Physics and Chemistry

Aims

Teaching in the subjects of physics and chemistry is aimed at students developing the ability to observe natural phenomena, and through this observation gain an understanding of themselves. In this process, it is the teacher's task to convey wonder and curiosity for the natural phenomena that the students encounter in everyday life.
Through processes and experiments, students must practice the ability to observe and experience through the senses, in order to then be able to pass on an accurate description of the observations that have been made. From what is observed, students will then be able to derive the physical and chemical laws. These understandings will form the basis for conversation and further questions. Observing phenomena will not only be used in physics and chemistry, but can also be brought into other natural subjects such as biology, astronomy and the teaching of geography and weather phenomena.
The pupils' confidence in their own observations and thinking will be strengthened in this process. In the description of the process, an artistic expression will always support what is observed and bring an extra dimension to the description and understanding of the process.
Natural science is an important element for understanding and seeing through the world we surround ourselves with, and thus also our self-understanding. It is important that we teach the students to see through the new technology and science, which helps to shape the future, while daring to ask questions about future society and scientific development.

The central content of the physics subject can be described as a mapping of the contexts or relationships which pervade the world and which can be recognized as what we call natural laws.
The mathematical expression of a physical law implies a high degree of abstraction. When the phenomenon is grasped and understood, mathematics can deepen the further understanding and make application of the knowledge possible in new areas.
Working with physical phenomena is a particularly good opportunity to practice precision in observation, coherence in thinking and vigilance in judgment. At the same time, knowledge of the subject's many themes and individual phenomena can arouse enthusiasm and interest in the outside world. Most of the teaching in this subject will follow the classic division into subjects: optics, acoustics, thermodynamics, electricity and magnetism, mechanics as well as hydro- and aeromechanics and meteorology.

Regarding the subjects about Earth and the Universe, please refer to the subject plan for Geography.
The subjects are distributed over four years from Class 6 to Class 9.

Objectives and Final Goals of the Subject

Investigation (I)
Includes six skill and knowledge areas:

Science studies are science objectives and are identical for the science subjects. These focus on research methods, evaluation of results, conclusion and generalization.
Matter and matter cycles focus on studies of elements, chemical reactions and processes in central matter cycles.
Particles, waves and radiation focuses on studies of sound waves, colours, electromagnetic radiation and atomic processes.
Energy turnover focuses on studies of energy turnover, transport and storage of energy.
Earth and the Universe focuses on studies of physical phenomena, the atmosphere and the earth's resources.
Production and technology focuses on studies of food production, as well as the utilization of raw materials, production methods and technologies related to electronic control.

End Goals for (I)
The teaching gives students the opportunity to:

- design, implement and evaluate studies in physics/chemistry

Modeling (M)
Includes six skill and knowledge areas:

Science modeling is a science goal and is the same for the science subjects. These focus on students being able to critically select and develop models for explaining science subjects.
Matter and matter cycles focus on the use of the periodic system of the elements, on chemical representations and on models of natural matter cycles.
Particles, waves and radiation focus on elementary models for emissions and absorption spectra based on a probability based on previous experiences.
Energy turnover focuses on visualizations of energy turnovers, models of electrical circuits, as well as modeling of energy chains.
Earth and the Universe focuses on models of the Earth's systems, the Solar System, and the Universe.
Production and technology focuses on models of technical facilities and processes, as well as modeling of technical solutions.

