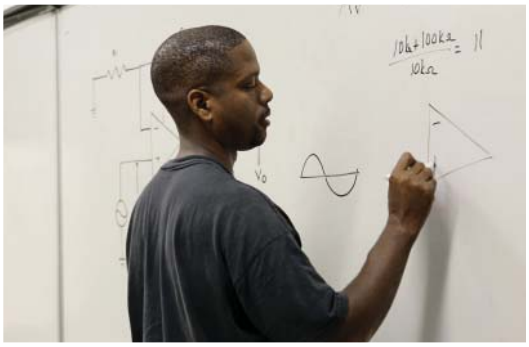
cde Improving Academic Achievement

Colorado Academic STANDARDS

High School

Science

Science



Colorado Academic Standards
Science

"Science is facts; just as houses are made of stone, so is science made of facts; but a pile of stones is not a house, and a collection of facts is not necessarily science." *--Jules Henri Poincaré (1854-1912) French mathematician.*

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High expectations in education are essential for the U.S. to continue as a world leader in the 21st century. In order to be successful in postsecondary education, the workforce, and in life, students need a rigorous, age-appropriate set of standards that include finding and gathering information, critical thinking, and reasoning skills to evaluate information, and use information in social and cultural contexts. Students must learn to comprehend and process information, analyze and draw conclusions, and apply the results to everyday life.

A quality science education embodies 21st century skills and postsecondary and workforce readiness by teaching students critical skills and thought processes to meet the challenges of today's world. Scientifically literate graduates will help to ensure Colorado's economic vitality by encouraging the development of research and technology, managing and preserving our environmental treasures, and caring for the health and well-being of our citizens.

Science is both a body of knowledge that represents the current understanding of natural systems, and the process whereby that body of knowledge has been established and is continually extended, refined, and revised. Because science is both the knowledge of the natural world and the processes that have established this knowledge, science education must address both of these aspects.

At a time when pseudo-scientific ideas and outright fraud are becoming more common place, developing the skepticism and critical thinking skills of science gives students vital skills needed to make informed decisions about their health, the environment, and other scientific issues facing society. A major aspect of science is the continual interpretation of evidence. All scientific ideas constantly are being challenged by new evidence and are evolving to fit the new evidence. Students must understand the collaborative social processes that guide these changes so they can reason through and think critically about popular scientific information, and draw valid conclusions based on evidence, which often is limited. Imbedded in the cognitive process, students learn and apply the social and cultural skills expected of all citizens in school and in the workplace. For example, during class activities, laboratory exercises, and projects, students learn and practice self-discipline, collaboration, and working in groups.

The Colorado Academic Standards in science represent what all Colorado students should know and be able to do in science as a result of their preschool through twelfth-grade science education. Specific expectations are given for students who complete each grade from preschool through eighth grade and for high school. These standards outline the essential level of science content knowledge and the application of the skills needed by all Colorado citizens to participate productively in our increasingly global, information-driven society.
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Standards Organization and Construction

As the subcommittee began the revision process to improve the existing standards, it became evident that the way the standards information was organized, defined, and constructed needed to change from the existing documents. The new design is intended to provide more clarity and direction for teachers, and to show how 21st century skills and the elements of school readiness and postsecondary and workforce readiness indicators give depth and context to essential learning.

The "Continuum of State Standards Definitions" section that follows shows the hierarchical order of the standards components. The "Standards Template" section demonstrates how this continuum is put into practice.

The elements of the revised standards are:

Prepared Graduate Competencies: The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Standard: The topical organization of an academic content area.

High School Expectations: The articulation of the concepts and skills of a standard that indicates a student is making progress toward being a prepared graduate. *What do students need to know in high school?*

Grade Level Expectations: The articulation (at each grade level), concepts, and skills of a standard that indicate a student is making progress toward being ready for high school. *What do students need to know from preschool through eighth grade?*

Evidence Outcomes: The indication that a student is meeting an expectation at the mastery level. *How do we know that a student can do it?*

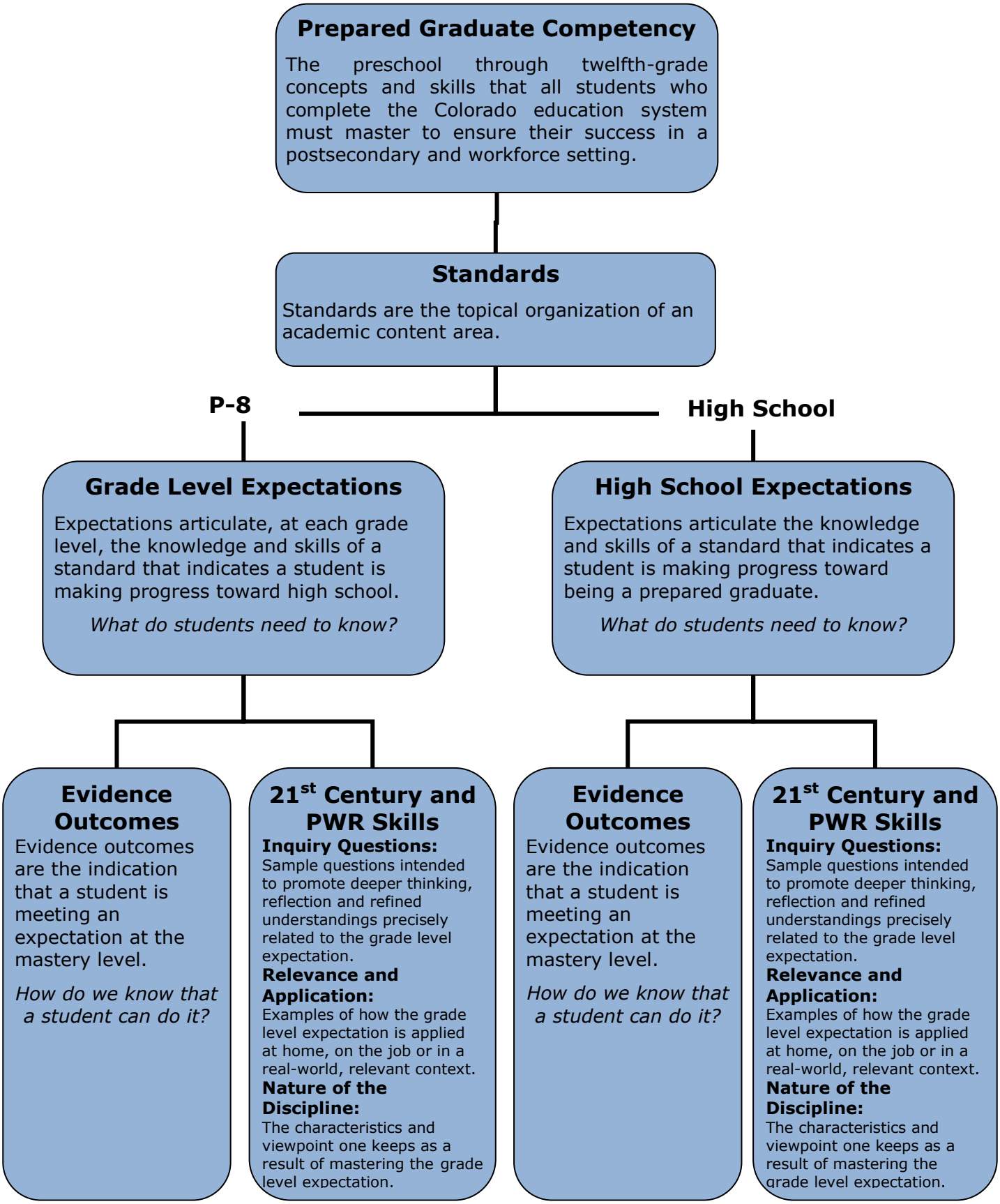
21st Century Skills and Readiness Competencies: Includes the following:

