Név: ..... osztály:.....

ÉRETTSÉGI VIZSGA • 2010. október 26.

KÉMIA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

2010. október 26. 14:00

Az írásbeli vizsga időtartama: 120 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

NEMZETI ERŐFORRÁS MINISZTÉRIUM

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.
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- Please, don’t write anything into the gray squares.

1. Four types of association

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

A) Glucose
B) Glycine
C) Both of them
D) None of them

1. At 25 ^{o}C and standard pressure it is a liquid substance.
2. It is a water-soluble substance.
3. It is a building unit of the macromolecules of living organisms.
4. In solid state, it forms an ionic lattice structure.
5. In solid state, it forms a molecular lattice structure.
6. It gives a positive silver mirror test.
7. It gives a positive biuret test.
8. It is a constitutional isomer of acetamide.
9. Its open-chain form contains a formyl group.
10. Two of its molecules can be combined under elimination of water.

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

10 points	

2. Essay

Read the following text carefully and answer the questions.

Super light gel from Debrecen – Hungarian development

A super light substance with a very large weight-bearing capacity, a silica-based aerogel was prepared by scientists in Debrecen. The material prepared in Debrecen is a transparent, non-flammable substance which is an excellent thermal insulator and can hold over 5500 times more than its own weight. Experiments revealed that the prepared aerogel can take fivefold more mechanical load than the specimen presented by NASA in the middle of the nineties.

The aerogel is a solid substance, it has a very low density, it is originating from a gel by replacing the liquid component by a gas. The substance is prepared using a process called supercritical drying (evaporation of frozen water in vacuum): water is extracted and then, it is replaced by different gases, for example by carbon dioxide. The silicon-based aerogel is the lightest solid material of the world, its density is 1.0mg/cm^3. For comparison, the density of air is 1.18mg/cm^3. It means that if the aerogel was dropped into a jar half-filled with carbon dioxide, the aerogel would float above the carbon dioxide layer.

It has several peculiar physical properties (for example as an insulator). For its cloudy translucent color and inner refraction it is called *frozen smoke*, *solid smoke* or *blue smoke* in English, but these nicknames are not used in Hungarian (even the word aerogel is unfamiliar in Hungary). Seen from outside, it really seems to be a piece cut from blue smoke but at a touch, it resembles polystyrene. At a touch, the aerogel gives a feeling of a light, but solid foam. Despite of its name, the aerogel is dry and its physical properties are completely different from those of gels. At a low pressure, it remains scatheless but high pressure leaves irreversible changes on its surface. At extremely high pressure, its structure undergoes a radical change and the aerogel breaks into pieces like glass. Despite of this latter property, the aerogel is structurally extremely strong and it is able to hold several thousand fold its own weight.

The first aerogels were silica gels. Since then, it was proved that aerogels can be prepared from several different substances. Experiments were made using aluminium, chromium and tin, too.

The new miracle material of the 21st century can mop up oil spillages, protect homes against bomb blasts and could even protect astronauts of a mission to Mars against extreme cold weather. The aerogel has been already used in tennis rackets but possibly, it has more beneficial applications, too. It is an excellent thermal insulator. Indeed, among solid substances, aerogels have the best insulating power. Based on this property, a company in California started to apply it as an insulator of refrigerators. Furthermore, according to scientists it is the best hygroscopic and vapor-absorbing material of the world – some aerogels are able to absorb lead or mercury, others can mop up oil completely.

The army can make use of some further properties of the new material: a metal coated in a 6mm thick aerogel was left almost unscathed by a direct blast of 1kg dynamite. Consequently, it is an ideal material for the armor of military vehicles.

Scientists in Debrecen stated that silica-based aerogels would have a wide application. Possibly, they can be used to prepare artificial bones for osteoplasty or to remove toxic metals – like cadmium, mercury or lead – from the body. As excellent insulators, they can be used to prepare more effective solar cells than the conventional ones.

(After articles of HVG.HU 23 August 2007 and 03 September 2008, and Wikipedia)

a) How are aerogels prepared?

b) The process used for preparation of aerogels is called supercritical drying ("evaporation of water"). Which other, more correct term can be used for this phase change of water?

c) Write two examples for already realized applications of the aerogel.

d) Write two further examples of possible applications of aerogels after appropriate development in the future.

e) List five characteristic physical properties of the aerogels.

f) How many % higher is the density of carbon dioxide than that of the aerogel mentioned in the text? (The data are referred to 25 ^{o}C and standard pressure.)

g) The aerogel should rather be called foam. Classify (real) gels.

A) Real solution
B) Colloidal system
C) Solid crystal with low density
D) Mixture
E) Suspension

15 points	

3. Simple choice

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

1. Which case yields a homogeneous system?

A) A piece of 0 °C ice is put into water at 0 °C.
B) Iron powder is mixed with sulfur powder.
C) Nitrogen gas is mixed with oxygen gas.
D) To a saturated sugar solution, more sugar is added.
E) Ether is added to water.

