



## The Nature of Matter

### Standard 1:

The student understands that all matter has observable, measurable properties. (SC.A.1.4)

1. knows that the electron configuration in atoms determines how a substance reacts and how much energy is involved in its reactions.
2. knows that the vast diversity of the properties of materials is primarily due to variations in the forces that hold molecules together.
3. knows that a change from one phase of matter to another involves a gain or loss of energy.
4. experiments and determines that the rates of reaction among atoms and molecules depend on the concentration, pressure, and temperature of the reactants and the presence or absence of catalysts.
5. knows that connections (bonds) form between substances when outer-shell electrons are either transferred or shared between their atoms, changing the properties of substances.

### Standard 2:

The student understands the basic principles of atomic theory. (SC.A.2.4)

1. knows that the number and configuration of electrons will equal the number of protons in an electrically neutral atom and when an atom gains or loses electrons, the charge is unbalanced.
2. knows the difference between an element, a molecule, and a compound.
3. knows that a number of elements have heavier, unstable nuclei that decay, spontaneously giving off smaller particles and waves that result in a small loss of mass and release a large amount of energy.
4. knows that nuclear energy is released when small, light atoms are fused into heavier ones.
5. knows that elements are arranged into groups and families based on similarities in electron structure and that their physical and chemical properties can be predicted.

6. understands that matter may act as a wave, a particle, or something else entirely different with its own characteristic behavior.

## Energy

### Standard 1:

The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.4)

1. understands how knowledge of energy is fundamental to all the scientific disciplines (e.g., the energy required for biological processes in living organisms and the energy required for the building, erosion, and rebuilding of the Earth).
2. understands that there is conservation of mass and energy when matter is transformed.
3. knows that temperature is a measure of the average translational kinetic energy of motion of the molecules in an object.
4. knows that as electrical charges oscillate, they create time-varying electric and magnetic fields that propagate away from the source as an electromagnetic wave.
5. knows that each source of energy presents advantages and disadvantages to its use in society (e.g., political and economic implications may determine a society's selection of renewable or nonrenewable energy sources).
6. knows that the first law of thermodynamics relates the transfer of energy to the work done and the heat transferred.
7. knows that the total amount of usable energy always decreases, even though the total amount of energy is conserved in any transfer.

### Standard 2:

The student understands the interaction of matter and energy. (SC.B.2.4)

1. knows that the structure of the universe is the result of interactions involving fundamental particles (matter) and basic forces (energy) and that evidence suggests that the universe contains all of the matter and energy that ever existed.

## Force and Motion

### Standard 1:

The student understands that types of motion may be described, measured, and predicted. (SC.C.1.4)

1. knows that all motion is relative to whatever frame of reference is chosen and that there is no absolute frame of reference from which to observe all motion.

2. knows that any change in velocity is an acceleration.

### **Standard 2:**

The student understands that the types of force that act on an object and the effect of that force can be described, measured, and predicted. (SC.C.2.4)

1. knows that acceleration due to gravitational force is proportional to mass and inversely proportional to the square of the distance between the objects.
2. knows that electrical forces exist between any two charged objects.
3. describes how magnetic force and electrical force are two aspects of a single force.
4. knows that the forces that hold the nucleus of an atom together are much stronger than electromagnetic force and that this is the reason for the great amount of energy released from the nuclear reactions in the sun and other stars.
5. knows that most observable forces can be traced to electric forces acting between atoms or molecules.
6. explains that all forces come in pairs commonly called action and reaction.

## **Processes that Shape the Earth**

### **Standard 1:**

The student recognizes that processes in the lithosphere, atmosphere, hydrosphere, and biosphere interact to shape the Earth. (SC.D.1.4)

1. knows how climatic patterns on Earth result from an interplay of many factors (Earth's topography, its rotation on its axis, solar radiation, the transfer of heat energy where the atmosphere interfaces with lands and oceans, and wind and ocean currents).
2. knows that the solid crust of Earth consists of slow-moving, separate plates that float on a denser, molten layer of Earth and that these plates interact with each other, changing the Earth's surface in many ways (e.g., forming mountain ranges and rift valleys, causing earthquake and volcanic activity, and forming undersea mountains that can become ocean islands).
3. knows that changes in Earth's climate, geological activity, and life forms may be traced and compared.
4. knows that Earth's systems and organisms are the result of a long, continuous change over time.

### **Standard 2:**

The student understands the need for protection of the natural systems on Earth. (SC.D.2.4)

1. understands the interconnectedness of the systems on Earth and the quality of life.

## **Earth and Space**

### **Standard 1:**

The student understands the interaction and organization in the Solar System and the universe and how this affects life on Earth. (SC.E.1.4)

1. understands the relationships between events on Earth and the movements of the Earth, its moon, the other planets, and the sun.
2. knows how the characteristics of other planets and satellites are similar to and different from those of the Earth.
3. knows the various reasons that Earth is the only planet in our Solar System that appears to be capable of supporting life as we know it.

