

Chemistry

Chemistry is a scientific subject that has its origins in the need of human beings to understand and explain the world around them, and in their interest in how matter is structured and how different life processes function. Chemistry covers the properties, structure and function of matter, as well as chemical reactions and changes.

Aim of the subject

Teaching in the subject of chemistry should aim at helping students develop knowledge of the concepts, theories, models and methods of chemistry. It should contribute to students developing knowledge of both natural and man-made chemical processes. Teaching should also help students develop their understanding of the importance of chemistry for climate, the environment and the human body, knowledge of different applications of chemistry in areas such as the development of new medicines, new materials and new technologies. Teaching should give students the opportunity to develop a scientific approach to the surrounding world. Teaching should take advantage of current research and students' experiences, curiosity and creativity. Teaching should also help students participate in public debates and discuss ethical issues and views from a scientific perspective.

Chemistry is constantly developing in interaction between theory and experiment, where hypotheses, theories and models are tested, re-assessed and modified. Teaching should thus cover the development, limitations and areas of applicability of theories and models. It should contribute to students developing the ability to work theoretically and experimentally, and to communicate using scientific language. Teaching should also help students develop the ability to critically assess and distinguish between statements based on scientific and non-scientific foundations. Teaching should cover scientific working methods such as formulating and searching for answers to questions, planning and carrying out experiments and processing, interpreting and critically assessing results and information. Teaching should give students the opportunity to discuss and present analyses and conclusions. They should also be given the opportunity to use computerised equipment for collecting, simulating, calculating, processing and presenting data.

Teaching in the subject of chemistry should give students the opportunities to develop the following:

- 1) Knowledge of chemical concepts, models, theories and working methods, and understanding their development.
- 2) The ability to analyse and find answers to subject-related questions, and to identify, formulate and solve problems. The ability to reflect on and assess chosen strategies, methods and results.
- 3) The ability to plan, carry out, interpret and report experiments and observations, and also the ability to handle chemicals and equipment.

- 4) Knowledge of the importance of chemistry for the individual and society.
- 5) The ability to use a knowledge of chemistry to communicate, and also to examine and use information.

Courses in the subject

- Chemistry 1, 100 credits, which builds on knowledge from the compulsory school or equivalent.
- Chemistry 2, 100 credits, which builds on the course chemistry 1.

Chemistry 1

The course chemistry 1 covers points 1–5 under the heading Aim of the subject.

Core content

Teaching in the course should cover the following core content:

Materials and chemical bonding

- Models and theories of the structure and classification of matter.
- Chemical bonding and its impact on e.g. the occurrence, properties and application areas of organic and inorganic substances.

Reactions and changes

- Acid-base reactions, including the concept of pH and buffer effects.
- Redox reactions, including electrochemistry.
- Precipitation reactions.
- Energy transformations in phase transitions and chemical reactions.

Stoichiometry

- Understanding and writing formulae for chemical compounds and reactions.
- Substance relationships, concentrations, limiting reactants, and exchanges in chemical reactions.

Analytical chemistry

- Qualitative and quantitative methods of chemical analysis, e.g. chromatography and titration.

The nature of chemistry and its working methods

- The characteristics of a scientific problem.
- Models and theories as simplifications of reality. How models and theories can change over time.
- How problems and questions are defined and studied using reasoning from chemistry.
- The importance of experimental work in testing, re-assessing and revising hypotheses, theories and models.
- Planning and carrying out experiments and formulating and testing hypotheses related to these.
- Assessing results and conclusions by analysing choice of methods, work processes and sources of error.

- Determining views on social issues on the basis of chemical models, e.g. sustainable development issues.

Knowledge requirements

Grade E

Students give an account **in basic terms** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to look for answers to issues, and also to describe and **exemplify** chemical processes and phenomena. Based on **some** example, students give an account **in basic terms** of how the models and theories of chemistry are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **simple** questions in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with some certainty** their own **simple** issues. Students plan and carry out **in consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, evaluate their methods in **simple** assessments and give the reasons for their conclusions with **simple** reasoning.

Students discuss **in basic terms** issues concerning the importance of chemistry for the individual and society. In their discussions, students put forward **simple** arguments and give an account **in basic terms** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to some extent** their communication to purpose and context. In addition, students use different types of sources and make **simple** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

Grade D

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

Grade C

Students give an account **in detail** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to look for answers to issues, and also to describe and **exemplify** chemical processes and phenomena. Based on **some** examples, students give an account **in detail** of how the models and theories of chemistry are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **complex** issues in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses, and formulate **with some certainty** their own issues. Students plan and carry out **after consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, assess their methods in **simple** assessments and give the reasons for their conclusions with **well grounded** reasoning.

