UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Chimica Fisica I

1920-2-E2702Q009

Aims

The aim of the course is to provide the basic concepts of classical thermodynamics for the study of macroscopic systems, in order to predict the spontaneous evolution of the processes and the achievement of the equilibrium state.

Knowledge and understanding

Applying knowledge and understanding

Making judgements

Communication skills

Contents

Description of macroscopic systems; perfect gases and real gases; first law of thermodynamics, Energy and Enthalpy; Entropy, second and third law of thermodynamics; free energy and equilibrium; physical transformations of pure substances; simple mixtures; chemical equilibrium.

Detailed program

Description of macroscopic systems*: thermodynamic representation of physical systems; work and heat definitions; mathematical description of the systems; cyclic processes.* ***Perfect gases and real gases****: the state equation of perfect gases; real gases; modeling of real gases.* ***First law of thermodynamics****, Energy and Enthalpy: molecular interpretation of energy variations; measurement of exchanged heat as a state variable; thermal capacity of gases; pure compounds: dependence of Cv, Cp, E and H from the temperature; expansion of an ideal gas; changes in Energy and Enthalpy; Thermochemistry: calculation of enthalpy variations.* ***Entropy, second and third law of thermodynamics****: spontaneous processes and second law; the second law of thermodynamics; criterion of spontaneous transformations in terms of Entropy; molecular interpretation of Entropy; mathematical combination of the first and second law; the third law of thermodynamics; Entropy variation in physical transformations of pure compounds; variation of Entropy in physical transformation of mixtures: mixing Entropy; reaction Entropy and its temperature dependence; heat engine; refrigeration cycle.* ***Free energy and equilibrium****: Gibbs free energy and Helmholtz free energy; the criterion of spontaneous transformations in terms of free energy; meaning of free energy; Gibbs free energy variation in pure compounds.* ***Physical transformations of pure substances****: phases and phase transformations; phase diagrams; Clausius-Clapeyron equation; changes in properties in correspondence with phase transitions.* ***Simple mixtures****: the partial molar quantities; the thermodynamics of mixing; the chemical potential of liquids; the thermodynamic properties of solutions; real solutions and activities; phase diagrams of binary systems.* ***Chemical equilibrium****: molar standard free energy of reaction; the response of equilibria to the conditions; electrochemical equilibrium.*

Prerequisites

Mathematics: differential calculus for functions with one or more variables; integrals; differential equations. General Chemistry: properties of gases and solutions; stoichiometric calculations related to chemical equilibria. Physics: work and energy.

Teaching form

The course includes 5 CFU (35 hours) of lectures and 3 CFU (36 hours) of numerical exercises in the classroom. During the exercises, problems are presented, with increasing complexity, to be solved using the knowledge acquired in frontal lessons. The issues addressed during the exercises will be the subject of the written tests. The performance of the problems, led by the teacher, tends to develop and strengthen the student's ability to identify

the most suitable procedures to find the solution.

Textbook and teaching resource

Lecture notes of the teachers: U. Cosentino, D. Pitea *Elementi di Chimica Fisica*

P.W. Atkins, J. de Paula Physical Chemistry, 9a edition, 2011, Oxford University Press

Videotaping of the lessons on the e-learning page of the course.

Semester

First semester

Assessment method

During the course there are two partial written tests: the first at mid-term, the second at the end of the course. Students who achieve an average mark higher than or equal to 15 out of thirty can access the oral test and present themselves with a grade given by the average of the marks obtained. Those who do not or do not pass the partial written tests must take the written test proposed at each appeal, which must be passed with a mark higher than or equal to 15/30.

All written tests are divided into 2 or 3 exercises to be performed in two hours; the exercises proposed generally have the same "weight" from the point of view of evaluation. The exercises focus on the topics of the course that were the subject of the exercises carried out in class. The partial written tests and the written test of the individual appeals are valid for 1 year.

The final grade, expressed in thirtieths with possible praise, is given by the average of the two tests.

Office hours

Every day, by appointment