# Linking Science and Engineering Practices, the Georgia Standards of Excellence in Science and NAAEE *Excellence in Environmental Education: Guidelines for Learning (K-12)*

For ease of decoding, skills related guidelines – those from Strands 1 and 3 – are displayed in blue font.

| KINDERGARTEN |
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| **NGSS Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning K-4** |
| **K-PS2 Motion and Stability: Forces and Interactions** |
| **K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.**  | **SKP2.** **Obtain, evaluate, and communicate information to compare and describe different types of motion.** a. Plan and carry out an investigation to determine the relationship between an object’s physical attributes and its resulting motion (straight, circular, back and forth, fast and slow, and motionless) when a force is applied. (Examples could include toss, drop, push, and pull.) b. Construct an argument as to the best way to move an object. |  |
| **K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.** | **S2P2. Obtain, evaluate, and communicate information to demonstrate changes in speed and direction using pushes and pulls.** a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object. b. Design and evaluate a device to change the speed or direction of an object. c. Record and analyze data to decide if a design solution works as intended to change the speed or direction of an object with a push or a pull. |  |
| **K-PS3 Energy** |
| **K-PS3-1. Make observations to determine the effect of sunlight on Earth’s surface** | **S2E2.** **Obtain, evaluate, and communicate information to develop an understanding of the patterns of the Sun and the moon and the sun’s effect on Earth.** a. Plan and carry out an investigation to determine the effect of the position of the sun in relation to a fixed object on earth at various times of the day. b. Design and build a structure that demonstrates how shadows change throughout the day. c. Represent data in tables and/or graphs of the length of the day and night to recognize the change in seasons. d. Use data from personal observations to describe, illustrate, and predict how the appearance of the moon changes over time in a predictable pattern. (Clarification statement: Students are not required to know the phases of the moon or tilt of the Earth.) | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.C. Energy** – While they may have little understanding of formal concepts associated with energy, learners are familiar with the basic behavior of some different forms of energy.  |
| **K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.B. Designing investigations –** Learners are able to design simple investigations.**2.1 The Earth as a Physical System****2.1.C. Energy** – While they may have little understanding of formal concepts associated with energy, learners are familiar with the basic behavior of some different forms of energy.**2.4 Environment and Society****2.4.A. Human/environment interactions –** Learners understand that people depend on, change, and are affected by the environment. |
| **K-LS1 From Molecules to Organisms: Structures and Processes** |
| **K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.**  | **SKL1.Obtain, evaluate, and communicate information about how organisms (alive, not alive) and non-living materials are grouped.** a. Construct an explanation based on observations to recognize the difference between organisms and nonliving materials. b. Develop a model to represent how a set of organisms and nonliving materials are sorted into groups based on their attributes. | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information –** Learners are able to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.D. Flow of matter and energy** – Learners know that living things need some source of energy to live and grow. |
| **K-ESS2 Earth’s Systems** |
| **K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.**  | **SKE1.** **Obtain, evaluate, and communicate observations about time patterns (day to night and night to day) and objects (such as sun, moon, stars) in the day and night sky.** a. Ask questions to classify objects according to those seen in the day sky, the night sky, and both. b. Develop a model to communicate with pictures and words the changes that occur in the sky during the day, as day turns into night, during the night, and as night turns into day. (Clarification statement: Students are not expected to understand tilt of the Earth, rotation, or revolution.) | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **1.E. Organizing information –** Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.** | **S2E3. Obtain, evaluate, and communicate information about how weather, plants, animals, and humans cause changes to the environment.** a. Ask questions and obtain information about major changes to the environment in your community. b. Construct an explanation of the causes of a change to the environment in your community. | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms.**2.4 Environment and Society****2.4.A Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment. |
| **KESS3 Earth and Human Activity** |
| **K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.**  | **SKL2**. **Obtain, evaluate, and communicate information to compare the similarities and differences in groups of organisms.** a. Construct an argument supported by evidence for how animals can be grouped according to their features. b. Construct an argument supported by evidence for how plants can be grouped according to their features. c. Ask questions and make observations to identify the similarities and differences of offspring to their parents and to other members of the same species. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand that relationships, patterns, and processes can be represented by models.**2.2 The Living Environment****2.2.C.** **Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms.**2.4 Environment and Society****2.4.A Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment.**2.4.B Places** – Learners understand that places differ in their physical and human characteristics. |
| **K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.**  | **S1E1. Obtain, evaluate, and communicate weather data to identify patterns in weather and climate.** a. Represent data in tables and/or graphs to identify and describe different types of weather and the characteristics of each type. b. Ask questions to identify forms of precipitation such as rain, snow, sleet, and hailstones as either solid (ice) or liquid (water). c. Plan and carry out investigations on current weather conditions by observing, measuring with simple weather instruments (thermometer, wind vane, rain gauge), and recording weather data (temperature, precipitation, sky conditions, and weather events) in a periodic journal, on a calendar seasonally, and graphically. d. Analyze data to identify seasonal patterns of change. (Clarification statement: Examples could include temperature, rainfall/snowfall, and changes to the environment.) | **1 Questioning, Analysis and Interpretation Skills****1. A. Questioning –** Learners are able to develop questions that help them learn about the environment and do simple investigations.**2.4 Environment and Society****2.4.A. Human/environment interactions –** Learners understand that people depend on, change, and are affected by the environment. |
| **K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment.**2.4.C. Resources –** Learners understand the basic concepts of resource and resource distribution.**2.4.E. Environmental** issues – Learners are familiar with some local environmental issues and understand that people in other places experience environmental issues as well.  |
| **NOT IN NGSS** | **SKE2.** **Obtain, evaluate, and communicate information to describe the physical attributes of rocks and soils.** a. Ask questions to identify and describe earth materials—soil, rocks, water, and air. b. Construct an argument supported by evidence for how rocks can be grouped by physical attributes (size, weight, texture, color). c. Use tools to observe and record physical attributes of soil such as texture and color. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **1.E. Organizing information –** Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |

| FIRST GRADE |
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| **NGSS Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning K-4** |
|  | **1-PS4 Waves and their Applications in Technologies for Information Transfer** |
| **1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.**  | **S1P1.** **Obtain, evaluate, and communicate information to investigate light and sound.** a. Use observations to construct an explanation of how light is required to make objects visible. b. Ask questions to identify and compare sources of light. c. Plan and carry out an investigation of shadows by placing objects at various points from a source of light. d. Construct an explanation to observe and provide evidence that vibrating materials can make sound and that sound can make materials vibrate. e. Design a device that can serve as an emergency alert system using light and/or sound to communicate over a distance. |  |
| **1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated.**  |  |  |
| **1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.**  | **S4P1. Obtain, evaluate, and communicate information about the nature of light and how light interacts with objects.** a. Plan and carry out investigations to observe and record how light interacts with various materials to classify them as opaque, transparent, or translucent. b. Plan and carry out investigations on the path light travels from a light source to a mirror and how it is reflected by the mirror using different angles. c. Plan and carry out an investigation utilizing everyday materials to explore examples of when light is refracted. (Clarification statement: Everyday materials could include prisms, eyeglasses, and a glass of water.) |  |
| **1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.** | **S4P2. Obtain, evaluate, and communicate information about how sound is produced and changed and how sound and/or light can be used to communicate.** a. Plan and carry out an investigation utilizing everyday objects to produce sound and predict the effects of changing the strength or speed of vibrations. b. Design and construct a device to communicate across a distance using light and/or sound. |  |
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| **1-LS1 From Molecules to Organisms: Structures and Processes** |
| **1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.** | **S1L1. Obtain, evaluate, and communicate information about the characteristics and basic needs of plants and animals.** a. Ask questions to identify the parts of a plant—root, stem, leaf, and flower. b. Ask questions to compare and contrast the basic needs of plants (air, water, light, and nutrients) and animals (air, water, food, and shelter). c. Design a solution to ensure that a plant or animal has all of its needs met | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat. |
| **1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.2 The Living Environment****2.2.C.** **Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms. |
| **1-LS3 Heredity: Inheritance and Variation of Traits** |
| **1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.2 The Living Environment****2.2.B Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited. |
| **1-ESS1 Earth’s Place in the Universe** |
| **1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.**  | **S2E1. Obtain, evaluate, and communicate information about stars having different sizes and brightness.** a. Ask questions to describe the physical attributes of stars—size and brightness. b. Ask questions and construct an argument that although the Sun appears to be the brightest and largest star, it is actually medium in size and brightness. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |

| SECOND GRADE |
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| **NGSS Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning K-4** |
| **2-PS1 Matter and its Interactions** |
| **2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.**  | **S2P1. Obtain, evaluate, and communicate information about the properties of matter and changes that occur in objects**. a. Ask questions to describe and classify different substances according to their physical properties. (Clarification statement: Examples could include color, mass, length, texture, hardness, strength, absorbency, and flexibility.) b. Construct an explanation for how structures made from small pieces (linking cubes, building blocks, Legos) can be disassembled and then rearranged to make new and different structures. c. Provide evidence from observations to construct an explanation that some changes in matter caused by heating or cooling can be reversed and some changes are irreversible. (Clarification statement: Changes in matter could include heating or freezing of water, baking a cake, boiling an egg.) | **1 Questioning, Analysis and Interpretation Skills****1.B. Designing investigations –** Learners are able to design simple investigations.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners are able to identify basic characteristics of and changes in matter. |
| **2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.** |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners are able to identify basic characteristics of and changes in matter. |
| **2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object**.  |  |   |
| **2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot**.  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners are able to identify basic characteristics of and changes in matter. |
| **2-LS2 Ecosystems: Interactions, Energy, and Dynamics** |
| **2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow** |  | **1 Questioning, Analysis and Interpretation Skills****1. B. Designing investigations –** Learners are able to design simple investigations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2D Flow of matter and energy** – Learners know that living things need some source of energy to live and grow. |
| **2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand that relationships, patterns, and processes can be represented by models.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms. |
| **2-LS4 Biological Evolution: Unity and Diversity** |
| **2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.**  | **S3L1. Obtain, evaluate, and communicate information about the similarities and differences between the habitats found within geographical regions (Blue Ridge Mountains, Piedmont, Coastal Plains, Valley and Ridge, and Appalachian Plateau) of Georgia.** a. Ask questions to differentiate between plants and animals that live in different habitats. b. Identify external features and adaptations (camouflage, use of hibernation, protection, migration, mimicry) of animals to construct an explanation of how these features/adaptations allow them to survive in their habitat. c. Use evidence to construct an explanation of why some organisms can thrive in one habitat and not in another. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms. |
| **2-ESS1 Earth’s Place in the Universe** |
| **2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **2-ESS2 Earth’s Systems** |
| **2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.**  |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment.**2.4 Environment and Society****2.4.A. Human/environment interactions –** Learners understand that people depend on, change, and are affected by the environment. |
| **2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand that relationships, patterns, and processes can be represented by models.**2.1 The Earth as a Physical System****2.1. A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.** |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |

| THIRD GRADE |
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| **NGSS – Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning K-4** |
| **3-PS2 Motion and Stability: Forces and Interactions** |
| **3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.**  | **S4P3. Obtain, evaluate, and communicate information about the relationship between balanced and unbalanced forces.** a. Plan and carry out an investigation on the effects of balanced and unbalanced forces on an object and communicate the results. b. Construct an argument to support the claim that the gravitational force affects the motion of an object. c. Ask questions to identify and explain the uses of simple machines (lever, pulley, wedge, inclined plane, wheel and axle, and screw) and how forces are changed when simple machines are used to complete tasks. (Clarification statement: The use of mathematical formulas is not expected.) |  |
| **3-PS2-2. Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.**  |  |  |
| **3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.** | **S1P2.** **Obtain, evaluate, and communicate information to demonstrate effects of magnets on other magnets and other objects**. a. Construct an explanation of how magnets are used in everyday life. (Clarification statement: Everyday life objects could include refrigerator magnets, toys, magnetic latches, and name tags.) b. Plan and carry out an investigation to demonstrate how magnets attract and repel each other and the effect of magnets on common objects. |  |
| **3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.**  | **S5P3. Obtain, evaluate, and communicate information about magnetism and its relationship to electricity.** a. Construct an argument based on experimental evidence to communicate the differences in function and purpose of an electromagnet and magnet. (Clarification statement: Function is limited to understanding temporary and permanent magnetism.) b. Plan and carry out an investigation using materials (wood, paper, glass, metal, and rocks) that do or do not block magnetic force. |  |
| **3-LS1 From Molecules to Organisms: Structures and Processes** |
| **3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.**  | **S2L1. Obtain, evaluate, and communicate information about the life cycles of different living organisms.** a. Ask questions to determine the sequence of the life cycle of common animals in your area: a mammal such as a cat, dog or classroom pet, a bird such as a chicken, an amphibian such as a frog, and an insect such as a butterfly. b. Plan and carry out an investigation of the life cycle of a plant by growing a plant from a seed and by recording changes over a period of time. c. Develop a simple model that depicts an animal’s role in dispersing seeds or in the pollination of plants. d. Develop models to illustrate the unique and diverse life cycles of organisms other than humans. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand that relationships, patterns, and processes can be represented by models.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat. |
| **3-LS2 Ecosystems: Interactions, Energy, and Dynamics** |
| **3-LS2-1. Construct an argument that some animals form groups that help members survive.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat. |
| **3-LS3 Heredity: Inheritance and Variation of Traits** |
| **3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.**  | **S5L2. Obtain, evaluate, and communicate information showing that some characteristics of organisms are inherited and other characteristics are acquired.** a. Ask questions to compare and contrast the characteristics of instincts and learned behaviors. b. Ask questions to compare and contrast inherited and acquired physical traits. (Clarification statement: Punnett squares and genetics are taught in future grades.) | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited. |
| **3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and to other organisms. |
| **3-LS4 Biological Evolution: Unity and Diversity** |
| **3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.**  | **S3E2. Obtain, evaluate, and communicate information on how fossils provide evidence of organisms that lived long ago.** a. Construct an argument from observations of fossils (authentic or reproductions) to communicate how they serve as evidence of organisms and the surrounding environments of long ago. b. Develop a model to describe the sequence and conditions required for an organism to become fossilized. (Clarification statement: Types of fossils (cast, mold, trace, and true) are not addressed in this standard.) | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and to other organisms. |
| **3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.**  | **S5L1. Obtain, evaluate, and communicate information to group organisms using scientific classification procedures.** a. Develop a model that illustrates how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibians, reptiles, bird, and mammal) using data from multiple sources. b. Develop a model that illustrates how plants are sorted into groups (seed producers, non-seed producers) using data from multiple sources. | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and to other organisms. |
| **3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and to other organisms. |
| **3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.** |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.2 The Living Environment****2.2.A.** **Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.B.** **Heredity and evolution** – Learners understand that plants and animals have different characteristics and that many of the characteristics are inherited.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and to other organisms. |
| **3-ESS2 Earth’s Systems** |
| **3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.** | **S4E4. Obtain, evaluate, and communicate information using weather charts/maps and collect weather data to predict weather events and infer weather patterns**. a. Ask questions to explain how weather instruments (thermometer, rain gauge, barometer, wind vane, and anemometer) are used in gathering weather data and making forecasts. b. Interpret data from weather maps to identify fronts (warm, cold, and stationary), temperature, and precipitation to make an informed prediction about tomorrow’s weather c. Ask questions and use observations of cloud types (cirrus, stratus, and cumulus) and data of weather conditions to predict weather events and patterns throughout the year. d. Construct on explanation based on research to communicate the difference between weather and climate. | **1 Questioning, Analysis and Interpretation Skills****1. E. Organizing information** – Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **1.E. Organizing information** – Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
| **NOT IN NGSS** | **S3E1. Obtain, evaluate, and communicate information about the physical attributes of rocks and soils.** a. Ask questions and analyze data to classify rocks by their physical attributes (shape, color, texture, luster, and hardness) using simple tests. (Clarification statement: Mohs scale should be studied at this level. Cleavage and streak as well as classification of rocks into sedimentary, igneous, and metamorphic are not addressed at this level.) b. Plan and carry out investigations to describe properties (color, texture, capacity to retain water, and ability to support growth of plants) of soils and soil types (sand, clay, loam). c. Make observations of the local environment to construct an explanation of how water and/or wind have made changes to soil and/or rocks over time. (Clarification statement: Examples could include ripples in dirt on a playground and a hole formed under gutters.) | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **1.E. Organizing information** – Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment. |
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| **3-ESS3 Earth and Human Activity** |
| **3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.** |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment.**2.4.D. Technology** – Learners understand that technology is an integral part of human existence and culture. |

