

QUICK REFERENCE: 12TH GRADE SCIENCE STANDARDS

A. SCIENCE CONNECTIONS

Content Standard

Students in Wisconsin will understand that among the science disciplines, there are unifying themes: systems, order, organization, and interactions; evidence, models, and explanations; constancy, change, and measurement; evolution, equilibrium, and energy; and form and function.

These themes relate and interconnect the Wisconsin science standards to one another. Each theme is further defined in the glossary following the science standards.

Rationale:

These unifying themes are ways of thinking rather than theories or discoveries. Students should know about these themes and realize that the more they learn about science the better they will understand how the themes organize and enlarge their knowledge. Science is a system and should be seen as a single discipline rather than a set of separate disciplines. Students will also understand science better when they connect and integrate these unifying themes into what they know about themselves and the world around them.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

- A.12.1 Apply* the underlying themes* of science to develop defensible visions of the future
- A.12.2 Show* how conflicting assumptions about science themes* lead to different opinions and decisions about evolution*, health, population, longevity, education, and use of resources, and show* how these opinions and decisions have diverse effects on an individual, a community, and a country, both now and in the future
- A.12.3 Give examples that show* how partial systems*, models*, and explanations* are used to give quick and reasonable solutions that are accurate enough for basic needs
- A.12.4 Construct* arguments that show* how conflicting models* and explanations* of events can start with similar evidence*
- A.12.5 Show* how the ideas and themes* of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources
- A.12.6 Identify* and replace inaccurate personal models* and explanations* of science-related phenomena using evidence* learned or discovered
- A.12.7 Re-examine the evidence* and reasoning that led to conclusions drawn from investigations*, using the science themes*

B. NATURE OF SCIENCE

Content Standard

Students in Wisconsin will understand that science is ongoing and inventive, and that scientific understandings have changed over time as new evidence is found.

Rationale:

Students will realize that scientific knowledge is developed from the activities of scientists and others who work to find the best possible explanations of the natural world. Researchers and those who are involved in science follow a generally accepted set of rules to produce scientific knowledge that others can confirm through experimentation. This knowledge is public, replicable, and undergoing revision and refinement based on new experiments and data.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

- B.12.1 Show* how cultures and individuals have contributed to the development of major ideas in the earth and space, life and environmental, and physical sciences
- B.12.2 Identify* the cultural conditions that are usually present during great periods of discovery, scientific development, and invention
- B.12.3 Relate* the major themes* of science to human progress in understanding science and the world
- B.12.4 Show* how basic research and applied research contribute to new discoveries, inventions, and applications
- B.12.5 Explain* how science is based on assumptions about the natural world and themes* that describe the natural world

C. SCIENCE INQUIRY

Content Standard

Students in Wisconsin will investigate questions using scientific methods and tools, revise their personal understanding to accommodate knowledge, and communicate these understandings to others.

Rationale:

Students should experience science in a form that engages them in actively constructing ideas and explanations and enhances their opportunities to develop the skills of doing science. Such inquiry (problem solving) should include questioning, forming hypotheses, collecting and analyzing data, reaching conclusions and evaluating results, and communicating procedures and findings to others.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

- C.12.1 When studying science content, ask questions suggested by current social issues, scientific literature, and observations* of phenomena; build hypotheses that might answer some of these questions; design possible investigations*; and describe results that might emerge from such investigations
- C.12.2 Identify* issues from an area of science study, write questions that could be investigated*, review previous research on these questions, and design and conduct responsible and safe investigations to help answer the questions
- C.12.3 Evaluate* the data collected during an investigation*, critique the data-collection procedures and results, and suggest ways to make any needed improvements
- C.12.4 During investigations*, choose the best data-collection procedures and materials available, use them competently, and calculate the degree of precision of the resulting data
- C.12.5 Use the explanations* and models* found in the earth and space, life and environmental, and physical sciences to develop likely explanations* for the results of their investigations*
- C.12.6 Present the results of investigations* to groups concerned with the issues, explaining* the meaning and implications of the results, and answering questions in terms the audience can understand
- C.12.7 Evaluate* articles and reports in the popular press, in scientific journals, on television, and on the Internet, using criteria related to accuracy, degree of error, sampling, treatment of data, and other standards of experimental design

D. PHYSICAL SCIENCE

Content Standard

Students in Wisconsin will demonstrate an understanding of the physical and chemical properties of matter, the forms and properties of energy, and the ways in which matter and energy interact.

