Fourth Grade Performance Targets

for the
South Carolina College- and Career-Ready Science Standards 2021

For use 2025-2026

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Contents

Purpose and Use

Science is a way of understanding the physical universe using observation and experimentation to explain natural phenomena. Science also refers to an organized body of knowledge that includes core ideas to the disciplines and common themes that bridge the disciplines. As science educators we must take a 3-dimensional approach in facilitating student learning. By addressing content, science and engineering practices and crosscutting concepts, students can have relevant and evidence-based instruction that can help solve current and future problems.

This document is intended as a guide for discerning and describing features of students and their work who have met the stated Performance Expectation (PE). This document is not intended to be read from cover to cover, but to be used, when needed, to support teacher professional learning and curriculum decisions. This is not intended for student use, and thus is not written in student-friendly language. This is not a curriculum or a means to limit instruction in the classroom. Although each PE states a dedicated Science and Engineering Practice (SEP) and Crosscutting Concept (CCC), students will need to use the whole range of SEPs and CCCs to achieve success by the end of instruction.

Three-dimensional science learning requires discipline specific communication skills. This means that effective science learning occurs when students are expected to speak, listen, read, and write in ways that are appropriate to science. With each Performance Target, there are question/sentence stems and terminology to support student discourse about phenomena to help teachers facilitate the acquisition of science discourse. Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding. The terms and stems in this section are intended to provide a baseline for teachers, neither list is exhaustive nor complete.

In addition to the doing (SEP), thinking (CCC), and learning of science knowledge (Disciplinary Core Ideas) outlined here, students will also require a working knowledge of grade-level appropriate tools and techniques of science. Students should know and recognize how scientists and engineers use these tools and techniques, not just identify them. Students should be able to use these tools to gather data, describe how these tools gather data, and/or interpret data sampled from them. These tools and techniques for Fourth Grade include all those previously identified and add or emphasize:

- beaker
- coiled metal spring
- color filter
- compass
- convex lens
- digital scale
- eyedropper
- graduated cylinder
- graduated syringe
- magnifier (hand lens)
- measuring cup
- meter stick
- mirror
- plane mirror
- prism
- ruler (Metric)
- simple electrical circuit
- stream table
- timing device
- tuning fork
- tweezers

Document Updates

August 2025

- All Performance Expectation statements have been reformatted to call out each of the dimensions as follows:
    - Science and Engineering Practice – **bold**
    - Crosscutting Concept – *italicize*
    - Disciplinary Core Idea – regular
- The watermark from previous versions of this resource has been replaced with the wording "For use 2025-2026" on the title page and in the footer. This change was made to improve accessibility of this resource.
- Adjusted formatting and grammar
- 4-PS3-1 edits in observable features
    - Reasoning: added "v. Friction can slow down an object."
- 4-PS3-2 edits in Academic Language
    - Added opaque, translucent, and transparent
- 4-ESS2-2
    - Identifying Relationships
        - Added "Mountain ranges can form where plates are moving toward each other or where plates are moving apart.
- 4-ESS3-2
    - Using Scientific Knowledge to generate design solutions
        - Added severe weather and tsunamis
    - Academic Vocabulary
        - Added early warning systems and tsunami

June 2024

- Updated watermark to 2024-2025
- Adjusted formatting and grammar
- 4-PS4-1 edits in observable features.
    - Components of a model: "motion of objects" replaced with "amount of energy".
    - Relationships: "object" replaced with "energy", "motion" replaced with "amount", "object" replaced with "energy",
    - Connections: "object" replaced with "energy", "motion" replaced with "amount", "object" replaced with "energy", added statement "The higher the amplitude, the greater the energy.", replaced "motion" with "amount", and replaced "an object" with "energy".

PS3 – Energy

4-PS3-1. Use evidence to construct an explanation relating the speed of an object *to the energy of that object*.

State Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
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. Use evidence (for example: measurements, observations, patterns) to construct an explanation.	**PS3.A: Definitions of Energy** The faster a given object is moving, the more energy it possesses.	**Energy and Matter** Energy can be transferred in various ways and between objects.

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

1. **Articulating the explanation of phenomena**
    a. Students articulate a statement that relates phenomenon to a scientific idea, including that the speed of an object is related to the energy of the object (for example: the faster an object moves, the more energy it possesses).
    b. Students use evidence and reasoning to construct an explanation for a phenomenon.
2. **Evidence**
    a. Students identify and describe the relevant evidence for the explanation, including:
        i. The relative speed of the object (for example: faster vs. slower objects).

ii. The amount of energy of the object, as determined by a transfer of energy from that object:
    1. the amount of sound produced in a collision,
    2. the amount of heat produced when objects rub together (friction),
    3. relative speed of a ball that was stationary (not moving) followed by a collision with a moving object,
    4. the distance a stationary object is moved.

