Washington Comprehensive Assessment of Science

Test Design

&

Item Specifications

Grade 5

Washington Office of Superintendent of
PUBLIC INSTRUCTION

Developed by OSPI in collaboration with WestEd

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Purpose Statement

The purpose of the Washington Comprehensive Assessment of Science (WCAS) is to measure the level of science proficiency that Washington students have achieved based on the *Washington State 2013 K–12 Science Learning Standards*. The standards are the *Next Generation Science Standards* (NGSS) and are organized into four domains: Physical Sciences; Life Sciences; Earth and Space Sciences; and Engineering, Technology, and the Applications of Science. Each domain has three-dimensional performance expectations that integrate science and engineering practices, disciplinary core ideas, and crosscutting concepts. The assessments were first administered in grades 5, 8, and 11 for federal and state accountability purposes in spring 2018.

This item specifications document describes how the item clusters (stimuli and items) and standalone items for the WCAS assessments are developed to assess the NGSS (referred to as "the standards" in the remainder of this document) and includes the second publicly released drafts of the item specifications for the WCAS.

The item specifications are based on the Performance Expectations (PEs) in the standards. The item specification for an individual PE describes how students can demonstrate understanding of the PE on the WCAS. The item specifications are updated annually based on input from Washington educators. Each draft will be accompanied by a modifications log that is updated at each subsequent publication.

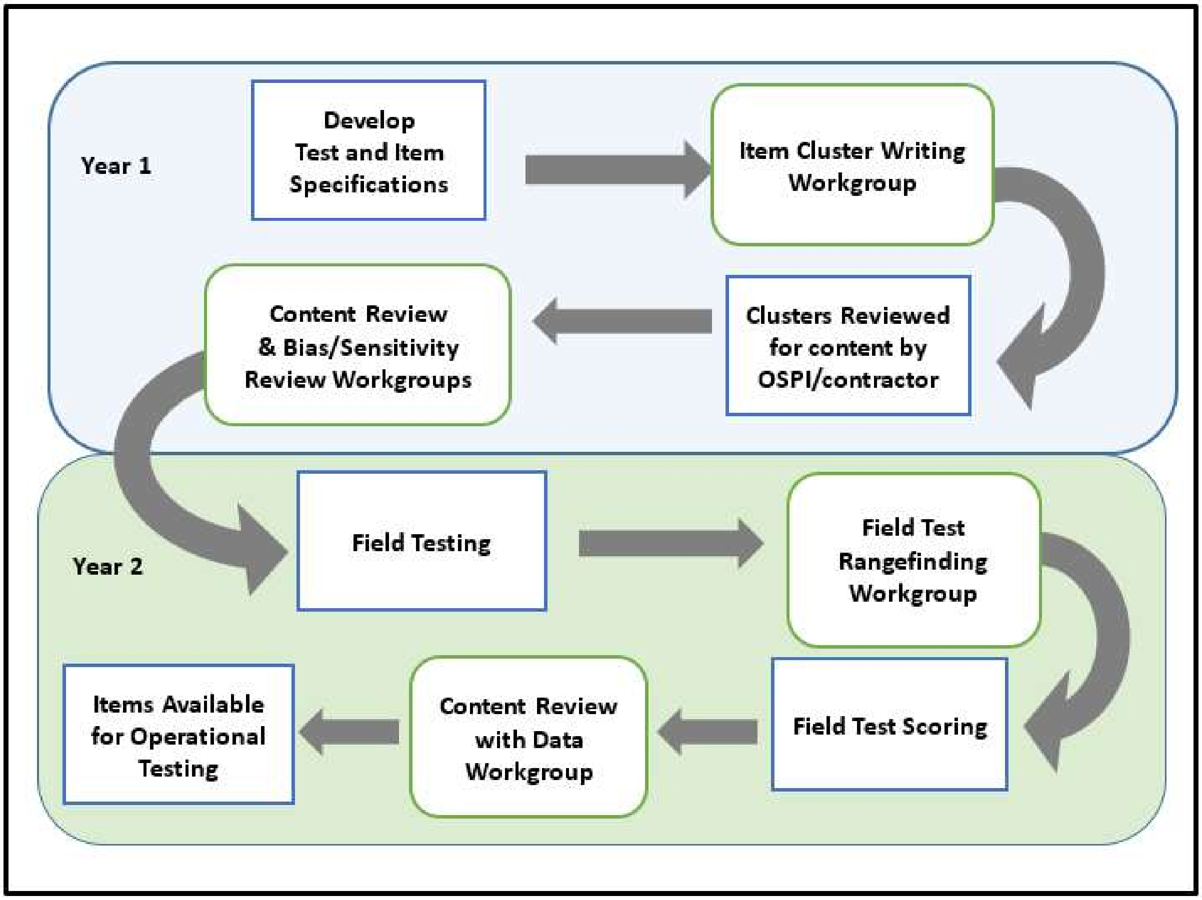
Assessment Development Cycle

The WCAS is written by trained science educators from Washington. Each item cluster and standalone item is planned by the Office of Superintendent of Public Instruction (OSPI) Science Assessment Development Team in conjunction with an educational assessment contractor and then written, reviewed, and revised by educators during an item cluster writing workshop. From there, the development process involves formal reviews with science educators for all clusters and standalone items and for the scoring criteria in the rubrics of technology-enhanced and short-answer items. The development process assures the assessment contains items that meet the following criteria:

- Include authentic stimuli describing scientific phenomena that are grade-level appropriate
- Achieve tight alignment to a specified two- or three-dimensional item specification
- Provide a valid measure of a specified science learning standard
- Include item scoring rubrics that can be validly applied
- Include technology-enhanced and short-answer items that can be reliably scored

The Science Assessment Development Cycle flowchart summarizes the two-year process of review and field testing that precedes clusters and standalone items being used on an operational test.

Science Assessment Development Cycle



OSPI solicits critical input from Washington educators by means of four key workgroups each year:

In the **Item Cluster Writing Workgroup**, teams of two to three educators write stimuli, items, and rubrics designed to validly measure student understanding of the standards.

In the **Content Review Workgroup**, educators review the products of the item cluster writing workgroup to ensure that every stimulus, item, and rubric is scientifically accurate and gathers appropriate evidence about student understanding and application of the standards. At the same time, a separate committee of community members reviews the items and stimuli for any bias or sensitivity issues.

In the **Field Test Rangefinding Workgroup**, educators look at a range of student responses to short answer items and decide how to score each response. This educator workgroup refines scoring rubrics and produces the materials that are used to score the field test items.

In the **Content Review with Data Workgroup**, educators use item performance data, as well as participants' science content knowledge, to decide whether the item should become available for operational testing.

Universal Design

Each phase of the test development process reflects the integration of Universal Design principles with sound measurement theory, current research, and best practices in assessment. These practices result in assessments that are valid, reliable, fair, free from bias, and accessible to all students, including English language learners and students with disabilities.

Universal Design provides a framework for maximizing student participation in an assessment and for providing all students with an opportunity to truly demonstrate what they know and are able to do. The National Center on Educational Outcomes has identified seven elements of universally designed assessments: inclusive assessment population; precisely defined constructs; accessible, non-biased items; amenability to accommodations; simple, clear, and intuitive instructions and procedures; maximum readability and comprehensibility; and maximum legibility (Thompson, Johnstone, Anderson, & Miller, 2005).

Structure of the Test

The WCAS is composed of item clusters and standalone items aligned to the PEs. Advisory groups composed of national education experts, science assessment experts, and science educators recommend the item cluster structure for large-scale assessment of the standards because item clusters involve significant interaction of students with stimulus materials leading to a demonstration of the students' application of knowledge and skills. Standalone items increase the PE coverage that can be achieved in a single test administration.

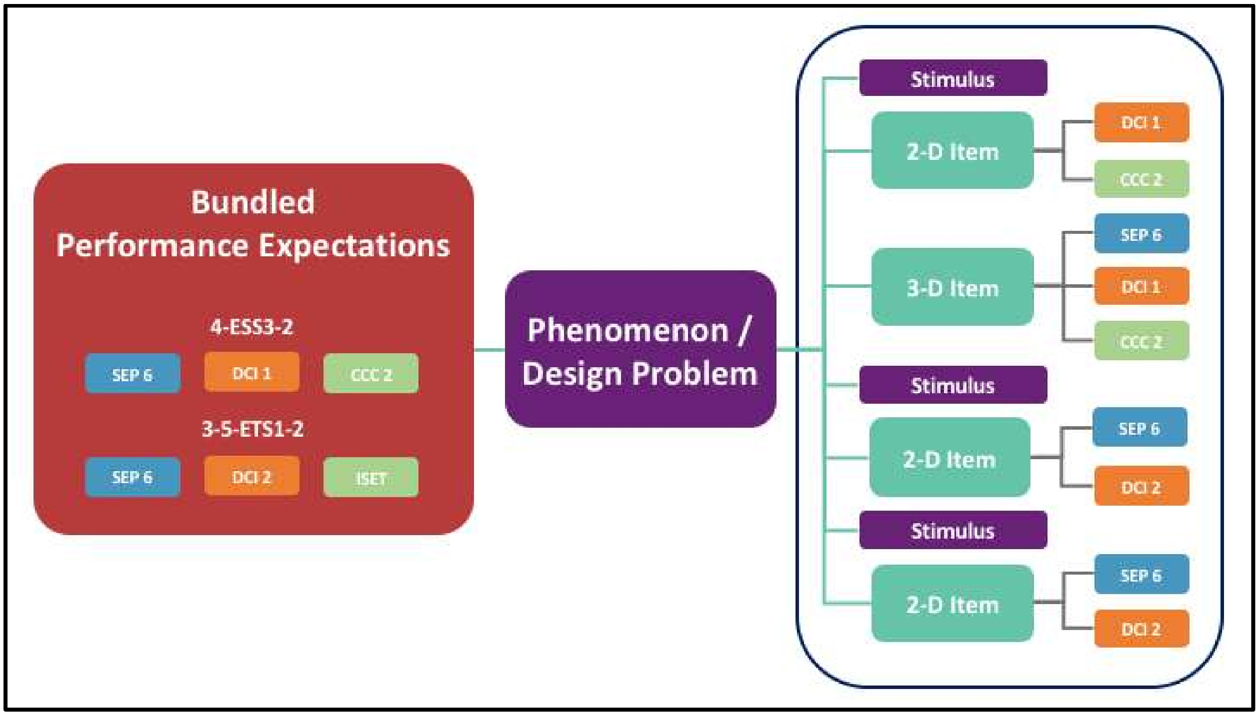
Item Clusters

Item clusters that assess a PE bundle make up the core of the WCAS. A PE bundle is generally two or three related PEs that are used to explain or make sense of a scientific phenomenon or a design problem. A phenomenon gives an item cluster conceptual coherence. The items within an item cluster are interconnected and focused on the given phenomenon. Items are also structured to support a student's progression through the cluster.

Students must make sense of the phenomenon for an item cluster by using the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) represented in the PE bundle. PE bundles are often within a single domain but may include PEs from different domains. PE bundles sometimes share a similar practice or crosscutting concept or may include multiple practices or crosscutting concepts. Each item within the cluster aligns to two or three dimensions (2-D, 3-D) from one or more of the PEs in the bundle, and there is at least one item in the cluster that aligns to all three dimensions of each PE in the bundle. Achieving as full coverage as possible requires developing items that target a variety of the dimensions represented in the PE bundle. In all cases, item clusters achieve full coverage of the dimensions of each PE within a PE bundle.

The Sample Item Cluster Map shows how the items in a sample cluster work together to achieve full coverage of the dimensions in a two-PE bundle.

Sample Item Cluster Map



Standalone Items

A standalone item is a focused measurement tool that uses a single item to address two or three dimensions of one PE.

Online Test Delivery

The WCAS is delivered online using the same platform as the Smarter Balanced ELA and Mathematics assessments. Students should be familiar with most of the online features of the WCAS; however, there are a few unique features that support efficient and reliable delivery of the clusters and standalone items.

Collapsible Stimuli

The WCAS has some item clusters that include more than one stimulus. Each stimulus is delivered along with the items most closely associated to that stimulus. Once a stimulus is presented, it is available to the student throughout the cluster. To minimize vertical scrolling and the need to move back to previous screens within a cluster, a stimulus is collapsed once the next stimulus is provided. A +/- icon in the heading of a collapsed stimulus section allows the stimulus to be hidden from view or expanded to suit a student's current need.

Locking Items

WCAS clusters include some locking items in which the student cannot change their answer once they have moved to a different item. A padlock icon next to the item number alerts students that they are answering a locking item. When they start to move on from the item, an "attention" box warns the student that they will not be able to change their answer once they move on. The student can either return to the item or move on and lock in their answer.

Locking items allow the student to be updated with correct information in subsequent items or stimuli. In addition, locking items help to limit item interaction effects or clueing between items in a cluster.

Students can return and view an item that has been locked. The student will see their answer, but they cannot change their answer.

Animation

In addition to diagrams and graphics, the online platform supports the use of animations in stimuli. The animations provide additional scaffolding for the student.

Screen Display

Item clusters are displayed with a stimulus pane and an item pane on the same screen. The stimulus occupies 40% of the screen, while the item occupies 60% of the screen. However, by clicking expansion arrows, a student can expand either pane to a width of 90% of the screen. Standalone items are displayed on the entire width of the screen.

Color

WCAS graphics are developed and delivered in color. An educational assessment contractor's graphics team evaluates the text and colors in each graphic using standard tools (e.g., Colour Contrast Analyser (CCA), Sim Daltonism) to ensure the graphic's content is discernible for the widest range of viewers, including those with common types of colorblindness. In the graphics team's use of the tool to determine acceptable color contrast, they consider indicators defined in the Web Content Accessibility Guidelines (WCAG 2.1), which were adopted by the federal government for compliance to Section 508 of the Rehabilitation Act (29 U.S.C. § 794d) . Information about supports and/or accommodations for students with visual impairments can be found in the Guidelines on Tools, Supports, & Accommodations, which can be downloaded from the Washington Comprehensive Assessment Program (WCAP) Portal.

Item Types

The WCAS include several item types. Collectively, these item types enable measurement of understanding and core competencies in ways that support student engagement. The majority of the item types are represented on the WCAS Training Tests, which are accessed on the WCAP Portal.

Edit Task Inline Choice (ETC)

- Students select words, numbers, or phrases from drop-down lists to complete a statement.
- The number of drop-down lists in an item is typically between two and four.
- The length of options in a drop-down list is typically one to four words.
- A drop-down list can be part of a table.

