Grade Eight

Science Guidelines

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Dear Eighth Grade Teacher,

This latest revision of the curriculum guidelines contains material to be taught for this grade. All the content should be covered. The fundamental revision has been to reorganize more logically and to align the guidelines more closely with the Pennsylvania State Science Standards. The contents of these guidelines are not written to follow one science textbook, however, we did not seek to reinvent the wheel. There are many fine "Earth Science" textbooks available for your students as well as for yourself. Take the time to look at current textbooks. There are sure to be textbooks that will provide you and your students with the background and information to be successful. Sometimes this means that you will be using additional sources: explore, investigate, and research – you won't be sorry.

It is anticipated that you will present this content in a variety of teaching styles in order to allow maximum success and enthusiasm in your students. It is therefore imperative that you use process skills and inquiry skills throughout the school year. Many students will understand and participate better if permitted hands-on experiences as well as opportunities to research and explore. We urge you to provide these experiences in your classroom.

Finally, earth science exposes our students to questions related to Catholic teachings. To ignore such topics when they arise is the equivalent of putting your head in the sand; however, when presenting topics that fall into this category, please be certain of the Church's teachings.

It is hoped that these guidelines will serve as a help to the eighth grade teachers in preparing lesson. Thank you for your dedication in teaching our children.

Sincerely,

Elementary Science
Curriculum Committee

SCIENCE
GENERAL OBJECTIVES – Grades 1 to 8

At the conclusion of the science program prescribed for the elementary school in the Archdiocese of Philadelphia, students should have achieved the skills enumerated in the following six categories of objectives:

Knowledge

To read and state the meaning of certain scientific facts and concepts. When a problem situation is stated requiring application of some scientific principles, a child has learned that he/she should be able to apply the principle.

Instrumental Skills

To manipulate basic science equipment, interpret and prepare maps, graphs, charts, and tables appropriate to problems.

Problem-Solving Skills

To demonstrate problem-solving skills such as observing, inferring, sensing and defining problems, making hypotheses, outlining scientific procedures to test hypotheses, carrying out an investigation, controlling and manipulating variables, formulating models, making valid conclusions, recognizing and using space and time relationships, recognizing and using number relationships, classifying, measuring, communicating, and making operational definitions.

Scientific Attitudes

To demonstrate such scientific attitudes as open-mindedness by being willing to consider new facts in making judgments, withholding conclusions until all available facts are in, using controls, generalizing with sufficient evidence.

Appreciation

To describe the uses, benefits, and limitations of science to society.

Interest

To demonstrate interest in science by reading, collecting, studying, or becoming involved in some scientific activity as a leisure time pursuit.

SCIENTIFIC

PROCESSES

SCIENTIFIC PROCESS SKILLS

Science education involves process as well as content. The content learned helps the students understand and interpret their environment. The process involves using diverse skills to solve different problems. This leads to effective ways of working and provides experience in thinking critically and creatively. The process skills with expectations for each grade are found below. It is hoped that teachers will develop these skills through hands-on experiences.

(I – introduce) (R – reinforce) (M – master)	**K**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Observing: ability to identify properties, structures, etc. through use of all the senses	I	R	R	M					
2. Classifying: ability to group, match, compare by commonality	I	R	R	M					
3. Identifying: ability to describe and interpret sensory and qualitative aspects of learning		I	R	R	R	M			
4. Questioning: ability to ask pertinent questions regarding experiences		I	R	R	R	M			
5. Measuring: ability to find quantitative differences, to estimate, calculate, etc. (metric)	I	R	R	R	R	M			
6. Recording: ability to collect, record, and tabulate data meaningfully				I	R	R	R	M	
7. Predicting: ability to guess outcomes on basis of previous experiences				I	R	R	R	M	
8. Formulating Models: ability to represent cognitive data graphically					I	R	R	M	
9. Formulating a Hypothesis: to predict and generalize from experiences/data; to make an educated assumption as to the possible outcomes of an experiment					I	R	R	M	
10. Interpreting: ability to analyze data validly (similarities, dissimilarities, cause/effect)						I	R	R	M
11. Designing Investigations: ability to control variables, record and interpret data, summarize data, graph						I	R	R	M

12. Inferring: ability to make conclusions referring to causes, effects, etc.				I	R	R	M		
13. Generalizing: ability to sum up experiences into some kind of conclusion						I	R	R	M
14. Experimenting: to try something out to see whether or not it works			I	R	R	R	M		
15. Manipulating Variables: to identify and selectively change experimental conditions such as time, intervals, temperature, distance					I	R	R	R	M
16. Handling Equipment: to know the purpose for and manner of using lab resources and equipment for the purpose of experimentation			I	R	R	R	M		
17. Using Space-Time Relationships: ability to consider position and motions from vantage points other than the child's own						I	R	R	M
18. Communication: ability to verbally relate experiences, inform-ation, and procedures with clarity	I	R	R	R	M				
19. Recognizing Problem Areas: ability to be aware of areas where alternative solutions are possibilities					I	R	R	R	M
20. Researching: ability to seek additional information, sources, conditions, personnel, events			I	R	R	R	M		
21. Interdisciplinary Skills: to be able to identify those areas of science which are interrelated to other disciplines such as math, English, and social studies	I	R	R	R	M				

SCIENTIFIC PROCESS SKILLS

Science education involves process as well as content. The content learned helps the students understand and interpret their environment. The process involves using diverse skills to solve different problems. This leads to effective ways of working and provides experience in thinking critically and creatively. A blank process skills chart has been provided for teachers to use as a work in progress: identify which skills your students should have mastered, record dates of when skills were introduced or used. Feel free to duplicate this form.

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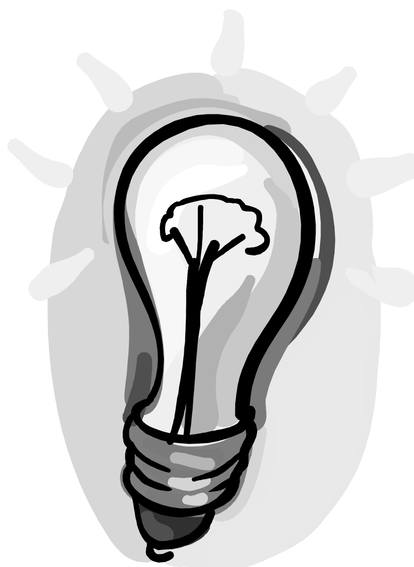
Scientific Inquiry



SCIENTIFIC METHOD

(Expectations by Grade Level)

Primary – Observe and Inquire: Grades One to Three

1. Ask questions and make observations.
2. State the problem.
3. Identify the materials.
4. Follow the procedures to conduct the investigation.
5. Tell what was learned as a result of the investigation.

