INDIANA DEPARTMENT *of* EDUCATION

ILEARN Science Grade 4
Item and Item Cluster Specifications

Beginning School Year 2023-2024

Introduction

This document presents *cluster specifications* for use with the Next Generation Science Standards (NGSS). These standards are based on the Framework for K-12 Science Education. The present document is not intended to replace the standards, but rather to present guidelines for the development of items and item clusters used to measure those standards.

The remainder of this section provides a very brief introduction to the standards and the framework, an overview of the design and intent of the item clusters, and a description of the cluster specifications that follow. The bulk of the document is composed of cluster specifications, organized by grade and standard.

Background on the framework and standards

The Framework for K-12 Science Education are organized around three core dimensions of scientific understanding. The standards are derived from these same dimensions:

- Disciplinary Core Ideas: The fundamental ideas that are necessary for understanding a given science discipline. The core ideas all have broad importance within or across science or engineering disciplines, provide a key tool for understanding or investigating complex ideas and solving problems, relate to societal or personal concerns, and can be taught over multiple grade levels at progressive levels of depth and complexity.

- Science and Engineering Practices: The practices are what students DO to make sense of phenomena. They are both a set of skills and a set of knowledge to be internalized. The SEPs reflect the major practices that scientists and engineers use to investigate the world and design and build systems.

- Cross-Cutting Concepts: These are concepts that hold true across the natural and engineered world. Students can use them to make connections across seemingly disparate disciplines or situations, connect new learning to prior experiences, and more deeply engage with material across the other dimensions. The NGSS requires that students explicitly use their understanding of the CCCs to make sense of phenomena or solve problems.

- There is substantial overlap between and among the three dimensions. For example, the cross-cutting concepts are echoed in many of the disciplinary core ideas. The core ideas are often closely intertwined with the practices. This overlap reflects the nature of science itself. For example, we often come to understand and communicate causal relationships by employing models to make sense of observations. Even within a dimension, overlap exists. Quantifying characteristics of phenomena is important in developing an understanding of them, so employing computational and mathematical thinking in the construction and use of models is a very common scientific practice, and one of the cross-cutting concepts suggests that scientists often infer causality by observing patterns. In short, the dimensions are not orthogonal.

The framework envisions effective science education as occurring at the intersection of these interwoven dimensions: students learn science by doing science—applying the practices through the lens of the cross-cutting concepts to investigate phenomena that relate to the content of the disciplinary core ideas.

Item clusters

Each item cluster is designed to engage the examinee in a grade-appropriate, meaningful scientific activity aligned to a specific standard.

Each cluster begins with a phenomenon, an observable fact or design problem that engages student interest and can be explained, modeled, investigated, or designed using the knowledge and skill described by the standard in question. What it means to be observable varies across practices. For example, a phenomenon for a performance expectation exercising the a*nalyze data* practice may be observable through regularities in a data set, while standards related to the *development and use of models* might be something that can be watched, seen, felt, smelled, or heard.

What it means to be observable also varies across grade levels. For example, elementary-level phenomena are very concrete and directly observable. At the high school level, an observation of the natural world may be more abstract--for example, "observing" changes in the chemical composition of cells through the observation of macroscopic results of those changes on organism physiology, or through the measurement of system- or organ-level indications.

Content limits refine the intent of the performance expectations and provide limits on what may be asked of items in the cluster to structure the student activity. The content limits also reflect the disciplinary core ideas learning progressions that are present in the K-12 Framework for Science Education.

The task or goal should be explicitly stated in the stimulus or the first item in the cluster: statements such as “In the questions that follow, you will develop a model that will allow you to identify moons of Jupiter,” or “In the questions below, you will complete a model to describe the processes that lead to the steam coming out of the teapot.”

Whereas item clusters have been described elsewhere as “scaffolded,” they are better described as providing structure to the task. For example, some clusters begin with students summarizing data to discover patterns that may have explanatory value. Depending on the grade level and nature of the standard, items may provide complete table shells or labeled graphs to be drawn, or may require the student to choose what to tabulate or graph. Subsequent items may ask the student to note patterns in the tabulated or graphed data and draw on domain content knowledge to posit explanations for the patterns.

These guidelines for clusters do not appear separately in the specifications. Rather, they apply to all clusters.

Structure of the cluster specifications

The item cluster specifications are designed to guide the work of item writers and the review of item clusters by stakeholders.

Each item cluster has the following elements:

- The text of the performance expectations, including the practice, core idea, and cross-cutting concept.
- Content limits, which refine the intent of the performance expectations and provide limits of what may be asked of examinees. For example, they may identify the specific formulae that students are expected to know or not know.
- Vocabulary, which identifies the relevant technical words that students are expected to know, and related words that they are explicitly not expected to know. Of course, the latter category should not be considered exhaustive, since the boundaries of relevance are ambiguous, and the list is limited by the imagination of the writers.
- Sample phenomena, which provide some examples of the sort of phenomena that would support effective item clusters related to the standard in question. In general, these should be guideposts, and item writers should seek comparable phenomena, rather than drawing on those within the documents. Novelty is valued when applying scientific practices.
- Task demands comprise the heart of the specifications. These statements identify the types of items and activities that item writers should use, and each item written should be clearly linked to one or more of the demands. The verbs in the demands (e.g., *select, identify, illustrate, describe*) provide guidance on the types of interactions that item writers might employ to elicit the student response. We avoid explicitly identifying interaction types or item formats to accommodate future innovations and to avoid discouraging imaginative work by the item writers.
- For each cluster we present, the printed documentation includes the cluster, the task demands represented by each item, and its linkage to the practice and cross-cutting concept identified in the performance expectation.