- ***Inquiry Questions:***
  Sample questions are intended to promote deeper thinking, reflection and refined understandings precisely related to the grade level expectation.

- ***Relevance and Application:***
  Examples of how the grade level expectation is applied at home, on the job or in a real-world, relevant context.

- ***Nature of the Discipline:***
  The characteristics and viewpoint one keeps as a result of mastering the grade level expectation.

Continuum of State Standards Definitions



STANDARDS TEMPLATE

Content Area: NAME OF CONTENT AREA

Standard: The topical organization of an academic content area.

Prepared Graduates:

- The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

High School and Grade Level Expectations

Concepts and skills students master:

Grade Level Expectation: High Schools: The articulation of the concepts and skills of a standard that indicates a student is making progress toward being a prepared graduate.

Grade Level Expectations: The articulation, at each grade level, the concepts and skills of a standard that indicates a student is making progress toward being ready for high school.

What do students need to know?

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: Evidence outcomes are the indication that a student is meeting an expectation at the mastery level. *How do we know that a student can do it?*	**Inquiry Questions:** Sample questions intended to promote deeper thinking, reflection and refined understandings precisely related to the grade level expectation.
	Relevance and Application: Examples of how the grade level expectation is applied at home, on the job or in a real-world, relevant context.
	Nature of the Discipline: The characteristics and viewpoint one keeps as a result of mastering the grade level expectation.

Prepared Graduate Competencies in Science

The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Prepared Graduates:

- Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects
- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions
- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable
- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection
- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment
- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment
- Explain how biological evolution accounts for the unity and diversity of living organisms
- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet
- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system
- Describe how humans are dependent on the diversity of resources provided by Earth and Sun

Standards in Science

Standards are the topical organization of an academic content area. The three standards of science are:

1. **Physical Science**
   Students know and understand common properties, forms, and changes in matter and energy.

2. **Life Science**
   Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

3. **Earth Systems Science**
   Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.

Science
Grade Level Expectations at a Glance

Standard	Grade Level Expectation
High School	
1. Physical Science	1. Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations 2. Matter has definite structure that determines characteristic physical and chemical properties 3. Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy 4. Atoms bond in different ways to form molecules and compounds that have definite properties 5. Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined 6. When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases
2. Life Science	1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem 2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem 3. Cellular metabolic activities are carried out by biomolecules produced by organisms 4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken. 5. Cells use the passive and active transport of substances across membranes to maintain relatively stable intracellular environments 6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments 7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins 8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome 9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment

Science
Grade Level Expectations at a Glance

Standard	Grade Level Expectation
High School (continued)	
3. Earth Systems Science	1. The history of the universe, solar system and Earth can be inferred from evidence left from past events 2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways 3. The theory of plate tectonics helps to explain geological, physical, and geographical features of Earth 4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere 5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources 6. The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes 7. Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms

21st Century Skills and Readiness Competencies in Science

Colorado's Description of 21st Century Skills

Colorado's description of 21st century skills is a synthesis of the essential abilities students must apply in our rapidly changing world. Today's students need a repertoire of knowledge and skills that are more diverse, complex, and integrated than any previous generation. These skills do not stand alone in the standards, but are woven into the evidence outcomes, inquiry questions, and application and are within the nature of science. Science inherently demonstrates each of Colorado's 21st century skills, as follows:

Critical Thinking and Reasoning

Science requires students to analyze evidence and draw conclusions based on that evidence. Scientific investigation involves defining problems and designing studies to test hypotheses related to those problems. In science, students must justify and defend scientific explanations and distinguish between correlation and causation.

Information Literacy

Understanding science requires students to research current ideas about the natural world. Students must be able to distinguish fact from opinion and truth from fantasy. Science requires a degree of skepticism because the ideas of science are subject to change. Science students must be able to understand what constitutes reliable sources of information and how to validate those sources. One key to science is understanding that converging different lines of evidence from multiple sources strengthens a scientific conclusion.

Collaboration

Science students must be able to listen to others' ideas, and engage in scientific dialogs that are based on evidence – not opinion. These types of conversations allow them to compare and evaluate the merit of different ideas. The peer review process helps to ensure the validity of scientific explanations.

Self-Direction

Students in science must have persistence and perseverance when exploring scientific concepts. Students must generate their own questions, and design investigations to find the answers. Students must be open to revising and redefining their thinking based on evidence.

