

## Chemistry - programme subject in Programmes for Specialization in General Studies

Dette er en oversettelse av den fastsatte læreplanteksten. Læreplanen er fastsatt på Bokmål

Laid down as a regulation by the Norwegian Directorate for Education and Training on 3 April 2006 as delegated in a letter of 26 September 2005 from the Ministry of Education and Research pursuant to the Act of 17 July 1998 no. 61 relating to primary and secondary education (Education Act) Section 3-4 first paragraph.

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Utdannings-

## Purpose

Everything in nature and everything that lives consists of matter, or substance. Chemists research, determine and describe how substances are built up at a micro level, and on this basis explain their properties and how substances react. The development of the science of chemistry is the result of an interaction between experiment and theory. This interaction is reflected in the programme subject *Chemistry*, in which the planning and implementation of experiments play a key role.

Chemists make an important contribution to the development of biotechnology, nanotechnology, medicine, pharmacy, environmental science, new materials and new energy sources. Through the programme subject, the individual shall acquire an insight into the significance of chemical research on technology and economic development. The programme subject shall help pupils understand how substances affect the environment, and how the development of new industrial methods can reduce strain on the environment. In this way, the programme subject can help focus on the environment and sustainable development. At the same time, the programme subject shall make it clear that chemical research is subject to ethical criteria.

The purpose of the programme subject is to create interest in chemistry and natural science, and at the same time provide the knowledge necessary for participating in current debate. In this programme subject, the individual shall develop confidence in natural science concepts and scientific working methods, and learn how to assess one's own work and results. One of the purposes of the programme subject is to provide insight into the significance of chemistry and its various applications in everyday life and society. The historical development of the subject is part of our cultural heritage, and this should come across in the teaching.

Training in chemistry shall link theory with practical laboratory work. Teaching arenas outside the school, in laboratories and companies, can provide an insight into how chemistry is put to practical use in society. Knowledge and competence in chemistry are important in many professions and can provide a good basis for further studies.

## Structure

Chemistry comprises two programme subjects: *Chemistry 1* and *Chemistry 2*. Chemistry 2 builds on Chemistry 1.

These programme subjects have been structured into main subject areas, for which competence aims have been formulated. The main subject areas complement each other, and should be viewed in relation to one another.

### Overview of the main subject areas:

Programme subject	Main subject areas				
Chemistry 1	Language and models in chemistry	Methods and experimentation	Water chemistry	Acids and bases	Organic chemistry 1
Chemistry 2	Research	Analysis	Organic chemistry 2	Redox reactions	Materials

## Main subject areas

### Chemistry 1

#### Language and models in chemistry

This main subject area deals with chemical nomenclature, and chemical phenomena are explained by models at a micro level. It also deals with how chemical reactions are described by equations and how these equations are used to evaluate and estimate resource use and yield. The main subject area also gives an insight into how models have changed in the course of history.

### **Methods and experimentation**

This main subject area deals with how knowledge in chemistry is gained through processes that involve hypotheses, experimentation, observations, evaluation and reasoned conclusions. It also deals with the fact that chemistry is a practical discipline that uses laboratory equipment and analytical processes, and how theories and models are tested and illustrated through experiments.

### **Water chemistry**

This main subject area deals with the structure and properties of water and aquatic solutions. It also deals with the evaluation of the solubility of substances in water in everyday life as well as environmental and industrial contexts.

### **Acids and bases**

This main subject area deals with acids, bases and pH. It also deals with how chemical processes in water are affected by pH. The subject area also covers experiments and calculations linked to everyday life, healthcare, industrial processes and research.

### **Organic chemistry 1**

This main subject area deals with natural and synthetic organic substances. The central element in the subject area is the structure of organic substances and how they react. In addition, it deals with nomenclature, which is used to systemize the increasingly large number of organic compounds.

### **Chemistry 2**

#### **Research**

This main subject area deals with current research in chemistry and with what is required to prove the reliability of research findings.

#### **Analysis**

This main subject area deals with methods of chemical analysis, which are used to control both quality and quantity in numerous contexts. It also deals with open experimentation and instrumental analyses.

### **Organic chemistry 2**

This main subject area deals with how organic substances react. In addition to focusing on practical work and experiments, it deals with the determination and description of the composition, functions and reactions of organic molecules. The main subject area also covers biochemical reactions linked to energy conversion in living cells.

### **Redox reactions**

This main subject area deals with corrosion, combustion reactions and electrochemistry. It also involves linking these subjects to a large selection of experiments, which provides a basis for many types of calculations.

### **Materials**

This main subject area deals with polymers and nano materials. In addition, it deals with possible environmental impacts from the production, use and controlled dumping of different materials.

## Teaching hours

Teaching hours are given in 60-minute units.

Chemistry 1: 140 teaching hours per year

Chemistry 2: 140 teaching hours per year

## Basic skills

Basic skills are integrated into the competence aims for this course in areas where they contribute to the development of and are part of the subject competence. In the Chemistry programme subject, basic skills are understood as follows:

*Being able to express oneself orally and in writing* in Chemistry involves the precise evaluation and presentation of one's case in scientific discussions, as well as the planning and implementation of experiments and field trips. This includes describing observations and experiences from nature and the laboratory in the terminology of chemistry. This means formulating questions and hypotheses and presenting results.

*Being able to read* in Chemistry means gathering relevant information from a document and understanding articles on chemistry that vary in degree of difficulty. This means understanding texts, tables and diagrams from textbooks, reference works, newspapers, journals, advertisements and the Internet.