Range Performance Level Descriptors (PLDs)

The Grade 4 Science Range PLDs provide content-specific claims across each Performance Expectation to represent the range of expectations for student performance within each proficiency level. These PLDs can be used to inform instructional practices as educators consider proficiency of the content. Additionally, educators may use the content examples to consider how to remediate or extend key instructional concepts to transition students across proficiency levels of performance.

Item cluster specifications follow, organized by domain and standard.

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS3-1
Use evidence to construct an explanation relating the speed of an object to the energy of that object.</td></tr>
<tr><td>Dimensions</td><td>Constructing Explanations and Designing Solutions
• Use evidence (e.g., measurements, observations, patterns) to construct an explanation.</td><td>PS3.A: Definitions of Energy
• The faster a given object is moving, the more energy it possesses.</td><td>Energy and Matter
• Energy can be transferred in various ways and between objects.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Content Limits
• Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.
• Students are expected to know that energy can be expressed through sound, heat, light, and motion.
• <u>Students do not need to know:</u> Students do not need to know how to calculate speed, the change in speed (acceleration), or energy. This standard is limited to making strictly qualitative or comparative observations.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Volume, collision, heat transfer, spring (coil), forms of energy (sound, heat, light, motion), conservation of energy, stored energy, energy transfer, gravity.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Potential energy, kinetic energy, thermal energy, acceleration, velocity.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS3-1:
• One drum can be used to produce loud or quiet percussion sounds.
• A small bouncing basketball sounds louder than a large bouncing basketball.
• Damage caused during a high-speed collision is greater than when speeds are slower.
• A ceramic bowl dropped from a greater height will have a larger debris pattern.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Articulate, describe, illustrate, or select the relationships, interactions, and/or processes to be explained. This may entail sorting relevant from irrelevant information or features.**</td></tr>
<tr><td colspan="4">2. Express or complete a causal chain explaining that changes in energy and speed are related. This may include indicating directions of causality in an incomplete model such as a flow chart or diagram, or completing cause-and-effect chains.*</td></tr>
<tr><td colspan="4">3. Identify evidence supporting the inference of causation that is expressed in a causal chain.</td></tr>
<tr><td colspan="4">4. Use an explanation to predict how the speed of an object changes given a change in energy or how the expression of energy will change given a change in speed.</td></tr>
<tr><td colspan="4">5. Describe, identify, and/or select information needed to support an explanation.</td></tr>
</table>

*denotes those task demands which are deemed appropriate for use in stand-alone item development

**TD 1 should only be used if paired with TD2. TD 2 can be used alone.

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<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS3-2
Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.</td></tr>
<tr><td>Dimensions</td><td>Planning and Carrying Out Investigations
• Make observations to produce data to serve as the basis for evidence for an explanation of a phenomena or to test a design solution.</td><td>PS3.A: Definitions of Energy
• Energy can be moved from place to place by moving objects — or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer
• Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
• Light also transfers energy from place to place.
• Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.</td><td>Energy and Matter
• Energy can be transferred in various ways and between objects.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Content Limits
• Assessment does not include quantitative measurements of energy.
• Identifying how energy is transferred (example: conduction vs. convection) is not part of this PE.
• <u>Students do not need to know</u>: Students do not need to know how to do energy calculations. This standard is limited to strictly making observations. Students should know that energy can be given off as heat or light, but not specifics such as convection, thermal radiation, etc.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Collision, speed, flow, heat conduction, conversion.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Kinetic energy, potential energy, radiation, convection, transmission, reflection, decibels, resonance, friction, hertz, electromagnetic radiation, magnitude, motion energy, electric circuit, thermal, conservation of energy.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS3-2:
• A light bulb can be powered using the motion of a hamster wheel.
• A drinking glass can be broken by a person singing a certain note.
• A fan (with blades angled at 45 degrees) will spin when placed safely over burning candles.
• Touching a Van der Graaf generator will make your hair stick up.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Identify the materials/tools needed for an investigation of how energy is transferred from place to place through heat, sound, light, or electric currents.</td></tr>
</table>

2.	Identify the data that should be collected in an investigation of how energy is transferred from one place to another through heat, sound, light, or electric currents.
3.	Make and/or record observations about the transfer of energy from one place to another via heat, sound, light, or electric currents.**
4.	Interpret and/or communicate the data from an investigation.**
5.	Select, describe, or illustrate a prediction made by applying the findings from an investigation.

*denotes those task demands which are deemed appropriate for use in stand-alone item development
**TD3 and TD4 must be used together.