Invention

Designing investigations and engineering new products involves a large degree of invention. Scientists and engineers often have to think "outside the box" as they push the limits of our current knowledge. They must learn from their failures to take the next steps in understanding. Science students also must integrate ideas from multiple disciplines to formulate an understanding of the natural world. In addition to using invention to design investigations, scientists also use findings from investigations to help them to invent new products.

Colorado's Description for School Readiness
(Adopted by the State Board of Education, December 2008)
School readiness describes both the preparedness of a child to engage in and benefit from learning experiences, and the ability of a school to meet the needs of all students enrolled in publicly funded preschools or kindergartens. School readiness is enhanced when schools, families, and community service providers work collaboratively to ensure that every child is ready for higher levels of learning in academic content.

Colorado's Description of Postsecondary and Workforce Readiness
(Adopted by the State Board of Education, June 2009)
Postsecondary and workforce readiness describes the knowledge, skills, and behaviors essential for high school graduates to be prepared to enter college and the workforce and to compete in the global economy. The description assumes students have developed consistent intellectual growth throughout their high school career as a result of academic work that is increasingly challenging, engaging, and coherent. Postsecondary education and workforce readiness assumes that students are ready and able to demonstrate the following without the need for remediation: Critical thinking and problem-solving; finding and using information/information technology; creativity and innovation; global and cultural awareness; civic responsibility; work ethic; personal responsibility; communication; and collaboration.

How These Skills and Competencies are Embedded in the Revised Standards
Three themes are used to describe these important skills and competencies and are interwoven throughout the standards: *inquiry questions; relevance and application; and the nature of each discipline.* These competencies should not be thought of stand-alone concepts, but should be integrated throughout the curriculum in all grade levels. Just as it is impossible to teach thinking skills to students without the content to think about, it is equally impossible for students to understand the content of a discipline without grappling with complex questions and the investigation of topics.

Inquiry Questions – Inquiry is a multifaceted process requiring students to think and pursue understanding. Inquiry demands that students (a) engage in an active observation and questioning process; (b) investigate to gather evidence; (c) formulate explanations based on evidence; (d) communicate and justify explanations, and; (e) reflect and refine ideas. Inquiry is more than hands-on activities; it requires students to cognitively wrestle with core concepts as they make sense of new ideas.

Relevance and Application – The hallmark of learning a discipline is the ability to apply the knowledge, skills, and concepts in real-world, relevant contexts. Components of this include solving problems, developing, adapting, and refining solutions for the betterment of society. The application of a discipline, including how technology assists or accelerates the work, enables students to more fully appreciate how the mastery of the grade level expectation matters after formal schooling is complete.

Nature of Discipline – The unique advantage of a discipline is the perspective it gives the mind to see the world and situations differently. The characteristics and viewpoint one keeps as a result of mastering the grade level expectation is the nature of the discipline retained in the mind's eye.

1. Physical Science

Students know and understand common properties, forms and changes in matter and energy.

Prepared Graduates
The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Prepared Graduate Competencies in the Physical Science standard:

- Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects
- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions
- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Observe, explain, and predict natural phenomena governed by Newton's laws of motion, acknowledging the limitations of their application to very small or very fast objects

Grade Level Expectation: High School

Concepts and skills students master:

1. Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Gather, analyze and interpret data and create graphs regarding position, velocity and acceleration of moving objects (DOK 1-3) b. Develop, communicate and justify an evidence-based analysis of the forces acting on an object and the resultant acceleration produced by a net force (DOK 1-3) c. Develop, communicate and justify an evidence-based scientific prediction regarding the effects of the action-reaction force pairs on the motion of two interacting objects (DOK 1-3) d. Examine the effect of changing masses and distance when applying Newton's law of universal gravitation to a system of two bodies (DOK 1-2) e. Identify the limitations of Newton's laws in extreme situations (DOK 1)	**Inquiry Questions:** 1. How can forces be acting on an object without changing the object's motion? 2. Why do equal but opposite action and reaction forces not cancel? **Relevance and Application:** 1. Newton's laws are used in a variety of design processes such as vehicle safety, aerospace, bridge design and interplanetary probes. 2. An understanding of forces leads to safer building designs such as earthquake-safe buildings. 3. Forces present in the earth lead to plate tectonics. **Nature of Science:** 1. Use an inquiry approach to answer a testable question about an application of Newton's laws of motion. (DOK 1-4) 2. Share experimental data, respectfully discuss conflicting results, and analyze ways to minimize error and uncertainty in measurement. (DOK 2-3) 3. Differentiate between the use of the terms "law" and "theory" as they are defined and used in science compared to how they are used in other disciplines or common use. (DOK 1-2) 4. Use technology to perform calculations and to organize, analyze and report data. (DOK 1-2)

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions

Grade Level Expectation: High School

Concepts and skills students master:

2. Matter has definite structure that determines characteristic physical and chemical properties

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation supporting the current model of an atom (DOK 1-3) b. Gather, analyze and interpret data on chemical and physical properties of elements such as density, melting point, boiling point, and conductivity (DOK 1-2) c. Use characteristic physical and chemical properties to develop predictions and supporting claims about elements' positions on the periodic table (DOK 1-2) d. Develop a model that differentiates atoms and molecules, elements and compounds, and pure substances and mixtures (DOK 2-3)	**Inquiry Questions:** 1. What patterns can be observed in the properties of elements and families in the periodic table? 2. What properties do nanoscale particles have that are different than those of macroscopic samples of the same substance? **Relevance and Application:** 1. The unique properties of various elements make them useful for specific applications. For example, metalloids and semiconductors are useful in electronic applications. 2. Alloys are created by combining metals with other elements to produce materials with useful properties that are not found in nature. For example, iron and carbon make steel. 3. Consumers can make informed decisions regarding the purchase of household chemicals when they understand chemical properties and their implications. For example, choosing lead based versus non-lead based paints weighs safety concerns against color and durability in applications. 4. The unique properties of nanoscale particles provide special benefits and dangers. **Nature of Science:** 1. Recognize that the current understanding of molecular structure related to the physical and chemical properties of matter has developed over time and become more sophisticated as new technologies have led to new evidence. 2. Ask testable questions about the nature of matter, and use an inquiry approach to investigate it. (DOK 1-4)

