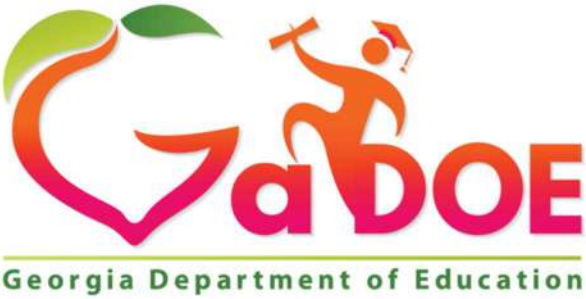

Richard Woods, Georgia's School Superintendent
"Educating Georgia's Future"

CROSSWALK

SCIENCE

Georgia Performance Standards (GPS)

to

Georgia Standards of Excellence (GSE)

Kindergarten – Grade 12

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Kindergarten	
GPS	**GSE**
SKE1. Students will describe time patterns (such as day to night and night to day) and objects (such as sun, moon, stars) in the day and night sky. a. Describe changes that occur in the sky during the day, as day turns into night, during the night, and as night turns into day. b. Classify objects according to those seen in the day sky and those seen in the night sky. c. Recognize that the Sun supplies heat and light to Earth.	**SKE1. Obtain, evaluate, and communicate observations about time patterns (day to night and night to day) and objects (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 the changes that occur in the sky during the day, as day turns into night, during the night, and as night turns into day using pictures and words. (*Clarification statement:* Students are not expected to understand tilt of the Earth, rotation, or revolution.)
SKE2. Students will describe the physical attributes of rocks and soils. a. Use senses to observe and group rocks by physical attributes such as large/small, heavy/light, smooth/rough, dark/light, etc. b. Use senses to observe soils by physical attributes such as smell, texture, color, particle/grain size. c. Recognize earth materials— soil, rocks, water, air, etc.	**SKE2. Obtain, evaluate, and communicate information to describe the physical attributes of earth materials (soil, rocks, water, and air).** 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.

Kindergarten	
GPS	**GSE**
SKP1. Students will describe objects in terms of the materials they are made of and their physical properties. a. Compare and sort materials of different composition (common materials include clay, cloth, paper, plastic, etc.). b. Use senses to classify common materials, such as buttons or swatches of cloth, according to their physical attributes (color, size, shape, weight, texture, buoyancy, flexibility).	**SKP1. Obtain, evaluate, and communicate information to describe objects in terms of the materials they are made of and their physical attributes.** a. Ask questions to compare and sort objects made of different materials. (Common materials include clay, cloth, plastic, wood, paper, and metal.) b. Use senses and science tools to classify common objects, such as buttons or swatches of cloth, according to their physical attributes (color, size, shape, weight, and texture). c. Plan and carry out an investigation to predict and observe whether objects, based on their physical attributes, will sink or float.
SKP2. Students will investigate different types of motion. a. Sort objects into categories according to their motion. (straight, zigzag, round and round, back and forth, fast and slow, and motionless) b. Push, pull, and roll common objects and describe their motions.	**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 based on its physical attributes.
SKP3. Students will observe and communicate effects of gravity on objects. a. Recognize that some things, such as airplanes and birds, are in the sky, but return to earth. b. Recognize that the sun, moon, and stars are in the sky, but don't come down. c. Explain why a book does not fall down if it is placed on a table, but will fall down if it is dropped.	**While not explicit, the concept of gravity is incorporated into SKP2 when students are investigating the motion of objects in relation to the application of a force.**

Kindergarten	
GPS	**GSE**
SKL1. Students will sort living organisms and non-living materials into groups by observable physical attributes. a. Recognize the difference between living organisms and nonliving materials. b. Group animals according to their observable features such as appearance, size, motion, where it lives, etc. (Example: A green frog has four legs and hops. A rabbit also hops.) c. Group plants according to their observable features such as appearance, size, etc.	**SKL1. Obtain, evaluate, and communicate information about how organisms (alive and not alive) and non-living objects are grouped.** a. Construct an explanation based on observations to recognize the differences between organisms and nonliving objects. b. Develop a model to represent how a set of organisms and nonliving objects are sorted into groups based on their attributes.
SKL2. Students will compare the similarities and differences in groups of organisms. a. Explain the similarities and differences in animals. (Color, size, appearance, etc.) b. Explain the similarities and differences in plants. (Color, size, appearance, etc.) c. Recognize the similarities and differences between a parent and a baby. d. Match pictures of animal parents and their offspring explaining your reasoning. (Example: dog/puppy; cat/kitten; cow/calf; duck/ducklings, etc.) e. Recognize that you are similar and different from other students. (senses, appearance)	**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.

First Grade	
GPS	**GSE**
S1E1. Students will observe, measure, and communicate weather data to see patterns in weather and climate. a. Identify different types of weather and the characteristics of each type. b. Investigate weather 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 or on a calendar seasonally. c. Correlate weather data (temperature, precipitation, sky conditions, and weather events) to seasonal changes.	**S1E1. Obtain, evaluate, and communicate weather data to identify weather patterns.** 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.)
S1E2. Students will observe and record changes in water as it relates to weather. a. Recognize changes in water when it freezes (ice) and when it melts (water). b. Identify forms of precipitation such as rain, snow, sleet, and hailstones as either solid (ice) or liquid (water). c. Determine that the weight of water before freezing, after freezing, and after melting stays the same. d. Determine that water in an open container disappears into the air over time, but water in a closed container does not.	**The concepts of liquid and solid water were incorporated with S1E1. The additional concepts were removed based on developmental appropriateness feedback from survey.**

First Grade	
GPS	**GSE**
S1P1. Students will investigate light and sound. a. Recognize sources of light. b. Explain how shadows are made. c. Investigate how vibrations produce sound. d. Differentiate between various sounds in terms of (pitch) high or low and (volume) loud or soft. e. Identify emergency sounds and sounds that help us stay safe.	**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 signal that can serve as an emergency alert using light and/or sound to communicate over a distance.
S1P2. Students will demonstrate effects of magnets on other magnets and other objects. a. Demonstrate how magnets attract and repel. b. Identify common objects that are attracted to a magnet. c. Identify objects and materials (air, water, wood, paper, your hand, etc.) that do not block magnetic force.	**S1P2. Obtain, evaluate, and communicate information to demonstrate the 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 uses 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.

First Grade	
GPS	**GSE**
S1L1. Students will investigate the characteristics and basic needs of plants and animals. a. Identify the basic needs of a plant. 1. Air 2. Water 3. Light 4. Nutrients b. Identify the basic needs of an animal. 1. Air 2. Water 3. Food 4. Shelter c. Identify the parts of a plant—root, stem, leaf, and flower. d. Compare and describe various animals—appearance, motion, growth, basic needs.	**S1L1. Obtain, evaluate, and communicate information about the 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.

Second Grade	
GPS	**GSE**
S2E1. Students will understand that stars have different sizes, brightness, and patterns. a. Describe the physical attributes of stars—size, brightness, and patterns.	**S2E1. Obtain, evaluate, and communicate information about stars having different sizes and brightness.** a. Ask questions to describe the physical attributes (size and brightness) of stars. b. Construct an argument to support the claim that although the sun appears to be the brightest and largest star, it is actually medium in size and brightness.
S2E2. Students will investigate the position of sun and moon to show patterns throughout the year. a. Investigate the position of the sun in relation to a fixed object on earth at various times of the day. b. Determine how the shadows change through the day by making a shadow stick or using a sundial. c. Relate the length of the day and night to the change in seasons (for example: Days are longer than the night in the summer.). d. Use observations and charts to record the shape of the moon for a period of time.	**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 pattern. (*Clarification statement:* Students are not required to know the names of the phases of the moon or understand the tilt of the Earth.)

Second Grade	
GPS	**GSE**
S2E3. Students will observe and record changes in their surroundings and infer the causes of the changes. a. Recognize effects that occur in a specific area caused by weather, plants, animals, and/or people.	**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.
S2P1. Students will investigate the properties of matter and changes that occur in objects. a. Identify the three common states of matter as solid, liquid, or gas. b. Investigate changes in objects by tearing, dissolving, melting, squeezing, etc.	**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 objects according to their physical properties. (*Clarification statement:* Examples of physical properties 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) 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.)
S2P2. Students will identify sources of energy and how the energy is used. a. Identify sources of light energy, heat energy, and energy of motion. b. Describe how light, heat, and motion energy are used.	**Based on survey feedback and current research, concepts not appropriate at this grade level. The standard was deleted.**

Second Grade	
GPS	**GSE**
S2P3. Students will demonstrate changes in speed and direction using pushes and pulls. a. Demonstrate how pushing and pulling an object affects the motion of the object. b. Demonstrate the effects of changes of speed on an object.	**S2P2. Obtain, evaluate, and communicate information to demonstrate changes in speed and direction using a force (a push or a pull).** a. Plan and carry out an investigation to demonstrate how pushing and pulling on an object affects the motion of the object. b. Design 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 force (a push or a pull).
S2L1. Students will investigate the life cycles of different living organisms. a. Determine the sequence of the life cycle of common animals in your area: a mammal such as a cat or dog or classroom pet, a bird such as a chicken, an amphibian such as a frog, and an insect such as a butterfly. b. Relate seasonal changes to observations of how a tree changes throughout a school year. c. Investigate the life cycle of a plant by growing a plant from a seed and by recording changes over a period of time. d. Identify fungi (mushroom) as living organisms.	**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.

