CENTRALNA KOMISJA EGZAMINACYJNA

Arkusz zawiera informacje prawnie chronione do momentu rozpoczęcia egzaminu.

WYPEŁNIA ZDAJĄCY

KOD

PESEL

Miejsce na naklejkę.
Sprawdź, czy kod na naklejce to **M-100**.
Jeżeli tak – przyklej naklejkę.
Jeżeli nie – zgłoś to nauczycielowi.

Egzamin maturalny ***Formuła 2023***

CHEMIA

Poziom rozszerzony

Dodatkowe zadania w języku angielskim

Symbol arkusza
MCHA-Z0-**100**-2605

DATA: **21 maja 2026 r.**

GODZINA ROZPOCZĘCIA: **9:00**

CZAS TRWANIA: **80 minut**

LICZBA PUNKTÓW DO UZYSKANIA: **25**

Przed rozpoczęciem pracy z arkuszem egzaminacyjnym

1. Sprawdź, czy nauczyciel przekazał Ci **właściwy arkusz egzaminacyjny**, tj. arkusz we **właściwej formule**, z **właściwego przedmiotu** na **właściwym poziomie**.
2. Jeżeli przekazano Ci **niewłaściwy** arkusz – natychmiast zgłoś to nauczycielowi. Nie rozrywaj banderol.
3. Jeżeli przekazano Ci **właściwy** arkusz – rozerwij banderole po otrzymaniu takiego polecenia od nauczyciela. Zapoznaj się z instrukcją na stronie 2.

Instrukcja dla zdającego

1. Sprawdź, czy arkusz egzaminacyjny zawiera 14 stron (zadania 1–13). Ewentualny brak zgłoś przewodniczącemu zespołu nadzorującego egzamin.
2. Na pierwszej stronie arkusza oraz na karcie odpowiedzi wpisz swój numer PESEL i przyklej naklejkę z kodem.
3. Odpowiedzi i rozwiązania zapisz w miejscu na to przeznaczonym przy każdym zadaniu.
4. W rozwiązaniach zadań rachunkowych przedstaw tok rozumowania prowadzący do ostatecznego wyniku oraz pamiętaj o jednostkach.
5. Pisz czytelnie. Używaj długopisu/pióra tylko z czarnym tuszem/atramentem.
6. Nie używaj korektora, a błędne zapisy wyraźnie przekreśl.
7. Pamiętaj, że zapisy w brudnopisie nie będą oceniane.
8. Możesz korzystać z *Wybranych wzorów i stałych fizykochemicznych na egzamin maturalny z biologii, chemii i fizyki*, z linijki oraz z kalkulatora naukowego. Upewnij się, czy przekazano Ci broszurę z taką okładką jak widoczna poniżej.

Zadania egzaminacyjne są wydrukowane na kolejnych stronach.

Task 1.

The atomic numbers of three elements designated as E1, E2, and E3 satisfy the following relation: $Z_{E1} + Z_{E2} = Z_{E3}$.

Atom E3 has the following ground-state configuration:

- its electrons occupy four shells
- all valence electrons are in the same shell
- the number of paired valence electrons equals the number of unpaired electrons.

Moreover, it is known that the number of protons in the nucleus of atom E2 is three times the number of protons in the nucleus of atom E1.

Task 1.1. (0–2)

Complete the table. For each of the elements (E1 and E3), write:

- **its chemical symbol**
- **its group number**
- **its block symbol.**

	Chemical symbol	Group number	Block symbol
Element E1			
Element E3			

Task 1.2. (0–1)

Write the partial electron configuration of atom E2 in its ground state showing the subshell distribution of electrons involved in bonding.
Write the electron configuration of the atom in orbital box notation. Include the shell numbers and subshell symbols.

.....

Task 2. (0–1)

Ionic crystals are composed of monatomic ions or polyatomic ions in which the atoms forming the cation or anion are held together by covalent bonds.

From among the substances listed below, select <u>all</u> the compounds that form ionic crystals with <u>polyatomic ions</u>. Mark the formulas of the selected substances.

MgO KOH NaCl NH_4Cl Na_2SO_3

Task 3. (0–1)

Polymorphism is a phenomenon in which the same substance, depending on the conditions, exists in at least two forms that have different crystal structures.
Polymorphic forms differ in their physical properties and sometimes show differences in their chemical properties as well. When polymorphism is observed in elements, the different forms are called allotropes.

Source: A. Bielański, *Podstawy chemii nieorganicznej*, Warszawa 2018.

Complete the sentences below. Select the correct answer in each of the brackets.

In nature, zinc sulphide occurs in two forms: wurtzite and sphalerite, which differ in their crystal structures. Wurtzite and sphalerite are classified as (allotropic / polymorphic) forms.