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions

Grade Level Expectation: High School

Concepts and skills students master:

3. Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Recognize, analyze, interpret, and balance chemical equations (synthesis, decomposition, combustion, and replacement) or nuclear equations (fusion and fission) (DOK 1-2) b. Predict reactants and products for different types of chemical and nuclear reactions (DOK 1-2) c. Predict and calculate the amount of products produced in a chemical reaction based on the amount of reactants (DOK 1-2) d. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate the conservation of mass and energy (DOK 1-2)	**Inquiry Questions:** 1. What patterns of chemical reactions exist? 2. How are chemical reactions distinguished from nuclear reactions? **Relevance and Application:** 1. Products formed in different types of reactions are useful to people. For example, polymerase reactions making nylon. 2. The use of chemicals can have both positive and negative environmental effects. For example, the use of lime to make acidic soils more productive or the use of CFCs causing the ozone hole. 3. When using radioactive substances, there are benefits such as medicine and energy production as well as dangers such as environmental and health concerns. **Nature of Science:** 1. Critically evaluate chemical and nuclear change models. (DOK 2-3) 2. Identify the strengths and weaknesses of a model which represents complex natural phenomenon. (DOK 2-3) 3. Use an inquiry approach to test predictions about chemical reactions. (DOK 1-4) 4. Share experimental data, and respectfully discuss conflicting results. (DOK 2-3)

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Apply an understanding of atomic and molecular structure to explain the properties of matter, and predict outcomes of chemical and nuclear reactions

Grade Level Expectation: High School

Concepts and skills students master:

4. Atoms bond in different ways to form molecules and compounds that have definite properties

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding (DOK 1-3) b. Gather, analyze, and interpret data on chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity (DOK 1-2) c. Use characteristic physical and chemical properties to develop predictions and supporting claims about compounds' classification as ionic, polar or covalent (DOK 1-2) d. Describe the role electrons play in atomic bonding (DOK 1) e. Predict the type of bonding that will occur among elements based on their position in the periodic table (DOK 1-2)	**Inquiry Questions:** 1. How can various substances be classified as ionic or covalent compounds? 2. What role do electrons play in different types of chemical bonds? **Relevance and Application:** 1. Related compounds share some properties that help focus chemists when looking for a substance with particular properties for a specific application. For example, finding new super conductors. 2. Carbon atoms bond in ways that provide the foundation for a wide range of applications. For example, forming chains and rings such as sugars and fats that are essential to life and developing synthetic fibers and oils. 3. Living systems create and use various chemical compounds such as plants making sugars from photosynthesis and chemicals that can be used as medicine, and endocrine glands producing hormones. **Nature of Science:** 1. Recognize that the current understanding of molecular structure related to the physical and chemical properties of matter has developed over time and become more sophisticated as new technologies have led to new evidence. 2. Employ data-collection technology to gather, view, analyze, and interpret data about chemical and physical properties of different compounds. (DOK 1-2)

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable

Grade Level Expectation: High School

Concepts and skills students master:

5. Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation regarding the potential and kinetic nature of mechanical energy (DOK 1-3) b. Use appropriate measurements, equations and graphs to gather, analyze, and interpret data on the quantity of energy in a system or an object (DOK 1-3) c. Use direct and indirect evidence to develop predictions of the types of energy associated with objects (DOK 2-3) d. Identify different energy forms, and calculate their amounts by measuring their defining characteristics (DOK 1-2)	**Inquiry Questions:** 1. What factors can be measured to determine the amount of energy associated with an object? 2. What are the most common forms of energy in our physical world? 3. What makes an energy form renewable or nonrenewable? 4. What makes some forms of energy hard to measure?
	Relevance and Application: 1. Society and energy providers must conduct a cost-benefit analysis of different ways to provide electricity to our society. 2. An understanding of energy transformations is necessary when designing clean energy systems that convert any type of energy into electricity such as wind generators and solar cells. 3. There are advantages and disadvantages to using various energy sources such as gasoline, diesel, ethanol, hydrogen, and electricity as transportation fuel. 4. Politics plays a role in shaping energy policy such as balancing conflicting stakeholder needs. 5. Energy plays a role in living systems and Earth's systems. For example, cells convert sugar to ATP and then to energy, energy inside the earth drives plate tectonic phenomena such as earthquakes and volcanoes, and energy from the Sun drives weather.
	Nature of Science: 1. Critically evaluate scientific claims made in popular media or by peers regarding the application of energy forms, and determine if the evidence presented is appropriate and sufficient to support the claims. (DOK 2-3) 2. Use the historical context and impact of early energy research and consider the potential implications for current energy studies on science and our society. (DOK 1-3)

Content Area: Science
Standard: 1. Physical Science

Prepared Graduates:

- Apply an understanding that energy exists in various forms, and its transformation and conservation occur in processes that are predictable and measurable

Grade Level Expectation: High School

Concepts and skills students master:

6. When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Use direct and indirect evidence to develop and support claims about the conservation of energy in a variety of systems, including transformations to heat (DOK 1-3) b. Evaluate the energy conversion efficiency of a variety of energy transformations (DOK 1-2) c. Describe energy transformations both quantitatively and qualitatively (DOK 1-2) d. Differentiate among the characteristics of mechanical and electromagnetic waves that determine their energy (DOK 2) e. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate energy conservation and loss (DOK 1-2)	**Inquiry Questions:** 1. Why is 100 percent efficiency impossible in an energy transformation? 2. How does the law of conservation of energy help us solve problems involving complex systems? 3. Scientists or engineers often say energy is "lost." Is there a word that might be better than "lost?" Why? **Relevance and Application:** 1. Incremental strides have been made in improving the efficiency of different forms of energy production and consumption. For example, today's engines are much more efficient than those from 50 years ago, and batteries are more powerful and last longer than those from just a few years ago. 2. Different technologies such as light-emitting diodes, compact fluorescent lights, and incandescent light bulbs have different efficiencies and environmental impacts. **Nature of Science:** 1. Critically evaluate scientific claims made in popular media or by peers regarding the application of energy transformations, and determine if the evidence presented is appropriate and sufficient to support the claims. 2. Ask testable questions and make a falsifiable hypothesis about the conservation of energy, and use an inquiry approach to find an answer. (DOK 1-4) 3. Share experimental data, and respectfully discuss conflicting results emulating the practice of scientists. (DOK 2-3)

2. Life Science

Students know and understand the characteristics and structure of living things, the processes of life and how living things interact with each other and their environment.

