

SAMPLE

K-12

SCIENCE

CURRICULUM

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Roger D. Breed, Ed.D., Commissioner
Scott Swisher, Ed.D., Deputy Commissioner

NEBRASKA DEPARTMENT OF EDUCATION

301 CENTENNIAL MALL SOUTH

LINCOLN, NE 68509-4987

Telephone: 402-471-2295 ♦ Fax: 402-471-0117

Website: www.education.ne.gov

AUTHORS

Joan Anthony
Elkhorn Public Schools

Stephani Ballagh
Wahoo Public Schools

Tyler Berzina
Millard Public Schools

Jesse Busse
Omaha Public Schools

Christina Elf
Omaha Public Schools

Vanita Jarmon
Omaha Public Schools

Randy Johnson
Gering Public Schools

Jay Kuecker
Kearney Public Schools

Elissa Oliver
Omaha Archdiocese Schools

Melanie Olson
Educational Service Unit #2/Fremont

Deb Paulman
Educational Service Unit #16/Ogallala

Jon Pedersen
University of Nebraska-Lincoln

Sheree Person-Pandil
Educational Service Unit #3/Omaha

Chris Schaben
Omaha Public Schools

Dan Sitzman
Omaha Public Schools

Kirsten Smith
Lincoln Public Schools

Dan Van Bibber
Lincoln Public Schools

Michelle Wilt
Wahoo Public Schools

PROJECT DIRECTOR

Jim Woodland
Science Education Director
Nebraska Department of Education

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OVERVIEW

Every five years the Nebraska Department of Education is charged with developing standards in science education which are sufficiently clear and measurable to be used for testing student performance with respect to mastery of the content described in the state standards. Because Nebraska is a local control state each district is responsible to determine the science content and curricular materials necessary for all of their students to become science literate. The *Sample K-12 Science Curriculum* is a resource developed to assist in this endeavor. The authors of this document are Nebraska educators who have been involved in various science improvement efforts throughout the state. Their task was to create a resource to provide guidance to K-12 science teachers as they develop science curriculum for Nebraska students. This document provides content boundaries for each of the curricular indicators found within the Nebraska Science Standards. Included in the content boundaries are examples, types of measurement, clarifications, appropriate vocabulary, and exclusions for various science concepts and skills.

The Nebraska Science Standards are designed to expend eighty percent of the instructional time available to science educators. The remaining twenty percent of classroom time allows teachers the flexibility to respond to the teachable moment and to provide instruction for teacher selected content not included within the standards.

Unlike the Nebraska Reading/Writing and Mathematics Standards, which were written for specific grade levels (K, 1, 2, 3, 4, 5, 6, 7, 8, and a grade band of 9-12), the Nebraska Science Standards were written at four grade bands (K-2, 3-5, 6-8, and 9-12). This document assigns the standards found within a grade band to a specific grade level. Districts have the option of changing the sequence of the science standards within this document. For example, the concept that sound is created by vibrating objects, which is found within the 3-5 grade band, is incorporated into the fourth grade level within this document. This concept could be moved to either the third or the fifth grade. It should not be moved to a grade level in a different grade band (K-2, 6-8, or 9-12.) After reviewing this sample curriculum local district curriculum developers may decide to closely follow this guide in the development of their district's science curriculum or modify this document to meet the district's curricular needs. To be effective, teachers from every grade level must be directly involved in the creation of their district's science curriculum.

The *Sample K-12 Science Curriculum* articulates the science standards using spiraling and sequencing to eliminate repetition of science concepts across grade bands. Following this sequence will allow elementary schools the opportunity to find time to teach science to all students at all grades. Middle school science teachers will be able to ensure that their science offerings build upon the groundwork developed at the elementary level and continue to develop this groundwork to ensure mastery of senior high science concepts. At the high school level Nebraska students are required to take three years of science in order to meet graduation requirements. Specific science course titles are not tied to this requisite. This sample curriculum incorporates inquiry and Earth science standards into two science courses, physical science and biology. Students who complete this sequence will have a solid foundation to use as they select their third (and optional fourth) year of science based on aptitude, interest, and career choice.

Science literacy is necessary for all citizens to make choices in everyday life, to participate in public discussions, to function in today's work force, and to enjoy our natural world. A district's K-12 science curriculum should ensure that all students have the opportunity to learn what is essential for scientific literacy. Nebraska schools are among the best in the nation. The *Sample K-12 Science Curriculum* is a resource to make the best even better.

KINDERGARTEN

Inquiry, the Nature of Science, and Technology

Inquiry – Students will ask questions and conduct investigations that lead to observations and communication of findings. 2.1.1

- **Scientific Questioning:** Explore teacher generated questions that relate to a science topic **2.1.1.a**
- **Scientific Investigations:** Participate in simple, teacher-facilitated investigations **2.1.1.b**
- **Scientific Tools:** Explore the guided use of tools (e.g., hand lens, balance, nonstandard measurement tools) **2.1.1.c**
- **Scientific Observations:** Using the five senses, describe objects, organisms, or events through pictures, words, and numbers **2.1.1.d**
- **Scientific Data Collection:** Collect and record observations using pictures, words, and symbols (e.g., weather charts, birthdays, lost teeth) **2.1.1.e**
- **Scientific Communication:** Use drawings and words to describe and share observations with others **2.1.1.f**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **2.1.1.g**

Physical Science

Matter – Students will observe and describe properties of objects and their behavior. 2.2.1

- **Properties and Structure of Matter:** Observe physical properties of objects (color, size, shape) **2.2.1a**
- **Properties and Structure of Matter:** Sort objects by physical attributes (color, size, shape) **2.2.1.b**
- **Properties and Structure of Matter:** Measure objects using comparative terms (heavier, lighter, longer, shorter) and non-standard units **2.2.1.c**

Force and Motion – Students will compare relative position and motion of objects. 2.2.2

- **Motion:** State location and/or motion relative to another object or its surroundings (in front of, behind, between, over, under, up, and down) **2.2.2.a**

Life Science

Structure and Function of Living Systems – Students will investigate the characteristics of living things. 2.3.1

- **Characteristics of Life:** Differentiate between living and nonliving things **2.3.1.a**
- **Characteristics of Living Organisms:** Identify the basic needs of living things (food, water, air, space, shelter) **2.3.1.b**

Heredity – Students will recognize changes in living things. 2.3.2

- **Inherited Traits:** Describe how offspring resemble their parents **2.3.2.a**

Earth and Space Sciences

Earth in Space – Students will observe and identify objects of the sky. 2.4.1

- **Objects in the Sky and Universe:** Identify objects in the sky (Sun, Moon, stars) and when they are observable **2.4.1.a**

Energy in Earth's Systems – Students will observe simple patterns of change on Earth. 2.4.3

- **Weather and Climate:** Observe and describe simple daily changes in weather **2.4.3.b**

FIRST GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will ask questions and conduct investigations that lead to observations and communication of findings. 2.1.1

- **Scientific Questioning:** Recognize questions that relate to a science topic **2.1.1.a**
- **Scientific Investigations:** Conduct simple investigations **2.1.1.b**
- **Scientific Tools:** Use simple tools appropriately (e.g., observation and measurement tools) **2.1.1.c**
- **Scientific Observations:** Using the five senses, describe objects, organisms, or events through pictures, words, and numbers **2.1.1.d**
- **Scientific Data Collection:** Collect and record observations using pictures, words, and symbols **2.1.1.e**
- **Scientific Communication:** Use drawings and words to describe and share observations with others **2.1.1.f**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **2.1.1.g**

Physical Science

Matter – Students will observe and describe properties of objects and their behavior. 2.2.1

- **Properties and Structure of Matter:** Observe physical properties of objects (texture, weight) **2.2.1.a**
- **Properties and Structure of Matter:** Sort objects by physical attributes (texture, weight) **2.2.1.b**
- **Properties and Structure of Matter:** Measure objects using non-standard (e.g., paperclip length, pencil length) and standard (e.g., inches, centimeters) units **2.2.1.c**
- **Properties and Structure of Matter:** Use size-appropriate metric measurements to describe physical properties **2.2.1.c**