Grid Interaction (GI)

- Drag and drop
    - Students place arrows, symbols, labels, or other graphical elements on a background graphic.
    - The elements are designated as refreshable (able to be used multiple times) or non-refreshable (able to be used only one time).
- Hot Spot
    - Students construct simple graphs or select a region on a graphic.

Hot Text (HT)

- Students move statements into an ordered sequence.
- The statements are designated as refreshable (able to be used multiple times) or non-refreshable (able to be used only one time).

Multiple Choice (MC)

- Includes a question, or a statement followed by a question.
- The question presents a clear indication of what is required so students know what to do before looking at the answer choices.
- Students typically select from four options (one correct answer and three distractors).
- The options are syntactically and semantically parallel.
- The options are arranged in numerical or chronological order or according to length.
- Distractors can reflect common errors, misunderstandings, or other misconceptions.
- Distractors are not partially correct.
- The options “All of the above” and “None of the above” are not used.

Multiple Select (MS)

- Includes a clear direction or includes a statement followed by a clear direction.
- The clear direction indicates how many options a student should select to complete the item (e.g., "Select **two** pieces of evidence that support the student's claim").
- The direction presents a clear indication of what is required so students know what to do before looking at the answer choices.
- Students select from a maximum of eight options that have at least two correct responses.
- There should be at least three more distractors than correct answers.
- The options are syntactically and semantically parallel.
- The options are arranged in numerical or chronological order or according to length.
- Distractors can reflect common errors, misunderstandings, or other misconceptions.
- Distractors are not partially correct.
- The options "All of the above" and "None of the above" are not used.

Short Answer (SA)

- Students write a response based on a specific task statement.
- Directions give clear indications of the response required of students.
- When appropriate, bullets after phrases like "In your description, be sure to:" provide extra details to assist students in writing a complete response.
- A response that requires multiple parts may be scaffolded with response boxes to draw attention to the parts.
- Any SA item that requires the students to use information from a stimulus specifically prompts for the information, such as "Use data from the table to …" or "Support your answer with information from the chart."
- Students type text and/or numbers into a response box using the keyboard. SA items are scored by human readers using a scoring rubric.

Simulation (SIM)

- Students use a simulation to control an investigation and/or generate data.
- Simulations can vary in their interaction, design, and scoring.
- The data can be scored directly or used to answer related questions, or both.

Table Input (TI)

- Students complete a table by typing numeric responses into the cells of the table using the keyboard.
- Positive values, negative values, and decimal points are accepted.

Table Match (MI)

- Students check boxes within the cells of a table to make identifications, classifications, or predictions.
- Students are informed when a row or column may be checked once, more than once, or not at all.

Scoring Rubric Development Guidelines

- An item-specific scoring rubric is developed for each ETC, GI, HT, SIM, TI, MI, and SA during the writing of the item.
- Scoring rubrics do not consider conventions of writing (complete sentences, usage/grammar, spelling, capitalization, punctuation, and paragraphing).
- Scoring rubrics are edited during field test rangefinding and rubric validation based on student responses.
- Scoring rubrics may be edited during operational rangefinding based on student responses.

Multipart Items

Some items are divided into multiple parts. Typically, this includes two parts (part A and part B). Item parts are mutually reinforcing and strengthen alignment to a PE.

Multipart items can use different types of interactions in each part (e.g., an MC followed by an ETC). One example of this approach is an item that asks a student to evaluate a claim in part A, and then in part B asks the student to identify how a particular trend in data or piece of evidence supports their evaluation of that claim.

Multipart items are scored collectively, with each part contributing toward a single point, or separately, with each part earning a single point.

When assessed in an item that does not have multiple parts, the following score points are typically assigned for each item type:

- ETC, GI, HT, MC, MS, SIM, TI, and MI items are worth 1 point.
- SA items are worth 1 or 2 points.

Test Design

Operational Test Form

Each operational test form contains the same items in a given year. This is known as a "fixed-form test," which is unlike the "adaptive" Smarter Balanced test. Approximately 33% of the points of the fixed-form test are anchoring (linking) items with established item calibrations from previous years.

The operational component of the WCAS counts toward a student's score and is composed of five clusters and six to twelve standalone items.

In addition:

- One PE from each domain (ESS, PS, LS, and ETS) is included in at least one item cluster.
- A minimum of three different SEPs are included across the clusters.
- A minimum of three different CCCs are included across the clusters.
- Standalone items increase DCI, SEP, and CCC coverage.

Field Test Items

Operational test forms contain embedded field test items, which are either a set of items associated with a cluster, a group of standalone items, or a combination of one cluster and one or more standalone items. Several clusters and standalone items are field tested in a given administration. The field test items do not contribute to the student's score.

Testing Times

The WCAS is intended to be administered online in one to three sessions. The approximate 120-minute administration time includes 30 minutes for giving directions and distributing materials, 75 minutes for the operational form, and 15 minutes for the embedded field test. Contact your district testing coordinator for further information on the specific test schedule for your district or building.

Online Calculator

A calculator is embedded in the online platform for all items in the WCAS. Students should be familiar with the functionality of the calculator prior to using it on the assessment. The calculator is available online and as an app for practice. In grade 5, students use a basic four-function calculator. In grades 8 and high school, students use a scientific calculator.

Tools, Supports, and Accommodations

The WCAS may be taken with or without tools, supports, or accommodations. Tools are available to all students and can be used at the student's discretion. Supports are available to English language learners and any student with a need identified by an educator. Accommodations are available for students who receive special education services with a documented need noted in an IEP or 504 plan. More information is available in the Guidelines on Tools, Supports, & Accommodations which can be downloaded from the WCAP Portal.

Test Blueprint

The total number of points for the WCAS at grade 5 is 35 points. The point percentages of the WCAS reflect the percentages of the PEs per domain within the standards.

The Engineering, Technology, and Applications of Science (ETS) domain is not represented by a separate item cluster, but is bundled in at least one item cluster with one or more PEs from the Physical Sciences (PS), Life Sciences (LS), or Earth and Space Sciences (ESS) domain. ETS points are not specified, and ETS PEs were not included when calculating the percentages in Table 1.

Table 1 specifies the percentage and point ranges of the WCAS in reference to the reporting claims.

Table 1

Reporting Area	Percentage of PEs per Science Domain in the Standards	Percentage Range for the WCAS per Science Domain	Score Point Range for the WCAS per Science Domain
Practices and Crosscutting Concepts in Physical Sciences	40%	35–45%	12–16
Practices and Crosscutting Concepts in Life Sciences	29%	25–35%	8–12
Practices and Crosscutting Concepts in Earth and Space Sciences	31%	25–35%	9–13

Washington Standards Overview

The WCAS is designed to align to the standards in a way that honors the original intent of the document *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and supports Washington educators in their interpretation of assessment results, instructional design, and classroom practice. This section discusses the structure and usage of PEs as a guiding framework for the development of the WCAS item specifications.

Performance Expectations

The standards are organized into Performance Expectations (PEs). Each PE provides a statement of what students should be able to do by the end of instruction. There are 45 PEs for grades 3–5, 59 PEs for middle school, and 71 PEs for high school. The PEs are further categorized by grade or grade band (K, 1, 2, 3, 4, 5, MS, HS) and by domain: Physical Sciences (PS); Life Sciences (LS); Earth and Space Sciences (ESS); and Engineering, Technology, and Applications of Science (ETS).

Identifying a PE

Each PE is identified by a three-part PE code. The first set of letters or numbers indicates the grade level (or grade band) of the PE (e.g., HS for high school). The middle set of letters and numbers in a PE code refers to an overarching organizing concept that is developed across grades. For example, in MS-ESS1-2, “ESS1” refers to “Earth’s Place in the Universe.”

Finding Related PEs

Searching the NGSS website for an organizing concept results in a complete list of associated PEs at the given grade level. For example, searching the website for MS-ESS1 results in a list of associated PEs at the middle school level (MS-ESS1-1 through MS-ESS1-4). Substituting another grade level for “MS” results in a complete list of standards related to “Earth’s Place in the Universe” for any other grade level. This strategy is helpful for understanding where a particular PE fits in a learning progression, and it can provide insight into the assessable boundaries of a PE.

PE Structure

Each PE starts with the PE statement, which is a brief synopsis of the performance the PE is meant to address. Each PE statement incorporates the three dimensions of the NGSS framework: one or more Science and Engineering Practices (SEPs), one or more Disciplinary Core Ideas (DCIs), and one or more Crosscutting Concepts (CCCs). The PE statement can provide some insight as to how students are expected to utilize the SEPs, DCIs, and CCCs together to achieve the PE.

Clarification Statements and Assessment Boundaries

The PE statement may be followed by a clarification statement and/or an assessment boundary. When present, the clarification statement supplies examples or additional clarification to the PE. The assessment boundaries are meant to specify limits for large-scale assessment of a PE. They are **not** meant to limit what can or should be taught or how it is taught. The main function of an assessment boundary statement is to provide guidance to assessment developers.

Dimensions—SEPs, DCIs, and CCCs

Science and Engineering Practices

The standards include a total of eight SEPs that develop across grade levels and grade bands:

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Planning and Carrying Out Investigations
4. Analyzing and Interpreting Data
5. Using Mathematical and Computational Thinking
6. Constructing Explanations and Designing Solutions
7. Engaging in Argument from Evidence
8. Obtaining, Evaluating, and Communicating Information

For the standards and the WCAS Item Specifications, the SEP statement is presented in the leftmost column inside a blue box. Each SEP statement contains a particular skill or practice from a particular grade level, as determined by the PE. Bulleted text under the grade-level description of the SEP presents a subskill associated with the specific PE. Additional details on the subskills and their progressions across grade bands are located in NGSS Appendix F.

Disciplinary Core Ideas

Science knowledge is represented as a collection of disciplinary core ideas, which have been explicitly developed in grade-level progressions. For the standards and the WCAS Item Specifications, the DCI statement is presented in the middle column inside an orange box. The number of DCIs is intentionally limited, so as to allow deeper exploration and eventual proficiency of key concepts as students broaden and deepen their understanding of science. The sum total of all DCIs is not meant to be an exhaustive list of all topics that should be taught in a science classroom. Rather, DCIs provide for links among classroom lesson or activity topics at a high level. DCIs are broken up into several groups within four domains: Physical Sciences (PS), Life Sciences (LS), Earth and Space Sciences (ESS), and Engineering, Technology, and Applications of Science (ETS).

Each DCI statement contains key ideas appropriate to a particular grade level, as determined by the PE. Bulleted text under the grade-level description of the DCI presents ideas and understandings associated with the specific DCI. Additional details on these ideas and understandings and their progressions across grade bands are located in NGSS Appendix E.

Crosscutting Concepts

The standards contain seven CCCs that progress throughout each grade level and grade band. The seven CCCs are:

1. Patterns
2. Cause and Effect
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter
6. Structure and Function
7. Stability and Change

For the standards and the WCAS Item Specifications, the CCC statement is presented in the rightmost column, inside a green box. Bulleted text under the grade-level description of the CCC presents sub-concepts associated with the specific PE. Additional details on these sub-concepts and their progressions across grade bands are located in NGSS Appendix G.

NGSS Progressions Appendices

When working to establish learning progressions or continuity and growth of skills across grade levels, educators will find value in the NGSS progressions appendices (see the "Resources" section). Organized by dimension (SEP, DCI, and CCC), the appendices present detailed learning progressions and comparisons of various skills and competencies across grade levels.

The WCAS Item Specifications use the NGSS progressions appendices in unpacking PE dimension statements to reveal and incorporate elements from a given learning progression. For example, consider a grade 4 PE that lists Planning and Carrying Out Investigations as its SEP dimension and has bulleted text that focuses on making observations. According to the NGSS learning progressions, making observations may be expanded within grade 4 to also include elements of planning, prediction, or evaluations of a fair test. Therefore, from an assessment perspective, items written using these linked subskills align to the SEP.

Evidence Statements

The NGSS evidence statements were designed to support a granular analysis of proficiency with specific PEs, via an explicit articulation of how students can use SEPs to demonstrate their understanding of DCIs through the lens of the CCCs. They do this by clarifying several important details related to the three dimensions:

- How the three dimensions can be assessed together, rather than in independent units
- The underlying knowledge required to develop each DCI
- The detailed approaches to application of the SEP
- How CCCs might be used to deepen content understanding and practice-driven learning

The NGSS evidence statements informed the development of the WCAS Item Specifications.

Resources

Resource	Description
K–12 Framework	Provides information about the foundational principles that were used to develop the NGSS.
SAIC Assessment Framework	Provides options and rationales for development of high-quality, NGSS-aligned summative assessment items.
SAIC Prototype Item Cluster	Demonstrates a three-dimensional NGSS-aligned item cluster using a variety of stimuli and innovative item types.
Developing Assessments for the Next Generation Science Standards	Provides guidance on an approach to science assessment that supports the vision of the NGSS.
NGSS Appendix E	Includes tables showing the **DCI** progressions by grade level.
NGSS Appendix F	Includes tables showing the **SEP** progressions by grade level.
NGSS Appendix G	Includes tables showing the **CCC** progressions by grade level.
NGSS Evidence Statements	Provides additional detail on what students should know and be able to do based on performance expectations.

References

Council of Chief State School Officers (CCSSO). (2015). *Science Assessment Item Collaborative (SAIC) Assessment Framework*. Council of Chief State School Officers.

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WCAS Item Specifications

Introduction

The science assessment team at OSPI worked with assessment research and development partners to create assessment item specifications that support multidimensional item development and assist teachers in their interpretation of WCAS assessment data. The following two pages present a sample of one such item specification.

The WCAS Item Specifications are a guiding framework that is built to evolve and change; OSPI revises them as needed, in collaboration with teachers and other stakeholders. While the item specifications are not intended to dictate curricula in any way, examples of science topics or contexts within the scope of the PE may occasionally be provided in the details and clarifications section. Such examples are noted in parenthetical remarks after a particular clarification, and denoted with the convention “e.g.”

The first page of a WCAS item specification consolidates key information under the same PE code used by the corresponding standard in the NGSS. It also directs users to pertinent pages in the *K–12 Framework* and the NGSS progressions appendices for each dimension (SEP, DCI, or CCC). The first page also presents any clarification statements or assessment boundaries associated with the PE. Items in the grade 5 WCAS use language targeted to the previous grade or lower reading level with the exception of the expected science terms. A list of expected SEP, DCI, and CCC vocabulary is included at the end of this document.

