Grade Three Science Content Standards

Students in grade three are introduced to some of the most fundamental patterns in nature and should be taught that science makes the world understandable. For example, by observing that the stars appear fixed in relation to one another, one can identify five planets in motion against the starry background. Students in grade three begin to build a foundation for understanding the structure of matter and forces of interaction. They will study the properties of light and gain an appreciation for how light affects the perception of direction, shadow, and color. Students in grade three will also extend their knowledge of ecology by learning about different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands, and the types of organisms adapted to live in each.

The curriculum and instruction offered in grade three enable students to read materials independently with literal and inferential comprehension and to support answers to questions about the material by drawing on background knowledge and details from the text. Instruction in information literacy that incorporates library resources will help students become skilled in locating information in texts by using titles, tables of contents, chapter headings, glossaries, and indexes. The science standards complement the mathematics standards by asking students to predict future events on the basis of observed patterns and not by random guessing.

STANDARD SET 1. Physical Sciences (Energy and Matter)

The discussion of energy and matter in grade three is at a simple level, but it sets a foundation for further study in later grade levels. Students learn that energy may be stored in various ways and that both living organisms and machines convert stored energy into heat and motion. Matter will also be studied in more detail than at the previous grade levels. Atoms will be introduced as the smallest component of the elements that compose all matter. Students will learn that there are different kinds of atoms and that their names and symbols are displayed on the periodic table of the elements. This standard set will prepare the students for a more detailed treatment of the properties of the elements and their combinations in grade five.

1. Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept:

a. *Students know* energy comes from the Sun to Earth in the form of light.

Energy is a physical attribute capable of causing changes in material objects. This concept is one of the more important ones in science. At a simple level, and

certainly for the treatment of the subject in grade three, energy is the ability to do work; to make things move, stretch, or grow; or to cause physical and chemical changes. Throughout the study of science, many more forms of energy and their effects will become evident. Students in grade three should understand that Earth's major source of energy is the Sun and that the Sun's energy is seen as light and felt as heat. It is important for students to realize that although light and heat are not exactly the same, both are forms of energy.

1. b. *Students know* sources of stored energy take many forms, such as food, fuel, and batteries.

Students should understand that the energy stored in food, fuel, and batteries can be released to create useful motion, light, and heat. For example, students may study the components of a flashlight and leave it on until the light goes out to emphasize that batteries store a limited amount of energy. Matches and candles are cold before lighting; but when burned, their stored energy is released in the form of light and heat. Students should be taught that they eat food in order to use its stored energy to make it possible for them to grow, maintain their warm body temperature, and be able to work and play. Teachers should note that all those forms of stored energy are contained in chemical substances and released through chemical changes.

1. c. *Students know* machines and living things convert stored energy to motion and heat.

This standard expands concepts introduced in earlier grades. The way in which machines and living things take different sources of energy and produce useful heat and motion should be examined in greater detail. An automobile engine releases the chemical energy stored in gasoline (and air) and uses it to turn the wheels and move the vehicle. Some students may be familiar with wind-up toys and will be able to understand that the potential energy stored in springs is used to turn the gears that activate the toy. Similarly, the energy stored in natural gas is converted to heat in a gas stove, oven, or furnace. Students learn that food is broken down into smaller components; some components are carried to the muscles, where the energy stored is released as movement and as heat, keeping the human body warm.

1. d. *Students know* energy can be carried from one place to another by waves, such as water waves and sound waves, by electric current, and by moving objects.

Energy movement or transfer should be discussed in terms of moving objects (e.g., thrown balls), waves (e.g., light, sound, seismic or earthquake waves, and ocean waves), and electricity (charges passing through a wire). The key point in this

standard is that energy is carried in those forms and transferred from one place to another. Simple toys that demonstrate transfer of motion to another object are good examples of this principle and form the foundation for understanding the conservation of energy. Energy of motion is transferred into heat through friction (such as when students rub their hands together rapidly and feel the heat generated by the rubbing motion).

Students can also study how waves transfer energy from one place to another through a medium (water or air), with no net motion or flow of matter. Students can demonstrate this principle by creating waves in a tub of water that contains materials (e.g., cork stoppers or small balls) floating on the water. Energy is required to start the wave at one end and is then transferred to the objects in the water, generating a bobbing motion. The students should note that this action can be accomplished without any net transfer of water from one end to the other. They should observe that waves make floating objects bob up and down and back and forth, but the objects stay in essentially the same position as they were in before the waves were generated.

Sound is made by vibrating objects and is carried in compression waves through the air. Sound can create vibrations in a distant second object (such as an eardrum) without direct physical contact between the two objects.

The evidence for electrical energy transfer surrounds students in their everyday lives. Electrical energy comes from power plants that may use fossil fuels, water, wind, or nuclear power. The key idea is that electrical energy has a source, is carried in wires as electricity, and is converted to more easily recognized forms of energy (such as heat, light, and motion).

1. e. *Students know* matter has three forms: solid, liquid, and gas.

Students in grade three must understand that matter is a substance that occupies space and may assume the form of a solid, liquid, or gas. Students should view pictures and read articles about lava and molten steel to make the point that most substances can turn to liquid when heated to a high enough temperature. Likewise, a gas can turn to a solid if sufficiently cooled. For example, carbon dioxide, a gas at room temperature, can be frozen into dry ice.

1. f. *Students know* evaporation and melting are changes that occur when the objects are heated.

This standard is an extension of what students will have learned about water in kindergarten and grade one. New to them is the generalization that melting and evaporation are processes that may occur when substances other than water are heated. Books and videos from the school library that show the process of making iron and steel may be helpful in providing instruction on this standard.

1. g. *Students know* that when two or more substances are combined, a new substance may be formed with properties that are different from those of the original materials.

This standard introduces the idea that pure substances have a fundamental character that is necessary in order to distinguish chemical changes from physical changes. Students are asked to build on some concepts that were introduced in earlier grades concerning changes in state and properties that may occur when two substances are mixed and react. Some students may begin to realize that there is a difference between mixtures and pure substances. The focus is on the new and different properties that are formed when two or more substances are mixed. The chemical reaction that occurs between baking soda and vinegar, producing carbon dioxide (and sodium acetate and water), is one of several simple reactions that may be used to illustrate this difference. Teachers can also use the burning of a candle to demonstrate this concept. The products with very different properties are the carbon dioxide gas and the soot produced and the heat and light released. Water vapor, also formed by burning a candle, may be observed as condensation on a cool object held above the candle.

1. h. *Students know* all matter is made of small particles called atoms, too small to see with the naked eye.

The important idea to convey is that all familiar substances are made of *atoms,* the term for the smallest particles of matter that retain the properties of the elements. To understand atoms, students must first be introduced to the idea that *matter* is the general name given to anything that has mass and occupies space. They should then be taught that matter comprises all solids, liquids, and even invisible gases. Just as a brick wall consists of many individual bricks, all matter consists of smaller bits that combine to make up what is seen. Students can discover this principle by looking through an inexpensive 30-power (30x) microscope to discover that the apparently solid colors on the cover of magazines actually consist of repeated patterns of colored dots.

Atoms are so tiny that detection requires techniques that go beyond the power of conventional microscopes. The following imaginary experiment may be helpful in understanding the basic concept of the atom. If a student were to take an object made of a pure element, such as a piece of aluminum foil, and cut it in half, both halves are still aluminum. If each of these pieces is then cut in half a second, third, fourth, and fifth time, the pieces become progressively smaller but are still aluminum. Is it possible to keep cutting the pieces in half forever and still have a piece of aluminum? How small must a piece be so that at the next cut it will no longer be aluminum? In pondering this question, early philosophers concluded that there must be a very small but indivisible piece of matter that still has the properties of aluminum or any other element. They named these smallest pieces *atoms.*

1. i. *Students know* people once thought that earth, wind, fire, and water were the basic elements that made up all matter. Science experiments show that there are more than 100 different types of atoms, which are presented on the periodic table of the elements.

In ancient times people believed that everything was made of combinations of just four elements: earth, air, fire, and water. This belief is understandable when one observes a log burn to become ash, fire, and hot gases, some of which condense into water. The Greeks, however, conjectured that matter is made of tiny particles. Today this belief is known to be true, and those particles are called *atoms.* More than 100 different types of elements are displayed on the periodic table of the elements. Students in grade three should know a chart exists that displays the names and symbols of known elements and other information.

The names of elements may fascinate students. Many elements may be familiar to the students (e.g., gold, silver, copper, iron, oxygen), but some will not be familiar. Students may enjoy finding names of familiar elements on the table. The custom of science is that discoverers have the right to name their elements. Some elements, such as einsteinium and seaborgium, are named after famous scientists (Albert Einstein and Glenn Seaborg) whose personal lives are the basis of interesting stories. Students may be fascinated to learn that one element is named californium and one is named for the city of Berkeley: berkelium. An important concept for students to know is that any substance not listed on the periodic table comprises a combination of different types of atoms (elements) that are listed. Living organisms, for example, are mostly made up of carbon, oxygen, nitrogen, and hydrogen atoms.

STANDARD SET 2. Physical Sciences (Light)

Light, like heat, is a form of energy. Standard Set 2 calls for students to know some of the properties of light but does not require them to understand light as energy in a waveform. They should know that light travels in a straight line away from its source and that the color of an object is affected by the color of light that strikes it.

2. Light has a source and travels in a direction. As a basis for understanding this concept:

a. *Students know* sunlight can be blocked to create shadows.

Teachers may draw an analogy between an opaque object casting a shadow in sunlight and the dry place created when an umbrella blocks the fall of raindrops. The energy of sunlight is absorbed by the opaque object and is prevented from passing through to the ground. Students should be encouraged to experiment with shadows and to think about the source and direction of the light. They can cut

cardboard into different shapes, compare the size and shape of the cardboard with the size and shape of its shadow, and notice whether the edges of the shadows are sharp or fuzzy.

2. b. *Students know* light is reflected from mirrors and other surfaces.

Light reflected from a mirror or other surface changes direction by reflection and then continues to travel in a straight line. To demonstrate reflection and note the path of a reflected beam of light, the teacher or a group of students can use chalk dust or a water mist to help trace the path of the light beam in a darkened room.

2. c. *Students know* the color of light striking an object affects the way the object is seen.

Two factors determine the color of an object: the color of the light illuminating the object and the interaction of the light with the object; for example, which colors are absorbed and which are reflected. Students can see this principle for themselves by being asked to describe an object's color viewed under lights of different colors. Because sunlight contains all the colors of the rainbow, light sources of different colors can be created by passing sunlight through colored cellophane. This principle can also be demonstrated by using colored light bulbs. To explore the principle in the standard, students may observe that a white object will be seen as the color of the light that illuminates it. For example, if a white piece of paper is seen under red lights, it appears to be a red piece of paper.

2. d. *Students know* an object is seen when light traveling from the object enters the eye.

Light is a form of energy to which the eye is sensitive. An object can be seen because the light that travels from the object enters and interacts with the eye. If opaque material comes between the eye and an object being viewed, the opaque material blocks the light and the object disappears from view, demonstrating that light travels in a straight line.

STANDARD SET 3. Life Sciences

The life sciences standards in grade three continue to develop students' concepts of ecology and evolution by relating adaptation to the survival and fitness of the organism. Although natural selection is not formally discussed at this grade level, the foundation is set for teaching that principle in later grade levels. A significant effort is made to enhance students' knowledge of the types of plants and animals in different environments as this understanding becomes an important base of knowledge. These standards challenge students to consider the effects of environmental changes on organisms. The concept of extinction

is introduced, and organisms in the fossil record are compared to contemporary organisms.

3. Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

a. *Students know* plants and animals have structures that serve different functions in growth, survival, and reproduction.

Students have learned about the roots and leaves of plants in grade one and the functions of flowers and fruit in grade two. Many other external structures of plants and animals (e.g., cactus thorn, porcupine quill, crab shell, bear claw, and kangaroo pouch) serve important functions, and students in grade three will recognize many common examples through reading and observing examples from nature. This standard can be taught in the context of the one that follows and can serve as the basis for extended study and discussion.

3. b. *Students know* examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

The organisms that live in oceans, deserts, tundras, forests, grasslands, and wetlands are different from one another because their environments are different. For example, animals with thick fur are able to survive a cold habitat. Gills allow fish to obtain oxygen from water, whereas lungs allow mammals to obtain oxygen from the atmosphere. Desert plants and animals have adapted by conserving the small amount of water they require. The thick, waxy leaves of some plants prevent water loss. Many desert animals are nocturnal and search for food during the cool of night.

Students should be taught about Earth's different habitats or *biomes* and be able to describe the characteristics of some of the plants and animals living in each. Students should be encouraged to locate information in nonfiction books and other library resources and be able to describe how living organisms are adapted for survival in their particular biome.

3. c. *Students know* living things cause changes in the environment in which they live: some of these changes are detrimental to the organism or other organisms, and some are beneficial.

Living organisms, including humans, inevitably cause changes (some minor and some major) in the environment as the organisms compete for food, shelter, light, and water. Those changes are different from external changes, such as a fire started by lightning or flooding related to excessive rainfall. When some organisms become more or less successful in their quest for survival, the environmental balance changes and so does the environment. For example, beavers build dams that block streams, forming small lakes in which they can then reside. This activity is

beneficial to plants and animals that prefer to live in still water, but it is detrimental to plants and animals that are used to living in an open stream. It is also detrimental to large trees as they are cut and become material for the beaver. Trees affect the environment by blocking the sunlight; consequently, the felling of a large tree by a beaver may benefit smaller plants and shrubs that can now grow in its place. These examples are some of the types of environmental relationships studied by ecologists.

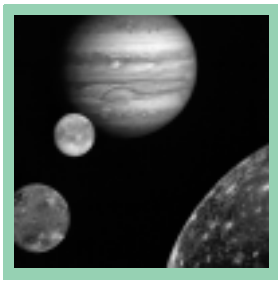
3. d. *Students know* when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

Many plants and animals have specialized structures that allow them to survive and reproduce in the environment in which they live. Consequently, they may be adversely affected by environmental changes. For example, many plants and animals not suited to desert conditions will die if their environment becomes dry and desertlike for an extended period of time. Plants and animals establish a balance with one another in their shared environment. Consequently, environmental changes that affect one or more plants or animals in a given biome may eventually affect all living organisms in that biome. Animals may move, and seeds may be blown or carried to new, more favorable locations.

3. e. *Students know* that some kinds of organisms that once lived on Earth have completely disappeared and that some of those resembled others that are alive today.

When an environment changes more quickly than a species of animal or plant can adapt, that species may become extinct. Fossils provide numerous examples of extinct plants and animals. By studying the characteristics of fossils, students can see that some extinct animals resemble animals that are alive today and that others are quite different.

Students can relate modern animal remains to the environments from which they came and then they can apply the same types of observations and reasoning to determine the kind of environment that may have supported the fossilized animals and plants.



STANDARD SET 4. Earth Sciences

Earth sciences standards in grade three center on the concept that objects in the sky move in regular and predictable patterns. It is important that students know and are familiar with the patterns and movements of the Sun, Moon, and stars, both as those bodies actually move and as they appear to move when viewed from Earth. Seasonal changes correlate with changes in both the amount of daily sunlight and the position of the Sun in the sky. Seasonal changes are caused by the tilt of Earth's axis of rotation and the position of Earth relative to the Sun. Students will also learn about the relationships between

the phases of the Moon and the changes in the positions of the Sun and Moon. Using models and telescopes may help students grasp the concepts presented in the standards.

4. Objects in the sky move in regular and predictable patterns. As a basis for understanding this concept:

a. *Students know* the patterns of stars stay the same, although they appear to move across the sky nightly, and different stars can be seen in different seasons.

The relative position of stars with respect to each other in the night sky is fixed. The apparent motion of the stars through the night sky is a function of Earth turning on its own axis. Starlike objects do move across the fixed pattern of stars in the night sky, but those "stars" are really planets. Stars appear stationary relative to one another because they are far outside the solar system. The positions of stars appear to change each season from a particular point of view on Earth because that point will face progressively different parts of the universe at night. The stars that are visible in the summer nighttime sky would be visible in the winter daytime sky if they were bright enough to outshine the Sun.

4. b. *Students know* the way in which the Moon's appearance changes during the four-week lunar cycle.

Students should be taught to observe the phases of the Moon; recognize the pattern of changes; and know such terms as the *full, quarter, waxing, waning,* and *crescent Moon.* The reason for this pattern of changes may then be explored.

One side of the Moon is always in sunlight (except in the case of an eclipse). How much of the sunlit surface of the Moon will be visible from Earth depends on the relative positions of Earth, the Moon, and the Sun. Earth and the Moon continuously cycle through changes in their positions relative to the Sun; therefore, the Moon will go through phases from "new" to "full" depending on how much of its lighted surface is visible from Earth.

