

Illinois Science Assessment Framework Grades 4 and 7

State Assessments Beginning
Spring 2006

Illinois State Board of Education

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Introduction to the Illinois Science Assessment Framework Grades 4 and 7

The Illinois Science Assessment Framework is designed to assist educators, test developers, policy makers and the public by clearly defining those elements of the Illinois Learning Standards that are suitable for state testing. It is not designed to replace a local science curriculum and should not be considered a state science curriculum. The Framework defines the science content that will be assessed in the Illinois Standards Achievement Test (ISAT) beginning with the 2005-2006 school year. The science ISAT will continue to be presented in a multiple-choice format.

Assessment Objectives

The Framework contains assessment objectives, clear and concise statements of testable material at each grade level assessed. Each assessment objective aligns to the Illinois Learning Standards and, in some cases, to the Performance Descriptors posted on the Illinois State Board of Education Web site (www.isbe.net/ils). Each year's assessment will measure a sample of the content in the Framework with sufficient overlap from year to year to allow for annual comparisons. Therefore, every objective will not be measured every year.

Content Emphasis

While the precise content on each year's tests will vary from year to year, the relative emphasis on the State Goals and Illinois Learning Standards will not. The proportion of each year's tests devoted to each category is clearly specified in the Science Content Category Table on page 7.

The Framework expectations at grade 7 include the content addressed at grade 4. While the assessment objectives from the specified grade will comprise the bulk of the tests in any given year, content from earlier grade levels is also eligible for state assessment.

Framework Structure

This document employs a general organizational structure designed for ease of use. Each State Goal for science is the main organizer, followed by the Illinois Learning Standards for science within each of these State Goals. Each assessment objective has a unique identifier with three components.

Example: 11.4.01

<i>11</i>	<i>4</i>	<i>01</i>
<i>State Goal</i>	<i>Grade Level</i>	<i>Objective Number</i>

The first component, "11," indicates the numbered State Goal as defined in the Illinois Learning Standards. The second component, "4," indicates the grade level. The third component, "01," indicates that this is the first assessment objective for this State Goal at this grade level.

Cognitive Complexity

Cognitive complexity refers to the level of reasoning called for in an assessment item. For example, some assessment items require simple recall, while others may require more complex levels of reasoning and/or application of knowledge and skills. Descriptions of the various levels are presented in the Science Productive Thinking Scale below.

Science Productive Thinking Scale Table¹

Level 1 Questions Recall of Conventions (e.g., names, vocabulary, measurement units, etc.)
Level 2 Questions Reproduction of Facts (e.g., empirical facts/relationships, steps in processes, scientific tools, etc.)
Level 3 Questions Reproduction of Theory (e.g., empirical theories/causes or reasons for scientific methods)
Level 4 Questions One-step applications of laws, rules, or knowledge of one-variable experiments
Level 5 Questions Two-step applications of laws, rules, or knowledge of two-variable experiments
Level 6 Questions Creation of scientific theories or new scientific methods, ranging from simple analogies to Galileo's development of systematic scientific methodology

¹ The Science Productive Thinking Scale, including descriptions of each of the six levels, is explained in greater detail in the publication *Illinois Science Productive Thinking Scale* from the Illinois State Board of Education.

Excerpt from *Illinois Learning Standards*²

The *Illinois Learning Standards for Science* were developed using the 1985 State Goals for Science, the National Science Education Standards, various other state and national works, and local education standards contributed by team members.

Science is a creative endeavor of the human mind. It offers a special perspective of the natural world in terms of understanding and interaction. The aim of science education is to develop in learners a rich and full understanding of the inquiry process; the key concepts and principles of life sciences, physical science, and earth and space sciences; and issues of science, technology, and society in historical and contemporary contexts. The National Science Education Standards present these understandings and their interactions with the natural world as eight science content standard categories. The *Illinois Learning Standards for Science* integrate these categories into a powerful resource for the design and evaluation of science curricula taught in Illinois schools.

The *Illinois Learning Standards for Science* are organized by goals that inform one another and depend upon one another for meaning. Expectations for learners related to the inquiry process are presented in standards addressing the doing of science and elements of technological design. Unifying concepts connect scientific understanding and process and are embedded in standards spanning life science, physical science, and earth and space science. The importance of this knowledge and its application is conveyed in standards describing the conventions and nature of the scientific enterprise and the interplay among science, technology and society in past, present and future contexts.

APPLICATIONS OF LEARNING

Through Applications of Learning, students demonstrate and deepen their understanding of basic knowledge and skills. These applied learning skills cross academic disciplines and reinforce the important learning of the disciplines. The ability to use these skills will greatly influence students' success in school, in the workplace and in the community.

SOLVING PROBLEMS

Recognize and investigate problems; formulate and propose solutions supported by reason and evidence.

Asking questions and seeking answers are at the heart of scientific inquiry. Following the steps of scientific inquiry, students learn how to gather evidence, review and understand their findings, and compare their solutions with those of others. They learn that there can be differing solutions to the same problem, some more useful than others. In the process, they learn and apply scientific principles. They also learn to be objective in deciding whether their solutions meet specifications and perform as desired.

COMMUNICATING

Express and interpret information and ideas.

Scientists must carefully describe their methods and results to a variety of audiences, including other scientists. This requires precise and complete descriptions and the presentation of conclusions supported by evidence. Young science students develop the powers of observation and description. Older students gain the ability to organize and study data, to determine its meaning, to translate their findings into clear understandable language and to compare their results with those of other investigators.

