UCLouvain

lepl1301

2024

Chemistry and Physical chemistry 1

5.00 credits	30.0 h + 30.0 h	Q2

Teacher(s)	. SOMEBODY ;Contino Francesco ;Demoustier Sophie ;Jonas Alain (compensates Contino Francesco) ;Nysten Bernard ;
Language :	French
Place of the course	Louvain-la-Neuve
Main themes	Three general topics are presented: • An introduction to the understanding of matter structure and properties which leads to study the structure of atoms, the periodicity of atomic properties, intra- and inter-molecular bonds and how they control the structure of materials. • An introduction to thermodynamics within the frame of physical and chemical equilibrium, in a rigorous way but without necessarily using the complete formalism of thermodynamics; the approach is based on the atomic structure of matter and ideas derived from statistical physics. This includes state variables, the first principle of thermodynamics (energy conservation, internal energy, enthalpy, heat and enthalpy of reaction), the second principle of thermodynamics (spontaneous and non-spontaneous processes, entropy), free energy (including its interest to describe equilibrated reactions and its link to equilibrium constants). The notion of ideal gas will also be briefly introduced. • How these notions are of interest to understand one-component phase transformations and chemical equilibria in aqueous solutions, such as acid/base reactions and solubility equilibria.
Learning outcomes	**At the end of this learning unit, the student is able to :** **Contribution of the course to the program objectives**: Regarding the learning outcomes of the program of Bachelor in Engineering, this course contributes to the development and the acquisition of the following learning outcomes: • LO 1.1 • LO 3.2 • LO 4.2, 4.4 **Specific learning outcomes of the course**: At the end of the course, the student will be able • to write the equation corresponding to simple reactions, to use the concepts of mole, atomic or molar mass, mass or molar yield to predict the reaction products; • to identify, define, explain and use the concepts of atom, molecule, compound, mole, atomic or molar mass, atomic or molecular orbitals, electronic configuration, ionisation and ionisation energy, electroaffinity, ionic, metallic, covalent and intermolecular bindings, molecular structure, binding energy; • to use the above mentioned conseptes to predict the electron configuration of an atom, an anion or a cation, to predict and explain the variation of ionisation energy or electroaffinity between elements, to predict the Lewis and the spatial structure of a molecule, to explain the formation of interatomic binding on the basis of the concepts of ionisation and hybridation, to predict the evolution of properties such as boiling temperature on the basis of intermolecular forces; • to apply the first principle of thermodynamics to analyze energy exchanges of an ideal gas, and to use tables and calculate reaction enthalpies of simple chemical reactions or of phase transformations from formation enthalpies; • to apply the second principle of thermodynamics to predict the evolution of simple systems, to compute entropy variations, and more specifically to calculate reaction entropies of simple chemical reactions from tables of absolute entropies; • to calculate equilibrium concentrations of simple reactions involving ideal gases and pure solids and liquids, from equilibrium constants and initial concentrations or vice-versa; to compute equilibrium constants from tables of thermodynamic data; to compute equilibrium vapour pressures of pure liquids from their enthalpies of vaporisation; • to identify the type of solutions (acid, base, salt, buffers), the main species present in solution and to calculate the concentration of these species, the pH, the pOH and to make the link with acidity or basicity constants; • to interpret the characteristics of acid-base titration curves and to calculate the pH on every point of the curve; • to predict the relative forces of acids and bases in relationship with the strength of chemical bindings and with the acidity or basicity constants; • to organise himself to, in group, to prepare and solve simple chemistry problems or to realise basic chemistry laboratories, interpret the results and write short reports(4.2, 5.2, 5.4).