Force and Motion – Students will compare relative position and motion of objects. 2.2.2

- **Motion:** Describe how objects move in many different ways (straight, zigzag, round and round, back and forth, and fast and slow) **2.2.2.b**

Life Science

Structure and Function of Living Systems – Students will investigate the characteristics of living things. 2.3.1

- **Characteristics of Living Organisms:** Identify external parts of plants and animals **2.3.1.c**

Heredity – Students will recognize changes in living things. 2.3.2

- **Reproduction:** Describe how living things change as they grow **2.3.2.b**

Earth and Space Sciences

Earth in Space – Students will observe and identify objects of the sky. 2.4.1

- **Motion of Objects in the Solar System:** Identify objects that appear to move in the sky (the Sun, the Moon, stars) **2.4.1.b**
Exclusion: movement of clouds, birds, airplanes, planets

Earth Structures and Processes – Students will observe, identify, and describe characteristics of Earth's materials. 2.4.2

- **Properties of Earth Materials:** Describe Earth materials (sand, soil, rocks, water) **2.4.2.a**

Energy in Earth's Systems – Students will observe simple patterns of change on Earth. 2.4.3

- **Weather and Climate:** Describe simple seasonal weather indicators and how they impact students' choices (activities, clothing) **2.4.3.c**

SECOND GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will ask questions and conduct investigations that lead to observations and communication of findings. 2.1.1

- **Scientific Questioning:** Ask questions that relate to a science topic **2.1.1.a**
- **Scientific Investigations:** Conduct simple investigations **2.1.1.b**
- **Scientific Tools:** Select and use simple tools appropriately (e.g., observation and measurement tools) **2.1.1.c**
- **Scientific Observations:** Describe objects, organisms, or events using pictures, words, and numbers **2.1.1.d**
- **Scientific Data Collection:** Collect and record observations **2.1.1.e**
- **Scientific Communication:** Use drawings and words to describe and share observations with others **2.1.1.f**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **2.1.1.g**

Physical Science

Matter – Students will observe and describe properties of objects and their behavior. 2.2.1

- **Properties and Structure of Matter:** Observe physical properties of objects (freezing, melting, sinking, and floating) **2.2.1.a**
- **Properties and Structure of Matter:** Sort objects by physical attributes (freezing, melting, sinking, and floating) **2.2.1.b**
- **Properties and Structure of Matter:** Measure objects using simple tools (ruler, balance, hand lens, thermometer) and standard units to quantify characteristics **2.2.1.c**
- **States of Matter:** Identify solids and liquids and recognize that liquids take the shape of their container **2.2.1.d**
Exclusion: unusual substances (such as mud, toothpaste, or oobleck) that cannot be clearly classified.

Life Science

Structure and Function of Living Systems – Students will investigate the characteristics of living things. 2.3.1

- **Characteristics of Living Organisms:** Observe and match plants and animals to their distinct habitats **2.3.1.d**
Exclusion: ecosystem

Biodiversity – Students will recognize changes in organisms. 2.3.4

- **Biological Adaptations:** Recognize seasonal changes in animals and plants **2.3.4.a**

Earth and Space Sciences

Earth Structures and Processes – Students will observe, identify, and describe characteristics of Earth’s materials. 2.4.2

- **Use of Earth Materials:** Recognize ways in which individuals and families can conserve Earth's resources by reducing, reusing, and recycling **2.4.2.b**

Energy in Earth’s Systems – Students will observe simple patterns of change on Earth. 2.4.3

- **Energy Sources:** Observe that the Sun provides heat and light **2.4.3.a**

THIRD GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will plan and conduct investigations that lead to the development of explanations.

5.1.1

- **Scientific Questioning:** Identify scientific questions that can be investigated **5.1.1.a**
- **Scientific Investigations:** Plan and conduct simple scientific investigations **5.1.1.b**
Exclusion: Do not hold students responsible for dependent and independent variables.
- **Scientific Tools:** Use equipment correctly and accurately **5.1.1.c**
- **Scientific Observations:** Make observations and measurements **5.1.1.d**
- **Scientific Data Collection:** Collect and organize data **5.1.1.e**
- **Scientific Interpretations, Reflections, and Applications:** Develop a reasonable explanation based on collected data (teacher guided) **5.1.1.f**
- **Scientific Communication:** Share information, procedures, and results with peers and/or adults **5.1.1.g**
- **Scientific Communication:** Provide feedback on previously conducted scientific investigations such as class experiments or appropriate science publications **5.1.1.h**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **5.1.1.i**

Nature of Science – Students will describe how scientists go about their work. 5.1.2

- **Scientific Knowledge:** Recognize that scientific explanations are based on evidence **5.1.2.a**
- **Science and Society:** Recognize that new discoveries are always being made which impact scientific knowledge **5.1.2.b**
- **Science as a Human Endeavor:** Recognize many different people study science **5.1.2.c**

Physical Science

Matter – Students will explore and describe the physical properties of matter and its changes. 5.2.1

- **Properties and Structure of Matter:** Identify and sort objects by physical properties of matter (color, odor, elasticity, weight, volume) **5.2.1.b**
- **Properties and Structure of Matter:** Use size-appropriate metric measurements to describe physical properties **5.2.1.c**
- **States of Matter:** Identify physical properties of solids, liquids, and gases **5.2.1.d**
Exclusion: plasma

Force and Motion – Students will identify the influence of forces on motion. 5.2.2

- **Universal Forces:** Describe magnetic behavior in terms of attraction and repulsion **5.2.2.c**

Energy – Students will observe and identify signs of energy transfer. 5.2.3

- **Electricity/Magnetism:** Recognize that the transfer of electricity in an electrical circuit requires a closed loop **5.2.3.f**

Life Science

Structure and Function of Living Systems – Students will investigate and compare the characteristics of living things. 5.3.1

- **Characteristics of Life:** Compare and contrast characteristics of living and nonliving things **5.3.1.a**
Examples: body covering, diet, locomotion
- **Characteristics of Living Organisms:** Identify how parts of animals function to meet basic needs (e.g., leg of an insect helps an insect to move) **5.3.1.b**

Heredity – Students will identify variations of inherited characteristics and life cycles. 5.3.2

- **Inherited Traits:** Identify inherited characteristics of animals **5.3.2.a**
- **Reproduction:** Identify the life cycle of an organism (animals) **5.3.2.b**
Exclusion: cells, cellular function; internal structures

Earth and Space Sciences

Earth in Space – Students will observe and describe characteristics, patterns, and changes in the sky. 5.4.1

- **Objects in the Sky and Universe:** Recognize that the observed shape of the Moon changes from day to day during a one month period **5.4.1.a**
Exclusion: terms and content related to moon phases (e.g., waxing, waning, gibbous)

Earth Structures and Processes – Students will observe and describe Earth’s materials, structure, and processes. 5.4.2

- **Properties of Earth Materials:** Describe the characteristics of rocks, minerals, soils, water, and the atmosphere **5.4.2.a**
Exclusion: carbon dioxide and other specific component gases of the atmosphere

Energy in Earth’s Systems – Students will observe and describe the effects of energy. 5.4.3

- **Weather and Climate:** Recognize the difference between weather, climate, and seasons **5.4.3.c**
Exclusion: terms related to pressure, humidity, and long-term climate trends

FOURTH GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will plan and conduct investigations that lead to the development of explanations. 5.1.1

- **Scientific Questioning:** Ask scientific questions that can be answered through investigations **5.1.1.a**
Examples: Questions usually begin with How, What, If, Does, or I wonder rather than Why.
- **Scientific Investigations:** Plan and conduct simple scientific investigations **5.1.1.b**
Exclusion: Do not hold students responsible for dependent and independent variables.
- **Scientific Tools:** Select and use equipment correctly and accurately **5.1.1.c**
- **Scientific Observations:** Differentiate between relevant and non-relevant observations **5.1.1.d**
- **Scientific Data Collection:** Collect and organize data **5.1.1.e**
- **Scientific Interpretations, Reflections, and Applications:** Develop a reasonable explanation based on collected data (teacher guided) **5.1.1.f**
- **Scientific Communication:** Share information, procedures, and results with peers and/or adults **5.1.1.g**
- **Scientific Communication:** Provide feedback on previously conducted scientific investigations such as class experiments or appropriate science publications **5.1.1.h**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **5.1.1.i**

