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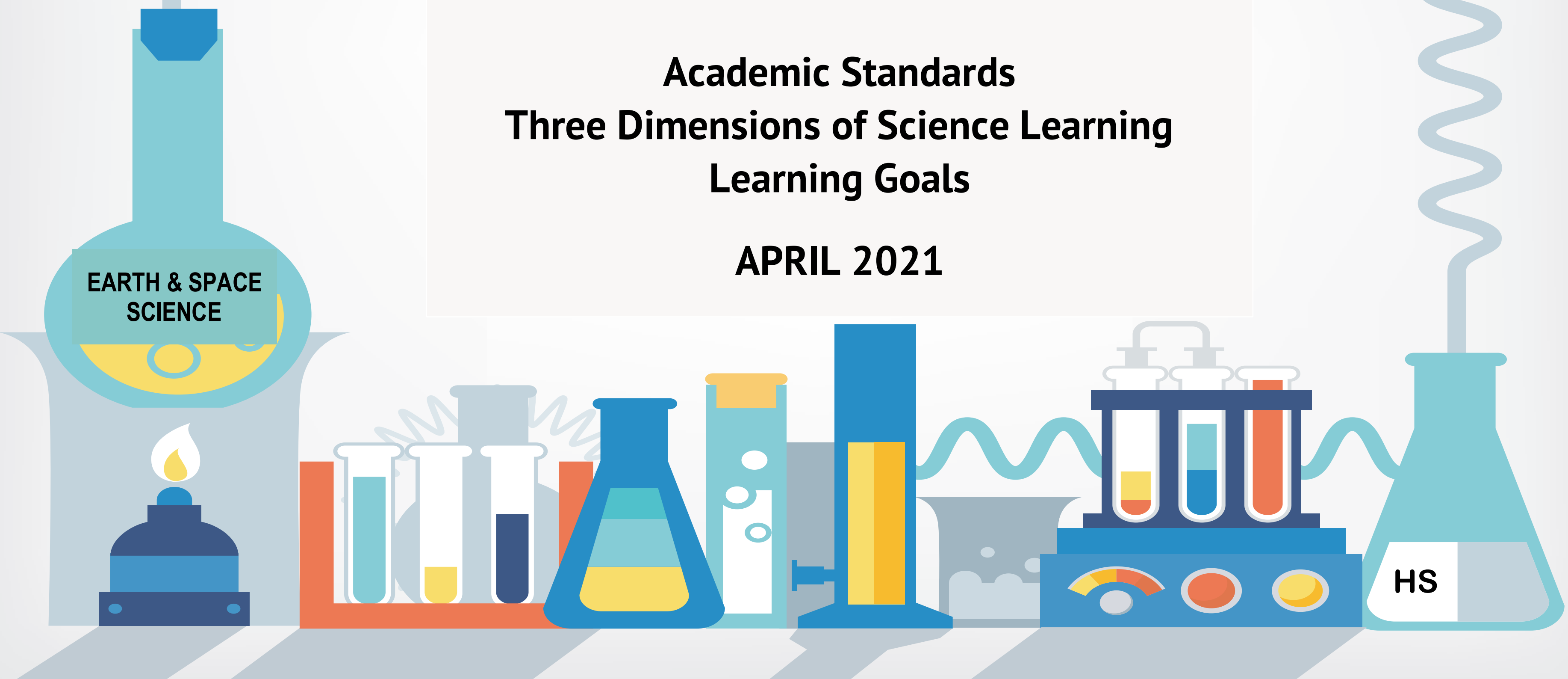
SCIENCE

Academic Standards
Three Dimensions of Science Learning
Learning Goals

APRIL 2021



HIGH SCHOOL
EARTH & SPACE SCIENCE

CATALINA FOOTHILLS SCHOOL DISTRICT
HIGH SCHOOL EARTH & SPACE SCIENCE OVERVIEW

The high school Earth & Space Science course encompasses processes that occur on Earth while also addressing Earth's place within our solar system and galaxy. Students gain an understanding of these processes through a wide scale: unimaginably large to invisibly small. Earth and Space Sciences, more than any other discipline, are rooted in other scientific disciplines. Students, through the close study of Earth and space, will find clear applications for their knowledge of gravitation, energy, magnetics, cycles, and biological processes. Students will explore the Earth's spheres including the geosphere, hydrosphere, and atmosphere, in addition to major Earth cycles such as the water, rock, and carbon cycles. Other topics of study include Earth's natural resources and hazards, human and natural influences on Earth systems, planetary motion, stellar evolution, and the nature of the universe. Students are expected to apply these concepts to real-world phenomena to gain a deeper understanding of causes, effects, and solutions for physical processes in the real world.

The essential standards are those that every high school student is expected to know and understand. Plus standards in Earth & Space Science are designed to extend the concepts learned in the essential standards to prepare students for entry level college courses.

Earth & Space Science is a third-year science course, which follows Physical Science. Students will have been taught the full set of "essential" standards upon completion of the course. The "essential" standards are those that every high school student is expected to know and understand by the end of the third year. Because students have some flexibility in the pathway they select to meet the graduation requirements for science, specific "essential" standards were integrated into some of the high school science courses to meet this Arizona State Board of Education requirement. The "essential" and "plus" standards for High School Earth and Space Science are grouped by topics based on areas of science.

The list of high school Earth & Space Science topics below does not indicate the instructional sequence or how the standards will be organized for instruction. Educators will make decisions about instructional sequence and how standards will be grouped by units for classroom instruction and assessment to best meet student needs.

High School Earth & Space Science Topics:

- Weather and Climate
- Roles of Water in Earth's Surface Systems
- Earth's Systems
- Earth and Human Activity
- Earth's Place in the Universe
- Earth and the Solar System
- The Universe and its Stars

High school students continue the pattern from previous years by engaging in the science and engineering practices to apply their knowledge of core ideas to understand how scientists continue to build an understanding of phenomena and see how people are impacted by natural phenomena or to construct solutions. The crosscutting concepts support their understanding of patterns, cause and effect relationships, and systems thinking as students make sense of phenomena in the natural and designed worlds.

Navigating the Science Standards: Abbreviated Version

The standards serve as the basis for the design of instruction and assessment of the district's science curriculum.

