WYOMING SCIENCE CONTENT AND PERFORMANCE STANDARDS

WYOMING STATE BOARD OF EDUCATION

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WYOMING SCIENCE CONTENT AND PERFORMANCE STANDARDS

RATIONALE

The mission of science education is to help young people develop the ability to reason, think creatively, make responsible decisions, and solve problems. Students do more than acquire knowledge; they work toward understanding and making sense of the world around them. They must process, apply, and effectively communicate scientific knowledge to become scientifically literate citizens. Scientific literacy is of critical importance for the United States to participate productively in an increasingly competitive technological society.

Organization of Standards

Standards specify the essential learning that students must master. They provide a K-12 framework to assist school districts, schools, and communities in developing and strengthening curriculum rather than prescribing courses, materials, or instructional methodology. Teachers ensure that students achieve standards by using a range of instructional strategies that they select based on their students' needs. Content and performance standards are identified for grade spans K-4, 5-8, and 9-12 with benchmarks at grades four, eight, and eleven. Terms used in this document are defined below and in the glossary at the end.

Content Standards: These statements define what students are expected to know and be able to do by the time they graduate. They do not dictate what methodology or instructional materials should be used, nor how the material is delivered.

Benchmarks: These statements specify what students are expect to know and be able to do at the end of each of the benchmark grade levels, in this document, grades 4, 8, and 11. These benchmarks specify the skills and content students must master along the way in order to master the content standards by the time they graduate.

Performance Standards Level Descriptors: These statements describe how well students must perform the benchmarks. The "proficient" level is required in order to demonstrate mastery of the standards. Descriptors help teachers judge where students are performing in relation to the benchmarks, and ultimately, the content standards. A general definition of each level is provided below.

> **Advanced:** Students at the advanced performance level use their knowledge of science in complex situations and can analyze, synthesize, and communicate information and ideas.

Proficient: Students at the proficient performance level use concepts and skills to acquire, analyze, and communicate information and ideas.

Basic: Students at the basic performance level ineffectively use or require assistance to use concepts and skills to acquire, analyze, and communicate information and ideas.

Below Basic: Students at the below basic performance level require extensive support or provide little or no evidence in meeting the standard.

The committee recognizes that course sequences tend to vary widely after the eighth grade. However, the knowledge and skills identified at the eleventh grade are intended for all students regardless of the sequences of science courses or combination of other courses with science content. Therefore, districts will need to ensure that their course sequences will enable students to demonstrate mastery of the designated knowledge and skills no later than the end of the eleventh grade. For advanced students, such mastery should occur much sooner than the eleventh grade. For a few students, such mastery will constitute a significant challenge. District, University, business, and community participants agreed that the standards reflect the necessary skills for success in study and work that need to be accomplished no later than the end of the eleventh grade. Success in meeting these standards will provide the foundation for students to apply science skills in many areas of adult life, or to a more specific career or post secondary course of study.

Although performance levels are specified for grades 4, 8 and 11, all grades prior to those designated are regarded as responsible to the benchmark level above them. For example, many skills are introduced at least two years before mastery can be expected, as described at the benchmark performance level. Teachers, parents, and students must be aware of the requirements at the next level, even as they prepare for the current level, so that prerequisite skills are introduced and experienced over time. They must also be aware of the requirements at the previous level so that students continue to practice and apply the knowledge and skills they have already mastered. Therefore, kindergarten through fourth grade teachers, parents, and students work toward the achievement of the fourth grade benchmarks. Fifth grade through eighth grade teachers, parents, and students work toward the achievement of the eighth grade benchmarks. Ninth grade through eleventh grade work toward the achievement of eleventh grade benchmarks. Success at each benchmark level requires the combined effort and commitment of all who prepare for that level.

Action Snapshot: The Action Snapshot is provided as an example to show how a standard might be implemented in the classroom. It may address performance tasks as well as performance assessments. Action Snapshots may also demonstrate how various standards may be integrated.

INTRODUCTION TO THE STANDARDS

The Wyoming Science Content and Performance Standards represent a cooperative effort. In 1997-1998, representatives from each of the districts participated in regional groups along with community college, University, students, and business representatives. The process began with regional meetings where the participants compiled drafts using local district standards. The state committee, consisting of regional representatives, utilized the regional documents to draft the state standards. National standards and several states' standards were referenced to establish the rigor of the Wyoming Science Content and Performance Standards. These documents are listed below:

- National Research Council, Inquiry and the National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, Pathways To The Science Standards: Elementary School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- National Science Teachers Association, Pathways To The Science Standards: High School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- National Science Teachers Association, Pathways To The Science Standards: Middle School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science, Benchmarks for Science Literacy: Project 2061, Oxford University Press, New York 1993.
- American Association for the Advancement of Science, Science For All Americans: Project 2061, Oxford University Press, New York 1990.
- Arizona – Science Standards, http://www.ade.state.az.us.
- California – The Challenge Initiative -- Superintendent's Challenge Initiative, California Department of Education, Telephone (916) 657-3011.
- Colorado – Colorado Model Science Standards, http://www.cde.state.co.us.
- Hawaii – Science Standards, http:www.k12.hi.us.
- Indiana – Science In Action For All Indiana Students, http://www.doe.state.in.us.
- New Jersey – Science Standards
- Virginia – Science Standards of Learning, http://www.pen.k12.va.us.

In 2002-2003, writing committees were convened to review and revise these standards.

STANDARD STRANDS

The Wyoming Science Standards describe what all students should know, understand, and apply in science. There are three overarching standards: Concepts and Processes, Science as Inquiry, and History and Nature of Science in Personal and Social Decisions. These standards should be learned in an integrated approach to science. A brief description is provided for each of these standards.

