RESOLUTION No. 13
OF THE TEACHING AND LEARNING COUNCIL OF THE FACULTY OF CHEMISTRY

of 29 February 2024

on detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw

Pursuant to § 68, section 2 of the Statute of the University of Warsaw (UW Monitor of 2019, item 190), and Resolution No. 4 of the University Council for Teaching and Learning (URK) regarding the graduation process at the University of Warsaw, the Teaching and Learning Council of the Faculty of Chemistry resolves as follows:

§ 1

1. The detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw are hereby adopted.
2. The rules and regulations, as specified in section 1, constitute an appendix to the resolution.

§ 2

1. Resolution No. 11 of the Teaching and Learning Council of the Faculty of Chemistry at the University of Warsaw of 12 April 2023 on detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw shall hereby become null and void.

§ 3

The resolution comes into force on 1 April 2024.

Chairperson of the Teaching and Learning Council

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prof. dr hab. Beata Krasnodębska-Ostręga

Appendix No. 1
to Resolution No. 13 of the Teaching and Learning Council of the Faculty of Chemistry of 29 February 2024 on detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw

THE DETAILED RULES AND REGULATIONS OF GRADUATION IN THE FIELD OF CHEMISTRY ORGANISED AT THE FACULTY OF CHEMISTRY AT THE UNIVERSITY OF WARSAW

§ 1

1. The Teaching and Learning Council of the Faculty of Chemistry, by way of a resolution, specifies detailed rules and regulations of graduation in the field of Chemistry consisting of:

1). Detailed rules for preparing and evaluating diploma theses.
2). Detailed rules for supervising diploma theses – general provisions.
3). Detailed rules for supervising diploma theses as part of second-cycle studies.
4). Detailed rules for monitoring the graduation process.

§ 2

1. Detailed rules for preparing and evaluating a diploma thesis.

1). A diploma thesis shall be submitted in electronic form on the Archive of Diploma Theses platform (APD).
2). A diploma thesis shall consist of the following components:
- a summary,
- a description of the current state of the art on a given subject and an explanation of the rationale of undertaking the research,
- research hypothesis or research goal,
- research methodology or experimental description,
- presentation of the results obtained and their analysis,
- conclusions,
- a list of cited literature.

3). A diploma thesis must be written in English. The following elements shall be included in the thesis in English and in Polish: a summary, statements by the student and the supervisor.
4). A diploma thesis shall be assessed according to the Rules and Regulations of Studies at the University of Warsaw (§ 46, sections 1 and 13) and the guidelines regarding the graduation process at the University of Warsaw (URK Resolution No. 4 § 2, section 1, points 1 and 2) relevant to the diploma thesis at the stage of second-cycle studies the thesis topic is defined by the supervisor to ensure that the student obtains the ability to carry out scientific research, therefore the research should include

novel elements. The research methodology, results and conclusions are then described.

5). The following elements must be included in the diploma thesis review: author's name and surname, title, supervisor's or reviewer's name and surname, place where the thesis was completed, assessment of the thesis content in terms of compliance with the subject specified in the title, formal assessment of the thesis (composition of the work, language accuracy, acquisition of the thesis writing techniques), substantive assessment of the thesis, potential use of the thesis (publication, source text, etc.), additional comments and assessment of the thesis according to the grading scale specified in § 34, section 2 of the Rules and Regulations of Studies at the University of Warsaw. The exact review form is available on the Archive of Diploma Theses platform (APD). The diploma thesis review must be approved and made available to the student at least three days before the date of the diploma examination.

6) Pursuant to the Rules and Regulations of the University of Warsaw (§ 46, section 6), joint preparation of a thesis by students is allowed after the Teaching and Learning Council of the Faculty of Chemistry has given a favourable opinion on the supervisor's application.

§ 3

1. Detailed rules for conducting a diploma examination at the stage of second-cycle studies shall include the following:

1). A diploma examination at the stage of second-cycle studies conducted at the Faculty of Chemistry is an oral examination consisting of two parts:

in the first part, the Student shall:

- briefly (about 5-10 minutes) present the most important results of the thesis and its main content,
- shall answer at least three questions regarding the content of the diploma thesis posed by the members of the examination committee,

in the second part:

- the Student shall answer a question from the list selected by the Chairperson.

