Current Standard
Scientific Concepts and Applications
Direct Science Experience - Primary
A student shall demonstrate knowledge of basic science concepts of physical science, life science, and earth and space science through direct experience, including an understanding of:
A. concepts related to everyday life through characteristic properties of objects, patterns and how they repeat, and cycles;
B. how the basic needs of organisms are met;
C. responses of organisms to changes in the environment;
D. how the personal use of materials, energy, and water impact the environment; and
E. the characteristics of objects or phenomena, including measuring changes that occur in objects or phenomena as a result of interaction, sorting and classifying objects based on one or two properties, displaying information using graphs, and describing how previously learned concepts apply to new situations.

Scientific Concepts and Applications

Direct Science Experience – Primary

Purpose: Engage students in active science experiences that promote understanding of basic science concepts and processes in order to develop a foundation for science literacy.

A. A student shall demonstrate an understanding of:
   1. observable characteristics of organisms;
   2. basic needs of organisms and how they are met;
   3. responses of organisms to changes in the environment;
   4. observable properties of objects including size, weight, shape, and temperature;
   5. patterns that occur in nature including objects in the sky, weather, growth, and seasonal change;
   6. how the environment is impacted by the personal use of materials, energy, and water;
   7. the nature of science including:
      a. performing experiment;s
      b. supporting ideas with personal observations; and
      c. understanding that all kinds of people around the world do science.

B. A student shall demonstrate the ability to:
   1. engage in teacher-guided inquiry using the Primary Inquiry Standard;
   2. practice safety in science including washing hands after participating in a science experiment, wearing goggles when appropriate, following directions related to science safety, not tasting substances or materials used in science activities or experiments, and practicing safe and humane care of animals;
   3. use simple technology including hand lenses, simple balances, and other basic measurement tools to extend their exploration and observation of objects and organisms.

Current Standard
Scientific Concepts and Applications
Living and Non-living Systems - Intermediate
A student shall demonstrate:
A. An understanding of the following:
(1) Characteristics of organisms including plants, animals, and microorganisms
(2) Basic structures and functions of the human body
(3) Cycles and patterns in living organisms, earth systems, and physical systems
(4) How human behavior and technology impact the environment
B. The ability to do the following:
(1) Measure and classify objects, organisms, and materials on the basis of properties and relationships
(2) Make systematic observations of objects, events, or phenomena by recording data and predicting change
(3) Create a model to illustrate a concept, law, theory, or principle
(4) Identify personal behaviors and use of materials that have a positive impact on the environment

Scientific Concepts and Applications

Living and Non-Living Systems – Intermediate

Purpose: Investigating living and non-living systems in order to make sense of the world and build a stronger foundation for science literacy.

A. A student shall demonstrate an understanding of:
1. basic structures and functions of the human body including the skeletal system, the circulatory system, and the digestive system;
2. all living organisms survival characteristics that help them thrive in their existing environment;
3. cycles in:
   a. living systems including life cycles;
   b. Earth systems including the water cycle, seasons, and weathering; and
   c. environmental systems including energy flow and material cycles, for example, in food webs and recycling;
4. patterns in:
   a. living systems including the grouping of plants and animals based on their observable characteristics;
   b. Earth systems including features of the Earth's surface, weather, and the Earth's relationship to the sun and moon;
   c. physical systems including the grouping of materials based on their properties including floating and sinking, solids and liquids, and change in the properties of materials caused by heating and cooling; and
   d. environmental systems including populations and the physical environment;
5. forces which cause changes in speed or direction of motion;
6. the impact of human behavior and technology use on the environment;
7. the nature of science including:

a. the role of experimentation and evidence in developing scientific ideas; and
b. the role men and women with diverse perspectives play in the development of scientific knowledge.

B. A student shall demonstrate the ability to:
1. plan and conduct a scientific inquiry with some assistance or scripting using the Intermediate Inquiry Standard;
2. create or use a model to explain how parts of a system interact;
3. communicate the relationship between variable and experimental results;
4. use simple technology to complete an inquiry including the use of magnifying equipment, mechanical balances, and thermometers; and
5. follow appropriate safety behavior as directed in the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.

