UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Physical Chemistry

2425-2-E3201Q092

Aims

To introduce the basic concepts: for the study of macroscopic systems in the different states of aggregation; for the prediction of the spontaneity of processes on the basis of thermodynamic properties; for the definition of the properties of equilibrium systems; to study the speed of chemical reactions and the factors that influence them.
The course aims to provide:

- knowledge and understanding of the principles of thermodynamics of physical and chemical transformations and the fundamentals of the kinetics of chemical and biochemical reactions, through lectures.

- ability to apply these principles to studies of interest to the sciences and technologies for the environment, through numerous examples presented in class and the classroom exercises.

- autonomy of judgment, through the analysis of real problems and the discussion and selection of solutions.

- communication skills, through active participation in lectures and exercises and the oral exam.

- ability to learn, stimulated by the constant effort to resume and integrate the previous knowledge of mathematics, physics and chemistry, to analyze complex physical and chemical transformations.

Contents

Thermodynamics: Thermodynamic properties and laws. Applications to: phase transitions; solutions; chemical reactions.

Chemical Kinetics: Rates of chemical reactions. Reaction mechanisms. Activation parameters. Catalysis.

Detailed program

a) Introduction to the properties of macroscopic systems.

b) Thermodynamics:

- Definition of the main thermodynamic properties (energy, enthalpy, entropy) and references to the laws of thermodynamics.
- Free energy and equilibrium; evaluation of the spontaneity of a process through calculation of the Gibbs free energy variations.
- Phase equilibrium: phase diagrams of pure substances; Clausius Clapeyron equation.
- Mixing equilibrium: ideal and real gas mixtures; mixtures and solutions of ideal and real liquids.
- Chemical equilibrium: variation of Gibbs free energy in reactions; equilibrium constant; van't Hoff equation.

c) Chemical Kinetics:

- Rates of chemical reactions. Rate law, rate constant and order of a reaction. Kinetic experiments.
- Methods for determining the reaction order and the rate constant.
- Reaction mechanisms.
- Reaction coordinate, transition state and activation parameters; Arrhenius equation.
- Catalysis; Michaelis Menten equation.

Prerequisites

Prerequisite. Basic knowledge of: general, inorganic and organic Chemistry, Mathematics, Physics.

Propaedeutics. There are no imposed propaedeutics, but it is recommended to have passed the exam of General and Inorganic Chemistry, Mathematics I, and General Physics.

Teaching form

Lessons, 4 credits (32 hours): 16 two-hour lectures, in person, Delivered Didactics. Lectures are also video-recorded and made available on the e-learning page.

Exercises, 2 credits (20 hours): 10 two-hour practical classes, in person, Interactive Teaching. Exercises are proposed to be solved in the classroom with the participation of the entire class.

Textbook and teaching resource

In the e-learning page of the course are provided: the slides presented during the lessons; some exercises with solutions for individual preparation for the written exam.

Recommended text: Elementi di Chimica Fisica, P. Atkins, J. De Paula, Zanichelli, 2007.

Semester

Second semester

Assessment method

The assessment of the Physical Chemistry course consists in a written and an oral examinations. The two examinations can be taken separately.

The ***written examination*** consists in the solution of thermodynamic and chemical kinetic exercises and has the objective of verifying the acquired knowledge, the ability to apply such knowledge to the solution of problems, and the ability of judgement. The test is evaluated with one of the following judgments: EXCELLENT, GOOD, DISCRETE, SUFFICIENT, NOT ALLOWED. Whoever passes the written test (at least SUFFICIENT) is admitted to the oral exam. The written examination is kept valid for 1 year.
There are 2 ***intermediate tests*** , one for the Thermodynamics part and one for the Kinetics part, which can replace the written examination. The tests are assessed with the same marks as the total written examination and are kept valid for 1 year.

The ***oral examination*** includes a brief discussion on the written examination (or the intermediate tests) and an interview on the topics covered in class. It aims to verify the knowledge and understanding of the exam program.

The final mark (18-30/30) is obtained by integrating the evaluations of the written and oral examinations.

Office hours

Students reception after e-mail appointment.

Sustainable Development Goals

QUALITY EDUCATION | GENDER EQUALITY | SUSTAINABLE CITIES AND COMMUNITIES