Washington Comprehensive Assessment of Science

Test Design & Item Specifications

High School

Office of Superintendent of Public Instruction

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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 Applications of Science. Each domain has three-dimensional performance expectations, which integrate science and engineering practices, disciplinary core ideas, and crosscutting concepts. The assessments will be administered in grades 5, 8, and 11 for federal and state accountability purposes beginning 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 first 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 current draft represents a small sample of PEs; the sample will continue to expand through the 2017–18 and 2018–19 school years until full PE coverage is achieved. Future item specifications drafts will include modification logs that will be updated at each subsequent publication, based on input from Washington educators.

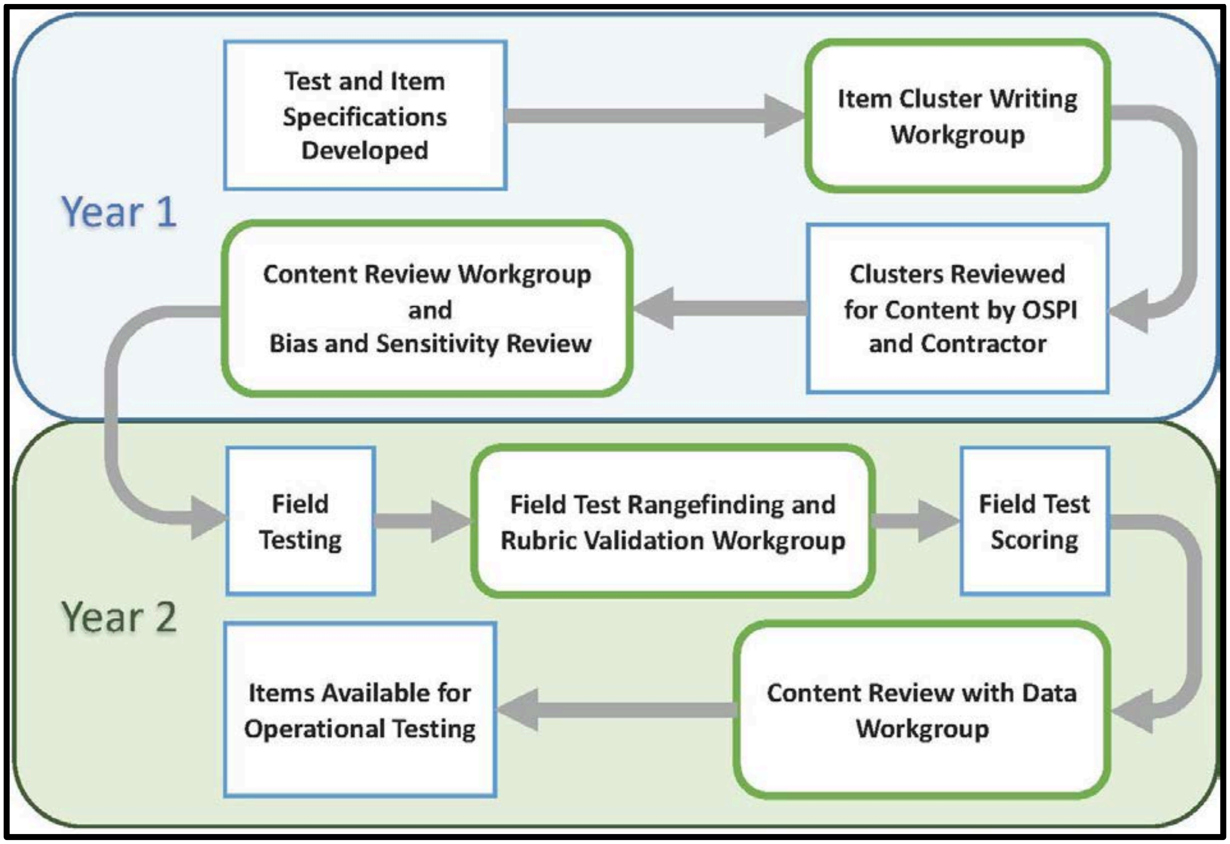
Assessment Development Cycle

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 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 students might encounter
- 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 applied in a valid manner
- Include technology-enhanced and short-answer items that can be scored in a reliable manner

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 2–3 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 and Rubric Validation Workgroup**, educators look at a range of student responses to each item and decide how to score each response. This educator workgroup refines scoring rubrics and produces the materials that will be 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.

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.