Third Grade	
GPS	**GSE**
S3E1. Students will investigate the physical attributes of rocks and soils. a. Explain the difference between a rock and a mineral. b. Recognize the physical attributes of rocks and minerals using observation (shape, color, texture), measurement, and simple tests (hardness). c. Use observation to compare the similarities and differences of texture, particle size, and color in top soils (such as clay, loam or potting soil, and sand). d. Determine how water and wind can change rocks and soil over time using observation and research.	**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 (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 as 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.)
S3E2. Students will investigate fossils as evidence of organisms that lived long ago. a. Investigate fossils by observing authentic fossils or models of fossils or view information resources about fossils as evidence of organisms that lived long ago. b. Describe how a fossil is formed.	**S3E2. Obtain, evaluate, and communicate information on how fossils provide evidence of past organisms.** a. Construct an argument from observations of fossils (authentic or reproductions) to communicate how they serve as evidence of past organisms and the environments in which they lived. 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.)

Third Grade	
GPS	**GSE**
S3P1. Students will investigate how heat is produced and the effects of heating and cooling, and will understand a change in temperature indicates a change in heat. a. Categorize ways to produce heat energy such as burning, rubbing (friction), and mixing one thing with another. b. Investigate how insulation affects heating and cooling. c. Investigate the transfer of heat energy from the sun to various materials. d. Use thermometers to measure the changes in temperatures of water samples (hot, warm, cold) over time.	**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.)
S3P2. Students will investigate magnets and how they affect other magnets and common objects. a. Investigate to find common objects that are attracted to magnets. b. Investigate how magnets attract and repel each other.	**Elements of this standard were moved to either First Grade or Fifth Grade.**

Third Grade	
GPS	**GSE**
S3L1. Students will investigate the habitats of different organisms and the dependence of organisms on their habitat. a. Differentiate between habitats of Georgia (mountains, marsh/swamp, coast, Piedmont, Atlantic Ocean) and the organisms that live there. b. Identify features of green plants that allow them to live and thrive in different regions of Georgia. c. Identify features of animals that allow them to live and thrive in different regions of Georgia. d. Explain what will happen to an organism if the habitat is changed.	**S3L1. Obtain, evaluate, and communicate information about the similarities and differences between plants, animals, and habitats found within geographic regions (Blue Ridge Mountains, Piedmont, Coastal Plains, Valley and Ridge, and Appalachian Plateau) of Georgia.** a. Ask questions to differentiate between plants, animals, and habitats found within Georgia's geographic regions. b. Construct an explanation of how external features and adaptations (camouflage, use of hibernation, protection, migration, mimicry) of animals 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.
S3L2. Students will recognize the effects of pollution and humans on the environment. a. Explain the effects of pollution (such as littering) to the habitats of plants and animals. b. Identify ways to protect the environment. • Conservation of resources • Recycling of materials	**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 information and create 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.

Fourth Grade	
GPS	**GSE**
S4E1. Students will compare and contrast the physical attributes of stars, star patterns, and planets. a. Recognize the physical attributes of stars in the night sky such as number, size, color and patterns. b. Compare the similarities and differences of planets to the stars in appearance, position, and number in the night sky. c. Explain why the pattern of stars in a constellation stays the same, but a planet can be seen in different locations at different times. d. Identify how technology is used to observe distant objects in the sky.	**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 stars (including the Earth's sun) appear to be larger or brighter than others. (*Clarification statement:* Differences are limited to distance and size, not age or stage.) c. Construct an explanation of the differences 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. (*Clarification statement:* Composition of planets is limited to rocky vs. gaseous.)
S4E2. Students will model the position and motion of the earth in the solar system and will explain the role of relative position and motion in determining sequence of the phases of the moon. a. Explain the day/night cycle of the earth using a model. b. Explain the sequence of the phases of the moon. c. Demonstrate the revolution of the earth around the sun and the earth's tilt to explain the seasonal changes. d. Demonstrate the relative size and order from the sun of the planets in the solar system.	**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.

Fourth Grade	
GPS	**GSE**
S4E3. Students will differentiate between the states of water and how they relate to the water cycle and weather. a. Demonstrate how water changes states from solid (ice) to liquid (water) to gas (water vapor/steam) and changes from gas to liquid to solid. b. Identify the temperatures at which water becomes a solid and at which water becomes a gas. c. Investigate how clouds are formed. d. Explain the water cycle (evaporation, condensation, and precipitation). e. Investigate different forms of precipitation and sky conditions. (rain, snow, sleet, hail, clouds, and fog).	**S4E3. Obtain, evaluate, and communicate information to demonstrate the water cycle.** a. Plan and carry out investigations to observe the flow of energy in 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.)
S4E4. Students will analyze weather charts/maps and collect weather data to predict weather events and infer patterns and seasonal changes. a. Identify weather instruments and explain how each is used in gathering weather data and making forecasts (thermometer, rain gauge, barometer, wind vane, anemometer). b. Using a weather map, identify the fronts, temperature, and precipitation and use the information to interpret the weather conditions. c. Use observations and records of weather conditions to predict weather patterns throughout the year. d. Differentiate between weather and climate.	**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 construct an explanation of 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 an explanation based on research to communicate the difference between weather and climate.

Fourth Grade	
GPS	**GSE**
S4P1. Students will investigate the nature of light using tools such as mirrors, lenses, and prisms. a. Identify materials that are transparent, opaque, and translucent. b. Investigate the reflection of light using a mirror and a light source. c. Identify the physical attributes of a convex lens, a concave lens, and a prism and where each is used.	**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.)
S4P2. Students will demonstrate how sound is produced by vibrating objects and how sound can be varied by changing the rate of vibration. a. Investigate how sound is produced. b. Recognize the conditions that cause pitch to vary.	**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.

Fourth Grade	
GPS	**GSE**
S4P3. Students will demonstrate the relationship between the application of a force and the resulting change in position and motion on an object. a. Identify simple machines and explain their uses (lever, pulley, wedge, inclined plane, screw, wheel and axle). b. Using different size objects, observe how force affects speed and motion. c. Explain what happens to the speed or direction of an object when a greater force than the initial one is applied. d. Demonstrate the effect of gravitational force 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 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.)

Fourth Grade	
GPS	**GSE**
S4L1. Students will describe the roles of organisms and the flow of energy within an ecosystem. a. Identify the roles of producers, consumers, and decomposers in a community. b. Demonstrate the flow of energy through a food web/food chain beginning with sunlight and including producers, consumers, and decomposers. c. Predict how changes in the environment would affect a community (ecosystem) of organisms. d. Predict effects on a population if some of the plants or animals in the community are scarce or if there are too many.	**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.
S4L2. Students will identify factors that affect the survival or extinction of organisms such as adaptation, variation of behaviors (hibernation), and external features (camouflage and protection). a. Identify external features of organisms that allow them to survive or reproduce better than organisms that do not have these features (for example: camouflage, use of hibernation, protection, etc.). b. Identify factors that may have led to the extinction of some organisms.	**This concept was moved to Third Grade for better alignment with other standards.**

Fifth Grade	
GPS	**GSE**
S5E1. Students will identify surface features of the Earth caused by constructive and destructive processes. a. Identify surface features caused by constructive processes. • Deposition (Deltas, sand dunes, etc.) • Earthquakes • Volcanoes • Faults b. Identify and find examples of surface features caused by destructive processes. • Erosion (water—rivers and oceans, wind) • Weathering • Impact of organisms • Earthquake • Volcano c. Relate the role of technology and human intervention in the control of constructive and destructive processes. Examples include, but are not limited to • Seismological studies, • Flood control, (dams, levees, storm drain management, etc.) • Beach reclamation (Georgia coastal islands)	**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 forecasting (GIS maps), engineering/construction methods and materials, and infrared/satellite imagery.)
S5P1. Students will verify that an object is the sum of its parts. a. Demonstrate that the mass of an object is equal to the sum of its parts by manipulating and measuring different objects made of various parts. b. Investigate how common items have parts that are too small to be seen without magnification.	**Element A was incorporated into the new S5P1. Element B was incorporated into S5L3.**