2). The selected question comes from one of four branches of chemistry:

- inorganic and analytical chemistry,
- organic chemistry, chemical technology and biochemistry,
- physical chemistry and spectroscopy,
- theoretical chemistry and crystallography.

3). Assigning a thesis topic, the supervisor must specify a section from which a master's student will have to answer a question. This section may not necessarily be consistent with the subject of specialisation in which the diploma thesis is carried out.

4). The requirements for the second-cycle diploma examination in the chemistry branches specified in §3, section 1, point 2 are made available on the website of the Faculty of Chemistry. They are prepared by a team of academic teachers nominated by the Head of the Teaching Unit and are attached as Annex No. 2 to the resolution.

5). The student is allowed to refrain from answering one selected question before commencing their response. In such a situation, the Committee Chairperson shall select another question, with the total number of questions selected from the pool not exceeding two.
6). The result of the diploma examination is the arithmetic mean of the grades obtained from the answers to the selected question and the questions of the committee members. It is necessary to pass each part of the diploma examination indicated in § 5 point 1, section 1 with at least a grade of 3.0.
7). Assessment of the diploma thesis shall be consistent with § 46, section 13 of the Rules and Regulations of Studies at the University of Warsaw.
8). The study final result within the meaning of § 52, section 2, point 2). of the Rules and Regulations of Studies at the University of Warsaw shall be the sum of the average of the study grade (0.5), the diploma thesis grade (0.4), the diploma examination result (0.1). This grade is rounded pursuant to the rule referred to in § 52, section 3 of the Rules and Regulations of Studies at the University of Warsaw.
9). Minutes of the diploma examination shall be drawn up; they are the form of recording the diploma examination and the committee's decision to award a professional title.

§ 4

In order to obtain credit for the master's thesis workshops it is necessary to submit a diploma thesis approved by the supervisor.

§ 5

1. The detailed rules of monitoring the graduation process are specified in the guidelines regarding the graduation process at the University of Warsaw (URK Resolution No. 4 § 4).
1) The analysis of the graduation process takes place between 1 October and 31 December of each academic year, and concerns diploma examinations carried out up to 30 September of the previous academic year.
2) The Teaching and Learning Council shall appoint a person responsible for the annual monitoring of the graduation process, in particular the timeliness of making the thesis reviews available to students.
3) Randomly selected theses (20% of the defended theses) and those in which the thesis supervisor's and reviewer's grades differ by at least 1 grade are analysed in detail. Verification will include the accuracy of the minutes, the compliance of the review with the guidelines (§ 2, section 5) and the compliance of the questions asked with the requirements in Appendix 2.

4) Minutes of monitoring the graduation process, including its assessment, are presented to the Teaching and Learning Council of the Faculty of Chemistry at the meeting in January and, after their analysis and indicating corrective actions to be implemented, they shall be submitted to the University Council for Teaching and Learning.

§ 6

1. In a given academic year, an academic teacher with a doctoral degree may supervise a maximum of one diploma thesis at the level of second-cycle studies in all fields of study, while an academic teacher with a habilitated doctoral degree or professor title may supervise a maximum of three diploma theses at the level of second-cycle studies in all fields of study.

2. Co-supervision of theses is allowed in the case of master's theses. If the thesis is of an interdisciplinary nature, another academic teacher may be appointed as a co-supervisor from the Faculty by the decision of the Head of the Teaching Unit. If the supervisor has not declared chemistry as the leading academic discipline, the Head of the Teaching Unit shall appoint a co-supervisor from the Faculty of Chemistry.

3. The student shall have the right to partially prepare the master’s thesis outside the University of Warsaw. In such a case, the supervisor is required to submit an application to the Teaching and Learning Council of the Faculty of Chemistry requesting permission for an external person to co-supervise the thesis.

4. The Teaching and Learning Council establishes a template for requesting permission for an external person to co-supervise the thesis, Annex 3, which is published on the website of the Faculty of Chemistry.

