

Archdiocese of Philadelphia



Science Guidelines

Grade 6

2005

GENERAL SCIENCE 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 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.

Introduce, Reinforce, Master	K	1	2	3	4	5	6	7	8
1. <u>Observing</u> : ability to identify properties, structures, etc. through use of all the senses	I	R	R	M					
2. <u>Classifying</u> : ability to group, match, compare by commonality	I	R	R	M					
3. <u>Identifying</u> : ability to describe and interpret sensory and qualitative aspects of learning		I	R	R	R	M			
4. <u>Questioning</u> : ability to ask pertinent questions regarding experiences		I	R	R	R	M			
5. <u>Measuring</u> : ability to find quantitative differences, to estimate, calculate, etc. (metric)	I	R	R	R	R	M			
6. <u>Recording</u> : ability to collect, record, and tabulate data meaningfully				I	R	R	R	M	
7. <u>Predicting</u> : ability to guess outcomes on basis of previous experiences				I	R	R	R	M	
8. <u>Formulating Models</u> : ability to represent cognitive data graphically					I	R	R	M	
9. <u>Formulating a Hypothesis</u> : 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. <u>Interpreting</u> : ability to analyze data validly (similarities, dissimilarities, cause/effect)						I	R	R	M

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

<u>I</u>ntr<u>o</u>duce, <u>R</u>einforce, <u>M</u>aster									
1. <u>O</u> bserving: ability to identify properties, structures, etc. through use of all the senses									
2. <u>C</u> lassifying: ability to group, match, compare by commonality									
3. <u>I</u> dentifying: ability to describe and interpret sensory and qualitative aspects of learning									
4. <u>Q</u> uestioning: ability to ask pertinent questions regarding experiences									
5. <u>M</u> easuring: ability to find quantitative differences, to estimate, calculate, etc. (metric)									
6. <u>R</u> ecording: ability to collect, record, and tabulate data meaningfully									
7. <u>P</u> redicting: ability to guess outcomes on basis of previous experiences									
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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.

PSS	Content	Suggested Strategies and Assessments
3.5.7.A.	<p>Unit One: Geology</p> <p>I. <u>Structure of the Earth</u></p> <p>A. <u>Core</u> - composed of iron and nickel, extremely hot</p> <ol style="list-style-type: none"> 1. <u>Inner Core</u> - solid metal due to pressure 2. <u>Outer Core</u> - extremely hot liquid metals <p>B. <u>Mantle</u> - thin, hot layer found under Earth's crust</p> <p>C. <u>Crust or Lithosphere</u> - thin, outer layer of the Earth composed of solid rock</p> <ol style="list-style-type: none"> 1. <u>Continental crust</u>, composed primarily of granite, is thicker. 2. <u>Oceanic crust</u>, composed primarily of basalt, is thinner. 	<p>Draw a diagram of the Earth's layers on poster or in copybook. Label the layers.</p> <p>Draw a diagram of the Earth's layers on the computer using AutoShapes in a MSWord document. Label the layers.</p> <p>Research formation of granite and basalt. Observe the state of matter in a cornstarch solution. Is it liquid or solid? Apply pressure to the mixture. Compare to inner and outer core of the Earth.</p>
3.2.4.C.	<p>II. <u>Plate Tectonics</u> - theory that the lithosphere is broken into moving plates.</p> <p>A. <u>History</u></p> <ol style="list-style-type: none"> 1. <u>Continental Drift Theory</u> was first proposed by Alfred Wegener in 1912. 2. Theory was not accepted until the ocean floor was explored using SONAR. <p>B. <u>Continental Drift Theory</u></p> <ol style="list-style-type: none"> 1. All continents were once joined to form a super continent called Pangaea. 2. Pangaea broke into plates to form the continents. 3. The plates are still drifting apart. 	<p>Research the life of Alfred Wegener: write a report; create an interview with Mr. Wegener; create a PowerPoint on his life.</p> <p>Research SONAR or the exploration of the ocean floor. Make a poster; write a report; draw a diagram.</p>
3.1.4.B.	<p>C. <u>Plates</u> - large sections of the Earth's crust</p> <ol style="list-style-type: none"> 1. About 20 plates - 7 large, 13 small 2. Largest plate is the Pacific Plate 	<p>Create a puzzle of the Earth's continents.</p> <p>Demonstrate the movement of the Earth's</p>

