Science Consensus Curriculum
Diocese of Richmond
2006
Science Standards Introduction

Science education provides an important basis for our understanding of the world and our life in it. The skills and knowledge of science that students now can acquire are drawn from areas of inquiry where the progress of human knowledge has been especially clear and striking, and represent an enormous resource for improving American students’ individual and social well-being. It doesn’t take a rocket scientist to see the value of scientific understanding for the ordinary citizen’s life, nor does it take one to appreciate the value of having a few rocket scientists. The science standards provide sound guidance for both those students who need a practical understanding of how nature works and those who may eventually choose to pursue scientific learning for loftier purposes.

The National Science Education Standards demand that science is an active process.

“Learning science is something that students do, not something that is done to them. ‘Hands-on’ activities, while essential, are not enough. Students must have ‘minds-on’ experiences as well. The Standards call for more than ‘science as process,’ in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills” (NSES, 1996).

Teachers should use multiple teaching and assessment strategies to develop student understandings, and promote active learning and inquiry.

This curriculum guide provides:

- Diocesan and national science content standards
- best practices for instruction
- ideas for alternative assessments
- helpful Internet resources
- sample lesson plans that encourage active learning
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Best Instructional Practices

Teachers should use the diocesan standards as their primary guide for planning the content of instruction. Science textbooks are merely one tool among many that teachers have to assist in instructional planning. Refer to page 65 of this document for helpful Internet sites, and use the strategies outlined below to promote active, productive learning.

Promoting Active Learning in the Science Classroom

- Take students to a science lab as often as possible. Primary teachers can often coordinate with middle school and/or high school teachers to use their labs periodically.
- Conduct experiments following the scientific method and identifying the steps beginning in pre-K.
- Do demonstration experiments when supplies are limited or materials are too dangerous for student handling. Get a lab coat – look like a scientist!
- Use journals to record predictions, observations, results, etc in the scientific method format for each experiment and investigation done in the classroom or lab throughout the year.

General Instructional Strategies that Promote Active Learning

- **Question, All Write**: Ask all students to write answers to questions before giving an answer or calling on one student. White erase boards are an excellent tool for this strategy if you have several questions to ask.
- **Outcome Sentences**: Ask students to reflect on an experience and write endings to such phrases as “I learned. . .”; “I was surprised. . .”
- **Sharing Pairs**: Ask students to pair up and share thoughts on a question or topic. For younger students you can assign each partners on a clock face at the beginning of the year. Then each time you need to assign sharing partners, simply say share with your 3 o’clock partner or with your 9 o’clock partner. Pre-set partners will allow you to use this strategy more often and for just a few minutes at a time.
- **Whip Around, Pass Option**: Ask a group of students each to take a turn responding to a question, or if they prefer, to say, “I pass.” Works great when there are multiple answers to a question.
- **Choral Work**: Flash a series of cards/pictures to which a class can respond in unison.
- **Voting**: Ask questions to which students can respond by raising hands or giving another non-verbal clue.
- **Experience Before Concepts**: Give students a meaningful experience of a concept before talking about it abstractly.
- **Socratic Method**: Ask pairs or groups of students to discuss opposing views especially in regards to scientific and technological advancements and their benefits/challenges to society.
- **Cooperative Learning**: Kagan Cooperative Learning Structures are an excellent resource for promoting cooperative learning in the classroom. “Kagan's structures not only lead to greater cooperativeness; they have proven positive results in many areas, including greater academic achievement, improved ethnic relations, enhanced self-

- **Multiple Intelligences:** Gearing activities for varied multiple intelligences can get more students involved in learning. For an excellent resource to get you started visit http://www.kaganonline.com/Catalog/index.html.

Alternative Assessments

Assessment should be an on-going process, not just conducted through an end-of-unit test, culminating project or performance task. Informal assessments are critical for checking student understandings. Such feedback should direct your instruction. Altering lesson plans to provide additional discussion, modeling, practice, observation, etc. will foster greater success for your students. Using alternative assessments, not just paper-pencil test/quizzes, will provide a deeper insight into students’ understandings.

Rubrics are an excellent tool to evaluate alternative assessment products and performances. A rubric is a criterion-based scoring guide consisting of a fixed measurement scale and descriptions of the characteristics for each score point. Rubrics describe degrees of quality, proficiency, or understanding along a continuum. Sample rubrics and resource web sites are provided on pages 65 and 98 of this document.

- **Exit Card:** On an index card, have students answer a question, work a problem, draw a picture, make a Venn diagram, etc. that relates to the concept taught on a given day.
- **Analogy prompt:** On an index card, have students write an analogy. (Designated concept, principle, or process) is like ____________ because ______________.
- **Misconception Check:** Present students with a problem that is solved incorrectly or an incorrect concept explanation and ask them to determine if the solution/explanation is correct or incorrect and why.
- **Visual Representation:** Ask students to create a web, concept map, flow chart, time line, KWL chart, etc. to show the elements or components of a topic or process.
- **Question Box or Board:** Establish a location (question box, bulletin board, e-mail address) where students may leave or post questions about concepts, principles, or processes that they do not understand. (This technique may be helpful to those students who are uncomfortable admitting publicly that they do not understand.)
- **Observation Checklist:** Create a checklist for your class where you record your observations of each student’s work or verbal explanations.
- **Authentic Performance Tasks:** Create a complex challenge that mirrors the issues and problems faced by adults. These tasks will yield a product and/or performance.
- **Models:** Students build models to show a concept or system. Modeling the solar system, a DNA molecule, or a plant cell are examples of science related models.
- **Mock Interview:** Have students to partner and present a mock interview with a scientist about a given topic. Both students will work together to write the interview questions and answers, then one student will play the role of interviewer and the other the interviewee.
- **Journals and Portfolios:** Journals work well for science inquiry. Portfolios are collections of work that students manage themselves. Portfolios work best when students must explain their selections and respond to the work either verbally or in written form.
- **Self Evaluation:** Give students prompts to self assess their own understandings.
- **Technology Based Products:** Technology provides numerous avenues for students to demonstrate learning: Power Point presentations, Excel tables, charts and graphs, digital movies, Podcasts, etc.

General Teacher Guidelines

PRE-KINDERGARTEN

Earth and Space Science

- Describe daily weather conditions.
- Distinguish between day and night.
- Identify the sun as an object in the daytime sky and the moon in the night sky.
- Recognize the four seasons of the year and characteristics of each.

Life Science

- Identify parts of the human body.
- Identify the five senses.
- Identify the parts of the body used to see, smell, hear, taste, and touch.
- Distinguish between living and non-living things.
- Identify adult animals and their offspring.

Science as Inquiry

- Make simple predictions and use experiments to find results.

Physical Science

- Demonstrate that some things sink or float in water.
- Demonstrate that magnets attract some metal objects.
- Demonstrate that wind makes things move.
- Describe and classify objects by their physical properties (color, size, shape).
- Demonstrate how blocking the light forms shadows.

Environmental Science

- Demonstrate that we must protect God’s world.
- Know that air and water need to be clean and healthy for all living things.
- Recognize that paper comes from trees and that humans depend on trees to breathe.
Historical Perspectives

- Demonstrate an awareness of extinct species.
- Recognize that technology as we know it today did not always exist.

Science and Technology

- Recognize an astronaut as a person who travels in space.
- Recognize the use of tools such as telescopes, binoculars, and magnifying glasses.
- Recognize computers as a tool to learn about science.

Personal and Social Perspectives

- Recognize that good nutrition, rest, exercise, and cleanliness are necessary to stay healthy.
- Germs that cannot be seen can make us ill.
- Identify ways of preventing illnesses.
- Identify poisons that can make you sick.
- Identify community helpers and their jobs.

Ethical/Moral Perspectives

- Recognize awareness of God as Creator of the Earth and all living things on it.
- Recognize that people need to be respectful and care for the Earth and all living things.
- Recognize that God is a part of everything in our world.
KINDERGARTEN

Earth and Space Science

- Identify and record daily weather data. Concepts may include:
  - weather vocabulary:
    - warm
    - sunny
    - cool
    - cloudy
- Relating weather trends to seasonal changes.
- Name the four seasons and list some characteristics of each.
- Identify landforms such as hills, mountains, and valleys.
- Identify lakes, rivers, and oceans as bodies of water.
- Recognize that the sun, moon, stars, and other objects in the sky have properties, locations, and movements that can be observed and described.
- Recognize the sun as a source of light and heat necessary to maintain the temperature of the earth.
- Recognize sun, moon, and stars as part of the solar system.
- Recognize that Earth materials are solids, liquids, and gases.

Life Science

- Identify and explain the functions of various body parts.
- Identify the five senses and how they relate to the parts of the body.
- Describe how objects feel, smell, etc.
- List things as living or non-living
- Investigate the basic needs of living things. Concepts may include:
  - food
  - shelter
  - water
  - air
- Recognize plants as living things.
- Know that plants grow and produce new plants.
- Sort seeds by similarities and differences.
- Match foods to the plants that produce them.
- Classify animals by their similar characteristics.
- Explain the different characteristics of an animal’s body covering.
- Match adult animals to their offspring.
- Explain how animals protect themselves from danger.
- Describe ways in which people use animals for food and clothing.
Science as Inquiry

- Conduct investigations in which basic properties of objects are identified through observation and classification. Concepts may include:
  - Identifying the basic properties of objects by direct observation
  - Sequencing a set of objects according to size
  - Separating a set of objects into two groups based on a single physical attribute
  - Constructing picture graphs using ten or fewer units
  - Using non customary units (A child’s foot or paper clip) to measure common objects
  - Predicting an unseen member in a sequence of objects
  - Developing questions from one or more observations
  - Describe objects both pictorially and verbally
  - Recognize usual or unexpected results in an activity or experiment
- Measure and record changes in an experiment.

Physical Science

- Compare and contrast objects. Concepts may include:
  - colors
  - textures
  - relative size and position in space
  - comparison of solids, liquids, and gases
- Explore the properties of matter. Concepts may include:
  - color
  - shape
  - size
  - mass
- Demonstrate and compare the capacity of containers.
- Identify the properties of water during water play activities. Concepts may include:
  - Prediction (predicting if an item will sink or float).
  - The natural flow of water downhill
  - The different forms of water (solid, liquid, and gas)
- Demonstrate examples of pushes and pulls
- Describe how magnets work
- Identify sources of heat and light
- Identify six rainbow colors
- Recognize that wind makes things move
- Demonstrate that a light source can make shadows and that shadows occur when an object blocks light
Environmental Science

- Identify things that pollute air, land, and water.
- List ways to take care of the Earth.
- Recognize that materials can be reduced, reused and recycled.
- Identify different types of environments: desert, ocean, mountainous, etc.
- Sort animals by their home environments.

Historical Perspectives

- Describe how animals become extinct (dinosaurs).
- Recognize that advances in technology change the way we live.
- Recognize that technology did not always exist and is ever changing.

Science and Technology

- Identify some science-related careers (astronaut, meteorologist, computer researcher, etc).
- Recognize tools that scientists use. Concepts may include:
  - rulers
  - scales
  - microscopes
  - magnifying glasses
- Recognize that computers are tools that may be used to learn more about science.

Personal and Social Perspectives

- List health and safety habits and responsibilities.
  - Excellent opportunity to invite a doctor, dentist, nutritionist, etc. to the classroom.
- Explain good nutrition and healthy habits of rest, exercise, and cleanliness.
- Identify dangers associated with natural disasters.
- Recognize the universal sign for poison and that poisons can make people sick.

Ethical/Moral Perspectives

- Recognize that God made the Earth and all living things on it.
- Recognize that people need to be respectful and care for the Earth and all living things.
- Recognize that God is a part of everything in this world.
Earth and Space Science

☐ ____ Investigate and understand the basic relationship between the sun and the Earth. Concepts may include:
  o The sun is the source of heat and light that warms the land, air, and water
  o Night and day are caused by the rotation of the Earth
  o Explain how a shadow occurs
  o Explain how seasonal changes and weather affect plants, animals, and people

☐ ____ Demonstrate the effects of gravity.

☐ ____ Observe and describe the properties of the sun and the moon, their locations, and patterns of movement.

☐ ____ Identify some different physical properties of earth materials (size, shape and mass).

Life Science

☐ ____ Identify the basic characteristics and needs of the human body.

☐ ____ Name the five senses and how we use them.

☐ ____ Observe and classify objects as living, non-living, and plant or animal.

☐ ____ Compare and contrast the characteristics and needs of living things. Concepts may include:
  o Needs: nutrients, water, a place to grow
  o Physical characteristics: shape, size, and locomotion
  o Classify animals according to one or more properties
  o Relationship of offspring to parent
  o Seasonal adaptations, hibernation, camouflage, and migration
  o Match animals to their habitats

☐ ____ Identify parts of plants and their functions. Concepts may include:
  o Needs of plants:
    • air
    • water
    • light
    • nutrients and a place to grow
  o Functions:
    • growth
    • reproduction

☐ ____ Observe the sequential life cycles of plants: seeds, roots, stems, leaves, flowers, seeds (life cycle).
Science as Inquiry

- Recognize that scientific investigation is a process.
- Create questions for simple investigations. Plan and conduct investigations which may include:
  - Using the senses and simple instruments
  - Using simple graphs, pictures, written statements, and numbers
- Predict possible outcomes/results. Predictions are based on patterns of observation rather than random guesses.
- Utilize the five senses during scientific investigation.

Physical Science

- Describe the physical properties of solids, liquids, and gasses.
- Classify objects by observable properties.
- Experiment with the force of magnetism.
- Develop an understanding that the position of an object can be described by locating it relative to another object or to the ground.
- Discover that the position and motion of objects can be changed by pushing or pulling and that the size of the change is related to the strength of the push or pull.
- Discover that sound is produced by vibrating objects.

Environmental Science

- Identify and discuss the ways living things affect and are affected by the environment. Concepts may include:
  - Climate, weather, availability of basic needs
  - Use and conservation of resources, both renewable and non-renewable
  - Pollution of land and water
- Investigate and understand that natural resources are limited. Concepts may include:
  - Identification of natural resources (plants, animals, water, air, land, minerals, forests, and soil)
  - Factors that affect air and water quality
  - Use of land as parks and recreational facilities
- Identify ways to preserve and protect our environment. Concepts may include:
  - Reducing, reusing and recycling
  - Recognize the significance of Earth Day

Historical Perspectives

- Identify famous scientists and their accomplishments. Scientists may include:
  - Nicholas Copernicus (solar system)
  - Galileo (telescope)
Science and Technology

- _____ Identify simple machines and how they help us.
- _____ Demonstrate how technology can be used to answer scientific questions.
  - o Recognize the Internet as a source to explore scientific questions
  - o Investigate scientific information utilizing computer software
- _____ Interpret how technology is used in daily life to make people more comfortable and their lives easier.

