# NATIONAL CHEMISTRY OLYMPIAD 2025

**MARKING SCHEME PRELIMINARY ROUND 2**
**To be held between 17th and 25th March 2025**

SCHEIKUNDE OLYMPIADE

Symeres
Making Molecules Matter. Together.

- This preliminary round consists of 20 multiple choice questions divided over 8 topics, and 3 problems with a total of 16 open questions.
- The maximum score for this paper is 98 points.
- Required materials: (graphic) calculator and BINAS 6th or 7th edition or ScienceData 1st edition or BINAS 5th edition, English version.
- The total number of points available for each question is stated.
- The attached marking scheme must be used when grading the work. In addition, the general rules for the Dutch Central Exams apply.

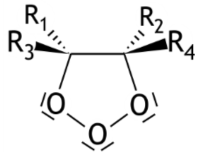
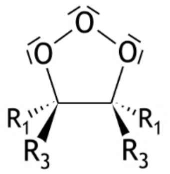
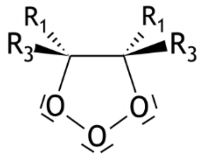
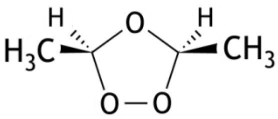
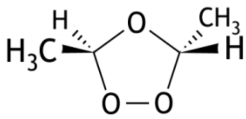
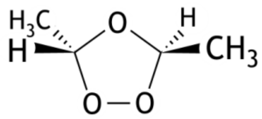
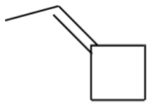
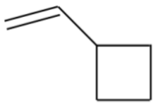
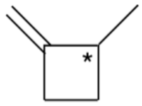
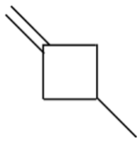
## Problem 1 Meerkeuzevragen (total 40 points)

### For every correct answer: 2 points

**Brief summary**

| nr. | answer |
|---|---|
| 1 | **C** |
| 2 | **C** |
| 3 | **D** |
| 4 | **A** |
| 5 | **D** |
| 6 | **E** |
| 7 | **D** |
| 8 | **A** |
| 9 | **B** |
| 10 | **C** |
| 11 | **C** |
| 12 | **E** |
| 13 | **A** |
| 14 | **C** |
| 15 | **D** |
| 16 | **D** |
| 17 | **C** |
| 18 | **D** |
| 19 | **C** |
| 20 | **D** |

## Carbon chemistry

<table>
<tr><td>1</td><td>C</td><td>If the ozone molecule approaches from 'above' in case I, the molozonide depicted in the question is formed.<br><br>If the ozone molecule approaches from ‘below’,  is formed<br><br>and that is the mirror image of the molozonide drawn in the question.<br>Also in case II, the ozone molecule can approach from two sides, and then it forms<br> and <br>These formulas are identical.</td></tr>
<tr><td>2</td><td>C</td><td>  </td></tr>
<tr><td>3</td><td>D</td><td>   <br>The C atom indicated with an asterisk is asymmetric, so there are two variants of this structure.</td></tr>
</table>

## Rate of reactions and equilibrium

<table>
<tr><td>4</td><td>A</td><td>5.00 g $NO_2$ is $\dfrac{5.00}{46.006}$ mol; at 310 K and a volume of 1.00 $dm^3$, the pressure is<br>$p_{NO_2} = \dfrac{5.00}{46.006} \times \dfrac{8.314 \times 310}{1.00 \cdot 10^{-3}} = 2.80 \cdot 10^5$ Pa.<br>
<table>
<tr><td></td><td>$N_2O_4$</td><td>$\rightleftharpoons$</td><td>2 $NO_2$</td></tr>
<tr><td>initial</td><td>0</td><td></td><td>$2.80 \cdot 10^5$ Pa</td></tr>
<tr><td>change</td><td>+ $x$ Pa</td><td></td><td>– $2x$ Pa</td></tr>
<tr><td>equilibrium</td><td>$x$ Pa</td><td></td><td>($2.80 \cdot 10^5 - 2x$) Pa</td></tr>
</table>
The equilibrium pressure is $2.80 \cdot 10^5 - 2x + x = 2.80 \cdot 10^5 - x = 1.71 \cdot 10^5$ Pa.<br>Thus $x = 1.09 \cdot 10^5$ Pa.<br>Thus $p_{NO_2} = 2.80 \cdot 10^5 - 2 \times 1.09 \cdot 10^5 = 0.62 \cdot 10^5$ Pa and $p_{N_2O_4} = 1.09 \cdot 10^5$ Pa.<br>Thus $K_p = \dfrac{(p_{NO_2} / p_0)^2}{p_{N_2O_4} / p_0} = \dfrac{(0.62 \cdot 10^5 / 10^5)^2}{1.09 \cdot 10^5 / 10^5} = 0.35$.</td></tr>
</table>

