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**-2405

DATA: **24 maja 2024 r.**

GODZINA ROZPOCZĘCIA: **12:10**

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 12 stron (zadania 1–18).
   Ewentualny brak zgłoś przewodniczącemu zespołu nadzorującego egzamin.
2. Na pierwszej stronie 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 okładką taką jak widoczna poniżej.
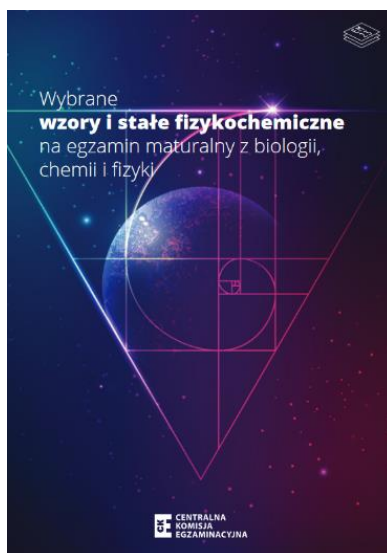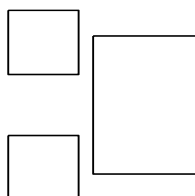
**Zadania egzaminacyjne są wydrukowane
na następnych stronach.**

Task 1.

There are five stable isotopes of zinc in nature. The most common is an isotope whose nucleus contains 34 neutrons.

Task 1.1. (0–1)

Complete the diagram below. Write the atomic number and the symbol of zinc as well as the mass number of the most common isotope of this element.
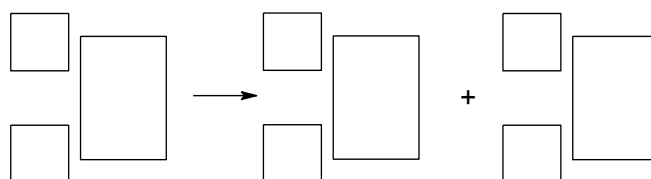
$$\boxed{}\;\boxed{}$$

Task 1.2. (0–1)

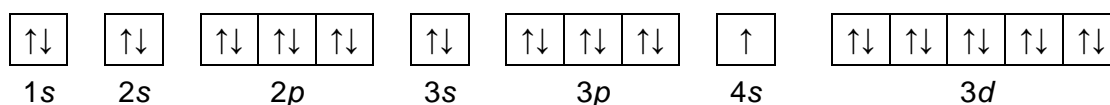Several radioactive isotopes of zinc are known. One of them is an isotope with the mass number $A = 72$, which undergoes β^- decay.

Write the β^- decay equation of the zinc isotope with the mass number $A = 72$. Complete the diagram below.

$$\boxed{}\;\boxed{} \longrightarrow \boxed{}\;\boxed{} \; + \; \boxed{}\;\boxed{}$$

Task 2.

The orbital diagram for an atom (in its ground state) of a certain element X is given as follows:

$\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$	$\uparrow\downarrow$	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$	$\uparrow$	$\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow\downarrow$
$1s$	$2s$	$2p$	$3s$	$3p$	$4s$	$3d$

Task 2.1. (0–1)

Complete the table. Write the name or symbol of the element X, its group number in the periodic table, and the block to which this element belongs.

Name of the element	Group number	Block symbol

Task 2.2. (0–1)

The element X is present in chemical compounds, among others in the form of X^{2+} ions.

Complete the following electron configuration notation of the X^{2+} ion in its ground state.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ ....

Task 3. (0–1)

Given below are the formulas of substances that are solids with a crystalline structure at a temperature of $25\ °C$ and a pressure of $1013\ hPa$.

From the substances listed below, choose all those that form <u>ionic crystals</u>. Mark the selected substances.

CaO $\quad$ CH_3COONa $\quad$ C_6H_5OH $\quad$ $C_6H_{12}O_6$ (glucose) $\quad$ I_2 $\quad$ NH_4NO_3

Task 4. (0–2)

Complete the following sentence about the nature of the bond between the nitrogen atom and the hydrogen atom. Select and mark the correct answer from those given in brackets. Then determine the hybridisation of the valence orbitals of the nitrogen atom in the ammonia molecule and draw the electron line structure (Lewis structure) for this molecule: mark the electron pairs of chemical bonds and the free electron pairs with dashes.