Prepared Graduates
The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Prepared Graduate Competencies in the Life Science standard:

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection
- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment
- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment
- Explain how biological evolution accounts for the unity and diversity of living organisms

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

Grade Level Expectation: High School

Concepts and skills students master:

1. Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze how energy flows through trophic levels (DOK 1-2) b. Evaluate the potential ecological impacts of a plant-based or meat-based diet (DOK 2) c. Analyze and interpret data from experiments on ecosystems where matter such as fertilizer has been added or withdrawn such as through drought (DOK 1-3) d. Develop, communicate, and justify an evidence-based scientific explanation showing how ecosystems follow the laws of conservation of matter and energy (DOK 1-3) e. Define and distinguish between matter and energy, and how they are cycled or lost through life processes (DOK 1-2) f. Describe how carbon, nitrogen, phosphorus, and water cycles work (DOK 1) g. Use computer simulations to analyze how energy flows through trophic levels (DOK 1-2)	**Inquiry Questions:** 1. How does a change in abiotic factors influence the stability or progression of an ecosystem? 2. What happens when the cycling of matter in ecosystems is disrupted? 3. What energy transformations occur in ecosystems? 4. How does the process of burning carbon-rich fossil fuels compare to the oxidation of carbon biomolecules in cells? **Relevance and Application:** 1. When the matter or energy flow in an ecosystem is disturbed, there are measurable effects such as the eutrophication of water. 2. Matter and energy are cycled in natural systems such as wetlands in both similar and different ways than in human-managed systems such as waste water treatment plants. **Nature of Science:** 1. Address differences between experiments where variables can be controlled and those where extensive observations on a highly variable natural system are necessary to determine what is happening – such as dead zones in the Gulf of Mexico. 2. Share experimental data, and respectfully discuss conflicting results emulating the practice of scientists. (DOK 2-3) 3. Design ecological experiments in a closed system. (DOK 2-4)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Explain and illustrate with examples how living systems interact with the biotic and abiotic environment

Grade Level Expectation: High School

Concepts and skills students master:

2. The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze and interpret data about the impact of removing keystone species from an ecosystem or introducing non-native species into an ecosystem (DOK 1-3) b. Describe or evaluate communities in terms of primary and secondary succession as they progress over time (DOK 1-2) c. Evaluate data and assumptions regarding different scenarios for future human population growth and their projected consequences d. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate ecosystem interactions (DOK 1-2)	**Inquiry Questions:** 1. How do keystone species maintain balance in ecosystems? 2. How does the introduction of a non-native species influence the balance of an ecosystem? 3. How is the succession of local organisms altered in an area that is disturbed or destroyed? **Relevance and Application:** 1. Earth's carrying capacity is limited, and as the human population grows, we must find ways to increase the production of resources all people need to live. 2. The extraction of resources by humans impacts nature ecosystems. **Nature of Science:** 1. Critically evaluate scientific explanations in popular media to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims. (DOK 2-3)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

Grade Level Expectation: High School

Concepts and skills students master:

3. Cellular metabolic activities are carried out by biomolecules produced by organisms

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Identify biomolecules and their precursors/building blocks (DOK 1) b. Develop, communicate, and justify an evidence-based explanation that biomolecules follow the same rules of chemistry as any other molecule c. Develop, communicate, and justify an evidence-based explanation regarding the optimal conditions required for enzyme activity (DOK 1-3) d. Infer the consequences to organisms of suboptimal enzyme function – such as altered blood pH or high fever – using direct and indirect evidence (DOK 1-3) e. Analyze and interpret data on the body's utilization of carbohydrates, lipids, and proteins (DOK 1-2)	**Inquiry Questions:** 1. How are rates of enzyme activity in cells affected by various factors such as pH or temperature? 2. How does one know that enzymes speed up chemical reactions? **Relevance and Application:** 1. Apply knowledge of biomolecular structure and activity to make consumer decisions, especially about diet with respect to saturated and unsaturated fatty acids, essential and nonessential amino acids, and simple and complex carbohydrates. 2. Explain how high temperatures such as a fever may alter cellular enzyme activity. 3. Recognize that many biomolecules can be made in the lab and have the exact same structure and function as ones made by living organisms. **Nature of Science:** 1. Critically evaluate scientific explanations in popular media to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims. (DOK 2-3)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

Grade Level Expectation: High School

Concepts and skills students master:

4. The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration. Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation the optimal environment for photosynthetic activity (DOK 1-3) b. Discuss the interdependence of autotrophic and heterotrophic life forms such as depicting the flow of a carbon atom from the atmosphere, to a leaf, through the food chain, and back to the atmosphere (DOK 1-2) c. Explain how carbon compounds are gradually oxidized to provide energy in the form of adenosine triphosphate (ATP), which drives many chemical reactions in the cell (DOK 1-2)	**Inquiry Questions:** 1. What variables can be manipulated to change the rate of photosynthesis? 2. What variables affect the rate of cell respiration? 3. How does body heat relate to cellular respiration? **Relevance and Application:** 1. Agriculture is of great importance to humans. For example, most food comes from agriculture. 2. Various foods such as cheeses, yogurts, alcohol, and breads are produced by fermentation – anaerobic respiration – that is carried out by various organisms. 3. The experience of muscle fatigue after intense exercise is related to anaerobic respiration in muscle cells. 4. Primary producers such as marine phytoplankton and rainforest flora play an integral role in sustaining all life on Earth. **Nature of Science:** 1. Recognize that the current understanding of photosynthesis and cellular respiration has developed over time and become more sophisticated as new technologies have lead to new evidence. (DOK 1) 2. Critically evaluate models for photosynthesis and cellular respiration, and identify their strengths and weaknesses. (DOK 2-3)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

Grade Level Expectation: High School

Concepts and skills students master:

5. Cells use passive and active transport of substances across membranes to maintain relatively stable intracellular environments