End Goals for (M)
The teaching gives students the opportunity to

- use and evaluate models in physics/chemistry

Perspective (P)
Includes six skill and knowledge areas:

Perspective in science subjects is a science subject goal and is consistent for the science subjects. These focus on relating conditions in the outside world to the acquired natural science knowledge, and on how natural science knowledge has come to be.
Matter and matter cycles focus on the use of materials and chemicals, combustion and respiration processes as well as pollution.
Particles, waves and radiation focus on the application of sound and light.
Energy turnover focuses on energy turnover in everyday life and in society as well as the development of society's energy needs.
The earth and the universe focuses on physical and chemical conditions that are important for life conditions and living conditions on earth as well as the development in the understanding of the structure of the earth and the universe.
Production and technology focuses on technology history and development, production processes and the sustainability of technologies.
End Goals for (P)
The teaching gives students the opportunity to:

- understand the perspective physics/chemistry has to the outside world and relate the content of the subject to the development of scientific knowledge

Communication (C)
Includes five skill and knowledge areas:

Communication focuses on suitable methods for the dissemination and assessment of science subjects.
Argumentation focuses on the formulation and assessment of scientific justifications and claims.
Vocabulary focuses on the use of professional language in working with and communicating the natural sciences.
Academic reading and writing focuses on the acquisition of scientific knowledge through reading and writing.
Language development must be included in the work with all goals in the four competence areas. Objectives for language development are primarily included in the skill and knowledge areas of vocabulary and professional reading and writing, and there is a focus on the four dimensions of spoken and written language: conversation, listening, reading and writing.

End Goals for C
The teaching gives students the opportunity to:

- communicate about science subjects with physics/chemistry

Development of the Subject

Content and Focus	Objectives	Final Goals
The Development of the Subject Content and exemplified procedural content of the class teaching can be read below. This also reflects the procedural goals for the students. Physics/chemistry is supplemented by periods of astronomy. The subjects in physics are distributed over four years from Class 6 to Class 9, and in chemistry over 3 years from Class 7 to Class 9. The applicable subject plans for the year supplement the teaching plans. **Class 6 Physics: Acoustics, optics, magnetism, electricity, theory of heat** The acoustics are primarily based on the students' experience from working with music, e.g. with the instruments from orchestra lessons. The musical instruments form a good starting point for the experience of different sounds and how they are produced by stroking, blowing and hitting, producing high and deep tones. The intervals and ratios are linked to the length of a string, the effect of materials on timbre, oscillation phenomena, and chladnic timbres	Investigation (I), Modeling (M), Perspective (P) and Communication (C)	Investigation (I) The teaching gives the student the opportunity to: • examine the lever principle. • examine the cogwheel principle. • know the concept of resonance. • know the refraction of light. • examine the eye and its lens. • investigate how the solar system is connected. • burn different substances and observe the process and the end product. • examine acids and bases. • examine salts, lime, phosphorus and sulphur. Modeling (M) The teaching gives the student the opportunity to: • describe based on models that can be both theoretical, but also everyday. • understand figures and board drawings and put them into perspective for reality. • take mechanical things apart and put them back together.

and resonance. Experimental work is carried out with Rayleigh's singing tubes, sound propagation and sound production in the larynx. Optics takes its starting point in painting lessons from darkness to blinding light, afterimages, complementary colors, colored shadows and how colors appear in cloudy media, the six-part and twelve-part color circle. Students investigate how colors appear on the border between black and white when looking through a prism, lighting and light sources, the experience of black, shadow images and shadow constructions. The mirror is also studied. Reflection, refraction and the focal point are the main subjects. Experiments and measurements are carried out with plane, concave and convex mirrors, from which the mirror laws are used for calculations. Based on the image-forming optics of the eye, work is done with the pinhole camera. (Camera Obscura)		Perspective (P) The teaching gives the student the opportunity to: ● describe, assume a hypothesis and conclude from observations. ● discuss in class how innovation projects can be started. ● perspectives for chemistry and physics at a higher level. Communication (C) The teaching gives the student the opportunity to: ● present small projects. ● describe with text and pictures so that the teaching material is explained.
Class 7 Physics: Mechanics, acoustics, optics, thermodynamics, electricity In mechanics, experiments are made with subsequent report writing in the following subjects: balance and equilibrium, center of gravity of different objects, levers in various practical designs, letter scales with different sensitivities, practical exercises with levers, which lead to the preparation of lever laws and torque. Inclined	Investigation (I), Modeling (M), Perspective (P) and Communication (C)	Investigation (I) The teaching gives the student the opportunity to: ● examine the lever principle. ● examine the cogwheel principle. ● know the concept of resonance. ● know the refraction of light. ● examine the eye and its lens. ● investigate how the solar system is connected.