Elementary – Hypothesize and Experiment: Grades Four to Six

1. Ask questions and make observations.
2. Recognize and state the problem.
3. Formulate a hypothesis based on content, research and previous experience.
4. Identify the materials.
5. Follow the procedures to conduct the investigation.
6. Collect data and record the results.
7. State a conclusion based on the data collected; include applications to everyday life.

Middle School – Analyze and Extend: Grades Seven and Eight

1. Ask questions and make observations.
2. Recognize and state the problem.
3. Formulate a hypothesis based on content, research and previous experience.
4. Identify the materials.
5. Follow and/or design the procedures to conduct the investigation.
6. Collect data and record the results making use of maps, charts, and graphs as well as tables and drawings.
7. State a conclusion based on the data collected; include applications to everyday life as well as suggestions for extended investigations.

Science

Content

FIRST TRIMESTER
UNIT ONE: GEOLOGY

I. Matter

Standard 3.4.4.A

A. Matter is anything that has mass and occupies space.
States of Matter – depend on the temperature and pressure of the substance
- a. solid: atoms or molecules are in fixed positions; definite volume and shape
- b. liquid: atoms or molecules are loosely connected; definite volume and takes the shape of the container
- c. gas: atoms or molecules are as far apart as possible; no definite volume or shape (will fill all available space)
- d. plasma: free electrons surround the nuclei of atoms; plasma occurs in stars or in matter through which a bolt of lightning has passed

B. Nature of Matter - matter cannot be created or destroyed.
1. Properties - characteristics
   - a. physical: characteristics you can detect with your senses; texture, density
   - b. chemical: characteristics that describe behavior; allows a substance to change; flammability; oxidation

Standard 3.4.7.A

2. Reactions
   - a. physical change: a change in the shape, size, form, or state of matter that can be observed without changing the identity of the matter
   - b. chemical change: the change of materials into other, new materials with different properties; digestion of food, wood burning, rust

C. Structure
1. Atom: smallest particle of an element that has the properties of that element
   - a. nucleus
     - 1) protons: positively charged particles
     - 2) neutrons: particles that have no charge
   - b. electrons: negatively charged particles that orbit the nucleus
   - c. identification of atoms
     - 1) atomic number: number of protons in an atom of an element; number of protons equals number of electrons in an electrically neutral atom
     - 2) atomic mass: sum of protons and neutrons in the nucleus of an atom
   - d. isotopes: atoms of the same element that differ in atomic mass due to the number of neutrons; atomic mass listed on the Periodic Table of Elements is the average mass of all isotopes of an element
   - e. ions: electrically charged atoms; number of electrons differs from the number of protons depending upon whether an atom tends to gain or lose electrons
2. Molecule: two or more atoms held together by chemical bonds

Standard 3.4.7.A

D. Form

1. Element: substance that cannot be broken down into simpler form by ordinary chemical means

   Periodic Table: orderly arrangement of elements according to atomic number; elements with repeated patterns of physical and chemical properties are grouped together

Standard 3.4.4.A

2. Compound: two or more substances chemically combined having characteristics different from the elements it contains; example, NaCl (salt) is made of two elements that are poisonous
3. Mixtures: two or more substances physically combined

II. Minerals: naturally occurring, inorganic solids that have a definite chemical composition and crystal structure

A. Investigating Physical Properties

1. color: easily observable; good for minerals like sulfur, but no help for minerals like quartz that has many colors
2. luster: the way a mineral's surface reflects light; example, shiny vs. dull
3. streak: the color of the powder left when a mineral is rubbed on a piece of unglazed porcelain
4. hardness: resistance to being scratched
   a. Mohs Scale of Hardness lists sample minerals from talc (softest) to diamond (hardest); each mineral on the scale leaves a scratch on a softer mineral
   b. Field Test of Hardness: tools to scratch minerals: fingernail (1-2); penny (3-4); nail (5-6); glass (7-8)
5. heft: weight of a mineral determined by picking up the sample and comparing it to a known substance
6. crystal shape: based on the internal atomic structure
7. breakage: the way a mineral breaks
   a. cleavage: tendency of a mineral to break along one or more smooth, flat surfaces; example, mica
   b. fracture: characteristics of a mineral that splinters or breaks unevenly; example, sulfur
8. special properties
   a. magnetism
   b. fluorescence
   c. radioactivity

B. Investigating Chemical Properties

1. Acid Test: reaction with dilute hydrochloric acid is a test for a carbonate mineral; the mineral surface will fizz when a drop of acid is placed on the surface
2. Flammability

Standard 3.5.7.A

III. <u>Rocks</u>: solid mineral material that comprises the Earth's surface

A. <u>Rock Cycle</u>: continuous changing of rocks from one kind to another over long periods of time: all rocks are igneous in origin but can be changed to sedimentary or metamorphic in any order
   1. <u>crystallization</u>: solidification
   2. <u>metamorphism</u>: changing as a result of heat, pressure, or chemical reaction
   3. <u>lithification</u>: changing into rock
   4. <u>weathering</u>: breaking down rocks and other materials at the Earth's surface
      a. decomposition: chemical change that breaks down rock as a result of reactions with organic substances in the soil or with acid rain
      b. disintegration: mechanical change that causes the breakdown of rock due to the action of wind, ice, plant roots, or water

   Standard 3.5.4.A

   5. <u>erosion</u>: process by which the products of weathering are moved from one place to another
   6. <u>melting</u>: reduction of a solid to a liquid state through the use of heat

Standard 3.5.10.A

B. <u>Types of Rocks</u>
   1. <u>Igneous rocks</u> are formed from melted rock
      a. magma: melted rock under Earth's surface
      b. lava: melted rock that has reached Earth's surface
      c. classes of igneous rocks
         1) intrusive: rocks formed beneath the Earth's surface that have large crystals due to slow cooling
         2) extrusive: rocks formed on the Earth's surface that have small crystals due to quick cooling
   2. <u>Metamorphic rocks</u> are formed when chemical reactions, tremendous heat, and/or great pressure change existing rocks into new kinds of rocks
      a. classes of metamorphic rocks
         1) foliated: layered or banded by either color or mineral
         2) non-foliated: random arrangement of minerals
      b. examples of metamorphism through heat and pressure
         1) sandstone (sedimentary) changes to quartzite
         2) shale (sedimentary) changes to slate
         3) granite (igneous) changes to gneiss
         4) limestone (sedimentary) changes to marble
         5) basalt (igneous) changes to schist
         6) anthracite (metamorphic) changes to graphite
   3. <u>Sedimentary rocks</u> are formed from sediments that have been carried along and deposited by wind and water
      a. sediments of sand and smaller particles are buried and cemented together by dissolved minerals to form solid rock again
      b. re-formed rock layers may be forced up again and become landforms

including mountains

1) layers of sedimentary rock confirm the long history of the changing surface of the earth: the youngest layers are not always found on top, because of folding, faulting, and uplifting