- **Standards** are what a student needs to know, understand, and be able to do by the end of each grade or course. They build across grade levels in a progression of increasing understanding and through a range of cognitive demand levels.
- **Curriculum** refers to the resources used for teaching and learning the standards (units, lessons, texts, materials, tech apps, assessments, etc.).
- **Instruction** refers to the methods or methodologies used by teachers to teach their students. Instructional techniques are employed by individual teachers in response to the needs of students in their classes to help them progress through the curriculum to achieve the standards.

Grade Level or Course and **Topic Area** for standard.

Life Science Description of what students will learn for the area of science under study (K-8 only).

Standard – What is Assessed
Describes what students should be able to do at the end of instruction to show what they have learned. Combines Science and Engineering Practices, Core Ideas, and Crosscutting Concepts.

Learning Goals
Indicators or evidence of learning at the end of a lesson or unit as aligned to the standard.

Core Ideas for Knowing and Using Science
"Understandings" or big ideas for physical, earth and space, and life sciences that build in complexity across grade levels and students develop over time.
Background Information (Content) is provided under each Core Idea.

Science and Engineering Practices
Skills and knowledge that scientists and engineers engage in to either understand the world or solve a problem.

Three Dimensions (3-D) of Science: The Practices, Core Ideas, and Crosscutting Concepts that were used to create the standards.

Crosscutting Concepts
Concepts that cut across all disciplines and help students deepen their understanding of core ideas.

KINDERGARTEN

LIFE SCIENCE: LIVING AND NON-LIVING THINGS

Students develop an understanding that the world is comprised of living and non-living things. They investigate the relationship between structure and function in living things; plants and animals use specialized parts to help them meet their needs and survive.

Science Standard: K.L2U1.8 **Observe, ask questions, and explain the differences between the characteristics of living and non-living things.**

Learning Goals

I can:

- Based on prior experiences, ask questions about living and non-living things.
- Make direct or indirect observations about living and non-living things:
  - Identify traits of living and non-living things.
  - Record observations (*e.g., through pictures and/or words*).
  - Make inferences about the characteristics of living and non-living things.
- List the characteristics of living things (*i.e., move, reproduce, react to stimuli*).
- Use evidence to explain how the characteristics of living things differ from the characteristics of non-living things.

Core Ideas

Knowing Science

L2: Organisms require a supply of energy and materials for which they often depend on, or compete with, other organisms.

- There is a wide variety of living things (organisms), including plants and animals. They are distinguished from non-living things by their ability to move, reproduce, and react to certain stimuli.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students ask questions to frame their exploration of living and non-living things.
- Students make observations about living and non-living things.
- Students use the evidence from their observations to make inferences about the characteristics of living and non-living things.

Science and Engineering Practices

Asking Questions and Defining Problems

- Ask questions based on observations of the natural and/or designed world.

Constructing Explanations and Designing Solutions

- Use information from direct or indirect observations to construct explanations.
- Distinguish between opinions and evidence in one's own explanations.

Crosscutting Concepts

Patterns

- Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Structure and Function

- The shape and stability of structures of natural and designed objects are related to their function(s).

Systems and System Models

- Objects and organisms can be described in terms of their parts.

WEATHER AND CLIMATE

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HIGH SCHOOL EARTH & SPACE SCIENCE	
EARTH & SPACE SCIENCES	
WEATHER AND CLIMATE	
Science Standard: **ESSENTIAL HS.E1U1.11 Develop and use models to explain how energy from the Sun affects weather patterns and climate.** Learning Goals I can: • Develop a model to explain how energy from the Sun affects weather patterns and climate. o Use design criteria to create representations of weather patterns and climate based on energy from the Sun. o Evaluate the merits and limitations of model types in order to select or revise a model that best fits the evidence or design criteria. o Design a test of a model to ascertain its reliability. o Revise models based on results of tests and design criteria to more appropriately represent weather patterns and climate based on energy from the Sun.	
Core Ideas	
Knowing Science E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate. • Weather, which varies from day to day and seasonally throughout the year, is the condition of the atmosphere at a given place and time. Climate is longer term and location sensitive; it is the range of a region's weather over 1 year or many years, and, because it depends on latitude and geography, it varies from place to place. • The foundation for Earth's global climate system 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 reradiation into space. • Climate change can occur when certain parts of Earth's systems are altered. Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. **Using Science** U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. • Students use models to explore relationships between weather, climate, and the Sun's energy.	
Science and Engineering Practices	Crosscutting Concepts
Developing and Using Models • Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system. • Use models (including mathematical and computational) to generate data to support explanation and predict phenomena, analyze systems, and solve problems.	**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. **Energy and Matter: Flows, Cycles, and Conservation** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems. **Cause and Effect: Mechanism and Prediction**

	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Changes in systems may have various causes that may not have equal effects.

HIGH SCHOOL EARTH & SPACE SCIENCE

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WEATHER AND CLIMATE

Science Standard: PLUS HS+E.E1U1.1 Construct an explanation based on evidence for how the Sun's energy transfers between Earth's systems.

Learning Goals

I can:

- Construct an explanation based on evidence (*e.g., scientific principles, models, theories, simulations*) to explain how energy from the sun transfers between Earth's systems:
  - Explain specific cause and effect relationships among the factors that cause energy to flow into and out of Earth's systems.
  - Apply scientific knowledge and evidence to explain how energy from the Sun (electromagnetic radiation) flows and how materials on Earth cycle due to energy transfer and conservation of matter.
  - Revise explanations based on evidence obtained from a variety of sources and peer review.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- The foundation for Earth's global climate system 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 reradiation into space.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use evidence to explain interactions between the Sun's energy and Earth's systems.

Science and Engineering Practices

Constructing Explanations and Designing Solutions:

- Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.
- Base causal explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.

Crosscutting Concepts

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.

Energy and Matter: Flows, Cycles, and Conservation

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
- Energy drives the cycling of matter within and between systems.
- The total amount of energy in and matter in closed systems is conserved.
- Energy cannot be created or destroyed-only moves between one place and another place, between objects and/or fields, or between systems.

Cause and Effect: Mechanism and Prediction

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Changes in systems may have various causes that may not have equal effects.