Concepts and Processes: This standard focuses on developing student understanding by blending content and process, and highlighting the connections among scientific ideas. The Concepts and Processes Standard addresses the scientific body of knowledge. Science is a dynamic process; concepts and content are best learned through inquiry and investigation. Concepts in **Life Systems** and **Earth, Space,** and **Physical Systems** are taught within the context of the following Unifying Concepts and Processes of Science:

- Systems, classification, order, and organization
- Evidence, models, and explanations
- Change, constancy, and measurement
- Evolution and equilibrium
- Form and function

Science as Inquiry: Inquiry is the foundation for the development of content and processes of science that enable students to construct their own knowledge. This standard addresses students' ability to safely conduct investigations and develop an understanding of inquiry, enriching their knowledge of science. The Science as Inquiry Standard emphasizes the process of confronting accepted ideas and gaining new information through research and investigation.

> **Applying Habits of Mind in Inquiry:** Habits of Mind, which are specific intelligent behaviors that support problem solving and critical and creative thought, are embedded within the content and performance standards to enhance students' understanding of science. When pursuing an investigation, students develop questions and pose problems, which can be based on others' points of view, applying past knowledge and experiences, and gathering information though the senses. In designing an investigation, students are encouraged to develop appropriate and deliberate procedures, to take responsible risks, venturing a step beyond the expected, and to consider a variety of innovative options in pursuing a solution to the problem or answering the question. To validate the reliability of the investigation, data is collected, organized, and analyzed with accuracy and exactness to avoid hasty, impulsive decisions. Through practiced perseverance, students remain focused throughout the

investigation, taking the investigative task to completion. Reporting the results of the investigation requires students to communicate with accuracy and precision, to make connections to scientific concepts, and to apply acquired knowledge to new situations. Often inquiry procedures require a cooperative setting, affording the opportunity for students to work with and learn from others. One of the fundamental outcomes of the inquiry process is to encourage students to pursue areas of interest, remaining open to continuous learning as lifelong learners.

History and Nature of Science in Personal and Social Decisions: An important purpose of science education is to give students a basis to understand and act on personal and social issues. Incorporating historical view into science programs acknowledges that scientific events have been of significant value and influence within our cultural heritage. It also provides concrete examples to clarify different aspects of scientific inquiry, the human aspects of science, and the role that science has played in the development of human understanding of natural phenomena.

Science Performance Standards Level Descriptors for the Body of Evidence

The science performance descriptors for the Body of Evidence are consistent across the grade levels. The depth of understanding and the consistency with which students understand the dynamic nature of science, make connections among unifying concepts and processes, and apply scientific information are the criteria for determining performance levels (advanced, proficient, basic, and below basic). The determining factor that differentiates the grade levels is the developmental appropriateness of the knowledge. For example, in grade four, students can demonstrate a developmentally appropriate understanding of life cycles of organisms by understanding that all living things go through a series of life events culminating in death of the organism. At grade 11, that same concept would embody the knowledge that DNA provides the blueprint for the entire life span of an organism, but that many other factors can have an influencing effect upon that DNA-coded blueprint.

Grades 11, 8, and 4

Advanced: Students performing at the advanced level in science understand the dynamic nature of science and make connections among unifying concepts and processes to explain the natural world. They are able to extend inquiry to analyze and synthesize scientific information to generate new questions. These students are able to construct personal knowledge independently and apply and critique scientific information to make informed decisions about societal issues. They employ a variety of appropriate technological tools and communication skills.

Proficient: Students performing at the proficient level in science understand the dynamic nature of science and use unifying concepts and processes that explain the natural world. They use inquiry to generate and validate scientific information and apply scientific information to make informed decisions about societal issues. These students are able to employ a variety of appropriate technological tools and communication skills.

Basic: Students performing at the basic level in science are able to identify concepts and processes that explain the natural world. With support, they are able to use inquiry to generate scientific information to make decisions. These students are able to implement limited use of technological tools and communication skills.

Below Basic: Students at the below basic level in science require extensive support or provide little or no evidence in meeting the standard.

WYOMING SCIENCE
CONTENT AND PERFORMANCE STANDARDS
GRADE SPAN 9-12

CONTENT STANDARD **1. CONCEPTS AND PROCESSES** **In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.**	
BENCHMARK **GRADE 11**	**PERFORMANCE STANDARDS** **LEVEL DESCRIPTORS** **GRADE 11**
UNIFYING CONCEPTS AND PROCESSES **Concepts in LIFE SYSTEMS and EARTH, SPACE, and PHYSICAL SYSTEMS are taught within the context of the following Unifying Concepts and Processes of Science:** ▪ **Systems, classification, order and organization** ▪ **Evidence, models, and explanations** ▪ **Change, constancy, and measurement** ▪ **Evolution and equilibrium** ▪ **Form and function**	**ADVANCED PERFORMANCE** **11th grade students at the advanced level, in addition to demonstrating the proficient level, make connections among unifying concepts and processes to explain the natural world and the dynamic nature of science. The cognitive complexity for students at this level reaches into a higher level of thinking, requiring frequent responses citing evidence, drawing conclusions, explaining phenomena, and using concepts to solve problems. Students extend many of the higher level thinking skills over a period of time, such as making connections between related concepts and phenomena and synthesizing ideas into new concepts.**

LIFE SYSTEMS

1. **<u>The Cell</u>: Students explain the processes of life, which necessitates an understanding of relationship between structure and function of the cell and cellular differentiation. They identify activities taking place in an organism related to metabolic activities in cells, including growth, regulation, transport, and homeostasis. Students differentiate between asexual and sexual reproduction.**

2. **<u>Molecular Basis of Heredity</u>: Students demonstrate an understanding that organisms ensure species continuity by passing genetic information from parent to offspring. They utilize genetic information to make predictions about possible offspring. Students apply concepts of molecular biology (DNA and genes) to recent discoveries.**