| | | |
|---|---|---|
| 5 | D | The rate of the total reaction is determined by the slowest (second) step, therefore $r = k_2[Cl][N_2O]$.<br>For the first step, it applies that $K = \frac{[Cl]^2}{[Cl_2]}$, thus $[Cl]=\sqrt{K \times [Cl_2]}$, thus<br>$r = k_2[N_2O]\sqrt{K \times [Cl_2]}$, or $r = k_2K^{1/2}[N_2O][Cl_2]^{1/2} = k[N_2O][Cl_2]^{1/2}$. |
| 6 | E | $K_1 = \frac{[NO]^2}{[N_2][O_2]}$<br>$K_2 = \frac{[NO_2]^2}{[NO]^2[O_2]}$<br>$K_3 = \frac{[N_2O_3]}{[NO][NO_2]}$<br>$K = \frac{[N_2]^2[O_2]^3}{[N_2O_3]^2} = \frac{[N_2]^2[O_2]^2}{[NO]^4} \times \frac{[NO_2]^2[O_2]}{[NO_2]^2} \times \frac{[NO]^2[NO_2]^2}{[N_2O_3]^2} = \frac{1}{K_1^2 \times K_2 \times K_3^2}$ |

## Structures and formulae

| | | |
|---|---|---|
| 7 | D | They both have the configuration $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,4s^2\,3d^{10}$. |
| 8 | A | F is the most electronegative halogen atom and makes the OH bond the most polar at a distance. |

## pH / acid-base

| | | |
|---|---|---|
| 9 | B | The following equilibrium reaction takes place:<br>$H_3PO_4^- + PO_4^{3-} \rightleftharpoons H_2PO_4^- + HPO_4^{2-}$<br>A buffer solution is produced with $H_2PO_4^-$ as acid and $HPO_4^{2-}$ as conjugated base, for which applies :<br>$pH = pK_a - \log \frac{\text{number of moles of acid}}{\text{number of moles of conjugated base}} =$<br>$7.21 - \log \frac{\text{number of moles of } H_2PO_4^-}{\text{number of moles of } HPO_4^{2-}}$<br>Because the same amount of $H_2PO_4^-$ as $HPO_4^{2-}$ is produced, the pH= $pK_a$ = 7.21. |
| 10 | C | After adding the 20 mL of the solution of sodium hydroxide, $[Ca^{2+}]$ and $[Mg^{2+}]$ have been reduced by half to 0.050 mol $L^{-1}$.<br>At pH = 10.00, $[OH^-] = 1.0 \cdot 10^{-4}$, thus, the ion products of $Ca(OH)_2$ and $Mg(OH)_2$ are $0.050 \times (1.0 \cdot 10^{-4})^2 = 5.0 \cdot 10^{-10}$.<br>This is smaller than the solubility product of $Ca(OH)_2$, $5.0 \cdot 10^{-6}$, so $Ca(OH)_2$ does not precipitate.<br>The ion product of $Mg(OH)_2$ is larger than the solubility product of $Mg(OH)_2$, $5.6 \cdot 10^{-12}$, so $Mg(OH)_2$ will precipitate. |