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS3-3
Ask questions and predict outcomes about the changes in energy that occur when objects collide.</td></tr>
<tr><td>Dimensions</td><td>Asking Questions and Defining Problems
• Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.</td><td>PS3.A: Definitions of Energy
• Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

PS3.B: Conservation of Energy and Energy Transfer
• Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.

PS3.C: Relationship Between Energy and Forces
• When objects collide, the contact forces transfer energy so as to change the objects’ motions.</td><td>Energy and Matter
• Energy can be transferred in various ways and between objects.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.

Content Limits
• Assessment does not include quantitative measurements of energy.
• <u>Students do not need to know</u>: names of energy types, how to calculate energy or forces</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Electric currents, speed, flow, conversion, motion, magnets, magnetism, heat conduction.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Kinetic energy, potential energy, friction, force fields, vector, magnitude, elastic, inelastic.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS3-3:
• A large wave crashes into the cliffs of Étretat and some rocks are knocked loose. A small wave then crashes into the cliffs.
• A person hits a nail with a hammer and the nail is driven into a board. The person swings the hammer again, but misses the nail.
• A person walks down a hallway. The sound of their shoes on the floor can be heard many feet away. The person then runs down the hallway.
• A bowler rolls a ball down a lane. It slams into the pins and knocks several of them down. After the pins are reset, the bowler rolls the ball down the lane again. The ball misses and knocks down no pins.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Select or identify from a collection, including distractors, questions that will help clarify the properties that are correlated with the changes in energy that occur in the phenomenon. In addition to distractors that are plausible responses, distractors may include non-testable (“nonscientific”) questions.</td></tr>
</table>

2.	Identify, describe, or select from a collection, including distractors, characteristics to be manipulated or held constant while gathering information to answer a well-articulated question.
3.	Select or describe conclusions relevant to the question posed and supported by the data, especially conclusions about causes and effects.
4.	Predict outcomes when properties or proximity of the objects are changed, given the inferred cause-and-effect relationships.
5.	Describe, identify, gather, and/or select information needed to identify patterns that can be used to predict outcomes about the changes in energy.

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS3-4
Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.</td></tr>
<tr><td>Dimensions</td><td>Constructing Explanations and Designing Solutions
• Apply scientific ideas to solve design problems.</td><td>PS3.B: Conservation of Energy and Energy Transfer
• Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

PS3.D: Energy in Chemical Processes and Everyday Life
• The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.

ETS1.A: Defining 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.</td><td>Energy and Matter
• Energy can be transferred in various ways and between objects.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.

Content Limits
• Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Magnetic, motion, speed, conservation, gravitational, battery, conversion, properties, chemical.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Mass, net force, velocity, relative position, constant speed, direction of motion, direction of a force, deceleration, independent, economic, control, impact, inertia, Newton’s laws (1st, 2nd, 3rd), stationary, frame of reference, potential energy, mechanical energy, kinetic energy, conserve, relative, chemical energy.</td></tr>
<tr><td colspan="4" align="center">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Engineering practices are built around meaningful design problems rather than phenomena. For this performance expectation, a design problem and associated competing solutions will replace phenomena.

Some examples of design problems for 4-PS3-4:
• A front door does not have an alarm. Any alarm that is added needs to be heard in the back hallway.
• A person hiking on a hot day needs to take a fan to stay cool. The fan must be small so that it does not add to the weight of the hiker’s pack but must also last the entire hike.</td></tr>
</table>

	• The water in a house is heated with electricity purchased from a power company. A decision is made to instead heat the water using electricity generated with solar panels on the roof. The water heater must heat enough water to meet the needs of the home but the cost of installation and/or maintenance cannot exceed the family's budget. • A motor is added to a toy car for a race. The motor must be able to move the car across a room at a high speed.

This Performance Expectation and associated Evidence Statements support the following Task Demands.
Task Demands
1. Express or complete a causal chain explaining how energy can be transferred via electric current to produce light, sound, heat, and/or motion. This may include indicating directions of causality in an incomplete model such as a flow chart or diagram, or completing cause-and-effect chains.
2. Identify evidence supporting the inference of causation that is expressed in a causal chain.
3. Use an explanation to predict how the motion, sound, heat, or light of an object changes, given a change in electrical energy—or, how the expression of energy will change, given a change in the conversion of stored energy.
4. Identify or assemble from a collection, including distractors, the relevant aspects of the problem that given design solutions, if implemented, will resolve/improve. The design solution must convert energy from one form to another within the content limits.
5. Using given information, select or identify constraints that the device that converts energy from one form to another must meet OR criteria against which it should be judged.
6. Using given information, design, propose, illustrate, assemble, test, or refine a potential device (prototype) that converts energy from one form to another.

<table>
<tr><td>Performance Expectation</td><td colspan="3">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.</td></tr>
<tr><td>Dimensions</td><td>Developing and Using Models
• Develop a model using an analogy, example, or abstract representation to describe a scientific principle.</td><td>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.
▪ Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).</td><td>Patterns
• Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.
• Acceptable clusters may include: amplitude and wavelength, motion of an object, or both.