3. **Reasoning**
    a. Students use reasoning to connect the evidence to support an explanation for a phenomenon. Students construct an explanation of their reasoning that includes:
        i. Motion can indicate the energy of an object.
        ii. The faster an object moves, the more observable impact it can have on another object.
        iii. Faster objects have a larger impact on their surroundings than objects moving more slowly, they have more energy due to speed.
        iv. The speed of an object is related to the energy of the object.
        v. Friction can slow down an object.

4-PS3-1 Academic Language

Question/Sentence Stems

- In order to conclude that _____ caused _____, the following evidence is needed _____.
- The flow of energy causes _____ to occur in the system.
- In this system, energy is entering by _____, doing _____ in the system, and leaving the system by _____.
- The energy for _____ is from _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- collide/collision
- control
- distance
- energy
- fast
- force
- friction
- heat
- impact
- minute
- motion
- problem
- relationship
- slow
- sound
- speed
- strong
- temperature
- thermometer
- time
- transfer
- variable
- weak

4-PS3-2. Make observations to provide evidence that *energy can be transferred* from place to place by sound, light, heat, and electric currents.

> ***State Assessment Boundary:*** Assessment does not include quantitative measurements of energy or the difference between transferring and transforming energy.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**PS3.A: Definitions of Energy** Energy can be moved [transferred] 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.	**Energy and Matter** Energy can be transferred in various ways and between objects.

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

1. **Identifying the phenomenon under investigation**
    a. From an investigation plan, students describe a phenomenon under investigation, which includes the following ideas:
        i. The transfer of energy, including:
            1. Collisions between objects.
            2. Light traveling from one place to another.
            3. Electric currents producing motion, sound, heat, or light.
            4. Sound traveling from one place to another.
            5. Heat passing from one object to another.
            6. Motion, sound, heat, and light causing a different type of energy to be observed after an interaction
                a. when two objects collide, one object may slow down or stop, the other object may speed up;
                b. a sound may cause the movement of an object;
                c. the energy associated with the motion of an object
                d. an electrical current (for example: a simple circuit with a fan, light bulb, etc.)
    b. Students describe the purpose of an investigation, which includes providing evidence for an explanation of a phenomenon, including the idea that energy can be transferred from place to place by:
        i. moving objects,
        ii. sound,
        iii. light,
        iv. heat, and
        v. electric currents.
2. **Identifying the evidence to address the purpose of the investigation**
    a. From an investigation plan, students describe the data to be collected that will serve as the basis for evidence, including:
        i. The motion and collision of objects before and after an interaction (for example: when a given object is moving fast, it can move another object farther than when the same object is moving more slowly).
        ii. The relative presence of sound, light, or heat (including in the surrounding air) before and after an interaction (for example: shining a light on an object can increase the temperature of the object; a sound can move an object).
        iii. The presence of electric currents flowing through wires causally linking one form of energy output (for example: a moving object) to another form of energy output (for example: another moving object; turning on a light bulb).

b. Students explain evidence of their observations of energy transfer from place to place in the form of light, sound, heat, and motion. For example:
    i. Evidence of energy transfer by electric currents. (For example, this could be demonstrated by the glowing of a light bulb or the spinning of a fan when a simple circuit is completed. If the circuit switch is opened, the glowing light bulb will stop glowing or the spinning fan will stop spinning.)
    ii. Evidence of energy transfer by heat. (For example, this could be demonstrated by exposing an object to a heat lamp or sunlight and measuring its temperature. Then the light source is blocked, and temperature is measured again. The temperature of an object will be lower when the heat source is blocked.)
    iii. Evidence of energy transfer by motion and sound. (For example, this could be demonstrated by a moving ball hitting a stationary ball. When the moving ball hits the stationary ball, a sound will occur).

3. Planning the investigation

a. From an investigation plan, students identify and describe how the data will be observed and recorded, including the tools and methods for collecting data on:
    i. The motion and collision of objects, including any sound or heat producing the motion/collision, or produced by the motion/collision.
    ii. The presence of energy in the form of sound, light, or heat in one place because of sound, light, or heat in a different place.
    iii. The presence of electric currents in wires and the presence of energy (in the form of sound, light, heat, or motion resulting from the flow of electric currents through a device).
b. Students describe the
    i. independent variable,
    ii. dependent variable,
    iii. number of trials,
    iv. controlled variables, and
    v. experimental set up.