Nature of Science – Students will describe how scientists go about their work. 5.1.2

- **Scientific Knowledge:** Recognize that scientific explanations are based on evidence and scientific knowledge **5.1.2.a**
- **Science and Society:** Recognize that new discoveries are always being made which impact scientific knowledge **5.1.2.b**
- **Science as a Human Endeavor:** Recognize many different people study science **5.1.2.c**

Technology – Students will solve a simple design problem. 5.1.3

- **Abilities to do Technical Design:** Identify a simple problem **5.1.3.a**
- **Abilities to do Technical Design:** Propose a solution to a simple problem **5.1.3.b**
- **Abilities to do Technical Design:** Implement the proposed solution **5.1.3.c**
- **Abilities to do Technical Design:** Evaluate the implementation **5.1.3.d**
- **Abilities to do Technical Design:** Communicate the problem, design, and solution **5.1.3.e**

Physical Science

Matter – Students will explore and describe the physical properties of matter and its changes. 5.2.1

- **Properties and Structure of Matter:** Create simple mixtures and identify the physical properties of the individual substances which make up the mixture **5.2.1.a**
- **Properties and Structure of Matter:** Use size-appropriate metric measurements to describe physical properties **5.2.1.c**

Energy – Students will observe and identify signs of energy transfer. 5.2.3

- **Sound/Mechanical Waves:** Recognize that sound is produced from vibrating objects; that sound can be changed by changing the vibration **5.2.3.a**
- **Light:** Recognize that light travels in a straight line and can be reflected by an object (mirror) **5.2.3.b**
- **Light:** Recognize that light can travel through certain materials and not others (transparent, translucent, opaque) **5.2.3.c**

Life Science

Structure and Function of Living Systems – Students will investigate and compare the characteristics of living things. 5.3.1

- **Characteristics of Living Organisms:** Identify how parts of plants function to meet basic needs (e.g., root of a plant helps the plant obtain water) **5.3.1.b**

Heredity – Students will identify variations of inherited characteristics and life cycles. 5.3.2

- **Inherited Traits:** Identify inherited characteristics of plants **5.3.2.a**
Exclusion: process of photosynthesis
- **Reproduction:** Identify the life cycle of an organism (plants) **5.3.2.b**
Exclusion: cells, cellular function; internal structures

Flow of Matter and Energy in Ecosystems – Students will describe relationships within an ecosystem. 5.3.3

- **Flow of Energy:** Diagram and explain a simple food chain beginning with the Sun **5.3.3.a**
Exclusion: process of photosynthesis

Earth and Space Sciences

Earth Structures and Processes – Students will observe and describe Earth’s materials, structure, and processes. 5.4.2

- **Earth's Processes:** Identify weathering, erosion, and deposition as processes that build up or break down Earth's surface **5.4.2.b**

Energy in Earth’s Systems – Students will observe and describe the effects of energy. 5.4.3

- **Energy: Sources** Describe the Sun's warming effect on the land and water **5.4.3.a**

Earth’s History – Students will describe changes in Earth. 5.4.4.

- **Past/Present Earth:** Describe how slow processes (erosion, weathering, deposition) change Earth's surface **5.4.4.a**
Exclusion: plate tectonics and mountain building

FIFTH GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will plan and conduct investigations that lead to the development of explanations. 5.1.1

- **Scientific Questioning:** Ask testable scientific questions **5.1.1.a**
- **Scientific Investigations:** Plan and conduct investigations and identify factors that have the potential to impact an investigation **5.1.1.b**
Exclusion: Do not hold students responsible for dependent and independent variables.
- **Scientific Tools:** Select and use equipment correctly and accurately **5.1.1.c**
- **Scientific Observations:** Make relevant observations and measurements **5.1.1.d**
- **Scientific Data Collection:** Collect and organize data **5.1.1.e**
- **Scientific Interpretations, Reflections, and Applications:** Develop a reasonable explanation based on collected data **5.1.1.f**
- **Scientific Communication:** Share information, procedures, and results with peers and/or adults **5.1.1.g**
- **Scientific Communication:** Provide feedback on previously conducted scientific investigations such as class experiments or appropriate science publications **5.1.1.h**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **5.1.1.i**

Nature of Science – Students will describe how scientists go about their work. 5.1.2

- **Scientific Knowledge:** Recognize that scientific explanations are based on evidence and scientific knowledge **5.1.2.a**
- **Science and Society:** Recognize that new discoveries are always being made which impact scientific knowledge **5.1.2.b**
- **Science as a Human Endeavor:** Recognize many different people study science **5.1.2.c**

Physical Science

Matter – Students will explore and describe the physical properties of matter and its changes. 5.2.1

- **Properties and Structure of Matter:** Identify pure substances and mixtures **5.2.1.a**
Pure substances are matter that cannot be separated into other kinds of matter by any physical process. It has the same color, taste, texture, and composition. Mixtures are two or more substances mixed together but not combined chemically.
Exclusion: Chemical properties and changes are addressed in the 6-8 band.
- **Properties and Structure of Matter:** Classify and categorize objects by multiple quantitative physical attributes (e.g., dimensions, mass, volume, temperature) **5.2.1.b**
Exclusion: volume measures using cubic centimeters; force or weight measures using Newtons
- **Properties and Structure of Matter:** Use size-appropriate metric measurements to describe physical properties **5.2.1.c**
- **States of Matter:** Identify state changes caused by heating and cooling for solids, liquids, and gases **5.2.1.d**

Force and Motion – Students will identify the influence of forces on motion. 5.2.2

- **Motion:** Describe motion by tracing and measuring an object's position over a period of time (relative speed) **5.2.2.a**
Exclusion: velocity, speed=distance/time and direction
- **Forces/Newton's 2nd Law:** Describe changes in motion due to outside forces (push, pull, gravity) **5.2.2.b**
Exclusion: friction

Energy – Students will observe and identify signs of energy transfer. 5.2.3

- **Heat:** Identify ways to generate heat (e.g., friction, burning, incandescent light bulb) **5.2.3.d**
Exclusion: thermal energy
- **Heat:** Identify materials that act as conductors or insulators of heat **5.2.3.e**

Life Science

Flow of Matter and Energy in Ecosystems – Students will describe relationships within an ecosystem. 5.3.3

- **Flow of Energy:** Identify the roles of producers, consumers, and decomposers in an ecosystem **5.3.3.b**
- **Ecosystems:** Recognize the living and nonliving factors that impact the survival of organisms in an ecosystem **5.3.3.c**
Exclusions: predation, symbiosis, parasitism
- **Impact on Ecosystems:** Recognize all organisms cause changes, some beneficial and some detrimental, in the environment where they live **5.3.3.d**

Diversity – Students will describe changes in organisms over time. 5.3.4

- **Biological Adaptations:** Describe adaptations made by plants or animals to survive environmental changes **5.3.4.a**
Exclusions: predation, symbiosis, parasitism, traits, species

Earth and Space Sciences

Earth in Space – Students will observe and describe characteristics, patterns, and changes in the sky. 5.4.1

- **Motion of Objects in the Solar System:** Recognize the motion of objects in the sky (the Sun, the Moon, stars) change over time in recognizable patterns **5.4.1.b**
Exclusion: observation of stars and galaxies; use of telescopes; ecliptic (use terms such as path of the Sun instead), planets, asteroids, comets

Earth Structures and Processes – Students will observe and describe Earth’s materials, structure, and processes. 5.4.2

- **Use of Earth Materials:** Identify how Earth materials are used (fuels, building materials, sustaining plant life) **5.4.2.c**

Energy in Earth’s Systems – Students will observe and describe the effects of energy. 5.4.3

- **Weather and Climate:** Observe, measure, and record changes in weather (temperature, wind direction and speed, precipitation) **5.4.3.b**
Exclusion: use of barometer to measure pressure or instruments to measure humidity

Earth’s History – Students will describe changes in Earth. 5.4.4.