Personal and Social Perspectives

- _____ Describe dangerous weather conditions and appropriate safety precautions.
- _____ Recognize the role of humans as caretakers of the Earth.
- _____ Explain and practice good nutrition and healthy habits of rest, exercise and cleanliness.

Ethical/Moral Perspectives

- _____ Recognize the beauty of God’s creation and describe ways to treat it with respect.
- _____ Demonstrate respect for all living creatures.
GRADE 2

Earth and Space Science

☐ _____ Identify the characteristics of the Earth, objects in space, and their changing natures. Concepts may include:
  o Compare and contrast the different types of landforms
  o Describe weather by measurable quantities (such as temperature, wind, direction)
  o Observe and describe the properties, locations, and movements of objects in the sky such as stars and clouds (color, shape, size, motion)

☐ _____ Describe how the varied physical and chemical properties of earth materials are useful to humans as resources.

Life Science

☐ _____ Compare and contrast the basic needs of living things.
☐ _____ Classify living things according to specific characteristics. Concepts may include:
  o animals as meat eaters (carnivore)
  o animals as plant eaters (herbivore)
☐ _____ Observe that habitats change over time due to many influences. Concepts may include:
  o Recognize how habitat changes affect organisms
☐ _____ Identify similarities and differences of organisms in a food chain.
☐ _____ Investigate and understand that animals go through a series of changes in their life cycles. Concepts may include:
  o Living things change in an orderly way as they grow
  o The pattern of change from birth to death is called the life cycle
  o Some animals (frogs and butterflies) go through distinct stages in their life cycles while others do not
☐ _____ Investigate and understand that plants go through a series of orderly changes in their life cycles. Concepts may include:
  o Flowering plants undergo many changes from the formation of flower to the development of fruit
☐ _____ Investigate and understand that living things are part of a system. Concepts may include:
  o Living organisms are interdependent with their living and nonliving surroundings
Science as Inquiry

Q _____ Demonstrate the process of scientific investigation.
Q _____ Make predictions and conduct investigations which may include:
   - Observations repeated to improve accuracy
   - Use of two or more attributes to classify items
   - Construction of pictures and bar graphs to illustrate data
   - Construction of simple physical models
   - Measure and compare using different instruments

Physical Science

Q _____ Identify and investigate the physical properties of objects and materials.
   Concepts may include:
   - Objects are made of one or more materials
   - Materials are composed of parts that are too small to be seen without magnification
Q _____ Describe energy and the motion of objects.
Q _____ Investigate the properties of light. Concepts may include:
   - Light travels in a straight line until it strikes an object
   - Colors are a part of the visible spectrum
   - Mirrors reflect light
Q _____ Explore and discover the properties of magnets. Concepts may include:
   - Magnets attract some metals (iron and steel), but do not attract non-metals
   - Magnets may be different shapes (horseshoe, bar, rod, ring)
   - Some magnets are stronger than others
   - All magnets have a north and south pole
   - Like poles repel and unlike attract
Q _____ Explore, create, and separate mixtures, using common materials, methods and tools:
   Concepts may include:
   - Interaction of substances with water: food coloring, oil, salt, sand, and gravel
   - Substances dissolve better in warm water than in cold water
   - Some substances change the way water acts (soap, detergent)
   - Mixtures can be separated: gravel and sand or sugar and rice (using a strainer), salt and water (by evaporation)
Q _____ Investigate and understand basic properties of solids, liquids, and gasses.
   Concepts may include:
   - Processes involved with changes in matter from one state to another (condensation, evaporation, melting, freezing, expanding, and contracting)
Environmental Science

- Demonstrate the need to care for our resources and environment.
- Recognize how pollution can change human/animal habitats.
- Recognize substances and conditions which lead to weathering and erosion of land.
- Identify toxic materials that contribute to the destruction of our natural resources (air, water, soil).
- Identify consequences and benefits of human intervention upon the environment (air, water, soil).
- Investigate plants as a source of oxygen, food, and other useful byproducts and the benefits these byproducts provide in nature. Concepts may include:
  - Important plant products (fiber, cotton, oil, spices, lumber, rubber, medicines, and paper)
  - Plants provide homes and food for many animals and prevent soil erosion.

Historical Perspectives

- Identify famous scientists and their accomplishments and explain how their contributions affect our lives. Scientists may include:
  - Louis Pasteur (bacteria)
  - Robert Koch (germs and disease)
  - Alexander Fleming (penicillin)
- Recognize how scientific advances have changed our world.
- Compare and contrast today’s animals and plants with fossil records to learn more about the history of life on Earth.

Science and Technology

- Use “hands-on” activities and discover information about the world around us by using scientific equipment.
- Discuss how people benefit from current and past technological advances.
- Recognize the use of the Internet to explore scientific ideas.

Personal and Social Perspectives

- Identify the ways that scientific knowledge can be used to help living things.
- Identify ways to keep our bodies healthy. Concepts may include:
  - Good nutrition, cleanliness, exercise and sleep.

Ethical/Moral Perspectives

- Explain the need to respect and care for all of God’s creation.
- Recognize life as a gift from God.
GRADE 3

Earth and Space Science

- Identify the position of the sun, moon, planets, and stars in the solar system.
- Demonstrate how the sun provides the light and heat necessary to maintain the temperature of the earth.
- Compare and classify rocks as igneous, metamorphic, and sedimentary.
- Explain the relationship between rocks and minerals.
- Describe weather by measurable quantities (such as wind speed and precipitation).
- Identify the ways weathering and erosion can occur.

Life Science

- Identify the components of the ecosystem, which assist in the survival of organisms. Concepts may include:
  - types of ecosystems
  - living and non-living
  - components of the ecosystems
  - water
  - dry land
- Explain how living things change through their lifetime and how they live, grow and reproduce. Concepts may include:
  - care of young
  - hibernation
  - habitat
  - behaviors (innate and learned)
- Explain how living things interact with each other and the environment. Concepts may include:
  - food chains
  - food web
  - predator-prey relationships
- Explain what may happen if a link is broken in a food chain.

Science as Inquiry

- Demonstrate the process of scientific investigations.
- Make predictions and conduct investigations which may include:
  - Observations repeated to improve accuracy
  - Use of two or more attributes to classify items
  - Construction of graphs to illustrate data
Construction of models

- Demonstrate the use of scientific instruments.
- Demonstrate an understanding of the metric system when measuring.

Physical Science

- Investigate an object’s physical properties. Concepts may include:
  - color
  - phase of matter
  - size
  - mass
  - volume
- Investigate simple machines. Concepts may include:
  - types of simple machines in the school and home
  - how simple machines function
- Investigate and demonstrate the characteristics of moving objects. Concepts may include:
  - forces cause a change in motion
  - friction—a force that opposes motion
  - how motion is described by distance and time
- Investigate and understand different sources of energy such as: the sun, water, wind, fossil fuels, electricity, and nuclear power.
- Demonstrate the use of magnification tools. Concepts may include:
  - use of magnifying glass
  - microscope
  - telescope

Environmental Science

- Identify consequences of pollution and specific ways of taking preventative measures.
- Identify consequences and benefits of human intervention upon the environment (air, water, and soil).
- Explain why water is our most important resource.
- Discuss ways in which toxic materials contribute to the destruction of our natural resources (air, water, and soil).

Historical Perspectives

- Compare and contrast techniques used by scientists both past and present for gathering data.
- Recognize the ways in which science has affected human life.
- Identify and evaluate contributions of scientists. Scientists may include:
  - Nicholas Copernicus (solar system)
  - Isaac Newton (gravity)
Science and Technology

- _____ Identify scientific discoveries that have led to the creation of technological devices.
- _____ Use the Internet to explore scientific ideas.

Personal and Social Perspectives

- _____ Identify the consequences of natural disasters on living things.
- _____ Identify ways to keep our bodies healthy. Concepts may include:
  - good nutrition
  - cleanliness
  - exercise
  - sleep habits

Ethical/Moral Perspectives

- _____ Demonstrate an awareness of God as creator of all things and man’s responsibility to care for God’s creation.
- _____ Recognize the sanctity of human life.
GRADE 4

Earth and Space Science

- Investigate and understand the Earth in relationship to the moon, sun and other planets. Comparisons may include relative size, position, age and makeup.
- Describe the rotation and the revolution of the Earth
- Explain the causes of the Earth’s seasons
- Compare physical properties of fresh and salt water.
- Explain differences between atmosphere, hydrosphere, and lithosphere.
- Describe the water cycle. (precipitation, evaporation, and condensation)

Life Science

- Compare and contrast different environments and habitats. Concepts may include:
  - desert
  - fresh water
  - salt water
  - tropical environments
- List animal and plant adaptations that enable them to live in different environments.
- Demonstrate the understanding of anatomy, classification, and life processes of plants. Concepts may include:
  - typical plant structure
  - reproduction of plants
  - photosynthesis

Science as Inquiry

- Demonstrate the process of scientific investigations by classifying, sorting, estimating, predicting, observing, experimenting, and hypothesizing.
- Use tools to measure experimental data.

Physical Science

- Recognize the different forms of energy. Concepts may include:
  - electrical
  - mechanical
  - chemical
  - potential
  - kinetic
- Demonstrate an understanding that energy is needed to do work.
- Define and explain friction and inertia.
- List the characteristics of electricity and magnetism. Concepts may include:
static electricity
current electricity
circuits
magnetic fields

☐ Describe properties, structure and changes in matter (solid, liquid, gas)
☐ Demonstrate how heating and cooling can change the different states of a material.

Environmental Science

☐ Demonstrate how plants and animals interact in an ecosystem.
☐ Compare and contrast between the living and non-living parts of an ecosystem.
☐ Specify ways to conserve natural resources.

Historical Perspectives

☐ Compare and contrast scientific discoveries of the Colonial period to present day.
☐ Explain how fossils record changes in the Earth and the organisms that inhabit it.
☐ Identify and evaluate contributions of scientists. Scientists may include:
  o Michael Faraday (electricity)
  o Anton Van Leeuwenhoek (microscope)

Science and Technology

☐ Research and report using available technology.
☐ Investigate how new technology affects scientific progress.

Personal and Social Perspectives

☐ Investigate important natural resources and man's use of them.
☐ Demonstrate the need to keep our bodies healthy including proper eating, exercising and proper health habits.
☐ Identify and use safe lab procedures.
☐ List ways to prepare for natural disasters.

Ethical/Moral Perspectives

☐ Discuss Catholic beliefs in relationship to science topics including being good stewards of the Earth.
☐ Discuss the importance of respecting mind, body, and spirit.
GRADE 5

Earth and Space Science

☐ _____ Develop an understanding of the earth and the solar system as a set of coupled systems.
☐ _____ Construct a model that explains the visual and physical relationships between earth, sun, moon, and the solar system.
☐ _____ Recognize and describe the motions and characteristics of the planets and other members of the solar system.
☐ _____ Identify the phases of the moon and their relationship to ocean tides
☐ _____ Identify the four major interacting components of the Earth: geosphere, hydrosphere, atmosphere, biosphere.
☐ _____ Identify the layers of the Earth associated with its formation.
☐ _____ Identify and sequence geologic eras and concepts.
☐ _____ Identify the characteristics of the Earth. Concepts may include:
  - the distribution of land and sea
  - features of the crust
  - the composition of the atmosphere
  - global climate
  - populations of living organisms in the biosphere
☐ _____ Explore the plate tectonic theory and its relationship to the movement of the Earth’s crust and how major geological events (earthquakes, volcanoes, and mountain building) result from these motions.
☐ _____ Plot the locations of volcanoes and earthquakes to illustrate a pattern of geological activity and how this pattern may help to predict them.
☐ _____ Identify how landforms are the result of constructive and destructive forces.
☐ _____ Demonstrate an understanding of the water cycle.
☐ _____ Summarize the processes of weathering, erosion, and deposition.
☐ _____ Identify and explain forms of energy provided by the Earth.
☐ _____ Identify and describe the different types of fronts and the weather conditions associated with each.

Life Science

☐ _____ Explain that all living organisms are made up of cells.
☐ _____ Differentiate between one-celled organisms and many celled organisms.
☐ _____ Compare and contrast animal and plant cells.
☐ _____ Identify the basic parts of cells (nucleus, cytoplasm, and cell membrane).
☐ _____ Illustrate the progression from cells to an organism, emphasizing that each cell, tissue, and organ has a distinct structure and set of functions.
☐ _____ List and define the living kingdoms.
☐ _____ Compare and contrast vertebrates and invertebrates.
☐ _____ Identify the sun as the major source of energy in an ecosystem, and how energy passes from organism to organism in a food web.
a. Identify abiotic and biotic resources and their effect on ecosystems
b. Identify the relationships between producers, consumers, and decomposers in an ecosystem

☐ _____ Classify and illustrate the basic body systems, and explain how these systems interact with one another.

**Physical Science**

☐ _____ Define matter, its states, and properties: elements, compounds, boiling point, melting point, and solubility, etc.
☐ _____ Recognize that atoms are the building blocks of matter, and are always in motion.
☐ _____ Recognize the organization of the periodic table.
☐ _____ Compare and contrast physical and chemical properties of matter.
☐ _____ Recognize that energy is transferred in many ways. Concepts may include:
  - heat-moving from warmer to cooler objects
  - light-refraction and reflection
  - chemical changes
  - mechanical motion
  - sun
  - sound
  - electricity
  - nuclei

**Science as Inquiry**

☐ _____ Identify, plan, and execute a scientific investigation through systematic observation, make accurate measurements, and identify controlling variables.
☐ _____ Select and use appropriate tools to make quantitative observations.
☐ _____ Interpret data and communicate results utilizing different kinds of charts and graphs.

**Environmental Science**

☐ _____ Evaluate effects of pollution on the environment.
☐ _____ Recognize that environment health includes establishing or monitoring quality standards related to use of soil, water, and air.
☐ _____ Compare and contrast renewable and nonrenewable resources.
Historical Perspectives

- Identify and analyze the contributions of scientists. Scientists may include:
  - Albert Einstein (theory of relativity)
  - J. J. Thomson (atoms)
  - Niels Bohr (atoms)
  - Carolus Linnaeus (classification – plants/animals)
  - Robert Brown (nucleus of a cell)
  - Alfred Wegener (continental drift)
  - Dmitry Mendeleev (periodic table)

- Compare and contrast past and present issues in science.