4. Collecting the data

a. Students make and record observations according to the given investigation plan to provide evidence that:
    i. Energy is present whenever there are moving objects, sound, light, or heat.

ii. That energy has been transferred from place to place, for example,
    1. a bulb in a circuit is not lit until a switch is closed and it lights, indicating that energy is transferred through electric current in a wire to light the bulb;
    2. a stationary ball is struck by a moving ball, causing the stationary ball to move and the moving ball to slow down, indicating that energy has been transferred from the moving ball to the stationary ball.

4-PS3-2 Academic Language

Question/Sentence Stems

- The flow of energy causes _____ to occur in the system.
- The energy is entering the system by _____.
- The energy is leaving the system by _____.
- In this system, energy is entering by _____, doing _____ in the system, and leaving the system by _____.
- The energy for _____ is from _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- circuit
- collide/collision
- distance
- control
- electric current
- energy
- energy transfer
- force
- friction
- heat
- heat transfer
- light
- motion
- opaque
- problem
- sound
- speed
- temperature
- thermometer
- time
- translucent
- transparent
- transfer
- variable
- vibration

4-PS3-3. Ask questions and predict outcomes about *the changes in energy* that occur when objects collide.

Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.

State Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object (acceleration) or quantitative measurements of energy.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
Asking Questions and Defining Problems Asking questions and defining problems in grades 3-5 builds on grades K-2 experiences and progresses to specifying qualitative relationships. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause-and-effect relationships.	**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.	**Energy and Matter** Energy can be transferred in various ways and between objects.

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

1. **Addressing phenomena of the natural world**
    a. Students ask questions about the changes in energy that occur when objects collide, the answers to which would clarify:
        i. A qualitative measure of energy (for example: relative motion, relative speed, relative brightness) of the object before the collision.

ii. The mechanism of energy transfer during the collision, including:
    1. The transfer of energy by contact forces between colliding objects resulting in a change in the motion of the objects.
    2. The transfer of energy to the surrounding air when objects collide resulting in sound and heat.

b. Students predict reasonable outcomes about the changes in energy that occur after objects collide, based on patterns linking object collision and energy transfer between objects and the surrounding air.

2. Identifying the scientific nature of the question

a. Students ask questions that can be investigated within the scope of the classroom or an outdoor environment.

4-PS3-3 Academic Language

Question/Sentence Stems

- Energy transformations take place during _____.
- The energy for _____ is from _____.
- When I/we change _____ in the system model, it transfers to _____ energy.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- collide/collision
- constant
- direction
- distance
- energy
- energy transfer
- force
- heat
- light
- motion
- problem
- sound
- speed
- variable

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts *energy from one form to another*.

> ***Clarification Statement:*** 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, and time to design the device.
> ***State Assessment Boundary:*** Devices should be limited to those that convert motion energy to electric energy or use stored energy (batteries) to cause motion or produce light or sound.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
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. Apply scientific ideas to solve design problems.	**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 and Delimiting an Engineering Problem** 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. **ETS1.B: Developing Possible Solution** 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. **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers improve existing technologies or develop new ones. (*secondary*)	**Energy and Matter** Energy can be transferred in various ways and between objects.

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

1. **Using scientific knowledge to generate design solutions**
    a. Students collaboratively design a solution that converts energy from one form to another. In the design, students:
        i. Specify the initial and final forms of energy (for example: electrical energy, motion, light).
        ii. Identify the device by which the energy will be transformed (for example: a light bulb to convert electrical energy into light energy, a motor to convert electrical energy into energy of motion).
2. **Describing criteria and constraints, including quantification when appropriate**
    a. Students describe the given criteria and constraints of the design, which include:
        i. Criteria:
            1. The initial and final forms of energy.
            2. Description of how the solution functions to transfer energy from one form to another.
        ii. Constraints:
            1. The materials available for the construction of the device.
            2. Safety considerations.
3. **Evaluating potential solutions**
    a. Students evaluate the proposed solution according to how well it meets the specified criteria and constraints of the problem.
4. **Modifying the design solution**
    a. Students test the device and use the results of the test to address problems in the design or improve its functioning.