Content Limits
• Limited to physically visible mechanical waves.
• Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.
• Examples of objects being moved by waves are limited to up and down motion. Horizontal motion is above grade level due to the other factors involved.
• Don’t directly reference energy. Energy is addressed in 4-PS3.
• <u>Students do not need to know</u>:
○ Types of waves: sound, light, non-periodic, compression
○ Particle movement
○ Quantitative models
○ Behaviors of waves: absorption, reflection, refraction, transmission, interactions with different materials (angle of incidence, amount of reflection or absorption, light being refracted into colors). Reflection is limited to the concept. How waves are reflected and the details of reflection (as well as other behaviors) are covered in MS-PS4-2.
○ Wave calculations
○ Motion of objects in the ocean due to ocean currents</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Crest, trough, peak, rate, property, medium, period</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Electromagnetic, compression, particle, transmission, seismic wave, radio wave, microwave, infrared, ultraviolet, gamma rays, x-rays, angle of incidence, concave, convex, diffraction, constructive interference, destructive interference, resonance, refraction, absorption, reflection, pitch, sound wave, light wave.</td></tr>
<tr><td colspan="4" align="center">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS4-1:
• A boat floating in the ocean is tied to a pier. The boat rises and falls with the waves.</td></tr>
</table>

	• Two students hold ends of a rope. One student lifts her end, and then drops it toward the ground. The rope forms a wave that travels from that student to the other student. • The sand waves on a windy beach get bigger and more pronounced over time. They are regular and evenly spaced. • A surfer riding a wave stays up if she moves along the wave but falls as soon as she stops moving.

This Performance Expectation and associated Evidence Statements support the following Task Demands.
Task Demands
1. Select or identify the components of a model that are needed to describe wave behavior, patterns of wave creation, and/or the motion of objects carried on/by waves. Components might include the source, amplitude, frequency, and/or wavelength.
2. Manipulate the components of a model to demonstrate properties, processes, and/or events that result in the patterns of wave behavior that are identified in the phenomenon. These patterns of wave behavior can include creation and replication of waves.
3. Describe, select, or identify the relationships among components of a model that describe wave behavior, patterns of wave creation, and/or the motion of objects carried on or by a wave.
4. Given a model of waves, illustrate the way in which the wave changes to yield a given result (more movement, less movement) and/or identify the result based on changes to the wave.
5. Make predictions about the effects of changes in model components (e.g., energy of wave source, distance from wave source), the amplitude or wavelength of a wave, or motion of objects affected by the wave. Item writer: Do not directly reference the energy of the wave source. Instead, show the speed and size of the object causing the wave, etc.

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS4-2
Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.</td></tr>
<tr><td>Dimensions</td><td>Developing and Using Models
• Develop a model to describe phenomena.</td><td>PS4.B: Electromagnetic Radiation
• An object can be seen when light reflected from its surface enters the eyes.</td><td>Cause and Effect
• Cause-and-effect relationships are routinely identified.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Content Limits
• Assessment does not include:
o knowledge of specific colors reflected and seen;
o the cellular mechanisms of vision;
o how the retina works.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Energy, light ray, reflection, reflective, surface</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Particle, transmission, angle of incidence, angle of reflection, concave, convex, diffraction, constructive interference, destructive interference, refraction, absorption, wave, field, illuminate, diffuse reflection, specular reflection, spectrum, prism.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS4-2:
• A person can see a cat in the mirror. The cat is otherwise hidden from view.
• A performance is being watched by a person. Another person stands up and blocks the view.
• A flashlight is pointed at a door in a dark room. The door is the only object seen in the room.
• The surface of a lake is very still. The reflection of a tree on the bank can be seen on the lake's surface.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Identify the components needed to model the phenomenon. Components might include the light, the light source, the object, the path the light follows, and the eye.</td></tr>
<tr><td colspan="4">2. Complete an illustration or flow chart that is capable of representing how light reflecting from objects and entering the eye allows objects to be seen. This <u>does not</u> include labeling an existing diagram.</td></tr>
<tr><td colspan="4">3. Manipulate the components of a model to demonstrate the changes, properties, processes, and/or events that act to result in the phenomenon.</td></tr>
<tr><td colspan="4">4. Make predictions about the effects of changes in the model, particularly using mirrors, changing positions of light sources, objects, and the eye. Predictions can be made by manipulating model components, completing illustrations, or selecting from lists with distractors.</td></tr>
<tr><td colspan="4">5. Identify missing components, relationships, or other limitations of the model.</td></tr>
<tr><td colspan="4">6. Describe, select, or identify the relationships among components of a model that describe how light reflecting from objects and entering the eye allows objects to be seen.</td></tr>
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<table>
<tr><td>Performance Expectation</td><td colspan="3">4-PS4-3
Generate and compare multiple solutions that use patterns to transfer information.</td></tr>
<tr><td>Dimensions</td><td>Constructing Explanations and Designing Solutions
• Generate and compare multiple solutions to a problem, based on how well they meet the criteria and constraints of the design solution.</td><td>PS4.C: Information Technologies and Instrumentation
• Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.

