6

Attachment 6

HIGH SCHOOL ASSESSMENT

SCIENCE

CORE LEARNING GOALS

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HIGH SCHOOL ASSESSMENT
SCIENCE
CORE LEARNING GOALS

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PREFACE

The Maryland School Performance Program began in 1989 in response to the report of the Governor's Commission on School Performance and reflects a major strategy for implementing school reform to improve educational opportunity and achievement by each student enrolled in Maryland's public schools. The high school assessment represents the final stage of the Maryland School Performance Assessment Program, which began with State-level assessments in grades 3, 5, and 8.

This document reflects the work of five content teams, appointed by the State Superintendent of Schools, to define Core Learning Goals that will serve as the basis of the assessment. This work is a direct outgrowth of the State Board of Education's Performance-Based Graduation Requirements Task Force.

The outcomes were prepared by a representative group of educators, recognized for their leadership in the fields of English, mathematics, social studies, and science. The Skills for Success component represents a cooperative effort between leading educators and the Maryland Business Round Table. The Core Learning Goals are meant to reflect the essential skills and knowledge that should be expected of Maryland high school students in the 21st century. There is no assumption that the State's high schools currently have the capacity to deliver these goals. Rather, if the goals are adopted, an infrastructure of support and professional development activities, including human and fiscal resources, will be necessary to implement these new standards. Each of the five documents is available upon request to the address listed below.

It is important to note that the Core Learning Goals for Skills For Success are meant to be part of each of the other four content areas. As such they will not be assessed by their own test, but rather within each of the four content areas. The test materials in each area will be developed in such a way that mastery of the Skills for Success is essential to high performance. Hence, you will notice that each of the documents has a section related to Skills For Success. It is also our intent that all teachers, not just those who are teaching English, mathematics, social studies, and science, will be responsible for Skills for Success. It will be important, therefore, that the Skills for Success document is shared with all high school teachers. The graphic that follows is intended to show the relationship between and among the content area and Skills for Success.

The content area information is provided as draft material representing the best thinking of the content teams for public consideration by educators and the public at large. The Content Team membership list is included as an appendix. Individuals and organizations may feel free to duplicate and disseminate the document as appropriate. It is also assumed that prior to adoption by the State Board of Education, or to curriculum redesign occurring at the local school system level, these documents should be shared with the appropriate departments in each high school in Maryland. Information should be gathered as to how departments are interpreting the goals, in order that the content teams may review the diversity of interpretations. Upon review of the anticipated diversity of responses, each Core Learning Goals Content Team would identify the level of specificity for the goals that clearly identifies the intent. At that point the outcomes would be published in the *Maryland Register* in preparation for State Board adoption.

Responses, reactions, and comments may be sent by mail or by fax to:

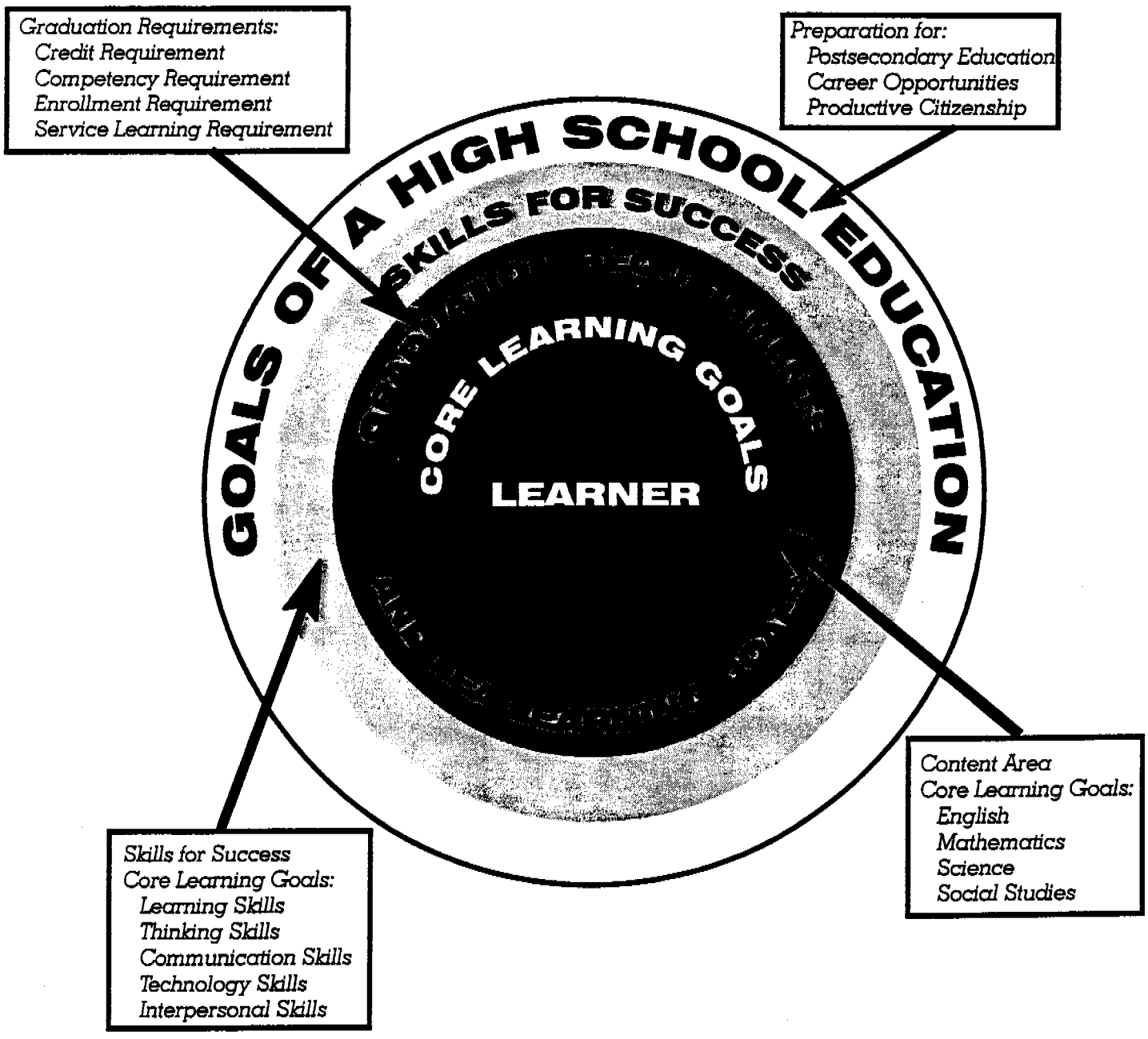
Robert E. Gabrys, Chair
High School Assessment Task Force
Maryland State Department of Education
200 West Baltimore Street
Baltimore, Maryland 21201
Fax: (410) 333-3867

Addresses are provided for each of the Content Team members at the end of the document. Any individual should feel free to discuss issues with these individuals. MSDE staff in the content area are also available for explanation of the Core Learning Goal documents.

