoms by accepting electrons.
   B) In the main groups of the periodic table, the size of atoms is increasing from top to bottom.
   C) The number of protons and electrons in the atom is equal to the mass number.
   D) Electronegativity is increasing in the periods of the periodic table from left to right.
   E) Loss of electrons is called oxidation.

3. Which statement is *not true* for white phosphorus?

   A) By its burning diphosphorous pentoxide is formed.
   B) It is a poisonous substance.
   C) It can be easily oxidized even in air.
   D) It is well dissolved in apolar solvents.
   E) It is well dissolved in water.

4. Which statement is *true* for disaccharides?

   A) Cellulose belongs to them.
   B) Their solid phase has an ionic lattice structure.
   C) They are well dissolved in water.
   D) They can be prepared from monosaccharides by hydrolysis.
   E) All of them give a positive silver mirror test.
5. Which two substances are each other’s constitutional isomers?
   A) Ethanol and dimethyl ether.
   B) Benzene and cyclohexane.
   C) Pentane and butadiene.
   D) Ethanol and diethyl ether.
   E) Formic acid and acetic acid.

6. Which is the anode and the cathode of the galvanic cell represented by the following cell diagram and how much is its electromotive force measured between standard electrodes?
   - Zn (s) | Zn^{2+} (aq) || Cu^{2+} (aq) | Cu (s) +
   A) Zinc is the cathode, copper is the anode. $E_{MF} = 1.1 \, \text{V}$
   B) Zinc is the anode, copper is the cathode. $E_{MF} = -1.1 \, \text{V}$
   C) Zinc is the anode, copper is the cathode. $E_{MF} = -0.42 \, \text{V}$
   D) Zinc is the anode, copper is the cathode. $E_{MF} = 1.1 \, \text{V}$
   E) Zinc is the cathode, copper is the anode. $E_{MF} = 0.42 \, \text{V}$

7. Hardness of water
   A) can be completely removed by boiling.
   B) can not be decreased by trisodium phosphate.
   C) is only characteristic for tap water.
   D) is caused by dissolved calcium and magnesium salts.
   E) increases the cleaning efficiency of soap.

8. Which statement is not true for phenol?
   A) In standard state it is a solid substance.
   B) It has a limited solubility in water.
   C) Its aqueous solution is slightly acidic.
   D) It is one of the raw materials of polymer industry.
   E) In its molecule, two hydroxy groups are connected to the benzene ring.

9. How many sulfate ions are contained in 2 mol alum whose formula is: $\text{KAl(SO}_4\text{)}_2 \cdot 12\text{H}_2\text{O}$?
   A) 2 pieces
   B) $2,4 \cdot 10^{24}$ pieces
   C) 4 pieces
   D) $1,2 \cdot 10^{24}$ pieces
   E) $4,8 \cdot 10^{24}$ pieces
10. Which substance is the oxidizing agent in the reaction: \( \text{SO}_2 + \text{I}_2 + 2 \text{H}_2\text{O} = \text{H}_2\text{SO}_4 + 2 \text{HI} \)?

A) \( \text{SO}_2 \)  
B) \( \text{I}_2 \)  
C) \( \text{H}_2\text{O} \)  
D) \( \text{H}_2\text{SO}_4 \)  
E) \( \text{HI} \)

11. Which reaction can be used for the laboratory preparation of oxygen?

A) Hydrochloric acid is added to potassium permanganate.  
B) Hydrochloric acid is added to zinc.  
C) Potassium permanganate is heated.  
D) Water is poured to calcium carbide.  
E) The reaction of copper and concentrated nitric acid.

12. Which statement is \textit{not true} for sulfuric acid?

A) It is a hygroscopic substance.  
B) One of its salts is blue vitriol (copper sulfate).  
C) It is a diprotic acid.  
D) Its mixing with water is an endothermic process.  
E) Its hot, concentrated solution dissolves copper.