The second page of each item specification presents four alignment codes for the PE. These codes identify the various combinations of PE dimensions that can be measured using a multidimensional item. Additionally, each item specification includes a list of details and clarifications that help unpack the elements used to determine item alignment.

For example, when using the WCAS Item Specifications, an item with an alignment code of 4-LS1-1.2 indicates that the item aligns to both the SEP and DCI dimensions of the PE 4-LS1-1. The item specification suggests that this type of item involves making observations of specific types of evidence related to the DCI. The Details and Clarifications section lists examples of observations that are permissible under this PE, as well as the forms of evidence that are within the bounds of the PE.

As stated earlier in this document, item specifications are updated annually based on input from Washington educators. Each publication of the updated item specifications includes a modifications log.

Physical Sciences

Disciplinary Core Ideas:

- PS1 Matter and Its Interactions
- PS2 Motion and Stability: Forces and Interactions
- PS3 Energy
- PS4 Waves and Their Applications in Technologies for Information Transfer

Performance Expectation	**5-PS1-1** Develop a model to describe that matter is made of particles too small to be seen.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS1.A: Structure and Properties of Matter** • Matter of any type can be subdivided into particles that are too small to see, but even then, the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 56–59	pp. 106–108	pp. 89–91
NGSS Appendices	Appendix F p. 6	Appendix E p. 7	Appendix G pp. 6–7
Clarification Statement	Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.		
Assessment Boundary	Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.		

Items may ask students to:

Code	Alignment	Item Specification
5-PS1-1.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to provide **evidence** that **matter** can be subdivided into particles that are at a **scale** that is too small to be seen.
5-PS1-1.2	SEP-DCI	**Develop** and/or **use** a **model** to describe **evidence** of **matter** that can be subdivided into particles that are too small to be seen.
5-PS1-1.3	DCI-CCC	Use the concept of **scale** to connect **matter** large enough to be seen to **matter** subdivided into particles too small to be seen.
5-PS1-1.4	SEP-CCC	**Develop** and/or **use** a **model** to describe the scale of matter.

Details and Clarifications

- **Develop** and/or **use** a model is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- **Models** that describe **evidence** of **matter** made up of particles too small to be seen may include, but are NOT limited to:
  - diagram, simulation, and/or description of solid material dissolving into a liquid
  - diagram, simulation, and/or description of how adding particles of gas can cause an increase in the volume of an elastic container
  - diagram, simulation, and/or description showing bulk matter is made up of much smaller particles

- **Scale** may include, but is NOT limited to:
  - observation that macroscopic scale matter can be very large
  - observation that microscopic scale matter or parts of larger matter can be too small to be seen

Performance Expectation	**5-PS1-2** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 3– 5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. • Measure and graph quantities such as weight to address scientific and engineering questions and problems.	**PS1.A: Structure and Properties of Matter** • The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. **PS1.B: Chemical Reactions** • No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.)	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 64–67	pp. 106–109 pp. 109–111	pp. 89–91
NGSS Appendices	Appendix F p. 10	Appendix E p. 7	Appendix G pp. 6–7 Appendix H p. 6
Clarification Statement	Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances.		
Assessment Boundary	Assessment does not include distinguishing mass and weight.		

Items may ask students to:

Code	Alignment	Item Specification
5-PS1-2.1	SEP-DCI-CCC	**Measure** and/or **graph** quantities using **standard units** to provide evidence that regardless of the **type** of **change** that occurs, the total **mass** of **matter** is **conserved**.
5-PS1-2.2	SEP-DCI	**Measure** and/or **graph** quantities to provide evidence that regardless of the **type** of **change** that occurs, the total **mass** of **matter** is **conserved**.
5-PS1-2.3	DCI-CCC	Use **standard units** to provide evidence that regardless of the **type** of **change** that occurs, the total **mass** of **matter** is **conserved.**
5-PS1-2.4	SEP-CCC	**Measure** and/or **graph quantities** using **standard units** to compare objects and/or events.

Details and Clarifications

- **Measure** and/or **graph quantities** is expanded to include:
  - using mathematics to represent variables and their relationships
  - measuring, comparing, and/or organizing quantitative attributes (e.g., area, volume, mass) to reveal patterns that suggest relationships
  - graphing quantities to address scientific questions and/or problems

- Examples of the **type** of **change** that occurs may include, but are NOT limited to:
  - heating
  - cooling
  - change in state
  - mixing substances, resulting in a mixture (physical change)
  - mixing substances, resulting in new substances (chemical change)

- Evidence of the total **mass** of **matter** being **conserved** may include, but is NOT limited to:
  - total mass of substances staying the same regardless of the type of change
  - total mass of substances staying the same regardless of a change in qualitative properties (e.g., sugar dissolving in water)

- **Standard units** may include, but are NOT limited to:
  - gram
  - kilogram

<table>
<tr><td>Performance Expectation</td><td colspan="3">5-PS1-3 Make observations and measurements to identify materials based on their properties.</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>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 measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.</td><td>PS1.A: Structure and Properties of Matter
• Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic scale mechanism of evaporation and condensation.)</td><td>Scale, Proportion, and Quantity
• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.</td></tr>
<tr><td colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K–12 Framework</td><td>pp. 59–61</td><td>pp. 106–109</td><td>pp. 89–91</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
pp. 7–8</td><td>Appendix E
p. 7</td><td>Appendix G
pp. 6–7</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">Assessment does not include density or distinguishing mass and weight.</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
5-PS1-3.1	SEP-DCI-CCC	**Make observations** and/or **measurements** using **standard units** to identify **materials** based on their **properties**.
5-PS1-3.2	SEP-DCI	**Make observations** and/or **measurements** to identify **materials** based on their **properties**.
5-PS1-3.3	DCI-CCC	Identify **materials** based on **properties** measured and/or described in **standard units.**
5-PS1-3.4	SEP-CCC	**Make observations** and/or **measurements** using standard units.

Details and Clarifications

- **Make observations** and/or **measurements** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- **Properties** of **materials** may include, but are NOT limited to:
  - mass
  - volume
  - temperature
  - color
  - hardness
  - reflectivity
  - electrical conductivity
  - thermal conductivity
  - response to magnetic forces
  - solubility

- Examples of **standard units** may include, but are NOT limited to:
  - kilograms
  - liters
  - Celsius

Performance Expectation	**5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances.		
Dimensions	**Science & 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. • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**PS1.B: Chemical Reactions** • When two or more different substances are mixed, a new substance with different properties may be formed.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 59–61	pp. 109–111	pp. 87–89
NGSS Appendices	Appendix F pp. 7–8	Appendix E p. 7	Appendix G pp. 5–6
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
5-PS1-4.1	SEP-DCI-CCC	**Plan** and/or **conduct** an **investigation** to produce **evidence** of **cause and effect** relationships to determine whether the **mixing** of two or more **substances** results in **new substances**.
5-PS1-4.2	SEP-DCI	**Plan** and/or **conduct** an **investigation** to produce **evidence** to determine whether the **mixing** of two or more **substances** results in **new substances**.
5-PS1-4.3	DCI-CCC	Use **cause and effect** relationships to determine whether the **mixing** of two or more **substances** results in **new substances**.
5-PS1-4.4	SEP-CCC	**Plan** and/or **conduct** an **investigation** to produce evidence of cause and effect relationships.

Details and Clarifications

- **Plan** and/or **conduct** an **investigation** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- Examples of **evidence** of **cause and effect** relationships include, but are NOT limited to:
  - quantitative properties (e.g., mass, volume, temperature) of substances before and after mixing
  - qualitative properties (e.g., state of matter, color, texture, odor, conductivity, solubility, response to magnetic forces) before and after mixing

- Examples of the **mixing** of two or more **substances** resulting in **new substances** may include, but are NOT limited to:
  - Mixing water and iron forms rust.
  - Mixing baking soda and vinegar forms carbon dioxide gas.
  - Mixing water and detergent results in a temperature increase.

Performance Expectation	**3-PS2-1** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.		
Dimensions	**Science & 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. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. **Connections to Nature of Science** **Scientific Investigations Use a Variety of Methods** • Science investigations use a variety of methods, tools, and techniques.	**PS2.A: Forces and Motion** • Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) **PS2.B: Types of Interactions** • Objects in contact exert forces on each other.	**Cause and Effect** • Cause and effect relationships are routinely identified.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 59–61	pp. 114–118	pp. 87–89
NGSS Appendices	Appendix F pp. 7–8 Appendix H p. 5	Appendix E p. 7	Appendix G pp. 5–6
Clarification Statement	Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.		
Assessment Boundary	Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.		

Items may ask students to:

Code	Alignment	Item Specification
3-PS2-1.1	SEP-DCI-CCC	**Plan** and/or **conduct** an **investigation** to produce **evidence** of **cause and effect** relationships between the **forces** acting on an object and the **motion** of an object.
3-PS2-1.2	SEP-DCI	**Plan** and/or **conduct** an **investigation** to produce **evidence** of the **forces** acting on an object and/or the **motion** of an object.
3-PS2-1.3	DCI-CCC	Use **cause and effect** relationships to connect the **forces** acting on an object and the **motion** of an object.
3-PS2-1.4	SEP-CCC	**Plan** and/or **conduct** an **investigation** to produce evidence of cause and effect relationships between objects.

Details and Clarifications

- **Plan** and/or **conduct** an **investigation** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- **Evidence** of a change in **motion** may include, but is NOT limited to:
  - change in an object's speed (e.g., slowing down, speeding up)
  - change in an object's direction (e.g., up, down, left, right)

- **Forces** may include, but are NOT limited to:
  - a push
  - a pull
  - gravity

- **Cause and effect** relationships between **force** and **motion** may include, but are NOT limited to:
  - the force of gravity pulls an object towards Earth's center
  - balanced forces acting on an object will result in an object's motion staying constant
  - unbalanced forces acting on an object will result in an object's motion changing
  - applying different strengths and/or directions of force on an object at rest will result in motion
  - applying different strengths and/or directions of force on an object in motion will result in a change in motion
  - when objects exert forces on each other (e.g., collide), their motions change

Performance Expectation	**5-PS2-1** Support an argument that the gravitational force exerted by Earth on objects is directed down.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**PS2.B: Types of Interactions** • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 116–118	pp. 87–89
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 7	Appendix G pp. 5–6
Clarification Statement	"Down" is a local description of the direction that points toward the center of the spherical Earth.		
Assessment Boundary	Assessment does not include mathematical representation of gravitational force.		

Items may ask students to:

Code	Alignment	Item Specification
5-PS2-1.1	SEP-DCI-CCC	**Support** an **argument**, using **cause and effect** relationships, that the gravitational force exerted by Earth on objects is directed toward Earth's center.
5-PS2-1.2	SEP-DCI	**Support** an **argument** that the gravitational force exerted by Earth on objects is directed toward Earth's center.
5-PS2-1.3	DCI-CCC	Use **cause and effect** relationships to describe that the gravitational force exerted by Earth on objects is directed toward Earth's center.
5-PS2-1.4	SEP-CCC	**Support** an **argument** using **cause and effect** relationships.

Details and Clarifications

- **Support** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- **Cause and effect** relationships may include, but are NOT limited to:
  - Earth is spherical, so dropped objects appear to fall straight down at all locations on Earth.
  - An object that is initially stationary when held above the ground moves downward when it is released, so there must be a force acting on the object.
  - Earth is spherical and all objects appear to fall straight down, so objects fall toward Earth's center.

<table>
<tr><td>Performance Expectation</td><td colspan="3">3-PS2-2 Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>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 or test a design solution.

Connections to Nature of Science

Science Knowledge is Based on Empirical Evidence
• Science findings are based on recognizing patterns.</td><td>PS2.A: Forces and Motion
• The patterns of an object’s motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)</td><td>Patterns
• Patterns of change can be used to make predictions.</td></tr>
<tr><td colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K–12 Framework</td><td>pp. 59–61</td><td>pp. 114–116</td><td>pp. 85–87</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
pp. 7–8
Appendix H
p. 5</td><td>Appendix E
p. 7</td><td>Appendix G
pp. 3–5</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">Assessment does not include technical terms such as period and frequency.</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
3-PS2-2.1	SEP-DCI-CCC	**Make observations** and/or **measurements** of an **object's motion** to provide **evidence** of **patterns** that can be used to **predict** future **motion**.
3-PS2-2.2	SEP-DCI	**Make observations** and/or **measurements** of an **object's motion** to provide **evidence** that can be used to **predict** future **motion**.
3-PS2-2.3	DCI-CCC	Use **patterns** in an **object's motion** to **predict** future **motion**.
3-PS2-2.4	SEP-CCC	**Make observations** and/or **measurements** to provide evidence that patterns of change can be used to make predictions.

Details and Clarifications

- **Make observations** and/or **measurements** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- **Observations** and/or **measurements** that provide **evidence** may include, but are NOT limited to:
  - speed of an object's motion
  - direction of an object's motion
  - path of an object's motion
  - changes in the speed, direction, and/or path of an object's motion

- Examples of **patterns** of an **object's motion** that can be used to **predict** future **motion** may include, but are NOT limited to:
  - a swinging pendulum
  - a child swinging on a swing
  - a bouncing ball
  - a ball rolling back and forth in bowl
  - a rocking chair
  - the movement of hands on a clock

Performance Expectation	**3-PS2-3** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.		
Dimensions	**Science & 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 based on patterns such as cause and effect relationships.	**PS2.B: Types of Interactions** • Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 54–56	pp. 116–118	pp. 87–89
NGSS Appendices	Appendix F pp. 4–5	Appendix E p. 7	Appendix G pp. 5–6
Clarification Statement	Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.		
Assessment Boundary	Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.		

Items may ask students to:

Code	Alignment	Item Specification
3-PS2-3.1	SEP-DCI-CCC	**Ask questions** that can be investigated using **cause and effect** relationships to determine that **electric** and/or **magnetic forces** between two objects do not require the objects to be in contact.
3-PS2-3.2	SEP-DCI	**Ask questions** that can be investigated to determine that **electric** and/or **magnetic forces** between two objects do not require the objects to be in contact.
3-PS2-3.3	DCI-CCC	Use **cause and effect** relationships to determine that **electric** and/or **magnetic forces** can act between two objects that are not in contact.
3-PS2-3.4	SEP-CCC	**Ask questions** that can be investigated to determine cause and effect relationships between two objects.

