

# National Science Education Content Standards

## Levels 5-8

### UNIFYING CONCEPTS AND PROCESSES - LEVELS K-12

#### Systems, Order, and Organization

- A system is an organized group of related objects or components (organisms, machines, fundamental particles, galaxies, ideas, numbers, transportation, and education).
- Students should analyze in terms of systems (mass, energy, objects, organisms and events).
- Systems have structure and function.
- Feedback and equilibrium are associated with systems.
- Systems can be open or closed.
- The assumption of order establishes the basis for cause-effect relationships and predictability.
- Prediction can be used to explain change. Math can be used to do this through probability.
- Systems have levels of organization (periodic table & classification of organisms).
- Living systems have levels of organization (cells, tissues, organs, organisms, populations and communities).
- Interactions occur in systems.

#### Evidence, Models, and Explanation

- Evidence should be used in explanations.
- Models can be used in explanations.
- Terms such as hypothesis, model, law, principle, theory, and paradigm are used to explain scientific explanations.

#### Constancy, Change, and Measurement

- Interactions result in change.
- Changes vary in rate, scale, and pattern, including trends and cycles.
- Math measures change.
- Scientists use the metric system.
- Scale includes understanding that parts of a system might change as its size changes.
- Rate compares one measured quantity with another.

#### Evolution and Equilibrium

- Evolution is a series of changes. This includes changes in the universe.
- The present is a result of the past.
- Equilibrium is a physical state in which forces and changes occur in opposite

and offsetting directions.

- Steady state, balance, and homeostasis describe equilibrium states.

#### Form and Function

- Form follows function.
- Students should explain function in terms of form and form in terms of function.

### **SCIENCE AS INQUIRY**

#### Abilities Necessary to do Scientific Inquiry

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in all aspects of scientific inquiry.

#### Understandings About Scientific Inquiry

- Different kinds of questions suggest different kinds of scientific investigations, such as collecting specimens, doing experiments, seeking more information, making models, and discovering new objects.
- Current knowledge and understanding guide scientific investigations.
- Mathematics is important in all aspects of scientific inquiry.
- The use of technology to gather data enhances accuracy.
- Scientific explanations emphasize evidence, have logically consistent arguments and use scientific principles, models, and theories.
- Asking questions is part of scientific inquiry.
- Scientific investigations sometimes result in new ideas for study, generate new methods or procedures for an investigation, or develop new technologies for data collection.

### **PHYSICAL SCIENCE**

#### Properties of Objects and Materials

- Substances have characteristic properties which are independent of the amount of the sample and mixtures can be separated.
- Substances react chemically to form new substances whereas the total mass is conserved and they can be grouped if they react in similar ways (i.e. metals).
- Chemical elements do not break down during normal laboratory reactions. One hundred known elements combine to produce compounds and make up all living and nonliving things.

## Motion and Forces

- The motion of an object can be described by its position, direction, and speed, and can be measured and shown on a graph.
- An object will move at a constant speed and in a straight line if no force is on the object.
- If there is more than one force on an object along a straight line, the forces will reinforce each other or cancel each other.

## Transfer of Energy

- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, and the nature of a chemical. It is transferred in many ways.
- Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.
- Light interacts with matter by transmission, absorption, or scattering.
- Electrical circuits provide a means of transferring electrical energy.
- In most chemical and nuclear reactions, energy is transferred into or out of a system.
- The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light and arrives as light on Earth in a range of wavelengths.

## **LIFE SCIENCE**

- Structure and function in living systems
- Form follows function.
- All organisms are composed by cells.
- Cells carry on the functions of life.
- Cells have specialized functions in organisms.
- Humans have specialized systems for carrying out functions.
- Disease is a breakdown in the system caused by internal failures or infection.

## Reproduction and Heredity

- All living systems reproduce because it is essential for the continuation of a species.
- Organisms that reproduce sexually are created as a result of the mother's egg and a father's sperm, each carrying half of an offspring's genes.
- Heredity is the passage of the required set of instructions for specifying traits.
- Hereditary information is contained in genes that are located on chromosomes.
- Some traits are inherited others result from environmental influences.

## Regulation and Behavior

- All organisms must be able to obtain resources to grow, reproduce, and maintain stable internal conditions.
- Organisms must regulate their internal environment by sensing it and changing physiological activities to survive.
- Behavior is a response to an internal or environmental stimulus.
- An organism's behavior evolves through adaptation to its environment.

## Populations and Ecosystems

- A population consists of all of the organisms of a species living together in a given place at a given time.
- Populations can be categorized by their function in the ecosystem (consumer, producer...).
- Sunlight, the major energy source in an ecosystem, is passed through organisms in a food web.
- Numbers of organisms in an ecosystem depend on available resources and abiotic factors (space, temperature.)