## Redox and electrolysis

| | | |
|---|---|---|
| **11** | **C** | The three $Fe^{2+}$ ions donate a total of three electrons. The oxygen molecule gains four electrons. To make them equal to each other, the coefficient of $Fe_3(PO_4)_2$ is multiplied by 4 and that of $O_2$ by 3. The reaction equation becomes: $4\ Fe_3(PO_4)_2 + 3\ O_2 + 6\ H_2O \rightarrow 8\ FePO_4 + 4\ Fe(OH)_3$ |
| **12** | **E** | At the negative electrode, the strongest oxidizing agent reacts first, that is $Cu^{2+}$. At the positive electrode, the strongest reducing agent reacts first, that is $Br^-$. |
| **13** | **A** | $\Delta G_{total} = \Delta G_1 + \Delta G_2$ or $-4 \times F \times \Delta E = -2 \times F \times 1.468 + \{-2 \times F \times (-0.126)\}$, thus $\Delta E = \frac{-1.468 + 0.126}{-2} = 0.671\ V$. |

## Analysis

| | | |
|---|---|---|
| **14** | **C** | When the peak area of 85A in chromatogram B is equal to that in chromatogram A, the peak area of vitamin E in chromatogram B is $\frac{12.717}{12.600} \times 7.902 = 7.975$. The concentration of vitamin E in blueberry juice is $\frac{7.975}{7.617} \times 4.50 \cdot 10^{-4} = 4.71 \cdot 10^{-4}\ mol\ L^{-1}$. |
| **15** | **D** | The pH transition range of an indicator must fit on a steep part of the pH curve. |
| **16** | **D** | There is 0.1494 g $H_2A$ in the titrated 25.00 mL. After the addition of 18.0 mL 0.100 M sodium hydroxide solution, all of the $H_2A$ has been converted. Therefore $\frac{1}{2} \times 18.0 \times 0.100 \times 10^{-3}$ mol $H_2A$ has reacted. The molar mass is therefore $\frac{0.1494}{\frac{1}{2} \times 18.0 \times 0.100 \times 10^{-3}} = 166\ g\,mol^{-1}$. |

## Calculations and Green Chemistry

| | | |
|---|---|---|
| **17** | **C** | Suppose x g of Mg reacts to form MgO and y g of Mg reacts to form $Mg_3N_2$,<br>Then $\frac{x}{24.31}$ mol MgO is formed, which is $\frac{x}{24.31}\times 40.305 = 1.658x$ g MgO<br>and $\frac{1}{3}\times\frac{y}{24.31}$ mol $Mg_3N_2$ , which is $\frac{1}{3}\times\frac{y}{24.31}\times 101.0 = 1.385y$ g $Mg_3N_2$.<br>This produces the following system of two equations with two variables:<br>$x + y = 1.000$ and<br>$1.658x + 1.385y = 1.584$<br>Solving this gives $y = 0.27$.<br>The mass percentage of $Mg_3N_2$ is $\frac{0.27\times 1.385}{1.584}\times 100\% = 24\%$. |
| **18** | **D** | $E-\text{factor} = \frac{\text{total mass of all reactants} - \text{mass of desired product}}{\text{mass of desired product}} =$<br>$\frac{181.88 + 5\times 40.08 - 0.85\times 101.88}{0.85\times 101.88} = 3.4$ |

## Thermochemistry

| | | |
|---|---|---|
| **19** | **C** | A catalyst lowers the activation energy and does not influence the reaction enthalpy. |
| **20** | **D** | The reaction enthalpy is given by<br>$\Delta H_r = -\Delta H_f(CuSO_4(s)) - 5\times\Delta H_f(H_2O(l)) + \Delta H_f(CuSO_4.5H_2O(s))$<br>$= -(-7.71\cdot 10^5) - 5\times(-2.86\cdot 10^5) + (-22.78\cdot 10^5) = -0.77\cdot 10^5$ J per 5 mol $H_2O$.<br>That is $\frac{-0.77\cdot 10^5}{5} = -0.154\cdot 10^5$ J per mol $H_2O$ or $-15.4\ kJ\,mol^{-1}$. |

# Open questions (total 58 points)

## Problem 1 The decomposition of dinitrogen pentoxide (21 points)

□1 Maximum score 8

An example of a correct answer is:

$\Delta H_r = -11.3 + 2 \times 33.2 = +55.1\ \text{kJ mol}^{-1}$

$\Delta S_r = -355.6 + 2 \times 240 + ½ \times 205 = +227\ \text{J mol}^{-1}\ \text{K}^{-1}$

Thus $\Delta G_r = \Delta H_r - T\Delta S_r = 55.1 \times 10^3 - 323 \times 227 = -1.82 \cdot 10^4\ \text{J mol}^{-1}$

It is also true that $\Delta G_r = -RT\ln K$, thus $K = e^{-\frac{\Delta G}{RT}} = e^{-\frac{-1.82.10^4}{8.314 \times 323}} = 8.78 \cdot 10^2$.