4-PS3-4 Academic Language

Question/Sentence Stems

- The flow of energy causes _____ to occur in the system.
- Energy transformations take place during _____.
- _____ are some similarities and differences among the solutions.
- I/We can optimize my solution by _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- circuit
- constant
- constraints
- conversion
- convert
- criteria/criterion
- data
- electrical energy
- energy
- generator
- heat energy
- initial
- light energy
- mechanical energy
- models
- modify
- motion
- optimizing solutions
- problem
- properties
- solar cell
- solutions
- sound energy
- temperature
- test
- thermometer
- transfer
- variable

PS4 – Waves and their Applications in Technologies for Information Transfer

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 include diagrams, analogies, or physical models using (but not limited to) stringed beads, rubber bands, wire, or yarn to illustrate amplitude of waves and wavelength.

State Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

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 analogy, example, or abstract representation to describe a scientific principle.	**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).	**Patterns** Similarities and differences in patterns can be used to sort and classify natural phenomena.

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

1. **Components of the model**
    a. Students develop a model (for example: diagrams, analogies, examples, abstract representations, physical models, mental models) to make sense of a phenomenon that involves wave properties (limited to amplitude and wavelength). In the model, students identify the relevant components, including:
        i. wave amplitude,
            1. crest
            2. trough
        ii. baseline,
        iii. wavelength, and
        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.
        ii. Waves can cause an object to move.
        iii. The motion of an object 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 propagated (for example: by disturbing surface water or shaking a rope or spring).
        iii. The repeating pattern produced as a wave is propagated.
    b. Students use a model to describe that waves can vary in terms of amplitude and wavelength and describe how this might affect the motion of an object.
    c. Students identify similarities and differences in patterns of waves and use these patterns to describe simple relationships involving:
        i. wave amplitude,
        ii. wavelength, and
        iii. the motion of an object.

4-PS4-1 Academic Language

Question/Sentence Stems

- When observing patterns in the data _____ are some differences.
- When observing patterns in the data _____ are some similarities.
- I/We can observe the pattern of _____ presented in the data collected.
- The pattern seen in the collected data allows me to conclude that _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- amplitude
- baseline
- crest
- distance
- disturbance
- energy
- force
- matter
- motion
- peak
- period
- propagate
- trough
- wave
- wave property
- wavelength

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye *allows objects to be seen*.

> ***State Assessment Boundary:*** Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.

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 to describe phenomena.	**PS4.B: Electromagnetic Radiation** An object can be seen when light reflected from its surface enters the eyes.	**Cause and Effect** Cause-and-effect relationships are routinely identified.

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

1. **Components of the model**
    a. Students develop a model to make sense of a phenomenon involving the relationship between light reflection and visibility of objects. In the model, students identify the relevant components, including:
        i. light (including the light source),
        ii. objects,
        iii. the path that light follows, and
        iv. the eye.
2. **Relationships**
    a. Students identify and describe causal relationships between the components, including:
        i. Light reflects off objects, and then can travel and enter the eye.
        ii. Light enters the eye, allowing objects to be seen.
        iii. Objects can be seen only if light follows a path between a light source, the object, and the eye.
3. **Connections**
    a. Students use the model to describe that in order to see objects that do not produce their own light, light must reflect off the object and into the eye.

b. Students use the model to describe the effects of the following on seeing an object:
    i. removing, blocking, or changing the light source (for example: a dimmer light),
    ii. closing the eye, and
    iii. changing the path of the light. Including but not limited to:
        1. using mirrors to direct the path of light to allow the visualization of a previously unseen object, or
        2. changing the position in which the object can be seen, using an opaque or translucent barrier between
            a. the light source and the object, or
            b. the object and the eye to change the path light follows and the visualization of the object.

4-PS4-2 Academic Language

Question/Sentence Stems

- If _____ happens, I/we predict that _____ will occur.
- Even though I cannot see _____, it explains why _____ is happening.
- When I/we change _____ in the system model, _____ is affected.
- The evidence _____ presented in the system model supports the claim that _____ causes _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- barrier
- energy
- eye
- illuminate
- light
- light source
- light waves
- luminous
- mirror
- opaque
- path of light
- reflect/reflection
- surface
- translucent
- transparent
- visible/visibility

4-PS4-3. Generate and compare multiple solutions *that use patterns* to transmit information.

