University of Gdańsk

Subject card

Subject name and code	Graduate study lecture – Selected problems of physical chemistry", PG_00117699		
Field of study	Chemistry		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2024/2025
Education level	Master's studies	Subject group	Obligatory subject group in the field of study Optional subject group
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish Polish language
Semester of study	2	ECTS credits	3.0
Learning profile	academic	Assessment form	credit
Conducting unit	Faculty of Chemistry -> Rector		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Piotr Storoniak	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	0.0	0.0	30

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	5.0	40.0	75

Subject objectives

- Acquiring or deepening knowledge regarding the luminescence processes of organic substances and chemical thermodynamics, with particular emphasis on processes occurring in nature.
- Understanding the origins of luminescence phenomena (FL, Phosphorescecne, CL);

- Familiarization with practical uses of luminescecne processes;

- Understanding the processes occurring in the natural environment.

- Illustration of complex physicochemical issues using modern multimedia techniques. Instructing students to select and evaluate the acquired information.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[CHEMMU2_W05] Has extended knowledge in the field of the specialisation studied.	- knows and understands the principles of the interaction of electromagnetic radiation with matter; - distinguishes basic types of luminescence phenomena, is able to characterize them and indicate practical applications; - knows and understands basic photochemical laws; - can characterize the types of radiative and non-radiative processes occurring in excited organic molecules; - distinguishes types of electronic spectra, knows how bands are formed in these spectra and how band parameters can be determined; distinguishes spontaneous from forced processes; - describes, using thermodynamic concepts, chemical and physical changes that occur in everyday life; - explains the behavior of chemical substances in specific conditions based on their structure and knowledge of thermodynamic theory.	[SW4] test/exam - oral or written
[CHEMMU2_K01] Knows the limitations of her/his own knowledge; understands the need for further education and can inspire other people to do so.	demonstrates creativity and activity in independently obtaining information; demonstrates inquisitiveness and the ability to analyze original works chemicals; understands the need for further education; shows interest in physicochemical issues	[SK1] oral statement/conversation/ discussion
[CHEMMU2_U02] Critically assesses the results of conducted, performed observations and theoretical calculations and discusses errors.	Has the ability to critically evaluate the results of experiments, observations and/or theoretical calculations.	[SU1] oral statement/conversation/ discussion

Subject contents

The subject consists of two separate thematic blocks: "Fundamentals of practical photochemistry" and Thermodynamics of natural processes.

"Thermodynamics of natural processes": Thermodynamic state functions. Criteria of spontaneous transformations on the example of phenomena occurring in the natural environment. Thermodynamic description of chemical and physical transformations (single and multi-component phase equilibria liquid-vapor, solid-liquid, solid-vapour, liquid-liquid and influence of various factors on phase equilibria). Relationship between the structure of chemical compounds and their physical and chemical properties (reactivity).

"Principles of photophysical processes": Physical basics and practical aspects of luminescence and electron absorption phenomena: FL, CL, UV-Vis; Nature and laws of radiation absorption; Classification of electronic transitions; Creation and measurement of electronic spectra; Formation of excited states; Born-Oppenheimer approximation; Selection rules and types of electronic transitions; Chromophore groups; Radiative and non-radiative transitions and their lifetimes; Photophysical laws and rules; Equipment for measuring emission spectra. Fluorescence emission and fluorescence excitation spectra; Emission quantum yield (FL, CL) and how it is measured; Fluorescence patterns and their characteristics; Stokes shift and method of its determination; Time-resolved FL spectra; Phosphorescence - formation and measurement; Solvatochromia; Basics of the chemiluminescence (CL) process - requirements. Examples of CL systems and their applications; Bioluminescence (BL): characterization and physical chemistry; Biological functions and applications of BL.

Prerequisites and co-requisites

Passing courses in the following subjects at the first-cycle (bachelor's) level: mathematics, physics, general chemistry, physical chemistry.

The student has extensive chemical knowledge and shows interest in physicochemical issues, allowing him to understand more complex problems in this field. Is able to use source texts, obtains, analyzes, evaluates and processes information from various sources, including the Internet and the media. Acquires knowledge through research - observes, verifies, independently draws conclusions and generalizes.

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written exam, test "Thermodynamics of natural processes"	50.0%	50.0%
	written exam, open questions "Fundamentals of practical photochemistry"	50.0%	50.0%
Recommended reading	Basic literature	Electronic materials provided by the lecturers.	
	Supplementary literature	J. R. Lakowicz, "Principles of fluorescence spectroscopy", Wydanie 3, Springer 2006, lub wcześniejsze: Kluwer Academics Plenum Publ., New York 1999. A. M. Garcia-Campana, W.R. G. Bayenes, "Chemiluminescence in Analytical Chemistry", Marcel Dekker, Inc., New York 2001. A. Martin, Physical Pharmacy, 3rd ed, Lippincott Williams and Wilkins Publ. 1983 lub nowsze (2005). R.P. Schwarzenbach, P.M. Gschwend, D.M. Imboden, Environmental organic chemistry, John Wiley & Sons, Inc. New York 1993.	
	eResources addresses		
Example issues/ example questions/ tasks being completed	**"Thermodynamics of natural processes"** - first and second laws of thermodynamics - state functions: energy U, enthalpy H, entropy S, free enthalpy G - use of state functions to describe physical processes (e.g. phase transformations) and chemical reactions - thermodynamic criterion of spontaneous transformations - biochemical thermodynamics: endergonic and exergonic reactions in biological systems - biochemical thermodynamics: mechanisms of transport through biological membranes - biochemical thermodynamics: aerobic respiration. **"Basics of photophysical processes":** - Jabłoński's diagram distinguishing light anmd dark processes, including their time scale;- Basic photophysical laws and concepts: Stark-Einstein's and Kasha's laws, Wavilov's and Al Sayed rules;- Stokes shift and quantum efficiency - their meaning, classification and calculation;- Types of electronic spectra (absorption and emission) and parameters characterizing them;- Non-standard fluorescence spectra (excitation, time-resolved, synchronous, 3D) - their generation and applications.		
Work placement	Not applicable		

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