4th Grade - Topical Model - Bundle 5
Reducing Impacts

This is the fifth bundle of the 4th Grade Topic Model. Each bundle has connections to the other bundles in the course, as shown in the Course Flowchart

Bundle 5 Question: This bundle is assembled to address the question "how can we reduce negative impacts of natural hazards and of resource use?"

Summary

The bundle organizes performance expectations around the theme of *reducing impacts.* Instruction developed from this bundle should always maintain the three-dimensional nature of the standards, but recognize that instruction is not limited to the practices and concepts directly linked with any of the bundle performance expectations.

Connections between bundle DCIs

The idea that when waves move across the surface of deep water, there is no net motion in the direction of the wave except when the water meets a beach (PS4.A as in 4-PS4-1) connects to the idea that a variety of hazards results from natural processes such as tsunamis, earthquakes, volcanic eruptions (ESS3.B as in 4-ESS3-2). The idea that most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans (ESS2.B as in 4-ESS2-2) also connects to the idea that humans cannot eliminate the hazards but can take steps to reduce their impacts (ESS3.B as in 4-ESS3-2).

This concept that humans can affect the natural world and can change the way it affects us could also connect to the idea that energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways (ESS3.A as in 4-ESS3-1).

The engineering design idea that communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (ETS1.B as in 3-5-ETS1-2) could be applied to multiple science concepts, such as that energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways (ESS3.A as in 4-ESS3-1) and that humans cannot eliminate the hazards from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions) but can take steps to reduce their impacts (ESS3.B as in 4-ESS3-2). Connections could be made through tasks such as identifying solutions to reduce human impacts on the environment from energy and fuel use, and identifying solutions that reduce the impacts of hazards from natural processes. For either connection, students should communicate with their peers about solutions and reflect on how such communication can lead to improved solutions.

Bundle Science and Engineering Practices

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the practices of developing and using models (4-PS4-1), planning and carrying out investigations (4-ESS2-1), analyzing and interpreting data (4-ESS2-2), and constructing explanations and designing solutions (4-ESS3-2 and 3-5-ETS1-2), and obtaining, evaluating, and communicating information (4-ESS3-1). Many other practice elements can be used in instruction.

Bundle Crosscutting Concepts

Instruction leading to this bundle of PEs will help students build toward proficiency in elements of the crosscutting concepts of Patterns (4-PS4-1 and 4-ESS2-2) and Cause and Effect (4-ESS3-1 and 4-ESS3-2). Many other crosscutting concepts elements can be used in instruction.

All instruction should be three-dimensional.

Performance Expectations	4-PS4-1 **Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*] 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.] 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.] 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.*] 3-5-ETS1-2 **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.***
Example Phenomena	Hurricanes can damage houses. Oil from the ground can be used to make gasoline for cars.
Additional Practices Building to the PEs	**Asking Questions and Defining Problems** • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. Students could *ask questions* [about] ***waves moving across the surface of deep water*** *that can be investigated and predict reasonable outcomes based on patterns* [and] *cause and effect relationships* [between the waves and the movement of water]. 4-PS4-1 **Developing and Using Models** • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. Students could *collaboratively develop a model based on evidence that shows the relationships among variables for frequent and regular occurring events* [such as the relationship between] ***use of fuels*** [and effects on] ***the environment***. 4-ESS3-1 **Planning and Carrying Out Investigations** • Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success. Students could *test two different models of the same* ***tool*** [intended to] ***help locate the different land and water feature areas of Earth*** *to determine which better meets criteria for success*. 4-ESS2-2

Additional Practices Building to the PEs (Continued)	**Analyzing and Interpreting Data** • Analyze data to refine a problem statement or the design of a proposed object, tool, or process. Students could a*nalyze data to refine the design of a proposed process* [intended to] ***reduce the impact of a hazard resulting from a natural process (e.g., earthquakes, tsunamis, volcanic eruptions)***. 4-ESS3-2 **Using Mathematical and Computational Thinking** • Organize simple data sets to reveal patterns that suggest relationships. Students could *organize simple data sets to reveal patterns that suggest relationships* [between the] ***energy that humans use*** [and the effects on] ***the environment.*** 4-ESS3-1 **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve design problems. Students could *apply scientific ideas* [about the] ***energy and fuels that humans use*** *to solve problems*. 4-ESS3-1 **Engaging in Argument from Evidence** • Construct and/or support an argument with evidence, data, and/or a model. Students could *construct an argument* [about] ***the patterns in locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes*** *with evidence.* 4-ESS2-2 **Obtaining, Evaluating and Communicating Information** • Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts. Students could *communicate scientific information* [about the idea that] **waves of the same type can differ in amplitude and wavelength** *orally and/or in written formats*. 4-PS4-1
Additional Crosscutting Concepts Building to the PEs	**Patterns** • Patterns of change can be used to make predictions. Students could explain that *patterns of* ***earthquakes*** *can be used to make predictions* [about the location of future earthquakes]. 4-ESS2-2 **Systems and System Models** • A system can be described in terms of its components and their interactions. Students could explain that *a system can be described in terms of its components and their interactions* [using the example of] ***humans*** [and the] ***natural sources*** [they use for] ***energy and fuels and the*** [effect human use of energy and fuels has on] ***the environmen*****t**. 4-ESS3-1 **Energy and Matter** • Energy can be transferred in various ways and between objects. Students could describe how *energy can be transferred in various ways and between objects* [using] ***waves, which are regular patterns of motion*** [and] ***can be made in water by disturbing the surface***, [as an example]. 4-PS4-1