|  | FOURTH GRADE |
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| **NGSS – Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning K-4** |
| **4-PS3 Energy** |
| **4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.** |  |  |
| **4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.**  | **S5P2. Obtain, evaluate, and communicate information to investigate electricity.** a. Obtain and combine information from multiple sources to explain the difference between naturally occurring electricity (static) and human-harnessed electricity. b. Design and explain all necessary components required to complete a simple electric circuit. c. Investigate and test common materials to determine if they are insulators or conductors of electricity. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **2.1 The Earth as a Physical System****2.1.C. Energy** – While they may have little understanding of formal concepts associated with energy, learners are familiar with the basic behavior of some different forms of energy. |
| **4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.**  |  |  |
| **4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.** |  | **2.1 The Earth as a Physical System****2.1.C. Energy** – While they may have little understanding of formal concepts associated with energy, learners are familiar with the basic behavior of some different forms of energy. |
| **4-PS4 Waves and their Applications in Technologies for Information Transfer** |
| **4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.**  |  |  |
| **4-PS4-2 Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.** |  |  |
| **4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.** |  |  |
| **4-LS1 From Molecules to Organisms: Structures and Processes** |
| **4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners can develop simple explanations that address their questions about the environment.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat. |
| **4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand that relationships, patterns, and processes can be represented by models.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic similarities and differences among a wide variety of living organisms. They understand the concept of habitat.**2.2.C. Systems and connections** – Learners understand basic ways in which organisms are related to their environments and other organisms. |
| **4-ESS1 Earth’s Place in the Universe** |
| **4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.**  | **S5E1. Obtain, evaluate, and communicate information to identify surface features on the Earth caused by constructive and/or destructive processes.** a. Construct an argument supported by scientific evidence to identify surface features (examples could include deltas, sand dunes, mountains, volcanoes) as being caused by constructive and/or destructive processes (examples could include deposition, weathering, erosion, and impact of organisms). b. Develop simple interactive models to collect data that illustrate how changes in surface features are/were caused by constructive and/or destructive processes. c. Ask questions to obtain information on how technology is used to limit and/or predict the impact of constructive and destructive processes. (Clarification statement: Examples could include seismological studies, flood control, urban planning and construction, and beach restoration.) | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. * 1. **The Earth as a Physical System**

**2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment.**2.1.B. Changes in matter** – Learners are able to identify basic characteristics of and changes in matter. |
| **4-ESS2 Earth’s Systems** |
| **4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. * 1. **The Earth as a Physical System**

**2.1.A. Processes that shape the Earth** – Learners are able to identify changes and differences in the physical environment.**2.1.B. Changes in matter** – Learners are able to identify basic characteristics of and changes in matter. |
| **4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth’s features.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.* 1. **The Earth as a Physical System**

**2.1.A. Processes that shape the** Earth – Learners are able to identify changes and differences in the physical environment. |
| **4-ESS3 Earth and Human Activity** |
| **4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.**  | **S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.** a. Ask questions to collect observations and keep records of sources and effects of pollution on the plants and animals of Georgia. b. Explore, research, and communicate solutions, such as conservation of resources and recycling materials, to protect plants and animals of Georgia. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics. **1.E. Organizing information** – Learners are about to describe data and organize information to search for relationships and patterns concerning the environment and environmental topics.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment.**2.4.C. Resources** – Learnersunderstand the basic concepts of resource and resource distribution.**2.4.E. Environmental** **issues** – Learners are familiar with some local environmental issues and understand that people in other places experience environmental issues as well. |
| **4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.**  |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of actions** – Learners understand there are many approaches to resolving issues.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that people depend on, change, and are affected by the environment.2.4 Environment and Society**2.4.C Resources** – Learners understand the basic concepts of resource and resource distribution.**2.4.E. Environmental** **issues** – Learners are familiar with some local environmental issues and understand that people in other places experience environmental issues as well. |

| FIFTH GRADE |
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| **NGSS – Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning Grades 5-8** |
| **5-PS1 Matter and Its Interactions** |
| **5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.**   |  |  |
| **5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.**  | **S3P1. Obtain, evaluate, and communicate information about the ways heat energy is transferred and measured.** a. Ask questions to identify sources of heat energy. (Clarification statement: Examples could include sunlight, friction, and burning.) b. Plan and carry out an investigation to gather data using thermometers to produce tables and charts that illustrate the effect of sunlight on various objects. (Clarification statement: The use of both Fahrenheit and Celsius temperature scales is expected.) c. Use tools and every day materials to design and construct a device/structure that will increase/decrease the warming effects of sunlight on various materials. (Clarification statement: Conduction, convection, and radiation are taught in upper grades, and should not be taught at this grade level.) |  |
| **5-PS1-3. Make observations and measurements to identify materials based on their properties.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
| **5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.**  |  |  |
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| **5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.**  |  |  |
| **5-PS3 Energy** |
| **5-PS3-1 Use models to describe that that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models. **2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment. |
| **5-LS1 From Molecules to Organisms: Structures and Processes** |
| **5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water.** |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment. |
| **5-LS2 Ecosystems: Interactions, Energy, and Dynamics** |
| **5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations or organisms.**2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment.  |
| **5-ESS1 Earth’s Place in the Universe** |
| **5-ESS1-1 Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distance from Earth.** | **S4E1. Obtain, evaluate, and communicate information to compare and contrast the physical attributes of stars, and planets**. a. Ask questions to compare and contrast technological advances that have changed the amount and type of information on distant objects in the sky. b. Construct an argument on why some stars (including the Earth’s sun) appear to be larger or brighter than other stars. (Clarification statement: Differences are limited to distance and size, not age or stage.) c. Construct an explanation of the difference between stars and planets in the sky. d. Evaluate strengths and limitations of models of our solar system in describing relative size, order, appearance, and composition of planets and the sun. |  |
| **5-ESS1-2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearances of some stars in the night sky.** | **S4E2. Obtain, evaluate, and communicate information to model the effects of the position and motion of the Earth and the moon in relation to the sun as observed from the Earth.** a. Develop a model to support an explanation of why the length of day and night change throughout the year. b. Develop a model based on observations to describe the repeating pattern of the phases of the moon (new, crescent, quarter, gibbous, and full). c. Construct an explanation of how the Earth’s orbit, with its consistent tilt, affects seasonal changes. | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
| **5-ESS2 Earth’s Systems** |
| **5-ESS2-1 Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact**. |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
| **5-ESS2-2 Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.** |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.4 Environment and Society****2.4.C. Resources** – Learners understand that uneven distribution of resources influences their use and perceived value. |
| **5-ESS3 Earth and Human Activity** |
| **5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.** |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect information about the environment and environmental topics.**2.3 Humans and Their Societies****2.3.A. Individuals and groups** – Learners understand that how individuals perceive the environment is influenced in part by individual traits and group membership or affiliation.**2.4 Environment and Society****2.4.E. Environmental issues** – Learners are familiar with a range of environmental issues at scales that range from local to national to global. They understand that people in other places around the world experience environmental issues similar to the ones they are concerned about locally. |

| MIDDLE SCHOOL – GRADES 6-8 |
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| **NGSS – Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning Grades 5-8** |
| **MS-PS1 Matter and Its Interactions** |
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| **MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.**  |

 | **SC1. Obtain, evaluate, and communicate information about the use of the modern atomic theory and periodic law to explain the characteristics of atoms and elements.** a. Evaluate the merits and limitations of different models of the atom in relation to relative size, charge, and position of protons, neutrons, and electrons in the atom. b. Construct an argument for why the proton (and not the neutron or electron) defines the element’s identity. c. Construct an explanation, based on scientific evidence, of the production of elements heavier than hydrogen by nuclear fusion. d. Construct an explanation that relates the relative abundance of isotopes of a particular element to the atomic mass of the element. e. Construct an explanation of light emission and the movement of electrons to identify elements. f. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms (including atomic radii, ionization energy, and electronegativity of various elements). g. Develop and use models including electron configuration of atoms and ions to predict their chemical properties. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** –Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
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| **MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.**  |

 | **S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.** a. Develop and use a model to compare and contrast pure substances (elements and compounds) and mixtures. (Clarification statement: Include heterogeneous and homogeneous; don’t include types of bonds or types of compounds.) b. Develop and use models to identify the structure and properties of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed. (Clarification statement: Do not include gas laws.) c. Plan and carry out investigations to compare and contrast chemical (i.e., reactivity, combustibility) and physical properties of matter (i.e., density, melting point, boiling point). d. Construct an argument to support the claim that when a change occurs it is either chemical or physical. (Clarification statement: Evidence could include ability to separate mixtures, development of a gas, formation of a precipitate, change in energy, color, and/or form.) e. Develop models (e.g., atomic-level models, including drawings, and computer representations) by analyzing patterns within the periodic table that illustrate the structure, composition, and characteristics of atoms (including protons, neutrons, and electrons) and simple molecules. f. Construct an explanation based on evidence to describe conservation of matter and mass in a chemical reaction including the resulting differences between products and reactants. (Clarification statement: Evidence could include models with balanced chemical equations but students should not be expected to balance equations.) | **1 Questioning, Analysis and Interpretation Skills****1.E .Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
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| **MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
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| **MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment.**2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment. |
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| **MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.B. Designing investigations** – Learners are able to design environmental investigations to answer particular questions – often their own questions.**1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and develop action strategies for addressing particular issues.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
| **MS-PS2 Motion and Stability: Forces and Interactions** |
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| **MS-PS2-1. Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.** |