Standard 3.5.4.A

2) weathered rock and decomposed organic remains are the basic components of soil

c. classes of sedimentary rocks
   1) clastics: formed from fragments of weathered rocks
   2) nonclastics: dissolved minerals or remains of plants and animals

IV. Crustal Movement

Standard 3.5.7.A

A. Layers of the Earth
1. Core: dense center of iron and nickel
   a. inner core: solid
   b. outer core: liquid
2. Mantle: middle layer comprised of silicon, oxygen, iron and magnesium
   a. asthenosphere: fluid rock
   b. lithosphere: rigid outer layer including crust
3. Crust: solid and rocky outer layer; thinnest layer

B. Plate Tectonics

Standard 3.5.10.A

1. Continental Drift Theory was proposed by Alfred Wegener in 1912.
   a. Theory states that all the continents were once joined on one large land mass (Pangaea) that began breaking up and drifting apart millions of years ago.
   b. Evidence
      1) Matching fossils found in eastern South America and western Africa
      2) Continental coastlines fit together
      3) Some mountain ranges connect when continents are joined
      4) Glacial rocks found at the equator
2. Sea-Floor Spreading was proposed by Harry Hess in 1960.
   a. Theory states that molten material is continually added to the ocean floor.
   b. Evidence
      1) samples of molten material at the mid-ocean ridge
      2) magnetic memory of the rock material in the ocean
      3) drilling samples concluded that the further away from the mid-ocean ridge, the older the samples
3. Plate Tectonics Theory was proposed by J. Tuzo Wilson in 1965.
   a. Theory states that the pieces of Earth's lithosphere (plates) are in constant, slow motion, driven by convection currents in the mantle.
   b. Plate Boundaries

1) transform boundaries: two plates slip past one another in opposite directions – crust is neither created nor destroyed
2) divergent boundaries: two plates move apart – Great Rift Valley in east Africa
3) convergent boundaries: two plates come together; the density of the plates determines which one comes out on top – Himalayas

Standard 3.5.7.A

C. <u>Earth's Changing Surface</u>

1. <u>Abrupt (sudden) Changes</u> in the Earth's surface are due to faulting (pushing together or pulling away) of the rocks in the crust
   a. Earthquakes: the shaking and trembling that results from the sudden movement of Earth's crust.
      1) earthquake waves
         a) primary waves (P waves) – can travel through liquid and solid
         b) secondary waves (S waves) – can only travel through solids
         c) surface waves (L waves) – do the most damage
      2) seismologist is a scientist who studies seismic waves
      3) seismogram is a record of seismic vibrations
      4) seismograph is a sensitive instrument that records seismic waves
      5) Richter Scale: traditionally used to measure the relative strength of earthquakes

   Standard 3.5.7.A

   b. Volcanoes: places where hot liquid magma breaks through and flows onto the Earth's surface.
      1) volcanic features
         a) batholiths: intrusive rock bodies so large their bottoms are unknown
         b) stocks: similar to but smaller than batholiths
         c) dikes: formation of magma that cuts across existing rock layers
         d) sills: magma squeezed and hardened between layers of rock
         e) laccoliths: mushroom-shaped structures that are domed upward
      2) types of volcanoes
         a) cinder cone: eruption throws out rocks and ash, very little lava; Paracutin in Mexico
         b) shield: easy flowing lava, gentle slopes; Mauna Loa in Hawaii
         c) dome: thick lava flows; Mt. Pelee in Martinique
         d) strata/composite: layers of dust, ash, rock, and lava; Mt. St. Helens
2. <u>Subtle (gradual) Changes</u> are due to the folding of rock layers over long periods of time.

   Standards 3.5.4.A

   a. Mountains: natural landforms that reach high elevations
      1) folded mountains: mountains that form as a result of compression; Appalachian Mountains
         a) syncline: downward fold in rock layers
         b) anticline: upward fold in rock layers

c) geosyncline: sediment-filled trough that may be thousands of kilometers long; oil deposits are often found here

2) fault-block mountains: mountains formed when area between two parallel faults is uplifted; Grand Tetons in Wyoming

3) dome mountains: formed by the accumulation of material that has been forced out of the Earth's interior; Black Hills of South Dakota

b. Plateaus: landform with a relatively level surface at high altitudes; Columbia Plateau in Washington state

c. Plains: landform of flat or gently rolling land with low relief; Great Plains

V. Geological History

A. Fossils: preserved remains or traces of living things; paleontologists study fossils to discover the amount and type of preservation as well as age

1. Law of Superposition: In horizontal sedimentary rock layers, the oldest rock is on the bottom.
2. Radioactive Dating is used by paleontologists to determine the absolute age of rocks and fossils. The rate of decay of a radioactive element is its half-life: it is a constant that never changes.

B. Geological Time Scale

1. Units of Measurement
   a. eras: Paleozoic, Mesozoic, Cenozoic
   b. periods: eras are divided into periods
   c. epochs: Cenozoic periods are divided into smaller divisions because information is so much more complete
2. Index Fossils are useful because they tell the relative age of rock layers: index fossils are the remains of plants or animals that existed for a relatively short time in a wide area.

Second Trimester
Unit One: Oceanography

Standards 3.5.4.D and 3.5.7.D

I. <u>Introduction to Oceans</u>

A. <u>Oceanography</u> – the application of the basic sciences to the study of the marine environment

B. <u>Formation of the ocean waters</u> – water vapor and condensation of vapor as rain in the oceans basins

II. <u>Water Cycle</u> - process by which water moves from ocean to land and back to the ocean again.

A. Water cycle powered by solar energy

B. Process of water cycle

1. <u>Evaporation</u> – liquid water changes to gases
2. <u>Transpiration</u> – water escapes from the leaves of plants
3. <u>Condensation</u> – water vapor changes to a liquid
4. <u>Precipitation</u> – liquid water is released from the atmosphere as rain, hail, sleet, or snow
5. <u>Runoff</u> – water drains from the land and flows back into the ocean.