Fifth Grade	
GPS	**GSE**
S5P2. Students will explain the difference between a physical change and a chemical change. a. Investigate physical changes by separating mixtures and manipulating (cutting, tearing, folding) paper to demonstrate examples of physical change. b. Recognize that the changes in state of water (water vapor/steam, liquid, ice) are due to temperature differences and are examples of physical change. c. Investigate the properties of a substance before, during, and after a chemical reaction to find evidence of change.	**S5P1. Obtain, evaluate, and communicate information to explain the differences between a physical change and a chemical change.** a. Plan and carry out investigations by manipulating, separating and mixing dry and liquid materials and communicate collected data to demonstrate examples of physical change. b. Construct an argument based on observations that the physical changes in the state of water are due to temperature changes, which cause small particles that cannot be seen to move differently. c. Plan and carry out an investigation to determine if a chemical change occurred based on observable evidence (color, gas, temperature change, odor, new substance produced).
S5P3. Students will investigate the electricity, magnetism, and their relationship. a. Investigate static electricity. b. Determine the necessary components for completing an electric circuit. c. Investigate common materials to determine if they are insulators or conductors of electricity. d. Compare a bar magnet to an electromagnet.	**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 a complete, simple electric circuit, and explain all necessary components. c. Investigate and test common materials to determine if they are insulators or conductors of electricity.

Fifth Grade	
GPS	**GSE**
A new standard was written to combine existing magnetism standards with those moved from Third Grade.	**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 to observe the interaction between a magnet and a magnetic object on opposite sides of various materials such as wood, paper, glass, metal, and rocks.
S5L1. Students will classify organisms into groups and relate how they determined the groups with how and why scientists use classification. a. Demonstrate how animals are sorted into groups (vertebrate and invertebrate) and how vertebrates are sorted into groups (fish, amphibian, reptile, bird, and mammal). b. Demonstrate how plants are sorted into groups.	**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, amphibian, reptile, 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.
S5L2. Students will recognize that offspring can resemble parents in inherited traits and learned behaviors. a. Compare and contrast the characteristics of learned behaviors and of inherited traits. b. Discuss what a gene is and the role genes play in the transfer of traits.	**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.)

Fifth Grade	
GPS	**GSE**
S5L3. Students will diagram and label parts of various cells (plant, animal, single-celled, multi-celled). a. Use magnifiers such as microscopes or hand lenses to observe cells and their structure. b. Identify parts of a plant cell (membrane, wall, cytoplasm, nucleus, chloroplasts) and of an animal cell (membrane, cytoplasm, and nucleus) and determine the function of the parts. c. Explain how cells in multi-celled organisms are similar and different in structure and function to single-celled organisms.	**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.
S5L4. Students will relate how microorganisms benefit or harm larger organisms. a. Identify beneficial microorganisms and explain why they are beneficial. b. Identify harmful microorganisms and explain why they are harmful.	**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, Clostridium botulinum (Botox), E-coli, Algae, etc. Students are not expected to know these specific microorganisms. The list is provided to give teachers examples.) a. Construct an argument using scientific evidence to support a claim that some microorganisms are beneficial. b. Construct an argument using scientific evidence to support a claim that some microorganisms are harmful.

Sixth Grade	
GPS	**GSE**
S6E1. Students will explore current scientific views of the universe and how those views evolved. a. Relate the Nature of Science to the progression of basic historical scientific models (geocentric, heliocentric) as they describe our solar system, and the Big Bang as it describes the formation of the universe. b. Describe the position of the solar system in the Milky Way galaxy and the universe. c. Compare and contrast the planets in terms of • Size relative to the earth • Surface and atmospheric features • Relative distance from the sun • Ability to support life d. Explain the motion of objects in the day/night sky in terms of relative position. e. Explain that gravity is the force that governs the motion in the solar system. f. Describe the characteristics of comets, asteroids, and meteors.	**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. Analyze and interpret data to compare and contrast the planets in terms of: • size relative to Earth, • surface and atmospheric features, • relative distance from the sun, and • ability to support life. d. Develop and use a model to explain the interaction of gravity and inertia that governs the motion of objects in the solar system. e. Ask questions to compare and contrast the characteristics, composition, and location of comets, asteroids, and meteoroids.

Sixth Grade	
GPS	**GSE**
S6E2. Students will understand the effects of the relative positions of the earth, moon and sun. a. Demonstrate the phases of the moon by showing the alignment of the earth, moon, and sun. b. Explain the alignment of the earth, moon, and sun during solar and lunar eclipses. c. Relate the tilt of the earth to the distribution of sunlight throughout the year and its effect on climate.	**S6E2. Obtain, evaluate, and communicate information about the effects of the relative positions of the sun, Earth, and moon.** 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.
S6E3. Students will recognize the significant role of water in earth processes. a. Explain that a large portion of the Earth's surface is water, consisting of oceans, rivers, lakes, underground water, and ice. b. Relate various atmospheric conditions to stages of the water cycle. c. Describe the composition, location, and subsurface topography of the world's oceans. d. Explain the causes of waves, currents, and tides.	**S6E3. Obtain, evaluate, and communicate information to recognize the significant role of water in Earth processes.** a. Ask questions to determine where water is located on Earth's surface (oceans, rivers, lakes, swamps, groundwater, aquifers, and ice) and communicate the relative proportion of water at each location using a circle/pie graph. 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 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.

Sixth Grade	
GPS	**GSE**
S6E4. Students will understand how the distribution of land and oceans affects climate and weather. a. Demonstrate that land and water absorb and lose heat at different rates and explain the resulting effects on weather patterns. b. Relate unequal heating of land and water surfaces to form large global wind systems and weather events such as tornados and thunderstorms. c. Relate how moisture evaporating from the oceans affects the weather patterns and weather events such as hurricanes.	**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 of Earth's atmospheric layers (including the ozone layer) and greenhouse gases. (*Clarification statement:* Earth's atmospheric layers include the troposphere, stratosphere, mesosphere, and thermosphere.) b. Plan and carry out an investigation to demonstrate how energy from the sun transfers heat to air, land and water at different rates. (*Clarification statement:* Heat transfer should include the processes of conduction, convection, and radiation.) c. Develop a model demonstrating the interaction between 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 effects of moisture evaporating from the ocean on weather patterns and weather events such as hurricanes.

Sixth Grade	
GPS	**GSE**
S6E5. Students will investigate the scientific view of how the earth's surface is formed. a. Compare and contrast the Earth's crust, mantle, and core including temperature, density, and composition. b. Investigate the contribution of minerals to rock composition. c. Classify rocks by their process of formation. d. Describe processes that change rocks and the surface of the earth. e. Recognize that lithospheric plates constantly move and cause major geological events on the earth's surface. f. Explain the effects of physical processes (plate tectonics, erosion, deposition, volcanic eruption, gravity) on geological features including oceans (composition, currents, and tides). g. Describe how fossils show evidence of the changing surface and climate of the Earth. h. Describe soil as consisting of weathered rocks and decomposed organic material. i. Explain the effects of human activity on the erosion of the earth's surface. j. Describe methods for conserving natural resources such as water, soil, and air.	**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 of 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 of how 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 support a claim of 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.

Sixth Grade	
GPS	**GSE**
S6E6. Students will describe various sources of energy and with their uses and conservation. a. Explain the role of the sun as the major source of energy and its relationship to wind and water energy. b. Identify renewable and nonrenewable resources.	**S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.** a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives. b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air. c. Construct an argument evaluating contributions to the rise in global temperatures over the past century. (*Clarification statement:* Tables, graphs, and maps of global and regional temperatures, and atmospheric levels of greenhouse gases such as carbon dioxide and methane, should be used as sources of evidence.)

Seventh Grade	
GPS	**GSE**
S7L1. Students will investigate the diversity of living organisms and how they can be compared scientifically. a. Demonstrate the process for the development of a dichotomous key. b. Classify organisms based on physical characteristics using a dichotomous key of the six kingdom system (archaebacteria, eubacteria, protists, fungi, plants, and animals).	**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 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.)

Seventh Grade	
GPS	**GSE**
S7L2. Students will describe the structure and function of cells, tissues, organs, and organ systems. a. Explain that cells take in nutrients in order to grow and divide and to make needed materials. b. Relate cell structures (cell membrane, nucleus, cytoplasm, chloroplasts, mitochondria) to basic cell functions. c. Explain that cells are organized into tissues, tissues into organs, organs into systems, and systems into organisms. d. Explain that tissues, organs, and organ systems serve the needs cells have for oxygen, food, and waste removal. e. Explain the purpose of the major organ systems in the human body (i.e., digestion, respiration, reproduction, circulation, excretion, movement, control, and coordination, and for protection from disease).	**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.)