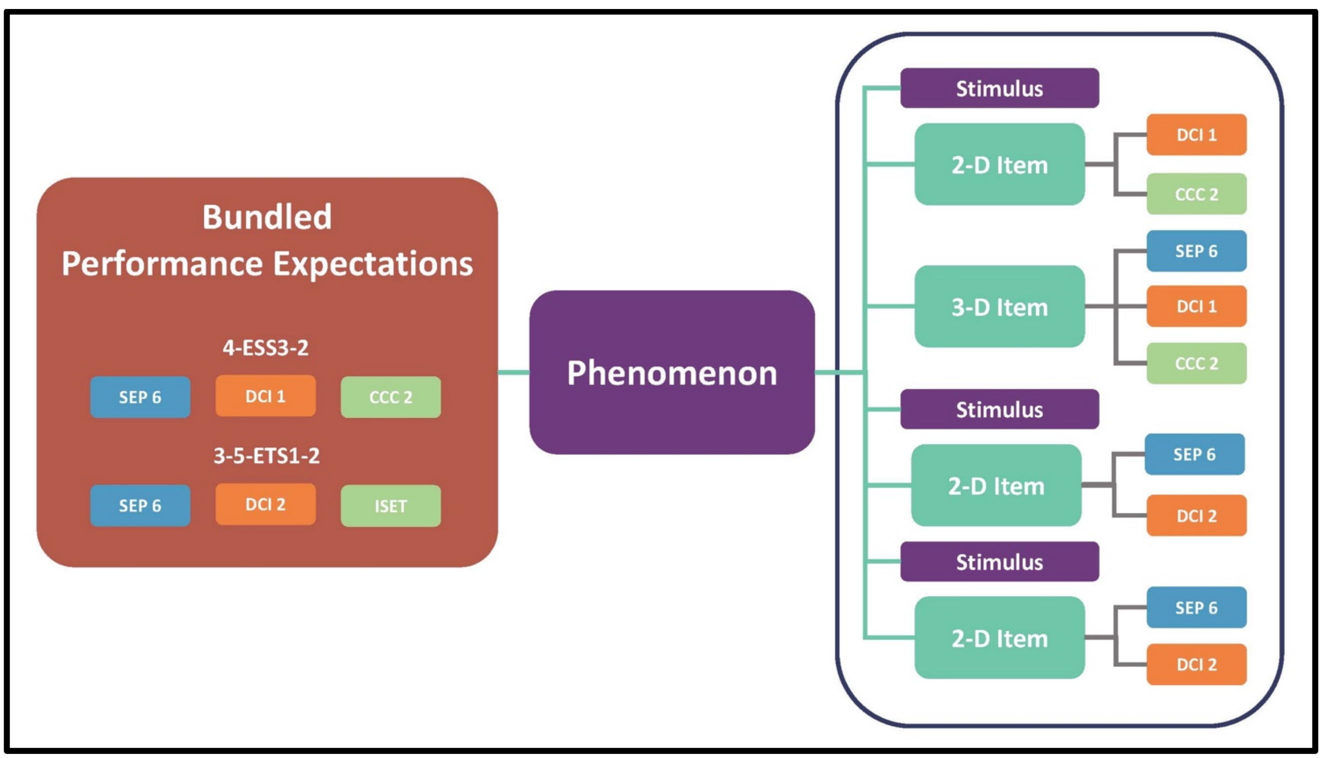
Item Clusters

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 a science and engineering practice (SEP), disciplinary core idea (DCI), and crosscutting concept (CCC) 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 will align to two or three dimensions (2-D, 3-D) from one or more of the PEs 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 will 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 on to the next 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 forward 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 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.

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 can be accessed on the [Washington Comprehensive Assessment Program (WCAP) Portal]() beginning late 2017.

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 will typically be between two and four.
- The length of options in a drop-down list will typically be 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 into predesignated boxes 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 interact with and construct simple graphs.

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 will present a clear indication of what is required so students will 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 or misunderstandings, naive preconceptions, or other misconceptions.
- Distractors will not be partially correct.
- The options “All of the above” and “None of the above” will not be 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 will present a clear indication of what is required so students will 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 or misunderstandings, naive preconceptions, or other misconceptions.
- Distractors will not be partially correct.
- The options "All of the above" and "None of the above" will not be used.