- **Past/Present Earth:** Describe how rapid processes (landslides, volcanic eruptions, earthquakes) change Earth’s surface **5.4.4.a**

SIXTH GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will design and conduct investigations that will lead to descriptions of relationships between evidence and explanations. 8.1.1

The 6-8 sample curriculum identifies specific indicators at each grade level that connect to grade level content.

- **Scientific Questioning:** Formulate testable questions that lead to predictions and scientific investigations **8.1.1.a**
Possible connections to:
 - 8.2.3.a investigating ripple tanks
 - 8.3.3.e investigating types of organisms found in different transects (defined areas)
 - 8.4.2.b investigating properties of soil such as percolation rates
 - 8.4.2.d investigations with a magnetic compass
 - 8.4.2.e investigations with simple stream tables (e.g. a cake pan and sand)
- **Scientific Investigations:** Design and conduct logical and sequential investigations including repeated trials **8.1.1.b**
Possible connections to:
 - 8.2.3.a investigating ripple tanks
 - 8.3.3.e investigating types of organisms found in different transects (defined areas)
 - 8.4.2.b investigating properties of soil such as percolation rates
 - 8.4.2.d such as investigations with a magnetic compass
 - 8.4.2.e such as investigations with simple stream tables (e.g. a cake pan and sand)
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **8.1.1.j**

Nature of Science – Students will apply the nature of science to their own investigations. 8.1.2

Nature of science (8.1.2) is included in the 7th and 8th grade sample curriculum

Technology – Students will solve a design problem that involves one or two science concepts. 8.1.3

Technology (8.1.3) is included in the 8th grade sample curriculum to streamline the 6-8 content standards and to align with indicators related to forces and motion

Physical Science

Energy – Students will identify and describe how energy systems and matter interact. 8.2.3

- **Sound/Mechanical Waves:** Recognize that vibrations set up wave-like disturbances that spread away from the source (sound, seismic, water waves) **8.2.3.a**
For example use ripple tank, pebble in water, online seismic wave simulation to model wave motion
- **Sound/Mechanical Waves:** Identify that waves move at different speeds in different materials **8.2.3.b**
Exclusions: wave properties (speed calculations, wavelength, frequency, amplitude)
- **Light:** Recognize that light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection) **8.2.3.c**
Exclusions: polarized light, fluorescent, phosphors, neon, index of refraction
- **Light:** Recognize that to see an object, light from the surface of the object must enter the eye; the color seen depends on the properties of the surface and the color of the available light sources **8.2.3.d**
Exclusions: primary, complimentary colors and pigments
- **Heat:** Recognize that heat moves from warmer objects to cooler objects until both reach the same temperature **8.2.3.e**

- **Conservation:** Describe transfer of energy from electrical and magnetic sources to different energy forms (heat, light, sound, and chemical) **8.2.3.f**
Connects to 8.4.2.d
- **Conservation:** Recognize all energy is neither created nor destroyed **8.2.3.g**
Relate to energy forms in 8.2.3.f
Exclusions: interpretation of Law of Conservation of Energy, kinetic, potential energy

Life Science

Flow of Matter and Energy in Ecosystems – Students will describe populations and ecosystems. 8.3.3

- **Flow of Energy:** Diagram and explain the flow of energy through a simple food web **8.3.3.a**
- **Flow of Energy:** Compare the roles of producers, consumers, and decomposers in an ecosystem **8.3.3.b**
Builds on 5.3.3.b
- **Ecosystems:** Recognize that producers transform sunlight into chemical energy through photosynthesis **8.3.3.c**
Connects 8.4.3.a
Exclusions: the chemical process of photosynthesis
- **Ecosystems:** Recognize a population is all the individuals of a species at a given place and time **8.3.3.e**
- **Ecosystems:** Identify symbiotic relationships among organisms **8.3.3.f**

Earth Science

Earth in Space – Students will investigate and describe Earth and the solar system. 8.4.1

- **Objects in the Sky and Universe:** Describe the components of the solar system (the Sun, planets, moons, asteroids, comets) **8.4.1.a**
Connects to 8.4.2.d, builds on 5.4.1.b (5th grade in State Sample Curriculum)

Earth Structures and Processes – Students will investigate and describe Earth's structure, systems, and processes. 8.4.2

- **Properties of Earth Materials:** Describe the layers of Earth (core, mantle, crust, atmosphere) **8.4.2.a**
- **Properties of Earth Materials:** Describe the physical composition of soil **8.4.2.b**
- **Properties of Earth Materials:** Describe evidence of Earth's magnetic field **8.4.2.d**
Connects to 8.2.3.f, examples could include exploration with compass
Connects to 8.4.1.a, examples could include aurora borealis
- **Earth's Processes:** Compare and contrast constructive and destructive forces (deposition, erosion, weathering, plate motion causing uplift, volcanoes, and earthquakes) that impact Earth's surface **8.4.2.e**
Builds on 5.4.4.a (4th and 5th grade in State Sample Curriculum)
Exclusion: heat convection in mantle propels plates (why plates move)
- **Earth's Processes:** Describe the rock cycle **8.4.2.f**
Rock types (igneous, metamorphic, sedimentary), formation, and changes over time

Energy in Earth's Systems – Students will investigate and describe energy in Earth's systems. 8.4.3

- **Energy Sources:** Describe how energy from the Sun influences the atmosphere and provides energy for plant growth **8.4.3.a**
Describe greenhouse effect and define photosynthesis (exclusion chemical equation for photosynthesis)
Connects to 8.3.3.c

SEVENTH GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will design and conduct investigations that will lead to descriptions of relationships between evidence and explanations. 8.1.1

- **Scientific Controls and Variables:** Determine controls and use dependent (responding) and independent (manipulated) variables **8.1.1.c**
Possible connections to
8.2.1.c investigations with melting and freezing points
8.2.1.f investigations with chemical reactions in a closed system (e.g. kitchen chemistry reactions in a balloon)
- **Scientific Tools:** Select and use equipment appropriate to the investigation, demonstrate correct techniques **8.1.1.d**
Possible connections to:
8.2.1.b selecting and using appropriate tools with investigations of temperature and volume
8.2.1.d selecting and using appropriate tools with investigations relating to properties and states of matter
8.2.1.f selecting and using appropriate tools with investigations with chemical reactions in a closed system (e.g. kitchen chemistry reactions in a balloon)
8.4.3.c selecting and using appropriate tools with investigations relating to weather
- **Scientific Communication:** Share information, procedures, results, and conclusions with appropriate audiences **8.1.1.h**
Possible connections to:
8.2.1.c investigations with melting and freezing points
8.2.1.f investigations with chemical reactions in a closed system (e.g. kitchen chemistry reactions in a balloon)
8.2.1.d selecting and using appropriate tools with investigations relating to properties and states of matter
8.4.3.c selecting and using appropriate tools with investigations relating to weather
- **Scientific Communication:** Analyze and provide appropriate critique of scientific investigations **8.1.1.i**
Possible connections to:
8.2.1.c investigations reflecting on or related to melting and freezing points
8.2.1.f investigations with chemical reactions in a closed system (e.g. kitchen chemistry reactions in a balloon)
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **8.1.1.j**

Nature of Science – Students will apply the nature of science to their own investigations. 8.1.2

- **Scientific Knowledge:** Recognize science is an ongoing process and the scientific community accepts and uses explanations until they encounter new experimental evidence not matching existing explanations **8.1.2.a**
Possible connections to:
8.2.1.b examples could include discrepant events related to physical properties modeling how new experimental evidence may not match existing knowledge
8.3.1.b discovery of cells due to the invention of the microscope
- **Science as a Human Endeavor:** Recognize scientists from various cultures have made many contributions to explain the natural world **8.1.2.c**

Technology – Students will solve a design problem that involves one or two science concepts. 8.1.3

Technology (8.1.3) is included in the 8th grade sample curriculum to streamline the 6-8 content standards and to align with indicators related to forces and motion.