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| **MS-PS2-2. Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.**  |

 | **S8P3. Obtain, evaluate, and communicate information about cause and effect relationships between force, mass, and the motion of objects.** a. Analyze and interpret data to identify patterns in the relationships between speed and distance, and velocity and acceleration. (Clarification statement: Students should be able to analyze motion graphs, but students should not be expected to calculate changes in velocity or acceleration.) b. Construct an explanation from evidence to describe the effects of balanced and unbalanced forces on the motion of an object (e.g., gravity, friction). c. Construct an argument from evidence to support the claim that larger objects require a greater force to accelerate (inertia). |  |
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| **MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.**  |

 | **S8P5. Obtain, evaluate, and communicate information about the phenomena of gravity, electricity, and magnetism as major forces acting in nature**. 1. Construct an argument using evidence to support the claim that fields (i.e., magnetic fields, gravitational fields, and electric fields) exist between objects exerting forces on each other even when the objects are not in contact.
2. Plan and carry out investigations to describe the processes that cause electrostatic forces between objects. (Clarification statement: Include conduction, induction, and friction.)

Plan and carry out investigations to identify factors (e.g., distance between objects, magnetic force produced by an electromagnet with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) that affect the strength of electric and magnetic forces. (Clarification statement: The investigations included, but are not limited to, generators or motors.) |  |
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| **MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.**  |

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|  | **MS-PS3 Energy** |
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| **MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.E .Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.** |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.**1.B. Designing investigations** – Learners are able to design environmental investigations to answer particular questions – often their own questions.**1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**  |

 | **S8P2. Obtain, evaluate, and communicate information about the law of conservation of energy to develop arguments that energy can transform from one form to another within a system.** a. Analyze and interpret data to create graphical displays that illustrate the relationships of kinetic energy to mass and speed and the potential energy to mass and height of an object. b. Plan and carry out an investigation to explain the transformation between kinetic and potential energy within a system (e.g., roller coasters, pendulums, rubber bands). c. Obtain, evaluate, and communicate explanations about energy transformations within a system [e.g., lighting a match (light to heat), turning on a light (electrical to light)].d. Plan and carry out investigations on the effects of heat transfer on molecular motion as it relates to the collision of atoms (conduction) or through space (radiation) or in currents in a liquid or a gas (convection). | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.**1.B. Designing investigations** – Learners are able to design environmental investigations to answer particular questions – often their own questions.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
| **MS-PS4 Waves and Their Applications in Technologies for Information Transfer** |
| **MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** |  |  |
| **MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** | **S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves.** a. Ask questions to develop explanations about the similarities and differences between electromagnetic and mechanical waves. (Clarification statement: Include transverse and longitudinal waves and wave parts such as crest, trough, compressions, and rarefactions.) b. Construct an explanation using data to illustrate the relationship between the electromagnetic spectrum and energy. c. Obtain, evaluate, and communicate information to explain practical applications of the electromagnetic spectrum (e.g., communication, medical, military). d. Develop and use a model to compare and contrast how light and sound waves are reflected, refracted, absorbed, diffracted, or transmitted through various materials. (Clarification statement: Include echo and how color is seen but not interference and scattering.) e. Analyze and interpret data to predict patterns in the relationship between density of media and wave behavior (i.e., speed). f. Develop and use a model (e.g., simulations, graphs, illustrations) to predict and describe the relationships between wave properties (e.g., frequency, amplitude, and wavelength) and energy. g. Develop and use models to demonstrate the effects and functions of lenses. |  |
| **MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.** |  |  |
| **MS-LS1 From Molecules to Organisms: Structures and Processes** |
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| **MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.**  |

 | **S5L3. Obtain, evaluate, and communicate information to compare and contrast the parts of plant and animal cells.** a. Gather evidence by utilizing technology tools to construct an explanation that plants and animals are comprised of cells too small to be seen without magnification. b. Develop a model to identify and label parts of a plant cell (membrane, wall, cytoplasm, nucleus, chloroplasts) and of an animal cell (membrane, cytoplasm, and nucleus). c. Construct an explanation that differentiates between the structure of plant and animal cells. |  |
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| **MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.**  |

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| **MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.**  |

 | **S7L2. Obtain, evaluate, and communicate information to construct scientific explanations to describe how cell structures, cells, tissues, organs, and organ systems interact to maintain the basic needs of organisms.** a. Develop a model and construct an explanation of how cell structures (specifically the nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, and mitochondria) contribute to the function of the cell as a system in obtaining nutrients in order to grow, reproduce, make needed materials, and process waste. (Clarification statement: The intent is for students to demonstrate how the component structures of the cell interact and work together to allow the cell as a whole to carry out various processes. Additional structures, beyond those listed, will be addressed in high school Biology.) b. Develop and use a conceptual model of how cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms. c. Construct an argument that systems of the body (Cardiovascular, Excretory, Digestive, Respiratory, Muscular, Nervous, and Immune) interact with one another to carry out life processes. (Clarification statement: The emphasis is not on learning individual structures and functions associated with each system, but on how systems interact to support life processes.) |  |
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| **MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments. |
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| **MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability –** Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments. |
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| **MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability –** Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment. |
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| **MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** –Learners understand many of the uses and limitations of models.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment. |
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| **MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.**  |

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| **MS-LS2 Ecosystems: Interactions, Energy, and Dynamics** |
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| **MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.**  |

 | **SB5. Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment**. a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems. (Clarification statement: Factors include size, carrying capacity, response to limiting factors, and keystone species.) b. Develop and use models to analyze the flow of matter and energy within ecosystems through the processes of photosynthesis and respiration by • Arranging components of a food web according to energy flow. • Comparing the quantity of energy in the steps of an energy pyramid. • Explaining the need for cycling of major biochemical elements (C, O, and H). c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem. d. Design a solution to reduce the negative impact of a human activity on the environment. (Clarification statement: Human activities may include climate change, population growth, chemical use, natural resources consumption, and introduction of nonnative species.) e. Construct explanations that predict an organism’s ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire). | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms.**2.4 Environment and Society****2.4.C. Resources** – Learners understand that uneven distribution of resources influences their use and perceived value. |
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| **MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.**  |

 | **S7L4. Obtain, evaluate, and communicate information to examine the interdependence of organisms with one another and their environments**. a. Construct an explanation to describe the patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of the ecosystem. (Clarification statement: The interactions include, but are not limited to, predator/prey relationships, competition, mutualism, parasitism, and commensalism.) b. Develop a model to describe the cycling of matter and the flow of energy among biotic and abiotic components of an ecosystem. (Clarification statement: Emphasis is on tracing movement of matter and flow of energy, not on the biochemical mechanisms of photosynthesis and cellular respiration.) c. Analyze and interpret data to provide evidence for how resource availability, disease, climate, and human activity affect individual organisms, populations, communities, and ecosystems. (Clarification statement: Limiting factors, carrying capacity, and population growth are not included.) d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth’s major terrestrial biomes (i.e., tropical rain forest, savannah, temperate forest, desert, taiga, tundra, and mountain) and aquatic ecosystems (i.e., freshwater, estuaries, and marine). (Clarification statement: Emphasis is on the factors that influence patterns across biomes such as the climate, availability of food and water, temperature.) | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms. |
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| **MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.**  |

 | **S4L1. Obtain, evaluate, and communicate information about the roles of organisms and the flow of energy within an ecosystem**. a. Develop a model to describe the roles of producers, consumers, and decomposers in a community. (Clarification statement: Students are not expected to identify the different types of consumers – herbivores, carnivores, omnivores, and scavengers.) b. Develop simple models to illustrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers. c. Communicate a scenario to demonstrate the effect of a change on an ecosystem. (Clarification statement: Include living and non-living factors in the scenario.) d. Use printed and digital data to develop a model illustrating and describing changes to the flow of energy in an ecosystem when plants or animals become scarce, extinct, or over-abundant. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.B Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment.**2.1.C. Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners understand how energy and matter flow among the abiotic and biotic components of the environment. |
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| **MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.**  |
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 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times. |
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| **MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and develop action strategies for addressing particular issues.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times. |
| **MS-LS3 Heredity: Inheritance and Variation of Traits** |
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| **MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.**  |