Details and Clarifications

- **Ask questions** is expanded to include:
  - asking questions about what would happen if a variable is changed
  - asking and/or identifying questions that can be answered through observation and/or investigation
  - predicting the outcome of questions that can be answered through observation and/or investigation
  - asking questions about observations, data, claims, and/or proposed designs
  - defining a simple design problem that can be solved through the development of an object, tool, process, and/or system.
  - describing criteria for a successful solution
  - describing constraints on materials, time, and/or cost that could limit the success of a solution

- **Electric forces** may include:
  - forces between objects with opposite charges
  - forces between objects that have similar charges

- **Magnetic forces** may include:
  - forces between objects with opposite poles
  - forces between objects with similar poles

- **Cause and effect** relationships may include, but are NOT limited to:
  - objects with opposite charges and/or poles attract each other
  - objects with similar charges and/or poles repel each other
  - an electromagnet attracts magnetic objects
  - the strength of the force between two objects increases as the distance between the objects decreases
  - the magnetic force between two objects changes as the orientation of the objects in relation to each other changes

Performance Expectation	**3-PS2-4** Define a simple design problem that can be solved by applying scientific ideas about magnets.		
Dimensions	**Science & 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. • Define a simple problem that can be solved through the development of a new or improved object or tool.	**PS2.B: Types of Interactions** • Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	**Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 54–56	pp. 116–118	pp. 210–214
NGSS Appendices	Appendix F pp. 4–5	Appendix E p. 7	Appendix J p. 3
Clarification Statement	Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-PS2-4.1	SEP-DCI-CCC	**Define** a **simple design problem** that can be solved by **applying scientific ideas** about **magnetic forces** between objects.
3-PS2-4.2	SEP-DCI	**Define** a **simple design problem** that can be solved using **magnetic forces** between objects.
3-PS2-4.3	DCI-CCC	**Apply scientific ideas** to **magnetic forces** between objects.
3-PS2-4.4	SEP-CCC	**Define** a **simple design problem** that can be solved by applying scientific ideas.

Details and Clarifications

- **Define** a **simple design problem** is expanded to include:
  - asking questions about what would happen if a variable is changed
  - asking and/or identifying questions that can be answered through observation and/or investigation
  - predicting the outcome of questions that can be answered through observation and/or investigation
  - asking questions about observations, data, claims, and/or proposed designs
  - defining a simple design problem that can be solved through the development of an object, tool, process, and/or system
  - describing criteria for a successful solution
  - describing constraints on materials, time, and/or cost that could limit the success of a solution

- **Applying scientific ideas** may include, but is NOT limited to:
  - using scientific ideas to design a solution, such as:
    - the opposite poles of a magnet attracting each other
    - magnets that are not in contact exerting forces on each other
    - the force between two magnets decreasing as distance between them increases
  - using engineering processes to design a solution, like:
    - describing the desirable features for a solution (e.g., uses few materials, lightweight)
    - describing limitations to the success of a solution (e.g., “high cost,” “unsafe,” “noisy”)

- Using **magnetic forces** to solve a simple design problem may include, but is NOT limited to:
  - designing a way to open a door from a distance
  - designing a way to softly close a cupboard door
  - designing a way to hold two objects together
  - designing a way to pick up paperclips that have fallen on the floor
  - designing a way to organize safety pins so they do not get jumbled together

Performance Expectation	**4-PS3-1** Use evidence to construct an explanation relating the speed of an object to the energy of that object.		
Dimensions	**Science & 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 (e.g., 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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 120–124	pp. 94–96
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 7	Appendix G pp. 8–9
Clarification Statement	A clarification statement is not provided for this PE.		
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.		

Items may ask students to:

Code	Alignment	Item Specification
4-PS3-1.1	SEP-DCI-CCC	**Use evidence** to construct an explanation **relating** the **speed** of an object to the **energy** of that object.
4-PS3-1.2	SEP-DCI	**Use evidence** to construct an explanation about the **speed** of an object.
4-PS3-1.3	DCI-CCC	Connect concepts of **energy** to the **speed** of a moving object.
4-PS3-1.4	SEP-CCC	**Use evidence** to construct an explanation that energy can be transferred in various ways and/or between objects.

Details and Clarifications

- **Use evidence** is expanded to include:
    - using measurements, observations, and/or patterns to support an explanation
    - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
    - using evidence to design a solution to a problem
    - comparing solutions to a problem as to how well they meet criteria for success
    - comparing solutions in terms of constraints that limit the success of the solution

- **Relating** the **speed** of a object to the **energy** of that object may include, but is NOT limited to:
    - a faster-moving object having more energy than a slower-moving object
    - a slower-moving object having less energy than a faster-moving object
    - an object at rest having no motion energy

- Examples of **evidence** may include, but are NOT limited to:
    - a stationary object moving faster following a collision with a fast-moving object than following a collision with a slow-moving object
    - a stationary object moving farther following a collision with a fast-moving object than following a collision with a slow-moving object
    - the sound produced when fast-moving objects collide being louder than the sound produced when slow-moving objects
    - the amount of heat produced when a fast-moving object moves over a surface being greater than when a slow-moving object moves over a surface

Performance Expectation	**5-PS3-1** Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS3.D: Energy in Chemical Processes and Everyday Life** • The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). **LS1.C: Organization for Matter and Energy Flow in Organisms** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary)*	**Energy and Matter** • Energy can be transferred in various ways and between objects.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 56–59	pp. 128–130 pp. 147–148	pp. 94–96
NGSS Appendices	Appendix F p. 6	Appendix E p. 8 p. 4	Appendix G pp. 8–9
Clarification Statement	Examples of models could include diagrams, and flow charts.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
5-PS3-1.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to describe that the **energy** in animals' food was once **energy** from the **sun** and/or that **energy** can be **transferred** between **organisms** and/or that **organisms** use **energy** from food for **life functions.**
5-PS3-1.2	SEP-DCI	**Develop** and/or **use** a **model** to describe that the energy in animals' food can be used for **life functions.**
5-PS3-1.3	DCI-CCC	Track **energy** flow from the **sun** to animals' food and/or between **organisms** and/or for maintaining for **life functions**.
5-PS3-1.4	SEP-CCC	**Develop** and/or **use** a **model** to describe that energy can be transferred among objects.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- A **model** may include, but is NOT limited to:
  - diagram
  - flow chart
  - food chain
  - food web
  - description

- Examples of **life functions** may include, but are NOT limited to:
  - body repair
  - growth
  - motion
  - maintaining warmth

- Examples of **energy transfer** among **organisms** and the **sun** may include, but are NOT limited to:
  - plants capture energy from sunlight to produce food
  - sun → grass → deer (arrows represent energy)

<table>
<tr><th>Performance Expectation</th><th 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.</th></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>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.</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 colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K–12 Framework</td><td>pp. 59–61</td><td>pp. 120–124
pp. 124–126</td><td>pp. 94–96</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
pp. 7–8</td><td>Appendix E
p. 7</td><td>Appendix G
pp. 8–9</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">A clarification statement is not provided for this PE.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">Assessment does not include quantitative measurements of energy.</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
4-PS3-2.1	SEP-DCI-CCC	**Make observations** to serve as **evidence** that **energy** can be **transferred** from place to place by sound, light, heat, electric currents, and/or colliding objects.
4-PS3-2.2	SEP-DCI	Due to a strong overlap between the DCI and the CCC, items are not coded 4-PS3-2.2.
4-PS3-2.3	DCI-CCC	Use the concept of **energy transfer** to connect energy flow by sound, light, heat, electric currents, and/or colliding objects.
4-PS3-2.4	SEP-CCC	**Make observations** to serve as evidence that energy can be transferred in various ways and/or between objects.

Details and Clarifications

- **Make observations** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- Types of **evidence** of **energy transfer** may include, but are NOT limited to:
  - presence of sound by hearing or using a sound meter or other recording device
  - presence of light by seeing or using a light meter, photography, or other method of recording light
  - presence of heat by feeling or measuring temperature change
  - presence of electric current by observing the sound, light, heat, and/or kinetic energy output from devices in a circuit
  - motion of objects before and after a collision

- **Energy transfers** may include, but are NOT limited to:
  - the transfer of sound energy from a vibrating object to the surrounding air
  - the transfer of light energy from a source of light to an object that absorbs light
  - the transfer of electric energy to produce motion, sound, heat, and/or light
  - the transfer of heat energy from a source of heat to the surrounding air or to an object
  - the transfer of kinetic energy between colliding objects

Performance Expectation	**4-PS3-3** Ask questions and predict outcomes about the changes in energy that occur when objects collide.		
	Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Dimensions	**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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 54–56	pp. 120–124 pp. 124–126 pp. 126–127	pp. 94–96
NGSS Appendices	Appendix F p. 4–5	Appendix E pp. 7–8	Appendix G pp. 8–9
Clarification Statement	Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.		
Assessment Boundary	Assessment does not include quantitative measurements of energy.		

Items may ask students to:

Code	Alignment	Item Specification
4-PS3-3.1	SEP-DCI-CCC	**Ask questions** and/or **predict** outcomes about the **transfers** and/or changes in **energy** that occur when objects **collide**.
4-PS3-3.2	SEP-DCI	**Ask questions** and/or **predict** outcomes when objects **collide**.
4-PS3-3.3	DCI-CCC	Connect the changes in motion of objects to **transfers** and/or changes in **energy** that occur during **collisions** between objects.
4-PS3-3.4	SEP-CCC	**Ask questions** and/or **predict** outcomes about energy transfers.

Details and Clarifications

- **Ask questions** is expanded to include:
  - asking questions about what would happen if a variable is changed
  - asking and/or identifying questions that can be answered through observation and/or investigation
  - predicting the outcome of questions that can be answered through observation and/or investigation
  - asking questions about observations, data, claims, and/or proposed designs
  - defining a simple design problem that can be solved through the development of an object, tool, process, and/or system
  - describing criteria for a successful solution
  - describing constraints on materials, time, and/or cost that could limit the success of a solution

- Examples of **questions** about **transfers** and/or changes in **energy** when objects **collide** may include, but are NOT limited to:
  - Does the motion energy of object 1 increase or decrease after object 1 collides with object 2?
  - Which object (object 2, object 3, object 4) transfers the most motion energy to object 1 during a collision?

- **Predictions** about **transfers** and/or changes in **energy** when objects **collide** may include, but are NOT limited to:
  - The speed of an object will increase due to a collision.
  - An object will reverse direction due to a collision.
  - Sound energy and/or heat will be transferred when two objects collide.

<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 rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>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.</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. (secondary)</td><td>Energy and Matter
• Energy can be transferred in various ways and between objects.

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World
• Engineers improve existing technologies or develop new ones.

Connections to Nature of Science

Science is a Human Endeavor
• Most scientists and engineers work in teams.
• Science affects everyday life.</td></tr>
<tr><td colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K–12 Framework</td><td>pp. 67–71</td><td>pp. 124–126
pp. 128–130
pp. 204–206</td><td>pp. 94–96
pp. 210–214</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
pp. 11–12</td><td>Appendix E
p. 7
p. 8
Appendix I
pp. 1–7</td><td>Appendix G
pp. 8–9
Appendix J
pp. 3–4
Appendix H
p. 6</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">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.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">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>
</table>

Items may ask students to:

Code	Alignment	Item Specification
4-PS3-4.1	SEP-DCI-CCC	**Apply scientific ideas** to **solve** a **design problem** that includes an **energy conversion**.
4-PS3-4.2	SEP-DCI	**Apply scientific ideas** to describe how well a proposed solution meets the specified **criteria** and/or **constraints** of a **design problem.**
4-PS3-4.3	DCI-CCC	Describe **energy conversions** in a system.
4-PS3-4.4	SEP-CCC	**Apply scientific ideas** to **solve** a **design problem** that involves **energy**.

Details and Clarifications

- **Apply scientific ideas** to **solve** a **design problem** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- **Solve** a **design problem** includes, but is NOT limited to:
  - designing, testing, and/or refining a device

- Examples of **criteria** for a successful solution may include, but are NOT limited to:
  - relatively high degree of safety
  - relatively high effectiveness in solving specific aspects of the given problem
  - relatively low cost
  - readily available materials
  - relatively short time needed to implement

- Examples of **constraints** that could limit the success of a solution may include, but are NOT limited to:
  - relative lack of safety
  - relative deficiency in solving specific aspects of the given problem
  - relatively high cost
  - materials that are difficult to acquire
  - relatively long period of time to implement

- Examples of a device that includes an **energy conversion** may include, but are NOT limited to:
  - light bulb converting electrical energy to light energy
  - a motor converting electrical energy to energy of motion
  - brakes converting motion energy to thermal energy
  - a spinning turbine transforming energy of motion in water to electric currents

Performance Expectation	**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.		
	Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Dimensions	**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. **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**PS4.A: Wave Properties** • Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. *(Note: This grade band endpoint was moved from K–2.)* • Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Patterns** • Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 56–59	pp. 131–133	pp. 85–87
NGSS Appendices	Appendix F p. 6 Appendix H p. 5	Appendix E p. 8	Appendix G pp. 3–5
Clarification Statement	Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.		
Assessment Boundary	Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.		

Items may ask students to:

Code	Alignment	Item Specification
4-PS4-1.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** of **waves** to describe **similarities** and/or **differences** in **patterns** of amplitude and/or wavelength, and/or that **waves** can cause objects to move.
4-PS4-1.2	SEP-DCI	**Develop** and/or **use** a **model** of **waves** to show **patterns** in amplitude and/or wavelength, and/or that **waves** can cause objects to move.
4-PS4-1.3	DCI-CCC	Connect **similarities** and/or **differences** in **patterns** of amplitude and/or wavelength to **waves** causing objects to move.
4-PS4-1.4	SEP-CCC	**Develop** and/or **use** a **model** to describe the similarities and/or differences in patterns.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- **Models** may include, but are NOT limited to:
  - diagrams
  - tables
  - descriptions

- Examples of **waves** may include, but are NOT limited to:
  - water waves
  - waves made with a rope
  - seismic waves in Earth's crust

- **Similarities** and/or **differences** in **patterns** may include, but are NOT limited to:
  - similarities and/or differences in amplitude among waves
  - similarities and/or differences in wavelength among waves
  - similarities and/or differences in speed among waves
  - similarities and/or differences in the forces used to produce various water waves
  - similarities and/or differences in the motion of floating objects in water as various waves travel

Performance Expectation	**4-PS4-2** Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.		
Dimensions	**Science & 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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 56–59	pp. 133–136	pp. 87–89
NGSS Appendices	Appendix F p. 6	Appendix E p. 8	Appendix G pp. 5–6
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.		