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WEATHER AND CLIMATE

Science Standard: PLUS HS+E.E1U1.2 Develop and use models to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Learning Goals

I can:

- Develop a model to explain Earth's energy budget and the impact of energy entering and cycling throughout Earth's climate system:
  - Use design criteria to create representations of the flow of energy into and out of Earth's systems.
  - Evaluate the merits and limitations of model types in order to select or revise a model that best fits the evidence or design criteria.
  - Design a test of a model to ascertain its reliability.
  - Revise models based on results of tests and criteria to more appropriately represent cause and effect relationships between the flow of Energy into and out of Earth's systems and changes in climate.
- Use models to show how variations in the flow of energy into and out of Earth's systems result in changes in climate:
  - Describe variations in reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems.
  - Describe reradiation of energy into space.
  - Describe causal relationships between variations in the flow of energy and changes in climate.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- The foundation for Earth's global climate system 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 reradiation into space.
- Climate change can occur when certain parts of Earth's systems are altered.
- Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use models to explore relationships between weather, climate, and the Sun's energy.

Science and Engineering Practices	Crosscutting Concepts
Developing and Using Models • Develop, revise, and use models to predict and support explanations between systems or between components of a system. • Design a test of a model to ascertain its reliability.	**Energy and Matter: Flows, Cycles, and Conservation** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems. **Stability and Change**

• Use models (including mathematical and computational) to generate data to support explanations and predict phenomena, analyze systems, and solve problems.	• Much of science deals with constructing explanations of how things change and how they remain stable. **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

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WEATHER AND CLIMATE

Science Standard: PLUS HS+E.E1U1.3 Analyze geoscience data and the results from global climate models to make evidence-based predictions of current rate and scale of global or regional climate changes.

Learning Goals

I can:

- Collect data (*e.g., from investigations, demonstrations, scientific texts, data sets, simulations, etc.*) to make predictions of current rate and scale of global or regional climate changes:
  - Ask questions to frame data collection, analysis, and interpretation.
  - Decide on types, how much, and accuracy of data needed to make valid predictions.
  - Select appropriate tools to collect and record data.
- Use tools, technologies, and models to analyze and interpret data:
  - Identify and describe patterns in data that connect natural processes and changes in global temperatures over the past century.
  - Evaluate limitations (*e.g., measurement error, sample selection*) when analyzing and interpreting data.
  - Compare and contrast various types of data sets to (*e.g., self-generated, archival*) to examine observations about rate and scale of climate changes.
  - Analyze and interpret data on increasing Greenhouse gas amounts in the atmosphere and the impact of those gases on energy cycling on Earth.
  - Use data to quantitatively describe the rate and scale of global or regional climate changes.
  - Use data to make claims regarding Earth's historical climate patterns.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Climate change can occur when certain parts of Earth's systems are altered.
- Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years.
- Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use data from accepted models to explore rates and scales of global or regional climate changes.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. **Analyzing and Interpreting Data**	**Patterns** • Empirical evidence is needed to identify patterns. **Energy and Matter: Flows, Cycles, and Conservation**

• Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations.	• Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems. • Energy cannot be created or destroyed-only moves between one place and another place, between objects and/or fields, or between systems. **Scale, Proportion, and Quantity** • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales.

ROLES OF WATER IN EARTH'S SURFACE PROCESSES

HIGH SCHOOL EARTH & SPACE SCIENCE

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ROLES OF WATER IN EARTH'S PROCESSES

Science Standard: ESSENTIAL HS.E1U1.12 Develop and use models of the Earth that explain the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere).

Learning Goals

I can:

- Develop models of the Earth that explain the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere):
  - Use design criteria to develop diagrams, drawings, physical replicas, mathematical representations, analogies, and/or computer simulations that represent the role of energy and matter in Earth's constantly changing internal and external systems.
  - Use multiple types of models to represent the role of energy and matter in Earth's constantly changing internal and external systems.
  - Design a test of a model to ascertain its reliability.
  - Develop a model of a dynamic Earth that demonstrates feedback systems between various spheres *(e.g., tectonic plates/geosphere and hydrosphere/biosphere/atmosphere)*.
- Use models of the Earth that explain the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere):
  - Use evidence from models to explain how energy arrives and is stored on Earth.
  - Use evidence from models to explain how all matter is recycled on Earth over time, including how matter is recycled due to the outward flow of energy from the Earth's interior and the gravitational movement of denser materials toward its interior.
  - Use evidence from models to demonstrate and predict changes in global and regional climate that can be caused by the sun's energy output and the Earth's orbit, tectonic events, ocean circulation, human activities, etc.
  - Use evidence from models to explain fast and slow changes in Earth's history *(e.g., ice ages throughout time, volcanoes, Pangea).*

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- A model of Earth has a hot but solid inner core, a liquid outer core, a solid mantle and crust. The top part of the mantle, along with the crust, forms structures known as tectonic plates. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.
- Beneath the Earth's solid crust is a hot layer called the mantle. The mantle is solid when under pressure but melts (and is called magma) when the pressure is reduced. In some places there are cracks (or thin regions) in the crust which can allow magma to come to the surface, for example in volcanic eruptions.
- The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. Where plates collide, mountain ranges are formed and there is a fault line along the plate boundary where earthquakes are likely to occur and there may also be volcanic activity

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Interactions among Earth's systems are incredibly complex. Students use models to help them make sense of the relationships within these interrelated spheres. Models are developed through an iterative process of comparing what they predict and what is found in the real world.

Science and Engineering Practices	Crosscutting Concepts
Developing and Using Models • Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system. • Use models (including mathematical and computational) to generate data to support explanations and predict phenomena, analyze systems, and solve problems. • Design a test of a model to ascertain its reliability.	**Systems and System Models** • Empirical evidence is needed to identify patterns. When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. **Energy and Matter: Flows, Cycles, and Conservation** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. **Cause and Effect: Mechanism and Prediction** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

ROLES OF WATER IN EARTH'S PROCESSES

Science Standard: PLUS HS+E.E1U1.4 Analyze and interpret geoscience data to make the claim that dynamic interactions with Earth's surface can create feedbacks that cause changes to other Earth systems.