Science and Technology

- Recognize that technology provides tools for investigation, inquiry, and analysis.
- Identify the relationship between science and technology.
- Utilize technology resources for research.
- Report scientific findings using available technology.

Personal and Social Perspectives

- Identify and illustrate ways to keep the body healthy.
- Describe the effects of tobacco and alcohol on the body.
- Identify and use safe lab practices.

Ethical/Moral Perspectives

- Discuss the ethical treatment of living organisms in our environment.
- Articulate the importance of respecting mind, body, and spirit.
- Determine how human activities (good and bad) change the environment.
GRADE 6
GENERAL SCIENCE

Earth and Space Science

☐ _____ Describe the rock cycle.
☐ _____ Describe the phases of the moon and their effects on the Earth.
☐ _____ Describe the factors affecting the weather on the Earth.
☐ _____ The student will investigate and understand the organization of the solar system and the relationships among the various bodies that comprise it. Concepts may include:
  o the sun, moon, Earth, other planets and their moons, meteors, asteroids, and comets
  o relative size of and distance between planets
  o the role of gravity
  o revolution and rotation
  o the mechanics of day and night and the phases of the moon
  o the unique properties of Earth as a planet
  o the relationship of the Earth’s tilt and the seasons
  o the cause of tides

Life Science

☐ _____ Explore the various traits of organisms, such as diversity and adaptation. Concepts may include:
  o producer
  o consumer
  o decomposer
  o food webs
  o food chains

☐ _____ Investigate reproduction, heredity, and genetics. Concepts may include:
  o dominant genes
  o recessive genes
  o Punnett squares
  o blending

Science as Inquiry

☐ _____ Plan and conduct investigations. Concepts may include:
  o observations involving close examination of objects and organisms
  o develop classification systems based on multiple attributes
  o record precise and approximate measurements
use scale models to estimate distance, volume, and quantity
state hypotheses in ways that identify the independent (manipulated) and dependent (responding) variables
develop a method to test the validity of predictions and inferences
collect, record, analyze, and report data using appropriate metric measurements
data are organized and communicated through graphical representation (graphs, charts, and diagrams)
design models to explain a sequence
an understanding of the nature of science is developed and reinforced

Utilize a variety of means to communicate scientific findings. Concepts may include:
- lab reports
- data sheets
- visuals

Differentiate between scientific laws and theories.

**Physical Science**

Recognize matter is made up of atoms. Concepts may include:
- atoms are made up of electrons, protons, and neutrons
- atoms of any element are alike but are different from atoms of other elements
- elements are represented by chemical symbols
- two or more atoms may be chemically combined
- compounds are represented by chemical formulas
- chemical equations are used to model chemical changes
- a limited number of elements comprise the largest portion of the solid Earth

Identify different forms of energy and explain how they are transferred. Concepts may include:
- potential and kinetic energy
- the role of the sun in the formation of most energy sources on Earth
- energy transfer (heat/light to mechanical, chemical and electrical energy)
- nonrenewable energy sources (fossil fuels including petroleum, natural gas, and coal)
- renewable energy sources (wood, wind, hydroelectric, geothermal, tidal, and solar)

Investigate matter. Concepts may include:
- states of matter
- physical and chemical properties and changes
☐ ____ Introduce and investigate the uses of the periodic table.
☐ ____ Demonstrate an understanding of the basic principles of electricity and magnetism.

**Environmental Science**

☐ ____ Explore how human activities can affect the environment.
☐ ____ Identify non-renewable and renewable resources and their management.
☐ ____ Explore cost/benefit of conservation policies.
☐ ____ Analyze environmental issues related to air, land and water.
☐ ____ Explain how various toxic substances affect the body. Concepts may include:
  - acid rain
  - smog

**Historical Perspectives**

☐ ____ Identify scientific advancements that contribute to the quality of human life.
☐ ____ Evaluate the contributions of significant people in history through their inventions or theories. Scientists may include:
  - Gregor Mendel (genetics)
  - Edwin Hubble (galaxies)
  - Dmitry Mendeleev (periodic table)
  - Hans Christian Oersted (electromagnetism)
  - Charles Darwin (survival of the fittest)
☐ ____ Relate how various scientists in history affected the control of disease.

**Science and Technology**

☐ ____ Recognize the effect space exploration has on the development of technology.
☐ ____ Recognize scientific advancements made possible by technology.

**Personal and Social Perspectives**

☐ ____ Examine public policy decisions relating to the environment.
☐ ____ Explore science-related career options.
☐ ____ Explain current events in the field of science and determine their possible effects on society.
☐ ____ Use safe practices in the lab.

**Ethical/Moral Perspectives**

☐ ____ Appraise the order and beauty of all God’s creation.
☐ ____ Examine the need for moral and ethical solutions to problems.
☐ ____ Explain science in relationship to Catholic morals and beliefs.
☐ ____ Demonstrate respect for life by proper handling and care of all living things.
GRADE 7
LIFE SCIENCE

The Science Curriculum in this grade is a Seventh Grade Requirement. This Program is the minimum expectation for this grade level. All must complete this course to complete the Curriculum for Total Education in our Elementary Schools. (Pre-K through Grade 8)

Life & Environmental Science

- Discuss various theories of the origin of life. Concepts may include:
  - spontaneous generation
  - biogenesis
- Investigate and understand that organisms change over time. Concepts may include:
  - the relationships of mutation, adaptation, natural selection, and extinction
  - evidence of evolution of different species in the fossil record
  - how environmental influences, as well as genetic variation can lead to diversity of organisms
- Define, classify, and describe the basic characteristics of the kingdoms of living organisms. Concepts may include:
  - viruses, eubacteria, archeobacteria, fungi, plants, protists, animals
  - dichotomous key
  - binomial nomenclature
- Define and explain the life processes and needs. Concepts may include:
  - use of energy
  - growth and development
  - ability to adapt
  - respiration
  - reproduction
  - response to stimuli
- Recognize a model of DNA.
- Construct and interpret the cell model. Hands-on activities may include observation of the following:
  - cell wall
  - nucleus
  - cell processes
  - respiration
  - cell membrane
  - organelles
  - osmosis
  - mitosis and meiosis
  - cell theory
cell specialization

Describe the utilization of matter and energy in the life process. Concepts may include:
- organic compounds of carbohydrates, proteins and lipids
- cellular respiration
- growth, cellular repair
- locomotion

Define and explain the process of photosynthesis and the role of the plant in the environment. Concepts may include:
- reactants
- products
- carbon dioxide–oxygen cycle
- role in ecosystems
- catalyst
- producer

Investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Concepts may include:
- the carbon, water, and nitrogen cycles
- interactions resulting in a flow of energy and matter throughout the system
- complex relationships within terrestrial, freshwater, and marine ecosystems
- energy flow in food webs and food chains

Investigate and understand that interactions exist among members of a population. Concepts may include:
- competition, cooperation, social hierarchy, territorial imperative
- influence of behavior on a population

Investigate and understand interactions among populations in a biological community. Concepts may include:
- the relationships among producers, consumers, and decomposers in food webs
- the relationship between predators and prey
- competition and cooperation
- symbiotic relationships
- niches

Investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Concepts may include:
- differences between ecosystems and biomes
- characteristics of land, marine, and freshwater ecosystems
- adaptations that enable organisms to survive within a specific ecosystem

Investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time (daily, seasonal, and long term). Concepts may include:
- phototropism, hibernation, and dormancy
Factors that increase or decrease population size
- Eutrophication, climate changes, and catastrophic disturbances

Investigate and understand the relationships between ecosystem dynamics and human activity. Concepts may include:
- Food production and harvest
- Change in habitat size, quality, or structure
- Change in species competition
- Population disturbances and factors that threaten or enhance species survival
- Environmental issues (water supply, air quality, energy production, and waste management)

Identify the major organs and systems of the human body. Concepts may include:
- Respiratory
- Nervous
- Excretory
- Musculoskeletal
- Circulatory
- Digestive
- Endocrine
- Reproductive

Science as Inquiry

Plan and conduct investigations in which:
- Data are organized into tables showing repeated trials and means
- Variables are defined
- Metric units (SI—International System of Units) are used
- Models are constructed to illustrate and explain phenomena
- Sources of experimental error are identified
- Dependent variables, independent variables, and constants are identified
- Variables are controlled to test hypotheses, and trials are repeated
- Continuous line graphs are constructed, interpreted, and used to make predictions
- Predictions are made and tested
- Interpretations from a set of data are evaluated and defended
- An understanding of the nature of science is developed and reinforced
**Historical Perspectives**

- Illustrate the history of the development of technological advancements used in scientific research.
- Research various scientists and their contributions to the scientific field.
  - Scientists may include:
    - Gregor Mendel (genetics)
    - Walter Flemming (mitosis)
    - Wilhelm Roetgen (x-rays)
    - Luc Montagnier & Robert Gallo (HIV/AIDS)
    - Charles Darwin (survival of the fittest)
    - James Watson and Francis Crick (DNA)

**Science and Technology**

- Research and report on various scientific topics that have advanced due to technology.
- Use a database file that will store and retrieve scientific information.
- Recognize the advances and limitations of technology in science.
- Distinguish between technology advances in different societies and their effects on different communities and groups within those societies.

**Personal and Social Perspectives**

- Investigate interaction among the populations in a biological community.
- Investigate the relationships between ecosystem dynamics and human activity.

**Ethical/Moral Perspectives**

- Develop values, which lead to the ethical treatment of organisms in our environment.
- Relate our understanding of the world to God and the gifts we have been given by him.
- Document the relationship between science and Catholic morality and doctrine.
- Analyze and demonstrate knowledge of science related issues and present a Catholic vision. Concepts may include:
  - genetics
  - stem cells research
  - cloning
The Science Curriculum in this grade is an Eighth Grade Requirement. This Program is the minimum expectation for this grade level. All must complete this course to complete the Curriculum for Total Education in our Elementary Schools. (Pre-K through Grade 8)

Science as Inquiry

- Plan and conduct investigations that may include:
  - Chemicals and equipment are used safely
  - Length, mass, volume, density, temperature, weight, and force are accurately measured and reported using metric units (SI—International System of Units)
  - Conversions are made among metric units, applying appropriate prefixes
  - Triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and spring scales are used to gather data
  - Numbers are expressed in scientific notation where appropriate
  - Research skills are utilized using a variety of resources
  - Independent and dependent variables, constants, controls, and repeated trials are identified
  - Data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted
  - Data tables for descriptive statistics showing specific measures of central tendency, the range of the data set, and the number of repeated trials are constructed and interpreted
  - Valid conclusions are made after analyzing data
  - Research methods are used to investigate practical problems and questions
  - Experimental results are presented in appropriate written form
  - An understanding of the nature of science is developed and reinforced

Physical Science

- Investigate and explain the forms of matter and energy, and discuss the relationship of each with reference to the kinetic theory. Concepts may include:
- solid, liquid, gas, and plasma
- melting, freezing, boiling, evaporation, condensation, and sublimation
- melting point, freezing point, and boiling point
- latent heat of vaporization
- absolute zero

- Investigate and identify the characteristics of the classes of matter. Concepts may include:
  - elements, compounds, and mixtures
  - acids, bases, and salts
  - solutions and suspensions/colloids
  - organic and inorganic

- Investigate, classify and identify physical and chemical properties of matter. Concepts may include:
  - physical properties: shape, density, color, odor, boiling point, melting point, solubility
  - chemical properties: acidity, basicity, pH, combustibility, reactivity

- Investigate and explain physical changes of matter. Concepts may include:
  - effect of temperature
  - effect of particle size on solubility
  - formation of a suspension
  - effect of temperature on solubility (saturated, supersaturated solutions)

- Investigate and explain chemical changes of matter using the theory of conservation of matter and energy. Concepts may include:
  - evidence of reaction
  - reactants and products
  - type of reaction
  - balanced chemical equations

- Research and discuss nuclear changes in matter using the theory of conservation of matter and energy. Concepts may include:
  - fusion and fission
  - products of nuclear reactions
  - effects on humans and the environment
  - alternative energy sources

- Construct and explain models that illustrate the structures of the atom. Concepts may include:
  - nucleus, proton, neutrons, electrons
  - Bohr model and electron cloud model (modern model of the atom)
  - ions
  - isotopes
  - the historical development of atomic theory (including Dalton, Thomson, Rutherford, and Bohr)
☐ _____ Obtain and explain information from the Periodic Table of Elements. Concepts may include:
  o symbol
  o atomic number and atomic mass
  o chemical families (groups) and periods
  o metals, non-metals, inert gases
  o oxidation number
  o synthetic elements

☐ _____ Analyze the periodic table of elements and develop correct inferences regarding elements and binary compounds. Concepts may include:
  o chemical activity
  o formulas for compounds
  o nature of bonding (ionic, covalent)
  o physical properties
  o names of compounds

☐ _____ Define and explain work. Concepts may include:
  o power
  o force
  o horsepower
  o simple machines and complex machines
  o mechanical advantage

☐ _____ Understand the basic principles of force and motion. Concepts may include:
  o force
  o acceleration
  o velocity and speed
  o gravity, friction, and centripetal force
  o projectiles
  o Newton’s Laws of Motion

☐ _____ Use of ratios required to establish the derived units applicable to forces, motion and work. Concepts may include:
  o kg-m
  o joule
  o Newton

☐ _____ Define and explain energy states and energy forms. Concepts may include:
  o energy states – kinetic and potential energy
  o forms of energy: heat, mechanical, electrical, sound, light, nuclear, and chemical energy

☐ _____ Investigate how energy is transferred, transformed, and utilized. Concepts may include:
  o conduction, convection, and radiation
  o energy transformations: kinetic to potential, potential to kinetic, chemical to electrical, heat to light
  o law of conservation of energy (energy is not created or destroyed)

☐ _____ Investigate and explain the basic characteristics of light. Concepts may include:
  o wave behavior of light
- the electromagnetic spectrum
- color
- reflection and refraction
- diffraction
- interference

☐ Investigate and explain the basic characteristics of mechanical waves. Concepts may include:
  - longitudinal (compression) waves, transverse waves
  - reflection and refraction
  - reverberation, resonance, and interference
  - sound waves

☐ Investigate and explain the characteristics and technological applications of electricity and magnetism. Concepts may include:
  - attraction and repulsion
  - alternating and direct current
  - static electricity
  - magnetic fields and magnetic field lines
  - series and parallel circuits
  - generators
  - motors
  - appliances
  - electronics
  - computers

**Historical Perspectives**

☐ Document the history of various technological advances.
☐ Trace the history of the periodic table.
☐ Research various scientists and their contributions to the scientific field.