Clarification Statement: Examples of solutions include drums sending coded information through sound waves, using a grid of 0s and 1s representing black and white to send information about a picture, QR codes, barcodes, and using Morse code to send text. The coding method does not need to be electronic or digital, and the code should only be two possible values such as on/off, 0/1, black/white.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
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.	**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. When in digitized form, information can be recorded, stored for future recovery, and transmitted over long distances without significant degradation of the wave. **ETS1.C: Optimizing the Design Solution** Different solutions need to be tested in order to determine which of the best solves the problem, given the criteria and the constraints. **ETS2.A: Interdependence of Science, Engineering, and Technology** Knowledge of relevant scientific concepts and research findings is important in engineering.	**Patterns** Similarities and differences in patterns can be used to sort and classify designed products.

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

1. **Using scientific knowledge to generate design solutions**
    a. Students generate at least two design solutions, for a given problem, that use patterns to transmit a given piece of information (for example: picture, message). Students describe how the design solution is based on:
        i. knowledge of digitized information transfer (for example: information can be converted from a sound wave into a digital signal such as patterns of 0s and 1s and vice versa; visual or verbal messages can be encoded in patterns of flashes of light to be decoded by someone else across the room), and
        ii. ways that devices convert and transmit information (for example: cell phones convert sound waves into digital signals for transmission over long distances, and convert the digital signals back into sound waves; a picture or message can be encoded using light signals to transmit the information over a long distance).
2. **Describing criteria and constraints, including quantification when appropriate**
    a. Students describe the given criteria for the design solutions, including:
    b. the accuracy of the final transmitted information and that digitized information (patterns) transfer is used.
    c. Students describe the given constraints of the design solutions, including:
        i. the distance over which information is transmitted,
        ii. safety considerations, and
        iii. available materials.
3. **Evaluating potential solutions**
    a. Students compare the proposed solutions based on how well each meets the criteria and constraints.
    b. Students identify similarities and differences in the types of patterns used in the solutions to determine whether some ways of transmitting information are more effective than others at addressing the problem.

4-PS4-3 Academic Language

Question/Sentence Stems

- _____ are some similarities and differences among the solutions.
- _____ are patterns that I/we observe in the data from testing my solutions.
- The pattern seen in the collected data allows me to conclude that _____.
- The observed patterns of _____ demonstrate the cause of the failure in the design solution.
- I/We can optimize my solution by _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- barcode
- binary
- code
- code
- constraints
- convert
- criteria/criterion
- data
- decode
- digital
- digitized information
- encode/encrypt
- models
- Morse code
- optimizing solutions
- pattern
- problem
- QR code
- solutions
- test
- transmit
- wave

LS1 – From Molecules to Organisms: Structures and Processes

4-LS1-1. Construct an argument that plants and animals *have internal and external structures that function together in a system* to support survival, growth, behavior, and reproduction.

> ***Clarification Statement:*** Examples of structures could include thorns, roots, heart, lungs, or skin.
>
> ***State Assessment Boundary:*** Assessment does not include microscopic structures within plant and animal systems.

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). Construct an argument with evidence, data, and/or a model.	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**Systems and System Models** A system can be described in terms of its components and their interactions.

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

1. **Supported claims**
    a. Students make a claim to be supported about a phenomenon. In the claim, students include the idea that plants and animals have internal and external structures that function together as part of a system to support survival, growth, behavior, and reproduction.
2. **Identifying scientific evidence**
    a. Students describe evidence, including:
        i. The internal and external structures of selected plants and animals.
        ii. The primary functions of those structures.
3. **Evaluating and critiquing evidence**
    a. Students determine the strengths and weaknesses evidence, including whether the evidence is relevant and sufficient to support a claim about the role of internal and external structures of plants and animals in supporting survival, growth, behavior, and/or reproduction.

4. **Reasoning and synthesis**
    a. Students use reasoning to connect relevant and appropriate evidence and construct an argument that includes the idea that plants and animals have structures that, together, support survival, growth, behavior, and/or reproduction. Students describe a chain of reasoning that includes:
        i. Internal and external structures serve specific functions within plants and animals (for example: the heart pumps blood to the body, thorns discourage predators).
        ii. The functions of internal and external structures can support survival, growth, behavior, and/or reproduction in plants and animals (for example: the heart pumps blood throughout the body, which allows the entire body access to oxygen and nutrients; thorns prevent predation, which allows the plant to grow and reproduce).
        iii. Different structures work together as part of a system to support survival, growth, behavior, and/or reproduction (for example: the heart works with the lungs to carry oxygenated blood throughout the system; thorns protect the plant, allowing reproduction via stamens and pollen to occur).