² Illinois State Board of Education (1997). *Illinois Learning Standards*

USING TECHNOLOGY

Use appropriate instruments, electronic equipment, computers and networks to access information, process ideas and communicate results.

Technology is invented and improved by the use of scientific principles. In turn, scientists depend on technology in performing experiments, analyzing data and communicating the results. Science students learn to use a range of technologies: instruments, computer hardware and software, on-line services and equipment, primary source data and images, and communication networks. They learn how technology, in turn, is the result of a scientific design process that includes continual refinements and improvements.

WORKING ON TEAMS

Learn and contribute productively as individuals and as members of groups.

The practical application of science requires both individual and group efforts. Individuals bring unique insight and focus to the work of inquiry and problem solving. Working in groups, scientists pose questions, share hypotheses, divide their experimental efforts, and share data and results. Science students have the opportunity to work both ways—as individuals and as members of teams organized to conduct complex investigations and solve problems.

MAKING CONNECTIONS

Recognize and apply connections of important information and ideas within and among learning areas.

Science has many disciplines, all interrelated. Understanding the functioning of living things depends on knowing chemistry; understanding chemistry depends on knowing physics. In the same way, science itself is highly dependent on mathematics—and it also relates strongly to medicine, geography, physical development and health, social trends and issues, and many other topics. Science, at its best, provides knowledge and skills that improve the understanding of virtually all subjects.

STATE GOAL 11: Understand the processes of scientific inquiry and technological design to investigate questions, conduct experiments and solve problems.

Why This Goal Is Important: The inquiry process prepares learners to engage in science and apply methods of technological design. This understanding will enable students to pose questions, use models to enhance understanding, make predictions, gather and work with data, use appropriate measurement methods, analyze results, draw conclusions based on evidence, communicate their methods and results, and think about the implications of scientific research and technological problem solving.

STANDARD 11A

Know and apply the concepts, principles and processes of scientific inquiry.

STANDARD 11B

Know and apply the concepts, principles and processes of technological design.

STATE GOAL 12: Understand the fundamental concepts, principles and interconnections of the life, physical and earth/space sciences.

Why This Goal Is Important: This goal is comprised of key concepts and principles in the life, physical and earth/space sciences that have considerable explanatory and predictive power for scientists and non-scientists alike. These ideas have been thoroughly studied and have stood the test of time. Knowing and being able to apply these concepts, principles and processes help students understand what they observe in nature and through scientific experimentation. A working knowledge of these concepts and principles allows students to relate new subject matter to material previously learned and to create deeper and more meaningful levels of understanding.

STANDARD 12A

Know and apply concepts that explain how living things function, adapt and change.

STANDARD 12B

Know and apply concepts that describe how living things interact with each other and with their environment.

STANDARD 12C

Know and apply concepts that describe properties of matter and energy and the interactions between them.

STANDARD 12D

Know and apply concepts that describe force and motion and the principles that explain them.

STANDARD 12E

Know and apply concepts that describe the features and processes of the Earth and its resources.

STANDARD 12F

Know and apply concepts that explain the composition and structure of the universe and Earth's place in it.

STATE GOAL 13: Understand the relationships among science, technology and society in historical and contemporary contexts.

Why This Goal Is Important:

Understanding the nature and practices of science such as ensuring the validity and replicability of results, building upon the work of others and recognizing risks involved in experimentation gives learners a useful sense of the scientific enterprise. In addition, the relationships among science, technology and society give humans the ability to change and improve their surroundings. Learners who understand this relationship will be able to appreciate the efforts and effects of scientific discovery and applications of technology on their own lives and on the society in which we live.

STANDARD 13A

Know and apply the accepted practices of science.

STANDARD 13B

Know and apply concepts that describe the interaction between science, technology and society.

Science Content Category Table

Grade	4	7
State Goal 11	20%	20%
Standard 11A – Scientific Inquiry	10%	10%
Standard 11B – Technological Design	10%	10%
State Goal 12	60%	60%
Standard 12A – Living Things ³	10%	10%
Standard 12B – Environment and Interaction of Living Things	10%	10%
Standard 12C – Matter and Energy ⁴	10%	10%
Standard 12D – Force and Motion	10%	10%
Standard 12E – Earth Science ⁵	10%	10%
Standard 12F – Astronomy	10%	10%
State Goal 13	20%	20%
Standard 13A – Safety and Practices of Science	10%	10%
Standard 13B – Science, Technology, Society ⁶	10%	10%
Total	100%	100%

³ Includes the following topics: Classification, Cell Biology (Grade 7 only), Reproduction (Grade 4 only), Genetics and Reproduction (Grade 7 only), Botany (Grade 7 only), Change Over Time (Grade 7 only)

⁴ Includes the following topics: Properties of Matter, The Atom (Grade 7 only), Acids and Bases (Grade 7 only), Energy/Electricity (Grade 4 only), Electricity (Grade 7 only), Light

⁵ Includes the following topics: Basic Earth Science (Grade 4 only), The Earth’s Structure (Grade 7 only), The Earth’s Dynamic Processes, The Atmosphere, Water

⁶ Includes the following concept: Measurement

Science – State Goal 11

Grade 4

STANDARD 11A – SCIENTIFIC INQUIRY

11.4.01 Understand how to design and perform simple experiments.

11.4.02 Distinguish among and answer questions about performing the following: observing, drawing a conclusion based on observation, forming a hypothesis, conducting an experiment, organizing data, constructing and reading charts and graphs, and comparing data.