Thank you in advance for your interest and willingness to aid in the development of high-quality expectations for Maryland high school students prior to graduation.

July 3, 1995
preface.reg

CONTEXT OF THE HIGH SCHOOL ASSESSMENT



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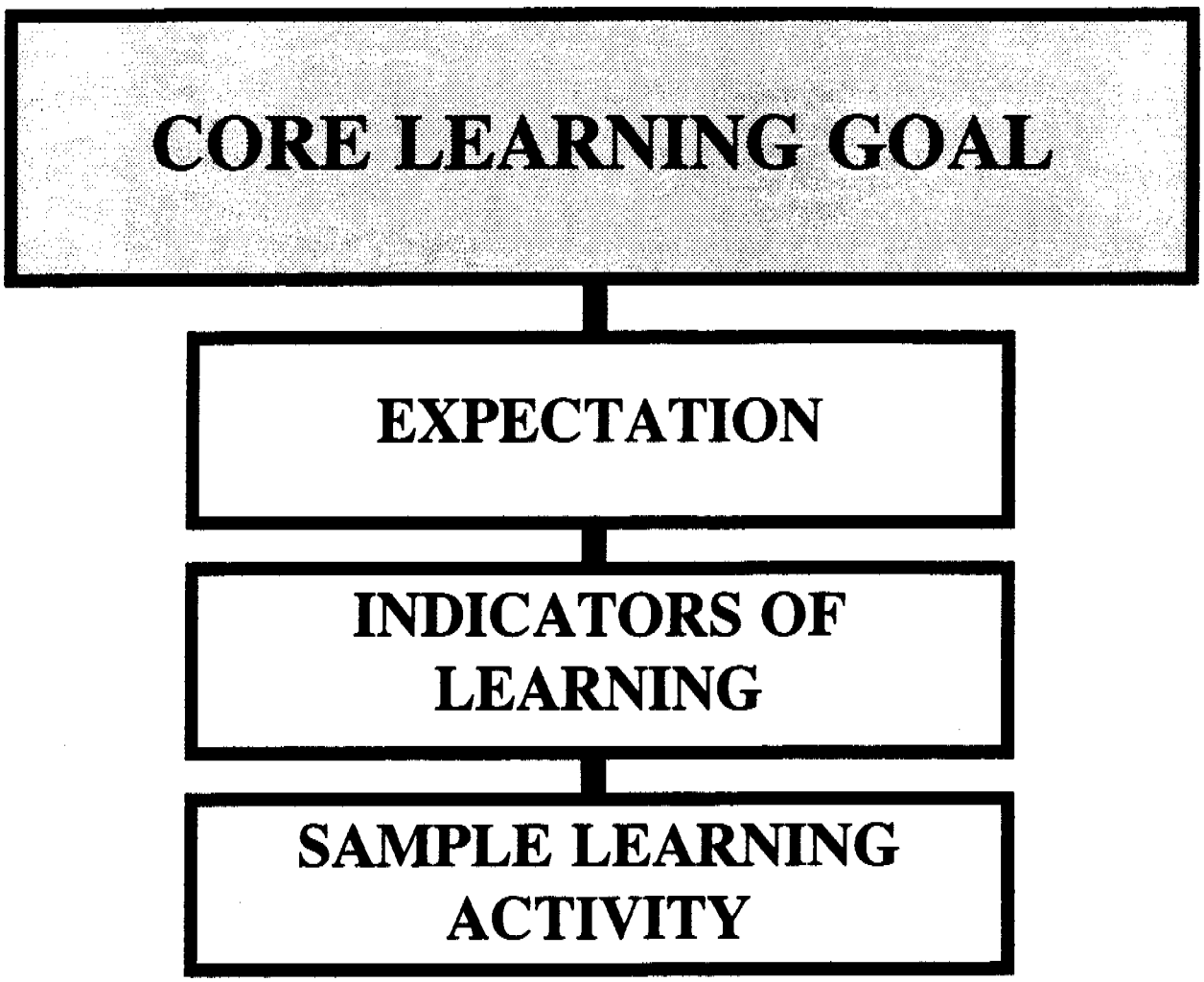


SCIENCE
CORE LEARNING GOALS

Introduction/Rationale

The Science Content Team for the High School Assessment Program views Core Learning as that knowledge which includes the processes of science as well as its concepts. The Core Learning Goals, Expectations, Examples, and Instructional Indicators in this document reflect the Team's commitment to Scientific Literacy for **all** Maryland high school graduates. The team feels that it is important to continue the instructional changes that have been initiated in Maryland. These changes are helping all students know that they can do science. They will enter high school with the self-confidence to pursue a study of science that extends beyond a textbook survey of concepts. For this reason, the scope described in the existing six Maryland Science Outcomes has been preserved and enhanced in the Core Learning Goals for high school students. The intent is to provide students with a seamless transition so that they may continue their pursuit of Scientific Literacy.

Scientific Literacy includes "being aware of some of the important ways in which mathematics, technology, and the sciences depend on one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; and being able to use scientific knowledge and ways of thinking for personal and social purposes." (Science for All Americans) All students should experience a balanced science program in their classes. This means that they should learn that science is more than a body of knowledge. Science is also a way of thinking and a way of investigating. Students must also have the opportunity to examine the impact science has had and will continue to have on society.

For organizational purposes, the content portion of the high school document is divided into four disciplines: Earth/Space Science, Biology, Chemistry, and Physics. The processes and skills essential for all of these four disciplines of science are summarized in a single listing under Core Learning Goal 1 and define how the concepts of science should be taught. Planning for classroom instruction must include an integration of the indicators appropriate for the topic. Since the skills and processes cannot be taught in isolation, these are embedded in the examples in each of the subject areas.

The Core Learning Goals described in these pages are based upon the following premises:

- That the material be behaviorally and cognitively appropriate for all students;
- That the material reflect the scientific contributions of diverse cultures and be relevant to various student populations;
- That the material not be dependent upon the completion of a single given science course;
- That the material reflect broad-based information that will allow persons to be better citizens, good problem-solvers, and able to make decisions of a scientific nature;
- That the materials be linked to the appropriate expectations in the Skills for Success Core Learning Goals (see Appendix A to identify the match between Core Learning Goal 1 and the Skills for Success Core Learning Goals);
- That the material represent process as well as the concepts as the indicators; and
- That the material be measurable with reliability.

The members of the committee acknowledge that the expectations and indicators included under each Core Learning Goal represent a high standard of achievement. We believe that students and teachers both will recognize and welcome the challenges of preparing for success in the 21st century that this document reflects.

SCIENCE
CORE LEARNING GOALS

GOAL 1: SKILLS AND PROCESSES

The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information.

