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Time	Unit	Standards	Evidence of Understanding	Assessments
10-12 Days Early September	**Earth and Space Science (ESS)** **Physical Earth**	The composition and properties of Earth's interior are identified by the behavior of seismic waves.	The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate layers of Earth's interior. Heat released from the core of Earth drives convection currents throughout mantle and crust.	Be able to: Answer critical questions Observational data based on class participation Lab activities Homework
It is important to provide the background knowledge regarding how scientists know about the structure and composition of the interior of Earth (without being able to see it). Seismic data, graphics, charts, digital displays and cross sections must be used to study Earth's interior. Actual data from the refraction and reflection of seismic waves can be used to demonstrate how scientists have determined the different layers of Earth's interior. New discoveries and technological advances relating to understanding Earth's interior also play an important role in this content. Earth and other planets in the solar system formed as heavier elements coalesced in their centers. Planetary differentiation is a process in which more dense materials of a planet sink to the center, while less dense materials stay on the surface. A major period of planetary differentiation occurred approximately 4.6 billion years ago (College Board Standards for College Success, 2009). In addition to the composition of Earth's interior, the history of the formation of Earth and the relationship of energy transfer, transformation and convection currents within the mantle and crust are essential in understanding sources of energy.				
10-12 Days Late September	**Earth and Space Science (ESS)** **Physical Earth**	Earth's crust consists of major and minor tectonic plates that move relative to each other.	There are three main types of plate boundaries. Each type of boundary results in specific motion, and causes events or features that are indicative of the type of boundary.	Be able to: Answer critical questions Observational data based on class participation Lab activities Earthquake resistant building Homework
The historical data related to the present plate tectonic theory must include continental "puzzle-like-fit" noticed as early as Magellan and by other mapmakers and explorers, paleontological data, paleoclimate data, paleomagnetic data, continental drift (Wegener), convection theory (Holmes) and sea floor spreading (Hess, Deitz). Contemporary data must be introduced, including seismic data, GPS/GIS data (documenting plate movement and rates of movement), robotic studies of the sea floor and further exploration of Earth's interior.				

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Physical world maps, cross sections, models (virtual or 3D) and data must be used to identify plate boundaries, movement at the boundary and the resulting feature or event. The relationship between heat from Earth's core, convection in the magma and plate movement should be explored. World distribution of tectonic activity of possible interest should be investigated. Volcanic activity, earthquakes, tsunamis, geysers, hot springs, faults, oceanic vents, island arcs, hot spots and rift valleys should all be included in the identification of plates and plate boundaries. Plate boundary identification (converging, diverging, transform) must be based on the resulting features or events. The focus must be on the cause of plate movement, the type and direction of plate movement and the result of the plate movement, not on memorizing plate names.				
10-12 Days October	**Earth and Space Science (ESS)** **Physical Earth**	A combination of constructive and destructive geologic processes formed Earth's surface.	Earth's surface is formed from a variety of different geological processes (plate tectonics).	Be able to: Answer critical questions Observational data based on class participation Lab activities Homework Mapping the Seafloor/ Build a Mountain
The interactions between the hydrosphere and lithosphere are studied as they relate to erosional events (e.g., flooding, mass wasting). The characteristics of rocks and soil, the climate, location, topography and geologic process are studied. Distinguishing between major geologic processes (e.g., tectonic activity, erosion, deposition) and the resulting feature on the surface of Earth is the focus of this content statement. It is important to build on what was included in the elementary grades (recognizing features), enabling students to describe conditions for formation. Topographic, physical and aerial maps, cross-sections, field trips and virtual settings are methods of demonstrating the structure and formation of each type of feature. The use of technology (remote sensing, satellite data, LANDSAT) can be used to access real-time photographs and graphics related to landforms and features. Factors that affect the patterns and features associated with streams and floodplains (e.g., discharge rates, gradients, velocity, erosion, deposition), glaciers (e.g., moraines, outwash, tills, erratic, kettles, eskers), tectonic activity (should include the features listed in the content statement above), coastlines, flooding and deserts should be studied.				
10-12 Days Mid to Late October	**Earth and Space Science (ESS)** **Physical Earth**	Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.	There are different methods to determine relative and absolute age of rock layers in the geologic record. The geologic record can help identify past environmental and climate conditions.	Be able to: Answer critical questions Observational data based on class participation Lab activities

