Intermediate Level Science

Core Curriculum

Grades 5-8

THE UNIVERSITY OF THE STATE OF NEW YORK THE STATE EDUCATION DEPARTMENT

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PREFACE

This *Intermediate Level Science Core Curriculum* has been written to assist teachers and supervisors as they prepare curriculum, instruction, and assessment for the intermediate level (grades 5, 6, 7, and 8) content of Standards 1, 2, 4, 6, and 7 of the New York State *Learning Standards for Mathematics, Science, and Technology*. The *Learning Standards for Mathematics, Science, and Technology* identify Key Ideas and Performance Indicators. Key Ideas are broad, unifying, general statements of what students need to know. The Performance Indicators for each Key Idea are statements of what students should be able to do to provide evidence that they understand the Key Idea. As part of this continuum, this Core Curriculum guide presents Major Understandings that give more specific detail to the concepts underlying each Performance Indicator.

This Core Curriculum is *not* a syllabus. It addresses only the content and skills to be tested by the Intermediate Level Science Assessment. The Core Curriculum has been prepared with the assumption that the content and skills as outlined in the *Learning Standards for Mathematics, Science, and Technology* at the elementary level have been taught previously. This is a guide for the preparation of intermediate level curriculum, instruction, and assessment, the middle stage in a K-12 continuum of science education. The lack of detail in the document should not be seen as a shortcoming. Rather, the focus on conceptual understanding in the guide is consistent with the approaches recommended in the *National Science Education Standards* and *Benchmarks of Science Literacy: Project 2061.*

It is essential that instruction focus on understanding important relationships, processes, mechanisms, and applications of concepts. Less important is the memorization of specialized terminology and technical details. Future assessments will test students' ability to explain, analyze, and interpret scientific processes and phenomena more than their ability to recall specific facts. It is hoped that the general nature of these statements will encourage the teaching of science for understanding, instead of for memorization. The question has been asked for each Key Idea: What do students need to know to have science literacy within that broad theme? The general nature of the Major Understandings in this guide will also permit teachers more flexibility in instruction and greater variation in assessment than would a more explicit syllabus.

The order of presentation and numbering of all statements in this guide are not meant to indicate any recommended sequence of instruction. For example, in the Living Environment section, teachers may decide to deal with the concepts in Key Idea 4 before Key Ideas 2 and 3. Major Understandings have not been prioritized, nor have they been organized in any manner to indicate time allotments. Teachers are encouraged to find and elaborate for students the conceptual cross-linkages that interconnect many of the Key Ideas to each other and to other mathematics, science, and technology learning standards.

The courses designed using this Core Curriculum will hopefully prepare our students to explain, both accurately and with appropriate depth, the most important ideas about our physical setting and our living environment. Students, in attaining science literacy, ought to be able to give these explanations, in their own words, by the time they graduate and long after they have completed their high school education. The science educators throughout New York State who collaborated on the writing of this guide fervently hope that this goal is realized in the years ahead.

Laboratory Recommendations: Critical to understanding science concepts is the use of scientific inquiry to develop explanations of natural phenomena. Therefore, it is recommended that students have the opportunity to develop their skills of analysis, inquiry, and design through active laboratory work on a regular basis in grades 5, 6, 7, and 8.

Prior to the written portion of the Intermediate Level Science Assessment, students will be required to complete a laboratory performance test during which concepts and skills from Standards 1, 2, 4, 6, and 7 will be assessed.

STANDARDS 1, 2, 6, AND 7: EXPANDED PROCESS SKILLS

Science process skills should be based on a series of discoveries. Students learn most effectively when they have a central role in the discovery process. To that end, Standards 1, 2, 6, and 7 incorporate in the Intermediate Core Curriculum *a student-centered, problem-solving approach to intermediate science. The following is an expanded version of the skills found in Standards 1, 2, 6, and 7 of the* Learning Standards for Mathematics, Science, and Technology. *This list is not intended to be an all-inclusive list of the content or skills that teachers are expected to incorporate into their curriculum. It should be a goal of the instructor to encourage science process skills that will provide students with background and curiosity sufficient to prompt investigation of important issues in the world around them.*

STANDARD 1—Analysis, Inquiry, and Design

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

STANDARD 1
Analysis, Inquiry, and Design

MATHEMATICAL ANALYSIS:

Key Idea 1:

Abstraction and symbolic representation are used to communicate mathematically.