Additional Connections to Nature of Science	**Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Science explanations describe the mechanisms for natural events. Students could *describe the mechanisms,* [such as] ***disturbing the surface of water***, [in their] *science explanations of natural events*, [such as the creation of] ***waves***. 4-PS4-1 **Science is a Human Endeavor** • Science affects everyday life. Students could use their understanding that ***energy and fuels that humans use are derived from natural sources*** [to describe that] *science affects everyday life.* 4-ESS3-1

4-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Students who demonstrate understanding can:

4-PS4-1. **Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.** [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [*Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*]

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

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 analogy, example, or abstract representation to describe a scientific principle.

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Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science findings are based on recognizing patterns.

Disciplinary Core Ideas

PS4.A: Wave Properties

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. *(Note: This grade band endpoint was moved from K–2.)*
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

Crosscutting Concepts

Patterns

- Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.

Observable features of the student performance by the end of the grade:		
1	Components of the model	
	a	Students develop a model (e.g., diagrams, analogies, examples, abstract representations, physical models) to make sense of a phenomenon that involves wave behavior. In the model, students identify the relevant components, including:
		i. Waves.
		ii. Wave amplitude.
		iii. Wavelength.
		iv. Motion of objects.
2	Relationships	
	a	Students identify and describe* the relevant relationships between components of the model, including:
		i. Waves can be described* in terms of patterns of repeating amplitude and wavelength (e.g., in a water wave there is a repeating pattern of water being higher and then lower than the baseline level of the water).
		ii. Waves can cause an object to move.
		iii. The motion of objects varies with the amplitude and wavelength of the wave carrying it.
3	Connections	
	a	Students use the model to describe*:
		i. The patterns in the relationships between a wave passing, the net motion of the wave, and the motion of an object caused by the wave as it passes.
		ii. How waves may be initiated (e.g., by disturbing surface water or shaking a rope or spring).
		iii. The repeating pattern produced as a wave is propagated.
	b	Students use the model to describe* that waves of the same type can vary in terms of amplitude and wavelength and describe* how this might affect the motion, caused by a wave, of an object.

	c	Students identify similarities and differences in patterns underlying waves and use these patterns to describe* simple relationships involving wave amplitude, wavelength, and the motion of an object (e.g., when the amplitude increases, the object moves more).

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:
		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.

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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.

3-5-ETS1-2 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-2. **Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.**

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 problem.

Disciplinary Core Ideas

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions.
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.

Crosscutting Concepts

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

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

Observable features of the student performance by the end of the grade:		
1	Using scientific knowledge to generate design solutions	
	a	Students use grade-appropriate information from research about a given problem, including the causes and effects of the problem and relevant scientific information.
	b	Students generate at least two possible solutions to the problem based on scientific information and understanding of the problem.
	c	Students specify how each design solution solves the problem.
	d	Students share ideas and findings with others about design solutions to generate a variety of possible solutions.
	e	Students describe* the necessary steps for designing a solution to a problem, including conducting research and communicating with others throughout the design process to improve the design [note: emphasis is on what is necessary for designing solutions, not on a step-wise process].
2	Describing* criteria and constraints, including quantification when appropriate	
	a	Students describe*:
		i. The given criteria (required features) and constraints (limits) for the solutions, including increasing benefits, decreasing risks/costs, and meeting societal demands as appropriate.
		ii. How the criteria and constraints will be used to generate and test the design solutions.
3	Evaluating potential solutions	
	a	Students test each solution under a range of likely conditions and gather data to determine how well the solutions meet the criteria and constraints of the problem.
	b	Students use the collected data to compare solutions based on how well each solution meets the criteria and constraints of the problem.