planes, cranks and wheels, pulleys and pulleys, the wedge, the screw and the gear are also treated by experiments and summarized in the rules of mechanics. In acoustics, the treatment of oscillation phenomena from Class 6 continues with experiments with tuning forks etc. which results in measurement and calculation of frequency. Students also experiment with sirens, gramophone and echo. In thermodynamics, experiments are carried out with opposite effects of heat and cold, sources of heat and the possibility of producing cold. Experiments are carried out with: heat conduction, insulation and thermal expansion. Students also work with temperature measurement, different temperature scales and thermometer liquids. In the doctrine of electricity, static electricity is dealt with, as well as attraction and repulsion by rubbing. It is carried out experiments with shelf marrow. There is work with galvanic elements, the construction of a battery and visible experiments which give an experience of current strength, voltage and resistance: Ritter's principles. The heating effect of the current, experience with different resistances, conductivity of different materials, short circuit, circuit are also studied. Students investigate technical applications in ammeter, hob, iron, fuse etc. and review safety measures when handling electrical current.		• burn different substances and observe the process and the end product. • examine acids and bases. • examine salts, lime, phosphorus and sulphur. Modeling (M) The teaching gives the student the opportunity to: • describe based on models that can be both theoretical, but also everyday. • understand figures and board drawings and put them into perspective for reality. • take mechanical things apart and put them back together. Perspective (P) The teaching gives the student the opportunity to: • describe, assume a hypothesis and conclude from observations. • discuss in class how innovation projects can be started. • perspectives for chemistry and physics at a higher level. • Communication (C) The teaching gives the student the opportunity to: • present small projects. • describe with text and pictures so that the teaching material is explained.

Magnetism is introduced based on experiences with natural magnetic ironstone. Through student's own experiments, we work with methods for magnetization, which substances can be magnetized and affected by magnetism, compass division into south and north poles, and rules for attraction and repulsion. **Class 7 Chemistry: Combustion – acid/base – salts – metals** The starting point for the first chemistry lesson is the transforming effects of fire. By lighting a large fire, we can study how different combustible materials behave, and we can observe, describe and categorize them into light and heat, steam and smoke, ash and cold. A continuation in the chemistry room can be the burning candle, where the four classical elements are present simultaneously, and where students can see the importance of air for combustion, etc., and thus importance of fire for man in a historical perspective can be a subtopic. A further consideration of fire shows that the most frequently combustible materials primarily originate from the plant kingdom and that the plant does the opposite of fire, it creates or builds up combustible substance. Of combustible, pure substances, one can show coal, sulfur and phosphorus and their special properties and talk about their occurrence in natural contexts. Based		

on the fire, it is now relevant to produce acid and base. The ash from hardwoods can be used to produce ash liquor, and when the gases from burning sulphur, coal or phosphorus are directed into water, acids are produced. Students look at the polar properties of base and acid and define/measure their strength by indicator. This takes place through the students' own laboratory experiments and measurements. Salt formation is shown through the meeting between acid and base, preferably in a dramatic and concentrated form, then also in the metal-acid and oxide-acid combinations. The salts are precipitated and their neutral properties are emphasized. A number of examples of solution and crystallization of salts can round off this theme, especially the copper salts with their beautiful colors can give impressive results. Calcium and its circulation are investigated through limestone deposits in nature. We can see that lime's connection with the animal kingdom is important. The geological processes are described. The lime burning is shown in a kiln for the purpose. The big difference between burnt and unburnt stone is shown. One observes the violent development of heat when slaking the quicklime. Production of mortar from the lime and practical experiments with mortar are done. The limestone cycle is further demonstrated by experiment and description.		

