Faculty of Science

KEMB39, Chemistry: Physical Chemistry - Basic Course, 15 credits

Kemi: Fysikalisk kemi - grundkurs, 15 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2023-06-08 to be valid from 2023-06-08, spring semester 2024.

General Information

The course is a compulsory first cycle course for a degree of Bachelor of Science in Chemistry.

Language of instruction: Swedish

Main field of studies	*Depth of study relative to the degree requirements*
Chemistry	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The overall learning outcome for the course is to give the students basic knowledge in physical chemistry in the fields of thermodynamics and quantum mechanics and their applications in natural sciences. The included laboratory course intends to give skills for both experimental and theoretical studies within these fields.

Knowledge and understanding

On completion of the course, the student shall be able to:

- account for the basic concepts and terminology of thermodynamics
- describe the nature of both ideal and non-ideal gases
- explain key concepts such as pressure–volume work, adiabatic process, isothermal process, reversible process, irreversible process and state functions
- explain the differences between a heat engine and a heat pump
- account for physical phase transformations of pure substances
- account for the thermodynamics of ideal and non-ideal mixtures

- describe the fundamentals of quantum mechanics
- account for the quantum mechanical treatment of translation, rotation and vibration
- describe the structure of atoms and their electrons
- describe the concept of chemical binding using the valence-bond theory and molecular orbital theory
- explain the symmetry properties of molecules and their applications
- account for various scientific and societal applications of thermodynamics and quantum mechanics

Competence and skills

On completion of the course, the student shall be able to:

- apply the first and second laws of thermodynamics on physicochemical problems
- calculate internal energy, entropy, Gibb's energy and Helmholtz energy and how they vary with temperature and pressure
- calculate the equilibrium for chemical reactions
- calculate entropy changes for reversible and irreversible processes and entropy of reactions at different temperatures
- calculate vapor pressure at different temperatures
- calculate freezing point and boiling point for mixtures
- carry out pressure, volume and temperature calculations for ideal and non-ideal gases
- master phase diagrams for pure substances and two-component systems
- master the concepts of osmotic pressure and chemical potential
- apply the quantum mechanical concepts of translation, rotation, vibration and spin on physicochemical problems
- draw molecular orbital diagrams and give an account for hybrid orbitals
- calculate electron configuration for arbitrary atoms
- present the point group for arbitrary molecules and draw conclusions based on these
- present and evaluate physicochemical calculations with correct units and numerical accuracy in a logical and relevant way
- critically discuss and interpret basic thermodynamic and quantum mechanical expressions and concepts
- apply knowledge in thermodynamics and quantum mechanics on some scientific, technological and societal problems

Judgement and approach

On completion of the course, the student shall be able to:

- assess the reasonableness in arguments connected to physicochemical problems
- assess risks with chemicals and handle these in a safe way
- interpret and evaluate experimental results independently
- demonstrate the ability to identify their own need for additional knowledge and to develop their competence in the field

Course content

The course consists of two modules:

Module 1 Theory 10 hp

The theoretical module consists of two parts:

Thermodynamics

In this the part, the following concepts are discussed: gases, pressure–volume work, the first law of thermodynamics, state functions, the concept of entropy, the second second law of thermodynamics, heat engines, Helmholtz energy, Gibb's energy, chemical potential, activities, ideal solutions, colligative properties, the phase rule and phase diagrams, the pressure and temperature dependence of the equilibrium constant, ion activities, Debye–Hückel limiting law.

Quantum Mechanics
In this the part, the following parts are discussed: the Schrödinger equation, wave functions, the Born interpretation, operators, expected values and the uncertainty principle and its applications. The electron structure of the atom and the structure of the periodic system are discussed, as well as molecules and chemical binding. The concept of symmetry is introduced, and its use in quantum mechanics and spectroscopy are illustrated.

Module 2 Laboratory sessions and associated compulsory components 5 credits

In this module, students will:

- plan and perform simple physicochemical experiments as well as carry out calculations and data analysis in connection with the interpretation of the results
- apply the knowledge that has been acquired in Module 1 in practice
- become acquainted with different physicochemical methods of measurement
- perform risk assessments at chemical laboratory work
- summarise their laboratory results in written scientific reports and give oral presentations
- carry out a computer-based laboratory session

Course design

Teaching consists of lectures, tutorials, exercises, and laboratory sessions. Participation in laboratory sessions and associated elements is compulsory.

Assessment

Assessment takes the form of a written exam at the end of the course and laboratory sessions during the course as well as participation in compulsory components.

Students who do not pass a regular assessment will be offered another opportunity for assessement soon thereafter.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a Pass grade on the whole course, the student must have Pass grades on the exam, the laboratory reports and the compulsory components.

The grading scale for the laboratory reports and the compulsory components is Fail and Pass, whereas the exam is graded according to the scale Fail, Pass and Pass with

Distinction.

The final grade is determined by the grade on the exam.

Entry requirements

To be admitted to the course, student must have basic eligibility, Physics B, and 45 credits in natural science studies, including knowledge equivalent to:

- KEMA20 General Chemistry, 15 credits
- KEMA41 Organic Chemistry - Basic Course 7.5 credits
- KEMA13 Biochemistry - Basic Course 7.5 credits
- MATA03 Mathematics for Scientists 1, 15 credits

Students who have obtained the equivalent knowledge by other means may also be admitted to the course.

Further information

The course replaces KEMB09 Physical Chemistry - Basic Course, 15 credits, and credits from that course cannot count towards a degree together with this course.

The course is offered at the Department of Chemistry, Lund University.

Subcourses in KEMB39, Chemistry: Physical Chemistry - Basic Course

Applies from V24

2401 Written exam, 10,0 hp
Grading scale: Fail, Pass, Pass with distinction
2402 Laboratory reports, 5,0 hp
Grading scale: Fail, Pass