3. **<u>Biological Evolution</u>: Students explain how species evolve over time. They understand that evolution is the consequence of various interactions, including the genetic variability of offspring due to mutation and recombination of genes, and the ensuing selection by the environment of those offspring better able to survive and leave additional offspring. Students discuss natural selection and that its evolutionary consequences provide a scientific explanation for the great diversity of organisms as evidenced by the fossil record. They examine how different species are related by descent from common ancestors. Students are able to explain how organisms are classified based on similarities that reflect their evolutionary relationships, with species being the most fundamental unit of classification.**

<u>PROFICIENT PERFORMANCE</u>

11th grade students at the proficient level demonstrate an accurate understanding of science content. Students make connections to the major related unifying concepts and processes, building on their prior knowledge and experiences. The cognitive complexity at this level identifies students who recognize, use, identify, describe, and recall scientific information. In addition to these levels of performance, students explain, classify, organize, model, illustrate, systematize, evaluate, relate, interpret, observe, and predict, which extends beyond a habitual response.

<u>BASIC PERFORMANCE</u>

11th grade students at the basic level demonstrate an accurate understanding of some basic science facts and principles. With support, they make connections to related unifying concepts and processes. The cognitive complexity for students at this level identifies students who recognize, use, identify, describe, and recall scientific information with support.

<u>BELOW BASIC PERFORMANCE</u>

11th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard. The cognitive complexity for students at this level identifies students who have difficulty with skills to recognize, use, identify, describe, and recall scientific information.

4. <u>Interdependence of Organisms</u>: Students investigate the inter-relationships and interdependence of organisms, including the ecosystem concept, energy flow, competition for resources, and human effects on the environment.	
5. <u>Matter, Energy, and Organization in Living Systems</u>: Students describe the need of living systems for a continuous input of energy to maintain chemical and physical stability. They explain the unidirectional flow of energy and organic matter through a series of trophic levels in living systems. Students investigate the distribution and abundance of organisms in ecosystems, which are limited by the availability of matter and energy and the ability of the living system to recycle materials.	
6. <u>Behavior and Adaptation</u>: Students examine behavior as the sum of responses of an organism to stimuli in its environment, which evolves through adaptation, increasing the potential for species survival. They identify adaptations as characteristics and behaviors of an organism that enhance the chance for survival and reproductive success in a particular environment.	
EARTH, SPACE, AND PHYSICAL SYSTEMS	
7. <u>Geochemical Cycles</u>: Students describe the Earth as a closed system and demonstrate a conceptual understanding of the following systems: geosphere, hydrosphere, atmosphere, and biosphere. Students explain the role of energy in each of these systems, such as weather patterns, global climate, weathering, and plate tectonics.	

8. <u>Origin and Evolution of the Earth System</u>: Students investigate geologic time through comparing rock sequences, the fossil record, and decay rates of radioactive isotopes.	
9. <u>Origin and Evolution of the Universe</u>: Students examine evidence for the Big Bang Theory and recognize the immense time scale involved in comparison to human-perceived time. They describe the process of star and planet formation, planetary and stellar evolution including the fusion process, element formation, and dispersion.	
10. <u>Structure and Properties of Matter</u>: Students describe the atomic structure of matter including subatomic particles, their properties, and interactions. They recognize that elements are organized into groups in the periodic table based on their outermost electrons and these groups have similar properties. They explain chemical bonding in terms of the transfer or sharing of electrons between atoms. Students describe physical states of matter and phase changes. Students differentiate between chemical and physical properties, and chemical and physical changes.	
11. <u>Chemical Reactions</u>: Students recognize that chemical reactions take place all around us. They realize that chemical reactions may release or consume energy, occur at different rates, and result in the formation of different substances. They identify the factors that affect reaction rates.	

12. <u>Conservation of Energy and Increase in Disorder</u>: Students demonstrate an understanding of the laws of conservation of mass and energy within the context of physical and chemical changes. They realize the tendency for systems to increase in disorder.	
13. <u>Energy and Matter</u>: Students demonstrate an understanding of types of energy, energy transfer and transformations, and the relationship between energy and matter.	
14. <u>Force and Motion</u>: Students develop a conceptual understanding of Newton's Laws of Motion, gravity, electricity, and magnetism.	

Snapshot In Action

<u>The Cell</u>: Students relate the cell, its organelles, and activities (i.e., growth, regulation, transport, and balance) to their school or community, focusing on the parts and activities that enable it to function.
<u>Behavior and Adaptation</u>: Given physical, climatic, and biotic conditions for a hypothetical planet in a far-off solar system, students design and justify a plant's and animal's structure and behavior, so that they can survive on that planet.
<u>Origin and Evolution of the Earth System</u>: Students visit a field site, or are given a geologic cross-section from a specific site, which displays various underlying rock layers. From this cross-section, they create an illustrated narrative history for the location through geologic time.
<u>Properties of Matter</u>: Students investigate the concept of density and apply it in experimental procedures. Students use a density column to determine the densities of solids and liquids, and then develop and prove or disprove statements about the relative densities of other substances.

For greater detail and description refer to the following resources:

- National Research Council, <u>National Science Education Standards</u>, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, <u>Inquiry and the National Science Education Standards</u>, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, <u>Pathways To The Science Standards: High School Edition</u>, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science: <u>Benchmarks for Science Literacy: Project 2061</u>, Oxford University Press, New York 1993.