11.4.03 Compare observations of individual and group results.

11.4.04 Distinguish among the following: recording the data from an experiment, organizing the data into a more useful form, analyzing it to identify relevant patterns, and reporting and displaying results.

STANDARD 11B – TECHNOLOGICAL DESIGN

11.4.05 Identify a design problem and identify possible solutions. Assess designs or plans to build a prototype.

11.4.06 Assess given test results on a prototype (i.e., draw conclusions about the effectiveness of the design using given criteria). Analyze data and rebuild and retest prototype as necessary.

Grade 7

11.7.01 Understand how to follow procedures relating to scientific investigations including formulating hypotheses, controlling variables, collecting and recording and analyzing data, interpreting results, and reporting and displaying results.

11.7.02 Distinguish among and answer questions about performing the following: observing, drawing a conclusion based on observation, forming a hypothesis, conducting an experiment, organizing data, constructing and reading charts and graphs, and comparing data. Recognize the common units of the metric system.

11.7.03 Define a theory as an explanation or model based on observation, experimentation, and reasoning; especially one that has been tested and confirmed as a general principle helping to explain and predict natural phenomena.

11.7.04 Define a variable as some factor which changes in different phases of an experiment. Define a constant as something kept the same in every phase of the experiment. Understand that most scientific experiments are designed so that only one variable is tested in each experiment. Identify constants and variables in described experiments.

11.7.05 Define the control group or control setup as a group of subjects that are the same in all important ways as the subjects on which we are performing the experiment, except that the control is isolated from what we suspect to be the cause we are seeking to evaluate—the control helps to increase our certainty that the suspected cause really is the cause.

11.7.06 Analyze patterns in data from an experiment to determine whether the information gathered helps to answer a given question or hypothesis (e.g., all of the plants fertilized in a vegetable garden grew taller than the ones not fertilized. Understand that this is an indication that the fertilizer caused the plants to grow taller.)

11.7.07 Identify a design problem and establish criteria for determining the success of a solution.

11.7.08 Compare design solutions; select which one is best given certain restrictions on available materials, tools, cost effectiveness, and safety.

11.7.09 Given certain tests which could be performed on a prototype, identify which one is testing for a given feature (e.g., “Given certain tests to be performed on a car, which one is testing for its fuel efficiency?”).

11.7.10 Identify improvements to a prototype indicated by given test results.

Science – State Goal 12

Grade 4

STANDARD 12A – LIVING THINGS

Classification

12.4.01 Distinguish between living and non-living things.

12.4.02 Identify the basic divisions of animals and their common characteristics (e.g., define mammal, fish, bird, reptile, amphibian, insect, arachnid; give examples of each).

Grade 7

Classification

12.7.01 Understand how scientists classify organisms. Identify common insects, flowers, birds, reptiles, and mammals using a dichotomous key.

Cell Biology

12.7.02 Understand that all living things are composed of cells: small parts which function similarly in all living things. Understand that different tissues have different, specialized cells with specific functions. Understand the levels of organization in living organisms—cells, tissues, organs, and organ systems.

12.7.03 Identify the main differences between plant cells and animal cells, namely that plant cells have chloroplasts and cell walls (which provide rigidity to the plant, since plants have no skeletons). Identify the basic cell organelles and their functions.

12.7.04 Understand that some organisms are unicellular, others multi-cellular. Understand that some unicellular organisms are like tiny animals, able to propel themselves or change their shape and that they are endowed with sensation.

12.7.05 Understand that the nucleus of cell contains the genetic information for the plant or animal to which it belongs.

12.7.06 Understand that cells divide to increase their numbers, and the process of cell division called mitosis results in two daughter cells each with identical sets of chromosomes.

12.7.07 Understand that multi-cellular organisms begin as zygotes (a single egg cell fertilized by a single sperm cell) and that a zygote grows by cell division and that as the cells multiply, they also differentiate. Understand the process of meiosis.

Science – State Goal 12

Grade 4

STANDARD 12A – LIVING THINGS (Continued)

Reproduction

12.4.03 Identify the life cycle of familiar animals and compare their various stages: birth, growth and development, reproduction, and death. Understand that metamorphosis occurs in some animals (e.g., butterflies, frogs).

12.4.04 Identify the basic needs of living things: animals need air, water, food, and shelter; plants need air, water, nutrients, and light.

12.4.05 Understand the functions of component parts of living things.

12.4.06 Understand that some characteristics of living things are inherited from parents, such as the color of a flower in a plant, or the number of limbs on an animal. Understand that other features, however, are acquired by an organism through interactions with its environment (or learned) and cannot be passed down to the next generation merely through reproduction.

Grade 7

Genetics and Reproduction

12.7.08 Understand the distinction between sexual and asexual reproduction. Understand that the offspring of sexual reproduction inherits half its genes from each parent.

12.7.09 Understand that only some animals are capable of limb-regeneration (e.g., sea stars, some amphibians, many crustaceans).

12.7.10 Understand that an inherited trait can be determined by one or more genes.

12.7.11 Understand that DNA (deoxyribonucleic acid) is the genetic material of each living thing—like a blueprint or set of instructions for building the organism—and that it is located in the chromosomes of each cell.

12.7.12 Understand that heredity is based on the probability of inheriting a given trait for which one or both of the parents carries a gene, and that this probability can be calculated given the genetic make-up of the parents with regard to that kind of trait (e.g., blue eyes) using a Punnett Square.

12.7.13 Understand that male animals produce sperm cells, and females produce egg cells, and that the combination of these cells results in fertilization.