Short Answer (SA)

- Students write a response based on a specific task statement.
- Directions will give clear indications of the response required of students.
- When appropriate, bullets after phrases like “In your description, be sure to:" will 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 will specifically prompt 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 will be developed for each ETC, HT, SIM, TI, MI, and SA during the writing of the item.
- Scoring rubrics will not consider conventions of writing (complete sentences, usage/grammar, spelling, capitalization, punctuation, and paragraphing).
- Scoring rubrics will be 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 interaction in each part (e.g., an MC followed by an ETC). One example of this approach would be 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 can be 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, HT, MC, MS, SIM, TI, and MI items are worth 1 point.
- GI and SA items are worth 1 or 2 points.

Test Design

Operational Test Form

Each operational test form will contain 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 test are anchored or 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 six clusters and six to twelve standalone items.

In addition:

- One PE from 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 will increase DCI, SEP, and CCC coverage to achieve overall expectations.

Field Test Items

Operational test forms will contain embedded field test items, which will either be a set of items associated with a cluster or a group of standalone items. Several clusters and standalone items will be field tested in a given administration. The field test items will not contribute to the student’s score.

Testing Times

The WCAS is intended to be administered online in one to three sessions. The approximate 150-minute administration time includes 30 minutes for giving directions and distributing materials, 105 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.

A periodic table is embedded in the online platform for all items in the WCAS for grade 8 and high school. A printable version of the periodic table can be downloaded for classroom use on the WCAP Portal.

Test Blueprint

The total number of points for the WCAS in high school will be 45 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 will not be represented by a separate item cluster, but will be bundled in at least one item cluster. ETS points are not specified, and ETS PEs were not included when calculating the percentages.

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

Table 1

Reporting Claim	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	36%	31–41%	14–18
Practices and Crosscutting Concepts in Life Sciences	36%	31–41%	14–18
Practices and Crosscutting Concepts in Earth and Space Sciences	28%	23–33%	11–15

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 will pull up a complete list of associated PEs at the given grade level. For example, searching the website for MS-ESS1 will pull up a list of associated PEs at the middle school level (MS-ESS1-1 through MS-ESS1-4). Substituting another grade level for "MS" will pull up 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 can be found 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.

To build the links, DCIs are broken up into several groups within three primary domains: Life Sciences (LS), Physical Sciences (PS), and Earth and Space Sciences (ESS). The Engineering, Technology, and Applications of Science (ETS; also sometimes called Engineering Design) DCIs are treated somewhat differently from the other DCIs in that they appear in separate ETS PEs.

For both the standards and the WCAS Item Specifications, the DCI statement is presented in the central column, inside an orange box. 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 can be found 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 both 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 can be found in NGSS Appendix G.

Evidence Statements

OSPI uses the NGSS evidence statements to guide development of two- and three-dimensional items. The 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

Evidence statements are written primarily from the focus of the SEP dimension. Therefore, developing two-dimensional items aligned to a DCI and a CCC sometimes requires moving entirely outside the scope of the evidence statement. With that said, it is also acceptable to write items to a particular part of an evidence statement (e.g., leaving the SEP portion of the evidence statement out of the item design and writing only to the CCC and DCI elements). Aligning an item to a combination of evidence statements is also permissible, and is often done when items leverage the complexity of real-world scientific phenomena.

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 still align to the SEP.

WCAS Item Specifications

The science assessment team at OSPI has been working 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 will revise 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 will be 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, and examples of expected DCI science vocabulary that might be employed in assessment of the PE. Items in the high school WCAS use language targeted to a reading level of eighth grade or lower with the exception of the expected science terms. A list of expected SEP 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 will involve making observations of specific types of evidence related to the DCI. The Details and Clarifications section lists types of observations that are permissible under this PE, as well as the forms of evidence that are within the bounds of the PE.

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 Practice**	**Disciplinary Core Idea**	**Crosscutting Concept**
	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.		
Expected DCI Vocabulary	behavior, function, growth, reproduction, structure, survival		

Items may ask students to:

Code	Alignment	Item Specification
4-LS1-1.1	SEP-DCI-CCC	**Construct** an **argument** using **system models** to describe plants and/or animals 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 **function**s.
4-LS1-1.3	DCI-CCC	Connect the crosscutting concept of systems and **system models** to plant and/or animal **structures** that serve various survival, growth, behavioral, 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:
  - developing an argument based on evidence, data, or a simple model
  - distinguishing between observations and inferences in an explanation or argument
  - comparing and/or refining arguments based on evidence
  - providing feedback on an explanation or argument
  - using evidence to evaluate claims
- **Structures** and **functions** may include, but are NOT limited to structures that work together to support:
  - plants
    - obtaining water/sunlight/air
    - growing toward sunlight and/or water
    - defending against herbivores
    - attracting pollinators
  - animals
    - pumping blood/breathing/moving/digesting food
    - obtaining food
    - defending against predators
    - attracting mates
- **System models** 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