CONTENT STANDARD

2. SCIENCE AS INQUIRY

Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK GRADE 11	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 11
1. Students research scientific information and present findings through appropriate means. 2. Students use inquiry to conduct scientific investigations. • Pose problems and identify questions and concepts to design and conduct an investigation. • Collect, organize, analyze and appropriately represent data. • Give priority to evidence in drawing conclusions and making connections to scientific concepts. • Clearly and accurately communicate the result of the investigation. 3. Students clearly and accurately communicate the result of their own work as well as information from other sources.	**ADVANCED PERFORMANCE** **11th grade students at the advanced level, in addition to demonstrating the proficient level, are able to propose new problems and questions based on experimental results or research. Students analyze information to provide new insight and draw logical conclusions that are not immediately obvious.** **PROFICIENT PERFORMANCE** **11th grade students at the proficient level design and safely conduct experiments. Students appropriately represent the data obtained through experiments or research. Students draw appropriate conclusions, based on the data collected. They accurately communicate the results of scientific investigations or research - through written, oral, and visual means - using scientific vocabulary, mathematics, and technology. Students accurately describe the role technology plays in science inquiry and the role that inquiry plays in science and technology. Students choose and safely use appropriate technology and recognize limitations in science inquiry.**

4. Students investigate the relationships between science and technology and the role of technological design in meeting human needs. **5. Students properly use appropriate scientific and safety equipment, recognize hazards and safety symbols, and observe standard safety procedures.**	**BASIC PERFORMANCE** **11th grade students at the basic level gather information and data obtained from scientific investigation or research. With support, students use written, oral, and/or visual means to organize, analyze, and communicate the results of scientific investigations. Students demonstrate limited use of scientific and mathematical language to communicate findings.** **BELOW BASIC PERFORMANCE** **11th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

Inquiry: Students propose, design, and carry out an experiment, draw conclusions from the results, organize and represent the data, and present their findings with both a written report and an oral presentation in a peer review session.
Science and Technology: Students use science principles and technology to develop a project that attempts to solve a problem around school or home that the student has identified.
Safety: Students use physics principles with application of Newton's Laws of Motion, to create a demonstration with props to show why wearing a seat belt is a wise choice.

For greater detail and description refer to the following resources:

- National Research Council, Inquiry and the National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, Pathways To The Science Standards: Elementary School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science: Benchmarks for Science Literacy: Project 2061, Oxford University Press, New York 1993.

CONTENT STANDARD

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK GRADE 11	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 11
1. Students examine the nature and history of science. • **As scientific knowledge evolves, it impacts personal, social, economic, and political decisions.** • **The historical misuse of scientific information to make personal, social, economic, and political decisions.** **2. Students examine how scientific information is used to make decisions.** • **Interdisciplinary connections of the sciences and connections to other subject areas and career opportunities.** • **The role of science in solving personal, local, national, and global problems.** • **The origins, limitations, and conservation of natural resources, including Wyoming examples.**	**ADVANCED PERFORMANCE** **11th grade students at the advanced level, in addition to demonstrating the proficient level, analyze the impact of scientific knowledge on social, economic, or political decisions. Students evaluate complex relationships within and among the life, physical, and earth/space sciences. Students explore a variety of careers in scientific or technical fields, natural resource issues, and the role of science in solving problems.** **PROFICIENT PERFORMANCE** **11th grade students at the proficient level examine the evolution of scientific knowledge and its impact on specific areas of human endeavor. Students explain the implications of the misuse of scientific research to make important decisions. Students investigate the interdisciplinary nature of life, physical, and earth or space sciences. Students explain the historical role of science and the significance of contributions of individuals to scientific thought. Students compare options for a career in scientific or technical fields. Students apply science concepts to investigate natural resource issues: past, present, and future. Students explore a variety of careers in scientific or technical fields, natural resource issues, and the role of science in solving problems.**

	BASIC PERFORMANCE **11th grade students at the basic level describe careers in science or technical fields, but require additional support to investigate the use of science in decision-making.** **BELOW BASIC PERFORMANCE** **11th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

History of Science: Students research a prominent scientist of interest, and then present their findings about the scientist. The oral presentation will include biographic information, a description of a major contribution or discovery, a justification about why this person is considered influential, and a visual aid or prop selected or made by the student to characterize the scientist and enrich the presentation.

Scientific Information in Decisions: Students investigate how different science careers are utilized in Wyoming industries, report on a discovery made through that career, and develop a pro or con evaluation of one of the careers from their personal perspective.

Science Information in Decisions: Students use interdisciplinary connections to conduct a comprehensive case study on a piece of land, including field data collection, use the study results to develop a management plan for the land through a cooperative process with stakeholders, and then propose a system to monitor the management plan.

GRADE SPAN 5-8

CONTENT STANDARD

1. CONCEPTS AND PROCESSES

In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

BENCHMARK GRADE 8	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 8
UNIFYING CONCEPTS AND PROCESSES **Concepts in LIFE SYSTEMS and EARTH, SPACE, and PHYSICAL SYSTEMS are taught within the context of the following Unifying Concepts and Processes of Science:** ▪ **Systems, classification, order and organization** ▪ **Evidence, models, and explanations** ▪ **Change, constancy, and measurement** ▪ **Evolution and equilibrium** ▪ **Form and function** **LIFE SYSTEMS** **1. Levels of Organization in Living Systems: Students model the cell as the basic unit of a living system. They realize that all functions that sustain life act within a single cell and cells differentiate into specialized cells, tissues, organs, and organ systems.**	**ADVANCED PERFORMANCE** **8th grade students at the advanced level, in addition to demonstrating the proficient level, make connections among unifying concepts and processes to explain the natural world and the dynamic nature of science. The cognitive complexity for students at this level reaches into a higher level of thinking, requiring frequent responses citing evidence, drawing conclusions, explaining phenomena, and using concepts to solve problems. They extend many of the higher level thinking skills over an extended period of time, making connections between related concepts and phenomena and synthesizing ideas into new concepts.**