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				Homework Examine and place fossils to a relative time period
The representation of the age of the Earth must include a graphic demonstration of the immensity of geologic time, as this is a very difficult concept to grasp. The different methods used to determine the age of the Earth are an important factor in this concept. In elementary grades, fossils are used to compare what once lived to what lives now, but the concept of Earth's age and the age of the fossils were not included (the concept of billions or millions of years was not age-appropriate). In grade 8, the concept of index fossils is a way to build toward understanding relative dating. Superposition, crosscutting relationships and index fossils play an important role in determining relative age. Radiometric dating plays an important role in absolute age. The inclusion of new advances and studies (mainly due to developing technological advances) is important in learning about the geologic record. Uniformitarianism can be an important key in understanding how scientists have interpreted the environmental conditions that existed throughout Earth's history. Fossil evidence also can indicate specific environments and climate conditions that help interpret the geologic record. Relating Earth's climate history to present-day climate issues should include evidence from ice core sampling as well as evidence from the geologic record. Using actual data to generate geologic maps of local or statewide formations can connect to the real world. Field studies or geologic research (can be virtual/digital) can help identify local formations and interpret the environment that existed at the time of the formation. Analyzing and interpreting the data to draw conclusions about geologic history is an important part of this content statement. Note: This content is closely connected to LS grade 8 content pertaining to diversity of species as documented in the fossil record, tracing changes evident in the fossil record and relating this content to evolution.				
12-15 Days Late October/ November	**Physical Science (PS) Force and Motion**	Forces between objects act when the objects are in direct contact or when they are not touching.	Magnetic, electrical, and gravitational forces can act at a distance.	Be able to: Answer critical questions Observational data based on class participation Various lab activities Homework Crash Test Dummies
A field model can be used to explain how two objects can exert forces on each other without touching. An object is thought to have a region of influence, called a field, surrounding it. When a second object with an appropriate property is placed in this region, the field exerts a force on and can cause changes in the motion of the object. Electric fields exist around objects with charge. If a second object with charge is placed in the field, the two objects experience electric forces that can attract or repel them, depending on the charges involved. Electric force weakens rapidly with increasing distance.				

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Magnetic fields exist around magnetic objects. If a second magnetic object is placed in the field, the two objects experience magnetic forces that can attract or repel them, depending on the objects involved. Magnetic force weakens rapidly with increasing distance. Magnetic field lines can be seen when iron filings are sprinkled around a magnet.

Gravitational fields exist around objects with mass. If a second object with mass is placed in the field, the two objects experience attractive gravitational forces toward each other. Gravitational force weakens rapidly with increasing distance.

Every object exerts a gravitational force on every other object with mass. These forces are hard to detect unless at least one of the objects is very massive (e.g., sun, planets). The gravitational force increases with the mass of the objects, decreases rapidly with increasing distance and points toward the center of objects. Weight is gravitational force and is often confused with mass. Weight is proportional to mass, but Ohio Department of Education, October 2013 Page 266 of 282
depends upon the gravitational field at a particular location. An object will have the same mass when it is on the moon as it does on Earth. However, the weight (force of gravity) will be different at these two locations.
Electricity is related to magnetism. In some circumstances, magnetic fields can produce electrical currents in conductors. Electric currents produce magnetic fields. Electromagnets are temporary magnets that lose their magnetism when the electric current is turned off. Building an electromagnet to investigate magnetic properties and fields can demonstrate this concept.

Generators convert mechanical energy into electrical energy and are used to produce electrical energy in power plants. Electric motors convert electrical energy into mechanical energy. Motors are in blenders and washing machines. Both motors and generators have magnets (or electromagnets) and a coil of wire that creates its own magnetic field when an electric current flows through it.

Note 1: Magnetic poles are often confused with electric charges. It is important to emphasize the differences.

Note 2: Mathematics is not used to describe fields at this level.

Note 3: This content statement involves a basic introduction to the field model. Details about the field model are not required other than the idea that a field is a concept that is used to understand forces that act at a distance.

