

# Content and Instruction



## Science as Inquiry

The abilities to conduct scientific inquiry and the development of understandings about scientific inquiry.



## Physical Science

Facts, concepts, principles, theories, and models that are fundamental to understanding and using the physical sciences.



## Life Science

Facts, concepts, principles, theories, and models that are fundamental to understanding and using the life sciences.



## Earth & Space Science

Facts, concepts, principles, theories, and models that are fundamental to understanding and using earth and space science.



## Science & Technology

The abilities associated with technological design and understandings about the connections between science and technology.



## Science in Personal & Social Perspectives

Understandings which are a foundation on which to base personal and social decisions.



## History & Nature of Science

Science as an ongoing, changing human enterprise, and an appreciation of the role of science throughout history and in many cultures.

# The focus of instruction for all students at the high school level is on:



## Unifying Concepts and Processes

Systems, order and organization; Evidence, models and explanation; Constancy, change, and measurement; Evolution and equilibrium; Form and function



## Science as Inquiry

providing opportunities for students to develop an understanding of the nature of scientific inquiry through active participation in full, meaningful inquiry investigations directed toward learning scientific content.



## Physical Science

**Chemistry:** providing opportunities for students to develop an understanding of the relationship among the properties and structure of matter and to explore a variety of chemical reactions and their applications.

**Physics:** providing opportunities for students to explore, develop, and use physical, conceptual and mathematical models as they develop qualitative and quantitative understanding of force, motion, energy, and matter, and apply their understandings to a variety of situations.



## Life Science

developing students' understanding of cell structure and function, the relationship of matter and energy in biological systems, heredity, biological evolution, and the behavior and interdependence of organisms and apply their understandings in a variety of situations.



## Earth and Space Science

providing opportunities for students to develop an understanding of the role of cycles in structuring the earth system, the use of evidence to develop an understanding of deep space and deep time, and apply their understandings in a variety of situations.



## Science and Technology

deepening students' understanding of the close relationship between science and technology and providing opportunities for them to apply science content and use their abilities of technological design to solve complex problems.



## Science in Personal and Social Perspectives

improving students' scientific understandings of science, technology, and societal challenges, how they interact, and on developing their abilities to evaluate the consequences of associated actions or decisions.



## History and Nature of Science

using historical examples to understand the human dimension of science and technology, the nature of scientific knowledge, and the enterprise of science and technology in a variety of historical and cultural perspectives.

# The focus of instruction for students pursuing further study is on:



## Unifying Concepts and Processes

Systems, order and organization; Evidence, models and explanation; Constancy, change, and measurement; Evolution and equilibrium; Form and function



## Science as Inquiry

providing opportunities to participate in independent exploration of sophisticated content using the abilities and understandings of inquiry.



## Physical Science

**Chemistry:** providing opportunities for students to develop a deeper understanding of atomic structure, explore the complex relationships among the structure and properties of matter including mathematical relationships, and apply their understandings to a variety of situations.

**Physics:** providing opportunities to explore, develop, and use conceptual and mathematical models as they develop a deeper understanding of force, motion, energy, and matter, and apply their understandings to a variety of situations.



## Life Science

providing opportunities to explore and expand their understandings of molecular genetics, biological evolution and interactions, the structure and function of living systems, natural ecosystems and apply their understandings in a variety of situations.



## Earth and Space Science

increasing students' knowledge and understanding of the origin and evolution of the earth system and the universe and apply their understandings in a variety of situations.



## Science and Technology

providing opportunities for independent problem solving experiences which involve the full range of abilities and understandings of technological design.



## Science in Personal and Social Perspectives

providing support for students as they engage in personal actions and inform and persuade others to make appropriate decisions relating to personal, community, and global actions.



## History and Nature of Science

providing opportunities for students to analyze and replicate historical and contemporary scientific investigations and explore their cultural and historical implications.

# Science for High School Learners

The NRC *National Science Education Standards* (NSES) call for all students to study science at each grade level, 9-12. The challenge is to develop curriculum which will encourage all students to take science for all four years. This curriculum must be attractive and accessible to students who have a wide variety of interests and needs and include inquiry investigations that are derived from questions and issues that students find meaningful.

Along with inquiry investigations in the traditional content areas of physical, life, and earth and space science, the areas of science and technology, science in personal and social perspectives, and history and nature of science are to be integrated throughout the science curriculum. Some argue that there is not time in a traditional curriculum to teach using an inquiry approach or to include the new areas of science and technology, science in personal and social perspectives, and history and nature of science. They are right. The amount of traditional, factual content taught must be greatly reduced, and the opportunities for students to understand science and to do science greatly increased. A variety of instructional strategies must be used to ensure that all students are successful in learning high school science. Along with reducing content and employing many instructional strategies, including increased attention to inquiry, teachers must also be sure that what is taught from ninth to twelfth grades is coordinated, and the science curricula is organized so that it is based on what has been learned and experienced prior to the current course.

High school students rely less on rote memory as they continue to develop their cognitive powers of creativity, judgment, and reasoning. They are able to read about and understand new developments in science. Developmentally, the ability of high school students to conduct scientific investigations, use technology, and formulate and revise scientific explanations and models using logic and evidence greatly improves from the ninth to the twelfth grades. Students can understand and appreciate conflicting points of view and the development of ideas. They come to understand issues which are related to scientific decision making as they use data to build a reasoned case for supporting or not supporting such decisions. Students welcome opportunities to explore science in personal and social perspectives and the history and nature of science because they are interested in practical, meaningful applications of science.

Advanced courses include not only more in-depth and complex content, but also full inquiry investigations and opportunities to integrate science and technology, science in personal and social perspectives, and the history and nature of science. The challenge is to teach science concepts through an inquiry approach which develops students' higher-order thinking skills, and enables students to build on previously taught material as they develop understanding of complex concepts.

The pages that follow provide focus for educators in the teaching and learning of science at the high school level. Note that the focus of instruction in each discipline describes science for all high school students. It then goes on to describe the focus of instruction in courses that provide further study for interested or high achieving students. This may be through elective coursework, postsecondary option programs, Advanced Placement programs, independent study or mentorships.

The NSES describe the science that all students should have the opportunity to learn. These standards should be viewed as the base line for school science programs. In many ways this describes what is available for some students in many Minnesota schools. We have a long way to go, however, before every student in every school is provided with the opportunity to learn the rigorous science described by the NSES. There is also much science to learn beyond that described in the NSES. Many of the High Standards of the Minnesota Profile of Learning require learnings beyond the NSES and are addressed in the *Framework* in the section that describes science for students pursuing further study in science.