Items may ask students to:

Code	Alignment	Item Specification
4-PS4-2.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to describe the **cause and effect** relationships that allow **objects** to be **seen** when light reflecting from objects enters the eye.
4-PS4-2.2	SEP-DCI	**Develop** and/or **use** a **model** to describe that **objects** are **seen** when light reflecting from objects enters the eye.
4-PS4-2.3	DCI-CCC	Use **cause and effect** relationships to connect light reflecting from objects, light entering the eye, and **objects** being **seen**.
4-PS4-2.4	SEP-CCC	**Develop** and/or **use** a **model** to describe cause and effect relationships.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- Components of a **model** may include, but are NOT limited to:
  - light source
  - light
  - object(s)
  - path of light
  - eye

- **Cause and effect** relationships that allow an **object** to be **seen** may include, but are NOT limited to:
  - a light source (e.g., sun, light bulb) giving off light
  - light reflecting off an object and traveling toward the eye
  - light entering the eye and allowing an object to be seen
  - light being blocked from entering the eye and preventing an object from being seen

Performance Expectation	**4-PS4-3** Generate and compare multiple solutions that use patterns to transfer information.		
Dimensions	**Science & 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. **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. *(secondary)*	**Patterns** • Similarities and differences in patterns can be used to sort and classify designed products. **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 136–137 pp. 208–210	pp. 85–87 pp. 210–214
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 8 Appendix I pp. 1–7	Appendix G pp. 3–5 Appendix J p. 3
Clarification Statement	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, and using Morse code to send text.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
4-PS4-3.1	SEP-DCI-CCC	**Generate** and/or **compare solutions** that use **patterns** to **transfer information**.
4-PS4-3.2	SEP-DCI	**Generate** and/or **compare solutions** that **transfer information**.
4-PS4-3.3	DCI-CCC	Connect the use of **patterns** to the **transfer** of **information**.
4-PS4-3.4	SEP-CCC	**Generate** and/or **compare solutions** that involve patterns.

Details and Clarifications

- **Generate** and/or **compare solutions** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- Examples of **patterns** used to **transfer information** may include, but are NOT limited to:
  - a pattern of light flashes communicating a message over a relatively short distance
  - cell phones converting sound waves into a pattern of digital signals (e.g., 1's and 0's) that travel over relatively long distances
  - a pattern of digital signals from satellites traveling over relatively long distances and being converted into an image

Life Sciences

Disciplinary Core Ideas:

- LS1 From Molecules to Organisms: Structures and Processes
- LS2 Ecosystems: Interactions, Energy, and Dynamics
- LS3 Heredity: Inheritance and Variation of Traits
- LS4 Biological Evolution: Unity and Diversity

Performance Expectation	**3-LS1-1** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
	Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Dimensions	**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 models to describe phenomena. **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science findings are based on recognizing patterns.	**LS1.B: Growth and Development of Organisms** • Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	**Patterns** • Patterns of change can be used to make predictions.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 56–59	pp. 145–147	pp. 85–87
NGSS Appendices	Appendix F p. 6 Appendix H p. 5	Appendix E p. 4	Appendix G pp. 3–5
Clarification Statement	Changes organisms go through during their life form a pattern.		
Assessment Boundary	Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS1-1.1	SEP-DCI-CCC	**Develop** and/or use a **model** to show **patterns** in the **life cycle stages** of plants and/or animals, and/or use **patterns** of change in **life cycle stages** to make predictions.
3-LS1-1.2	SEP-DCI	**Develop** and/or use a **model** to describe plant and/or animal **life cycle stages**.
3-LS1-1.3	DCI-CCC	Use **patterns** to connect similarities and/or differences among plant and/or animal **life cycle stages**, and/or make predictions about plant and/or animal **life cycle stages**.
3-LS1-1.4	SEP-CCC	**Develop** and/or use a **model** to describe how patterns can be used to describe relationships and/or make predictions.

Details and Clarifications

- **Develop** and/or use a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- **Models** may include, but are NOT limited to:
  - a diagram and/or description of an organism's life cycle that includes birth, growth, reproduction, and/or death
  - a diagram and/or description that compares life cycles of different types of organisms

- **Life cycle stages** for all organisms include birth, growth, reproduction, and/or death.

- **Patterns** in plant and/or animal **life cycles** may include, but are NOT limited to:
  - similarities and/or differences among life cycle stages for plants and/or animals
  - predictable characteristics at each life cycle stage for plants and/or animals
  - unique and/or diverse characteristics in each life cycle stage when considered across categories (plant, animal) or within a specific group of organisms
  - changes in one life cycle stage cause changes in other stages (e.g., if growth is disrupted, reproduction becomes less likely)
  - reproduction is essential to continued survival of an organism

Performance Expectation	**4-LS1-1** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.		
Dimensions	**Science & 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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 143–145	pp. 91–94
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 4	Appendix G pp. 7–8
Clarification Statement	Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.		
Assessment Boundary	Assessment is limited to macroscopic structures within plant and animal systems.		

Items may ask students to:

Code	Alignment	Item Specification
4-LS1-1.1	SEP-DCI-CCC	**Construct** an **argument** to describe plant **systems** and/or animal **systems** in terms of their **structures** and how the structures interact to serve various survival, growth, behavioral, and/or reproductive **functions**.
4-LS1-1.2	SEP-DCI	**Construct** an **argument** to show that plant and/or animal **structures** serve various survival, growth, behavioral, and/or reproductive **functions**.
4-LS1-1.3	DCI-CCC	Use **system models** to show how plant and/or animal **structures** serve various survival, growth, behavioral, and/or reproductive **functions.**
4-LS1-1.4	SEP-CCC	**Construct** an **argument** that connects system components and interactions in a system model.

Details and Clarifications

- **Construct** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- **Structures** and **functions** may include, but are NOT limited to, structures that work together to support:
  - plants
    - obtaining water, sunlight, and/or air
    - growing toward sunlight and/or water
    - defending against herbivores
    - attracting pollinators

  - animals
    - pumping blood, breathing, moving, and/or digesting food
    - obtaining food
    - defending against predators
    - attracting mates

- **Systems** may include, but are NOT limited to:
  - an entire organism (plant or animal)
  - a subsystem within a plant or animal
  - the interactions of structures working together within a plant or animal system or subsystem

Performance Expectation	**5-LS1-1** Support an argument that plants get the materials they need for growth chiefly from air and water.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Plants acquire their material for growth chiefly from air and water.	**Energy and Matter** • Matter is transported into, out of, and within systems.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 71–74	pp. 147–148	pp. 94–96
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 4	Appendix G pp. 8–9
Clarification Statement	Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
5-LS1-1.1	SEP-DCI-CCC	**Support** an **argument** that plants get the **materials** they need for **growth** chiefly by **transporting** air and/or water into, out of, and/or within systems.
5-LS1-1.2	SEP-DCI	**Support** an **argument** that plants get the **materials** they need for **growth** chiefly from air and/or water.
5-LS1-1.3	DCI-CCC	Connect the **transport** of air and/or water into, out of, and/or within systems to the **materials** plants need for **growth**.
5-LS1-1.4	SEP-CCC	**Support** an **argument** about matter being transported into, out of, and/or within a system.

Details and Clarifications

- **Support** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- Types of **evidence** may include, but are NOT limited to:
  - observed plant growth over time when air and/or water are provided
  - observations of changes in the mass of soil and/or water, compared to the mass of a growing plant over time
  - observations of plants that grow without soil

- **Materials** that are **transported** into, out of, and/or within a system for **growth** may include:
  - air
  - water

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	**Science & 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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 56–59	pp. 149–150	pp. 91–94
NGSS Appendices	Appendix F p. 6	Appendix E p. 4	Appendix G pp. 7–8
Clarification Statement	Emphasis is on systems of information transfer.		
Assessment Boundary	Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.		

Items may ask students to:

Code	Alignment	Item Specification
4-LS1-2.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to describe **system components** and **interactions** when an animal receives different types of information, processes the information, and/or responds to the information.
4-LS1-2.2	SEP-DCI	**Develop** and/or **use** a **model** to describe how an animal receives different types of information, processes the information, and/or responds to the information.
4-LS1-2.3	DCI-CCC	Use **system components** and **interactions** to describe how an animal receives different types of information, processes the information, and/or responds to the information.
4-LS1-2.4	SEP-CCC	**Develop** and/or **use** a **model** to describe components and interactions in a system.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
    - revising a complete or partial model
    - comparing complete or partial models
    - using a model to describe a scientific principle
    - using a model to describe a process
    - using a model to make predictions

- **System components** may include, but are NOT limited to:
    - information inputs (e.g., sound, odor, temperature)
    - sense receptors
    - brain
    - memories
    - actions (e.g., run, blink)

- **Interactions** among **system components** may include, but are NOT limited to:
    - sense receptors detecting inputs from the surroundings (e.g., receptors in eyes detecting light, receptors in skin detecting heat, receptors in the nose detecting smell)
    - sense receptors sending information to the brain
    - brain processing information as perception and/or storing information as memory
    - organism responding to sensory input and/or processing

Performance Expectation	**3-LS2-1** Construct an argument that some animals form groups that help members survive.		
Dimensions	**Science & 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.	**LS2.D: Social Interactions and Group Behavior** • Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size *(Note: Moved from K–2).*	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 71–74	pp. 156–157	pp. 87–89
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 5	Appendix G pp. 5–6
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS2-1.1	SEP-DCI-CCC	**Construct** an **argument** using **cause and effect** relationships to describe how forming a **group** helps animals survive.
3-LS2-1.2	SEP-DCI	**Construct** an **argument** that forming a **group** helps animals survive.
3-LS2-1.3	DCI-CCC	Use **cause and effect** relationships to connect forming a **group** and animal survival.
3-LS2-1.4	SEP-CCC	**Construct** an **argument** that cause and effect relationships are used to describe relationships.

Details and Clarifications

- **Construct** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- A **group** of animals may include, but is NOT limited to:
  - a group of equal individuals (e.g., copepods)
  - a group with dominant members (e.g., elephant herd)
  - small families (e.g., mountain lion mother and cubs)
  - a single-sex group or a mixed-sex group
  - a group composed of individuals similar in age (e.g., duckling crèche)
  - a group that is stable over long periods of time
  - a group with members moving in and/or out (e.g., dolphin pod)
  - a group that assigns specialized tasks to each member (e.g., bee colony, ant colony)
  - a group in which all members perform the same function or a similar range of functions (e.g., schooling anchovies)

- **Cause and effect** relationships that describe how being in a **group** helps animals may include, but are NOT limited to:
  - being in a group can cause individuals in the group to obtain more food than solitary individuals do
  - being in a group can cause individuals in the group to survive predation more frequently than solitary individuals do
  - being in a group can cause individuals in the group to survive environmental or ecological changes (e.g., seasons, climate, habitat disruption, species introduction) more frequently than solitary individuals do

Performance Expectation	**5-LS2-1** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.		
Dimensions	**Science & 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. **Connections to the Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Science explanations describe the mechanisms for natural events.	**LS2.A: Interdependent Relationships in Ecosystems** • The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	**Systems and System Models** • A system can be described in terms of its components and their interactions.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 56–59	pp. 150–152 pp. 152–154	pp. 91–94
NGSS Appendices	Appendix F p. 6 Appendix H p. 5	Appendix E p. 5	Appendix G pp. 7–8
Clarification Statement	Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.		
Assessment Boundary	Assessment does not include molecular explanations.		

Items may ask students to:

Code	Alignment	Item Specification
5-LS2-1.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to describe **system components** and/or their **interactions** when **matter moves** among plants, animals, decomposers, and/or the environment.
5-LS2-1.2	SEP-DCI	**Develop** and/or **use** a **model** to describe how **matter moves** among plants, animals, decomposers, and/or the environment.
5-LS2-1.3	DCI-CCC	Use **system components** and/or their **interactions** to track the **movement** of **matter** among plants, animals, decomposers, and/or the environment.
5-LS2-1.4	SEP-CCC	**Develop** and/or **use** a **model** to describe system components and/or their interactions in a system.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- **System components** may include, but are NOT limited to:
  - matter
  - plants
  - animals
  - decomposers (e.g., fungi, bacteria)
  - environment

- **Interactions** among **system components** that **move matter** may include, but are NOT limited to:
  - organisms obtaining matter from the environment
  - organisms releasing waste/matter to the environment
  - decomposers recycling matter to the environment
  - animals consuming plants and/or other animals
  - decomposers breaking down dead plants and/or animals

<table>
<tr><td>Performance Expectation</td><td colspan="3">3-LS3-1 Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>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.</td><td>LS3.A: Inheritance of Traits
• Many characteristics of organisms are inherited from their parents.

LS3.B: Variation of Traits
• Different organisms vary in how they look and function because they have different inherited information.</td><td>Patterns
• Similarities and differences in patterns can be used to sort and classify natural phenomena.</td></tr>
<tr><td colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K–12 Framework</td><td>pp. 61–63</td><td>pp. 158–159
pp. 160–161</td><td>pp. 85–87</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
p. 9</td><td>Appendix E
p. 6</td><td>Appendix G
pp. 3–5</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
3-LS3-1.1	SEP-DCI-CCC	**Analyze** and/or **interpret data** to provide evidence from **patterns** showing that plants and/or animals **inherit traits** from their parents and/or that a group of similar organisms can have **variation** in their **traits**.
3-LS3-1.2	SEP-DCI	**Analyze** and/or **interpret data** to provide evidence that plants and/or animals **inherit traits** from their parents and/or that a group of similar organisms can have **variation** in their **traits.**
3-LS3-1.3	DCI-CCC	Use **patterns** to support that **traits** are **inherited** from their parents and/or that similar organisms can have **variation** in their **traits.**
3-LS3-1.4	SEP-CCC	**Analyze** and/or **interpret data** to provide evidence from patterns to classify organisms.

Details and Clarifications

- **Analyze** and/or **interpret data** is expanded to include:
  - recording observations
  - organizing data in a table or graphical display (e.g., chart, graph)
  - summarizing data to identify relationships between data sets
  - comparing and/or contrasting data collected by different groups

- **Data** may include, but are NOT limited to:
  - traits of plant and/or animal parents
  - traits of plant and/or animal offspring
  - similarities and/or differences in traits among offspring that are from the same parents

- Examples of **patterns** that provide evidence of **inherited traits** and/or **variation** in **traits** may include, but are NOT limited to:
  - all of the daisy plants in a flower bed having flowers with the same number of petals
  - a puppy having the coloration of its male parent and the ear shape of its female parent
  - plant offspring of one pair of parents having a range of heights

Performance Expectation	**3-LS3-2** Use evidence to support the explanation that traits can be influenced by the environment.		
Dimensions	**Science & 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 (e.g., observations, patterns) to support an explanation.	**LS3.A: Inheritance of Traits** • Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. **LS3.B: Variation of Traits** • The environment also affects the traits that an organism develops.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 158–159 pp. 160–161	pp. 87–89
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 6	Appendix G pp. 5–6
Clarification Statement	Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS3-2.1	SEP-DCI-CCC	**Use evidence** from **cause and effect** relationships to support the explanation that **interactions** with the **environment** influence **traits**.
3-LS3-2.2	SEP-DCI	**Use evidence** to support the explanation that **interactions** with the **environment** influence **traits**.
3-LS3-2.3	DCI-CCC	Use **cause and effect** relationships to connect **interactions** with the **environment** to observable **traits**.
3-LS3-2.4	SEP-CCC	**Use evidence** from cause and effect relationships to support an explanation about change.