That is very large, so the equilibrium lies far to the right and the reaction can be considered as to proceed to completion.

- in the calculation of $\Delta H_r$, the formation enthalpy of $N_2O_5$ with a negative sign 1
- in the calculation of $\Delta H_r$, 2 × formation enthalpy of $NO_2$ with a positive sign 1
- correct summation of the formation enthalpies 1
- in the calculation of $\Delta S_r$, the absolute entropy of $N_2O_5$ with a negative sign 1
- in the calculation of $\Delta S_r$, 2 × the absolute entropy of $NO_2$ and ½ × the absolute entropy of $O_2$ with a positive sign 1
- correct summation of the absolute entropies 1
- calculation of $\Delta G_r$ 1
- calculation of $K$, and noting that it is very large (meaning the equilibrium lies far to the right) 1

□2 Maximum score 1

Since the oxygen escapes, the reverse reaction cannot take place.

□3 Maximum score 4

An example of a correct answer is:

At completion, $\dfrac{1.01 \cdot 10^5 \times V_\infty \times 10^{-6}}{8.314 \times 303} = 4.01 \cdot 10^{-5} \times V_\infty$ mol $O_2$ is formed.

There was initially $2 \times 4.01 \cdot 10^{-5} \times V_\infty$ mol $N_2O_5$ present in 0.100 L solution, thus

$[N_2O_5]_0 = \dfrac{2 \times 4.01 \cdot 10^{-5} \times V_\infty}{0.100} = 8.02 \cdot 10^{-4} \times V_\infty\ \text{mol L}^{-1}$.

At time $t$, $V_t$ cm$^3$ of $O_2$ has formed, so $8.02 \times 10^{-4} \times V_t$ moles of $N_2O_5$ per litre have been converted.

Thus $[N_2O_5]_t = 8.02 \cdot 10^{-4} \times V_\infty - 8.02 \cdot 10^{-4} \times V_t = (V_\infty - V_t) \times 8.02 \cdot 10^{-4}\ \text{mol L}^{-1}$, thus

$F = 8.02 \cdot 10^{-4}$.

- correct conversion from cm$^3$ to m$^3$ and °C to K 1
- calculation of the number of moles of $O_2$ in $V_\infty$ cm$^3$ and $V_t$ cm$^3$ respectively 1
- calculation of the number of moles of $N_2O_5$ initially present and the number of moles of $N_2O_5$ converted in $t$ sec 1
- calculation of the decrease of $[N_2O_5]$ in $t$ sec and of $F$ 1

□4 Maximum score 4
An example of a correct answer is:
At $t = 0$ s, $[N_2O_5]$ is equal to $6.80·10^{-2}$ mol $L^{-1}$, at $t = 8.5·10^3$ s, $[N_2O_5]$ has decreased to $3.40·10^{-2}$ mol $L^{-1}$ and again $8.5·10^3$ s later, at $t = 17·10^3$ s, to $1.70·10^{-2}$ mol $L^{-1}$.
The half-life is therefore $8.5·10^3$ s and is independent of concentration, which is the case for a first order reaction.