III. <u>Oceans</u> – a continuous body of saltwater that covers approximately 70% of the Earth

A. <u>Pacific</u> – largest, deepest, covers 1/3 of Earth's surface, contains approximately ½ of Earth's water

B. <u>Atlantic</u> – second largest, contains Mediterranean, Caribbean and North Seas, shallower than Pacific and Indian

C. <u>Indian</u> – deeper than Atlantic, shallower than the Pacific

D. <u>Arctic</u> – surrounds the geographic North Pole

IV. <u>Topography of Ocean Floor</u>

A. <u>Continental shelf</u> – shallow-water platform that slopes gently from a continent to the deep ocean bottom.

B. <u>Continental slope</u> – area of steeply sloping seafloor between the continental shelf and the deep ocean bottom.

C. <u>Submarine canyons</u> – deep furrows cut into the continental slope.

D. <u>Abyssal plain</u> – flat, almost level area in the deepest part of ocean basin.

E. <u>Seamounts</u> – underwater volcanic mountains.

F. <u>Guyots</u> – flat-topped, underwater mountains.

G. <u>Mid-ocean ridge</u> – underwater mountain range that is the longest topographic feature on the earth's solid surface.

H. <u>Trench</u> – a long, v-shaped channel located on the edges of the ocean basin, i.e., Marianas Trench and Aleutian Trench.

V. Properties of Ocean Water

A. Composition of Ocean Water
1. H_2O – 96.5%, other elements – 3.5%
2. Salinity – measure of the amount of chemicals dissolved in ocean water. As salinity increases, density increases.

B. Temperature of Ocean Water
1. As temperature increases, density decreases.
2. Surface temperature – from 2°C (Arctic) to 28°C (equator).
3. Subsurface temperature – from 1°C to 3°C.
4. Thermocline – zone where there is a sharp difference in temperature between surface and deeper water.

C. Pressure – pressure increases as the ocean depth increases.

D. Color – natural color is blue, but can be affected by pollutants or microscopic plants.

VI. Waves and Wave Action

A. Causes – wind and earthquakes

B. Characteristics of Waves
1. Crest – highest point of wave.
2. Trough – lowest part of wave.
3. Wavelength – horizontal distance between crests or troughs.
4. Wave frequency – the number of waves that pass a point in a certain amount of time.
5. Wave height – the vertical distance from crest to trough.
6. Near shore, the wave height increases and the wavelength decreases.

C. Tsunami – wave caused by sudden shift in ocean floor.

VII. Tides

A. Tides – movement of the oceans caused by the gravitational pull among the earth, sun, and moon.
1. High tides – occur twice a day, when the ocean water bulges as a result of the gravitation pull of the overhead moon.
2. Low tides – occur twice a day, when the two areas of the earth are not experiencing high tides.

B. Spring tide – tides that occur twice a month, at full and new moon, when the moon, earth, and sun are in a straight line.

C. Neap tide – tides that occur twice a month, at first and third quarter moon, when the moon, earth, and sun form a right angle.

VIII. Currents and Climates

A. Surface Currents
1. Are driven by winds and can affect movement to a depth of several hundred meters.
2. Either cool or warm the air above it influencing the climate of the land near the coast, i.e., Gulf Stream.

B. Coriolis effect – apparent westward deflection of objects moving across the

Earth's surface due to Earth's rotation.

C. Deep currents – caused by differences in water density.

D. Upwelling – upward movement of cold water from the ocean depths bringing organisms, minerals and nutrients to the surface.

E. El Nino – unusual pattern of winds formed in the western Pacific that often brings severe or unusual weather conditions.

IX. Life in the Ocean

A. Plankton – tiny organisms that float in the water and are carried by waves and currents.
   1. Phytoplankton – plant plankton, i.e., diatoms.
   2. Zooplankton – animal-like plankton, i.e., protists, crustaceans.

B. Nekton – free swimming life forms, i.e., larger fish, squid, sea turtles, whales.

C. Benthos – bottom dwellers, both mobile and stationary, i.e. crabs, coral.

X. Ocean Zones

A. Neritic Zone – extends from the low tide line out to the edge of the continental shelf.
   1. Receives sunlight and nutrients, contains most of the world's fishing grounds.
   2. Includes kelp forests and coral reefs.

B. Open Ocean Zone – begins where neritic zone ends
   1. Surface zone, approximately 200 meters, receive light.
   2. Deep zone – dark, harsh area with few, highly adapted organisms and hydrothermal vents.

XI. Instruments of Investigation

A. SCUBA – Self-Contained Underwater Breathing Apparatus. Tanks of compressed air strapped on a diver's back and connected by hoses to a mouthpiece for breathing.

B. SONAR – SOund Navigation And Radar. Method of mapping the ocean floor by transmission and reflection of sound waves.

C. Geostationary operational environmental satellites (GOES) orbit the Earth at 22,000 miles. They are highly advanced observation platforms supplying detailed imagery of the Earth's oceans.

D. Underwater laboratories - The *Aquarius* Underwater Laboratory is the only undersea laboratory dedicated to marine science operating in the world. *Aquarius* provides life support systems that allow scientists to live and work underwater, in reasonably comfortable living quarters, with sophisticated research capabilities.

E. Deep ocean submersibles – Over the last few decades, engineers have developed submersible technologies capable of meeting the many challenges that the deep sea imposes upon explorers. To get the latest knowledge on submersible, check the following website: **http://www.oceanexplorer.noaa.gov**

SECOND TRIMESTER
Unit Two: Astronomy

Standard 3.4.7.D

Astronomy - study of planets, stars, and other cosmic bodies
(Due to the on-going exploration of the universe, available data about planets, comets, meteors and other objects in the known universe is constantly expanding. Taking the time to use newspaper and magazine articles and the Internet will give your students the most current information)

I. History

A. Nicolaus Copernicus – Polish astronomer, first suggested the sun was the center of the solar system and put six known planets in proper order.

B. Galileo Galilei – Italian scientist whose greatest contributions were his descriptions of moving objects
   1. Laid groundwork for the study of gravity by demonstrating that the weight of an object does not affect its rate of fall
   2. Discovered four moons of Jupiter; observed and recorded the phases of Venus; studied the moon's surface; tracked sunspots
   3. Tried by Inquisition in the 1600s for teaching against current belief of the Catholic Church (sun was enter of the universe); declared innocent by John Paul II in 1980s

C. Albert Einstein – a German-born American physicist, developed the theory of relativity to explain motion of particles traveling at the spend of light

D. Edwin Hubble – American astronomer, first discovered light beyond our galaxy

II. Instruments of Astronomy

A. Refracting telescope – uses an objective lens to collect light coming from an object in space; Galilei developed first refracting telescope

B. Reflecting telescope – uses mirrors to reflect and form a magnified image of an object which is seen through a lens; Issac Newton invented the reflecting telescope.