Physical Science

Matter – Students will identify and describe the particulate nature of matter including physical and chemical interactions. 8.2.1

- **Properties and Structures of Matter:** Compare and contrast elements, compounds, and mixtures **8.2.1.a**
The periodic table is used as a tool, not to be memorized.
Exclusions: atomic structure, determination of chemical formulas, ionic and covalent bonding
- **Properties and Structures of Matter:** Describe physical and chemical properties of matter **8.2.1.b**
- **States of Matter:** Recognize most substances can exist as a solid, liquid, or gas depending on temperature **8.2.1.c**
Exclusion: energy transfer
- **States of Matter:** Compare and contrast solids, liquids, and gases based on properties of these states of matter **8.2.1.d**
- **Physical and Chemical Changes:** Distinguish between physical and chemical changes (phase changes, dissolving, burning, rusting) **8.2.1.e**
Exclusions: chemical reaction rate, chemical equations
- **Physical and Chemical Changes:** Recognize conservation of matter in physical and chemical changes **8.2.1.f**
- **Classification of Matter:** Classify substances into similar groups based on physical properties **8.2.1.g**
Exclusion: chemical properties and properties of atoms, ions, and isotopes

Life Science

Structure and Function of Living Systems – Students will investigate and describe the structure and function of living organisms. 8.3.1

- **Characteristics of Life:** Recognize the levels of organization in living organisms (cells, tissues, organs, organ systems, and organisms) **8.3.1.a**
- **Cellular Composition of Organisms:** Recognize that all organisms are composed of one or many cells; that these cells must grow, divide, and use energy; and that all cells function similarly **8.3.1.b**
Exclusions: sub-cellular structures
- **Cellular Composition of Organisms:** Recognize specialized cells perform specialized functions in multi-cellular organisms **8.3.1.c**
- **Cellular Composition of Organisms:** Identify the organs and functions of the major systems of the human body and describe ways that these systems interact with each other **8.3.1.d**
The major systems of the human body include: circulatory, digestive, endocrine, excretory, immune, integumentary, nervous, muscular, reproductive, respiratory, and skeletal.

Heredity – Students will investigate and describe the relationship between reproduction and heredity. 8.3.2

- **Inherited Traits:** Recognize that hereditary information is contained in genes within the chromosomes of each cell **8.3.2.a**
For example dominant, recessive, numbers of chromosomes from parents, etc.
Exclusions: Punnett squares, pedigrees, DNA structure, protein synthesis
- **Reproduction:** Compare and contrast sexual and asexual reproduction **8.3.2.b**
Exclusions: mitosis, meiosis

Earth Science

Earth Structures and Processes – Students will investigate and describe Earth's structure, systems, and processes. 8.4.2

- **Properties of Earth Materials:** Describe the mixture of gases in Earth's atmosphere and how the atmosphere's properties change at different elevations **8.4.2.c**
- **Earth's Processes:** Describe the water cycle (evaporation, condensation, precipitation) **8.4.2.g**

Energy in Earth's Systems – Students will investigate and describe energy in Earth's systems. 8.4.3

- **Weather and Climate:** Identify factors that influence daily and seasonal changes on Earth (tilt of Earth, humidity, air pressure, air masses) **8.4.3.b**
- **Weather and Climate:** Describe atmospheric movements that influence weather and climate (air masses, jet stream) **8.4.3.c**

EIGHTH GRADE

Inquiry, the Nature of Science, and Technology

Inquiry – Students will design and conduct investigations that will lead to descriptions of relationships between evidence and explanations. 8.1.1

- **Scientific Observations:** Make qualitative and quantitative observations **8.1.1.e**
- **Scientific Data Collection:** Record and represent data appropriately and review for quality, accuracy, and relevancy **8.1.1.f**
- **Scientific Interpretations, Reflections, and Applications:** Evaluate predictions, draw logical inferences based on observed patterns/relationships, and account for non-relevant information **8.1.1.g**
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **8.1.1.j**

Nature of Science – Students will apply the nature of science to their own investigations. 8.1.2

- **Science and Society:** Describe how scientific discoveries influence and change society **8.1.2.b**

Possible connection to:

8.1.3.g describe how science and technology are reciprocal

8.1.3.h recognize that solutions have intended and unintended consequences

8.3.3.g positive and negative effects of natural and human activity on an ecosystem

8.4.2.h classify Earth materials as renewable or nonrenewable

Technology – Students will solve a design problem that involves one or two science concepts. 8.1.3

- **Abilities to do Technical Design:** Identify problems for technical design **8.1.3.a**
- **Abilities to do Technical Design:** Design a solution or product **8.1.3.b**
- **Abilities to do Technical Design:** Implement the proposed design **8.1.3.c**
- **Abilities to do Technical Design:** Evaluate completed technological designs or products **8.1.3.d**
- **Abilities to do Technical Design:** Communicate the process of technical design **8.1.3.e**
- **Understanding of Technical Design:** Distinguish between scientific inquiry (asking questions about the natural world) and technological design (using science to solve practical problems) **8.1.3.f**
- **Understanding of Technical Design:** Describe how science and technology are reciprocal **8.1.3.g**
- **Understanding of Technical Design:** Recognize that solutions have intended and unintended consequences **8.1.3.h**
- **Understanding of Technical Design:** Compare and contrast the reporting of scientific knowledge and the reporting of technological knowledge **8.3.3.i**

Physical Science

Forces and Motion – Students will investigate and describe forces and motion. 8.2.2

- **Motion:** Describe motion of an object by its position and velocity **8.2.2.a**
Math is related to constant speed, $\text{speed} = \text{distance}/\text{time}$.
Exclusions: acceleration
- **Inertia/Newton's 1st Law:** Recognize examples of Newton's First Law, an object that is not being subjected to a force will continue to move at a constant speed in a straight line or stay at rest **8.2.2.b**
- **Inertia/Newton's 2nd Law:** Compare the motion of objects related to the effects of balanced and unbalanced forces **8.2.2.c**
Such as tug of war, large truck hits small car, etc.
Exclusions: mathematical calculations using Newton's 2nd Law ($F=ma$).
- **Universal Forces:** Recognize that everything on or around Earth is pulled toward Earth's center by gravitational force **8.2.2.d**

Life Science

Structure and Function of Living Systems – Students will investigate and describe the structure and function of living organisms. 8.3.1

- **Characteristics of Life:** Describe how plants and animals respond to environmental stimuli **8.3.1.e**

Flow of Matter and Energy in Ecosystems – Students will describe populations and ecosystems. 8.3.3

- **Ecosystems:** Determine the biotic and abiotic factors that impact the number of organisms an ecosystem can support **8.3.3.d**
- **Impact on Ecosystems:** Identify positive and negative effects of natural and human activity on an ecosystem **8.3.3.g**

Biodiversity – Students will identify characteristics of organisms that help them survive. 8.3.4

- **Biological Adaptations:** Describe how an inherited characteristic enables an organism to improve its survival rate **8.3.4.a**
- **Biological Evolution:** Recognize the extinction of a species is caused by the inability to adapt to an environmental change **8.3.4.b**
- **Biological Evolution:** Use anatomical features of an organism to infer similarities among other organisms **8.3.4.c**

Earth Science

Earth in Space – Students will investigate and describe Earth and the solar system. 8.4.1

- **Motion of Objects in the Solar System:** Describe the relationship between motion of objects in the solar system and the phenomena of day, year, eclipses, phases of the Moon and seasons **8.4.1.b**
- **Gravitational Effects:** Describe the effects of gravity on Earth (tides) and the effect of gravity on objects in the solar system **8.4.1.c**

Earth Structures and Processes – Students will investigate and describe Earth's structure, systems, and processes. 8.4.2

- **Use of Earth Materials:** Classify Earth materials as renewable or nonrenewable **8.4.2.h**
[Connects to 8.3.3.g](#)

Earth's History – Students will use evidence to draw conclusions about changes in Earth. 8.4.4

- **Past/Present Earth:** Recognize Earth processes we see today are similar to those that occurred in the past (uniformity of processes) **8.4.4.a**
- **Past/Present Earth:** Describe how environmental conditions have changed through use of the fossil record **8.4.4.b**

PHYSICAL SCIENCE

Earth and Space Sciences Standards were split between Physical Science and Biology. Earth and Space Standards included in Physical Science are: 12.4.1.a, 12.4.1.b, 12.4.1.c, 12.4.2.b, 12.4.3.a, 12.4.3.b, 12.4.3.c. Those included in Biology are: 12.4.2.a, 12.4.2.c, 12.4.3.d, 12.4.4.a, 12.4.4.b, 12.4.4.c.

