

4-ESS1-1 Earth's Place in the Universe

Students who demonstrate understanding can:

- 4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.** [Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Identify the evidence that supports particular points in an explanation.

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.

Crosscutting Concepts

Patterns

- Patterns can be used as evidence to support an explanation.

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes consistent patterns in natural systems.

Observable features of the student performance by the end of the grade:

1	Articulating the explanation of phenomena
a	Students identify the given explanation for a phenomenon, which includes a statement about the idea that landscapes change over time.
b	From the given explanation, students identify the specific aspects of the explanation they are supporting with evidence.
2	Evidence
a	Students identify the evidence relevant to supporting the explanation, including local and regional patterns in the following: <ol style="list-style-type: none"> Different rock layers found in an area (e.g., rock layers taken from the same location show marine fossils in some layers and land fossils in other layers). Ordering of rock layers (e.g., layer with marine fossils is found below layer with land fossils). Presence of particular fossils (e.g., shells, land plants) in specific rock layers. The occurrence of events (e.g., earthquakes) due to Earth forces.
3	Reasoning
a	Students use reasoning to connect the evidence to support particular points of the explanation, including the identification of a specific pattern of rock layers and fossils (e.g., a rock layer containing shells and fish below a rock layer containing fossils of land animals and plants is a pattern indicating that, at one point, the landscape had been covered by water and later it was dry land). Students describe* reasoning for how the evidence supports particular points of the explanation, including: <ol style="list-style-type: none"> Specific rock layers in the same location show specific fossil patterns (e.g., some lower rock layers have marine fossils, while some higher rock layers have fossils of land plants). Since lower layers were formed first then covered by upper layers, this pattern indicates that the landscape of the area was transformed into the landscape indicated by the upper layer (e.g., lower marine fossils indicate that, at one point, the landscape was covered by water, and upper land fossils indicate that later the landscape was dry land).

		iii. Irregularities in the patterns of rock layers indicate disruptions due to Earth forces (e.g., a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock).
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4-ESS2-1 Earth's Systems

Students who demonstrate understanding can:

- 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.** [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems

- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

ESS2.E: Biogeology

- Living things affect the physical characteristics of their regions.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.

Observable features of the student performance by the end of the grade:

1	Identifying the phenomenon under investigation		
	a	From the given investigation plan, students identify the phenomenon under investigation, which includes the following idea: the effects of weathering or the rate of erosion of Earth's materials.	
	b	From the given investigation plan, students identify the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon.	
2	Identifying the evidence to address the purpose of the investigation		
	a	From the given investigation plan, students describe* the data to be collected that will serve as the basis for evidence.	
	b	From the given investigation plan, students describe* the evidence needed, based on observations and/or measurements made during the investigation, including:	
		i.	The change in the relative steepness of slope of the area (e.g., no slope, slight slope, steep slope).
		ii.	The kind of weathering or erosion to which the Earth material is exposed.
		iii.	The change in the shape of Earth materials as the result of weathering or the rate of erosion by one of the following:
1.		Motion of water.	
2.	Ice (including melting and freezing processes).		
3.	Wind (speed and direction).		
4.	Vegetation.		
c	Students describe* how the data to be collected will serve as evidence to address the purpose of the investigation, including to help identify cause and effect relationships between weathering or erosion, and Earth materials.		
3	Planning the investigation		
	a	From the given investigation plan, students describe* how the data will be collected, including:	
		i.	The relative speed of the flow of air or water.
		ii.	The number of cycles of freezing and thawing.
iii.	The number and types of plants growing in the Earth material.		

		iv. The relative amount of soil or sediment transported by erosion.
		v. The number or size of rocks transported by erosion.
		vi. The breakdown of materials by weathering (e.g., ease of breaking before or after weathering, size/number of rocks broken down).
	b	Students describe* the controlled variables, including:
		i. Those variables that affect the movement of water (e.g., flow speed, volume, slope).
		ii. Those variables that affect the movement of air.
		iii. The water temperature and forms of matter (e.g., freezing, melting, room temperature).
	iv. The presence or absence of plants growing in or on the Earth material.	
4	Collecting the data	
	a	Students make and record observations according to the given investigation plan to provide evidence for the effects of weathering or the rate of erosion on Earth materials (e.g., rocks, soils, and sediment).