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| **MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.**  |

 | **S7L3. Obtain, evaluate, and communicate information to explain how organisms reproduce either sexually or asexually and transfer genetic information to determine the traits of their offspring**. a. Construct an explanation supported with scientific evidence of the role of genes and chromosomes in the process of inheriting a specific trait. Science Georgia Standards of Excellence Georgia Department of Education January 14, 2016 • Page 27 of 58 b. Develop and use a model to describe how asexual reproduction can result in offspring with identical genetic information while sexual reproduction results in genetic variation. (Clarification statement: The model includes, but is not limited to, the use of monohybrid Punnett squares to demonstrate the heritability of genes and the resulting genetic variation, identification of heterozygous and homozygous, and comparison of genotype vs. phenotype.) c. Ask questions to gather and synthesize information about the ways humans influence the inheritance of desired traits in organisms through selective breeding. (Clarification statement: The element specifically refers to artificial selection and the ways in which it is fundamentally different than natural selection.) | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.2 The Living Environment****2.2.B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage. |
| **NOT IN NGSS** | **S5L4. Obtain, evaluate, and communicate information about how microorganisms benefit or harm larger organisms. (Clarification statement: Possible microorganisms could include Tardigrades, Lactobacillus, Probiotics, Rotifers, Salmonella, Botox, E-coli, Algae, etc.)** a. Construct an argument using scientific evidence to support an argument that microorganisms are beneficial. b. Construct an argument using scientific evidence to support an argument that microorganisms are harmful. |  |
| **MS-LS4 Biological Evolution: Unity and Diversity** |
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| **MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms. |
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| **MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms. |
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| **MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage. |
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| **MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms. |
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| **MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.**2.4.D. Technology** – Learners understand the human ability to shape and control the environment as a function of the capacities for creating knowledge and developing new technologies. |
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| **MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.2 The Living Environment****2.2.B. Heredity and evolution** – Learners have a basic understanding of the importance of genetic heritage. |
| **MS-ESS1 Earth’s Place in the Universe** |
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| **MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.**  |

 | **S6E2. Obtain, evaluate, and communicate information about the effects of the relative positions of the Earth, moon and sun.** a. Develop and use a model to demonstrate the phases of the moon by showing the relative positions of the sun, Earth, and moon. b. Construct an explanation of the alignment of the sun, Earth, and moon during solar and lunar eclipses. c. Analyze and interpret data to relate the tilt of the Earth to the distribution of sunlight throughout the year and its effect on seasons. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
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| **MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.**  |

 | **S6E1. Obtain, evaluate, and communicate information about current scientific views of the universe and how those views evolved.** a. Ask questions to determine changes in models of Earth’s position in the solar system, and origins of the universe as evidence that scientific theories change with the addition of new information. (Clarification statement: Students should consider Earth’s position in geocentric and heliocentric models and the Big Bang as it describes the formation of the universe.) b. Develop a model to represent the position of the solar system in the Milky Way galaxy and in the known universe. c. Construct an explanation using a model of the interaction of gravity and inertia that governs the motion of objects in the solar system. |  |
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| **MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.**  |

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| **MS-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s 4.6-billion-year-old history.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
| **MS-ESS2 Earth’s Systems** |
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| **MS-ESS2-1. Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.1.B Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment.**2.1.C Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.**  |

 | **S6E5. Obtain, evaluate, and communicate information to show how Earth’s surface is formed.** a. Ask questions to compare and contrast the Earth’s crust, mantle, inner and outer core, including temperature, density, thickness, and composition. b. Plan and carry out an investigation of the characteristics of minerals and how minerals contribute to rock composition. c. Construct an explanation on how to classify rocks by their formation and how rocks change through geologic processes in the rock cycle. d. Ask questions to identify types of weathering, agents of erosion and transportation, and environments of deposition. (Clarification statement: Environments of deposition include deltas, barrier islands, beaches, marshes, and rivers.) e. Develop a model to demonstrate how natural processes (weathering, erosion, and deposition) and human activity change rocks and the surface of the Earth. f. Construct an explanation to support the claim that the movement of lithospheric plates (convergent boundary, divergent boundary, transform boundary), called plate tectonics, is due to convection currents below the lithosphere, and can cause major geologic events such as earthquakes and volcanic eruptions. g. Construct an argument using maps and data collected to describe how fossils show evidence of the changing surface and climate of the Earth. h. Plan and carry out an investigation to provide evidence that soil is composed of layers of weathered rocks and decomposed organic material | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
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| **MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
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| **MS-ESS2-4. Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity.**  |

 | **S4E3. Obtain, evaluate, and communicate information to demonstrate the water cycle**. a. Plan and carry out investigations to observe water as it changes states from solid (ice) to liquid (water) to gas (water vapor) and changes from gas to liquid to solid. b. Develop models to illustrate multiple pathways water may take during the water cycle (evaporation, condensation, and precipitation). (Clarification statement: Students should understand that the water cycle does not follow a single pathway.) | **1 Questioning, Analysis and Interpretation Skills****1F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.1.B Changes in matter** – Learners understand the properties of the substances that make up objects or materials found in the environment.**2.1.C Energy** – Learners begin to grasp formal concepts related to energy by focusing on energy transfer and transformations. They are able to make connections among phenomena such as light, heat, magnetism, electricity, and the motion of objects. |
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| **MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
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| **MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.**  |

 | **S6E4. Obtain, evaluate, and communicate information about how the sun, land, and water affect climate and weather.** a. Analyze and interpret data to compare and contrast the composition (including ozone and greenhouse gases) of Earth’s atmospheric layers. b. Plan and carry out an investigation to demonstrate how energy from the sun transfers heat to the Earth (air, land and water) at different rates. (Clarification statement: Heat transfer should include the processes of conduction, convection and radiation.) c. Develop a model of the interaction between the unequal heating and the rotation of the Earth that causes local and global wind systems. d. Construct an explanation of the relationship between air pressure, fronts, and air masses and meteorological events such as tornados and thunderstorms. e. Analyze and interpret weather data to explain the contribution of moisture evaporating from the ocean as it affects weather patterns and weather events such as hurricanes. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations** – Learners understand many of the uses and limitations of models.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns. |
| **MS-ESS3 Earth and Human Activity** |
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| **MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth’s mineral, energy, and groundwater resources are the result of past and current geoscience processes.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability –** Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.4. Environment and Society****2.4.C. Resources** – Learners understand that uneven distribution of resources influences their use and perceived value. |
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| **MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability –** Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.4. Environment and Society****2.4.B. Places –** Learners begin to explore the meaning of places both close to home and around the world.**2.4.D. Technology** – Learners understand the human ability to shape and control the environment as a function of the capacities for creating knowledge and developing new technologies. |
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| **MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.**1.B. Designing investigations** – Learners are able to design environmental investigations to answer particular questions – often their own questions.**1.C. Collecting information** – Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.**1.D. Evaluating accuracy and reliability –** Learners are able to judge the weaknesses and strengths of the information they are using.**1.E. Organizing information** – Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and develop action strategies for addressing particular issues.**2.4. Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.**2.4.D. Technology** – Learners understand the human ability to shape and control the environment as a function of the capacities for creating knowledge and developing new technologies. |
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| **MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.**  |

 | **S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.** a. Construct an explanation of the sun as the major source of energy and its relationship to wind and water energy. b. Ask questions to determine the differences between renewable/sustainable (i.e., hydro, solar, wind, geothermal, tidal, and biomass) and nonrenewable energy resources (i.e., nuclear: uranium, and fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives. c. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air. d. Construct an argument of the natural processes and human factors that have caused the rise in global temperatures over the past century. (Clarification statement: Tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities should be used as sources of evidence.) | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** –Learners are able to judge the weaknesses and strengths of the information they are using.**1.G. Drawing conclusions and developing explanations** – Learners are able to synthesize their observations and findings into coherent explanations.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.**2.2.C. Systems and connections** – Learners understand major kinds of interactions among organisms or populations of organisms.**2.3 Humans and Their Societies****2.3.D. Global connections** – Learners become familiar with ways in which the world’s environmental, social, economic, cultural, and political systems are linked.**2.4. Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.**2.4.C. Resources** – Learners understand that uneven distribution of resources influences their use and perceived value.**2.4.E. Environmental issues** – Learners are familiar with a range of environmental issues at scales that range from local to national to global. They understand that people in other places around the world experience environmental issues similar to the ones they are concerned about locally. |
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| **MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.**  |