Inquiry – Students will design and conduct investigations that lead to the use of logic and evidence in the formulation of scientific explanations and models. 12.1.1

- **Scientific Questioning:** Formulate a testable hypothesis supported by prior knowledge to guide an investigation **12.1.1.a**
 1. Questioning
 2. Predicting
 - e.g. (supporting standard 12.2.2.c) Have students contemplate examples of net forces influencing the motion of objects (such as different sized football players colliding, cars crashing). Have students formulate testable questions relating forces, mass, and motion. Ask students to predict the outcome of a testable scenario and explain why; create a testable hypothesis.
- **Scientific Investigations:** Design and conduct logical and sequential scientific investigations with repeated trials and apply findings to new investigations **12.1.1.b**
 1. Understand that multiple trials lead to make accurate results.
 - e.g. (supporting standard 12.2.2.c) Have students design and conduct an experiment to investigate their hypothesis regarding the relationship between force, mass, and motion.
- **Scientific Controls and Variables:** Identify and manage variables and constraints **12.1.1.c**
 1. Identify dependent (responding) and independent (manipulated) variables.
 2. Understand that only one variable should be manipulated at a time during an experiment.
- **Scientific Tools:** Select and use lab equipment, and technology, appropriately and accurately **12.1.1.d**
- **Scientific Observations:** Use tools and technology to make detailed qualitative and quantitative observations **12.1.1.e**
 1. Understand that measurement errors may affect results of calculations.
 2. (supporting standard 12.2.2.c) Have equipment available (such as motion detectors, stop watches, scales, force probes) for students to measure their variables. Have students make observations that include qualitative descriptions (such as shape of object and texture of surface) and quantitative descriptions (such as time, rate, mass).
- **Scientific Data Collection:** Represent and review collected data in a systematic, accurate, and objective manner **12.1.1.f**
- **Scientific Interpretations, Reflections, and Applications:** Analyze and interpret data, synthesize ideas, formulate and evaluate models, and clarify concepts and explanations **12.1.1.g**
 1. Understand that a model is a physical, mental, or mathematical representation to show how objects and processes are connected.
 2. Evaluate the reasonableness of answer to questions.
 3. Understand that a correlation between two variables does not mean that either one causes the other.
 4. Compare data for two groups by using averages and ranges of values.
 5. Describe rate of change by comparing one measured quantity to another measured quantity.
 6. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.
 7. Test the usefulness of the model by comparing its prediction to actual observations.
- **Scientific Interpretations, Reflections, and Applications:** Use results to verify or refute a hypothesis **12.1.1.h**
- **Scientific Interpretations, Reflections, and Applications:** Propose and/or evaluate possible revisions and alternate explanations **12.1.1.i**
 1. (supporting standard 12.2.2.c) Have students examine their own experiment for possible revisions (such as not accounting for friction).

- **Scientific Communication:** Share information, procedures, results, conclusions, and defend findings to a scientific community (peers, science fair audience, policy makers) **12.1.1.j**
e.g. (supporting standard 12.2.2.c Make predictions based on relationships among net force, mass, and acceleration) Have students share and defend their experimental conclusions to their peers; encourage peers to critically evaluate each experiment.
- **Scientific Communication:** Evaluate scientific investigations and offer revisions and new ideas as appropriate **12.1.1.k**
 1. Asking further questions
 2. Determining possible applications
 3. Evaluating experimental design of others
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **12.1.1.l**

Nature of Science – Students will apply the nature of scientific knowledge to their own investigations and in the evaluation of scientific explanations. 12.1.2

- **Scientific Knowledge:** Recognize that scientific explanations must be open to questions, possible modification, and must be based upon historical and current scientific knowledge **12.1.2.a**
12.2.1.f subatomic particles
12.4.1.a Big Bang Theory
12.4.2.b plate tectonics
- **Science and Society:** Describe how society influences the work of scientists and how science, technology, and current scientific discoveries influence and change society **12.1.2.b**
Done in biology
- **Science as a Human Endeavor:** Recognize that the work of science results in incremental advances, almost always building on prior knowledge, in our understanding of the world **12.1.2.c**
e.g. (supporting standard 12.4.2.b) Students will examine the development of the theory of plate tectonics.

Technology – Students will solve a complex design problem. 12.1.3

- **Abilities to do Technical Design:** Propose designs and choose between alternative solutions of a problem **12.1.3.a**
e.g. (supporting standard 12.2.3) Have students design a Rube-Goldberg-like device to accomplish a given simple task (such as ejecting a ping-pong ball) while going through several different energy transformations.
- **Abilities to do Technical Design:** Assess the limits of a technical design **12.1.3.b**
e.g. (supporting standard 12.4.2.b) Students will examine the development of the theory of plate tectonics.
e.g. (supporting standard 12.2.3.i conservation of energy) Students will recognize that no device can undergo perpetual motion (such as a car running off the power of the air resistance it generates when driving forward); energy is always conserved.
- **Abilities to do Technical Design:** Implement the selected solution **12.1.3.c**
e.g. (supporting standard 12.2.3) Have students implement a Rube-Goldberg solution.
- **Abilities to do Technical Design:** Evaluate the solution and its consequences **12.1.3.d**
e.g. (supporting standard 12.2.3) Have students evaluate others' Rube-Goldberg solutions and identify possible consequences related to their technical design.
- **Abilities to do Technical Design:** Communicate the problem, process, and solution **12.1.3.e**
e.g. (supporting standard 12.2.3) Students will present their device to their peers.
- **Understanding of Technical Design:** Compare and contrast the reasons for the pursuit of science and the pursuit of technology **12.1.3.f**
- **Abilities to do Technical Design:** Explain how science advances with the introduction of new technology **12.1.3.g**
e.g. (supporting standard 12.2.1.f) Students will explain how the observations by J.J. Thomson of a cathode ray tube and its interactions with a magnet led to the discovery of electrons and their charge.
- **Understanding of Technical Design:** Understand creativity, imagination, and a good knowledge base are all needed to advance the work of science and engineering **12.1.3.h**

Matter – Students will investigate and describe matter in terms of its structure, composition and conservation. 12.2.1

- **Properties and Structure of Matter:** Recognize bonding occurs when outer electrons are transferred (ionic) or shared (covalent) bonds **12.2.1.a**
- **States of Matter:** Describe the energy transfer associated with phase changes between solids, liquids, and gases **12.2.1.b**
 1. **Exclusions: mathematical calculations such as $Q=mC\Delta T$**
- **States of Matter:** Compare and contrast the three normal states of matter (solid, liquid, gas) in terms of energy, particle arrangement, particle motion, and strength of force of attraction between particles **12.2.1.c**
- **Physical and Chemical Changes:** Recognize a large number of chemical reactions involve the transfer of either electrons (oxidation/reduction) or hydrogen ions (acid/base) between reacting ions, molecules, or atoms **12.2.1.d**
- **Physical and Chemical Changes:** Identify factors affecting rates of chemical reactions (temperature, particle size, surface area) **12.2.1.e**
- **Atomic Structure:** Recognize the charges and relative locations of subatomic particles (neutrons, protons, electrons) **12.2.1.f**
- **Atomic Structure:** Describe properties of atoms, ions, isotopes **12.2.1.g**
- **Classification of Matter:** Describe the organization of the periodic table of elements with respect to patterns of physical and chemical properties **12.2.1.h**
 1. **Exclusion: electron configuration**

Force and Motion – Students will investigate and describe the nature of field forces and their interactions with matter. 12.2.2