12.7.14 Understand the basics of plant reproduction and define and state the purposes of pollen, ovules, seeds, and fruit.

STANDARD 12A – LIVING THINGS (Continued)

Botany

12.7.15 Identify the common characteristics of plants and plant growth. Understand the purpose of various plant parts such as roots, stems, and leaves.

12.7.16 Understand that energy for life primarily derives from the sun; understand the process of photosynthesis.

12.7.17 Identify the basic anatomy of leaves: blade, vein, and petiole; classify leaves as dicot or monocot, simple or compound, and palmately compound or pinnately compound.

12.7.18 Classify roots as either fibrous roots or tap roots.

12.7.19 Understand that flowers are the reproductive organs of flowering plants and that their function is to produce male gametes (sperm) and female gametes (eggs) and to provide a structure for fertilization.

12.7.20 Understand that some of the structures of flowers are adaptations that enable plants to reproduce sexually while they remain stationary. Understand that a plant's production of pollen is one such adaptation, since it can be transported (by wind, water, insects or other organisms) to the parts of the flowers that contain eggs. Know that this process is called pollination.

12.7.21 Identify a seed as a reproductive structure consisting of a plant embryo and its stored food. Understand that in flowering plants the seeds develop in a structure called a fruit, which houses and protect seeds and may also help to disperse them to new locations.

Change Over Time

12.7.22 Understand natural selection or survival of the fittest, and understand that this is thought to be one of the explanations for how animals and plants change over time and that it was the explanation given by Charles Darwin.

12.7.23 Understand that fossils of complete skeletons are rare, and that many skeletons have to be reconstructed based on what scientists believed the whole body to look like. Understand that the fossil record is not complete or representative of the times in which the fossilized animals and plants lived.

12.7.24 Understand how fossils provide evidence that animals and plants have changed over time, and that new species of organisms changed over time out of older ones.

Science – State Goal 12

Grade 4

Grade 7

STANDARD 12B – ENVIRONMENT AND INTERACTION OF LIVING THINGS

12.4.07 Understand the concept of food chains and food webs and the related classifications of plants or animals (e.g., producers, decomposers, consumers, herbivores, carnivores).

12.4.08 Know that the world contains many kinds of environments, and that different animals and plants are suited to live in different environments.

12.4.09 Understand that each plant or animal has different structures that serve different functions in its growth, survival, and reproduction. Understand the concept of animal camouflage and how it relates to the survival of living things.

12.4.10 Identify the basic classifications of animals based on how they interact with their environment [e.g., (a) Some animals are active in the daytime (diurnal), others in the night time (nocturnal). (b) Some animals have a body temperature that stays the same regardless of significant temperature changes in their immediate environment (warm blooded), others have a body temperature that rises and falls with the temperature changes of their environment (cold blooded). (c) Some animals are herbivores, others are carnivores].

12.4.11 Understand that an ecosystem is made of living and nonliving things.

12.4.12 Understand that some animals survive winter by being fitted for an active life during winter (e.g., penguins), others by hibernation (e.g., certain bears), and others by migration (e.g., monarch butterflies).

12.4.13 Understand that human activities can change the number of species in an area, whether by increasing it or decreasing it.

12.7.25 Understand that three important cycles for the survival of living things in Earth's ecosystems are the carbon dioxide-oxygen cycle, the water cycle, and the nitrogen cycle.

12.7.26 Understand that the number of organisms an ecosystem can support depends on the resources available and abiotic factors (e.g., the quantity of light and water, the range of temperatures, soil composition). Know that given adequate biotic and abiotic resources and no disease or predators, populations can increase at rapid rates. Understand that lack of resources and other factors (e.g., predation, climate) limit the growth of populations in specific niches in the ecosystem.

12.7.27 Understand that competitive feeding habits between species can have a negative effect on their populations. Understand that animals and plants compete for food, shelter, mates, and other things necessary for life and reproduction.

12.7.28 Distinguish the various members of a food web and identify the order of dependence among these members.

12.7.29 Understand that many plants depend upon certain animals for pollination and the spreading out of their seeds, and therefore to reproduce. Conversely, understand that animals depend on plants for food (either immediately, like herbivores; or intermediately, like carnivores) and shelter.

12.7.30 Understand that the behavior of different organisms influences and is influenced by their environment (e.g., hunger, changes in available resources).

12.7.31 Understand that animals have parts well suited to the places they live in and to their needs.

12.7.32 Identify and describe the major biomes and habitats and their characteristics: desert, grassland, savannah, tropical forest, coniferous forest, tundra, freshwater, and saltwater.

Science – State Goal 12

Grade 4

STANDARD 12C – MATTER AND ENERGY

Properties of Matter

12.4.14 Understand that matter is usually found in 3 states: liquid, solid, and gas and be able to identify the properties of each. Understand that water can be found in all three forms.

12.4.15 Understand that an increase in temperature generally causes things to expand, and that a decrease in temperature generally causes things to contract. Understand that particles move more slowly in a solid than they do in a liquid or a gas.

12.4.16 Understand that some substances will dissolve in water and some will not. Understand the property of density.

Grade 7

Properties of Matter

12.7.33 Understand that matter can be changed in different ways. 1. Physically, a change in the size shape or state of matter (e.g., the melting of an ice cube, tearing of paper). 2. Chemically, where matter can change into another kind of matter (e.g., burning of wood, rusting of iron).

12.7.34 Define and distinguish the properties of matter: mass, weight, volume, density, color, odor, shape, texture, and hardness.