4-ESS2-2 Earth's Systems

Students who demonstrate understanding can:

- 4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.** [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Analyzing and Interpreting Data

Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.

- Analyze and interpret data to make sense of phenomena using logical reasoning.

Disciplinary Core Ideas

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.

Crosscutting Concepts

Patterns

- Patterns can be used as evidence to support an explanation.

Observable features of the student performance by the end of the grade:

1	Organizing data
a	Students organize data using graphical displays (e.g., table, chart, graph) from maps of Earth's features (e.g., locations of mountains, continental boundaries, volcanoes, earthquakes, deep ocean trenches, ocean floor structures).
2	Identifying relationships
a	Students identify patterns in the location of Earth features, including the locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes. These relationships include: <ul style="list-style-type: none"> i. Volcanoes and earthquakes occur in bands that are often along the boundaries between continents and oceans. ii. Major mountain chains form inside continents or near their edges.
3	Interpreting data
a	Students use logical reasoning based on the organized data to make sense of and describe* a phenomenon. In their description*, students include that Earth features occur in patterns that reflect information about how they are formed or occur (e.g., mountain ranges tend to occur on the edges of continents or inside them, the Pacific Ocean is surrounded by a ring of volcanoes, all continents are surrounded by water [assume Europe and Asia are identified as Eurasia]).

4-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

- 4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.** [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.

- Obtain and combine information from books and other reliable media to explain phenomena.

Disciplinary Core Ideas

ESS3.A: Natural Resources

- Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified and used to explain change.

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering.

Influence of Engineering, Technology, and Science on Society and the Natural World

- Over time, people's needs and wants change, as do their demands for new and improved technologies.

Observable features of the student performance by the end of the grade:

1	Obtaining information	
	a	Students gather information from books and other reliable media about energy resources and fossil fuels (e.g., fossil fuels, solar, wind, water, nuclear), including:
		i. How they are derived from natural sources (e.g., which natural resource they are derived from) [note: mechanisms should be limited to grade appropriate descriptions*, such as comparing the different ways energy resources are each derived from a natural resource).
		ii. How they address human energy needs.
		iii. The positive and negative environmental effects of using each energy resource.
2	Evaluating information	
	a	Students combine the obtained information to provide evidence about:
		i. The effects on the environment of using a given energy resource.
		ii. Whether the energy resource is renewable.
		iii. The role of technology, including new and improved technology, in improving or mediating the environmental effects of using a given resource.
3	Communicating information	
	a	Students use the information they obtained and combined to describe* the causal relationships between:
		i. Energy resources and the environmental effects of using that energy source.
		ii. The role of technology in extracting and using an energy resource.

4-ESS3-2 Earth and Human Activity

Students who demonstrate understanding can:

- 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*** [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Disciplinary Core Ideas

ESS3.B: Natural Hazards

- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. *(Note: This Disciplinary Core Idea can also be found in 3.WC.)*

ETS1.B: Designing Solutions to Engineering Problems

- Testing a solution involves investigating how well it performs under a range of likely conditions. *(secondary)*

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships are routinely identified, tested, and used to explain change.
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Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

Observable features of the student performance by the end of the grade:

1	Using scientific knowledge to generate design solutions	
	a	Given a natural Earth process that can have a negative effect on humans (e.g., an earthquake, volcano, flood, landslide), students use scientific information about that Earth process and its effects to design at least two solutions that reduce its effect on humans.
	b	In their design solutions, students describe* and use cause and effect relationships between the Earth process and its observed effect.
2	Describing* criteria and constraints, including quantification when appropriate	
	a	Students describe* the given criteria for the design solutions, including using scientific information about the Earth process to describe* how well the design must alleviate the effect of the Earth process on humans.
	b	Students describe* the given constraints of the solution (e.g., cost, materials, time, relevant scientific information), including performance under a range of likely conditions.
3	Evaluating potential solutions	
	a	Students evaluate each design solution based on whether and how well it meets the each of the given criteria and constraints.
	b	Students compare the design solutions to each other based on how well each meets the given criteria and constraints.
	c	Students describe* the design solutions in terms of how each alters the effect of the Earth process on humans.