4-LS1-1 Academic Language

Question/Sentence Stems

- The _____ (structure) in a(n) _____ (organism) allow the _____ (organism) to _____(function).
- _____ (behavior) helps the _____ (organism) to function because _____.
- The _____ (structure) help the _____ (organism) to function because _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- behavior
- camouflage
- external structure
- function
- growth
- internal structure
- organism
- reproduction
- structure
- survive/survival
- system
- variation

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.

Clarification Statement: Emphasis is on systems of information transfer.

State Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.

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 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.

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

1. **Components of the model**
    a. From a model, students identify and describe the relevant components for testing interactions concerning the functioning of a given natural system, including:
        i. different types of information about the surroundings (for example: sound, light, odor, temperature),
        ii. sense receptors that detect different types of information from the environment,
        iii. brain, and
        iv. animals' actions/responses.
2. **Relationships**
    a. Students describe the relationships between components in the model, including:
        i. Different types of sense receptors detect specific types of information within the environment.
        ii. Sense receptors send information about the surroundings to the brain.
        iii. Information that is transmitted to the brain by sense receptors can be processed immediately as perception of the environment and/or stored as memories.

iv. Immediate perceptions or memories processed by the brain influence an animal's action or responses to features in the environment.

3. Connections

a. Students use the model to describe that:
   i. Information in the environment interacts with animal behavioral output via interactions mediated by the brain.
   ii. Different types of sensory information are relayed to the brain via different sensory receptors, allowing experiences to be perceived, stored as memories, and influence behavior. For example:
      1. Sense of smell could help an animal remember an odor.
      2. Sense of vision could help an animal remember a food source or predator.
   iii. Sensory input, the brain, and behavioral output are all parts of a system that allow animals to engage in appropriate behaviors.

b. Students use the model to test interactions involving sensory perception and its influence on animals' actions/responses in a natural system, including interactions between:
   i. information in the environment,
   ii. different types of sense receptors,
   iii. perception and memory of sensory information, and
   iv. animals' actions/responses.

4-LS1-2 Academic Language

Question/Sentence Stems

- The key components of the system are _____.
- In the model of the system, I/we notice _____.
- In the system, _____ and _____ work together to _____.
- The _____ (animal) uses _____, _____, and _____ (system) to _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- brain
- ear
- environment
- eye
- feel
- hear
- heat
- instinct/instinctive
- light
- memory
- nose
- odor
- perceive/perception
- processing information
- receiving information
- responding to information
- sense
- sense receptors
- sensory input
- sight/vision
- skin
- sound
- stimulus/stimuli
- system
- taste
- temperature
- tongue
- touch
- visible/visibility

ESS1 – Earth's Place in the Universe

4-ESS1-1. Identify evidence *from patterns* in rock formations and fossils in rock layers **to support an explanation** for changes in a landscape over time.

Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.

State Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Identify the evidence that supports particular points in an explanation.	**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.	**Patterns** Patterns can be used as evidence to support an explanation.

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

1. **Articulating the explanation of phenomena**
    a. Students identify the explanation for a phenomenon, which includes a statement about the idea that landscapes change over time.
    b. From an explanation, students identify the specific aspects of the explanation they are supporting with evidence.

2. **Evidence**
    a. Students identify the evidence relevant to supporting the explanation, including local and regional patterns in the following:
        i. Different rock layers found in an area (for example: rock layers taken from the same location show marine fossils in some layers and land fossils in other layers).
        ii. Ordering of rock layers (for example: layer with marine fossils is found below layer with land fossils).
        iii. The presence of fossils (for example: shells, land plants) in specific rock layers.
        iv. The occurrence of events (for example: earthquakes) due to Earth forces.
3. **Reasoning**
    a. Students use reasoning to connect the evidence to support points of the explanation, including the identification of a specific pattern of rock layers and fossils (for example: a rock layer containing shells and fish below a rock layer containing fossils of land animals and plants is a pattern indicating that, at one point, the landscape had been covered by water and later it was dry land).
    b. Students describe reasoning for how the evidence supports points of the explanation, including:
        i. Specific rock layers in the same location show specific fossil patterns (for example: some lower rock layers have marine fossils, while some higher rock layers have fossils of land plants).
        ii. Since lower layers were formed first then covered by upper layers, this pattern indicates that the landscape of the area was transformed into the landscape indicated by the upper layer (for example: lower marine fossils indicate that, at one point, the landscape was covered by water, and upper land fossils indicate that later the landscape was dry land).
        iii. Irregularities in the patterns of rock layers indicate disruptions due to Earth forces (for example: 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).