12.7.35 Understand the phases of matter and how they depend on how the atoms and molecules of a substance move.

12.7.36 Understand the concepts of melting point, boiling point, and freezing point, and understand the concepts of evaporation, condensation, and sublimation.

12.7.37 Understand that there is another state of matter called plasma, which can be produced under artificial conditions on Earth. The sun's matter is in the plasma state, as is the matter of the other stars.

12.7.38 Understand that substances can be grouped by similarities in their physical properties.

12.7.39 Define element as a substance that cannot be broken down into simpler substances by chemical interactions. Understand that there are over 100 known elements that combine in many ways to form many kinds of compounds. Each element has its own number on the periodic table.

12.7.40 Identify the properties common to most metals (e.g., luster, malleability, ductility, the ability to conduct electricity).

12.7.41 Identify simple compounds (e.g., H₂O, NaCl).

Grade 4

STANDARD 12C – MATTER AND ENERGY (Continued)

Energy/Electricity

12.4.17 Understand that a magnet attracts iron, but not plastic, paper, and other nonmetals; nor does it attract all metals (since it does not attract copper or aluminum). Identify conductors and insulators.

12.4.18 Understand that rubbing together certain objects produces a static electrical charge; in particular, rubbing a balloon on someone's hair or walking in a dry room can build up a charge on the person walking (which is felt as a shock when that person touches someone else). Understand that objects can be positively charged, or negatively charged.

12.4.19 Understand that objects of like charge repel each other and that objects of opposite charge attract each other.

12.4.20 Understand that electrical energy can be converted to other types of energy such as heat, light, or mechanical energy.

12.4.21 Understand that besides static electricity, there is also such a thing as current electricity. For example, given a battery, bulb, and wire, students will understand the proper configuration to make the bulb light.

Grade 7

The Atom

12.7.42 Define atom as the smallest part of an element that still has the properties of that element.

12.7.43 Identify the 3 subatomic building blocks and their properties. Know that the electron has a negative charge, the proton has a positive charge, and the neutron is electrically neutral.

12.7.44 Understand that a molecule made of two or more atoms.

12.7.45 Identify the number of different kinds of elements in a chemical formula.

12.7.46 Understand that during a chemical change atoms are neither created nor destroyed but are rearranged to make new substances.

Acids and Bases

12.7.47 Identify the basic properties of acids and bases. Know the relationship between acids, bases, and indicators (e.g., blue litmus paper changes to red when placed in an acid).

Energy

12.7.48 Know the laws of the conservation of matter and energy. Apply the conservation of matter as a reason why the number and kinds of atoms in a chemical change remains constant.

12.7.49 Understand that energy appears in many forms, such as heat, light, sound, chemical, mechanical, solar, nuclear, and electromagnetic energy. Understand the basic characteristics of each of these kinds of energy. Understand the nature of kinetic and potential energy.

12.7.50 Understand that heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature (thermal equilibrium).

12.7.51 Understand that energy can be transferred by radiation, conduction, and convection.

12.7.52 Identify electrical conductors and insulators. Define and give examples of each. Understand that electricity can be converted into heat and light by forcing an electrical current through a conductor. Understand that this is what happens in a toaster and in a light bulb.

Science – State Goal 12

Grade 4

STANDARD 12C – MATTER AND ENERGY (Continued)

Light

12.4.22 Understand that lighter colors reflect more light, darker absorb more, and that the color one sees depends on what kind of light is reflected (rather than absorbed) by the object seen.

12.4.23 Understand that white light can be broken into all the colors of the rainbow by means of prisms.

12.4.24 Understand that light travels in a straight line and can be reflected, refracted, transmitted, and absorbed by matter.

Grade 7

Light

12.7.53 Understand that light travels in straight lines as long as it is traveling through one uniform medium.

12.7.54 Understand that almost all of Earth's energy comes from the sun. Understand that this energy is in the form of visible and invisible light with a range of wavelengths (electromagnetic spectrum).

12.7.55 Understand that visible light is a small band within a very broad electromagnetic spectrum.

12.7.56 Understand that when a light beam hits an object and is reflected off of it, the angle of incidence equals the angle of reflection.

12.7.57 Understand that light travels at different speeds in different materials. Understand that this is why light refracts—or changes direction—namely because it goes from one material in which it moves at one speed into another material through which it moves at a different speed.

12.7.58 Understand that the angle of refraction is determined by (1) the angle of incidence and (2) the index of refraction of the new material which the light is entering.

12.7.59 Understand that many lenses operate by refracting light beams that hit their surface in such a way that they will all meet at one point called a focal point. Understand that this is the way refracting telescopes increase the ability of an image to be magnified, and this is also how they magnify it with another lens. Likewise, know that light microscopes and magnifying glasses work in the same way.

12.7.60 Understand that light has a dual nature—exhibiting particle properties and also wave properties—depending on the situation.

12.7.61 Identify the basic properties of waves: frequency, wavelength, and velocity.

12.7.62 Understand that in the spectrum of visible light, lower frequency colors are toward red, and higher frequency colors are toward blue.

Science – State Goal 12

Grade 4

STANDARD 12D – FORCE AND MOTION

12.4.25 Define a force as a push or a pull that tends to move an object. Understand that forces may be balanced or unbalanced. Know that when the forces applied to an object are balanced, the motion or rest of that object does not change.

12.4.26 Identify the basic forces, such as friction, magnetism, and gravity. Identify which force is operative in a simple scenario.

