Név: ..... osztály:.....

ÉRETTSÉGI VIZSGA • 2019. május 17.

KÉMIA
ANGOL NYELVEN

KÖZÉPSZINTŰ
ÍRÁSBELI VIZSGA

2019. május 17. 8:00

Időtartam: 150 perc

Pótlapok száma	
Tisztázati	
Piszkozati	

EMBERI ERŐFORRÁSOK MINISZTÉRIUMA

Important information

- The questions can be answered in any order.
- For the solution of the problems, calculators without text-storage capability and four-place logarithm tables can be used. The use of electronic or written support material other than mentioned above is not permitted.
- 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 cancelled work cannot be evaluated.
- You can get maximum points for the calculations only if the main steps of the solution are also indicated.
- Please, do not write anything into the grey squares.

1. Case study

Read the following text carefully, and answer the questions below based on your knowledge and the text.

The rocket engine

Reaching the outer space can most easily and inexpensively be achieved by rocket engines. Their operation is based on the theory of effect and counter effect: fuel burnt in a combustion chamber expands, and it is ejected through a nozzle into the surroundings with a large speed. Thus, the rocket starts moving into the opposite direction in order to keep their total momentum constant. A characteristics of the rockets is that they are independent of the outer air, or the lack of it, because they also carry the oxygen needed for the combustion with themselves. Although this increases their mass, thus they can operate under all circumstances.

Among rocket engines, solid- and liquid-propellant ones are distinguished. The solid-propellant rockets do not require oxygen for their reaction; their set-up is simpler. Moreover, they are cheaper and their handling is easier, however, once they are started, they cannot be stopped. Although the liquid-propellant rockets are more complex, as they also have to carry the oxygen needed for the combustion besides their own fuel, they are more reliable and can be stopped in case a problem occurs. They can be propelled by kerosene or liquid hydrogen.

The power of a simple, single stage rocket engine is not enough to leave the atmosphere of Earth. In order to solve this, multistage rockets were prepared, where the individual stages are detached from the rest of the rocket after burning to complete, making it lighter. As the mass of the rocket becomes smaller and smaller, it can accelerate to an increasingly higher velocity, and thus the 7.91 km/s velocity can be reached, which is needed to be launched on an orbit around Earth. With the inclusion of additional stages, the final velocity can be further increased; and thus even an escape velocity can be reached in order to leave the solar system.

The space shuttle on the picture is equipped with two solid-propelled speeding rocket, which are detached at approx. 40 km altitude. The main power units are supplied by fuel from the middle big container during take-off.

The solid propellant contains ammonium perchlorate (NH_4ClO_4) and aluminium. After the reaction started, that cannot be stopped. The oxygen content of ammonium perchlorate reacts with aluminium, and aluminium oxide, aluminium chloride, water vapour and nitrogen gas are produced. This reaction heats the inside of the speeding rockets up to 3200 °C, therefore, the two gas expand very rapidly, and the expanding gases lift the rocket with an enormous force.

Meanwhile, an extremely high temperature can be achieved (approx. 3300 °C) by the reaction between the liquid hydrogen in the main fuel tank and oxygen, which expands the water vapour produced and additional upward thrust is resulted.

based on "astro.u-szeged.hu/szakdolg/vegiandras/mukodes/raketahajtomu.html"

a) Write down the advantages and disadvantages of solid-propellant rocket compared to liquid-propellant one.

advantages: ……

disadvantages: …….

b) Based on the text, complete and balance the equation of the reaction of the solid propellant.

……..(s) + ……(s) = ……(s) + ……..(s) + ……..(g) + 3 N_2 (g)

c) What can the fuel of liquid-propellant rockets be?

d) Are any environmentally hazardous gas emitted into the atmosphere in the case of solid and liquid propellants? If yes, write down what it is, and how does it pollute the environment.

e) Write down the balanced equation of the reaction occurring in the liquid fuel container of the rocket on the picture.

f) Which gases put the rocket on the picture onto the orbit around the Earth?

g) Based on the text and your knowledge in chemistry, underline the correct answers.