Models may help in the teaching of the standard. Students may be shown the rotation of Earth on its axis; how the day and night cycle works; and why the Moon, like the Sun, appears to rise and set. Students may also be shown Earth's position relative to the Sun, the Moon's position relative to Earth, and how Earth orbits the Sun once a year. Students can observe the actual position changes in the Moon and in the background star patterns at the same time each night, continuing their observations long enough to include a full lunar cycle. They can be shown how the motion of the Moon around Earth accounts for those observations.

4. c. *Students know* telescopes magnify the appearance of some distant objects in the sky, including the Moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than the number that can be seen by the unaided eye.

Students are often startled the first time they look at details of the Moon through a telescope or even through high-quality binoculars. They quickly come to appreciate how those instruments facilitate the study of very distant objects. With the help of a telescope or very high-powered binoculars, students can see the rings of Saturn and some of the details of other planets. Students must never be permitted to look directly or stare at the Sun with the naked eye through binoculars, telescopes, or any other optical instruments. There are many pictures taken by powerful telescopes of planets, stars, and galaxies that students should have the opportunity to study in books.

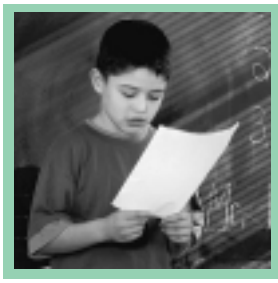
4. d. *Students know* that Earth is one of several planets that orbit the Sun and that the Moon orbits Earth.

The patterns of the stars stay the same relative to one another although they appear to move because of the rotation of Earth. Several starlike objects move across the sky's star patterns. They are planets that shine by light reflected from the Sun. Five planets can be seen without the aid of a telescope: Mercury, Venus, Mars, Jupiter, and Saturn. Three can be seen only with the aid of a telescope: Uranus, Neptune, and Pluto. Earth is also a planet and moves about the Sun in a path (orbit) that is similar to that of the other planets. Nine planets are in the solar system.* The Moon orbits Earth. Because Earth itself is a planet, measuring the orbits of other planets is a complex process. The process is so complex that scientists took a long time to figure out the different spatial relationships between the Moon, Earth, other planets, and the Sun.

* Under resolutions passed by the International Astronomical Union on August 26, 2006, there are eight planets. Pluto no longer meets the definition of a "planet" but is now classified under a new distinct class of objects called "dwarf planets."

4. e. *Students know* the position of the Sun in the sky changes during the course of the day and from season to season.

During a single day the rotation of Earth causes the position of the Sun to change on the horizon. It may be helpful for students to keep track of the Sun's position and watch how shadows lengthen rapidly as sunset approaches. From season to season the length of day and the angle of the Sun vary. Students should know that they live in the Northern Hemisphere, where the Sun at noon is lower and to the south in the sky in the winter and more directly overhead in the summer. Shorter or longer days and more or less direct sunlight characterize the seasons. The angle of the Sun in the sky at noon and the length of the day vary throughout the year because Earth's axis is tilted in comparison to the plane of its orbit.



STANDARD SET 5. Investigation and Experimentation

Children should be taught to make careful measurements, but they also need to learn that some errors in measurement are unavoidable. Sometimes errors arise through carelessness, misuse of measurement instruments, or recording mistakes. These human errors can be minimized by instruction and practice in measuring carefully and properly and by double (or triple) checking of measurements. Even then errors may be introduced because of limitations in the precision of the instruments used to make the measurements. Students should be taught how to make the most precise measurements possible with the tools available. They should also repeat their measurements several times. Sometimes they will obtain results that are different each time. If those differences are significant, students should examine their measurement methods to see whether an obvious error occurred.

Students can begin to make predictions based on observations, prior knowledge, and logic. Predictions should not be confused with random guesses. Students should know that their predictions must be verified by experiments and the analysis of data gathered from careful measurements.

5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

- **a.** Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
- **b.** Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
- **c.** Use numerical data in describing and comparing objects, events, and measurements.
- **d.** Predict the outcome of a simple investigation and compare the result with the prediction.
- **e.** Collect data in an investigation and analyze those data to develop a logical conclusion.