GOAL 2: CONCEPTS OF EARTH SCIENCE

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain the physical behavior of the environment, earth, and the universe.

GOAL 3: CONCEPTS OF BIOLOGY

The student will demonstrate the ability to use the scientific skills and processes (Core Learning Goal 1) and major biological concepts to explain the uniqueness and interdependence of living organisms, their interactions with the environment, and the continuation of life on earth.

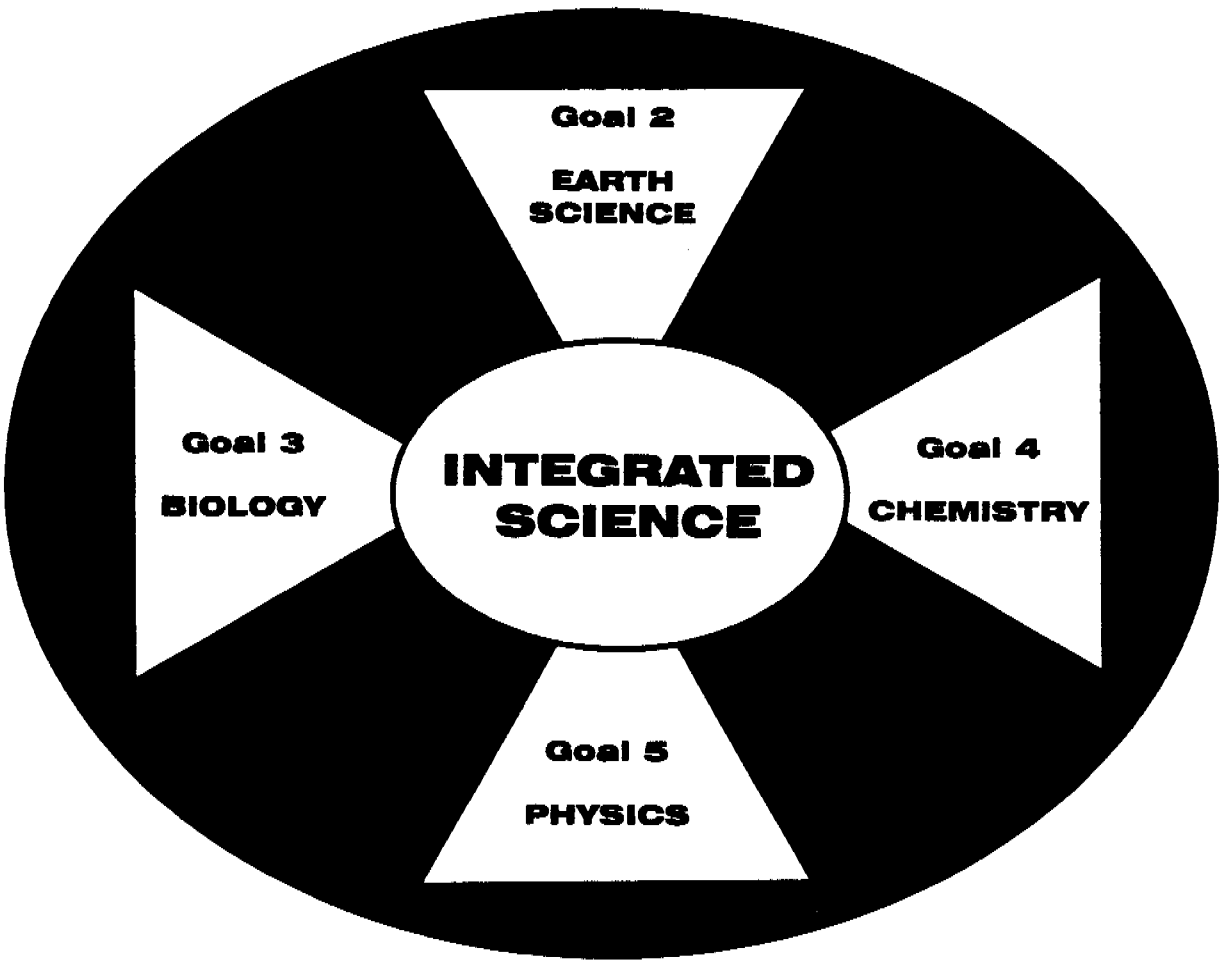
GOAL 4 : CONCEPTS OF CHEMISTRY

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter.

GOAL 5: CONCEPTS OF PHYSICS

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain and predict the interactions which occur between matter and energy.

SCIENCE CORE LEARNING GOALS



GOAL 1: SKILLS AND PROCESSES

The student will demonstrate ways of thinking and acting inherent in the practice of science. The student will use the language and instruments of science to collect, organize, interpret, calculate, and communicate information.

1. ***Expectations****. The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.*

A. Indicators of Learning

At least --

(1) The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues.

(2) The student will modify or affirm scientific ideas according to accumulated evidence.

(3) The student will critique arguments that are based on faulty, misleading data or on the incomplete use of numbers.

(4) The student will recognize data that are biased.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a team preparing for a mock town meeting. The purpose of the meeting is to determine what type of power plant is to be constructed on a site near the community to serve the community. Each student will assume the role of a person who is for or against a particular power plant. Each team will prepare a two-minute argument supported by facts, data in charts and graphs, and a visual aid summarizing the team's position. During the activity, the teams will collect newspaper articles on the issue and analyze them for bias. As the arguments are presented, other

students complete and record an error analysis of the presentation. Biased data that are misrepresented or displayed by inappropriate scales, the use of opinion instead of fact, etc., are listed and shared with the presenters. As a culminating activity, the student will research an issue that is important to the student and write an essay on the misrepresentation of facts or the bias that was detected in the articles selected.

2. ***Expectation**: The student will pose scientific questions and suggest experimental approaches to provide answers to questions.*

A. Indicators of Learning

At least --

(1) The student will identify and pose meaningful answerable scientific questions.

(2) The student will formulate and test a working hypothesis.

(3) The student will select appropriate instruments and materials to conduct an experiment.

(4) The student will use relationships discovered in the lab to explain phenomena observed outside the laboratory.

(5) The student will defend the need for verifiable data.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will develop a model of a pond. Component organisms of the pond will be identified by using a microscope and hand lens. Population levels will be determined by the student using sampling techniques. By asking questions and investigating factors, such as predator populations, dissolved oxygen levels, nitrogen concentrations, water temperature, and pH, the effects of these changes on population size can be demonstrated. The student can extend the concepts learned in the pond investigation by researching issues in the Chesapeake Bay, such as the Blue Crab, Rockfish, submerged aquatic vegetation, and oysters.

3. ***Expectation: The student will carry out scientific investigations effectively and employ the instruments and materials of science appropriately.***

A. Indicators of Learning

At least --

(1) The student will develop skills in using lab and field equipment to perform investigative techniques.