Rationale:

Knowledge of the physical and chemical properties of matter and energy is basic to an understanding of the earth and space, life and environmental, and physical sciences. The properties of matter can be explained in terms of the atomic structure of matter. Natural events are the result of interactions of matter and energy. When students understand how matter and energy interact, they can explain and predict chemical and physical changes that occur around them.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

Structures of Atoms and Matter

- D.12.1 Describe* atomic structure and the properties of atoms, molecules, and matter during physical and chemical interactions*
- D.12.2 Explain* the forces that hold the atom together and illustrate* how nuclear interactions* change the atom
- D.12.3 Explain* exchanges of energy* in chemical interactions* and exchange of mass and energy in atomic/nuclear reactions

Chemical Reactions

- D.12.4 Explain* how substances, both simple and complex, interact* with one another to produce new substances
- D.12.5 Identify* patterns in chemical and physical properties and use them to predict* likely chemical and physical changes and interactions
- D.12.6 Through investigations*, identify* the types of chemical interactions*, including endothermic, exothermic, oxidation, photosynthesis, and acid/base reactions

Motions and Forces

- D.12.7 Qualitatively and quantitatively analyze* changes in the motion of objects and the forces that act on them and represent analytical data both algebraically and graphically
- D.12.8 Understand* the forces of gravitation, the electromagnetic force, intermolecular force, and explain* their impact on the universal system
- D.12.9 Describe* models* of light, heat, and sound and through investigations* describe* similarities and differences in the way these energy* forms behave

Conservation of Energy and the Increase in Disorder

D.12.10 Using the science themes*, illustrate* the law of conservation of energy* during chemical and nuclear reactions

Interactions of Matter and Energy

D.12.11 Using the science themes*, explain* common occurrences in the physical world

D.12.12 Using the science themes* and knowledge of chemical, physical, atomic, and nuclear interactions*, explain* changes in materials, living things, earth's features, and stars

E. EARTH AND SPACE SCIENCE

Content Standard

Students in Wisconsin will demonstrate an understanding of the structure and systems of the earth and other bodies in the universe and their interactions.

Rationale:

By studying the earth, its composition, history, and the processes that shape it, students gain a better understanding of the planet on which they live. Understanding these geologic, meteorological, astronomical, and oceanographic processes allows students to make responsible choices and to evaluate the consequences of their choices. In addition, all bodies in space, including the earth, are influenced by forces acting throughout the solar system and the universe. Studying the universe enhances students' understanding of the earth's origins, its place in the universe, and its future.

For more details of the content of life and environmental sciences, see *National Science Education Standards* (1996, p. 115 - 201), Washington, D.C., National Academy Press.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

Energy in the Earth System

- E. 12.1 Using the science themes*, distinguish between internal energies* (decay of radioactive isotopes, gravity) and external energies (sun) in the earth's systems and show* how these sources of energy have an impact on those systems

Geochemical Cycles

- E.12.2 Analyze* the geochemical and physical cycles of the earth and use them to describe* movements of matter

The Origin and Evolution of the Earth System

- E.12.3 Using the science themes*, describe* theories of the origins and evolution* of the universe and solar system, including the earth system* as a part of the solar system, and relate* these theories and their implications to geologic time on the earth
- E.12.4 Analyze* the benefits, costs, and limitations of past, present, and projected use of resources and technology and explain* the consequences to the environment

The Origin and Evolution of the Universe

- E.12.5 Using the science themes*, understand* that the origin of the universe is not completely understood, but that there are current ideas in science that attempt to explain its origin

F. LIFE AND ENVIRONMENTAL SCIENCE

Content Standard

Students in Wisconsin will demonstrate an understanding of the characteristics and structures of living things, the processes of life, and how living things interact with one another and their environment.