Learning Goals

I can:

- Collect geoscience data (*e.g., from investigations, demonstrations, scientific texts, data sets, simulations, etc.*) regarding changes to Earth systems:
  - Ask questions to frame data collection, analysis, and interpretation.
  - Decide on types, how much, and accuracy of data needed to make claims about feedbacks that cause changes to Earth systems.
  - Select appropriate tools to collect and record data.
- Use tools, technologies, and models to analyze and interpret data to describe feedbacks created by dynamic interactions with Earth's surface:
  - Identify and describe patterns in data that indicate relationships.
  - Evaluate limitations (*e.g., measurement error, sample selection*) when analyzing and interpreting data.
  - Compare and contrast various types of data sets to (*e.g., self-generated, archival*) to examine changes to Earth systems as a result of dynamic interactions with Earth's surface.
  - Use data to make claims about various negative and positive feedback loops that cause changes to other Earth systems.
  - Interpret data to explain examples of negative feedback loops that can change or stabilize the climate on Earth.
  - Interpret data to explain examples of positive feedback loops that can change or stabilize the climate on Earth.
- Construct, use, and present oral and written arguments regarding feedbacks that cause changes to Earth systems:
  - Make and defend a claim that the dynamic interactions with Earth's surface can create feedbacks that cause changes to other Earth systems.
  - Use geoscience data to develop and support the claim.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use data to examine relationships among Earth's systems in order to explore changes over time.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. **Analyzing and Interpreting Data** • Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. • Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. **Engaging in Argument from Evidence** • Make and defend a claim about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.	**Patterns** • Empirical evidence is needed to identify patterns. **Energy and Matter: Flows, Cycles, and Conservation** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems. • Energy cannot be created or destroyed-only moves between one place and another place, between objects and/or fields, or between systems. **Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

ROLES OF WATER IN EARTH'S PROCESSES

Science Standard: PLUS HS+E.E1U1.5 Obtain, evaluate, and communicate information on the effect of water on Earth's materials, surface processes, and groundwater systems.

Learning Goals

I can:

- Obtain information about the effect of water on Earth's materials, surface processes, and groundwater systems:
  - Ask questions to frame the search for information.
  - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  - Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Evaluate information from scientific texts on the effect of water on Earth's materials, surface processes, and groundwater systems:
  - Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate scientific ideas about the effect of water on Earth's materials, surface processes, and groundwater systems:
  - Communicate in writing and/or oral presentations about the effects of water on Earth.
  - Compare, integrate, and evaluate multiple sources of information presented in different media or formats (*e.g., visually, quantitatively*) to explain the effects of water on Earth's materials, surface processes, and groundwater systems.
  - Explain how the abundance of liquid water on Earth's surface and its unique physical and chemical properties (*i.e., heat capacity, density, transmit sunlight, expand upon freezing, polar nature, etc.*) affect Earth's materials and surface processes.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks.
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedbacks work within and among Earth's systems is still lacking, thus limiting scientists' ability to predict some changes and their impacts.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students will explore the critical roles and complexities of water on Earth through examination of evidence.

Science and Engineering Practices	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.	**Energy and Matter: Flows, Cycles, and Conservation** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. • Energy drives the cycling of matter within and between systems.

• Synthesize, communicate, and evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Compare, integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) in order to address a scientific question or solve a problem.	**Cause and Effect: Mechanism and Prediction** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Changes in systems have various causes that may not have equal effects.

EARTH'S SYSTEMS

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: ESSENTIAL HS.E1U1.13 Evaluate explanations and theories about the role of energy and matter in geologic changes over time.

Learning Goals

I can:

- Apply scientific reasoning, theory, and models to evaluate explanations and theories about the role of energy and matter in geologic changes over time:
    - Identify and explain examples of evidence that support scientific theories that Earth has evolved over geologic time due to natural processes.
    - Explain the mechanisms of heat transfer *(i.e., convection, conduction, radiation)* in a chemical system and then correlate it to the Earth's core and mantle, and why heat transfer is important for the layers of the Earth.
    - Connect Bowen's Reaction Series to the chemical evolution of the continental and oceanic crust composition.
    - Compare and evaluate scientific information and theories to explain the relationships between the different forms of carbon and how they are related.
    - Base causal explanations on valid and reliable empirical evidence from multiple sources that geologic processes that happened in the past can be explained by those same processes that are happening today (uniformitarianism) *(e.g., Japanese war balloon situation).*

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.
- Active geological processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock records on Earth. Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students examine evidence pertaining to geologic change over time. Not all explanations are equally valid, so students must compare and evaluate the claims, methods, theories, and conclusions presented in order to better understand the role of energy and matter in geologic changes over time.

Science and Engineering Practices	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion. • Base causal explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.	**Energy and Matter: Flows, Cycles, and Conservation** • Energy drives the cycling of matter within and between systems. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable.

	• Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U1.6 Obtain, evaluate, and communicate information about the theory of plate tectonics to explain the differences in age, structure, and composition of the Earth's crust.

Learning Goals

I can:

- Obtain information about the theory of plate tectonics:
  - Ask questions to frame the search for information.
  - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  - Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Evaluate information from scientific texts on plate tectonics and the age, structure, and composition of the Earth's crust:
  - Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate scientific ideas about differences in age, structure, and composition of the Earth's crust:
  - Communicate in writing and/or oral presentations about the theory of plate tectonics.
  - Compare, integrate, and evaluate multiple sources of information presented in different media or formats (*e.g., visually, quantitatively*) to explain the differences in age, structure, and composition of Earth's crust.
- Use evidence about the theory of plate tectonics to construct an explanation about differences in age, structure, and composition of the Earth's crust:
  - Explain how tectonic processes create and destroy ocean seafloor.
  - Explain how radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations.
  - Explain how movement and convergence of tectonic plates affect Earth's crust.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches.
- Beneath the Earth's solid crust is a hot layer called the mantle. The mantle is solid when under pressure but melts (and is called magma) when the pressure is reduced. In some places there are cracks (or thin regions) in the crust which can allow magma to come to the surface, for example in volcanic eruptions.
- The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. Where plates collide, mountain ranges are formed and there is a fault line along the plate boundary where earthquakes are likely to occur and there may also be volcanic activity.
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust.
- Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and the gravitational movement of denser materials toward the interior.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students examine evidence pertaining to the theory of plate tectonics. Not all explanations are equally valid, so students must compare and evaluate the claims, methods, theories, and conclusions presented in order to better understand differences in age, structure, and composition of the Earth's crust.

Science and Engineering Practices	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Synthesize, communicate, and evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Compare, integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) in order to address a scientific question or solve a problem. **Constructing Explanations and Designing Solutions** • Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion. • Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.	**Energy and Matter: Flows, Cycles, and Conservation** • Energy drives the cycling of matter within and between systems. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U1.7 Engage in argument from evidence of ancient Earth materials, meteorites, and other planetary surfaces to explain Earth's formation and early history.