- **Motion:** Describe motion with respect to displacement, velocity, and acceleration **12.2.2.a**
 1. **Be able to use and manipulate formulas such as $v=d/t$ or $a=\Delta v/\Delta t$ to solve for a variable**
- **Inertia/Newton's 1st Law:** Describe how the law of inertia (Newton's 1st law) is evident in a real-world event **12.2.2.b**
 - Use of student created examples of Newton's First Law with real-world examples.
- **Forces/Newton's 2nd Law:** Make predictions based on relationships among net force, mass, and acceleration (Newton's 2nd law). **12.2.2.c**
 1. **Be able to use the formula $F=ma$; for example if the mass is doubled . . .**
- **Newton's 3rd Law:** Recognize that all forces occur in equal and opposite pairs (Newton's 3rd law) **12.2.2.d**
- **Newton's 3rd Law:** Describe how Newton's 3rd law of motion is evident in a real-world event **12.2.2.e**
 1. **Exclusions: math calculations**
- **Universal Forces:** Recognize gravity is a force each mass exerts on another mass, which is directly proportional to the masses and inversely proportional to the distance between them **12.2.2.f**
 1. **Describe the relationship between mass and distance in a conceptual manner without calculations. For example, as distance increases. . . or which would have more gravitational force or attraction between different sized objects. . .**
- **Universal Forces:** Recognize that an attractive or repulsive electric force exists between two charged particles and that this force is directly proportional to the magnitude of the charges and inversely proportional to the distance between **12.2.2.g**
 1. **Describe the relationship between charge and distance in a conceptual manner without calculations.**

Energy – Students will describe and investigate energy systems relating to the conservation and interaction of energy and matter. 12.2.3

- **Sound/Mechanical Waves:** Describe mechanical wave properties (speed, wavelength, frequency, amplitude) and how waves travel through a medium—be able to use and manipulate the formula $v=f\lambda$ **12.2.3.a**
- **Sound/Mechanical Waves:** Recognize that the energy in waves can be changed into other forms of energy **12.2.3.b**
- **Light:** Recognize light can behave as a wave (diffraction and interference) **12.2.3.c**
- **Heat:** Distinguish between temperature (a measure of the average kinetic energy of atomic or molecular motion) and heat (the quantity of thermal energy that transfers due to a change in temperature) **12.2.3.d**
- **Heat:** Compare and contrast methods of heat transfer and the interaction of heat with matter via conduction, convection, and radiation **12.2.3.e**
- **Electricity/Magnetism:** Recognize that the production of electromagnetic waves is a result of changes in the motion of charges or by changing magnetic field **12.2.3.f**
 1. **Conceptual understanding only: for example when a change in magnetic or electrical field occurs, electromagnetic waves are produced.**
- **Electricity/Magnetism:** Compare and contrast segments of the electromagnetic spectrum (radio, micro, infrared, visible, ultraviolet, x-rays, gamma) based on frequency and wavelength **12.2.3.g**
- **Nuclear:** Recognize that nuclear reactions (fission, fusion, and radioactive decay) convert a fraction of the mass of interacting particles into energy, and this amount of energy is much greater than the energy in chemical interactions **12.2.3.h**
 1. **Conceptual understanding only**
- **Conservation:** Interpretation of Law of Conservation of Energy including kinetic and potential energy
- **Conservation:** Interpret the law of conservation of energy to make predictions for the outcome of an event **12.2.3.i**
 1. **Includes kinetic and potential energy**
- **Mechanical Energy:** Identify that all energy can be considered to be either kinetic, potential, or energy contained by a field (e.g., as electromagnetic waves) **12.2.3.j**
 1. **Be able to describe the relative amounts of potential and kinetic energy in a system, such as a swing, a pendulum, etc.**
 2. **Recognize that light, microwaves, radio waves, etc. are forms of energy.**
 3. **Recognize that there are two models of energy described in this standard, Newtonian and Quantum.**
- **Chemical Energy:** Identify endothermic and exothermic reactions **12.2.3.k**
 1. **Conceptual understanding only**

Earth and Space – Students will investigate and describe the known universe. 12.4.1

- **Objects in the Sky and Universe:** Describe the formation of the universe using the Big Bang Theory **12.4.1.a**
- **Objects in the Sky and Universe:** Recognize that stars, like the Sun, transform matter into energy by nuclear reactions, which leads to the formation of other elements **12.4.1.b**
 1. **Conceptual understanding only**
- **Objects in the Sky and Universe:** Describe stellar evolution **12.4.1.c**
 1. **This includes formation and life cycles of stars**

Earth Structures and Processes – Students will investigate the relationships among Earth's structure, systems, and processes. 12.4.2

- **Earth's Processes:** Describe how heat convection in the mantle propels the plates comprising Earth's surface across the face of the globe (plate tectonics) **12.4.2.b**

Energy in Earth's Systems – Students will investigate and describe the relationships among the sources of energy and their effects on Earth's systems. 12.4.3

- **Energy Sources:** Describe how radiation, conduction, and convection transfer heat in Earth's systems **12.4.3.a**
- **Energy Sources:** Identify internal sources of heat energy in Earth's systems **12.4.3.b**
 1. **nuclear**

BIOLOGY

Earth and Space Sciences Standards were split between Physical Science and Biology. Earth and Space Standards included in Physical Science are: 12.4.1.a, 12.4.1.b, 12.4.1.c, 12.4.2.b, 12.4.3.a, 12.4.3.b, 12.4.3.c. Those included in Biology are: 12.4.2.a, 12.4.2.c, 12.4.3.d, 12.4.4.a, 12.4.4.b, 12.4.4.c.

Inquiry – Students will design and conduct investigations that lead to the use of logic and evidence in the formulation of scientific explanations and models. 12.1.1

- **Scientific Questioning:** Formulate a testable hypothesis supported by prior knowledge to guide an investigation **12.1.1.a**
 1. Questioning
 2. Predicting
 - e.g. (supporting standard 12.3.1.c cellular functions) Conduct an activity showing the reaction of CO₂ and bromothymol blue (BTB) by blowing through a straw into a beaker of water and BTB. Have students formulate testable questions about this activity and how it could relate to life forms in natural bodies of water. Ask students to predict what happens to CO₂ levels in natural bodies of water containing plants and animals and why; create a testable hypothesis.
- **Scientific Investigations:** Design and conduct logical and sequential scientific investigations with repeated trials and apply findings to new investigations **12.1.1.b**
 1. Understand that larger, appropriately chosen samples produce more accurate estimates of the characteristics of the total population.
 - e.g. (supporting standard 12.3.1.c Cellular functions) Have students design and conduct an experiment to investigate their hypothesis. Teachers should have containers, BTB, live plants (such as elodea) and underwater animals (such as snails) available for student use. Stress the importance of multiple trials.
- **Scientific Controls and Variables:** Identify and manage variables and constraints **12.1.1.c**
 1. Identify dependent (responding) and independent (manipulated) variables.
 2. Understand that only one variable should be manipulated at a time during an experiment.
 - e.g. (supporting standard 12.3.1.c Cellular functions) Have students identify the controls and variables in their design (such as beaker one containing plant and animal, beaker two contains animals only, beaker three contains plants only, and a control beaker without organisms).
- **Scientific Tools:** Select and use lab equipment, and technology, appropriately and accurately **12.1.1.d**
- **Scientific Observations:** Use tools and technology to make detailed qualitative and quantitative observations **12.1.1.e**
 1. Understand that measurement errors may affect results of calculations.
 - e.g. (supporting standard 12.3.1.c) Have students use indicators to make observations that include qualitative descriptions (such as color change and contents in beaker) and quantitative descriptions (such as pH and temperature).
- **Scientific Data Collection:** Represent and review collected data in a systematic, accurate, and objective manner **12.1.1.f**
- **Scientific Interpretations, Reflections, and Applications:** Analyze and interpret data, synthesize ideas, formulate and evaluate models, and clarify concepts and explanations **12.1.1.g**
 1. Understand that a model is a physical, mental, or mathematical representation to show how objects and processes are connected.
 2. Evaluate the reasonableness of answer to questions.
 3. Understand that a correlation between two variables does not mean that either one causes the other.
 4. Compare data for two groups by using averages and ranges of values.
 5. Describe rate of change by comparing one measured quantity to another measured quantity.
 6. Investigate and describe how different characteristics, properties, or relationships within a system change as their dimensions increase or decrease.
 7. Test the usefulness of the model by comparing its prediction to actual observations.
- **Scientific Interpretations, Reflections, and Applications:** Use results to verify or refute a hypothesis **12.1.1.h**

