Southern Regional High School

Manahawkin, New Jersey

Course of Study

For

Chemistry II AP
3230

Submitted By:
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Southern Regional High School District
Course of Study

Department____Science_____

Course Title: AP Chemistry

Essential Questions of the Course:

1. The AP Chemistry course is driven by a 180 minute examination that is very comprehensive covering topics of General College Chemistry I & II.

Assessments:

- Multiple choice tests
- Free response tests
- Lab portfolios

Unit of Study

Unit Title: Structure of Matter

Essential Questions of the Unit:

1. Classify matter
2. What are metric units? How do we use significant figures?
3. What are the properties of substance?
4. State the Atomic Theory.
5. What are the components of an atom?
6. Distinguish between atomic #, mass#, isotopes and atomic mass.
7. Discuss role of Periodic Table to predict properties?
8. Write chemical formulas.
9. Electronic energy levels: atomic spectra, quantum #, atomic orbitals and their significance.
10. Explain the H atom using Bohr model and quantum mechanical model.
11. Write electron configuration of any atom or ion.
12. Explain chemical bonding: binding forces, molecular models, and geometry.
13. Nuclear chemistry: nuclear equations, half-lives and radioactivity.

Assessments:

- Chapter multiple choice test (Chapter 1, 2, 6 & 7, 19, 22)
- Review Free Response Test
- Lab Portfolio

Content:

1. Atomic theory and atomic structure.
2. Chemical bonding.
3. Nuclear chemistry.

Skills:

- Explain atomic theory and role of the atom.
- Explain chemical bonding with regard to binding forces, relationship to states of matter, polarity and electronegativity.
- Know the role that the geometry of molecules and ions plays, structural significance of isomerism, dipoles as it relates to properties.
- Be able to recognize and balance nuclear equations.
- Solve problems using half-life relationships.
- Chemical applications of radioactivity are learned.

Purpose / Rational of the Unit:

Students develop a comprehensive understanding of the role of the atom, its structure and how the atomic theory, bonding and nuclear applications affect their everyday lives.

New Jersey Core Curriculum Content Standards:

5.1 SCIENTIFIC PROCESS
- A. Habits of Mind
- B. Inquiry and Problem Solving
- C. Safety

5.2 SCIENCE AND SAFETY
- A. Cultural Contributions
- B. Historical Perspectives

5.3 MATHEMATICAL APPLICATIONS
- A. Numerical Operations
- B. Geometry and Measurement
- C. Patterns and Algebra
- D. Data Analysis and Probability

5.4 NATURE AND PROCESS OF TECHNOLOGY
- A. Science and Technology
- B. Nature of Technology
- C. Technological Design

5.6 PHYSICAL SCIENCE – CHEMISTRY
- A. Structure and Properties of Matter

For descriptive narrative, see Appendix

Career Education and Technology standards will be infused throughout the curriculum

Time Frame of Unit: 7 – 10 weeks

Instructional Activities:

- Extensive homework assignments for each chapter
- Laboratory activities (can be 2 weeks in duration):
    - Lab safety
    - Water of Hydration
    - Determining chemical formula
    - Building organic molecules

Materials and Resources:

Textbook: Chemistry: Principle & Reactions, Masterton & Hurley, 4th ed.
Chemistry, R. Chang, 7th edition
Chemistry, Zumdal, 3rd edition
Chemistry, Central Science, Brown, 5th edition

Related lab books
AP Syllabus

Unit of Study

Unit Title: States of Matter

Essential Questions of the Unit:

1. Solve problems involving gas laws.
2. What is the significance of Kinetic-Molecular Theory.
3. Explain liquid and solid state from the kinetic-molecular viewpoint.
4. Explain phase diagrams.
5. Explain structure of solids.
6. Explain changes of state.
7. Describe types of solutions.
8. Calculate and solve problems involving concentrations.
9. Explain deviations from ideal behavior.

Assessments:

- Chapter multiple choice tests (ch. 5, 9, 10)
- Review free response
- Lab portfolio

Content:

States of Matter

- Gases
- Liquids and solids
- Solutions

Skills:

- Able to define gas laws: ideal, combined, partial pressure, Avogrado's, Graham's Law.
- Able to interpret ideal gas laws on basis of kinetic theory, use Avogrado's hypothesis, role of kinetic energy and temperature, explain deviations in behavior.
- Explain liquids and solids on a molecular basis, phase diagrams, changes of state and structure of solid.
- Know types of solutions, means of expressing concentration.
- Apply Raoult's Law.
- Study colligative properties.
- Explain non idea behavior (qualitative and non-qualitative).

Purpose / Rationale of the Unit:

Students are to gain a comprehensive understanding of the states of matter and applications of the kinetic-molecular theory.

New Jersey Core Curriculum Content Standards:

5.1 SCIENTIFIC PROCESS
- A. Habits of Mind
- B. Inquiry and Problem Solving
- C. Safety

5.2 SCIENCE AND SAFETY
- B. Historical Perspectives

5.3 MATHEMATICAL APPLICATIONS
- A. Numerical Operations
- C. Patterns and Algebra
- D. Data Analysis and Probability

5.4 NATURE AND PROCESS OF TECHNOLOGY
- A. Science and Technology
- C. Technological Design

5.6 PHYSICAL SCIENCE – CHEMISTRY
- A. Structure and Properties of Matter

For descriptive narrative, see Appendix

Time Frame of Unit: 4-6 weeks.

Instructional Activities:

- Extensive homework and problem solving on each chapter
- Lab activities:
    - Thin layer chromatography/liquid gel chromatography (separation techniques)
    - Writing net ionic equations
    - Molecular weight determined by vapor pressure

Materials and Resources:

Textbooks (see previous)

Unit of Study

Unit Title: Reactions

Essential Questions of the Unit:

1. Explain chemical reactions.
2. Describe significant stoichiometric relationships.
3. Describe equilibrium: qualitatively and quantitatively.
4. Explain kinetics of chemical relationships.
5. Explain and apply thermochemical principles.
6. Describe electrochemical processes.
7. Apply electrochemical principles.