ETS1.C: Optimizing the Design Solution
• Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.</td><td>Patterns
• Similarities and differences in patterns can be used to sort and classify designed products.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Examples of solutions could include:
  • drums sending coded information through sound waves;
  • using a grid of 1’s and 0’s, representing black and white, to send information about a picture;
  • using Morse code to send text.

Content Limits
• <u>Students do not need to know:</u>
  o the different parts of the electromagnetic spectrum (visible, microwave, x-ray, radio wave, etc.);
  o binary coding or how it works;
  o that light is made up of an electric and magnetic field;
  o transverse vs. longitudinal waves;
  o how information gets encoded;
  o how different forms of communicating information work (Morse code vs. something like a telephone).</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Amplitude, wavelength, reflect, vibrate, vibration, absorb, properties, sound wave, wave, communicate, electricity, coded, Morse code, digital, store, transfer, convert.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Light emission, light refraction, transmit, wave peaks, light wave, electromagnetic, frequency, radiation, wave packet, light scattering, light transmission, electric field, magnetic field, photon, radio wave, x-ray, binary, electron, pixel, CCD, transverse, longitudinal.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-PS4-3:
• In July 2015, the New Horizons Space Probe flew past Pluto. The space probe is tasked with taking detailed pictures of Pluto so that scientists on Earth can study its features. However, the spacecraft can only send sequences of numbers back to Earth.
• A man wants to send an urgent message to his wife who is a long distance away. It would take too long to drive to his wife and deliver the message himself. The only way he can communicate is through an electrical wire that is set up between the two locations.</td></tr>
</table>

	• Two people want to communicate a number 1 through 10 over a large distance. They have no telephones or other means of communication. They are close enough that they can see or hear each other, however, a river separates them so they cannot reach each other. • Two people want to communicate over a large distance. However, the power is out and so they cannot use the telephone. All they have is a string that is stretched between their two houses. Attached to the end of each string is a metal can. The messages they want to be able to send consists of numbers 1 through 10.

This Performance Expectation and associated Evidence Statements support the following Task Demands.
Task Demands
1. Articulate, describe, illustrate, or select the relationships, interactions, and/or processes to be explained. This may entail sorting relevant from irrelevant information or features.
2. Express or complete a causal chain explaining how each pattern is used to transmit information. This may include indicating directions of causality in an incomplete model such as a flow chart or diagram, or completing cause-and-effect chains.
3. Identify evidence supporting the inference of causation that is expressed in a causal chain.
4. Use an explanation to compare the two solutions and select which one is better for the transmitting of information.
5. Describe, identify, and/or select information needed to support an explanation.

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-LS1-1
Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.</td></tr>
<tr><td>Dimensions</td><td>Engaging in Argument from Evidence
• Construct an argument with evidence, data, and/or a model.</td><td>LS1.A: Structure and Function
• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.</td><td>Systems and System Models
• A system can be described in terms of its components and their interactions.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.

Content Limits
• Assessment is limited to macroscopic structures within plant and animal systems.
• The student does not need to know about cellular structures like the nucleus, mitochondria, the Golgi apparatus or the endoplasmic reticulum.
• <u>The student does not need to know:</u> about organ systems like the circulatory system, reproductive system, or nervous system.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Brain, body, flow, flower, heart, lung, muscle, movement, grasp, habit, moisture, organization, petal, predator, prey, roots, skin, stem, stomach, temperature</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Cell, detect, response, body plan, elastic, external, intellectual, internal, invertebrate, organ, vertebrate, multicellular, stimulus, tissue, enzyme, xylem, phloem, parenchyma, and cambium cells.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Some example phenomena for 4-LS1-1:
• In a field of grass, a butterfly lands on one of the only red poppy flowers in sight.
• A manta ray has a flat circular body. Its fins spread out like wings from its body.
• A pelican can hold up to 3 gallons of water in its pouch.
• A student sees a hollow, brown copy of a cicada insect attached to the bark of a tree.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Identify evidence or patterns in the data that support inferences and/or determine relationships between a particular structure of an organism and a function that supports survival, growth, behavior, and reproduction.</td></tr>
<tr><td colspan="4">2. Understand and generate simple bar graphs or tables to document patterns, trends, or relationships between a particular structure of an organism and a function that supports survival, growth, behavior, and reproduction.</td></tr>
<tr><td colspan="4">3. Sort observations/evidence into those that appear to support or not support an argument.</td></tr>
</table>

4.	Based on the provided data, identify or describe a claim regarding the relationship between a structure of an organism and a function that supports survival, growth, behavior, and reproduction.
5.	Summarize or organize given data or other information to support or refute a claim regarding an organism's structure and its function.
6.	Sort, tabulate, classify, separate, and/or categorize relevant from irrelevant information regarding an organism's structure and its function.