M1.1 Extend mathematical notation and symbolism to include variables and algebraic expressions in order to describe and compare quantities and express mathematical relationships.

- M1.1a identify independent and dependent variables
- M1.1b identify relationships among variables including: direct, indirect, cyclic, constant; identify non-related material
- M1.1c apply mathematical equations to describe relationships among variables in the natural world

Key Idea 2:

Deductive and inductive reasoning are used to reach mathematical conclusions.

M2.1 Use inductive reasoning to construct, evaluate, and validate conjectures and arguments, recognizing that patterns and relationships can assist in explaining and extending mathematical phenomena.

- M2.1a interpolate and extrapolate from data
- M2.1b quantify patterns and trends

Key Idea 3:

Critical thinking skills are used in the solution of mathematical problems.

M3.1 Apply mathematical knowledge to solve real-world problems and problems that arise from the investigation of mathematical ideas, using representations such as pictures, charts, and tables.

- M3.1a use appropriate scientific tools to solve problems about the natural world

STANDARD 1
Analysis, Inquiry, and Design

SCIENTIFIC INQUIRY:

Key Idea 1:

The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

S1.1 Formulate questions independently with the aid of references appropriate for guiding the search for explanations of everyday observations.

- S1.1a formulate questions about natural phenomena
- S1.1b identify appropriate references to investigate a question
- S1.1c refine and clarify questions so that they are subject to scientific investigation

S1.2 Construct explanations independently for natural phenomena, especially by proposing preliminary visual models of phenomena.

STANDARD 1
Analysis, Inquiry, and Design

SCIENTIFIC INQUIRY:

continued

S1.2a independently formulate a hypothesis
S1.2b propose a model of a natural phenomenon
S1.2c differentiate among observations, inferences, predictions, and explanations

S1.3 Represent, present, and defend their proposed explanations of everyday observations so that they can be understood and assessed by others.

S1.4 Seek to clarify, to assess critically, and to reconcile with their own thinking the ideas presented by others, including peers, teachers, authors, and scientists.

Key Idea 2:

Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

S2.1 Use conventional techniques and those of their own design to make further observations and refine their explanations, guided by a need for more information.

S2.1a demonstrate appropriate safety techniques
S2.1b conduct an experiment designed by others
S2.1c design and conduct an experiment to test a hypothesis
S2.1d use appropriate tools and conventional techniques to solve problems about the natural world, including:

- measuring
- observing
- describing
- classifying
- sequencing

S2.2 Develop, present, and defend formal research proposals for testing their own explanations of common phenomena, including ways of obtaining needed observations and ways of conducting simple controlled experiments.

S2.2a include appropriate safety procedures
S2.2b design scientific investigations (e.g., observing, describing, and comparing; collecting samples; seeking more information, conducting a controlled experiment; discovering new objects or phenomena; making models)
S2.2c design a simple controlled experiment
S2.2d identify independent variables (manipulated), dependent variables (responding), and constants in a simple controlled experiment
S2.2e choose appropriate sample size and number of trials

S2.3 Carry out their research proposals, recording observations and measurements (e.g., lab notes, audiotape, computer disk, videotape) to help assess the explanation.

S2.3a use appropriate safety procedures
S2.3b conduct a scientific investigation
S2.3c collect quantitative and qualitative data

Key Idea 3:

The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

S3.1 Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.

S3.1a organize results, using appropriate graphs, diagrams, data tables, and other models to show relationships
S3.1b generate and use scales, create legends, and appropriately label axes

S3.2 Interpret the organized data to answer the research question or hypothesis and to gain insight into the problem.

