1.

$H_2C=N-CH(R)-COOH$ is also accepted, if water is shown as one of the products.

2. $HOCH_2-NH-CHR-COOH + OH^- \rightarrow HOCH_2-NH-CHR-COO^- + H_2O$

3. $c_{amino\ acid} = (c_{NaOH}(V_{NaOH} - V_{cor})) / V_{amino\ acid}$.

4. $M = m_{amino\ acid} / c_{amino\ acid} \cdot V_{flask}$

5. $c_{amino\ acid} = (c_{NaOH}(V_{NaOH} + 2.0 - V_{cor})) - c_{HCl}V_{HCl}) / V_{amino\ acid}$.

7. The relationship between the amino acids and spectra is found based on the number of peaks in the ^{13}C spectra as well as integral intensity and multiplicity of the signals in ^1H spectra: 1 – isoleucine, 2 – methionine, 3 – norvaline, 4 – valine.

8. The prevailing forms are: C in acidic, B in neutral, and D in alkaline media.

9. Amino acid residues can be found in all the given classes of biomolecules except nucleic acids and oligosaccharides.
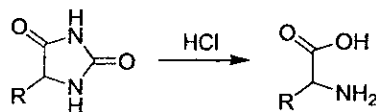
10. C, H, N, O, S, Se.

11. 4 dipeptides can be formed (Asn-Asn, Asp-Asp, Asn-Asp, Asp-Asn). The acidic hydrolysis will give the initial amino acids Asn and Asp. Only aspartic acid will be found in the case of complete hydrolysis.

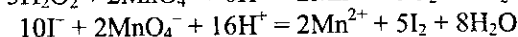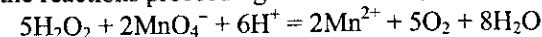**12.** *L*-cysteine having *S*-configuration is the natural isomer. Both isomers are given hereunder:
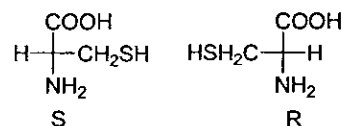
13. Hydantoin hydrolysis affords the amino acid:

1. $5Fe^{2+} + MnO_4^- + 8H^+ = 5Fe^{3+} + Mn^{2+} + 4H_2O$.

2. Equations of the reactions proceeding when $KMnO_4$ is added to the aliquot:
$$5H_2O_2 + 2MnO_4^- + 6H^+ = 2Mn^{2+} + 5O_2 + 8H_2O$$
$$10I^- + 2MnO_4^- + 16H^+ = 2Mn^{2+} + 5I_2 + 8H_2O$$

Calculation of the $KMnO_4$ amount needed for complete H_2O_2 oxidation (for the initial H_2O_2 concentration of 0.176 M):
$$V_{max} = \frac{c(KI) \cdot 0.005/5 + c(H_2O_2) \cdot 0.005 \cdot 2/5}{c(KMnO_4)} = \frac{0.007 \cdot 0.005/5 + 0.176 \cdot 0.005 \cdot 2/5}{5.00 \cdot 10^{-2}} = 7.2 \text{ (mL)}.$$

Sample titration results:

| Absolute time, h.min.s.	Relative time (time of the experiment minus the initial time), s	V (KMnO₄) total, mL	V (FeSO₄), mL	c (H₂O₂), mol/L	Note showing outlier results
10.00.10	370	8.0	3.8	0.159	
10.04.50	650	6.1	0.5	0.144	
10.08.20	860	7.0	2.3	0.149	–
10.13.20	1160	6.1	2.5	0.124	
10.15.40	1300	6.1	3.0	0.119	
10.22.00	1680	5.6	3.0	0.107	
10.28.00	2040	5.1	3.0	0.094	
10.33.15	2355	4.6	2.6	0.086	
10.37.00	2580	3.6	1.5	0.072	–
10.45.00	3060	3.6	1.8	0.069	

3. Peroxide concentration:
$$c(H_2O_2) = \frac{c(KMnO_4) \cdot V(KMnO_4) - c(KI) \cdot 0.005/5 - c(FeSO_4) \cdot V(FeSO_4)/5}{0.005} \cdot \frac{5}{2}$$

4. Calculation of the reaction order: linear dependence is found in coordinates $\ln c(H_2O_2)$ – time. The slope of the line ($\ln c = \ln c_0 - kt$) equals $-k$. The reaction order on H_2O_2 equals unity.