12.4.27 Identify simple machines (lever, inclined plane, pulley, screw, and wheel and axle) and understand how they function. Understand how they apply forces with advantage, and identify which machine is suited for accomplishing a simple task.

12.4.28 Identify equilibrium conditions (e.g., in a diagram of balanced weights on levers or pulleys).

Grade 7

12.7.63 Understand the concept of force as any influence that tends to accelerate an object. Know that a force, for example, can speed up an object, or slow it down, or change its direction. Understand that forces can be measured in various ways. Understand how to calculate the acceleration of an object.

12.7.64 Identify and understand Newton's laws of motion. The first law of motion states that things at rest or in motion tend to stay at rest or continue in motion unless some force is applied to them. Newton's second law of motion ($\text{force} = \text{mass} \times \text{acceleration}$) shows how force, mass, and acceleration are related. The third law states that for every action there is an equal and opposite reaction.

12.7.65 Understand the concept of work. A force acting through distance is work. Recognize applications of simple machines (wedge, lever, inclined plane, pulley, screw, and wheel and axle) in common tools.

12.7.66 Understand that density is mass per volume, and that what is denser than something else at the same volume will have more mass, but at the same mass it will have less volume. Understand that less dense bodies have greater buoyant force in water.

12.7.67 Understand that the gravitational force between two bodies decreases as the bodies get farther apart from each other. Know that the gravitational force between two bodies decreases as their masses decrease.

12.7.68 Understand how to calculate average speeds, given the distance traveled and the time taken.

12.7.69 Distinguish between mass and weight. Know that the mass of a body remains the same regardless of where it is but that the weight of it depends on how strong the force of gravity is in its current location.

Science – State Goal 12

Grade 4

STANDARD 12E – EARTH SCIENCE

Basic Earth Science

12.4.29 Understand that Earth’s basic materials are land, water, and air.

12.4.30 Understand that a natural resource is any material found on Earth that is used by people. Understand the difference between renewable and nonrenewable resources. Know that fossil fuels come from animals and plants, and that oil, coal, and natural gas are examples of fossil fuels.

12.4.31 Identify which everyday materials decompose most slowly (e.g., plastics, glass and ceramics decompose slower than metals, wood, or food substances).

The Earth’s Dynamic Processes

12.4.32 Understand that the surface of the earth changes. Know that some changes are due to slow processes (e.g., erosion, weathering), whereas others are due to sudden events (e.g., landslides, volcanic eruptions, earthquakes, asteroid impacts).

Grade 7

The Earth’s Structure

12.7.70 Understand that lithospheric plates constantly move at rates of centimeters per year in response to movements in the mantle. Understand that major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions. Understand that over very long periods of time (millions of years), old mountains wear down, but new ones arise from catastrophic volcanic and earthquake activity.

12.7.71 Understand that land forms are the result of combination of constructive and destructive forces. Understand that constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, whereas destructive forces include weathering and erosion.

12.7.72 Understand that soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Understand that soils are often found in layers, with each having a different chemical composition and texture.

12.7.73 Understand that glaciers can move at a rate of centimeters per year (sometimes faster), and that in the past, glacial movement has carved new geological features on various continents.

12.7.74 Understand that radioactive elements are useful for dating materials because the time it takes for the atoms in them to break apart is known. Know that this information can be used to determine the age of a rock within a certain number of years.

12.7.75 Understand that there are strata (layers) in many places in the crust of the earth. Understand that the crust of the earth is mostly igneous/metamorphic, with a relatively thin veneer of sedimentary rock layers in many, but not all places. Understand the principle of superposition: in a layered sedimentary sequence, the oldest rocks are usually at the bottom.

The Earth’s Dynamic Processes

12.7.76 Compare seasonal climates in major regions of the globe, considering effects of latitude, altitude, and geography. (e.g., 1. Higher altitude generally means colder temperatures and lower air pressure; 2. Places along the equator have a 12-hour day and a 12-hour night every day of the year and do not have strict seasons; 3. Places along latitudes between the equator and one of the earth’s poles have seasons and differing amounts of daylight throughout the year: they have a longest day, a shortest day, and two equinoxes on which the daylight lasts for 12 hours; 4. Places along the Arctic and Antarctic circles have one day of exactly 24-hour daylight and one day of exactly 24-hour darkness each year).

Science – State Goal 12

Grade 4

STANDARD 12E – EARTH SCIENCE (Continued)

The Earth's Dynamic Processes (Continued)

12.4.33 Understand that some rocks contain plant and animal fossils. Know how they were formed.

12.4.34 Identify the three basic kinds of rocks: igneous, sedimentary, and metamorphic and the processes that created them. Use information to identify physical properties of minerals.

12.4.35 Understand that movement in parts of the earth's crust causes earthquakes.

12.4.36 Understand that the main cause of erosion is moving water. Understand that when water erodes landmasses, it carries the land away by rainfall and rivers and re-deposits it in the form of pebbles, sand, silt, and mud. Understand that the delta of a river is formed by such deposits. Understand that deposition of new soil over a flood plain is what makes a river valley fertile. Identify other causes of erosion besides erosion by water (e.g., wind, chemical erosion).

12.4.37 Understand that land formations (mountains, valleys, shorelines, and caves) change slowly over time, and identify the major natural causes of such changes: (a) Slow causes: erosion, caused by wind, rain, glaciers, water freezing inside cracks of rocks (which expands and splits the rocks), the growth of tree roots; (b) Sudden causes: rare catastrophes (e.g., earthquakes, volcanic activity, asteroid impacts, floods).

