SCIENCE BACKGROUND—*States of Matter*

Matter is anything that has **mass** and **volume.** We can measure the amount of material in it—its mass—and we can measure the amount of space it takes up—its **size,** or **volume.** Most matter on Earth exists in one of three states: **solid, liquid,** or **gas.** A fourth state—**plasma**—exists at extremely high **temperatures,** such as in stars, but this program will deal with only the three familiar ones.

Water, for example, is one substance familiar to us in all its three states—as **ice, liquid water,** and **water vapor.** In all substances, the smallest particle that retains the properties of that substance is the molecule. Although they are strongly attracted to one another, molecules in all substances, even solid ice, are in constant motion because of their thermal (heat) energy. Added heat, however, can cause a substance to undergo a change of state. As heat is applied to ice, for example, it begins to change state—first to liquid water and then, as more heat is added, to a gas. As heat is removed from water vapor, the process reverses. The changes of state have no effect on the chemical properties of water itself.

We identify the state of matter of a substance by its distinctive properties of **shape** and **volume.** A solid has a definite shape and a definite volume, which do not readily change. Solids can be divided into two broad classes: crystals, whose molecules are arranged into regular symmetrical patterns; and amorphous solids, whose molecules are arranged randomly. Quartz, salt, and metals such as aluminum and gold are examples of crystalline solids; glass, cold butter, and some plastics are considered to be amorphous solids.

A liquid has a definite volume, but its shape changes readily. Its molecules are more loosely bound together than those of a solid. The shape of a liquid takes on the shape of its container. Water, vinegar, oil, and alcohol are examples of substances that are liquids at room temperature.

A gas has neither a definite shape nor a definite volume. Distances between its molecules are relatively vast, and their mutual attraction is virtually nil. Its volume will expand to fill a large container or compress to fit a small container. Its shape as well as its volume is determined by the shape and volume of its container. Helium, oxygen, and hydrogen are examples of substances that are gases at room temperature.

The process of changing from a solid to a liquid is called **melting.** The **melting point** of a substance is a characteristic property of that substance; it is the temperature at which it gains enough heat to change from a solid state to a liquid state. The process of changing from a liquid to a solid is called **freezing.** The **freezing point** of a substance, also a characteristic property of that substance, is the temperature at which it loses enough heat to change from a liquid to a solid. The freezing point and the melting point of a particular substance are the same. The difference lies in the process—whether heat is being removed or added to the substance.

During **evaporation,** molecules escape from the surface of a liquid and form a gas. The rate of evaporation increases with temperature. The temperature at which liquid boils is called its **boiling point,** a characteristic property. When liquid boils, gas not only escapes from the surface, but also forms throughout the liquid as bubbles.

© Delta Education. Photocopying and distribution prohibited.

When a gas is cooled sufficiently, it will **condense,** or change to its liquid state. This process occurs when even a small amount of heat is taken away, but it can occur rapidly with a sudden drop in temperature, such as when water vapor in the air condenses on the outside of a glass of ice water.

The sun's heat drives the changes of state we know as the **weather**—ice melts, water evaporates, vapor condenses into clouds, rain falls, snow and ice form, and the cycle of change begins all over again.

© Delta Education. Photocopying and distribution prohibited.

SCIENCE BACKGROUND—*The Moon*

The **Moon** is our closest neighbor in the **solar system**. Its gravity and cycles affect Earth's rotation and tides and have formed the basis of many cultures' calendars. At only 385,000 kilometers (approximately 239,000 miles) from Earth, the Moon is the second brightest object in our sky. And, because the Moon rotates only once per orbit, the same side is always facing Earth. The Moon is one of the most observable objects in space and one that almost all children recognize.

Many of the planets in our solar system also have moons. Some have more than a dozen, but Earth has only one. The Moon is Earth's only natural satellite. A **satellite** is a smaller object that orbits, or travels around, a larger object. A planet is a body that orbits the Sun. Just as the Moon is a satellite of Earth, planet Earth is a satellite of the Sun. And like Earth, the Moon is a terrestrial, or rocky, body.

Unlike Earth, the Moon has no air or atmosphere. There is no sound, because there is no air to carry sound waves. And there is no weather, because there is no atmosphere. Therefore, there is no wind or rain to cause erosion. And because there is no atmosphere to slow or burn meteorites, the Moon has scores of craters—all still visible because there is no erosion.

The gravity on the Moon is only one-sixth that of Earth. This is because the Moon has less iron in its core than Earth. If a person weighs 80 pounds on Earth he or she would weigh just over 13 pounds on the Moon.