(2) The student will demonstrate safe handling of the chemicals and materials of science.

(3) The student will learn the use of new instruments and equipment by following instructions in a manual or from oral direction.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use a computer-linked temperature probe to record and graph the temperature change in a water system heated by solar panels. After studying the heat production and transfer in systems, the student will use a calorimeter and thermometer to determine the amount of heat needed to melt a sample of ice. The student will compare the energy of the system before and after melting. To conclude this unit, the student will investigate one of the following heat-related topics: global warming or climate differences of land masses located near large bodies of water.

4. ***Expectation: The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.***

A. Indicators of Learning

At least --

(1) The student will use analyzed data to evaluate an hypothesis.

(2) The student will compare data for two groups by representing their distribution graphically.

(3) The student will use graphs to determine the relationships between quantities and develop the mathematical model that describes these relationships.

(4) The student will check graphs to determine that they do not misrepresent results by using inappropriate scales or by failing to specify the axis clearly.

(5) The student will choose appropriate summary statistics to describe tendencies revealed by data.

(6) The student will use spreadsheet, graphing, and database programs and probeware on computers and/or graphing calculators.

(7) The student will determine the sources of error when a disparity exists between an experimental or estimated value and a calculated answer.

(8) The student will use models and computer simulations to represent systems.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use appropriate instrumentation to determine the mass and the volume for a variety of samples. Class data will be collected to create a graph of mass vs. volume so that the density for each sample may be determined from the slope of the line. The experimental value for the densities will then be compared to the accepted values. Students will then use the property of density to identify unknown substances.

Another example of analysis that may be used is paper or liquid chromatography to separate a mixture of colored substances. This is done with filter paper, black ink, water and alcohol to separate the ink into its component dyes. The activity helps the student to understand how the broad use of chromatography is essential to the food industry, medicine, and environmental protection.

5. ***Expectation: The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.***

A. Indicators of Learning

At least --

(1) The student will demonstrate the ability to summarize scientific concepts, processes, and data through written communication.

(2) The student will use tables, graphs, and charts to display data in making arguments and claims in both written and oral communication.

(3) The student will write clear, step-by-step instructions for conducting investigations or following a procedure.

(4) The student will create and interpret scale drawings.

(5) The student will use computers and/or graphing calculators to produce tables, graphs, and spreadsheet calculations.

(6) The student will read a technical report and interpret it appropriately.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a group of students who are told that they are employees of a soap manufacturing company whose stock has dropped. The group's job is to develop a new product that will be more profitable for the company and will be viewed by the public as "natural" and environmentally safe. Working in teams, the group will form a research division, a marketing division, and an advertising division. Each team will give a presentation to persuade the company's board of directors that their product is the best for the company. In this unit, the student will learn the chemistry of soap (the materials needed to make various kinds of soap, how to dispose of waste products, how to manipulate the pH of their soap, and how to make the soap more palatable). The student will also learn how to develop a marketing and advertising scheme that will include methods of organizing and presenting data in order to make a persuasive presentation.

6. ***Expectation: The student will use mathematical processes.***

A. Indicators of Learning

At least --

(1) The student will use ratio and proportion in appropriate situations to solve problems.

(2) The student will express and compare small and large quantities using scientific notation and relative order of magnitude.

(3) The student will manipulate quantities and/or numerical values in algebraic equations.

(4) The student will judge the reasonableness of an answer.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will design an experiment to investigate how waves change direction when they encounter objects by observing a laser beam passing through a block of glass. The student will use a protractor to measure the angle of the beam entering the glass (incident) and the angle of the beam within the glass (refracted). By rotating the glass block to change the angle of incidence, more data is collected. Using graphing and word processing computer software as tools, the student will analyze the data, discussing any relationship they find between the incident and refracted beam angles. Finally, the student will use the information gained in the experiment to estimate the results for angles that he or she did not try. An advanced class could then explore how trigonometric equations provide an alternate method for predicting angles.

7. ***Expectation: The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.***

A. Indicators of Learning

At least --

(1) The student will apply the concepts of biology, chemistry, physics, and earth science to environmental issues.

(2) The student will identify and evaluate the impact of scientific findings on the evolution of society.

(3) The student will describe the role of science in the development of literature, art, music, etc.

(3) The student will recognize mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking, and become familiar with key mathematical ideas and skills.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The space program has a multitude of connections between science and society that the student will explore. The student may work with satellite images to detect changes that may occur over a period of time in a tropical rainforest. This may be followed by a role-playing exercise to debate land clearing development versus forest preservation.

The student may also work on laboratory activities related to some of the chemical principles at work on the Space Shuttle. They may be constructing solar panels to make electricity, analyzing freeze dried food, or simulating a low 'g' environment to study crystal growth. By doing so, the student will apply and connect the concepts learned in science, mathematics, and social studies.

GOAL 2: CONCEPTS OF EARTH SCIENCE

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain the physical behavior of the environment, earth, and the universe.

1. ***Expectation:*** ***The student will use a variety of resources to identify techniques used to investigate Earth and the Universe.***

A. Indicators of Learning

(1) The student will describe current efforts and technologies used to study the land and oceans of Earth.

At least --

- remote sensing from space
- undersea exploration
- seismology
- weather data collection

(2) The student will describe current efforts and technologies used to study the universe.

At least --

- optical telescopes
- radio telescopes
- spectroscopes
- satellites
- space probes
- manned missions

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use data bases, laser disks, texts, and references to create a chart that summarizes the space probes and satellites now in operation. The chart shows the timeline of the project, the purpose and function of the probe or satellite, knowledge that has been gained, and the cost of the program.

When this has been completed, the student will work as part of a team with a scenario and a simulated budget to construct a space probe program designed to solve the problem identified in the scenario. The team will decide how the funds should be allocated and construct the timeline of the project.

2. ***Expectation: The student will describe and apply the concept of gravity in the study of Earth Science.***

A. Indicators of Learning

(1) The student will explain the role of gravity in the universe.

At least --

- formation of planets
- orbital mechanics
- stellar evolution

(2) The student will explain the role of gravity on Earth.

At least --

- retention of an atmosphere
- an agent of erosion

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The teacher will demonstrate a mass on a string being slung in a circle at a constant speed and distance. A discussion will build the analogy between the mass and a planet, between the centripetal force and the gravitational force, and between the teacher's arm and the sun. The student will use string, a balance, stop watch, and distance and speed of revolution to investigate circular motion. The student's conclusions are based on an analysis of the data collected. In a written paragraph, the student will predict how this activity applies to Earth.

3. ***Expectation**: The student will explain how weather and climate affect the transfer of energy within the atmosphere.*

A. Indicators of Learning

(1) The student will describe heat transfer systems in the atmosphere, on land, and in the oceans.

At least --

- convection
- conduction
- radiation

(2) The student will investigate meteorological phenomena.