Seventh Grade	
GPS	**GSE**
S7L3. Students will recognize how biological traits are passed on to successive generations. a. Explain the role of genes and chromosomes in the process of inheriting a specific trait. b. Compare and contrast that organisms reproduce asexually and sexually (bacteria, protists, fungi, plants & animals). c. Recognize that selective breeding can produce plants or animals with desired traits.	**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. 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:* Models could include, but are 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 is specifically in reference to artificial selection and the ways in which it is fundamentally different than natural selection.)

Seventh Grade	
GPS	**GSE**
S7L4. Students will examine the dependence of organisms on one another and their environments. a. Demonstrate in a food web that matter is transferred from one organism to another and can recycle between organisms and their environments. b. Explain in a food web that sunlight is the source of energy and that this energy moves from organism to organism. c. Recognize that changes in environmental conditions can affect the survival of both individuals and entire species. d. Categorize relationships between organisms that are competitive or mutually beneficial. e. Describe the characteristics of Earth's major terrestrial biomes (i.e. tropical rain forest, savannah, temperate, desert, taiga, tundra, and mountain) and aquatic communities (i.e. freshwater, estuaries, and marine).	**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 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. d. Ask questions to gather and synthesize information from multiple sources to differentiate between Earth's major terrestrial biomes (i.e., tropical rain forest, savanna, temperate forest, desert, grassland, taiga, and tundra) 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, and location.)

Seventh Grade	
GPS	**GSE**
S7L5. Students will examine the evolution of living organisms through inherited characteristics that promote survival of organisms and the survival of successive generations of their offspring. a. Explain that physical characteristics of organisms have changed over successive generations (e.g. Darwin's finches and peppered moths of Manchester). b. Describe ways in which species on earth have evolved due to natural selection. c. Trace evidence that the fossil record found in sedimentary rock provides evidence for the long history of changing life forms.	**S7L5. Obtain, evaluate, and communicate information from multiple sources to explain the theory of 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 will be addressed in high school.) d. Ask questions to gather and synthesize information about the ways humans influence the inheritance of desired traits in organisms through selective breeding.

Eighth Grade	
GPS	**GSE**
S8P1. Students will examine the scientific view of the nature of matter. a. Distinguish between atoms and molecules. b. Describe the difference between pure substances (elements and compounds) and mixtures. c. Describe the movement of particles in solids, liquids, gases, and plasmas states. d. Distinguish between physical and chemical properties of matter as physical (i.e., density, melting point, boiling point) or chemical (i.e., reactivity, combustibility). e. Distinguish between changes in matter as physical (i.e., physical change) or chemical (development of a gas, formation of precipitate, and change in color). f. Recognize that there are more than 100 elements and some have similar properties as shown on the Periodic Table of Elements. g. Identify and demonstrate the Law of Conservation of Matter.	**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 mixtures. Types of bonds and compounds will be addressed in high school physical science.) b. Develop and use models to describe the movement of particles in solids, liquids, gases, and plasma states when thermal energy is added or removed. 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 such as balanced chemical equations.)

Eighth Grade	
GPS	**GSE**
S8P2. Students will be familiar with the forms and transformations of energy. a. Explain energy transformation in terms of the Law of Conservation of Energy. b. Explain the relationship between potential and kinetic energy. c. Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics. d. Describe how heat can be transferred through matter by the collisions of atoms (conduction) or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection).	**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 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, etc.). c. Construct an explanation 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), through space (radiation), or in currents in a liquid or a gas (convection).

Eighth Grade	
GPS	**GSE**
S8P3. Students will investigate relationship between force, mass, and the motion of objects. a. Determine the relationship between velocity and acceleration. b. Demonstrate the effect of balanced and unbalanced forces on an object in terms of gravity, inertia, and friction. c. Demonstrate the effect of simple machines (lever, inclined plane, pulley, wedge, screw, and wheel and axle) on work.	**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 velocity or acceleration.) b. Construct an explanation using Newton's Laws of Motion to describe the effects of balanced and unbalanced forces on the motion of an object. c. Construct an argument from evidence to support the claim that heavier objects require a greater force to accelerate (inertia).

Eighth Grade	
GPS	**GSE**
S8P4. Students will explore the wave nature of sound and electromagnetic radiation. a. Identify the characteristics of electromagnetic and mechanical waves. b. Describe how the behavior of light waves is manipulated causing reflection, refraction diffraction, and absorption. c. Explain how the human eye sees objects and colors in terms of wavelengths. d. Describe how the behavior of waves is affected by medium (such as air, water, solids). e. Relate the properties of sound to everyday experiences. f. Diagram the parts of the wave and explain how the parts are affected by changes in amplitude and pitch.	**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 do not cover 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.

Eighth Grade	
GPS	**GSE**
S8P5. Students will recognize characteristics of gravity, electricity, and magnetism as major kinds of forces acting in nature. a. Recognize that every object exerts gravitational force on every other object and that the force exerted depends on how much mass the objects have and how far apart they are. b. Demonstrate the advantages and disadvantages of series and parallel circuits and how they transfer energy. c. Investigate and explain that electric currents and magnets can exert force on each other. d. Investigate static electricity in terms of friction, conduction and induction.	**S8P5. Obtain, evaluate, and communicate information about the phenomena of gravity, electricity, and magnetism as major forces acting in nature.** a. 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. b. Plan and carry out investigations to demonstrate the distribution of charge in conductors and insulators. (*Clarification statement:* Include conduction, induction, and friction.) c. Plan and carry out investigations to identify the 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:* Included, but not limited to, generators or motors.)

Biology	
GPS	**GSE**
SB1. Students will analyze the nature of the relationships between structures and functions in living cells. a. Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction. b. Explain how enzymes function as catalysts. c. Identify the function of the four major macromolecules (i.e., carbohydrates, proteins, lipids, nucleic acids). d. Explain the impact of water on life processes (i.e., osmosis, diffusion).	**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 flow of 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

Biology	
GPS	**GSE**
	glycolysis, Krebs cycle, electron transport chain, light reactions, and Calvin cycle.)
SB2. Students will analyze how biological traits are passed on to successive generations. a. Distinguish between DNA and RNA. b. Explain the role of DNA in storing and transmitting cellular information. c. Using Mendel's laws, explain the role of meiosis in reproductive variability. d. Describe the relationships between changes in DNA and potential appearance of new traits including • Alterations during replication. ➢ Insertions ➢ Deletions ➢ Substitutions • Mutagenic factors that can alter DNA. ➢ High energy radiation (x-rays and ultraviolet) ➢ Chemical e. Compare the advantages of sexual reproduction and asexual reproduction in different situations. f. Examine the use of DNA technology in forensics, medicine, and agriculture.	**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 via the processes of replication, transcription, and translation. b. Construct an argument based on evidence to support the claim 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~~ advancements may include Genetically Modified Organisms.)

Biology	
GPS	**GSE**
The original SB2 standard was split into two standards. This is the second standard.	**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 (monohybrid and dihybrid crosses) 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.

Biology	
GPS	**GSE**
SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems. a. Explain the cycling of energy through the processes of photosynthesis and respiration. b. Compare how structures and function vary between the six kingdoms (archaebacteria, eubacteria, protists, fungi, plants, and animals). c. Examine the evolutionary basis of modern classification systems. d. Compare and contrast viruses with living 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. The term 'protist' is useful in describing those eukaryotes that are not within the animal, fungal or plant clades but the term does not describe a well-defined clade or a natural taxonomic group.) b. Analyze and interpret data to develop models (i.e., cladograms and phylogenetic trees) based on patterns of common ancestry and the theory of 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.

Biology	
GPS	**GSE**
SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems. a. Investigate the relationships among organisms, populations, communities, ecosystems, and biomes. b. Explain the flow of matter and energy through ecosystems by • Arranging components of a food chain according to energy flow. • Comparing the quantity of energy in the steps of an energy pyramid. • Explaining the need for cycling of major nutrients (C, O, H, N, and P). c. Relate environmental conditions to successional changes in ecosystems. d. Assess and explain human activities that influence and modify the environment such as global warming, population growth, pesticide use, and water and power consumption. e. Relate plant adaptations, including tropisms, to the ability to survive stressful environmental conditions. f. Relate animal adaptations, including behaviors, to the ability to survive stressful environmental conditions.	**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 cycling of matter and flow of energy within ecosystems through the processes of photosynthesis and respiration. • 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, N, P, 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 impact of a human activity on the environment. (*Clarification statement:* Human activities may include chemical use, natural resources consumption, introduction of non-native species, greenhouse gas production.) e. Construct explanations that predict an organism's ability to survive within changing environmental limits (e.g., temperature, pH, drought, fire).