Sample Plot #1:
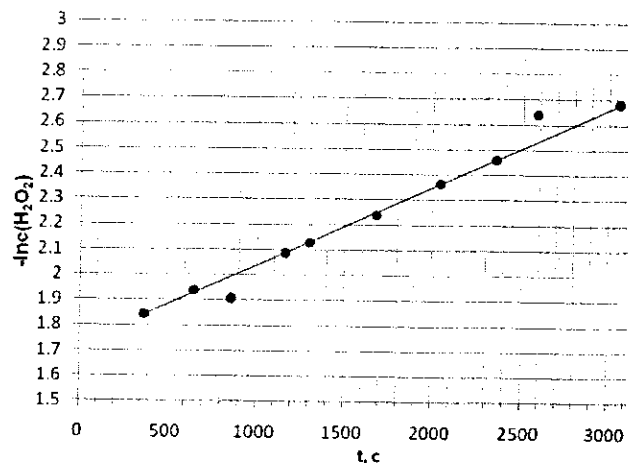
The slope of the above plot equals $3.1 \cdot 10^{-4}$. The reaction rate of H_2O_2 decomposition found from the graph: $k' = 3.1 \cdot 10^{-4} \, c^{-1}$.

When marking, the Jury calculates the k value and corresponding error using the least square procedure (the outliers are not counted). $k = \frac{<x><y>-<xy>}{<x>^2-<x^2>}$, where $x = t$, time in seconds (from the Table), $y = \ln c$. The error: $\Delta k = 2\sqrt{\frac{1}{n-2}\left(\frac{<y^2>-<y>^2}{<x^2>-<x>^2}-k^2\right)}$, where n is the number of measurements; $\varepsilon_1 = \frac{\Delta k}{k} \cdot 100\%$, ε_1 accounts the experiment quality. Besides, $\varepsilon_2 = \frac{|k_{calc}(part)-k_{calc}(jury)|}{k_{calc}(jury)} \cdot 100\%$ is calculated. This value indicates whether k was calculated from the experimental data adequately. The $c(H_2O_2)$ values reported by the participants are not recalculated. Besides, $\varepsilon_3 = \frac{|k_{calc}(jury)-k_{true}|}{k_{true}} \cdot 100\%$ value is also calculated. The latter characterizes the quality of the aliquot removal and the solution preparation.

The criteria for giving points:
- $\varepsilon_1 \leq 5\%$: 12 points (maximum); $\varepsilon_1 > 15\%$: 0 points; $5\% < \varepsilon_1 \leq 15\%$: linear dependence of the number of points on $(1-\varepsilon_1)$.
- $\varepsilon_2 \leq 3\%$: 7 points (maximum); $\varepsilon_1 > 10\%$: 0 points; $2.5\% < \varepsilon_2 \leq 10\%$: linear dependence of the number of points on $(1-\varepsilon_1)$.
- $\varepsilon_3 \leq 5\%$: 6 points (maximum); $\varepsilon_1 > 10\%$: 0 points; $5\% < \varepsilon_3 \leq 15\%$: linear dependence of the number of points on $(1-\varepsilon_1)$.

5.1. $H_2O_2 = H_2O + \frac{1}{2}O_2$ (catalysis by manganese dioxide)

5.2. $2MnO_4^- + 3H_2O_2 = 2OH^- + 2MnO_2 + 2H_2O + 3O_2$

5.3. $H_2O_2 + 2I^- + 2H^+ = 2H_2O + I_2$

6. The reaction order corresponding to the plots:

a	b	c
$n = 2$	$n = 1$	$n = 3$

7. The inclined line refers to $E(MnO_4^-/Mn^{2+})$, the lower horizontal one to $E(I_2/I^-)$, and the upper horizontal line to $E(Cl_2/Cl^-)$. Iodide oxidation by $KMnO_4$ in the presence of chloride is possible in the pH range between the intercepts of the lines.