- choice of (at least) two concentrations that differ by a factor of 2 — 1
- reading the corresponding times — 1
- calculation of the half-life — 1
- observation that the half-life is independent of concentration (so it is a first order reaction) — 1

□5 Maximum score 2

$$k = \frac{\ln 2}{t_{1/2}} = \frac{0.693}{8.5 \cdot 10^3} = 8.2 \cdot 10^{-5}\ \text{s}^{-1}$$

- calculation of $k$ — 1
- correct unit — 1

*Note*
*If an incorrect answer to question 5 is the consequential result of an incorrect answer to question 4, mark the answer to question 5 as correct.*

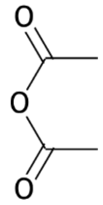
□6 Maximum score 2
An example of a correct answer is:
For this first order reaction we have $\ln\frac{[N_2O_5]_0}{[N_2O_5]_t} = kt$. Substituting $[N_2O_5]_0 = V_\infty \times F$ and $[N_2O_5]_t = (V_\infty - V_t) \times F$ gives $\ln\frac{V_\infty \times F}{(V_\infty - V_t) \times F} = \ln\frac{V_\infty}{(V_\infty - V_t)} = kt$.
So if you plot $\ln\frac{V_\infty}{(V_\infty - V_t)}$ versus time in a diagram, you get a straight line. The slope of this line is $k$.

- demonstrate that $\frac{[N_2O_5]_0}{[N_2O_5]_t} = \frac{V_\infty}{(V_\infty - V_t)}$ — 1
- rest of the answer — 1

## Problem 2 Paracetamol 19 points

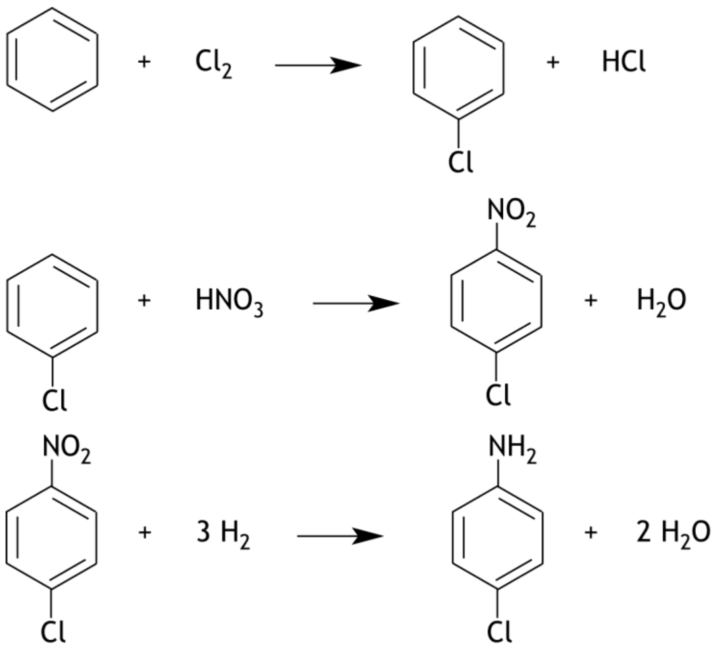
□7 Maximum score 1

An example of a correct answer is:



□8 Maximum score 7

An example of a correct answer is:



- in the first equation correct formulas before the arrow 1
- in the first equation correct formulas after the arrow 1
- in the second equation correct formulas before the arrow 1
- in the second equation correct formulas after the arrow 1
- in the third equation correct formulas before the arrow 1
- in the third equation correct formulas after the arrow 1
- correct coefficients in the third equation 1

*Note:*

*When HCl and/or $HNO_3$ are written as $H^+ + Cl^-$ and $H^+ + NO_3^-$ respectively, mark this as correct.*

▫9 Maximum score 3

An example of a correct answer is:

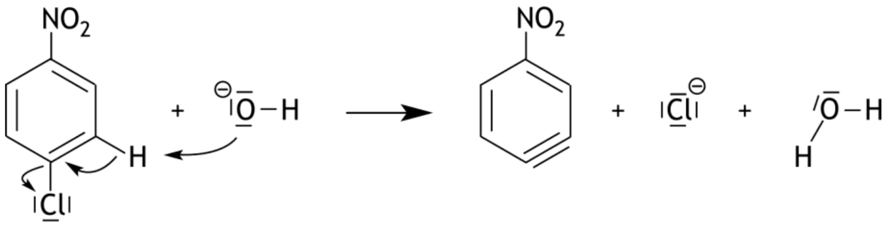
A synthesis route that starts with the nitration of benzene is possible. After the nitration, the nitro group must first be converted into an amino group, followed by chlorination, and then the chlorine atom is replaced by an OH group.