Current Standard
Scientific Concepts and Applications
Physical Systems – Middle Level
A student shall demonstrate an understanding of the fundamental laws and concepts of the physical world including properties of matter, physical and chemical changes, transfer of energy, and force and motion by:
(1) formulating questions to be answered based on systematic observation;
(2) designing and conducting investigations and field studies;
(3) analyzing data to support or refute hypotheses by identifying patterns in data; and comparing results to known scientific theories, current models, or personal experience; and considering multiple interpretations of data;
(4) describing how a premise is supported by scientific concepts, principles, theories, or laws; and
(5) creating a model to illustrate a contemporary or historical concept, principle, theory, or law.

Scientific Concepts and Research

Physical Systems – Middle Level

Purpose: Develop understanding of the cause and effect relationships in everyday observations of materials, motion, and other energy forms.

A. A student shall demonstrate an understanding of:
1. properties of materials that are independent of the size of the sample including but not limited to density, solubility, and electrical conductivity;
2. physical and chemical changes including those resulting from heating and simple chemical reactions;
3. the idea that in chemical reactions the total amount of mass does not change;
4. forces and motion including speed, acceleration, and laws of motion;
5. transfer of energy including motion, heat, light, and electricity;
6. the history and nature of science including:
   a. the idea that scientific ideas are tentative, reproducible, and subject to change;
   b. that it is normal for scientists to question the interpretation of data;
   c. that questioning, response to criticism, and open communication are important to the process of science; and
   d. that the body of science knowledge has been built by men and women from many cultures and beliefs.

B. A student shall demonstrate the ability to:
1. independently formulate questions based on prior observations and evidence to provide answers through scientific investigations;
2. design and conduct, with minimal assistance, a scientific investigation, for example, an experiment or a field study;
3. choose appropriate scientific technology to gather and analyze data and evidence;
4. use mathematical representations or two- and three-dimensional models to interpret and communicate data and evidence;

5. use their own and other students' evidence collected by valid scientific investigations to develop descriptions, explanations, predictions, and models;
6. describe how evidence and established science ideas do or do not support a claim made in public media, for example, advertisements and reports of scientific studies;
7. use appropriate safety equipment and follow safety procedures including:
   a. using goggles when working with glass, chemicals, heat and projectiles;
   b. disposing of materials properly;
   c. following established laboratory rules; and
   d. operating safety equipment provided in the laboratory or field.

Current Standard
Scientific Concepts and Applications
Living Systems - Middle Level
A. Living Systems
A student shall demonstrate knowledge of interactions and interdependence of living systems by understanding the human body, including heredity, reproduction, and regulation, and behavior; plants, animals, and microorganisms including diversity and adaptation of organisms, populations, and ecosystems; and the dynamic effect of humans interacting with the environment by:
(1) Formulating questions to be answered based on systematic observation;
(2) Designing and conducting investigations and field studies;
(3) Analyzing data to support or refute hypotheses by identifying patterns in data; comparing results to known scientific theories, current models, or personal experience; and considering multiple interpretations of data
(4) Describing how a premise is supported by scientific concepts, principles, theories, or laws
(5) Creating a model to illustrate a contemporary or historical concept, principle, theory, or law

Scientific Concepts and Applications

Living Systems - Middle Level

Purpose: Identify and analyze interactions and interdependence of living systems

A. A student shall demonstrate understanding of:
1. the relationship among groups of organisms including:
    a. animals, including humans;
    b. plants;
    c. micro-organisms;
2. cell structure and function, for example, the cell as a building block and the cell's role in reproduction;
3. diversity and adaptation including:
    a. how natural selection accounts for the diversity of species;
    b. how changes in environmental conditions can affect the survival of individual organisms and entire species;
4. populations and ecosystems including:
    a. that an ecosystem includes all populations living together and their interactions with physical factors;
    b. how populations are categorized by the function they serve in an ecosystem;
    c. the importance of sunlight as the major source of energy for an ecosystem;
    d. that the number of organisms that an ecosystem can support depends on adequate biotic and abiotic resources;
5. behavior and regulation including:
    a. how organisms maintain a stable life cycle in a constantly changing external environment;
    b. how regulation of an organism's internal environment involves sensing and changing;
    c. how an organism's behavior evolves through adaptation to its environment;
6. reproduction and heredity including:

a. how some organisms reproduce sexually and some asexually;
b. how hereditary information is contained in the genes and is passed from one generation to another;