13. Which of the following statements is \textit{true}?

A) In \(^{63}\text{Cu}\) atoms, there are 92 pieces of elementary particles.  
B) In the nucleus of \(^{35}\text{Cl}\) atoms, there are 35 protons.  
C) \(^{13}\text{C}\) atoms contain 13 pieces of neutrons.  
D) In \(^2\text{H}\) atoms, there is one more electron than in \(^1\text{H}\) atoms.  
E) In \(^{18}\text{O}\) atoms, the number of protons and neutrons is equal.

14. What is the correct systematic name of the following compound?

\[
\begin{array}{ccc}
\text{CH} & \text{–} & \text{CH}_2 \\
\| & | & |
\text{CH}_2 & \text{–} & \text{CH}_3
\end{array}
\]

A) 1-methylene-3-methylpentane  
B) 1,3-dimethylpentane  
C) 4-methylhex-1-ene  
D) 4-ethylpent-1-ene  
E) n-octene
15. What has a pH = 3 hydrochloric acid in common with a pH = 3 acetic acid?

A) The hydronium ion concentration of both solutions: $3 \cdot 10^{-3}$ mol/dm$^3$.
B) The acid concentration of both solutions: $1 \cdot 10^{-3}$ mol/dm$^3$.
C) The acid concentration of both solutions: $3 \cdot 10^{-3}$ mol/dm$^3$.
D) The hydroxide ion concentration of both solutions: $1 \cdot 10^{-3}$ mol/dm$^3$.
E) The hydronium ion concentration of both solutions: $1 \cdot 10^{-3}$ mol/dm$^3$.

3. Four types of association

Below, you have to compare two substances. Write the correct letter mark in the empty cells of the table.

A) Graphite
B) Aluminium
C) Both of them
D) None of them

1. It conducts electric current.
2. It can be used to prepare household foils.
3. It has an ionic lattice structure.
4. It can be dissolved in hydrochloric acid.
5. In a powder-like form it can be burnt in air, it is an inflammable substance.
6. Its solid phase contains a delocalized electronic system.
7. It is a reducing substance.
8. It occurs in nature in the elemental form.
4. Panel question

*Fill the numbered cells of the two tables in a well readable handwriting.*

Preparation of **hydrogen** and its chemical reactions with organic and inorganic substances.

<table>
<thead>
<tr>
<th>Way of preparation</th>
<th>Reaction equation</th>
<th>Type of reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory</td>
<td>1.</td>
<td>Redox process</td>
</tr>
<tr>
<td>Industrial</td>
<td>2.</td>
<td>Thermal decomposition of methane</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reactant</th>
<th>Reaction equation</th>
<th>Further questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethene</td>
<td>3.</td>
<td>4. Spherical structure of the molecule of the reactant:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Type of reaction:</td>
</tr>
<tr>
<td>Acetaldehyde (in the presence of a catalyst)</td>
<td>6.</td>
<td>7. Name of the product:</td>
</tr>
<tr>
<td>Oxygen</td>
<td>8.</td>
<td>9. The strongest secondary bonding in the phase of the product at 25 °C and standard pressure:</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>10.</td>
<td>11. Oxidation number of nitrogen in the product:</td>
</tr>
</tbody>
</table>

16 points
5. Alternative question

_In the following question – depending on your field of interest – you have to solve only one version._ At the corresponding place of the examination paper, you have to indicate the letter mark of the chosen question (A or B). If it doesn’t happen and the fact of your choice doesn’t emerge unambiguously from the test-paper, in every case the solution of the first alternative question will be evaluated.

Letter mark of the chosen question:

A.) Panel question

_In the empty cells of the table, write your answers given to the aspects of the comparison in a well readable handwriting._

<table>
<thead>
<tr>
<th>Nitric acid</th>
<th>Sulfuric acid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Oxidation number of the central atom of the molecule</strong></td>
<td>1.</td>
</tr>
<tr>
<td><strong>How to mix its concentrated solution with water?</strong></td>
<td>3.</td>
</tr>
<tr>
<td><strong>Effect of its concentrated solution on iron</strong></td>
<td>4.</td>
</tr>
<tr>
<td><strong>What happens to its concentrated solution, if it is exposed to air?</strong></td>
<td>5.</td>
</tr>
<tr>
<td><strong>Its reaction with sodium hydroxide (reaction equation)</strong></td>
<td>6.</td>
</tr>
<tr>
<td><strong>Application of its concentrated solution in organic chemistry (1 example to each substance)</strong></td>
<td>8.</td>
</tr>
<tr>
<td><strong>Reaction of the mixture of their concentrated solutions with benzene (equation)</strong></td>
<td>10.</td>
</tr>
<tr>
<td><strong>Name of the organic product</strong></td>
<td>11.</td>
</tr>
<tr>
<td><strong>Type of the beforegoing reaction</strong></td>
<td>12.</td>
</tr>
</tbody>
</table>
B.) Calculation problem