Learning Goals

I can:

- Evaluate arguments regarding Earth's formation and early history:
    - Evaluate the claims, evidence, and reasoning of oral and/or written arguments to determine merits of arguments and elicit elaboration from peers.
    - Critique and evaluate competing arguments about Earth's formation and early history in light of scientific evidence.
- Construct, use, and present oral and written arguments regarding Earth's formation and early history:
    - Make and defend a claim about the law of conservation of energy.
    - Construct a counter-argument that is based on data and evidence that challenges another proposed argument.
    - Use quantitative and qualitative scientific evidence to develop and support the claim.
    - Use evidence of ancient Earth materials, meteorites, and other planetary surfaces to explain Earth's formation and early history.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time.
- Although active geological processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students evaluate, develop, and defend arguments using scientific evidence from texts, observations, and investigations. As they weigh evidence regarding ancient Earth materials, meteorites, and other planetary surfaces, students will refine their understanding of Earth's formation and early history.

Science and Engineering Practices	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Make and defend a claim about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.	**Cause and Effect: Mechanism and Prediction** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Changes in systems may have various causes that may not have equal effects. **Scale, Proportion, and Quantity**

	• The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U1.8 Develop and use models to illustrate how Earth's internal and surface processes operate over time to form, modify, and recycle continental and ocean floor features.

Learning Goals

I can:

- Develop and use models to demonstrate how Earth's internal and surface processes operate over time to form, modify, and recycle continental and ocean floor features:
  - Use design criteria to create representations of how Earth's internal and surface processes affect continental and ocean floor features over time.
  - Evaluate the merits and limitations of model types in order to select or revise a model that best fits the evidence or design criteria.
  - Design a test of a model to ascertain its reliability.
  - Revise models based on results of tests and design criteria to more appropriately represent the effects of Earth's internal and surface processes on continental and ocean floor features over time.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Beneath the Earth's solid crust is a hot layer called the mantle. The mantle is solid when under pressure but melts (and is called magma) when the pressure is reduced. In some places there are cracks (or thin regions) in the crust which can allow magma to come to the surface, for example in volcanic eruptions.
- The Earth's crust consists of a number of solid plates which move relative to each other, carried along by movements of the mantle. Where plates collide, mountain ranges are formed and there is a fault line along the plate boundary where earthquakes are likely to occur and there may also be volcanic activity.
- The Earth's surface changes slowly over time, with mountains being eroded by weather, and new ones produced when the crust is forced upwards.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use models to explore changes over time in the Earth's continental and ocean floor features.

Science and Engineering Practices	Crosscutting Concepts
Developing and Using Models • Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system. • Use models (including mathematical and computational) to generate data to support explanations and predict phenomena, analyze systems, and solve problems.	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. **Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

EARTH AND HUMAN ACTIVITY

HIGH SCHOOL EARTH & SPACE SCIENCE
EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: ESSENTIAL HS.E1U3.14 Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other.

Learning Goals

I can:

- Evaluate arguments regarding the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other:
  - Evaluate the claims, evidence, and reasoning of oral and/or written arguments to determine merits of arguments and elicit elaboration from peers.
- Construct, use, and present oral and written arguments regarding the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other:
  - Make and defend a claim about the distribution of natural resources (*e.g., air, water, soil, minerals, metal, plants, animals, etc.*) and the need for sharing limited natural resources in ways that do not damage the planet (*e.g., renewable resources, trade, shipping, use of technology*).
  - Construct and defend an argument about ways in which population growth affects outcomes of natural hazards and climate change (*e.g., higher temperatures intensify hurricane storms which cause increased flooding*).
  - Make and defend a claim about the interrelationships among resource availability, natural hazards, climate change, and human activity over time.
  - Use scientific evidence to develop and support the claim.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Historically, humans have populated regions that are climatically,
- hydrologically, and geologically advantageous for fresh water availability, food production via agriculture, commerce, and other aspects of civilization.
- Resource availability affects geopolitical relationships and can limit development.
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
- Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts. Materials important to modern technological societies are not uniformly distributed across the planet (e.g., oil in the Middle East, gold in California). Most elements exist in Earth's crust at concentrations too low to be extracted, but in some locations—where geological processes have concentrated them—extraction is economically viable.
- Most energy production today comes from nonrenewable sources, such as coal and oil. However, advances in related science and technology are reducing the cost of energy from renewable resources, such as sunlight. As a result, future energy supplies are likely to come from a much wider range of sources. As a result, future energy supplies are likely to come from a much wider range of sources.

Using Science

U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

- Students explore arguments about climate change, human activity, and natural hazards from various perspectives. Not all evidence is equally valid, however, so students must evaluate the information, findings, and studies contained in the arguments they examine.
- Effective arguments also consider various ethical, social, economic, and/or political implications.

Science and Engineering Practices	Crosscutting Concepts

Engaging in Argument from Evidence • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • Construct a counter-argument that is based on data and evidence that challenges another proposed argument. • Make and defend a claim about the natural world or the effectiveness of a design solution that reflects scientific knowledge, and student-generated evidence.	**Cause and Effect: Mechanism and Prediction** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Changes in systems may have various causes that may not have equal effects. **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. • Feedback (negative or positive) can stabilize or destabilize a system.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U3.9 Construct an explanation, based on evidence, for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Learning Goals

I can:

- Construct explanations based on evidence obtained from a variety of sources (*e.g., scientific principles, models, theories, simulations*):
  - Apply scientific reasoning to explain how the availability of natural resources has influenced human activity.
  - Apply scientific reasoning to explain how occurrence of natural hazards has influenced human activity.
  - Apply scientific reasoning to explain how changes in climate have influenced human activity.
- Revise explanations based on evidence obtained from a variety of sources and peer review.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts.
- Historically, humans have populated regions that are climatically, hydrologically, and geologically advantageous for fresh water availability, food production via agriculture, commerce, and other aspects of civilization. Resource availability affects geopolitical relationships and can limit development. As the global human population increases and people's demands for better living conditions increase, resources considered readily available in the past, such as land for agriculture or drinkable water, are becoming scarcer and more valued.

Using Science

U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

- Students explore interactions between human activity, natural resources, natural hazards, and changes in climate. They examine evidence to construct explanations about how the environment affects humans.

Science and Engineering Practices

Constructing Explanations and Designing Solutions

- Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.
- Base causal explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.

Crosscutting Concepts

Cause and Effect: Mechanism and Prediction

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.
- Systems can be designed to cause a desired effect.
- Changes in systems may have various causes that may not have equal effects.

Stability and Change

- Much of science deals with constructing explanations of how things change and how

	they remain stable. • Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. • Systems can be designed for greater or lesser stability.