· (a synthesis route that starts with the nitration of benzene is possibe) after nitration, the nitro group must be converted into an amino group 1
· followed by chlorination 1
· then replacement of Cl with OH 1

If an answer is given as: „It is not possible because the nitro group is a meta-directing group, and therefore, chlorination will (mainly) result in *meta*-chloronitrobenzene". 2

▫10 Maximum score 3

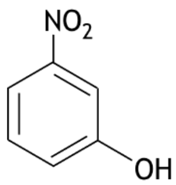
An example of a correct answer is:




· the structural formula of *para*-chloronitrobenzene and $OH^-$ before the arrow and the structural formulas of the nitrobenzyne, $Cl^-$ and $H_2O$ after the arrow 1
· all charges and relevant electron pairs correctly represented 1
· the curly arrows correctly represented 1

▫11 Maximum score 1

An example of a correct answer is:



□12 Maximum score 4

An example of a correct calculation is:

The yield of the total conversion of benzene to paracetamol is

$0.90 \times 0.92 \times 0.65 \times 0.48 \times 0.85 = 0.22$.

That means that per Mmol benzene ultimately 0.22 Mmol paracetamol can be formed.

1.00 ton benzene is $\frac{1.00}{78.11}$ Mmol, thus, from that $0.22 \times \frac{1.00}{78.11}$ Mmol paracetamol can be formed, that is $0.22 \times \frac{1.00}{78.11} \times 151.17 = 0.43$ ton paracetamol.

- calculation of the yield of the total conversion of benzene to paracetamol 1
- calculation of the number of Mmoles of benzene in 1.00 ton of benzene 1
- calculation of the number of Mmoles of paracetamol that can be formed from this 1
- calculation of the number of tons of paracetamol that can be formed 1

## Problem 3 Wüstite (18 points)

▫13 Maximum score 3

Examples of a correct calculation are:

Suppose that wüstite contains $p$ mol $Fe^{2+}$ and $q$ mol $Fe^{3+}$ per mol $O^{2-}$, then it follows that:
$p + q = 0.87$ and $2p + 3q = 2$.
Solving this system of two equations with two unknowns results in $p = 0.61$ and $q = 0.26$.
Thus $p : q = 2.3 : 1.0$.

- formulation of the equation $p + q = 0.87$ 1
- formulation of the equation $2p + 3q = 2$ 1
- rest of the calculation 1

and

The average charge of the iron ions is $\frac{2}{0.87} = +2.3$. Suppose there are $p$ moles $Fe^{2+}$ in one mol of iron ions with an average charge of $+2.3$, then there are $(1-p)$ moles $Fe^{3+}$, and the following equation applies $2p + 3(1-p) = 2.3$. This results in $p = 0.7$.
Thus per mol of iron ions, there is 0.7 mol $Fe^{2+}$ and 0.3 mol $Fe^{3+}$.
Thus the molar ratio $Fe^{2+} : Fe^{3+} = 0.7 : 0.3 = 2.3 : 1.0$.

- calculation of the average charge of the iron ions 1
- (supposing that there are $p$ moles of $Fe^{2+}$ per mol of iron ions) notion that $2p + 3(1-p) = 2.3$ 1
- rest of the calculation 1

▫14 maximum score 1

Examples of a correct answer are:

- If all positions of positive ions in the lattice were occupied by $Fe^{2+}$ and $Fe^{3+}$ ions, the substance would not be neutral.
- If two $Fe^{3+}$ ions are present in the lattice, one $Fe^{2+}$ ion must be missing.

▫15 Maximum score 6

An example of a correct answer is:

The volume of the unit cell is $(2 \times 214)^3 = 7.84 \cdot 10^7$ pm$^3$ or $7.84 \cdot 10^{-29}$ m$^3$.
The unit cell contains 4 oxide ions and (on average) $4x$ iron ions.
The (average) mass of the unit cell is thus $4 \times 16.00 + 4x \times 55.85$ u, or
$(4 \times 16.00 + 4x \times 55.85) \times 1.66 \cdot 10^{-27}$ kg.