5. The supervisor has the right to appoint a laboratory supervisor for the thesis who may only have the status of an assistant or doctoral student.

6. The supervisor must hold a doctoral degree and a selected reviewer must hold at least a habilitated doctoral degree.

7. In justified cases, the Head of the Teaching Unit may agree to allow an academic teacher with a doctoral degree to supervise the thesis beyond the limit specified in § 6, point 1 at the level of second-cycle studies.

Appendix No. 2
to Resolution No. 13 of the Teaching and Learning Council of the Faculty of Chemistry of 29 February 2024 on detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw

REQUIREMENTS FOR THE DIPLOMA EXAMINATION IN SECOND-CYCLE STUDIES AT THE FACULTY OF CHEMISTRY OF THE UNIVERSITY OF WARSAW IN THE FIELD OF CHEMISTRY

INORGANIC AND ANALYTICAL CHEMISTRY

1). Discuss the analytical parameters characterising measurement procedure capabilities (qualitative and quantitative parameters, properties of the measuring outcomes).
2). Discuss key aspects of the analytical method validation process.
3). Discuss the specific problems of trace component analysis and speciation analysis.
4). Discuss the basics of atomic optical methods used in chemical analysis (radiation range, distribution, temperature dependence).
5). Discuss the basics of molecular optical methods used in chemical analysis (radiation range, distribution, temperature dependence).
6). Discuss the Lambert-Beer law and deviations from it (nature and causes of observed phenomena) and its applicability in analytical measurements.
7). Discuss the working principle of a mass spectrometer, the analytical capabilities together with advantages and disadvantages of mass spectrometry as well as the detectors used.
8). Discuss the principles (similarities and differences) of the techniques applicable to imaging and surface composition studies (SEM, TEM, AFM/STM, XPS, EDS, …).
9). Atomic spectrometry - theoretical foundations of the method (electron transitions), apparatus used in AAS and AES.
10). Discuss the theoretical foundations and mechanisms of the separation process in adsorption, partition, ion exchange and gel filtration chromatography.
11). Discuss the similarities and differences between liquid and gas chromatography.
12). Discuss the parameters characterising the chromatographic separation process (retention time, partition constant, retention factor, separation capacity).
13). Discuss the theoretical foundations of potentiometry together with structure and division of ion-selective electrodes by type of membrane.
14). Discuss the principles of carrying out ion-selective electrode measurements using a pH measurement system as an example.
15). Discuss the basics of the division of the current electroanalytical methods, the measurement systems used and the role of individual electrodes.
16). Ways of lowering the limit of detection in electrochemical current methods and capacitive current elimination methods.
17). Advantages and limitations of electroanalytical methods over spectroscopic methods (molecular and atomic).

18). Concentration polarisation in current electrochemical methods - its effects on assay results, electroanalytical stationary and non-stationary methods.
19). Types of working electrodes used in electroanalysis - influence of electrode material on measurement conditions and method of determination (mercury, platinum, carbon, gold electrodes).
20). Pulse voltammetric techniques, their advantages and disadvantages, current sampling methods.
21). Discuss the advantages of using microelectrodes in electroanalysis, the formula describing the limiting current, diffusion into the microelectrode.
22). Flow analysis - effect of measurement conditions on the recorded analytical signal, detection methods, applications.
23). Chemical sensors - analytical parameters, types, design, applications, comparison with apparatus methods.
24). Relative and absolute analytical methods – examples, advantages and limitations.
25). Volumetric versus nanostructured materials, types of nanostructured materials (materials and types of structures), their properties, metallic and polymer nanostructures, synthesis, applications.
26). Complex compounds – crystal field theory, its possibilities and limitations, what properties can be explained using this theory.
27). Examples, structure and function of biologically important complexes.
28). Self-assembly on the electrode surface, monolayer structure, methods for studying monolayers, applications.
29). Molecular layers - subdivision, methods of obtaining, methods for studying layer properties.
30). Fuel cells - types, principle of operation, applications.
31). Supramolecular systems, examples of applications of supramolecular systems in nanotechnology, medicine and microelectronics.
32). Oscillating chemical reactions - what are the conditions for the occurrence of such reactions? Discuss a selected example of an oscillating reaction.
33). Discuss the process of electrocatalysis using a selected example (oxygen reduction, CO2, oxidation of ethanol).
34). Conductive polymers – collection, electrochemical and optical properties, their applications including analytical ones.
35). The use of rapid prototyping techniques in the chemistry laboratory.
36). Metal alloys, depositing of alloyed protective coatings, methods of production, composition analysis.
37). Discuss methods to determine protein structures and their interactions with lipid membranes.
38). Methods of environmental sampling (water, sediment and soil samples) and preparation of sample for testing. Selection of analytical method by type and concentration of components to be determined.
39). Analytical methods in relation to the possibilities of determining the different analyte forms which are present in a sample (free ions, complexes, isotopes).
40). Methods of calibration of analytical methods - standard addition method, calibration curve method, use of internal standard.