C. Radio telescope – consists of a reflector, a receiver, and an antenna; radio waves are collected by the antenna and focused on a receiver.
   1. Grote Reber built first in 1939.
   2. Can be used day and night, in any weather
   3. Quasars and pulsars – two radio energy sources discovered with radio telescope

D. Spectroscope – separates light into wavelengths by means of glass prisms or ruled gratings; can determine elements in stars

E. RADAR – system that detects an object beyond the range of visible light; determines the object's distance or range

III. Distances in Astronomy

A. Astronomical unit (AU) – the average distance between the Earth and the sun
   1. 150 million km (93 million miles)
   2. used for measurement within the solar system

B. Light year – the distance light travels in one year, 9.5 trillion km
   1. 8 min. for light to reach earth from sun
   2. used to measure distances to stars and beyond

IV. Origins

A. Universe

   Big Bang Theory- most widely accepted theory of the origin of the universe; states that a cosmic explosion occurred 15 to 20 billion years ago, sending matter and energy in all directions; from this matter all objects in the universe developed

B. Solar system

   Nebular Hypothesis: most commonly accepted of many theories states that a a nebula of dust and gases collapsed due to gravitational forces. Gravity, rotation and pressure flattened it. Local regions of condensation eventually became the sun and planets, moon and other space objects.

V. Sun: a medium size yellow star composed mostly of hydrogen and helium; exerts gravity on planets holding them in orbit.

A. Rotates once each month

B. Revolves around Milky Way Galaxy about every 225 million years

C. 109 times the size of Earth

D. Structure
   1. Core – nuclear fusion occurs here, hottest part
   2. Radiative zone – very dense zone
   3. Convective zone – gases circulate in convection currents
   4. Photosphere – lower atmosphere, visible surface
   5. Chromosphere – deep red, seen during a total eclipse
   6. Corona – outer atmosphere, extends for millions of miles

E. Solar Activity
   1. Sunspots – dark, cooler areas on the photosphere, caused by disturbances in sun's magnetic field
   2. Solar flares – intense magnetic storms on sun's surface
   3. Prominences – arcs of gas that erupt from surface of the sun

VI. Planets: *What is taught on the planets depends on what students have been taught in previous grades and what material is in your textbooks. Students should be able to read the following table.*

Planets	Distance from the Sun (Astronomical Units million miles & km)	Period of Revolution Around the Sun	Period of Rotation	Mass (kg)	Diameter (miles km)	Temperature (k Range or Average)	Number of Moons
Mercury	**0.39AU, 36m,57 .9km**	**87.96 Earth days**	**58.7 Earth days**	**3.3 x 10 23**	**3,031m 4878kg**	**452k**	**0**
Venus	**0.723AU, 67.2m,108.2km**	**224.68 Earth days**	**243 Earth days**	**4.87 x 10 24**	**7,521m 12,104km**	**726 k**	**0**
Earth	**1 AU, 93 m,149.6 km**	**365.26 days**	**24 hours**	**5.98 x 10 25**	**7,926m 12,756km**	**260-310 k**	**1**
Mars	**1.524AU, 141.6m,227.9km**	**686.98 Earth days**	**24.6 Earth hours**	**6.42 x 10 23**	**4,222m 6,787km**	**150-310 k**	**2**
Jupiter	**5.203AU, 483.6m,778.3km**	**11.862 Earth years**	**9.84 Earth hours**	**1.90 x 10 27**	**88,729m 142,796 km**	**120 k**	**18 (plus many more smaller ones)**
Saturn	**9.539AU, 886.7m,1427.0km**	**29.456 Earth years**	**10.2 Earth hours**	**5.69 x 10 26**	**74,600m 120,660 km**	**88 k**	**18**
Uranus	**19.18AU,1784.0m, 2871.0km**	**84.07 Earth years**	**17.9 Earth hours**	**8.68 x10 25**	**32,600m 51,118km**	**59 k**	**15**

VII. Comet: a small mass of ice, rock and dust

A. Orbit the sun in an elliptical orbit, have varying periods of revolution, ex. Halley's appears every 76 years, next 2061

B. Originate in an area outside our solar system; possibilities include Oort cloud and Kuiper belt

C. Tail: as comet approaches sun the heat vaporizes parts of it, solar wind and energy force the particles to stream away from the sun

VIII. Asteroids: small, rocky bodies orbiting the sun in same direction as the planets

A. Most are found in a region between Mars and Jupiter

B. Believed to be fragments of pre-planet material

C. Some cross Earth's orbit

IX. Meteoroids: similar to asteroids, but smaller

A. Meteor – a meteoroid that enters Earth's atmosphere, friction with gas particles causes it to burn, a "falling star"

B. Meteorite – a meteor that doesn't completely burn and reaches Earth's surface

C. Meteor showers – occur when Earth passes through debris left in a comet's orbit

Adequate time should be spent on space beyond our solar system.

X. Stars – bright spheres of gases; energy is produced by nuclear fusion

A. Properties
  1. Magnitude – the brightness of a star depends on its composition and distance from Earth
     a. Absolute – its actual brightness
     b. Apparent – its brightness as it appears from Earth
  2. Color and temperature are related
     a. hot – blue
     b. cooler – red
     c. medium – yellow
  3. Hertzberg-Russell diagram – a graph that plots absolute magnitude vs. temperature of a star

B. Life cycle
  1. Nebula – gravity pulls gas and dust together, temperature increases
  2. Protostar – beginning stage, nuclear fusion begins
  3. Main sequence – hydrogen changes to helium, may last for billions of years depending on mass
  4. Red giant – star's outer surface cools, expands and becomes red
  5. Death – final stage depends on mass
     a. low mass – red giant collapses and becomes white dwarf
     b. medium – forms planetary nebula then white dwarf
     c. massive – supernovas, then may become a very dense neutron star or an extremely dense black hole

C. Other stellar objects:
   1. Pulsars – a spinning neutron star, sends out beams of radiation
   2. Quasars – very bright centers of some distant galaxies
D. Constellations – a group of stars that form a pattern, 88 accepted world-wide
   1. Used in the past for navigation and as a yearly calendar
   2. Circumpolar – five constellations seen throughout the year, rotate around the North Star, include:
      a. Ursa Major, the Great Bear, part of which is the Big Dipper; stars at the end of its bowl point to the North Star
      b. Ursa Minor, the Little Bear or Little Dipper; Polaris, the North Star is at the end of its handle
   3. Zodiacal constellations – band of twelve constellations moving across the sky throughout the year
E. Galaxies – huge system of billions of stars held together by gravity
   1. Spiral – disk-shaped with a bulge in the center and spiral arms
      a. Milky Way – our sun is on one arm
      b. Andromeda Galaxy
   2. Elliptical – slightly flattened spheres, bright centers, very little gas and dust
   3. Irregular – no regular shape, many stars, great clouds of gas and dust
      a. Large Magellanic Cloud
      b. Small Magellanic Cloud – both seen from the Southern Hemisphere
F. Other star groups
   1. Globular clusters
   2. Open clusters
   3. Nebulas

