# Basics of Atmospheric Chemistry

Educational subject description sheet

## Basic information

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| **Field of study**<br>Joint Bachelor in Sustainability<br>**Speciality**<br>Sustainable Physics & Chemistry<br>**Organizational unit**<br>Faculty of Law and Administration<br>**Study level**<br>first cycle (joint degree programme)<br>**Study form**<br>full-time degree programme<br>**Education profile**<br>General academic<br>**Mandatory**<br>obligatory | **Education cycle**<br>2025/26<br>**Subject code**<br>UJ.WPAJBSSPCS.8100.16414.25<br>**Lecture languages**<br>english<br>**Subject related to scientific research**<br>Yes<br>**Disciplines**<br>Chemical sciences, Physical sciences, Earth sciences and the environment<br>**ISCED classification**<br>0532 Earth sciences<br>**USOS code** |

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| **Subject coordinator** | Piotr Szwedo |
| **Lecturer** | Theo Kurtén, Matti Rissanen |

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| **Period**<br>Semester 5 | **Examination**<br>graded credit<br><br>**Activities and hours**<br>Lecture: 26<br>Classes: 10 | **Number of ECTS points**<br>5.0 |

## Goals

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| C1 | The course focuses on teaching the fundamentals of atmospheric chemistry. We will cover topics such as unifying and common concepts in atmospheric chemistry, atmospheric composition, and concentration unit conversions, thermodynamic and kinetic tools needed in atmospheric chemistry, elemental cycles of N, C, O, H and S, key features of stratospheric (ozone) chemistry, and key features of tropospheric (radical oxidation) chemistry, including air pollution. |

## Subject's learning outcomes

| Code | Outcomes in terms of | Effects | Examination methods |
|---|---|---|---|
| **Knowledge – Student knows and understands:** | | | |
| W1 | the basic concepts and unifying features of atmospheric chemistry, including the concept of oxidation and the relationship between altitude, chemical energy and chemical complexity, as well as the key chemical features of the atmospheric N, C, O, H and S cycles. | JBS_K1_W06, JBS_K1_W07 | written credit, credit with grade, project |
| W2 | the main features of stratospheric chemistry (Chapman mechanism, catalytic ozone-depleting cycles) and tropospheric chemistry (formation of oxidants, radical oxidation mechanisms, the role of NOx, and the characteristics of photochemical smog). | JBS_K1_W04, JBS_K1_W06, JBS_K1_W07 | written credit, credit with grade, project |
| W3 | the facilities, instrumentation and current relevant atmospheric chemistry research topics within the faculty. | JBS_K1_W06, JBS_K1_W07 | written credit, credit with grade, project |
| **Skills – Student can:** | | | |
| U1 | apply kinetic and thermodynamic tools to solve simple atmospheric chemical problems, including concentration unit conversions, computing lifetimes using given rate coefficients, and using the pseudo-steady state approximation to simplify reaction rate expressions. | JBS_K1_U02, JBS_K1_U03 | written credit, credit with grade, project |

## Calculation of ECTS points

| Activity form | Activity hours* |
|---|---|
| Lecture | 26 |
| Classes | 10 |
| preparation of a project | 25 |
| exercises performance | 40 |
| preparation for final test | 34 |

| Student workload | Hours | ECTS |
|---|---|---|
| | 135 | 5.0 |

* hour means 45 minutes

## Study content

| No. | Course content | Subject's learning outcomes |
|---|---|---|
| 1. | Interactive lecture: Introduction to the course and introducing fundamental concepts in atmospheric chemistry | W1 |