Assessments:

- Chapter multiple choice tests on Chapter 3, 4, 8, 11, 12, 13, 14, 16, 17, 18.
- Review free response tests
- Lab portfolio

Content:

- Reactive types
- Stoichiometry
- Equilibrium
- Kinetics
- Thermodynamics

Skills:

- Explain acid-base reactions, precipitation reactions, redox reaction.
- Write net ionic equations, balance equations.
- Apply mole concept with regard to mass and volume relations including empirical formulas and limiting reactant.
- Apply LeChatelier's principle.
- Calculate equilibrium constants: K, Kp, Ka, Kb, Ksp
- Apply pK, pH
- Discuss common ion effect: buffers and hydrolysis.
- Calculate rates of reaction, rate order, rate constants
- Describe how temperature affects rates: energy of activation, role of catalyst.
- Apply state functions, laws of thermodynamics.
- Relate free energy to equilibrium constants.

Purpose / Rationale of the Unit:

Students gain an understanding of the nature of reactions, stoichiometric relationships, role of equilibrium in chemical reactions, the kinetics and thermodynamics of chemical reactions.

New Jersey Core Curriculum Content Standards:

5.1 SCIENTIFIC PROCESS
- A. Habits of Mind
- B. Inquiry and Problem Solving
- C. Safety

5.2 SCIENCE AND SAFETY
- A. Cultural Contributions

5.3 MATHEMATICAL APPLICATIONS
- A. Numerical Operations
- C. Patterns and Algebra
- D. Data Analysis and Probability

5.4 NATURE AND PROCESS OF TECHNOLOGY
- A. Science and Technology
- B. Nature of Technology
- C. Technological Design

5.6 PHYSICAL SCIENCE – CHEMISTRY
- B. Chemical Reactions

5.7 PHYSICAL SCIENCE – PHYSICS
- B. Energy Transformations

For descriptive narrative, see Appendix

Time Frame of Unit: 15-18 weeks

Instructional Activities:

Extensive homework and problem solving for each chapter.

Lab activities:

- Thermodynamic: Hess's Law
- Colligative properties: $\Delta T = kmi$
- Percentage of Cu in a compound
- Spec 20 analysis
- Coordination of complex ion formation
- Rates of reaction
- Chemical equilibrium
- Electrochemical studies
- Titration
- Determing pKa

Materials and Resources:

See previous

Unit of Study

Unit Title: Descriptive Chemistry

Essential Questions of the Unit:

While knowledge of specific facts is essential for an understanding of principles and concepts, these are also applied in environmental and societal issues throughout the AP course, questions might include:

1. What are the products of various types of chemical reactions?
2. What are the relationships inherent to the periodic table?
3. What are some applications of organic chemistry to everyday life?
4. What is the role of amines in "ordinary" compounds?
5. Explain the Greenhouse Effect.
6. Describe some properties of Lanthanides and Actinides.
7. Explain some noble gas compounds.
8. Energy and ATP.

Assessments:

- Chapter 22 multiple choice test and test of Net Ionic Equation.
- Review free response questions.
- Lab

Content:

- Organic chemistry – introduction
- Net ionic equations – packet for AP test
- All of perspectives following each chapter

Skills:

- Differentiate between saturated and unsaturated hydrocarbons.
- Learn aromatics and their derivations.
- Learn various organic functional groups and their structures.
- Learn to name organic compounds.
- Role of isomerism is learned.
- Able to write net ionic equations for all reactions that occur.
- Learn some unique properties for various groups in the periodic table.

Purpose / Rationale of the Unit:

Students gain insight into how the basic principles and concepts of chemistry play a role in environmental and societal issues.

New Jersey Core Curriculum Content Standards:

5.1 SCIENTIFIC PROCESS
- A. Habits of Mind
- B. Inquiry and Problem Solving
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5.2 SCIENCE AND SAFETY
- A. Cultural Contributions
- B. Historical Perspectives

5.4 NATURE AND PROCESS OF TECHNOLOGY
- A. Science and Technology
- B. Nature of Technology
- C. Technological Design

5.6 PHYSICAL SCIENCE – CHEMISTRY
- A. Structure and Properties of Matter
- B. Chemical Reactions

For descriptive narrative, see Appendix

Time Frame of Unit: 3 weeks and throughout the course.

Instructional Activities:

- Extensive homework assignments for chapter.
- Extensive worksheets on AP equations.
- Laboratory activities -
    - Net ionic equations.
    - Synthesis of aspirin.
    - Synthesis of coordination complexes.
    - Build organic modes.
    - Synthesis of esters.

Materials and Resources:

- Textbook: Chemistry: Principles and Reactions, Masterton & Hurley, 4th edition
- AP Syllabus
- AP equation worksheets
- Various lab books

Unit of Study

Unit Title: Laboratory

Essential Questions of the Unit:

Students have the opportunity to do meaningful laboratory work as suggested by the AP Chemistry Program.

Assessments:

Lab portfolio of 18-22 completed labs.

Content:

Varied – follow AP Chemistry syllabus

Skills:

The following skills are gained:

- Making observations of chemical reactions and substances
- Recording data
- Calculating and interpreting results based on the quantitative data obtained.
- Communicating effectively the results of one's lab work.

Purpose / Rationale of the Unit:

To develop the lab skills and communicative skills necessary to succeed in scientific study beyond the secondary level.

New Jersey Core Curriculum Content Standards:

5.1 SCIENTIFIC PROCESS
- A. Habits of Mind
- B. Inquiry and Problem Solving
- C. Safety

5.2 SCIENCE AND SAFETY
- A. Cultural Contributions
- B. Historical Perspectives

5.3 MATHEMATICAL APPLICATIONS
- A. Numerical Operations
- C. Patterns and Algebra
- D. Data Analysis and Probability

5.4 NATURE AND PROCESS OF TECHNOLOGY
- A. Science and Technology
- B. Nature of Technology
- C. Technological Design

5.6 PHYSICAL SCIENCE – CHEMISTRY
- A. Structure and Properties of Matter
- B. Chemical Reactions

For descriptive narrative, see Appendix

Time Frame of Unit: Throughout the course – 36 weeks

Instructional Activities:

Labs completed:

- Determining the % of H_20 in a Hydrate
- Determine the formula of a compound
- Determining molar mass by vapor density
- Separation techniques: TLC and liquid chromatography
- Hess's Law and Enthalpy
- Synthesis of aspirin
- % of Cu/mole
- Spec 20 analysis using Beer's law
- Colligative properties: determine molar mass by F.P. Depression
- Synthesis: coordination complexes
- Rates of reaction
- Determining K
- Qualitative analysis scheme: Group I
- Molar volume of a gas
- Indicators and pH
- Titration
- Redox studies
- Water testing – spec 20
- Gravimetric det. of Ba
- Electrochemical series
- Study of reactions

Materials and Resources:

- Various college lab textbooks have been used to develop labs
- Advanced placement kits
- Teacher-developed labs

New Jersey Core Curriculum Content Standards for Science

INTRODUCTION

The Vision

The New Jersey Core Curriculum Content Standards for Science reflect the belief that all students can and must learn enough science to assume their role as concerned citizens, equipped with necessary information and decision-making skills.