THIRD TRIMESTER
Unit One: Meteorology

Meteorology - study of weather processes and forecasting

I. <u>Atmosphere</u> – the mass of air surrounding the Earth

A. <u>Composition</u>

1. Nitrogen – 78%
   a. dilutes oxygen, prevents rapid burning of the Earth's surface
   b. nitrogen cycle
2. Oxygen – 21%
   a. animals use oxygen directly from the air or dissolved in water
   b. product of photosynthesis
3. Other gases
   a. Carbon Dioxide
      1) helps prevent escape of heat into space
      2) used by plants in photosynthesis
   b. Water vapor
      1) varies in amount from place to place
      2) helps prevent loss of heat from the Earth
   c. Trace gases: argon, neon, helium, ozone, local pollutants

B. <u>Structure</u> – based on temperature

1. <u>Troposphere</u> – layer nearest the Earth
   a. 75% of atmosphere's gases found here
   b. Weather occurs here
   c. Temperature decreases with height
2. <u>Stratosphere</u>
   a. Constant temperature of -60ºC
   b. Clear; planes fly here
   c. Jet streams – high winds associated with a polar front
   d. Ozone – 3 atoms of oxygen combine to form 1 molecule of ozone- O_3
      1) absorbs most of sun's UV radiation reaching Earth
      2) 10 – 50 km above Earth's surface
   e. Temperature increases to 0º due to absorption of UV radiation
3. <u>Mesosphere</u> – 50 to 80 km above Earth
   a. Coldest zone – outer mesosphere temperature -100ºC
   b. Meteors burn up here
4. <u>Thermosphere</u> – extends upward from 80 km to 500-750 km
   a. Temperatures increase rapidly as solar energy is absorbed
   b. Contains 2 layers
      1) Ionosphere – begins at 80 km
         a) Positively charged ions and free electrons reflect radio waves back to Earth
         b) Affects radio transmissions
         c) Aurora at poles: ions interact with air molecules to produce colors in the sky

2) Exosphere - highest layer of the atmosphere; extends to 10,000 km above Earth
   a) Gases escape into space
   b) Where satellites orbit

5. Magnetosphere – magnetic field surrounding the Earth
   a. Extends far into space
   b. Radiates between North and South poles
   c. Composed of charged protons and electrons
   d. Protects Earth from harmful solar winds
6. Van Allen belts – areas in the magnetosphere with high concentrations of charged particles

II. Weather – sum of all the conditions of the atmosphere that affect Earth's surface

A. Components

1. Temperature
   a. Sun is basic source of heat
      1) Radiation – transfer of heat by means of wave energy
      2) Conduction – direct transfer of heat energy by actual contact of molecules
      3) Convection – transfer of heat energy in a fluid by movement of molecules from one area to another
   b. Instrument – thermometer
2. Wind – caused by differences in temperature, pressure, and the Coriolis effect (curving of currents due to rotation of the Earth)
   a. Global wind patterns
      1) Polar easterlies – from east to west, away from poles
      2) Prevailing westerlies – mid-latitude, curve toward poles
      3) Horse latitudes – belt of calm air 30° north and south of equator
      4) Trade winds – blow from horse latitudes toward equator
      5) Doldrums − windless zone around equator
   b. Local winds – caused by unequal heating of Earth's surface a small area
      1) Sea breeze – during the day warm air over land rises, replaced by cooler air above water
      2) Land breeze – during the night warmer air over ocean rises, replaced by cooler air above land
      3) Monsoons – similar to land and sea breezes, but occurring seasonally and over a larger area
   c. Jet stream – high altitude winds blowing from west to east
   d. Instruments
      1) Wind vane – shows wind direction
      2) Anemometer – made of small cups that catch the wind; measures wind speed
      3) Beaufort Scale – used by meteorologists to indicate wind force

3. <u>Humidity</u> – amount of moisture in the air
   a. The warmer the air the more moisture it holds
   b. Relative humidity – how much water vapor air holds at a given temperature, compared to the total it can hold
      1) When relative humidity is low, evaporation/cooling occur quickly
      2) When relative humidity is high, evaporation/cooling occur slowly
   c. Saturated air holds all the water vapor possible at a given temperature and pressure
   d. Dew point – temperature at which water vapor condenses
   e. Frost – water vapor that has condensed as a solid when temperatures drop below freezing
   f. Instrument – psychrometer
      1) Compares temperature difference between wet bulb and dry bulb thermometers
      2) The drier the air, the faster the rate of evaporation, and the lower the wet bulb reading
      3) Relative humidity table – used with readings from both thermometers to determine relative humidity
4. <u>Clouds</u> – tiny droplets of water vapor and dust suspended in the air
   a. Cirrus: feathery, wispy, high altitudes; fair weather now inclement weather in 3 to 5 days
   b. Stratus: low uniform sheets or layers
   c. Nimbostratus: dark, gray, low-layered; uniformly dense and threatening, rain or snow may develop
   d. Cumulus: formed by vertically rising air currents, piled high in thick fleecy masses
   e. Cumulonimbus: storm clouds; heavy precipitation, often accompanied by thunder and lightning
   f. Fog: formed close to the ground
5. <u>Precipitation</u>
   a. Rain
   b. Snow
   c. Sleet – ice particles smaller than 5mm
   d. Hail – ice particles larger than 5 mm, formed in thunderstorms
6. <u>Air Masses</u> - a huge body of air that has similar temperature, pressure, and humidity throughout
   a. Types
      1) Tropical – originate near the equator
      2) Polar – originate at higher latitudes
      3) Maritime – form over oceans, humid
      4) Continental – form over land, usually dry
   b. Fronts: boundary between two air masses
      1) Cold – occurs when cold air replaces warmer air; brief heavy storms, clear afterwards
      2) Warm – occurs when warm air is displacing colder air, moves slowly; steady precipitation