Carbon forms several allotropes. In one of them, each carbon atom combines with four other carbon atoms, resulting in a very hard crystal. This form is known as (diamond / graphite).

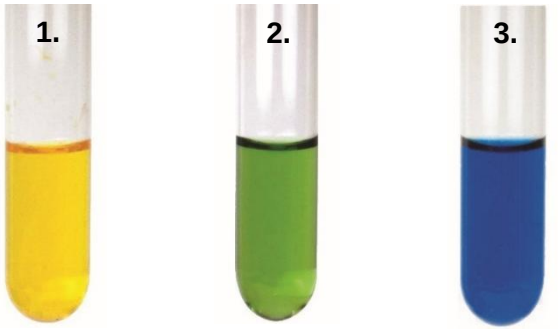
Information for tasks 4.–5.

Under standard conditions, metals in the first group of the periodic table are solids. They react violently with water, and one of the products of these reactions is hydrogen. All metals in the first group react with oxygen. The combustion product of lithium is lithium oxide (Li_2O), of sodium – sodium peroxide (Na_2O_2), and of potassium – potassium superoxide (KO_2).
In reaction with hydrogen, lithium, sodium, and potassium form ionic hydrides, which are classified as basic. In reaction with water, the metals produce aqueous hydroxide solutions.

Source: K.-H. Lautenschläger et al., *Nowoczesne kompendium chemii*, Warszawa 2020.

Task 4. (0–1)

In an experiment, a small piece of metallic sodium was added to a beaker of water in a fume hood. After the completion of the reaction, one drop of the resulting solution was transferred to a test tube containing water with bromothymol blue.



Decide whether it is possible for the solution in the test tube to look like the one shown in Photograph 1. Give the reasoning behind your answer.

Decision: .....

Reasoning: .....

.....

.....

Task 5. (0–2)

Write the following reactions:

- **the equation <u>in the molecular form</u> of the reaction that produces sodium peroxide (Reaction 1)**
- **the equation <u>in the ionic form</u> of the reaction of potassium hydride with water (Reaction 2).**

Reaction 1:

.....

Reaction 2:

.....

Task 6.

A student was asked to carry out an experiment in which a redox reaction occurred. The student could use potassium manganate(VII) or sodium dichromate(VI) as the oxidizing agent. According to the teacher's instruction, the reducing agent in the experiment was to be a sodium sulphate(IV) solution, and the reaction was to be carried out in $0.1\ \mathrm{mol \cdot dm^{-3}}$ sulphuric acid(VI). The photographs below show the initial (Photograph 1) and final (Photograph 2) phases of the experiment.

Task 6.1. (0–1)

The teacher determined that the experiment was carried out <u>incorrectly</u>.

Explain what the student's mistake was.

Explanation: .....

.....

.....

Task 6.2. (0–1)

Write the equation <u>in the ionic form</u> of the reaction that the student carried out.

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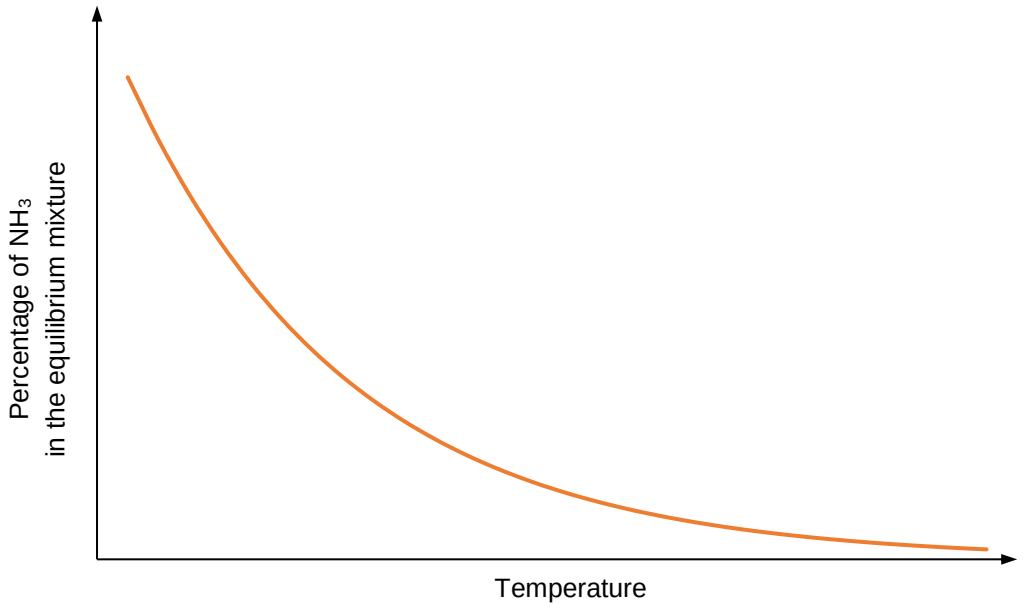
Task 7.

