BPS SCIENCE

Middle School
Grades 6-8

Science Learning: Nature of Scientific Knowledge

Nature of Scientific Knowledge:

- Sciences aim at discovering the elements natural world, their properties and their interactions in order to discover laws that allow us to predict and control these elements, to the benefit of humanity.
- Science laws are validated by their success in predicting and controlling, and are subject to review when one single well-controlled experiment proves the law to be wrong.
- Scientist work then on refining the law to allow it to cover more cases that initially considered.
- In our Science Subject Guide, we focus more on the Skills involved in discovering science laws and reflecting on the processes that lead to their discovery, rather than on memorizing the content of the science topics and related laws.
- This is the Essence of Scientific Knowledge, and we adhere fully to adopting and implementing teaching-learning modalities that reflect and respect this essence.
- To that effect we have adopted a teaching-learning approach based on Inquiry and on collaborative work involving all learners, students and teachers.
- Most of the work will take place in the various laboratories.
- In each grade level from Kindergarten through Grade 8, the science curriculum covers three Strands:
  - ***Strand 1: Life Sciences***
  - ***Strand 2: Earth Sciences***
  - ***Strand 3: Physical Sciences***

- ***In Grades 9-12, the Science Tracks become Separate Science Subjects including Biology, Chemistry, Physics, in addition to integrated/Applied sciences such as Biochemistry, Physical Sciences, Environmental Studies, Health and Nutrition, Marine Sciences, Space Sciences, Agriculture, Food Industries, etc.***

- ***In Grade 9, every student is required to take the following two courses:***
  - ***One Introductory Course in Biology, BIO-1***
  - ***One Introductory Course in Chemistry, CHM-1***
- ***In Grade 10, every student is required to take a minimum of One Credit in Sciences***
  Grades 9 and 10 are a solid preparation for the IB Diploma
- ***In Grades 11-12, the Science requirements will be those of the IB Diploma Program or equivalent (AP, A-Level, or similar)***

"Equipped with his five senses, man explores the universe around him and calls the adventure Science. "Edwin Powell Hubble

GRADE 6	STRAND 1 Life sciences	STRAND 2 Earth sciences	STRAND 3 Physical sciences
6.1	**Concept: All living things are made up of cells** All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). ***Competency:*** *Students can investigate to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells*	**Concept: The Roles of Water in Earth's Surface Processes** - Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. ***Competency:*** *Students develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.* *Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.*	**Concept: Definitions of Energy** Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. ***Competency:*** *Students apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*
6.2	**Concept: Structure and Function** Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. ***Competency:*** *Students can develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.*	**Concept: Weather and Climate** -Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. ***Competency:*** *Students collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.*	**Concept: Conservation of Energy and Energy Transfer** When the motion energy of an object changes, there is inevitably some other change in energy at the same time. The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment ***Competency:*** *Students who demonstrate understanding can* *Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.*
6.3	**Concept: Structure and Function** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. ***Competency:*** *Students can use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells*	**Concept: Human Impacts on Earth Systems** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. ***Competency:*** *Students apply scientific principles to design a method for monitoring and minimizing a human impact on the environment*	

6.4	**<u>Concept: Growth and Development of Organisms</u>** - Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. - Genetic factors as well as local conditions affect the growth of the adult plant. - Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. - Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds; and, creating conditions for seed germination and growth. **<u>Competency</u>**: *Students can construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms*	**<u>Concept: Global Climate Change</u>** Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. ***<u>Competency</u>***: *Students can ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.*	

6.5	**Concept: Information Processing** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. **Competency**: *Students can gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.*		

GRADE 7	STRAND 1 Life sciences	STRAND 2 Earth sciences	STRAND 3 Physical sciences
7.1	**Concept: Organization for Matter and Energy Flow in Organisms** Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. **Concept: Energy in Chemical Processes and Everyday Life** The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. **Competency:** *Students can construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.*	**Concept: A - The History of Planet Earth** Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. **Concept B - Plate Tectonics and Large-Scale System Interactions** Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. ***Competency:*** *Students can analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.*	**Concept: Structure and Properties of Matter** A - Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. B - Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). ***Competency:*** *Students can develop models to describe the atomic composition of simple molecules and extended structures.*
7.2	**Concept: Organization for Matter and Energy Flow in Organisms** Within individual organisms, food moves through a series of chemical reactions in which it is broken down and	**Concept: Earth's Materials and Systems** All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the	**Concept: Structure and Properties of Matter** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

	rearranged to form new molecules, to support growth, or to release energy. **<u>Concept: Energy in Chemical Processes and Everyday Life</u>** Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. ***Competency:*** *Students can develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.* - Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released. - Assessment does not include details of the chemical reactions for photosynthesis or respiration.	sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. ***Competency***: *Students can develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.*	***<u>Competency:</u>*** *Students can analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*
7.3	**<u>Concept: Interdependent Relationships in Ecosystems</u>** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. - In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. - Growth of organisms and population increases are limited by access to resources. ***<u>Competency:</u>*** *Students can analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.*	**<u>Concept: A - Earth's Materials and Systems</u>** The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **<u>Concept B - The Roles of Water in Earth's Surface Processes</u>** Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. ***<u>Competency:</u>*** *Students can construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.*	**<u>Concept: Structure and Properties of Matter</u>** A - Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. B - In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. C - The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. ***<u>Competency:</u>*** *Students can develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.* *- Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases*

			kinetic energy of the particles until a change of state occurs.
7.4	**Concept: Interdependent Relationships in Ecosystems** Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. ***Competency:*** *Students can **c**onstruct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.* *Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems.*	**Concept: Natural Resources** Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. ***Competency:*** *Students can construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.*	**Concept: Chemical Reactions** A - Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. B - The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. ***Competency***: *Students can analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.* *Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.* *Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.*
7.5	**Concept: Cycle of Matter and Energy Transfer in Ecosystems** Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. ***Competency:*** *Students can develop a model to describe the cycling of matter and flow of energy*	**Concept: Natural Hazards** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. ***Competency:*** *Students can analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.* *Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.*	**Concept: Chemical Reactions** The total number of each type of atom is conserved, and thus the mass does not change. ***Competency:*** *Students can develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.*

	among living and nonliving parts of an ecosystem. Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.		