At least --

- Coriolis effect
- hurricanes
- tornadoes
- floods
- thunderstorms
- blizzards

(3) The student will research topics of current concern with regard to climate.

At least --

- greenhouse effect
- ozone depletion
- global warming (or cooling)
- ocean currents

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The teacher will demonstrate and give examples of the different means of heat transfer (convection, conduction, and radiation). The student will use temperature probes and appropriate computer software to conduct an investigation that compares heat loss in a solid (earth), liquid (oceans), and

gas (atmosphere). Using the experimental data and authentic data (daily temperatures, barometric pressure, relative humidity, and wind speed and direction), the student will make predictions about the cause of high- and low-pressure areas, thunderstorms, tornadoes, hurricanes, and local wind directions.

4. ***Expectation: The student will describe Earth's surface and the theory of plate tectonics and explain the dynamic nature of Earth's crust.***

A. Indicators of Learning

(1) The student will describe the structure of Earth.

At least --

- inner core
- outer core
- mantle
- lithosphere - crust and upper mantle

(2) The student will identify common rock forming mineral groups using a key and the properties of minerals.

At least --

- hardness
- luster
- specific gravity
- streak
- color
- cleavage

(3) The student will use texture and composition to describe various types of rocks.

At least --

- igneous
- sedimentary
- metamorphic

(4) The student will apply the law of conservation to the processes that affect rocks and minerals.

At least --

- metamorphism
- weathering
- erosion
- deposition
- melting
- crystallization

(5) The student will explain the dynamic activity of the earth.

At least --

- plate tectonics
- sea floor spreading
- faulting
- earthquakes
- volcanoes

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Using a relief map of the world, the student will record the position of recent earthquake and volcanic activity. This data is collected from a search through an appropriate electronic bulletin board. This profile will be compared to a world map showing plate boundaries.

5. ***Expectation: The student will know how to connect prior understanding and new experiences to evaluate natural cycles.***

A. Indicators of Learning

(1) The student will investigate various cycles found in the natural world.

At least --

- water cycle
- tides
- lunar phases
- eclipses
- seasons

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a team using a heat lamp, meter stick, and graph paper to investigate the effect of light and heat on a tilted surface. The team will examine an Earth-Sun Model to relate authentic seasonal data with Earth's tilt toward and away from the Sun. With Ocean City as a reference point, the team will complete an activity in which they determine how the tilt of Earth affects temperature and the amount of daylight for the area. The team will use this knowledge to design a travel brochure highlighting what the climate of Ocean City would be like if Earth were not tilted in its orbit. The team will answer the question, "What would happen to tourism in the area if this change in the tilt of the earth should occur?"

6. ***Expectation: The student will investigate how the political climate affects the development of a scientific theory or model.***

A. Indicators of Learning

(1) The student will research the various planetary models.

At least --

- Ptolemy
- Copernicus
- Kepler
- Galileo

(2) The student will research the change in belief in the age of the earth caused by Charles Lyell's work with fossils and rock layers.

At least --

- Charles Lyell's work with fossils and
- rock layers
- radioactive dating
- Big Bang theory

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Using laser disks, data bases, texts, and references, the student will research the development of the planetary model. A paper timeline is constructed to proper scale summarizing the names and events that led to a modification of the model. Inventions and cultural and political events are added to the time line. The student will discuss these additional events to determine how some of them probably contributed to the change from an Earth-centered to a Sun-centered planetary model. Following this model, the student will examine the current political and cultural climate of the United States to identify positive and negative factors that affect scientific understanding and progress. The student will conclude this work by writing an essay on the topic, "Why Science Is a Human Endeavor."

7. ***Expectation: The student will know how to use analogies, ratios, scale drawings, and orders of magnitude to construct a model.***

A. Indicators of Learning

(1) The student will create a geologic time scale.

At least --

- eras
- periods
- epochs

(2) The student will construct a model to show human's place in the time continuum.

(3) The student will demonstrate the relative sizes and distances of planets in the solar system.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use a roll of adding machine tape, a meter stick, and a geologic time scale to construct a timeline of Earth from the first appearance of life to the time of humans. The student will predict the number of

centimeters that will represent the appearance of humans on the timeline. The student will also determine the number of centimeters required to represent the Jurassic dinosaurs on the time line. To complete this task, the student will be engaged in using ratios to determine how distances on the tape are proportional to time durations and sequences. The student will investigate the significance of the short time span of humans and most other presently existing vertebrates. When the activity is completed, the student will discuss ways a scale model can be adjusted when the measurements range beyond a few orders of magnitude.

8. ***Expectation: The student will know how to investigate an environmental issue to develop an action plan.***

A. Indicators of Learning

(1) The student will investigate an issue such as Chesapeake Bay pollution, oil spills, wetland development, electric power generation (fossil fuel vs. nuclear), land and water resource management.

(2) The student will identify data that are biased.

(3) The student will use tables, charts, and graphs in making oral and written presentations.

(4) The student will know why curiosity, honesty, openness, and skepticism are highly regarded in science.

(5) The student will understand that real problems have more than one solution, and the decisions to accept one solution over another are made on the basis of many issues.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a team preparing for a mock town meeting. The purpose of the meeting is to determine what type of power plant is to be constructed on a site near the community to serve the community. Each student will assume the role of a person who is for or against nuclear power. Each team will prepare a two-minute argument supported by facts, data in charts and graphs, and a visual aid summarizing the team's position. During the activity, the teams will collect newspaper articles on the issue and analyze

them for bias. As the arguments are presented, other students complete and record an error analysis of the presentation. Biased data, data that is misrepresented or displayed by inappropriate scales, the use of opinion instead of fact, etc., are listed and shared with the presenters. As a culminating activity, the student will research an issue that is important to the student and write an essay on the misrepresentation of facts or the bias that was detected in the articles selected.

GOAL 3: CONCEPTS OF BIOLOGY

The student will demonstrate the ability to use the scientific skills and processes (Core Learning Goal 1) and major biological concepts to explain the uniqueness and interdependence of living organisms, their interactions with the environment, and the continuation of life on earth.

1. ***Expectation:*** ***The student will be able to explain the correlation between the structure and function of biologically important molecules and their relationship to cell processes.***

A. Indicators of Learning

(1) The student will be able to describe the unique characteristics of chemical compounds and macromolecules utilized by living systems.

At least --

- water
- carbohydrates
- lipids
- proteins
- nucleic acids
- minerals
- vitamins

(2) The student will be able to discuss factors involved in the regulation of chemical activity as part of a homeostatic mechanism.

At least --

- osmotic pressure
- temperature
- pH
- enzyme regulation

(3) The student will be able to compare the transfer and use of energy in photosynthetic and non-photosynthetic organisms.