The need for scientific literacy in today's increasingly technological world, for fundamental reforms in how science is taught, and for established standards in science education are by now well known and documented. Presidential appeals for excellence, combined with expressions of concern from scientists and educators, have led to national, state, and local initiatives. New Jersey is host to an impressive array of scientific and technological industries, and should play a leadership role in the development and implementation of standards for the teaching and learning of science.

The Core Curriculum Content Standards for Science are influenced by certain understandings, events, and principles in the continuing improvement of science education in New Jersey and the nation. Efforts to establish standards for the teaching and learning of science have been pursued actively at the state and national level. In 1993, Benchmarks for Science Literacy was published by the American Association for the Advancement of Science (AAAS), followed in 1994 by a comprehensive draft of the National Science Education Standards (NSES) by the National Research Council. Both of these documents contributed to an ongoing interest in the formulation of world-class educational standards rooted in reform movements such as Project 2061 of the American Association for the Advancement of Science, and the Scope, Sequence and Coordination Project of the National Science Teachers Association. The simultaneously emerging national standards presented a reliable model that was often consulted in the formulation of the original New Jersey science standards.

In New Jersey, the call for science education standards was heightened when the State was awarded a grant from the National Science Foundation for the establishment of a Statewide Systematic Initiative (NJ SSI) for the reform of mathematics, science, and technology education. The combined funding of the NJ SSI and the Mid-Atlantic Eisenhower Consortium for Math and Science Education made possible the widespread distribution of an initial draft of science standards during the 1994-95 school year.

Following extensive public exposure and review, the science standards along with those for other subjects and a newly formulated set of Cross Content Workplace Readiness Standards were adopted by the State Board of Education as New Jersey’s Core Curriculum Content Standards in May of 1996.

Revised Standards

Concurrent with the adoption of the standards themselves was a mandate that they be regularly reviewed, and revised if necessary, every five years. This process began for the science standards

during the winter of 2000-2001, when a review committee was organized to oversee the revision process.

Much had occurred since the 1996 adoption as New Jersey was joined by nearly every state in the nation in formulating rigorous academic standards as part of a growing national interest in educational reform. This resulted in the availability of several nationwide surveys that acknowledged the excellence of our science standards but more importantly served to inform the committee's careful review of those standards. Particularly useful were a comprehensive research project conducted by the Council of Chief State School Officers (CCSSO) that provided a framework for the benchmarking of the New Jersey standards and a detailed assessment of our science standards reported by Achieve, Inc., an independent, bipartisan, nonprofit organization founded at the 1996 National Education Summit. Additionally, the revisions have benefited from the ongoing work of the organizations that were at the forefront of the science standards movement, particularly the Atlas for Science Literacy published by AAAS in 2001.

An enormous amount of scientific content has accumulated at an accelerating rate over the years, causing textbooks to thicken as material is added but rarely deleted. Science educators across the nation have come to recognize this as a disturbing and counterproductive trend. The science standards in this section, therefore, are not intended to include all of science, but rather are an attempt to define what all students should understand and be able to apply as they grow towards scientific literacy. A guiding principle of these standards is that an understanding of fundamental scientific principles and the development of science-related skills are not limited by gender, economic status, cultural background, or ability. While we recognize the need for the inclusion of fundamental understandings in the life, earth and space, and physical sciences, the development of critical thinking skills is considered of paramount importance. Also important are safe practices, the attitudes students display as they learn science, and the development of qualities inherent in the practice of science, such as curiosity, skepticism, open-mindedness, and honesty when collecting and interpreting findings. While these habits of mind cannot be measured easily, no science program can be considered complete or successful that does not promote them.

Science should be taught at all levels with awareness of its connection to other subjects and the needs of society. While these standards do not suggest a specific curriculum design or sequence of courses, they assume that the relationship of the various disciplines of science to each other, and of science to the overall learning experience, will be strongly emphasized. The grade clustering system implemented in the current version of the standards reflects developmental appropriateness of the content and skills to provide guidance for developmentally appropriate implementation. The standards also reflect the needs of the students and teachers of New Jersey; indeed, incorporating New Jersey's unique natural resources in the teaching of science should be a primary goal of school districts as they move towards implementation.

The formulation of standards does not ensure their proper implementation. The NSES mentioned above includes standards that address the preparation of science teachers as well as the school environment in which science is taught. While New Jersey standards are not intended to deal with such issues, these issues must be considered if the standards are to be realized. The standards are only of value if they are part of a larger, ongoing effort to improve the teaching and learning of science in New Jersey schools. Defining scientific literacy for the citizens of New Jersey is an important first step toward achieving this goal.

Standards and Strands

There are 10 standards, each of which has a number of identified strands. These standards and their associated strands are listed below:

5.1 Scientific Processes
A. Habits of Mind
B. Inquiry and Problem Solving
C. Safety

5.2 Science and Society
A. Cultural Contributions
B. Historical Perspectives

5.3 Mathematical Applications
A. Numerical Operations
B. Geometry and Measurement
C. Patterns and Algebra
D. Data Analysis and Probability

5.4 Nature and Process of Technology
A. Science and Technology
B. Nature of Technology
C. Technological Design

5.5 Life Science
A. Matter, Energy, and Organization in Living Systems
B. Diversity and Biological Evolution
C. Reproduction and Heredity

5.6 Physical Science – Chemistry
A. Structure and Properties of Matter
B. Chemical Reactions

5.7 Physical Science – Physics
A. Motion and Forces
B. Energy Transformations

5.8 Earth Science
A. Earth's Properties and Materials
B. Atmosphere and Weather
C. Processes that Shape the Earth
D. How We Study the Earth

5.9 Astronomy and Space Science
A. Earth, Moon, Sun System
B. Solar System
C. Stars
D. Galaxies and Universe

5.10 Environmental Studies
A. Natural Systems and Interactions
B. Human Interactions and Impact

References

American Association for the Advancement of Science. (2001). *Atlas of science literacy.* American Association for the Advancement of Science and National Science Teachers Association, Washington, D.C.