Most of what we know about the Moon comes from data gathered in the past 40 years. However, humans have been abundantly aware of the Moon since they were first able to look into the sky and wonder what glowed above them.

Ancient Egyptians, Greeks, and Romans prayed to gods and goddesses of the Moon. Stories are told of soldiers dropping their weapons in battle and fleeing with the onset of a solar eclipse, which occurs when the Moon moves between **Earth** and the **Sun.** In the fourteenth century, it was thought that insanity fluctuated with the phases of the Moon. The word lunatic is derived from the Latin word *lunaticus* meaning "moonstruck."

Even as people feared and worshipped the Moon, they studied it. Early civilizations noticed a pattern to the changing appearance of the Moon—called phases—and used it to mark the passage of time. Around 450 B.C.E., a Greek philosopher named Anaxagoras proposed, correctly, that moonlight was actually reflected light from the Sun and that lunar eclipses occur when Earth moves between the Moon and the Sun, blocking sunlight. By 150 B.C.E., Greek astronomers and mathematicians had correctly calculated the Moon's size and distance from Earth.

The next great leap in lunar study occurred in 1609, when **Galileo** first used a telescope to distinguish the light and dark regions on the Moon's surface.

The light regions are rocky, cratered highlands called ***terrae*** (Latin for land). The dark regions are smooth lowlands called ***maria*** (Latin for seas). These aren't like any seas on Earth, however. The maria are regions where, long ago, lava poured out onto the Moon's surface.

Although telescopes improved greatly in the next three and a half centuries, humans didn't get a close-up view of these features until 1959 when the Soviet spacecraft *Luna 3* photographed the far side of the Moon. The photographs revealed a stark, lifeless world.

© Delta Education. Photocopying and distribution prohibited.

In the years that followed, more data were gathered by dozens of robotic spacecraft from the United States and Soviet Union. These first missions marked the beginning of the Space Age—and the race to put a human on the Moon.

That race ended on July 20, 1969, when the U.S. spacecraft *Eagle*—the lunar module from Apollo 11—landed in *Mare Tranquillitatis,* the Sea of Tranquility. Astronaut Neil Armstrong climbed down the ladder and became the first human to walk on a celestial body other than Earth. The first sentence he spoke from the Moon, "That's one small step for man, one giant leap for mankind," is one of the most famous in history.

Since then, eleven other astronauts have also walked on the Moon and more spacecraft have visited. They collected data and samples that are still helping scientists learn about the Moon. More than 382 kilograms (842 pounds) of Moon rocks and soil have been collected. The oldest rocks were found to be 4.5 billion years old. On Earth, erosion has worn away most rocks of that age. The Moon rocks provided scientists with information about the birth of our solar system and the origin of the Moon.

The origin of the Moon has long been debated. One theory stated that the Moon was once a planet that was "captured" by Earth's gravity as it sped past our planet. Another held that the Moon was a molten blob that spun off the early Earth as it whipped around at an extraordinary velocity. Yet another theory proposed that Earth and the Moon formed simultaneously from a whirling cloud of dust and gas left over from the formation of the Sun. All of these have been rejected for one reason or another, but the most widely accepted theory contains some element of each.

The theory suggests that the Moon formed when a speeding meteor larger than Mars collided with Earth. The violent impact knocked off a huge molten chunk of Earth's mantle, which was ejected into orbit along with the remnants of the meteor. The debris fused and the Moon was born.

Study of the lunar landforms, rocks, and soil suggest that, like Earth, the Moon's early history was a violent one. During the first billion years, it experienced heavy bombardment by meteorites. Then, just as the number of impacts was decreasing, massive volcanic eruptions began. Dark lavas flowed onto the surface covering many craters. This explains why the lowlands appear smooth and dark while the highlands appear cratered and light. Although the Moon's volcanic phase ended billions of years ago, meteorites and comets have continued to strike the Moon.

Although people have not walked on the Moon since 1972, scientific research continues. Although there is no water in a liquid state, scientists have discovered that water may exist on the Moon in the form of ice buried near the poles. They believe the water could have come from comets that collided with the Moon.

© Delta Education. Photocopying and distribution prohibited.

SCIENCE BACKGROUND—*Soil Science*

Soil science is the study of different soils—their component parts, their role in various natural ecosystems, and their function in human agriculture.

Although the **composition** of soil varies from one location to another, all **soil** is made up of minerals and decayed organic matter. The **minerals** are derived from rock particles broken off larger rocks by the agents of weathering. Erosion by water, wind, or glaciers causes the weathered pieces to move from one place to another.

Physical weathering is the breaking up of rocks into smaller pieces. Temperature and water are major climatic forces that influence physical weathering. Alternate freezing and thawing causes water trapped in cracks of rocks to expand and exert great pressure on the rock. This causes the rock to fracture into smaller pieces.

Plant and tree roots that find their way into cracks in rocks can also exert enough pressure, when they increase in size, to break the rock. Rocks can be physically broken down when they rub against one another in fast-moving water. In desert areas, wind carrying sand is an abrasive force that can weather rocks.

Chemical weathering is a process by which rocks decompose into materials that have a different chemical makeup. Oxygen in the air may react with certain minerals in a rock to form oxides. Some dissolved chemicals in water may react with certain minerals in rocks when they come in contact with them.

Weathering is a very slow process that goes on all the time. It takes between several hundred and one thousand years to produce 2.5 cm (1 in.) of weathered material that will become soil.

The **organic matter** in soil is composed of decayed animal and plant material. The amount of organic matter present determines the richness of the soil. Without organic matter, soil would be lifeless, broken-down rock. Many organisms that inhabit the soil spend their lives breaking down dead animals and plants. These organisms are known as shredders and decomposers.

Of the many animals that inhabit the soil, the best known is the **earthworm.** Earthworms enrich soil by ingesting large bits of organic material and excreting them as smaller bits. These smaller bits of organic material may then be further broken down by **decomposers,** including fungi and some bacteria. The action of these organisms releases nutrients from the organic materials, making them available for use by plants. In addition, the earthworms' tunnels provide places for air and water to enter the soil. Earthworms keep soils rich and productive.

Many characteristics differentiate one soil from another. One important physical characteristic is **texture.** In fact, soil is often classified according to texture. For instance, if coarse particles of **sand** are the predominant soil component, then the texture of the soil is sandy. Similarly, what is called clay soil is predominately fine particles of **clay.** An ideal soil texture is called *loam.* **Loam** is soil that contains equal amounts of sand and **silt,** some clay, and lots of organic matter, called **humus.**

© Delta Education. Photocopying and distribution prohibited.

Pollution in the form of hazardous chemicals gets into soil in many ways. The chemical **pollutants** may be improperly used or carelessly dumped. They may be inadvertently applied to fields as agricultural chemicals. Although some of these chemicals break down quickly, others remain in the soil for hundreds or thousands of years, or even permanently.

Soil erosion is the unwanted movement of soil from one place to another because of moving water or air. The removal of trees and other vegetation for agriculture and construction in urban areas exposes the soil to the **agents of erosion.**

The presence of plants, trees, and vegetation on the land offers much protection against erosion. Farmers often plant rows of trees and plants around their fields to act as windbreaks and to help keep valuable topsoil in place. When fields are not in use, farmers may also plant cover crops, such as alfalfa, since plant roots bind the soil and hold it in place.

Soil contains **nutrients** that plants need in order to live and grow. A soil with sufficient nutrients to support healthy plants is said to be **fertile. Food webs** show the flow of energy throughout an ecosystem from producers to multiple consumers in interconnected food chains. All **food chains** in every ecosystem begin with a producer—a plant. Therefore, because most plants grow in soil, most plant and animal life on Earth depends on soil.

© Delta Education. Photocopying and distribution prohibited.

SCIENCE BACKGROUND—*Plant and Animal Populations*

An **organism** is a living thing such as a plant or an animal. All the stages that a living thing goes through during its life are called a **life cycle.**

The life cycle of many types of plants begins with a **seed.** The life cycle of many types of animals begins with an **egg.**

Some insects have four stages in their life cycles. In these insects, the young insect that hatches from the egg does not resemble the adult form. This is the **larva** stage, during which the insect eats and grows. The larva then enters the **pupa** stage, during which metamorphosis occurs. When the insect emerges from this stage, it is a fully formed **adult.** Other insects have only three stages in their life cycle: egg, **nymph,** and adult. In these insects, the nymph form somewhat resembles the adult form. When the adult **reproduces,** another life cycle begins.

A single organism is an **individual.** However, an individual is rarely found living alone. It usually lives in a group of its own kind, or **species.** A group of organisms of the same species living in any one area, or **environment,** is called a **population.** All the populations of organisms living together in an environment make up a **community.**

A community, when considered with its nonliving environment, is an **ecosystem.** It includes the plants, animals, and microorganisms that make up the living community as well as the interactions they have with the nonliving environment.

Many different kinds of populations usually inhabit an ecosystem. They may share the same habitat, such as a pond, marsh, meadow, or tide pool. In a shared habitat, different populations are usually dependent on one another for survival—mainly for food.

