WASHINGTON LEADERSHIP ACADEMY

Integrated and Experimental Sciences I

The National Academies of
SCIENCES · ENGINEERING · MEDICINE

Course Overview for Science

Science education must more than just the basic concepts of science. Students need to understand the characteristic features of science as a form of human inquiry and knowledge acquisition, and to be aware of how science and resulting technologies shape our material environments and our intellectual worldviews. Students need to be equipped with the skills to be able to use scientific knowledge to identify questions, and to draw evidence-based conclusions in order to understand and make decisions about the natural world and the changes made to it through human activity. Students also need to be equipped with ethics and attitudes to engage wisely in science- and technology-related issues as concerned citizens.

The science curriculum at Washington Leadership Academy is developed from the Next Generation Science Standards (NGSS), and A Framework for K–12 Science Education published by the National Research Council of the National Academy of Sciences. The goal of science education is outlined in their Framework: the overarching goal of our framework for K–12 science education is to ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology. (National Research Council 2012)

The power of these science standards is that they support teachers in customizing their courses, aligned with the best thinking about learning progressions and practices in science education. The standards support curriculum design based on several principles, including:

Three-dimensional learning Science education has too often been just a memorization of facts in what appear to students to be disconnected disciplines not relevant to their experience. The NGSS instead establishes explicit performance expectations (PE) – allowing students to clearly demonstrate what they have learned and can do - based upon three dimensions of science: disciplinary core ideas, science and engineering practices, and crosscutting concepts. Students should learn that science is a collective effort and a way of thinking and acquiring knowledge, not just a collection of facts.

Meaningful assessment Student learning should be assessed in multiple ways to help guide instruction and to evaluate student progress towards mastery. The standards are based on performance expectations, which are designed to reflect that what we know science cannot be understood as distinct from how it is known through scientific investigation or how it applied through technology or engineering. Performance expectations provide teachers with a variety of informal assessment opportunities to monitor student thinking and progress.

Student motivation and engagement The context for learning is important for effective science education. Students learn science by actively engaging in the practice of science in a community of learner, linked to students' interests and experiences. Motivation will be sparked with projects that promote autonomy, creativity, and teamwork, and that are relevant to students' interests. Whenever possible, this will include consideration of technological applications and social implications of the science concepts students are learning.

Competency Sets

Next Generation Science Standards/ Science and Engineering Practices
ACT College and Career Readiness Standards for Science

Organizing Concepts and Modules for this Course

Learning modules are organized around three large organizing concepts – models, systems, and interactions - and associated essential questions.

Organizing Concept	Modules
Models	1. Models of the Structure and Properties of Matter 2. Structure and Function in Living Systems 3. Wave Properties
Systems	4. Chemical Reactions 5. Growth and Development of Organisms
Interactions	6. Forces and Motion 7. Conservation of Energy and Energy Transfer 8. Interdependent Relationships in Ecosystems 9. Plate Tectonics and Large Scale Interactions

Instructional Model and Implementation Strategies for Science

Students will take Science every other day for 90-minutes. The course will integrate a scientific anchor topic (see modules) with a set of experimental skills. The course aligns experimentation to the study of a topic and vis versa meaning that students learn concepts both through direct instruction and the capturing of core knowledge but also through experimentation, modeling, and observation. A variety of instructional methods will be used.

Instructional Playlists: Students will acquire factual knowledge of science topics through curated playlists that introduce topics and concepts using a variety of multimedia including video-based instruction, slide decks, short reads, and experimental demonstration. These playlists are accompanied by digital assessments at intervals where the curator feels is appropriate for assessment.

Close Reading: Students will regularly engage in text associated with the scientific concepts they are learning. The science teacher will model these close using the pre-complex text sequencing laid out in the ELA curriculum as well as the CERCA method.

Experiment-based Instruction: courses will be taught using variable methods of experimentation that engage students in concepts through modeling and inquiry:

- **Prescriptive/Confirmation Experimentation:** students follow a list of instructions to complete an experiment, test, or observation that models or demonstrates a concept
- **Challenge-based Experimentation:** students are given a challenge or problem to solve using scientific concepts they have learned and an allotted set of materials
- **Guided/Structured Experimentation:** the teacher facilitates an experiment with specific checkpoints for students to extrapolate connections to concepts and then determine the next steps
- **Open Experimentation:** the teacher allots time, materials and space for a student to investigate a concept

Engineering and Design Thinking Challenges: students are provided materials and a challenge to engineer a physical solution to a problem, test prototypes, and design new models. Students work independently and collaboratively to reach specific outcomes.