Biology	
GPS	**GSE**
SB5. Students will evaluate the role of natural selection in the development of the theory of evolution. a. Trace the history of the theory. b. Explain the history of life in terms of biodiversity, ancestry, and the rates of evolution. c. Explain how fossil and biochemical evidence support the theory. d. Relate natural selection to changes in organisms. e. Recognize the role of evolution to biological resistance (pesticide and antibiotic resistance).	**SB6. Obtain, evaluate, and communicate information to assess the theory of evolution.** a. Construct an explanation of how new understandings of Earth's history, 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. c. Construct an argument using valid and reliable sources 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. (*Clarification statement:* 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 natural selection plays in causing biological resistance (e.g., pesticides, antibiotic resistance, and influenza vaccines).

Chemistry	
GPS	**GSE**
SC1. Students will analyze the nature of matter and its classifications. a. Relate the role of nuclear fusion in producing essentially all elements heavier than helium. b. Identify substances based on chemical and physical properties. c. Predict formulas for stable ionic compounds (binary and tertiary) based on balance of charges. d. Use IUPAC nomenclature for both chemical names and formulas: • Ionic compounds (Binary and tertiary) • Covalent compounds (Binary and tertiary) • Acidic compounds (Binary and tertiary)	**Elements A and B were incorporated into the new SC1. Elements C and D were incorporated into the new SC3.**

Chemistry	
GPS	**GSE**
This is a new standard created by combining elements from multiple GPS standards.	**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 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 to support the claim that 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 (i.e. including atomic radii, ionization energy, and electronegativity of various elements). g. Develop and use models, including electron configuration of atoms and ions, to predict an element's chemical properties.

Chemistry	
GPS	**GSE**
SC2. Students will relate how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions. a. Identify and balance the following types of chemical equations: • Synthesis • Decomposition • Single Replacement • Double Replacement • Combustion b. Experimentally determine indicators of a chemical reaction specifically precipitation, gas evolution, water production, and changes in energy to the system. c. Apply concepts of the mole and Avogadro's number to conceptualize and calculate • Empirical/molecular formulas, • Mass, moles and molecules relationships, • Molar volumes of gases. d. Identify and solve different types of stoichiometry problems, specifically relating mass to moles and mass to mass. e. Demonstrate the conceptual principle of limiting reactants. f. Explain the role of equilibrium in chemical reactions.	**This standard was reordered to SC3 to make a more logical progression.**

Chemistry	
GPS	**GSE**
This is a new standard.	**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 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.

Chemistry	
GPS	**GSE**
SC3. Students will use the modern atomic theory to explain the characteristics of atoms. a. Discriminate between the relative size, charge, and position of protons, neutrons, and electrons in the atom. b. Use the orbital configuration of neutral atoms to explain its effect on the atom's chemical properties. c. Explain the relationship of the proton number to the element's identity. d. Explain the relationship of isotopes to the relative abundance of atoms of a particular element. e. Compare and contrast types of chemical bonds (i.e. ionic, covalent). f. Relate light emission and the movement of electrons to element identification.	**This standard was incorporated into the new SC1.**
The original SC2 was reordered to make a more logical progression.	**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 an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (specifically precipitate formation, gas evolution, color change, water production, and changes in energy to the system).

Chemistry	
GPS	**GSE**
	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 mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking and 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.
SC4. Students will use the organization of the Periodic Table to predict properties of elements. a. Use the Periodic Table to predict periodic trends including atomic radii, ionic radii, ionization energy, and electronegativity of various elements. b. Compare and contrast trends in the chemical and physical properties of elements and their placement on the Periodic Table.	**This standard now serves as the foundation of the new SC1.**

Chemistry	
GPS	**GSE**
SC5. Students will understand that the rate at which a chemical reaction occurs can be affected by changing concentration, temperature, or pressure and the addition of a catalyst. a. Demonstrate the effects of changing concentration, temperature, and pressure on chemical reactions. b. Investigate the effects of a catalyst on chemical reactions and apply it to everyday examples. c. Explain the role of activation energy and degree of randomness in chemical reactions.	**SC4. Obtain, evaluate, and communicate information about how to refine the design of a chemical system by applying engineering principles to manipulate the factors that affect a chemical reaction.** a. Plan and carry out an investigation to provide evidence of the effects of changing concentration, temperature, and pressure on chemical reactions. (*Clarification statement:* Pressure should not be tested experimentally.) b. Construct an argument using collision theory and transition state theory to explain the role of activation energy in chemical reactions. (*Clarification statement:* Reaction coordinate diagrams could be used to visualize graphically changes in energy (direction flow and quantity) during the progress of a chemical reaction.) c. Construct an explanation of the effects of a catalyst on chemical reactions and apply it to everyday examples. d. Refine the design of a chemical system by altering the conditions that would change forward and reverse reaction rates and the amount of products at equilibrium. (*Clarification statement:* Emphasis is on the application of LeChatelier's principle.)

Chemistry	
GPS	**GSE**
SC6. Students will understand the effects motion of atoms and molecules in chemical and physical processes. a. Compare and contrast atomic/molecular motion in solids, liquids, gases, and plasmas. b. Collect data and calculate the amount of heat given off or taken in by chemical or physical processes. c. Analyzing (both conceptually and quantitatively) flow of energy during change of state (phase).	**SC5. Obtain, evaluate, and communicate information about the Kinetic Molecular Theory to model atomic and molecular motion in chemical and physical processes.** a. Plan and carry out an investigation to calculate the amount of heat absorbed or released by chemical or physical processes. (*Clarification statement:* Calculation of the enthalpy, heat change, and Hess's Law are addressed in this element.) b. Construct an explanation using a heating curve as evidence of the effects of energy and intermolecular forces on phase changes. c. Develop and use models to quantitatively, conceptually, and graphically represent the relationships between pressure, volume, temperature, and number of moles of a gas.

Chemistry	
GPS	**GSE**
SC7. Students will characterize the properties that describe solutions and the nature of acids and bases. a. Explain the process of dissolving in terms of solute/solvent interactions: • Observe factors that affect the rate at which a solute dissolves in a specific solvent, • Express concentrations as molarities, • Prepare and properly label solutions of specified molar concentration, • Relate molality to colligative properties. b. Compare, contrast, and evaluate the nature of acids and bases: • Arrhenius, Bronsted-Lowry Acid/Bases • Strong vs. weak acids/bases in terms of percent dissociation • Hydronium ion concentration • pH • Acid-Base neutralization	**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. Communicate scientific and technical information on how 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:* Understanding of the mathematical relationship between negative logarithm of the hydrogen concentration and pH is not expected in this element. Only a conceptual understanding of pH as related to acid/basic conditions is needed.) 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.

Earth Systems	
GPS	**GSE**
SES1. Students will investigate the composition and formation of Earth systems, including the Earth's relationship to the solar system. a. Describe the early evolution of the Earth and solar system, including the formation of Earth's solid layers (core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the mechanism by which heat transfer drives plate tectonics. b. Explain how the composition of the Earth's crust, mantle and core is determined and compare it to that of other solar system objects. c. Describe how the decay of radioactive isotopes is used to determine the age of rocks, Earth, and solar system. d. Describe how the Earth acquired its initial oceans and atmosphere. e. Identify the transformations and major reservoirs that make up the rock cycle, hydrologic cycle, carbon cycle, and other important geochemical cycles.	**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:* The nebular hypothesis should be included 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:* The differentiation by density of Earth into crust, mantle and core should be included 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 should include crust, mantle, inner core and outer core.)

Earth Systems	
GPS	**GSE**
SES2. Students will understand how plate tectonics creates certain geologic features, materials, and hazards. a. Distinguish among types of plate tectonic settings produced by plates diverging, converging, and sliding past each other. b. Relate modern and ancient geologic features to each kind of plate tectonic setting. c. Relate certain geologic hazards to specific plate tectonic settings. d. Associate specific plate tectonic settings with the production of particular groups of igneous and metamorphic rocks and mineral resources. e. Explain how plate tectonics creates and destroys sedimentary basins through time.	**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:* Subduction zones, continental collisions, rift zones, and ocean basins should be included.) 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 processes of all rock types (sedimentary, igneous, and metamorphic) and specific plate tectonic settings. (*Clarification statement:* The plate tectonic settings to be considered here are continental collision, subduction zone, mid-ocean ridge, transformation fault, hot spot, and passive zone.) e. Construct an argument using multiple forms of evidence that supports the theory of plate tectonics (e.g., fossils, paleomagnetism, seafloor age, etc.).