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze and interpret data to determine the energy requirements and/or rates of substance transport across cell membranes (DOK 1-2) b. Compare organisms that live in freshwater and marine environments, and identify the challenges of osmotic regulation for these organisms (DOK 2) c. Diagram the cell membrane schematically, and highlight receptor proteins as targets of hormones, neurotransmitters, or drugs that serve as active links between intra and extracellular environments (DOK 1) d. Use tools to gather, view, analyze, and interpret data produced during scientific investigations that involve passive and active transport (DOK 1-2) e. Use computer simulations and models to analyze cell transport mechanisms (DOK 1-2)	**Inquiry Questions:** 1. What variables affect the rate of transport across a membrane? 2. Why is it important that cell membranes are selectively permeable? **Relevance and Application:** 1. Osmotically balanced solutions such as intravenous and ophthalmic solutions are critical in medical settings. 2. Drugs target receptor proteins such as hormones and neurotransmitters in membranes and mimic the action of natural signals there. 3. Technology is used to support humans on dialysis. **Nature of Science:** 1. Ask testable questions and make a falsifiable hypothesis about how cells transport materials into and out of the cell and use an inquiry approach to find the answer. (DOK 1-4) 2. Share experimental data, and respectfully discuss conflicting results emulating the practice of scientists. (DOK 2-3) 3. Recognize and describe the ethical traditions of science: value peer review; truthful reporting of methods and outcomes; making work public; and sharing a lens of professional skepticism when reviewing the work of others.

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze the relationship between structure and function in living systems at a variety of organizational levels, and recognize living systems' dependence on natural selection

Grade Level Expectation: High School

Concepts and skills students master:

6. Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Discuss how two or more body systems interact to promote health for the whole organism (DOK 1-2) b. Analyze and interpret data on homeostatic mechanisms using direct and indirect evidence to develop and support claims about the effectiveness of feedback loops to maintain homeostasis (DOK 1-2) c. Distinguish between causation and correlation in epidemiological data, such as examining scientifically valid evidence regarding disrupted homeostasis in particular diseases (DOK 2) d. Use computer simulations and models of homeostatic mechanisms (DOK 1-2)	**Inquiry Questions:** 1. How can an experiment be designed and conducted to test for adaptive homeostasis during exercise and other body activities? 2. Where and when are negative versus positive feedback loops more effective in the human body? **Relevance and Application:** 1. The disruption of homeostatic mechanisms may lead to disease, and if severe enough, death. 2. Body systems differ when in a state of health and disease. For example, buildup and rupture of atherosclerotic plaque inside a blood vessel can cause a heart attack. 3. The regulatory responses of autoimmune diseases such as Type I diabetes, multiple sclerosis and rheumatoid arthritis are different than those of healthy immune systems. **Nature of Science:** 1. Research and present findings about the results of dietary deficiencies or excesses. (DOK 1-2) 2. Research and present findings about how medical problems that impact life span have changed throughout history due to altered lifestyles and advances in medicine. (DOK 1-2) 3. Differentiate between scientific evidence evaluated by the Food and Drug Administration (FDA) for drug approval and anecdotal evidence shared among individuals or in magazines/newspapers that a food or supplement is effective for a given problem.

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment

Grade Level Expectation: High School

Concepts and skills students master:

7. Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Analyze and interpret data that genes are expressed portions of DNA. (DOK 1-2) b. Analyze and interpret data on the processes of DNA replication, transcription, translation, and gene regulation, and show how these processes are the same in all organisms (DOK 1-2) c. Recognize that proteins carry out most cell activities and mediate the effect of genes on physical and behavioral traits in an organism (DOK 1) d. Evaluate data showing that offspring are not clones of their parents or siblings due to the meiotic processes of independent assortment of chromosomes, crossing over, and mutations (DOK 1-2) e. Explain using examples how genetic mutations can benefit, harm, or have neutral effects on an organism (DOK 1-2)	**Inquiry Questions:** 1. Why is it possible for a cell from one species to express genes from another species as in genetic modification of organisms? 2. Why are human offspring not genetic clones of their parents or siblings? 3. How is it possible to distinguish learned from instinctual behaviors such as imprinting etiquette, and suckling by mammals? **Relevance and Application:** 1. Recombinant DNA technology has many uses in society such as the development of new medical therapies and increased production of drugs. 2. Selective breeding differs from genetic modification, yet shares a common goal. 3. There are benefits and risks to having genetically modified organisms in the food supply. 4. There are implications to inheriting DNA replication errors. **Nature of Science:** 1. Recognizing that research on genetically modified organisms is done in university laboratories and seed companies, discuss the implications of different types of funding and the ethical traditions of science: value peer review; truthful reporting of methods and outcomes; making work public; and sharing a lens of professional skepticism when reviewing the work of others. 2. Understand that scientists work from the assumption that the universe is a single system in which the basic rules are the same everywhere – that basic principles for genetics apply to all organisms. (DOK 1)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Analyze how various organisms grow, develop, and differentiate during their lifetimes based on an interplay between genetics and their environment

Grade Level Expectation: High School

Concepts and skills students master:

8. Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome.

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation of how cells form specialized tissues due to the expression of some genes and not others (DOK 1-3) b. Analyze and interpret data that show most eukaryotic deoxyribonucleic acid (DNA) does not actively code for proteins within cells (DOK 1-2) c. Develop, communicate, and justify an evidence-based scientific explanation for how a whole organism can be cloned from a differentiated – or adult – cell (DOK 1-3) d. Analyze and interpret data on medical problems using direct and indirect evidence in developing and supporting claims that genetic mutations and cancer are brought about by exposure to environmental toxins, radiation, or smoking	**Inquiry Questions:** 1. Why is it possible to clone a whole organism from an undifferentiated cell? 2. Why are stem cells sought by researchers as potential cures to medical problems? **Relevance and Application:** 1. Stem cells may be used to improve medical disorders such as diabetes, Parkinson's disease, torn cartilage, and damaged hearts. 2. Recent research and insights into DNA and genes have changed many aspects of society such as the criminal justice system, food supply, and medical treatments. **Nature of Science:** 1. Debate the advantages and disadvantages of bioengineering – cloning or genetically modifying – organisms in the food supply. (DOK 2-3) 2. Science is influenced by the cultural norms of a society. Discuss the ethical and political issues associated with stem cell research and how these have impacted both the research done and its applications. (DOK 1-3) 3. Debate the ethical and political issues associated with stem cell research and how these affect research. (DOK 2-3)