Modification Log

Date	Comments

As stated earlier in this document, the item specifications that follow represent a small sample of PEs; the sample will continue to expand through the 2017–18 and 2018–19 school years until full PE coverage is achieved. Future item specifications drafts will include modification logs that will be updated at each subsequent publication, based on input from Washington educators.

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*. Washington, DC: Council of Chief State School Officers.

National Research Council (NRC). (2012). *A framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: National Academies Press.

National Research Council. (2014). *Developing Assessments for the Next Generation Science Standards*. Washington, DC: The National Academies.

Next Generation Science Standards (NGSS) Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

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	**HS-PS1-5** Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.		
Dimensions	**Science & Engineering Practice**	**Disciplinary Core Idea**	**Crosscutting Concept**
	Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**PS1.B: Chemical Reactions** • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 67–71	pp. 109–111	pp. 85–87
NGSS Appendices	Appendix F p. 11	Appendix E p. 7	Appendix G pp. 3–4
Clarification Statement	Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.		
Assessment Boundary	Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.		
Expected DCI Vocabulary	atom, bond, chemical process, collision, concentration, energy, kinetic energy, molecule, reaction, reaction rate, temperature		

Items may ask students to:

Code	Alignment	Item Specification
HS-PS1-5.1	SEP-DCI-CCC	**Provide** an **explanation** for how **patterns** observed when a chemical reaction is studied provide **evidence** of **chemical processes**.
HS-PS1-5.2	SEP-DCI	**Provide** an **explanation** that chemical reactions can provide **evidence** of **chemical processes**.
HS-PS1-5.3	DCI-CCC	Connect the crosscutting concept of **patterns** to an understanding of **chemical processes**.
HS-PS1-5.4	SEP-CCC	**Provide** an **explanation** that **patterns** can provide **evidence** for causality in an observed phenomenon.

Details and Clarifications

- **Provide** an **explanation** is expanded to:
  - making claims regarding dependent and/or independent variables
  - constructing and/or revising an explanation supported by valid and reliable evidence
  - linking evidence to claims to assess support of an explanation or conclusion
- **Evidence** may include, but is not limited to:
  - changes in temperature
  - changes in reactant concentration
  - changes in product concentration
  - changes in reaction rate
- **Chemical processes** include, but are not limited to:
  - collisions between molecules that break or form new bonds
  - the rearrangement of atoms into new molecules
  - changes in the bond energy and/or kinetic energy of molecules in a reaction
- **Patterns** may include, but are not limited to:
  - the relationship between temperature and reaction rate
  - the relationship between reactant concentration and reaction rate
  - the relationship between product concentration and reaction rate

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Performance Expectation	**HS-PS2-6** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.		
Dimensions	**Science & Engineering Practice**	**Disciplinary Core Idea**	**Crosscutting Concept**
	Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Communicate scientific and technical information (e.g., about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**PS2.B: Types of Interactions** • Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.	**Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 74–77	pp. 116–118	pp. 96–98
NGSS Appendices	Appendix F p. 15	Appendix E p. 7	Appendix G pp. 9–10
Clarification Statement	Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.		
Assessment Boundary	Assessment is limited to provided molecular structures of specific designed materials.		
Expected DCI Vocabulary	atom, attraction, chemical bond, collision, contact force, electric charge, electrostatic force, intermolecular force, molecule, polarity, repulsion		

Items may ask students to:

Code	Alignment	Item Specification
HS-PS2-6.1	SEP-DCI-CCC	**Communicate information** about the role of **attraction and repulsion** of electric charges at the atomic scale in determining the **structure**, properties, and/or transformations of matter and the resulting **function** of designed materials.
HS-PS2-6.2	SEP-DCI	**Communicate information** about how atomic-level **attraction and repulsion** explains the structure, properties, and/or transformations of matter.
HS-PS2-6.3	DCI-CCC	Connect the crosscutting concept of **structure and function** to the **attraction and repulsion** between electric charges at the atomic level.
HS-PS2-6.4	SEP-CCC	**Communicate information** about how **structure** and/or properties of systems can reveal the **function** of the system.