Performance Expectation	**4-LS1-2** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.		
Dimensions	**Developing and Using Models** • Use a model to test interactions concerning the functioning of a natural system.	**LS1.D: Information Processing** • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	**Systems and System Models** • A system can be described in terms of its components and their interactions.
Clarifications and Content Limits	**Clarification Statements** • Emphasis is on systems of information transfer. **Content Limits** • Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.		
Science Vocabulary Students Are Expected to Know	Lens, vision, hearing, muscle, ear, middle ear, outer ear, inner ear, eardrum, response, habitat, eye, lens, memory		
Science Vocabulary Students Are Not Expected to Know	Sensory, brain, cells, retina, pupil, saliva, salivary gland, vibration, cornea, iris, brainstem, consumer, nerve, optic nerve, nerve cell, nerve tissue, nerve impulse, connecting nerve, nerve fiber, organ system, reflex, reflex action, reaction time, cue.		
Phenomena			
Context/ Phenomena	Some example phenomena for 4-LS1-2: • A bear cub in the woods cries out. Its mother immediately runs toward it. • A deer walks in the woods. It turns suddenly and moves off in a different direction. A few minutes later, a skunk appears from the bushes. • A cat sits on a stone wall. A mouse appears at the base of a nearby tree. The cat springs after the mouse. • A hawk flies overhead. Suddenly, it dives toward the tall grass. A moment later, it returns to the sky, a snake in its claws.		
This Performance Expectation and associated Evidence Statements support the following Task Demands.			
Task Demands			
1. Select or identify from a collection of potential model components the components needed to model the phenomenon. Components might represent organ systems or parts of a system needed for collection and/or processing of sensory information.			
2. Assemble or complete, from a collection of potential model components, an illustration or flow chart that is capable of representing the flow and/or processing of sensory information in an animal. This does not include labeling an existing diagram.			
3. Manipulate the components of a model to demonstrate the changes, properties, processes, and/or events that act to result in the phenomenon.*			

4.	Given models or diagrams of the flow and/or processing of sensory information in an animal, identify responses to sensory inputs and how they change in each scenario OR identify the properties of organs and/or organ systems that allow animals to respond to sensory information.*
5.	Identify missing components, relationships, or other limitations of a model that shows the flow and/or processing of sensory information in an animal.
6.	Describe, select, or identify the relationships among components of a model that describe how sensory information is processed or explain how an animal responds to sensory inputs.

*denotes those task demands which are deemed appropriate for use in stand-alone item development

<table>
<tr><td>Performance Expectation</td><td colspan="3">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.</td></tr>
<tr><td>Dimensions</td><td>Constructing Explanations and Designing Solutions
• Identify the evidence that supports particular points in an explanation.</td><td>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.</td><td>Patterns
• Patterns can be used as evidence to support an explanation.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">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.

Content Limits
• 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.
• Assessment does not include earthquakes—the clarification statement focuses on geomorphology and landscape change through time. The focus is not on tectonics, despite its mention in the DCI.</td></tr>
<tr><td>Science Vocabulary Students are Expected to Know</td><td colspan="3">Weathering, erode, glacier, climate, fossil, landscape, shell, river, mountain, canyon, deposit, marine.</td></tr>
<tr><td>Science Vocabulary Students are Not Expected to Know</td><td colspan="3">Rock strata, ocean basins, glaciation, watersheds, geological, mountain chains, igneous rock, metamorphic rock, sedimentary rock, terrestrial, aquatic.</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Sample phenomena for 4-ESS1-1:
• The rock walls on both sides of the Grand Canyon contain layers with marine fossils, interspersed with layers containing terrestrial fossils.
• Church Rock, New Mexico, is a very dry place far from the sea. However, exposures of rocks in the area contain many fossils of marine organisms.
• Axel Heiberg Island in the Canadian Arctic is too cold for trees to grow. However, sedimentary rocks on the island preserve hundreds of fossil stumps from large evergreen trees.
• Sihetun, China, is dry and mountainous. Sedimentary rocks exposed in the area preserve thousands of fish fossils. These sedimentary rocks are sandwiched between lava flow rocks. There are no active volcanoes in this part of China.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Describe, identify, and/or select evidence from patterns of rock formations and/or patterns of fossils in rock layers to support the explanations of changes in the landscape over time.</td></tr>
</table>

2. Express or complete a causal chain explaining changes in patterns of fossils in rock layers.
3. Identify patterns of rock formations and/or patterns of fossils in rock layers.

Performance Expectation	**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.		
Dimensions	**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.	**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.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change.
Clarifications and Content Limits	**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. **Content Limits** • Students aren't expected to know the flow of energy that causes the phenomena. • Assessment is limited to one form of erosion. • Assessment does not include chemical erosion. • <u>Students do not need to know</u>: Sedimentation, Earth's interior, crystallization, minerals, the rock cycle, dynamic forces, feedback interactions, constructive forces, or deformation.		
Science Vocabulary Students are Expected to Know	Erosion, freeze, movement, cycle, weathering, ocean, sediment, vegetation, particle, earthquake, volcanoes, thaw.		
Science Vocabulary Students are Not Expected to Know	Composition, slope, continental boundaries, trench, minerals, plate tectonics, topography.		
Phenomena			
Context/ Phenomena	Some example phenomena for 4-ESS2-1: • Rocks in the bottom of a river are usually smooth, but the rocks sitting on the ground nearby often have sharp edges and corners. • Near its start in Colorado, the bed of the North Platte River is covered with boulders. Some five hundred miles away in Nebraska, the bed of the river is mostly sand. • New gullies appear in a gravel driveway after a heavy rain. • Over the course of a summer there is a series of major storms. At the end of the season, the channel of a small stream running through a grassy park is significantly wider than it was before the storms.		
This Performance Expectation and associated Evidence Statements support the following Task Demands.			
Task Demands			
1. Identify the factors that affect weathering or the rate of erosion by water, ice, wind, or vegetation.			
2. Identify from a list the materials/tools needed for an investigation of how wind affects the factors that affect weathering or the rate of erosion by water, ice, wind, or vegetation.			