S3.2a accurately describe the procedures used and the data gathered
S3.2b identify sources of error and the limitations of data collected
S3.2c evaluate the original hypothesis in light of the data

STANDARD 1
Analysis, Inquiry, and Design

SCIENTIFIC INQUIRY:

continued

- S3.2d formulate and defend explanations and conclusions as they relate to scientific phenomena
- S3.2e form and defend a logical argument about cause-and-effect relationships in an investigation
- S3.2f make predictions based on experimental data
- S3.2g suggest improvements and recommendations for further studying
- S3.2h use and interpret graphs and data tables

S3.3 Modify their personal understanding of phenomena based on evaluation of their hypothesis.

STANDARD 1
Analysis, Inquiry, and Design:

ENGINEERING DESIGN:

Key Idea 1:
Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.

T1.1 Identify needs and opportunities for technical solutions from an investigation of situations of general or social interest.
- T1.1a identify a scientific or human need that is subject to a technological solution which applies scientific principles

T1.2 Locate and utilize a range of printed, electronic, and human information resources to obtain ideas.
- T1.2a use all available information systems for a preliminary search that addresses the need

T1.3 Consider constraints and generate several ideas for alternative solutions, using group and individual ideation techniques (group discussion, brainstorming, forced connections, role play); defer judgment until a number of ideas have been generated; evaluate (critique) ideas; and explain why the chosen solution is optimal.
- T1.3a generate ideas for alternative solutions
- T1.3b evaluate alternatives based on the constraints of design

T1.4 Develop plans, including drawings with measurements and details of construction, and construct a model of the solution, exhibiting a degree of craftsmanship.
- T1.4a design and construct a model of the product or process
- T1.4b construct a model of the product or process

T1.5 In a group setting, test their solution against design specifications, present and evaluate results, describe how the solution might have been modified for different or better results, and discuss trade-offs that might have to be made.
- T1.5a test a design
- T1.5b evaluate a design

STANDARD 2—Information Systems

Students will access, generate, process, and transfer information, using appropriate technologies.

STANDARD 2

INFORMATION SYSTEMS:

Key Idea 1:
Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

1.1 Use a range of equipment and software to integrate several forms of information in order to create good-quality audio, video, graphic, and text-based presentations.

STANDARD 2

INFORMATION SYSTEMS:

continued

1.2 Use spreadsheets and database software to collect, process, display, and analyze information. Students access needed information from electronic databases and on-line telecommunication services.
1.3 Systematically obtain accurate and relevant information pertaining to a particular topic from a range of sources, including local and national media, libraries, museums, governmental agencies, industries, and individuals.
1.4 Collect data from probes to measure events and phenomena.
   1.4a collect the data, using the appropriate, available tool
   1.4b organize the data
   1.4c use the collected data to communicate a scientific concept
1.5 Use simple modeling programs to make predictions.

Key Idea 2:

Knowledge of the impacts and limitations of information systems is essential to its effectiveness and ethical use.

2.1 Understand the need to question the accuracy of information displayed on a computer because the results produced by a computer may be affected by incorrect data entry.
   2.1a critically analyze data to exclude erroneous information
   2.1b identify and explain sources of error in a data collection
2.2 Identify advantages and limitations of data-handling programs and graphics programs.
2.3 Understand why electronically stored personal information has greater potential for misuse than records kept in conventional form.

Key Idea 3:

Information technology can have positive and negative impacts on society, depending upon how it is used.

3.1 Use graphical, statistical, and presentation software to present projects to fellow classmates.
3.2 Describe applications of information technology in mathematics, science, and other technologies that address needs and solve problems in the community.
3.3 Explain the impact of the use and abuse of electronically generated information on individuals and families.

STANDARD 6—Interconnectedness: Common Themes

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

STANDARD 6

Interconnectedness: Common Themes

SYSTEMS THINKING:

Key Idea 1:

Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

1.1 Describe the differences between dynamic systems and organizational systems.
1.2 Describe the differences and similarities among engineering systems, natural systems, and social systems.
1.3 Describe the differences between open- and closed-loop systems.
1.4 Describe how the output from one part of a system (which can include material, energy, or information) can become the input to other parts.