    3) Stationary – occurs when neither mass moves; many days of clouds and precipitation
    4) Occluded – a warm air mass is caught between two cooler masses; cloudy and wet
7. <u>Air Pressure</u> – weight of air pressing down at Earth's surface
    a. Related to altitude and density: air pressure decreases as altitude increases, but as air pressure decreases so does density
    b. Relationship to temperature
        1) As temperature increases, pressure decreases – as heating takes place, atoms move farther apart and weight of air is less
        2) As temperature decreases, pressure increases – as cooling takes place, atoms move closer together and weight of air is greater
    c. Common indicators
        1) Falling air pressure – precipitation
        2) Rising air pressure – clearing
    d. Instrument – barometer
        1) Mercury barometer (Torricelli) − balances the weight of the atmosphere against the weight of a column of liquid mercury
        2) Aneroid barometer − an airtight metal box with a thin metal disk that bends under air pressure, connected to a spring indicating air pressure

B. <u>Storms</u> – severe disturbances in the atmosphere
1. <u>Thunderstorms</u> - heavy rainstorm resulting from masses of warm, moist air rising rapidly into colder drier upper air; accompanied by
    a. Lightning
    b. Thunder
    c. Flooding
2. <u>Hurricanes</u> − tropical storm that begins over the ocean, also called cyclones or typhoons
    a. Circular pattern of clouds
    b. Reaches 600 km across
    c. Eye, or center, is calm
    d. Winds exceed 119 km per hour
3. <u>Tornadoes</u> – rapidly spinning funnel-shaped cloud caused by the meeting of two masses of air with different characteristics
    a. Usually form in cumulonimbus clouds
    b. Air pressure may be as much as 1/3 lower than normal
    c. Winds may reach 500 km/h
    d. Move in narrow paths along the ground
4. <u>Blizzard</u> – severe snowstorms, accompanied by
    a. High winds
    b. Temperatures near zero
    c. Low visibility

C. Forecasting Weather

1. Meteorologist – scientist who studies weather and tries to predict it
    a. Must accurately measure all components of weather
    b. Must monitor changes hourly
2. Collecting Weather Data
    a. Land stations
    b. Weather balloons
    c. Satellites
        1) GOES – geostationary operational environmental satellite
        2) POES – polar orbiting environmental satellite
    d. Doppler RADAR
3. Weather Maps
    a. Show location of major fronts and areas of high and low pressure
    b. Station model: symbol on weather map that indicates wind speed and direction, cloud cover, temperature, atmospheric pressure
    c. Isobars: lines connecting points of equal pressure
    d. Isotherms: lines drawn to connect points of equal temperature

III. Climate: pattern or cycle of weather conditions over a large area averaged over many years

A. Factors that affect climate

1. Latitude
2. Altitude
3. Distance from oceans
4. Prevailing winds
5. Surface features – nearby mountains, lakes, etc.

B. Climate Zones

1. Polar
2. Tropical
3. Temperate

C. Changes caused by:

1. Global Warming – increased buildup of CO_2 due to industrialization
2. Ozone destruction – loss of ozone layer above Antarctica, due to CFC's used in refrigerators, air conditioners, spray can propellants
3. Ice Ages
4. El Nino – temporary disruption of the ocean/atmospheric system in the tropical Pacific; causes heavy rains, mudslides, droughts, increased hurricanes and tornadoes

Third Trimester
Unit Two: Energy Resources

I. <u>Fossil Fuel</u> - nonrenewable resources formed by the decay of plant and animal matter in the Earth's crust.

A. <u>Coal</u> – formed in the absence of oxygen from swamp plants, which were buried for a long period of time under heavy layers of rock.
   1. <u>Stages of Coal Formation</u> - characterized by removal of impurities and moisture
      a. Peat
         1) 50-60% carbon
         2) Dark, brown, spongy substance that looks like rotted wood
         3) Is cut, stacked, dried, and is important fuel source in Ireland and Russia
         4) Produces much smoke but little heat
      b. Lignite
         1) 70 % carbon
         2) Has lost most of its moisture, oxygen and nitrogen
         3) Burns with a smoky flame and produces relatively little heat
      c. Bituminous
         1) 80% carbon
         2) More compact and efficient than lignite
         3) Burns with a smoky flame
      d. Anthracite
         1) 90% carbon
         2) Burns hotter and longer with a blue, nearly smokeless flame
         3) The largest known anthracite coal deposits are found in Pennsylvania
   2. <u>Advantages of Coal</u>
      a. Plentiful supply
      b. Burns with great heat
   3. <u>Disadvantages of Coal</u>
      a. Produces physical and chemical pollution, including fly ash, acid rain, carbon dioxide, and smog
      b. Mining can destroy the surface of the land

B. <u>Petroleum</u> – thick, black, liquid, flammable hydrocarbon formed from the decay of marine organisms
   1. Name means "oil from rock"
   2. Formed from dead one-celled organisms collected on the muddy ocean floor
   3. Pumped from wells drilled into oil fields
   4. Can be separated into various compounds, including propane, butane, ethane, gasoline, jet fuel, lubricants, waxes, asphalt
   5. <u>Advantages</u>
      a. Easy to transport
      b. Cleaner burning than coal

c. Produces greater heat

6. Disadvantages
   a. Limited supply
   b. More expensive than coal
   c. Major chemical pollutant from oil spills

C. Natural Gas – methane (CH_4) formed from the decay of marine organisms
   1. Formed in the same manner as petroleum
   2. Advantages
      a. Clean burning, less expensive than coal or oil
      b. Produces great heat
      c. Easily transported
   3. Disadvantage – limited supply

II. **Nuclear Energy** (Suggested field trip to Limerick)

A. Fission – splitting of atomic nuclei resulting in the release of large amounts of energy
   1. Uranium-235
      a. Chain reaction – neutron hits uranium nucleus, resulting in the release of a great amount of energy, Barium-140, Krypton-94, and three neutrons, which can in turn bombard other uranium-235 nuclei
      b. Energy produced is in the form of heat that turns water to steam. Steam turns turbines that run generators that produce electricity. The water is cooled and recycled.
      c. Reactor
         1) Consists of 20cm thick steel vessel that stands 10m tall
         2) Uranium is in tubes in the lower part; top part contains control rods that move up and down so as to absorb neutrons and thus regulating the rate of the reaction
         3) Contained within large, heavy, concrete containment building
   2. Uranium-238 used in breeding reactor in which Uranium-238 nuclei split to produce Plutonium-239, which is split to produce heat energy
   3. Advantages
      a. Great amount of heat
      b. Small amount of material
   4. Disadvantages
      a. Safety hazard due to radioactivity
      b. Problem of waste storage, for every 100g used, 99g of waste is produced; waste needs 600 to 1000 years until it is not harmful
      c. Thermal pollution
      d. Most Uranium-235 will be used up in 35-40 years

B. Fusion – union of atomic nuclei to form heavier nuclei resulting in release of large amounts of energy
   1. Four hydrogen nuclei join to form helium; reaction much the same as the reaction on the Sun

2. Advantages
    a. Unlimited supply of hydrogen from ocean
    b. Non-air polluting
3. Disadvantage – requires extremely high temperature to initiate the reaction; thus, more research is needed to find safe, practical way to achieve fusion.