7. the dynamic effect of humans interacting with the environment;
8. the history and nature of science including:
   a. the idea that scientific ideas are tentative, reproducible, and subject to change;
   b. that it is normal for scientists to question the interpretation of data;
   c. that questioning, response to criticism, and open communication are important to the process of science;
   d. that the body of science knowledge has been built by men and women from many cultures and beliefs.

B. A student shall demonstrate the ability to:

1. independently formulate questions based on prior observations and evidence and to provide answers through scientific investigations;
2. design and conduct, with minimal assistance, a scientific investigation, for example, an experiment or a field study;
3. choose appropriate scientific technology to gather and analyze data and evidence, for example, microscopes, probes, computers, and thermometers to measure liquids, air, and soil;
4. use mathematical representations or two- and three-dimensional models to interpret and communicate data and evidence;
5. use their own and other students' evidence collected by valid scientific investigations to develop description, explanations, predictions, and models;
6. describe how evidence and established science ideas do or do not support a claim made in public media, for example, advertisements and reports of scientific studies;
7. use appropriate safety equipment and follow safety procedures including:
   a. using goggles when working with glass, chemicals, heat, and projectiles;
   b. disposing of materials properly;
   c. following established laboratory rules; and
   d. operating safety equipment provided in the laboratory or field.

Current Standard
Scientific Concepts and Applications
Earth systems – Middle Level
A student shall demonstrate understanding of the structure of earth systems, including the geosphere, hydrosphere, and atmosphere; concepts of change and constancy in the earth's history and theories of origin through evidence found in fossils, rocks and layers, land forms, and natural events; and the relative position and motion of objects in the solar system including moon phases and tides, seasons, eclipses, gravitational force, and planetary motion by:

(1) formulating questions to be answered based on systematic observation;
(2) designing and conducting investigations and field studies;
(3) analyzing data to support or refute hypotheses by identifying patterns in data; and comparing results to known scientific theories, current models, or personal experience; and considering multiple interpretations of data;
(4) describing how a premise is supported by scientific concepts, principles, theories, or laws; and
(5) creating a model to illustrate a contemporary or historical concept, principle, theory, or law.

Earth and Space Systems

Earth Systems - Middle Level

Purpose: Students will utilize concepts and investigations to evaluate interactions of Earth and space systems and how they impact the Earth and its human life.

A. A student shall demonstrate an understanding of:
   1. the structures and processes of Earth systems including:
      a. plate tectonics and Earth layers occurring in the geosphere;
      b. the water cycle, erosion, and water bodies in the hydrosphere;
      c. weather and climate as a function of the atmosphere;
   2. concepts of change and constancy in the Earth's history including evidence found in rocks, landforms, and fossils;
   3. scientific theories of the Earth's origin and evolution including:
      a. formation from a nebular cloud of dust;
      b. methods of estimating geologic time;
      c. interactions among the solid Earth, the oceans, the atmosphere, and organisms;
   4. the relative positions and motion of objects in the solar system including:
      a. planetary motion;
      b. moon phases and tides;
      c. seasons;
      d. eclipses;
   5. the structure and evolution of the universe including:
      a. galaxies;
      b. stars;
      c. time and distance relationships;
   6. the history and nature of science including:
      a. the idea that scientific ideas are tentative and subject to change;
      b. that it is normal for scientists to question the interpretation of data;
      c. that questioning, response to criticism, and open communication are important to the process of science; and

d. that the body of science knowledge has been built by men and women from many cultures and beliefs.