- 3.1.4.E.** **3.5.7.A.** **D. Plate Movement** - plates move as a result of convection currents in hot magma.
- 1. Colliding Boundaries** - plates push against each other; formation of the Himalayas
 - 2. Spreading Boundaries** - plates are pulled apart formation of the Great Rift Valley in Africa
 - 3. Fault Boundary** - two plates moving past each other; formation of the San Andreas fault
- 3.1.4.E.** **3.5.7.A.** **III. Earthquakes** - occur when built up pressure from moving plates is released
- A.** Major earthquakes usually occur at fault boundaries.
 - B. Focus** - point where the rock first breaks, or moves, causing the earthquake
 - C.** Energy is released in waves.
 - 1.** The closer to the focus, the stronger the wave.
 - 2.** Waves can cause damage to structures.
 - 3.** Earthquakes can cause **tsunami** - large wave of water that destroys coastal areas; may be over 30 meters high
- 3.6.7.C.** **D. Richter Scale** is used to compare strengths of earthquakes.
- 1.** Scale of 1 to 10
 - 2.** Each increasing number is 10 times stronger than the preceding number.
 - 3.** Damage is caused in 5+ earthquakes.
 - 4.** The Richter Scale number will be higher the closer to the focus the measurement is taken.
- 3.2.4.C.**

plates by creating the different boundaries using a Milky Way candy bar.

Diagram the types of boundaries on posters or in copybooks.

Using Microsoft Publisher, create an earthquake safety brochure.

Build a model seismograph.

Research two major earthquakes that have taken place in cities and compare and contrast the affects on the city and its people.

Group or individual research on the tsunami in Indonesia in December, 2004.

Collect information of Charles Richter.

Investigate what buildings are less damaged by earthquakes.

3.5.7.A.

IV. Volcanoes - an opening in the Earth's surface through which magma rises.

A. Formation of Volcanoes

1. Most observed volcanoes occur at colliding boundaries.
 - a. One lighter plate (oceanic plate) sinks below a heavier one (continental plate).
 - b. Less dense magma rises up through the fault.
2. Other volcanoes occur at spreading boundaries on the ocean floor
 - a. Gentler eruptions - lava quietly flows onto the surface of the plate
 - b. New ocean floor is created

B. Types of Volcanoes

1. **Shield** - formed from lava flows that harden
2. **Cinder Cone** - formed from explosive eruptions in which volcanic materials are thrown high in the air and pile up around the vent of the volcano.
3. **Composite** - formed from alternating explosions and lava flow

3.1.4.B.

C. Volcanic Features

1. **Crater** - deep sided depression at the top or on the side of a volcano formed during an eruption
2. **Magma** - molten rock inside the Earth
3. **Lava** - molten rock which reaches Earth's surface
4. **Caldera** - crater at least 1.6 km wide: i.e., Crater Lake in the Cascade Mountains
5. **Geysers** - groundwater heated to boiling by

Write a newspaper article on the eruption of an actual volcano as though you were there.

Create an experiment to demonstrate how convection currents cause plate movement.

Group or individual research on Kilauea and its impact on Hawaii

Group or individual research on Mt. St. Helens past and current status.

Build and label a 3-D model of a volcano.

trapped magma which erupts on the Earth's surface; i.e., Old Faithful

6. Volcanic Ash - tiny bits of rock that fly into the air during an eruption, can form a thick cloud of ash and cinders.

3.1.4.E.

3.5.4.A.

3.5.7.A.

3.5.4.A.

V. Weathering and Erosion

A. Weathering - group of processes that break rocks into smaller pieces

B. Erosion - wearing away of the Earth's surface by natural forces; caused by:

1. Wind - over a period of time wind erosion can carry away topsoil and wear away at rocks and minerals.

2. Running Water

a. Surface Water - as the water moves to drainage basin, a land area from which a river system gets its water; it picks up sediment and sculpts the land; i.e., Grand Canyon

b. Groundwater - underground system of water which erodes rocks and mineral underground sculpting caves and caverns; i.e., Carlsbad Caverns

3. Glacier - large mass of moving ice which shapes the land in many ways. The sediment at the end of the glacier is called a **moraine**.

C. Deposition - process in which the sediments from erosion are carried away to another place and deposited; caused by:

Make a flip book that shows soil being eroded by wind, water, or ice.

Investigate how slope affects erosion by running water.

Use a bar of soap to demonstrate erosion by glaciers (ice cube frozen with sand).

1. Wind
2. Running Water
3. Moving Glacier

Unit Two: Physical Science

3.4.4.C.

I. Forces and Motion

3.4.7.C.

A. Force - push or pull

1. A force can cause an object to speed up, to slow down to change direction, or to stop moving.
2. Gravity - force that is always working on objects on Earth. It is the force that pulls us and everything around us toward the center of the Earth.
3. Gravitation is different than gravity. It is the universal pull of all objects on one another, causing them to move closer together.
 - a. Objects with larger masses have a greater pull.
 - b. As distance between objects increases, gravitational pull decreases.
 - c. All force is measured in newtons.