Scientists may include:
  - Newton (laws of motion)
  - Galileo (law of falling bodies)
  - Dmitry Mendeleev (periodic table)
  - Manhattan Project Scientists (atomic bomb)
  - Marie and Pierre Curie (radioactive materials)
Science and Technology

- Define and describe science and technology and how they are related to one another.
- Recognize the limitations of technology in science and understand advances.

Ethical/Moral Perspectives

- Relate one’s understanding of the world to God and the gifts which have been given by him.
- Document the relationship between science and Catholic morality and doctrine.
- Analyze and demonstrate knowledge of science related issues and present a Catholic vision. Concepts may include:
  - nuclear energy
  - toxic waste disposal
HIGH SCHOOL
EARTH SCIENCE

Geochemical Cycles

Geology

☐ _____ Classify and identify rock-forming minerals. Concepts may include:
   ○ Physical and chemical properties
   ○ Uses of minerals
☐ _____ Investigate and identify common rock types. Concepts may include:
   ○ Mineral compositions and textures
   ○ Rock cycle

Oceanography and Meteorology

☐ _____ perform investigations relating to the complex, interactive, physical,
chemical, biological, and geological systems of the oceans.
☐ _____ explain biogeochemical relationships within the ocean (rocks, living
things, water)
☐ _____ Long and short term variations in the oceans and atmosphere. Concepts
may include:
   ○ Physical and chemical changes
   ○ Tectonic processes
   ○ Climate and weather

Origin and Evolution of the Earth System

Astronomy

☐ _____ Investigate the principal theory for the origin of the Earth. Concepts may
include:
   ○ Solar nebular theory
   ○ Accretion of Earth
   ○ other solar system bodies and
   ○ the resulting properties of those bodies

Geology

☐ _____ Investigate the evolution of the geosphere. Concepts may include:
   ○ Density stratification
   ○ Tectonic processes (plate interactions, faulting, folding,
     volcanism, metamorphism)
- Surface processes (weathering, erosion, deposition, sedimentation)
- Paleontology and historical geology
- Relative and absolute age dating
- Superposition, cross-cutting relationships
- Fossils (index)
- Radioactive decay
- Paleoclimatology
- VA geology

**Oceanography and Meteorology**

- Investigate the evolution of the atmosphere and oceans.
  - Current theories concerning the origin of the first atmosphere
  - Evidence for atmospheric changes over geologic time
  - Effects of early life on the ocean and atmosphere
  - Compositional changes of atmosphere and oceans due to human, biologic, and geologic activity

**Energy in the Earth System**

* Astronomy, Oceanography, Geology, and Meteorology *

- Analyze how science explains and predicts the interactions and dynamics of complex Earth systems
- Investigate and understand that energy transfer between the sun and Earth and how this drives weather and climate on Earth. Concepts may include:
  - Observation and collection of weather data
  - Prediction of weather patterns
  - Weather phenomena and the factors affect climate
  - System interactions
  - Atmosphere
  - Oceans
    - Physical and Chemical changes in the environment (examples: tides, salinity, sea level, heat flow)
- Explain how the processes of convection play a role in the movement of material in the mantle, atmosphere, and oceans.
Origin and Evolution of the Universe

Astronomy

☐ _____ Investigate cosmology and the origin of stars and galaxies. Concepts may include:
  ○ Big Bang
  ○ Solar nebular theory

Geology and Meteorology

☐ _____ Investigate the planets of the solar system and their moons, and compare them to Earth.
☐ _____ Investigate the minor members of the solar system (comets, meteors, asteroids, dwarf planets, etc.)

Science and Technology

☐ _____ Recognize the impact of new technologies on scientific discovery
☐ _____ Use tools to collect, analyze, and report data. Tools may include:
  ○ Spreadsheets
  ○ Internet
  ○ Probeware
☐ _____ Interpret and construct scales, diagrams, maps, charts, graphs, tables, etc. as pertain to earth science topics.
☐ _____ Use of math as a tool in science. Concepts may include:
  ○ Calculate rate, concentration, density
  ○ Perform unit conversions within metric system and between English and metric
  ○ Gradient
  ○ Describe technology available to study earth science concepts and identify the advantages and disadvantages of its use
  ○ Recall the history and contributions of the space program

Historical Perspectives

Geology and Astronomy

☐ _____ Investigate the recorded history of Earth and space science, including major scientists and their contributions.
☐ _____ Recognize the tentative nature of science and how scientific knowledge evolves over time.
☐ _____ Review the role of the Church through history in both supporting and inhibiting science thought.
☐ _____ Understand the geologic time scale and identify major events through time. Concepts may include:
  o Formation of Earth
  o Evolution of oceans and atmosphere
  o Origin of life

Science as Inquiry

☐ _____ Recognize scientific knowledge as the description of nature and the natural laws.
☐ _____ Explore the surrounding world (make observations, inferences)
☐ _____ Conduct scientific inquiry activities. Concepts may include:
  o Controls
  o Variables
  o Sensors
  o Data collection
☐ _____ Identify, understand, and use scientific methods.
☐ _____ Recognize that there are many ways to facilitate discovery, including:
  o chance
  o accident
  o observation, hypothesis, tests, analysis, explanation

Ethical and Moral Perspectives

☐ _____ Discuss the legitimate role of science in solving societal problems/issues in earth and space science. Concepts may include:
  o Environmental stewardship
  o Resources
  o Global climate change

Personal and Social Perspectives

☐ _____ Discuss the legitimate role of science in answering difficult questions of nature within the realm of earth and space science. Concepts may include:
  o Cosmology
  o Earth history

Personal and Social Perspectives

☐ _____ Recognize human impacts on natural systems.
☐ _____ Investigate and understand the differences between renewable and non-renewable resources.
☐ _____ Investigate possible career opportunities in Earth and Space Science.
☐ _____ Recognize and demonstrate individual responsibility for environmental decision.
BIOLOGY

Science and Technology

- Evaluate the impacts of new technologies, discoveries, and achievements. Concepts may include:
  - The application, benefits, and risks of:
    - genetic engineering
    - cloning
    - stem cell research
- Demonstrate competence in the use of appropriate equipment for scientific investigation. Appropriate tools may include:
  - Spreadsheets
  - Internet
  - Probeware
  - Microscopes
- Interpret and construct scales, diagrams, maps, charts, graphs, tables, etc. as pertain to biology topics.
- Use of math as a tool in science. Concepts may include:
  - Calculate rate, gradient, concentration
  - Perform unit conversions within metric system and between English and metric

Matter, Energy, and Organization in Living Systems

- Investigate the energy transfer between the Sun, Earth, and living organisms.
  - Photosynthesis
  - Cellular respiration
- Describe the importance of energy to living things.
- Analyze energy flow within and between living systems.
  - Describe the structure and function of the ATP molecule
  - Summarize ATP-ADP cycle
- Demonstrate the energy flow through different levels of organization of living systems such as cells, organs, organisms, and communities.

Cells

- Identify cell sources.
- Explain the development of cell theory.
- Compare and contrast prokaryotic and eukaryotic cells.
- Explain and diagram the events of the cell cycle.
  - Interphase
  - Mitosis
  - Cytokinesis
☐ _____ Describe the structure and function of the cell and its parts including:
  o Cell membrane
  o Nucleus
  o Organelles
☐ _____ Identify energy requirements of the specific organelles.
☐ _____ Identify factors that limit cell size.
☐ _____ Compare and contrast the different levels of organization of living things.
☐ _____ Describe the formation and function of organic and inorganic substances in cells
  and organisms.
☐ _____ Compare and contrast plant and animal cells.

Molecular Basis of Heredity

☐ _____ Understand the basic principles of human genetics.
☐ _____ Recognize the structure and function of DNA.
☐ _____ Apply Mendel’s Principles of Genetics to the inheritance of traits.
☐ _____ Evaluate the roles and implications of the structure and function of DNA and
  RNA.

Biological Evolution

☐ _____ Describe the basis of the modern classification system.
☐ _____ Classify organisms into kingdoms based on their characteristics.
☐ _____ Evaluate evidence for theories on the origin of life.
☐ _____ Explain natural selection and analyze its evolutionary consequences.
☐ _____ Enumerate the logical sequences of Darwinian evolution based on modern
  genetics.
☐ _____ Explore the history and evolution of life on Earth.

Comparative Anatomy and Physiology

☐ _____ Compare and contrast the structure and function of a range of organisms, including
  human beings.
☐ _____ Discuss human health issues and associated life functions.

Historical Perspective

☐ _____ Apply the nature of science to the history of biology and biological research.
☐ _____ Identify the contributions of modern biologists to modern society and the
  significance of each. Examples may include: Watson and Crick.
Ethical and Moral Perspectives

- Discuss the similarities and differences of certain aspects of modern biology and Catholic morality and beliefs. Concepts may include:
  - stem cell research
  - cloning
  - genetic engineering

Interdependence of Organisms

- Recognize the geological and biological formation of ecosystems and the relationships within and among them.
- Recognize the interaction among ecosystems and evaluate the processes involved and the consequences of these interactions.
- Identify the cycles in the biosphere and energy flow through ecosystems.
- Construct food chains, food webs and food pyramids and describe the role of each level.
- Describe the relationship of organisms to ecosystems and the effects of population growth.
- Explain the relationship of populations to their habitat.
- Document the behavior of organisms and ways in which their behavior contributes to survival.
- Compare and contrast biotic and abiotic environmental factors.

Personal and Social Perspectives

- Explore the role of medicine and pathogens in personal and community health.
- Define the role of personal responsibility for conservation of natural resources and environmental quality.
- Assess the role of biology and associated technology in local, national, and global challenges.
- Investigate possible careers in the field of biological science.

Science as Inquiry

- Demonstrate the mastery of the skills of observation and measurement necessary to do scientific inquiry through laboratory experience.
- Compare, contrast, and implement different scientific methods used in laboratories.
- Conduct scientific inquiry activities. Concepts may include:
  - controls
  - variables
  - sensors
  - data collection
CHEMISTRY

Science and Technology

☐ _____ Describe the impact of technology on the field of chemistry and chemical engineering.
☐ _____ Apply technology in the chemistry classroom.
☐ _____ Recognize the role of technology and chemistry in modern society.

Chemical Reactions

☐ _____ Explain conservation of energy/mass and their importance to chemistry.
☐ _____ Define matter, energy, and forms of energy and understand the transformation of energy in chemical reactions.
☐ _____ Define factors affecting rates of chemical reactions.
☐ _____ Identify and discuss the role of catalysts and enzymes.
☐ _____ Understand enthalpy, entropy, and free energy and use them to determine the spontaneity of a reaction.
☐ _____ Define equilibrium and identify factors that affect chemical equilibrium.

Structure and Properties of Matter

☐ _____ Identify, describe, and define properties of solids, liquids, gases, and plasma in terms of kinetic theory.
☐ _____ Understand and use gas laws to determine the relationships between pressure, volume, temperature, and number of moles.
☐ _____ Explain how elements combine to form molecules, compounds, and mixtures.
☐ _____ Compare and contrast elements, mixtures, solutions and compounds.
☐ _____ Identify and explain processes involved in chemical bonding.
☐ _____ Produce written valid chemical formulas and balanced chemical equations.
☐ _____ Recognize the mole and perform calculations using the mole concept.
☐ _____ Describe the properties of acids and bases.

Structure of Atoms

☐ _____ Define the structure of the atom and identify the components which determine the properties of materials.
☐ _____ Describe the composition of matter at the molecular, atomic and subatomic levels.
☐ _____ Explain the basis for the arrangement of the modern periodic table.
☐ _____ Understand the periodic properties exhibited in the arrangement of the modern periodic table.
☐ Use the periodic table as a tool to investigate the structural properties of atoms, including average atomic mass, mass number, atomic number, isotopes, ions, and electron configuration.
☐ Know the chemical behavior and nuclear stability of isotopes and their applications
☐ Define and discuss radioactivity, nuclear stability, rates, half-life, and types of decay and cite examples of applications of radioactivity.

Historical Perspectives

☐ Identify and describe the events that occurred and the scientists involved in the advancement of chemistry.
☐ Describe the historical impact of chemistry on the world and examine how this knowledge has been expanded and modified as further research has been done.
☐ Describe early attempts at classifying elements.
☐ Recognize scientific knowledge as the description of nature and the natural laws.

Ethical and Moral Perspectives

☐ Describe the ethical and moral implications of efforts by chemists as they pertain to Catholic morality and beliefs.
☐ Describe the individual and corporate responsibility to provide safety in relationship to the environment.

Science as Inquiry

☐ Apply the scientific method to chemical experiments in a laboratory setting.
☐ Master the skills of observation and measurement necessary to do scientific inquiry through laboratory experience.
☐ Practice laboratory techniques used by chemists.
☐ Design and execute a research project, which demonstrates mastery of the scientific method.

Personal and Social Perspectives

☐ Recognize and analyze the positive and negative impacts of humans and the field of chemistry have on community health, natural resources, changes in the environment, and world societies.
☐ Investigate possible careers in the field of chemistry.
☐ Assess the role of chemistry and technology in local, national and global challenges.
PHYSICS

Science and Technology

☐ Analyze the differences and relationships among: physics, technology, research, development and engineering.
☐ Explore the historical and current roles and contributions of science and technology.

Conservation of Energy

☐ Investigate, understand and predict the transference and transformation of energy from one form of energy (kinetic, potential, electromagnetic, thermal, gravitational, chemical and nuclear) to another.
☐ Apply the law of conservation of energy.
☐ Investigate, predict and calculate the transformation of energy into work.
☐ Determine the efficiency of machines.
☐ Investigate, understand and determine the mechanical equivalent of thermal energy, chemical energy, electromagnetic energy, chemical energy and nuclear energy.

Motions and Forces

☐ Investigate Newton’s Laws of Motion and the Universal Law of Gravitation through examination, calculation and prediction.
☐ Investigate Kepler’s Laws of Planetary Motion through examination, calculation, and prediction.
☐ Calculate the relationship among mechanical work, power, energy and efficiency as related to objects in motion.
☐ Calculate, predict and apply the impact of frictional forces (static, starting and rolling) on moving systems.
☐ Apply the concepts of kinetic and potential energy.
☐ Apply the concepts of thrust and momentum (linear and angular) coupled with elastic and inelastic collisions to predict resulting motion.
☐ Investigate and apply the Law of Conservation of Momentum.
☐ Recognize the concepts of the interrelationships among the effects of mechanical, electromagnetic, atomic and nuclear forces.
☐ Apply the laws governing wave motion and wave properties.
☐ Recognize transnational and rotational kinematics.
☐ Investigate and understand the relationships among mass, distance, force and time through mathematical and experimental processes.
☐ Recognize the limitations of Newtonian physics.
Interaction of Energy and Matter

- Investigate and describe properties of fluids.
- Investigate and understand Archimedes’, Bernoulli’s, and Pascal’s Principles.
- Apply the concepts of wave theory to the nature, characteristics, properties and calculations of all types of waves.
- Investigate and explain images produced by lenses and mirrors.
- Demonstrate conceptual understanding of the historical development of quantum-Electro Dynamics and its application.
- Compare and contrast the interrelationships between magnetic and electric forces.
- Investigate and diagram basic electrical circuits and explain the function of various components.

Historical Perspectives

- Recognize and appreciate the historical development of physics concepts and laws.
- Demonstrate an understanding of the capabilities and limitation to the “scientific method” employed by early physicists and mathematicians.
- Recognize the scientific method as an essential step of progress to modern society.

Ethical and Moral Perspectives

- Observe and appreciate the orderliness and predictability of physical phenomena.
- Evaluate the principles of physics in relationship to Catholic morality and beliefs.

Science as Inquiry

- Employ the scientific method to conduct investigating of natural phenomena.
- Define and utilize components of the investigated system.
- Select appropriate instruments and tools to collect, record, and integrate data.
- Master the skills of observation and measurement necessary to do scientific inquiry through laboratory experience.
- Design and execute a research project which demonstrates mastery of the scientific method.
Personal and Social Perspectives

- _____ Demonstrate appreciation using physics and technology in the solution of individual, environmental and societal challenges.
- _____ Recognize the use of physics and technology in local, national, and global challenges.
- _____ Evaluate the impact and application of scientific advances on society.
- _____ Apply developing knowledge to educational and career decisions.
Reference
Materials
Benchmarks for Science Literacy

These standards and benchmarks are based on *Benchmarks for Science Literacy*, a publication of the AAAS’s Project 2061, which offers recommendations for what all American students should know and be able to do. Project 2061’s publications – especially *Science for All Americans* – present a unified and coherent picture of expectations for student learning in the natural sciences, social sciences, mathematics, and technology and include several different products designed to strengthen standards-based science education.

**Habits of Mind**

1. Students will be aware of the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.
2. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
3. Students will be able to use tools and instruments for observing, measuring, and manipulating objects in scientific activities.
4. Students will be able to use the ideas of system, model, change, and scale in exploring scientific and technological matters.
5. Students will be able to communicate scientific ideas and activities clearly.
6. Students will be able to question scientific claims and arguments effectively.

**The Nature of Science**

7. Students will be familiar with the character of scientific knowledge and how it is achieved.
8. Students will understand important features of the process of scientific inquiry.

**The Physical Setting**

9. Students will be familiar with current scientific views of the universe and how those views evolved.
10. Students will understand how the position and motion of the earth in the solar system determine seasons and phases of the moon, and know how key features of the earth influence climate and weather.
11. Students will be familiar with the scientific view of how the earth’s surface is formed and how that view came about.
12. Students will be familiar with the scientific view of the nature of matter and with how that view evolved.
13. Students will be familiar with the forms and transformations of energy and with the significance of energy in understanding the structure of matter and the universe.
14. Students will be familiar with the wave nature of sound and electromagnetic radiation, and understand the relationship between force, mass, and the motion of objects.
15. Students will recognize gravitational, electrical, and magnetic forces as major kinds of forces acting in nature.

The Living Environment

16. Students will be aware of the diversity of living organisms and how they can be compared scientifically.
17. Students will understand how biological traits are passed on to successive generations.
18. Students will be familiar with the structure, functions, and reproduction of living cells.
19. Students will be aware of the dependence of all organisms on one another and their environments.
20. Students will understand the cycling of matter and the flow of energy through systems of living things.
21. Students will be familiar with the evolution of life on earth and understand the arguments for natural selection as a scientific explanation of biological evolution.

Human Organisms and Society

22. Students will be aware of the biological, cultural, and social explanations for why human beings have important traits in common yet differ from one another.
23. Students will be familiar with important aspects of human development from fertilization to death.
24. Students will understand the basic functions of the human body.
25. Students will be familiar with what influences learning in human beings.
26. Students will understand how diet, exercise, disease and toxic substances influences the physical health of individuals.
27. Students will be aware of physiological and cultural factors that affect individuals’ mental health.
28. Students will be familiar with how groups, cultural beliefs, and social settings individual behavior.

Technology and Its Applications

29. Students will understand how technologies are developed and used to investigate and change the world.
30. Students will understand how technology shapes social, cultural, economic, and ecological aspects of human life and has influenced history.
31. Students will be familiar with important aspects of the agricultural and manufacturing revolutions.
32. Students will be familiar with the various sources of energy and with their uses and conservation.
33. Students will understand the nature of information and communications technologies and their impact on human life.
34. Students will be aware of the advantages and limitations of health technologies and the social and moral issues they raise.
Teaching Standard A:
Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- Develop a framework of yearlong and short-term goals for students.
- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.
- Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.
- Work together as colleagues within and across disciplines and grade levels.

Teaching Standard B:
Teachers of science guide and facilitate learning. In doing this, teachers

- Focus and support inquiries while interacting with students.
- Orchestrate discourse among students about scientific ideas.
- Challenge students to accept and share responsibility for their own learning.
- Recognize and respond to student diversity and encourage all students to participate fully in science learning.
- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.

Teaching Standard C:
Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers

- Use multiple methods and systematically gather data about student understanding and ability.
- Analyze assessment data to guide teaching.
- Use student data, observations of teaching, and interactions with colleagues to reflect on and improve teaching practice.
- Use student data, observations of teaching, and interactions with colleagues to report student achievement and opportunities to learn to students, teachers, parents, policy makers, and the general public.

Teaching Standard D:
Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers
➢ Structure the time available so that students are able to engage in extended investigations.
➢ Create a setting for student work that is flexible and supportive of science inquiry.
➢ Ensure a safe working environment.
➢ Make the available science tools, materials, media, and technological resources accessible to students.
➢ Identify and use resources outside the school.
➢ Engage students in designing the learning environment.

**Teaching Standard E:**
Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

➢ Display and demand respect for the diverse ideas, skills, and experiences of all students.
➢ Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community.
➢ Nurture collaboration among students.
➢ Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.
➢ Model and emphasize the skills, attitudes, and values of scientific inquiry.

**Teaching Standard F:**
Teachers of science actively participate in the ongoing planning and development of the school science program. In doing this, teachers

➢ Plan and develop the school science program.
➢ Participate in decisions concerning the allocation of time and other resources to the science program.
➢ Participate fully in planning and implementing professional growth and development strategies for themselves and their colleagues.
PROFESSIONAL DEVELOPMENT STANDARDS

Professional Development Standard A:
Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. Science learning experiences for teachers must

- Involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding.
- Address issues, events, problems, or topics significant in science and of interest to participants.
- Introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge.
- Build on the teacher's current science understanding, ability, and attitudes.
- Incorporate ongoing reflection on the process and outcomes of understanding science through inquiry.
- Encourage and support teachers in efforts to collaborate.

Professional Development Standard B
Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching. Learning experiences for teachers of science must

- Connect and integrate all pertinent aspects of science and science education.
- Occur in a variety of places where effective science teaching can be illustrated and modeled, permitting teachers to struggle with real situations and expand their knowledge and skills in appropriate contexts.
- Address teachers' needs as learners and build on their current knowledge of science content, teaching, and learning.
- Use inquiry, reflection, interpretation of research, modeling, and guided practice to build understanding and skill in science teaching.

Professional Development Standard C:
Professional development for teachers of science requires building understanding and ability for lifelong learning. Professional development activities must

- Provide regular, frequent opportunities for individual and collegial examination and reflection on classroom and institutional practice.
- Provide opportunities for teachers to receive feedback about their teaching and to understand, analyze, and apply that feedback to improve their practice.
- Provide opportunities for teachers to learn and use various tools and techniques for self-reflection and collegial reflection, such as peer coaching, portfolios, and journals.
- Support the sharing of teacher expertise by preparing and using mentors, teacher advisers, coaches, lead teachers, and resource teachers to provide professional development opportunities.
➢ Provide opportunities to know and have access to existing research and experiential knowledge.
➢ Provide opportunities to learn and use the skills of research to generate new knowledge about science and the teaching and learning of science.

**Professional Development Standard D:**
Professional development programs for teachers of science must be coherent and integrated. Quality pre-service and in-service programs are characterized by

➢ Clear, shared goals based on a vision of science learning, teaching, and teacher development congruent with the National Science Education Standards.
➢ Integration and coordination of the program components so that understanding and ability can be built over time, reinforced continuously, and practiced in a variety of situations.
➢ Options that recognize the developmental nature of teacher professional growth and individual and group interests, as well as the needs of teachers who have varying degrees of experience, professional expertise, and proficiency.
➢ Collaboration among the people involved in programs, including teachers, teacher educators, teacher unions, scientists, administrators, policy makers, members of professional and scientific organizations, parents, and business people, with clear respect for the perspectives and expertise of each.
➢ Recognition of the history, culture, and organization of the school environment.
➢ Continuous program assessment that captures the perspectives of all those involved, uses a variety of strategies, focuses on the process and effects of the program, and feeds directly into program improvement and evaluation.
SCIENCE ASSESSMENT STANDARDS

Assessment Standard A:
Assessments must be consistent with the decisions they are designed to inform.

- Assessments are deliberately designed.
- Assessments have explicitly stated purposes.
- The relationship between the decisions and the data is clear.
- Assessment procedures are internally consistent.

Assessment Standard B:
Achievement and opportunity to learn science must be assessed.

- Achievement data collected focus on the science content that is most important for students to learn.
- Opportunity-to-learn data collected focus on the most powerful indicators.
- Equal attention must be given to the assessment of opportunity to learn and to the assessment of student achievement.

Assessment Standard C:
The technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation.

- The feature that is claimed to be measured is actually measured.
- Assessment tasks are authentic.
- An individual student's performance is similar on two or more tasks that claim to measure the same aspect of student achievement.
- Students have adequate opportunity to demonstrate their achievements.
- Assessment tasks and methods of presenting them provide data that are sufficiently stable to lead to the same decisions if used at different times.

Assessment Standard D:
Assessment practices must be fair.

- Assessment tasks must be reviewed for the use of stereotypes, for assumptions that reflect the perspectives or experiences of a particular group, for language that might be offensive to a particular group, and for other features that might distract students from the intended task.
- Large-scale assessments must use statistical techniques to identify potential bias among subgroups.
- Assessment tasks must be appropriately modified to accommodate the needs of students with physical disabilities, learning disabilities, or limited English proficiency.
- Assessment tasks must be set in a variety of contexts, be engaging to students with different interests and experiences, and must not assume the perspective or experience of a particular gender, racial, or ethnic group.
Assessment Standard E:
The inferences made from assessments about student achievement and opportunity to learn must be sound.

➢ When making inferences from assessment data about student achievement and opportunity to learn science, explicit reference needs to be made to the assumptions on which the inferences are based.
Science as Inquiry

**Content Standard A:**
As a result of activities in grades K-4, all students should develop

- Abilities necessary to do scientific inquiry.
- Understanding about scientific inquiry.

Physical Science

**Content Standard B:**
As a result of the activities in grades K-4, all students should develop an understanding of

- Properties of objects and materials.
- Position and motion of objects.
- Light, heat, electricity, and magnetism.

Life Science

**Content Standard C:**
As a result of activities in grades K-4, all students should develop understanding of

- The characteristics of organisms.
- Life cycles of organisms.
- Organisms and environments.

Earth and Space Science

**Content Standard D:**
As a result of their activities in grades K-4, all students should develop an understanding of

- Properties of earth materials.
- Objects in the sky.
- Changes in earth and sky.

Science and Technology

**Content Standard E:**
As a result of activities in grades K-4, all students should develop

- Abilities of technological design
- Understanding about science and technology.
- Abilities to distinguish between natural objects and objects made by humans.

Science in Personal and Social Perspectives

**Content Standard F:**
As a result of activities in grades K-4, all students should develop understanding of
History and Nature of Science

**Content Standard G:**
As a result of activities in grades K-4, all students should develop understanding of

- Science as a human endeavor.

**SCIENCE CONTENT STANDARDS: 5-8**

Science as Inquiry

**Content Standard A:**
As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry.
- Understandings about scientific inquiry.

Physical Science

**Content Standard B:**
As a result of their activities in grades 5-8, all students should develop an understanding of

- Properties and changes of properties in matter.
- Motions and forces.
- Transfer of energy.

Life Science

**Content Standard C:**
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems.
- Reproduction and heredity.
- Regulation and behavior.
- Populations and ecosystems.
- Diversity and adaptations of organisms.
Earth and Space Science

**Content Standard D:**
As a result of their activities in grades 5-8, all students should develop an understanding of

- Structure of the earth system.
- Earth's history.
- Earth in the solar system.

Science and Technology

**Content Standard E:**
As a result of activities in grades 5-8, all students should develop

- Abilities of technological design.
- Understandings about science and technology.

Science in Personal and Social Perspectives

**Content Standard F:**
As a result of activities in grades 5-8, all students should develop understandings of

- Personal health.
- Populations, resources, and environments.
- Natural hazards.
- Risks and benefits.
- Science and technology in society.

History and Nature of Science

**Content Standard G:**
As a result of activities in grades 5-8, all students should develop understanding of

- Science as a human endeavor.
- Nature of science.
- History of science.

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**SCIENCE CONTENT STANDARDS: 9-12**

Science as Inquiry

**Content Standard A:**
As a result of activities in grades 9-12, all students should develop

- Abilities necessary to do scientific inquiry.
- Understandings about scientific inquiry.

Physical Science

**Content Standard B:**
As a result of their activities in grades 9-12, all students should develop an understanding of:

- Structure of atoms.
- Structure and properties of matter.
- Chemical reactions.
- Motions and forces.
- Conservation of energy and increase in disorder.
- Interactions of energy and matter.

**Life Science**

**Content Standard C:**
As a result of their activities in grades 9-12, all students should develop understanding of:

- The cell
- Molecular basis of heredity.
- Biological evolution.
- Interdependence of organisms.
- Matter, energy, and organization in living systems.
- Behavior of organisms.

**Earth and Space Science**

**Content Standard D:**
As a result of their activities in grades 9-12, all students should develop an understanding of:

- Energy in the earth system.
- Geochemical cycles.
- Origin and evolution of the earth system.
- Origin and evolution of the universe.

**Science and Technology**

**Content Standard E:**
As a result of activities in grades 9-12, all students should develop:

- Abilities of technological design.
- Understandings about science and technology.

**Science in Personal and Social Perspectives**

**Content Standard F:**
As a result of activities in grades 9-12, all students should develop understanding of:

- Personal and community health.
- Population growth.
- Natural resources.
- Environmental quality.
- Natural and human-induced hazards.
- Science and technology in local, national, and global challenges.
History and Nature of Science

**Content Standard G:**
As a result of activities in grades 9-12, all students should develop understanding of

- Science as a human endeavor.
- Nature of scientific knowledge.
- Historical perspectives.
Helpful Internet Resources for Science Teachers

**Teacher Resource and Lesson/Experiment Idea Sites**

**Hands-on Lesson Ideas for Grades 1 to 6**
http://www.uq.edu.au/_School_Science_Lessons/year1to6.html

**Earth Science Unit for Grades 1-3 by NASA**
http://kids.earth.nasa.gov/guide/index.htm

**Science Links (K-12)** – provides links to sites that are approved by NSTA by subject. This site is also referenced in many of your science textbooks with appropriate sites for students to access for given topics of study!
http://www.scilinks.org/

**Jefferson Lab Awesome Hands-on Lessons (4-12)** – ideas for states of matter, atoms, elements, chemistry, etc. Also has links to on-line science related games and activities.
http://education.jlab.org/index.php

**Earth and Space Science Activities, Lessons and Information by NOAA** – The National Oceanic and Atmospheric Administration provides wonderful tools for exploring weather, climate changes, oceans/coasts, satellites and space.
http://www.education.noaa.gov/

**Alternative Strategies for Science Teaching and Assessments (K-12)** – links to virtual field trips and much more!
http://science.uniserve.edu.au/school/support/strategy.html

**Kindergarten Science Experiments**
http://hastings.lexingtonma.org/staff/SLee/science/

**Easy Science Experiments (4-8)** – plans for experiments you can do in the classroom and on-line videos of experiments being conducted.
http://www.stevespanglerscience.com/experiments

**Virginia Standards of Learning (K-12)** – essential knowledge, skills and processes sections have some ideas for non-traditional ways in which students can demonstrate knowledge.
http://www.pen.k12.va.us/VDOE/Instruction/Science/sciCF.html

**Student Activity Sites**
Visit the site first yourself. Create a response activity that you can use to assess student explorations and understandings. Some examples of such activities include: short Powerpoint presentation, graphic organizer showing cause and effect or topic, sub-topics and details,
physical demonstration of a concept, poster, Podcast, brochure, debate, concept maps and
graphic organizers, etc. It is best practice to create a rubric for assessing student responses.
Sample rubrics can be found at http://school.discovery.com/schrockguide/assess.html.

**Hurricanes (4-6)** - (includes a virtual tour)
http://kids.earth.nasa.gov/archive/hurricane/

**Volcanoes (5)**
http://volcano.und.edu/

**Earth and Space (K-12)** - (includes actual satellite pictures)

**Amelia the Pigeon (K-4)** – NASA produced activity exploring measurement, spatial imagery
and components of scientific method. Contains interdisciplinary ideas with reading and
language arts as well as a teacher guide!
http://science.hq.nasa.gov/kids/imagers/

**Echo the Bat (5-8)** – NASA produced activity exploring light, biodiversity, and remote sensing.
http://science.hq.nasa.gov/kids/imagers/

**ExploraVision (K-12)** – a student contest that combines technology with the tools of science.
http://www.exploravision.org/
Sample Lesson Kindergarten

The Extraordinary Egg

**Objective:** Conduct investigations in which basic properties of objects are identified through observation and classification.

**Materials:** (1 each per two students)
- Egg
- Light weight cookie sheet
- Two wooden blocks
- Soft clay
- Books

**Procedure:**
- Talk about the properties of an egg: it is round, light, smooth and white. Ask students to hypothesize (make a scientific guess) about the egg's strength. Is an egg strong and powerful, or weak and fragile? Take a class vote and record the results on the board. Have each student individually record the problem (question) and his/her hypothesis on the lab sheet. Be sure to emphasize the scientific process throughout this activity.
- Conduct an experiment to test the students’ hypotheses. First, (demonstrate to the whole class) place an uncooked egg on a soft round of clay on a table top (you will probably want to place a paper towel underneath as well). Place two wooden blocks across the table from the egg resting in the clay. Then balance the cookie sheet on the wooden blocks and the egg.
- Ask students if they think the egg will break if they carefully place a book on top of the cookie sheet. Place the book. Ask the students to predict how many books they can place on the cookie sheet before the egg breaks. Allow students to work in pairs to conduct the experiment. Have the pairs carefully continue placing books until their egg breaks. Have student pairs record the number of books they were able to place on top of the cookie sheet in a table on the board.
- Ask the students to talk with their partner about the results. Why might some groups have more books than others? (heavier books, pressure when placing books on the sheet, etc.) Have the students record the results on the lab sheet and draw a conclusion. (Lead students to understand that the egg’s shape – its arch – is an excellent structure for supporting weight. So the egg is both fragile and strong! Nature provides for the egg to withstand the impact when it falls to the ground when laid.)
Students in one class were able to place 65 books on the cookie sheet supported by the egg and wooden blocks. Kindergarteners will be amazed!

**Assessment:**
- Teacher observations
- Lab sheets

<table>
<thead>
<tr>
<th>The Extraordinary Egg</th>
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<tbody>
<tr>
<td><strong>Problem</strong></td>
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<td><strong>Research</strong></td>
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<td><strong>Predict</strong></td>
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<td><strong>Test</strong></td>
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<tr>
<td><strong>Results</strong></td>
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<tr>
<td><strong>Draw Conclusion</strong></td>
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</table>
Sample Lesson Grade 1

PALEO COOKIE DIG

INTRODUCTION/OBJECTIVES

Objective: Science as Inquiry: Plan and conduct investigations which include using the senses and simple instruments, and using simple graphs, pictures, written statements and numbers.

Time: Approximately one hour.

Overview: Students examine a variety of soil samples and then conduct a simulated "dig" in a grid of no-bake cookie bars.

Skills: The science and mathematics process skills used include: observation, classification, simple grids and bar graphs.

MATERIALS

• A variety of soil samples, such as potting soil, sandy soil, soil with more pebbles or clay. Samples may be collected from various places on the school grounds or from students' yards. Create a plot of soil or bone-bed in a large box. Use string to create a grid over the soil.
• Paper plates to hold soil samples and cookie bars for each student.
• Toothpicks for each student to "dig" in soil and cookie bars.
• Large pan of no-bake cookie bars, such as Rice Krispie bars, with up to four non-melting ingredients such as raisins, macaroni, lima beans, peanuts, or sunflower seeds still in the shell. The idea is to provide a chunky cookie bar with obvious parts. Students may bring ingredients from home and make the pan of cookie bars during class as practice in measurement skills or parents are always looking for opportunities to volunteer.
• Sticky notes. Small squares or circles of different colors, one type for each non-melting ingredient in the cookie bars.
• Optional poster board grid (laminated for re-use) for constructing bar graphs and dry erase markers for labeling the grid. Alternatively a grid can be drawn on the chalk board.

PROCEDURES

• Students work in small groups to examine and compare a variety of soil samples. Using paper plates and toothpicks to separate and group similar materials, they examine the materials.
• Students discuss what they observed, what soil is made of and how soil varies depending on where it is found. As discussion occurs,
teacher creates a word bank on the chalkboard for students to use in the assessment activity.

• The teacher introduces the concept of systematic investigation of an area of soil dividing the area into squares called "quadrants". The teacher then cuts the pan of cookie bars into quadrants.

• Each student places a quadrant on a paper plate and carefully picks it apart using a toothpick. All parts of their quadrant are grouped by type on their plate, e.g. all raisins together. The Rice Krispies are also placed in a large pile.

• After digging apart their quadrants, students then count how many of each type of material is on their plate.
  — Students construct a class bar graph using "sticky" notes on a laminated poster board grid.

• Students analyze the graph to see if all the quadrants were the same or different.

• The class discusses how this procedure is used by scientists to systematically study a plot of soil or bone-bed.

**ASSESSMENT**

• Students work in pairs to complete a graphic organizer that has the types of soils with space for two or three characteristics each. It is recommended that this occur after discussion of soil samples and before the cookie investigation.

• Students complete a graphic organizer that compares how many of each type of material are in their quadrant and how many are in the class data.

Resource: [http://www.ucmp.berkeley.edu/fosrec/Heindel2.html](http://www.ucmp.berkeley.edu/fosrec/Heindel2.html) (Sharon Heindel)
Sample Lesson Grade 2

Magnetism

**Objective:** Explore and discover the properties of magnets. Magnets attract some metals but not non-metals. All magnets have a north and south pole. Like poles repel and unlike attract.

**Background:** Magnetic compasses work on the basic scientific principle known as the Law of Poles, which states that the north pole of one magnet will always be attracted to the south pole of another magnet. A magnetic compass works because its needle is actually a small bar magnet that aligns itself with the Earth's own magnetic field.

The Earth's magnetic field is generated deep within the planet by the motion of the liquid outer core, which contains highly conductive iron and nickel. When a bar magnet is free to swing, its south end will generally point to the Earth's magnetic north pole. In this activity, you'll create a simple compass and experiment with magnetism. (Remember: The Earth’s magnetic north pole is not in the same place as it’s geographic North Pole.)

**Materials**

- Popsicle stick
- 3 small bar magnets with north and south ends marked
- cellophane tape
- thumbtack
- quarter
- steel bar
- piece of paper

**Procedure:**

1. Place the Popsicle stick on a flat surface, such as a table or your desk.
2. Take the first bar magnet and lay it on top of the Popsicle stick so that the magnet's north end is aligned with the top of the stick. Carefully tape the magnet in place.
3. Take the second bar magnet and lay it on top of the other end of the Popsicle stick, making sure that the south end of the magnet is aligned with the bottom of the stick. Carefully tape the magnet in place.
4. Place the thumbtack on the same flat surface so that the point is sticking straight up. Now, balance the Popsicle stick on the tack's point so that the stick is parallel to the flat surface. This will take some careful maneuvering.
5. Once you have perfectly balanced the Popsicle stick, carefully press down on it so that the point of the thumbtack sticks into the wood. Your compass should now be able to spin freely.
6. Answer the questions on the attached activity sheet.
Name: ____________________________________________

1. Find the north pole with your popsicle-stick compass. Describe where the north pole is by using the objects in your classroom as reference points.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

2. Test the effects of the following objects on your popsicle-stick compass. Slowly bring the object near the north end of your compass and then slowly bring it near the south end. Write your observations in the table below.

<table>
<thead>
<tr>
<th>Object</th>
<th>What happens when I bring it near the compass’ . . .</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>. . . north end?</td>
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<tr>
<td>North end of a magnet</td>
<td></td>
</tr>
<tr>
<td>South end of a magnet</td>
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<tr>
<td>Quarter</td>
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</tr>
<tr>
<td>Steel bar</td>
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<tr>
<td>Piece of paper</td>
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</tbody>
</table>

Discovery Channel School’s Curriculum Center
Sample Lesson Grade 3

Erosion - Going, Going, Gone!

Objectives

- Students will identify the ways weathering and erosion can occur.

- Students will understand how weathering causes erosion and name two forces—constructive and destructive—that affect it.

Materials

Set-Up Materials
Egg cartons
Coarse grain sand
Small gravel
Water
Create your “mountains” several days in advance to allow drying time. Mix sand and gravel with just enough water to moisten the mixture. Press mixture into each of the 12 egg holders in the carton. You are basically making sand castles. The goal is to have the sand/gravel mixture hold together to make mini mountains which the students will then erode. You will need 3 “mountains” per group of 3-4 students.

Experiment Materials
Water
Eye droppers
Foam disposable bowls (each group needs one per mountain)
Experiment worksheet

Lesson

1. Vocabulary: Erosion, Landforms, Destructive, Constructive

2. Discuss with the students the concept of destructive and constructive forces that effect landforms. Divide students into groups and give them pictures that illustrate landforms effected by both destructive and constructive forces. Groups should divide pictures into each category and discuss what forces they think effected the landform.

3. Distribute materials to students. Each group of 3-4 students will need 3 “mountains”, water, an eyedropper, four bowls, and 4 worksheets.
4. Teach students how to use eyedroppers, cleaning eyedropper between each sample to avoid contamination.

5. Record hypothesis and predictions in lab journal.

6. Have each group place one “mountain” in each of the bowls. Have students sketch one “mountain” on the experiment sheet.

7. Label one bowl “control”, one bowl “erosion”, and the third bowl “earthquake”. Label all bowls with group names.

8. Have each group drop 10 drops of liquid on the erosion bowl. Record observations.

9. Have each group drop 10 drops of liquid on the earthquake bowl, and then gently shake the bowl for 60 seconds. Record observations.

10. Make no changes to the control bowl.

11. Each day for the next 2-3 weeks, have students repeat steps 7, 8, and 9. Have the students record observations in lab journals and make new sketches every 3-4 days.

12. At the end of the experiment, have students analyze results and record conclusions in their lab journals.

13. Have students discuss the results in pairs. Have each pair share one result with entire class.

**Extension**

1. Use more than 3 “mountains” per group, testing various types of liquids.

2. Add some water to a mountain and freeze it. What affect does this have on erosion?

3. Use 10 drops of water on one mountain, 20 drops on a second, 30 drops on a third, and so on. How do erosion rates compare?

4. Use Ph strips and test the acidity of various liquids. Then erode mountains with the liquids. What predictions can the class make about acid raid affecting landforms?

5. Using what you know about erosion, draw a picture of a mountain on a planet that has wind erosion, but no earthquakes or water. Explain your reasoning.
Evaluation/Assessment

- Exit card: Students name two forces - constructive and destructive - that show how weathering causes erosion. Students give two examples of destructive forces of nature and how they affect landforms.

- Journal entries

Resource: Space Foundation Graduate Course: 2006 Earth Systems Science
Sample Lesson Grade 4

Electrical Circuits

OVERVIEW: This is a hands-on science investigation on electricity. Students learn through the discovery method how electricity works. The student's natural curiosity and sense of exploration will enable them to explore and learn on their own with little input from the teacher.

OBJECTIVES: As a result of this activity, the students will:

1. Be able to draw and explain how an electrical circuit works.

2. Be able to define and use vocabulary associated with electricity. Vocabulary: circuits, electrons, force, conductors, switch, insulation

3. Be able to construct a simple circuit and a parallel circuit.

4. Be able to make an electrical motor work and add a switch to turn it on and off.

RESOURCES/MATERIALS: All items can be bought very inexpensively at Radio Shack or from Edmond Scientific Elementary Catalogue.

ACTIVITIES AND PROCEDURES:

1. The teacher will prepare ahead of time a kit for each two or three students. If students work in larger groups, some will not get hands on experience. Each kit will include a brown lunch sack, one C cell battery, two insulated copper wires, one battery holder and two brass battery clips, one small flashlight bulb and socket. All these items must be separate and in random order in the bag. The bag must be closed, sometimes I close it with one of the copper wires like a twisty.

2. Give each pair of students a bag and allow 10 minutes for exploration. During this time the teacher must remain quiet unless asked a question. The students will be very busy trying to find out what to do with the contents of the bag. Do not give any clues as to use of contents. This is exploration time.
3. Before the 10 minutes are up some students will have undoubtedly made a simple circuit with the contents of the bag. At this time you can stop for discussion. Have the students explain what they did so others can follow. You can now talk about the concept of electricity, the flow of electrons through a conductor, discuss what things are conductors, etc. Discuss where the electricity comes from and where it goes, how does it make the light bulb light. Discuss how the battery stores electricity. How do we know that electrons are flowing?

4. After all students have been successful with the simple circuit, each pair must draw what they have done in their science log or on a piece of paper. You may require students to label all the parts of the circuit, etc.

5. At this time, I give each pair of students a second battery and let them experiment. Does the second battery change anything? Does the light get brighter or dimmer? Does the way the batteries are connected make any difference in the way the light works. Try different ways of connecting the batteries. Some students will make a parallel circuit. At this time stop and have the students tell what they did. Discuss the concept of parallel circuits. Each pair of students draw what they have done.

6. A follow up activity if you have time is to have switches available. For those students that finish quickly, they get a switch. See if they can connect it into the circuit to make the light come on and off. Discuss how electricity flows. Why does the electricity not cross over the switch when it is open? Does electricity jump? Again, each pair must draw what they have done. This completes the thinking process and makes the learning more personal.

7. Electrical motors can also be added. Students enjoy making small fans out of the motors. Each pair of students can exchange their light bulb and socket for a small electric motor and try to connect it into the circuit. Torn or cut paper makes great fan blades. Let the students experiment to find the best size and shape to make the fan go very fast.

8. The role of the teacher in this activity is to be a facilitator. Please refrain from your urge to teach. In this activity, students discover the concept of electricity. The less you show and tell the better.
ASSESSMENT:

- Student diagrams
- Teacher observations and interactions with students during the activity. May require partners/groups to demonstrate their circuit to the class or with another group.

Resource: Judy Adair, Spring Creek Elementary, Broken Arrow, OK
http://www.proteacher.net/
Sample Lesson Grade 5

Earth Science - Landforms

Objectives:
• Identify how landforms are the result of constructive and destructive forces.
• Discuss the use of satellites, including GPS application.
• Compare satellite images of locations and describe the natural forces that shape them.
• Identify additional landforms shaped by these forces.
• Create a "forces of nature" document.

Materials:
• Science Investigations: Investigating the Earth’s Surface video
• Internet access

Procedure:

1. After watching the video, ask students to define a satellite. (An artificial object or vehicle that orbits the Earth.) How are satellites used in GPS? (A satellite network plots coordinates on the Earth’s surface.) How is GPS technology used? Discuss how GPS can be used for navigation, tracking, and creating detailed maps.

2. Next, show students a satellite image of the United States at this Web site: http://maps.google.com/maps. Click "Satellite" in the pink bar. Ask students to talk about how this map differs from your classroom map. Then have students describe variations in the Earth’s surface in the United States.

3. Show satellite images of three locations featured in the video: Tallgrass Prairie National Preserve, Mammoth Cave, and the Grand Canyon; images available from the Web site above. Enter one name listed below into the search bar at the top of the page, then click the Search button:
   o Strong City, Kansas (Tallgrass Prairie National Preserve two miles away)
   o Mammoth Cave, Kentucky
   o Grand Canyon, Arizona

   You may wish to show the images and see if students can identify the locations. As you view the images, ask students to identify landforms in these images.

4. As a class, describe the natural forces that shape these landforms, including the following:
   o erosion
   o weathering
   o movement of tectonic plates
   o movement of glaciers
   o deposition
   o fire
Assessment:

• Have students work with a partner to find other landforms shaped by natural forces. Each pair should draw a picture of the landform and write a few sentences underneath about how it was formed. Use a simple rubric to evaluate.
• Once students have presented their findings, hang their work on a bulletin board titled "Forces of Nature."

Vocabulary

deposition
Definition: The act or process by which an agent of erosion such as wind or water deposits sediment
Context: Deposition forms stalactites and stalagmites in caves.

erosion
Definition: The wearing away of the land by wind, water, or the movement of glaciers
Context: Weathering and erosion are at work in Mammoth Cave, lengthening and adding passages.

GPS (Global Positioning System)
Definition: A navigation system that utilizes a network of satellite signals
Context: GPS technology is transforming the ways in which we make and use maps.

limestone
Definition: A type of sedimentary rock consisting of the mineral calcium carbonate
Context: Mammoth Cave was originally made of solid limestone.

sandstone
Definition: A type of sedimentary rock made from grains of sand cemented by water and acids
Context: Some layers of sedimentary rock in the Grand Canyon walls are sandstone.

satellite
Definition: A manufactured object or vehicle that orbits Earth and sends information back
Context: GPS satellites travel in precise orbits.

weathering
Definition: The chemical or physical processes that break down rocks on the Earth's surface
Context: The powerful forces of weathering, erosion, and deposition contribute to the formation of caves.
Objectives: The student will investigate and understand the organization of the solar system and the relationship among the various bodies that comprise it. Students will investigate and understand the role of gravity, revolution and rotation.

Background Information: In 1924 astronomer Edwin Hubble discovered that the Milky Way was just one of many different galaxies in the universe. Each galaxy contains billions of stars, and the stars rotate around a mass at or near the center of the galaxy. As Hubble discovered more galaxies, he noticed that they could be categorized by groups based on their shapes. The most common types of galaxies are called spirals (like the Milky Way), ellipticals, and irregulars. Later, Hubble set up a classification system based on the galactic shape, which is also related to the speed at which a galaxy rotates. In this activity, you are going to make models of galactic motion where individual milk particles represent stars within the galaxy. Then, you'll use your models to determine how the shape of a galaxy is affected by gravity and the speed of rotation.

Materials: • 7 wide-mouth plastic cups • water • dry powdered milk • plastic spoon • photos of different galaxies, including spirals, ellipticals, and irregulars

Procedure: 1. Place a small amount of dry powdered milk in a plastic cup. Fill six cups half full with water.

2. Rotate the cup slowly to get the water flowing in a circular motion. Using the spoon, sprinkle about half a teaspoon of powdered milk into the water at the center of the rotation. Then stop rotating the cup, and observe the pattern the milk particles make in the water. Sketch what you see on the activity sheet.

3. Repeat step 2 with a fresh cup of water, and sketch the results on the activity sheet.

4. With a fresh cup of water, rotate the cup slower than the initial tests. Using the spoon, sprinkle about half a teaspoon of powdered milk into the water at the center of the rotation. Then stop rotating the cup, and observe the pattern the milk particles make in the water. Sketch what you see on the activity sheet.

5. Repeat step 4 with a fresh cup of water, and sketch the results on the activity sheet.

6. With a fresh cup of water, rotate the cup faster than the previous tests. Using the spoon, sprinkle about half a teaspoon of powdered milk into the water at
the center of the rotation. Then stop rotating the cup, and observe the pattern that the milk particles make in the water. Sketch what you see on the activity sheet.

7. Repeat step 6 with a fresh cup of water, and sketch the results on the activity sheet.

8. Answer the follow-up questions on the activity sheet.

**Assessment:**
Evaluation of the activity sheet or a separate exit card where students respond to a prompt related to the experiment.

**Enrichment Ideas:**

- Students will research Hubble galaxy classification and create a classification chart.
- Students will complete a web quest where they can view the Hubble Galaxy Gallery, view images of the stages of evolution of a galaxy including one such as C153 being ripped apart, and/or view various discovered galaxies.

Resource: Discovery Channel School’s Curriculum Center
Sample Lesson for Grade 7 or High School Biology

CLIMATE ANALYSIS USING PLANKTONIC FORAMINIFERA

INTRODUCTION

Prerequisites: Students should have an understanding of planktonic foraminifera. They should have a concept that our planet's climate has not always been as it is today. A review of the use of Neogloboquadrina pachyderma coiling ratios as a proxy for paleoclimate would be useful. Neogloboquadrina pachyderma is an excellent recorder of climatic temperatures through geologic time. When the earth experiences periods of relatively cold temperatures, ocean waters are cooler and Neogloboquadrina pachyderma forms its test (shell) such that it coils to the left. Alternatively, during periods of relatively warm temperatures when ocean waters are warmer, Neogloboquadrina pachyderma constructs its test with a coiling direction to the right. Students should be able to perform simple arithmetic procedures, namely, adding and formulation of percentage data. An answer key to the data chart is provided for you in Table 2. In addition, the students should know how to plot scientific data on graph paper. A graph of the data is given in Figure 1.

Objective: This exercise allows students to manipulate scientific data, plot the data and then interpret their results. You might query the students as to what is the "cause" and what is the "effect" in this scientific problem. The fact that our planet's climate has changed drastically throughout geologic time will be emphasized. Students should recognize that the climate will likely continue to change in the future.

Grade 7: Investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time.

High School Biology: Describe the relationship of organisms to ecosystems. Use math as a tool of science.

Follow-Up: You might want to follow this activity with a discussion of the causes for climate change, past, present and future. This exercise can foster discussions on current climate change. The class could discuss current evidence for climate change and what might be the potential causes, both natural and man-made, for this change.

CLIMATE ANALYSIS USING PLANKTONIC FORAMINIFERA

Instructions: Follow the instructions given below and those of your teacher to complete this activity.

1) You have been given a series of samples containing planktonic foraminifera representing time from the present to 160,000 years ago. After your analysis of the material, you decide to look at the climatic signal from these samples. You are aware that a particular species of foraminifera,
Neogloboquadrina pachyderma, is an excellent recorder of water temperature through geologic time. When the earth experiences periods of relatively cold temperatures, ocean waters are cooler and Neogloboquadrina pachyderma forms its test (shell) such that it coils to the left. Alternatively, during periods of relatively warm temperatures when ocean waters are warmer, Neogloboquadrina pachyderma constructs its test with a coiling direction to the right. Therefore, you have separated out the specimens of Neogloboquadrina pachyderma from your samples. For each sample you have counted how many of this species coil to the left and how many coil to the right. Your data is recorded in Table 1. Your next step is to calculate the percentage data for each sample. You must calculate percentage data so that your information is not biased by the total amount of foraminifera present in the sample. Complete the worksheet in Table 1 by calculating the total number of Neogloboquadrina pachyderma for each sample and the percentages of right- and left-coiling forms of the species. The first sample is done for you on the worksheet.

2) Next, use graph paper to plot your results. On the vertical axis you should plot the age of the samples with "0" at the top and "-160,000" at the bottom. On the horizontal axis, plot the percentage of right-coiling Neogloboquadrina pachyderma with "0%" on the left side and "100%" on the right side. You should now have a graph representing the climatic signal derived from the coiling ratios of Neogloboquadrina pachyderma.

3) Analyze your graph and make an interpretation of the climatic history on our planet during the last 160,000 years. Describe this history below and provide evidence for this interpretation.

<table>
<thead>
<tr>
<th>Age (years ago)</th>
<th>Right coiling Neogloboquadrina pachyderma</th>
<th>Left coiling Neogloboquadrina pachyderma</th>
<th>Total number Neogloboquadrina pachyderma</th>
<th>% Right coiling Neogloboquadrina pachyderma</th>
<th>% Left coiling Neogloboquadrina pachyderma</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>230</td>
<td>50</td>
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<td>135</td>
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</table>
Table 2. Answers to *Neogloboquadrina pachyderma* coiling rations worksheet

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<th>Age (years ago)</th>
<th>Right coiling <em>Neogloboquadrina pachyderma</em></th>
<th>Left coiling <em>Neogloboquadrina pachyderma</em></th>
<th>Total number <em>Neogloboquadrina pachyderma</em></th>
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Figure 1. Climatic signal derived from coiling ratios of *Hoploloboceratites pachyderma*.

Resource: http://www.ucmp.berkeley.edu/fosrec/Olson2.html (Hilary Olson)
Objective: Students will investigate the changes that occur in matter during a chemical reaction.

Materials:

Each group of 3-5 students need:
Note: The falcon tubes can easily be substituted by plastic cups if needed.

- 50 ml falcon tube of milk
- 50 ml falcon tube of white vinegar
- 15 ml falcon tube of baking soda
- 15 ml falcon tube of cabbage juice (boiled red cabbage in H2O)
- 15 ml falcon tube of calcium chloride (road salt)(Prestone Highway Heat works well)
- 15 ml falcon tube of ammonium nitrate (plant fertilizer)
- 2 clear plastic cups
- lab sheet and pencil
- paper towels for cleanup

Background For Teachers:
A chemical change or reaction occurs when new kinds of matter are formed. The composition of the matter changes and the new kinds of matter have different properties from the old matter. Evidence of a chemical change may be the result of chemicals reacting with one another. A gas or a solid may be formed where the products are in a different state than the reactants. A change in temperature, pressure, or color may also be evidence of a chemical change. These changes are called indicators. Physical properties, such as the boiling point and the melting point, are often altered as matter undergoes a chemical change (e.g., a raw egg when cooked becomes a hard-boiled egg). All the materials for this activity can be obtained easily at a grocery store and nursery. Jars or cups can easily be substituted for falcon tubes. The red cabbage juice needs to be prepared within 24 to 36 hours of conducting the activity or it will go stale and may not work properly. Red cabbage juice can be made by placing four or five leaves of red cabbage in about one cup of water and boiling it for a few minutes. Then drain the juice.

Procedures:

Invitation to Learn: Vinegar and Baking Soda
1. Have the students gather around a desk or table that has a funnel, scale, baking soda, vinegar, a pop bottle, and a balloon on it.
2. Weigh the baking soda, vinegar, pop bottle, and balloon separately and record them on paper. Add the weights together to get the total weight.
3. Pour the vinegar into the pop bottle and put the baking soda into the balloon. Use a funnel for ease in pouring. Carefully put the balloon over the bottle opening so the baking soda doesn’t go into the bottle. Let the balloon hang down over the side of the bottle.
4. Ask the students to predict what will happen when the baking soda is mixed with vinegar inside the bottle.
5. Mix the two substances together by holding the balloon upright and letting the baking soda fall into the bottle of vinegar.
6. Have a discussion of the observations. (The substances that were mixed together produced a chemical reaction, giving off a gas called CO2 that inflated the balloon.)
7. After the fizzing stops, record the collective weight of the bottle, balloon, gas and the new substance. Is it the same weight as the total weight recorded before? (The weight of an object is always equal to the sum of its parts, regardless of how it is assembled.)
8. Remove the balloon filled with the CO2 gas and allow the gas to leave the balloon. Put the balloon back on the bottle. Ask the students how the weight of the items might now be affected. (Students will hopefully be able to understand because a gas was given off that some of the weight is now distributed into the room and out of the items in the bottle.)
9. Weigh the pop bottle, balloon, and contents one last time and record the weight. Compare all three weights. Have a discussion about each of the weights.

Experiment:

1. Organize students in groups of three, four, or five.
2. Discuss the materials that will be given to each group. Explain that each of the substances are reactants (materials that can be mixed with other materials to create new products). Discuss the indicators that constitute a chemical change (materials may heat or cool, give off light, give off a gas, or change colors).
3. Explain that each group is going to conduct experiments where they are going to mix substances together. Discuss what a hypothesis is and why it is important for scientists to hypothesize (predict what will happen) as they conduct experiments. Explain that like real scientists, their group is going to experiment mixing the substances together. They are also going to develop hypotheses, record observations, and
draw conclusions. As they complete these experiments they are going to record the results on a lab or journal sheet.

4. Discuss when reactants or substances are mixed together to create new products it is important that scientists use exactness in their measurements. Explain to students that they should try to be exact with their measurements. Show students how to read the measurements on the falcon tubes. (Students, however, should know that the information gathered from these experiments will be somewhat accurate even if they don’t measure with preciseness.)

5. Give each group the lab sheet. Explain how to complete the experiments. Model the first experiment with them. Have each group write a hypothesis on their lab sheet. Then have each group mix the reactants as the teacher demonstrates. Help groups record their observations and conclusions about the new products that are created.

6. Have each group complete the remaining experiments and record the results on the lab sheet.

7. When students finish the lab experiments, have them plan and conduct an experiment of their own. Have groups plan which substances or reactants they will use and the amounts of each substance. Have them make a hypothesis before testing the chemicals. Have them list their hypothesis, observations, and conclusion on their lab sheet. Ask students to identify the indicators that showed a chemical reaction or change occurred.

8. Clean up the activity by pouring liquids down the sink or into a bucket. Rinse out cups, milk tubes, and red cabbage juice tubes.

9. Debrief the activity by having individual groups share their results with the class. The results are:
   a. Vinegar & Milk – curdling of the milk (forming a precipitate) Indicator: Production of a solid.
   c. Vinegar & Cabbage Juice -changes from purple to pink Indicator: Change of color.
   d. Milk & Ammonium Nitrate (fertilizer)– solution gets cold as granules dissolve Indicator: Change of temperature (cold).
   e. Milk & Calcium Chloride (road salt)– solution gets hot as granules dissolve Indicator: Change of temperature (hot).

10. Have students use the data they have collected to share with the class the indicators that resulted when the chemical changes occurred. Have students share their hypotheses and evaluate their results.
Extensions:

1. Brainstorm with students about how bread is baked and formed. What are the ingredients used to make bread? Ask students to identify why yeast is an important ingredient in the process, and how we can determine that a chemical reaction has occurred during the bread-making process.

2. Suggest to students that you will offer bonus points to students who complete the following activity at home. Hypothesize with students what the results might be if no yeast were added to the other ingredients used to make bread. What would happen if you added twice the amount of yeast to the recipe? What might happen if you added five times the amount of yeast?

3. Have students make four small samples of bread at home under the direction of their parents. Discuss with students what a control group is, and explain that the normal recipe will be the control group. Help students to understand that a control group is needed to determine the changes in the variables in the other recipes. Have them make four small samples of bread: (1) one with the regular amount of yeast that their recipe calls for; (2) one with no yeast; (3) one with twice the amount of yeast from the control group; (4) one with five times the amount of yeast.

4. Encourage students to bring their bread samples to school to share with the rest of the class. Ask students to observe the bread samples and determine how they can tell if a chemical reaction occurred and what changes the variables caused in the bread. Using hand-held magnifying glasses will help students see the size of the air pockets created by the gas producing yeast. Have them reflect on their original hypotheses and determine how accurate they were.

Assessment:

Present the following scenarios either written or oral and have students identify the indicators that show a chemical reaction or change occurred.

Chemistry Lab Experiments on Planet Warnock

Alien scientists from a planet named Warnock located in another solar system are working in a lab to prepare food items to bring with them on their journey to visit Earth.
Note: This part of the plan could be enhanced by showing graphics of space aliens.

Identify the indicators in the products below that show that a chemical change occurred.

1. The scientists took 15 ml of zip and mixed it with 50 ml of quig. The mixture cooled down to 4 degrees C, turned into an elastic-type substance, and took on a shiny glue-like appearance. They named their new product jorg. It tasted delicious.

2. The scientists took a cube of rant and placed drops of fap on the top of the cube. The cube started to dissolve. A large hole was carved into the cube of rant and changed colors. It gave off an undesirable smell and did not taste good. They decided not to take it on their trip.

3. The aliens from the planet Warnock took 50 ml of zap that weighed 50 grams and mixed it with 50 ml of lorn that also weighed 50 grams. The solution didn't mix well together. It started to fizz and bubble. The colors didn't mix well together. When they measured the new product, its volume was 100 ml and the weight was 98 grams. They named the new product tig and decided to mix it with the fluids they would drink on their way to Earth.

4. The scientists took a bar of tuz and placed it into a container with 1 liter of brig. At first, the two substances didn't appear to mix well together. After 1 minute the bar of tuz started to melt. The container heated up and was hot to the touch. They named the new product wophi. The aliens took the mixture and placed it in a freezer. When they took it out of the freezer the substances of the product (tuz and brig) had separated. They kept the container at room temperature, and the tuz and brig soon melted together again. They turned the lights off to go home and the entire room filled with light coming from the wophi. They decided not to eat the wophi on their journey to Earth, but to use it instead as a night-light to help them see aboard their spacecraft in the dark.

**Answer to the Assessment Scenarios**

1. The scientists took 15 ml of zip and mixed it with 50 ml of quig. The mixture cooled down to 4 degrees C, turned into an elastic-type substance, and took on a shiny glue-like appearance. They named their new product jorg. It tasted delicious. *The product absorbed heat by turning cold.*

2. The scientists took a cube of rant and placed drops of fap on the top of the cube. The cube started to dissolve. A large hole was carved into the cube of rant and changed colors. It gave off an undesirable smell
and did not taste good. They decided not to take it on their trip. 

*The product changed color.*

3. The aliens from the planet Warnock took 50 ml of zap that weighed 50 grams and mixed it with 50 ml of lorn that also weighed 50 grams. The solution didn't mix well together. It started to fizz and give off bubbles. The colors didn’t mix well together. When they measured the new product, its volume was 100 ml and the weight was 98 grams. They named the new product tig and decided to mix it with their fluids they would drink on their way to Earth.

*A gas was given off as the two reactants were mixed together.*

(The teacher could reinforce Objective 3, indicator b, from this question. Help students to understand that the measured weight of a remaining product is less than its reactants when a gas is produced.)

4. The scientists took a bar of tuz and placed it into a container with 1 liter of brig. At first, the two substances didn't appear to mix well together. After 1 minute the bar of tuz started to melt. The container heated up and was hot to the touch. They named the new product wophi. The aliens took the mixture and placed it in a freezer. When they took it out of the freezer the substances of the product (tuz and brig) had separated. They kept the container at room temperature and soon the tuz and brig melted together again. They turned the lights off to go home and the entire room filled with light coming from the wophi. They decided not to eat the wophi on their journey to Earth, but to use it instead as a night-light to help them see aboard their spacecraft in the dark.

*Heat and light was given off.*

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**Resource:** Science Teacher Resource Book (TRB3) [http://www.usoe.org/_curr/science/core](http://www.usoe.org/curr/science/core)
Science Journal Prompts and Rubric
A teaching tip given by A Project ISIS Teacher, 2004

This is a great way to avoid hearing the response “I don’t know what to write!” Here are six science journal-writing prompts to get the ball rolling:

• Today I discovered that........ I also learned that........The most interesting part of the experiment was........I am still wondering........
• Today I experimented with........My hypothesis was........I concluded that........My next experiment will be about............
• Today I observed........I predict that........I also measured........I concluded that............
• Today I learned about (vocabulary word). I discovered that (vocabulary word)................
• Today I observed (topic). I now know what happened to ............I am still unsure about............
• Today I conducted a science lab on (topic). I predicted that ............I analyzed my results and concluded that............Another question that I have is....................

Science Journal
Scientist: __________________ Date: ________________

Science Journal Rubric

3 = Satisfactory 2 = Needs Improvement 1 = Unsatisfactory

Completed journal and wrote down information accurately
3  2  1
Clearly showed knowledge learned
3  2  1
Provided detailed descriptions using scientific terms
3  2  1
Made correct conclusions
3  2  1

Total Points Earned: _____

Total Points Possible: 12
GRASPS Task Design Prompts

Creating a project (performance task) as an alternative form of assessment? Use the GRASPS design prompts below to design the project.

Goal
• Your task is
• The goal is to
• The problem or challenge is
• The obstacles to overcome are

Role
• You are
• You have been asked to
• Your job is

Audience
• Your clients are
• The target audience is
• You need to convince

Situation
• The context you find yourself in is
• The challenge involves dealing with

Product, Performance, and Purpose
• You will create a _________ in order to
• You need to develop _________ so that

Standards and Criteria for Success
• Your performance needs to
• Your work will be judged by
• Your product must meet the following standards

SAMPLE

Sample performance task in science for assessing understanding of multivariable experimental design:

Goal and Role: As a scientist with a consumer research group, your task is to design an experiment to determine which of four brands of detergent will most effectively remove three different types of stains on cotton fabric.
**Audience:** Your target audience is the testing department for *Consumer Research* magazine.

**Situation:** You have a two-part challenge: (1) to develop an experimental design for isolating the key variables, and (2) to clearly communicate the procedure so that the staff of the testing department can conduct the experiment to determine which cleaner is most effective for each type of stain.

**Product:** You need to develop a written experimental procedure (following the given format) outlining the steps in sequence. You may include an outline or graphic format to accompany the written description.

**Standards:** Your experimental design needs to follow the criteria for good design accurately and completely; appropriately isolate the key variables; include a clear and accurate written description of the procedure; and enable the testing department staff to determine which cleaner is most effective for each type of stain.

## Sample Rubric for Science Project

<table>
<thead>
<tr>
<th>Quest 1: Concept Map</th>
<th>Quest 2: Mathematical Calculations (Background Research)</th>
<th>Quest 2: Mathematical Calculations (Maximum Cargo of the Boat)</th>
<th>Quest 3: Boat Design and Construction</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning 1</td>
<td>Incorrect AND incomplete calculations of the questions related to the assigned web sites with little indication of any understanding of the mathematics describing buoyancy. Work is not shown or not clearly organized.</td>
<td>All work is shown. Cargo weight is within 20% of actual weight.</td>
<td>Boat carries withing 75% of highest cargo weight in class.</td>
<td></td>
</tr>
<tr>
<td>Developing 2</td>
<td>Incorrect or incomplete calculations of the questions related to the assigned web sites with some indication of any understanding of the mathematics describing buoyancy. Work is mostly shown and somewhat organized.</td>
<td>All work is shown. Cargo weight is within 40% of actual weight.</td>
<td>Boat carries withing 50% of highest cargo weight in class.</td>
<td></td>
</tr>
<tr>
<td>Accomplished 3</td>
<td>Complete and correct (for the most part) calculations of the questions related to the assigned web sites with strong indication of any understanding of the mathematics describing buoyancy. All work is shown and organized.</td>
<td>All work is shown. Cargo weight is within 60% of actual weight.</td>
<td>Boat carries withing 25% of highest cargo weight in class.</td>
<td></td>
</tr>
<tr>
<td>Exemplary 4</td>
<td>Complete and correct calculations of the questions related to the assigned web sites with a clear indication of an understanding of the mathematics describing buoyancy. All work is shown and clearly organized.</td>
<td>All work is shown. Cargo weight is within 80% of actual weight.</td>
<td>Boat carries highest cargo weight in class.</td>
<td></td>
</tr>
</tbody>
</table>

- **Score:**
  - **1:** Description of identifiable performance characteristics reflecting a beginning level of performance.
  - **2:** Description of identifiable performance characteristics reflecting development and movement toward mastery of performance.
  - **3:** Description of identifiable performance characteristics reflecting mastery of performance.
  - **4:** Description of identifiable performance characteristics reflecting the highest level of performance.
| Quest 4: Written Report | Report demonstrates the beginning level of performance of the concepts relevant to the assignment. | Report demonstrates development and movement toward mastery of performance of the concepts relevant to the assignment; report also includes an assessment of the successes/failures of the boat construction. | Report demonstrates the mastery of the concepts relevant to the assignment; report also includes an accurate assessment of the successes/failures of the boat construction. | Report demonstrates the highest level of mastery of the concepts relevant to the assignment; report also includes an accurate and detailed assessment of the successes/failures of the boat construction. |

| Quest 5: Portfolio/ Collaboration | Collaboration is not evident in more than one of the tasks of the assignment. | Collaboration is clear in at least 2 of the tasks of the assignment. Portfolio is complete, though it lacks the organization of a group effort. | Collaboration is clear in at least 3 of the tasks of the assignment. Portfolio is an organized representation of the group process. | Collaboration is clear in each task of the assignment. Portfolio is an organized, coherent representation of the group process. |
Scientific Method

- Ask Question
- Do Background Research
- Construct Hypothesis
- Test with an Experiment
- Analyze Results
- Draw Conclusion
- Report Results

Think! Try Again