B. A student shall demonstrate the ability to:

1. independently formulate questions based on prior observations and evidence and to provide answers through scientific investigations;
2. design and conduct, with minimal assistance, a scientific investigation, for example, an experiment or a field study;
3. choose appropriate scientific technology to gather and analyze data and evidence, for example, microscopes, probes, computers, and thermometers to measure liquids, air, and soil;
4. use mathematical representations or two- and three-dimensional models to interpret and communicate data and evidence;
5. use their own and other students' evidence collected by valid scientific investigations to develop descriptions, explanations, predictions, and models;
6. describe how evidence and established science ideas do or do not support a claim made in public media, for example, advertisements and reports of scientific studies;
7. use appropriate safety equipment and follow safety procedures including:
   a. using goggles when working with glass, chemicals, heat and projectiles;
   b. disposing of materials properly;
   c. following established laboratory rules; and operating safety equipment provided in the laboratory or field.

Current Standard
Scientific Concepts and Applications
Concepts in Biology - High School
A student shall:

A. demonstrate understanding of biological concepts, theories, and principles including cell theory, mechanisms of heredity, biological change over time, the interdependence of organisms, material cycles and energy flow in living systems, the behavior of organisms, and the historical significance of major scientific advances through the investigation and analysis of cells, organisms, and ecosystems;
B. demonstrate understanding:
(1) of how historical and current scientific concepts and knowledge guide scientific inquiries;
(2) that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
(3) of how the use of various technologies influence the quality of data and the investigation;
(4) of the essential role of mathematical tools and models and how they are essential to scientific inquiry;
(5) of how explanations based on evidence adhere to established criteria including empirical standards, logic, openness to criticism, and reporting of methods and procedures; and
(6) of how traditions govern the conduct of science, including ethics, peer review, and consensus;
C. design and conduct an experiment to investigate a question and test a hypothesis by:
(1) formulating a question and hypothesis;
(2) designing and conducting an investigation;
(3) recording relevant data;
(4) analyzing data using mathematical methods;
(5) constructing reasonable explanations to answer the question and supporting or refuting a hypothesis;
(6) identifying and considering alternative interpretations of results; and
(7) specifying implications for further investigation;
D. design and conduct one investigation through a problem-based study, service learning project, or field study by identifying scientific issues based on observations and the corresponding scientific concepts; analyzing data to clarify scientific issues or define scientific questions; and comparing results to current models, personal experience, or both; and
E. use scientific evidence to defend or refute an idea in a historical or contemporary context by identifying scientific concepts found in evidence; evaluating the validity of the idea in relationship to scientific information; and analyzing the immediate and long-term impact on the individual, society, or both, in the areas of technology, economics, and the environment.

Scientific Concepts and Applications

Biology - High School Level

Purpose: Investigate living systems at a molecular level

A. A student shall demonstrate understanding of:
   1. mechanisms of heredity including:
      a. how new genes have a wide variety of effects;
      b. how sorting and recombining genes result in a wide variety of possibilities in offspring;
      c. how information is passed from parent to offspring through coding in DNA;
      d. that gene mutations can be caused by such things as radiation and chemicals, for example, ingested and inhaled drugs;
      e. how cell differentiation provides organisms with tissues, organs, and systems;

   2. biological evolution including:

a. that the Earth's present day range of species developed from pre-existing species;
b. how mechanisms for evolution are provided through natural selection;
c. that natural selection gives rise to cells' and organisms' behaviors and to cells and organisms that are able to survive in particular environments;
d. that the theory of natural selection provides a scientific explanation for the history of life on Earth;

3. interdependence between organisms and environments including:
   a. how ecosystems can be reasonably stable over hundreds or thousands of years;
   b. that ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution;
   c. human activities can, deliberately or inadvertently, alter the equilibrium of an ecosystem;
4. flow of matter and energy including how the amount of life any environment can support is limited by the available energy, water, oxygen, minerals, and by the ability of ecosystems to recycle the residue of dead organic material;
5. behavior of cells and organisms including:
   a. how nervous systems in multi-cellular animals generate behavior;
   b. how behavioral responses to internal changes and external stimuli occur in organisms;
   c. how behavioral responses can be either innate or learned and have evolved to ensure reproductive success;
6. the historical significance of a major scientific or technological advance in biological systems including contributions of men and women with diverse perspectives;
7. the nature of science including:
   a. how historical and current scientific concepts and knowledge guide scientific inquiries;
   b. that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
   c. how the use of various technologies influences investigations;
   d. the essential role of mathematics in scientific inquiry;
   e. how science knowledge based on evidence adheres to established scientific criteria; and
   f. the traditions that govern the conduct of scientists.

B. A student shall demonstrate the ability to:

1. design and conduct a scientific investigation using one of the following high school inquiry standards:
   a. Research Process **OR;**
   b. Issue Analysis **OR;**
   c. Field Study **OR;**

d. Case Study;

2. apply technology, for example, the use of sensors and probes, microscopes, environmental sampling tools, analysis with spreadsheets, computer simulations to solve problems, computerized electron microscope images, and invention of equipment or tools;
3. practice science safely including:
   a. using equipment properly and following other standard laboratory procedures;
   b. identifying safety hazards and risk factors of technological equipment being used;
   c. using proper methods of disposing of chemicals and biological materials; and
   d. knowing emergency procedures and the location of safety equipment.

Current Standard
Scientific Concepts and Applications
Concepts in Chemistry- High School
A. demonstrate understanding of concepts, theories, and principles in chemistry by investigating and analyzing atomic theory; relationships between the structure and properties of matter including organic and inorganic bonding, periodicity, and solutions chemistry; chemical reactions; interactions of energy and matter; and the historical significance of major scientific advances;
B. demonstrate understanding:
(1) of how historical and current scientific concepts and knowledge guide scientific inquiries;
(2) that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
(3) of how the use of various technologies influence the quality of data and the investigation;
(4) of the essential role of mathematical tools and models and how they are essential to scientific inquiry;
(5) of how explanations based on evidence adhere to established criteria including empirical standards, logic, openness to criticism, and reporting of methods and procedures; and
(6) of how traditions govern the conduct of science, including ethics, peer review, and consensus;
C. design and conduct an experiment to investigate a question and test a hypothesis by:
(1) formulating a question and hypothesis;
(2) designing and conducting an investigation;
(3) recording relevant data;
(4) analyzing data using mathematical methods;
(5) constructing reasonable explanations to answer the question and supporting or refuting the hypothesis;
(6) identifying and considering alternative interpretations of results; and
(7) specifying implications for further investigation;
D. design and conduct an investigation through a problem-based study, service learning project, or field study by identifying scientific issues based on observations and the corresponding scientific concepts; analyzing data to clarify scientific issues or define scientific questions; and comparing results to current models, personal experience, or both; and
E. use scientific evidence to defend or refute an idea in a historical or contemporary context by identifying scientific concepts found in evidence; evaluating the validity of the idea in relation to the scientific information; and analyzing the immediate and long-term impact on the individual, society, or both, in the areas of technology, economics, and the environment.

Scientific Concepts and Applications

Concepts in Chemistry - High School

Purpose: Develop scientific literacy through understanding concepts, theories and principles in chemistry by analysis and investigation

A. A student shall demonstrate an understanding of:
1. atomic structure including:
   a. structure of atoms;
   b. properties of isotope;s
   c. radioactive processes;
2. structure and properties of matter including:
   a. knowledge of elements;
   b. measurement of basic properties of matter, for example, thermal expansion, electrical conductivity, crystal structure, and solubility;
   c. patterns in the periodic table;
   d. the role of electrons in all types of bonding;
   e. formation and properties of inorganic and organic substances, for example polymers and large molecules essential to life;

3. chemical reactions including:
   a. evidence of chemical reactions;
   b. energy changes in chemical system;
   c. determining the factors that affect the rate of a reaction;
   d. common chemical reactions that occur in kitchens, living systems, and the environment;
4. the history of science including the historical significance of a major scientific or technological advance in chemistry and the importance of multiple contributions by men and women with diverse perspectives;
5. the nature of science including:
   a. how historical and current scientific concepts and knowledge guide scientific inquiries;
   b. that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
   c. how the use of various technologies influences the investigations;
   d. the essential role of mathematics in scientific inquiry;
   e. how science knowledge based on evidence adheres to established scientific criteria; and
   f. that traditions govern the conduct of scientists.

