5th Grade – Topic Model - Bundle 3
Earth's Major Systems

This is the third bundle of the Fifth Grade Topic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart.

Bundle 3 Question: This bundle is assembled to address the question "Where does rain come from?"

Summary

The bundle organizes performance expectations with a focus on helping students build understanding of Earth's major systems and how they interact. Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, and is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

The disciplinary core ideas in this bundle are linked through the concept of Earth's major systems. The idea that matter of any type can be subdivided into particles that are too small to see (PS1.A as in 5-PS1-1) can connect to the concept that Earth's major systems interact in multiple ways to affect Earth's surface materials and processes (ESS2.A as in 5-ESS2-1), since matter sometimes moves through the systems as particles that are too small to see.

Earth's major systems also connect to the concept that nearly all of Earth's available water is in the ocean, and most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere (ESS2.C as in 5-ESS2-2) as this concept is about the hydrosphere.

The Earth's major systems are affected by gravity as the gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center (PS2.B as in 5-PS2-1).

Finally, the idea that human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, and air also connects to our understanding of Earth's major systems.

The engineering design concept that different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success (ETS1.A as in 3-5-ETS1-1) could connect to multiple science concepts, such as that the ocean supports a variety of ecosystems and organisms (ESS2.A as in 5-ESS2-1) and that nearly all of Earth's available water is in the ocean, and most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere (ESS2.C as in 5-ESS2-2). The first connection could be made by having students propose solutions regarding threatened ecosystems that are supported by the ocean. The second connection could be made by having students design processes to locate and identify drinkable water. In either case, students should have an opportunity to compare different proposals on the basis of how well they meet given criteria.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of asking questions and defining problems (3-5-ETS1-1); developing and using models (5-PS1-1 and 5-ESS2-1); using mathematical and computational thinking (5-ESS2-2); engaging in argument from evidence (5-PS2-1); and obtaining, evaluating, and communicating information (5-ESS3-1). Many other practice elements can be used in instruction.

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Bundle Crosscutting Concepts Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Patterns (5-ESS1-2); Cause and Effect (5-PS2-1); Scale, Proportion, and Quantity (5-PS1-1 and 5-ESS2-2); and Systems and System Models (5-ESS2-1). Many other crosscutting concepts elements can be used in instruction. *All instruction should be three-dimensional.*	
Performance Expectations 5-PS1-1 is partially assessable	5-PS1-1. **Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*] 5-PS2-1. **Support an argument that the gravitational force exerted by Earth on objects is directed down.** [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*] 5-ESS2-1. **Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [*Assessment Boundary: Assessment is limited to the interactions of two systems at a time.*] 5-ESS2-2. **Describe and graph the amounts of saltwater and freshwater in various reservoirs to provide evidence about the distribution of water on Earth.** [*Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.*] 5-ESS3-1. **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.** 3-5-ETS1-1. **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**
Example Phenomena	One side of a mountain is often much drier than is the other side. Less smoke comes out of the back of new cars than it did from cars a long time ago.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** ● Use prior knowledge to describe problems that can be solved. Students could *use prior knowledge* [about] ***human activities in everyday life*** [that] ***have had major effects on the land, vegetation, streams, ocean, or air*** *to describe problems that can be solved*. 5-ESS3-1 **Developing and Using Models** ● Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Students could *develop a diagram or simple physical prototype to convey a proposed process* ***to help protect Earth's resources and environments***. 5-ESS3-1

Additional Practices Building to the PEs (Continued)	**Planning and Carrying Out Investigations** ● Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Students could *make observations to serve as the basis for evidence that* ***the ocean supports a variety of ecosystems and organisms***. 5-ESS2-1 **Analyzing and Interpreting Data** ● Analyze and interpret data to make sense of phenomena using logical reasoning, mathematics, and/or computation. Students could *analyze and interpret data, using computation, to make sense of* [how] ***Earth's major systems interact to affect Earth's surface materials***. 5-ESS2-1 **Using Mathematical and Computational Thinking** ● Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success. Students could *decide if qualitative or quantitative data are best to determine if a tool* [that measures] ***the gravitational force of Earth acting on an object*** [meets criteria for success]. 5-PS2-1 **Constructing Explanations and Designing Solutions** ● Identify the evidence that supports particular points in an explanation. Students could *identify the evidence that supports particular points in an explanation* [that] ***the ocean influences climate***. 5-ESS2-1 **Engaging in Argument from Evidence** ● Use data to evaluate claims about cause and effect. Students could *use data to evaluate claims about cause and effect* [related to] ***human activities in everyday life and effects on vegetation***. 5-ESS3-1 **Obtaining, Evaluating and Communicating Information** ● Communicate scientific information orally, including various forms of media as well as tables, diagrams, and charts. Students could *use various forms of media to communicate* [that] ***winds and clouds in the atmosphere interact with the landforms to determine patterns of weather***. 5-ESS2-1
Additional Crosscutting Concepts Building to the PEs	**Patterns** ● Patterns can be used as evidence to support an explanation. Students could describe how *patterns can be used as evidence to support the explanation* [that] ***winds and clouds in the atmosphere interact with the landforms to determine patterns of weather***. 5-ESS2-1 **Cause and Effect** ● Cause and effect relationships are routinely identified, tested, and used to explain change. Students could *identify cause and effect relationships* [between] ***the gravitational force of Earth and objects near Earth's surface*** *and use* [the relationships] *to explain change*. 5-ESS2-1

