UCLouvain

# lchm2181

*2024*

# Homogeneous and heterogeneous catalysis

| 3.00 credits | 22.5 h + 7.5 h | Q1 |
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| Teacher(s) | Gaigneaux Eric ;Riant Olivier ; |
| Language : | English<br>> French-friendly |
| Place of the course | Louvain-la-Neuve |
| Main themes | **Generalities on catalysis :**<br>Recall of the basic principle of catalysis. Homogeneous, heterogeneous catalysis and heterogenisation of homogeneous catalysis.<br>Description and comparison of elementary processes in these two categories of catalysis.<br>**Part I : homogeneous catalysis :**<br>1. Basic principles of homogeneous catalysis.<br>- Recall of basics in organometallic chemistry (16-18 electron rule, classification of ligands, donation and retrodonation).<br>- Elementary reactions: ligand substitution, oxidative addition, reductive elimination, insertion, oxidative coupling.<br>- Ancillary ligands: mono and di-phosphines case, cone angles, diaminocarbenes ligands.<br>- Principle of catalysis by phase transfer.<br>2. Some examples of important industrial processes using homogeneous catalysis. Examples: alkene hydrocyanation (nylon channel), alkene hydroformylation, acid acetic synthesis, oxidation processes, biphasic processes.<br>**Part II : heterogeneous catalysis :**<br>1. Basic principles of heterogeneous catalysis.<br>2. Review of principal kinetic models of heterogeneous catalysis (Langmuir-Hinshelwood, Eley-Rideal, Mars -van Krevelen)<br>3. Illustrations in the following areas: petrochemistry (hydrotreatment, catalytic craking, oxidation and ammoxidation of propene, epoxidation of ethylene, oxidation of butane in maleic anhydride, use of zeolites,<br>), environment (DeNOx, exhaust gases<br>) and basic inorganic chemistry synthesis (ammonia, sulphuric acid,<br>). |
| Learning outcomes | **At the end of this learning unit, the student is able to :**<br>1 This teaching aims :<br>1. at providing future chemists a global and unified vision of catalysis, describing and comparing elementary processes in homogeneous and heterogeneous catalysis, and<br>2. at illustrating the importance of the two categories of catalysis at the industrial level. |
| Evaluation methods | The exam consists of two parts (homogeneous catalysis and heterogeneous catalysis), each of which is worth 10 points;<br>the sum of the marks of each part constitutes the mark out of 20 for the whole course.<br>For the heterogeneous catalysis part specifically :<br>closed book written exam, with specific questions, but also transversal questions requiring to activate the knowledge on the whole course. |
| Teaching methods | For the heterogeneous catalysis part :<br>Lecture with use of a powerpoint available on Moodle at the beginning of the teaching. A constant interaction with the students is established in the form of questions and answers involving them in debates on specific issues, allowing them to integrate the material during the session. |
| Content | Heterogeneous catalysis part :<br>1. Basic principles of heterogeneous catalysis; description of the different steps of the heterogeneous catalytic cycle: diffusions, adsorption-desorption, reaction, and their impact on the global performances<br>2. Review of the main kinetic models of heterogeneous catalysis (Langmuir-Hinshelwood, Eley-Rideal, Mars -van Krevelen)<br>3. Illustration via two case studies: the automotive catalytic converter, and biomimetic catalysts, as well as via examples from the petrochemical industry discussed continuously in the course. |

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| Inline resources | For the heterogeneous catalysis part :<br>The course notes used by the teacher constitute a syllabus, and are made available on the Moodle platform before the start of the course; printing them (in mode 2, max 4 slides per side) is highly recommended. |
| Other infos | For the heterogeneous catalysis part :<br>this part of the course can be given in English. |
| Faculty or entity in charge | CHIM |

| Programmes containing this learning unit (UE) | | | | |
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| Program title | Acronym | Credits | Prerequisite | Learning outcomes |
| Master [120] in Chemistry | CHIM2M | 3 | | 🔍 |
| Master [60] in Chemistry | CHIM2M1 | 3 | | 🔍 |