The nitrogen-hydrogen bond is (ionic $\ /\ $ covalent $\ /\ $ polar covalent).

Hybridisation of valence orbitals of the nitrogen atom: ....

Electron line structure:

Task 5. (0–1)

Phosphorus forms a hydride called phosphine with the formula PH_3. The molecule of this compound has a structure similar to that of an ammonia molecule. The table gives the values of molecular mass and boiling point ($p = 1013\ \text{hPa}$) of ammonia and phosphine.

| Name of the compound	Molecular mass, u	Boiling point, °C
ammonia	17	−33.33
phosphine	34	−87.75

Source: *CRC Handbook of Chemistry and Physics* 97th Edition, CRC Press 2017.

Complete the following sentences. Select and mark the correct answer in each set of brackets.

At a temperature of 25 °C and a pressure of 1013 hPa, the density of phosphine is (lower / higher) than the density of ammonia. Phosphine is a substance (less / more) volatile than ammonia, because the interactions between phosphine molecules are (weaker / stronger) than those between ammonia molecules.

Information for tasks 6.–7.

In an aqueous solution, hydrogen peroxide decomposes according to the formula:

$$2H_2O_2\ (aq) \rightarrow 2H_2O\ (c) + O_2\ (g)$$
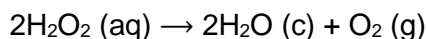
This reaction is slow, so it is difficult to notice the release of oxygen.

Task 6. (0–1)

At the temperature $T = 40\ °C$ and at the temperature T_1, the relationship between the hydrogen peroxide decomposition rate and the concentration of an aqueous solution of this substance was tested. The results of the experiment are presented in the chart.
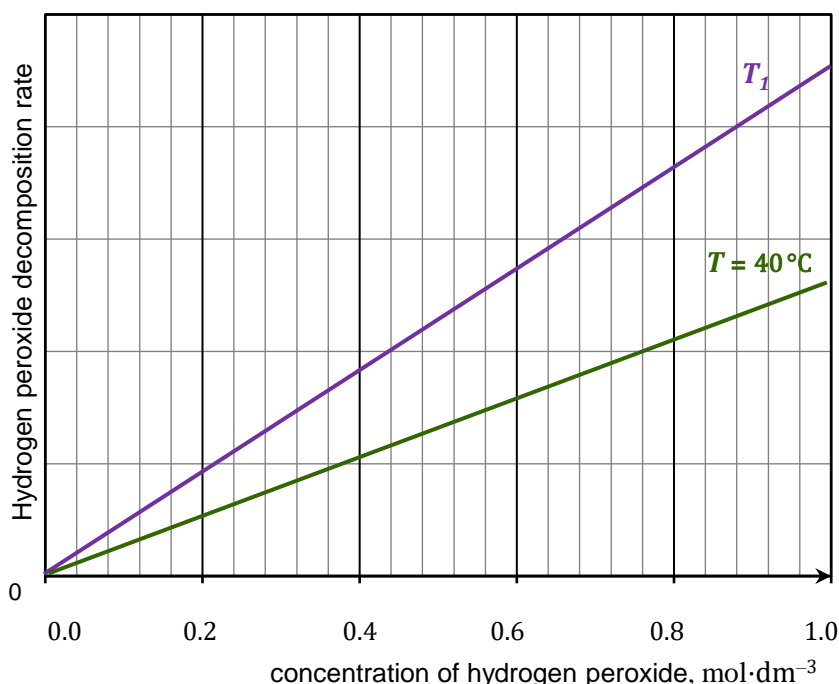
Source: H.F. Holtzclaw, W.R. Robinson, *College Chemistry*, Lexington, Toronto 1988.

Complete the following sentence. Select and mark the correct answer given in each set of brackets.