Rationale:

Students will enhance their natural curiosity about living things and their environment through study of the structure and function of living things, ecosystems, life cycles, energy movement (transfer), energy change (transformation), and changes in populations of organisms through time. Knowledge of these concepts and processes of life and environmental science will assist students in making informed choices regarding their lifestyles and the impact they have on communities of living things in their environment.

For more details of the content of life and environmental sciences, see *National Science Education Standards* (1996, p. 115 - 201), Washington, D.C., National Academy Press.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

The Cell

- F.12.1 Evaluate* the normal structures and the general and special functions* of cells in single-celled and multiple-celled organisms
- F.12.2 Understand* how cells differentiate and how cells are regulated

The Molecular Basis of Heredity

- F.12.3 Explain* current scientific ideas and information about the molecular and genetic basis of heredity
- F.12.4 State the relationships between functions* of the cell and functions of the organism as related to genetics and heredity

Biological Evolution*

- F.12.5 Understand* the theory of evolution*, natural selection, and biological classification
- F.12.6 Using concepts of evolution* and heredity, account for changes* in species and the diversity of species, include the influence of these changes on science, e.g., breeding of plants or animals

The Interdependence of Organisms

- F.12.7 Investigate* how organisms both cooperate and compete in ecosystems
- F.12.8 Using the science themes*, infer* changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water, or earth pollution

Matter, Energy, and Organization in Living Systems

- F.12.9 Using the science themes*, investigate* energy* systems* (related to food chains) to show* how energy is stored in food (plants and animals) and how energy is released by digestion and metabolism
- F.12.10 Understand* the impact of energy* on organisms in living systems*
- F.12.11 Investigate* how the complexity and organization* of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy* used to sustain an organism

The Behavior of Organisms

- F.12.12 Trace how the sensory and nervous systems* of various organisms react to the internal and external environment and transmit survival or learning stimuli to cause changes in behavior or responses

G. SCIENCE APPLICATIONS

Content Standard

Students in Wisconsin will demonstrate an understanding of the relationship between science and technology and the ways in which that relationship influences human activities.

Rationale:

Science and technology complement each other. Science helps drive technology and technology provides science with tools for investigation, inquiry, and analysis. Together, science and technology applications provide solutions to human problems, needs, and aspirations. Students should understand that advances in science and technology affect the earth's systems.

PERFORMANCE STANDARDS**By the end of grade 12 students will:**

- G.12.1 Identify* personal interests in science and technology; account for implications that these interests might have for future education, and options to be considered
- G.12.2 Design, build, evaluate, and revise models* and explanations related to the earth and space, life and environmental, and physical sciences
- G.12.3 Analyze* the costs, benefits, or problems resulting from a scientific or technological innovation, including implications for the individual and the community
- G.12.4 Show* how a major scientific or technological change has had an impact on work, leisure, or the home
- G.12.5 Choose a specific problem in our society, identify* alternative scientific or technological solutions to that problem and argue its merits

H. SCIENCE IN SOCIAL AND PERSONAL PERSPECTIVES**Content Standard**

Students in Wisconsin will use scientific information and skills to make decisions about themselves, Wisconsin, and the world in which they live.

Rationale:

An important purpose of science education is to give students a means to understand and act on personal, economic, social, political, and international issues. Knowledge and methodology of the earth and space, life and environmental, and physical sciences facilitate analysis of topics related to personal health, environment, and management of resources, and help evaluate the merits of alternative courses of action.

PERFORMANCE STANDARDS

By the end of grade 12 students will:

- H.12.1 Using the science themes* and knowledge of the earth and space, life and environmental, and physical sciences, analyze* the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region
- H.12.2 Evaluate* proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning, and implications, both short and long term
- H.12.3 Show* how policy decisions in science depend on many factors, including social values, ethics, beliefs, time-frames, and considerations of science and technology
- H.12.4 Advocate a solution or combination of solutions to a problem in science or technology
- H.12.5 Investigate* how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology, and quality of life in a community or region
- H.12.6 Evaluate* data and sources of information when using scientific information to make decisions
- H.12.7 When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning

