North Carolina Department of Public Instruction
INSTRUCTIONAL SUPPORT TOOLS
FOR ACHIEVING NEW STANDARDS

This document is designed to help North Carolina educators teach the Essential Standards (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

Essential Standards: Grade 1 Science ● Unpacked Content

For the Essential Standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

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Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/k-2.pdf .

Forces and Motion

Essential Standard and Clarifying Objectives

1.P.1 Understand how forces (pushes or pulls) affect the motion of an object.

1.P.1.1 Explain the importance of a push or pull to changing the motion of an object.
1.P.1.2 Explain how some forces (pushes and pulls) can be used to make things move without touching them, such as magnets.
1.P.1.3 Predict the effect of a given force on the motion of an object, including balanced forces.

Unpacking

What does this standard mean a child will know, understand and be able to do?

1.P.1.1
Students know a force is a push or pull. Students know a force, a push or a pull, can change the motion of an object in three ways: go faster, slower or change the direction of the motion. Students know a force (push or pull) is needed to start objects moving, keep objects moving or stop objects that are moving.

1.P.1.2
Students know magnets exert an unseen force that makes some things move without touching them. Students know magnets have poles that attract or repel each other.

1.P.1.3
Students know the size of the change in motion of an object is based on the amount of force applied to the object. Students know that balance is associated with position and weight.

Earth in the Universe

Essential Standard and Clarifying Objectives

1.E.1 Recognize the features and patterns of the earth/moon/sun system as observed from Earth.

1.E.1.1 Recognize differences in the features of the day and night sky and apparent movement of objects across the sky as observed from Earth.

1.E.1.2 Recognize patterns of observable changes in the Moon's appearance from day to day.

Unpacking

What does this standard mean a child will know, understand and be able to do?

1.E.1.1

Students know that objects in the sky have patterns of movement. Students know the sun is a star that can only be seen in the daytime, but the moon can be seen sometimes at night and sometimes during the day. Students know there are more stars in the sky than anyone can count, but they are not scattered evenly, and they are not all the same in brightness or color. Students know the sun, moon and stars all appear to move slowly across the sky.

1.E.1.2

Students know the moon looks a little different every day but looks the same again about every four weeks. They know that the moon's observable changes follow a pattern.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

1.E.2 Understand the physical properties of Earth materials that make them useful in different ways.

1.E.2.1 Summarize the physical properties of earth materials, including rocks, minerals, soils and water that make them useful in different ways.

1.E.2.2 Compare the properties of soil samples from different places relating their capacity to retain water, nourish and support the growth of certain plants.

Unpacking

What does this standard mean a child will know, understand and be able to do?

1.E.2.1

Students know earth materials include solid rocks, soil and water, which all have different observable properties. Students know from prior experiences that earth materials (matter) may be described by their physical properties (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets, floating or sinking in water). Students know that earth materials that retain their shape regardless of the container they occupy are classified as solids. Students know that water is an Earth material that takes the shape of the container it occupies and is classified as a liquid. Students know that earth materials have different properties that sustain plant and animal life. Students know that some Earth materials have properties that make them useful in solving human problems.

1.E.2.2

Students know that soils have different properties based on where they are located on the earth. Students know that some soils retain more water, nutrients and provide better structural support than others and therefore enhance the growth and development of certain plants.

Ecosystems

Essential Standard and Clarifying Objectives

1.L.1 Understand characteristics of various environments and behaviors of humans that enable plants and animals to survive.

1.L.1.1 Recognize that plants and animals need air, water, light (plants only), space, food and shelter and that these may be found in their environment.

1.L.1.2 Give examples of how the needs of different plants and animals can be met by their environments in North Carolina or different places throughout the world.

1.L.1.3 Summarize ways that humans protect their environment and/or improve conditions for the growth of the plants and animals that live there (e.g., reuse or recycle products to avoid littering).

Unpacking

What does this standard mean a child will know, understand and be able to do?

1.L.1.1

Students know that living things need food, water, air; a way to dispose of waste; and an environment in which they can live. Students know animals eat plants or other animals for food and may also use plants (or even other animals) for shelter and nesting.

1.L.1.2

Students know people need water, food, air, waste removal and a particular range of temperatures in their environment, just as other animals (and plants) do. Students know that living things are found almost everywhere in the world. In North Carolina, from the coast to the mountains, students should observe how different environments support the needs of different organisms (crab/seashore, raccoon/piedmont, elk/mountains). There are different kinds of organisms in different places.

1.L.1.3

Students know that humans depend on their natural and constructed environment and that humans can change the natural environment in ways

that are beneficial or detrimental to humans or other living things. Students know that it is beneficial for humans to participate in activities that provide protection for the environment and/or improve the conditions of the environment for the growth of plants and animals that live there. Students know many materials can be recycled and used again, sometimes in different forms.

Molecular Biology

Essential Standard and Clarifying Objectives

1.L.2 Summarize the needs of living organisms for energy and growth.

1.L.2.1 Summarize the basic needs of a variety of different plants (including air, water, nutrients, and light) for energy and growth.
1.L.2.2 Summarize the basic needs of a variety of different animals (including air, water, and food) for energy and growth.

Unpacking

What does this standard mean a child will know, understand and be able to do?

1. L.2.1
Students know plants are living things that need energy and grow. Students know plants need to take in water, nutrients and light (to make their own food) for energy and growth.

1. L.2.2
Students know animals are living things that grow and have basic needs for energy, air, and water. Animals depend on plants to provide them with energy directly or indirectly. Animals take in plants or other animals as an energy source.

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Essential Standards: Grade 2 Science ● Unpacked Content

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Forces and Motion

Essential Standard and Clarifying Objectives

2.P.1 Understand the relationship between sound and vibrating objects.

2. P.1.1 Illustrate how sound is produced by vibrating objects and columns of air.
2. P.1.2 Summarize the relationship between sound and objects of the body that vibrate – eardrum and vocal cords.

Unpacking

What does this standard mean a child will know, understand and be able to do?

2.P.1.1

Students know that vibrating objects produce sound. Students know that sound can be described in terms of pitch, which may be higher or lower. Students know that the length of an air column determines if its pitch is high or low. Students know that the shorter the air column is, the higher the pitch is. Students also know that the longer the air column is, the lower the pitch.

2.P.1.2

Students know parts of the body vibrate in order to produce and receive sound. Our voices produce sound when air from the lungs passes over our vocal cords and makes them vibrate. The pitch and volume of the sounds humans can produce are changed by changing the properties of the vocal cords. Students know that sound waves are collected by the outer ear, which helps to funnel sound to the eardrum. The eardrum vibrates when sound waves hit it, and causes the tiny bones in the middle ear to vibrate as well. The vibrations move through the bones to the inner ear where the sounds are changed into a form that is understood by the brain.

Matter: Properties and Change

Essential Standard and Clarifying Objectives

2.P.2 Understand properties of solids and liquids and the changes they undergo.

2.P.2.1 Give examples of matter that change from a solid to a liquid and from a liquid to a solid by heating and cooling.
2.P.2.2 Compare the amount (volume and weight) of water in a container before and after freezing.
2.P.2.3 Compare what happens to water left in an open container over time as to water left in a closed container.

Unpacking

What does this standard mean a child will know, understand and be able to do?

2.P.2.1
Students know that solids are materials that maintain their own shapes, while liquids tend to assume the shapes of their containers. Students know examples of materials that can be classified as solid and materials that can be classified as liquid. Students know water can be a liquid or a solid and can go back and forth from one form to the other when heat is added or removed. (Other examples include: candle wax, shortening, rock/lava). Students know things can be done to materials to change some of their properties, but not all materials respond the same way to what is done to them.

2.P.2.2
Students know how to measure and compare the volume of a liquid poured into different containers. Students know how to measure and compare the weight of water poured into different containers. Students know if water is turned into ice and then the ice is allowed to melt, the amount of water is the same as it was before freezing.

2.P.2.3
Students know how to measure and compare the volume of liquid poured into different containers. Students know that a container of water left open will contain less water over time, while a closed container of water will not change.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

2.E.1 Understand patterns of weather and factors that affect weather.

2.E.1.1 Summarize how energy from the sun serves as a source of light that warms the land, air and water.

2.E.1.2 Summarize weather conditions using qualitative and quantitative measures to describe:

- Temperature
- Wind direction
- Wind speed
- Precipitation

2.E.1.3 Compare weather patterns that occur over time and relate observable patterns to time of day and time of year.

2.E.1.4 Recognize the tools that scientists use for observing, recording, and predicting weather changes from day to day and during the seasons.

Unpacking

What does this standard mean a child will know, understand and be able to do?

2.E.1.1

Students know that light travels from the sun to the earth. Some of this light is reflected back into space, some is absorbed by the land, water, and air.

2.E.1.2

Students know that numbers are used to describe air temperature, wind speed, and the amount of precipitation that occurs. Students know that wind direction is described using cardinal directions (N, S, E, W) and numbers. Students know how to measure air temperature with a thermometer, wind direction with a wind sock or vane, wind speed with an anemometer, and precipitation with a rain gauge.

2.E.1.3
Students know that over time there are patterns that can be observed in the weather and that these patterns are influenced by the time of day (cooler morning, warmer afternoon) and the time of year (seasonal changes).

2.E.1.4
Students are familiar with manual and electronic weather instruments, sensors, and computers as well as how they can produce a 'running record' of weather changes that occur over time by collecting and recording data. This collection of data can be analyzed as a basis for predicting weather trends.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

2.L.1 Understand animal life cycles.

2.L.1.1 Summarize the life cycle of animals including:

- Birth
- Developing into an adult
- Reproducing
- Aging and death

2.L.1.2 Compare life cycles of different animals such as, but not limited to, mealworms, ladybugs, crickets, guppies or frogs.

Unpacking

What does this standard mean a child will know, understand and be able to do?

2.L.1.1

Students know that animals experience a cycle of life which begins with birth, then a period of time in which the animal develops into an adult. At adulthood, animals reproduce in order to sustain their species. In nature, all animals are programmed to age and eventually die. The details of the life cycle are different for specific animals.

2.L.1.2
Students know that different animals spend varying periods of time in each stage of the life cycle and that some animals have few stages, while others have several. Students know that animals might look the same, similar, or completely different at specific stages of development. Students know that animals may have varied needs at different stages of development, and may occupy unique habitats according to these needs.

Evolution and Genetics

Essential Standard and Clarifying Objectives

2.L.2 Remember that organisms differ from or are similar to their parents based on the characteristics of the organism.

2.L.2.1 Identify ways in which plants and animals closely resemble their parents in observed appearance and ways they are different.
2.L.2.2 Recognize that there is variation among individuals that are related.

Unpacking

What does this standard mean a child will know, understand and be able to do?

2.L.2.1
Students know that plants and animals resemble their parents in appearance, needs, life processes, and interactions with the environment, even while being unique.

2.L.2.2
Students know that groups of organisms of the same type have characteristics in common as well as characteristics that may vary.

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Essential Standards: Grade 3 Science ● Unpacked Content

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Forces and Motion

Essential Standard and Clarifying Objectives

3.P.1 Understand motion and factors that affect motion.

3.P.1.1 Infer changes in speed or direction resulting from forces acting on an object.
3.P.1.2 Compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.
3.P.1.3 Explain the effect of earth's gravity on the motion of any object on or near the earth.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.P.1.1
Students know that when a force acts on an object it will result in a change of speed and / or direction.

3.P.1.2
Students know that speed can vary. Students know that varying the speed of a moving object will affect the time it takes for the object to travel a particular distance.

3.P.1.3
Students know that the earth 'pulls' on all objects on or near the earth without touching those objects.

Matter: Properties and Change

Essential Standard and Clarifying Objectives

3.P.2 Understand the structure and properties of matter before and after they undergo a change.

3.P.2.1 Recognize that air is a substance that surrounds us, takes up space and has mass.

3.P.2.2 Compare solids, liquids, and gases based on their basic properties.

3.P.2.3 Summarize changes that occur to the observable properties of materials when different degrees of heat are applied to them, such as melting ice or ice cream, boiling water or an egg, or freezing water.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.P.2.1
Students know that air surrounds us, takes up space and has mass.

3.P.2.2
Students know that all matter exhibits properties. Students know that matter can be differentiated based on properties. Students know that gases, liquids and solids are all made up of particles, but the behaviors of these particles differ in the three states (gas, liquid, solid). Students know that solids, liquids, and gases (each) display unique properties characteristic of that particular state (phase) of matter. Students also know that the characteristics of particular states influence the functional applications of a given material.

3.P.2.3
When heat is applied to an object the particles in that object begin to vibrate more rapid. They also begin to move further apart. As the particles move further apart the object may change from one state to another (solid to liquid, liquid to gas). Students know that heating or cooling matter will alter the properties of that matter.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

3.P.3 Recognize how energy can be transferred from one object to another.

3.P.3.1 Recognize that energy can be transferred from one object to another by rubbing them against each other.

3.P.3.2 Recognize that energy can be transferred from a warmer object to a cooler one by contact or at a distance and the cooler object gets warmer.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.P.3.1

Students know that rubbing objects together results in friction which releases heat energy.

3.P.3.2

Students know that objects can transfer energy by touching or by giving off or receiving energy waves. Heat can move from one object to another in more than one way. Convection (more commonly gasses and liquids) and conduction (more commonly solids) are best understood at this level not as vocabulary terms, but rather through effects that may be observed using everyday materials such as water, air, cooking and heating utensils.

Earth in the Universe

Essential Standard and Clarifying Objectives

3.E.1 Recognize the major components and patterns observed in the earth/moon/sun system.

3.E.1.1 Recognize that the earth is part of a system called the solar system that includes the sun (a star), planets, and many moons and the earth is the third planet from the sun in our solar system.

3.E.1.2 Recognize that changes in the length and direction of an object's shadow indicate the apparent changing position of the Sun during the day although the patterns of the stars in the sky, to include the Sun, stay the same.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.E.1.1

Students know that we live on a planet that is part of a solar system. Students know that a solar system includes a star and planets, and other objects. The planets and other objects revolve around the star. Students know that in our solar system Earth is the third planet from the sun.

3.E.1.2

Students know that the Sun and stars in the sky move in consistent patterns. Students know that shadows are created by objects blocking the light. Students know that as the Sun changes its apparent position in the sky, the shadows cast by objects will change. Students know that the Earth rotates on its axis and revolves around the Sun.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

3.E.2 Compare the structures of the Earth's surface using models or three-dimensional diagrams.

3.E.2.1 Compare Earth's saltwater and freshwater features (including oceans, seas, rivers, lakes, ponds, streams, and glaciers).

3.E.2.2 Compare Earth's land features (including volcanoes, mountains, valleys, canyons, caverns, and islands) by using models, pictures, diagrams, and maps.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.E.2.1

Students know that there are bodies of water on the surface of the earth and that they are often named based on their characteristics and location. Some bodies of water are salty, some are 'fresh', some are 'brackish', and some are frozen in ice sheets and glaciers. Different types of organisms have developed to live in these different bodies and types of water.

3.E.2.2

Students know that the surface of the earth has many different types of physical features and that these features are named according to their structure. There are many representations for any given land feature and these possess correspondences consistent with their attributes. (models, maps, etc.).

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

3.L.1 Understand human body systems and how they are essential for life: protection, movement and support.

3.L.1.1 Compare the different functions of the skeletal and muscular system.

3.L.1.2 Explain why skin is necessary for protection and for the body to remain healthy.

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.L.1.1

Students know that the muscles and the skeleton provide a structural framework that protects and supports mobility of the human body. Students know that the skeletal system is comprised of bone. Bone is a hard material that provides support and protection to the body's soft tissues. Students know that muscles are formed from tissues that contract and relax, producing motion. Muscles are attached to bones and initiate and regulate movement. Muscles are also found in internal organs that are responsible for essential life processes (heart, stomach, intestines).

3.L.1.2

Students know that the skin is the largest organ of the human body, that it covers and protects the human body from external conditions and forces. Students know that the skin contains nerve receptors that provide information about external conditions.

Ecosystems

Essential Standard and Clarifying Objectives

3.L.2 Understand how plants survive in their environments.

3.L.2.1 Remember the function of the following plant structures as it relates to the survival of plants in their environments:

- Roots – absorb nutrients
- Stems – provide support
- Leaves – synthesize food
- Flowers – attract pollinators and produce seeds for reproduction.

3.L.2.2 Explain how environmental conditions determine how well plants survive and grow.

3.L.2.3 Summarize the distinct stages of the life cycle of seed plants.

3.L.2.4 Explain how the basic properties (texture and capacity to hold water) and components (sand, clay and humus) of soil determine the ability of soil to support the growth and survival of many plants**.**

Unpacking

What does this standard mean a child will know, understand and be able to do?

3.L.2.1
Students know the names and functions of major plant parts (roots, leaves, stems, flowers).
Students know that plants have special parts that perform special functions in order for the plant to survive.

3.L.2.2
Students know that how well plants grow and survive is determined by a combination of environmental conditions. For example, drought conditions will tend to diminish plant health and growth.

3.L.2.3
Students know the distinct stages of the life cycle of seed plants (seed, germination, seedling, adult).

3.L.2.4 Students know that different soils possess different textures and capacities for the retention of water and nutrients. Students know that soil consists of different components. Students know that these characteristics of soil influence the growth and survival of plants.

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Forces and Motion

Essential Standard and Clarifying Objectives

4.P.1 Explain how various forces affect the motion of an object.

4.P.1.1 Explain how magnets interact with all things made of iron and with other magnets to produce motion without touching them.

4.P.1.2 Explain how electrically charged objects push or pull on other electrically charged objects and produce motion.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.P.1.1

Students know that a magnet pulls on all things made of iron without touching them, and that this pulling can result in motion. Students know that a magnet attracts some metals, but not all of them. Students know that a magnet has a force field and poles that determine how a metal affected by the magnet will behave within its field.

4.P.1.2

Students know that an object that has been electrically charged pulls or pushes on all other charged objects and that this can result in motion. Students know that electrical charges can result in attraction, repulsion or electrical discharge.

Matter: Properties and Change

Essential Standard and Clarifying Objectives

4.P.2 Understand the composition and properties of matter before and after they undergo a change or interaction.

4.P.2.1 Compare the physical properties of samples of matter (strength, hardness, flexibility, ability to conduct heat, ability to conduct electricity, ability to be attracted by magnets, reactions to water and fire).

4.P.2.2 Explain how minerals are identified using tests for the physical properties of hardness, color, luster, cleavage, and streak.

4.P.2.3 Classify rocks as metamorphic, sedimentary, or igneous based on their composition, how they are formed and the processes that create them.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.P.2.1

Students know that samples of matter have many observable properties that can be measured. Students know that samples of matter can be described according to the characteristics of the materials they are made from. Students are familiar with, and can test for the following properties: strength, hardness, flexibility, ability to conduct heat, ability to conduct electricity, ability to be attracted by magnets, reactions to water (dissolve) and heat/fire (melt, evaporate).

4.P.2.2

Students know that minerals can be identified by using particular tests. Students know how to perform tests for hardness and streak. Students are able to describe the color, luster, and cleavage of a mineral.

4.P.2.3

Students know that rocks are classified as metamorphic, igneous or sedimentary, and that these classifications are based on the processes that created the rock. Igneous rocks are formed from molten rock. Sedimentary rocks are formed from deposited rock particles (sediments) that are then compacted. Igneous and sedimentary rocks can be transformed into metamorphic rocks through the application of heat and pressure over

long periods of time.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

4.P.3 Recognize that energy takes various forms that may be grouped based on their interaction with matter.

4.P.3.1 Recognize the basic forms of energy (light, sound, heat, electrical, and magnetic) as the ability to cause motion or create change.

4.P.3.2 Recognize that light travels in a straight line until it strikes an object or travels from one medium to another, and that light can be reflected, refracted, and absorbed.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.P.3.1

Students know basic forms of energy: light, heat, sound, electrical, and energy of motion. Students know that electricity flowing through an electrical circuit produces magnetic effects in the wires. In an electrical circuit containing a battery, a bulb, and a bell, energy from the battery is transferred to the bulb and the bell, which in turn transfer the energy to their surroundings as light, sound, and heat (thermal energy).

4.P.3.2

Students know that light travels in a straight line. Students know that light can be refracted, reflected, and/or absorbed.

Earth in the Universe

Essential Standard and Clarifying Objectives

4.E.1 Explain the causes of day and night and phases of the moon.

4.E.1.1 Explain the cause of day and night based on the rotation of Earth on its axis.

4.E.1.2 Explain the monthly changes in the appearance of the moon, based on the moon's orbit around the Earth.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.E.1.1

Students know that the Earth rotates on an axis and that this rotation causes one side of our planet to receive light rays from the sun while the other side is in darkness (day/night). This rotation occurs over a 24-hour period.

4.E.1.2

Students know that the moon rotates and revolves around the Earth. The moon's appearance (phase) is determined by its position relative to the Earth and the Sun. The appearance of the moon changes in a specific pattern and repeats this sequence over the course of approximately 28 days. During part of this cycle, the moon's visible portion appears to grow larger (waxes). This is followed by a period during which the moon's visible portion appears to reduce in size (wanes). Students are familiar with the following phases of the moon: New Moon, First Quarter, Full Moon, and Last Quarter.

Earth History

Essential Standard and Clarifying Objectives

4.E.2 Understand the use of fossils and changes in the surface of the earth as evidence of the history of the Earth and its changing life forms.

4.E.2.1 Compare fossils (including molds, casts, and preserved parts of plants and animals) to one another and to living organisms.
4.E.2.2 Infer ideas about Earth's early environments from fossils of plants and animals that lived long ago.
4.E.2.3 Give examples of how the surface of the earth changes due to slow processes such as erosion and weathering, and rapid processes such as landslides, volcanic eruptions, and earthquakes.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.E.2.1
Students know that fossils are evidence of living organisms that once existed on Earth. Students know that fossils share some characteristics based on where, how, and from what they formed. Students know that some organisms that lived long ago are similar to existing organisms, but some are quite different. Students know that organisms that are alive today, will, under the right conditions, leave fossil evidence.

4.E.2.2
Students know that fossils provide information about the environmental conditions that existed when the fossil organism was alive, as well as information about where, when and how, the organism lived.

4.E.2.3
Students know that the surface of the earth changes over time. Students know that there are many factors that contribute to these changes. Students know that such changes may be slow or rapid, subtle or drastic. Erosion and weathering are processes that change the Earth. Wind, water (including ice), and chemicals break down rock and can carry soil from one place to another. Under the right conditions, gravity can cause large sections of soil and rock to move suddenly down an incline. This is known as a landslide. Volcanic eruptions occur when heat and

pressure of melted rock and gases under the ground cause the crust of the Earth to crack and release these materials. Solid rock can deform or break if it is subject to sufficient pressure. The vibration produced by this is called an earthquake.

Ecosystems

Essential Standard and Clarifying Objectives

4.L.1 Understand the effects of environmental changes, adaptations and behaviors that enable animals (including humans) to survive in changing habitats.

4.L.1.1 Give examples of changes in an organism's environment that are beneficial to it and some that are harmful.
4.L.1.2 Explain how animals meet their needs by using behaviors in response to information received from the environment.
4.L.1.3 Explain how humans can adapt their behavior to live in changing habitats (e.g., recycling wastes, establishing rain gardens, planting trees and shrubs to prevent flooding and erosion).
4.L.1.4 Explain how differences among animals of the same population sometimes give individuals an advantage in surviving and reproducing in changing habitats.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.L.1.1
Students know that for any particular environment, some kinds of plants and animals survive well, some survive less well and some do not survive at all. When the insect population grows in an area that is frequented by insect eating birds, this is advantageous for the birds. Conversely, if the insect populations are decreased by disease in a similar scenario, the population of birds would be stressed and likely, reduced.

4.L.1.2

Students know that animals collect information about the environment using their senses. Animals also exhibit instinctive (inborn) behaviors that help them to survive. Students know that in animals, the brain processes information, and signals the performance of behaviors that help the organism survive.

4.L.1.3
Students know that humans can adapt their behavior in order to conserve the materials and preserve the ecological systems that they depend on for survival.

4.L.1.4
Students know that there is variation among individuals of one kind within a population. Students know that sometimes this variation results in individuals having an advantage in surviving and reproducing. Survival advantage is not something that is acquired by an organism through choice; rather it is the result of characteristics that the organism already possesses.

Molecular Biology

Essential Standard and Clarifying Objectives

4.L.2 Understand food and the benefits of vitamins, minerals and exercise.

4.L.2.1 Classify substances as food or non-food items based on their ability to provide energy and materials for survival, growth, and repair of the body.
4.L.2.2 Explain the role of vitamins and minerals, and exercise in maintaining a healthy body.

Unpacking

What does this standard mean a child will know, understand and be able to do?

4.L.2.1

Students know that living things derive their energy from food. Plants produce their own food, while other organisms must consume plants or other organisms in order to meet their food (energy) needs.

4.L.2.2
Students know that humans have needs for vitamins, minerals, and exercise in order to remain healthy. Students know that vitamins and minerals are found in healthy foods, as well as dietary supplements. Students also know that movement is essential to the growth, development and maintenance of the human body and its systems.

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Essential Standards: Grade 5 Science ● Unpacked Content

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Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/3-5.pdf .

Forces and Motion

Essential Standard and Clarifying Objectives

5.P.1 Understand force, motion and the relationship between them.

5.P.1.1 Explain how factors such as gravity, friction, and change in mass affect the motion of objects.
5.P.1.2 Infer the motion of objects in terms of how far they travel in a certain amount of time and the direction in which they travel.
5.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time.
5.P.1.4 Predict the effect of a given force or a change in mass on the motion of an object.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.P.1.1
Students know that gravity pulls any object on or near the earth toward it without touching it. Students know that friction is a force that is created anytime two surfaces move or try to move across each other. Students know that all matter has mass. Students understand that changing any or all of these factors will affect the motion of an object.

5.P.1.2
Students know that it is possible to measure the motion of an object based on the distance it will travel in a certain amount of time.

5.P.1.3
Students know that a graph can be created using one axis to represent the distance that an object travels, and the other axis to represent the period of time the object is traveling. Students know how to construct a graph that demonstrates a relation of distance to time.

5.P.1.4
Students know that the greater a force is, the greater the change (in motion) it produces. The greater the mass of the object being acted on, the less the effect of the (same) force.

Matter: Properties and Change

Essential Standard and Clarifying Objectives

5.P.2 Understand the interactions of matter and energy and the changes that occur.

5.P.2.1 Explain how the sun's energy impacts the processes of the water cycle (including, evaporation, transpiration, condensation, precipitation and runoff).

5.P.2.2 Compare the weight of an object to the sum of the weight of its parts before and after an interaction.

5.P.2.3 Summarize properties of original materials, and the new material(s) formed, to demonstrate that a change has occurred.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.P.2.1

Students know that the sun provides the energy that is a driving force for most biotic and abiotic cycles on the surface of the earth. Students know that the sun's energy fuels the water cycle and impacts different aspects of the water cycle (evaporation, transpiration, condensation, precipitation).

5.P.2.2

Students know that the weight of an object is equal to the weight of the sum of its parts. This is true in all closed systems.

5.P.2.3

Students know that by making qualitative and quantitative data records, we are able to create before/after representations of materials (and their properties), so that we can compare before/after versions of materials.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

5.P.3 Explain how the properties of some materials change as a result of heating and cooling.

5.P.3.1 Explain the effects of the transfer of heat (either by direct contact or at a distance) that occurs between objects at different temperatures. (conduction, convection or radiation).

5.P.3.2 Explain how heating and cooling affect some materials and how this relates to their purpose and practical applications.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.P.3.1

Students know that when warmer things are put with cooler things, the warmer things lose heat and the cool things gain it until they are all at the same temperature. Students know that a warmer object can warm a cooler object by contact or at a distance. Conduction is the transfer of thermal energy between things that are touching. Conduction can happen within one object. (For example, thermal energy can be conducted through the handle of a metal pot.) Convection is the movement of thermal energy by the movement of liquids or gases. Convection in the oceans and atmosphere helps to move thermal energy around Earth, and is an important factor influencing weather and climate. Radiation is the transfer of energy by electromagnetic waves. Electromagnetic waves can carry energy through places with or without any matter. The Sun is the main source of electromagnetic energy on Earth. Part of this energy, light, is used by producers to make food. Radiation can also happen in other circumstances (i.e. sitting in front of a fireplace).

5.P.3.2

Students know that heating and cooling can cause changes in the properties of materials, but not all materials respond the same way to being heated and cooled. Students know that heating and cooling cause changes in the properties of materials, such as water turning into steam by boiling and water turning into ice by freezing. Students know and notice that many kinds of changes occur faster at higher temperatures. Students know that some materials conduct heat much better than others, and poor conductors can reduce heat loss.

Students need not come out of this grade span understanding heat or its difference from temperature. More important, students should become familiar with the warming of objects that start out cooler than their environment, and vice versa. Computer lab ware probes and graphic displays that detect small changes in temperature and plot them can be used by students to examine many instances of heat exchange. Because many students think of cold as a substance that spreads like heat, there may be some advantage in translating descriptions of transfer of cold into terms of transfer of heat.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

5.E.1 Understand weather patterns and phenomena, making connections to the weather in a particular place and time.

5.E.1.1 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

5.E.1.2 Predict upcoming weather events from weather data collected through observation and measurements.

5.E.1.3 Explain how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.E.1.1

Students know that weather can change from day to day, and that many factors are measured to describe and predict weather conditions. (EG: wind speed and direction, precipitation, temperature and air pressure). Students know that in different latitudes and hemispheres there are different (and sometimes opposite) seasonal weather patterns.

5.E.1.2
Students know that one can collect and compare weather data in order to predict the likelihood of a particular weather condition occurring. Students know how to read basic weather instruments: thermometer, barometer, anemometer, wind vane, and rain gauge. Students also can identify atmospheric conditions (presence and type of clouds [stratus, cirrus, cumulous], fronts) that are associated with predictable weather patterns. Students can make basic weather predictions using these skills.

5.E.1.3
Students know that local weather conditions are influenced by global factors such as air and water currents. The jet stream is an air current in the upper atmosphere, located over North America that has a powerful influence on the weather conditions there. The jet stream flows from the west to the east and changes location depending on global conditions. The Gulf stream is a warm water surface current in the Atlantic ocean that moves from south of Florida up the eastern seaboard and then across the Atlantic. The Gulf stream moderates weather along the eastern seaboard, warming the air and land there during the cooler months. In the Pacific, there is an oscillation of water temperatures known as El Nino/La Nina. This oscillation impacts the climate of North and South America for long periods of time. Hurricanes are major storms that form over warm ocean water and are caused by global weather patterns.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.

5.L.1.1 Explain why some organisms are capable of surviving as a single cell while others require many cells that are specialized to survive.

5.L.1.2 Compare the major systems of the human body (digestive, respiratory, circulatory, muscular, skeletal, and cardiovascular) in terms of their functions necessary for life.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.L.1.1

Students know that unicellular organisms consist of a single cell and perform all life processes within a single cell. Students know that multicellular organisms are organisms that consist of more than one cell and have differentiated cells that perform specialized functions in the organism. Students know that many organisms –including humans – are multicellular. Students know that in complex multicellular organisms, only the surface cells that are in contact with the external environment are able to exchange substances with it. Cells within the organism are too far away from the environment for direct exchange. This is the reason multicellular organisms have developed transport systems.

5.L.1.2

Students know that there are many systems in the human body. Some of these systems are:

- Circulatory System (heart, blood, vessels)
- Respiratory System (nose, trachea, lungs)
- Skeletal System (bones)
- Muscular System (muscles)
- Digestive System (mouth, esophagus, stomach, intestines)
- Nervous System (brain, spinal cord, nerves)

Students know that each system performs a special life process function and that the systems work together to maintain health and fitness.

Ecosystems

Essential Standard and Clarifying Objectives

5.L.2 Understand the interdependence of plants and animals with their ecosystem.

5.L.2.1 Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds,

forests, and grasslands.

5.L.2.2 Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors).

5.L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5. L.2.1

Students know that there are different types of ecosystems (terrestrial and aquatic). These ecosystems can be divided into two types according to their characteristics:

Terrestrial

Land-based ecosystems include forests and grasslands.

Forests have many trees (with needles or with leaves), shrubs, grasses and ferns, and a variety of animals. They usually get more rain than grasslands. Diverse types of animals can be found in forests, depending on their type. Deciduous: black bear, deer, red fox, vole, rabbit, cardinal. Rain forest: panther, monkeys, capybara, snakes, spiders. Temperatures in the forests may vary depending on where the forest is located.

Grasslands have fertile soil and are covered with tall grasses. They usually get a medium amount of rain, but less than forests. Temperatures may also vary depending on where the grassland is located. Some examples of animals that live in the grasslands are prairie dogs, bison, and grasshoppers.

Aquatic

Water-based ecosystems may be fresh water (lakes and ponds) or saltwater (oceans, estuaries and saltwater marshes).

Lakes and *ponds* are bodies of freshwater that are surrounded by land. Ponds are usually shallower than lakes and the temperature of the water usually stays the same from top to bottom. Plants and algae usually grow along the edges where the water is shallow. Some examples of animals may be different types of fish, amphibians, ducks, turtles, or beavers.

Oceans are large bodies of saltwater divided by continents. Oceans have many types of ecosystems depending on the conditions (sunlight, temperature, depth, salinity) of that part of the ocean.

Most organisms live where the ocean is shallow (from the shoreline to the continental shelf) because sunlight can reach deep and the water is warm making food abundant. Some examples of organisms that live in the shallow ocean are drifters (jellyfish or seaweed), swimmers (fish),

crawlers (crabs), and those anchored to the ocean floor (corals).
Some organisms live in the open ocean, near the surface or down to the deep ocean bottom. Plankton float in the upper regions of the water. Some organisms swim to the surface to find food or for air (whales, turtles, sharks) while others live closer to the bottom (certain fish, octopus, tubeworms).

Students know typical visual representations of the various ecosystems, as well as graphic representations of the food chains and webs, cycles and energy pyramids that are commonly associated with ecosystems.

5.L.2.2
Students know that organisms in an ecosystem can be producers, consumers, or decomposers. Students know that producers convert energy from the sun into organic matter through the process of photosynthesis. This organic matter is used by producers and consumers as food which provides the energy that fuels basic life processes. Consumers sometimes consume only or mostly other consumers as a food source. Producers and consumers produce wastes as they perform their life processes, and become waste organic matter when they die. Decomposers use these waste materials and other non living organic matter to fuel their life processes and recycle nutrients that are necessary for producers to carry out their life processes.

5.L.2.3
Students know that all of the organisms in an ecosystem have interconnected relationships. Students know that because of this, factors that impact one population within an ecosystem may impact other populations within that ecosystem.

Evolution and Genetics

Essential Standard and Clarifying Objectives

5.L.3 Understand why organisms differ from or are similar to their parents based on the characteristics of the organism.

5.L.3.1 Explain why organisms differ from or are similar to their parents based on the characteristics of the organism.
5.L.3.2 Give examples of likenesses that are inherited and some that are not.

Unpacking

What does this standard mean a child will know, understand and be able to do?

5.L.3.1

Students know that the life processes and species characteristics that define a population will be transmitted from parent to offspring. Students also know that these processes and characteristics cover a broad range of structures, functions and behaviors that can vary substantially from individual to individual.

5.L.3.2

Students know some likenesses between parents and children are inherited. Other likenesses are learned from parents or within the community (population/culture). Students know that in order for offspring to resemble their parents there must be a reliable way to transfer genetic information from parent to offspring. Students can be encouraged to keep lists of characteristics that animals and plants acquire from their parents, things that they don't, and things that the students are not sure about either way. This is also the time to start building the notion of a population whose members are alike in many ways but show some variation.

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Forces and Motion

Essential Standard and Clarifying Objectives

6.P.1 Understand the properties of waves and the wavelike property of energy in earthquakes, light and sound.

6.P.1.1 Compare the properties of waves to the wavelike property of energy in earthquakes, light and sound.
6.P.1.2 Explain the relationship among visible light, the electromagnetic spectrum, and sight.
6.P.1.3 Explain the relationship among the rate of vibration, the medium through which vibrations travel, sound and hearing.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.P.1.1
All waves transmit energy not matter. Nearly all waves travel through matter. Waves are created when a source (force) creates a vibration. Vibrations in materials set up wavelike disturbances that spread away from the source. Wave behavior can be described in terms of how fast the disturbance spreads, and in terms of the distance between successive peaks of the disturbance (the wavelength). Sound and earthquake waves are examples. These and other waves move at different speeds in different materials. Waves are moving energy. Light waves are unique in their ability to travel through a vacuum (space). Sound is a form of energy that results when vibrating materials produce waves that move through matter.

Earthquakes are vibrations in the earth that release the (potential) energy stored in rocks (due to their relative positions and consequent pressure). Earthquakes create seismic waves. Compare sound waves (longitudinal waves) to light waves (transverse waves). Energy will cause materials to vibrate. These vibrations are carried as "waves" and transfer energy. Identify the basic characteristics of a transverse wave: trough, crest, amplitude, and wavelength. Identify the basic characteristics of a longitudinal (compressional) wave: amplitude, rarefaction, and compression.

6.P.1.2
Something can be "seen" when light waves emitted or reflected by it enter the eye. Human eyes respond to only a narrow range of wavelengths of electromagnetic waves-visible light. Differences of wavelength within that range are perceived as differences of color. Light travels in

transverse waves. Light is a form of energy emitted by the Sun as well as light-producing objects on Earth. Light can be absorbed or reflected by objects depending upon the properties of the object and the type and angle of light when it hits the object. Some materials scatter light and others allow light rays to pass through, but refract the light by changing its speed.

The structure of the human eye can detect many colors in visible light that are reflected by objects. Investigate how the eye works: structures within the eye, functions of these structures in the eye. Optical illusions. Investigate conditions that impair vision.

6.P.1.3

Something can be "heard" when sound waves from it enter the ear. Sound is a form of energy that is caused when vibrating materials produce waves that move through matter. These waves have different characteristics such as frequency and amplitude, which will determine the properties of sound such as pitch and loudness.

The form of the human ear can receive sound waves as vibrations and convert them to signals that are processed by the brain. Investigate how sound travels through different solid materials. Compare how sound travels through different states of matter. Investigate how the vocal cords work to produce sound: structure of vocal cords, function of vocal cords and conditions that affect the sound vocal cords make. Investigate how the ear works: structures within the ear, functions of those structures, conditions that affect hearing.

Matter: Properties and Change

Essential Standard and Clarifying Objectives

6.P.2 Understand the structure, classifications and physical properties of matter.

6.P.2.1 Recognize that all matter is made up of atoms and atoms of the same element are all alike, but are different from the atoms of other elements.

6.P.2.2 Explain the effect of heat on the motion of atoms through a description of what happens to particles during a change in phase.

6.P.2.3 Compare the physical properties of pure substances that are independent of the amount of matter present including density, boiling point, melting point and solubility to properties that are dependent on the amount of matter present to include volume, mass and weight.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.P.2.1

Recognize that there are more than 100 elements that combine in a multitude of ways that make up all of the living and nonliving things that we encounter. Recognize that matter is composed of extremely small particles, too small to be seen with a classroom microscope, called *atoms*. Atoms have all of the properties of matter in that all atoms have mass and occupy space. Atoms are the smallest part of an element that has the chemical properties of the element. Recognize that all atoms of the same element have the same properties; i.e. all iron atoms have the same mass and occupy the same amount of space; therefore, all matter made of iron has the same properties because of the iron atoms. Also, iron atoms are different from carbon atoms or from any other element.

NOTE: It is not essential for students to know the subatomic particles, for example, protons, neutrons, and electrons, which compose atoms. Atomic models do not need to be constructed or drawn.

6.P.2.2

A substance in a: Solid phase is relatively rigid, has a definite volume and shape. The atoms that comprise a solid are packed close together and are not compressible. Because all solids have some thermal energy, its atoms do vibrate. However, this movement is very small and very rapid, and cannot be observed under ordinary conditions. When heat is added a solid can become a liquid. Liquids have a definite volume, but are able to change their shape by flowing. Liquids are similar to solids in that the particles touch. However the particles are able to move around. Since particles are able to touch the densities of liquid will be close to that of a solid (water is a special exception). Since the liquid molecules can move they will take the shape of their container. When heat is added a liquid can become a gas. Gases have no definite volume or shape. If unconstrained gases will spread out indefinitely. If confined they will take the shape of their container. This is because gas particles have enough energy to overcome attractive forces. Each of the particles are well separated resulting in a very low density. Energy appears in different forms. Heat energy is in the disorderly motion of molecules. Atoms and molecules are perpetually in motion. Increased temperature means greater average energy of motion so most substances expand when heated. Most substances can exist as a solid, liquid or gas depending on temperature.

6.P.2.3

A substance has characteristic properties such as density, a boiling point, melting point and solubility, all of which are independent of the amount of the substance and can be used to identify it. Physical properties involve things that can be measured without changing the chemical

properties. Matter can undergo physical changes which affect only physical properties. Physical changes can involve changes in energy.

Solubility means the amount of solute that can be dissolved in a specific volume of solvent under certain conditions. A solute's solubility depends on the chemical nature of the solvent. Another important factor that influences solubility is the temperature of the system (the solute and the solvent). The most common solvent is water.

Density is a property that describes the relationship between mass and volume. Investigate the physical properties of pure substances in terms of the unique temperatures at which each substance undergoes state changes. Investigate that melting and freezing of a pure substance takes place at the same temperature and the boiling temperature is the same as the maximum condensing temperature. The temperature remains constant during state changes of pure substances.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

6.P.3 Understand characteristics of energy transfer and interactions of matter and energy.

6.P.3.1 Illustrate the transfer of heat energy from warmer objects to cooler ones using examples of conduction, radiation and convection and the effects that may result.

6.P.3.2 Explain the effects of electromagnetic waves on various materials to include absorption, scattering, and change in temperature.

6.P.3.3 Explain the suitability of materials for use in technological design based on a response to heat (to include conduction, expansion, and contraction) and electrical energy (conductors and insulators).

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.P.3.1

Energy can be transferred from one system to another (or from a system to its environment) in different ways:

- thermally, when a warmer object is in contact with a cooler one

- mechanically, when two objects push or pull on each other over a distance
- electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device
- by electromagnetic waves.

Thermal energy is transferred through a material by the collisions of atoms within the material. Heat flows through materials or across space from warm objects to cooler objects, until both objects are at equilibrium. Heat travels through solids, primarily by conduction. Heat is circulated in fluids, both liquids and gases, through the process of convection. Radiation is energy that travels across distances in the form of electromagnetic waves. Over time, thermal energy tends to spread out through a material and from one material to another if they are in contact (conduction). Thermal energy can also be transferred by means of currents in air, water, or other fluids (convection).

6.P.3.2

Light and other electromagnetic waves can warm objects. How much an object's temperature increases depends on how intense the light striking its surface is, how long the light shines on the object, and how much of the light is absorbed. When light interacts with matter it is either absorbed, transmitted, refracted) and/or reflected (scattered). An example of scattering is when the sky is blue. The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of the light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of:

Visible spectrum is the portion of the electromagnetic spectrum that is visible to (can be detected by) human eyes. Electromagnetic radiation in this range of wavelengths is called visible light or simply light.

Infrared light has a longer wavelength than visible light and is detected most often by its heating effect. Infrared imaging has applications in space exploration and with satellite imaging.

Ultraviolet light has shorter wavelengths than visible light. These waves lengths are responsible for causing our sunburns. Most of these waves are blocked from entering Earth's atmosphere by the ozone but some days, more ultraviolet waves get through our atmosphere. Scientists have developed a UV index to help people protect themselves from these harmful ultraviolet waves. These are the types of waves used in tanning beds.

6.P.3.3

Thermal energy is transferred through a material by the collisions of atoms within the material. Over time, thermal energy tends to spread out through a material and from one material to another if they are in contact (conduction). Thermal energy can also be transferred by means of currents in air, water, or other fluids (convection). In addition, some thermal energy in all materials is transformed into light energy and radiated into the environment by electromagnetic waves; that light energy can be transformed back into thermal energy when the

electromagnetic waves strike another material. As a result, a material tends to cool down unless some other form of energy is converted to thermal energy in the material.

There are some things that we use daily that we want to conduct heat easily. Most of these items are made of materials that conduct heat readily: aluminum, steel, copper. We call these materials thermal conductors. Similarly, there are things that we do not want to conduct heat (pot handles, spatula, cooking utensils) and these items are generally made of materials that limit heat transfer. We call such materials thermal insulators. Expansion joint strips in bridges allow for the bridge to expand in hot weather and not break. These same joint strips allow for the bridge to contract in cold weather and not break.

Electrical energy also passes through conductors. An electrical conductor is a material through which an electrical current can flow easily. An electrical insulator is a material through which electrical current does not readily flow. Electrical conductors include most metals, while most nonmetallic solids (rubber, glass, porcelain, ceramic) are insulators.

Earth in the Universe

Essential Standard and Clarifying Objectives

6.E.1 Understand the earth/moon/sun system, and the properties, structures, and predictable motions of celestial bodies in the Universe.

6.E.1.1 Explain how the relative motion and relative position of the sun, Earth and moon affect the seasons, tides, phases of the moon, and eclipses.

6.E.1.2 Explain why Earth sustains life while other planets do not based on their properties (including types of surface, atmosphere and gravitational force) and location to the Sun.

6.E.1.3 Summarize space exploration and the understandings gained from them.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.E.1.1

The number of hours of daylight and the intensity of the sunlight both vary in a predictable pattern that depends on how far north or south of the equator the place is. This variation explains why temperatures vary over the course of the year and at different locations. The Earth's moon revolves around the Earth as both go through space and revolve around the Sun. From Earth, our moon appears in a series of phases that repeat in a regular cycle. Since the rotational period of the moon is the same as its period of revolution around the Earth, the same side of the moon is always viewed from Earth.

The moon and the Sun each exert a gravitational pull on the Earth. These gravitational forces can be aligned or in opposition to one another. These forces as well as the Earth rotation have a major impact on the Earth's ocean tides. Ocean tides follow a predictable pattern. The alignment of the Sun, Earth and Moon can produce shadows on the Earth or Moon resulting in Lunar or Solar Eclipses. Eclipses are also predictable. The Earth's north-south axis is tilted at an angle, as compared with the plane of its revolution around the Sun. The rotation of the Earth causes all parts of the Earth to experience periods of daylight and darkness. The revolution of the Earth around the Sun on its tilted axis along with its daily rotation causes varying lengths of daylight on the Earth's surface as well as changes in the directness and intensity of sunlight. This results in a yearly cycle of seasons for much of the Earth's surface. The tilt of the Earth's axis also results in the seasons being 'reversed' in the Northern and Southern hemispheres. (e.g.: winter in North America corresponds to summer in South America.)

6.E.1.2

Eight planets of very different size, composition, and surface features move around the sun in nearly circular orbits. Some planets have a variety of moons and even flat rings of rock and ice particles orbiting around them. Some of these planets and moon show evidence of geologic activity. The earth is orbited by one moon, many artificial satellites, and debris. The Solar System consists of the Sun, planets, moons, asteroids, meteors, comets, dust, gases and primarily empty space. The Sun is the major source of heat and light for the solar system. Everything in the solar system is under the direct influence of the Sun's gravitational pull. Planets are the largest objects in the solar system and due to the Sun's gravitational pull, they revolve around the sun with known frequencies. Atmosphere is a layer of air, made up of many layers and gases that surround the Earth's surface keeping humans safe from the sun's radiation. The Earth formed in just the right place with just the right ingredients for life to flourish. Our planet has liquid water, a breathable atmosphere and a suitable amount of sunshine to sustain life.

6.E.1.3

Space exploration has allowed humans to learn much about the workings of the solar system, the composition of planets and moons, and the effects of many types of solar radiation on the Earth and its inhabitants. In preparing for the challenges of space exploration, people have

developed tools and products that have become very important in enriching our lives. Humans have traveled to the moon, landed probes on Mars and Venus, and sent probes speeding past Jupiter, Saturn and Uranus. An International Space Station, through the joint effort of many countries, was built to allow space to be studied continually. We also had the Hubble Telescope built so scientists could learn much more about the uniqueness of Earth and its place in our solar system and universe. Scientists have also learned that there are millions of galaxies in space, each containing solar systems. Many of our modern conveniences such as microwaves and hand held calculators are the result of products developed for use in the space program. The Chandra X-ray Observatory is part of NASA's fleet of "Great Observatories" along with the Hubble Space Telescope, the Spitizer Space Telescope and the now de-orbited Compton Gamma Ray Observatory. Chandra allows scientists from around the world to obtain X-ray images of exotic environments to help understand the structure and evolution of the universe. Other telescopes, such as the Fermi-Gamma-ray Space Telescope has unveiled a previously unseen structure centered in the Milky Way. The feature spans 50,000 light-years and may be the remnant of an eruption from a supersized black hole at the center of our galaxy.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

6.E.2 Understand the structure of the earth and how interactions of constructive and destructive forces have resulted in changes in the surface of the Earth over time and the effects of the lithosphere on humans.

6.E.2.1 Summarize the structure of the earth, including the layers, the mantle and core based on the relative position, composition and density.

6.E.2.2 Explain how crustal plates and ocean basins are formed, move and interact using earthquakes, heat flow and volcanoes to reflect forces within the earth.

6.E.2.3 Explain how the formation of soil is related to the parent rock type and the environment in which it develops.

6.E.2.4 Conclude that the good health of humans requires: monitoring the lithosphere, maintaining soil quality and stewardship.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.E.2.1
The earth is composed – primarily- of rock. Three-fourths of the earth's surface is covered by a relatively thin layer of water (some of it frozen), and the entire planet is surrounded by a relatively thin layer of gas we call the atmosphere. The Earth has a solid inner core that is surrounded by a liquid outer core. The inner core is a solid section of the Earth and is unattached to the mantle, being suspended by the molten outer core. The inner core is predominantly iron metal with significant amounts of the element nickel. This inner layer in mutual combination with the rotational motion of the Earth creates a dynamo effect where a force field is generated. This field is also known as Earth's magnetic field. In terms of the physical aspects of the outer core, the layer is dense but not as dense as pure molten iron. Surrounding the entire dense, metallic core is a thick, hot, convective layer called the mantle. The crust consists of many continental and oceanic plates that have slowly moved and changed positions on the globe throughout geologic time.

6.E.2.2
The earth's plates sit on a dense, hot, somewhat melted layer of the earth. The plates move very slowly, pressing against one another in some places and pulling apart in other places, sometimes scraping alongside each other as they do. Mountains form as two continental plates, or an ocean plate and a continental plate, press together. There are worldwide patterns to major geological events (such as earthquakes, volcanic eruptions, and mountain building) that coincide with plate boundaries. Lithospheric plates on the scale of continents and oceans constantly move at rates of centimeters per year as a result of movements in the mantle coupled with characteristics of the plates themselves. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions. The crustal plates range in thickness from a few to more than 100 kilometers. Ocean floors are the tops of thin oceanic plates that spread outward from mid-ocean rift zones; land surfaces are the tops of thicker, less-dense continental plates. Earth is made up of 4 different layers: inner core, outer core, mantle, crust. Seismologists have studied how wave energy travels through the different layers of Earth. Waves have characteristics: frequency, wavelength, amplitude and speed. During an earthquake, energy is released into the Earth as: Primary waves, Secondary waves and Surface waves.

6.E.2.3
Although weathered rock is the basic component of soil, the composition and texture of soil and its fertility and resistance to erosion are greatly influenced by plant roots and debris, bacteria, fungi, worms, insects, rodents, and other organisms. The upper-most layer of the continental crust is covered by soil. The ingredients in soils can vary from place to place and around the Earth. Different soils have many properties such as texture, particle size, pH, fertility and ability to hold moisture. Depending upon the combination of properties, soils have great variability in

their ability to support structures and plant growth. Forces deep inside Earth and at the surface produce a slow cycle that builds, destroys, and changes the rocks in the crust. Plate movements start the rock cycle by helping to form magma, the source of igneous rocks. Plate movements also cause faulting, folding and other motions of the crust that help to form sedimentary and metamorphic rock. Minerals form as hot magma cools inside the crust, or as lava hardens on the surface. When these liquids cool to a solid state, they form crystals. When elements and compounds that are dissolved in water leave a solution, crystallization of minerals occurs. Soil is a mixture of: rock particles, minerals, decayed organic matter, water and air. Soil forms as rock is broken down by weathering and mixes with other materials on the surface.

6.E.2.4
The environment may contain dangerous levels of substances that are harmful to human beings. Therefore, the good health of individuals requires monitoring the soil, air, and water and taking steps to make these factors safe for all organisms. Evaluate ways in which human activities have affected Earth's pedosphere and the measures taken to control the impact: vegetative cover, agriculture such as (contour plowing, conservation plowing), land use, nutrient balance (crop rotation), soil as a vector. Technology, such as remote sensing, has allowed humans to better study the human impact on soil quality and erosional processes so that the soil can be protected and preserved. Over time, remote sensing information can tell us how humans are constantly changing the surface of the Earth and what impact these changes are likely to produce. Technologies can also assist in finding ways to help prevent erosion. It is important that humans be stewards of the pedosphere.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

6.L.1 Understand the structures, processes and behaviors of plants that enable them to survive and reproduce.

6.L.1.1 Summarize the basic structures and functions of flowering plants required for survival, reproduction and defense.

6.L.1.2 Explain the significance of the processes of photosynthesis, respiration and transpiration to the survival of green plants and other organisms.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.L.1.1
Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food and reproduce. The process of sexual reproduction in flowering plants takes place in the flower, which is a complex structure made up of several parts. Some parts of the flower are directly involved in fertilization and seed production. Other flower parts have functions in pollination. A flower is made up of six parts: petals-are leaf like, usually colorful structures arranged in a circle around the top of a flower stem. Sepals are modified leaves that encase the developing flower. They are sterile floral parts and may be either green or leaf like or composed of petal like tissue. Inside the circle of petals are the stamens. A stamen is the male reproductive structure of a flower. At the tip of the stamen is the anther. The anther produces pollen that contains sperm. At the center of the flower, attached to the top of the flower stem lie one or more pistils. The pistil is the female structure of the flower. The bottom portion of the pistil enlarges to form the ovary, a structure with one or more ovules, each containing one egg. When fertilization occurs the ovary grows into the fruit or vegetable. The length of night or dark period controls flowering.

6.L.1.2
One of the most general distinctions among organisms is between plants, which use sunlight to make their own food (photosynthesis) and animals, which consume energy-rich foods. Photosynthesis and cellular respiration are complementary processes. Plants carry on photosynthesis and cellular respiration where food is broken down into energy. The requirements of one process are the products of the other.

Photosynthesis	**Cellular Respiration**
Food accumulated	Food broken down
Energy from sun stored in glucose	Energy of glucose released
Carbon dioxide taken in	Carbon dioxide given off
Oxygen given off	Oxygen taken in
Produces glucose	Produces carbon dioxide and water
Goes on only in light	Goes on day and night
Occurs only in the presence of chlorophyll	Occurs in all living cells

Leaves have an epidermis with a waxy cuticle and stomata that help prevent water loss. Guard cells that surround and control the size of the opening in stomata. The loss of water through the stomata is called transpiration. The opening and closing of guard cells regulate transpiration.

Ecosystems

Essential Standard and Clarifying Objectives

6.L.2 Understand the flow of energy through ecosystems and the responses of populations to the biotic and abiotic factors in their environment.

6.L.2.1 Summarize how energy derived from the sun is used by plants to produce sugars (photosynthesis) and is transferred within a food chain or food web (terrestrial and aquatic) from producers to consumers to decomposers.

6.L.2.2 Explain how plants respond to external stimuli (including dormancy and forms of tropism) to enhance survival in an environment.

6.L.2.3 Summarize how the abiotic factors (such as temperature, water, sunlight, and soil quality) of biomes (freshwater, marine, forest, grasslands, desert, Tundra) affect the ability of organisms to grow, survive and/or create their own food through photosynthesis.

Unpacking

What does this standard mean a child will know, understand and be able to do?

6.L.2.1

Food provides molecules that serve as fuel and building material for all organisms. Plants use the energy from light to make sugars from carbon dioxide and water. Green plants are the producers of food that is used directly or indirectly by consumers. Plants can use the food they make immediately or store it for later use. Energy flows through ecosystems in one direction, from the sun through producers to consumers to decomposers. Matter is transferred from one organism to another and between organisms and their environments. Water, nitrogen, carbon dioxide, and oxygen are substances cycled between the living and non-living environments. Investigate how decomposers return nutrients to the environment—such as fungi on fallen logs, mold on bread. Explore the importance and role of bacteria in the guts of animals and plant roots at it relates to the recycling of matter.

6.L.2.2
Changes in environmental conditions can affect the survival of individual organisms and entire species. Dormancy is a period of inactivity in a mature seed prior to germination; seed remains dormant until conditions are favorable for growth and development of the new plant. Plants have mechanisms that enable them to respond to their environment. Plants grow, reproduce, and shift the position of their roots, stems and leaves in response to environmental conditions such as gravity, sunlight, temperature and day length. Tropism is a plant's turning or bending movement of an organism toward or away from an external stimulus such as light, heat or gravity. If the tropism is positive, the plant grows toward the stimulus. If the tropism is negative, the plant grows away from the stimulus. This enhances the survival rate for that plant in a given environment.

6.L.2.3
The world contains a wide diversity of physical conditions, which creates a wide variety of environments: freshwater, marine, forest, desert, grasslands, mountain, and others. In any particular environment, the growth and survival of organisms depend on the physical conditions. Environmental factors that affect an organism's ability to survive in its environment, such as food availability, predators, and temperature, are limiting factors. A limiting factor is any biotic or abiotic factor that restricts the existence, number, reproduction, or distribution of organisms. For example, at high elevations, temperatures are too low, winds too strong and the soil too thin to support the growth of large trees. Vegetation is limited to small, shallow-rooted plants, mosses, ferns and lichen. Factors that limit one population in a community may also have an indirect effect on another population. For example, a lack of water could limit the growth of grass in a grassland, reducing the number of seeds produced. The population of rabbits dependent on those seed for food will also be reduced and the hawks depending on the rabbits will be reduced too as a result of a decrease in their food supply. Another factor for survive is the ability of an organism to withstand fluctuations in biotic and abiotic environmental factors. The limits of an organism's tolerance are reached when the organism receives too much or too little of some environmental factor. Organisms become fewer as conditions move toward either extreme of the range of tolerance (too much or too little).

North Carolina Department of Public Instruction
INSTRUCTIONAL SUPPORT TOOLS
FOR ACHIEVING NEW STANDARDS

This document is designed to help North Carolina educators teach the Essential Standards (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

Essential Standards: Grade 7 Science ● Unpacked Content

For the Essential Standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

How do I send Feedback?
We intend the explanations and examples in this document to be helpful and specific. That said, we believe that as this document is used, teachers and educators will find ways in which the unpacking can be improved and made ever more useful. Please send feedback to us at feedback@dpi.state.nc.us and we will use your input to refine our unpacking of the standards. Thank You!

Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/6-8.pdf .

Forces and Motion

Essential Standard and Clarifying Objectives

7.P.1 Understand motion, the effects of forces on motion and the graphical representations of motion.

7.P.1.1 Explain how the motion of an object can be described by its position, direction of motion, and speed with respect to some other object.

7.P.1.2 Explain the effects of balanced and unbalanced forces acting on an object (including friction, gravity and magnets).

7.P.1.3 Illustrate the motion of an object using a graph to show a change in position over a period of time.

7.P.1.4 Interpret distance versus time graphs for constant speed and variable motion.

Unpacking

What does this standard mean a child will know, understand and be able to do?

7.P.1.1

The motion of an object is always judged with respect to some other object or point. When an object changes position over time relative to a reference point, the object is in motion. Motion can be described with a reference direction such as North, South, East, West, up or down. The speed of an object is a measure of how quickly the object gets from one place to another.

7.P.1.2

An unbalanced force acting on an object changes its speed or direction of motion, or both. The change in motion (direction or speed) of an object is proportional to the applied force and inversely proportional to the mass. All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion. Friction is a force that opposes motion between two surfaces that are in contact. The amount of friction depends on factors such as the roughness of the surfaces and the force pushing the surfaces together. Newton's law describes the relationship between gravitational force, mass, and distance. An object will not start moving until a force acts upon it. An object will stay in motion forever unless an unbalanced force acts upon it. Inertia is the tendency of objects to resist any change in motion. Likewise, inertia is the reason a moving object stays in motion with the same velocity unless a force changes its speed or direction or both. *Note: Newton's Laws should not be memorized at this age. Rather, the principles which underpin the Laws ought to be well*

conceptualized and applied.

7.P.1.3
When an object changes position over time relative to a reference point, the object is in motion. You can describe the direction of motion with a reference direction such as north, south, east, west, up or down. Collect and organize data to show how the motion of an object changes in position over a period of time. Communicate and graph data showing how the motion of an object changes in position over a period of time.

7.P.1.4
Students should collect and organize their own data for graphing distance versus time. Graphs for constant speed and variable motion. Students will interpret prepared graphs for distance versus time for constant speed and variable motion.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

7.P.2 Understand forms of energy, energy transfer and transformation and conservation in mechanical systems.

7.P.2.1 Explain how kinetic and potential energy contribute to the mechanical energy of an object.
7.P.2.2 Explain how energy can be transformed from one form to another (specifically potential energy and kinetic energy) using a model or diagram of a moving object (roller coaster, pendulum, or cars on ramps as examples).
7.P.2.3 Recognize that energy can be transferred from one system to another when two objects push or pull on each other over a distance (work) and electrical circuits require a complete loop through which an electrical current can pass.
7.P.2.4 Explain how simple machines such as inclined planes, pulleys, levers and wheel and axels are used to create mechanical advantage and increase efficiency.

Unpacking

What does this standard mean a child will know, understand and be able to do?

7.P.2.1
Mechanical energy is the energy possessed by an object due to its motion or its stored energy of position. Mechanical energy can be either kinetic (energy of motion) or potential (energy of position). An object that possesses mechanical energy is able to do work. Mechanical energy is the form involved in the operation of simple machines.

7.P.2.2
Objects that have potential energy do not use their energy until they move. That is why it is called "potential" energy. Potential means that something is capable of becoming active. Any object that can move to a lower place has the potential to do work on the way down, such as a marble rolling down a driveway. Objects also store energy in motion. A moving mass can certainly exert forces, as you would quickly observe if someone ran into you during a basketball game. Energy of motion is called kinetic energy. Energy appears in different forms, such as motion and heat. Energy can travel in different forms, such as light, sound or electricity. The workings of the universe plus all of present day technology can be viewed from the perspective of energy flowing from one place to another and changing back and forth from one form to another.

7.P.2.3
Energy can be transferred from one system to another (or from a system to its environment) in different ways: 1) thermally, when a warmer object is in contact with a cooler one; 2) mechanically, when two objects push or pull on each other over a distance; 3) electrically, when an electrical source such as a battery or generator is connected in a complete circuit to an electrical device; or 4) by electromagnetic waves. Energy is one of the fundamental building blocks of our universe. Energy can change from one form to another, although in the process some energy is always converted to heat. Some systems transform energy with less loss of heat than others. Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy. Batteries store energy and transfer energy to components in a circuit. In the battery the energy comes from chemical reactions. Electricity is important because we can use it to make so many things work (electrical energy). For example, a bulb converts electrical energy into light energy and a speaker converts it into sound energy. The electrical energy generated by windmills, waterfalls and power plants is actually a secondary source of energy. To produce electricity, a heat source is needed to create the conditions in which electrical currents form. In effect, the primary source of electrical energy is the heat generated by burning fossil fuels, water power and wind power. A natural form of electrical energy can be seen in the lightning that appears during storms. Solar energy, water and wind power are sources of green energy—meaning they do not pollute the environment. *Note: It is not necessary to investigate nuclear energy.*

7.P.2.4
A machine is a device that makes work easier by changing the size or direction of a force. When you use a machine, you do the work on the machine, and the machine does the work on something else. Mechanical advantage is the number of times the machine multiplies force. Ideal Mechanical Advantage (IMA) is what is desired of a machine, where Actual Mechanical Advantage (AMA) is what the machine actually does. A lever is a simple machine that has a bar that pivots at a fixed point called a fulcrum. A pulley is a simple machine that consists of a wheel over which a rope, chain, or wire passes. A simple machine that consists of two circular objects of different sizes is known as a wheel and axle. The mechanical advantage of a wheel and axle is the radius of the wheel divided by the radius of the axle. A simple machine that is a straight, slanted surface, and facilitates the raising of loads is an inclined plane. A compound machine consists of two or more simple machines put together. In fact, most machines are compound machines. Some examples are a pair of scissors and a bicycle.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

7.E.1 Understand how the cycling of matter (water and gases) in and out of the atmosphere relates to Earth's atmosphere, weather and climate and the effects of the atmosphere on humans.

7.E.1.1 Compare the composition, properties and structure of Earth's atmosphere to include mixtures of gases and differences in temperature and pressure within layers.

7.E.1.2 Explain how the cycling of water in and out of the atmosphere and atmospheric conditions relate to the weather patterns on earth.

7.E.1.3 Explain the relationship between the movement of air masses, high and low pressure systems, and frontal boundaries to storms (including thunderstorms, hurricanes, and tornadoes) and other weather conditions that may result.

7.E.1.4 Predict weather conditions and patterns based on information obtained from:

- Weather data collected from direct observations and measurement (wind speed and direction, air temperature, humidity and air pressure).
- Weather maps, satellites and radar

- Cloud shapes and types and associated elevation

7.E.1.5 Explain the influence of convection, global winds and the jet stream on weather and climatic conditions.

7.E.1.6 Conclude that the good health of humans requires: monitoring the atmosphere, maintaining air quality and stewardship.

Unpacking

What does this standard mean a child will know, understand and be able to do?

7.E.1.1

The earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind, over time in a particular place. The atmosphere is a mixture of gases, such as nitrogen (78%), oxygen (21%), argon (0.93%), carbon dioxide (0.04%), trace gases and water vapor. The amount of each gas in the mixture is usually very constant from the surface of the planet up to the top of the troposphere. These gases are constantly being used and renewed by the processes of respiration, photosynthesis, evaporation and condensation, the weathering of rock, and the decay of organic matter. The atmosphere has different properties at different elevations and different locations around the Earth. Air pressure, also known as atmospheric pressure, refers to the weight of the Earth's atmosphere pressing down on everything at the surface. Air pressure varies slightly over the Earth's surface, and variations in pressure are responsible for the weather. Low pressure is associated with storms, tornadoes, and hurricanes. High pressure is associated with clear and dry conditions. The air pressure is less on the top of mountains (higher elevation) than in valleys. At the equator the atmosphere is warmer; at the poles it is cooler. The uneven heating of land and water causes a rising and sinking of warm and cool air masses creating convection currents and causes winds. Five layers make up the atmosphere: the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. Each of these layers has very unique properties. Weather occurs in the troposphere and is the physical condition of the atmosphere at a specific place at a specific time. Fronts, global wind systems, atmospheric pressure changes and many other factors influence the weather. Major atmospheric activities such as thunderstorms, tornadoes and hurricanes affect humans and can result in huge natural disasters. Air has weight. Air molecules are in constant motion and are affected by gravity. The force of this movement causes air pressure. Air pressure changes with elevation. As you move up into the atmosphere, the air molecules are further apart. So, air pressure decreases as distance above the surface increases. Air pressure also decreases as the amount of water vapor in the air goes up. Since warm air is less dense than cool air, when temperatures are higher, the air pressure is usually lower. Air pressure is measured with a mercury barometer (mm of mercury) or and aneroid barometer (millibars-mb). The atmosphere has constant change but strives to maintain equilibrium.

7.E.1.2

Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. The water falling on land collects in rivers and lakes, soil, and porous layers of rock, and much of it flows back into the oceans. The cycling of water in and out of the atmosphere is a significant aspect of the weather patterns on Earth. Sunlight provides the energy that evaporates water from the surface of Earth. Some of the water vapor comes from the continents, but most comes from the oceans. Winds carry the water vapor from the ocean over the continents. Part of the water vapor condenses into clouds, then falls as rain or snow. Some of the rain returns to the ocean from rivers and streams as runoff. Some seeps into the ground to become groundwater. Some returns to the air by evaporation from the ground or by transpiration from plant leaves. When runoff from the continents returns to the ocean, one turn of the water cycle is completed. Other routes are possible. For example, water that evaporates from the ocean can return to the ocean as rain. The water cycle never ends. The salt water of the ocean supplies fresh water to the continents over and over again. Weather is the state of the atmosphere at a given time and place. A complete description of the weather includes the amount and type of clouds. Rain, snow, thunderstorms, lightning, and even dust storms are part of the weather. Measurements of temperature, air pressure, wind speed and direction, and the amount of moisture in the air are also included in a description of the weather. Weather is studied and predicted by scientists called Meteorologists. The science of meteorology is the study of the entire atmosphere, including the weather. To understand and predict the weather, meteorologist must first understand how the atmosphere heats and cools, how clouds form and produce rain, and what makes the wind blow.

7.E.1.3

An air mass is a large section of the lower troposphere that has the same weather throughout. Air masses can form over continents, icecaps or the ocean. Air masses are controlled by patterns of heating and cooling over large areas of the Earth's surface. Changes in air pressure readings indicate the passing of high and low pressure systems. Differences in air pressure cause Earth's winds and weather changes. Storms are natural disturbances in the atmosphere that involve air pressure, clouds, precipitation, and strong winds. The major types of storms are thunderstorms, hurricanes, tornadoes, and winter storms. Each type has its own characteristics and dangers. Tornadoes are violently whirling winds sometimes visible as a funnel-shaped cloud. They are produced by severe thunderstorms. Spiraling high winds and extremely low pressure are the unique features of tornadoes. Thunderstorms are known as electrical storms. A thunderstorm is characterized by the presence of lightning and thunder. They are produced rapidly when rising air causes cumulus clouds to build upward into a thunderhead. The cloud type associated with thunderstorms are cumulonimbus. Thunderstorms are usually accompanied by strong winds, heavy rain and sometimes snow, hail or no precipitation at all. Thunderstorms are brief, intense storms that affect a small area. Hurricanes are huge, rotating storms that form over the ocean near the equator. They produce very strong winds, heavy rains, and large, powerful waves and can cause severe flooding and damage from strong winds. Floods occur when an area is inundated with water. Weather related flooding is most often associated with hurricanes and thunderstorms. Winter storms are associated with quickly moving cold fronts and they can produce high winds, very low

temperatures plus include blizzards, ice storms and large accumulations of snow.

7.E.1.4
The earth has a variety of climates, defined by average temperature, precipitation, humidity, air pressure, and wind, over time in a particular place. Weather forecasting is an attempt to make accurate predictions of future weather. The accuracy of weather prediction is improving as technology advances. A weather map is useful for making predictions. Weather maps usually show precipitation, wind direction, temperature, cloud cover, high or low pressure, cold and warm fronts, stationary and occluded fronts. Weather systems generally move from west to east across the USA. Long rang weather forecasting is more difficult than short-range weather predictions. Technologies such as computer, satellite images and radar enable forecasters to track movements of large-scale weather systems like air masses and fronts. Weather data collection results from using direct observations and measurements such as wind speed, wind direction, air temperature, humidity and air pressure. Wind direction can be shown by flags or blowing dust. The actual wind speed can be estimated by observing its affects. Temperature is a measure of the energy of molecules. The more energy the molecules in air have, the hotter it feels. Relative humidity compares the actual amount of water vapor in the air with the maximum amount of water vapor the air can hold at that temperature (its capacity). Differences in air pressure cause Earth's winds and weather changes. Air pressure is simply the weight of the atmosphere per unit area. Air pressure is directed equally in all directions. Clouds have three simple names: Cirrus, Stratus, and Cumulus. These three names represent the three main cloud types. Cirrus clouds are high level clouds and due to high altitude, the water is almost frozen to form ice crystals. If there are isolated Cirrus clouds, they do not indicate any instability in the weather and may not bring rain. However, if the clouds are dense, they often indicate that a storm might be approaching. Both Stratus clouds and Cumulus clouds are low-level. Stratus clouds are layered clouds that usually bring a drizzle and there is widespread rain and in some cases ocean air. Cumulus clouds are neutral weather clouds. All the other clouds are combinations or variations of these types. Technology has greatly influenced the ease and accuracy of making weather predictions. Weather data at thousands of locations can be gathered instantaneously and applied to weather prediction models to produce weather maps. A cold front is the leading edge of a cooler air mass of air, replacing at ground level a warmer mass of air. The cooler, denser air wedges under the less-dense warmer air, lifting it. The upward motion causes lowered pressure along the cold front and can cause the formation of a narrow line of showers and thunderstorms when enough moisture is present. On weather maps, the surface position of the cold front is marked with the symbol of a blue line of triangles/spike pointing in the direction it is traveling. Cold fronts can move up to twice as fast as warm front and can produce sharper changes in the weather. Cold fronts are usually associated with an area of high pressure. A warm front is the leading edge of a warm air mass that displaces colder air, bringing a temperature increase and heavy rain where the front makes contact with the ground. On a weather map a warm front is represented by a solid line with semicircles pointing towards the colder air and in the direction of the movement. On a colored weather map, a warm front is drawn with a solid red line.

7.E.1.5
Thermal energy carried by ocean currents has a strong influence on climates around the world. Areas near oceans tend to have more moderate temperatures than they would if they were farther inland but at the same latitude because water in the oceans can hold a large amount of thermal energy. Changes in weather involve air movements, formation of clouds, and precipitation. Energy is needed to make all these things happen. That energy comes from the sun. Convection is very important in moving heat through the atmosphere and the oceans. It transfers heat from one place to another. All winds result from uneven heating of the atmosphere. An island, is surrounded by cool water. During the day, the island heats faster than the water and so the air above the island becomes warmer. The molecules in the air become farther apart; so the air expands upward and outward. This expansion lowers the air pressure at the island's surface. The cooler ocean air moves in toward the low-pressure area over the island. There is a pressure gradient between the ocean and the island. The wind moves form high to low pressure. The speed of the wind depends on the pressure gradient. The lower the pressure (the hotter the island), the steeper the pressure gradient and the stronger the wind. The pressure gradient provides the force that makes the wind blow. This force is called the pressure-gradient force. Wind speeds are very high in the upper troposphere. It is here that the spectacular jet stream is found. Jet streams are a fairly narrow zone of very strong winds in the upper troposphere. Jet streams are most common in the middle latitudes, so the winds in the jet streams are usually from the west. Winds are also influenced by the Coriolis effect, which is due to the Earth rotating on its axis. Rather than flowing directly from areas of high pressure to low pressure, as they would on a non-rotating planet, winds and currents tend to flow to the right of this direction north of the equator, and to the left of this direction south of the equator. This effect is responsible for the rotation of large cyclones. The Gulf Stream is a powerful, warm surface current in the North Atlantic Ocean. It is one of the strongest know currents. As the Gulf Stream reaches Cape Hatteras, North Caroling the cold current that flows from the north separates it from the coast. When the warm Gulf Stream waters from the south (Florida) combine with the cold winds a dense concentration of fog forms along with an immense heat transfer causing atmospheric storms to intensify in this region.

7.E.1.6
Air quality affects the quality of life for all organisms on Earth. Natural and human activities greatly influence the quality of the air. The environment may contain dangerous levels of substances that are harmful to human beings. Therefore, the good health of individuals requires monitoring the soil, air, and water and taking steps to make them safe. Air quality affects the quality of life for all organisms on Earth. Natural and human activities greatly influence the quality of the air. Technology has allowed us to measure the characteristics of the air and to monitor how air quality changes. This information helps us to make informed decisions to protect air quality and risks to human health and other organisms. The cumulative ecological effects of global ozone depletion, air pollution, increased particulate matter, acid rain, and global

warming concern the entire global community. Studies have shown that the human impact on these factors has impacted the global system. Using less fossil fuel is the best way to improve air quality. Most forms of transportation and many industries produce carbon dioxide and add particles to the air and reduce the quality of the atmosphere. The burning of fossil fuels is the major cause of air pollution. Smog is a colloid of smoke, fog, and chemicals. Many areas have smog problems. Smog irritates the lungs. The burning of fossil fuels releases large amounts of carbon dioxide and other gases into the air. Some of these gases mix with water vapor and then form acid rain. Acid rain is harmful to both living and non-living things. Natural events also release pollutants such as forest fires, volcanic eruptions and plant pollen. Because air pollutants are often carried along by prevailing winds, acid rain may fall far from the source of pollution. Laws exist to help control and reduce air pollution. The Environmental Protection Agency (EPA) provides daily information about air quality. Local weather channels also issue information related to the health of the atmosphere. Air pollution does not consist entirely of man-made substances. Many pollutants are released directly from natural sources, and some pose as much of a health hazard as man-made substances. These "natural" pollutants include radon, pollen and mold spores. Others are dust from plowed fields and volcanic eruptions. These eruptions could create situations where planes could not fly.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

7.L.1 Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.

7.L.1.1 Compare the structures and life functions of single-celled organisms that carry out all of the basic functions of life including:

- Euglena
- Amoeba
- Paramecium
- Volvox

7.L.1.2 Compare the structures and functions of plant and animal cells, including major organelles (cell membrane, cell wall, nucleus, chloroplasts, mitochondria, and vacuoles).

7.L.1.3 Summarize the hierarchical organization of multi-cellular organisms from cells to tissues to organs to systems to organisms.

7.L.1.4 Summarize the general functions of the major systems of the human body (digestion, respiration, reproduction, circulation, and excretion) and ways that these systems interact with each other to sustain life.

Unpacking

What does this standard mean a child will know, understand and be able to do?

7.L.1.1

Within cells, many of the basic functions of organisms—such as extracting energy from food, getting rid of waste, movement and secreting waste—are carried out. The way in which cells function is similar in all living organisms. Even the simplest organisms have parts which enable them to move, take in food, to reproduce and to detect the environment they are in. Euglena-moves by a flagellum, know for a unique feature-- an eye spot, some contain chlorophyll and are common in fresh water. The amoeba moves by cytoplasmic streaming, surrounds food and engulfs it using pseudopods. Paramecium is the most complex and specialized of the protists. It moves by cilia. Volvox is a colony of ciliates, some containing chlorophyll.

7.L.1.2

All living things are composed of cells, from just one to many millions, whose details usually are visible only through a microscope. A cell is the smallest part of any living thing. There are many parts of a cell. Each part of a cell completes a certain function for the cell.
These parts are found in plant and animal cells.

- Cell Membrane - forms the outer boundary of the cell and allows only certain materials to move into or out of the cell
- Cytoplasm - a gel-like material inside the cell; it contains water and nutrients for the cell
- Nucleus - directs the activity of a cell; it contains chromosomes with the DNA
- Nuclear Membrane - separates the nucleus from the cytoplasm
- Mitochondria - break down food and release energy to the cell
- Vacuoles - are storage areas for the cell

Some organelles are found only in Plant cells. These organelles are:

- Cell Wall - provides structure to the plant cell
- Chloroplasts - contain chlorophyll that is make food for the plant cell

7.L.1.3
Different body tissues and organs are made up of different kinds of cells. The cells in similar tissues and organs in other animals are similar to those in human beings but differ somewhat from cells found in plants. Important levels of organization for structure and function include cells, tissues, organs, organ systems, whole organisms and ecosystems. Specialized cells perform specialized functions in multi-cellular organisms. Groups of specialized cells cooperate to form a tissue, such as muscle. Different tissues are in turn grouped together to form larger functional units, called organs. Organs group together to form systems and systems group together to form organisms. Each type of cell, tissue, organ, organ system has a distinct structure and functions that serve the organism as a whole.

7.L.1.4
To burn food for the release of energy stored in it, oxygen must be supplied to cells, and carbon dioxide removed. Lungs take in oxygen for the combustion of food and eliminate the carbon dioxide produced. The urinary system disposes of dissolved waste molecules, the intestinal tract removes solid wastes, and the skin and lungs aid in the transfer of thermal energy from the body. The circulatory system moves all these substances to or from cells where they are needed or produced, responding to changing demands. The human body has a set of systems, which regulate the internal environment and strive to give our cells the necessary conditions they need to function. These systems are made up of organs; each organ system functions in the human body and works in cooperation with other systems to benefit the entire organism. The skeletal system provides the support for movement and protection of internal organs. The muscular system creates the force that enables the body to move and carry out different functions related to movement. The body's circulatory, respiratory, digestive and urinary systems work in combination to supply all cells with what they need to function properly and remove wastes. The reproductive system enables the organism to make more of its kind. The immune system protects cells from microscopic invaders. The nervous system controls body processes by using electrical impulses via a network of nerves. The endocrine system uses chemical messages called hormones, which are released into the blood and regulate many bodily processes. The endocrine and nervous systems are two control systems that keep the body in balance (homeostasis). Body systems work together in maintaining a constant internal environment. When the balance is disrupted, the body systems may not function properly and human health can suffer.

Evolution and Genetics

Essential Standard and Clarifying Objectives

7.L.2 Understand the relationship of the mechanisms of cellular reproduction, patterns of inheritance and external factors to potential variation and survival among offspring.

7.L.2.1 Explain why offspring that result from sexual reproduction (fertilization and meiosis) have greater variation than offspring that result from asexual reproduction (budding and mitosis).

7.L.2.2 Infer patterns of heredity using information from Punnett squares and pedigree analysis.

7.L.2.3 Explain the impact of the environment and lifestyle choices on biological inheritance (to include common genetic diseases) and survival.

Unpacking

What does this standard mean a child will know, understand and be able to do?

7.L.2.1

In some kinds of organisms, all the genes come from a single parent. In organisms that have two sexes, typically half of the genes come from each parent. In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male. Budding is a type of asexual reproduction in which a cell or group of cells pinch off from the parent to form a new individual. Mitosis is a type of asexual reproduction is when a nucleus undergoes cell division in which two daughter cells are formed, each containing a complete set of chromosomes. Meiosis is a type of sexual reproduction. A form of cell division that allows offspring to have the same number of chromosomes as their parent. This kind of cell division, which produces gametes (sex cell) containing half the number of chromosomes as a parent's body cell, is called meiosis. Fertilization is a type of sexual reproduction where there is a fusion of male (sperm) and female (egg) sex cells. Genetics explains why you have inherited certain traits from your parents. If you understand how meiosis occurs, you can see how these traits were passed on to you. A gene is a segment of DNA that controls the protein production and the cell cycle. Chromosomes are cell structures that carry the genetic material that is copied and passed from generation to generation of cells. People have noticed for thousands of years that family resemblances were inherited from generation to generation so characteristics that are inherited are called traits. A dominant trait is an observable trait of an organism that masks the recessive form of a trait. A recessive trait of an organism can be masked by the dominant form of a trait. Two organisms can look alike but have different underlying gene combinations. The way an organism looks and behaves makes up its phenotype. The phenotype of a tall plant is tall, regardless of the genes it contains. The gene combination an organism contains is known as it genotype. You cannot always know an organism's genotype simply by looking at its phenotype. New varieties of

cultivated plants and domestic animals have resulted from selective breeding for particular traits. In sexual reproduction, a single specialized cell from a female merges with a specialized cell from a male. In some kinds of organism, all the genes come from a single parent. In organisms that have two sexes, typically half of the genes come from each parent. The fertilized egg cell, carrying genetic information from each parent, multiplies to form the complete organism. Cultivated plants are plants that have been changed somewhat to promote survival in different conditions due to intentional human activity. Agriculture, forestry and horticulture use these cultivated plants.

7.L.2.2

A pedigree is a diagram of family relationships that uses symbols to represent people and lines to represent genetic relationships. These diagrams make it easier to visualize relationships within families. Pedigrees are often used to determine the mode of inheritance (dominate, recessive, etc.) of genetic diseases. A Punnett Square is a chart wherein all possible gene combinations are shown in a cross of parents. Reginald Punnett was an English Geneticist who discovered some very basic principles of genetics including the determination of sex and linkage. His work involved using the color characteristics of a chicken's feathers, efficiently separating the female gender of the chicken from the male. In plants, a tall plant is considered dominant over a short plant. In using Punnett Squares, you can easily predict genotype and phenotypes of any offspring.

7.L.2.3

Individual organisms with traits conducive to the environment's stressors are more likely than others to survive and have offspring. Changes in environmental conditions can affect the survival of individual organisms and entire species. Analysis of the patterns of genetic traits enhances the understanding of genetic diseases and allows for predictions to be made by studying pedigrees. Some traits are inherited and others result from interactions with the environment, life style choices, and environmental influence human characteristics that may or may not be passed on to future generations. Some animal species are limited to a repertoire of genetically determined behaviors; other have more complex brains and can learn and modify a wide variety of behaviors. All behavior is affected by both inheritance and experience. The length and quality of human life are influenced by many factors, including sanitation, diet, medical care, sex, genes, environmental conditions, and personal health behaviors. Faulty genes can cause body parts or systems to work poorly. Some genetic diseases appear only when an individual has inherited a certain faulty gene from both parents.

North Carolina Department of Public Instruction
INSTRUCTIONAL SUPPORT TOOLS
FOR ACHIEVING NEW STANDARDS

This document is designed to help North Carolina educators teach the Essential Standards (Standard Course of Study). NCDPI staff are continually updating and improving these tools to better serve teachers.

Essential Standards: Grade 8 Science ● Unpacked Content
For the Essential Standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

How do I send Feedback?
We intend the explanations and examples in this document to be helpful and specific. That said, we believe that as this document is used, teachers and educators will find ways in which the unpacking can be improved and made ever more useful. Please send feedback to us at feedback@dpi.state.nc.us and we will use your input to refine our unpacking of the standards. Thank You!

Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/6-8.pdf .

Matter: Properties and Change

Essential Standard and Clarifying Objectives

8.P.1 Understand the properties of matter and changes that occur when matter interacts in an open and closed container.

8.P.1.1 Classify matter as elements, compounds, or mixtures based on how the atoms are packed together in arrangements.

8.P.1.2 Explain how the physical properties of elements and their reactivity have been used to produce the current model of the Periodic Table of elements.

8.P.1.3 Compare physical changes such as size, shape and state to chemical changes that are the result of a chemical reaction to include changes in temperature, color, formation of a gas or precipitate.

8.P.1.4 Explain how the idea of atoms and a balanced chemical equation support the law of conservation of mass.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.P.1.1

Students know:

- **the structure of the atom:**
  - that it is composed of extremely small particles that are too small to be seen with an optical microscope and that size at the atomic level is measured on the nanoscale.
  - that there are three basic particles in the atom (proton, neutron, and electron).

- **that the atom is the basic building block of matter, that a single atom has mass and takes up space, and that all matter is composed of atoms.** Students know that each of the elements has distinct properties and a distinct atomic structure. All forms of matter are composed of one or more of the elements. Students recognize that scientists have identified more than 100 elements that combine in a multitude of ways to produce compounds that make up all living and nonliving things.

- **that an atom is the smallest unit of an element and that a compound is composed of two or more elements chemically combined.** Students know that scientists identify and classify elements, compounds and mixtures according to their physical and chemical makeup.

- **the differences among elements, compounds and mixtures.**

  Elements
  - Elements are pure substances that cannot be changed into simpler substances.
  - Elements are composed of one kind of atom.

  Compounds
  - Compounds are pure substances that are composed of two or more types of elements that are chemically combined.
  - Compounds can only be changed into simpler substances called elements through chemical changes

  Mixtures
  - Mixtures are physical combinations of two or more different substances that retain their own individual properties and are combined physically (mixed together).
  - Mixtures can be separated by physical means (filtration, sifting, or evaporation). Characteristic properties can be used to identify different materials and to separate a mixture into its components.
  - Mixtures may be heterogeneous or homogeneous.
    - In a *heterogeneous mixture*, which is not uniform throughout, the component substances can be visibly distinguished. Tossed salad, granite, and iced tea are examples of heterogeneous mixtures.
    - In a *homogeneous mixture,* which is uniform throughout, the substances are evenly mixed and cannot be visibly distinguished. Air, steel, clear salt-water are examples of homogeneous mixtures.

- **that in solids the atoms are closely locked in position and can only vibrate; in liquids the atoms and molecules can collide with and move past one another; and in gases the atoms and molecules move independently, colliding frequently.** The atoms or molecules of a solid form a pattern that minimizes the structural energy of the solid. At the melting point temperature, the atoms or molecules acquire enough energy to slide past one another so that the material, now a liquid, can flow. In a gas the atoms or molecules move about freely and collide randomly with the walls of a container and with each other. The distance between molecules in a gas is much larger than that in a solid or a liquid.

- **that there is a relationship between phase and density and that density is mass per unit volume.**

Teacher Notes:

(1) It is not essential for students to understand isotopes or distinguish between covalent and ionic compounds.

(2) Atoms interact to form molecules or crystals. The term molecule is used to describe particles of a pure covalent substance – element or compound. Examples are oxygen (O_2), water (H_2O), and sugar ($C_{12}H_{22}O_{11}$) molecules. Crystalline solids can be metallic elements or ionic compounds. Examples are gold (Au), table salt (NaCl), and hematite (Fe_2O_3). These distinctions will be identified in high school courses.

(3) Heterogeneous and homogeneous mixtures are merely introduced at this grade. Further examination of heterogeneous and homogeneous mixtures will be included in a physical science course.

8.P.1.2

Students know:

- **how the periodic table of elements is organized and how to use the periodic table in order to obtain information about the atom of an element:**
  - symbol
  - atomic number
  - atomic mass
  - state of matter at room temperature
  - number of outer energy level (valence) electrons.

- **how the periodic table of elements is an arrangement of elements according to their properties.** The periodic table of elements is arranged horizontally in order of increasing atomic number (number of protons) and vertically in columns of elements with similar chemical properties. An atom's identity is directly related to the number of protons in its nucleus. This information can be used to predict chemical reactivity.

- **how to use the periodic table as a quick reference for associating the name and symbol of an element**.

- **how to find the atomic number and atomic mass of an element listed on the table.** The periodic table of elements is also an arrangement of elements according to properties. The periodic table is both a tool and an organized arrangement of the elements that reveals the underlying atomic structure of the atoms. The periodic table is a tool that is used in all the domains of science.

- **how groups of elements can be classified based on similar properties,** including highly reactive metals, less reactive metals, highly reactive non-metals, less reactive non-metals, and some almost completely non-reactive gases. Students understand that substances are often placed in categories together if they react in similar ways. Examples of this in the periodic table include metals, nonmetals, and noble gases. Students know these are major groups of elements that have different physical properties.

- **that the information that is organized in the periodic table is based on the observations of many scientists over a long period time.** Dmitri Mendeleev is generally credited with the creation of the basis for our modern day table. Mendeleev was not the first to suggest a table, but he was the first to create one that predicted the existence of as-yet-undiscovered elements which were later discovered. As of 2012, the periodic table contains 118 confirmed chemical elements, of which 114 have been recognized by the International Union of Pure

and Applied Chemistry (IUPAC) and named.

- **that *chemical symbols* show the atoms of the elements composing a substance.** Symbols are written with one, two, or three letters. The first letter is always capitalized. Each element has a different symbol.
  - Elements are made up of one kind of atom and the symbol for each element is unique.
  - Compounds are composed of more than one element and their formulas have more than one type of symbol showing the different elements that compose the compound.

- **that *chemical formulas* are constructed from the symbols of the elements composing the substances.**
  - In a chemical formula, the numbers as *subscripts* show how many of each kind of atom are in the compound.
  - The subscript is written to the lower right of the element symbol.
  - If no subscript is written, only one atom of that element is part of the compound. For example, in H_2O, the number 2 is the subscript for hydrogen and means that there are 2 atoms of hydrogen in the compound of water; since there is no subscript for oxygen it is assumed to be one atom of oxygen.

- **that atoms are composed of 3 subatomic particles- protons, neutrons and electrons.** The thing that makes elements different is the number of electrons, protons, and neutrons. The protons and neutrons are always in the nucleus (center of the atom). The electrons are always found around the center in areas called orbitals. Protons have a "+" or positive charge. If the charge of an entire atom is "0", that means there are equal numbers of electrons and protons. Neutrons have a neutral charge (a charge of zero). Electrons have a "-" or negative charge.

Students should recognize common substances such as water (H_2O), carbon dioxide (CO_2), sucrose ($C_{12}H_{22}O_{11}$), table salt (NaCl), oxygen (O_2), household bleach (NaClO), hydrochloric acid (HCl), ammonia (NH_3), baking soda ($NaHCO_3$), and vinegar ($HC_2H_3O_2$, 5% solution) through chemical formulas and symbols.

Teacher Note: It is not essential for students to construct atomic models of subatomic particles. They do need to use visual representations and concrete models of elements, compounds and mixtures.

8.P.1.3

Students know:

- **that physical and chemical properties can be used to identify substances.**

- **how to distinguish between physical properties (i.e., shape, density, solubility, odor, melting point, boiling point, and color) and**

chemical properties (i.e., acidity, basicity, combustibility, and reactivity).

- **how to determine the identity of an unknown substance by comparing its properties to those of known substances.**

- **how to compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).**

- **that matter can undergo physical and chemical changes.** In physical changes, the chemical composition of the substances does not change. In chemical changes, different substances are formed. Students know that when a substance is broken apart or when substances are combined and at least one new substance is formed, a *chemical reaction* has occurred.

- **how to differentiate between physical and chemical properties:**

  Physical properties can be observed and measured without changing the kind of matter being studied. The following physical properties can be used to help identify a substance:

  Melting Point
  - The temperature at which a solid can change to a liquid.
  - The temperature at which a pure substance melts is unchanging under constant conditions.
  - Therefore, the melting point of a pure substance can be used as a physical property for identification. Ice melts to form liquid water at 0^0C (32^oF).

  Boiling Point
  - The temperature at which a liquid boils.
  - During the process of boiling a substance changes from a liquid to a gas.
  - Boiling begins when the liquid starts to form bubbles throughout, which grow larger, rise to the surface, and burst.
  - As long as the substance is boiling the temperature of the liquid remains constant (at the boiling point).
  - Boiling point is unchanging under constant conditions for a given substance and therefore can be used as a physical property for identification of the substance.
  - The boiling point for pure water at sea level is 100^oC or 212^oF.

  Density
  - Density is a property that describes the relationship between the mass of a material and its volume.
  - Substances that have higher densities contain more matter in a given volume.
  - The density of a substance will stay the same no matter how large or small the sample of the substance, and therefore, density can be used as a physical property for identification of the substance.
  - For example, the density of lead is much greater than the density of aluminum.

Color

- Color can be used to help identify a substance, along with other properties.
- By itself color is not a significant identifier of a substance.
- Absence of color is also a physical property.

Chemical properties can also be used to help identify a substance. Chemical properties can be recognized only when substances react or do not react chemically with one another, that is, when they undergo a change in composition. A chemical property of one substance usually involves its ability to react or not react with another specific substance. Two examples of chemical properties include:

- ***Reacting with Oxygen*** The ability of a substance to ***burn*** is a chemical property that involves a substance reacting quickly with oxygen to produce light and heat. Reacting with oxygen slowly occurs when iron rusts or apples turn brown.
- ***Reacting with Acids*** The ability of a substance to react with an acid is a chemical property. Some metals react with various acids to form compounds. All metals do not react with all acids. Bases react with acids to form water and neutralize the acid.

- **how to differentiate between physical and chemical changes:**

Physical changes do not change the composition of a substance, only the physical properties. Evidences of a physical change include:

Change in state of matter

- When a substance changes from one state of matter to another (for example, changing from solid to liquid, from liquid to solid, or from liquid to gas), the composition of the substance remains the same.
- Examples of change in state might include: melting of ice cream, hardening of melted wax, or evaporating of water from wet clothes.
- When a substance changes directly from a gas to a solid (the forming of frost from water vapor) or from a solid to a gas (dry ice, solid air fresheners) that change of state is called *sublimation*. This is still a physical change because the composition of the substance remains the same.

Change in size or shape

- When a substance changes in size or shape (for example, cutting, tearing, dissolving, stretching, or wrinkling), its composition remains the same.
- Examples of change in size or shape might include: shredding paper, dissolving sugar in water, stretching a rubber band, wadding up a piece of paper, or denting a piece of metal.

Chemical changes result in the formation of one or more new substances with new chemical and physical properties. Evidences that a chemical change may have occurred include:

Color change

- When a substance changes color, the chemical composition of the substance may have changed (for example, iron turns to a reddish-brown when it rusts, apples brown when they react with oxygen in the air, or marshmallows turn black when burned).
- It is possible to have a color change without a chemical change (for example, adding food coloring to water).

Temperature change

- When a substance is combined with another substance, there may be an increase or decrease in temperature (for example, when wood burns to ash and gases, the temperature increases.
- It is possible to have a temperature change without a chemical change (for example, warming of the water in a pond).

Formation of a precipitate

- When two solutions are combined, they may form a solid substance. This solid substance is called a *precipitate* and indicates that a chemical change has occurred.
- For example when carbon dioxide is combined with aqueous calcium hydroxide (limewater), solid calcium carbonate (chalk) is formed as the precipitate.
- The precipitate may be in the form of very small particles, appearing as cloudiness in the solution or as a solid which settles to the bottom of the container.

Formation of a gas

- When solid or liquid substances are combined, they may form gas bubbles.
- The formation of the gas may indicate that a chemical reaction has taken place. For example when vinegar is added to baking soda, it forms carbon dioxide bubbles.
- It is possible to form gas without a chemical change (for example, when water is heated to boiling).

Students know:

- **that reactions occur at different rates, slow to fast, and that reaction rates can be changed by changing the concentration of reactants, the temperature, the surface areas of solids, and by using a catalyst.**

- **that many substances dissolve in water**. Water is often called the universal solvent, because so many substances can dissolve in it.

- **that solutions can be acidic, basic, or neutral.** The pH scale is used to classify solutions. Neutral solutions have a pH of 7. Acids have a pH of less than 7. Bases have a pH of more than 7.

- **how to distinguish acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.**
- **that a chemical equation can be used to represent a chemical reaction that has occurred.** A chemical equation contains the chemical

names or formulas of the substance involved in the reaction. An arrow is used to distinguish between the substance that are broken apart or combined, and can be understood as meaning "yields" or "makes".

- Reactants are the substances broken apart or combined in a chemical reaction and that they are located on the left side of the arrow in a chemical equation.
- Products are new substances formed in a chemical reaction and that they are located on the right side of the arrow in a chemical equation.
- The amount of matter does not change during a chemical reaction, only that the atoms are rearranged to form new substances. This is evidenced in a balanced chemical equation.

8.P.1.4

Students know:

- **that when materials react with each other, many changes can take place, but that in every case the total amount of matter afterward is the same as before.**
- **that a balanced chemical equation supports the law of conservation of matter.**
- **how to identify examples that support the law of conservation of matter and can explain the conservation of matter using the idea of atoms.** In chemical reactions, the number of atoms stays the same no matter how they are arranged, and the mass of atoms does not change significantly in chemical reactions, so their total mass stays the same.

Teacher Note: Experiences using concrete models to simulate chemical changes will build conceptual understanding of conservation of matter. Ask students to explain a chemical change identifying how products are formed from the atoms in the reactants.

Example: Hydrogen gas (H_2) reacts with oxygen gas (O_2) to form water (H_2O).

One molecule of hydrogen has two atoms and one molecule of oxygen has two atoms. A molecule of water has one oxygen and two hydrogen atoms. So, the two hydrogen atoms bond with one of the oxygen atoms to form a water molecule. There is an atom of oxygen left over, so another hydrogen molecule is needed in order to make a second water molecule.

The balanced chemical equation would be $2H_2 + O_2 \rightarrow 2H_20$. Two molecules of water are formed from four hydrogen and two oxygen atoms.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

8.P.2 Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources.

8.P.2.1 Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.

8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.P.2.1

Students know:

- **that all organisms on Earth, including humans, use energy derived from resources provided by the environment**. Earth supplies a variety of natural resources that living things use, change, and reuse. Some of these resources can be replaced and/or reused in nature; these are renewable resources. Natural resources that cannot be replaced in nature are nonrenewable.

- **that renewable resources are replaced through natural processes at a rate that is equal to or greater than the rate at which they are being used.** Air, freshwater, soil, living things, and sunlight are renewable resources. Air can be cleaned and purified by plants during the process of photosynthesis as they remove carbon dioxide from the air and replace it with oxygen. The water cycle allows Earth's water to be used over and over within the environment. Topsoil is formed to replace soil that has been carried away by wind and water (although new soil forms very slowly). Trees and other new plants grow to replace those that have been cut down or died. Animals are born to replace animals that have died. Sunlight, or solar energy, is considered a renewable resource because it will continue to be available for billions of years. It provides a source of energy for all processes on Earth.

- **that some resources are nonrenewable.** Nonrenewable resources are exhaustible because they are being extracted and used at a much faster rate than the rate at which they were formed. Fossil fuels (coal, oil, and natural gas), diamonds, metals, and other minerals are nonrenewable. Fossil fuels exist in a fixed amount and can only be replaced by processes that take millions of years.

8.P.2.2

Students know:

- **that natural resources can be depleted or used to the point that they are in effect no longer available.** Conservation measures are necessary for nonrenewable resources because they are known to be in a non-replenishing supply. If renewable resources are used at an increasing rate so that they cannot be naturally replaced fast enough, they too can be depleted.

- **that freshwater can be depleted because of increased demands for water on account of population shifts.** This results in water not being available or not being sufficient to meet demands. Soil can be lost because it is left bare of vegetation and allowed to erode depletes the land of the fertile topsoil needed for plant growth in that area. If living resources, such as trees, are removed without being replanted, this can contribute to environmental changes in the land, air, and water in that area that leads to negative consequences.

- **that as Earth's human population grows, the need for natural resources increases.**
    - The terms *reduce, reuse, recycle* are important ways that people can be involved in conservation of natural resources. *Reducing* involves making a decision to not use a resource when there is an alternative, such as walking or riding a bicycle rather than traveling in a car. *Reusing* involves finding a way to use a resource (or product from a resource) again without changing it or reprocessing it, such as washing a drinking glass rather than throwing away plastic or Styrofoam. *Recycling* involves reprocessing a resource (or product from a resource) so that the materials can be used again as another item, such as metals, glass or plastics being remade into new metal or glass products or into fibers.
    - *Conservation* involves preventing the loss of a resource by way of thoughtful management of it. Increased human consumption can have long-term consequences. Since the Industrial Revolution, human activities have resulted in major impacts on air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

8.E.1 Understand the hydrosphere and the impact of humans on local systems and the effects of the hydrosphere on humans.

8.E.1.1 Explain the structure of the hydrosphere including:

- Water distribution on earth
- Local river basin and water availability

8.E.1.2 Summarize evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life forms:

- Estuaries
- Marine ecosystems
- Upwelling
- Behavior of gases in the marine environment
- Value and sustainability of marine resources
- Deep ocean technology and understandings gained

8.E.1.3 Predict the safety and potability of water supplies in North Carolina based on physical and biological factors, including:

- Temperature
- Dissolved oxygen
- pH
- Nitrates and phosphates
- Turbidity
- Bio-indicators

8.E.1.4 Conclude that the good health of humans requires:

- Monitoring of the hydrosphere
- Water quality standards
- Methods of water treatment
- Maintaining safe water quality
- Stewardship

Unpacking
What does this standard mean a child will know, understand and be able to do?

8.E.1.1

Students know:

- **that water is one of the most common substances on the surface of the Earth.** They know that water has unique properties that impact the role it plays on the Earth in all the spheres (hydrosphere, lithosphere, atmosphere, and biosphere). These properties include:
  - Polarity
  - Cohesion
  - Adhesion
  - High surface tension
  - Density
  - High specific heat
  - High heat of vaporization

Water is the only substance on Earth that occurs naturally as a solid, a liquid, and a gas. It is often referred to as 'the universal solvent' because so many other substances dissolve in it. This characteristic is one reason that the water encountered on Earth is rarely pure.

Water covers approximately 71% of the Earth's surface (USGS). Most of this water (97%) is not drinkable because it is saltwater. The majority of freshwater (3%) exists in ice caps, glaciers, and oceans. 77% of the freshwater is frozen. Of the 23% that is not frozen, approximately a half of a percent is available to supply living organisms with what they need to survive. The availablilty of water varies with local geography and allows humans to utilize water as a resource.

The ocean is salty because of dissolved chemicals eroded from the Earth's crust and washed into the sea. Solid and gaseous ejections from volcanoes, suspended particles swept to the ocean from the land by onshore winds, and materials dissolved from sediments deposited on the ocean floor have also contributed. Salinity in ocean waters is increased by evaporation or by freezing of sea ice and it is decreased as a result of rainfall, runoff, or the melting of ice. The average salinity of seawater is 35 parts per thousand. Salinities are much less than average in coastal waters, in the polar seas, and near the mouths of large rivers.

Hydrothermal vents are recently-discovered features on the crest of oceanic ridges that release dissolved minerals into the oceans. These vents are the exit point on the ocean floor from which sea water that has seeped into the rocks of the oceanic crust (heated and containing dissolved materials from the crust) flows back into the ocean. This super-heated water brings large amounts of dissolved minerals with it.

Estimates of the amount of hydrothermal fluids now flowing from these vents show that the entire volume of the oceans could seep through the oceanic crust in about 10 million years. Thus, this process has a very important effect on salinity.

- **that the ocean is an integral component of the world's climate due to its capacity to collect, drive and mix water, heat, and carbon dioxide.** The ocean can hold and circulate more water, heat and carbon dioxide than the atmosphere although the components of the Earth's climate are constantly exchanged. Because the ocean can store so much heat, seasons occur later than they would and air above the ocean is warmed. Heat energy stored in the ocean in one season will affect the climate almost an entire season later. The ocean and the atmosphere work together to form complex weather phenomena like the North Atlantic Oscillation and El Niño. The many chemical cycles occurring between the ocean and the atmosphere also influence the climate by controlling the amount of radiation released into ecosystems and our environment. Air temperatures all over the world are regulated by the circulation of heat by the oceans. The ocean stores heat in the upper two meters of the photic zone. This is because seawater has a very high density and specific heat and as a result can store vast quantities of energy in the form of heat. The ocean can then buffer changes in temperature by storing heat and releasing heat. Evaporation cools ocean water which cools the atmosphere. It is most noticeable near the equator and the effect decreases closer to the poles.

- **that the water cycle is the continuous movement of water in and around the Earth.** The sun drives the entire water cycle and is responsible for its two major components: condensation and evaporation. When the sun heats the surface of water, it evaporates and ends up in the atmosphere as water vapor. It cools and rises, becoming clouds, which eventually condense into water droplets. Depending on the temperature of the atmosphere and other conditions, the water precipitates as rain, sleet, hail or snow.

  Some of this precipitation is captured by tree canopies and evaporates again into the atmosphere. The precipitation that falls to the ground becomes runoff, which courses over the surface of the earth in streams. (Runoff also comes from snowmelt, which occurs when the sun and climate changes melt snow and ice.) Runoff can accumulate and freeze into snow caps or glaciers. Runoff can also infiltrate the ground and accumulate, becoming groundwater. Permeability is a measure of the ability of a rock or sediment to transmit water or other liquids. Water does not pass through impermeable materials. A substantial amount of water is stored in permeable soil and rock underground. An aquifer is a large deposit of groundwater that can be extracted and used. Finally, runoff makes its way back into lakes and oceans, where it is again evaporated by the sun.

- **that a river basin is the portion of land drained by a river and its tributaries.** It encompasses the entire land surface drained by the various streams and creeks that flow downhill into one another, and eventually into one river. The final destination of the water drained by a river basin is an estuary or an ocean. A river basin sends all the water falling on the surrounding land into a central river and out to the sea.

- **that for land-dwellers, everyone lives in a river basin.** Even if they do not live near the water, land-dwellers live on land that drains to a

river or estuary or lake, and their actions on that land affect water quality and quantity far downstream. There are 17 river basins in North Carolina. The topography of each basin determines the area that it drains, and whether that water - from creeks, rivers, springs, and aquifers - flows into the Atlantic Ocean or Gulf of Mexico.

8.E.1.2

Students know:

- **that the ocean is a dynamic system in which many chemical, biological, and physical changes are taking place.** The ocean is an important source of food and mineral resources as well as a venue for human recreation and transportation. Students know that the ocean is the largest reservoir of water on the surface of the Earth. They also know that the ocean is the single largest reservoir of heat at Earth's surface. The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents. Many of the cycles that circulate materials between the atmosphere, lithosphere and hydrosphere originate in the ocean. Ocean currents are a source of large scale distribution of energy and resources on the Earth.

- **that estuaries are areas where fresh and salt water mix, producing variations in salinity and high biological activity.** Estuaries trap nutrients and sediment that are carried from the land by rivers and from the ocean by tides. In an estuary, these nutrients are constantly being mixed, due to tidal action and river flow. These conditions create a fertile repository of plant and animal life. Estuaries are one of the most productive ecosystems on earth.

  Because estuarine waters are shallow (in North Carolina, less than thirty feet deep), sunlight penetrates to the bottom. This promotes plant growth. The rivers that feed estuaries deposit sediments rich in nutrients, which settle onto the sand and mud of the estuary floor. These conditions create unique habitats for both plants and animals, and provide the basis for great biological diversity in species (of fish, shrimp, crabs, clams and oysters) that are able to adapt to the brackish conditions. Estuaries are also good nurseries as they provide a protected environment for species to hatch and grow in before they migrate to the sea to live out their adult lives.

  Estuaries are numerous in North Carolina. The largest North Carolina estuary is Pamlico Sound. Water drains into this system from eastern North Carolina and southeastern Virginia, from the Chowan, Roanoke, Pasquotank, Pamlico, and Neuse Rivers, from marshes, swamps, forests, and grasslands. Estuaries help control erosion and reduce flooding of the mainland. Sand bars buffer the impact of waves, while plants and shellfish beds anchor the shore against tides. Swamps and marshes take the initial impact of high winds moving in from the ocean, soak up heavy rain and storm surges, and release the extra water gradually into rivers and groundwater supplies.

  Estuaries are a type of environmental filter. Plants and animals in estuaries filter pollutants out of the water. For instance, salt marsh plants trap some of the chemicals and pathogens carried by rivers and move them into soils where they can be neutralized. Oysters filter impurities out of water as they eat, collecting the contaminants in their bodies. One oyster can filter twenty-five gallons of water per day. Bacteria eat organic matter found in the sediment and in turn release carbon dioxide, hydrogen sulfate and methane into the atmosphere preventing these

gases from being excessively stored up in the estuary. However, toxins can accumulate in estuaries causing many environmental and health problems. Chemical pollution and sedimentation are great threats to the well-being of estuaries and oceans.

- **that from the seashore to the deepest depths, oceans are home to some of the most diverse life on Earth.** Oceanographers divide the ocean into zones according to how far down sunlight penetrates. Plants are found only in the sunlit zone where there is enough light for photosynthesis, however, animals are found at all depths of the oceans. As far as we know, nearly all life in the ocean is dependent on plants. Only plants have the ability to manufacture food out of inorganic substances. Algae in the ocean are an important food source as well as an important source of atmospheric oxygen. The most abundant plants in the ocean are known as phytoplankton. To grow, phytoplankton needs nutrients from sea water and an abundance of sunlight. Currents in the ocean recycle and circulate a variety of organic and inorganic materials. This makes nutrients, minerals, and gases available to organisms.

- **that in the ocean there are innumerable individual food chains overlapping and intersecting to form complex food webs.** Most marine creatures eat a variety of foods. If one link in a chain is depleted, the other consumers in the chain have alternate food sources. Ocean organisms generally belong to several different food chains that are linked to form a food web. Ocean food chains and webs are also connected to land-dwelling organisms.

- **how winds have a powerful effect on the oceans and are an important force in creating ocean currents.** From global circulation to microscopic patterns of turbulence, winds move water and its resident animals and plants. Under certain conditions, a special kind of ocean event known as upwelling can occur. Upwelling happens when warm surface water near coastal areas is blown offshore by winds. This creates a condition in which the cold water along the bottom of the ocean near the shore rises, carrying sediment and organic material to the surface. Phytoplankton uses these nutrients to grow and reproduce at a rapid rate. This attracts organisms that rely on the phytoplankton as food and their consumers in turn. As a result, areas of upwelling tend to become areas of rich biological activity, providing resources to a great diversity of ocean organisms. Approximately half of the fish caught in the world come from areas where there is upwelling.

- **that seawater has many different gases dissolved in it, especially nitrogen, oxygen and carbon dioxide.** The action of ocean wind and waves agitates the ocean surface, stimulating the exchange of these gases between the ocean and the atmosphere. Marine plants depend on dissolved carbon dioxide in order to perform photosynthesis. Photosynthesis releases oxygen into ocean water which is in turn used by ocean organisms for respiration. Respiration releases energy from stored carbohydrates and produces carbon dioxide and water as byproducts. Some properties of seawater affect how much gas can be dissolved in it:
    - Cold water holds more gas than warm water.
    - Seawater with low salinity holds more gas than high salinity water.
    - Deep water, which has a high pressure, holds more gas than shallow water.
- **that carbon dioxide is one of the most important gases that dissolve in the ocean.** Some of it remains as dissolved gas, but most reacts

with the water to form carbonic acid or reacts with carbonates already in the water to form bicarbonates. This reaction removes dissolved carbon dioxide from the water. Many marine organisms use the bicarbonate to form calcium carbonate shells. When these organisms die, some of the bicarbonate is returned to the water, but a lot of it settles down to the sea bed. This process locks up, for long periods of time, carbon that originated in carbon dioxide in the atmosphere. As atmospheric levels of gases rise, so do the levels of the same gases dissolved in ocean water rise.

- **that the ocean is one of Earth's most valuable natural resources.** Marine resources include biotic, mineral and energy resources. The ocean provides food. It is used for travel and shipping. It provides a source of recreation for humans. It is mined for minerals and drilled for crude oil.

  The ocean plays a critical role in removing carbon from the atmosphere and providing oxygen. It regulates Earth's climate. The ocean is an increasingly important source of biomedical organisms with potential for fighting disease. The ocean is very important to life on land.

  The oceans have been fished for thousands of years and are an integral part of human society. Fish have been important to the world economy for a very long time. Fisheries today provide about 16% of the total world's protein with higher percentages occurring in developing nations.

  The word *shipping* refers to the activity of moving cargo with ships in between seaports. Wind-powered ships exist, but more often ships are powered by steam turbine plants or diesel engines. The various types of ships include container ships, tankers, crude oil ships, chemical ships, bulk carriers, cable layers, general cargo ships, ferries, gas and car carriers, tugboats, barges and dredgers.

  Tourism is the fastest growing division of the world economy and is responsible for more than 200 million jobs all over the world. The tourism industry is based on natural resources present in each country and tourism often has a negative impact on coastal and ocean ecosystems. However, sustainable tourism can actually promote conservation of the environment. The negative effects of tourism originate with the over development of coastal habitats and the annihilation of entire ecosystems. Garbage and sewage generated by natives and visitors can add to an already existing solid waste and garbage disposal issue. Often visitors produce more waste than locals, and much of it ends up as untreated sewage dumped in the ocean. This causes eutrophication because it results in excessive algal bloom. It can also lead to disease epidemics. Ecotourism and cultural tourism are a new trend that favors low impact tourism and fosters a respect for local cultures and ecosystems.

  Humans began to mine the ocean floor for diamonds, gold, silver, metal ores like manganese nodules and gravel in the 1950's. Sands and gravels are often mined for in the United States and are used to protect beaches and reduce the effects of erosion. Mining the ocean can be

devastating to natural ecosystems. Dredging of any kind pulls up the ocean floor and a cloud of sediment rises up in the water, interfering with photosynthetic processes of phytoplankton and other marine life. Dredging also introduces previously benign heavy metals into the ocean food chain.

Drilling for oil is another activity that extracts resources from the ocean. Before an offshore oil well can be drilled, it must first be located. Geologists locate potential oil wells beneath the ocean floor through the use of magnetic and seismic surveys. This surveying does not indicate for certain whether a site contains oil until exploratory drilling takes place. In order to drill exploratory wells, government permission must first be obtained. An environmental impact assessment may be carried out at this stage. Then, using an exploratory drilling rig, geologists drill temporary wells to find out if there's a source of oil. If they think they've found a good source of oil, then more drilling takes place to substantiate the findings. Once oil or gas is discovered, then a production well is drilled and a production oil rig is built to replace the exploratory drilling rig. An average well will last from ten to twenty years, and even after it has run dry an oil rig may still be used for processing or storage of petroleum from other wells, so the production oil rig is built to last. The platforms are normally made of steel and are secured to the seabed using concrete or metal foundations. Initially the pressure from the reservoir is enough to pump the oil or gas, but as the pressure decreases various techniques are used to increase the pressure in the reservoir. These techniques include pumping in gas, water, compressed air or steam. The crude oil obtained from the well is then refined at oil refineries onshore.

Drilling for oil under the ocean has many different environmental impacts. The rigs themselves impact living creatures, the actions and processes of drilling affect the oceans and ocean life, and the danger of accidental release of petroleum into the oceans is constant. Conservation of ocean resources and thoughtful long term cost /benefit analyses with regard to the use of the ocean's many natural resources are an integral part of sustaining our oceans well into the future.

- **that the deep ocean has long been of interest to scientists.** In order to understand the ocean, scientists must gain access for themselves or their instruments to very specific parts of it. Traditionally, scientists have used ships to photograph the depths, to drop floats and drifters into the currents, and to collect samples of water, rock, and marine life. In recent years, the spectrum of available observing tools has grown to include human-occupied submersibles, remote-controlled vehicles, and autonomous robots.

  At one time, scientists thought that life could not exist on the deep ocean floor. In 1977, scientists diving in *Alvin* to the Galápagos Rift discovered a new community of organisms. These organisms can withstand tremendous pressure, high temperatures, utter darkness, and toxic chemicals. These organisms are called extremophiles because of the extreme nature of their living conditions.

  The discovery of life at vents and seeps revolutionized what scientists understand about how and where life can exist on Earth. The organisms that thrive at deep-sea vents and seeps have to survive freezing cold, perpetual darkness, high-pressure, and toxic chemicals.

Hydrothermal vents and cold seeps are places where chemical-rich fluids emanate from the seafloor, often providing the energy to sustain lush communities of life in some very harsh environments. Studying the organisms at hydrothermal vents and cold seeps expands our understanding of how life first took hold and slowly evolved on our planet as well as where it might exist elsewhere in the solar system and beyond.

On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into the organic carbon, the fundamental source of nutrients for animals higher up the food chain. Below the photic zone (the sunlit, upper reaches of the ocean) many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids.

Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators. Some vent and seep animals, such as tubeworms and shrimp, also host chemosynthetic microbes on or within their bodies, providing a place for the microbes to live in exchange for nutrients produced by the microbes.

Cold seeps and hydrothermal vents differ from one another in the underlying conditions that form and drive them. This has implications for the kinds of animals that are able to survive at each.

Hydrothermal vents are driven by heat from volcanism beneath the seafloor. In this environment, chemical reactions take place as seawater percolates through cracks in the seafloor to produce hot (more than 400°C or 750°C), acidic fluids that eventually rise back to the seafloor. Vents, and the ecosystems they support, are created and destroyed as underlying volcanic activity waxes and wanes over tens or hundreds of years. On land and near the ocean surface, sunlight provides the energy that allows photosynthetic plants to convert carbon dioxide and water into a fundamental source of nutrients for organisms in proximal food chains and webs. Below the photic zone many microbes have evolved chemosynthetic (instead of photosynthetic) processes that create organic matter by using oxygen in seawater to oxidize hydrogen sulfide, methane, and other chemicals present in vent and seep fluids. Animals such as clams, mussels, snails, and shrimp feed on the microbes, and in turn, provide food for fish and other predators.

Cold seeps are a little bit different. They produce a diffuse flow of lower-temperature fluids, often composed of natural gas and a mixture of hydrocarbons, at slower rates for longer periods. The methane seeping from the seafloor sustains microbes that serve as the base of the food chain for communities of animals which thrive in the sunless depths. Far more natural gas is sequestered on the seafloor—or leaking from it—than can be drilled from all the existing wells on Earth. Some seeps may be thousands of years old.

8.E.1. 3

Students know:

- **that the health of a water system is determined by the balance between physical, chemical and biological variables.** Physical variables include temperature, turbidity, and water movement. Chemical variables include dissolved oxygen and other gases, pH, nitrates, and salinity. Both natural and man-made forces are constantly changing these variables. Freshwater systems are of particular concern because they are the source of most of the potable water consumed by humans. Testing for the occurrence of chemicals and other factors that can influence water quality, such as nutrients and pesticides in water resources is a normal part of public health maintenance and stewardship of freshwater resources. Water that is safe to drink is called potable water, or drinking water, in contrast to safe water, which can be used for bathing or cleaning. In the United States, the Environmental Protection Agency sets maximum levels for the 90 most commonly occurring contaminants.

- **that the temperature of water in rivers and lakes determines the kinds of organisms that can survive there.** Particular aquatic species have preferred water temperature ranges within which they will live and thrive. Warm water dissolves more of a solid substance as it gets warmer, but it also dissolves less of important gases like oxygen and carbon dioxide. Very warm water may not contain enough dissolved oxygen for aquatic life to survive.

- **that measuring dissolved oxygen is an important factor in determining water quality**. Dissolved oxygen (commonly called DO, pronounced dee-oh) is oxygen that is dissolved in water. Dissolved oxygen (DO) is a measure of the amount of oxygen in water that is available for chemical reactions and for use by aquatic organisms. In the aquatic ecosystem, dissolved oxygen balance in water is important for the survival of certain microorganisms and higher organisms such as zooplankton and fish. Normally oxygen in water gets there through diffusion with the air and as a waste product of photosynthesis by aquatic plants. Dissolved oxygen in surface water is used by all forms of aquatic life; therefore, it is measured to assess the "health" of lakes and streams. Dissolved oxygen levels vary with seasons, and over 24 hour cycles. When dissolved oxygen levels in a body of water decline, sensitive animals may move away, weaken, or die. High DO levels in potable water usually make it taste better.

- **that pH is a measure of how acidic or basic water is.** pH is important because it controls many chemical and biological processes that occur in the water. pH is measured on a scale that ranges from 0 to 14, with 7 considered neutral. Values of pH less than 7 are acidic, while values higher than 7 are basic. The pH scale ranges from 0 (high concentration of positive hydrogen ions, strongly acidic) to 14 (high concentration of negative hydroxide ions, strongly basic). In pure water the pH measures exactly 7. Students know that the pH of a body of water is important because pH has a synergistic effect. This means that the impact of other materials in a body of water - such as iron, aluminum, ammonia, or mercury - is amplified or diminished depending on the pH of the water. For example, when acidic waters

come into contact with certain chemicals and metals, it makes these chemicals and metals more poisonous than normal. This has special significance in water treatment processes, because specific water treatment processes require specific pH ranges.

- **that nitrogen and phosphorous are essential plant nutrients.** The nitrates and phosphates derived from them are chemicals that pose possible health risks to humans if their presence in drinking water is not controlled. The major sources of nitrates in surface water include runoff contaminated with fertilizers, septic tank leakage, sewage, and erosion of natural deposits. Phosphates, on the other hand, usually enter waterways from human and animal waste, laundry, cleaning and industrial effluents.

- **that turbidity is a measure of how clear water is.** The more suspended solids there are in a water sample, the less transparent it is. Turbidity is considered a good measure of water quality. In drinking water, high turbidity is generally not considered a favorable sign because it can be associated with organic pollution that might include pathogenic materials. In surface bodies of water, high turbidity can lead to increased water temperatures, low dissolved oxygen, and even physical impairment of aquatic organisms.

- **that the water quality of a body of water can also be assessed by using bioindicators (macroinvertebrates)**. The presence, condition, and numbers of the types of fish, insects, algae, plants and other aquatic life provide accurate information about the health of freshwater, coastal and marine waters. Bioindicators include living macroinvertebrates. Macroinvertebrates are easy for people to collect and identify. Because many macroinvertebrates are sensitive to pollution in water, they are a good indicator of whether or not a body of water is livable. Good water quality is indicated by a variety of macroinvertebrates. Poor water quality is indicated by a few of one type of macroinvertebrates in one place.

8.E.1.4

Students know:

- **that water quality is a term used to describe the chemical, physical, and biological characteristics of water.** Scientifically, an array of chemical, physical, and biological measurements is used to define water quality. Water quality is also described in terms of the purpose for which water is intended to be used. Water that is safe to drink is called potable water, or drinking water, in contrast to safe water, which can be used for bathing or cleaning. In the United States, the Environmental Protection Agency sets maximum levels for the 90 most commonly occurring contaminants.

- **that water quality standards outline the water quality pollution control program that is mandated and regulated by local, regional and federal agencies.** Standards outline the goals for a body of water by identifying its uses, establishing how to protect those uses and establishing provisions to protect and preserve the water bodies in the long term. Point and non-point environmental stressors such as urban and/or agricultural runoff, industrial inputs and over-fishing can impact a variety of aquatic and land-based populations. Because the water quality of a given water body is so closely linked to the surrounding environment and land use, monitoring and regulation at local, regional,

and national levels is important.

- **clear water may contain odorless, tasteless, and colorless harmful contaminants.** Water must be tested for specific contaminants such as bacteria, nitrates, arsenic and others. Natural supplies of potable water are very limited and do not exist in sufficient quantities to meet human needs. Because of this, humans have developed water treatments that process water so that it can be used for a particular purpose. Drinking water treatment requires some basic steps:
    - Water collection
    - Coagulation, during which lime and alum are added to the water, causing particulates to clump together.
    - Next, the water is shaken to form larger clumps, called flocs.
    - During the sedimentation process water stands for approximately 24 hours, which allows the clumps to settle to the bottom.
    - The water is then filtered, disinfected (usually with chlorine) and aerated.

  The substances removed during the drinking water treatment process include suspended solids, bacteria, algae, viruses, fungi, minerals, and chemical pollutants.

- **that water is essential to life.** Water quality determines the sustenance of ecosystems, human activity such as agriculture, fishing, and recreation, as well as public health of human societies. Water quality supports healthy environments in which rich and varied communities of organisms can be found. The importance of monitoring and maintaining water quality cannot be overstated. Cultivating an awareness of their connection to North Carolina's hydrologic system is the first step towards developing stewardship skills and dispositions in students.

Earth History

Essential Standard and Clarifying Objectives

8.E.2 Understand the history of Earth and its life forms based on evidence of change recorded in fossil records and landforms.

8.E.2.1 Infer the age of Earth and relative age of rocks and fossils from index fossils and ordering of rock layers (relative dating and radioactive dating).

8.E.2.2 Explain the use of fossils, ice cores, composition of sedimentary rocks, faults, and igneous rock formations found in rock layers as evidence of the history of the Earth and its changing life forms.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.E.2.1

Students know:

- **that fossils provide important evidence of how life and environmental conditions have changed.** The earth processes we see today, including erosion, movement of lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth's history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.

- **that a *fossil* is the preserved remains or traces of an organism that lived in the past.** Fossils give clues to the diversity of living things over the history of Earth, give clues to past climate and surface changes on Earth, and give clues to changes that have occurred with organisms over time.

- **the formation process of mold, cast, petrified, preserved, carbonized, and trace fossils.**

- **the different types of fossils based on how they were formed.** The formation process of fossils varies depending on where and under what environmental conditions they formed.
  - ***Mold fossil* –** forms when sediments bury an organism and the sediments change into rock; the organism decays leaving a cavity in the shape of the organism.
  - ***Cast fossil* –** forms when a mold is filled with sand or mud that hardens into the shape of the organism.
  - ***Petrified fossil (permineralized fossil)* –** forms when minerals soak into the buried remains, replacing the remains, and changing them into rock.
  - ***Preserved fossil* –** forms when entire organisms or parts of organisms are prevented from decaying by being trapped in rock, ice, tar, or amber.

- ***Carbonized fossil* –** forms when organisms or parts, like leaves, stems, flowers, fish, are pressed between layers of soft mud or clay that hardens squeezing almost all the decaying organism away leaving the carbon imprint in the rock.
- ***Trace fossil* –** forms when the mud or sand hardens to stone where a footprint, trail, or burrow of an organism was left behind.

- **that the geologic time scale is a record of the major events and diversity of life forms present in Earth's history.** The geologic time scale began when Earth was formed and goes on until the present. At the end of each era a mass extinction occurred, many kinds of organisms died out, although there were other extinctions going on during each period of geologic time. Using the fossil record, paleontologists have created an idea of the different types of common organisms in each geologic period.
  - ***Precambrian Era***
    - The Precambrian Era is Earth's first era of time. It began with the creation of the Earth around 4.6 billion years ago.
    - 5 major events occurred during this era: (1) the formation of the Sun and light, (2) the creation of the Earth, (3) the creation of the atmosphere through volcanic out-gassing, (4) the creation of the oceans, and (5) the creation of life.
    - Began with simple life forms such as bacteria and simple algae.
    - There was a rise of simple organisms such as jellyfish and sea worms by the end of the era.
    - Few fossils because the life forms were soft-bodied and had no hard skeleton.
  - ***Paleozoic Era***
    - Began with the early invertebrates, such as trilobites and brachiopods; continued to develop early vertebrate fish, then arachnids and insects; later came the first amphibians, and near the era's end the reptiles became dominant.
    - Early land plants included simple mosses, ferns, and then cone-bearing plants.
    - By the end of the era, seed plants were common.
    - The mass extinction that ended the era caused most marine invertebrates as well as amphibians to disappear.
  - ***Mesozoic Era***
    - Reptiles were the dominant animals of this era, including the various dinosaurs.
    - Small mammals and birds also appeared.
    - Toward the end of the era, flowering plants appeared and the kinds of mammals increased.
    - The mass extinction that ended the era caused the dinosaurs to become extinct.
  - ***Cenozoic Era***
    - New mammals appeared while others became extinct.
    - The diversity of life forms increased.
    - Flowering plants became most common.
    - Humans are also part of the most recent period of this era.

- **that various models, diagrams, and pictures can be used to illustrate the vastness of time involved in geologic time and to show the**

diversity of life evident across geologic time. Through the illustrations, not only does the diversity of life-forms increase, but the complexity of those life-forms also increases.

- **that millions of fossils have been collected and studied.** The *fossil record* gives important information about past life and environments on Earth. Certain fossilized organisms could only live in specific environments or under particular climate conditions. Extinction of life-forms as well as how and when new life-forms appeared is part of the fossil record.

- **that the *relative age* means the age of one object compared to the age of another object.** Relative age does not tell the exact age of an object. The relative age of rocks and fossils can be determined using two basic methods: ordering of rock layers and index fossils:
    - ***Ordering of Rock Layers*** Scientists read the rock layers knowing that each layer is deposited on top of other layers. The *law of superposition* states that each rock layer is older than the one above it. This law is used to read rock layers. Using this understanding of layering, scientists infer that the relative age of the rock or fossil in the rock is older if farther down in the rock layers. Relative dating is best used when the rock layers have been preserved in their original sequence. Over millions of years, tectonic plate motion can distort these layers. As a result of this, the youngest layers of rock are not always found on top, because of folding, breaking, and uplift of layers.

    - ***Index Fossils*** Certain fossils, called *index fossils*, can be used to help find the relative age of rock layers. To be an index fossil –an organism must have lived only during a short part of Earth's history; many fossils of the organism must be found in rock layers; the fossil must be found over a wide area of Earth; the organism must be unique.

      The shorter time period a species lived, the better an index it is. A key example of an organism used as an index fossil are *trilobites*, a group of hard-shelled animals whose body had three sections, lived in shallow seas, and became extinct about 245 million years ago. Therefore, if a trilobite is found in a particular rock layer, it can be compared with trilobites from other layers to estimate the age of the layer in which it was found.

- **that geologists use radiometric dating to estimate how long ago rocks formed, and to infer the ages of fossils contained within those rocks.** The universe is full of naturally occurring radioactive elements. Radioactive atoms are inherently unstable; over time, radioactive "parent atoms" decay into stable "daughter atoms." When molten rock cools, forming what are called igneous rocks, radioactive atoms are trapped inside. Afterwards, they decay at a predictable rate. By measuring the quantity of unstable atoms left in a rock and comparing it to the quantity of stable daughter atoms in the rock, scientists can estimate the amount of time that has passed since that rock formed. Absolute geologic dating and relative geologic dating are two methods by which scientists try to determine the age of geologic evidence. Carbon-14 dating is an example of absolute dating, and the law of superposition is an example of relative dating.

Teacher Note: It is not necessary for students to calculate radioactive decay.

8.E.2.2
Students know:

- **that a variety of artifacts are used to determine the geological history of the Earth, as well as how its life forms have changed over time.** *Ice cores* are cylinders of ice that are drilled out of glaciers and polar ice sheets. Ice cores play an important role in helping scientists to gain an understanding of the Earth's history, particularly how earth's climate has changed over time. When snow falls it carries with it the compounds that are in the air at the time. In areas where temperatures are rarely above freezing (ice sheets and glacial areas), this builds up layer upon layer of compacted snow which becomes ice. Within these ice layers there is a record of the atmosphere at the time that the snow creating the ice layers fell.

  Sedimentary rock makes up about 75% of the rocks on the Earth's surface. Sedimentary rocks form on the surface of the Earth, anywhere that sand, mud, or other types of sediment collect. Scientists can gain an understanding of Earth's climate, biological, and geologic history by examining the contents of different layers of sedimentary rock. Sedimentary rock layers can be disturbed by igneous rock. This happens when molten rock forces it way up through the layers above it. This forms igneous rock sections within and across the sedimentary layers. The sedimentary rock layers must be there first, therefore the igneous rock intrusions are younger than the layers it cuts through. Sometime the molten rock will force its way to the surface and erupt, creating a younger igneous layer at the surface. With time, more sedimentary layers can form on top of the igneous rock. Igneous rock is always younger than rock layers it cuts through.

- **that a fault is a break in the rocks that make up the Earth's crust that is formed due to the movement of rock on either side of the fault.** Generally, faults occur where there is movement (a slip) of tectonic plates. Sudden movement of this type is associated with earthquakes. Students know that the two main types of faults involve dip slips and strike slips. In a dip slip, two pieces of land change their vertical position compared to one another. Afterward, one side of the fault is higher than the other. In a strike slip, two pieces of land move horizontally.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

8.L.1 Understand the structure and hazards caused by agents of disease that effect living organisms.

8.L.1.1 Summarize the basic characteristics of viruses, bacteria, fungi and parasites relating to the spread, treatment and prevention of disease.

8.L.1.2 Explain the difference between epidemic and pandemic as it relates to the spread, treatment and prevention of disease.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.L.1.1

Students know that:

- **microbiology as a basic science explores microscopic organisms including viruses, bacteria, protozoa, parasites, and some fungi and algae.** These organisms lack tissue differentiation, are unicellular, and exhibit diversity of form and size.

- **viruses, bacteria, fungi and parasites may infect the human body and interfere with normal body functions.** Some kinds of bacteria or fungi may infect the body to form colonies in preferred organs or tissues.
  - ***Viruses***
    - Viruses are non-living particles composed of a nucleic acid (DNA or RNA) and a protein coat.
    - Viruses need a host cell to reproduce.
    - Viruses invade healthy cells and use the enzymes and organelles of the host cell to make more viruses, usually killing those cells in the process.
    - Viral diseases are among the most widespread illnesses in humans. These illnesses range from mild fevers to some forms of cancer and include several other severe and fatal diseases. Transmission of these illnesses varies; some are transmitted by human contact, while others are transmitted through water or an insect bite.
    - Vaccines and some anti-viral drugs are used to control and prevent the spread of viral diseases.
  - ***Bacteria***
    - Bacteria are prokaryotic single-celled organisms.
    - Bacteria can live in a variety of places (with oxygen, without oxygen, extreme hot, extreme cold).
    - Bacteria reproduce through binary fission, a form of asexual reproduction. Under optimal conditions, bacteria can grow and divide extremely rapidly, and bacterial populations can double very quickly.

        - Antibiotics are used to inhibit the growth of bacteria. Because antibiotics have been overused, many diseases that were once easy to treat are becoming more difficult to treat. Antibiotic resistance in bacteria occurs when mutant bacteria survive an antibiotic treatment and give rise to a resistant population.
    - ***Fungi***
        - Fungi are eukaryotic, nonphotosynthetic organisms, and most are multicellular heterotrophs.
        - Most fungi reproduce both sexually and asexually (producing spores). This provides an adaptive advantage. When the environment is favorable, rapid asexual reproduction ensures an increased spread of the species. During environmental stress, sexual reproduction ensures genetic recombination, increasing the likelihood that offspring will be better adapted to the new environmental conditions.
        - Fungi can sometimes attack the tissues of living plants and animals and cause disease. Fungal disease is a major concern for humans because fungi attack not only us but also our food sources, making fungi competitors with humans for nutrients.
        - Mold spores can cause mild to serious allergies in some people. Billions of mold spores can become airborne and may then be inhaled, triggering an allergic reaction.
    - ***Parasites***
        - A parasite is an organism that feed on another individual, known as the host. They either live on or in their host's body.
        - Natural selection favors adaptations that allow a parasite to efficiently exploit its host. Parasites are usually specialized anatomically and physiologically. Tapeworms are so specialized for a parasitic lifestyle that they do not even have a digestive system. They live in the small intestine of their host and absorb nutrients directly through their skin.
        - Infectious disease may also be caused by animal parasites, which may take up residence in the intestines, bloodstream, or tissues.

Teacher Note: It is not necessary for students to know specific diseases or disorders caused by microorganisms.

8.L.1.2

Students know that:

- **a disease outbreak happens when a disease occurs in greater numbers than expected in a community or region, or during a season.** An outbreak may occur in one community or even extend to several countries. It can last from days to years. Sometimes a single case of a contagious disease is considered an outbreak. This may be true if it is an unknown disease, is new to a community, or has been absent from a population for a long time. An outbreak can be considered as an *epidemic* or *pandemic*.

- **epidemic and pandemic are similar terms that refer to the spread of infectious diseases among a population.** There are two main differences between epidemic and pandemic. The term *pandemic* normally is used to indicate a far higher number of people affected than an epidemic. *Pandemic* also refers to a much larger region being affected. In the most extreme case, the entire global population would be affected by a pandemic.

- **the terms *epidemic* and *pandemic* usually refer to the rate of infection, the area that is affected or both.** An epidemic is defined as an illness or health-related issue that is showing up in more cases than would normally be expected. It occurs when an infectious disease spreads rapidly to many people. In 2003, the severe acute respiratory syndrome (SARS) epidemic took the lives of nearly 800 people worldwide.

- **in the case of a pandemic, even more of the population is affected than in an epidemic.** A pandemic typically is in a widespread area (usually worldwide) rather than being confined to a particular location or region and affect global populations. An epidemic is not worldwide. For example, malaria can reach epidemic levels in regions of Africa but is not a threat globally. Whereas a flu strain can begin locally (epidemic) but eventually spread globally (pandemic). This is not unusual for a new virus, because if people have not been exposed to the virus before, their immune systems are not ready to fight it off, and more people become ill. Swine flu started in Mexico city where it was feared to lead to epidemic proportions in North America, now that the flu has been found in New Zealand, Israel, Scotland and many other countries, it has become pandemic. The 1918 Spanish flu and the Black Plague are extreme examples of pandemics. Keep in mind, though, that a pandemic doesn't necessarily mean millions of deaths-it means a geographically widespread epidemic.

- **influenza pandemics have occurred more than once.** Spanish influenza killed 40-50 million people in 1918. The Asian influenza killed 2 million people in 1957. The Hong Kong influenza killed 1 million people in 1968. An influenza pandemic occurs when: A new subtype of virus arises. This means humans have little or no immunity to it; therefore, everyone is at risk. The virus spreads easily from person to person, such as through sneezing or coughing. The virus begins to cause serious illness worldwide. With past flu pandemics, the virus reached all parts of the globe within six to nine months. With the speed of air travel today, public health experts believe an influenza pandemic could spread much more quickly. A pandemic can occur in waves. And all parts of the world may not be affected at the same time.

Teacher Note: It is not necessary for students to know specific examples of epidemics and pandemics. Examples provided are for teaching purposes only.

Essential Standard and Clarifying Objectives

8.L.2 Understand how biotechnology is used to affect living organisms.

8.L.2.1 Summarize aspects of biotechnology including:

- Specific genetic information available
- Careers

- Economic benefits to North Carolina
- Ethical issues
- Implications for agriculture

Unpacking
What does this standards mean a child will know and be able to do?

8.L.2.1

Students know that:

- **technology is essential to science for such purposes as sample collection and treatment, measurement, data collection and storage, computation, and communication of information.**

- **traditional biotechnology was (and still is) the use of living organisms to solve problems and make useful products.** Domesticating crop plants and farm animals through selective breeding, and using yeast to make bread rise and produce wine are examples of traditional biotechnology. New biotechnology involves the use of living cells and their molecules to solve problems and make useful products.

- **biotechnology is not just one technology, but many.** Biotechnology is a toolbox filled with many different kinds of living cells and their component molecules, and different ways to use them. Because there are millions of different species of plants, animals, and microorganisms in the world, each having cells and molecules with unique characteristics, there are a lot of potential tools in this toolbox. This is why biotechnology is so powerful and can be applied in so many different ways. There are three basic kinds of biotechnology tools: working with cells, working with proteins, and working with genes.

- **many industries are finding uses for the new tools provided by biotechnology.** The health care industry is developing better ways to diagnose, treat, and prevent disease. The food and agriculture industries are rapidly adopting the tools of biotechnology. The "third wave" of biotechnology applications is just beginning to emerge in energy and the environment, where living cells and their molecules can help us develop new methods to clean up our environment, detect environmental contamination, and reduce our dependence on petroleum.

- **the microbial world has led to the emerging field of biotechnology which has given us many advances and new careers in medicine, agriculture, genetics, and food science.** Biotechnology, while it has benefited North Carolina in many ways, has also raised many ethical issues for an informed community to consider. As we increase our knowledge and make advances in technology we are able to reduce the threat of microbial hazards.

- **biotechnology affects us in every area of our lives: our food, water, medicine and shelter.** Uses of modern biotechnology include: making medicine in large quantities (e.g. penicillin) and human insulin for the treatment of diabetes, combating crime through DNA testing and forensic testing, removing pollution from soil and water (bioremediation), and improving the quality of agricultural crops and livestock products. Some new areas such as Genetic Modification (GM) and cloning are controversial.

Ecosystems

Essential Standard and Clarifying Objectives

8.L.3 Understand how organisms interact with and respond to the biotic and abiotic components of their environment.

8.L.3.1 Explain how factors such as food, water, shelter, and space affect populations in an ecosystem.

8.L.3.2 Summarize the relationships among producers, consumers, and decomposers including the positive and negative consequences of such interactions including:

- coexistence and cooperation
- competition (predator/prey)
- parasitism
- mutualism

8.L.3.3 Explain how the flow of energy within food webs is interconnected with the cycling of matter (including water, nitrogen, carbon dioxide, and oxygen).

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.L.3.1

Students know that:

- **ecosystems are complex, interactive systems that include both biological communities (biotic) and physical (abiotic) components of the environment.** Organisms and populations of organisms are dependent on their environmental interactions both with living and nonliving factors. As with individual organisms, a hierarchal structure exists; groups of the same organisms (species) form populations, different populations interact to form communities, communities live within an ecosystem, and all of the ecosystems on Earth make up the biosphere. Like individual organisms, ecosystems are sustained by the continuous flow of energy.

- **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. Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health.

- **a *population* is a group of organisms belonging to the same species that live in a particular area.** Populations can be described based on their size, density, or distribution.

- **population density measures the number of individual organisms living in a defined space.** Regulation of a population is affected by limiting factors that include density-dependent, density-independent, abiotic and biotic factors.
    - ***Density-dependent factors*** Limiting factors that are density-dependent are those that operate more strongly on large populations than on small ones. Density-dependent limiting factors include competition (for food, water, shelter & space), predation, parasitism, and disease. These limiting factors are triggered by increases in population density (crowding).
    - ***Density-independent factors*** Limiting factors that are density-independent are those that occur regardless of how large the population is and reduce the size of all populations in the area in which they occur by the same proportion. Density-independent factors are mostly abiotic (such as weather changes), human activities (such as pollution), and natural disasters (such as fires).
    - ***Abiotic and biotic factors*** Limiting factors can change within an ecosystem and may affect a population.
        - *Abiotic factors* are nonliving things in an ecosystem and may be chemical or physical. Some examples are water, nitrogen, oxygen, salinity, pH, soil nutrients and composition, temperature, amount of sunlight, and precipitation.
        - *Biotic factors* include all of the living components of an ecosystem. Some examples are bacteria, fungi, plants, and animals.

      A change in an abiotic or biotic factor may decrease the size of a population if it cannot acclimate or adapt to or migrate from the change. A change may increase the size of a population if that change enhances its ability to survive, flourish or reproduce.

Teacher Note: It is not essential for students to calculate population growth patterns or population density.

8.L.3.2

Students know:

- **that organisms in an ecosystem constantly interact.** These interactions among the organisms:
    - generate stability within ecosystems.
    - can facilitate or restrain growth.
    - can enhance or limit the size of populations, maintaining the balance between available resources and those who consume them.
    - can change both biotic and abiotic characteristics of the environment.

- **that an *ecosystem* is defined as a community (all the organisms in a given area) and the abiotic factors (such as water, soil, or climate) that affect them.** A *stable ecosystem* is one where
    - the population numbers of each organism fluctuate at a predictable rate.

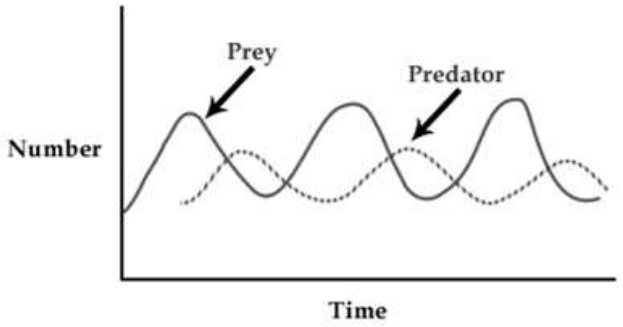
- the supply of resources in the physical environment fluctuates at a predictable rate.
- energy flows through the ecosystem at a fairly constant rate over time.

These fluctuations in populations and resources ultimately result in a stable ecosystem.

Predation is an interaction between species in which one species (the *predator*) eats the other (the *prey*). This interaction helps regulate the population within an ecosystem thereby causing it to become stable. Fluctuations in predator–prey populations are predictable. At some point the prey population grows so numerous that they are easy to find.

A graph of predator–prey density over time shows how the cycle of fluctuations results in a stable ecosystem.

- As the prey population increases, the predator population increases.
- As the predator population increases, the prey population decreases.



- **that in any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources.**
  - ***Competition*** is a relationship that occurs when two or more organisms need the same resource at the same time. Competition can be among the members of the same or different species and usually occurs with organisms that share the same niche.
    - An ecological *niche* refers to the role of an organism in its environment including type of food it eats, how it obtains its food and how it interacts with other organisms.
    - Two species with identical ecological niches cannot coexist in the same habitat.
  - Competition usually results in a decrease in the population of a species less adapted to compete for a particular resource.
  - A ***symbiotic relationship*** exists between organisms of two different species that live together in direct contact. The balance of the ecosystem is adapted to the symbiotic relationship. If the population of one or other of the symbiotic organisms becomes unbalanced,

the populations of both organisms will fluctuate in an uncharacteristic manner. Symbiotic relationships include parasitism, mutualism, and commensalism.

- ***Parasitism*** is a symbiotic relationship in which one organism (the parasite) benefits at the expense of the other organism (the host). In general, the parasite does not kill the host.
  - Some parasites live within the host, such as tape worms, heartworms, or bacteria.
  - Some parasites feed on the external surface of a host, such as aphids, fleas, or mistletoe.
  - The parasite-host populations that have survived have been those where neither has a devastating effect on the other.
  - Parasitism that results in the rapid death of the host is devastating to both the parasite and the host populations. It is important that the host survive and thrive long enough for the parasite to reproduce and spread.
- ***Mutualism*** is a symbiotic relationship in which both organisms benefit. Because the two organisms work closely together, they help each other survive. For example,
  - bacteria, which have the ability to digest wood, live within the digestive tracts of termites;
  - plant roots provide food for fungi that break down nutrients the plant needs.

8.L.3.3

Students know that the sun is the ultimate source of energy.

- Energy entering ecosystems as sunlight is transferred by producers into chemical energy through the process of photosynthesis.
- Energy then passes from organisms to organisms.
- Energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat.
- Almost all food energy comes originally from sunlight.

Students know that food provides molecules that serve as fuel and building material for all organisms. Plants, algae (including phytoplankton), and many microorganisms use the energy in light to make sugars (food) from carbon dioxide and from the atmosphere and water through the process of photosynthesis, which also releases oxygen. This food can be used immediately for fuel or materials or it may be stored for later use. Animals obtain food from eating plants or eating other animals. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy;. In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not require oxygen. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

Students know that over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.

Students know that the flow of energy through ecosystems can be described and illustrated in food chains, food webs, and pyramids (energy, number, and biomass). These are all models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact- primarily for food- within an ecosystem. Transfers of matter into and out of the physical environment occur at every level, for example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal material. 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.

Students know how the flow of energy is interconnected with the cycling of matter.

- A ***food chain*** is the simplest path that energy takes through an ecosystem. Energy enters an ecosystem from the Sun. Each level in the transfer of energy through an ecosystem is called a *trophic level*. The organisms in each trophic level use some of the energy in the process of cellular respiration, lose energy due to heat loss, and store the rest.
  - The first trophic level consists of *producers* (green plants or other *autotrophs*).
    - Primary producers capture the Sun's energy during photosynthesis, and it is converted to chemical energy in the form of simple sugars.
    - The autotroph uses some of the simple sugars for energy and some of the simple sugars are converted to organic compounds (carbohydrates, proteins, and fats) as needed for the structure and functions of the organism.
    - Examples of primary producers include land plants and phytoplankton in aquatic environments.
  - The second trophic level consists of *primary consumers (heterotrophs).*
    - Primary consumers that eat green plants are called *herbivores*.
    - The herbivore uses some of the organic compounds for energy and some of the organic compounds are converted into the proteins, carbohydrates and fats that are necessary for the structure and functions of the herbivore. Much of the consumed energy is lost as heat.
    - Examples of primary consumers include grasshoppers, rabbits and zooplankton.
  - The third trophic level, or any higher trophic level, consists of *consumers*.
    - Consumers that eat primary consumers are called *carnivores*; consumers that eat both producers and primary consumers are called *omnivores*.
    - The carnivores or omnivores use some of the organic compounds for energy and some of the organic compounds are converted into the proteins, carbohydrates and fats that are necessary for their body structures and functions. Much of the consumed energy is lost as heat.
    - Examples of consumers include humans, wolves, frogs, and minnows.

- A heterotroph that breaks down organic material and returns the nutrients to soil, water, and air making the nutrients available to other organisms is called a *decomposer*.
- The energy available for each trophic level in an ecosystem can be illustrated with a food chain diagram.

- A ***food web*** represents many interconnected food chains describing the various paths that energy takes through an ecosystem. The energy available in an ecosystem can be illustrated with a food web diagram.

- ***Ecological pyramids*** are models that show how energy flows through ecosystems. Pyramids can show the relative amounts of energy, biomass, or numbers of organisms at each trophic level in an ecosystem. The base of the pyramid represents producers. Each step up represents a different level of consumer. The number of trophic levels in the pyramid is determined by the number of organisms in the food chain or food web.

  - An *energy pyramid* represents the energy available for each trophic level in an ecosystem.
    - The energy needs of organisms are greater from level to level in an ecosystem.
    - Therefore, the total amount of energy available at each level decreases in an ecosystem.
    - Each successive level in an ecosystem can support fewer numbers of organisms than the one below. With each level of the pyramid, only 10% of the energy available is used by organisms while there is an energy loss of about 90% to the environment.
  - A *number pyramid* represents the number of individual organisms available for energy at each trophic level in an ecosystem. It can be used to examine how the population of a certain species affects another.
    - The autotrophic level is represented at the base of the pyramid. This represents the total number of producers available to support the energy needs of the ecosystem.
    - The total numbers of individual organisms tend to decline as one goes up trophic levels.
  - A *biomass pyramid* represents the total mass of living organic matter (biomass) at each trophic level in an ecosystem.
    - Since the number of organisms is reduced in each successive trophic level, the biomass at each trophic level is reduced as well.
    - Even though a biomass pyramid shows the total mass of organisms available at each level, it does not necessarily represent the amount of energy available at each level. For example, the skeleton and beak of a bird will contribute to the total biomass but are not available for energy.

Evolution and Genetics

Essential Standard and Clarifying Objectives

8.L.4 Understand the evolution of organisms and landforms based on evidence, theories and processes that impact the Earth over time.

8.L.4.1 Summarize the use of evidence drawn from geology, fossils, and comparative anatomy to form the basis for biological classification systems and the theory of evolution.

8.L.4.2 Explain the relationship between genetic variation and an organism's ability to adapt to its environment.

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.L.4.1

Students know that:

- life on Earth, as well as the shape of Earth's surface, has a history of change that is called ***evolution.***

- the evidence that organisms and landforms change over time is scientifically described using the ***Theory of Evolution***, the ***Plate Tectonics Theory***, *and the* ***Law of Superposition*.**

- ***biological evolution*** **accounts for the diversity of species developed through gradual processes over many generations.** Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations. Biological adaptations include changes in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment. Similarities among organisms can infer the degree of relatedness: homologous structures—anatomical and cellular, analogous structures--anatomical and cellular, embryological similarities—anatomical and cellular, human developmental patterns are similar to those of other vertebrates.

- ***fossils*** (mineral replacements, preserved or traces of organisms that lived in the past) **can be compared to one another and to living organisms according to their similarities and differences.** Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks. Sediments, sand and smaller particles (sometimes containing the remains of organisms) are gradually buried and cemented together to form solid rock again. More recently deposited rock layers are more likely to contain fossils resembling existing species. Thousands of layers of sedimentary rock not only provide evidence of the history of Earth itself, but also of changes in organisms whose fossil remains have been found in these layers. 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 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 in Earth. Because of the conditions necessary for their preservation, not all types of organisms that existed in the past have left fossils that can be retrieved. 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.

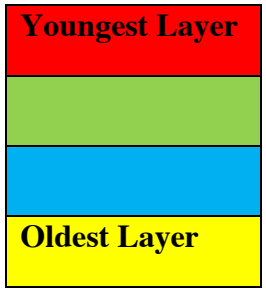
- **most species that have lived on the earth are now extinct.** Extinction of species is common. Extinction of species occurs when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Some organisms that lived long ago are similar to existing organisms, but some are quite different. Extinction of organisms is apparent in the fossil record.

- ***biological classification*** is a system which is used to organize and codify all life on Earth. There are a number of goals to biological classification, in addition to the obvious need to be able to precisely describe organisms. Creating a system of classification allows scientists to examine the relationships between various organisms, and to construct evolutionary trees to explore the origins of life on Earth and the relationship of modern organisms to historical examples. Biological classification is also referred to as ***taxonomy.*** Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.

Theory of Evolution: The theory states that species change over time. Living things evolve in response to changes in their environment. Charles Darwin is widely known as the "Father of Evolution". His theory of evolution is the widely held notion that all life is related and has descended from a common ancestor. As random genetic mutations occur within an organism's genetic code, the beneficial mutations are preserved because they aid survival -- a process known as *natural selection*. These beneficial mutations are passed on to the next generation. Over time, beneficial mutations accumulate and the result is an entirely different organism (not just a variation of the original, but an entirely different creature).

Plate Tectonics Theory: The movements of Earth's continental and oceanic plates have caused mountains and deep ocean trenches to form and continually change the shape of Earth's crust throughout time. These same movements have caused these plates to pass through different climatic ones. Natural processes and human activities result in environmental challenges. Sea level changes over time have expanded and contracted continental shelves, created and destroyed inland seas and shaped the surface of land. Sea level changes as plate tectonics cause the volume of the oceans and the height of land to change, as ice caps on land melt or enlarge and/or as sea water expands when ocean water warms and cools. The processes responsible for changes we observe today are similar to the processes that have occurred throughout Earth's history. The evolution of Earth's living things is strongly linked to the movements of the lithospheric plates. The movements of the plates cause changes in climate, in geographic features such as mountains, and in the types of living things in particular places.

Law of Superposition: Many thousands of layers of sedimentary rock provide evidence for the long history of the earth and for the long history of changing life forms whose remains are found in the rocks (fossils). More recently deposited rock layers are more likely to contain fossils resembling existing species.



The Law of Superposition states that in any undisturbed sequence of rocks deposited in layers, the youngest layer is on top and the oldest on bottom, each layer being younger than the one beneath it and older than the one above it.

8.L.4.2

Students know that:

- **within every population, variation exists within the inherited traits of the individuals.** Variation exists in the phenotypes (body structures and characteristics) of the individuals within every population. An organism's phenotype may influence its ability to find, obtain, or utilize its resources (food, water, shelter, etc.) and also might affect the organism's ability to reproduce.

- **in any particular environment, the growth and survival of organisms depend on physical conditions.** Changes in environmental conditions can affect the survival of individual organisms and entire species. If an environment changes, organisms that have characteristics which are well-suited to the new environment will be able to survive and reproduce at higher rates than those with less favorable traits. Therefore, the alleles associated with favorable phenotypes increase in frequency and become more common and increase the chances of survival of the species.

- **individual organisms with certain traits (those that are "favored" in the environment) are more likely than others to survive, reproduce and pass these "favorable" traits (such as courting behaviors, coloration or odors in plants and animals, competitive strength) to their offspring.** Those organisms that do not interact well with the environment are more likely to die or produce fewer offspring than those organisms having "favored" traits.

- **within a species there is a variability of phenotypic traits leading to diversity among the organisms of the species. The greater the diversity, the greater the chances are for that species to survive during environmental changes.**

Molecular Biology

Essential Standard and Clarifying Objectives

8.L.5 Understand the composition of various substances as it relates to their ability to serve as a source of energy and building materials for growth and repair of organisms.

8.L.5.1 Summarize how food provides the energy and the molecules required for building materials, growth and survival of all organisms (to include plants).

8.L.5.2 Explain the relationship among a healthy diet, exercise, and the general health of the body (emphasis on the relationship between respiration and digestion).

Unpacking

What does this standard mean a child will know, understand and be able to do?

8.L.5.1

Students know that:

- **food provides molecules that serve as fuel and building material for all organisms.** Plants use the energy in light to make sugars out of carbon dioxide and water. This food can be used immediately for fuel or materials or it may be stored for later use. Organisms that eat plants break down the plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

- **cells carry on the many functions needed to sustain life.** They grow and divide (mitosis or meiosis), thereby producing more cells. This requires that they take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs. The way in which all cells function is similar in all living organisms. Within cells many of the basic functions of organisms, such as releasing energy from food and getting rid of waste, are carried out by different cell elements.

- **matter is transferred among organisms in an ecosystem when organisms eat, or are eaten by others for food.** Matter is transferred from organisms to the physical environment when molecules from food react with oxygen to produce carbon dioxide and water in a process called cellular respiration. Through the process of cellular respiration, cells convert energy (glucose) to a usable form of energy (ATP). The energy stored in ATP provides the means by which cells are able to carry out their functions such as growth, development, and repair of organisms, locomotion and transportation of molecules across cell membranes.

- **in plants and animals, molecules from food (a) react with oxygen to provide energy that is needed to carry out life functions, (b)**

build and become incorporated into the body structure, or (c) are stored for later use. (Also in Matter and Energy)

- **matter moves within individual organisms through a series of chemical reactions in which food is broken down and rearranged to form new molecules.**
- **plants use the energy from light to make sugars (food) from carbon dioxide and water. This process transforms light energy from the sun into stored chemical energy.**
- **minerals and other nutrients from the soil are not food (they don't provide energy), but they are needed for plants to make complex molecules from the sugar they make.**
- **chemical energy is transferred from one organism in an ecosystem to another as the organisms interact with each other for food.**
- **the atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.** Over a long time, matter is transferred from one organism to another repeatedly and between organisms and their physical environment. As in all material systems, the total amount of matter remains constant, even though its form and location change.
- **energy can change from one form to another in living things. Animals get energy from oxidizing their food, releasing some of its energy as heat. Almost all food energy comes originally from sunlight.**

Teacher Notes:

1) The term *food* is commonly known as whatever nutrients plants and animals must take in if they are to grow and survive. In scientific terms, *food* refers only to those substances, such as carbohydrates, proteins, and lipids, from which organisms derive the energy they need to grow and operate and the material of which they are made. It is also important to emphasize that the sugars that plants make out of water and carbon dioxide are their only source of food. Water and minerals dissolved in it are not sources of energy for plants or for animals.

2) *It is not essential for students to know the structural components of proteins, lipids, and carbohydrates*.

8.L.5.2

Students know that:

- **A balanced diet combined with regular exercise aid in the overall general health of the body.** Humans require energy to function. The

total energy used by an individual depends on the type and intensity of the activity and the energy required for basic life processes. The amount of energy required to maintain minimum essential life functions is called *basal metabolic rate*, or BMR. Humans obtain the energy required to carry out basic life processes from the food they consume. Food energy is measured in calories. The amount of food energy (calories) a person requires varies with body weight, age, sex, activity level, and natural body efficiency.

- **For the body to use food (proteins, lipids, carbohydrates) for energy and building materials, the food must first be digested into molecules that are absorbed and transported to cells.**

- **Metabolism is the set of chemical reactions involved in storing fuel (food) molecules and converting fuel (food) molecules into energy.** In order for the body to use the fuel energy stored in food, the food must first be digested and combined with oxygen (oxidized).

- **Three factors contribute to the overall metabolic rate of the body.** The Basal Metabolic Rate (BMR) accounts for about 60% of all energy used by the body. Daily physical activities such as walking and moving around account for another 30% of the energy used by the body. Finally, 10% of the energy used by the body is used to digest and process (oxidize) food.

- **If one consumes more calories than the body uses, the excess is stored and weight is gained. Weight loss occurs when fewer calories are taken in than the body needs.**

- **To burn food for the release of energy stored in it, oxygen must be supplied to cells, and carbon dioxide removed**. The heart /lung system work together to deliver oxygen rich blood to all of the organs, tissues and cells of the body. Lungs take in oxygen for the combustion of food and they eliminate the carbon dioxide produced. The circulatory system moves all these substances to or from cells where they are needed or produced, responding to changing demands.

- **In order for systems to work properly, energy from the cells must be transformed into a useable form for cells and ultimately, organs, to perform work.** These systems work together in order for the body to function properly and maintain a balance. Regular exercise is important to maintain a healthy heart/lung system, good muscle tone, and bone strength. Regular exercise and physical activity increases the heart rate providing more oxygen for the body to use for processing food. A healthy body requires a delicate balance between a healthy diet and physical activity.

- **In order for energy balance to occur, Energy In = Energy Out.** This means that caloric intake equals caloric output. Food components (protein, fat, and carbohydrate) taken into the body have the following fates: they can be used to fuel metabolic activities and physical activities, they can be incorporated into growing body tissues, and they can be stored as fat.

- **There are two important concepts of energy balance for adolescents. First, to allow for normal body growth, more food energy must be consumed than can be accounted for solely on the basis of energy required for metabolic and physical activities. Second, insufficient energy intake may affect cellular metabolic activities, body weight, growth, tissue formation, and health.**

Teacher Note: It is not essential for students to know how to calculate calories and BMI or to know the USDA food pyramid/plate.

North Carolina Department of Public Instruction
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Essential Standards: Kindergarten Science ● Unpacked Content

For the Essential Standards that will be effective in all North Carolina schools in the 2012-13 school year.

What is the purpose of this document?
To increase student achievement by ensuring educators understand specifically what the new standards mean a student must know, understand and be able to do.

What is in the document?
Descriptions of what each standard means a student will know, understand and be able to do. The "unpacking" of the standards done in this document is an effort to answer a simple question "What does this standard mean that a student must know and be able to do?" and to ensure the description is helpful, specific and comprehensive for educators.

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Just want the standards alone?
You can find the standards alone at http://www.ncpublicschools.org/docs/acre/standards/phase1/science/k-2.pdf .

Forces and Motion

Essential Standard and Clarifying Objectives

K.P.1 Understand the positions and motions of objects and organisms observed in the environment.

K.P.1.1 Compare the relative position of various objects observed in the classroom and outside using position words such as: in front of, behind, between, on top of, under, above, below and beside.

K.P.1.2 Give examples of different ways objects and organisms move (to include falling to the ground when dropped):

- Straight
- Zigzag
- Round and round
- Back and forth
- Fast and slow

Unpacking

What does this standard mean a child will know, understand and be able to do?

K.P.1.1

Students know that their senses are used to make observations and learn about their environment. Students know that the position of an object can be described by locating the object relative to another object, fixed point, or background. Students know the difference between words used to describe the location of an object such as: (in front of, behind, between, on top of, under, above, below, beside) and can communicate using oral language so that all observers can agree on the position of an object in relation to another object.

K.P.1.2

Students know the various ways that living and nonliving things can move, to include falling to the ground when dropped unless something holds them up. Students know that earth pulls down on all objects. Students know how to observe, describe, and discuss all kinds of moving things—themselves, insects, birds, trees, doors, rain, fans, swings, volleyballs, wagons, etc.—keeping notes, drawing pictures to suggest their motion. Students know how to raise questions about the movement of various organisms to include: *Do they move in a straight line or zigzag?*

Is their motion fast or slow? How can you tell? How many ways does an organism move?

Matter: Properties and Change

Essential Standard and Clarifying Objectives

K.P.2 Understand how objects are described based on their physical properties and how they are used.

K.P.2.1 Classify objects by observable physical properties (including size, color, shape, texture, weight and flexibility).

K.P.2.2 Compare the observable physical properties of different kinds of materials (clay, wood, cloth, paper, etc) from which objects are made and how they are used.

Unpacking

What does this standard mean a child will know, understand and be able to do?

K.P.2.1

Students know objects and substances have properties. Students know objects can be described in terms of the materials they are made of (e.g., clay, cloth, paper) and their physical properties (e.g., color, size, shape, weight, texture, flexibility, magnetic attraction, floating or sinking in water). Students know some materials, such as clay and wood, make things hard and sturdy which helps to determine how they are used. Other materials such as cloth and paper make things flexible which gives them a different use compared to things that are hard.

K.P.2.2

Students know objects may be sorted based on a list of observable properties such as size, color, shape, texture, weight, and flexibility.

Earth Systems, Structures and Processes

Essential Standard and Clarifying Objectives

K.E.1 Understand change and observable patterns of weather that occur from day to day and throughout the year.

K.E.1.1 Infer that change is something that happens to many things in the environment based on observations made using one or more of their senses.

K.E.1.2 Summarize daily weather conditions noting changes that occur from day to day and throughout the year.

K.E.1.3 Compare weather patterns that occur from season to season.

Unpacking

What does this standard mean a child will know, understand and be able to do?

K.E.1.1

Students know how to use observation skills to note characteristics of their environment on a daily basis. Students know that the weather may be sunny one day and cloudy another day. Students know how to compare their observations and describe how each observation is similar to or different from a previous observation.

K.E.1.2

Students know that weather changes from day to day. Students know how to maintain a daily weather journal and describe how the weather changes daily.

K.E.1.3

Students build on the concept that change is something that happens to many things in the environment to include weather. Change can happen quickly or slowly. By observing daily weather changes, students can infer patterns that occur from season to season. Some weather patterns include sunny days, rainy days, windy or cloudy days, snowy days and stormy days. Students compare the weather patterns associated with each season: winter, spring, summer and fall (autumn). Students know seasons occur in a particular order and therefore the weather patterns associated with seasons occur in a particular order.

Structures and Functions of Living Organisms

Essential Standard and Clarifying Objectives

K.L.1 Compare characteristics of animals that make them alike and different from other animals and nonliving things.

K.L.1.1 Compare different types of the same animal (i.e. different types of dogs, different types of cats, etc.) to determine individual differences within a particular type of animal.

K.L.1.2 Compare characteristics of living and nonliving things in terms of their:

- Structure
- Growth
- Changes
- Movement
- Basic needs

Unpacking

What does this standard mean a child will know, understand and be able to do?

K.L.1.1

Students know that animals of the same type (i.e. dogs-spaniels/shepherds, cats- solids/tabby, birds-hawk/sparrow, etc.) have individual differences.

K.L.1.2

Students know living and nonliving things are made of parts and people give names to the parts that are different from the name of the whole object, plant or animal. Students know that the parts of living and nonliving things work best as a whole and some objects can easily be taken

apart and put back together again while other objects cannot be taken apart without damaging them (e.g., books, pencils, plants, and animals). Students know some of the characteristics that all animals share that can be used to compare living and nonliving things. Students know that all animals, including humans, have a basic structure that is similar in all animals of the same kind.

- **Structure**: Students know that the human body has distinct structures and that they serve different functions that is similar in other animals. Students know how to describe the structure of various animals, to include humans, and tell how the structures are alike and different and how each structure is used in a similar or different way.
- **Growth and Changes:** Students observe and compare how different organisms grow and develop over time. Students know that animals change as they grow. The distinct stages of growth and change are called a *life cycle*. The life cycle begins when the organism is born and begins to develop and ends when the organism dies.
- **Movement:** Students know how various animals move noting similarities and differences.
- **Basic needs:** Students know that all animals are living things that have basic needs to stay alive. Animals need air, water, food, and shelter for protection. If an organism does not get everything that it needs to stay alive, it will die. By comparing these characteristics of several animals, students begin to classify things as living and nonliving based on these characteristics.

Students know that animals (including humans) are living things that grow and develop, and need food, air, and water but nonliving things do not. At this grade level, it is appropriate to define living things as anything that is alive or has ever been alive and nonliving as anything that is not now and has never been alive.

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Essential Standards: Physical Science ● Unpacked Content

For the new Essential Standards that will be effective in all North Carolina schools in the 2012-13.

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Note on Numbering: **PSc**–Physical Science

Forces and Motion

Essential Standard and Clarifying Objectives

PSc.1.1 Understand motion in terms of speed, velocity, acceleration, and momentum.

PSc.1.1.1 Explain motion in terms of frame of reference, distance, and displacement.

PSc.1.1.2 Compare speed, velocity, acceleration, and momentum using investigations, graphing, scalar quantities, and vector quantities.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.1.1.1

- Interpret all motion as relative to a selected reference point. Identify distance and displacement as a scalar-vector pair.
- Describe motion qualitatively and quantitatively in terms of an object's change of position, distance traveled, and displacement.

PSc.1.1.2

- Compare speed and velocity as a scalar-vector pair. Velocity is a relationship between displacement and time: $\bar{v} = \frac{\Delta d}{\Delta t}$
- Apply concepts of average speed and average velocity to solve conceptual and quantitative problems.
- Explain acceleration as a relationship between velocity and time: $\bar{a} = \frac{\Delta v}{\Delta t}$
- Using graphical analysis, solve for displacement, time, and average velocity. Analyze conceptual trends in the displacement vs. time graphs such as constant velocity and acceleration.
- Using graphical analysis, solve for velocity, time, and average acceleration. Analyze conceptual trends in the velocity vs. time graphs such as constant velocity and acceleration.
- Infer how momentum is a relationship between mass and velocity of an object, $p = mv$. The focus should be on the conceptual understanding that the same momentum could be associated with a slow-moving massive object and an object moving at high velocity with a very small mass (e.g.- 100 kg object moving 1 m/s has the same momentum as a 1-kg object moving 100m/s)
- Explain change in momentum in terms of the magnitude of the applied force and the time interval that the force is applied to the object. Everyday examples of the impulse/momentum relationship include: the use of airbags in cars; time of contact and "follow-through" in

throwing, catching, kicking, and hitting objects in sports; bending your knees when you jump from a height to the ground to prevent injury.

Essential Standard and Clarifying Objectives

PSc.1.2 Understand the relationship between forces and motion.

PSc.1.2.1 Explain how gravitational force affects the weight of an object and the velocity of an object in freefall.

PSc.1.2.2 Classify frictional forces into one of four types: static, sliding, rolling, and fluid.

PSc.1.2.3 Explain forces using Newton's three laws of motion.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.1.2.1

- Recognize that the weight of an object is a measure of the force of gravity and is the product of its mass and the acceleration due to gravity: $F_g = mg$
- With negligible air resistance, explain acceleration due to gravity as an example of uniformly changing velocity: $g = 9.8\frac{m}{s^2}$
- Relate the presence of air resistance to the concept of terminal velocity of an object in free fall.

PSc.1.2.2

- Identify friction as a force that opposes motion of an object. (Review from middle school.)
- Classify the frictional forces present in a situation such as a book resting on a table (static), a box pushed across the floor (sliding), a ball rolling across the floor (rolling), a boat moving through a river (fluid), or an object in free-fall (fluid).

PSc.1.2.3

- Explain the property of inertia as related to mass - the motion of an object will remain the same (either at rest or moving at a constant speed in a straight line) in the absence of unbalanced forces; if a *change in motion* of an object is observed, there must have been a net force on the object.
- Explain balanced and unbalanced forces mathematically and graphically with respect to acceleration to establish the relationship between net force, acceleration, and mass: $a \propto F$ and $a \propto \frac{1}{m}$ (no trigonometry).

- Explain qualitatively and quantitatively the relationship between force, mass and acceleration– the greater the force on an object, the greater its change in motion; however, the *same amount of force* applied to an object with *less mass* results in a *greater acceleration*.
- While the second law describes a single object, forces always come in equal and opposite pairs due to interaction between objects. Give examples of interaction between objects describing Newton's third law – whenever one object exerts a force on another, an equal and opposite force is exerted by the second on the first. The third law can be written mathematically as $F_{A\to B} = -F_{B\to A}$. Students should explain why these forces do not "cancel each other out".

Matter: Properties and Change

Essential Standard and Clarifying Objectives

PSc.2.1 Understand types, properties, and structure of matter.

PSc.2.1.1 Classify matter as homogeneous or heterogeneous; pure substance or mixture; element or compound; metals, nonmetals, or metalloids; solution, colloid, or suspension.

PSc.2.1.2 Explain the phases of matter and the physical changes that matter undergoes.

PSc.2.1.3 Compare physical and chemical properties of various types of matter.

PSc.2.1.4 Interpret the data presented in the Bohr model diagrams and dot diagrams for atoms and ions of elements 1 through 18.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.2.1.1

- Classify a sample of matter as homogeneous or heterogeneous based on uniformity of the material.
- Classify a sample of matter as a pure substance or mixture based on the number of elements or compounds in the sample.
- Classify an element as a metal, nonmetal, or metalloid based on its location on the periodic table.
- Classify a substance as an element or compound using its chemical formula.
- Classify samples and sets of matter as a solution, colloid or suspension based on the application of characteristic properties: particle size, "settling out" of one or more components, and interaction with light (Tyndall Effect).

PSc.2.1.2

- Develop a conceptual cause-and-effect model for the phase change process that shows the relationship among particle attraction, particle motion, and gain or loss of heat - when a solid melts it has absorbed heat that increased the potential energy of its particles (space between particles) thus reducing the attraction between particles so that they can flow in a liquid phase. (Consider conditions of normal atmospheric pressure as well as the qualitative affects of changes in pressure involving gases.)
- The focus should be on the following phase changes: solid to liquid (melting), liquid to gas (vaporization), gas to liquid (condensation), and liquid to solid (freezing).
- Compare the process of evaporation to vaporization – materials that evaporate verses those which do not; attraction between surface particles and colliding air molecules.
- Recognize that the formation of solutions is a physical change forming a homogenous mixture. (Review from 8^{th} grade.)
- Develop a conceptual model for the solution process with a cause and effect relationship involving forces of attraction between solute and solvent particles. A material is insoluble due to a lack of attraction between particles.
- Interpret solubility curves to determine the amount of solute that can dissolve in a given amount of solvent (typically water) at a given temperature.
- Qualitatively explain concentration of solutions as saturated, unsaturated or supersaturated; dilute or concentrated.

PSc.2.1.3

- Calculate the density of different substances using the relationship $D = \frac{m}{V}$.
- Compare physical properties of a mixture that could be used to separate its components such as solubility, density, boiling point, magnetic property, etc.
- Compare various physical and chemical properties of metals, nonmetals and metalloids such as state of matter at a given temperature, density, melting point, boiling point, luster, conductivity, ductility, malleability, color, reactivity, etc.
- Compare physical and chemical properties of various everyday materials such as salt, sugar, baking soda, corn starch, rubbing alcohol, water, etc.

PSc.2.1.4

- Describe the charge, relative mass, and the location of protons, electrons, and neutrons within an atom.
- Calculate the number of protons, neutrons, electrons, and mass number in neutral atoms and ions.
- Explain how the different mass numbers of isotopes contributes to the average atomic mass for a given element (conceptual, no calculations).
- Use isotopic notation to write symbols for various isotopes (ex. Carbon-12, C-12, ^{12}C, etc.)
- Explain Bohr's model of the atom.

- Draw Bohr models from hydrogen to argon including common isotopes and ions.
- Construct dot diagrams, a shorthand notation for Bohr models, using the element symbol and dots to represent electrons in the outermost energy level.

* Note: While there is value in students understanding the historical development of atomic theory, the focus is on understanding the relationship between structure and properties of matter. The Quantum Mechanical Model of the atom provides a more in-depth understanding of atomic structure; it can be included as an enrichment topic, but goes beyond the level of the objective. Students taking Chemistry would extend to this depth of understanding.

Essential Standard and Clarifying Objectives

PSc.2.2 Understand chemical bonding and chemical interactions.

PSc.2.2.1 Infer valence electrons, oxidation number, and reactivity of an element based on its location in the Periodic Table.
PSc.2.2.2 Infer the type of chemical bond that occurs, whether covalent, ionic, or metallic, in a given substance.
PSc.2.2.3 Predict chemical formulas and names for simple compounds based on knowledge of bond formation and naming conventions.
PSc.2.2.4 Exemplify the law of conservation of mass by balancing chemical equations.
PSc.2.2.5 Classify types of reactions such as synthesis, decomposition, single replacement, or double replacement.
PSc.2.2.6 Summarize the characteristics and interactions of acids and bases.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.2.2.1

- Predict the number of valence electrons of representative elements (A Groups or 1, 2, 13-18) based on its location in the periodic table.
- Predict an element's oxidation number based on its position in the periodic table and valence electrons. (Representative groups including multiple oxidation states for tin and lead.)
- Predict reactivity of metals and nonmetals from general periodic trends.

PSc.2.2.2

- Describe how ionic, covalent, and metallic bonds form and provide examples of substances that exhibit each type of bonding.
- Predict the type of bond between two elements in a compound based on their positions in the periodic table.

PSc.2.2.3

- Name and write formulas for simple binary compounds containing a metal and nonmetal using representative elements (A Groups or 1, 2, 13-18) and compounds involving common polyatomic ions: ammonium (NH_4^+), acetate ($C_2H_3O_2^-$), chlorate (ClO_3^-), nitrate (NO_3^-), hydroxide (OH^-), carbonate (CO_3^{2-}), sulfate (SO_4^{2-}), phosphate (PO_4^{3-}).
- Name and write formulas for binary compounds of two nonmetals using Greek prefixes (mono-, di-, tri-, tetra-, etc.).

PSc.2.2.4

- Use coefficients to balance simple chemical equations involving elements and/or binary compounds.
- Conclude that chemical equations must be balanced because of the law of conservation of matter.

PSc.2.2.5

- Classify chemical reactions as one of four types: single replacement, double replacement, decomposition and synthesis. (Neutralization reaction is a type of double replacement reaction.)
- Summarize reactions involving combustion of hydrocarbons as *not* fitting into one of these four types. Hydrocarbon + oxygen → carbon dioxide + water

PSc.2.2.6

- Recognize common inorganic acids including hydrochloric (muriatic) acid, sulfuric acid, acetic acid, nitric acid and citric acid.
- Recognize common bases including sodium bicarbonate, and hydroxides of sodium, potassium, calcium, magnesium, barium and ammonium.
- Define acids and bases according to the Arrhenius theory.
- Develop an understanding of the pH scale and the classification of substances therein.
- Generalize common characteristics of acids and bases– pH range, reactivity with metals and carbonates (acids) or fats/oils (bases), conductivity.
- Relate general household uses of acids and bases with their characteristic properties.
- Explain what happens in a neutralization reaction, identifying each component substance.

Essential Standard and Clarifying Objectives

PSc.2.3 Understand the role of the nucleus in radiation and radioactivity.

PSc.2.3.1 Compare nuclear reactions including: alpha decay, beta decay, and gamma decay; nuclear fusion and nuclear fission.
PSc.2.3.2 Exemplify the radioactive decay of unstable nuclei using the concept of half-life.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.2.3.1

- Compare the characteristics of alpha and beta particles and gamma rays – composition, mass, penetrability.
- Compare alpha, beta, and gamma decay processes –alpha decay reduces the mass of an atom by 4 and the atomic number by 2; beta decay increases the atomic number by 1 (a neutron decays into a proton and electron); gamma rays are electromagnetic waves released from the nucleus along with either an alpha or beta particle.
- Compare the processes of fission (splitting of a very large atom) and fusion (joining of atoms) in terms of conditions required for occurrence, energy released, and the nature of products.

PSc.2.3.2

- Conceptually explain half-life using models.
- Perform simple half-life calculations based on an isotope's half-life value, time of decay, and/or amount of substance.

Energy: Conservation and Transfer

Essential Standard and Clarifying Objectives

PSc.3.1 Understand types of energy, conservation of energy and energy transfer.

PSc.3.1.1 Explain thermal energy and its transfer.
PSc.3.1.2 Explain the law of conservation of energy in a mechanical system in terms of kinetic energy, potential energy and heat.
PSc.3.1.3 Explain work in terms of the relationship among the applied force to an object, the resulting displacement of the object, and the energy transferred to an object.
PSc.3.1.4 Explain the relationship among work, power and simple machines both qualitatively and quantitatively.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.3.1.1

- Infer the ability of various materials to absorb or release thermal energy in order to conceptually relate mass, specific heat capacity, and temperature of materials to the amount of heat transferred. (Calculations with $q = mC_p\Delta T$ should be used to aid in conceptual development through laboratory investigation and analysis, not as problem-solving exercises.)
- Compare thermal energy, heat, and temperature.
- Relate phase changes to latent heat that changes the potential energy of particles while the average kinetic energy of particles (temperature) remains the same. (Link to PSc.2.1.2)
- Compare conduction, convection, and radiation as methods of energy transfer.

PSc.3.1.2

- Exemplify the relationship between kinetic energy, potential energy, and heat to illustrate that total energy is conserved in mechanical systems such as a pendulum, roller coaster, cars/balls on ramps, etc.
- Relate types of friction in a system to the transformation of mechanical energy to heat.

PSc.3.1.3

- Explain scenarios in which work is done, identifying the force, displacement, and energy transfer- work requires energy; when work is done on an object, the result is an increase in its energy and is accompanied by a decrease in energy somewhere else.

- Compare scenarios in which work is done and conceptually explain the differences in magnitude of work done using the relationship $W = F\Delta d$.

PSc.3.1.4

- Infer the work and power relationship: $P = \frac{W}{\Delta t} = \frac{F\Delta d}{\Delta t} = F\bar{v}$
- Determine the component simple machines present in complex machines – categorize a wedge and screw as variations of an inclined plane; a pulley and wheel & axle as variations of a lever.
- Explain the relationship between work input and work output for simple machines using the law of conservation of energy.
- Define and determine ideal and actual mechanical advantage: $IMA = \frac{d_E}{d_R}$ $AMA = \frac{F_R}{F_E}$
- Define and determine efficiency of machines: $Efficiency = \frac{W_{out}}{W_{in}} x100$
- Explain why no machine can be 100% efficient.

Essential Standard and Clarifying Objectives

PSc.3.2 Understand the nature of waves.

PSc.3.2.1 Explain the relationships among wave frequency, wave period, wave velocity, amplitude, and wavelength through calculation and investigation.
PSc.3.2.2 Compare waves (mechanical, electromagnetic, and surface) using their characteristics.
PSc.3.2.3 Classify waves as transverse or compressional (longitudinal).
PSc.3.2.4 Illustrate the wave interactions of reflection, refraction, diffraction, and interference.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.3.2.1

- Identify the basic characteristics of a longitudinal (compressional) wave: amplitude, rarefaction, and compression.
- Recognize the relationship between period and frequency (focus on conceptual understanding of this inverse relationship).

- Explain the relationships among velocity, frequency, and wavelength and use it to solve wave problems: $v_w = f\lambda$
- Exemplify wave energy as related to its amplitude and independent of velocity, frequency or wavelength.

PSc.3.2.2
- Classify waves as one of three types: mechanical, electromagnetic or surface waves based on their characteristics.
- Compare different wave types based on how they are produced, wave speed, type of material (medium) required, and motion of particles.

PSc.3.2.3 Compare compressional (longitudinal) and transverse waves in terms of particle motion relative to wave direction.

PSc.3.2.4
- Illustrate reflection and refraction of waves at boundaries: reflection of a transverse pulse at the fixed-end of a spring or rope; reflection of sound (SONAR) and radio waves (RADAR); reflection of water (surface) waves; refraction of water waves as the depth of the water changes; sound as it changes media; refraction of light as it passes from air into water, glass, oil etc.
- Illustrate the effects of wave interference (superposition)–constructive and destructive interference of surface waves, mechanical waves (sound, pulses in springs/ropes, etc.), light (soap bubbles/thin films, diffraction gratings). Emphasis is on conceptual understanding – not mathematical relationships.

Essential Standard and Clarifying Objectives

PSc.3.3 Understand electricity and magnetism and their relationship.

PSc.3.3.1 Summarize static and current electricity.
PSc.3.3.2 Explain simple series and parallel DC circuits in terms of Ohm's law.
PSc.3.3.3 Explain how current is affected by changes in composition, length, temperature, and diameter of wire.
PSc.3.3.4 Explain magnetism in terms of domains, interactions of poles, and magnetic fields.
PSc.3.3.5 Explain the practical application of magnetism.

Unpacking

What does this standards mean a child will know and be able to do?

PSc.3.3.1
- Identify interactions between charged objects - opposite charges attract and like charges repel.
- Compare the three methods of charging objects: conduction, friction, and induction – explain the re-distribution or transfer of electrons for

each method for both positively and negatively charged objects.
- Compare static and current electricity related to conservation of charge and movement of charge (without calculations).

PSc.3.3.2
- Interpret simple circuit diagrams using symbols.
- Explain open and closed circuits.
- Apply Ohm's law and the power equation to simple DC circuits: $V = IR$ and $P = VI$.
- Compare series and parallel circuits. Conceptually explore the flow of electricity in series and parallel circuits. (Calculations may be used to develop conceptual understanding or as enrichment.)
- Explain how the flow of electricity through series and parallel circuits is affected by voltage and resistance.

PSc.3.3.3
- Explain how the wire in a circuit can affect the current present – for a set voltage, the current in a wire is inversely proportional to its resistance (more current exists where resistance is low); the resistance of a material is an intensive property called resistivity; increasing the length of a wire increases the resistance; increasing the temperature increases the resistance; increasing the diameter of a wire decreases its resistance.
- Explain using a cause-and-effect model how changes in composition, length, temperature, and diameter of a wire would affect the current in a circuit.

PSc.3.3.4
- Describe the characteristics and behaviors of magnetic domains.
- Explain the attractions of unlike poles and the repulsion of like poles in terms of magnetic fields.
- Explain magnetic fields produced around a current-carrying wire and wire coil (solenoid).
- Explain the relationship between strength of an electromagnet and the variance of number of coils, voltage, and core material.

PSc.3.3.5
- Explain the relationship between electricity and magnetism in practical applications such as generators and motors – the process of electromagnetic induction in electric generators that converts mechanical energy to electrical energy; transformation of electric energy to mechanical energy in motors.
- Extrapolate other practical applications such as security cards (ATM, credit or access cards), speakers, automatic sprinklers, traffic signal triggers, seismometers, battery chargers, transformers, AC-DC adapters.