# lchm1211a

*2021*

# Chimie générale 2

| | | |
|---|---|---|
| 5.00 credits | 30.0 h + 30.0 h | Q2 |

| | |
|---|---|
| Teacher(s) | Devillers Michel ;Hautier Geoffroy ;Leyssens Tom (compensates Hautier Geoffroy) ; |
| Language : | French |
| Place of the course | Louvain-la-Neuve |
| Prerequisites | *The prerequisite(s) for this Teaching Unit (TU) are specified at the end of this sheet, in relation to the programs/ training courses that offer this TU.*<br>*The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.* |
| Main themes | **0. INTRODUCTION TO PHYSICAL CHEMISTRY**<br>Chemical equilibrium and partition coefficients. Applications.<br>**1. THERMODYNAMICS**<br>First principle of thermodynamics. Thermochemistry. Second principle of thermodynamics. Free Enthalpy.<br>**2. PHASE EQUILIBRIA**<br>Generalities. One-component systems: state diagram of a pure body. Thermodynamics and phase transition temperature.<br>Phase rule. Two-component systems: binary phase diagrams.<br>**3. CHEMICAL EQUILIBRIA IN SOLUTION**<br>A/ Complements of acid-base equilibria and pH-metry.<br>B/ Solubility and complexation. Complex reaction networks. Quantitative study of some cases.<br>**4. COMPLEMENTS OF ELECTROCHEMISTRY**<br>Electrolysis. Conductivity of solutions. Batteries.<br>*Part 3A is not included in LCHM1211A.* |
| Learning outcomes | |
| Evaluation methods | Written examination at the end of the year, supplemented by continuous evaluation during the year (preparation of laboratory sessions and reports).<br>Practical training is an integral and inseparable part of the general chemistry course.<br>Participation in all **practical sessions** is therefore **MANDATORY**.<br>The laboratories are taken into account in the final grade of LCHM1211 taken in deliberation.<br>Any **REASONED** absence (justified by a medical certificate in case of illness, or by an official document in other cases) will result in the recovery of the missed session during the last week of the term.<br>Any **NON-MOTIVATED** absence will in principle be sanctioned by **a NEGATIVE mark of 5 POINTS** on the final mark of LCHM1211 taken into account in the deliberation, and may, depending on the degree of recurrence and the assessment of the situation by the teaching staff, result in a non-negotiable final mark of **ZERO out of 20**.<br>Should the number of unjustified and/or justified absences become significant, the teaching staff reserves the right to activate the articles of the RGEE allowing the jury to prohibit the student from registering for the corresponding exam. |
| Content | **I. Thermodynamics.**<br>First principle of thermodynamics<br>1. Internal energy, work, heat. Conservation of total energy, first principle. Enthalpy. Molar heat. Global enthalpy balance with phase changes. Adiabatic transformation and calorimetry.<br>Applications of the 1st principle to chemical transformations: Thermochemistry<br>2. Thermochemical equations: with heat balance. H and U are state functions. Hess's law. Standard enthalpy of formation. Standard enthalpy of combustion. Enthalpy of atomization. Enthalpy of binding. Standard enthalpy of reaction. Thermochemistry of solutions. (DHf°) of ions in aqueous solution. Applications and illustrations of the concepts (e.g. acid-base neutralization).<br>Variation of DH with temperature. The second principle of thermodynamics<br>3. Entropy and disorder. Spontaneity. Standard entropy as a function of temperature. Standard entropy of reaction. Microscopic interpretation of entropy. Global variation of entropy. The free enthalpy<br>4. Definition. Relation with spontaneity. Standard free enthalpy of formation. Standard free enthalpy of reaction. Influence of temperature on spontaneity. Non-spontaneous reaction becoming spontaneous at another temperature.<br>Applications and illustrations (e.g. Ellingham diagrams for the reduction of oxides). Chemical equilibrium and thermodynamics |

| | |
|---|---|
| | 5. Entropy of mixing. Link with the equilibrium constant. Reaction of equilibria to changing conditions.<br>Van't Hoff relation: influence of T on K.<br>**II. Phase equilibria.**<br>Generalities<br>1. Definitions: physical states of matter, phase, constituents. One-component systems: state diagram of a pure body<br>2. P-T diagrams of a one-component system. Link between thermodynamics and one-component phase diagrams. Gibbs' phase rule. Examples of one-component P-T diagrams ($H_2O$, $CO_2$, Fe, ..). Multi-component systems<br>3. Phase diagram of multicomponent phases. Link between thermodynamics and multicomponent phase diagrams. Entropy of mixing and free enthalpy for ideal solutions. Multi-component phase rule. Construction of phase diagrams from free enthalpy curves: common tangent rule. Reading phase diagrams: lever rule. Colligative properties of solutions<br>4. Cryoscopy, ebullioscopy. Entropy of mixing and free enthalpy for regular solutions. Applications and illustrations with binary phase diagrams (liquid-gas, liquid-solid, solid-solid).<br>**III. Chemical equilibria in solution.**<br>A/ Complements of acid-base equilibria and pH-metry: Mixtures of several solutes. Polyfunctional solutes.<br>B/ Complex reaction networks: Reminders on chemical acid-base, solubility and complexation equilibria. Reactions of an acid with a weakly soluble acid salt. Precipitation of a weak acid salt. Precipitation of a hydroxide in the presence of a weak base. Competition between precipitation and complexation. Quantitative study of some cases: Selective precipitation of sulfides, Solubilization by complexation.<br>**IV. Complements of electrochemistry.**<br>Reminders on electrochemical cells: electrolysis and batteries. Notions of electricity. Electrolysis<br>1. General principle. Faraday's laws. Reactions at electrodes and industrial applications. Conductivity of solutions<br>2. Principles and definitions. Mobility of ions. Experimental aspects. Transport numbers and balance of an electrolysis. Applications: Degree of dissociation of a weak electrolyte. Ionic product of water. Determination of a solubility product. Conductimetric titrations.<br>Batteries, or galvanic cells<br>3. Reminders: electromotive force of a battery, standard electrode potential and Nernst relation, energy balance of the battery. Main types of electrodes: metal-ion electrodes, insoluble metal-salt electrodes, gas electrodes, redox electrodes.<br>Analytical applications: pH measurement, potentiometric titrations, commercial batteries, primary batteries, secondary batteries, or accumulators, fuel cells.<br>**Laboratory sessions (4x3h + 4x3h30) :**<br>Each student individually prepares and performs an experiment illustrating a theme of the course. They write a report. A laboratory manual allows the student to prepare each laboratory session. A verification of this preparation takes place at the beginning of each session.<br>**Exercise sessions (13 x 2h) :**<br>Theoretical problem solving and numerical exercises in the presence of assistants.<br>***Part LCHM1211A does not include part A of chapter III. It includes only 4 laboratory sessions of 3 hours and 7 exercise sessions of 2 hours.***<br>Supervision: weekly individualized contacts in order to answer specific questions. |
| Inline resources | moodleucl |
| Bibliography | Livre de P. Atkins, L. Jones et L. Laverman : "Principes de Chimie", Trad. Française de A. Pousse (De Boeck), ou édition anglaise originale correspondante, complété par des notes de cours. Manuel de travaux pratiques et fascicule d'exercices. Documents fournis sur Moodle. |
| Faculty or entity in charge | CHIM |

## Programmes containing this learning unit (UE)

| Program title | Acronym | Credits | Prerequisite | Learning outcomes |
|---|---|---|---|---|
| Bachelor in Bioengineering | BIR1BA | 5 | LBIR1140 AND LBIR1170 | 🔍 |