Details and Clarifications

- **Use evidence** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- Examples of **interactions** with the **environment** may include, but are NOT limited to:
  - an organism taking in food and/or water
  - an organism obtaining chemicals from soil, water, and/or food
  - a plant absorbing sunlight
  - an animal doing a physical activity

- Examples of **traits** may include, but are NOT limited to:
  - height and/or weight of a plant or animal
  - color and/or quantity of flowers on a plant
  - speed and/or distance that an animal can run

- Examples of **cause and effect** relationships may include, but are NOT limited to:
  - Plants that do not get enough sunlight are shorter than similar plants that do get enough sunlight.
  - Plants grown in nutrient-poor soil produce fewer berries than plants grown in nutrient-rich soil.
  - Horses that run every day can run faster and/or farther than similar horses that do not run regularly.

Performance Expectation	**3-LS4-1** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.		
Dimensions	**Science & 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.	**LS4.A: Evidence of Common Ancestry and Diversity** • Some kinds of plants and animals that once lived on Earth are no longer found anywhere. *(Note: moved from K–2)* • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**Scale, Proportion, and Quantity** • Observable phenomena exist from very short to very long time periods. **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 61–63	pp. 162–163	pp. 89–91
NGSS Appendices	Appendix F p. 9	Appendix E p. 6	Appendix G pp. 6–7 Appendix H p. 6
Clarification Statement	Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.		
Assessment Boundary	Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS4-1.1	SEP-DCI-CCC	**Analyze** and/or **interpret data** from **fossils** to provide **evidence** of the **organisms** and/or the **environments** in which they lived long ago.
3-LS4-1.2	SEP-DCI	**Analyze** and/or **interpret data** from **fossils** to provide **evidence** of the **organisms** and/or the **environments** in which they lived.
3-LS4-1.3	DCI-CCC	Connect **patterns** in **fossil evidence** to the **organisms** and/or the **environments** in which they lived long ago.
3-LS4-1.4	SEP-CCC	**Analyze** and/or **interpret data** to provide evidence that organisms lived long ago.

Details and Clarifications

- **Analyze** and/or **interpret data** is expanded to include:
  - recording observations
  - organizing data in a table or graphical display (e.g., chart, graph)
  - summarizing data to identify relationships between data sets
  - comparing and/or contrasting data collected by different groups

- **Data** from **fossils** may include, but are NOT limited to:
  - sizes
  - distributions
  - relative ages

- **Evidence** of **organisms** and/or their **environments** may include, but is NOT limited to:
  - Some organisms from long ago have modern counterparts.
  - Some organisms from long ago are extinct.
  - Shelled organisms found on dry land indicate that the area was once a marine environment (e.g., tropical plant fossils in Antarctica).

Performance Expectation	**3-LS4-2** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.		
Dimensions	**Science & 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 (e.g., observations, patterns) to construct an explanation.	**LS4.B: Natural Selection** • Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 163–165	pp. 87–89
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 6	Appendix G pp. 5–6
Clarification Statement	Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS4-2.1	SEP-DCI-CCC	Use **evidence** to construct an explanation about **cause and effect** relationships between **variations** in **characteristics** among individuals of the same species and **advantages** in surviving, finding mates, and/or reproducing.
3-LS4-2.2	SEP-DCI	Use **evidence** to construct an explanation about how **variations** in **characteristics** among individuals of the same species may provide **advantages** in surviving, finding mates, and/or reproducing.
3-LS4-2.3	DCI-CCC	Use **cause and effect** relationships to explain how **variations** in **characteristics** among individuals of the same species may provide **advantages** in surviving, finding mates, and/or reproducing.
3-LS4-2.4	SEP-CCC	Use **evidence** from cause and effect relationships to construct an explanation about change.

Details and Clarifications

- **Use evidence** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- **Variations** in **characteristics** may include, but are NOT limited to, differences in:
  - coloration in plants and/or animals
  - sizes and/or shapes of specific physical features of plants and/or animals
  - growth rates of plants and/or animals

- **Advantages** may include, but are NOT limited to:
  - increased survival rate
  - increased likelihood of finding a mate
  - increased rate of reproduction

- Examples of **cause and effect** relationships may include, but are NOT limited to:
  - Dark-colored gypsy moths that are difficult for predators to see on tree bark are more likely to survive and/or reproduce than light-colored gypsy moths that are easy to see.
  - Chorus frogs with louder mating calls are more likely to attract mates more often than those with softer mating calls, and are therefore more likely to reproduce.
  - Sunflowers that grow quickly obtain more sunlight than sunflowers that grow slowly, and are therefore more likely to survive and/or reproduce.

Performance Expectation	**3-LS4-3** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Dimensions	**Science & 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.	**LS4.C: Adaptation** • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**Cause and Effect** • Cause and effect relationships are routinely identified and used to explain change.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 164–166	pp. 87–89
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 6	Appendix G pp. 5–6
Clarification Statement	Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS4-3.1	SEP-DCI-CCC	**Construct** an **argument** with evidence that establishes a **cause and effect** relationship between organism **characteristics** and **survival** in a particular habitat.
3-LS4-3.2	SEP-DCI	**Construct** an **argument** with evidence that organisms in a particular habitat can have different **characteristics** and/or different levels of **survival**.
3-LS4-3.3	DCI-CCC	Use **cause and effect** relationships to relate organism **characteristics** to **survival** in a particular habitat.
3-LS4-3.4	SEP-CCC	**Construct** an **argument** with **evidence** about a cause and effect relationship.

Details and Clarifications

- **Construct** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- Organism **characteristics** may include, but are NOT limited to:
  - physical characteristics
  - behaviors
  - resource needs

- Measures of **survival** in a particular habitat may include, but are NOT limited to:
  - average lifespan
  - overall health
  - ability to successfully reproduce
  - the number of organisms with a specific characteristic

- **Cause and effect** relationships may include, but are NOT limited to:
  - relating changes in the availability of resources to changes in survival
  - relating changes in the number organisms with a specific characteristic to changes in survival
  - relating changes in survival to changes in habitat

Performance Expectation	**3-LS4-4** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.		
	Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Dimensions	**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). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. **LS4.D: Biodiversity and Humans** • Populations live in a variety of habitats, and change in those habitats affects the organisms living there.	**Systems and System Models** • A system can be described in terms of its components and their interactions. **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Engineering, Technology, and Science on Society and the Natural World** • Knowledge of relevant scientific concepts and research findings is important in engineering.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 71–74	pp. 154–156 pp. 166–167	pp. 91–94 pp. 210–212
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 5 Appendix E p. 6	Appendix G pp. 7–8 Appendix J pp. 3–4
Clarification Statement	Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.		
Assessment Boundary	Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.		

Items may ask students to:

Code	Alignment	Item Specification
3-LS4-4.1	SEP-DCI-CCC	**Make** a **claim** about the **merit** of a **solution** to a problem caused when the environment in a given system **changes**, which may result in changes to the types of plants and/or animals in that **system**.
3-LS4-4.2	SEP-DCI	**Make** a **claim** about the **merit** of a **solution** to a problem caused when an environmental **change** causes changes to the types of plants and/or animals.
3-LS4-4.3	DCI-CCC	Connect changes to the types of plants and/or animals in a **system** to **changes** in the environment of the **system**.
3-LS4-4.4	SEP-CCC	**Make a claim** about the **merit** of a **solution** to a problem caused by interactions among the components of a system.

Details and Clarifications

- **Make** a **claim** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or a making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- The **merit** of a **solution** may include, but is NOT limited to:
  - how well a solution meets given criteria
  - constraints on the success of a given solution
  - how well a solution reduces the impact of the problem

- A **change** in the environment of a given **system** may include, but is NOT limited to:
  - a change in the size, shape, and/or distribution of local landscape features
  - a change in the quality of the air, water, and/or soil
  - a change in the availability of air, water, food, and/or shelter
  - a change in temperature
  - a change caused by human activity (e.g., mining, pollution, habitat destruction)

- A **change** in the plants and/or animals of a given **system** may include, but is NOT limited to:
  - a decrease in the population of a particular plant or animal species within the system
  - migration of organisms into or out of a given system
  - migration of invasive species into a given system

Earth and Space Sciences

Disciplinary Core Ideas:

- ESS1 Earth’s Place in the Universe
- ESS2 Earth’s Systems
- ESS3 Earth and Human Activity

Performance Expectation	**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.		
Dimensions	**Science & 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. **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes consistent patterns in natural systems.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 177–179	pp. 85–87
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 2	Appendix G pp. 3–5 Appendix H p. 6
Clarification Statement	Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.		
Assessment Boundary	Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.		

Items may ask students to:

Code	Alignment	Item Specification
4-ESS1-1.1	SEP-DCI-CCC	**Identify evidence** from **patterns** in rock formations and/or fossils in rock layers to support an explanation of **change over time**.
4-ESS1-1.2	SEP-DCI	**Identify evidence** that supports an explanation of **change over time**.
4-ESS1-1.3	DCI-CCC	Use **patterns** in rock formations and/or **patterns** in the fossils in rock layers to support an explanation of **change over time**.
4-ESS1-1.4	SEP-CCC	**Identify evidence** from patterns to support an explanation.

Details and Clarifications

- **Identify evidence** is expanded to include:
    - using measurements, observations, and/or patterns to support an explanation
    - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
    - using evidence to design a solution to a problem
    - comparing solutions to a problem as to how well they meet criteria for success
    - comparing solutions in terms of constraints that limit the success of the solution

- Types of **evidence** may include, but are NOT limited to:
    - vertical ordering of rock layers
    - presence or absence of rock layers
    - presence or absence of fossils in rock layers
    - types of fossils in rock layers

- **Changes over time** may include, but are NOT limited to:
    - changes in a landscape and/or fossils due to changing climate
    - changes in a landscape due to weathering, erosion, and/or deposition
    - changes in a landscape due to tectonic forces and/or earthquakes

- **Patterns** used as evidence may include, but are NOT limited to:
    - sequence of fossils in rock layers
    - sequence of rock types in rock layers
    - presence, absence, or thickness of rock formations
    - presence, absence, or abundance of fossil types across rock layers

Performance Expectation	**5-ESS1-1** Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.	**ESS1.A: The Universe and its Stars** • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.	**Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 173–174	pp. 89–91
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 2	Appendix G pp. 6–7
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).		

Items may ask students to:

Code	Alignment	Item Specification
5-ESS1-1.1	SEP-DCI-CCC	**Support** an **argument** that **stars** closer to Earth have different **scales** of apparent size and/or apparent brightness than those of stars farther from Earth.
5-ESS1-1.2	SEP-DCI	**Support** an **argument** that **stars** closer to Earth appear larger and/or brighter than stars that are farther from Earth.
5-ESS1-1.3	DCI-CCC	Use the concept of **scale** to connect the apparent sizes and/or brightnesses of **stars** to their distances from Earth.
5-ESS1-1.4	SEP-CCC	**Support** an **argument** that objects exist at different scales.

Details and Clarifications

- **Support** an **argument** is expanded to include:
  - using evidence to support an argument and/or a claim
  - developing an argument and/or making a claim based on evidence, data, and/or a simple model
  - distinguishing between observations and inferences in an explanation and/or argument
  - comparing and/or refining arguments and/or claims based on evidence
  - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- Descriptions of **stars** may include, but are NOT limited to:
  - the sun
  - visible stars in the night sky

- Descriptions of **scale** may include, but are NOT limited to:
  - apparent sizes (e.g., large, small) of the sun and other stars
  - apparent brightnesses (e.g., bright, dim) of the sun and other stars
  - relative distances of the sun and other stars relative to Earth (e.g., closer to, farther away from)
  - comparisons of relative brightnesses, sizes, and distances of lit objects (e.g., bulbs, candles) in an investigation

Performance Expectation	**5-ESS1-2** Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.		
Dimensions	**Science & 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. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.	**ESS1.B: Earth and the Solar System** • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.	**Patterns** • Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 61–63	pp. 175–176	pp. 85–87
NGSS Appendices	Appendix F p. 9	Appendix E p. 2	Appendix G pp. 3–5
Clarification Statement	Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.		
Assessment Boundary	Assessment does not include causes of seasons.		

Items may ask students to:

Code	Alignment	Item Specification
5-ESS1-2.1	SEP-DCI-CCC	**Represent data** to show **patterns** of daily changes in length and/or direction of shadows, day and/or night, and/or the seasonal appearance of some stars in the night sky caused by Earth's **rotation** on its axis and/or **orbital relationships** among Earth, the sun, and/or the moon**.**
5-ESS1-2.2	SEP-DCI	**Represent data** to show changes in length and/or direction of shadows, day and/or night, and/or the appearance of some stars in the night sky caused by Earth's **rotation** on its axis and/or **orbital relationships** among Earth, the sun, and/or the moon**.**
5-ESS1-2.3	DCI-CCC	Use **patterns** to connect the daily changes in length and/or direction of shadows, day and/or night, and/or the seasonal appearance of some stars in the night sky caused by Earth's **rotation** on its axis and/or **orbital relationships** among Earth, the sun, and/or the moon**.**
5-ESS1-2.4	SEP-CCC	**Represent data** to show similarities and/or differences in patterns.

Details and Clarifications

- **Represent data** is expanded to include:
  - recording observations
  - organizing data in a table and/or graphical display (e.g., chart, graph)
  - summarizing data to identify relationships between data sets
  - comparing and/or contrasting data collected by different groups

- **Data** may include, but are NOT limited to, graphical displays of:
  - hours of daylight
  - length and/or direction of shadows
  - presence or absence of stars and/or constellations
  - phases of the moon

- **Rotational** and/or **orbital relationships** may include, but are NOT limited to:
  - Earth completes a single rotation on its axis once a day.
  - Earth completes a single orbit around the sun once a year.
  - Earth's moon completes a single orbit around Earth about once a month.