### **Standard 2:**

The student recognizes the vastness of the universe and the Earth's place in it. (SC.E.2.4)

1. knows that the stages in the development of three categories of stars are based on mass: stars that have the approximate mass of our sun, stars that are two-to-three-stellar masses and develop into neutron stars, and stars that are five-to-six-stellar masses and develop into black holes.
2. identifies the arrangement of bodies found within and outside our galaxy.
3. knows astronomical distance and time.
4. understands stellar equilibrium.
5. knows various scientific theories on how the universe was formed.
6. knows the various ways in which scientists collect and generate data about our universe (e.g., X-ray telescopes, computer simulations of gravitational systems, nuclear reactions, space probes, and supercollider simulations).
7. knows that mathematical models and computer simulations are used in studying evidence from many sources to form a scientific account of the universe.

## **Processes of Life**

### **Standard 1:**

The student describes patterns of structure and function in living things. (SC.F.1.4)

1. knows that the body processes involve specific biochemical reactions governed by biochemical principles.
2. knows that body structures are uniquely designed and adapted for their function.
3. knows that membranes are sites for chemical synthesis and essential energy conversions.
4. understands that biological systems obey the same laws of conservation as physical systems.
5. knows that complex interactions among the different kinds of molecules in the cell cause distinct cycles of activity governed by proteins.
6. knows that separate parts of the body communicate with each other using electrical and/or chemical signals.
7. knows that organisms respond to internal and external stimuli.
8. knows that cell behavior can be affected by molecules from other parts of the organism or even from other organisms.

## Standard 2:

The student understands the process and importance of genetic diversity. (SC.F.2.4)

1. understands the mechanisms of asexual and sexual reproduction and knows the different genetic advantages and disadvantages of asexual and sexual reproduction.
2. knows that every cell contains a “blueprint” coded in DNA molecules that specify how proteins are assembled to regulate cells.
3. understands the mechanisms of change (e.g., mutation and natural selection) that lead to adaptations in a species and their ability to survive naturally in changing conditions and to increase species diversity.

## How Living Things Interact with Their Environment

### Standard 1:

The student understands the competitive, interdependent, cyclic nature of living things in the environment. (SC.G.1.4)

1. knows of the great diversity and interdependence of living things.
2. understands how the flow of energy through an ecosystem made up of producers, consumers, and decomposers carries out the processes of life and that some energy dissipates as heat and is not recycled.
3. knows that the chemical elements that make up the molecules of living things are combined and recombined in different ways.

## Standard 2:

The student understands the consequences of using limited natural resources. (SC.G.2.4)

1. knows that layers of energy-rich organic materials have been gradually turned into great coal beds and oil pools (fossil fuels) by the pressure of the overlying earth and that humans burn fossil fuels to release the stored energy as heat and carbon dioxide.
2. knows that changes in a component of an ecosystem will have unpredictable effects on the entire system but that the components of the system tend to react in a way that will restore the ecosystem to its original condition.
3. understands how genetic variation of offspring contributes to population control in an environment and that natural selection ensures that those who are best adapted to their surroundings survive to reproduce.
4. knows that the world ecosystems are shaped by physical factors that limit their productivity.
5. understands that the amount of life any environment can support is limited and that human activities can change the flow of energy and reduce the fertility of the Earth.
6. knows the ways in which humans today are placing their environmental support systems at risk (e.g., rapid human population growth, environmental degradation, and resource depletion).

## The Nature of Science

### Standard 1:

The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)

1. knows that investigations are conducted to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
2. knows that from time to time, major shifts occur in the scientific view of how the world works, but that more often the changes that take place in the body of scientific knowledge are small modifications of prior knowledge.
3. understands that no matter how well one theory fits observations, a new theory might fit them as well or better, or might fit a wider range of observations, because in science, the testing, revising, and occasional discarding of theories, new and old, never ends and leads to an increasingly better understanding of how things work in the world, but not to absolute truth.
4. knows that scientists in any one research group tend to see things alike and that therefore scientific teams are expected to seek out the possible

- sources of bias in the design of their investigations and in their data analysis.
5. understands that new ideas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.
  6. understands that, in the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism and that, in the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.
  7. understands the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.
6. knows that scientific knowledge is used by those who engage in design and technology to solve practical problems, taking human values and limitations into account.

## **Standard 2:**

**The student understands that most natural events occur in comprehensible, consistent patterns. (SC.H.2.4)**

1. knows that scientists assume that the universe is a vast system in which basic rules exist that may range from very simple to extremely complex, but that scientists operate on the belief that the rules can be discovered by careful, systemic study.
2. knows that scientists control conditions in order to obtain evidence, but when that is not possible for practical or ethical reasons, they try to observe a wide range of natural occurrences to discern patterns.

## **Standard 3:**

**The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)**

1. knows that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the chance of system failure.
2. knows that technological problems often create a demand for new scientific knowledge and that new technologies make it possible for scientists to extend their research in a way that advances science.
3. knows that scientists can bring information, insights, and analytical skills to matters of public concern and help people understand the possible causes and effects of events.
4. knows that funds for science research come from federal government agencies, industry, and private foundations and that this funding often influences the areas of discovery.
5. knows that the value of a technology may differ for different people and at different times.