ORGANIC CHEMISTRY, CHEMICAL TECHNOLOGY AND BIOCHEMISTRY

1). Alkanes - states of aggregation, structure, reactivity, production and economic importance.

2). Discuss the phenomenon of isomerism of organic compounds, with particular reference to stereochemistry.
3). Reactions of alkenes as model polar organic transformations. Regio- and stereoselective processes resulting from this mechanism.
4). Organic redox reactions: oxidation-reduction processes of saturated and unsaturated hydrocarbons, alcohols and carbonyl compounds.
5). Discuss the acid-base properties of organic compounds including scale and substituents effects, taking phenols, carboxylic acids and amines as examples.
6). Radical reactions: mechanism, selectivity, product distribution and examples.
7). Competition between substitution and elimination processes exemplified by the reactions of alkyl halides and alcohols. Factors controlling the course of the reaction.
8). Coupling reaction as a cause of different reactivity and physicochemical properties of organic compounds.
9). Reasons and effects of aromaticity, examples of compounds and their reactions.
10). Induction and resonance effects of substituents on the example of properties of aromatic and carbonyl compounds.
11). Application of Grignard reagents in organic chemistry: preparation, limitations, synthetic possibilities.
12). Organic derivatives of water and hydrogen sulphide: synthesis and transformations.
13). Addition, substitution, replacement at the α position as elementary reactions of carbonyl compounds.
14). Acidity of carbonyl compounds and resulting reactions.
15). Nitrogen-containing organic compounds: properties, synthesis and transformations.
16). Electrophilic aromatic substitution reactions: examples, mechanism, orientation and reactivity, limitation.
17). Geometry of C, N, O atoms in organic compounds, hybridisation and valence angles, types of strains in molecules, conformers and their equilibria.
18). Ability to interpret simple ^{1}H-NMR, ^{13}C-NMR and infrared spectra (knowledge of vibrational frequencies for basic functional groups) to identify compounds.
19). Petroleum - composition, processing, types of products obtained in refineries and petrochemical plants.
20). Polymers - definition, polymerisation methods and ways to study polymers' physicochemical properties.
21). Types and characteristics of homo- and heterogeneous catalysts used in the chemical industry.
22). Relationships between chemistry, industry and business: discuss and explain the steps involved in commercialising research results using a selected example from chemistry (or biotechnology/environmental protection).
23). The structure of the nucleosides and nucleotides comprising nucleic acids.
24). DNA structure and interactions stabilising the double helix structure.
25). The replication process (general regularities of the course, stages, enzymes involved). PCR reaction.
26). Types of RNA - their structure and functions.
27). The processes comprising the gene expression (where and how do they occur).

28). Primary, secondary, tertiary and quaternary structures of proteins. Supersecondary structures and their examples. Protein denaturation and the factors causing it.
29). Methods for the determination and prediction of protein structure.
30). The functions that proteins perform in the body. Correlation between structure and function.
31). Structure, characterisation and classification of enzymes.
32). Mechanism of enzyme action and role of the active centre.
33). Factors affecting the rate of enzymatic reaction. Michaelis - Menten kinetics.
34). Strategies for regulating enzyme activity in the body.
35). ATP as the main energy carrier in the cell - structure, mode of formation (substrate and oxidative phosphorylation) and action.
36). Characteristics and steps involved in cellular respiration.