Earth Systems	
GPS	**GSE**
SES3. Students will explore the actions of water, wind, ice, and gravity that create landforms and systems of landforms (landscapes). a. Describe how surface water and groundwater act as the major agents of physical and chemical weathering. b. Explain how soil results from weathering and biological processes acting on parent rock. c. Describe the processes and hazards associated with both sudden and gradual mass wasting. d. Relate the past and present actions of ice, wind, and water to landform distribution and landscape evolution. e. Explain the processes that transport and deposit material in terrestrial and marine sedimentary basins, which result, over time, in sedimentary rock.	**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. 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.

Earth Systems	
GPS	**GSE**
SES4. Students will understand how rock relationships and fossils are used to reconstruct the Earth's past. a. Describe and apply principles of relative age (superposition, original horizontality, cross-cutting relations, and original lateral continuity) and describe how unconformities form. b. Interpret the geologic history of a succession of rocks and unconformities. c. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. d. Explain how sedimentary rock units are correlated within and across regions by a variety of methods (e.g., geologic map relationships, the principle of fossil succession, radiometric dating, and paleomagnetism). e. Use geologic maps and stratigraphic relationships to interpret major events in Earth history (e.g., mass extinction, major climatic change, tectonic events).	**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, rates of erosion, rates of deposition, and varve count). 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.)

Earth Systems	
GPS	**GSE**
SES5. Students will investigate the interaction of insolation and Earth systems to produce weather and climate. a. Explain how latitudinal variations in solar heating create atmospheric and ocean currents that redistribute heat globally. b. Explain the relationship between air masses and the surfaces over which they form. c. Relate weather patterns to interactions among ocean currents, air masses, and topography. d. Describe how temperature and precipitation produce the pattern of climate regions (classes) on Earth. e. Describe the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). f. Relate changes in global climate to variation in Earth/Sun relationships and to natural and anthropogenic modification of atmospheric composition.	**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.

Earth Systems	
GPS	**GSE**
SES6. Students will explain how life on Earth responds to and shapes Earth systems. a. Relate the nature and distribution of life on Earth, including humans, to the chemistry and availability of water. b. Relate the distribution of biomes (terrestrial, freshwater, and marine) to climate regions through time. c. Explain how geological and ecological processes interact through time to cycle matter and energy, and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion). d. Describe how fossils provide a record of shared ancestry, evolution, and extinction that is best explained by the mechanism of natural selection. e. Identify the evolutionary innovations that most profoundly shaped Earth systems: photosynthetic prokaryotes and the atmosphere; multicellular animals and marine environments; land plants and terrestrial environments.	**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.

Environmental Science	
GPS	**GSE**
SEV1. Students will investigate the flow of energy and cycling of matter within an ecosystem and relate these phenomena to human society. a. Interpret biogeochemical cycles including hydrologic, nitrogen, phosphorus, oxygen, and carbon cycles. Recognize that energy is not recycled in ecosystems. b. Relate energy changes to food chains, food webs, and to trophic levels in a generalized ecosystem, recognizing that entropy is a primary factor in the loss of usable food energy during movement up the trophic levels. c. Relate food production and quality of nutrition to population growth and the trophic levels. d. Relate the cycling of matter and the flow of energy to the Laws of Conservation of matter and energy. Identify the role and importance of decomposers in the recycling process. e. Distinguish between abiotic and biotic factors in an ecosystem and describe how matter and energy move between these.	**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). (*Clarification statement:* The first and second law of thermodynamics should be used to support the model.) 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. Evaluate claims, evidence, and reasoning of 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.)

Environmental Science	
GPS	**GSE**
SEV2. Students will demonstrate an understanding that the Earth is one interconnected system. a. Describe how the abiotic components (water, air, and energy) affect the biosphere. b. Recognize and give examples of the hierarchy of the biological entities of the biosphere (organisms, populations, communities, ecosystems, and biosphere). c. Characterize the components that define a Biome. Abiotic Factors – to include precipitation, temperature and soils. Biotic Factors – plant and animal adaptations that create success in that biome. d. Characterize the components that define fresh-water and marine systems. Abiotic Factors – to include light, dissolved oxygen, phosphorus, nitrogen, pH and substrate. Biotic Factors – plant and animal adaptations characteristic to that system.	**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 (CO_2 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.

Environmental Science	
GPS	**GSE**
SEV3. Students will describe stability and change in ecosystems. a. Describe interconnections between abiotic and biotic factors, including normal cyclic fluctuations and changes associated with climatic change (i.e. ice ages). b. Explain succession in terms of changes in communities through time to include changes in biomass, diversity, and complexity. c. Explain how succession may be altered by traumatic events. d. Explain how biotic and abiotic factors influence populations. e. Describe interactions between individuals (i.e. mutualism, commensalisms, parasitism, predation, and competition).	**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 your location.

Environmental Science

GPS

SEV4. Students will understand and describe availability, allocation and conservation of energy and other resources.

a. Differentiate between renewable and nonrenewable resources including how different resources are produced, rates of use, renewal rates, and limitations of sources. Distinguish between natural and produced resources.
b. Describe how technology is increasing the efficiency of utilization and accessibility of resources.
c. Describe how energy and other resource utilization impact the environment and recognize that individuals as well as larger entities (businesses, governments, etc.) have impact on energy efficiency.
d. Describe the relationship of energy consumption and the living standards of societies.
e. Describe the commonly used fuels (e.g. fossil fuels, nuclear fuels, etc.) and some alternative fuels (e.g. wind, solar, ethanol, etc.) including the required technology, availability, pollution problems and implementation problems. Recognize the origin of fossil fuels and the problems associated with our dependence on this energy source.
f. Describe the need for informed decision making of resource utilization. (i.e. energy and water usage allocation, conservation, food and land, and long-term depletion)

GSE

SEV4. Obtain, evaluate, and communicate information to analyze human impact on natural resources.

a. Construct and revise a claim based on evidence on the effects of human activities on natural resources.

Human Activities	Natural Resources
Agriculture Forestry Ranching Mining Urbanization Fishing Water use Pollution Desalination Waste water treatment	Land Water Air Organisms

b. Design, evaluate, and refine solutions to reduce human impact on the environment including, but not limited to, smog, ozone depletion, urbanization, and ocean acidification.
c. Construct an argument to evaluate how human population growth affects food demand and food supply (GMOs, monocultures, desertification, Green Revolution).

Environmental Science	
GPS	**GSE**
SEV5. Students will recognize that human beings are part of the global ecosystem and will evaluate the effects of human activities and technology on ecosystems. a. Describe factors affecting population growth of all organisms, including humans. Relate these to factors affecting growth rates and carrying capacity of the environment. b. Describe the effects of population growth, demographic transitions, cultural differences, emergent diseases, etc. on societal stability. c. Explain how human activities affect global and local sustainability. d. Describe the actual and potential effects of habitat destruction, erosion, and depletion of soil fertility associated with human activities. e. Describe the effects and potential implications of pollution and resource depletion on the environment at the local and global levels (e.g. air and water pollution, solid waste disposal, depletion of the stratospheric ozone, global warming, and land uses). f. Describe how political, legal, social, and economic decisions may affect global and local ecosystems.	**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 your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.

Physical Science	
GPS	**GSE**
SPS1. Students will investigate our current understanding of the atom. a. Examine the structure of the atom in terms of • proton, electron, and neutron locations. • atomic mass and atomic number. • atoms with different numbers of neutrons (isotopes). • explain the relationship of the proton number to the element's identity. b. Compare and contrast ionic and covalent bonds in terms of electron movement.	**SPS1. Obtain, evaluate, and communicate information from the Periodic Table to explain the relative properties of elements based on patterns of atomic structure.** a. Develop and use models to compare and contrast the structure of atoms, ions and isotopes. (*Clarification statement:* Properties include atomic number, atomic mass and the location and charge of subatomic particles.) b. Analyze and interpret data to determine trends of the following: • Number of valence electrons • Types of ions formed by main group elements • Location and properties of metals, nonmetals, and metalloids • Phases at room temperature c. Use the Periodic Table as a model to predict the above properties of main group elements.