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Oxford University Press, New York.

American Association for the Advancement of Science. (1989). *Project 2061*. Oxford University Press, New York.

International Technology Education Association (2000). *Standards for technological literacy*. International Technology Education Association

National Research Council. (1996). *National science education standards.* National Academy Press, Washington, D.C.

National Science Teachers Association. (1992). *Scope, sequence and coordination of secondary school science, vol. 1*. National Science Teachers Association, Washington, DC.

STANDARD 5.1 (SCIENTIFIC PROCESSES) ALL STUDENTS WILL DEVELOP PROBLEM-SOLVING, DECISION-MAKING AND INQUIRY SKILLS, REFLECTED BY FORMULATING USABLE QUESTIONS AND HYPOTHESES, PLANNING EXPERIMENTS, CONDUCTING SYSTEMATIC OBSERVATIONS, INTERPRETING AND ANALYZING DATA, DRAWING CONCLUSIONS, AND COMMUNICATING RESULTS.

Descriptive Statement: Students best learn science by doing science. Science is not merely a collection of facts and theories but a process, a way of thinking about and investigating the world in which we live. This standard addresses those skills that are used by scientists as they discover and explain the physical universe-skills that are an essential and ongoing part of learning science.

Strands and Cumulative Progress Indicators

By the end of Grade 4, students will:

A. Habits of Mind

1. Raise questions about the world around them and be willing to seek answers through making careful observations and experimentation.
2. Keep records that describe observations, carefully distinguish actual observations from ideas and speculations, and are understandable weeks and months later.
3. Recognize that when a science investigation is replicated, very similar results are expected.
4. Know that when solving a problem it is important to plan and get ideas and help from other people.

B. Inquiry and Problem Solving

1. Develop strategies and skills for information–gathering and problem-solving, using appropriate tools and technologies.
2. Identify the evidence used in an explanation.

C. Safety

1. Recognize that conducting science activities requires an awareness of potential hazards and the need for safe practices.
2. Understand and practice safety procedures for conducting science investigations.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Habits of Mind

1. Evaluate the strengths and weaknesses of data, claims, and arguments.
2. Communicate experimental findings to others.
3. Recognize that the results of scientific investigations are seldom exactly the same and that replication is often necessary.
4. Recognize that curiosity, skepticism, open-mindedness, and honesty are attributes of scientists.

B. Inquiry and Problem Solving

1. Identify questions and make predictions that can be addressed by conducting investigations.
2. Design and conduct investigations incorporating the use of a control.
3. Collect, organize, and interpret the data that result from experiments.

C. Safety

1. Know when and how to use appropriate safety equipment with all classroom materials.
2. Understand and practice safety procedures for conducting science investigations.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Habits of Mind

1. When making decisions, evaluate conclusions, weigh evidence, and recognize that arguments may not have equal merit.
2. Assess the risks and benefits associated with alternative solutions.
3. Engage in collaboration, peer review, and accurate reporting of findings.
4. Explore cases that demonstrate the interdisciplinary nature of the scientific enterprise.

B. Inquiry and Problem Solving

1. Select and use appropriate instrumentation to design and conduct investigations.
2. Show that experimental results can lead to new questions and further investigations.

C. Safety

1. Understand, evaluate and practice safe procedures for conducting science investigations.

STANDARD 5.2 (SCIENCE AND SOCIETY) ALL STUDENTS WILL DEVELOP AN UNDERSTANDING OF HOW PEOPLE OF VARIOUS CULTURES HAVE CONTRIBUTED TO THE ADVANCEMENT OF SCIENCE AND TECHNOLOGY, AND HOW MAJOR DISCOVERIES AND EVENTS HAVE ADVANCED SCIENCE AND TECHNOLOGY.

Descriptive Statement: Science is a human endeavor involving successes and failures, trials and tribulations. Students should know that great numbers of people from many cultures have contributed to our understanding of science and that science has a rich and fascinating history. This standard encourages students to learn about the people and events that have shaped or revolutionized important scientific theories and concepts.

Strands and Cumulative Progress Indicators

By the end of Grade 4, students will:

A. Cultural Contributions

1. Describe how people in different cultures have made and continue to make contributions to science and technology.

B. Historical Perspectives

1. Hear, read, write, and talk about scientists and inventors in historical context.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Cultural Contributions

1. Recognize that scientific theories:
   - develop over time,
   - depend on the contributions of many people, and
   - reflect the social and political climate of their time.
2. Know that scientists are men and women of many cultures who often work together to solve scientific and technological problems.
3. Describe how different people in different cultures have made and continue to make contributions to science and technology.

B. Historical Perspectives

1. Develop a time line. Describe the impact of major events and people in the history of science and technology, in conjunction with other world events.
2. Describe the development and exponential growth of scientific knowledge and technological innovations.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Cultural Contributions

1. Recognize the role of the scientific community in responding to changing social and political conditions and how scientific and technological achievement effect historical events.

B. Historical Perspectives

1. Examine the lives and contributions of important scientists who effected major breakthroughs in our understanding of the natural and designed world.
2. Discuss significant technological achievements in which science has played an important part as well as technological advances that have contributed directly to the advancement of scientific knowledge.
3. Describe the historical origin of important scientific developments such as atomic theory, genetics, plate tectonics, etc., showing how scientific theories develop, are tested, and can be replaced or modified in light of new information and improved investigative techniques.

STANDARD 5.3 (MATHEMATICAL APPLICATIONS) ALL STUDENTS WILL INTEGRATE MATHEMATICS AS A TOOL FOR PROBLEM-SOLVING IN SCIENCE, AND AS A MEANS OF EXPRESSING AND/OR MODELING SCIENTIFIC THEORIES.

Descriptive Statement: Science cannot be practiced or learned without appreciation of the role of mathematics in discovering and expressing natural laws. This standard recognizes the need for students to fully integrate mathematics skills with their learning of science.

Strands and Cumulative Progress Indicators

By the end of Grade 4, students will:

A. Numerical Operations

1. Determine the reasonableness of estimates, measurements, and computations of quantities when doing science.
2. Recognize and comprehend the orders of magnitude associated with large and small physical quantities.
3. Express quantities using appropriate number formats, such as:
   - integers.
   - fractions.