4-ESS1-1 Academic Language

Question/Sentence Stems

- The pattern(s) I/we observe from the evidence of _____ shows/proves _____.
- _____ has changed over time, because _____.
- I/We can observe (notice) the pattern of _____ presented in the data collected.
- Based on _____ about the rock layers, I/we can tell that _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- canyon
- climate
- deposition/deposit
- earthquake
- environment
- erosion
- fault
- folding
- fossil
- geologic column
- geology/geologic
- landscape
- marine
- rock
- rock layers
- sediment
- sedimentary rock
- topography
- weathering

ESS2 – Earth's Systems

4-ESS2-1. Make observations and/or measurements to provide evidence of *the effects of* weathering or the rate of erosion by water, ice, wind, or vegetation.

> ***Clarification Statement:*** Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow. State Assessment Boundary: Assessment is limited to a single form of weathering or erosion.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3-5 builds on K-2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **ESS2.E: Biogeology** Living things affect the physical characteristics of their regions.	**Cause and Effect** Cause-and-effect relationships are routinely identified, tested, and used to explain change.

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

1. **Identifying the phenomenon under investigation**
    a. Students identify a phenomenon to investigate, which includes the following idea: the effects of weathering or the rate of erosion of Earth's materials.
    b. From an investigation plan, students identify the purpose of the investigation, which includes providing evidence for an explanation of the phenomenon.
2. **Identifying the evidence to address the purpose of the investigation**
    a. From an investigation plan, students describe the data to be collected that will serve as the basis for evidence.

b. From an investigation plan, students describe the evidence needed, based on observations and/or measurements made during the investigation, including:
    i. The change in the relative steepness of slope of the area (for example: no slope, slight slope, steep slope).
    ii. The kind of weathering or erosion to which the Earth material is exposed.
    iii. The change in the shape of Earth materials as the result of weathering or the rate of erosion by one of the following:
        1. motion of water,
        2. ice (including melting and freezing processes),
        3. wind (speed and direction), and
        4. vegetation.
c. Students describe how the data to be collected will serve as evidence to address the purpose of the investigation, including to help identify cause and effect relationships between weathering or erosion, and Earth materials.

3. Planning the investigation

a. From an investigation plan, students describe how the data will be collected, including:
    i. the relative speed of the flow of air or water,
    ii. the number of freeze-thaw cycles, and
    iii. the number and types of plants growing in the earth material.

4-ESS2-1 Academic Language

Question/Sentence Stems

- _____ caused the patterns I/we a/are observing. I/We know this because _____.
- If _____ happens, I/we predict that _____ will occur.
- Even though I/we cannot see _____, it explains why _____ is happening.
- In this situation, even a small change of _____ can cause a big effect of _____.
- The evidence _____ presented in the scenario supports the claim that _____ causes _____.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- angle of slope
- balance
- biosphere
- deposition
- effects
- erosion
- freeze-thaw cycle
- geosphere
- glacier
- graduated cylinder
- gravity
- heat-cool cycle
- hydrosphere
- protractor
- rate of flow
- sediment
- stream table
- temperature
- vegetation
- volume
- weathering
- weight
- wind speed

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, or earthquakes.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
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.	**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.	**Patterns** Patterns can be used as evidence to support an explanation.

*Note: The term "continental boundary" is more correctly described as "plate boundary."

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

1. **Organizing data**
    a. Students organize data using graphical displays (for example: table, chart, graph) from maps of Earth's features (for example: locations of mountains, plate 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.
            1. Mountain ranges can form where plates are moving toward each other or where plates are moving apart.

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's features occur in patterns that reflect information about how they are formed or occur (for example: 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-ESS2-2 Academic Language

Question/Sentence Stems

- I/We can observe (notice) the pattern of _____ presented in the data collected.
- The observed pattern supports the conclusion that _____ is caused by _____, because _____.
- The following mathematical representation could help me to identify patterns in _____ data.
- I/We can classify (group) the following patterns of _____ to create groups that are like each other based on the _____ attributes.

Terminology to Support Student Discourse about Phenomena

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- boundary
- compass rose
- continent
- contour line
- earthquake
- elevation
- epicenter
- hot spot
- landform
- lava
- magma
- mountain chain
- mountain range
- ocean
- ocean floor
- ocean trench
- plate boundary
- relief map
- sea level
- topographic
- topographic map
- topography
- volcano

ESS3 – Earth and Human Activity

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources *and how their uses affect the environment*.