For a given concentration of hydrogen peroxide, its decomposition rate at the temperature T_1 is (lower / higher) than at the temperature $T = 40\,°C$, which means that the temperature T_1 is (higher / lower) than $40\,°C$.

Task 7. (0–1)

An aqueous solution of hydrogen peroxide was prepared and divided into two portions of the same volume. The first portion was poured into beaker I, and the second – into beaker II. Beaker I was left at $25\,°C$, and a small amount of manganese(IV) oxide was added to beaker II at the same temperature. No changes were noticed in beaker I. In beaker II, a rapid release of colourless, odourless and combustible gas was observed. After the completion of the reaction, the solution over the sediment in beaker II remained colourless.

Complete the following sentences. Select one of the answers given in each set of brackets.

In the reaction described, manganese(IV) oxide performs the function of a (catalyst / substrate / product). Its action consists in (increasing the activation energy / decreasing the activation energy / increasing the concentration of the substrate) of the reaction.

Task 8. (0–1)

The reaction of the decomposition of hydrogen iodide proceeds according to the formula:

$$2HI\,(g) \rightleftarrows H_2\,(g) + I_2\,(g)$$
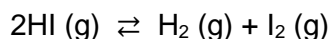
The table gives the values of the equilibrium constant of this reaction at selected temperatures (under a pressure $p = 1013\,hPa$).

Temperature, K	400	600	800
Equilibrium constant	$4.07 \cdot 10^{-3}$	$1.24 \cdot 10^{-2}$	$2.31 \cdot 10^{-2}$

Source: W. Mizerski, *Tablice chemiczne*, Warszawa 2013.

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

1.	An increase in temperature (at p = const) results in <u>a decrease</u> in the efficiency of the hydrogen iodide decomposition reaction.	T	F
2.	An increase in pressure (at T = const) <u>does not</u> result in a change in the efficiency of the hydrogen iodide decomposition reaction.	T	F

The acid molecule of a certain element E contains one atom of this element, two atoms of hydrogen and oxygen atoms. The molar mass of this acid is equal to $193.6 \text{ g} \cdot \text{mol}^{-1}$, and the mass of the element E constitutes $65.9\ \%$ of the mass of the acid.

**Based on calculations, identify the element E and write the molecular formula of the acid described.**

Supporting calculations:

Molecular formula of the acid: ....

Task 10. (0–1)

In an experiment, two colourless aqueous solutions were mixed. After mixing the solutions, a white precipitate formed.

From the salts listed below, select two whose aqueous solutions could have been used in the described experiment. Mark the formulas of the selected salts.

CH_3COONa $\qquad$ $CaCl_2$ $\qquad$ KNO_3 $\qquad$ NH_4Br $\qquad$ Na_3PO_4
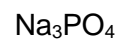
Task 11. (0–1)

Hydrochloric acid was added to an aqueous solution of sodium bicarbonate. The release of a colourless gas was observed.

Write down the <u>net ionic equation</u> of the reaction from which the colourless gas was released, and specify what function – a Brønsted-Lowry acid or base – the hydrogen-carbonate ion plays in this reaction.

Equation of the reaction:

....

Function of the hydrogen-carbonate ion: ....

Task 12.

In separate beakers, aqueous solutions of the following substances were prepared:

I	II	III	IV	V
CH_3COONa	HCl	KOH	NH_4Cl	NaCl

All solutions had a molar concentration of $0.1 \ mol \cdot dm^{-3}$ and were stored at $25 \ °C$.

Task 12.1. (0–1)
From among the listed solutions, choose the solution: with the lowest pH, with pH = 7, and with the highest pH. Write down the appropriate numbers that mark these solutions in the table.

Solution with the lowest pH	Solution with pH = 7	Solution with the highest pH

Task 12.2. (0–1)
Specify the pH value of the potassium hydroxide solution listed in the table above.