Grade 7

The Earth's Dynamic Processes (Continued)

12.7.77 Understand that the solid Earth is layered with a crust, under which is a hot convecting mantle, and that at the center of the earth is a dense, metallic core.

12.7.78 Understand that some changes in the solid earth can be described as the rock cycle: rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and thus the rock cycle continues. Identify the three basic kinds of rock. Igneous rock is the result of cooled magma; granite, pumice, and scoria are examples. Sedimentary rock is the result of fine particles from eroded rocks being re-deposited by water or wind; sandstone and limestone are examples. Metamorphic rock is the result of rocks being changed by high temperatures and/or pressures; marble is an example.

12.7.79 Understand that the theory of plate tectonics explains the formation and movement of the earth's plates. Understand that the similar contours of the continents, seafloor spreading, and the location of frequent earthquakes and volcanoes provide evidence for plate tectonics.

12.7.80 Understand that movements of the earth's continental and oceanic plates have affected the distribution of living things on Earth. Understand that major earthquake and volcanic activity can give rise to new mountain ranges, severing different species from each other, which from then on undergo independent lines of gradual change, each adapting to its own, new ecosystem.

12.7.81 Understand that changes in climate (e.g., the ice ages) have affected the distribution of living things on Earth. A change in climate from warm to cold might force many animals to move closer to the equator in order to survive. Identify dynamic forces that affect land and water distributions between solid Earth, oceans, atmosphere, and organisms.

12.7.82 Understand that geologic layers and radioactive dating of rocks and meteorites provide evidence that the earth is about 4.6 billion years old, and that life has existed on Earth for over 3 billion years. Understand how to use a geologic time table.

12.7.83 Understand that life on Earth has been changed by major catastrophes (e.g., the impacts of asteroids, volcanic eruptions).

Science – State Goal 12

Grade 4

STANDARD 12E – EARTH SCIENCE (Continued)

The Atmosphere

12.4.38 Name and distinguish the different kinds of clouds based on their appearance and place in the atmosphere: cirrus, cumulus, and stratus.

12.4.39 Identify types of precipitation and the conditions that cause them to form.

12.4.40 Understand that weather changes from day to day and over the seasons. Identify the order of the seasons and the different characteristics of each season.

12.4.41 Understand that weather is described using measurements of temperature, wind direction and speed, amounts of precipitation, humidity, and air pressure.

12.4.42 Understand that weather systems can be tracked—and their motions roughly predicted.

Water

12.4.43 Understand the stages of the water cycle: evaporation, condensation, and precipitation.

12.4.44 Understand that most of Earth's surface is covered by water, and identify the major kinds of land and water formations: continent, mountain, valley, island, cave, ocean, lake, and river.

Grade 7

The Atmosphere

12.7.84 Understand that the atmosphere is a mixture of nitrogen, oxygen, argon, and trace gases that include water vapor and carbon dioxide. Understand that atmospheric conditions vary as one changes latitude and altitude. Understand that the atmosphere consists of layers and be able to distinguish the layers and their significance. Understand that the ozone layer protects life on Earth by absorbing ultraviolet radiation from the sun.

12.7.85 Understand that clouds, formed by the condensation of water vapor, affect weather and climate. Understand that clouds cause precipitation and lightning and that they insulate heat and moisture in the air.

12.7.86 Understand how jet streams affect weather. Identify weather fronts and understand how they are formed. Understand how to read and interpret weather maps.

12.7.87 Understand patterns of atmospheric movement and how they influence weather. Understand that oceans have a major affect on climate because water in the oceans holds and distributes a large amount of heat.

Water

12.7.88 Understand the stages in the water cycle on Earth: evaporation, condensation, and precipitation.

12.7.89 Understand that water below the surface is groundwater and it forms when precipitation moves slowly downward through rocks and soil.

12.7.90 Know that about three fourths of the earth is covered with water. Understand that most of the earth's water is salt water (oceans), and only about 3 percent of the earth's water is freshwater. Know that freshwater is found mainly in icecaps, glaciers, lakes, groundwater, rivers, and the atmosphere.

Science – State Goal 12

Grade 4

STANDARD 12F – ASTRONOMY

12.4.45 Understand that moons and planets do not produce their own light—the light we see when we look at them is the sunlight which they reflect.

12.4.46 Identify the relative positions of the earth, moon, and sun during a solar eclipse, a lunar eclipse, a full moon, a half moon, and a new moon. Given a diagram of the earth, moon, and sun, identify which of these is depicted.

12.4.47 Identify the order of planets from the sun, and know that the further planets take longer to go around the sun. Understand that all planets in our solar system revolve around the sun. Because Earth revolves around the sun, objects (e.g., stars, planets, constellations) in the sky appear to change positions throughout the year. Know that it takes Earth 365 $\frac{1}{4}$ days to revolve around the sun.

12.4.48 Understand that the earth rotates on its axis and this is responsible for the change from day to night. Understand that the tilt of the earth is responsible for the seasons.

12.4.49 Define a constellation as a group of stars that form a pattern in the sky. Understand that constellations are useful in the study of space because they help create a map of the sky. Know that locations in the sky are often described using the names of constellations.

12.4.50 Understand that the Milky Way is our galaxy, so-called because there appears to be a milky-white path or road in the sky.

12.4.51 Understand that the mass of a body stays the same on different planets but the weight changes depending on the mass of the planet.

Grade 7

12.7.91 Understand that objects in the solar system are for the most part in regular and predictable motion. Know that those motions explain such phenomena as the day, the year, the phases of the moon, and eclipses.

