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.

Valid from 01.08.2006

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# Purpose

Man has always been fascinated by nature and obsessed with understanding it. Through experiments, observations and theoretical work, physicists have come a long way in discovering the basic principles and laws that explain and predict phenomena in nature and the universe.

The programme subject *Physics* shall help pupils understand nature, technology and phenomena in everyday life. It serves as a basis for applying scientific knowledge in different contexts, from practical everyday situations to decisions that affect society, nature and the environment. The programme subject gives an introduction to concepts, symbols and language, and links theory and arithmetical calculations with observations and practical laboratory work. The programme subject shall help demonstrate how mathematics is used in physics and how it is used to model reality. In addition, the programme subject shall help create an awareness that physics is part of our cultural heritage and that the subject must be viewed in a historical perspective.

The programme subject shall help develop a critical approach to experimentation and postulations and provide training in how to make a case for solutions to physics problems. The course will thus strengthen pupils' ability to differentiate between scientifically-based knowledge and knowledge not based on scientific methods. The programme subject shall provide an understanding of subject-specific problems and of processes that result in greater insight, which is an important springboard for further studies in higher education and for lifelong learning. In this way, physics as a programme subject shall help provide society with a skilled workforce, and promote innovation and development for the benefit of industry and society. At the same time, teaching in the subject shall emphasize the general educative aspects of physics.

The programme subject shall provide the foundation for creativity, critical acumen and methodological insight in physics studies. The development of skills and competence calls for practical as well as theoretical work in the programme subject.

# Structure

Physics comprises two programme subjects: *Physics 1* and *Physics 2*. Physics 2 builds on Physics 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** | | | | |
|---|---|---|---|---|---|
| Physics 1 | Classical physics | Modern physics | Explaining nature through mathematics | The young researcher | Physics and technology |
| Physics 2 | Classical physics | Modern physics | Explaining nature through mathematics | The young researcher | Physics and technology |

# Main subject areas

## Physics 1

**Classical physics**

This main subject area deals with the oldest and most applied laws of physics, and how they find expression in mechanics, electrotechnology and thermophysics. A central principle is the conservation of energy in different processes. The subject area also deals with fundamental concepts that are necessary for working with wave phenomena.

**Modern physics**

This main subject area deals with the building blocks of nature and how they are joined together, from microcosm to macrocosm. It also deals with information that can be obtained from radiation in various contexts, and how it can be used to create models to explain the world.

**Explaining nature through mathematics**

This main subject area deals with how mathematics is applied in physics, particularly in the main subject areas of Classical Physics and The Young Researcher. In this main subject area, mathematics is used to systematize observations through the laws of physics. It also involves the use of mathematics to describe phenomena and predict how a system will behave in the future.

**The young researcher**

This main subject area is about physics as an experimental science, where training to plan, implement and evaluate experiments is the key. It also involves learning about and training in the use of measuring instruments, documenting experiments, collecting data and presenting results. The main subject area also deals with how scientific knowledge is established and with conflicts and dilemmas that might arise during this process.

**Physics and technology**

This main subject area deals with principles of physics that form the basis of certain components in modern technology. It also deals with important assumptions and limitations in the technology.

## Physics 2

**Classical physics**

This main subject area deals with the field concept and how it can be used in various areas of physics to describe and explain phenomena. It also includes Newton's laws, energy and acceleration as applied to circular motion. The subject area also covers important laws relating to conservation and shock modelling.

**Modern physics**

This main subject area deals with two theories – Quantum Theory and Relativity Theory. The subject area covers many of nature's surprising quantum effects and relativistic effects that run counter to accepted notions.

**Explaining nature through mathematics**

This main subject area deals with how mathematics is used as a language in physics, with use of vector calculus, differential calculus and integral calculus. Central to this subject area is mathematics as a basis for modelling, carrying out calculations by computer, and assessing the model's validity.

**The young researcher**

This main subject area deals with the planning, implementation, evaluation and development of experiments. It also involves learning about and training in the use of measuring instruments, documenting experiments, collecting data and presenting results. It deals with evaluating methods and equipment and estimating uncertainty. The main subject area also looks at what impact disagreement and discussion have on the development of this area of natural science.

**Physics and technology**

This main subject area deals with the technological applications of induction and the principles that form the basis for modern mapping equipment in medicine. The subject area also covers digital technology.

# Teaching hours

Teaching hours are given in 60-minute units.

Physics 1: 140 teaching hours per year

Physics 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 Physics programme subject, basic skills are understood as follows:

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 Physics programme subject, basic skills are understood as follows:

*Being able to express oneself orally and in writing* in Physics involves describing observations and experiences from nature, experiments, field trips and information in the media. It also includes formulating questions and hypotheses and using concepts and expressions in physics. It means being able to make a case for one's own evaluations, offer feedback and present results – that is to say, master a clear and precise language, including being able to differentiate between everyday use of ideas and use of the same concepts in physics.

*Being able to read* in Physics involves extracting, interpreting and reflecting on information in physics documents, brochures, newspapers, popular science magazines, books and on the Internet. It means understanding instruction manuals, tables, diagrams, symbols and physics documents, as well as the contents of tables, graphs, illustrations, written text and equations.

*Numeracy* in Physics involves using figures and mathematical calculations to record and process results from one's own measurements, as well as producing tables and diagrams in a physics context. It means applying and interpreting formulas and models of reality, and processing and interpreting various types of data. Being able to do calculations means applying methods from mathematics. In addition, it involves the use of vectors, parameter curves and differential and integral calculus.