STANDARD 6

Interconnectedness: Common Themes

MODELS:

Key Idea 2:

Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

2.1 Select an appropriate model to begin the search for answers or solutions to a question or problem.

2.2 Use models to study processes that cannot be studied directly (e.g., when the real process is too slow, too fast, or too dangerous for direct observation).

2.3 Demonstrate the effectiveness of different models to represent the same thing and the same model to represent different things.

STANDARD 6

Interconnectedness: Common Themes

MAGNITUDE AND SCALE:

Key Idea 3:

The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems.

3.1 Cite examples of how different aspects of natural and designed systems change at different rates with changes in scale.

3.2 Use powers of ten notation to represent very small and very large numbers.

STANDARD 6

Interconnectedness: Common Themes

EQUILIBRIUM AND STABILITY:

Key Idea 4:

Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium).

4.1 Describe how feedback mechanisms are used in both designed and natural systems to keep changes within desired limits.

4.2 Describe changes within equilibrium cycles in terms of frequency or cycle length and determine the highest and lowest values and when they occur.

STANDARD 6

Interconnectedness: Common Themes

PATTERNS OF CHANGE:

Key Idea 5:

Identifying patterns of change is necessary for making predictions about future behavior and conditions.

5.1 Use simple linear equations to represent how a parameter changes with time.

5.2 Observe patterns of change in trends or cycles and make predictions on what might happen in the future.

STANDARD 6

Interconnectedness: Common Themes

OPTIMIZATION:

Key Idea 6:

In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.

6.1 Determine the criteria and constraints and make trade-offs to determine the best decision.

6.2 Use graphs of information for a decision-making problem to determine the optimum solution.

STANDARD 7—Interdisciplinary Problem Solving

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

STANDARD 7

Interdisciplinary Problem Solving

CONNECTIONS:

Key Idea 1:

The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/technology/society, consumer decision making, design, and inquiry into phenomena.

1.1 Analyze science/technology/society problems and issues at the local level and plan and carry out a remedial course of action.

1.2 Make informed consumer decisions by seeking answers to appropriate questions about products, services, and systems; determining the cost/benefit and risk/benefit tradeoffs; and applying this knowledge to a potential purchase.

1.3 Design solutions to real-world problems of general social interest related to home, school, or community using scientific experimentation to inform the solution and applying mathematical concepts and reasoning to assist in developing a solution.

1.4 Describe and explain phenomena by designing and conducting investigations involving systematic observations, accurate measurements, and the identification and control of variables; by inquiring into relevant mathematical ideas; and by using mathematical and technological tools and procedures to assist in the investigation.

STANDARD 7

Interdisciplinary Problem Solving

STRATEGIES:

Key Idea 2:

Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

2.1 Students participate in an extended, culminating mathematics, science, and technology project. The project would require students to:

- **Working Effectively:** Contributing to the work of a brainstorming group, laboratory partnership, cooperative learning group, or project team; planning procedures; identify and managing responsibilities of team members; and staying on task, whether working alone or as part of a group.
- **Gathering and Processing Information:** Accessing information from printed media, electronic data bases, and community resources and using the information to develop a definition of the problem and to research possible solutions.
- **Generating and Analyzing Ideas:** Developing ideas for proposed solutions, investigating ideas, collecting data, and showing relationships and patterns in the data.
- **Common Themes:** Observing examples of common unifying themes, applying them to the problem, and using them to better understand the dimensions of the problem.
- **Realizing Ideas:** Constructing components or models, arriving at a solution, and evaluating the result.
- **Presenting Results:** Using a variety of media to present the solution and to communicate the results.