B. Geometry and Measurement

1. Select appropriate measuring instruments based on the degree of precision required.
2. Use a variety of measuring instruments and record measured quantities using the appropriate units.

C. Patterns and Algebra

1. Identify patterns when observing the natural and constructed world.

D. Data Analysis and Probability

1. Use tables and graphs to represent and interpret data.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Numerical Operations

1. Express quantities using appropriate number formats, such as:
   - decimals.
   - percents.
   - scientific notation.

B. Geometry and Measurement

1. Perform mathematical computations using labeled quantities and express answers in correctly derived units.

C. Patterns and Algebra

1. Express physical relationships in terms of mathematical equations derived from collected data.

D. Data Analysis and Probability

1. Represent and describe mathematical relationships among variables using:
   - graphs.
   - tables.
2. Analyze experimental data sets using measures of central tendency:
   - mean.
   - mode.
   - median
3. Construct and use a graph of experimental data to draw a line of best fit and identify a linear relationship between variables.
4. Use computer spreadsheets, graphing and database applications to assist in quantitative analysis of data.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Numerical Operations

1. Reinforce indicators from previous grade level.

B. Geometry and Measurement

1. When performing mathematical operations with measured quantities, express answers to reflect the degree of precision and accuracy of the input data.

C. Patterns and Algebra

1. Apply mathematical models that describe physical phenomena to predict real world events.

D. Data Analysis and Probability

1. Construct and interpret graphs of data to represent inverse and non-linear relationships, and statistical distributions.

STANDARD 5.4 (NATURE AND PROCESS OF TECHNOLOGY) ALL STUDENTS WILL UNDERSTAND THE INTERRELATIONSHIPS BETWEEN SCIENCE AND TECHNOLOGY AND DEVELOP A CONCEPTUAL UNDERSTANDING OF THE NATURE AND PROCESS OF TECHNOLOGY.

Descriptive Statement: This standard focuses on developing students' understanding of the interrelationship between science and technology. It introduces students to and expands their understanding of the nature of technology. In addition, it introduces and develops students' abilities with technological design including experiences in predicting, decision making, critical thinking, and problem solving.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Science and Technology

1. Indicators for this strand are introduced at a higher grade level.

B. Nature of Technology

1. Select and use simple tools and materials to complete a task.

C. Technological Design

1. Make a plan in order to design a solution to a problem.
2. Describe a toy or other familiar object as a system with parts that work together.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Science and Technology

1. Distinguish between things that occur in nature and those that have been designed to solve human problems.

B. Nature of Technology

1. Demonstrate how measuring instruments are used to gather information in order to design things that work properly.

C. Technological Design

1. Describe a product or device in terms of the problem it solves or the need it meets.
2. Choose materials most suitably based on their characteristics to make simple mechanical constructions.
3. Use the design process to identify a problem, look for ideas, and develop and share solutions with others.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Science and Technology

Reinforce indicators from previous grade level.

B. Nature of Technology

Reinforce indicators from previous grade level.

C. Technological Design

1. Select a technological problem and describe the criteria and constraints and criteria that are addressed in solving the problem.
2. Identify the basic components of a technological system:
   - input.
   - process.
   - output.
   - feedback.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Science and Technology

1. Compare and contrast science with technology, illustrating similarities and differences between these two human endeavors.

B. Nature of Technology

1. Analyze a product or system to determine the problem it was designed to solve, the design constraints, trade-offs and risks involved in using the product or system, how the product or system might fail, and how the product or system might be improved.

C. Technological Design

1. Recognize how feedback loops are used to control systems.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Science and Technology

1. Know that scientific inquiry is driven by the desire to understand the natural world and seeks to answer questions that may or may not directly influence humans, while technology is driven by the need to meet human needs and solve human problems.

B. Nature of Technology

1. Assess the impacts of introducing a new technology in terms of alternative solutions, costs, tradeoffs, risks, benefits and environmental impact.

C. Technological Design

1. Plan, develop, and implement a proposal to solve an authentic, technological problem.

STANDARD 5.5 (CHARACTERISTICS OF LIFE) ALL STUDENTS WILL GAIN AN UNDERSTANDING OF THE STRUCTURE, CHARACTERISTICS, AND BASIC NEEDS OF ORGANISMS AND WILL INVESTIGATE THE DIVERSITY OF LIFE.

Descriptive Statement: The study of science must include the diversity, complexity, and interdependence of life on Earth. Students should know how organisms evolve, reproduce, and adapt to their environments.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Matter, Energy and Organization in Living Systems

1. Investigate the basic needs of humans and other organisms.
2. Compare and contrast essential characteristics that distinguish living things from nonliving things.

B. Diversity and Biological Evolution

1. Recognize that different types of plants and animals live in different parts of the world.
2. Recognize that some kinds of organisms that once lived on earth have completely disappeared.

C. Reproduction and Heredity

1. Recognize that humans and other organisms resemble their parents.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Matter, Energy and Organization in Living Systems

1. Identify the roles that organisms may serve in a food chain.
2. Differentiate between the needs of plants and those of animals.
3. Recognize that plants and animals are composed of different parts performing different functions and working together for the well being of the organism.
4. Describe the basic functions of the major systems of the human body including, but not limited to:
   - digestive system
   - circulatory system
   - respiratory system
   - nervous system
   - skeletal system
   - muscular system
   - reproductive system

B. Diversity and Biological Evolution

1. Develop a simple classification scheme for grouping organisms.
2. Recognize that individuals vary within every species, including humans.

C. Reproduction and Heredity

1. Identify different stages in the lives of various organisms.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Matter, Energy and Organization in Living Systems

1. Explain how systems of the human body are interrelated and regulate the body's internal environment.
2. Identify and describe the structure and function of cells and cell parts.

B. Diversity and Biological Evolution

1. Describe and give examples of the major categories of organisms and of the characteristics shared by organisms.
2. Compare and contrast acquired and inherited characteristics in human and other species.

C. Reproduction and Heredity

1. Describe life cycles of humans and other organisms.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Matter, Energy and Organization in Living Systems

1. Explain how the products respiration and photosynthesis are recycled.
2. Recognize that complex multicellular organisms, including humans, are composed of and defined by interactions of the following:
   - cells
   - tissues
   - organs
   - systems

B. Diversity and Biological Evolution

1. Compare and contrast kinds of organisms using their internal and external characteristics.
2. Discuss how changing environmental conditions can result in evolution or extinction of a species.
3. Recognize that individual organisms with certain traits are more likely to survive and have offspring.