Details and Clarifications

- **Communicate information** is expanded to include:
  - identifying scientific and/or technical evidence, concepts, processes, or information
  - evaluating the validity and/or reliability of claims from different sources
  - integrating multiple sources of information to construct and/or support an explanation
  - summarizing complex information
- **Information** may include, but is not limited to:
  - graphs
  - text
  - tables
  - diagrams
  - graphs
  - models
- Examples of **attraction and repulsion** may include, but are not limited to:
  - attractive and/or repulsive electrical (i.e. electrostatic) forces between molecules
  - attraction and/or repulsion among electric charges among atoms within a molecule
- Examples of **structure and function** relationships may include, but are not limited to:
  - how the structure and/or properties of matter and/or the types of interactions of matter at the atomic scale determine macroscopic properties of a designed material
  - how a designed material's properties make it suitable for use in its designed function

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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

<table>
<tr><td>Performance Expectation</td><td colspan="3">HS-LS2-6 Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.</td></tr>
<tr><td rowspan="2">Dimensions</td><td>Science & Engineering Practice</td><td>Disciplinary Core Idea</td><td>Crosscutting Concept</td></tr>
<tr><td>Engaging in Argument from Evidence
Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.
• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence
• Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.</td><td>LS2.C: Ecosystem Dynamics, Functioning, and Resilience
• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.</td><td>Stability and Change
• Much of science deals with constructing explanations of how things change and how they remain stable.</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. 71–74</td><td>pp. 154–156</td><td>pp. 98–101</td></tr>
<tr><td>NGSS Appendices</td><td>Appendix F
pp. 13–14

Appendix H
pp. 4–5</td><td>Appendix E
p. 5</td><td>Appendix G
pp. 10–11</td></tr>
<tr><td>Clarification Statement</td><td colspan="3">Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.</td></tr>
<tr><td>Assessment Boundary</td><td colspan="3">There is no assessment boundary provided for this PE.</td></tr>
<tr><td>Expected DCI Vocabulary</td><td colspan="3">biodiversity, ecosystem, equilibrium, negative feedback, organism, positive feedback, resilience, stability</td></tr>
</table>

Items may ask students to:

Code	Alignment	Item Specification
HS-LS2-6.1	SEP-DCI-CCC	**Evaluate** the claims, evidence, and/or reasoning behind currently accepted **explanations** of how the **complex interactions** within an ecosystem help maintain **stability** and/or cause **change**.
HS-LS2-6.2	SEP-DCI	Due to strong overlap between the DCI and the CCC, items are not coded HS-LS2-6.2.
HS-LS2-6.3	DCI-CCC	Connect the crosscutting concept of **stability and change** to the **complex interactions** within an ecosystem that help maintain **stability** and/or cause **change**.
HS-LS2-6.4	SEP-CCC	**Evaluate** the claims, evidence, and/or reasoning behind currently accepted **explanations** of how things **change** and/or how things **remain stable**.

Details and Clarifications

- **Evaluate explanations** is expanded to include:
    - identifying criteria used to critique claims
    - comparing competing arguments in light of evidence
    - determining the merit of an explanation
    - constructing and/or supporting an argument based on evidence
    - constructing and/or supporting a claim with evidence
- **Complex interactions** may include, but are not limited to:
    - relationships among different species
    - relationships between populations and their environment
    - biological disturbances and the effect on populations
    - physical disturbances and the effect on populations
    - resources affecting population size
- **Explanations** of **stability and change** may include, but are not limited to:
    - biological and/or physical disturbances can change the types and/or numbers of the ecosystem's species
    - ecosystems with modest disruptions maintain stable conditions or return to their original state after the disruption
    - extreme fluctuations in ecosystem conditions can change the resources and/or habitat availability to such a degree that the ecosystem cannot return to its original state and instead becomes a very different ecosystem
    - feedback can stabilize or destabilize an ecosystem

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Performance Expectation	**HS-LS3-1** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.		
Dimensions	**Science & Engineering Practice**	**Disciplinary Core Ideas**	**Crosscutting Concept**
	Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. • Ask questions that arise from examining models or a theory to clarify relationships.	**LS1.A: Structure and Function** • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary) *(Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)* **LS3.A: Inheritance of Traits** • Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 54–56	pp. 143–145 pp. 158–159	pp. 87–89
NGSS Appendices	Appendix F p. 4	Appendix E p. 4 Appendix E p. 6	Appendix G p. 5
Clarification Statement	There is no clarification statement provided for this PE.		
Assessment Boundary	Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.		
Expected DCI Vocabulary	chromosome, code, DNA, gene, gene expression, protein, trait		