All living things within an ecosystem are connected. **Plants** grow in soil and are eaten by **animals.** A plant-eating animal will be food for a meat-eating animal, and that animal, in turn, will be food for yet another animal.

Green plants have the ability to produce their own food. For this reason, they are known as **producers.** Producers use sunlight to make food. Plants also produce the oxygen that animals need to breathe, and plants absorb the carbon dioxide that animals produce during respiration.

Most other living things on Earth are directly or indirectly dependent on the food produced by green plants. Many animals eat green plants directly or eat animals that do. Since these animals are not able to produce their own food energy and must obtain it by eating, they are called **consumers.** First-order consumers eat producers directly. Second-order consumers eat first-order consumers.

The animal being hunted and eaten is called the **prey.** The animal doing the hunting and eating is called a **predator.** The predator-prey relationship in the food web is a natural balance that is continually shifting in favor of one or the other. If a predator depletes a prey population, it will thereby deplete its own population. As predators become scarce, the prey population has a chance to revive. Thus the cycle continues and balance is restored.

Predator-prey interactions are just one of the environmental pressures that can cause evolutionary **adaptations.** An adaptation is a physical feature or a behavior that becomes prevalent in a population because it gives the organism an advantage—helps it survive to reproduce—in that species' environment.

For example, the English peppered moth occurs in two varieties, light gray and dark

© Delta Education. Photocopying and distribution prohibited.

gray. On trees with pale lichens growing on the bark, the light gray moth blends in better. In parts of the country that have heavy industrial pollution, the lichens die off, exposing the darker tree bark. Then the dark moths blend in better with their environment. The light gray moths are more easily seen and preyed upon by birds. After just a few generations, dark moths are more prevalent than light moths in areas with industrial pollution.

This type of adaptation—when a species evolves to better blend in with its environment—is called **camouflage.** When a species evolves to look like a more dangerous species, the adaptation is called **mimicry.**

Despite adaptations that may help an organism survive, eventually, each will come to the end of its life cycle. When plants and animals die, specialized organisms called **decomposers** break them down in a process called **decomposition** or decay. Through this process, organic (living or once-living) material is changed into inorganic (nonliving) nutrients. The nutrients are returned to the soil where they support the growth of green plants, which begins the cycle again.

However, when all the members of a species die, the species becomes **extinct.** For example, the American Passenger Pigeon is extinct. The last living specimen died in the Cincinnati Zoo on September 1, 1914. Although the North American population had once numbered in the billions, European settlers hunted the birds to **extinction.** A population that is in danger of becoming extinct is called **endangered.**

© Delta Education. Photocopying and distribution prohibited.

SCIENCE BACKGROUND—*Measurement*

Measuring tools help us compare objects by allowing us to learn and label information about size. Different types of tools are used to take different types of **measurements,** using different sets of **standard units.** For example, rulers and meter sticks are used to measure length, width, height, and distance. Measuring cups and pitchers are used to measure volume. Scales and balances measure weight and mass. Thermometers measure temperature. Clocks measure time.

At one time, every country had its own system of units of measure, and often several different systems. During the 1790s, the metric system was devised in Europe to bring uniformity to measurement. The metric system largely replaced the traditional, variable units. A basic metric unit was established for each quantity: the meter for length, the gram for weight and mass, and the liter for volume. Multiples and fractions of the basic units are created by multiplying or dividing by 10. (For example, 10 millimeters equal 1 centimeter; 100 centimeters equal 1 meter; 1,000 meters equal one kilometer.) Most countries, and all scientists, use the metric system of measurement. In the United States today, two systems are used: the **metric system** and the **U.S. customary system.** The following list shows how they compare:

Length/Distance
1 inch = 2.54 centimeters
1 foot = 0.3048 meter
1 yard = 0.9144 meter
1 mile = 1.6093 kilometers
1 millimeter = 0.03937 inch
1 centimeter = .3937 inch
1 meter = 39.37 inches
1 kilometer = 0.621 mile

Weight/Mass
1 ounce = 28 grams
1 pound = 0.45 kilograms
1 gram = 0.035 ounces
1 kilogram = 2.2 pounds

Volume/Capacity
1 teaspoon = 5 milliliters
1 tablespoon = 15 milliliters
1 cup = 0.24 liters
1 pint = 0.47 liters
1 quart = 0.95 liters
1 gallon = 3.8 liters
1 milliliter = 0.03 fluid ounces
1 liter = 1.06 quarts

© Delta Education. Photocopying and distribution prohibited.

© Delta Education. Photocopying and distribution prohibited.