Students discuss **in detail** issues concerning the importance of chemistry for the individual and society. In their discussions, students put forward **well grounded** arguments, and give an account **in detail** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. In addition, students use different types of sources and make **well grounded** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

Grade B

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

Grade A

Students give an account **in detail and in a balanced way** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with certainty** to look for answers to issues, and to describe and **generalise about** chemical processes and phenomena. Based on **some** examples, students give an account **in detail and in a balanced way** of how the models and theories of chemistry are developed. Students also assess the validity and limitations of models and theories in **balanced** assessments.

Students analyse and look for answers to **complex** questions in **familiar and new situations** with **good** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with certainty complex** issues. Students plan and carry out **after consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, assess their methods in **balanced** assessments and give reasons for their conclusions with **well grounded and balanced** reasoning. **Where necessary, students also propose changes.**

Students discuss **in detail and in a balanced way complex** issues concerning the importance of chemistry for the individual and society. In their discussions, students put forward **well grounded and balanced** arguments and give an account **in detail and in a balanced way** of the consequences of **several** possible viewpoints. **Students also propose new issues for discussion.**

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. Students use different types of sources and make **well grounded and balanced** assessments of the credibility and relevance of their sources and information.

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Chemistry 2

The course chemistry 2 covers points 1–5 under the heading Aim of the subject.

Core content

Teaching in the course should cover the following core content:

Reaction speed and chemical equilibrium

- Reaction speed, e.g. the effect of catalysts and concentrations on how quickly chemical reactions take place.
- Factors affecting equilibrium and equilibrium constants.
- Calculations of and reasoning about equilibrium systems in different environments e.g. in oceans, in the human body and in industrial processes.

Organic chemistry

- Different categories of organic substances, their properties, structure and reactivity.
- Reaction mechanisms, including qualitative reasoning about how and why reactions take place, and about the rate of use of energy in different kinds of organic reactions.

Biochemistry

- The genetic flow of information, including the main elements of the replication of biochemical processes, transcription and translation.
- The main features of human metabolism at the molecular level.
- Structure and function of proteins, with special focus on enzymes.

Analytical chemistry

- Qualitative and quantitative methods of chemical analysis e.g. mass spectrometry and spectrophotometry.
- Reasoning concerning sampling, level of detection, correctness and accuracy, and also systematic and random sources of error.

The nature of chemistry and its working methods

- Models and theories as simplifications of reality. Models and their areas of applicability and how they can be developed, generalised or replaced by other models and theories over time.
- Identifying and studying problems and issues using reasoning from chemistry.
- The importance of experimental work in testing, re-assessing and revising hypotheses, theories and models.
- Planning and implementation of experimental investigations and observations, and formulating and testing hypotheses in connection with this.

- Assessing results and conclusions by analysing choice of methods, work processes and sources of error.
- Issues concerning ethics and sustainable development linked to different ways of working in chemistry and activity areas.

Knowledge requirements

Grade E

Students give an account **in basic terms** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to look for answers to issues, and also to describe and **exemplify** chemical processes and phenomena. Based on **some** example, students give an account **in basic terms** of how the models and theories of chemistry are developed. Students also evaluate the validity of the models and theories and their limitations in simple assessments.

Students analyse and look for answers to **simple** questions in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with some certainty** their own **simple** issues. Students plan and carry out **in consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, evaluate their methods in **simple** assessments and give the reasons for their conclusions with **simple** reasoning.

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Grade D

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Grade C

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chemistry are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **complex** issues in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses, and formulate **with some certainty** their own issues. Students plan and carry out **after consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, assess their methods in **simple** assessments and give the reasons for their conclusions with **well grounded** reasoning.

Students discuss **in detail** issues concerning the importance of chemistry for the individual and society. In their discussions, students put forward **well grounded** arguments, and give an account **in detail** of the consequences of **some** possible viewpoints.

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In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

Grade B

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Grade A

Students give an account **in detail and in a balanced way** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with certainty** to look for answers to issues, and to describe and **generalise about** chemical processes and phenomena. Based on **some** examples, students give an account **in detail and in a balanced way** of how the models and theories of chemistry are developed. Students also assess the validity and limitations of models and theories in **balanced** assessments.

Students analyse and look for answers to **complex** questions in **familiar and new situations** with **good** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with certainty complex** issues. Students plan and carry out **after consultation** with the supervisor experiments and observations in a satisfactory way. In addition, students handle chemicals and equipment safely. Furthermore, students interpret their results, assess their methods in **balanced** assessments and give reasons for their conclusions with **well grounded and balanced** reasoning. **Where necessary, students also propose changes.**

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