HIGH SCHOOL EARTH & SPACE SCIENCE
EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U3.10 Ask questions, define problems, and evaluate a solution to a complex 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.

Learning Goals

I can:

- Define a complex problem pertaining to human interactions with the environment:
  - Identify the initial conditions and boundaries of the system.
  - Determine constraints, including cost, safety, reliability, and aesthetics.
  - Analyze social, cultural, and environmental impacts of the problem.
- Evaluate solutions to a complex environmental problem:
  - Ask and evaluate questions that challenge the suitability of a solution.
  - Test and compare multiple solutions (*e.g., using experimentation, simulations and/or criteria*).
  - Evaluate solutions based on scientific knowledge, student-generated sources of evidence, prioritized criteria, tradeoffs, constraints, and implications (*i.e., social, cultural, and environmental*).

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- As the global human population increases and people's demands for better living conditions increase, resources considered readily available in the past, such as land for agriculture or drinkable water, are becoming scarcer and more valued.
- All forms of resource extraction and land use have associated economic, social, environmental, and geopolitical costs and risks, as well as benefits. New technologies and regulations can change the balance of these factors.
- Much energy production today comes from nonrenewable sources, such as coal and oil. However, advances in related science and technology are reducing the cost of energy from renewable resources, such as sunlight. As a result, future energy supplies are likely to come from a much wider range of sources.

Using Science

U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

- Students explore problems and evaluate solutions pertaining to human activity and the environment.
- Effective solutions consider a variety of constraints and implications.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design.	**Cause and Effect: Mechanism and Prediction** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.	• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects. **Systems and System Models** • Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S SYSTEMS

Science Standard: PLUS HS+E.E1U3.11 Develop and use a quantitative model to illustrate the relationship among Earth systems and the degree to which those relationships are being modified due to human activity.

Learning Goals

I can:

- Develop and use a quantitative model to illustrate interactions between and among Earth systems and human activity:
  - Use design criteria to create representations of interrelationships among Earth systems and human activity.
  - Evaluate the merits and limitations of model types in order to select or revise a model that best fits the evidence or design criteria.
  - Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world.
  - Design a test of a model to ascertain its reliability.
  - Revise models based on results of tests and design criteria to more appropriately represent interactions between and among Earth's systems and human activity.

Core Ideas

Knowing Science

E1: The composition of the Earth and its atmosphere and the natural and human processes occurring within them shape the Earth's surface and its climate.

- Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts.

Using Science

U3: Applications of science often have both positive and negative ethical, social, economic, and/or political implications.

- Students use models to explore interrelationships among Earth's systems and human activity.

Science and Engineering Practices

Developing and Using Models

- Use multiple types of models to represent and support explanations of phenomena, and move flexibly between model types based on merits and limitations.
- Develop, revise, and use models to predict and support explanations of relationships between systems or between components of a system.
- Use models (including mathematical and computational) to generate data to support explanations and predict phenomena, analyze systems, and solve problems.
- Design a test of a model to ascertain its reliability.

Using Mathematics and Computational Thinking

- Create a simple computational model or simulation of a designed device, process, or system.

Crosscutting Concepts

Cause and Effect: Mechanism and Prediction

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- Changes in systems may have various causes that may not have equal effects.

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Stability and Change

	• Much of science deals with constructing explanations of how things change and how they remain stable. • Feedback (negative or positive) can stabilize or destabilize a system. • Systems can be designed for greater or lesser stability.

EARTH'S PLACE IN THE UNIVERSE

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S PLACE IN THE UNIVERSE

Science Standard: ESSENTIAL HS.E2U1.15 Construct an explanation based on evidence to illustrate the role of nuclear fusion in the life cycle of a star.

Learning Goals

I can:

- Construct explanations based on evidence obtained from a variety of sources (*e.g., scientific principles, models, theories, simulations*) about the role of nuclear fusion in the life cycle of a star:
    - Apply scientific knowledge and evidence to illustrate and/or model the life cycle of a star (*e.g., nebula, protostar, main sequence, etc.*).
    - Apply scientific knowledge and evidence to describe the role of nuclear fusion in the star's core to release energy.
    - Revise explanations based on evidence obtained from a variety of sources and peer review.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- Our Sun is one of many stars that make up the Universe, essentially made of hydrogen. The source of energy that the Sun and all stars radiate comes from nuclear reactions in their central cores.
- Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. Elements other than these remnants of the Big Bang continue to form within the cores of stars.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students examine a variety of sources to better understand the role of nuclear fusion in the life cycle of a star. They then select valid, scientific evidence to construct their explanation.

Science and Engineering Practices	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion. • Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.	**Structure and Function** • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. **Energy and Matter: Flows, Cycles, and Conservation** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH'S PLACE IN THE UNIVERSE

Science Standard: PLUS HS+E.E2U1.12 Obtain, evaluate, and communicate scientific information about the way stars, throughout their stellar stages, produce elements and energy.

Learning Goals

I can:

- Obtain information about the way stars, throughout their stellar stages, produce elements and energy:
  - Ask questions to frame the search for information.
  - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  - Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Evaluate information from scientific texts about the way stars, throughout their stellar stages, produce elements and energy:
  - Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate scientific ideas about the stellar stages of stars and how they produce elements and energy:
  - Communicate in writing and/or oral presentations information about how observations of distant stars provide insight on various stages of development.
  - Compare, integrate, and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) to explain the process of stellar evolution from star birth to star death.
  - Use evidence to connect stellar evolution to stellar nucleosynthesis (element production).
  - Use evidence to describe how stars evolve along the main sequence including changes in size, temperature, luminosity, spectral type, and color (Hertzsprung-Russell diagram).

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- Our Sun is one of many stars that make up the Universe, essentially made of hydrogen. The source of energy that the Sun and all stars radiate comes from nuclear reactions in their central cores.
- Nearly all observable matter in the universe is hydrogen or helium, which formed in the first minutes after the Big Bang. Elements other than these remnants of the Big Bang continue to form within the cores of stars.
- Nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases the energy seen as starlight. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- A scientific theory is a well-substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and so become well-established.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems	**Structure and Function**

• Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. • Ask questions that require relevant empirical evidence to answer. • Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. **Obtaining, Evaluating, and Communicating Information** • Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Synthesize, communicate, and evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Produce scientific and/or technical writing and/or oral presentations that communicate scientific ideas and/or the process of development and the design and performance of a proposed process or system.	• The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. **Energy and Matter: Flows, Cycles, and Conservation** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

EARTH AND THE SOLAR SYSTEM

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH AND THE SOLAR SYSTEM

Science Standard: ESSENTIAL HS.E2U1.16 Construct an explanation of how gravitational forces impact the evolution of planetary motion, structure, surfaces, atmospheres, moons, and rings.