*Numeracy* in Chemistry involves calculating quantities, concentrations and pH values, and evaluating the results. It means working with and interpreting formulas, models and various types of data, as well as solving equations.

*Being able to use digital tools* in Chemistry involves collecting scientific information and examining, recording, processing and presenting results from personal observations. It means being able to use digital tools to simulate experiments that can be time-consuming, costly or hazardous. It also means using animations to illustrate and explain chemistry-related concepts.

## Competence aims

### Chemistry 1

#### Language and models in chemistry

*The aims of the studies are to enable pupils to*

- give an account of the historical development of the concept of the atom and describe and compare Bohr's atomic model and today's model
- explain, illustrate and evaluate the composition, valency and properties of matter using the periodic table
- give names to simple inorganic compounds using nomenclature rules

- write chemical equations with state symbols, and use chemical equations in calculations with amounts of matter
- explain the concepts entropy and enthalpy and use them to assess whether or not a reaction is spontaneous
- give an account of conditions that affect the rate of chemical reactions
- carry out calculations on chemical equilibria and discuss the equilibria

## Methods and experimentation

*The aims of the studies are to enable pupils to*

- plan and carry out experiments and evaluate risk, sources of error and results
- write reports from experiments and present processes, methods and results with or without digital tools
- discuss and evaluate the chemical content in media reports and advertisements

## Water chemistry

*The aims of the studies are to enable pupils to*

- give an account of the properties of water
- give an account of water as a solvent for polar and non-polar substances
- evaluate the solubility and precipitation of salts in water based on experiments and calculations
- make aqueous solutions with different concentrations by weighing and diluting
- carry out experiments with water treatment and give an account of the contamination of drinking water sources
- explain how the key components in detergents work

## Acids and bases

*The aims of the studies are to enable pupils to*

- define the terms acid and base and give an account of acid-base reactions
- calculate values of  $K_a$ ,  $K_b$  and  $K_w$
- measure pH by different methods and calculate pH in strong and weak acids and bases
- plan and carry out acid-base titrations; justify choice of indicator and interpret titration curves
- give an account of hydrolysis of salts and gases in water

## Organic chemistry 1

*The aims of the studies are to enable pupils to*

- give an account of the structure, nomenclature, production, properties and use of aliphatic hydrocarbons, alkyl halides, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers and amines
- give an account of the structure of benzene and some simple benzene derivatives, and give examples of their uses
- give an account of different forms of isomerism

## Chemistry 2

### Research

*The aims of the studies are to enable pupils to*

- find and present examples of current chemical research within environmental science and industry
- publish reports from their own experiments, with and without digital tools
- discuss how researchers ensure that research is ethically defensible
- give an account of features of scientific method in chemistry, and give examples of explanatory models that are inconsistent with chemical evidence

## Analysis

*The aims of the studies are to enable pupils to*

- detect metals in alloys and ions in salts and give an account of the results
- carry out analyses with colorimetry and interpret simple mass spectra and  $^1\text{H-NMR}$  spectra
- plan and implement simple water analyses and evaluate the results in relation to the water's range of use
- explain how buffer solutions function, and calculate pH and capacity in buffers

## Organic chemistry 2

*The aims of the studies are to enable pupils to*

- give an account of oxidation, substitution, addition, elimination, condensation and hydrolysis as types of reactions, and carry out experiments with at least two of them
- explain the reaction mechanism of addition and elimination
- carry out experiments to detect simple organic compounds
- give an account of and carry out experiments with chromatography, distillation and recrystallization
- give an account of the structure and properties of amino acids, proteins, lipids, carbohydrates and ATP
- explain the role of hydrogen as energy carrier in photosynthesis and cell respiration
- explain the significance of stereoisomerism in biochemical reactions
- carry out experiments with enzymes and explain how they function

## Redox reactions

*The aims of the studies are to enable pupils to*

- carry out experiments with combustion reactions and explain what happens
- balance redox reactions using half-reactions and oxidation number
- carry out corrosion experiments and explain how corrosion can be prevented
- plan and carry out analyses using redox titration
- carry out experiments with electrochemical cells and give an account of spontaneous and non-spontaneous redox reactions
- calculate the capacity and cell potential of a battery and the yield in electrolysis
- carry out experiments with anti-oxidants and explain how they work

## Materials

*The aims of the studies are to enable pupils to*

- describe the chemical structure and properties of some synthetic polymers and their additives
- give examples of nano materials, how they are produced, what differentiates them from ordinary materials, and what they can be used for
- assess the production, storage and controlled dumping of traditional and new materials in terms of their environmental impact

## Assessment

Provisions for final assessment:

### **Overall achievement grades**

Programme subject	Provision
Chemistry 1	The pupils shall have an overall achievement mark.
Chemistry 2	The pupils shall have an overall achievement mark.

### **Examination for pupils**

Programme subject	Provision
Chemistry 1	The pupils may be selected for an oral-practical exam. The oral-practical exam is prepared and marked locally.
Chemistry 2	The pupils may be selected for a written or oral-practical exam. The written exam is prepared and marked centrally. The oral-practical exam is prepared and marked locally.

### **Examination for external candidates**

Programme subject	Provision
Chemistry 1	The external candidates shall sit for an oral-practical exam. The oral-practical exam is prepared and marked locally.
Chemistry 2	The external candidates shall sit for a written exam and oral-practical exam. The written exam is prepared and marked centrally. The oral-practical exam is prepared and marked locally.

The provisions for assessment are stipulated in the regulations of the Norwegian Education Act.