At least --

Matter	Energy
• water cycle	• photosynthesis
• carbon dioxide cycle	• cellular respiration
• nitrogen cycle	• other biochemical reactions

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as a member of a cooperative group to produce a representative model which shows the relationship between photosynthesis and cellular respiration in living organisms. Groups of students will illustrate the processes using appropriate materials and essential terminology.

2. ***Expectation: The student will demonstrate that all things are composed of cells which can be systems themselves or combined as parts of larger systems capable of all life functions.***

A. Indicators of Learning

(1) The student will examine structures of cellular and multicellular organisms and explain their role in maintaining life.

At least --

- transportation of materials
- capture and release of energy
- protein synthesis
- waste disposal
- feedback
- movement
- reproduction
- storage of genetic material

(2) The student will conclude that cells exist within a narrow range of environmental conditions and changes to that environment, either naturally occurring or induced, may cause death of the cell or organism.

At least --

- pH
- temperature
- light
- water
- oxygen
- carbon-dioxide
- radiation
- other chemicals

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use a microscope to examine the unique characteristics of lung tissue. After studying the structure of the respiratory system, the student will use appropriate materials to construct a functioning, physical model of the system. The manipulation of this model helps the student to understand the flow of air through all the organs of the system. By studying the sensitivity of these tissues and the physiological consequences of smoking on the system, the student is better able to make informed decisions about his or her own health.

3. ***Expectation: The student will analyze how traits are inherited and passed on from one generation to another.***

A. Indicators of Learning

(1) The student will demonstrate that the sorting and combination of genes during sexual reproduction.

At least --

- meiosis
- fertilization
- genotypes
- punnett square
- monohybrid cross

(2) The student will illustrate and explain how expressed traits are passed from parent to offspring.

At least --

- phenotypes
- dominant and recessive traits
- sex-linked traits

(3) The student will explain how a genetic trait is determined by the code in a DNA molecule.

At least --

- definition of gene
- structure of DNA (sugar, phosphate, & nitrogen bases)
- sequence of bases directing protein formation
- proteins' control of traits

(4) The student will interpret how the effect of gene alteration through technological advances may have beneficial or harmful effects on the individual, society, and/or the environment.

At least --

- mutations
- chromosome number
- cloning
- genetic recombination

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use a microscope or stereoscope to sort and count the offspring from a genetic cross between two varieties of fruit flies. This data is compared with ratios determined by calculations. Following this, the student will construct a paper model of DNA to demonstrate a particular gene sequence. The student will manipulate the model to demonstrate how radiation could cause alterations in genes and/or how genetic engineers produce alterations to cure genetic diseases. The questions of other students during the activity may lead to a formal debate on the bioethics of genetic engineering.

4. ***Expectation: The student will explain the mechanism of evolutionary change.***

A. Indicators of Learning

(1) The student will explain how new traits may result from new combinations of existing genes or from mutations of genes in reproductive cells.

At least --

- natural selection
- adaptations
- variation

(2) The student will estimate degrees of kinship among organisms or species.

At least --

- classification
- anatomical similarities
- similarities of DNA sequence

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

Investigations dealing with changes in living things will involve the student in computer simulations. These simulations allow the student to genetically alter bacteria and analyze DNA sequences. As a result of the student's exposure to these investigations, the student will be expected to draw conclusions about evolutionary relationships based on the similarities of DNA.

5. ***Expectation: The student will investigate the interdependence of diverse living organisms and their interactions with the components of the biosphere.***

A. Indicators of Learning

(1) The student will formulate the relationships between biotic diversity and abiotic factors in environments and the resulting influence on ecosystems.

At least --

Abiotic/Biotic Factors	Relationships
• space	• producer - consumer
• soil	• predator - prey
• water	• parasite - host
• oxygen	• scavenger - decomposer
• temperature	• predation - symbiosis
• food	• food web
• light	• omnivores
• plants	• herbivores
• animals	• carnivores

(2) The student will analyze the five kingdoms to identify the differences in an organism's structure, function, and energy relationships that provide variations which increase the likelihood of survival of the species under changed conditions.

At least --

- variation
- natural selection
- succession

(3) The student will investigate how natural and man-made changes in environmental conditions will affect individual organisms and the dynamics of populations.

At least --

- depletion of food
- destruction of habitats
- disease
- natural disasters
- pollution
- population increase
- urbanization

(4) The student will illustrate that all organisms are part of and depend on two major global food webs that are positively or negatively influenced by human activity and technology.

At least --

- oceanic food web
- terrestrial food web

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will observe the characteristics of living things in a population of organisms such as crickets, beans, paramecia, bacteria, and yeasts. These observations are used to determine the biotic and abiotic conditions that must be met for the population to grow and survive. By collecting and analyzing measurable data about the population, the student will make predictions about the health of the population and its likelihood for survival.

6. ***Expectation:*** ***The student will investigate a biological issue and develop an action plan.***

A. Indicators of Learning

(1) The student will analyze the consequences and/or trade-offs between technological changes and their effect on the individual society and the environment. They may select topics such as bioethics, genetic engineering, endangered species, food supply.

(2) The student will investigate a biological issue and be able to defend their position on topics such as animal rights, drug and alcohol abuse, viral diseases (e.g., AIDS), genetic engineering, bioethics, biodiversity, overpopulation, global sustainability, origin of life.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student has been given an opportunity to investigate a biological issue of personal interest. Data on the issue is being gathered from multiple sources (e.g., online computer references, videotapes, CD ROM) and technical documents. One of the tasks will be to write a position paper that evaluates the quality of the information gathered. The student's ideas will be presented to the appropriate audience using charts and graphs to promote the student's position. The student will use the feedback from the audience and his or her own research and analysis to develop an action plan to address concerns and possible solutions.

GOAL 4: CONCEPTS OF CHEMISTRY

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain composition and interactions of matter.

1. ***Expectation:*** ***The student will explain how the observation of the properties of matter forms the basis for understanding its structure and changes in its structure.***

A. Indicators of Learning

(1) The student will select and use appropriate devices to measure directly or indirectly the length, mass, volume, or temperature of a substance.

At least --

- centigram balances
- graduated cylinders & pipettes
- metric rulers
- thermometers & temperature probes

(2) The student will gather and interpret data related to physical and chemical properties of matter such as density and percent composition.

At least --

- constructing data tables
- graphing linear relationship
- appropriate technology to analyze data

(3) The student will demonstrate how matter may be identified and classified in various ways based upon common properties.

At least --

- states of matter
- elements, compounds, mixtures, solutions
- metals/nonmetals

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use appropriate instrumentation to determine the mass and volume for a variety of samples. Class data will be collected to create a graph of mass vs. volume so that the density for each sample can be determined from the slope of the line graph. The experimental values for the densities will then be compared to the accepted values. Students will then use the property of density to identify unknown substances.