Items may ask students to:

Code	Alignment	Item Specification
HS-LS3-1.1	SEP-DCI-CCC	**Ask questions** to clarify **cause and effect** relationships between the structure and function of **DNA** and **chromosomes** and the **inherited traits** observed in an organism.
HS-LS3-1.2	SEP-DCI	**Ask questions** about the structure and function of **DNA** and **chromosomes** and the **inherited traits** observed in an organism.
HS-LS3-1.3	DCI-CCC	Connect the crosscutting concept of **cause and effect** to the structure and function of **DNA**, **chromosomes**, and the **inherited traits** observed in an organism.
HS-LS3-1.4	SEP-CCC	**Ask questions** to clarify **cause and effect** relationships.

Details and Clarifications

- **Ask questions** is expanded to include:
    - asking, identifying, and/or refining questions that can be answered with evidence from an investigation
    - asking and/or identifying questions to clarify a model, argument, explanation, and/or data
    - evaluating the testability and/or relevance of a question
    - asking or evaluating questions that challenge the premise of an argument
- Relationships among **DNA**, **chromosomes**, and **inherited traits** may include, but are NOT limited to:
    - chromosomes consist of genes made from DNA
    - each chromosome pair in a cell contains two variants of each gene
    - DNA contains instructions that code for specific proteins
    - proteins produced by a cell affect an organism's inherited traits
    - mutations to genes and/or chromosomes can result in changes to proteins, resulting in changes to an organism's traits
    - not all sections of DNA on a chromosome code for inherited traits
    - the cells of an organism express different inherited traits as a result of expressing different genes
- Evidence of **cause and effect** relationships may include, but is NOT limited to:
    - the effects of cell types on the type of proteins produced by a cell
    - the effects of a genetic mutation on the type of protein produced or trait expressed
    - the effects of DNA and/or gene sequence on the type of protein produced or trait expressed

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Earth and Space Sciences

Disciplinary Core Ideas:

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

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Performance Expectation	**HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.		
Dimensions	**Science & Engineering Practice** **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**Disciplinary Core Ideas** **ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	**Crosscutting Concept** **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. **Connections to Engineering, Technology, and Applications of Science** **Influence of Engineering, Technology, and Science on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 61–63	pp. 179–182 pp. 186–189	pp. 98–101
NGSS Appendices	Appendix F p. 9	Appendix E p. 2 Appendix E p. 3	Appendix G pp. 10–11 Appendix J pp. 2–4
Clarification Statement	Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.		
Assessment Boundary	There is no assessment boundary provided for this PE.		
Expected DCI Vocabulary	absorption, atmosphere, biosphere, climate, cryosphere, electromagnetic radiation, equilibrium, feedback, geosphere, hydrosphere, radiation, reflection		

Items may ask students to:

Code	Alignment	Item Specification
HS-ESS2-2.1	SEP-DCI-CCC	**Analyze data** to make claims that **interactions** within and/or between Earth's systems cause **feedback** that can affect **stability** and/or **cause change** to other Earth systems.
HS-ESS2-2.2	SEP-DCI	**Analyze data** to make claims that **interactions** within and/or between Earth's systems cause **feedback**.
HS-ESS2-2.3	DCI-CCC	Connect the crosscutting concept of **stability** and/or **change** resulting from **feedback** to **interactions** within and/or between Earth's systems.
HS-ESS2-2.4	SEP-CCC	**Analyze data** to make claims that **feedback** can affect **stability** and/or cause **change** in Earth's systems.