Additional Crosscutting Concepts Building to the PEs (Continued)	**Systems and System Models** ● A system can be described in terms of its components and their interactions. Students could describe ***Earth's available water*** [as a system and identify] *its components and their interactions*. 5-ESS2-1 and 5-ESS2-2
Additional Connections to Nature of Science	**Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Basic laws of nature are the same everywhere in the universe. Students could describe that the *basic laws of nature* – [such as that] ***matter of any type can be subdivided into particles that are too small to see*** – *are the same everywhere in the universe*. 5-PS1-1 **Science is a Human Endeavor** ● Science affects everyday life. Students could describe how ***the interactions of Earth's major systems*** [can] *affect everyday life*. 5-ESS2-1

5-PS1-1 Matter and Its Interactions

Students who demonstrate understanding can:

5-PS1-1. **Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.] [*Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*]

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	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.

Observable features of the student performance by the end of the grade:			
1	Components of the model		
	a	Students develop a model to describe* a phenomenon that includes the idea that matter is made of particles too small to be seen. In the model, students identify the relevant components for the phenomenon, including:	
		i.	Bulk matter (macroscopic observable matter; e.g., as sugar, air, water).
		ii.	Particles of matter that are too small to be seen.
2	Relationships		
	a	In the model, students identify and describe* relevant relationships between components, including the relationships between:	
		i.	Bulk matter and tiny particles that cannot be seen (e.g., tiny particles of matter that cannot be seen make up bulk matter).
		ii.	The behavior of a collection of many tiny particles of matter and observable phenomena involving bulk matter (e.g., an expanding balloon, evaporating liquids, substances that dissolve in a solvent, effects of wind).
3	Connections		
	a	Students use the model to describe* how matter composed of tiny particles too small to be seen can account for observable phenomena (e.g., air inflating a basketball, ice melting into water).	

5-PS2-1 Motion and Stability: Forces and Interaction

Students who demonstrate understanding can:

5-PS2-1. **Support an argument that the gravitational force exerted by Earth on objects is directed down.** [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [*Assessment Boundary: Assessment does not include mathematical representation of gravitational force.*]

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	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**PS2.B: Types of Interactions** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.

Observable features of the student performance by the end of the grade:			
1	Supported claims		
	a	Students identify a given claim to be supported about a phenomenon. The claim includes the idea that the gravitational force exerted by Earth on objects is directed down toward the center of Earth.	
2	Identifying scientific evidence		
	a	Students identify and describe* the given evidence, data, and/or models that support the claim, including:	
		i.	Multiple lines of evidence that indicate that the Earth's shape is spherical (e.g., observation of ships sailing beyond the horizon, the shape of the Earth's shadow on the moon during an eclipse, the changing height of the North Star above the horizon as people travel north and south).
		ii.	That objects dropped appear to fall straight down.
		iii.	That people live all around the spherical Earth, and they all observe that objects appear to fall straight down.
3	Evaluation and critique		
	a	Students evaluate the evidence to determine whether it is sufficient and relevant to supporting the claim.	
	b	Students describe* whether any additional evidence is needed to support the claim.	
4	Reasoning and synthesis		
	a	Students use reasoning to connect the relevant and appropriate evidence to support the claim with argumentation. Students describe* a chain of reasoning that includes:	
		i.	If Earth is spherical, and all observers see objects near them falling directly "down" to the Earth's surface, then all observers would agree that objects fall toward the Earth's center.
		ii.	Since an object that is initially stationary when held moves downward when it is released, there must be a force (gravity) acting on the object that pulls the object toward the center of Earth.