2. <u>Reproduction and Heredity</u>: Students describe reproduction as a characteristic of all living systems, which is essential to the continuation of species, and identify and interpret traits, patterns of inheritance, and the interaction between genetics and environment. **3. <u>Evolution as a Theory</u>: Students explain evolution as a theory and apply the theory to the diversity of species, which results from natural selection and the acquisition of unique characteristics through biological adaptation.** **4. <u>Diversity of Organisms</u>: Students investigate the interconnectedness of organisms, identifying similarity and diversity of organisms through a classification system of hierarchical relationships and structural homologies.** **5. <u>Behavior and Adaptation</u>: Students recognize behavior as a response of an organism to an internal or environmental stimulus and connect the characteristics and behaviors of an organism to biological adaptation.** **6. <u>Interrelationships of Populations and Ecosystems</u>: Students illustrate populations of organisms and their interconnection within an ecosystem, identifying relationships among producers, consumers, and decomposers.**	**<u>PROFICIENT PERFORMANCE</u>** **8th grade students at the proficient level demonstrate an accurate understanding of science content. They make connections to related unifying concepts and processes, building on prior knowledge and experiences. The cognitive complexity at this level identifies students who recognize, use, identify, describe, and recall scientific information. In addition to these levels of performance, students explain, classify, organize, model, illustrate, systematize, evaluate, relate, interpret, observe, and predict, which extended beyond a habitual response.** **<u>BASIC PERFORMANCE</u>** **8th grade students at the basic level demonstrate an understanding of some basic science facts and principles. With support, they make connections to related unifying concepts and processes. The cognitive complexity at this level identifies students who recognize, use, identify, describe, and recall scientific information with support.** **<u>BELOW BASIC PERFORMANCE</u>** **8th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard. The cognitive complexity at this level identifies students who have difficulty with skills to recognize, use, identify, describe, and recall scientific information.**

EARTH, SPACE, AND PHYSICAL SCIENCE

7. **<u>The Earth in the Solar System</u>: Students describe Earth as the third planet in the Solar System and understand the effects of the sun as a major source of energy, gravitational forces, and motions of objects in the Solar System.**

8. **<u>The Structure of the Earth System</u>: Students examine the structure of the Earth, identifying layers of the Earth, considering plate movement and its effect, and recognizing landforms resulting from constructive and destructive forces.**

9. **<u>The Earth's History</u>: Students systematize the Earth's history in terms of geologic evidence, comparing past and present Earth processes and identifying catastrophic events and fossil evidence.**

10. **<u>The Structure and Properties of Matter</u>: Students identify characteristic properties of matter such as density, solubility, and boiling point and understand that elements are the basic components of matter.**

11. **<u>Physical and Chemical Changes in Matter</u>: Students evaluate chemical and physical changes, recognizing that chemical change forms compounds with different properties and that physical change alters the appearance but not the composition of a substance.**

12. **<u>Forms and Uses of Energy</u>: Students investigate energy as a property of substances in a variety of forms with a range of uses.**

13. <u>The Conservation of Matter and Energy</u>: Students identify supporting evidence to explain conservation of matter and energy, indicating that matter or energy cannot be created or destroyed but is transferred from one object to another. **14. <u>Effects of Motions and Forces</u>: Students describe motion of an object by position, direction, and speed, and identify the effects of force and inertia on an object.**	

Snapshot In Action

<u>Reproduction and Heredity</u>: Students develop a list of human genetic traits (i.e., attached ear lob, ability to roll tongue, presence of dimples). They determine the genetic make-up of each member of the group, using the listed traits. The data is then shared, and percent for each trait in the class's sample population is calculated. Students use this information to predict a larger sampling, and predict whether the small sample is a true representation of a larger sample. Individuals can then investigate the genetic make-up of their family members to look for patterns of inheritance.

<u>Ecology</u>: Groups of students conduct field and library research of an assigned plot of vacant land. Students take necessary measurements periodically throughout the school year, documenting changes and connections in ecological elements including plant and animal life, soil, weather and climate. At the end of the observation period, students write a description of the results and create a presentation utilizing their findings and visuals. Through class discussion, students classify physical elements, producers, consumers, decomposers, and other elements of ecological connections in each study plot. Comparisons can be made of different types of plots.

<u>Properties of Matter</u>: To investigate characteristic properties of mixtures, students examine three containers of unknown mixtures (i.e., saltwater, gelatin, muddy water). Students identify each of the unknowns as a solution, colloid, or suspension by determining the size of particle and if each scatters light, settles, and if each can be separated using filter paper. Students classify the various mixtures according to observed properties and write an operational definition of solution, colloid, and suspension. Students expand this by testing additional examples of thre three types of mixtures.

For greater detail and description refer to the following resources:

- National Research Council, <u>Inquiry and the National Science Education Standards</u>, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, <u>National Science Education Standards</u>, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, <u>Pathways To The Science Standards: Middle School Edition</u>, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science: <u>Benchmarks for Science Literacy: Project 2061</u>, Oxford University Press, New York 1993.