Accountable video-based Instruction: videos used to introduce or review a specific scientific concept that includes practice problems and scenarios within the video ensuring that students attention and time spent. Student usage data is tracked as well as their achievement data on video-associated assessments.

Other Instructional Strategies:

- Harkness Model Seminars for Science
- Socratic Seminar/Autonomous Discussion Structures
- Argument-centered Reading and Writing
- Collaborative Group Experiments

Methods of Assessment for Integrated and Experimental Sciences

Digital Formative Assessments (Exit Tickets): students will take small digital assessments at the end of a lesson that assesses their understanding of scientific concepts and skills addressed in the lesson. These assessments provide small, instantaneous feedback to students on their learning.

Performance-based Assessments for ACT Science Standards: Students will be given research and experimental tasks to complete as they acquire specific experimentation skills. These skills will align themselves to the ACT Science College Readiness Standards and integrate each standard domain into the assessments as they apply (interpretation of data; scientific investigation; Evaluation of Models, Inferences, and Experimental Results). See sample table below:

Score Range	Interpretation of Data (IOD)
13–15	IOD 201. Select one piece of data from a simple data presentation (e.g., a simple food web diagram) IOD 202. Identify basic features of a table, graph, or diagram (e.g., units of measurement) IOD 203. Find basic information in text that describes a simple data presentation

Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.

Modular Assessments: At the completion of a module students will take a Modular assessment that assesses their understanding of each topic and associate that topic with the relevant experimental skills for that scientific concept.

Interim Assessments: At the completion of every interim students will take interim assessments. These assessments will emulate ACT-styled benchmarks.

Project Artifacts and Exhibitions: Throughout each interim students will be asked to investigate a challenge or problem aligned to the interim topic and complete a project that addresses the topic while also integrating skills learned in each course. Each project will have a course-specific artifact or exhibition that is assessed by the course teacher.

Core Knowledge and Comprehension Assessments: As the course provides students with factual or conceptual knowledge of a course's content they will be assessed on their mastery of knowledge and concepts. These assessments will emulate the college-board AP-styled exams or ACT exams for this content area.

NGSS & Concepts Coverage

Interim Session	Date Range	Standards Covered
1	**Aug 29-Nov 3** (47 days)	1. Models of the Structure and Properties of Matter 2. Structure and Function in Living Systems
2	**Nov 7-Feb 3** (48 Days)	3. Wave Properties 4. Chemical Reactions
3	**Feb 6-Apr 12** (47 Days)	5. Growth and Development of Organisms 6. Forces and Motion
4	**Apr 24-June 30** (45 days)	7. Conservation of Energy and Energy Transfer 8. Interdependent Relationships in Ecosystems 9. Plate Tectonics and Large Scale Interactions

Module 1: Models of the Structure and Properties of Matter

In this unit of study, students use investigations, simulations, and models to makes sense of the substructure of atoms and to develop explanations of the properties of substances. Students will use the periodic table as a tool to explain and predict the properties of elements. Students are expected to communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. Students use developing and using models, planning and conducting investigations, using mathematical thinking, and constructing explanations and designing solutions. Students will use the science and engineering practices to demonstrate mastery of the core ideas.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
25	HS-PS1-1 HS-PS1-2 HS-PS1-3 HS-PS2-6 HS-ETS1-3	Developing and using models. Engaging in an argument from evidence.	Patterns Energy and Matter

Module 1: Standards Breakdown

Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.] (HS-PS1-1)
Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] (HS-PS1-2)
Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as

graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.] (HS-PS1-3)
Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* [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.] (HS-PS2-6)
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)

Module 2: Structure and Function in Living Systems

Students investigate how the structures of organisms enable life. Students investigate explanations for the structure and functions of cells as the basic unit of life, and of the role of specialized cells for maintenance and growth. The crosscutting concepts of structure and function, matter and energy, and systems and system models are called out as organizing concepts for the disciplinary core ideas. Students use critical reading, modeling, and conducting investigations. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
20	HS-LS1-1 HS-LS1-2 HS-LS1-3	Developing & Using models. Constructing explanations and designing solutions.	Systems and System Models