C. Reproduction and Heredity

1. Describe how the sorting and recombining of genetic material results in the potential for variation among offspring of humans and other species.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Matter, Energy and Organization in Living Systems

1. Relate the structure of molecules to their function in cellular structure and metabolism.

2. Explain how plants convert light energy to chemical energy.
3. Describe how plants produce substances high in energy content that become the primary source of energy for life.
4. Relate disease in humans and other organisms to infections or intrinsic failures of system.

B. Diversity and Biological Evolution

1. Explain that through evolution the Earth's present species developed from earlier distinctly different species.
2. Explain how the theory of natural selection accounts for extinction as well as an increase in the proportion of individuals with advantageous characteristics within a species.

C. Reproduction and Heredity

1. Describe how information is encoded and transmitted in genetic material.
2. Explain how genetic material can be altered by natural and/or artificial means; mutations and new gene combinations may have positive, negative, or no effect on organisms or species.
3. Assess the impact of current and emerging technologies on our understanding of inherited human characteristics.

STANDARD 5.6 (CHEMISTRY) ALL STUDENTS WILL GAIN AN UNDERSTANDING OF THE STRUCTURE AND BEHAVIOR OF MATTER.

Descriptive Statement: Exploring the nature of matter and energy is essential to an understanding of the physical universe. This standard leads students from their experiences with the states and properties of matter to the development of models of the atom and the underlying principles of chemistry.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Structure and Properties of Matter

1. Sort objects according to the materials from which they are made or their physical properties, and give a rationale for sorting.
2. Use magnifiers to observe materials, then draw and describe what more can be seen using the tools.
3. Observe that water can be a liquid or a solid and can change from one form to the other.

B. Chemical Reactions

1. Indicators for this strand are introduced at a higher grade level.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Structure and Properties of Matter

1. Sort materials based on physical characteristics that can be seen by using magnification.
2. Observe that water can be a liquid or a solid and can change from one form to the other and the mass remains the same.
3. Recognize that water, as an example of matter, can exist as a solid, liquid or gas and can be transformed from one state to another by heating or cooling.
4. Show that not all materials respond in the same way when exposed to similar conditions.

B. Chemical Reactions

1. Combine two or more materials and show that the new material may have properties that are different from the original material.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Structure and Properties of Matter

1. Recognize that about 100 different elements have been identified and most materials on Earth are made of a few of them.
2. Show that equal volumes of different substances usually have different masses.

3. Describe the properties of mixtures and solutions, including concentration and saturation.
4. Describe characteristic physical properties such as boiling point, melting point, and solubility, and recognize that the property is independent of the amount of sample.

B. Chemical Reactions

1. Recognize evidence of a chemical change.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Structure and Properties of Matter

1. Know that all matter is composed of atoms that may join together to form molecules.
2. Recognize that the phase of matter is determined by the arrangement and motion of atoms and molecules and that the motion of these particles is related to the energy of the system.
3. Know that there are groups of elements that have similar properties, including highly reactive metals, less reactive metals, highly reactive non-metals, and some almost completely non-reactive gases.
4. Recognize that a mixture often can be separated into the original substances using one of more of their characteristic physical properties

B. Chemical Reactions

1. Show how substances can chemically react with each other to form new substances having properties different from those of the original substances.
2. Show that in most chemical reactions energy is transferred into or out of a system.
3. Demonstrate that regardless how substances within a simple closed system interact, the total mass of the system remains the same.
4. Illustrate how atoms are rearranged when substances react, but that the total number of atoms and the total mass of the products remain the same as the original substances.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Structure and Properties of Matter

1. Know that atoms are made of a positive nucleus surrounded by negative electrons and that the nucleus, a tiny fraction of the volume of an atom, is composed of protons and neutrons, each almost 2,000 times more massive than an electron.
2. Know that the number of protons in the nucleus defines the element.
3. Know that an atom's electron arrangement, particularly the outermost electrons, determines how the atom can interact with other atoms.
4. Explain that atoms form bonds (ionic and covalent) with other atoms by transferring or sharing electrons.
5. Explain how the Periodic Table of Elements reflects the relationship between the properties of elements and their atomic structure.
6. Know that many biological, chemical and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.

7. Recognize that the properties of matter are related to the structure and arrangement of their molecules and atoms, such as in metallic and nonmetallic crystals and carbon compounds.
8. Know that different levels of energy of an atom are associated with different configurations of its electrons.

B. Chemical Reactions

1. Explain that the rate of reactions among atoms and molecules depends on how often they encounter one another and that the rate is affected by nature of reactants, concentration, pressure, temperature, and the presence of a catalyst.
2. Show that some changes in chemical bonds require a net input or net release of energy.

STANDARD 5.7 (PHYSICS) ALL STUDENTS WILL GAIN AN UNDERSTANDING OF NATURAL LAWS AS THEY APPLY TO MOTION, FORCES, AND ENERGY TRANSFORMATIONS.

Descriptive Statement: Basic principles of physics emerge in this standard, where the study of force and motion leads students to the concept of energy. All forms of energy are introduced and investigated, and principles of transformation and laws of conservation are developed.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Motion and Forces

1. Distinguish among the different ways objects can move such as:
   - fast and slow.
   - in a straight line.
   - in a circular path.
   - back and forth.
2. Show that the position and motion of an object can be changed by pushing or pulling the object.

B. Energy Transformations

1. Demonstrate that sound can be produced by vibrating objects.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Motion and Forces

1. Recognize that changes in the speed or direction of a moving object are caused by force and that the greater the force, the greater the change in motion will be.
2. Recognize that some forces can act at a distance.
   - gravity
   - magnetism
   - static electricity

B. Energy Transformations

1. Identify sources of heat and demonstrate that heat can be transferred from one object to another.
2. Identify sources of light and demonstrate that light can be reflected from some surfaces and pass through others.
3. Use devices that show electricity producing heat, light, sound, and magnetic effects.
4. Show that differences in sound (loud or soft, high or low) can be produced by varying the way objects vibrate.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Motion and Forces

1. Recognize that an object at rest will remain at rest and an object moving in a straight line at a steady speed will continue to move in a straight line at a steady speed unless a net (unbalanced) force acts on it.
2. Recognize that motion can be retarded by forces such as friction and air resistance.
3. Recognize that everything on or near the earth is pulled toward the earth's center by gravitational force.

B. Energy Transformations

1. Recognize that heat flows through materials or across space from warmer objects to cooler ones.
2. Show that vibrations in materials can generate waves that can transfer energy from one place to another.
3. Design an electric circuit to investigate the behavior of a system.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Motion and Forces

1. Use quantitative data to show that when more than one force acts on an object at the same time, the forces can reinforce or cancel each other producing a net (unbalanced) force that will change speed and/or direction of the object.
2. Recognize that every object exerts a gravitational force on every other object, and that the force depends on how much mass the objects have and how far apart they are.
3. Recognize that the sun is a major source of the Earth's energy and that solar energy includes visible, infrared and, ultraviolet radiation.

B. Energy Transformations

1. Recognize that the sun is a major source of the Earth's energy and that solar energy includes visible, infrared and, ultraviolet radiation.
2. Describe the nature of various forms of energy, including heat, light, sound, chemical, mechanical, and electrical and trace energy transformations from one form to another.
3. Describe how heat can be conducted through materials or transferred across space by radiation and know that if the material is a fluid, convection currents may aid the transfer of heat.
4. Show that light is reflected, refracted, or absorbed when it interacts with matter and that colors may appear as a result of this interaction.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Motion and Forces

1. Apply the mathematical relationship between the mass of an object, the net force exerted on it, and the resulting acceleration.

2. Explain that whenever one object exerts a force on another, an equal and opposite force is exerted on the first object.
3. Recognize gravity as a universal force of attraction between masses and that the force is proportional to the masses and inversely proportional to the square of the distance between them.
4. Recognize that electrically charged bodies can attract or repel each other with a force that depends upon the size and nature of the charges and the distance between them and know that electric forces play an important role in explaining the structure and properties of matter.
5. Know that there are strong forces that hold the nucleus of an atom together and that significant amounts of energy can be released in nuclear reactions (fission, fusion, and nuclear decay) when these binding forces are disrupted.
6. Explain how electromagnetic, gravitational, and nuclear forces can be used to produce energy by causing chemical, physical, or nuclear changes and relate the amount of energy produced to the nature and relative strength of the force.
7. Demonstrate that moving electric charges can produce magnetic forces and moving magnets can produce electric forces.
8. Recognize that magnetic and electrical forces are different aspects of a single electromagnetic force.

B. Energy Transformations

1. Explain how the various forms of energy (heat, electricity, sound, light) move through materials and identify the factors that affect that movement.
2. Explain that while energy can be transformed from one form to another, the total energy of a closed system is constant.
3. Recognize that whenever mechanical energy is transformed, some heat is dissipated and is therefore unavailable for use.
4. Explain the nature of electromagnetic radiation and compare the components of the electromagnetic spectrum from radio waves to gamma rays.

STANDARD 5.8 (EARTH SCIENCE) ALL STUDENTS WILL GAIN AN UNDERSTANDING OF THE STRUCTURE, DYNAMICS, AND GEOPHYSICAL SYSTEMS OF THE EARTH.

Descriptive Statement: The study of science should include a study of the planet Earth and its relationship to the rest of the universe. This standard describes what students should know about the composition of the Earth and the forces that shape it.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students:

A. Earth's Properties and Materials

1. Observe and describe rocks and soil.

B. Atmosphere and Water

1. Identify the sources and uses of water.
2. Recognize that water can disappear (evaporate) and collect on cold surfaces (condense).
3. Describe current weather conditions and recognize how those conditions affect our daily lives.
4. Describe daily and seasonal changes and patterns in the weather.

C. Processes that Shape the Earth

Indicators for this strand are introduced at a higher grade level.

D. How We Study the Earth

1. Record observations that describe the features of the natural world in their local environment.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Earth's Properties and Materials

1. Observe that most rocks and soils are made of several substances or minerals.
2. Observe that the properties of soil vary from place to place and will affect the soil's ability to support life.
3. Recognize that fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

B. Atmosphere and Water

1. Recognize that air is a substance that surrounds us, takes up space, and moves around us as wind.
2. Recognize that most of Earth's surface is covered by water and be able to identify the characteristics of those sources of water.
   - oceans
   - rivers

- lakes
- underground sources
- glaciers

3. Observe weather changes and patterns by measurable quantities such as temperature, wind direction and speed, and amounts of precipitation.
4. Observe that when liquid water disappears, it turns into a gas (vapor) in the air and can reappear as a liquid when cooled, or as a solid if cooled below its freezing point.
5. Observe that rain, snow, and other forms of precipitation come from clouds, but that not all clouds produce precipitation.
6. Recognize that clouds and fog are made of tiny droplets of water and possibly tiny particles of ice.

C. Processes that Shape the Earth

1. Recognize that some changes of the Earth's surface are due to slow processes such as erosion and weathering, and some changes are due to rapid changes such as landslides, volcanic eruptions, and earthquakes.
2. Recognize that moving water, wind, and ice continually shape the Earth's surface by eroding rock and soil in some areas and depositing them in other areas.

D. How We Study the Earth

1. Use maps to locate and identify physical features on the Earth.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Earth's Properties and Materials

Reinforce indicators from previous grade level

B. Atmosphere and Water

1. Describe the composition, circulation, and distribution of the world's oceans, estuaries, and marine environments.
2. Describe and illustrate the water cycle.

C. Processes that Shape the Earth

1. Summarize the process involved in the rock cycle and describe the characteristics of the rocks involved.

D. How We Study the Earth

1. Utilize various tools such as map projections and topographical maps to interpret features of Earth's surface.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Earth's Properties and Materials

Reinforce indicators from previous grade level.

B. Atmosphere and Water

1. Describe conditions in the atmosphere that lead to weather systems and how these systems are represented on weather maps.

C. Processes that Shape the Earth

1. Explain how Earth's landforms and materials are created through constructive and destructive processes.
2. Show how successive layers of sedimentary rock and the fossils contained in them can be used to confirm the age, history, changing life forms, and geology of Earth.

D. How We Study the Earth

1. Utilize data gathered from emerging technologies (e.g., geographic information systems (GIS) and global positioning systems (GPS)) to create representations and describe processes of change on the Earth's surface.
2. Explain how technology designed to investigate features of the Earth's surface impacts how scientists study the Earth.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Earth's Properties and Materials

1. Explain the interrelationship of the geosphere, hydrosphere, and the atmosphere.

B. Atmosphere and Water

1. Describe how weather (in the short term) and climate (in the long term) involve the transfer of energy in and out of the atmosphere.

C. Processes that Shape the Earth

1. Use the theory of plate tectonics to explain the relationship among earthquakes, volcanoes, mid-ocean ridges, and deep-sea trenches.
2. Know that Earth is a system in which chemical elements exist in fixed amounts and move through the solid Earth, oceans, atmosphere, and living things as part of geochemical cycles.
3. Recognize that the evolution of life on Earth has changed the composition of Earth's atmosphere through time.

D. How We Study the Earth

1. Analyze the evidence produced by a variety of techniques that is used to understand changes in the Earth that have occurred over time.
    - topography
    - fossils
    - rock stratification
    - ice cores
    - radiometric data

STANDARD 5.9 (ASTRONOMY and SPACE SCIENCE) ALL STUDENTS WILL GAIN AN UNDERSTANDING OF THE ORIGIN, EVOLUTION, AND STRUCTURE OF THE UNIVERSE

Descriptive Statement: The study of science should include a study of the planet Earth and its relationship to the rest of the universe. This standard describes what students should know about astronomy and space science.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Earth, Moon, Sun System

1. Recognize that the sun supplies light and heat to the Earth.
2. Observe the patterns of day and night and the movements of the shadows of an objects on the Earth during the course of a day.

B. Solar System

1. Recognize that the sun can only be seen during the day, but the moon can be seen sometimes at night and sometimes during the day.

C. Stars

1. Observe that stars are many, scattered, and different in brightness.
2. Observe that the position of the stars, with respect to each other (constellations) is unchanging.

D. Galaxies and Universe

Indicators for this strand are introduced at a higher grade level.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Earth, Moon, Sun System

1. Observe patterns that result from the Earth's position relative to the sun and rotation of the Earth on its axis.
2. Recognize and describe the phases of the moon.

B. Solar System

1. Describe Earth as one of several planets that orbit the sun and the moon as a satellite of the Earth.

C. Stars

1. Observe that stars are not all the same in brightness, size, and color.

D. Galaxies and Universe

1. Recognized that images of celestial objects can be magnified and seen in greater detail when observed using binoculars and light telescopes.

2. Observe and record short-term and long-term changes in the night sky.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Earth, Moon, Sun System

1. Explain how the motions of the Earth, sun, and moon, define units of time including:
   - days
   - months
   - years

2. Recognize that changes in the Earth's position relative to the sun produces differing amounts of daylight seasonally.

B. Solar System

1. Using models, demonstrate an understanding of the scale of the solar system that shows distance and size relationships among the sun and planets.
2. Recognize that the sun's gravitational pull holds the planets in their orbits and that the planets' gravitational pull holds their moons in their orbits.

C. Stars

1. Observe and record short-term and long-term changes in the positions of the constellations in the night sky.
2. Observe that the planets appear to change their position against the background of stars.

D. Galaxies and Universe

Reinforce indicators from previous grade level.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Earth, Moon, Sun System

1. Investigate the Earth, moon, and sun as a system and explain how the motion of these bodies results in the phases of the moon and eclipses.
2. Explain how the regular and predictable motions of the Earth and moon produce tides.
3. Explain how the tilt, rotation, and orbital pattern of the Earth relative to the sun produce seasons and weather patterns.

B. Solar System

1. Describe the physical characteristics of the planets and other objects within the solar system and compare Earth to the rest of the planets.

C. Stars

1. Understand that the sun is a star and that it shares characteristics with other stars.

D. Galaxies and Universe

1. Know that the universe consists of many billions of galaxies, each including billions of stars.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Earth, Moon, Sun System

Reinforce indicators from previous grade level.

B. Solar System

1. Explain that our solar system coalesced from a nebular cloud of gas and dust left from exploding stars.

C. Stars

1. Describe the physical characteristics, stages of development, and the apparent motions of stars.

D. Galaxies and Universe

1. Describe data gathering and observation technologies and explain how they are used to explore the solar system and beyond.
2. Cite evidence to describe the scientific theory of the origin of the universe and the current explanations of its evolution.

STANDARD 5.10 (ENVIRONMENTAL STUDIES) ALL STUDENTS WILL DEVELOP AN UNDERSTANDING OF THE ENVIRONMENT AS A SYSTEM OF INTERDEPENDENT COMPONENTS AFFECTED BY HUMAN ACTIVITY AND NATURAL PHENOMENA.

Descriptive Statement: Creating an awareness of the need to protect, conserve, and preserve natural resources is a goal of science education. This standard calls for students to develop knowledge of environmental issues, including management of natural resources, production and use of energy, waste management, and the interdependence of ecosystems.

Strands and Cumulative Progress Indicators

By the end of Grade 2, students will:

A. Natural Systems and Interactions

1. Associate organisms' basic needs with how they meet those needs within their surroundings.

B. Human Interactions and Impact

1. Identify various needs of humans that are supplied by the natural or constructed environment.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 4, students will:

A. Natural Systems and Interactions

1. Differentiate between natural resources that are renewable and those that are not.

B. Human Interactions and Impact

1. Explain how meeting human requirements affects the environment.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 6, students will:

A. Natural Systems and Interactions

1. Explain how organisms interact with other components of an ecosystem.
2. Describe the natural processes that occur over time in places where direct human impact is minimal.

B. Human Interactions and Impact

1. Describe the effect of human activities on various ecosystems.
2. Evaluate the impact of personal activities on the local environment.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 8, students will:

A. Natural Systems and Interactions

1. Investigate the impact of catastrophic events such as forest fires, floods, and hurricanes on the environment of New Jersey.

B. Human Interactions and Impact

1. Compare and contrast practices that affect the use and management of natural resources.

Building upon knowledge and skills gained in preceding grades, by the end of Grade 12, students will:

A. Natural Systems and Interactions

1. Distinguish naturally occurring process from those believed to have been modified by human interaction or activity.
   - climate change
   - ozone production
   - erosion and deposition
   - threatened and endangered species

B. Human Interactions and Impact

1. Assess the impact of human activities on the cycling of matter and the flow of energy through ecosystems.
2. Use scientific, economic, and other data to assess environmental risks and benefits associated with societal activity.