Physical Science	
GPS	**GSE**
SPS2. Students will explore the nature of matter, its classifications, and its system for naming types of matter. a. Calculate density when given a means to determine a substance's mass and volume. b. Predict formulas for stable binary ionic compounds based on balance of charges. c. Use IUPAC nomenclature for transition between chemical names and chemical formulas of • binary ionic compounds (containing representative elements). • binary covalent compounds (i.e. carbon dioxide, carbon tetrachloride). d. Demonstrate the Law of Conservation of Matter in a chemical reaction. e. Apply the Law of Conservation of Matter by balancing the following types of chemical equations: • Synthesis • Decomposition • Single Replacement • Double Replacement	**SPS2. Obtain, evaluate, and communicate information to explain how atoms bond to form stable compounds.** a. Analyze and interpret data to predict properties of ionic and covalent compounds. (*Clarification statement*: Properties are limited to types of bonds formed, elemental composition, melting point, boiling point, and conductivity.) b. Develop and use models to predict formulas for stable, binary ionic compounds based on balance of charges. c. Use the International Union of Pure and Applied Chemistry (IUPAC) nomenclature for translating between chemical names and chemical formulas. (*Clarification statement:* Limited to binary covalent and binary ionic, containing main group elements, compounds but excludes polyatomic ions.)

Physical Science	
GPS	**GSE**
The new SPS3 is designed to addressed elements d and e from the old SPS2 standard.	**SPS3. Obtain, evaluate, and communicate information to support the Law of Conservation of Matter.** a. Plan and carry out investigations to generate evidence supporting the claim that mass is conserved during a chemical reaction. (*Clarification statement:* Limited to synthesis, decomposition, simple replacement, and double replacement reactions.) b. Develop and use a model of a chemical equation to illustrate how the total number of atoms is conserved during a chemical reaction. (*Clarification statement:* Limited to chemical equations that include binary ionic and covalent compounds and will not include equations containing polyatomic ions.)
SPS3. Students will distinguish the characteristics and components of radioactivity. a. Differentiate among alpha and beta particles and gamma radiation. b. Differentiate between fission and fusion. c. Explain the process half-life as related to radioactive decay. d. Describe nuclear energy, its practical application as an alternative energy source, and its potential problems.	**SPS4. Obtain, evaluate, and communicate information to explain the changes in nuclear structure as a result of fission, fusion and radioactive decay.** a. Develop a model that illustrates how the nucleus changes as a result of fission and fusion. b. Use mathematics and computational thinking to explain the process of half-life as it relates to radioactive decay. (*Clarification statement:* Limited to calculations that include whole half-lives.) c. Construct arguments based on evidence about the applications, benefits, and problems of nuclear energy as an alternative energy source.

Physical Science	
GPS	**GSE**
SPS4. Students will investigate the arrangement of the Periodic Table. a. Determine the trends of the following: • Number of valence electrons • Types of ions formed by representative elements • Location of metals, nonmetals, and metalloids • Phases at room temperature b. Use the Periodic Table to predict the above properties for representative elements.	**This standard was included in the new SPS1 standard.**
SPS5. Students will compare and contrast the phases of matter as they relate to atomic and molecular motion. a. Compare and contrast the atomic/molecular motion of solids, liquids, gases and plasmas. b. Relate temperature, pressure, and volume of gases to the behavior of gases.	**SPS5. Obtain, evaluate, and communicate information to compare and contrast the phases of matter as they relate to atomic and molecular motion.** a. Ask questions to compare and contrast models depicting the particle arrangement and motion in solids, liquids, gases, and plasmas. b. Plan and carry out investigations to identify the relationships among temperature, pressure, volume, and density of gases in closed systems. (*Clarification statement:* Using specific Gas laws to perform calculations is beyond the scope of this standard; emphasis should focus on the conceptual understanding of the behavior of gases rather than calculations.)

Physical Science	
GPS	**GSE**
SPS6. Students will investigate the properties of solutions. a. Describe solutions in terms of • solute/solvent • conductivity • concentration b. Observe factors affecting the rate a solute dissolves in a specific solvent. c. Demonstrate that solubility is related to temperature by constructing a solubility curve. d. Compare and contrast the components and properties of acids and bases. e. Determine whether common household substances are acidic, basic, or neutral.	**SPS6. Obtain, evaluate, and communicate information to explain the properties of solutions.** a. Develop and use models to explain the properties (solute/solvent, conductivity, and concentration) of solutions. b. Plan and carry out investigations to determine how temperature, surface area, and agitation affect the rate a solute dissolves in a specific solvent. c. Analyze and interpret data from a solubility curve to determine the effect of temperature on solubility. d. Obtain and communicate information to explain the relationship between the structure and properties (e.g., pH, and color change in the presence of an indicator) of acids and bases. (*Clarification statement:* Limited to only the structure of simple acids and bases (e.g., HCl and NaOH) that demonstrates the presence of an H^+ or OH^-. e. Plan and carry out investigations to detect patterns in order to classify common household substances as acidic, basic, or neutral.

Physical Science	
GPS	**GSE**
SPS7. Students will relate transformations and flow of energy within a system. a. Identify energy transformations within a system (e.g. lighting of a match). b. Investigate molecular motion as it relates to thermal energy changes in terms of conduction, convection, and radiation. c. Determine the heat capacity of a substance using mass, specific heat, and temperature. d. Explain the flow of energy in phase changes through the use of a phase diagram.	**SPS7. Obtain, evaluate, and communicate information to explain transformations and flow of energy within a system.** a. Construct explanations for energy transformations within a system. (*Clarification statement:* Types of energy to be addressed include chemical, mechanical, electromagnetic, light, sound, thermal, electrical, and nuclear.) b. Plan and carry out investigations to describe how molecular motion relates to thermal energy changes in terms of conduction, convection, and radiation. c. Analyze and interpret specific heat data to justify the selection of a material for a practical application (e.g., insulators and cooking vessels). d. Analyze and interpret data to explain the flow of energy during phase changes using heating/cooling curves.

Physical Science	
GPS	**GSE**
SPS8. Students will determine relationships among force, mass, and motion. a. Calculate velocity and acceleration. b. Apply Newton's three laws to everyday situations by explaining the following: • Inertia Relationship between force, • mass and acceleration • Equal and opposite forces c. Relate falling objects to gravitational force. d. Explain the difference in mass and weight. e. Calculate amounts of work and mechanical advantage using simple machines.	**SPS8. Obtain, evaluate, and communicate information to explain the relationships among force, mass, and motion.** a. Plan and carry out an investigation and analyze the motion of an object using mathematical and graphical models. (*Clarification statement:* Mathematical and graphical models could include distance, displacement, speed, velocity, time and acceleration.) b. Construct an explanation based on experimental evidence to support the claims presented in Newton's three laws of motion. (*Clarification statement:* Evidence could demonstrate relationships among force, mass, velocity, and acceleration.) c. Analyze and interpret data to identify the relationship between mass and gravitational force for falling objects. d. Use mathematics and computational thinking to identify the relationships between work, mechanical advantage, and simple machines.

Physical Science	
GPS	**GSE**
SPS9. Students will investigate the properties of waves. a. Recognize that all waves transfer energy. b. Relate frequency and wavelength to the energy of different types of electromagnetic waves and mechanical waves. c. Compare and contrast the characteristics of electromagnetic and mechanical (sound) waves. d. Investigate the phenomena of reflection, refraction, interference, and diffraction. e. Relate the speed of sound to different mediums. f. Explain the Doppler Effect in terms of everyday interactions.	**SPS9. Obtain, evaluate, and communicate information to explain the properties of waves.** a. Analyze and interpret data to identify the relationships among wavelength, frequency, and energy in electromagnetic waves and amplitude and energy in mechanical waves. b. Ask questions to compare and contrast the characteristics of electromagnetic and mechanical waves. c. Develop models based on experimental evidence that illustrate the phenomena of reflection, refraction, interference, and diffraction. d. Analyze and interpret data to explain how different media affect the speed of sound and light waves. e. Develop and use models to explain the changes in sound waves associated with the Doppler Effect.

Physical Science	
GPS	**GSE**
SPS10. Students will investigate the properties of electricity and magnetism. a. Investigate static electricity in terms of • friction • induction • conduction b. Explain the flow of electrons in terms of • alternating and direct current. • the relationship among voltage, resistance and current. • simple series and parallel circuits. c. Investigate applications of magnetism and/or its relationship to the movement of electrical charge as it relates to • electromagnets • simple motors • permanent magnets	**SPS10. Obtain, evaluate, and communicate information to explain the properties of and relationships between electricity and magnetism.** a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance. b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits. (*Clarification statement:* Advantages and disadvantages of series and parallel circuits should be addressed.) c. Plan and carry out investigations to determine the relationship between magnetism and the movement of electrical charge. (*Clarification statement:* Investigations could include electromagnets, simple motors, and generators.)