> ***Clarification Statement:*** Examples of renewable resources could include wind energy, water behind dams, and sunlight; non- renewable resources are fossil and nuclear fuels.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
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.	**ESS3.A: Natural Resources** All materials, 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. **ETS2.A: Interdependence of Science, Engineering, and Technology** Knowledge of relevant scientific concepts and research findings is important in engineering. **ETS2.B: 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.	**Cause and Effect** Cause-and-effect relationships are routinely identified and used to explain change.

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

1. **Obtaining information**
    a. Students gather information from books and other reliable media about energy resources and fossil fuels (for example: fossil fuels, solar, wind, water, nuclear), including:
        i. how energy and fuels are derived from natural sources,
        ii. comparing the different ways energy is obtained from natural resources,
        iii. how the natural resources address human energy needs, and
        iv. 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 an 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 cause and effect relationships between:
        i. Energy resources and the environmental effects of using that energy.
        ii. The role of technology in extracting and using an energy resource.

4-ESS3-1 Academic Language

Question/Sentence Stems

- I/We can observe (notice) the pattern of _____ presented in the information collected.
- The observed pattern supports the conclusion that _____ is caused by _____, because _____.
- The evidence _____ presented in the scenario supports the claim that _____ causes _____.
- Even though I/we cannot see _____, it explains why _____ is happening.

Terminology to Support Student Discourse about Phenomena

*Teaching words or concepts in isolation or prior to experiences that give context (frontloading) deprives students of sense-making opportunities that lead to a greater depth of conceptual understanding.

- dam
- fossil fuel
- habitat loss
- hydroelectric energy
- natural resources
- non-renewable energy
- nuclear energy/fuel
- oil
- petroleum
- pollution
- renewable energy
- solar energy
- solar panel
- turbine
- wind energy
- windmill

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 earthquake or hurricane resistant buildings, improving the monitoring of tornadic or volcanic activity, and constructing waterways for floodwaters.

State Assessment Boundary: Assessment is limited to earthquakes, floods, hurricanes, tornadoes, and coastal erosion.

Science and Engineering Practices	Disciplinary Core Ideas	*Crosscutting Concepts*
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3-5build 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. Use evidence in creating multiple solutions to design problems. Generate and compare multiple solutions	**ESS3.B Natural Hazards** A variety of hazards result from natural processes (for example:, earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. **ETS1.B: Developing Possible Solutions** Testing a solution involves investigating how well it performs under a range of likely conditions. Communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. **ETS2.B: 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.	**Cause and Effect** Cause-and-effect relationships are routinely identified, tested, and used to explain change.

Observable features of student performance by the end of course:

1. **Using scientific knowledge to generate design solutions**
    a. Students use scientific information about Earth processes and their effects to design at least two solutions that reduce the negative impact of a natural process on humans (for example: earthquake, volcano, tornado, flood, coastal erosion, severe weather, and tsunamis).
2. **Describing criteria and constraints, including quantification when appropriate**
    a. Students identify and describe the criteria (desirable features) for a successful solution to the problem.
    b. Students describe the constraints, including:
        i. time,
        ii. cost, and
        iii. materials.
3. **Evaluating potential solutions**
    a. Students describe the design solutions in terms of how each alters the effect of the Earth process on humans.
    b. Students evaluate each design solution based on whether and how well it meets each of the given criteria and constraints.
    c. Students compare the design solutions to each other based on how well each meets the given criteria and constraints.

4-ESS3-2 Academic Language

Question/Sentence Stems

- _____ caused the patterns being observed. I/we know this because _____.
- If _____ happens, I/we predict that _____ will occur.
- In this situation, even a small change of _____ can cause a big effect of _____.
- In order to conclude that _____ caused _____, the following evidence is needed _____.
- Testing the design can provide evidence that _____ causes _____ because _____.
- _____ are some similarities and differences among the solutions.
- I/We can optimize my solution by _____.

Terminology to Support Student Discourse about Phenomena

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- base isolation
- constraints
- criteria/criterion
- data
- early warning systems
- earthquake
- earthquake rod
- effects
- estuary
- evacuate
- flood
- floodplain
- hurricane
- impact
- levee
- models
- modify
- natural disaster
- natural hazard
- optimizing solutions
- problem
- reduce
- reinforce
- restore
- seawall
- shear wall
- solutions
- stilts
- storm surge
- test
- tornado
- tsunami

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