CONTENT STANDARD
2. SCIENCE AS INQUIRY

Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK GRADE 8	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 8
1. Students research scientific information and present findings through appropriate means. **2. Students use inquiry to conduct scientific investigations.** • **Ask questions that lead to conducting an investigation** • **Collect, organize, and analyze and appropriately represent data.** • **Draw conclusions based on evidence and make connections to applied scientific concepts.** • **Clearly and accurately communicate the result of the investigation.** **3. Students clearly and accurately communicate the result of their own work, as well as information obtained from other sources.** **4. Students recognize the relationship between science and technology in meeting human needs.**	**ADVANCED PERFORMANCE** **8th grade students at the advanced level, in addition to demonstrating the proficient level, propose new problems, questions, and/or experimental designs based on results or research. Students analyze information to provide new insights and draw related logical conclusions that are not immediately obvious.** **PROFICIENT PERFORMANCE** **8th grade students at the proficient level, when given a problem and an experiment, form a logical hypothesis; safely conduct the experiment demonstrating a systematic process of collecting, organizing and reporting data; and examine results to form a valid conclusion. Students clearly and accurately communicate the results of scientific investigation or research through formal and/or informal reports. Using written, oral, and visual means, they accurately use scientific vocabulary, mathematics and technology. Students consistently use equipment and technology appropriately.**

5. Students properly use appropriate scientific and safety equipment, recognize hazards and safety symbols, and observe standard safety procedures.	**BASIC PERFORMANCE** **8th grade students at the basic level require support to safely conduct experiments, organize and apply data, and communicate results obtained from scientific investigations or research. Students demonstrate limited use of scientific and mathematical language to communicate findings.** **BELOW BASIC PERFORMANCE** **8th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

Research: Students select a current event topic of interest and access information from a local community member, the Internet, and the local library to develop a presentation.

Inquiry: Students conduct an investigation to measure the effects of force on a model bridge by designing a series of experiments to address student questions about the effects of different materials and designs on the strength of a bridge. The results are then applied to ask further questions of local experts about local bridge materials and design.

Science and Technology: Students design and construct a robotic arm that can pick up an object at least 10 feet away, and then extend their research to investigate a current development in the use of robots.

Safety: Students invite Emergency Task Force or Search and Rescue personnel to visit the class to discuss topics of their town's safety procedures, precautions, and answers to questions prepared in advance by students.

CONTENT STANDARD

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK GRADE 8	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 8
1. Students explore the nature and history of science. **A. Students explore how scientific knowledge changes and grows over time, and impacts personal and social decisions.** **B. Students explore the historical use of scientific information to make personal and social decisions.** **2. Students explore how scientific information is used to make decisions.** **A. The role of science in solving personal, local, and national problems** **B. Interdisciplinary connections of the sciences and connections to other subject areas and careers in science or technical fields** **C. Origins and conservation of natural resources, including Wyoming examples**	**ADVANCED PERFORMANCE** **8th grade students at the advanced level, in addition to demonstrating the proficient level, identify issues, evaluate science information and principles, and make and support decisions, with justification. Students independently research how scientific knowledge changes and grows due to the contributions of individuals.** **PROFICIENT PERFORMANCE** **8th grade students at the proficient level examine and explain how scientific knowledge changes and grows due to the contributions of individuals. When given a situation, students use scientific concepts to make responsible decisions about personal and social issues. Students explore a variety of careers in scientific or technical fields and the role of science in solving problems.** **BASIC PERFORMANCE** **8th grade students at the basic level, with support, use scientific information and principles to make responsible decisions about personal and social issues.**

	BELOW BASIC PERFORMANCE **8th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

Scientific Information in Decisions: Students investigate a common situation in Wyoming: benefits and hazards of a landfill dump, by researching the concepts of soil types and percolation, groundwater aquifers, rates of decomposition, etc. Then, students use assorted maps to search for a primary and an alternative site near their town that would be suitable for placement of a new landfill. Students then prepare, present, and defend findings and recommendations to the "town council". The council is made up of rotations of students who will be presenting their own "landfill science research" and set of recommendations. The presenters and council will conduct a respectful meeting to hear and debate each recommendation.

GRADE SPAN K-4

CONTENT STANDARD

1. CONCEPTS AND PROCESSES

In the context of unifying concepts and processes, students develop an understanding of scientific content through inquiry. Science is a dynamic process; concepts and content are best learned through inquiry and investigation.

BENCHMARK GRADE 4	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 4
UNIFYING CONCEPTS AND PROCESSES **Concepts in LIFE SYSTEMS and EARTH, SPACE, and PHYSICAL SYSTEMS are taught within the context of the following Unifying Concepts and Processes of Science:** ▪ **Systems, classification, order, and organization** ▪ **Evidence, models, and explanations** ▪ **Cycles and change over time** ▪ **Measurement** ▪ **Form and function** **LIFE SYSTEMS** **1. Characteristics of Organisms: Students describe observable characteristics of living things, including structures that serve specific functions and everyday behaviors.** **2. Life Cycles of Organisms: Students sequence life cycles of living things, and recognize that plants and animals resemble their parents.**	**Advanced Performance** **4th grade students at the advanced level, in addition to demonstrating the proficient level, make connections among unifying concepts and processes that go beyond those required at the proficient level. The cognitive complexity for students at this level reaches into a higher level of thinking, requiring frequent responses citing evidence, drawing conclusions, explaining phenomena, and using concepts to solve problems. Students identify adaptations of plants and animals that enhance survival in their environments and explain how environmental changes could affect survival. They compare cycles of change to see patterns and interrelationships among them. Students make generalizations about cause-effect relationships in the physical world.**