III. Wind

A. Used directly to pump water or to run generators to produce electricity
B. Advantages – power source is free and non-polluting
C. Disadvantages
    1. Wind must be constant
    2. No practical way of storing energy during periods of calm

IV. Solar

A. Types of Solar Power
    1. Solar cell - made of silicon and small amounts of arsenic and boron; produces an electric current as sunlight strikes electrons loose from top layers
    2. Solar collector (solar panels) – sunlight heats water as it passes through black tubes located inside a box which has a clear plastic or glass top; hot water can be collected in a tank
    3. Power tower – many mirrors are used to reflect sunlight to the top of a structure, where concentrated sunlight heats water to produce steam that generates electricity
    4. Passive solar power – through a greenhouse-type structure on the side of a building, the sunlight strikes a storage mass of concrete, brick or stone, which absorbs radiant energy during the day, which causes convection currents to carry warm air to the rest of the house.

B. Advantages
    1. Free supply of power source
    2. Nonpolluting

C. Disadvantages
    1. Direct and constant use not available in some places
    2. Some collection methods are expensive to build
    3. Storage problems during cloudy periods

V. Geothermal – energy contained in intense heat that continually flows outward from deep within the Earth. This heat originates primarily in the core. Some heat is generated in the crust by the decay of radioactive elements in the Earth’s crust.

A. Types
    1. Flash Steam Plants – Most operating geothermal power plants are flash steam plants. In a flash steam plant, hot water from wells is piped into the plant, where, released from the high pressure of its underground location, some of the hot water boils (flashes) to steam.

2. Dry Steam Plants – Steam from a steam reservoir is used in a dry steam plant. In such a plant, the steam is piped directly through a turbine generator.
3. Binary power plant - heat from geothermal water is transferred through heat exchangers to a second liquid (usually isobutane) contained in adjacent but separate pipes. Heat transferred from the geothermal water converts this low-boiling point working fluid into vapor, which powers a turbine generator. This undeveloped energy source will utilize water under pressure due to dissolved natural gas.

B. Advantage – free and clean source of energy

C. Disadvantages
1. Limited availability
2. Thermal pollution

VI. Hydroelectricity – water stored behind dams falls through large pipes in the dam to a powerhouse where it moves turbines to run electrical generators

A. Advantages
1. Power source is generally free
2. Self-renewing resource

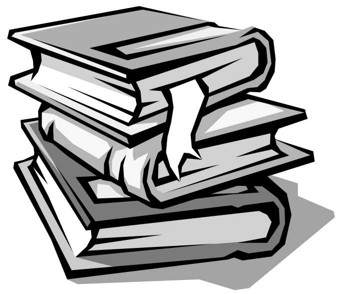
B. Disadvantages
1. Dams are expensive
2. Limited location
3. Environmental concerns: lakes behind dams cover farmland, deposits of mineral, alters ecosystem

VII. Biomass – parts of plants or other organic materials that can be used for energy

A. Uses
1. Can be burned directly for heat energy
2. Can be converted into fuels
   a. Biomass rotted in a closed container without air produces methane
   b. Biomass containing sugar or starch, with the addition of yeast, produces alcohol for burning

B. Advantages – generally an inexpensive, renewable source of energy

C. Disadvantages
1. Could never be a sole source of energy
2. Practical aspects need to be researched



APPENDIX

ROLE OF THE SCHOOL SCIENCE COORDINATOR

In order to provide for articulation in the science curriculum and to make science an important and functional learning situation, the principal should appoint a science coordinator.

This coordinator should be an experienced teacher (if possible), but above all one who is interested in science and is familiar with the latest books and programs. The coordinator must be aware of innovations and new methods and be willing to implement them.

Responsibilities of the Science Coordinator

1. To work with the principal and teachers to define the curriculum for each grade level and to make sure that the archdiocesan curriculum guidelines are adapted for the school.

2. To be responsible for keeping the texts or programs up to date and to prepare orders for additional texts and workbooks to be used for the next school year.

3. To consult with the principal about providing equipment and materials so that investigative science can be performed in the school.

4. To inform teachers of the availability of materials and equipment for their level.

5. To hold periodic meetings with the teachers to discuss the implementation of the science program and to provide for a sharing of ideas and methods.

6. To assist the teacher whenever needed and to encourage science experimentation.

7. To acquaint new staff members with curriculum guidelines and to see that the teachers have a copy; to offer any help needed by teachers in the implementation of the science program.

8. To present interesting articles and new ideas in the field of science through periodicals, books, workshops, etc.

9. To attend workshops or meetings provided by the archdiocese or any other seminars provided by professionals.

10. To plan and organize a science fair.

11. To keep the principal informed of meetings and any new developments in classroom science.

WEB SITES FOR TEACHERS

1. **The MAD Science Library** http://www.madsci.org/libs
2. **Science and Mathematics News Sources** http://www.unc.edu/depts/cmse/news-sources.html
3. **Teaching with the Internet** http://www.usd.edu/engl/teachinternet.html
4. **Educators' Source Page** http://pelican.gmpo.gov/gulfed/teacher.html
5. **A+ Educational Web Sites** http://www.esi10k12.ne.u.s/~kearney/kellefile/teacher.html
6. **The Franklin Institute** http://sln.fi.edu/
7. **NSTA Science Store** www.nsta.org/scistore
8. **NSTA Organization** http://www.nsta.org/programs/new.htm
9. **Kit & Kaboodle** http://www.kotkaboodle.org
10. **Newton's Apple** http://ericir.syr.edu/Projects/Newton/
11. **Living Things** http://www.fi.edu/tfi/units/life
12. **Weather Eye** http://weathereye.kgan.com
13. **Auroras: Paintings in the Sky** http://www.exploratorium.edu/learning-studio/auroras
14. **Volcano World** http://volcano.und.nodak.edu/
15. **Space Day – Embrace Space** http://www.spaceday.com/home.htm
16. **Space Available** http://octopus.gma.org/surfing/space.html
17. **Wizard's World** http://www.mcn.org/ed/cur/cwl/cwhome.html
18. **Galileo** http://www-hpcc.astro.washington.edu/scied/galileo.html