Future Application of Concepts
High School: The strength of the force between two charges is calculated using Coulomb's Law. Electromagnetic induction is applied to generator and motors. DC circuits are studied.

10-12 Days December	**Physical Science (PS)** **Force and Motion**	Forces have magnitude and direction.	The motion of an object is always measured with respect to a reference point. Forces can be added, and a detailed explanation of a net force.	Be able to: Answer critical questions Observational data based on class participation Lab activities Homework Crash Test Dummies

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Motion can be described in different ways by different observers (e.g., a pencil held in someone's hand may appear to be at rest, but to an observer in a car speeding by, the pencil may appear to be moving backward).

A force is described by its strength (magnitude) and in what direction it is acting. Many forces can act on a single object simultaneously. The forces acting on an object can be represented by arrows drawn on an isolated picture of the object (a force diagram). The direction of each arrow shows the direction of push or pull. When many forces act on an object, their combined effect is what influences the motion of that object. The sum of all the forces acting on an object depends not only on how strong the forces are, but also in what directions they act. Forces can cancel to a net force of zero if they are equal in strength and act in opposite directions. Such forces are said to be balanced. If all forces are balanced by equal forces in the opposite direction, the object will maintain its current motion (both speed and direction). This means if the object is stationary, it will remain stationary. If the object is moving, it will continue moving in the same direction and at the same speed. Such qualitative, intuitive understandings and descriptions of inertia must be developed through inquiry activities.

Kinetic friction is a force that occurs when two objects in contact interact by sliding past one another. Drag is a force that opposes the motion of an object when an object moves through a fluid (e.g., gas, liquid). Kinetic friction and drag affect the motion of objects and may even cause moving objects to slow to a stop unless another force is exerted in the direction of motion. This phenomenon leads to the misconception that objects require a sustained force to continue moving. Experimentation with objects that have limited friction (e.g., a puck on an air hockey table, dry ice on a surface) can address the misconception that objects with a net force of zero naturally slow down.

If the forces are not balanced, the object's motion will change, either by speeding up, slowing down or changing direction. Qualitative, intuitive understandings of the influence of unbalanced forces on objects must be developed through inquiry investigations.

Note 1: The concept of fields for objects that exert forces without touching is introduced at this grade level.

Note 2: The content description states that there will be acceleration when "the net force is greater than zero." When positive and negative values are used to represent the direction of forces, this statement will need to be expanded. Any nonzero net force, including a negative net force, also may result in a change in speed or direction (acceleration).

20-25 Days January	**Physical Science (PS)** **Force and Motion**	There are different types of potential energy.	Gravitational potential energy changes in a system as the masses of objects are changed. Elastic poten tial energy is a change in the amount of compression or stretch of an elastic object when it has been changed.	Be able to: Answer critical questions Observational data based on class participation Various lab activities Homework Roller coaster project

Gravitational potential energy is associated with the mass of an object and its height above a reference point (e.g., above ground level, above floor level). A change in the height of an object is evidence that the gravitational potential energy has changed.

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Elastic potential energy is associated with how much an elastic object has been stretched or compressed and how difficult such a compression or stretch is. A change in the amount of compression or stretch of an elastic object is evidence that the elastic potential energy has changed.

Chemical potential energy is associated with the position and arrangement of the atoms within substances. Rearranging atoms into new positions to form new substances (chemical reaction) is evidence that the chemical potential energy has most likely changed. The energy transferred when a chemical system undergoes a reaction is often thermal energy.

Electrical potential energy is associated with the position of electrically charged objects relative to each other and the amount of charge they have. A change in the position of charged particles relative to each other is evidence of a change in electrical potential energy.

Magnetic potential energy is associated with the position of magnetic objects relative to each other.

The different types of potential energy must be explored through experimentation and investigation that include the relationship of energy transfer and springs, magnets or static electricity.

Note: Potential energy is often taught as "stored" energy. If the word "stored" means that it is kept by the object and not given away to another object, then kinetic energy also can be classified as "stored" energy. A rocket moving at constant speed through space has kinetic energy and is not transferring any of this energy to another object.