Metals such as gold, silver, iron, zinc, tin, copper, etc. and known alloys of these are treated. The commonality of metals is first and foremost their plasticity. There are many differences: weight, colour, melting point, firmness, sound, etc. The occurrences of metals in nature and their history are part of the curriculum.		
Class 8 - Physics: Hydro- and aerodynamics, meteorology, electromagnetism, optics. Hydro- and aerodynamics: experiments are carried out with Archimedes' principle for water and air, hydrostatic buoyancy in relation to side pressure and buoyancy in water, connected vessels, Pascal's law, the Cartesian diver, self-weight of various substances, hydraulic pressure systems (brakes, lifting cranes) , pressure pump and suction pump, laminar and turbulent flows, vortex formation and resistance to movement in air and water, depending on the shape of the object. Barometer and air pressure are also studied. Hydrodynamics can also be extended to a more comprehensive period about water and can, for example, contain: Suspension forces, capillary tubes, surface tension in drops and soap bubbles, water currents in streams, ocean currents, the water cycle, rhythmic flows in "flowforms".	Investigation (I), Modeling (M), Perspective (P) and Communication (C)	Investigation (I) The teaching gives the student the opportunity to: ● formulate and investigate a limited problem with science content, including collecting and evaluating data from own and others' studies in science, as well as concluding and generalizing on the basis of own and others' practical and investigative work. ● have knowledge of the application possibilities and limitations of research methods, including the collection and validation of data as well as criteria for evaluating studies in science. Substance and Substance Cycle ● investigate elements and simple chemical compounds, their reactions and ● sub-elements of longer reaction chains.

For the subject of meteorology, review the geography curriculum. Electromagnetism experiments are made with the magnetic effect of current, Ørsted's discovery and right-hand rule, electromagnet, the use of electromagnetism in various devices: the Morse apparatus and the telegraph with feedback through the ground, bell (automatic interruption and connection of the current), the coil instrument, electric motor, dynamo, possibly generator, transformer, introduction to the concepts of voltage, current, resistance and their mathematical connection in Ohm's law (simple calculation examples) Optics experiments are carried out with lenses, focal point, binoculars, microscope, camera. Heat production is investigated using fire glass and a pinhole mirror. **Class 8 - Chemistry: Carbohydrates, fats and proteins** The period is usually started by examining the sugar's relationship to water and heat. The sugar's ability to dissolve in water gives insight into how syrup, glaze, jam, etc. are produced. If you heat sugar without water, you get caramelization and then combustion. Along the way, phenomena are pointed out that show which substances the sugar consists of. The sugar formation in the plant is then treated, and the relationship between air, light and		• have knowledge of the physical and chemical properties of substances and their commonly occurring properties • reactions and stability, with particular focus on the carbon and nitrogen cycle. Particles, waves and radiation • investigate light, sound and colours, qualitatively and quantitatively, including types of radiation, with causal reference to an atomic understanding. • have knowledge of wave types, sound and light phenomena, as well as radiation with reference to hypotheses of electronic structure. Energy turnover • Investigate energy turnover and storage in relation to calorimetry and electromagnetism, with a view to challenges in man-made and natural processes. • have knowledge of forms of energy, electromagnetic phenomena and energy flows and the societal challenges. The Earth and the Universe • investigate connections between forces and movement, describe relationships about