- **Scientific Interpretations, Reflections, and Applications:** Propose and/or evaluate possible revisions and alternate explanations **12.1.1.i**
e.g. (supporting standard 12.3.1.c) Have students examine their own experiment for possible revisions (such as not accounting for differences in light levels).
- **Scientific Communication:** Share information, procedures, results, conclusions, and defend findings to a scientific community (peers, science fair audience, policy makers) **12.1.1.j**
e.g. (supporting standard 12.3.1.c) Have students share and defend their experimental conclusions on rates of photosynthesis to their peers; encourage peers to critically evaluate each experiment.
- **Scientific Communication:** Evaluate scientific investigations and offer revisions and new ideas as appropriate **12.1.1.k**
 1. Asking further questions
 2. Determining possible applications
 3. Evaluating experimental design of others
- **Mathematics:** Use appropriate mathematics in all aspects of scientific inquiry **12.1.1.l**

Nature of Science – Students will apply the nature of scientific knowledge to their own investigations and in the evaluation of scientific explanations. 12.1.2

- **Scientific Knowledge:** Recognize that scientific explanations must be open to questions, possible modification, and must be based upon historical and current scientific knowledge **12.1.2.a**
e.g. (supporting standards)
 1. 12.3.1.b the evolution of sub-cellular organelles (introduction of mitochondria into cells)
 2. 12.3.4.c students can examine the changing thoughts of scientists as new evidence becomes available regarding the ancestry of living organisms (such as that between modern birds and dinosaurs)
- **Science and Society:** Describe how society influences the work of scientists and how science, technology, and current scientific discoveries influence and change society **12.1.2.b**
e.g. (supporting standard 12.3.2.b Basic structure of DNA, Inheritance) Genetic characteristics led scientists to develop the technology to investigate and decode genomes. New discoveries uncovered allow scientists, individuals and society to potentially manipulate genes.
- **Science as a Human Endeavor:** Recognize that the work of science results in incremental advances, almost always building on prior knowledge, in our understanding of the world **12.1.2.c**
e.g. (supporting standard 12.3.1.b) The incremental development of microscopes (from Leeuwenhoek’s first microscope to modern electron microscopes) has lead scientists to a better understanding of the structure and function of cells.
- **Science as a Human Endeavor:** Research and describe the difficulties experienced by scientific innovators who had to overcome commonly held beliefs of their times to reach conclusions that we now take for granted **12.1.2.d**
e.g. (supporting standard 12.3.4.b) Students will examine the adversity Charles Darwin encountered while communicating his theory of evolution through natural selection.

Structure and Function of Living Systems – Students will investigate and describe the chemical basis of the growth, development, and maintenance of cells. 12.3.1

- **Characteristics of Life:** Identify the complex molecules (carbohydrates, fats, lipids, proteins, and nucleic acids) that make up living organisms **12.3.1.a**
- **Cellular Composition of Organisms:** Identify the form and function of sub-cellular structures that regulate cellular activities **12.3.1.b**
- **Cellular Composition of Organisms:** Describe the cellular functions of photosynthesis, respiration, cell division, protein synthesis, transport of materials, and energy capture/release **12.3.1.c**
 1. Exclusions: Calvin cycle, Krebs cycle, glycolysis, and intermediate products in cellular respiration and photosynthesis.
- **Behavior:** Describe how an organism senses changes in its internal and external environment and responds to ensure survival **12.3.1.d**

Heredity – Students will describe the molecular basis of reproduction and heredity. 12.3.2

- **Inherited Traits:** Identify that information passed from parents to offspring is coded in DNA molecules **12.3.2.a**
 1. [Include the inheritance of a trait over time.](#)
- **Inherited Traits:** Describe the basic structure of DNA and its function in genetic inheritance **12.3.2.b**
- **Inherited Traits:** Recognize how mutations could help, harm, or have no effect on individual organisms **12.3.2.c**
- **Reproduction:** Describe that sexual reproduction results in a largely, predictable, variety of possible gene combinations in the offspring of any two parents **12.3.2.d**
 1. [Includes Punnett Squares.](#)

Flow of Matter and Energy in Ecosystems – Students will describe, on a molecular level, the cycling of matter and the flow of energy between organisms and their environment. 12.3.3

- **Flow of Energy:** Explain how the stability of an ecosystem is increased by biological diversity **12.3.3.a**
- **Ecosystems:** Recognize atoms and molecules cycle among living and nonliving components of the biosphere **12.3.3.b**
 1. [Include the carbon, nitrogen, oxygen, and the water cycle. This also addresses 12.4.2.a.](#)
- **Ecosystems:** Explain how distribution and abundance of different organisms in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials **12.3.3.c**
 1. [Include a description of natural influences on global climate, which addresses 12.4.3.d.](#)
- **Impact on Ecosystems:** Analyze factors, which may influence environmental quality **12.3.3.d**

Biodiversity – Students will describe the theory of biological evolution. 12.3.4

- **Biological Adaptations:** Identify different types of adaptations necessary for survival (morphological, physiological, behavioral) **12.3.4.a**
- **Biological Evolution:** Recognize that the concept of biological evolution is a theory which explains the consequence of the interactions of: (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring **12.3.4.b**
- **Biological Evolution:** Explain how natural selection provides a scientific explanation of the fossil record and the molecular similarities among the diverse species of living organisms **12.3.4.c**
- **Biological Evolution:** Apply the theory of biological evolution to explain diversity of life over time **12.3.4.d**

Earth Structures and Process – Students will investigate the relationships among Earth's structure, systems, and processes. 12.4.2

- **Properties of Earth Materials:** Recognize how Earth materials move through geochemical cycles (carbon, nitrogen, oxygen) resulting in chemical and physical changes in matter **12.4.2.a**
 1. Partially addressed in 12.3.3.b.
- **Use of Earth Materials:** Evaluate the impact of human activity and natural causes on Earth's resources (groundwater, rivers, land, fossil fuels) **12.4.2.c**

Energy in Earth's Systems – Students will investigate and describe the relationships among the sources of energy and their effects on Earth's systems. 12.4.3

- **Energy Sources:** Identify external sources of heat energy in Earth's systems **12.4.3.b**
 1. Solar
- **Energy Sources:** Compare and contrast benefits of renewable and nonrenewable energy sources **12.4.3.c**
- **Weather and Climate:** Describe natural influences (Earth's rotation, mountain ranges, oceans, differential heating) on global climate **12.4.3.d**
 1. This could be addressed when teaching about biomes. 12.3.3.c

Earth's History – Students will explain the history and evolution of Earth. 12.4.4

- **Past/Present Earth:** Recognize in any sequence of sediments or rocks that has not been overturned, the youngest sediments or rocks are at the top of the sequence and the oldest are at the bottom (law of superposition) **12.4.4.a**
- **Past/Present Earth:** Interpret Earth's history by observing rock sequences, using fossils to correlate the sequences at various locations, and using data from radioactive dating methods **12.4.4.b**
- **Past/Present Earth:** Compare and contrast the physical and biological differences of early Earth with the planet we live on today **12.4.4.c**

APPENDIX

Examples of Mathematics that Students Should Use and Understand

GRADES K-4	GRADES 5-8	GRADES 9-12
Measure, collect, and organize data Explore chance Recognize and describe patterns Use variables to express relationship Develop skills of estimation and judgment	Represent situations verbally, numerically, graphically, geometrically, or symbolically Use Estimations Identify and use functional relationships Develop and use tables, graphs, and rules to describe situations Use statistical methods to describe, analyze, evaluate, and make decisions Use geometry in solving problems Create experimental and theoretical models of situations involving probabilities	Develop ability to use realistic applications and modeling in trigonometry Understand connections within a problem situation, its model as a function in symbolic form, and the graph of that function Use functions that are constructed as models of real-world problems Know how to use statistics and probability

Source: NCTM, 1989