The Haber-Bosch process is an industrial method that allows the synthesis of ammonia from nitrogen and hydrogen. In this process, the equilibrium described by the following equation is established:

$$N_2(g) + 3H_2(g) \rightleftarrows 2NH_3(g)$$

The yield of ammonia depends on temperature. This relationship can be illustrated by the simplified graph below, which shows the percentage of ammonia in the equilibrium mixture as a function of temperature.



Task 7.1. (0–1)

Decide whether the synthesis of ammonia from nitrogen and hydrogen is an endothermic reaction. Give the reasoning behind your answer.

Decision: .....

Reasoning: .....

.....

.....

Task 7.2. (0–1)

Determine and explain the impact of an increase in pressure on the ammonia yield under isothermal conditions. Select the correct answer from the options given in brackets and complete the sentence below.

As the pressure increases under isothermal conditions, the yield of ammonia

(increases / decreases) because .....

.....

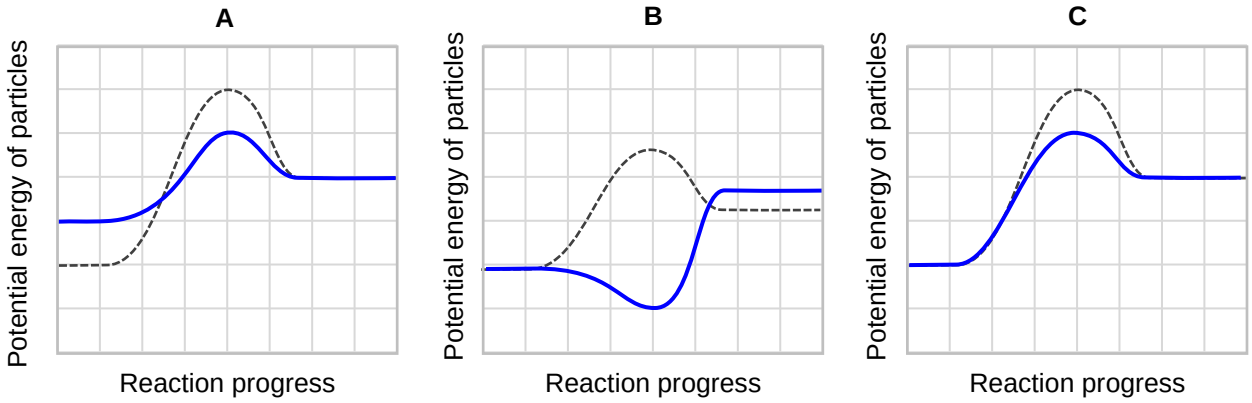
.....

Task 8.

Catalysts are substances that affect the energy barrier of a reaction because they alter its mechanism and allow an equilibrium to be reached faster.

Task 8.1. (0–1)

Only one of the diagrams below illustrates, in simple terms, the changes in energy during the course of a reaction carried out with (solid line) or without (dashed line) a catalyst.
The energy axis scale is the same for all the graphs.



Decide which diagram (A, B, or C) correctly illustrates a reaction involving a catalyst. Then determine whether the change in enthalpy in the reaction involving a catalyst was positive or negative.

Decision: .....

Change in enthalpy:

.....

Task 8.2. (0–1)

Decide whether the sentences below are true (T) or false (F). Mark the appropriate letter.

1.	A chemical reaction involving a catalyst proceeds along a lower-energy pathway compared to a reaction that does not involve a catalyst.	**T**	**F**
2.	The yield of a reaction involving a catalyst is higher than the yield of a reaction that does not involve a catalyst.	**T**	**F**

Task 9.

Under standard conditions, an electrochemical cell was constructed as shown in the diagram below.

$$Pt \mid Fe^{3+}, Fe^{2+} \parallel Cr_2O_7^{2-}, Cr^{3+}, H^+ \mid Pt$$

Task 9.1. (0–1)

Write the equation <u>in the ionic form</u> of the reaction that occurs within the cell during its operation.

.....

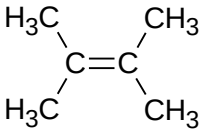
Task 9.2. (0–1)

Decide whether the sentences below are true (T) or false (F). Mark the appropriate letter.