water is discussed of which a simple overview of photosynthesis is made. The importance of sugar for animals and humans is described. Furthermore, a distinction is made between the different types of sugar and the plants used for sugar production are treated. Fehling's sample is demonstrated. A historical review of the importance of sugar for world society and for the individual person occurs. Starting from the flour, starch is processed. The relationship of starch to water and fire is demonstrated and compared to the properties of sugar. The formation and appearance of starch in the plant is reviewed. The next step will be to demonstrate and review the transformation of sugar to starch and from starch to sugar as it takes place in the plant. Starch grains from various plants can be studied under a microscope. The importance and areas of use of flour are shown through student demonstration experiments, e.g. production of potato flour. Other demonstration experiments include the detection of starch using iodine-iodine-potassium. In the study of cellulose, the starting point is again the circulation of sugar found in plants. A comparison between cellulose and sugar shows important differences which are described and demonstrated. An important topic here is the manufacture of paper and other cellulose products, which is described historically and from the perspective of modern industry. In the		meteorological and oceanographic data and investigate selected local and global resource problems. ● have knowledge of forces and movement, including concrete scenarios such as convection conditions and Coriolis effect conditions in water and air circulation. ● have knowledge of resource consumption and recycling. Production and Technology ● examine food production, raw material utilization and digital monitoring of processes. ● have knowledge of nutrients and additives in food, raw materials and selected products and production processes. Modeling (M) The teaching gives the student the opportunity to: ● use purpose-relevant models to explain phenomena and problems in science, with an understanding of the applicability and limitations of the individual methods. ● have knowledge of modelling, the structure of selected models and their advantages and disadvantages. Substance and substance cycle

investigations of fat and oil, sources of vegetable and animal fat are described, with an emphasis on vegetable oils. Oils from different plants are examined. Smell, consistency, relationship to fire and water are aspects that are highlighted. Extraction through cold pressing, hot pressing and extraction is shown and described. This topic can be concluded with making soap. Using egg whites, the protein's relationship to water, air and heat is studied. Essential is the special smell that arises from burning eggs, hair, meat etc. It tells that the protein contains more than the individual substances that the students have learned about previously. Extraction of gluten from grains is a successful student experiment. **Class 9 Physics: Heat.** The theory of heat is generally introduced through conversation in class, where the students' own understanding of heat and energy is written down and discussed. The understanding of the molecular activity when something is cold or hot is highlighted as a background for defining temperature scales. The students are presented with a historical insight into the theory of heat. They hear, among other scientists, about the Fahrenheit, Kelvin and Celcius, as well as how they arrived at their temperature scales.		• describe selected atomic models and their development history. • use models of electron configurations to explain and predict chemical reactions. • have knowledge of symbolism, important general chemical reactions and the structure of the periodic table. Particles, waves and radiation • describe a model of the wave aspects of elements and light. • have knowledge of waves as a model for the propagation of light. Energy turnover • visualize energy turnovers, including electrical circuits. • have knowledge of energy chains and standard representations of electrical circuits. Earth and the Universe • describe planetary movements based on gravity models, as well as visualize models of aspects of the development of the solar system and the universe. • produce and interpret representations of surface phenomena on earth, including energy flows, weather systems and climate.

Experiments are made with a cold mixture to determine Fahrenheit's zero point. The theory behind the three states solid-liquid-gas is reviewed, and work is done to gain an understanding of the different phases and transitions the substance undergoes when heating or cooling. The example of ice-water-steam is brought up. An experiment with hot ice, Sodium Acetate, can for example be carried out to show the process of solid-liquid and liquid-solid matter. The main theorems of thermodynamics are worked on. In practice, a calorimetric experiment is carried out to determine the specific heat capacity of a substance. The concept of energy is an important topic, and it is also brought up in connection with our daily life. Where does the energy that we use come from? We work with the connection between energy and effect; for example, we look at how much it costs to boil 1 liter of water. In this connection, a visit to an incineration plant is a good opportunity to see how energy is generated from our waste. Various forms of energy are also discussed such as mechanical, chemical and thermal energy. The turnover between different energy forms and energy qualities is worked on, and in this context the four-stroke engine is examined. Below, the connection between heat/cold and pressure is explained, both through theory and practice. For example, students investigate the implosion of a hot can dipped in ice		• have knowledge of theories in astronomy and cosmology for the structure and development of the universe. • have knowledge of the earth's magnetic field, energy flows, weather systems and climate. Production and technology • use model understanding to describe technical plant processes and think independently in simple solutions. • have knowledge of supply, purification and incineration plants as well as general technological processes in agriculture and industry. Perspective (P) • use general models to describe conditions in the immediate environment, shed light on societal issues and contextualize scientific arguments. • have knowledge of relevant current scientific issues, conflicts of interest, sustainable development and the development of scientific statements. Substance and substance cycle • deal with and use substances qualifiedly and with due safety in everyday. • describe the importance of photosynthesis and combustion for atmospheric conditions and can make simple assessments of the consequences of