In the case of the rocket on the picture

the reaction occurring in the solid propellant: acid-base reaction redox reaction
exothermic reaction endothermic reaction

the reaction occurring in the liquid propellant: acid-base reaction redox reaction
exothermic reaction endothermic reaction

14 points	

2. Multiple choice

A) Ethanol
B) Acetic acid
C) Both of them
D) None of them

1. It is a gas at room temperature and atmospheric pressure.
2. Fully miscible with water at room temperature.
3. Odourless substance.
4. Used in food industry as well.
5. Its molecule contains a complex functional group.
6. It produces acetaldehyde when reacted with copper(II) oxide.
7. Its aqueous solution is alkaline.
8. An ester can be produced from it.
9. It reacts with sodium hydroxide.

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

9 points	

3. Single choice

Write the symbol of the single correct answer of each question into the box on the right-hand-side of the answers.

1) Which statement is <u>true</u> for chlorine?

A) It has the smallest electronegativity among the main group elements of the third period.
B) It usually forms a single charge cation in chemical reactions.
C) If forms diatomic molecules with a single bond.
D) It is a colourless gas.
E) When reacting it with sodium metal, it reduces sodium producing sodium chloride.

2) Which statement concerning the elements is <u>true</u>?

A) Every element molecule is diatomic.
B) Only a single bond can be formed between the atoms in an element molecule.
C) Every element molecule is non-polar.
D) Every element is stable in a molecular form.
E) In the solid state of matter, they can crystallise in molecular crystals, covalent network or ionic ones.

3) Which statement concerning water is <u>not true</u>?

A) Its density is the lowest at +4°C.
B) Its molecule is capable of accepting or donating protons.
C) Its molecule can form four hydrogen bonds.
D) Its pH decreases by dissolving hydrogen chloride in it.
E) It occurs in all three states of matter in nature.

4) Which statement concerning aluminium production is <u>not true</u>?

A) The ore of aluminium is bauxite.
B) Aluminium is dissolved from the ore by concentrated sulphuric acid.
C) Alumina is produced by heating aluminium hydroxide.
D) Aluminium is obtained by the electrolysis of molten aluminium oxide.
E) Red sludge is the residual by-product of aluminium production.

5) For which compound (set of compounds) macromolecules are not typical?

A) Rubber.
B) Cellulose.
C) Teflon.
D) Glycine.
E) DNA.

5 points	

4. Experiment analysis and calculation task

The compounds of calcium

During a construction work, only quicklime bought long time ago was found; so, a new sack of quicklime had to be bought. It was found that the quicklime bought previously completely turned into calcium carbonate, while the newly bought quicklime indeed contained calcium oxide. Samples from both sacks were taken, and experiments were run parallel.

Write down the observations. If a reaction occurs, write the equation of the reaction. Write a reasoning, and if necessary, perform calculations.

The information and data that can be used for these:

- *calcium hydroxide dissolves poorly in water, the mole concentration of the saturated calcium hydroxide solution is 0.020 mol/dm^3*
- *calcium chloride readily dissolves in water*

A 1.12 g of samples from each sack is taken into two beakers each. Thus, four samples are prepared, each weighing 1.12 g.

a) 50.0 cm^3 of distilled water is added to each powder sample, and a drop of phenolphthalein was added to the solutions.

Pure quicklime	Carbonated quicklime
Observation, experience: A part of the solid material is dissolved, but some solid material remains at the bottom of the solution (the solution remains opaque). Due to phenolphthalein ……	**Observation, experience:**
Equation of the reaction:	**Equation of the reaction:**
Reasoning, calculation:	**Reasoning, calculation:**

b) 50.0 cm^3 of 2.00 mol/dm^3 concentration of hydrochloric acid is added to each (a new aliquot) powder sample.

Pure quicklime	Carbonated quicklime
Observation, experience:	**Observation, experience:**
Equation of the reaction:	**Equation of the reaction:**
Reasoning, calculation:	**Reasoning, calculation:**

20 points	

5. Alternative question

In the following question* only one version of the task should be solved *depending on your field of interest. In the empty square below, the letter mark of the chosen question (A or B) should be indicated. If the box is left empty, and your choice is not evident from the test-paper, the solution of the first alternative question will be evaluated in any case.

Letter mark of the chosen question: ☐

A) Analytical task

Find which description belongs to which of the substances listed, and write the substance after the appropriate letter mark (each letter symbolises a different substance):

ammonia ethene sodium sulphuric acid chlorine methane water

a) It is a yellow-green coloured gas with a density higher than that of air, highly poisonous:

(A) …….

b) It reacts with gas (A) in an addition reaction under suitable circumstances.

(B) …….

Write the equation of the reaction occurring.