In the human body, there are two possibilities of energy production: biological oxidation and lactic acid fermentation. In both processes, conversion of glucose takes place in a number of enzyme-catalyzed steps. This organic substance is absorbed by the cells from the bloodstream where it is found in an average concentration of 1.00 g/dm³. The total amount of blood in an adult person has a volume of 5.50 liters in average. In the periods between the meals, glucose is stored in the body in form of glycogen in the liver and in the muscles.

Biological oxidation is a more effective energy-producing process. It can take place, if enough oxygen is available in the body. By this process, sugar burns to carbon dioxide and water.

Performing an average-level work, an adult men above 14 years needs 12000 kJ and a woman 10000 kJ useful energy a day.
\[
\Delta \hat{H} (\text{CO}_2) = -394 \text{ kJ/mol}
\]
\[
\Delta \hat{H} (\text{H}_2\text{O, l}) = -286 \text{ kJ/mol}
\]
\[
\Delta \hat{H} (\text{glucose}) = -1271 \text{ kJ/mol}
\]

a) Give the chemical formula of glucose. Write the reaction equation of the biological oxidation. Calculate the heat of reaction of the process.

b) Give the average value of the blood sugar level in mmol/l.
c) How many g of glucose has to be burnt a day in the body of a man performing average-level work, assuming that the energy need is covered only by this process? (Assume that the released energy is used completely (100%) by the body.)
6. Analytical question

Give the name and chemical symbol or formula of one convenient substance for each of the statements below.

1. A yellow, solid substance:

2. A salt which can be used as a fertilizer:

3. Gives a positive silver-mirror test:

4. Is produced by burning PVC and is damaging the environment:

5. A poisonous inorganic substance:

6. A gas emitted by industrial plants and causing acid rain:

7. An ion having noble gas electronic structure:

8. A hydroxy carboxylic acid:

9. In an aqueous solution a coloured ion:

10. A colorless, odorless, poisonous gas, its density is equal to that of nitrogen gas at the same conditions:
7. Calculation problem

Among the alloys of copper, the most important ones are bronzes of different composition, brasses and copper-nickel alloys. Beside copper, brass contains mostly zinc, possibly a small amount of tin, lead, manganese and iron.

The composition of a decoration article has to be determined which contains only the two main components. For the determination, 1.635 g sample is filed off, and after adding an excess amount of hydrochloric acid, evolution of 122.5 cm$^3$ gas is measured at 25 °C temperature and standard pressure.

\[ \text{Ar(Zn)} = 65.4 \quad \text{Ar(Cu)} = 63.5 \]

a) Calculate the mass percent composition of the alloy. Write the equation of the occurring reaction(s).

b) What volume of a 0.50 mol/dm$^3$ hydrochloric acid solution was used during the dissolution of the above sample? Take into account at the calculation that hydrochloric acid solution was used in 10 % excess for the dissolution.
Attention, please! It should be filled by the evaluating teacher!

<table>
<thead>
<tr>
<th></th>
<th>maximum points</th>
<th>Reached points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Essay</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>2. Simple choice</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>3. Four types of assoiation</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4. Panel question</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>5. Alternative question</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>6. Analytical question</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>7. Calculation problem</td>
<td>13</td>
<td></td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
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marking teacher

Date: ...........................................

Feladatsor/Test paper

elér pontszám/ reached points | programba beírt pontszám/ points written in the program

javitó tanár/marketing teacher
Dátum/Date: ..........................

Jegyző/Underwriter
Dátum/Date: ..........................