2. Which statement is <u>not</u> true?

A) Among the elements, there are examples for atomic, metallic and ionic lattice structure.
B) Among the compounds, there are examples for atomic, metallic and ionic lattice structure.
C) In the atomic, metallic and ionic lattice structure, primary forces are holding the units together.
D) At the lattice points of molecular crystals, molecules or atoms are the units.
E) In molten state, metallic and ionic substances are good electric conductors.

3. Which statement is <u>not</u> true?

A) During redox reactions, an electron transfer occurs.
B) During electrolysis, redox reactions occur.
C) In acid-base reactions, proton transfer occurs.
D) In galvanic cells, chemical energy of an acid-base reaction is converted into electric energy.
E) In precipitation reactions, a solid substance separates from the solution.

4. Which statement is <u>not</u> true?

A) Hydrogen chloride dissolved in water behaves as a strong acid.
B) Acetic acid dissolved in water behaves as a weak acid.
C) Aqua regia is a specified mixture of concentrated hydrochloric acid and concentrated nitric acid.
D) In the past, concentrated sulfuric acid was called aqua fortis.
E) Acetic acid solution can dissolve iron.

5. Which equation describes the equilibrium constant of the equilibrium process

$$2\ NOCl \rightleftharpoons 2\ NO + Cl_2$$

correctly?

A) $K = \dfrac{2 \cdot [NOCl]}{2 \cdot [NO] + [Cl_2]}$

B) $K = \dfrac{[NO]^2 + [Cl_2]}{[NOCl]^2}$

C) $K = \dfrac{[NO]^2 \cdot [Cl_2]}{[NOCl]^2}$

D) $K = \dfrac{2 \cdot [NO] \cdot [Cl_2]}{2 \cdot [NOCl]}$

E) $K = \dfrac{[NO] \cdot [Cl_2]}{[NOCl]}$

6. In which of the following cases does an addition occur (supposing necessary conditions for the reaction are given)?

A) Benzene is reacting with bromine - in the presence of iron catalyst.
B) Methane is reacting with chlorine.
C) Acetic acid is reacting with ethanol.
D) Acetylene is reacting with hydrogen chloride.
E) Ethanol is reacting with metallic sodium.

7. Which gas is coloured?

A) Hydrogen-chloride
B) Carbon monoxide
C) Carbon dioxide
D) Sulfur dioxide
E) Nitrogen dioxide

8. Which statement is <u>not</u> true for ozone?

A) Inhalation of ozone-rich air is rather unhealthy.
B) Ozone dissolved in rain water causes acid rain.
C) Ozone present in higher layers of the atmosphere, absorbs UV radiation.
D) Ozone is produced by UV radiation.
E) Freons are initiating decomposition of ozone.

8 points	

4. Analytical question and calculation problem

Leakage of chlorine gas in Báta

Yesterday morning at 8.45, the Office for Catastrophe Control in County Tolna was alarmed and experts were called to come to the waterworks in Báta because of the defect of the valve of a gas bottle containing 130 kilograms of chlorine gas used for disinfection of drinking water. Leakage of the toxic gas seemed to be unstoppable…

…firemen - in safety clothing and breathing apparatus – converted the chlorine gas flowing from the bottle to hydrochloric acid by a water curtain and then, the acid was neutralized by lime. *(From a newspaper, 17 June 2008.)*

a) In fact, not pure hydrochloric acid was produced when "firemen converted the chlorine gas to hydrochloric acid by a water curtain". Write balanced equation of the occurring chemical reaction.

b) Lime used to neutralization of the acid could have been quicklime or slaked lime. Write the reaction of hydrochloric acid both with quicklime and with slaked lime.

c) Which environmental problem could have followed the linkage of large amounts of chlorine gas into the air?

d) What would have been the volume of the gas outflow at 25 ^{o}C and standard pressure?

e) Chlorine gas can be prepared by electrolysis of hydrochloric acid. Write the equation of the reaction occurring during electrolysis.

cathode process: .....

anode process: .....

f) How many dm^3 of 15.0 mass%, d=1.08 g/cm^3 hydrochloric acid solution would have been needed to prepare the above amount of chlorine gas? (It is supposed that the whole amount of the dissolved hydrochloric acid is electrolyzed.)

16 points	

5. Panel question

Fill the numbered empty cells of the table in a well readable handwriting.

Name of the element	**1.**	**9.**
Atomic number of the element	12	**10.**
Lattice structure of the element in solid state	**2.**	**11.**
Valence electron shell structure of the atoms of the element	**3.**	**12.**
Symbol of the cation formed from the atom	**4.**	
Symbol of the anion formed from the atom		O^{2-}
Equation of the formation of the ion from the atom	**5.**	**13.**
Redox classification of the formation of the ion	**6.**	**14.**
Number of protons in the ion	**7.**	**15.**
Number of electrons in the ion	**8.**	**16.**

12 points	

6. 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

Fill the numbered empty cells of the table in a well readable handwriting.

	Sodium hydroxide	**Acetic acid**	**Sodium chloride**
Formula	**1.**	**2.**	**3.**
Trivial name	**4.**		**5.**
Phase state (at 25 ^{o}C and standard pressure)	**6.**	**7.**	**8.**
Type of lattice		**9.**	**10.**
Is the aqueous solution acidic, neutral or basic?	**11.**	**12.**	**13.**
One example for household use		**14.**	**15.**
Equation of the reaction of sodium hydroxide and acetic acid	**16.**		
Name of the product of the reaction	**17.**		

B) Calculation problem

2.50 dm^3 solution is made from a 5:1 mass ratio mixture of sodium hydroxide and sodium chloride. The pH of the prepared solution is 12.0.

$A_r(H) = 1.00$, $A_r(O) = 16.0$, $A_r(Na) = 23.0$, $A_r(Cl) = 35.5$

a) What is the mass% concentration of the mixture?

b) What is the mass of the above mixture dissolved in water?

c) What would be the pH of the solution, if 0.250 dm^3 solution was made from the mixture of the above mass? Explain your answer.

15 points	

7. Analytical experimental question

The following experiments were made with a diluted (about 0.10 mol/dm^3) $CaCl_2$ solution:
1. Diluted Na_2CO_3 solution was added (in a stoichiometric ratio) to a given portion of the $CaCl_2$ solution. A white precipitate was formed.
2. Soda water was added to the precipitate-containing solution obtained in experiment 1. The precipitate was dissolved.
3. The solution obtained in experiment 2 was boiled for a short time and then cooled down. Again, a precipitate was formed.
4. Diluted soap solution was added to another portion of the $CaCl_2$ solution. A white precipitate was formed, the solution did not form a foam.
5. Na_3PO_4 solution was poured to a new portion of the $CaCl_2$ solution. The obtained precipitate was filtered. To the solution obtained this way, a diluted soap solution was added and the mixture was shaken. In the solution, a large amount of foam was formed.

a) Write the equation of the reaction occurring in experiment 1 and underline the precipitate formed.

b) Which dissolved substance is contained in soda water?

Write the equation of the reaction occurring in experiment 2.

Where do we find a similar process in nature?

c) What are name and formula of the precipitate obtained in experiment 3?

During boiling of tap water, a similar process occurs. What is the name of the "precipitate" separating on the wall of dishes in everyday life?

d) Which compounds can yield soap?

e) What are name and formula of the precipitate obtained and filtered in experiment 5?

Explain why soap did not form a foam in experiment 4 and why did it form a foam if soap was added to the filtered solution in experiment 5.

f) Which of the reactions described in the above experiments are used during softening of water?

13 points	

8. Calculation problem

A saturated hydrocarbon contains 83.3 mass% carbon and 16.7 mass% hydrogen.
14.4g of the hydrocarbon is completely burned.

A_r(H) = 1.00, A_r(C) = 12.0

Name of compound	$\Delta_f H$ (kJ/mol)
Methane (g)	– 74.4
Ethane (g)	– 83.3
Ethene (g)	52.5
Propane (g)	–105
Propene (g)	20,0
Propyne (g)	185
Butane (g)	–126
Butyne (l)	141
Pentane (g)	–147

Name of compound	$\Delta_f H$ (kJ/mol)
Cyclopentane (g)	– 76.3
Hexane (l)	–167
Heptane (l)	–188
Octane (l)	–209
Nonane (l)	–228
Benzene (l)	82.6
Toluene (l)	111
Carbon dioxide (g)	–394
Water (l)	–286

a) What is the formula of the hydrocarbon molecule?

b) Write the equation of complete combustion!

c) Calculate the heat of combustion of the hydrocarbon using the data of the table.

d) How much heat is liberated during the combustion of the given 14.4 g hydrocarbon?

11 points	

	maximum points	reached points
1. Four types of association	**10**	
2. Essay	**15**	
3. Simple choice	**8**	
4. Analytical question and calculation problem	**16**	
5. Panel question	**12**	
6. Alternative question	**15**	
7. Analytical and experimental question	**13**	
8. Calculation problem	**11**	
Points of the written exam	**100**	

marking teacher

date

	reached points rounded to a **whole number**/elért pontszám **egész számra** kerekítve	**whole** points written in the program/programba beírt **egész** pontszám
Test/Feladatsor		

marking teacher/javító tanár

underwriter/jegyző

date/dátum

date/dátum