Details and Clarifications

- **Analyze data** is expanded to include:
  - organizing and/or interpreting data using tables, graphs, and/or statistical analysis
  - identify relationships in data using tables and/or graphs
  - identifying limitations (e.g., measurement error, sample selection) in data
  - comparing the consistency in measurements and/or observations in sets of data
  - using analyzed data to support a claim and/or an explanation
- Examples of **interactions** may include, but are NOT limited to:
  - atmospheric phenomena and/or oceanic processes that interact with the land, living things, or each other to influence weather and/or climate
  - energy inputs from the sun interacting with matter in the atmosphere and Earth's surface to influence climate, living things, and/or Earth's surface features
  - energy released from Earth's interior driving changes in Earth's surface features that influence weather, climate, living things, and/or oceans
  - water, ice, wind, or organisms interacting with materials on Earth's surface to shape landforms (i.e., through erosion, weathering, deposition)
- **Feedback** that affects **stability** or **change** may include, but is NOT limited to:
  - examples in which the magnitude or impact of an initial change is counteracted to stabilize a condition in one or more of Earth's systems
  - examples in which the magnitude or impact of an initial change is increased and can destabilize a condition in one or more of Earth's systems
  - examples of effects of a technology that can stabilize or destabilize a condition in one or more of Earth's systems

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Performance Expectation	**HS-ESS3-2** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.		
Dimensions	**Science & Engineering Practice** **Engaging in Argument from Evidence** Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).	**Disciplinary Core Ideas** **ESS3.A: Natural Resources** • All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary)	**Crosscutting Concepts** **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to Nature of Science** **Science Addresses Questions About the Natural and Material World** • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. • Science knowledge indicates what can happen in natural systems — not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.
These item specifications were developed using the following reference materials:			
K–12 Framework	pp. 71–74	pp. 191–192 pp. 206–208	N/A
NGSS Appendices	Appendix F pp. 13–14	Appendix E p. 3 Appendix I pp. 1–7	Appendix H pp. 4-6 Appendix J pp. 2–4
Clarification Statement	Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.		
Assessment Boundary	There is no assessment boundary provided for this PE.		
Expected DCI Vocabulary	conservation, constraint, cost-benefit ratio, extraction, mineral resources, nonrenewable energy, recycle, regulation, renewable energy		

Items may ask students to:

Code	Alignment	Item Specification
HS-ESS3-2.1	SEP-DCI-CCC	**Evaluate** competing design **solutions** for **energy production** and/or **resource extraction** based on analysis of **costs, risks,** and/or **benefits**.
HS-ESS3-2.2	SEP-DCI	Due to strong overlap between the DCI and the CCC, items are not coded HS-ESS3-2.2.
HS-ESS3-2.3	DCI-CCC	Connect the analysis of **costs, risks,** and/or **benefits** to **energy production** and/or **resource extraction**.
HS-ESS3-2.4	SEP-CCC	**Evaluate** competing design **solutions** while analyzing **costs, risks,** and/or **benefits.**

Details and Clarifications

- **Evaluate** competing design solutions is expanded to include**:**
  - using reasoning and/or argument to identify the best solution to a problem
  - identifying criteria used to judge the success of solutions
  - comparing competing design solutions in light of evidence and/or cost-benefit ratios
  - assessing claims, evidence, and/or reasoning behind currently accepted solutions
- **Solutions** related to **energy production** and/or **resource extraction** may include, but are not limited to, technologies or methods for:
  - enhancing renewable energy as a source of energy production
  - improving benefits or decreasing costs of renewable energy sources
  - decreasing costs and/or risks associated with the extraction of metal, mineral, and/or fossil fuel resources
  - decreasing costs and/or risks associated with the use of natural resources
  - increasing the availability of natural resources through conservation, recycling, and/or reuse
  - determining locations where resource extraction is viable and impact is minimal
- Examples of **costs, risks,** and/or **benefits** may include, but are NOT limited to:
  - economic (e.g., cost of extracting resources or developing energy, value of resources)
  - social (e.g., resource locations correlated to size of human populations, societal needs for resources)
  - environmental (e.g., earthquakes after extracting resources, displacement of organisms, habitat destruction)
  - geopolitical (e.g., international trade of resources, collaborative design solutions)
- **Solutions** related to **costs, risks,** and/or **benefits** may include, but are NOT limited to:
  - conserving, recycling, and/or reusing resources (e.g., minerals, metals) to increase cost-benefit ratios
  - suggesting new tools or technology for resource production or usage
  - proposing technology/engineering designs or practices that reduce risks and/or costs
  - identifying improvements for a component of a current design solution

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Expected Vocabulary Specific to the Science & Engineering Practices and Crosscutting Concepts

- cause
- change
- claim
- constraints
- criteria
- data
- effect
- energy
- evidence
- explanation
- function
- graph
- interaction
- investigation
- limitations
- mass
- matter
- model
- pattern
- proportion
- quantity
- scale
- solution
- stability
- structure
- system
- system model
- volume