## Diversity and Adaptations of Organisms

- Organisms are similar in internal structures, chemical processes and common ancestry although they may have different outward appearances.
- Diversity in species is a result of biological evolution.
- Fossils show us that many organisms that lived long ago are extinct.
- Extinction occurs due to a lack of the ability to adapt.

## **EARTH AND SPACE SCIENCE**

### Structure of the Earth

- Earth is layered and has a solid crust, hot, convecting mantle, and a dense metallic core.
- Crustal plates constantly move in response to the movements of the mantle.
- Landforms are the result of a combination of constructive (sedimentation, volcanoes and destructive forces (weathering and erosion).
- Some changes in the solid earth can be described as the “rock cycle.”
- Soil consists of weathered rocks and decomposed organic material from dead animals, plants, and bacteria, and have a different chemical composition and texture.
- Water circulates through the crust, atmosphere, and oceans (water cycle).
- Water is a solvent-it dissolves minerals and gases during the water cycle and carries them to the oceans.
- The atmosphere is a mixture of nitrogen, oxygen, and trace gases and water vapor and has different properties at different elevations.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate because they hold heat.
- Living organisms have played many roles in the earth system, including the composition of the atmosphere, producing some kinds of rocks, and contributing to weathering of rocks.

### Earth's History

- The earth processes we observe today are similar to those that occurred in the past.
- Fossils provide important evidence of how life and environmental conditions have changed.

### Earth in the Solar System

- Earth is third planet from the sun in a system that includes the moon, sun, eight

other planets, etc.

- The sun, an average star, is central and the largest body in our solar system.
- Most objects in the solar system are in regular and predictable motion and explain day, year, moon phases, and eclipses.
- Gravity is the force that keeps planets in orbit and governs the motion of the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides.
- The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.

## **SCIENCE AND TECHNOLOGY**

### Abilities of Technological Design

- Identify a simple problem.
- Design or propose a solution.
- Implement a proposed solution.
- Evaluate a product of design.
- Communicate a problem, design, and solution.

### Understanding About Science and Technology

- Scientific inquiry and technological design have similarities and differences.
- Many different people in different cultures have made and continue to make contributions to science and technology.
- Science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique.
- Perfectly designed solutions do not exist. All technology solutions have tradeoffs, such as safety, cost, efficiency, and appearance.
- Technological designs have constraints.
- Technological solutions have intended benefits and unintended consequences.

## **SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES**

### Personal Health

- Regular exercise is important to the maintenance and improvement of health.
- The potential for accidents and the existence of hazards imposes the need for injury prevention.
- The use of tobacco increases the risk of illness.
- Alcohol and other drugs are often abused substances.
- Food provides energy and nutrients for growth and development.
- Sex drive is a natural human function that requires understanding.
- Natural environments may contain substances (for example, radon and lead)

that are harmful to human beings.

- Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

#### Populations, Resources, and Environments

- When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.
- Causes of environmental degradation and resource depletion vary from region to region and from country to country.

#### Natural Hazards

- Internal and external processes of the earth system cause natural hazards, events that change or destroy human and wildlife habitats.

#### Risks and Benefits

- Risk analysis considers the type of hazard and estimates the number of people that might be exposed and the number likely to suffer consequences.
- Understand the risks associated with natural hazards (fires, earthquakes, volcanic eruptions), biological hazards (pollen, viruses, bacterial, and parasites), social hazards (occupational safety and transportation), and personal hazards (smoking, dieting, and drinking).
- Think critically about risks and benefits.
- Important decisions are based on perceptions of benefits and risks.

#### Science and Technology in Society

- Science influences society through its knowledge and world view.
- Societal challenges often inspire questions for scientific research, and social priorities often influence research priorities through funding or research.
- Technology influences society through its products and processes.
- Science and technology have advanced through contributions of others at different times in history.
- Scientists and engineers work in many different settings.
- Scientists and engineers have ethical codes regarding human subjects.
- Science cannot answer all questions and technology cannot solve all human problems or meet all human needs.

## **HISTORY AND NATURE OF SCIENCE**

#### Science as a Human Endeavor

- People of various ethnic backgrounds engage in science.
- Science relies on basic human qualities such as reasoning, insight, energy, skill and creativity as well as on scientific habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism and openness to new ideas.
- Recognize that scientific theories emerge over time, depending on the contributions of many and reflect the social and political climate of their time.

#### Nature of Science

- Scientists formulate and test ideas.
- Different scientists may publish differing results based on the same data.
- Part of scientific inquiry is to evaluate the results of scientific investigations.

#### History of Science

- Many individuals have contributed to science.
- Some scientists are considered to be among the most valued contributors to their culture.
- The history of science can show how difficult it has been for scientific innovators to break through the accepted ideas of their time to reach conclusions that are now taken for granted.