- **Patterns** in day and/or night may include, but are NOT limited to:
  - seasonal patterns in the duration of daylight
  - daily patterns of change in the length and/or direction of shadows
  - patterns of sunrise and/or sunset
  - patterns of appearance for stars and/or constellations

Performance Expectation	**3-ESS2-1** Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.		
Dimensions	**Science & 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. • Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.	**ESS2.D: Weather and Climate** • Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	**Patterns** • Patterns of change can be used to make predictions.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 61–63	pp. 186–189	pp. 85–87
NGSS Appendices	Appendix F p. 9	Appendix E p. 3	Appendix G pp. 3–5
Clarification Statement	Examples of data could include average temperature, precipitation, and wind direction.		
Assessment Boundary	Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.		

Items may ask students to:

Code	Alignment	Item Specification
3-ESS2-1.1	SEP-DCI-CCC	**Represent data** to show **patterns** of **change** in **weather conditions** across different seasons and/or locations that can be used to make **predictions**.
3-ESS2-1.2	SEP-DCI	**Represent data** of **weather conditions** across different seasons and/or locations.
3-ESS2-1.3	DCI-CCC	Use **patterns** of **change** in **weather conditions** across different seasons and/or locations to make **predictions**.
3-ESS2-1.4	SEP-CCC	**Represent data** to show patterns of change that can be used to make predictions.

Details and Clarifications

- **Represent data** is expanded to include:
  - recording observations
  - organizing data in a table and/or graphical display (e.g., chart, graph)
  - summarizing data to identify relationships between data sets
  - comparing and/or contrasting data collected by different groups

- **Data** may include, but are NOT limited to:
  - average temperature
  - amount and/or type of precipitation
  - wind direction and/or speed

- **Patterns** of **change** in **weather conditions** may include, but are NOT limited to:
  - average precipitation, temperature, and/or wind direction experienced in a location for several seasons and/or during the same season over several years
  - weather data recorded in different locations during the same season

- Weather **predictions** based on a **pattern** may include, but are NOT limited to:
  - the most likely temperature (e.g., high, low) during a future season and/or in a particular location
  - the most likely type and/or amount of precipitation in a future season and/or in a particular location

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.		
	Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Dimensions	**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.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 59–61	pp. 179–182 pp. 189–190	pp. 87–89
NGSS Appendices	Appendix F pp. 7–8	Appendix E p. 2 Appendix E p. 3	Appendix G pp. 5–6
Clarification Statement	Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.		
Assessment Boundary	Assessment is limited to a single form of weathering or erosion.		

Items may ask students to:

Code	Alignment	Item Specification
4-ESS2-1.1	SEP-DCI-CCC	**Make observations** and/or **measurements** to provide **evidence** of the **effects** of weathering and/or the rate of erosion by water, ice, wind, and/or vegetation on the physical characteristics of **Earth materials**.
4-ESS2-1.2	SEP-DCI	**Make observations** and/or **measurements** to provide **evidence** of weathering and/or erosion by water, ice, wind, and/or vegetation and/or changes in the physical characteristics of **Earth materials**.
4-ESS2-1.3	DCI-CCC	Use **cause and effect** relationships to connect weathering and/or the rate of erosion by water, ice, wind, and/or vegetation to changes in the physical characteristics of **Earth materials**.
4-ESS2-1.4	SEP-CCC	**Make observations** and/or **measurements** to provide evidence of cause and effect relationships used to explain change.

Details and Clarifications

- **Make observations** and/or **measurements** is expanded to include:
    - identifying relevant variables and/or data to be gathered in an investigation
    - describing appropriate methods and/or tools to collect data
    - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- **Observations** and/or **measurements** that provide **evidence** may include, but are NOT limited to:
    - relative slope of an angle for the downhill movement of water
    - relative frequency of freezing and/or thawing of water
    - relative amount of soil and/or sediment carried by water
    - relative water and/or wind speed
    - relative changes in the shape of Earth materials
    - type and/or amount of vegetation

- **Cause and effect** relationships that explain changes to physical characteristics may include, but are NOT limited to:
    - animal behavior (e.g., eating plants, building nests/dams) alters the physical environment
    - movement of wind, water, and/or ice breaks down rocks and/or changes the shape of landforms
    - movement of wind and/or water erodes rocks and/or removes vegetation

- **Earth materials** include, but are NOT limited to:
    - rocks
    - soil
    - water

Performance Expectation	**5-ESS2-1** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop a model using an example to describe a scientific principle.	**ESS2.A: Earth Materials and Systems** • Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	**Systems and System Models** • A system can be described in terms of its components and their interactions.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 56–59	pp. 179–182	pp. 91–94
NGSS Appendices	Appendix F p. 6	Appendix E p. 2	Appendix G pp. 7–8
Clarification Statement	Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.		
Assessment Boundary	Assessment is limited to the interactions of two systems at a time.		

Items may ask students to:

Code	Alignment	Item Specification
5-ESS2-1.1	SEP-DCI-CCC	**Develop** and/or **use** a **model** to describe **interactions** within and/or between **Earth systems**: the geosphere, the biosphere, the hydrosphere, and/or the atmosphere.
5-ESS2-1.2	SEP-DCI	**Develop** and/or **use** a **model** of the geosphere, the biosphere, the hydrosphere, and/or the atmosphere.
5-ESS2-1.3	DCI-CCC	Connect **interactions** within and/or between **Earth systems**: the geosphere, the biosphere, the hydrosphere, and/or the atmosphere.
5-ESS2-1.4	SEP-CCC	**Develop** and/or **use** a **model** to describe interactions within and/or between the components of a system.

Details and Clarifications

- **Develop** and/or **use** a **model** is expanded to include:
  - revising a complete or partial model
  - comparing complete or partial models
  - using a model to describe a scientific principle
  - using a model to describe a process
  - using a model to make predictions

- **Models** may include, but are NOT limited to:
  - diagrams
  - simulations
  - descriptions of interactions

- Components of **Earth systems** may include, but are NOT limited to:
  - geosphere: rock, soil, sediments
  - biosphere: living things
  - hydrosphere: water, ice
  - atmosphere: air, wind

- Examples of **interactions** between two **Earth systems** may include, but are NOT limited to:
  - wind shaping the land
  - organisms producing soil
  - landforms influencing weather conditions
  - the ocean affecting climate
  - water moving rocks, soil, and/or sediment

Performance Expectation	**3-ESS2-2** Obtain and combine information to describe climates in different regions of the world.		
Dimensions	**Science & 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 evaluating the merit and accuracy of ideas and methods. • Obtain and combine information from books and other reliable media to explain phenomena.	**ESS2.D: Weather and Climate** • Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	**Patterns** • Patterns of change can be used to make predictions.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 74–77	pp. 186–189	pp. 85–87
NGSS Appendices	Appendix F p. 15	Appendix E p. 3	Appendix G pp. 3–5
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-ESS2-2.1	SEP-DCI-CCC	**Obtain** and/or **combine information** to describe **climate patterns** in different regions of the world.
3-ESS2-2.2	SEP-DCI	**Obtain** and/or **combine information** to describe **climates** in different regions of the world.
3-ESS2-2.3	DCI-CCC	Use **patterns** to describe **climates** in different regions of the world.
3-ESS2-2.4	SEP-CCC	**Obtain** and/or **combine information** to make claims based on patterns.

Details and Clarifications

- **Obtain** and/or **combine information** is expanded to include:
  - summarizing information to describe a scientific concept and/or support a scientific claim
  - comparing information to describe a scientific concept and/or support a scientific claim

- **Information** formats may include, but are NOT limited to:
  - text
  - diagrams
  - graphs
  - tables
  - models
  - animations

- Examples of **climate patterns** may include, but are NOT limited to:
  - average temperatures
  - amounts and/or types of precipitation
  - seasonal variation of conditions within one or more regions

Performance Expectation	**4-ESS2-2** Analyze and interpret data from maps to describe patterns of Earth's features.		
Dimensions	**Science & 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.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 61–63	pp. 182–183	pp. 85–87
NGSS Appendices	Appendix F p. 9	Appendix E p. 2	Appendix G pp. 3–5
Clarification Statement	Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
4-ESS2-2.1	SEP-DCI-CCC	**Analyze** and/or **interpret data** from maps to describe **patterns** in the locations of **Earth's features**.
4-ESS2-2.2	SEP-DCI	**Analyze** and/or **interpret data** from maps to describe the locations of **Earth's features**.
4-ESS2-2.3	DCI-CCC	Use **patterns** to connect **Earth's features** to locations.
4-ESS2-2.4	SEP-CCC	**Analyze** and/or **interpret data** from patterns to support a description and/or explanation.

Details and Clarifications

- **Analyze** and/or **interpret data** is expanded to include:
  - recording observations
  - organizing data in a table or a graphical display (e.g., chart, graph)
  - summarizing data to identify relationships between data sets
  - comparing and/or contrasting data collected by different groups

- **Data** may include, but are NOT limited to:
  - locations of volcanoes
  - locations of deep ocean trenches and/or other ocean floor features
  - records of earthquake events

- Examples of **Earth's features** may include, but are NOT limited to:
  - boundaries between continents
  - mountain ranges
  - deep ocean trenches
  - volcanoes

- Examples of **patterns** in **Earth's features** may include, but are NOT limited to:
  - volcanoes occurring on continents and/or the ocean floor
  - earthquakes occurring deep below Earth's surface
  - mountain ranges forming within a continent and/or near the edges of continents
  - mountains, earthquakes, and/or volcanoes occurring near deep ocean trenches

Performance Expectation	**5-ESS2-2** Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.		
Dimensions	**Science & Engineering Practice**	**Disciplinary Core Idea**	**Crosscutting Concept**
	Using Mathematics and Computational Thinking Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. • Describe and graph quantities such as area and volume to address scientific questions.	**ESS2.C: The Roles of Water in Earth's Surface Processes** • Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.	**Scale, Proportion, and Quantity** • Standard units are used to measure and describe physical quantities such as weight and volume.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 64–67	pp. 184–186	pp. 89–91
NGSS Appendices	Appendix F p. 10	Appendix E p. 3	Appendix G pp. 6–7
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	Assessment is limited to oceans, lakes, rivers, glaciers, groundwater, and polar ice caps, and does not include the atmosphere.		

Items may ask students to:

Code	Alignment	Item Specification
5-ESS2-2.1	SEP-DCI-CCC	**Describe** and/or **graph quantities** using **standard units** to show that Earth's **available water** is distributed in various **reservoirs**.
5-ESS2-2.2	SEP-DCI	**Describe** and/or **graph quantities** to show that Earth's **available water** is distributed in various **reservoirs**.
5-ESS2-2.3	DCI-CCC	Use **standard units** to describe the quantities of Earth's **available water** distributed in various **reservoirs**.
5-ESS2-2.4	SEP-CCC	**Describe** and/or **graph quantities** using standard units.

Details and Clarifications

- **Describe** and/or **graph quantities** is expanded to include:
  - using mathematics to represent variables and their relationships
  - measuring, comparing, and/or organizing quantitative attributes (e.g., area, volume, mass) to reveal patterns that suggest relationships
  - graphing quantities to address scientific questions and/or problems

- **Reservoirs** containing Earth's **available water** include:
  - glaciers
  - groundwater
  - lakes
  - oceans
  - polar ice caps
  - rivers

- Descriptions of Earth's **available water** may include, but are NOT limited to:
  - comparison of the relative amounts of fresh water and/or salt water available on Earth
  - quantitative statements of the differences in amount and/or type of water in two or more reservoirs

- **Graphs** of Earth's **available water** may include, but are NOT limited to:
  - graphs showing amounts of fresh water and/or salt water in two or more reservoirs
  - graphs showing relative amounts of fresh water and/or salt water in two or more reservoirs

- **Standard units** may include, but are NOT limited to:
  - cubic meters
  - kilograms
  - liters

Performance Expectation	**3-ESS3-1** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.		
Dimensions	**Science & 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). • Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**ESS3.B: Natural Hazards** • A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. *(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)*	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones). **Connections to Nature of Science** **Science is a Human Endeavor** • Science affects everyday life.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 192–194	pp. 87–89 pp. 210–214
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 3	Appendix G pp. 5–6 Appendix J pp. 3–4 Appendix H p. 6
Clarification Statement	Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lighting rods.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-ESS3-1.1	SEP-DCI-CCC	**Make** a **claim,** using **cause and effect** relationships**,** about the merit of a **design solution** that reduces the impact of a **weather-related natural hazard.**
3-ESS3-1.2	SEP-DCI	**Make** a **claim** about the merit of a **design solution** that reduces the impact of a **weather-related natural hazard.**
3-ESS3-1.3	DCI-CCC	Use **cause and effect** relationships to connect a **weather-related natural hazard** to the impacts of that hazard.
3-ESS3-1.4	SEP-CCC	**Make** a **claim,** using cause and effect relationships, about the merit of a design solution.

Details and Clarifications

- **Make** a **claim** is expanded to include:
    - using evidence to support an argument and/or a claim
    - developing an argument and/or making a claim based on evidence, data, and/or a simple model
    - distinguishing between observations and inferences in an explanation and/or argument
    - comparing and/or refining arguments and/or claims based on evidence
    - using evidence to make a claim about the merit of a solution to a problem by describing how well the solution meets the criteria and/or the constraints of a problem

- Examples of a **design solution** may include, but are NOT limited to:
    - a dam or levee
    - a lightning rod
    - a change to the structure of a building
    - a coastal barrier

- **Weather-related natural hazards** may include, but are NOT limited to:
    - heavy rain and/or snow
    - lightning
    - low-pressure weather systems

- **Cause and effect** relationships may include, but are NOT limited to:
    - heavy rain or snow causing flooding and/or coastal erosion
    - lightning causing a forest fire or damage due to electrical energy
    - low-pressure weather systems causing tornadoes and/or hurricanes
    - a dam or levee controlling flooding in a town
    - a lightning rod reducing the chance of fire resulting from a lightning strike
    - changing the structure of a building to reduce wind or water damage
    - adding a coastal barrier to protect roads and/or buildings from high waves

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	**Science & 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** • 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. **Connections to Engineering, Technology, and Applications of Science** **Interdependence of Science, Engineering, and Technology** • Knowledge of relevant scientific concepts and research findings is important in engineering. **Influence of Engineering, Technology, and Science on Society and the Natural World** • Over time, people's needs and wants change, as do their demands for new and improved technologies.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 74–77	pp. 191–192	pp. 87–89 pp. 210–212 pp. 212–214
NGSS Appendices	Appendix F p. 15	Appendix E p. 3	Appendix G pp. 5–6 Appendix J pp. 3–4
Clarification Statement	Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
4-ESS3-1.1	SEP-DCI-CCC	**Obtain and combine information** to describe how human use of energy and/or fuels derived from **renewable** and/or **non-renewable resources** can **cause** changes to the environment**.**
4-ESS3-1.2	SEP-DCI	**Obtain and combine information** to describe the human use of energy and/or fuels derived from **renewable** and/or **non-renewable resources.**
4-ESS3-1.3	DCI-CCC	Use **cause and effect** relationships to connect the human use of energy and/or fuels derived from **renewable** and/or **non-renewable resources** to changes to the environment.
4-ESS3-1.4	SEP-CCC	**Obtain and combine information** to identify cause and effect relationships.