B. A student shall demonstrate the ability to:
1. design and conduct a scientific investigation using one of the following high school inquiry standards:
   a. Research Process **OR;**
   b. Issue Analysis **OR;**
   c. Field Study **OR;**
   d. Case Study;
2. apply technology, for example, the use of sensors and probes, analysis with spreadsheets, development of computer simulations to solve problems, and creation or invention of equipment and tools,
3. practice science safely including:
   a. using equipment properly and following other standard laboratory procedures;
   b. identifying safety hazards and risk factors of technological equipment being used;
   c. using proper methods of disposing of chemicals and materials; and
   d. knowing emergency procedures and the location and use of safety equipment.

Current Standard
Scientific Concepts and Applications
Earth and Space Systems – High School

A student shall:

A. demonstrate understanding of earth and space systems by investigating and analyzing earth systems through the interaction of forces and energy, geochemical processes and cycles, theories of the origin and evolution of the universe, energy in the earth system, and the historical significance of major scientific advances;

B. demonstrate understanding:

(1) of how historical and current scientific concepts and knowledge guide scientific inquiries;
(2) that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
(3) of how the use of various technologies influence the quality of data and the investigation;
(4) of the essential role of mathematical tools and models and how they are essential to scientific inquiry;
(5) of how explanations based on evidence adhere to established criteria including empirical standards, logic, openness to criticism, and reporting of methods and procedures; and
(6) of how traditions govern the conduct of science, including ethics, peer review, and consensus;

C. design and conduct an experiment to investigate a question and test a hypothesis by:

(1) formulating a question and hypothesis;
(2) designing and conducting an investigation;
(3) recording relevant data;
(4) analyzing data using mathematical methods;
(5) constructing reasonable explanations to answer the question and supporting or refuting the hypothesis;
(6) identifying and considering alternative interpretations of results; and
(7) specifying implications for further investigation;

D. design and conduct an investigation through a problem-based study, service learning project, or field study by identifying scientific issues based on observations and the corresponding scientific concepts; analyzing data to clarify scientific issues or define scientific questions; and comparing results to current models, personal experience, or both; and

E. use scientific evidence to defend or refute an idea in a historical or contemporary context by identifying scientific concepts found in evidence; evaluating the validity of the idea in relation to the scientific information; and analyzing the immediate and long-term impact on the individual, society, or both, in the areas of technology, economics, and the environment.

Scientific Applications and Concepts

Earth and Space Systems - High School Level

Purpose: Investigate and analyze earth and space systems through application of concepts, theories, and principles.

A. A student shall demonstrate an understanding of:

1. energy in the Earth system including internal and external sources of energy and the transfer of energy;
2. interaction of forces and energy including but not limited to fault systems, movement of earth materials, and star systems;
3. geochemical processes and cycles including movement and sinking of elements and the physical and chemical changes caused by this movement;
4. theory of origins and evolution of the universe including "big bang," gravitational attraction of matter, and nuclear reactions in stars to produce elements;
5. potential environmental problems related to Earth and space systems;
6. the history of science including the historical significance of a major scientific or technological advance in Earth and space systems and the importance of multiple contributions by men and women with diverse perspectives;

7. the nature of science including:
    a. how historical and current scientific concepts and knowledge guide scientific inquiries;
    b. that scientific inquiries are performed to test predictions, verify ideas, and to learn about the natural world;
    c. how the use of various technologies influences the investigations;
    d. the essential role of mathematics in scientific inquiry;
    e. how science knowledge based on evidence adheres to established scientific criteria;
    f. that traditions govern the conduct of scientists.