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Evaluation methods	In the course of the four-month term, a project (PBL) dealing with an issue of sustainable development and transition must be solved as a group. This project is followed by a group presentation in a practical session and the writing of a report, both of which are assessed. This assessment is worth a maximum bonus of 2 points, which will be added to the examination mark as specified below. Some parts of the course may comprise a continuous evaluation resulting in a grade. In that case, this grade will be added to the grade from 0 to 20 obtained at the exam *for this specific part*, the total being limited to 20. The written exam covers the whole material taught during the quadrimester. For the examination, students receive, with the questionnaire, a copy of the periodic table of elements and a copy of the forms drawn up by the teachers, previously available on the course Moodle site. All the data needed to solve the problems numerically are supplied with the questionnaire. The examination is in the form of an MCQ. To ensure that the final mark for the course reflects a minimum level of skills acquired in each of the three parts of the course, the examination mark is calculated on the basis of the geometric mean of the marks obtained for the three parts (any zero in one part is converted into a non-zero mark before this mean is calculated). The overall mark for the course is the sum of the examination mark and the PBL bonus mark, limited to 20/20 and rounded to the nearest whole number. However, to qualify for the bonus mark, one of the following conditions must be met: • none of the parts is deficient (mark equal to or above 10/20 for all three parts); • two out of three parts show a minor deficiency (mark above 8/20 for these two parts and above or equal to 10/20 for the 3rd part); • **only one** of the three parts shows an "average" failure (mark higher than 6/20 for this part and higher than or equal to 10/20 for the other 2 parts).
Teaching methods	Teaching consists of lectures and group-based learning through exercises (APE) and problems (APP). The APE and APP sessions are organised in the presence of tutors, who ensure that the students are given the opportunity to reflect on and solve the problem or exercise and, through this work, to learn the concepts involved. Some parts of the course may be given in a flipped classroom format.
Content	The LEPL1301 Chemistry and Physical Chemistry 1 course is the first chemistry and physical chemistry course in the civil engineering engineering sciences programme. The first part of the course focuses on an introduction to chemistry and the basic concepts needed to solve "chemical problems" (notions of atom, molecule, chemical notation, mole, concentration, energy of reaction, yield of reaction, limiting reagent, etc.). It continues with an understanding of matter from the microscopic to the macroscopic. This involves firstly studying the structure and properties of atoms and ions. The chemical bonds between atoms to form molecules and the associated energies are then presented. On this basis, the second part of the course focuses on the thermodynamic description of phase and chemical equilibria. After describing the properties of perfect gases, it develops the concepts of work, heat, enthalpy, statistical entropy, thermodynamic entropy and free enthalpy. Using the criteria for spontaneous evolution based on these concepts, she establishes the formalism describing equilibria (equilibrium constants, free enthalpies of reaction) and applies it to the study of equilibria involving pure solids, pure liquids and gases. Based on the notions of chemical equilibrium and equilibrium constant, the third part of the course deals with the concepts of acids and bases. Thermodynamics, in particular equilibrium constants, is used to study the strength of acids and bases quantitatively. Chemical equilibria in the aqueous phase are then discussed and illustrated through the study of acid-base titrations and solubility equilibria. Through exercises and a project carried out during the practical sessions, the impact of fuel use on greenhouse gas emissions, ocean acidification and biodiversity is addressed. The aim is to show the public that the basic concepts of chemistry and physical chemistry can be used to tackle these sustainable development issues with a critical eye.
Inline resources	*Moodle site :* *https://moodle.uclouvain.be/course/view.php?id=1892*
Bibliography	Ouvrage de référence : « Principes de Chimie », Atkins, Jones, Laverman (de boeck) (disponible au SICI). Certaines dias présentées au cours, les énoncés et les solutions des exercices sont disponibles sur Moodle. Pour certaines parties, des notes de cours sont aussi disponibles sur Moodle. Des vidéos et podcasts sont aussi mis à disposition sur Moodle ainsi que les correctifs des examens des années précédentes.
Faculty or entity in charge	BTCI

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Bachelor in Engineering	FSA1BA	5		🔍
Bachelor in Engineering : Architecture	ARCH1BA	5		🔍