……

c) It reacts with gas (A) in a substitution reaction under suitable circumstances.

(C) …….

Write the equation of the reaction occurring.

……

d) It is a colourless gas with a pungent odour and less dense than air.

(D) …….

e) An acid-base reaction occurs if gas (D) is driven into its dilute aqueous solution.

(E) …….

Write the equation of the reaction occurring.

……

f) Two of the substances listed were left out.

(F) ……. **(G)** ……

These react with each other. **Write the equation of the reaction occurring.**

……

B) Calculation task

A silver coating is to be made on the surface of a Christmas glass bulb using the solutions of acetaldehyde, silver nitrate and ammonia. The surface of the glass bulb is 300.0 cm^2, and a 0.001 cm thick silver plating is to be formed.
d(silver) = 10.5 g/cm^3.

a) Write the equation of the reaction occurring.

b) Calculate how many cm^3 of 40.0 percent by mass composition, 0.868 g/cm^2 density acetaldehyde solution and how many cm^3 of 0.500 mol/dm^3 concentration silver nitrate solution is needed theoretically for the preparation of the coating.

13 points	

6. Panel questions

Fill in the missing data of the table.

Formula	**Number of chemical entities (atom / molecule / ion) given by the formula (pieces)**	**Amount of chemical entities (atom / molecule / ion) given by the formula (moles)**	**Number of protons (pieces)**	**Number of electrons (pieces)**
Al^{3+}	**1.)**	2 mol	**2.)**	**3.)**
O_2	120	**4.)**	**5.)**	**6.)**
Na^+	**7.)**	**8.)**	33	**9.)**
HCO_3^-	1	**10.)**	**11.)**	**12.)**
Fe	**13.)**	**14.)**	**15.)**	7.8×10^{24}

15 points	

7. Analytical task

Estimating the direction of the redox processes

Three colourless solutions – $AgNO_3$, $Pb(NO_3)_2$, $ZnCl_2$ – are found in three beakers each. A copper plate is placed into each. In one of the solutions, metal deposition is observed on the copper plate, while no changes occur in the other two solutions.

The experiment is repeated with an iron plate. In this case, metal deposition is observed on two iron plates in two solutions.

a) For estimating the direction of the redox processes, the following rule can be applied (*Fill out the gaps*):

In a redox reaction, the element form of the metal with a …… standard potential can ……. the ion of the metal with a ……. standard potential.

Based on the rule formulated above, interpret the observations given.

b) Using the Mathematical, physical and chemical formula booklet (four-place logarithm tables), find the necessary data and write them into the table below.

c) Determine in which beaker of the first experiment metal deposition was observed. Give a reason to your answer.

d) Determine in which beaker of the second experiment metal deposition was observed. Give a reason to your answer.

10 points	

8. Calculation task

The so-called synthesis gas (mixture of CO and H_2) is produced also by a reaction between methane and water vapour according to the following equation:

$$CH_4(g) + H_2O(g) = CO(g) + 3\ H_2(g)$$

For this energy-consuming process, energy is ensured by combustion of methane.
$\Delta_f H(CH_4(g)) = -74.4$ kJ/mol, $\Delta_f H(H_2O(g)) = -242$ kJ/mol, $\Delta_f H(H_2O(l) = -286$ kJ/mol, $\Delta_f H(CO(g)) = -111$ kJ/mol, $\Delta_f H(CO_2(g)) = -394$ kJ/mol;

a) Calculate the reaction heat of the above reaction given by the equation.

b) If 20.0 m^3 of 25°C, standard pressure synthesis gas is to be produced according to the above reaction, how many m^3 of 25°C, standard pressure methane is needed initially?

c) Calculate the energy need for the preparation of 20.0 m^3 of synthesis gas.

d) How many m^3 of 25°C, standard pressure methane is to be combusted in order to ensure the energy need of the above if water condensates during combustion?

14 points	

	points	
	maximum	achieved
1. Case study	14	
2. Multiple choice	9	
3. Simple choice	5	
4. Experiment analysis and calculation task	20	
5. Alternative question	13	
6. Panel question	15	
7. Analytical task	10	
8. Calculation task	14	
Score of the written exam	**100**	

date _____ correcting teacher _____

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	pontszáma **egész számra** kerekítve	
	elért	programba beírt
Feladatsor		

dátum _____ dátum _____

javító tanár _____ jegyző _____