 |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.**3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.A. Identifying and investigating issues** – Learners are able to use primary and secondary sources of information, and apply growing research and analytical skills, to investigate environmental issues, beginning in their own community.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners have a basic understanding of most of the physical processes that shape the Earth. They are able to explore the origin of differences in physical patterns.**2.4. Environment and Society****2.4.A. Human/environment interactions** – Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.**2.4.C. Resources** – Learners understand that uneven distribution of resources influences their use and perceived value.**2.4.E. Environmental issues** – Learners are familiar with a range of environmental issues at scales that range from local to national to global. They understand that people in other places around the world experience environmental issues similar to the ones they are concerned about locally. |

| HIGH SCHOOL – GRADES 9-12 |
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| **NGSS – Performance Expectations** | **GSE – Science Literacy** | **NAAEE: Guidelines for Learning Grades 9-12** |
| **HS-PS1 Matter and Its Interactions** |
| **HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.** |  |  |
| **HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.** |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena. |
| **HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.** |  |  |
| **HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.**  | **SC2. Obtain, evaluate, and communicate information about the chemical and physical properties of matter resulting from the ability of atoms to form bonds.** a. Plan and carry out an investigation to gather evidence to compare the physical and chemical properties at the macroscopic scale to infer the strength of intermolecular and intramolecular forces. b. Construct an argument by applying principles of inter- and intra- molecular forces to identify substances based on chemical and physical properties. c. Construct an explanation about the importance of molecular-level structure in the functioning of designed materials. (Clarification statement: Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.) d. Develop and use models to evaluate bonding configurations from nonpolar covalent to ionic bonding. (Clarification statement: VSEPR bonding theory is not addressed in this element.) e. Ask questions about chemical names to identify patterns in IUPAC nomenclature in order to predict chemical names for ionic (binary and ternary), acidic, and inorganic covalent compounds. f. Develop and use bonding models to predict chemical formulas including ionic (binary and ternary), acidic, and inorganic covalent compounds. g. Develop a model to illustrate the release or absorption of energy (endothermic or exothermic) from a chemical reaction system depends upon the changes in total bond energy. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.**  |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.B. Changes in matter** – Learners apply their understanding of chemical reactions to round out their explanations of environmental characteristics and everyday phenomena.**2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.** | **SC6. Obtain, evaluate, and communicate information about the properties that describe solutions and the nature of acids and bases.** a. Develop a model to illustrate the process of dissolving in terms of solvation versus dissociation. b. Plan and carry out an investigation to evaluate the factors that affect the rate at which a solute dissolves in a specific solvent. c. Use mathematics and computational thinking to evaluate commercial products in terms of their concentrations (i.e., molarity and percent by mass). d. Ask questions to prepare and properly label solutions of specified molar concentration. e. Develop and use a model to explain the effects of a solute on boiling point and freezing point. f. Use mathematics and computational thinking to compare, contrast, and evaluate the nature of acids and bases in terms of percent dissociation, hydronium ion concentration, and pH. (Clarification statement: Emphasize conceptual understanding of pH, not mathematical.) g. Ask questions to evaluate merits and limitations of the Arrhenius and Bronsted Lowry models of acid and bases. h. Plan and carry out an investigation to explore acid-base neutralization. | **2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.** |  | **2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS2 Motion and Stability: Forces and Interactions** |
| **HS-PS2-1. Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.** |  |  |
| **HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.** |  |  |
| **HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.** |  |  |
| **HS-PS2-4. Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.** |  |  |
| **HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.** |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.**1.B. Designing investigations** – Learners know how to design investigations to answer particular questions about the environment. They are able to develop approaches for investigating unfamiliar types of problems and phenomena.**1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
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| **HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.** |