water, black bag in the sun, the freezer that will not open, boiling water at low pressure, and use of an air pump for demonstration of conditions at low pressure. Throughout the period, there is a focus on understanding the SI units used, including K, J, N, Pa, W, g, s. **Class 9 Chemistry: Stoichiometry, organic chemistry, nomenclature, eriodic system** We work with demonstration and student experiments, which form the framework for quantitative work with chemistry. Based on Lavoisier's thought on conservation of mass, the students' work with report writing is rounded off with coherent and completed calculations and rigorous use of symbols. In this process, the report writing focuses on keeping three aspects completely separate: description of procedure, indication of results and experiences and concluding theoretical considerations. Solubility experiments with inorganic salts provide a starting point for discussion of the molecular and ion concepts as well as inorganic nomenclature. A longer series of experiments with alkanes opens up the understanding of the series of organic substance groups that arise from the oxidation of alkanes, and the nomenclature system is reviewed through exercises		environmental influences for local and global climate and environment have relevant knowledge of properties of commonly occurring chemicals. ● have knowledge of contemporary changes in the composition of the atmosphere. ● have knowledge of generally discharged environmentally harmful substances Particles, waves and radiation ● describe the basic use of sound and light in the context of medicine and technology, as well as describe the possible uses of different types of electromagnetic radiation. ● have knowledge of the propagation of sound, light and other electromagnetic radiation as well as interaction with organic and inorganic material. Energy turnover ● recognize energy turnover in the immediate environment and relate to it energy quality in societal conditions and deal consciously with energy issues in society. ● have knowledge of energy sources and turnover in production and consumption. ● have knowledge of different types of energy resources and an estimate of future energy needs.

with structural formulas, naming and model sets. Initial experiments with fermentation and oxygenation are completed with ester synthesis of selected aroma substances. Relevant biological and industrial processes are highlighted by teacher review and reference to own experiences. Work is done with student experiments with acids and bases, where the results are interpreted based on Brøndsted's acid-base concept and form the basis for the sketch of a quantification of the strength by reviewing logarithmic scales. Lectures review the progression of historical ideas about the elements and their structure, with particular focus on Rutherford's experiments and Bohr's considerations. Pauli's exclusion principle is mentioned as a starting point for an understanding of the thoughts surrounding the underlying structure of the periodic table.		Earth and the Universe ● describe connections between the earth's position, atmosphere and magnetic field and the life conditions this produces. ● relate to human living conditions based on an understanding of the natural conditions. ● have knowledge of recent breakthroughs in the understanding of cosmology. ● have knowledge of the earth's structure, movements, climate and weather phenomena as well as the historical development of this understanding. Production and technology ● describe connections between technological development and social development, connection between raw materials, processes and product as well as associated sustainability considerations. ● have knowledge of key technological breakthroughs, technological application in industry and agriculture as well as relevant consequences for the natural environment. Communication (C) Dissemination

		• able to communicate about science using suitable media, as well as assess the quality of their own and others' communication about science subjects. • have knowledge of methods for conveying science subjects, as well as knowledge of source-aware dissemination of science subjects. Argumentation • formulate a claim and argue for it on a scientific basis • assess the validity of their own and others' scientific arguments. • have knowledge of claims and justifications, as well as knowledge of quality criteria for different types of arguments in a science context. Word knowledge • express him or herself orally and in writing precisely and nuanced by using technical terms and concepts. • have knowledge of words and concepts in science. Professional reading and writing • purposefully read and write texts in science subjects. • have knowledge of the purpose and structure of science texts and their objectivity requirements.