3. <u>Organisms and Their Environments</u>: Students show connections between living things, their basic needs, and the environments. **EARTH, SPACE, AND PHYSICAL SYSTEMS** **4. <u>Properties of Earth Materials</u>: Students investigate water, air, rocks, and soils to compare basic properties of earth materials.** **5. <u>Objects in the Sky</u>: Students describe observable objects in the sky and their patterns of movement.** **6. <u>Changes in Earth and Sky</u>: Students describe observable changes in earth and sky, including rapid and gradual changes to the earth's surface, and daily and seasonal changes in the weather.** **7. <u>Properties of Objects</u>: Students classify objects by properties that can be observed, measured, and recorded, including color, shape, size, weight, volume, texture, and temperature.** **8. <u>Changes in States of Matter</u>: Students demonstrate that the processes of heating and cooling can change matter from one state to another.** **9. <u>Physical Phenomena</u>: Students investigate physical phenomena commonly encountered in daily life, including light, heat, electricity, sound, and magnetism.**	**<u>Proficient Performance</u>** **4th grade students at the proficient level demonstrate an accurate understanding of science content in the context of major concepts and processes. The cognitive complexity for students at this level identifies students who recognize, use, identify, describe, and recall scientific information. In addition to these levels of performance, students explain, classify, organize, model, illustrate, observe, and predict, which extend beyond a habitual response. Students use observable characteristics to describe, compare, and classify objects and living things. They give examples of observable cycles and change - such as changes in objects in the sky, states of matter, and life cycles - and explain ways to measure or record those changes. Students show connections between living things, their needs, and their environments. They describe, predict, investigate, and record findings about physical phenomena and how forces affect objects.** **<u>BASIC PERFORMANCE</u>** **4th grade students at the basic level demonstrate an accurate understanding of some basic science facts and principles. With support, they make connections to related unifying concepts and processes. The cognitive complexity at this level identifies students who recognize, identify, describe, and recall scientific information with support. They describe and record some characteristics of objects and living things. With support, students demonstrate or explain: stages in life cycles of plants and animals, changes in the earth and sky, or changes in states of matter.**

10. Position and Motion of Objects: Students demonstrate that pushing and pulling can change the position and motion of objects.	**BELOW BASIC PERFORMANCE** **4th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard. The cognitive complexity for students at this level identifies students who have difficulty with skills to recognize, use, identify, describe, and recall scientific information.**

Snapshot In Action

Characteristics of Organisms: Ms. Wylde leads students on a field trip to look for tracks and signs of wildlife. Students document their findings with sketches, photographs, or lists. Back in the classroom, students further research tracks of local wildlife, matching track characteristics, sizes, and patterns to animals, behaviors, and habitat.

Changes in States of Matter: Ms. Drip helps students understand the changes in physical states of matter using water as an example. Students observe snow melting and becoming a liquid. Then by heating the liquid, it becomes liquid. By trapping the vapor with a cool pie tin, students observe that vapor returns to its liquid form. The students place the collected liquid in the freezer again, and the cycle repeats itself.

Position and Motion of Objects: Mr. Marble enhances a traditional "marble" game by having students play their game on butcher paper with a hula-hoop boundary. Students mark positions of each person's marble before and after a shot; marbles can be dipped into paint to show their pathways. Students explain the change in position and motion of each marble. Students make predictions and then investigate new shot strategies to improve their games.

For greater detail and description refer to the following resources:

- National Research Council, Inquiry and the National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, Pathways To The Science Standards: Elementary School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science: Benchmarks for Science Literacy: Project 2061, Oxford University Press, New York 1993.

CONTENT STANDARD
2. SCIENCE AS INQUIRY

Students demonstrate knowledge, skills, and habits of mind necessary to safely perform scientific inquiry. Inquiry is the foundation for the development of content, teaching students the use of processes of science that enable them to construct and develop their own knowledge. Inquiry requires appropriate field, classroom, and laboratory experiences with suitable facilities and equipment.

BENCHMARK GRADE 4	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 4
1. Students research answers to science questions and present findings through appropriate means. **2. Students use the inquiry process to conduct simple scientific investigations.** **A. Collect and organize data** **B. Use data to construct simple graphs, charts, diagrams, and/or models** **C. Draw conclusions and accurately communicate results, making connections to daily life** **D. Pose or identify questions and make predictions** **E. Conduct investigations to answer questions and check predictions** **3. Students identify and use appropriate scientific equipment.** **4. Students properly use safety equipment and recognize**	**ADVANCED PERFORMANCE** **4th grade students at the advanced level, in addition to demonstrating the proficient level, pose their own science questions and obtain information from multiple sources to answer them. Students conduct a simple investigation, using their own questions and selecting appropriate tools. They give various logical examples of applications to daily life and/or raise new questions.**

hazards and safety symbols while practicing standard safety procedures.	**PROFICIENT PERFORMANCE** **4th grade students at the proficient level, when given research questions, locate, collect, and utilize information from various sources; and present findings clearly and with understanding. Given a scenario, students pose questions, make related predictions, conduct a guided investigation, and safely use appropriate equipment to gather data in an organized manner. Students accurately represent data using graphs, charts, diagrams, and/or models. Students communicate results, consistently using scientific vocabulary, making logical connections to daily life. Students consistently and independently recognize safety symbols, hazards, and procedures.** **BASIC PERFORMANCE** **4th grade students at the basic level, given a question and procedure, conduct guided investigations or research topics with additional support. Students attempt to apply results to daily life. With support, students recognize safety symbols, hazards, and procedures.** **BELOW BASIC PERFORMANCE** **4th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

Inquiry & Characteristics of Organisms: Ms. Bean involves the students in a hands-on inquiry for bean sprout growth in different types of soil. The question to be investigated is growth rate in different types of soil. Students predict how much they think the sprouts in each soil type will growth each week. Data for height is collected, results are graphed, conclusions are explained, and recommendations for growing beans are written in a letter format to parents.

Inquiry & Electricity: Ms. D'Zine's students study electricity and inventions by designing homemade flashlights using a battery, wire, small bulb, toilet paper tube and tape. Then they investigate changes to the flashlight such as different strengths or numbers of batteries or different numbers of bulbs attached. They can also test materials by experimenting with the endurance of different brands of batteries left connected in the flashlights.