5-ESS2-1 Earth's Systems

Students who demonstrate understanding can:

5-ESS2-1. **Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** [Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [*Assessment Boundary: Assessment is limited to the interactions of two systems at a 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	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an example to describe a scientific principle.	**ESS2.A: Earth Materials and Systems** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	**Systems and System Models** • A system can be described in terms of its components and their interactions.

Observable features of the student performance by the end of the grade:		
1	Components of the model	
	a	Students develop a model, using a specific given example of a phenomenon, to describe* ways that the geosphere, biosphere, hydrosphere, and/or atmosphere interact. In their model, students identify the relevant components of their example, including features of two of the following systems that are relevant for the given example:
		i. Geosphere (i.e., solid and molten rock, soil, sediment, continents, mountains).
		ii. Hydrosphere (i.e., water and ice in the form of rivers, lakes, glaciers).
		iii. Atmosphere (i.e., wind, oxygen).
		iv. Biosphere (i.e., plants, animals [including humans]).
2	Relationships	
	a	Students identify and describe* relationships (interactions) within and between the parts of the Earth systems identified in the model that are relevant to the example (e.g., the atmosphere and the hydrosphere interact by exchanging water through evaporation and precipitation; the hydrosphere and atmosphere interact through air temperature changes, which lead to the formation or melting of ice).
3	Connections	
	a	Students use the model to describe* a variety of ways in which the parts of two major Earth systems in the specific given example interact to affect the Earth's surface materials and processes in that context. Students use the model to describe* how parts of an individual Earth system:
		i. Work together to affect the functioning of that Earth system.
		ii. Contribute to the functioning of the other relevant Earth system.

5-ESS2-2 Earth's Systems

Students who demonstrate understanding can:

5-ESS2-2. **Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** [*Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.*]

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

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.

- Describe and graph quantities such as area and volume to address scientific questions.

Disciplinary Core Ideas

ESS2.C: The Roles of Water in Earth's Surface Processes

- Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

Crosscutting Concepts

Scale, Proportion, and Quantity

- Standard units are used to measure and describe physical quantities such as weight and volume.

Observable features of the student performance by the end of the grade:			
1	Representation		
	a	Students graph the given data (using standard units) about the amount of salt water and the amount of fresh water in each of the following reservoirs, as well as in all the reservoirs combined, to address a scientific question:	
		i.	Oceans.
		ii.	Lakes.
		iii.	Rivers.
		iv.	Glaciers.
		v.	Ground water.
		vi.	Polar ice caps.
2	Mathematical/computational analysis		
	a	Students use the graphs of the relative amounts of total salt water and total fresh water in each of the reservoirs to describe* that:	
		i.	The majority of water on Earth is found in the oceans.
		ii.	Most of the Earth's fresh water is stored in glaciers or underground.
		iii.	A small fraction of fresh water is found in lakes, rivers, wetlands, and the atmosphere.

5-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

5-ESS3-1. **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.**

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 evaluating the merit and accuracy of ideas and methods.

- Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

Crosscutting Concepts

Systems and System Models

- A system can be described in terms of its components and their interactions.

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Connections to Nature of Science

Science Addresses Questions About the Natural and Material World.

- Science findings are limited to questions that can be answered with empirical evidence.

Observable features of the student performance by the end of the grade:			
1	Obtaining information		
	a	Students obtain information from books and other reliable media about:	
		i.	How a given human activity (e.g., in agriculture, industry, everyday life) affects the Earth's resources and environments.
		ii.	How a given community uses scientific ideas to protect a given natural resource and the environment in which the resource is found.
2	Evaluating information		
	a	Students combine information from two or more sources to provide and describe* evidence about:	
		i.	The positive and negative effects on the environment as a result of human activities.
		ii.	How individual communities can use scientific ideas and a scientific understanding of interactions between components of environmental systems to protect a natural resource and the environment in which the resource is found.

3-5-ETS1-1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

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

Asking Questions and Defining Problems
Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

Crosscutting Concepts

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

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

Observable features of the student performance by the end of the grade:		
1	Identifying the problem to be solved	
	a	Students use given scientific information and information about a situation or phenomenon to define a simple design problem that includes responding to a need or want.
	b	The problem students define is one that can be solved with the development of a new or improved object, tool, process, or system.
	c	Students describe* that people's needs and wants change over time.
2	Defining the boundaries of the system	
	a	Students define the limits within which the problem will be addressed, which includes addressing something people want and need at the current time.
3	Defining the criteria and constraints	
	a	Based on the situation people want to change, students specify criteria (required features) of a successful solution.
	b	Students describe* the constraints or limitations on their design, which may include:
		i. Cost.
		ii. Materials.
		iii. Time.