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| **HS-PS3 Energy** |
| **HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.** |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.A. Identifying and investigating issues** – Learners apply their research and analytical skills to investigate environmental issues ranging from local issues to those that are regional or global in scope.**3.1.B. Sorting out the consequences of issues** – Learners are able to evaluate the consequences of specific environmental changes, conditions, and issues for human and ecological systems.**3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and propose action strategies that are likely to be effective in particular situations and for particular purposes.**3.1.D. Working with flexibility, creativity, and openness** – While environmental issues and investigations can bring to the surface deeply held views, learners are able to engage each other in peer review conducted in the spirit of open inquiry.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).** |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.**1.B. Designing investigations** – Learners know how to design investigations to answer particular questions about the environment. They are able to develop approaches for investigating unfamiliar types of problems and phenomena.**1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS4 Waves and Their Applications in Technologies for Information Transfer** |
| **HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** |  |  |
| **HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.** |  |  |
| **HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.** |  |  |
| **HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**2.1 The Earth as a Physical System****2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them. |
| **HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.** |  |  |
| **HS-LS1 From Molecules to Organisms: Structures and Processes** |
| **HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.**  | **SB1. Obtain, evaluate, and communicate information to analyze the nature of the relationships between structures and functions in living cells.** a. Construct an explanation of how cell structures and organelles (including nucleus, cytoplasm, cell membrane, cell wall, chloroplasts, lysosome, Golgi, endoplasmic reticulum, vacuoles, ribosomes, and mitochondria) interact as a system to maintain homeostasis. b. Develop and use models to explain the role of cellular reproduction (including binary fission, mitosis, and meiosis) in maintaining genetic continuity. c. Construct arguments supported by evidence to relate the structure of macromolecules (carbohydrates, proteins, lipids, and nucleic acids) to their interactions in carrying out cellular processes. (Clarification statement: The function of proteins as enzymes is limited to a conceptual understanding.)d. Plan and carry out investigations to determine the role of cellular transport (e.g., active, passive, and osmosis) in maintaining homeostasis. e. Ask questions to investigate and provide explanations about the roles of photosynthesis and respiration in the cycling of matter and energy within the cell (e.g., single celled alga). (Clarification statement: Instruction should focus on understanding the inputs, outputs, and functions of photosynthesis and respiration and the functions of the major sub-processes of each, including glycolysis, Krebs cycle, electron transport chain, light reactions, and Calvin cycle.) |  |
| **HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.** | **SB4. Obtain, evaluate, and communicate information to illustrate the organization of interacting systems within single-celled and multi-celled organisms.** a. Construct an argument supported by scientific information to explain patterns in structures and function among clades of organisms, including the origin of eukaryotes by endosymbiosis. Clades should include: • archaea • bacteria • eukaryotes ♣ fungi ♣ plants ♣ animals (Clarification statement: This is reflective of 21st century classification schemes and nested hierarchy of clades and is intended to develop a foundation for comparing major groups of organisms.) b. Analyze and interpret data to develop models (i.e., cladograms and phylogenetic trees) based on patterns of common ancestry and evolution to determine relationships among major groups of organisms. c. Construct an argument supported by empirical evidence to compare and contrast the characteristics of viruses and organisms. |  |
| **HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** |  |  |
| **HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.** |  |  |
| **HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.** |  |  |
| **HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** | **SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions**. a. Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. b. Plan and carry out investigations to determine indicators of a chemical reaction. (Clarification statement: Specifically precipitate formation, gas evolution, color change, water production, and changes in energy to the system should be investigated.) c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro’s number to conceptualize and calculate • percent composition • empirical/molecular formulas • mass, moles, and molecules relationships • molar volumes of gases d. Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures. (Clarification statement for elements c and d: Emphasis is on use of proportional relationships in the reactants and the products and on assessing students’ use of mathematical thinking and is not on memorization and rote application of problem solving techniques.) e. Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.D. Flow of matter and energy** – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-LS2 Ecosystems: Interactions, Energy, and Dynamics** |
| **HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems. |
| **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** | **S7L1. Obtain, evaluate, and communicate information to investigate the diversity of living organisms and how they can be compared scientifically.** a. Develop and defend a model that categorizes organisms based on common characteristics. b. Evaluate historical models of how organisms were classified based on physical characteristics and how that led up to the six kingdom system (currently archaea, bacteria, protists, fungi, plants, and animals). (Clarification statement: This includes common examples and characteristics such as, but not limited, to prokaryotic, eukaryotic, unicellular, multicellular, asexual reproduction, sexual reproduction, autotroph, heterotroph, and unique cell structures. Modern classification will be addressed in high school.) | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems. |
| **HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** |  | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** | **SEV1. Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem.** a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere. b. Develop and use a model based on the Laws of Thermodynamics to predict energy transfers throughout an ecosystem (food chains, food webs, and trophic levels). c. Analyze and interpret data to construct an argument of the necessity of biogeochemical cycles (hydrologic, nitrogen, phosphorus, oxygen, and carbon) to support a sustainable ecosystem. d. Ask questions to determine the relationship between the physical factors (e.g., insolation, proximity to coastline, topography) and organismal adaptations within terrestrial biomes. e. Plan and carry out an investigation of how chemical and physical properties impact aquatic biomes in Georgia. (Clarification statement: Consider the diverse aquatic ecosystems across the state such as streams, ponds, coastline, estuaries, and lakes.) | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.**  | **SEV2. Obtain, evaluate, and communicate information to construct explanations of stability and change in Earth’s ecosystems**. a. Analyze and interpret data related to short-term and long-term natural cyclic fluctuations associated with climate change. (Clarification statement: Short-term examples include but are not limited to El Niño and volcanism. Long-term examples include but are not limited to variations in Earth’s orbit such as Milankovitch cycles.) b. Analyze and interpret data to determine how changes in atmospheric chemistry (CO2 and methane) impact the greenhouse effect. c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession. d. Construct an argument to support a claim about the value of biodiversity in ecosystem resilience including keystone, invasive, native, endemic, indicator, and endangered species. | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems. |
| **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.** |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.A. Identifying and investigating issues** – Learners apply their research and analytical skills to investigate environmental issues ranging from local issues to those that are regional or global in scope.**3.1.B. Sorting out the consequences of issues** – Learners are able to evaluate the consequences of specific environmental changes, conditions, and issues for human and ecological systems.**3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and propose action strategies that are likely to be effective in particular situations and for particular purposes.**3.1.D. Working with flexibility, creativity, and openness** – While environmental issues and investigations can bring to the surface deeply held views, learners are able to engage each other in peer review conducted in the spirit of open inquiry.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.3 Humans and Their Societies****2.3.D. Global connections** – Learners are able to analyze global, social, cultural, political, economic, and environmental linkages.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.**2.4.C. Resources** – Learners understand that the importance and use of resources change over time and vary under different economic and technological systems. |
| **HS-LS2-8. Evaluate the evidence for the role of** **group behavior on individual and species’** **chances to survive and reproduce.** |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems. |
| **HS-LS3 Heredity: Inheritance and Variation of Traits** |
| **HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.** |  | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.** | **SB2. Obtain, evaluate, and communicate information to analyze how genetic information is expressed in cells.** a. Construct an explanation of how the structures of DNA and RNA lead to the expression of information within the cell. (Clarification statement: The processes of replication, transcription, and translation should be addressed.) b. Construct an argument based on evidence that inheritable genetic variations may result from: • new genetic combinations through meiosis (crossing over, nondisjunction); • non-lethal errors occurring during replication (insertions, deletions, substitutions); and/or • heritable mutations caused by environmental factors (radiation, chemicals, and viruses). c. Ask questions to gather and communicate information about the use and ethical considerations of biotechnology in forensics, medicine, and agriculture. (Clarification statement: The element is intended to include advancements in technology relating to economics and society such as Genetically Modified Organisms.) | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** |  | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4 Biological Evolution: Unity and Diversity** |
| **HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.** | **SB6. Obtain, evaluate, and communicate information related to the theory of evolution.** a. Construct an explanation of how new understandings of the age of Earth, the emergence of new species from pre-existing species, and our understanding of genetics have influenced our understanding of biology. b. Analyze and interpret data to explain patterns in biodiversity that result from speciation (macroevolution). c. Construct an argument to support the claim that evidence from comparative morphology (analogous vs. homologous structures), embryology, biochemistry (protein sequence) and genetics support the theory that all living organisms are related by way of common descent. d. Develop and use mathematical models to support explanations of how undirected genetic changes in natural selection and genetic drift have led to changes in populations of organisms (microevolution). (Clarification statement: This element is intended to focus on basic statistical and graphic analysis. Hardy Weinberg would be an optional application to address this element.) e. Develop a model to explain the role evolution plays in causing biological resistance (e.g., pesticides, antibiotic resistance, and influenza vaccines). | **1 Questioning, Analysis and Interpretation Skills****1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.** | **S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the evolution of living organisms through inherited characteristics.** a. Use mathematical representations to evaluate explanations of how natural selection leads to changes in specific traits of populations over successive generations. (Clarification statement: Referencing data should be obtained from multiple sources including, but not limited to, existing research and simulations. Students should be able to calculate means, represent this data in a table or graph, and reference it when explaining the principles of natural selection.) b. Construct an explanation based on evidence that describes how genetic variation and environmental factors influence the probability of survival and reproduction of a species. c. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, and extinction of organisms and their relationships to modern organisms. (Clarification statement: Evidence of evolution found in comparisons of current/modern organisms such as homologous structures, DNA, and fetal development are not included.) | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** | **SB3. Obtain, evaluate, and communicate information to analyze how biological traits are passed on to successive generations.** a. Use Mendel’s laws (segregation and independent assortment) to ask questions and define problems that explain the role of meiosis in reproductive variability. b. Use mathematical models to predict and explain patterns of inheritance. (Clarification statement: Students should be able to use Punnett squares and/or rules of probability to analyze the following inheritance patterns: dominance, codominance, incomplete dominance.) c. Construct an argument to support a claim about the relative advantages and disadvantages of sexual and asexual reproduction for a population. | **1 Questioning, Analysis and Interpretation Skills****1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**2.2 The Living Environment****2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4-4. Construct an explanation based on** **evidence for how natural selection leads to** **adaptation of populations.** |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.** |  | **1 Questioning, Analysis and Interpretation Skills****1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution. |
| **HS-LS4-6. Create or revise a simulation to test a** **solution to mitigate adverse impacts of human** **activity on biodiversity.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs. |
| **HS-ESS1 Earth’s Place in the Universe** |
| **HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation.** |  |  |
| **HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.** |  |  |
| **HS-ESS1-3. Communicate** **scientific ideas about** **the way stars, over their** **life cycle, produce** **elements.** |  |  |
| **HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.** |  |  |
| **HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** |  |  |
