Grade Two – Instructional Segment 1: Landscape shapes

California is known for its majestic mountains, sculpted glacial valleys, rolling coastal hills, and expansive central valley. This Instructional Segment is the first step on students' path to understand how California came to look the way it does today. Many Grade Two students are not yet familiar with these broad features the state, but can recognize the local landscape such as a slight tilt in sections of their schoolyard or mountains seen in the distance between buildings. In this Instructional Segment, students notice and describe different shapes in their local landscape. They use physical or pictorial models to represent these landscapes (as 3-D models and 2-D maps) and use published maps and models to learn about landscape features in California and around the world. They ask questions about what causes these features to form and how long it takes.

Grade Two – Instructional Segment 1: Landscape Shapes		
Guiding Questions *How can we describe the shape of land and water on Earth?*		
Students who demonstrate understanding can: **2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.** **2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.** [Assessment Boundary: Assessment does not include quantitative scaling in models.]		
The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education:*		
Highlighted Science and Engineering Practices	**Highlighted Disciplinary Core Ideas**	**Highlighted Crosscutting Concepts**
Asking Questions and Defining Problems **Analyzing and Interpreting Data**	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** **ESS2.C: The Roles of Water in Earth's Surface Processes**	**Patterns** **Systems and System Models**

What sort of changes can happen to materials? *How do the properties of the materials relate to their use?*		
Students who demonstrate understanding can: **2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.** [Clarification Statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.] **2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*** [Clarification Statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.] [Assessment Boundary: Assessment of quantitative measurements is limited to length.] **2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.** [Clarification Statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.] **2-PS1-4. Construct an argument with evidence that some changes in matter, caused by mixing, heating, or cooling can be reversed and some cannot.** [Clarification Statement: Examples of reversible changes could include materials such as water and butter at different temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.] **K–2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.** *The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.		
The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:		
Highlighted Science and Engineering Practices	**Highlighted Disciplinary Core Ideas**	**Highlighted Crosscutting Concepts**
Planning and Carrying Out Investigations **Analyzing and Interpreting Data**	**PS1.A: Structure and Properties of Matter** **PS1.B: Chemical Reactions**	**Patterns** **Energy and Matter**
Highlighted California Environmental Principles & Concepts: Principle I The continuation and health of individual human lives and of human		

form to another. They relate these abstract ideas about energy forms to the specific energy resources they rely on in everyday life.

Grade Four – Instructional Segment 2: Renewable Energy

Guiding Questions:

How do we get electricity and fuel to run cars and power electronic devices?

How does human use of natural resources affect the environment?

Students who demonstrate understanding can:

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. [Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. [Assessment Boundary: Assessment does not include quantitative measurements of energy.]

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.* [Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.] [Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.]

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education:*

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
Developing and Using Models **Designing Solutions**	**PS3.A: Definitions of Energy** **PS3.B: Conservation of Energy and Energy Transfer**	**Energy and Matter** **Systems and System Models**

Grade Four – Instructional Segment 3: Sculpting Landscapes
Guiding Questions: How do water, ice, wind, and vegetation sculpt landscapes? What factors affect how quickly landscapes change? How are landscape changes recorded by layers of rocks and fossils? How can people minimize the effects of changing landscape on property while still protecting the environment?
Students who demonstrate understanding can: **4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.** [Clarification Statement: Examples of evidence from patterns could include rock layers with shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.] [Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.] **4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.** [Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.] **4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.** [Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.] (Introduced. Fully assessed in IS4) **4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*** [Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.] [Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.] (Introduced. Fully Assessed in IS4) **3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria**

Instructional Segment 2: Earth System Interactions Cause Weather

Preferred Integrated – Grade 6 – Instructional Segment 2: Earth System Interactions Cause Weather

Guiding Questions:

Why is the weather so different in different parts of California?

How do models help us understand the different kinds of weather in California?

Students who demonstrate understanding can:

MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect].

MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. * [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.]

MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education*:

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
Developing and Using Models **Analyzing and Interpreting Data** **Constructing Explanations and Designing Solutions** **Obtaining, Evaluating,**	**ESS2.C: The Roles of Water in Earth's Surface Processes** **ESS2.D: Weather and Climate** **PS3.A: Definitions of Energy** **PS3.B: Conservation**	**Systems and System Models** **Cause and Effect** **Patterns**

Instructional Segment 2: Noncontact Forces Influence Phenomena

Preferred Integrated – Grade 8 – Instructional Segment 2: Noncontact Forces Influence Phenomena
Guiding Questions: What causes the cyclical changes in the appearance of the Moon? How can an object influence the motion of another object without touching it? Does Earth's force of gravity attract other objects equally?
Students who demonstrate understanding can: **MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] **MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*** [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] **MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.] **MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.** [Clarification Statement: Examples of evidence for arguments could include

data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a practice or disciplinary core idea.

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education:*

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
Developing and Using Models	**ESS1.A: The Universe and Its Stars** **ESS1.B: Earth and the**	**Patterns** **Systems and System Models**

Instructional Segment 1: Oil and Gas

Without energy, California's transportation and commerce would come to a screeching halt. More than half of our electricity and almost all of our transportation is currently provided by fossil fuels. California holds about 10% of all the proven oil reserves in the US and is currently the third largest oil producing state in the country. This Instructional Segment explores where those fuels came from and the effects that extracting and burning them have on our global climate.

Earth and Space Sciences - Instructional Segment 1: Oil and Gas
Guiding Questions: Where do oil and gas come from? How are gas and oil deposits related to carbon cycling and Earth systems? What is the impact of driving cars and using other fossil fuels on the Earth system?
Students who demonstrate understanding can: **HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** [Clarification Statement: The carbon cycle is a property of the Earth system that arises from interactions among the hydrosphere, atmosphere, geosphere, and biosphere. Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.] **HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.** [Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include: how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.] [Assessment Boundary: Assessment does

not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.]

HS-ESS2-1. 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.] (Introduced here, but revisited from in IS3 and again in IS4)

The bundle of performance expectations above focuses on the following elements from the NRC document *A Framework for K–12 Science Education:*

Highlighted Science and Engineering Practices	Highlighted Disciplinary Core Ideas	Highlighted Crosscutting Concepts
Developing and Using Models **Engaging in an Argument from Evidence**	**ESS2.A: Earth Materials and Systems** **ESS2.E: Biogeology** **ESS3.A: Natural Resources**	**Energy and Matter: Flows, Cycles, and Conservation**

Highlighted California Environmental Principles & Concepts:

Principle III Natural systems proceed through cycles that humans depend upon, benefit from and can alter.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Understanding the importance of fossil fuels begins with an understanding of the interactions among life, the atmosphere, and rocks over geologic time (ESS2.A, ESS2.E). When asked what the Earth might have looked like 4.6 billion years ago when it first formed, students' image might be informed by prior knowledge that may include non-scientific sources and may not be consistent with the scientific understanding that Earth was lifeless. Teachers may need to explicitly discuss existing ideas and their sources before beginning instruction. When Earth first formed, its interior was still very

Chapter 6A

Grades Nine Through Twelve

This chapter is divided into ten parts:

Introduction to Grades Nine Through Twelve

A Framework for K-12 Science Education (NRC Framework, 2012) outlined a significant new vision for science education. *The Next Generation Science Standards for California Public Schools, Kindergarten through Grade Twelve* (*CA NGSS*) are just the first step to translate that vision into practice aided by the *CA Science Framework.*

Before schools and districts can implement the *CA NGSS*, they must organize the high school grade-banded performance expectations (PEs) into courses. This chapter describes ways in which the PEs for high school could be bundled together into units to form an appropriate sequence of courses. This chapter describes two high school course sequences: the High School 3 Course Model and High School 4 Course Model. Additionally, Appendix 4 outlines an integrated three year high school model called "Every Science, Every Year."

The High School 3 Course Model contains the Living Earth, Chemistry in the Earth System, and Physics in the Universe courses. The three-course model combines all high school performance expectations (PEs) into three courses. To highlight the nature of Earth and space sciences (ESS) as an interdisciplinary pursuit with crucial importance in California, the three courses present an integration of ESS and one of the other high school disciplines. The High School 4 Course Model is based on the Science Domains Model in which one course is assigned to each domain of the Framework: Life Science (LS), Physical Science (PS), and Earth and Space Science (ESS). The PS performance expectations have been further sub-divided to define a chemistry course and a physics course.