2. ***Expectation: The student will explain that all matter has structure and the structure serves as the basis for the properties of and the changes in matter.***

A. Indicators of Learning

(1) The student will illustrate the structure of the atom and describe the characteristics of the particles found there.

At least --

- protons, neutrons, & electrons
- nucleus

(2) The student will demonstrate that the arrangement and number of electrons determine the properties of an element and that these properties repeat in a periodic manner illustrated by their arrangement in the periodic table.

At least --

- atomic number
- mass number
- valence electrons
- chemical properties/families

(3) The student will explain how atoms interact with other atoms through the transfer and sharing of electrons in the formation of chemical bonds.

At least --

- characteristics of a neutral atom
- formation of ions
- ionic bonding
- covalent bonding

(4) The student will distinguish among metallic, ionic, and covalent solids in terms of observable properties.

At least --

- solubility
- melting point
- boiling point
- conductivity

(5) The student will summarize that the properties of a molecule are determined by the number and types of atoms it contains and how they are arranged.

At least --

- determine the types & numbers of atoms present in a given formula
- polar & nonpolar molecules

(6) The student will explain why organic compounds have such diverse properties and give examples of how they have had an impact on society.

At least --

- unique characteristics of carbon (tetrahedral structure)
- fuels and plastics

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use standard laboratory equipment and computers to observe and measure chemical and physical properties of solid ionic and molecular compounds, such as table salt and sugar. These activities will help the student to understand how the differences in the properties of these substances are related to the types of bonds and the structure that are formed. These experiences will lead to a project in which the student will use the information learned to explain one of the following: the melting of snow and ice by various salts, antifreeze used in cars, dry ice used in cooling, or moth balls used in clothing storage.

3. ***Expectation: The student will analyze how the basic laws of thermodynamics apply to phase, chemical, and nuclear changes, and why accounting for all the energy associated with change is difficult.***

A. Indicators of Learning

(1) The student will illustrate that heat energy in a material consists of the ordered and disordered motions of its colliding particles.

At least --

- phase changes

(2) The student will explain why the interactions among particles involve a change in the energy system.

At least --

- exothermic change
- endothermic change

(3) The student will conclude that the conservation of mass and energy holds true for all systems, and that the total amount of energy in any closed system remains constant.

At least --

- total amount of energy in any closed system remains constant

(4) The student will describe the observed changes in pressure, volume, or temperature of a sample of gas in terms of the behavior of particles.

At least --

- matter is made of small particles
- particles are in constant motion
- the collisions among particles are elastic collisions

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use a computer-linked temperature probe to record and graph the temperature change in a water system heated by solar panels. In an additional investigation, the student will use a calorimeter and thermometer to determine the amount of heat needed to melt a sample of ice. The student will calculate the energy change of the system before and after melting. To conclude this unit, the student will investigate one of the following heat-related topics: global warming or climatic differences of land masses near large bodies of water.

4. ***Expectation:*** ***The student will explain and demonstrate that matter undergoes transformations in such a way that the products have properties that are very different from those of the starting materials.***

A. Indicators of Learning

(1) The student will illustrate that substances can be represented by formulas.

At least --

- know that symbols are used to represent elements
- identify the atomic mass of the element
- write formulas for compounds given the change of the components
- name binary compounds given in the formula
- calculate the molecular weight of a compound given the periodic table

(2) The student will show that chemical reactions can be represented by symbolic or work equations that specify all reactions and products involved.

(3) The student will use the law of conservation of mass and energy to balance simple equations.

At least --

- use the coefficients of a balanced equation to predict amounts of reactants and products

(4) The student will classify chemical reactions into general types based on the nature of the observed changes.

At least --

- synthesis and decomposition
- combustion
- single and double displacement

(5) The student will demonstrate that adjusting quantities of reactants will affect the amounts of products formed.

At least --

- use appropriate coefficients to balanced a given symbolic equation.

(6) The student will describe a neutralization reaction

At least --

- properties of acids and bases
- characteristics of weak and strong acids and bases
- characteristics of salts
- indicators

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use household substances (baking soda, baking powder, vinegar, ammonia solution, Alka Seltzer tablets, and distilled water) to perform experiments. Evidence for chemical change such as color change, gas formation, temperature, and pH change will be recorded. The environmental

impact of acid rain will be examined. Students will neutralize a simulated waterway that is polluted. Calculations will support the quantities involved in the neutralization. The student can conclude the unit by composing an inventory of chemicals and their effects on human health and the environment.

5. ***Expectation: The student will investigate the impact of Chemistry on society.***

A. Indicators of Learning

(1) The student will investigate an issue such as chemical and nuclear waste disposal, the role of food additives, and the substitution of synthetic products for natural products.

(2) The student will conclude that the starting materials of the chemical industry such as petroleum, are limited resources and decisions must be made about their wise consumption.

(3) The student will recognize data that are biased.

(4) The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues.

(5) The student will use tables, graphs, and charts to display data in making arguments and claims in both written and oral communication.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a group of students who are told that they are employees of a soap manufacturing company whose stock has dropped. The group's job is to develop a new product that will be more profitable for the company and will be viewed by the public as "natural" and environmentally safe. Working in teams, the group will form a research division, a marketing division, and an advertising division. Each team will give a presentation to persuade the company's board of directors that their product is the best for the company. In this unit, the student will learn the chemistry of soap (the materials needed to make various kinds of soap, how to dispose of waste products, how to manipulate the pH of their soap, and how to make the soap

more palatable). The student will also learn how to develop a marketing and advertising scheme that will include methods of organizing and presenting data in order to make a persuasive presentation.

6. ***Expectation:*** ***The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.***

A. **Indicators of Learning**

(1) The student will apply chemistry to the concepts of biology, physics, earth science, and environmental science.

(2) The student will recognize mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking, and become familiar with key mathematical ideas and skills.

(3) The student will investigate the role of chemistry in all areas of human endeavor and achievement.

B. **The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.**

The student will work on laboratory activities related to some of the chemical principles at work on the Space Shuttle. The student may be constructing solar panels to make electricity, analyzing freeze dried food, doing investigations involving carbon dioxide gas, making and testing oxygen gas, or simulating a low 'g' environment to study crystal growth. The space program has a multitude of connections between science and society that the student will explore. By doing so, the student will apply and connect the concepts learned in science, mathematics, and social studies.

GOAL 5: CONCEPTS OF PHYSICS

The student will demonstrate the ability to use scientific skills and processes (Core Learning Goal 1) to explain and predict the interactions which occur between matter and energy.

1. ***Expectation:*** ***The student will know and apply the laws of mechanics to explain the behavior of the physical world.***

A. Indicators of Learning

(1) The student will use analytical techniques appropriate to the study of physics.

At least --

- symbolically representing vector quantities
- using signs to represent directions
- selecting and using appropriate equipment for measuring and investigating
- using appropriate units
- manipulating equations

(2) The student will graphically and mathematically describe an object's motion.