Thus, for the density applies $\frac{(4 \times 16.00 + 4x \times 55.85) \times 1.66 \cdot 10^{-27}}{7.84 \cdot 10^{-29}} = 5.71 \cdot 10^3 \text{ kg m}^{-3}$.

From this it follows that $x = 0.92$.

- notion that the edge length of the unit cell is $2 \times 214$ pm 1
- calculation of the volume of the unit cell 1
- notion that the unit cell contains 4 oxide ions and (on average) $4x$ iron ions 1
- calculation of the mass of the unit cell 1
- dividing the calculated mass of the unit cell by the calculated volume of the unit cell and equating this to the given density 1
- calculation of $x$ 1

□16 Maximum score 8

Examples of a correct calculation are:

26.41 mL 0.0200 M potassium permanganate solution contains 26.41 × 0.0200 mmol $MnO_4^-$.
This has reacted with 5 × 26.41 × 0.0200 = 2.64 mmol $Fe^{2+}$.
Because $Fe_xO$ can be interpreted as a mixture of FeO and $Fe_2O_3$, the 250 mg $Fe_xO$ must have contained 2.64 mmol FeO and this is 2.64 × 71.844 = 190 mg FeO.

Then it contained 250 – 190 = 60 mg $Fe_2O_3$ and this contains $2 \times \frac{60}{159.69} = 0.75$ mmol $Fe^{3+}$.

Thus, 250 mg $Fe_xO$ contained 2.64 + 0.75 = 3.39 mmol iron ions and

$2.64 + \frac{3}{2} \times 0.75 = 3.77$ mmol oxide ions.

Thus, the formula of the examined wüstite is $Fe_{3.39}O_{3.77}$ or $Fe_{0.90}O$.
Thus, $x$ = 0.90.

- calculation of the number of mmoles of $MnO_4^-$ used for the titration 1
- calculation of the number of mmoles of $Fe^{2+}$ that reacted with this 1
- calculation of the number of mg of FeO that the 250 mg $Fe_xO$ contained 1
- calculation of the number of mg of $Fe_2O_3$ that the 250 mg $Fe_xO$ contained 1
- calculation of the number of mmoles of $Fe^{3+}$ that the 250 mg $Fe_xO$ contained 1
- calculation of the total number of mmoles of iron ions in the 250 mg $Fe_xO$ 1
- calculation of the total number of oxide ions in the 250 mg $Fe_xO$ 1
- calculation of $x$ 1

and

26.41 mL 0.0200 M potassium permanganate solution contains 26.41 × 0.0200 mmol $MnO_4^-$.
This has reacted with 5 × 26.41 × 0.0200 = 2.64 mmol $Fe^{2+}$.
Thus, the 250 mg $Fe_xO$ contained 2.64 × 55.85 = 147 mg $Fe^{2+}$
and in total 250 – 147 = 103 mg $Fe^{3+}$ and $O^{2-}$.
Suppose it contains $p$ mmol $Fe^{3+}$ and $q$ mmol $O^{2-}$ than the following applies
$55.85p + 16.00q = 103$ (equation 1).
Because the substance is electrically neutral, the following also applies
$3p - 2q + 2 \times 2.64 = 0$ (equation 2).

Solving this system of two equations with two unknowns results in $p$ = 0.76 and $q$ = 3.78.
Thus, the 250 mg $Fe_xO$ contained 2.64 + 0.76 = 3.40 mmol iron ions and 3.78 mmol oxide ions.
Thus, the formula of the examined wüstite is $Fe_{3.39}O_{3.77}$ or $Fe_{0.90}O$.
Thus, $x$ = 0.90.

- calculation of the number of mmoles of $MnO_4^-$ used for the titration 1
- calculation of the number of mmoles of $Fe^{2+}$ that reacted with this 1
- calculation of the number of mg of $Fe^{2+}$ in the 250 mg $Fe_xO$ and of the total number of mg of $Fe^{3+}$ and $O^{2-}$ in the 250 mg $Fe_xO$ 1
- formulating equation 1 1
- formulating equation 2 1
- solving the system of equations 1
- calculation of the total number of mmoles of iron ions in the 250 mg $Fe_xO$ 1
- rest of the calculation 1