Content Area: Science
Standard: 2. Life Science

Prepared Graduates:

- Explain how biological evolution accounts for the unity and diversity of living organisms

Grade Level Expectation: High School

Concepts and skills students master:

9. Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation for how Earth's diverse life forms today evolved from common ancestors (DOK 1-3) b. Analyze and interpret multiple lines of evidence supporting the idea that all species are related by common ancestry such as molecular studies, comparative anatomy, biogeography, fossil record and embryology c. Analyze and interpret data suggesting that over geologic time, discrete bursts of rapid genetic changes and gradual changes have resulted in speciation (DOK 1-3) d. Analyze and interpret data on how evolution can be driven by three key components of natural selection – heritability, genetic variation, and differential survival and reproduction (DOK 1-3) e. Generate a model – an evolutionary tree – showing how a group of organisms is most likely diverged from common ancestry (DOK 2-3)	**Inquiry Questions:** 1. How do subtle differences among closely-related fossil species provide evidence of environmental change and speciation? 2. How does studying extinct species contribute to our current understanding of evolution? 3. How can patterns of characteristics shared among organisms be used to categorize life's diversity according to relatedness? 4. How does modern agriculture affect biodiversity? **Relevance and Application:** 1. Resistance can occur when antibiotics and pesticides are overused or abused. 2. Human activities can generate selective pressures on organisms, such as breeding new kinds of dogs and improving livestock. **Nature of Science:** 1. Understand that all scientific knowledge is subject to new findings and that reproducible, corroborated, and converging lines of data yield a scientific theory. (DOK 1) 2. Differentiate among the use of the terms "hypothesis," "theory," and "law" as they are defined and used in science compared to the usage of these terms in other disciplines or everyday use. (DOK 1-2)

3. Earth Systems Science

Students know and understand the processes and interactions of Earth's systems and the structure and dynamics of Earth and other objects in space.

Prepared Graduates:
The preschool through twelfth-grade concepts and skills that all students who complete the Colorado education system must master to ensure their success in a postsecondary and workforce setting.

Prepared Graduate Competencies in the Earth Systems Science standard:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet
- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system
- Describe how humans are dependent on the diversity of resources provided by Earth and Sun

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

Grade Level Expectation: High School

Concepts and skills students master:

1. The history of the universe, solar system and Earth can be inferred from evidence left from past events

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation addressing questions about Earth's history (DOK 1-3) b. Analyze and interpret data regarding Earth's history using direct and indirect evidence (DOK 1-2) c. Analyze and interpret data regarding the history of the universe using direct and indirect evidence (DOK 1-2) d. Seek, evaluate, and use a variety of specialized resources available from libraries, the Internet, and the community to find scientific information on Earth's history (DOK 1-2) e. Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate the history of the universe, solar system and Earth (DOK 1-2)	**Inquiry Questions:** 1. How do we know the age of Earth, Sun and universe? 2. How did the formation of Earth help shape its features today? 3. How can we interpret the geologic history of an area? **Relevance and Application:** 1. Geologic principles such as original horizontality, superposition, cross-cutting relationships, unconformities, and index fossils allow us to accurately interpret geologic history. 2. Employ data-collection technology such as geographic mapping systems and visualization tools to gather and analyze data and scientific information about Earth's history. **Nature of Science:** 1. Understand that all scientific knowledge is subject to new evidence and that the presence of reproducible results yields a scientific theory. (DOK 1) 2. Critically evaluate scientific claims in popular media and by peers regarding Earth's history, and determine if evidence presented is appropriate and sufficient to support the claims. (DOK 2-3)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Describe and interpret how Earth's geologic history and place in space are relevant to our understanding of the processes that have shaped our planet

Grade Level Expectation: High School

Concepts and skills students master:

2. As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth (DOK 1-3) b. Analyze and interpret data regarding extraterrestrial forces and energies (DOK 1-2) c. Clearly identify assumptions behind conclusions regarding extraterrestrial forces and energies and provide feedback on the validity of alternative explanations (DOK 2-3) d. Use specific equipment, technology, and resources such as satellite imagery, global positioning systems (GPS), global information systems (GIS), telescopes, video and image libraries, and computers to explore the universe)	**Inquiry Questions:** 1. What influences Earth's position in the universe? 2. How does Earth get its energy? 3. How does the electromagnetic spectrum positively and negatively impact Earth's systems? **Relevance and Application:** 1. Fusion is the most common source of energy in the universe, and it provides the basis of Earth's energy through fusion reactions in the Sun. 2. Different types of telescopes have given us data about the universe, galaxy, and solar system. **Nature of Science:** 1. Understand the physical laws that govern Earth are the same physical laws that govern the rest of the universe. (DOK 1) 2. Critically evaluate strengths and weaknesses of a model which represents complex natural phenomena. (DOK 2-3)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system

Grade Level Expectation: High School

Concepts and skills students master:

3. The theory of plate tectonics helps explain geological, physical, and geographical features of Earth

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation about the theory of plate tectonics and how it can be used to understand geological, physical, and geographical features of Earth b. Analyze and interpret data on plate tectonics and the geological, physical, and geographical features of Earth (DOK 1-2) c. Understand the role plate tectonics has had with respect to long-term global changes in Earth's systems such as continental buildup, glaciations, sea-level fluctuations, and climate change (DOK 1-2) d. Investigate and explain how new conceptual interpretations of data and innovative geophysical technologies led to the current theory of plate tectonics (DOK 2-3)	**Inquiry Questions:** 1. How do the different types of plate boundaries create different landforms on Earth? 2. How have scientists "discovered" the layers of Earth? 3. What drives plate motion? 4. What might happen to Earth's landforms in the future? **Relevance and Application:** 1. New conceptual interpretations of data and innovative geophysical technologies led to the current theory of plate tectonics. **Nature of Science:** 1. Understand that all scientific knowledge is subject to new findings and that the presence of reproducible results yields a scientific theory. (DOK 1) 2. Ask testable questions and make a falsifiable hypothesis about plate tectonics and design a method to find an answer. (DOK 2-4) 3. Share experimental data, and respectfully discuss conflicting results. 4. Recognize that the current understanding of plate tectonics has developed over time and become more sophisticated as new technologies have lead to new evidence. (DOK 1)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system

Grade Level Expectation: High School

Concepts and skills students master:

4. Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation that shows climate is a result of energy transfer among the atmosphere, hydrosphere, geosphere and biosphere (DOK 1-3) b. Analyze and interpret data on Earth's climate (DOK 1-2) c. Explain how a combination of factors such as Earth's tilt, seasons, geophysical location, proximity to oceans, landmass location, latitude, and elevation determine a location's climate (DOK 1-3) d. Identify mechanisms in the past and present that have changed Earth's climate (DOK 1) e. Analyze the evidence and assumptions regarding climate change (DOK 1-3) f. Interpret evidence from weather stations, buoys, satellites, radars, ice and ocean sediment cores, tree rings, cave deposits, native knowledge, and other sources in relation to climate change (DOK 1-3)	**Inquiry Questions:** 1. How can changes in the ocean create climate change? 2. How is climate influenced by changes in Earth's energy balance? 3. How have climates changed over Earth's history? 4. How does climate change impact all of Earth's systems? 5. How have climate changes impacted human society? **Relevance and Application:** 1. Much of the data we receive about the ocean and the atmosphere is from satellites. 2. Human actions such as burning fossil fuels might impact Earth's climate. 3. Technological solutions and personal choices such as driving higher mileage cars and using less electricity could reduce the human impact on climate. **Nature of Science:** 1. Understand how observations, experiments, and theory are used to construct and refine computer models. (DOK 1) 2. Examine how computer models are used in predicting the impacts of climate change. (DOK 1-2) 3. Critically evaluate scientific claims in popular media and by peers regarding climate and climate change, and determine if the evidence presented is appropriate and sufficient to support the claims. (DOK 2-3)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Describe how humans are dependent on the diversity of resources provided by Earth and Sun

Grade Level Expectation: High School

Concepts and skills students master:

5. There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources (DOK 1-3) b. Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use (DOK 2-3) c. Create a plan to reduce environmental impacts due to resource consumption (DOK 2-4) d. Analyze and interpret data about the effect of resource consumption and development on resource reserves to draw conclusions about sustainable use (DOK 1-3)	**Inquiry Questions:** 1. How do humans use resources? 2. How can humans reduce the impact of resource use? 3. How are resources used in our community? 4. What are the advantages and disadvantages of using different types of energy? **Relevance and Application:** 1. Technologies have had a variety of impacts on how resources are located, extracted, and consumed. 2. Technology development has reduced the pollution, waste, and ecosystem degradation caused by extraction and use. **Nature of Science:** 1. Infer assumptions behind emotional, political, and data-driven conclusions about renewable and nonrenewable resource use. (DOK 2-3) 2. Critically evaluate scientific claims in popular media and by peers, and determine if evidence presented is appropriate and sufficient to support the claims. (DOK 2-3)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system

Grade Level Expectation: High School

Concepts and skills students master:

6. The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation addressing questions regarding the interaction of Earth's surface with water, air, gravity, and biological activity (DOK 1-3) b. Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity, and biological activity create (DOK 1-3) c. Evaluate negative and positive consequences of physical and chemical changes on the geosphere (DOK 2-3) d. Use remote sensing and geographic information systems (GIS) data to interpret landforms and landform impact on human activity (DOK 1-2)	**Inquiry Questions:** 1. How do Earth's systems interact to create new landforms? 2. What are positive changes on Earth's geosphere due to water, air, gravity, and biological activity? 3. What are negative changes on Earth's geosphere due to water, air, gravity, and biological activity? **Relevance and Application:** 1. Geologic, physical, and topographic maps can be used to interpret surface features 2. Recognize that landform models help us understand the interaction among Earth's systems. 3. Human activities such as agricultural practices have impacts on soil formation and soil loss.) **Nature of Science:** 1. Ask testable questions and make a falsifiable hypothesis about physical and chemical changes on the geosphere and use an inquiry based approach to find an answer. (DOK 1-4) 2. Share experimental data, and respectfully discuss conflicting results. (DOK 2-3) 3. Use appropriate technology to help gather and analyze data, find background information, and communicate scientific information on physical and chemical changes. (DOK 1-2)

Content Area: Science
Standard: 3. Earth Systems Science

Prepared Graduates:

- Evaluate evidence that Earth's geosphere, atmosphere, hydrosphere, and biosphere interact as a complex system

Grade Level Expectation: High School

Concepts and skills students master:

7. Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms

Evidence Outcomes	21st Century Skills and Readiness Competencies
Students can: a. Develop, communicate, and justify an evidence-based scientific explanation regarding natural hazards, and explain their potential local and global impacts (DOK 1-3) b. Analyze and interpret data about natural hazards using direct and indirect evidence (DOK 1-2) c. Make predictions and draw conclusions about the impact of natural hazards on human activity – locally and globally (DOK 2-3)	**Inquiry Questions:** 1. Why are some natural hazards difficult to predict, while others are easier to predict? 2. How are humans impacted by natural hazards? 3. How can we prepare for natural hazards? 4. How is climate change expected to change the incidence of natural hazards? **Relevance and Application:** 1. Engineers must know the hazards of a local area and design for it such as building safe structures in zones prone to earthquakes, hurricanes, tsunamis, or tornadoes. 2. Differing technologies are used to study different types of natural hazards. 3. Natural hazard zones affect construction or explain why monitoring natural hazards through air traffic safety, evacuations, and protecting property is important. 4. Science is used by disaster planners who work with the scientific community to develop diverse ways to mitigate the impacts of natural hazards on the human population and on a given ecosystem. **Nature of Science:** 1. Collaborate with local, national, and global organizations to report and review natural disaster data, and compare their conclusions to alternate explanations. (DOK 2-3)

Colorado Department of Education
Office of Standards and Instructional Support
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