PHYSICAL CHEMISTRY AND SPECTROSCOPY

1). Laws of thermodynamics in isolated, closed and open systems.
2). Description of thermodynamic equilibrium through changes in thermodynamic functions.
3). Definition of chemical potential and temperature dependence of chemical potential at constant pressure.
4). The phenomenon of osmosis and its practical use.
5). Chemical kinetics (zero-, first-, and second-order reactions, determination of reaction rate constants, determination of order of reaction, half-life).
6). Adsorption (physical and chemical adsorption – comparison, Langmuir isotherm – derivation and graphic representation).
7). Surface tension (definition, units, temperature and concentration dependence, Gibbs isotherm, influence of other substances).
8). Types of colloidal systems (division, properties of lyophilic and lyophobic colloids, Tyndall effect),
9). Electrodes (classification, potential, equilibrium at the electrode-solution interface).
10). Galvanic cell vs. electrolytic cell (principle of operation, examples, characteristics and principle of operation of zinc-manganese, lithium hydride and lithium-ion cells).
11). Thermodynamically and chemically reversible processes (criteria for determining reversibility).
12). Diffusion (cause of diffusion, Fick's First Law, diffusion coefficient - what it depends on and what are the ways to determine it).
13). Fluid viscosity (kinematic and dynamic viscosity - definitions and units, laminar and turbulent flow).
14). Dipole moment (permanent and induced dipole moment, permanent dipole moment vs molecules chemical structure, molecular polarisation and refraction).
15). What information about molecules is revealed by microwave, infrared ultraviolet and visible light spectroscopy?
16). Description of chemical bonding (harmonic and anharmonic oscillator, dissociation and chemical bond energy - how to determine dissociation energy from electron spectra).
17). Application of molecular spectroscopy in quantitative and qualitative chemical analysis.
18). Raman spectrum vs infrared spectrum.
19). Transition dipole moment. Relationship with the intensity of optical spectra.

20). Selection rules in microwave, infrared ultraviolet and visible light spectroscopy.
21). Lasers (types, examples, conditions for achieving laser action, applications).
22). Types of nuclear radiation. The concept of half-life.
23). Interaction of ionising radiation with matter.
24). Applications of radioactive isotopes in medicine and technology.
25). Nuclear energy - nuclear reactors and safety issues.
26). The concept of nanomaterials, their classification and their types.
27). Synthesis methods of nanomaterials.
28). Selected microscopic methods: AFM, STM, SEM together with EDS in the study and shaping of nanostructures.
29). Applications of nanomaterials in catalysis, photocatalysis, electrocatalysis and photovoltaics.
30). NMR (conditions necessary to obtain a spectrum, information received from a spectrum).
31). Concepts used in NMR (magnetic shielding of the atomic nucleus, spin-spin coupling, nuclear relaxation).
32). NMR spectra in liquids and solids (comparison and reasons for the difference between them).

THEORETICAL CHEMISTRY AND CRYSTALLOGRAPHY

1). The wave function: probabilistic interpretation and method of determination. Time-dependent Schrödinger equation and Schrödinger equation for stationary states.
2). Solutions of the Schrödinger equation for model systems: particle in a box, harmonic oscillator, rigid rotor, hydrogen atom and hydrogen-like ions.
3). Hartree-Fock method. Form of one-electron functions and construction of multi-electron functions. Interpretation of solutions and limitations of the Hartree-Fock method.
4). Electron correlation. Computational methods for determining the correlation energy, based on the wave function or density functional theory.
5). Molecular orbitals in the LCAO-MO method. Formation of a chemical bond in diatomic molecules, bond order.
6). Electron structure of multi-electron atoms, diatomic molecules and polyatomic molecules. Hund's rules and atomic and molecular term symbols.
7). The Born-Oppenheimer approximation and the concept of potential energy surfaces. The electron-oscillation-rotation structure of energy levels of diatomic molecules. Equilibrium geometry and vibrations of polyatomic molecules.
8). Theoretical modelling of the chemical reaction path: intrinsic reaction coordinate, transition state, activation energy.
9). Intermolecular interaction energy: definition, supermolecular approach and perturbational approach. Physical interpretation of interaction energy components. Behaviour of the interaction energy at large intermolecular distances.
10). The microcanonical ensemble and the statistical definition of entropy. Statistical sum in canonical ensemble: definition, calculation for molecular systems, connection with the system’s thermodynamic parameters. Quantum statistics.