Learning Goals

I can:

- Construct explanations based on evidence obtained from a variety of sources *(e.g., scientific principles, models, theories, simulations)*:
    - Apply scientific reasoning to explain how Kepler's Laws show the formation and evolution of planetary motion.
    - Apply scientific reasoning to explain how Newton's Law of Universal Gravity predicts the formation of planetary structure, moons, and rings.
    - Apply scientific reasoning to explain how Newton's Law of Universal Gravity predicts the evolution of planetary surfaces and atmospheres.
    - Revise explanations based on evidence obtained from a variety of sources and peer review.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- Earth and the moon, sun, and planets have predictable patterns of movement. These patterns, which are explainable by gravitational forces and conservation laws, in turn explain many large-scale phenomena observed on Earth.
- Planetary motions around the sun can be predicted using Kepler's three empirical laws, which can be explained based on Newton's theory of gravity. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. (Note: application of the laws should be emphasized rather than memorization)

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students examine multiple sources of evidence to better understand gravitational forces in space. They use evidence and Kepler's laws to construct scientific explanations.

Science and Engineering Practices

Constructing Explanations and Designing Solutions

- Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion.
- Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.
- Base causal explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future.

Crosscutting Concepts

Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Cause and Effect: Mechanism and Prediction

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

HIGH SCHOOL EARTH & SPACE SCIENCE	
EARTH & SPACE SCIENCES	
EARTH AND THE SOLAR SYSTEM	

Science Standard: PLUS HS+E.E2U1.13 Construct an explanation of how gravitational forces are influenced by mass and the distance between objects.
 	
Learning Goals
I can:
• Construct explanations based on evidence obtained from a variety of sources *(e.g., scientific principles, models, theories, simulations):*
    ○ Apply scientific reasoning to explain how gravitational forces are affected by mass and the distance between objects.
    ○ Use Newton's Law of (Universal) Gravitation to explain relationships between gravitational forces, mass, and distance.
    ○ Revise explanations based on evidence obtained from a variety of sources and peer review.	

Core Ideas	
Knowing Science E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe. • The solar system consists of the sun and a collection of objects of varying sizes and conditions—including planets and their moons—that are held in orbit around the sun by its gravitational pull on them. This system appears to have formed from a disk of dust and gas, drawn together by gravity. **Using Science** U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. • Students make sense of gravitational forces through data analysis.	
Science and Engineering Practices	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions • Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion. • Construct and revise explanations based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories, simulations) and peer review.	**Cause and Effect: Mechanism and Prediction** • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Changes in systems may have various causes that may not have equal effects.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

EARTH AND THE SOLAR SYSTEM

Science Standard: PLUS HS+E.E2U1.14 Use mathematics and computational thinking to explain the movement of planets and objects in the solar system.

Learning Goals

I can:

- Use algebraic representations of Kepler's three Laws of Motion to predict and explain the movement of planets and objects in the solar system.
- Use Newton's Law of Gravitation and Law of Motion to predict how the acceleration of a planet towards the Sun varies with its distance from the Sun, and explain how this relates to the observed orbits.
- Show quantitative patterns that provide evidence of elliptical orbital motion including planets, moons, or human-made spacecraft.
- Create mathematical models for the paths of objects in the solar system, such as orbiting bodies, comets, asteroids, meteoroids, meteors, and meteorites.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- Earth and the moon, sun, and planets have predictable patterns of movement. These patterns, which are explainable by gravitational forces and conservation laws, in turn explain many large-scale phenomena observed on Earth.
- Gravity holds Earth in orbit around the sun, and it holds the moon in orbit around Earth. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.
- Planetary motions around the sun can be predicted using Kepler's three empirical laws, which can be explained based on Newton's theory of gravity. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and or scientific investigations. Evidence may lead to developing models and or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Planets and other objects in the solar systems are so large and so far away that mathematics and computational thinking are necessary to make sense of their movement and position.

Science and Engineering Practices	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical or algorithmic representations of phenomena to describe and support claims and explanations, and create computational models or simulations.	**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. **Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

THE UNIVERSE AND ITS STARS

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

THE UNIVERSE AND ITS STARS

Science Standard: ESSENTIAL HS.E2U1.17 Construct an explanation of the origin, expansion, and scale of the universe based on astronomical evidence.

Learning Goals

I can:

- Construct explanations based on astronomical evidence obtained from a variety of sources *(e.g., scientific principles, models, theories, simulations):*
  - Apply scientific reasoning to explain the origin and expansion of the universe.
  - Apply scientific reasoning to explain distances between planets, stars, moons, and other bodies in the *universe (e.g., next nearest star, furthest planet of Neptune*) using different scales (*e.g., light years*).
  - Use valid and reliable empirical evidence to quantify and estimate the scale and size of the universe.
  - Assess the extent to which the reasoning and evidence about the origin and expansion of the universe support the explanations.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- There are billions of galaxies in the universe, almost unimaginably vast distances apart and perceived as moving rapidly away from each other. This apparent movement of galaxies indicates that the universe is expanding from an event called a 'big bang', about 13.7 billion years ago.
- The next nearest star [from the Sun] is much further away than the distance of the furthest planet, Neptune. The distances between and within galaxies are so great that they are measured in 'light years', the distance that light can travel in a year.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Students use evidence from a variety of sources to develop their understanding of the universe.

Science and Engineering Practices	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Apply scientific reasoning, theory, and models to link evidence to claims to assess the extent to which the reasoning and data support the explanation or conclusion.	**Scale, Proportion, and Quantity** • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales. **Energy and Matter: Flows, Cycles, and Conservation** • Energy cannot be created or destroyed—only moved between one place and another place, between objects and/or fields, or between systems.

HIGH SCHOOL EARTH & SPACE SCIENCE
EARTH & SPACE SCIENCES

THE UNIVERSE AND ITS STARS

Science Standard: PLUS HS+E.E2U1.15 Obtain, evaluate, and communicate information on how the nebular theory explains solar system formation with distinct regions characterized by different types of planetary and other bodies.

