UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

PHYSICAL CHEMISTRY AND LABORATORY

Enrollment year	2018/2019
Academic year	2019/2020
Regulations	DM270
Department	DEPARTMENT OF CHEMESTRY
Course	CHEMISTRY
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	1st semester (01/10/2019 - 17/01/2020)
ECTS	15
Language	Italian

The activity is split

502121 - **PHYSICAL CHEMISTRY AND LABORATORY - 1**

503832 - **PHYSICAL CHEMISTRY AND LABORATORY - 2**

UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

PHYSICAL CHEMISTRY AND LABORATORY - 1	
Enrollment year	2018/2019
Academic year	2019/2020
Regulations	DM270
Academic discipline	CHIM/02 (PHYSICAL CHEMISTRY)
Department	DEPARTMENT OF CHEMESTRY
Course	CHEMISTRY
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	1st semester (01/10/2019 - 17/01/2020)
ECTS	9
Lesson hours	72 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	BERBENNI VITTORIO (titolare) - 6 ECTS CAPSONI DORETTA - 3 ECTS
Prerequisites	For what concerns General Chemistry, reference will be made to 1) Chemical Reactions and their stoichiometric balance . This will be useful to introduce the thermal balane of chemical reactions (Hess Law) 2) Chemical equilibrium. Law of mass action. This will serve as a basis for the introduce the chemical potential and the activity. This fine tunes the law of mass action and allow also the consideration of chemical equilibria in non ideal and/or inhomogeneous equilibrium. 3) Phase diagrams of pure compounds (e.g. water and carbon dioxide) . Diese knowledge will be extended by adding the variable composition so as that the students shoulbe capable of interpreting the two-components phase diagrams. For what concerns Physics the general concepts (first of all the electromagnetic spectrum) are needed while for what concerns mathematics the students will be requested to be able to execute derivative and integral of elementary functions.

Learning outcomes	The three principles of thermodynamics. The main thermodynamic functions: internal energy, enthalpy, entropy, free energy of Gibbs and Helmoltz. The chemical and the phase equilibrium. The thermodynamic properties of mixtures. The quantum mechanics: the Schroedinger equation. The operators. The solutions of the Schroedinger equation for the hydrogen athom.
Course contents	The first principle of thermodynamics: heat and work. The thermodynamic properties internal energy (U) and enthalpy (H).The relationship between U und H. Thermochemistry: the formation enthalpy. What is it, how can it be determined, what is its use. The integral enthalpy of dissolution: the formation enthalpy of ions. The thermodynamic cycle of Born-Haber. Enthalpy of chemical reaction and its dependence on the temperature. Relationship between the enthalpy of formation and the bond energy: some examples. Calorimetry: classification of calorimeters based on operation mode and on working principle. The second principle of thermodynamics: the function entropy and its thermodynamic and statistic definition. Entropy and spontaneous processes. Entropy changes with pressure and temperature. The transition entropy. The third principle of thermodynamics: the calculation of the absolute entropy of a substance as a function of temperature. The functions G and A: physical meaning. The differential of the functions U, H, S, G, A. The Maxwell's relationships. The relationships between Cp and Cv. Phase equilibrium: the Gibbs Theorem. Phase equilibrium in one-component system. The phase rule. Phase equilibrium in two-component systems: the liquid-vapor and the solid-liquid equilibria. Phase diagrams. The thermodynamic properties of mixtures: the partial molar volume and the chemical potential. Ideal and real mixtures: the activity and the activity coefficient. The chemical equilibrium: the equilibrium constant and its dependence on pressure and temperature. Calculation of the equilibrium constant. The unanswered questions of classical physics and the quantum mechanics. The Schroedinger equation. The Wave function and the Born interpretation of the wave function. The operators and the Heisemberg principle. Applications : the particle in a box, the harmonic oscillator, the rigid rotor and the particle on a spherical surface. Structure and spectra of the hydrogen atoms. The quantic numbers.
Teaching methods	All the topics will be presented in the lessons. At the end of every group of lesson (between 2 and 4 lessons) problems on the topics just presented will be solved through a discussion with the students. This should ease the understanding by the students of the presented topics
Reccomended or required readings	Peter Atkins- Julio de Paula "Chimica Fisica" (V italian edition translated from the IX english edition) Zanichelli. Some written material and excercises with solutions provided by the teacher per e-mail.
Assessment methods	Written and Oral Exams. In the written part the students will have to solve exercises on the three principles of thermodynamics (enthalpies of reactions and entripies of reactions with the aim to calculate the

	equilibrium constants of chemical reactions. Furthermore the students shall also be capable to solve exercises on partial molar volume, mixture properties (law of Raoult and Henry) and colligative properties so as to be able to calculate activities of the components of these systems. Finally the will have to show how a two components solid-liquid diagrams will be interpretated. The oral part will be devoted to the discussion of errors made from the students in the written part . Finally a discussion on simply topics of quantomechanics will complete the exam.
Further information	Nothing special
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile

UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

PHYSICAL CHEMISTRY AND LABORATORY - 2	
Enrollment year	2018/2019
Academic year	2019/2020
Regulations	DM270
Academic discipline	CHIM/02 (PHYSICAL CHEMISTRY)
Department	DEPARTMENT OF CHEMESTRY
Course	CHEMISTRY
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	1st semester (01/10/2019 - 17/01/2020)
ECTS	6
Lesson hours	72 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	BERBENNI VITTORIO (titolare) - 3 ECTS CAPSONI DORETTA - 3 ECTS
Prerequisites	=
Learning outcomes	The course aims at provide students with theoretical and laboratory knowledge in the areas of thermodynamics (calorimetry), of ion transport (conductimetry) and electrochemistry.
Course contents	The necessary arguments to deal with later laboratory experiments are first introduced at the theoretical level. The focus is on calorimetry and thermoanalytical techniques (at equilibrium and scanning), on the theory of ion transport (strong and weak electrolytes, transport number, Einstein, Nernst-Einstein, Stokes-Einstein equations), on electrochemical systems (coefficient of activity, galvanic and electrolytic cells, Nernst equation, the Nernst scale of the electrochemical potentials). The second part of the course will consist of laboratory experiments of conductimetry and electrochemistry.

Teaching methods	Frontal lessons and material provided by the teachers
Reccomended or required readings	-Peter Atkins Julio de Paula, Physical Chemistry, Fourth Edition Italian, Freeman Material provided by the teacher
Assessment methods	Written test based on solving problems Oral examination Assessment of the report on the laboratory experiences.
Further information	Written test based on solving problems Oral examination Assessment of the report on the laboratory experiences.
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile