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:
➤ 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:	**Inquiry Questions:**
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)	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?
b. Analyze and interpret data on Earth's climate (DOK 1-2)	**Relevance and Application:**
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)	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.
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)	**Nature of Science:**
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)	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:	**Inquiry Questions:**
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)	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?
b. Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use (DOK 2-3)	**Relevance and Application:**
c. Create a plan to reduce environmental impacts due to resource consumption (DOK 2-4)	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.
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)	**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)

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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:	**Inquiry Questions:**
a. Develop, communicate, and justify an evidence-based scientific explanation regarding natural hazards, and explain their potential local and global impacts (DOK 1-3)	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?
b. Analyze and interpret data about natural hazards using direct and indirect evidence (DOK 1-2)	4. How is climate change expected to change the incidence of natural hazards?
c. Make predictions and draw conclusions about the impact of natural hazards on human activity – locally and globally (DOK 2-3)	**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)