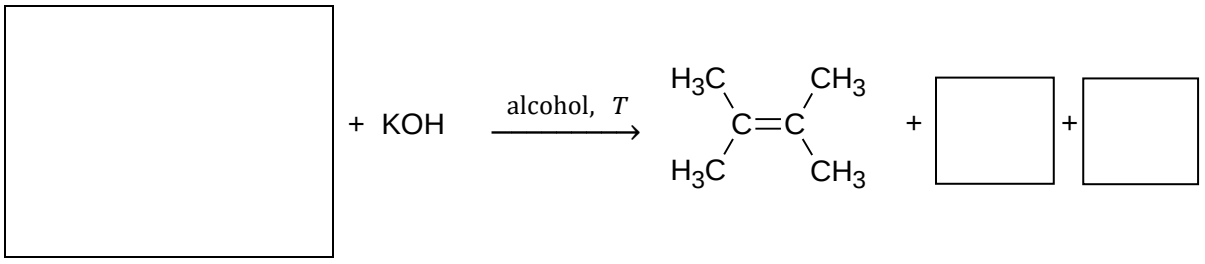
1.	Under standard conditions, the electromotive force of the cell described above is $0.589\ V$.	**T**	**F**
2.	During the operation of the cell, the concentration of $Cr_2O_7^{2-}$ ions increases in the cathode compartment.	**T**	**F**

Task 10. (0–2)

One method of obtaining alkenes is an elimination reaction in which the appropriate monobromo derivative of an alkane reacts with an alcoholic solution of KOH at an elevated temperature.
As a result of this elimination reaction, an alkene with the following formula was obtained:



Complete the diagram below with the formulas of appropriate substances to form the equation of the elimination reaction that produces this alkene. Give the systematic name of this alkene.



Name of the alkene:

.....

Task 11.

At temperature *T*, an experiment was carried out in which hydrochloric acid was poured into a test tube containing an aqueous solution of sodium phenolate (phenoxide). The contents of the test tube became cloudy.

Task 11.1. (0–1)

Complete the reaction diagram below to form the equation <u>in the net ionic form</u> of the reaction described above. Use Brønsted-Lowry's definition of acids and bases.

acid 1		base 2		base 1		acid 2
	+		⇄	H_2O	+	

Task 11.2. (0–1)

Decide whether an identical reaction could be observed if carbon dioxide were introduced into a test tube containing an aqueous solution of sodium phenolate (phenoxide). Give the reasoning behind your answer.

Decision: .....

Reasoning: .....

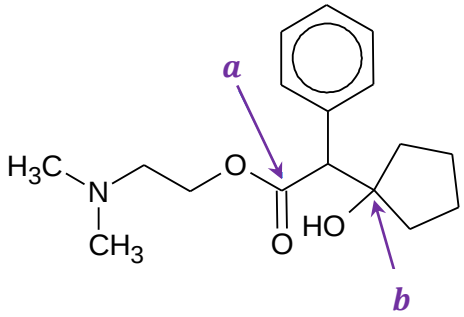
.....

.....

Task 12.

The skeletal formula of an organic compound reflects the shape of its carbon chain. In this formula, carbon atoms and the hydrogen atoms attached to them are not labelled, but instead, the line-angle carbon skeleton is drawn with multiple bonds shown, and formulas of functional groups and symbols of substituents (atoms) other than hydrogen are indicated. A carbon atom is sometimes included in this formula.

Cyclopentolate is a medicine used in ophthalmology. Its solution is administered prior to ophthalmological procedures and examinations, as it has fewer adverse effects compared to atropine, which was used previously. The skeletal formula of cyclopentolate is shown below.



Source: P. Graham, *Chemia medyczna*, Warszawa 2019.

Task 12.1. (0–2)

Complete the table. Give the formal oxidation states and the hybridisation of the valence orbitals of the carbon atoms marked with the letters *a* and *b* in the formula of the cyclopentolate molecule.

	Oxidation state	Hybridisation type
Carbon atom *a*		
Carbon atom *b*		

Task 12.2. (0–1)

Cyclopentolate was hydrolysed under appropriate conditions in an acidic environment. The reaction yielded two organic products, one of which was an ionic compound.

Draw the condensed (semi-structural) formula of the cation formed in this reaction.

Task 13.

Mannose and glucose are aldohexoses. The mannose molecule differs from the glucose molecule in the placement of the –OH group on the second carbon atom. Mannose is reduced to a polyhydric alcohol called mannitol.

Task 13.1. (0–1)

Draw a Fischer projection of D-mannitol.

Task 13.2. (0–1)

In an experiment, an aqueous solution of mannitol was added to a test tube containing a freshly precipitated alkaline suspension of copper(II) hydroxide. The contents of the test tube were stirred.

Select the photograph that shows the appearance of the contents of the test tube after the experiment. Write the correct number.

Photograph number: .....

NOTES (not subject to evaluation)

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