Details and Clarifications

- **Obtain and combine information** is expanded to include**:**
  - summarizing information to describe a scientific concept and/or support a scientific claim
  - comparing information to describe a scientific concept and/or support a scientific claim

- **Information** formats may include, but are NOT limited to**:**
  - text
  - diagrams
  - graphs
  - tables
  - models
  - animations

- **Renewable resources** may include, but are NOT limited to:
  - wind
  - water behind dams
  - sunlight
  - waves

- **Non-renewable resources** may include, but are NOT limited to:
  - fossil fuels
  - nuclear energy

- **Cause and effect** relationships may include, but are NOT limited to:
  - use of a natural resource decreases the availability of that resource
  - use of nonrenewable fuel resources decreases available habitats

<table>
<tr><td>Performance Expectation</td><td colspan="3">5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practices</td><td>Disciplinary Core Ideas</td><td>Crosscutting Concepts</td></tr>
<tr><td>Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.
• Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.</td><td>ESS3.C: Human Impacts on Earth Systems
• Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.</td><td>Systems and System Models
• A system can be described in terms of its components and their interactions.

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World
• Science findings are limited to questions that can be answered with empirical evidence.</td></tr>
<tr><td colspan="4">These item specifications were developed using the following reference materials:</td></tr>
<tr><td>K-12 Framework</td><td>pp. 74–77</td><td>pp. 194–196</td><td>pp. 91–94</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
p. 15</td><td>Appendix E
p. 3</td><td>Appendix G
pp. 7–8
Appendix H
p. 6</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">A clarification statement is not provided for this PE.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">An assessment boundary is not provided for this PE.</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
5-ESS3-1.1	SEP-DCI-CCC	**Obtain** and/or **combine information** about the components of and/or interactions between Earth's **resources** and/or **environments** and the ways individual communities use science ideas to **protect** them from the **effects** of **human activities**.
5-ESS3-1.2	SEP-DCI	**Obtain** and/or **combine information** about the **effects** of **human activities** on Earth's **resources** and/or **environments**.
5-ESS3-1.3	DCI-CCC	Connect the components of and/or interactions between Earth's **resources** and/or **environments** and the ways individual communities use science ideas to **protect** them from the **effects** of **human activities**.
5-ESS3-1.4	SEP-CCC	**Obtain** and/or **combine information** about the components of and/or interactions within a system.

Details and Clarifications

- **Obtain** and/or **combine information** is expanded to include**:**
  - summarizing information to describe a scientific concept and/or support a scientific claim
  - comparing information to describe a scientific concept and/or support a scientific claim

- **Information** formats may include, but are NOT limited to**:**
  - text
  - diagrams
  - graphs
  - tables
  - models
  - animations

- Ways to **protect** Earth's **resources** and/or **environments** may include, but are NOT limited to:
  - reusing and/or recycling materials to reduce trash
  - developing and/or choosing alternative sources of energy and/or fuels
  - developing technologies that preserve ecosystems
  - protecting areas to prevent future habitat loss

- **Effects** of **human activities** on Earth's **resources** and/or **environments** may include, but are NOT limited to:
  - modifying bodies of water affects the quality, availability, and/or distribution of Earth's water
  - use of forest land for development disrupts ecosystems
  - some industries decrease air quality

Performance Expectation	**4-ESS3-2** Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.		
Dimensions	**Science & 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.	**ESS3.B: Natural Hazards** • A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. *(Note: This Disciplinary Core Idea can also be found in 3.WC.)* **ETS1.B: Designing Solutions to Engineering Problems** • Testing a solution involves investigating how well it performs under a range of likely conditions. *(secondary)*	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 67–71	pp. 192–194 pp. 206–208	pp. 87–89
NGSS Appendices	Appendix F pp. 11–12	Appendix E p. 3 Appendix I pp. 1–7	Appendix G pp. 5–6 Appendix J pp. 3–4
Clarification Statement	Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.		
Assessment Boundary	Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.		

Items may ask students to:

Code	Alignment	Item Specification
4-ESS3-2.1	SEP-DCI-CCC	**Generate** and/or **compare solutions**, using **cause and effect** relationships, to reduce the **impacts** of **natural hazards** on humans.
4-ESS3-2.2	SEP-DCI	**Generate** and/or **compare solutions** to reduce the **impacts** of **natural hazards** on humans.
4-ESS3-2.3	DCI-CCC	Use **cause and effect** relationships to connect human solutions to the reduction of **impacts** from **natural hazards**.
4-ESS3-2.4	SEP-CCC	**Generate** and/or **compare** multiple **solutions** to a problem, using cause and effect relationships.

Details and Clarifications

- **Generate** and/or **compare solutions** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- **Solutions** may include, but are NOT limited to:
  - reducing the impact of a hazard through engineering of materials, structures, and/or landscapes
  - restricting humans from living in hazard-prone areas
  - monitoring and/or early warning systems

- **Impacts** of **natural hazards** may include, but are NOT limited to:
  - damage to or destruction of property
  - ecological changes (e.g., loss of habitat)
  - disruption of human activities

- **Natural hazards** resulting from natural processes include:
  - earthquakes
  - floods
  - tsunamis
  - volcanic eruptions

- **Cause and effect** relationships may include, but are NOT limited to:
  - an early warning system gives humans more time to evacuate an area
  - sandbags reduce water damage from a flood
  - tsunami evacuation routes allow people to move quickly to safe locations

Engineering, Technology, and Applications of Science

Disciplinary Core Ideas:

- ETS1 Engineering Design

Performance Expectation	**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.		
Dimensions	**Science & Engineering Practices**	**Disciplinary Core Ideas**	**Crosscutting Concepts**
	Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	**ETS1.A: Defining and Delimiting Engineering Problems** • Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • People's needs and wants change over time, as do their demands for new and improved technologies.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 54–56	pp. 204–206	pp. 212–214
NGSS Appendices	Appendix F pp. 4–5	Appendix I pp. 1–7	Appendix J pp. 3–4
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE		

Items may ask students to:

Code	Alignment	Item Specification
3-5-ETS1-1.1	SEP-DCI-CCC	**Define** a simple design **problem** reflecting a need and/or a want that includes specified **criteria** for a successful solution and/or **constraints** on materials, time, and/or cost that could limit the success of a solution.
3-5-ETS1-1.2	SEP-DCI	**Define** a simple design **problem** that includes specified **criteria** for a successful solution and/or **constraints** on materials, time, and/or cost that could limit the success of a solution.
3-5-ETS1-1.3	DCI-CCC	Connect **criteria** for a successful solution and/or **constraints** on materials, time, and/or cost that could limit the success of a solution to a design **problem** that reflects a need and/or a want.
3-5-ETS1-1.4	SEP-CCC	**Define** a simple design **problem** that reflects a need and/or a want.

Details and Clarifications

- **Define** a simple design **problem** is expanded to include:
    - asking questions about what would happen if a variable is changed
    - asking and/or identifying questions that can be answered through observation and/or investigation
    - predicting the outcome of questions that can be answered through observation and/or investigation
    - asking questions about observations, data, claims, and/or proposed designs
    - describing criteria for a successful solution
    - describing constraints on materials, time, and/or cost that could limit the success of a solution

- **Criteria** for a successful solution may include, but are NOT limited to:
    - relatively high degree of safety
    - relatively high effectiveness in solving specific aspects of the given problem
    - relatively low cost
    - relatively short time needed to implement
    - readily available materials

- **Constraints** that could limit the success of a solution may include, but are NOT limited to:
    - relative lack of safety
    - relative deficiency in solving specific aspects of the given problem
    - relatively high cost
    - relatively long period of time to implement
    - materials that are difficult to acquire

Performance Expectation	**3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.		
Dimensions	**Science & 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 problem.	**ETS1.B: Developing Possible Solutions** • Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. • At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs.	**Influence of Science, Engineering, and Technology on Society and the Natural World** • Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.
These item specifications were developed using the following reference materials:			
K-12 Framework	pp. 67–71	pp. 206–208	pp. 212–214
NGSS Appendices	Appendix F pp. 11–12	Appendix I pp. 1–7	Appendix J pp. 3–4
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-5-ETS1-2.1	SEP-DCI-CCC	**Compare solutions** to a problem using given **research** and/or **test results** to develop **improvements** that increase **benefits**, decrease **risks**, and/or meet **societal demands** while addressing known **criteria** and/or **constraints.**
3-5-ETS1-2.2	SEP-DCI	**Compare solutions** to a problem based on given **research** and/or **test results** and/or how well each solution addresses the known **criteria** and/or the **constraints** of each solution.
3-5-ETS1-2.3	DCI-CCC	Use given **research** and/or **test results** for solutions to a problem to develop **improvements** that increase **benefits**, decrease **risks**, and/or meet **societal demands** while addressing known **criteria** and/or **constraints.**
3-5-ETS1-2.4	SEP-CCC	**Compare solutions** to a problem based on improvements that increase benefits, decrease risks, and/or meet societal demands while addressing known criteria and/or constraints.

Details and Clarifications

- **Compare solutions** is expanded to include:
  - using measurements, observations, and/or patterns to support an explanation
  - using measurements, observations, and/or patterns to generate and/or compare solutions to a problem
  - using evidence to design a solution to a problem
  - comparing solutions to a problem as to how well they meet criteria for success
  - comparing solutions in terms of constraints that limit the success of the solution

- **Criteria** for a successful solution may include, but are NOT limited to:
  - relatively high degree of safety
  - relatively high effectiveness in solving specific aspects of the given problem
  - relatively low cost
  - relatively short time needed to implement
  - readily available materials

- **Constraints** that could limit the success of a solution may include, but are NOT limited to:
  - relative lack of safety
  - relative deficiency in solving specific aspects of the given problem
  - relatively high cost
  - relatively long period of time to implement
  - materials that are difficult to acquire

- **Research** and/or **test results** may include, but are NOT limited to:
  - Internet research
  - market research
  - experimental results
  - field observations

- **Improvements** of a solution to increase **benefits**, decrease **risks**, and/or meet **societal demands** may include, but are NOT limited to:
  - decreasing costs required to implement a solution
  - increasing the safety, resilience, and/or reliability of a solution
  - increasing the efficiency of a solution

Performance Expectation	**3-5-ETS1-3** Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		
Dimensions	**Science & 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. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**ETS1.B: Developing Possible Solutions** • Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. **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.	
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 59–61	pp. 206–208 pp. 208–210	
NGSS Appendices	Appendix F pp. 7–8	Appendix I pp. 1–7	
Clarification Statement	A clarification statement is not provided for this PE.		
Assessment Boundary	An assessment boundary is not provided for this PE.		

Items may ask students to:

Code	Alignment	Item Specification
3-5-ETS1-3.1	SEP-DCI-CCC	Due to the lack of a CCC, items are not coded 3-5-ETS1-3.1.
3-5-ETS1-3.2	SEP-DCI	**Plan** and/or **carry out fair tests** in which variables are controlled and/or **failure points** are considered to identify **aspects** of a **model** and/or **prototype** that can be improved.
3-5-ETS1-3.3	DCI-CCC	Due to the lack of a CCC, items are not coded 3-5-ETS1-3.3.
3-5-ETS1-3.4	SEP-CCC	Due to the lack of a CCC, items are not coded 3-5-ETS1-3.4.

Details and Clarifications

- **Plan** and/or **carry out fair tests** is expanded to include:
  - identifying relevant variables and/or data to be gathered in an investigation
  - describing appropriate methods and/or tools to collect data
  - collecting data that can be used to support an explanation, make comparisons, and/or make predictions

- Examples of **failure points** may include, but are NOT limited to:
  - not meeting one or more criteria for a successful solution
  - having one or more constraints that limit the success of a solution

- Examples of **aspects** of a **model** and/or **prototype** may include, but are NOT limited to:
  - inputs, outputs, and/or flow of energy and/or matter in a device
  - physical characteristics of a device
  - steps in a process

SEP, DCI, and CCC Vocabulary
Used in Assessment Items at Grade 5

Items use language targeted to the previous grade level or lower readability with the exception of the required SEP, DCI, and CCC terms in the following list.

a
absorb
acid
advantage
amplitude
angle
apparent brightness
attract
axis

b
balanced force
behavior
biosphere

c
camouflage
cause
characteristic
charge
claim
classify
climate
collision
communicate
compare
conclusion
condense
conductivity
conserve
constraint
continent
criteria

d
data
decomposer
decrease
deep ocean trench
defend
demonstration
describe
design
development
device
diagram
digital signal
disadvantage
disease
distance

e
earthquake
ecosystem
effect
electric current
electric force
electrical energy
electricity
electromagnet
energy
engineer
environment
erosion
eruption
evaporate
evidence
exert
extinct

f
factor
fault
food web
fossil
fossil fuel
function
fungi

g
gas
geosphere
glacier
global
graph
gravitational force
gravity
groundwater

h
habitat
hazard
heat energy
hydrosphere

i
impact
increase
information
inherit
input
interaction
investigation

l
landform
life cycle
light energy
limitation
liquid

m
magnet
magnetic force
marine
mass
mate
material
matter
measure
mineral
mixture
model
motion energy

n
nonrenewable

o
object
observation
offspring
orbit
organism
output

p
particle
pattern
physical property
planet
polar ice cap
pole (of a magnet)
pollen
pollution
population
precipitation
predator
prediction
prey
process
property

q
quantity

r
recycle
reduce
refine
reflect
relationship
renewable
repel
reproduction
research
resource
response
result
rock formation
rock layer
rotate
runoff

s
scientist
sediment
sense receptor
shelter
similarity
simulation
solar energy
solid
solution (to a problem)
sound energy
source
species
speed
sprout
stability
state (of matter)
stationary
structure
substance
subsystem
support
surface
survive
system

t
technology
temperature
toxin
trait
transfer
tsunami

u
unbalanced force

v
validity
variable
volcano
volume

w
wave
wavelength
weathering
wetland
wind energy