B. A student shall demonstrate the ability to:
1. design and conduct a scientific investigation using one of the following high school inquiry standards:
    a. Research Process **OR;**
    b. Issue Analysis **OR;**
    c. Field Study **OR;**
    d. Case Study;
2. apply appropriate learning and analysis technologies, for example, sensors and probes, graphing calculators, spread sheets, computer simulations, field sampling equipment, and downlinks from real time data bases;
3. practice science safely including:
    a. using equipment properly and following other standard laboratory procedures;
    b. identifying safety hazards and risk factors of technological equipment being used;
    c. using proper methods of disposing of chemicals and materials; and knowing emergency procedures and the location and use of safety equipment.

Current Standard
Scientific Concepts and Applications
Concepts in Physics – High School

A student shall:

A. demonstrate understanding of matter, forces, and energy by investigating and analyzing the concepts of motion, force, laws of conservation, electricity, magnetism, waves, energy, and work, and the historical significance of major scientific advances;

B. demonstrate understanding:
   (1) of how historical and current scientific concepts and knowledge guide scientific inquiries;
   (2) that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
   (3) of how the use of various technologies influence the quality of data and the investigation;
   (4) of the essential role of mathematical tools and models and how they are essential to scientific inquiry;
   (5) of how explanations based on evidence adhere to established criteria including empirical standards, logic, openness to criticism, and reporting of methods and procedures; and
   (6) of how traditions govern the conduct of science, including ethics, peer review, and consensus;

C. design and conduct an experiment to investigate a question and test a hypothesis by:
   (1) formulating a question and hypothesis;
   (2) designing and conducting an investigation;
   (3) recording relevant data;
   (4) analyzing data using mathematical methods;
   (5) constructing reasonable explanations to answer the question and supporting or refuting the hypothesis;
   (6) identifying and considering alternative interpretations of results; and
   (7) specifying implications for further investigation;

D. design and conduct an investigation through a problem-based study, service learning project, or field study by identifying scientific issues based on observations and the corresponding scientific concepts; analyzing data to clarify scientific issues or define scientific questions; and comparing results to current models, personal experience, or both; and

E. use scientific evidence to defend or refute an idea in a historical or contemporary context by identifying scientific concepts found in evidence; evaluating the validity of the idea in relation to the scientific information; and analyzing the immediate and long-term impact on the individual, society, or both, in the areas of technology, economics, and the environment.

Scientific Concepts and Research

Concepts in Physics – High School

Purpose: Investigate and develop an understanding of the make-up, structure, and function of the physical world.

A. A student shall demonstrate understanding of:
   1. how forces can produce a variety of types of motions;
   2. how the concepts of conservation of energy, momentum, and charge are used to analyze events and solve problems;
   3. wave motion including sound, light, and other electromagnetic waves;
   4. electricity, magnetism and electromagnetism;
   5. the development of ideas in modern physics including atomic and nuclear physics, relativity, quantum physics and fundamental particles;
   6. the history of science including the historical significance of a major scientific or technological advance in physics and the importance of multiple contributions by individuals with diverse perspectives;
   7. the nature of science including:
      a. how historical and current scientific concepts and knowledge guide scientific inquiries;

b. that scientific inquiries are performed to test predictions, verify ideas, and to learn about the natural world;
c. how the use of various technologies influences the investigations;
d. the essential role of mathematics in scientific inquiry;
e. how science knowledge based on evidence adheres to established scientific criteria; and
f. that traditions govern the conduct of scientists.

B. A student shall demonstrate the ability to:
1. design and conduct a scientific investigation using one of the following high school inquiry standards:
   a. Research Process **OR;**
   b. Issue Analysis **OR;**
   c. Field Study **OR;**
   d. Case Study;
2. apply appropriate learning and analysis technologies, for example, sensors and probes, analysis with spread sheets, computer simulations, and invention of equipment, tools, or circuits;
3. practice science safely including:
   a. using equipment properly and following other standard laboratory procedures;
   b. identifying safety hazards and risk factors of technological equipment being used;
   c. using proper methods of disposing of chemicals or materials; knowing emergency procedures and the location and use of safety equipment.