Supporting calculations:

pH = ………………

Task 13. (0–1)
A colourless aqueous solution of a certain substance was added to a test tube with an aqueous solution of potassium chromate(VI) (reaction 1). A colourless aqueous solution of another substance was then added to the resulting mixture (reaction 2). The course of the experiment is illustrated in the diagram below.

reaction 1 → reaction 2 →

Write down the net ionic equation of reaction 2.

....

Task 14. (0–2)

Under the influence of hydrochloric acid, manganese(IV) oxide is reduced according to the formula:

$$MnO_2 + Cl^- + H^+ \longrightarrow Mn^{2+} + Cl_2 + H_2O$$
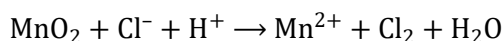
Write down the <u>ionic equations</u> of the reduction and oxidation reactions occurring during the process described, taking into account the number of electrons given or taken (ion-electron equation). Specify the molar ratio in which the oxidizing agent reacts with the reducing agent.
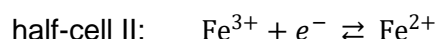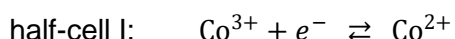
Equation of the reduction reaction:

....

Equation of the oxidation reaction:

....

Molar ratio of oxidizing agent to reducing agent $n_{\text{oxidizing agent}} : n_{\text{reducing agent}} =$ ....

Task 15. (0–2)

Given below are the equations of reactions that can occur in two redox half-cells:

half-cell I: $\quad Co^{3+} + e^- \rightleftarrows Co^{2+}$ $\qquad$ half-cell II: $\quad Fe^{3+} + e^- \rightleftarrows Fe^{2+}$

In standard conditions, half-cell I was connected with half-cell II, so that a cell was formed.

Write the equation of the reaction that occurs in the cell during its operation, and calculate the electromotive force *SEM* of this cell under standard conditions.

Equation of the reaction: ....

SEM: ....

Task 16. (0–1)

The molecule of a certain alkane X has a chain structure and contains 5 carbon atoms. This alkane reacts with chlorine to form 4 isomeric monochloro derivatives.

Write down the semi-structural (condensed) formula and give the systematic name of the alkane X.

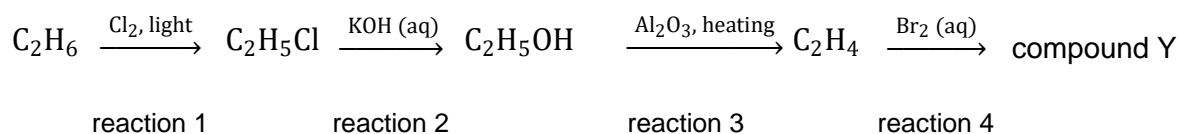Semi-structural (condensed) formula: ....

Systematic name: ....

Task 17.

Below is a sequence of transformations of ethane and its derivatives:

$$C_2H_6 \xrightarrow{\text{Cl}_2,\text{ light}} C_2H_5Cl \xrightarrow{\text{KOH (aq)}} C_2H_5OH \xrightarrow{\text{Al}_2O_3,\text{ heating}} C_2H_4 \xrightarrow{\text{Br}_2\text{ (aq)}} \text{compound Y}$$

reaction 1   reaction 2   reaction 3   reaction 4

Task 17.1. (0–1)

Complete the table. Enter the numbers of all reactions meeting the condition specified in the header of each column.

Addition	Elimination	Substitution

Task 17.2. (0–1)

Complete the following sentence. Select and mark the correct answer from those given in brackets. Write down the semi-structural (condensed) formula of compound Y.

Reaction 1 occurs according to the (electrophilic / nucleophilic / radical) mechanism.

Semi-structural (condensed) formula of compound Y: ....

Task 18. (0–1)

Below is the formula of a bifunctional alkane derivative.

$$CH_2(OH)-CH(OH)-CHO$$

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

1.	The bifunctional alkane derivative whose formula is given above is a hydroxy acid.	T	F
2.	The molecules of this compound are chiral because they lack a plane of symmetry.	T	F

NOTES (*not subject to evaluation*)

CHEMIA

Poziom rozszerzony

Formuła 2023