B. Motion is measured by the change of position of an object.

1. Speed - measure of how far something moves during a certain period of time.
 - a. Speed = distance divided by time
 - b. Students should be able to recognize the difference between constant and average speeds.
2. Velocity - speed of an object with a given direction
3. Acceleration - rate of change in velocity. This can be a change in speed or direction or both.
4. Momentum - mass times velocity

Write a descriptive paragraph about a situation in which a force acts on an object.

Calculate the "weight" of objects that are taken to the Space Station and describe why it is possible to "carry" the objects and build in space. Discuss "center of gravity" as the center of mass of each object (spinning a basketball on one finger).

Explore: Why does "weight" change if you go to the moon?

Write a narrative that describes the motion of a boy on a skateboard from the perspective of the boy, a dog, and a person driving by in a car.

Explore speed and acceleration using toys or students and a stop watch. Graph time vs. speed and time vs. distance.

See activity for the 3rd Law of Motion.

II. Newton's Laws of Motion

A. History

1. Over three hundred years before Christ, Aristotle wrote that moving objects need a push or pull to keep in motion.
2. Four hundred years ago, Galileo showed that moving object would keep moving in a straight line without a push or pull until something interfered with its motions.
3. Newton developed Galileo's laws into three laws of motion. His laws describe gravity, other forces, and the ways that objects in motion affect one another.

B. Newton's Laws of Motion

1. **First Law** - An object at rest tends to stay at rest and an object in motion tends to stay in motion in a straight line until an outside force acts on it.
 - a. When you pedal a bicycle it moves, when you stop, it stops.
 - b. A ball changes direction when it is hit by a bat.
2. **Second Law** - The acceleration of an object depends on the mass of an object and the size of the net force supplied to it. $\text{Force} = \text{mass} \times \text{acceleration}$.
 - a. It is easier to push an empty box than a full one.
 - b. A wagon with ten books is more difficult to pull than one with five books.

Predict how fast objects will fall. Conclude where Galileo was right and wrong.

Define "inertia."

Create a collage of magazine pictures to illustrate the 1st Law of Motion.

Experiment with lighter and heavier objects. Find the mass. Observe the speed (using a stopwatch) with which the object is moved from point A to point B. Calculate the amount of force needed.

3.4.4.B.

3. **Third Law** - For every action force, there is an equal and opposite reaction force.
 - a. When children who are facing each other push off from one another, they move backwards.
 - b. It would be unwise to jump to a dock from an untied boat because the boat would float away from the dock.
4. The study of Newton's Laws is enhanced by the addition of student inquiries and investigations.

C. How Forces Interact

1. **Friction** - force that opposes motion whenever two surfaces rub against each other
 - a. Causes heat
 - b. Slows objects down
2. **Balanced Forces** - equal in size, opposite in direction. There is no change in motion with balanced forces.
3. **Unbalanced Forces** - unequal in size, similar in direction. Unbalanced forces will cause an object at rest to move.

Launch balloon rockets.

Use "tug of war" is safe conditions can be provided
Predict reactions of various balls in collision.

Use the Laws of Motion to argue in favor of airbags in cars.

Research the types of friction and create a poster that shows them.

Design a series of exercises for people to do to balance body forces.

Write a persuasive essay to the principal describing why a trip to an amusement park would enhance your physical science education.

Unit Three: Cells

I. Cell Theory

- A. Cells are the basic units of living things.
- B. All living things are made of one or more cells.
- C. All cells come from existing cells.

II. Structures

A. Animal Cells

1. **Cell membrane** - surrounds cells; holding parts together
2. **Nucleus** - directs cell activities
3. **Cytoplasm** - material between the nucleus and cell membrane; fluid that contains the organelles
4. **Mitochondria** - convert chemical energy of food into a form that cells can use
5. **Vacuole** - contains fluid and is surrounded by a membrane; stores water and nutrients and helps the cell digest food.
6. **Endoplasmic Reticulum** - network of folded membranes; serves as a transportation system; helps make protein
7. **Ribosome** - found in the endoplasmic reticulum; begins the process of making proteins
8. **Lysosomes** - contains powerful chemicals that break down harmful molecules and recycle worn-out cell parts

3.1.4.B.

3.3.4.B.

3.3.7.B.

Create a room or schoolyard "walk around" model of a cell.

Create an edible model of a plant or animal cell.

Challenge students to observe plant and animal cell differences under a microscope.

Investigate sickle cell anemia, hemophilia, and cystic fibrosis on the Internet.

Create a newspaper Want Ad advertising some of the positions of cell structures.

3.3.4.B.

3.3.7.B.