7.6	**<u>Concept: Ecosystem Dynamics, Functioning, and Resilience</u>** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. **<u>Competency:</u>** *Students can construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.*		**<u>Concept: Chemical Reactions</u>** Some chemical reactions release energy, others store energy. ***<u>Competency:</u>*** *Students can undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes* *- Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance.* *- Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.* *- Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*
7.7	**<u>Concept: Biodiversity and Humans</u>** Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. **<u>Developing Possible Solutions</u>** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. ***<u>Competency:</u>*** *Students can evaluate compete design solutions for maintaining biodiversity and ecosystem services.* *Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion.* *Examples of design solution constraints could include scientific, economic, and social considerations.*		**<u>Concept: Definitions of Energy</u>** A - The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. B - The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. ***<u>Competency:</u>*** *Students can develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.*
7.8			**<u>Concept: Developing Possible Solutions</u>** A solution needs to be tested and modified on the basis of the results, in order to improve it.

			Competency: *Students can undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*
7.9			**<u>Concept: Optimizing the Design Solutions</u>** A - Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. B - The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and an optimal solution. ***<u>Competency:</u>*** *Students can undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

GRADE 8	STRAND 1 Life sciences	STRAND 2 Earth sciences	STRAND 3 Physical sciences
8-1	**Concept: Inheritance of Traits** Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. ***Competency:*** *Students can develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.*	**Concept: The Universe and Its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. Patterns can be used to identify cause-and-effect relationships. ***Competency:*** *Students can develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.*	**Concept: Forces and Motion** For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). ***Competency:*** *Students can apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*
8-2	**Concept: Variation of Traits** In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. ***Competency:*** *Students can develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.*	**Concept: The Universe and Its Stars** Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy, matter, and information flows within systems. ***Competency:*** *Students can develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.*	**Concept: Forces and Motion** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. ***Competency:*** *Students can plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.*
8-3 **8-3**	**Concept: Evidence of Common Ancestry and Diversity** The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through	**Concept: Earth and the Solar System** The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	**Concept: Forces and Motion** All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people,

	radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. ***Competency:*** *Students can analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.*	Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy, matter, and information flows within systems. ***Competency:*** *Students can develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.*	these choices must also be shared. ***Competency:*** *Students can plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object*
8-4	**Concept: Evidence of Common Ancestry and Diversity** Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. ***Competency:*** *Students can apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.*	**Concept: Earth and the Solar System** This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy, matter, and information flows within systems. ***Competency:*** *Students can develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.*	**Concept: Types of Interactions** Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. ***Competency:*** *Students can ask questions about data to determine the factors that affect the strength of electric and magnetic forces.*
8-5	**Concept: Evidence of Common Ancestry and Diversity** Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy ***Competency:*** *Students can analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.*	**Concept: Earth and the Solar System** The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. Models can be used to represent systems and their interactions – such as inputs, processes and outputs – and energy, matter, and information flows within systems. ***Competency:*** *Students can develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.*	***Concept: Types of Interactions*** *Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.* ***Competency:*** *Students can construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.*

8-6	**Concept: Natural Selection** Natural selection leads to the predominance of certain traits in a population, and the suppression of others. ***Competency:*** *Students can construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.*	**Concept: The History of Planet Earth** The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. ***Competency:*** *Students can make a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.*	**Concept: Types of Interactions** Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). ***Competency:*** *Students can conduct an investigation and evaluate the experimental design to provide evidence that fields exist*
8-7	**Concept: Natural Selection** In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. ***Competency:*** *Students can gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.*	***Concept: Human Impacts on Earth Systems*** *Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.* ***Competency:*** *Students can **c**onstruct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.* *- Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy).* *- Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.*	**Concept: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. ***Competency:*** *Students can construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.*
8-8 **8-8**	**Concept: Adaptation** Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more		**Concept: Definitions of Energy** A system of objects may also contain stored (potential) energy, depending on their relative positions.

	common; those that do not become less common. Thus, the distribution of traits in a population's changes. ***Competency:*** *Students can use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.* *- Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.*		***Competency:*** *Students can develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system*
8-9			**Concept: Relationship Between Energy and Forces** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. ***Competency:*** Students can develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
8-10			**Concept: Wave Properties** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. ***Competency:*** *Students can use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.*
8-11			**Concept: Wave Properties** A sound wave needs a medium through which it is transmitted. ***Competency:*** *Students can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.*
8-12			**Concept: Electromagnetic Radiation** When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's

			material and the frequency (color) of the light.

			Competency: *Students can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.*
8-13			**Concept: Electromagnetic Radiation** The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. ***Competency:*** *Students can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.*
8-14			**Concept: Electromagnetic Radiation** A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. ***Competency:*** *Students can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.*
8-15			**Concept: Electromagnetic Radiation** However, because light can travel through space, it cannot be a matter wave, like sound or water waves. ***Competency:*** *Students can develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.*

8-16			**<u>Concept: Information Technologies and Instrumentation</u>** - Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. - Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations, and influences advances in technology. ***<u>Competency:</u>*** *Students can integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.*