*Being able to use digital tools* in Physics involves investigating, measuring, recording, analysing, documenting and publishing results by digital means. It means applying animations and using the Internet to collect physics-related information. The ability to use digital tools in physics also includes simulating phenomena and experiments that are difficult to study otherwise.

# Competence aims

## Classical physics

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

- identify contact forces between objects and gravitational forces on objects, draw force vectors and apply Newton's Three Laws of Motion
- give an account of the concepts of energy, work and effect, carry out arithmetic calculations and discuss situations where mechanical energy is conserved
- give an account of situations where friction and air resistance mean that the mechanical energy is not conserved, and perform calculations in situations with constant friction
- state and discuss the first and second laws of qualitative thermophysics
- define the terms current, voltage and resistance, and apply the principles of conservation of charge and energy to simple and branched direct current circuits
- define and carry out calculations with the terms frequency, period, wavelength and wave speed, and explain qualitative bending and interference phenomena

## Modern physics

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

- describe Bohr's atom model and use it to work out frequencies and wavelengths of spectral lines in emission and absorption spectra
- use conservation laws to describe fission and fusion processes and calculate the energy released in such processes
- apply Stefan-Boltzmann's law and Wien's displacement law
- give an account of how information about stars are systemized in an HR diagram
- describe the life-cycle of a star and explain how elements are produced in stars
- describe and discuss the standard model for the evolution of the universe

## Explaining nature through mathematics

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

- use parameter presentation to describe the rectilinear movement of a particle, and use derivation to calculate velocity and acceleration when the position is known, with and without digital tools
- create one or more mathematical models for correlations between physical quantities found experimentally
- use mathematical models as sources for qualitative and quantitative information, present results and evaluate the area of validation of the models

## The young researcher

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

- elaborate on and discuss key features of scientific method in physics
- give examples of some explanation models that are inconsistent with physics, nor based on scientific methodology
- give an account of how a researcher's approach, expectations and experiences can affect research
- plan and implement experiments and carry out relevant experiments within the various main subject areas

- collect and process data and present and evaluate the results and conclusions of experiments and investigations, with and without digital tools
- use simulation programs to show phenomena and physical relations

## Physics and technology

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

- give an account of the difference between conductors, semi-conductors and insulators based on the current atom model, and explain doping of semi-conductors
- compare the construction of a diode and transistor, explain how they work, and give examples of their use
- give an account of how light detectors work in digital photography or digital video
- give an account of how modern sensors are characterized, and how the sensors' characteristics set limits for measurements

## Classical physics

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

- describe homogeneous and inhomogeneous electric fields and apply Coulomb's law
- describe homogeneous and inhomogeneous gravitational fields and apply Newton's law of universal gravitation
- describe magnetic fields around permanent magnets and electric currents, and calculate the magnetic flux density around a straight conductor and the force on a conductor in a magnetic field
- give an account of the term magnetic flux and apply Faraday's induction law
- use Newton's laws in vector form for motion in homogeneous magnetic fields and in a homogeneous gravitational field
- calculate acceleration and forces on objects that move at constant velocity in a circular path, and on objects at the top and bottom of a vertical circular path
- execute calculations with the law of conservation of momentum for one-dimensional collisions

## Modern physics

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

- give an account of the postulations that form the basis for the special theory of relativity, discuss qualitatively some of the consequences of this theory for time, momentum and energy, and give a qualitative description of the general theory of relativity
- give an account of Einstein's explanation of photoelectric effect, and give a qualitative account of how results from experiments with photoelectric effect, Compton scattering and the wave nature of particles represents a break with classical physics
- give an account of conservation laws that apply in processes with elementary particles, and describe the interaction between elementary particles
- give an account of Heisenberg's uncertainty relations, describe the phenomena "entangled photons" and give an account of their cognitive consequences

## Explaining nature through mathematics

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

- describe the path of a particle using parameter presentation, and use derivation and integral calculus to work out position, velocity and acceleration when one of the three quantities is known
- use integral calculus to determine work and change in potential energy in central fields and for a spring that stretches

- analyze different mathematical models for a physical situation, with and without digital tools, and assess which model best describes the situation

### The young researcher

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

- elaborate on and discuss how various theories of physics can exist side by side, even though they are contradictory
- give an example of a scientific conflict that has been resolved and how, and an example of a scientific conflict that remains unresolved and why
- carry out relevant experiments in the main subject areas, with and without digital tools
- estimate uncertainty in collected data and calculate the uncertainty in the final result
- assess the limitations of a chosen method and equipment and propose improvements and further experimentation

### Physics and technology

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

- elaborate on technological applications of induction
- describe physical principles behind medical examinations such as X-rays, ultrasonography and magnetic resonance imaging
- elaborate on sampling and digital processing of sound

## Assessment

Provisions for final assessment:

***Overall achievement grades***

| Programme subject | Provision |
|---|---|
| Physics 1<br><br>Physics 2 | The pupils shall have an overall achievement mark. |

***Examination for pupils***

| Programme subject | Provision |
|---|---|
| Physics 1 | The pupils may be selected for an oral-practical exam. The oral-practical exam is prepared and marked locally. |
| Physics 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 |
|---|---|
| Physics 1 | The external candidates shall sit for an oral-practical exam. The oral-practical exam is prepared and marked locally. |
| Physics 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.