3. Identify, among distractors, the outcome data that should be collected in the investigation.
4. Make and/or record observations about how input factors affect relevant outcomes while using fair tests in which variables are controlled.*
5. Make or communicate the conclusions from the investigation. Conclusions will be causal relationships.**

*denotes those task demands which are deemed appropriate for use in stand-alone item development
**TD5 can be used ONLY if used in concert with TD4

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-ESS2-2
Analyze and interpret data from maps to describe patterns of Earth’s features.</td></tr>
<tr><td>Dimensions</td><td>Analyzing and Interpreting Data
• Analyze and interpret data to make sense of phenomena using logical reasoning.</td><td>ESS2.B: Plate Tectonics and Large-Scale System Interactions
• The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes appear 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.</td><td>Patterns
• Patterns can be used as evidence to support an explanation.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• 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.

Content Limits
• <u>Students do not need to know:</u> the tectonic processes that form Earth’s features.</td></tr>
<tr><td>Science Vocabulary Students Are Expected to Know</td><td colspan="3">Earthquake, Earth’s surface, crust, volcanic eruption, region, barrier, global, local, physical characteristic, ocean, force, landscape, mountain chain, mountain range, continental boundary, sea floor, collide, properties, ocean trench, pressure, topographic map.</td></tr>
<tr><td>Science Vocabulary Students Are Not Expected to Know</td><td colspan="3">Geologic, impact, magnitude, frequency, sediment deposition, ancient, ocean basin, rock layer movement, formation, continental shelf, deform, density, tectonic process, distribution, oceanic crust, plate boundary/collision, seafloor spreading.</td></tr>
<tr><td colspan="4" align="center">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">For this performance expectation, the phenomena are the patterns of features on maps that the student examines. These patterns can sometimes be described with simple statements as shown below, but the actual phenomenon in each case is the pattern on the map. If descriptive statements are used, writers must be careful not to give the pattern or the point of the cluster away to the student.

Some example phenomena for 4-ESS2-2:
• There are active volcanoes in Alaska. There are no active volcanoes near Buffalo, New York. (If this statement were to be used to describe the map, then the students task would have to be something more than simply pointing out that there are volcanoes in Alaska and none near Buffalo, such as figuring out that Alaska is closer to a tectonic plate boundary than is New York.)
• Earthquakes occur often in western South America. Earthquakes almost never occur on the eastern side of the continent. (If this statement were to be used to describe the map, then the student’s task would have to be something more than simply pointing out that there are earthquakes on the eastern side more often than the western, such as figuring out that a plate boundary lies along the eastern coast of South America.)
• Many volcanoes are found in a ring around the Pacific Ocean. There are fewer found on the edges of the Atlantic Ocean. (If this statement were to be used to describe the map, then the students task would have to be something more than simply pointing out that there are many volcanoes around the Pacific and few around the Atlantic, such as figuring out that tectonic plate boundaries surround the Pacific Ocean.)</td></tr>
</table>

	• There are no mountain ranges in Kansas. There are many mountains in Washington State. (If this statement were to be used to describe the map, then the students task would have to be something more than simply pointing out that there are mountains in Washington and none in Kansas, such as figuring out that Washington is closer to a tectonic plate boundary than Kansas.)

This Performance Expectation and associated Evidence Statements support the following Task Demands.
Task Demands
1. Organize, arrange, or summarize map data and/or symbols to highlight/describe patterns of geological features on Earth's surface.**
2. Generate/construct graphs, tables, or assemblages of illustrations and/or labels, of map data that document patterns of geological features on Earth's surface. This may include sorting out distractors.*
3. Use relationships identified in the presented map data to predict the location of geological features on Earth's surface, such as mountain ranges, volcanoes, earthquake foci, and deep ocean trenches.*
4. Identify evidence or patterns in map data that support inferences about the patterns of geological features on Earth's surface.*

*denotes those task demands which are deemed appropriate for use in stand-alone item development