At least --

- direction
- position
- distance/displacement
- speed/velocity
- motion with a constant acceleration
- one and two dimensional motion
- frames of reference

(3) The student will analyze and explain how changes in an object's motion are described by Newton's Laws.

At least --

- inertia
- acceleration, force, and mass
- action/reaction

(4) The student will analyze the behavior of forces.

At least --

- recognize the four forces of nature
- comparison of relative magnitude
- inverse square nature of gravitational and electromagnetic forces
- relation to work and energy

(5) The student will analyze systems with regard to the conservation laws.

At least --

- conservation of momentum
- conservation of energy

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

As a unit-end activity, the student will use the theme of a baseball game to connect the laws of mechanics to a real-world example. Newton's Laws will be used to determine the acceleration, momentum, and velocity experienced by a ball as it is hit. The concepts of gravity and inertia will be applied to understand the path of a thrown ball. The player's movements around the bases (distance and direction) will be described by displacement vectors.

2. ***Expectation: The student will know and apply the laws of electricity and magnetism and explain their significant role in nature and technology.***

A. Indicators of Learning

(1) The student will describe the types of electric charges and the forces that exist between them.

At least --

- magnitude
- sign
- Coulomb's Law

(2) The student will describe the sources and effects of electric and magnetic fields.

At least --

- static charge
- moving charges
- simple circuits
- permanent magnets

(3) The student will describe how different kinds of materials respond to electric and magnetic fields.

At least --

- conductors
- insulators
- semiconductors
- magnetic materials

(4) The student will explain the principle of electromagnetic induction and its applications.

At least --

- motors
- generators

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will trace the generation of power from the power station to the home. Specifically, the student will describe the generation of electric power from the conversion of chemical, thermal, or gravitational energy; the transmission of electric current over large distances; and the re-conversion to mechanical energy in a home appliance.

3. ***Expectation:*** ***The student will recognize and relate the laws of thermodynamics to practical applications.***

A. Indicators of Learning

(1) The student will apply the concept of heat to systems.

At least --

- difference between heat and temperature
- specific heat

(2) The students will relate thermodynamics to the balance of energy in a system.

At least --

- heat transfer
- thermal equilibrium
- entropy

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will demonstrate the application of Thermodynamics in the function of the automobile engine. This will include descriptions of heat transfer to the cylinder walls, the conversion of the fuel's chemical energy to mechanical energy of the pistons, the removal of waste energy, and the delivery of useful work to the wheels.

4. ***Expectation:*** ***The student will explain and demonstrate how vibrations and waves provide a model for our understanding of various physical phenomena.***

A. Indicators of Learning

(1) The student will describe and demonstrate how waves can be used to transmit energy.
At least --

- physical
- electromagnetic

(2) The student will compare the propagation of physical waves.

At least --

- longitudinal
- transverse

(3) The student will describe and mathematically calculate wave characteristics.

At least --

- wavelength
- frequency
- velocity
- amplitude

(4) The student will describe and demonstrate the general behavior of waves.

At least --

- reflection
- refraction
- diffraction
- superposition
- interference
- Doppler effect

(5) The student will explain why both the wave model and the particle model are required to explain the behavior of light.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will design an experiment to investigate how waves change direction when they encounter objects by observing a laser beam passing through a block of glass. The student will use a protractor to measure the angle of the beam entering the glass (incident) and the angle of the beam within the glass (refracted). By rotating the glass

block to change the angle of incidence, more data is collected. Using graphing and word processing computer software as tools, the student will analyze the data, discussing any relationship they find between the incident and refracted beam angles. Finally, the student will use the information gained in the experiment to predict the results for angles that they did not try. An advanced class could then explore how trigonometric equations provide an alternate method for predicting angles.

5. ***Expectation: The student will relate the limitations of classical physics to the development of modern physics theories.***

A. Indicators of Learning

(1) The student will site evidence of the quantum nature of matter and its applications.

At least --

- photoelectric effect
- wave/particle duality
- applications (MRI, semiconductors, etc.)

(2) The student will explain the processes associated with atomic energy and

At least --

- applications of atomic energy
- radioactive decay
- fission
- fusion

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a team to design an experiment that investigates how the count rate (cpm) at a certain point changes as the distance is increased between the detector and a radioisotope. The team will use a safe radioactive source and a standard Geiger counter/scaler to collect data. Background count will be measured, and the corrected activity will be determined as the investigation proceeds. The data will be analyzed and

graphed with a graphing calculator. The student can follow this investigation by comparing the results obtained with the inverse square law. They may also measure the relative strength of common radioactive sources (smoke detectors, gas lamp mantles, "Fiesta Ware" dishes) and determine the distance at which the count rate disappears.

6. ***Expectation: The student will investigate the impact of Physics on society.***

A. Indicators of Learning

(1) The student will investigate a social issue related to physics such as alternate energy sources, fiber optics in telecommunications, nuclear power, microwave technology, effect of power lines, etc.

(2) The student will recognize data that are biased.

(3) The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues.

(4) The student will use tables, graphs, and charts to display data in making arguments and claims in both written and oral communication.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will work as part of a group with an assigned role to research topics in physics (alternate energy sources, nuclear power, fiber optics, etc.) The group will be required to support one side of a debatable topic with information collected from traditional library sources, news reports, data bases, and on-line computer services. Each group will make their arguments by creating a persuasive video tape (advertisement or news report). The class will then use the format of a town meeting to decide on the issue by evaluating the validity and importance of the data presented by group members.

7. ***Expectation: The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.***

A. Indicators of Learning

(1) The student will apply physics to the concepts of biology, chemistry, earth science, and environmental science.

(2) The student will recognize mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking, and become familiar with key mathematical ideas and skills.

(3) The student will investigated the role of physics in all areas of human endeavor and achievement.

B. The following is an example of the classroom learning activities that a teacher might use to help students work through the Learning Indicators to achieve the stated Expectation.

The student will use anatomical charts to analyze the human body as a system of simple machines. The student will use force equations to calculate the difference body shapes and sizes make on strength. As a concluding activity, the student will predict how technology might use this information to improve and develop medical devices.

MATCH OF SCIENCE CORE LEARNING GOAL 1 WITH SKILLS FOR SUCCESS CORE LEARNING GOALS

Shaded blocks indicate a match.

SCIENCE EXPECTATIONS	SKILLS FOR SUCCESS EXPECTATIONS																	
	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4	4.1	4.2	4.3	5.1	5.2	5.3
1.1											■	■	■						
1.2	■	■	■	■	■	■	■	■	■		■			■	■	■			
1.3						■		■	■					■	■	■	■	■	
1.4				■			■	■	■	■	■	■	■	■	■		■		■
1.5						■	■	■	■	■	■	■	■	■	■				
1.6																			
1.7			■	■		■	■	■	■					■	■	■		■	■

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