11). List the components of the classical (empirical) force field. Why exactly is it called classical/empirical?
12). Discuss the Monte Carlo method together with the Metropolis scheme.
13). Discuss the molecular dynamics method.
14). List the fundamental differences between the Monte Carlo modelling method and molecular dynamics.
15). Define the primary, secondary, tertiary and quaternary structure of proteins. What interactions are responsible for their formation?
16). Protein secondary structure: draw a Ramachandran plot, mark the areas corresponding to each type of secondary structure.
17). Describe what structures the DNA double helix adopts.
18). Explain the concept of protein homology. How do paralogues differ from orthologues?
19). How is the alignment of two protein sequences determined and what is it's interpretation?
What is the computational complexity of this problem?
20). Symmetry operations: definitions, types (including point, translational, crystallographic ones), examples, matrix notation; symmetry operation vs. symmetry element.
21). Symmetry groups: definition of a group, (crystallographic) point groups, space groups, Laue groups; how do they differ and what are their applications for describing the structure of molecules, crystals, and diffraction images.
22). Definition of a crystal and the main features that distinguish the crystalline state from other states of matter.
23). Crystal lattice: definition, concept of a unit cell (and how to calculate its volume), classification and applications of Bravais lattices, construction and applications of reciprocal lattice.
24). Crystallographic systems: definitions, properties, assignment of objects to the appropriate system; crystallographic system vs. physicochemical properties of crystals.
25). The phenomenon of diffraction and the description of a diffraction experiment: Bragg equation, Ewald construction, concepts of resolution and completeness of diffraction data, factors affecting the intensity of an X-ray beam diffracted on a crystal.
26). Structure factor and atomic scattering factors: definitions, relationship with the intensity of the diffracted radiation in a diffraction experiment; properties of diffraction image depending on the positions of the atoms in a unit cell.
27). Radiation sources used in structural studies: principles of operation, similarities and differences (atomic/nuclear scattering factors), examples of applications.
28). Solving and refining a crystal structure: what is a phase problem in crystallography and examples of methods to solve it, what is crystal structure refinement,

discrepancy indicators in crystal structure studies (what is their purpose), other methods for validating crystal structures.

29). Crystal structures of inorganic, molecular and macromolecular compounds (proteins, nucleic acids): similarities, differences and the most important experimental challenges.

Appendix No. 3

to Resolution No. 13 of the Teaching and Learning Council of the Faculty of Chemistry of 29 February 2024 on detailed rules and regulations of graduation in the field of Chemistry organised at the Faculty of Chemistry at the University of Warsaw

MODEL OF AN APPLICATION FOR AUTHORISATION TO CO-SUPERVISING THE DIPLOMA THESIS BY A PERSON FROM OUTSIDE THE UNIVERSITY OF WARSAW

<table>
<tr><td colspan="3">Application for the appointment of a co-supervisor of the diploma thesis</td></tr>
<tr><td colspan="3">……..
type of diploma thesis

……
name and surname, academic title
of the diploma thesis supervisor (UW Faculty of Chemistry employee)</td></tr>
<tr><td>……
student’s name and surname</td><td>……
student’s record book number</td><td>……
field of study</td></tr>
<tr><td colspan="3">……..……
name and surname, academic title
of the proposed co-supervisor of the diploma thesis
(from outside the UW)
……..……
place of employment</td></tr>
<tr><td colspan="3">Description of the diploma project</td></tr>
<tr><td colspan="3">Justification for cooperation</td></tr>
<tr><td colspan="2">……..……
name and surname
of the proposed co-supervisor
(from outside the Faculty of Chemistry)</td><td>……..……
name and surname
of the supervisor from the Faculty of Chemistry UW</td></tr>
</table>