12.7.92 Understand that gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Know that changes in gravitational forces explain the phenomenon of the tides. Know that what an object weighs on Earth is different than what it weighs on the moon or other planets in our solar system. This is due to gravity.

12.7.93 Identify the differences among the planets in our solar system: the four closest planets to the Sun are called the inner planets. The inner planets are small and have rocky surfaces. The five farthest planets from the Sun are called the outer planets. All outer planets except Pluto are much larger than Earth, are made of gases, and have no solid surfaces.

12.7.94 Understand that rock samples taken by astronauts walking on the moon show that the earth and moon have a common history.

12.7.95 Understand that because it takes the moon the same amount of time to rotate on its axis as it does to revolve around the earth, the same side of the moon always faces the earth. Understand that the tides are affected by the positions of the moon.

12.7.96 Understand that valleys on the surface of a planet or moon might be evidence that water is or once was there.

12.7.97 Understand that the speed of a planet's rotation is one cause of the daily variations in temperature on its surface.

12.7.98 Understand that the cause of the earth's seasons and the change in the amount of daylight throughout the year is the tilt of its axis of rotation with respect to the plane of its orbit. Given a diagram of the earth depicting (1) its relative position to the sun and (2) the orientation of its axis of rotation and (3) some circle of latitude, identify the following: (a) the season of the year (if the circle of latitude is other than the equator), and (b) whether there is more daylight or more dark hours at that time of year. Understand why the seasons and daylight hours in opposite hemispheres are opposite to each other.

Science – State Goal 12

Grade 4

Grade 7

STANDARD 12F – ASTRONOMY (Continued)

12.7.99 Understand that the sun is an average star. Know that a solar system consists of a sun and planets and other objects that revolve around it. Know that the planets closest to the sun are hotter than the planets farther away from the sun. Understand that the color of a star depends on its temperature.

12.7.100 Identify the relative positions of the earth, moon, and sun when the moon appears full, new, half, and when a lunar or solar eclipse occurs. Given a diagram of the sun and the earth in some definite position with its axis of rotation drawn (and with the poles labeled), identify the earth in the positions of summer solstice, winter solstice, spring equinox, and fall equinox (for the northern hemisphere).

12.7.101 Define light year, how many kilometers it is, and know that galactic distances may be measured in millions and billions of light years.

Science – State Goal 13

Grade 4

STANDARD 13A – SAFETY AND PRACTICES OF SCIENCE

13.4.01 Identify the basic safety equipment used in science, (e.g., gloves, goggles, lab coats, tongs).

13.4.02 Identify the basic safety procedures (e.g., “Keep your clothes and hair away from open flames,” “Don’t taste substances without permission.”) when conducting science activities.

13.4.03 Explain why similar results are expected when procedures are done the same way. Understand the importance of recording observations accurately and honestly.

13.4.04 Know that scientific results must be reproducible. Know that different scientists study different subjects but work in similar ways.

13.4.05 Know that scientists accept a theory that is supported by tests and experiments until it is disproved or improved upon.

13.4.06 Recognize that scientists share results so that each scientist may build upon what he or she learns from others.

13.4.07 Understand that when an experiment is performed a few times and yields conflicting results, one must repeat it many times. Understand that one should also try to find an explanation for the conflicting results.

Grade 7

13.7.01 Identify potential hazards in the laboratory and the means of reducing them.

13.7.02 Explain how peer review helps to assure the accurate use of data and improves the scientific process. Results from scientific investigations can be discussed.

13.7.03 Indicate that repeatability of results is necessary for the scientific community to accept someone's findings.

13.7.04 Understand that one set of data is not sufficient evidence for making a generalization. Identify the kind of reasoning called induction, and know that the more cases that are seen, the greater the certainty of the generalization drawn from those cases.

13.7.05 Understand that the scientific community has a standard procedure for determining nomenclature, units of measurement, and ways of presenting data.

13.7.06 Understand that important social decisions are made on the basis of risk/benefit analysis (e.g., whether to administer a smallpox vaccine or not).

Science – State Goal 13

Grade 4

STANDARD 13B – SCIENCE, TECHNOLOGY, SOCIETY

13.4.08 Identify important contributions men and women have made to science and technology.

13.4.09 Understand the impact of different scientific discoveries on society.

13.4.10 Identify occupations in the field of science.

13.4.11 Identify ways that science and technology affect people's lives (e.g., in transportation, medicine, agriculture, communication) and careers.

13.4.12 Identify ways that technology has changed local, national, or global environments.

13.4.13 Identify ways to reduce, reuse, and recycle materials.

Measurement

13.4.14 Know that using measuring tools results in greater accuracy than making estimates.

13.4.15 Identify basic scientific instruments and their functions (e.g., ruler, balance, graduated cylinder, clock, stopwatch, thermometer, microscope, telescope).

Grade 7

13.7.07 Compare the knowledge, skills, and methods of early and modern scientists.

13.7.08 Understand that the introduction of a new technology can affect human activities worldwide.

13.7.09 Describe how occupations use scientific and technological knowledge and skills.

13.7.10 Analyze the interaction of resource acquisitions, technological development and ecosystem impact.

13.7.11 Compare the effectiveness of reducing, reusing, and recycling in actual situations.

13.7.12 Analyze the effects of policies on science and technology issues.

Measurement

13.7.13 Select appropriate scientific instruments and technological devices to take measurements, perform calculations, organize data, or make observations.
