



PHYSICAL CHEMISTRY AND BIOPHYSICAL THINGS

Enrollment year	2019/2020
Academic year	2021/2022
Regulations	DM270
Academic discipline	CHIM/02 (PHYSICAL CHEMISTRY)
Department	DEPARTMENT OF BIOLOGY AND BIOTECHNOLOGY "LAZZARO SPALLANZANI"
Course	BIOTECHNOLOGY
Curriculum	Chem- Pharma-Tech
Year of study	3°
Period	2nd semester (01/03/2022 - 14/06/2022)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian
Activity type	ORAL TEST
Teacher	BERBENNI VITTORIO (titolare) - 6 ECTS
Prerequisites	Mathematics: physical meaning of derivative and integral. Derivation and Integration of simple functions. The equation of a straight line: least squares approximation. Physics: fundamentals of thermodynamics Chemistry: 1) Balance of chemical reactions. Endothermic and exothermic reactions 2) Chemical equilibrium and mass action law 3) Awareness of the factors affecting the reaction rate. Arrhenius equation 4) Good knowledge of measuring units
Learning outcomes	The physical meaning of the thermodynamic function H,S,G and A. Calculation of reaction enthalpies and entropies along with their

dependence on temperature. Calculation of the equilibrium constant of a chemical reaction. Meaning of reaction order and application of the various experimental methods to determine it. Relationship between the elementary processes of a reaction mechanism and the experimental reaction order: some discussed examples (e.g.: chain reactions, unimolecular reactions). The fundamentals of vibrational spectroscopy. The aspect of an infrared spectrum: the region of the characteristic vibrations and the fingerprint region. Practice in the interpretation of IR spectra of several organic compounds (Hydrocarbons, Alcohols and Phenols, Ethers, Amines and Carbonyl Compounds). The thermal methods of investigation: differential thermal analysis, differential scanning calorimetry (both power compensated and heat flux).

Course contents

The first law of thermodynamics: heat and work, internal energy and enthalpy. Molar heat capacity. Phase change enthalpy and its measure. Combustion reactions: the biological fuels. The dependence of the reaction enthalpy with temperature. The second law of thermodynamics and the thermodynamic function entropy. Entropy changes associate to temperature changes and to phase transitions. Entropy variations for system and ambient: the criterion in order to assess the spontaneity of the process. The third law of thermodynamics and the absolute entropy. Standard reaction entropy. From entropy to free energy. The chemical equilibrium and its thermodynamic basis. Changes of free energy with composition. The standard free energy of reaction. Effect of temperature, pressure and catalysts on the equilibrium constant. Definition and study of reaction rate. The kinetic law of a reaction: the reaction order. Experimental methods for the determination of reaction order. The integrated kinetic laws. The influence of the temperature on the reaction rate. Reaction mechanism: the Lindemann approximation and steady state method. Some examples of reaction mechanism: the unimolecular reactions and the chain reactions. Some physic-chemical techniques: Vibrational (infrared) spectroscopy. The thermal techniques: differential thermal analysis and differential scanning calorimetry (power compensated and heat flux). Thermogravimetric analysis. The FRET spectroscopy (Fluorescence Resonance Energy Transfer). The Scanning Electron Microscopy (SEM).

Teaching methods

As for the part of physical chemistry presence lectures are planned. The arguments will be completed with the discussion and the solution of numerical exercises to better understand the theory involved. The part of infrared spectroscopy will consist of some theoretical lectures and several practical sessions devoted to the interpretation of IR spectra of organic molecules. The IR FT-IR spectrophotometer will be showed to the students and the relevant experimental parameter along with their influence on the obtained spectra will be discussed.

Reccomended or required readings

A written summary of the parts of thermodynamics and kinetics will be provided by the Teacher. As for Spectroscopy, besides the copies of the tables shown in class, the students will receive a hardcopy of all the IR spectra discussed in class. For the other experimental techniques some supplementary material and information will be supplied to the students.

The oral examination will be constituted by 2 parts that the student can make separately or at one time. The arguments of the part on physical chemistry have been divided under 8 parts. Every student has to prepare a short discussion on one of the 8 parts. Then a short question on the remaining arguments will be proposed. As concerns the part on the experimental techniques a) IR spectroscopy : interpretation of 1 / 2 spectra selected among those discussed during the lectures. Finally a question on the others described experimental techniques (thermal analysis methods).

Further information

No further information is provided.