**TD1 may be used in combination with 2, 3, or 4 for stand-alone development.

Performance Expectation	**4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.		
Dimensions	**Obtaining, Evaluating, and Communicating Information** • Obtain and combine information from books and other reliable media to explain phenomena	**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.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
Clarifications and Content Limits	**Clarification Statements** • Examples of renewable energy resources could include: ○ Wind energy ○ Water behind dams ○ Sunlight • Examples of non-renewable energy resources are: ○ fossil fuels ○ fissile materials • Examples of environmental effects could include: ○ Loss of habitat due to dams ○ Loss of habitat due to surface mining ○ Air pollution from burning of fossil fuels **Content Limits** • The following things should be avoided: ○ Casting fossil fuels in a negative light and alternative fuels in a positive light ○ Pros and cons of one energy source vs. another ○ Negative effects of extracting and burning coal ○ Negative effects of fracking ○ Cause and effect of acid rain ○ The term "global warming" ○ <u>Students do not need to know:</u> how natural resources are used to generate energy (scientific specifics regarding how burning coal creates energy/how wind produces energy etc.).		
Science Vocabulary Students are Expected to Know	Recycle, reuse, coal, habitat, pollution, dam, population, atmosphere, oil, resource, fossil fuel, renewable, nonrenewable, conservation		
Science Vocabulary Students are Not Expected to Know	Agricultural, biosphere, mineral, geological, hydrothermal, metal ore, organic, deposition, petroleum, derive, extract, natural gas, oil shale, sustainability, tar sand		
Phenomena			
Context/ Phenomena	Some example phenomena for 4-ESS3-1 • A pipeline is built to transport oil from one location to another. As the oil moves across the landscape it leaks into a river along the way. • The Three Gorges dam was built along the Yangtze River in China to generate electricity. The Chinese dove tree lives along the Yangtze River. Building the dam affected this tree.		

	• Several wind turbines are placed in a field to provide electricity to neighboring areas. To do this, forest land had to be cut down to provide space for the wind turbines. • Oil can be used to generate electricity. Oil can be found under the ocean. Seismic waves are used to locate the oil. Because of this, 100 melon head whales were displaced off the coast of Madagascar.

This Performance Expectation and associated Evidence Statements support the following Task Demands.
Task Demands
1. Organize and/or arrange (e.g., using illustrations and/or labels), or summarize data/information to highlight trends, patterns, or correlations.
2. Express or complete a causal chain explaining how energy and fuel that are derived from natural resources affect the environment. This may include indicating directions of causality in an incomplete model such as a flow chart or diagram, or completing cause and effect chains.*
3. Identify evidence supporting the inference of causation that is expressed in a causal chain.*
4. Identify patterns or evidence in the data that supports inferences about the effects that the usage of certain natural resources has on the environment.
5. Describe, identify, and/or Select information needed to support an explanation.

*denotes those task demands which are deemed appropriate for use in stand-alone item development

<table>
<tr><td>Performance Expectation</td><td colspan="3">4-ESS3-2
Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.</td></tr>
<tr><td>Dimensions</td><td>Constructing Explanations and Designing Solutions
• Generate and compare multiple solutions to a problem based on how well they meet the criteria and constrains of the design solution</td><td>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.

ETS1.B: Designing Solutions to Engineering Problems
• Testing a solution involves investigating how well it performs under a range of likely condition (secondary)</td><td>Cause and Effect
• Cause and effect relationships are routinely identified, tested, and used to explain change.</td></tr>
<tr><td>Clarifications and Content Limits</td><td colspan="3">Clarification Statements
• Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.

Content Limits
• Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.</td></tr>
<tr><td>Science Vocabulary Students are Expected to Know</td><td colspan="3">Environment, nature, recycle, reuse, coal, habitat, pollution, dam, population, atmosphere, oil, resource, fossil fuel, renewable, nonrenewable, conservation</td></tr>
<tr><td>Science Vocabulary Students are Not Expected to Know</td><td colspan="3">Agricultural, biosphere, mineral, geological, hydrothermal, metal ore, organic, deposition, petroleum, derive, extract, natural gas, oil shale, sustainability, tar sand</td></tr>
<tr><td colspan="4">Phenomena</td></tr>
<tr><td>Context/ Phenomena</td><td colspan="3">Engineering performance expectations are built around meaningful design problems rather than phenomena. In this case, the design problems involve reducing the impact of earthquakes, floods, tsunamis, and volcanic eruptions on humans. For this performance expectation, the design problem and competing solutions replace phenomena.

Example phenomena for 4-ESS3-2:
• Hurricanes generate high winds. Several building designs are being considered to construct buildings that could withstand the force of the wind.
• Eyjafjallajokull is an active volcano in Iceland. In preparation for future volcanic activity, several evacuation routes are being considered.</td></tr>
<tr><td colspan="4">This Performance Expectation and associated Evidence Statements support the following Task Demands.</td></tr>
<tr><td colspan="4">Task Demands</td></tr>
<tr><td colspan="4">1. Organize and/or arrange (e.g., using illustrations and/or labels), or summarize data/information to highlight trends, patterns, or correlations in data regarding human activity and natural hazards.</td></tr>
<tr><td colspan="4">2. Express or complete a causal chain explaining how humans can reduce the impact of natural hazards.</td></tr>
</table>

3. Identify evidence supporting the inference of causation that is expressed in a causal chain.
4. Identify patterns or evidence in the data that supports inferences about the ways humans can reduce impacts of natural hazards.
5. Use an explanation to compare the two solutions and select which one is better for addressing the problem of the impact of natural hazards on humans and explain how well each solution meets the criteria and constraints of the design solution.
6. Describe, select, or identify components of competing design solutions.