B. Plant Cells

1. Cell wall - surrounds the cell membrane; since it is stiffer, it gives extra support
2. Cell membrane - surrounds cell holding parts together.
3. Nucleus - directs cell activities
4. Mitochondria - convert chemical energy of food into a form that cells can use
5. Vacuole - contains fluid and is surrounded by a membrane; stores water and nutrients and helps the cell digest food; plants usually have only one large vacuole instead of the many smaller ones of an animal cell
6. Chloroplasts - contain chlorophyll which gives plants their green color; plants make food when sunlight strikes chlorophyll

III. Functions

- A. Diffusion - movement of a substance from an area of higher concentration to an area of lower concentration
1. Diffusion occurs because the particles are always moving.
 2. Many substances can pass through a cell membrane by diffusion.
 - a. oxygen, water, carbon dioxide - can
 - b. salts, proteins - cannot
- B. Osmosis - diffusion of water across a cell membrane

Describe how an egg is a good model of an animal cell.

Explore how a cell membrane works by observing a potato or an apple in water.

Act out movement into and out of a cell.

Use a plastic bag to demonstrate how some materials can and cannot move through the cell membrane.

3.3.7.B.

IV. Division of Cells

- A. Single-celled organisms divide into two new organisms when they get too large.
- B. Multicellular organisms grow as the cells divide into two new cells.
- C. **Mitosis** is the process in which the cell nucleus divides.
 - 1. Nucleus contains DNA, a material that stores coded information about the organism.
 - 2. When mitosis begins, DNA forms **chromosomes** which carry information about the cell's activities.
- D. **Characteristics of Cancer Cells**
 - 1. Cell growth is uncontrolled.
 - 2. Cells do not function as part of the body.
 - 3. Cells take up space and interfere with normal body functions.
 - 4. Cells travel throughout the body.
 - 5. Cells produce tumors and abnormal growths.

Interview a cancer doctor.

3.1.7.A.

Unit Four: Human Body Systems

I. Nervous System - controls movement, thought, and behavior

A. Structure

1. Central Nervous System

a. Brain

- 1) **Brain stem** - maintains blood pressure, heart beat, respiration, and digestion
- 2) **Cerebellum** - controls balance and posture, helps fine-tune movements
- 3) **Cerebrum** - interprets information that the senses gather

b. Spinal cord - bundle of nerves that runs from the base of the brain to the hips

2. Peripheral Nervous System

a. Voluntary actions - cranial and spinal nerves travel from the central nervous system to the skeletal muscles

b. Involuntary actions - not under conscious control: heart rate, breathing, digestion and glandular functions

B. Function

1. Internal and external exchanges that bring about a response called a **stimulus**.
2. **Homostatis** - regulation of steady, life-maintaining conditions.

Create an investigation to observe response time; graph the data; make suggestions for improving response time.

Investigate how the brain interprets the artistic style known as pointillism.

Write a step-by-step description of the nervous system response when you touch something hot.

3.6.4.A.

C. Healthy Nervous System

3.6.7.A.

1. Do not take drugs unless prescribed by a doctor.
Even some prescription medications can affect the brain.
2. Eat a well balanced diet.
3. Learn new skills to build new nerve connections in the brain.

3.3.4.A.

II. Endocrine System - controls internal conditions, growth, development, and reproduction

A. Endocrine system is made up of **glands**, organs that produce a chemical, that release the chemical directly into the blood.

B. Structures and Functions

1. **Pituitary glands** - controls development and body growth; controls the thyroid, ovaries, testes, and other glands
 - a. **ovaries** - control female characteristics and the menstrual cycle
 - b. **testes** - control male characteristics
2. **Pineal glands** - regulate daily changes in body activity and temperature
3. **Thyroid gland** - control how cells release energy
4. **Parathyroid glands** - control the amount of calcium and phosphorous in the blood
5. **Pancreas** - controls the amount of glucose and insulin
6. **Adrenal glands** - controls the body's reaction to anger, fright, or fear.

Memorize a short and/or humorous poem by authors such as Ogden Nash or Dr. Seuss.

C. Diseases of the Endocrine System

1. **Diabetes** - a condition in which the pancreas produces too little insulin
2. **Dwarfism or Giantism** - the pituitary gland does not function properly; producing too little or too much somatotropin that causes an unusually short or unusually tall person
3. **Hypothyroidism** - thyroid function slows down and person becomes lethargic and often gain weight
4. **Hyperthyroidism** - thyroid function becomes overactive; person may exhibit extreme nervousness, increased heart rate, and erratic metabolism.

Interview a doctor.

Explore websites that are devoted to supporting people who suffer from diseases of the endocrine system.

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.