| No. | Course content | Subject's learning outcomes |
|---|---|---|
| 2. | Interactive lecture: Introducing fundamental concepts in atmospheric chemistry | W1 |
| 3. | Exercise session: Help available for solving the first exercise set | W1 |
| 4. | Interactive lecture: Atmospheric composition, history of the atmosphere | W1 |
| 5. | Interactive lecture: History of the atmosphere and unit conversion | W1, U1 |
| 6. | Exercise session: Help available for solving the first exercise set | W1, U1 |
| 7. | Interactive lecture: Biogeochemical cycles | W1 |
| 8. | Exercise session: Feedback and answers to the first exercise set and help available for solving the second exercise set | W1, U1 |
| 9. | Interactive lecture: Thermodynamic and kinetic tools needed in atmospheric chemistry | W1, U1 |
| 10. | Interactive lecture: Thermodynamic and kinetic tools needed in atmospheric chemistry | W1, U1 |
| 11. | Exercise session: Help available for solving the second exercise set | W1, U1 |
| 12. | Interactive lecture: Stratospheric chemistry | W1, W2 |
| 13. | Exercise session: Help available for solving the advanced exercise set | W1, U1 |
| 14. | Interactive lecture: Tropospheric chemistry | W1, W2, U1 |
| 15. | Lab visit | W3 |
| 16. | Interactive lecture: Tropospheric chemistry | W1, W2, U1 |
| 17. | Exercise session: Feedback and answers to the second exercise set and help available for solving the advanced exercise set | W1, U1 |
| 18. | Interactive lecture: Chemistry of air pollution | W1, W2 |
| 19. | Poster presentations by students (2h) | W1, W2 |

## Course advanced

### Teaching methods :

project method, conversation lecture, laboratories, practicals

| Activities | Examination methods | Credit conditions |
|---|---|---|
| Lecture | written credit | The final exam counts 30% towards the final grade. Students need to get at least 34% of exam points in order to pass the course. |
| Classes | credit with grade, project | Compulsory to attend. If unable, a supplementary task will be given. Students will get 2 points (out of a total of 100) which counts towards the final grade. Exercises count 38% towards the final grade. The course includes two sets of 5 ”basic” problems each. All of these needs to be completed and a student needs to get a minimum of 50% of the points. The course also includes one set of approximately 10 ”advanced” tasks (longer calculations, essays, mini-projects). A student needs to choose 4 of these tasks and complete them and a student needs to get a minimum of 50% of the points. The poster counts 30% towards the final grade. There is no minimum as to how many points the students need to get for this assignment in order to pass the course. |

## Entry requirements

No formal prerequisites, but high-school level understanding of chemistry or physics highly recommended.

## Literature

**Obligatory**

1. There is no official coursebook. Lecture notes will be distributed via Moodle. For deeper understanding, any of the following books could be useful. Jacob's book is freely available online (though a bit old by now). Holloway & Wayne especially recommended as a relatively cheap and modern introductory book.
2. D. J. Jacob: Introduction to atmospheric chemistry, Princetown Univ. Press, 1999. (Available online: http://acmg.seas.harvard.edu/people/faculty/djj/book/index.html)
3. J. H. Seinfeld & S.N. Pandis: Atmospheric chemistry and physics, 2nd/3rd ed, Wiley, 2006/2016
4. R. P. Wayne: Chemistry of atmospheres, 3rd ed., Oxford University Press, 2000
5. A. M. Holloway, R. P. Wayne: Atmospheric Chemistry, RSC Publishing, 2010

## Effects

| Code | Content |
|---|---|
| JBS_K1_U02 | The graduate can present and report knowledge, methodologies, ideas, problems and solutions, clearly and comprehensively, in different forms destined for different audiences – including discussions and debates which require defending a substantiated opinion, as well as conversations in a foreign language at the CEFR B2 level. |
| JBS_K1_U03 | The graduate can apply adequate methods and tools, including selected IT tools, to solve problems related to data collection, analysis, and management in the context of sustainability. |
| JBS_K1_W04 | The graduate can identify sustainability-related problems specific to selected cultural, geographical, and political contexts. |
| JBS_K1_W06 | The graduate can describe interconnections between various aspects of sustainability and identify their significance in the context of natural and social sciences, with a special focus on disciplines included in the selected specialisation track (law and politics; chemistry and physics; chemistry and biology; economics and geography; economics, management and engineering; humanities). |
| JBS_K1_W07 | The graduate can apply the theory and methodology of disciplines included in the selected specialisation track to sustainability-related problems, taking into consideration practical limitations such as protection of intellectual property. |