Communication: Mr. Vane uses a weather calendar with his 2nd grade students to chart changes in patterns. His students create a pictorial graph of sunny days, rainy days, snowy days, cloudy days, and windy days which, of course, is every day in Wyoming.
Safety: Mr. Safe sends a Polaroid camera home with each student, who returns to class with three snapshots of hazardous situations or warning symbols. Students write a caption advising appropriate safe personal behavior for each situation. A bulletin board display is made with the results.
For greater detail and description refer to the following resources:

- National Research Council, Inquiry and the National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Research Council, National Science Education Standards, National Academy Press, 2101 Constitution Avenue NW, Washington, DC 20418.
- National Science Teachers Association, Pathways To The Science Standards: Elementary School Edition, 1840 Wilson Blvd., Arlington, VA 22201.
- American Association for the Advancement of Science: Benchmarks for Science Literacy: Project 2061, Oxford University Press, New York 1993.

CONTENT STANDARD

3. HISTORY AND NATURE OF SCIENCE IN PERSONAL AND SOCIAL DECISIONS

Students recognize the nature of science, its history, and its connections to personal, social, economic, and political decisions. Historically, scientific events have had significant impacts on our cultural heritage.

BENCHMARK GRADE 4	PERFORMANCE STANDARDS LEVEL DESCRIPTORS GRADE 4
1. Students recognize the nature and history of science. **A. Discuss how scientific ideas change over time** **B. Describe contributions of scientists** **2. Students recognize how scientific information is used to make decisions.** **A. Identify and describe local science issues, such as environmental hazards or resource management** **B. Suggest feasible solutions and personal action plans to address an identified issue**	**ADVANCED PERFORMANCE** **4th grade students at the advanced level, in addition to demonstrating the proficient level, accurately sequence changes over time of a scientific concept and suggest a possible future development. Students choose a scientist and explain the importance of his/her contribution(s). Students take action to address resource conservation issues and evaluate how well it works.** **PROFICIENT PERFORMANCE** **4th grade students at the proficient level give examples of how scientific ideas change over time. Students describe the contributions of scientists. Students identify and thoughtfully describe local science issues and suggest feasible solutions and personal action plans.**

	BASIC PERFORMANCE **4th grade students at the basic level describe what a scientist does, but require additional support to give examples of how scientific ideas change over time, or to identify a local science problem and suggest a solution.** **BELOW BASIC PERFORMANCE** **4th grade students at the below basic level require extensive support or provide little or no evidence in meeting the standard.**

Snapshot In Action

Nature and History of Science: Professor Peoples' students practice role-playing when they report on findings of historic or current scientists; i.e., Thomas Edison, Amazing Children Series, Marie Curie, scientists in recent discoveries.
Scientific Information in Decisions: Mr. Steward asks his students to brainstorm the importance in saving energy and to suggest things they can do individually to save energy at home; i.e., turning off lights, turning off water while they brush their teeth, and limiting the amount of video games they play. Students contribute ideas to a large poster to hang in the hallway or present to younger students.

GLOSSARY

Wyoming Science Content and Performance Standards

Adaptation: the process in which a species becomes better suited to survive in an environment.

Biodiversity: the innumerable genetic combinations of organisms that results in a great variety within a species.

Biological adaptation: the changes an organism makes in order to become better suited to survive in its environment.

Biosphere: the area in which life is possible on our planet.

Classification: specific scientific nomenclature that describes natural relationships that exist between living things; also known as taxonomy.

Consumers: those organisms within an environment that are nutritionally dependent upon other organisms or their products.

Decomposers: organisms that break down the tissues and excretions of other organisms into simpler substances through the process of decay.

Density: the mass per unit of volume of a material (g/cm^3); describes how tightly packed the molecules are in a substance.

Ecosystem: a unit of the biosphere in which living and nonliving things interact, and in which materials are used over and over again.

Endothermic: a reaction that requires energy in order to be completed.

Equilibrium: the state of balance that all things, living and nonliving, seek to attain.

Exothermic: a reaction that gives off heat as a by-product.

Form: the structure of a substance or organism.

Fusion: the combining of the nuclei of two atoms to form another, heavier atom. Fusion, as in nuclear fusion in the sun, releases large amounts of energy.

Geochemical Cycle: a cycle that earth materials move through such as the water cycle or the rock cycle.

Geosphere: systems involving the solid Earth.

Hydrosphere: the water systems of the Earth including atmospheric water, oceans, rivers, and lakes.

Inertia: the tendency of an object to resist a change in its movement, whether the object is moving or is at rest.

Law of Conservation of Energy: the scientific law stating that the total energy in a system does not change (can be neither created nor destroyed) but transfers from one form to another.

Law of Conservation of Mass: The scientific law stating that mass cannot be created or destroyed in a chemical reaction. It is also called the Law of Conservation of Matter.

Newton's Law of Motion: Three laws of motion describing: 1) inertia; 2) the relationship between the acceleration of an object to its mass and the force applied to it; and 3) that for every action force there is an equal and opposite reaction force.

Patterns of Inheritance: patterns related to the transmission of genetic information.

Phenomena: observed or detected fact or event or an object known through senses rather than by thought or intuition; fact or event of scientific interest susceptible of scientific description and explanation.

Physical Phenomena: relating to, or according with material things or natural laws as opposed to things mental, moral, spiritual, or imaginary; of or relating to natural science.

Producers: organisms (typically green plants) that produce their own food.

Solubility: the ability of a substance to dissolve into another substance.

System: a group of individual parts and/or processes that function together.

Structural Homologies: similar structures found in different species such as the bone structure of the human hand and the bone structure in a bat's wing.

Tetonic Plate Activity: the movement of the rocky plates that compose the earth's crust.

Trophic Level: the position of a particular organism in the food chain. For example, green plants are in a trophic level at the beginning of the food chain or web and are known as producers, and those in succeeding levels are known as consumers.

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