| **HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history.** | **SES4. Obtain, evaluate, and communicate information to understand how rock relationships and fossils are used to reconstruct the Earth’s past.** a. Use mathematics and computational thinking to calculate the absolute age of rocks using a variety of methods (e.g., radiometric dating, ice cores, and tree rings). b. Construct an argument applying principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) to interpret a geologic cross-section and describe how unconformities form. c. Analyze and interpret data from rock and fossil succession in a rock sequence to interpret major events in Earth’s history such as mass extinction, major climatic change, and tectonic events. d. Construct an explanation applying the principle of uniformitarianism to show the relationship between sedimentary rocks and their fossils to the environments in which they were formed. e. Construct an argument using spatial representations of Earth data that interprets major transitions in Earth’s history from the fossil and rock record of geologically defined areas. (Clarification statement: Students should use maps and cross-sections with a focus on Georgia.) |  |
| **HS-ESS2 Earth’s Systems** |
| **HS-ESS2-1. Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.** | **SES3. Obtain, evaluate, and communicate information to explore the actions of water, wind, ice, and gravity as they relate to landscape change.** a. Plan and carry out an investigation that demonstrates how surface water and groundwater act as the major agents of physical and chemical weathering. b. Develop a model of the processes and geologic hazards that result from both sudden and gradual mass wasting. Science Georgia Standards of Excellence Georgia Department of Education January 14, 2016 • Page 43 of 58 c. Construct an explanation that relates the past and present actions of ice, wind, and water to landform distribution and landscape change. d. Construct an argument based on evidence that relates the characteristics of the sedimentary materials to the energy by which they were transported and deposited. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. |
| **HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems.** | **SES2. Obtain, evaluate, and communicate information to understand how plate tectonics creates certain geologic features, landforms, Earth materials, and geologic hazards.** a. Construct an explanation that describes radioactive decay as the source of energy that drives plate tectonics through the process of convection. b. Develop and use models for the different types of plate tectonic settings (convergent, divergent, and transform boundaries). (Clarification statement: Include subduction zones, continental collisions, rift zones, and ocean basins.) c. Construct an explanation that communicates the relationship of geologic features, landforms, Earth materials, and geologic hazards to each plate tectonic setting. d. Ask questions to compare and contrast the relationship between transformation of all rock types (sedimentary, igneous, and metaphoric) and specific plate tectonic settings. e. Construct an argument using multiple forms of evidence that supports the theory of plate tectonics (e.g., fossils, paleomagnetism, and seafloor age). | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems. |
| **HS-ESS2-3. Develop a model based on evidence****of Earth’s interior to describe the cycling of****matter by thermal convection.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. |
| **HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.** | **SES1. Obtain, evaluate, and communicate information to investigate the composition and formation of Earth systems, including the Earth’s place in the solar system.** a. Construct an explanation of the origins of the solar system from scientific evidence including the composition, distribution and motion of solar system objects. (Clarification statement: Include the nebular hypothesis in this element.) b. Ask questions to evaluate evidence for the development and composition of Earth’s early systems, including the geosphere (crust, mantle, and core), hydrosphere, and atmosphere. (Clarification statement: Include differentiation by density of Earth into crust, mantle, and core in this element.) c. Develop a model of the physical composition of Earth’s layers using multiple types of evidence (e.g., Earth’s magnetic field, composition of meteorites and seismic waves). (Clarification statement: Earth’s layers include crust, mantle, inner core and outer core.) | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** | **S6E3. Obtain, evaluate, and communicate information to recognize the significant role of water in Earth processes.** a. Ask questions to determine the proportion of Earth’s surface that is water (oceans, rivers, lakes, groundwater, aquifers, and ice) and communicate using a circle/pie graph the relative proportion covered by water. b. Plan and carry out an investigation to illustrate the role of the sun’s energy in atmospheric conditions that lead to the cycling of water. (Clarification statement: The water cycle should include but is not limited to evaporation, condensation, precipitation, transpiration, infiltration, groundwater, and runoff.) c. Ask questions to identify and communicate using graphs and maps the composition, location, and subsurface topography of the world’s oceans. d. Analyze and interpret data to create graphic representations of the causes and effects of waves, currents, and tides in Earth’s systems. | **1 Questioning, Analysis and Interpretation Skills****1.A. Questioning** – Learners are able to develop, modify, clarify, and explain questions that guide environmental investigations of various types. They understand factors that influence the questions they pose.**1.B. Designing investigations** – Learners know how to design investigations to answer particular questions about the environment. They are able to develop approaches for investigating unfamiliar types of problems and phenomena.**1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth. |
| **HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.** |  | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.** |  | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.2 The Living Environment****2.2.B. Heredity and evolution** – Learners understand the basic ideas and genetic mechanisms behind biological evolution.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.2.D. Flow of matter and** energy – Learners are able to account for environmental characteristics based on their knowledge of how matter and energy interact in living systems. |
| **HS-ESS3 Earth and Human Activity** |
| **HS-ESS3-1. 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.** | **SEV4. Obtain, evaluate, and communicate information to analyze human impact on natural resources.** a. Construct an argument from evidence on the effects of human activities on natural resourcesb. Design and defend solutions to reduce detrimental human impact on the environment including, but not limited to, smog, ozone depletion, land and sea temperature changes, and ocean acidification. c. Construct an argument to evaluate how human population growth affects food demand and food supply (GMOs, monocultures, desertification, Green Revolution) including types, availability, use, pollution, sustainability, and conservation of natural resources. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.**2.4.B. Paces** – Learners understand “place” as humans endowing a particular part of the Earth with meaning through their interactions with the environment.**2.4.C. Resources** – Learners understand that the importance and use of resources change over time and vary under different economic and technological systems. |
| **HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.** | **SEV3. Obtain, evaluate, and communicate information to evaluate types, availability, allocation, and sustainability of energy resources.** a. Analyze and interpret data to communicate information on the origin and consumption of renewable forms of energy (wind, solar, geothermal, biofuel, and tidal) and non-renewable energy sources (fossil fuels and nuclear energy). b. Construct an argument based on data about the risks and benefits of renewable and nonrenewable energy sources. (Clarification statement: This may include, but is not limited to, the environmental, social, and economic risks and benefits.) c. Obtain, evaluate, and communicate data to predict the sustainability potential of renewable and non-renewable energy resources. d. Design and defend a sustainable energy plan based on scientific principles for a specific location. e. Develop and use models of the relationship between energy availability and the growth of the human population to predict future changes in human populations. | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and propose action strategies that are likely to be effective in particular situations and for particular purposes.**3.1.D. Working with flexibility, creativity, and openness** – While environmental issues and investigations can bring to the surface deeply held views, learners are able to engage each other in peer review conducted in the spirit of open inquiry.**2.3 Humans and Their Societies****2.3.C. Political and economic systems** – Learners understand how different political and economic systems account for, manage, and affect natural resources and environmental quality.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.**2.4.C. Resources** – Learners understand that the importance and use of resources change over time and vary under different economic and technological systems.**2.4.D. Technology** – Learners are able to examine the social and environmental impacts of various technologies and technological systems. |
| **HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** | **SES6. Obtain, evaluate, and communicate information about how life on Earth responds to and shapes Earth’s systems.** a. Construct an argument from evidence that describes how life has responded to major events in Earth’s history (e.g., major climatic change, tectonic events) through extinction, migration, and/or adaptation. b. Construct an explanation that describes how biological processes have caused major changes in Earth’s systems through geologic time (e.g., nutrient cycling, atmospheric composition, and soil formation). c. Ask questions to investigate and communicate how humans depend on Earth’s land and water resources, which are distributed unevenly around the planet as a result of past geological and environmental processes. d. Analyze and interpret data that relates changes in global climate to natural and anthropogenic modification of Earth’s atmosphere and oceans. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.2 The Living Environment****2.2.A. Organisms, populations, and communities** – Learners understand basic population dynamics and the importance of diversity in living systems.**2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.3 Humans and Their Societies****2.3.D. Global connections** – Learners are able to analyze global, social, cultural, political, economic, and environmental linkages.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.**2.4.C. Resources** – Learners understand that the importance and use of resources change over time and vary under different economic and technological systems. |
| **HS-ESS3-4. Evaluate or** **refine a technological** **solution that reduces** **impacts of human** **activities on natural** **systems.** |  | **3.1 Skills for Analyzing and Investigating Environmental Issues****3.1.C. Identifying and evaluating alternative solutions and courses of action** – Learners are able to identify and propose action strategies that are likely to be effective in particular situations and for particular purposes.**3.1.D. Working with flexibility, creativity, and openness** – While environmental issues and investigations can bring to the surface deeply held views, learners are able to engage each other in peer review conducted in the spirit of open inquiry.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs.**2.4.D. Technology** – Learners are able to examine the social and environmental impacts of various technologies and technological systems. |
| **HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.** | **SES5. Obtain, evaluate and communicate information to investigate the interaction of solar energy and Earth’s systems to produce weather and climate.** a. Develop and use models to explain how latitudinal variations in solar heating create differences in air pressure, global wind patterns, and ocean currents that redistribute heat globally. b. Analyze and interpret data (e.g., maps, meteograms, and weather apps) that demonstrate how the interaction and movement of air masses creates weather. c. Construct an argument that predicts weather patterns based on interactions among ocean currents, air masses, and topography. d. Analyze and interpret data to show how temperature and precipitation produce the pattern of climate regions (zones) on Earth. e. Construct an explanation that describes the conditions that generate extreme weather events (e.g., hurricanes, tornadoes, and thunderstorms) and the hazards associated with these events. f. Construct an argument relating changes in global climate to variation to Earth/sun relationships and atmospheric composition. | **1 Questioning, Analysis and Interpretation Skills****1.C. Collecting information** – Learners are able to locate and collect reliable information for environmental investigations of many types. They know how to use sophisticated technology to collect information, including computer programs that access, gather, store, and display data.**1.D. Evaluating accuracy and reliability** – Learners can apply basic logic and reasoning skills to evaluate completeness and reliability in a variety of information sources.**1.E. Organizing information** – Learners are able to organize and display information in ways appropriate to different types of environmental investigations and purposes.**1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**1.G. Drawing conclusions and developing explanations** – Learners are able to use evidence and logic in developing proposed explanations that address their initial questions and hypotheses.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.1.C. Energy** – Learners apply their knowledge of energy and matter to understand phenomena in the world around them.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs. |
| **HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** | **SEV5. Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems.** a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product. b. Analyze and interpret data on global patterns of population growth (fertility and mortality rates) and demographic transitions in developing and developed countries. c. Construct an argument from evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems. d. Design and defend a sustainability plan to reduce individual contributions to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices. | **1 Questioning, Analysis and Interpretation Skills****1.F. Working with models and simulations –** Learners are able to create, use, and evaluate models to understand environmental phenomena.**2.1 The Earth as a Physical System****2.1.A. Processes that shape the Earth** – Learners understand the major physical processes that shape the Earth. They can relate these processes, especially those that are large-scale and long-term, to characteristics of the Earth.**2.2 The Living Environment****2.2.C. Systems and connections** – Learners understand the living environment to be comprised of interrelated, dynamic systems.**2.4 Environment and Society****2.4.A. Human/environment interactions** – Learners understand that humans are able to alter the physical environment to meet their needs and that there are limits to the ability of the environment to absorb impacts or meet human needs. |