Physics	
GPS	**GSE**
SP1. Students will analyze the relationships between force, mass, gravity, and the motion of objects. a. Calculate average velocity, instantaneous velocity, and acceleration in a given frame of reference. b. Compare and contrast scalar and vector quantities. c. Compare graphically and algebraically the relationships among position, velocity, acceleration, and time. d. Measure and calculate the magnitude of frictional forces and Newton's three Laws of Motion. e. Measure and calculate the magnitude of gravitational forces. f. Measure and calculate two-dimensional motion (projectile and circular) by using component vectors. g. Measure and calculate centripetal force. h. Determine the conditions required to maintain a body in a state of static equilibrium.	**SP1. Obtain, evaluate, and communicate information about the relationship between distance, displacement, speed, velocity, and acceleration as functions of time.** a. Plan and carry out an investigation of one-dimensional motion to calculate average and instantaneous speed and velocity. • Analyze one-dimensional problems involving changes of direction, using algebraic signs to represent vector direction. • Apply one-dimensional kinematic equations to situations with no acceleration, and positive, or negative constant acceleration. b. Analyze and interpret data using created or obtained motion graphs to illustrate the relationships among position, velocity, and acceleration, as functions of time. c. Ask questions to compare and contrast scalar and vector quantities. d. Analyze and interpret data of two-dimensional motion with constant acceleration. • Resolve position, velocity, or acceleration vectors into components (x and y, horizontal and vertical). • Add vectors graphically and mathematically by adding components. • Interpret problems to show that objects moving in two dimensions have independent motions along each coordinate axis. • Design an experiment to investigate the projectile motion of an object by collecting and analyzing data using kinematic equations.

Physics	
GPS	**GSE**
	• Predict and describe how changes to initial conditions affect the resulting motion. • Calculate range and time in the air for a horizontally launched projectile.
SP2. Students will evaluate the significance of energy in understanding the structure of matter and the universe. a. Relate the energy produced through fission and fusion by stars as a driving force in the universe. b. Explain how the instability of radioactive isotopes results in spontaneous nuclear reactions.	**This concept was incorporated into the new SP6.**

Physics	
GPS	**GSE**
This is a new standard. It resulted from the separation of SP1 into two standards; the new SP1 dealing with kinematics, and this one dealing with forces.	**SP2. Obtain, evaluate, and communicate information about how forces affect the motion of objects.** a. Construct an explanation based on evidence using Newton's Laws of how forces affect the acceleration of a body. • Explain and predict the motion of a body in absence of a force and when forces are applied using Newton's 1st Law (principle of inertia). • Calculate the acceleration for an object using Newton's 2nd Law, including situations where multiple forces act together. • Identify the pair of equal and opposite forces between two interacting bodies and relate their magnitudes and directions using Newton's 3rd Law. b. Develop and use a model of a Free Body Diagram to represent the forces acting on an object (both equilibrium and non-equilibrium). c. Use mathematical representations to calculate magnitudes and vector components for typical forces including gravitational force, normal force, friction forces, tension forces, and spring forces. d. Plan and carry out an investigation to gather evidence to identify the force or force component responsible for causing an object to move along a circular path. • Calculate the magnitude of a centripetal acceleration. e. Develop and use a model to describe the mathematical relationship between mass, distance, and force as expressed by Newton's Universal Law of Gravitation.

Physics	
GPS	**GSE**
SP3. Students will evaluate the forms and transformations of energy. a. Analyze, evaluate, and apply the principle of conservation of energy and measure the components of work-energy theorem by • describing total energy in a closed system • identifying different types of potential energy • calculating kinetic energy given mass and velocity • relating transformations between potential and kinetic energy b. Explain the relationship between matter and energy. c. Measure and calculate the vector nature of momentum. d. Compare and contrast elastic and inelastic collisions. e. Demonstrate the factors required to produce a change in momentum. f. Analyze the relationship between temperature, internal energy, and work done in a physical system. g. Analyze and measure power.	**SP3. Obtain, evaluate, and communicate information about the importance of conservation laws for mechanical energy and linear momentum in predicting the behavior of physical systems.** a. Ask questions to compare and contrast open and closed systems. b. Use mathematics and computational thinking to analyze, evaluate, and apply the principle of conservation of energy and the Work-Kinetic Energy Theorem. • Calculate the kinetic energy of an object. • Calculate the amount of work performed by a force on an object. c. Plan and carry out an investigation demonstrating conservation and rate of transfer of energy (power) to solve problems involving closed systems. d. Construct an argument supported by evidence of the use of the principle of conservation of momentum to~~:~~ • explain how the brief application of a force creates an impulse. • describe and perform calculations involving one dimensional momentum. • connect the concepts of Newton's 3rd law and impulse. • experimentally compare and contrast inelastic and elastic collisions.
SP4. Students will analyze the properties and applications of waves. a. Explain the processes that results in the production and energy transfer of electromagnetic waves. b. Experimentally determine the behavior of waves in various media in terms of reflection, refraction, and diffraction of waves.	**SP4. Obtain, evaluate, and communicate information about the properties and applications of waves.** a. Develop and use mathematical models to explain mechanical and electromagnetic waves as a propagating disturbance that transfers energy. (*Clarification statement:* Mathematically describe how the velocity, frequency, and

Physics	
GPS	**GSE**
c. Explain the relationship between the phenomena of interference and the principle of superposition. d. Demonstrate the transfer of energy through different mediums by mechanical waves. e. Determine the location and nature of images formed by the reflection or refraction of light.	wavelength of a propagating wave are related.) b. Develop and use models to describe and calculate characteristics related to the interference and diffraction of waves (single and double slits). c. Construct an argument that analyzes the production and characteristics of sounds waves. (*Clarification statement:* Includes, but not limited to, Doppler Effect, standing waves, wavelength, the relationship between amplitude and the energy of the wave, and the relationship between frequency and pitch.) d. Plan and carry out investigations to characterize the properties and behavior of electromagnetic waves. (*Clarification statement:* Properties of waves include, but not limited to, amplitude, frequency, wavelength, and the relationship between frequency or wavelength and the energy of the wave.) e. Plan and carry out investigations to describe common features of light in terms of color, polarization, spectral composition, and wave speed in transparent media. • Analyze experimentally and mathematically aspects of reflection and refraction of light waves and describe the results using optical ray diagrams. • Perform calculations related to reflections from plane surfaces and focusing using thin lenses. f. Plan and carry out investigations to identify the behavior of light using lenses.

Physics	
GPS	**GSE**
	(*Clarification statement:* Investigations concerning Snell's Law, optical ray diagrams, and thin lens equation should be conducted.) g. Plan and carry out investigations to describe changes in diffraction patterns associated with geometry and wavelength for mechanical and electromagnetic waves.

Physics	
GPS	**GSE**
SP5. Students will evaluate relationships between electrical and magnetic forces. a. Describe the transformation of mechanical energy into electrical energy and the transmission of electrical energy. b. Determine the relationship among potential difference, current, and resistance in a direct current circuit. c. Determine equivalent resistances in series and parallel circuits. d. Determine the relationship between moving electric charges and magnetic fields.	**SP5. Obtain, evaluate, and communicate information about electrical and magnetic force interactions.** a. Develop and use mathematical models and generate diagrams to compare and contrast the electric and gravitational forces between two charged objects. (*Clarification statement:* Coulomb's and Universal Gravitation Law should be addressed.) b. Plan and carry out investigations to demonstrate and qualitatively explain charge transfer by conduction, friction, and induction. c. Construct an explanation based on evidence of the behavior of charges in terms of electric potential energy. d. Plan and carry out an investigation of voltage, current, and power for direct current circuits. (*Clarification statement:* Application of Ohm's Law to different circuit configurations, not limited to parallel and series, and calculations of equivalent resistance are expected.) e. Plan and carry out investigations to clarify the relationship between electric currents and magnetic fields. (*Clarification statement:* This includes coils and their importance in the design of motors and generators.)

Physics	
GPS	**GSE**
SP6. The student will describe the corrections to Newtonian physics given by quantum mechanics and relativity when matter is very small, moving fast compared to the speed of light, or very large. a. Explain matter as a particle and as a wave. b. Describe the Uncertainty Principle. c. Explain the differences in time, space, and mass measurements by two observers when one is in a frame of reference moving at constant velocity parallel to one of the coordinate axes of the other observer's frame of reference if the constant velocity is greater than one-tenth the speed of light. d. Describe the gravitational field surrounding a large mass and its effect on a ray of light.	**Standard was eliminated due to survey feedback.**
The original SP2 standard serves as the foundation of the new SP6 standard.	**SP6. Obtain, evaluate, and communicate information about nuclear changes of matter and related technological applications.** a. Develop and use models to explain, compare, and contrast nuclear processes including radioactive decay, fission, and fusion. b. Construct an argument to compare and contrast mechanisms and characteristics of radioactive decay. (*Clarification statement:* Include alpha, beta, and gamma decays and their effects.) c. Develop and use mathematical models and representations to calculate the amount of substance present after a given amount of time based on its half-life and relate this to the law of conservation of mass and energy.