Learning Goals

I can:

- Obtain information about the nebular theory of solar system formation:
  - Ask questions to frame the search for information.
  - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  - Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Evaluate information from scientific texts on the nebular theory of solar system formation:
  - Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate scientific ideas about the stellar stages of stars and how they produce elements and energy:
  - Communicate in writing and/or oral presentations how the nebular theory supports solar system formation, including the orderly patterns of motion in our solar system, two major types of planetary bodies, and the existence of smaller bodies.
  - Compare, integrate, and evaluate multiple sources of information presented in different media or formats (*e.g., visually, quantitatively*) to explain the nebular theory's explanation of solar system formation.
  - Identify and explain the evident properties within the solar system that support the nebular theory.
  - Describe the processes that lead to the patterns (*i.e., motion - orbit in same direction and plane, size and location - two types of planets*) that we see in our solar system's structure.
  - Explain how the nebular theory supports the formation and location of rocky planets, gaseous planets, and other bodies, such as the Asteroid Belt.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- The solar system consists of the sun and a collection of objects of varying sizes and conditions—including planets and their moons—that are held in orbit around the sun by its gravitational pull on them.
- This system appears to have formed from a disk of dust and gas, drawn together by gravity.

Using Science

U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised.

- Theories help students make sense of phenomena. Students explore solar system formation through the lens of nebular theory.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, models, theory, or	**Cause and Effect: Mechanism and Prediction** • Changes in systems may have various causes that may not have equal effects.

unexpected results. • Ask questions that require relevant empirical evidence to answer. • Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. **Obtaining, Evaluating, and Communicating Information** • Compare, integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) in order to address a scientific question or solve a problem. • Produce scientific and/or technical writing and/or oral presentations that communicate scientific ideas and/or the process of development and the design and performance of a proposed process or system.	**Patterns** • Empirical evidence is needed to identify patterns.

HIGH SCHOOL EARTH & SPACE SCIENCE	
EARTH & SPACE SCIENCES	
THE UNIVERSE AND ITS STARS	

Science Standard: PLUS H+E.E2U1.16 Obtain, evaluate, and communicate information about patterns of size and scale of our solar system, galaxy, and the universe.
 	
Learning Goals
I can:
• Obtain information about the size and scale of astronomical structures (*i.e., our solar system, galaxy, and the universe*):
  ○ Ask questions to frame the search for information.
  ○ Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  ○ Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
• Evaluate information from scientific texts regarding the size and scale of astronomical structures (*i.e., our solar system, galaxy, and the universe*):
  ○ Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
• Communicate information about patterns of size and scale of our solar system, galaxy, and universe:
  ○ Communicate in writing and/or oral presentations how, due to gravitational forces, patterns appear in astronomical structures at different scales in the universe, despite vast size differences.
  ○ Compare, integrate and evaluate multiple sources of information presented in different media or formats *(e.g., visually, quantitatively)* regarding the size and scale of our solar system, galaxy, and universe.
  ○ Explain patterns of evidence (*i.e., composition of stars, existence of cosmic background radiation, redshift, hydrogen-helium ratio of stars and interstellar gases*) about the size and scale of the universe.
  ○ Explain the current theory for the origin of the universe and how astronomical evidence from numerous sources is used collectively to support that the universe is expanding.	

Core Ideas	
Knowing Science E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe. • There are billions of galaxies in the universe, almost unimaginably vast distances apart and perceived as moving rapidly away from each other. This apparent movement of galaxies indicates that the universe is expanding from an event called a 'big bang', about 13.7 billion years ago. The distances between and within galaxies are so great that they are measured in 'light years', the distance that light can travel in a year. **Using Science** U1: Scientists explain phenomena using evidence obtained from observations and/or scientific investigations. Evidence may lead to developing models and/or theories to make sense of phenomena. As new evidence is discovered, models and theories can be revised. • Students develop an understanding of the size and scale of our solar system, galaxy, and universe through examination of evidence and analysis of patterns.	
Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. • Ask questions that require relevant empirical evidence to answer.	**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. **Scale, Proportion, and Quantity**

• Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. **Obtaining, Evaluating, and Communicating Information** • Synthesize, communicate, and evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible. • Produce scientific and/or technical writing and/or oral presentations that communicate scientific ideas and/or the process of development and the design and performance of a proposed process or system.	• Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. • Patterns observable at one scale may not be observable or exist at other scales.

HIGH SCHOOL EARTH & SPACE SCIENCE

EARTH & SPACE SCIENCES

THE UNIVERSE AND ITS STARS

Science Standard: PLUS H+E.E2U2.17 Obtain, evaluate, and communicate the impact of technology on human understanding of the formation, scale, and composition of the universe.

Learning Goals

I can:

- Obtain information about the impact of technology on human understanding of the formation, scale, and composition of the universe:
  - Ask questions to frame the search for information.
  - Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text.
  - Summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- Evaluate information from scientific texts about the progression and impact of technology and tools used to understand astronomical concepts such as formation, scale, and composition:
  - Evaluate the validity and reliability of claims, methods, and designs that appear in scientific and technical texts or media reports, verifying the data when possible.
- Communicate information about the impact of technology on human understanding of the universe:
  - Communicate in writing and/or oral presentations the development and function of various tools scientists have developed to further study the expansion and scale of the universe.
  - Compare, integrate and evaluate multiple sources of information presented in different media or formats *(e.g., visually, quantitatively)* regarding how scientists have developed tools and methods to progressively overcome challenges in observational astronomy.

Core Ideas

Knowing Science

E2: The Earth and our solar system are a very small part of one of many galaxies within the Universe.

- The distances between and within galaxies are so great that they are measured in 'light years', the distance that light can travel in a year. There are billions of galaxies in the universe, almost unimaginably vast distances apart and perceived as moving rapidly away from each other. This apparent movement of galaxies indicates that the universe is expanding from an event called a 'big bang', about 13.7 billion years ago.

Using Science

U2: The knowledge produced by science is used in engineering and technologies to solve problems and/or create products.

- Students explore how technology has helped us develop an understanding of that which is too large to be studied directly.

Science and Engineering Practices	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that arise from careful observation of phenomena, models, theory, or unexpected results. • Ask questions that require relevant empirical evidence to answer. • Ask and evaluate questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design. **Obtaining, Evaluating, and Communicating Information**	**Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. • Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination

• Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. • Produce scientific and/or technical writing and/or oral presentations that communicate scientific ideas and/or the process of development and the design and performance of a proposed process or system.	of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.