Current Standard
Scientific Concepts and Applications
Environmental Systems – High School

A student shall:

A. demonstrate understanding of the use of decision-making models and scientific investigation and issues involving relationships among the individual, society, economy, and environment by investigating and analyzing the scientific concepts, principles, laws, or theories that affect and are effected by environmental changes; the interactions between social and natural systems; local, regional, or global implications of short-term or long-term environmental changes; and methods for citizenship action;

B. demonstrate understanding:
   (1) of how historical and current scientific concepts and knowledge guide scientific inquiries;
   (2) that scientific inquiries are performed to test ideas and predictions and to learn about the natural world;
   (3) of how the use of various technologies influence the quality of data and the investigation;
   (4) of the essential role of mathematical tools and models and how they are essential to scientific inquiry;
   (5) of how explanations based on evidence adhere to established criteria including empirical standards, logic, openness to criticism, and reporting of methods and procedures; and
   (6) of how traditions govern the conduct of science, including ethics, peer review, and consensus;

C. analyze a significant environmental topic to identify problems;

D. analyze an environmental problem to identify related issues;

E. develop a conceptual understanding of the local issue by identifying related scientific concepts and ecological systems; identifying related social systems; identifying interest groups, the point of view of interest groups, and possible solutions; and analyzing how humans and natural systems affect and are affected by the local issue;

F. design and conduct primary research to enhance understanding of the local issue;

G. develop and evaluate a personal action plan designed to promote a specific solution; and

H. design and conduct an experiment to investigate a question and test a hypothesis by:
   (1) formulating a question and hypothesis;
   (2) designing and conducting an investigation;
   (3) recording relevant data;
   (4) analyzing data using mathematical methods;
   (5) constructing reasonable explanations to answer the question and supporting or refuting the hypothesis;
   (6) identifying and considering alternative interpretations of results; and
   (7) specifying implications for further investigation.

Scientific Concepts and Application

Environmental Systems – High School level

Purpose: Evaluate a local or regional environmental issue, select a solution and prepare a plan to carry out the solution

A. A students shall have an understanding of:
   1. environmental systems representing the interaction of natural and social systems;
   2. local, regional or global environmental issues, for example:
      a. personal and community health
      b. population growth
      c. natural resources
      d. environmental quality
      e. natural and human induced hazards
   3. science concepts associated with environmental issues, including:
      a. processes that shape the Earth, for example, forces that change the surface of the Earth, energy flow and material cycles in Earth systems;

b. characteristics and processes of living systems, for example, organisms, populations and communities, heredity and evolution, systems and connections, the flow of energy, and the cycling of matter;

4. types of social systems that interact with natural systems, for example, economic, political, and technological
5. the historical significance of a major scientific or technological advance in environmental systems and the importance of multiple contributions by men and women with diverse perspectives;
6. the nature of science in environmental systems including:
   a. how historical and current understanding of natural systems guide environmental decision-making;
   b. that research and inquiries are performed to test ideas, verify ideas, and make predictions about changes in environmental systems;
   c. how progress in science and technology are effected by social issues and challenges;
   d. how environmental decisions involve assessment of alternatives, risks, costs, and benefits; and
   e. the traditions that govern the conduct of researchers.

B. A student shall demonstrate the ability to:

1. identify components of a existing local or regional environmental issue including:
   a. scientific concepts related to or embedded in the issue
   b. social systems involved in the issue
2. conduct a science-based investigation of a local or regional environmental issue using the Issue Analysis Standard from Inquiry and Research Learning Area;
3. develop and give rationale for a personal action plan designed to promote a specific solution;
4. apply appropriate learning and analysis technologies, for example, sensors and probes, graphing calculators, spread sheets, computer simulations and models, field sampling equipment, and downlinks from real-time data bases;
5. practice science safely including:
   a. using equipment properly and following standard laboratory and field procedures;
   b. identifying safety hazards and risk factors of technological equipment being used;
   c. using proper methods for disposing of chemicals, field waste and used materials; and
   d. knowing emergency procedures and the location and use of safety equipment.