Module 2: Standards Breakdown

Explain the connection between the sequence and the subcomponents of a biomolecule and its properties. [Clarification Statement: Emphasis is on the general structural properties that define molecules. Examples include r-groups of amino acids, protein shapes, the nucleotide monomers of DNA and RNA, hydrophilic and hydrophobic regions.] [Assessment Boundary: Assessment does not include identification or the molecular sequence and structure of specific molecules] (LS1.A)
Create representations that explain how genetic information flows from a sequence of nucleotides in a gene to a sequence of amino acids in a protein. (LS1.A)
Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. [Assessment Boundary: Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.] (HS-LS1-1)
Construct models that explain the movement of molecules across membranes with membrane structure and function. [Clarification Statement: Emphasis is on the structure of cell membranes, which results in selective

permeability; the movement of molecules across them via osmosis, diffusion and active transport maintains dynamic homeostasis.] (LS1.A)
Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.] (HS-LS1-2)
Provide examples and explain how organisms use feedback systems to maintain their internal environments. (LS1.A)
Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. [Clarification Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.] [Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism.] (HS-LS1-3)

Module 3: Wave Properties

Students investigate how waves transfer energy and information across long distances, and investigate nature on many scales. The crosscutting concept of cause and effect is highlighted as an organizing concept for these disciplinary core ideas. Students are expected to demonstrate proficiency in using mathematical thinking, and to use this practice to demonstrate understanding of the core idea.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
20	HS-PS4A HS-PS4-3	Engaging in argument from evidence Asking questions and defining problems Using mathematical thinking	Cause and effect Systems and system models

Module 3 Standards Breakdown

Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. [Clarification Statement: Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.] [Assessment Boundary: Assessment is limited to algebraic relationships and describing those relationships qualitatively.] (HS-PS4-1)
Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. [Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.] [Assessment Boundary: Assessment does not include using quantum theory.] (HS-PS4-3)

Module 4: Chemical Reactions

Students use models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they develop an understanding of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Students also apply an understanding of the process of engineering design to chemical reaction systems. Crosscutting concepts of patterns, energy and matter, and stability and change are the organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models, planning and conducting investigations, and constructing explanations and designing solutions.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
30	HS-PS1-7 HS-PS1-4 HS-PS1-5	Developing and using models Planning and carrying out investigations	Patterns Energy and matter Stability and change

Module 4 Standards Breakdown

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary: Assessment does not include complex chemical reactions.] (HS-PS1-7)
Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.] (HS-PS1-4)
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. [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, rate, and concentration data; and qualitative relationships between rate and temperature.] (HS-PS1-5)

Module 5: Growth and Development of Organisms

Students investigate how the structures of organisms enable life. Students investigate the structure and functions of interacting organ systems composed of tissues and organs that work together to meet the needs of the whole organism, and of the differentiation of specialized cells needed for distinct functions in complex organisms. The crosscutting concepts of structure and function, and stability and change support the disciplinary core ideas. Students use critical reading, modeling, and conducting investigations.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
20	HS-LS1-2 HS-LS1-4	Constructing explanations and designing solutions Planning and carrying out investigations	Structure and function Stability and change

Module 5 Standards Breakdown

Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. [Clarification Statement: Emphasis is on functions at the organism system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.] [Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction level.] (HS-LS1-2)
Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. [Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.] (HS-LS1-4)

Module 6: Forces and Motion

Students will plan and conduct investigations, analyze data analysis to support claims, and apply scientific ideas to develop an understanding of ideas related to why some objects begin or continue moving, and why some objects fall. Students will also build an understanding of forces and Newton's second law. Finally, they will develop an understanding that the total momentum of a system of objects is conserved when there is no net force on the system. The crosscutting concepts of patterns, cause and effect, and systems and systems models are called out as organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in planning and conducting investigations, analyzing data and using math to support claims, and applying scientific ideas to solve design problems and to use these practices to demonstrate understanding of the core ideas.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
25	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-ETS1-2 HS-ETS1-3	Analyzing and interpreting data Mathematics and computational thinking Developing and using models Planning and carrying out investigations Defining problems Designing solutions	Cause and effect Systems, and system models

Given a graph of position or velocity as a function of time, recognize in what time intervals the position, velocity and acceleration of an object are positive, negative, or zero and sketch a graph of each quantity as a function of time. [Clarification Statement: Students should be able to accurately move from one representation of motion to another.] (PS2.A)
Represent forces in diagrams or mathematically using appropriately labeled vectors with magnitude, direction, and units during the analysis of a situation. (PS2.A)
Understand and apply the relationship between the net force exerted on an object, its inertial mass, and its acceleration to a variety of situations. (PS2.A)

Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.] (HS-PS2-1)
Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. [Clarification Statement: Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.] [Assessment Boundary: Assessment is limited to systems of two macroscopic bodies moving in one dimension.] (HS-PS2-2)
Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. [Clarification Statement: Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.] [Assessment Boundary: Assessment is limited to qualitative evaluations and/or algebraic manipulations.] (HS-PS2-3)
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)
Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)

Module 7: Conservation of Energy and Energy Transfer

Students will develop and use models, plan and carry out investigations, use computational thinking and design solutions as they make sense of the transfer and conservation of energy. The disciplinary core idea of energy is broken down into subcore ideas: definitions of energy, conservation of energy and energy transfer, and the relationship between energy and forces. Energy is understood as a quantitative property of a system that depends on the motion and interactions of matter, and the total change of energy in any system is equal to the total energy transferred into and out of the system. Students also demonstrate their understanding of engineering principles when they design, build, and refine devices associated with the conversion of energy. The crosscutting concepts of cause and effect, systems and systems models, energy and matter, and the influence of science, engineering, and technology on society and the natural world are further developed in the performance expectations. Students are expected to demonstrate proficiency in developing and using models, planning and carry out investigations, using computational thinking and designing solutions, and they are expected to use these practices to demonstrate understanding of core ideas.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
20	HS-PS2-1 HS-PS2-2 HS-PS2-3 HS-ETS1-2 HS-ETS1-3	Analyzing and interpreting data. Mathematics and computational thinking. Developing and using models. Planning and carrying out investigations. Defining problems. Designing solutions.	Cause and effect. Systems and system models. Influence of science, engineering, and technology on society and the natural world.

Identify and quantify the various types of energies within a system of objects in a well-defined state, such as elastic potential energy, gravitational potential energy, kinetic energy, and thermal energy and represent how these energies may change over time. (PS3.A and PS3.B)
Calculate changes in kinetic energy and gravitational potential energy of a system using representations of that system. (PS3.A)
Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). [Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically charged

plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.] (HS-PS3-2)
Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.](HS-PS3-1)
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* [Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency. Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.] (HS-PS3-3)
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS-ETS1-1)
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)
Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS-ETS1-4)

Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.](HS-PS3-1)

Module 8: Interdependent Relationships in Ecosystems

Students investigate how and why organisms interact with each other (biotic factors) and their environment (abiotic factors). Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems. The crosscutting concepts of scale, proportion, and quantity and stability and change are called out as organizing concepts for the disciplinary core ideas. Students are expected to use mathematical reasoning and models to demonstrate proficiency with the disciplinary core ideas.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
15	HS-LS2-1 HS-LS2-2 HS-LS2-6	Mathematics and computational thinking. Constructing explanations and designing solutions.	Systems and system models. Energy and matter. Stability and change.

Illustrate how interactions among living systems and with their environment result in the movement of matter and energy. LS2.A
Graph real or simulated populations and analyze the trends to understand consumption patterns and resource availability, and make predictions as to what will happen to the population in the future. LS2.A
Provide evidence that the growth of populations are limited by access to resources, and how selective pressures may reduce the number of organisms or eliminate whole populations of organisms. LS2.A
Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including

boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.] (HS-LS2-1)
Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. [Clarification Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.] [Assessment Boundary: Assessment is limited to provided data.] (HS-LS2-2)
Evaluate the 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. [Clarification Statement: 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.] (HS-LS2-6)

Module 9:Plate tectonics and large-scale interactions

Students will investigate the reconstruction and dating of events in Earth's planetary history Earth scientists use the structure, sequence, and properties of rocks, sediments, and fossils, as well as locations of current and past ocean basins, lakes, and rivers, to reconstruct events in Earth's planetary history.

Days	Standards	Scientific and Engineering Practices	Cross-cutting concepts
10	HS-ESS1-6 HS-ESS1-5 HS-ESS2-1	Developing and using models. Planning and carrying out investigations. Analyzing and interpreting data.	Systems and system models. Stability and change.

Module 9 Standards Breakdown

Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. [Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.] (HS-ESS1-6)
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust increasing with distance away from a central ancient core (a result of past plate interactions).] (HS-ESS1-5)
Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. [Clarification Statement: Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor

features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).] [Assessment Boundary: Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.] (HS-ESS2-1)