10-15 Days February	**Life Science (LS)** **Species and Reproduction**	Reproduction is necessary for the continuation of every species.	Reproduction is the transfer of genetic information from one generation to the next. It can occur both as sexual reproduction or asexual reproduction.	Be able to: Answer critical questions Observational data based on class participation Various lab activities Homework Research cloning in different industries

An individual organism does not live forever. Reproduction is necessary for the continuation of every species. Most organisms reproduce either sexually or asexually. Some organisms are capable of both. In asexual reproduction, all genes come from a single parent, which usually means the offspring are genetically identical to their parent, allowing genetic continuity. Mitosis was investigated in grade 6. The end products of mitotic and meiotic cell divisions are compared as they relate to asexual and sexual reproduction. It is important that both mitosis and meiosis are addressed in preparation for future study of Mendelian genetics and embryology.

In sexual reproduction, a single specialized cell from a female (egg) merges with a specialized cell from a male (sperm). Typically, half of the genes come from each parent. The fertilized cell, carrying genetic information from each parent, multiplies to form the complete organism. The same genetic information is copied in each cell of the new organism. In sexual reproduction, new combinations of traits are produced which may increase or decrease an organism's chances for survival. Investigations and experimentation (3-D or virtual) must be used to compare offspring to parents in sexual and asexual reproduction.

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20-25 Days March/ April	**Life Science (LS)** **Species and Reproduction**	Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.	Fossils provide important evidence of how life and environmental conditions have changed.	Be able to: Answer critical questions Observational data based on class participation Various lab activities on populations Homework Examine and place fossils to a relative time period
The fossil record documents the variation in a species that may have resulted from changes in the environment. The fossil record is contained within the geologic record (ESS grade 8). Combining data from the geologic record and the fossil record, Earth's living history can be interpreted. Data and evidence from the fossil record must be used to develop further the concepts of extinction, biodiversity and the diversity of species. Diversity can result from sexual reproduction. The sorting and combination of genes results in different genetic combinations, which allow offspring to be similar to, yet different from, their parents and each other. (This statement must be connected to the grade 8 Life Science content statement on reproduction and Mendelian Genetics.) These variations may allow for survival of individuals when the environment changes. Diversity in a species increases the likelihood that some individuals will have characteristics suitable to survive under changed conditions. Evidence from geologic and fossil records can be used to infer what the environment was like at the time of deposition, The variations that exist in organisms can accumulate over many generations, so organisms can be very different in appearance and behavior from their distant ancestors. Note 1: Molecular clocks are not appropriate at this grade level. Note 2: The term "transitional form" should be used to describe parts of the fossil record that are incomplete.				
20-25 Days May	**Life Science (LS)** **Species and Reproduction**	The characteristics of an organism are a result of inherited traits received from parent(s).	Expression of all traits is determined by genes and environmental factors to varying degrees. During reproduction, genetic information (DNA) is transmitted between parent and offspring.	Be able to: Answer critical questions Observational data based on class participation Various lab activities on DNA Homework Dragon Genetics Fingerprinting

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				Punnett Squares

The traits of one or two parents are passed on to the next generation through reproduction. Traits are determined by instructions encoded in deoxyribonucleic acid (DNA), which forms genes. Genes have different forms called alleles. Introduce the principles of Mendelian genetics by reviewing Mendel's work. Mendel's two laws provide the theoretical base for future study of modern genetics. Mendel's first law, the Law of Segregation, and his second law, the Law of Independent Assortment, should be demonstrated and illustrated in a variety of organisms. The concepts of dominant and recessive genes are appropriate at this grade level. Codominant traits such as roan color in horses and cows may be useful to provide further validation of the theory and to help dispel some misconceptions. Pedigree analysis is appropriate for this grade level when limited to dominant, recessive or codominance of one trait. The Law of Independent Assortment should only be explored in simple cases of dominance and recessive traits. Conduct a long-term investigation to analyze and compare characteristics passed on from parent to offspring through sexual and asexual reproduction. Ask questions about the phenotypes that appear in the resulting generations and what they infer about genotypes of the offspring.

Note: Incomplete dominance is not suggested for this grade level to help avoid the misconception of "blending of traits." Codominance is encouraged because both traits are expressed in the resulting offspring.