PROCESS SKILLS
BASED ON STANDARD 4

General Skills

1. follow safety procedures in the classroom and laboratory
2. safely and accurately use the following measurement tools:
   - metric ruler
   - balance
   - stopwatch
   - graduated cylinder
   - thermometer
   - spring scale
   - voltmeter
3. use appropriate units for measured or calculated values
4. recognize and analyze patterns and trends
5. classify objects according to an established scheme and a student-generated scheme
6. develop and use a dichotomous key
7. sequence events
8. identify cause-and-effect relationships
9. use indicators and interpret results

Living Environment Skills

1. manipulate a compound microscope to view microscopic objects
2. determine the size of a microscopic object, using a compound microscope
3. prepare a wet mount slide
4. use appropriate staining techniques
5. design and use a Punnett square or a pedigree chart to predict the probability of certain traits
6. classify living things according to a student-generated scheme and an established scheme
7. interpret and/or illustrate the energy flow in a food chain, energy pyramid, or food web
8. identify pulse points and pulse rates
9. identify structure and function relationships in organisms

Physical Setting Skills

1. given the latitude and longitude of a location, indicate its position on a map and determine the latitude and longitude of a given location on a map
2. using identification tests and a flow chart, identify mineral samples
3. use a diagram of the rock cycle to determine geological processes that led to the formation of a specific rock type
4. plot the location of recent earthquake and volcanic activity on a map and identify patterns of distribution
5. use a magnetic compass to find cardinal directions
6. measure the angular elevation of an object, using appropriate instruments
7. generate and interpret field maps including topographic and weather maps
8. predict the characteristics of an air mass based on the origin of the air mass
9. measure weather variables such as wind speed and direction, relative humidity, barometric pressure, etc.
10. determine the density of liquids, and regular- and irregular-shaped solids
11. determine the volume of a regular- and an irregular-shaped solid, using water displacement
12. using the periodic table, identify an element as a metal, nonmetal, or noble gas
13. determine the identity of an unknown element, using physical and chemical properties
14. using appropriate resources, separate the parts of a mixture
15. determine the electrical conductivity of a material, using a simple circuit
16. determine the speed and acceleration of a moving object

STANDARD 4: The Living Environment

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:

Living things are both similar to and different from each other and from nonliving things.

Introduction: Living things are similar to each other yet different from nonliving things. The cell is a basic unit of structure and function of living things (cell theory). For all living things, life activities are accomplished at the cellular level. Human beings are an interactive organization of cells, tissues, organs, and systems. Viruses lack cellular organization.

PERFORMANCE INDICATOR 1.1

Compare and contrast the parts of plants, animals, and one-celled organisms.

Major Understandings:

1.1a Living things are composed of cells. Cells provide structure and carry on major functions to sustain life. Cells are usually microscopic in size.

1.1b The way in which cells function is similar in all living things. Cells grow and divide, producing more cells. Cells take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or an organism needs.

1.1c Most cells have cell membranes, genetic material, and cytoplasm. Some cells have a cell wall and/or chloroplasts. Many cells have a nucleus.

1.1d Some organisms are single cells; others, including humans, are multicellular.

1.1e Cells are organized for more effective functioning in multicellular organisms. Levels of organization for structure and function of a multicellular organism include cells, tissues, organs, and organ systems.

1.1f Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.

1.1g Multicellular animals often have similar organs and specialized systems for carrying out major life activities.

1.1h Living things are classified by shared characteristics on the cellular and organism level. In classifying organisms, biologists consider details of internal and external structures. Biological classification systems are arranged from general (kingdom) to specific (species).

PERFORMANCE INDICATOR 1.2

Explain the functioning of the major human organ systems and their interactions.

Major Understandings:

1.2a Each system is composed of organs and tissues which perform specific functions and interact with each other, e.g., digestion, gas exchange, excretion, circulation, locomotion, control, coordination, reproduction, and protection from disease.

1.2b Tissues, organs, and organ systems help to provide all cells with nutrients, oxygen, and waste removal.

1.2c The digestive system consists of organs that are responsible for the mechanical and chemical breakdown of food. The breakdown process results in molecules that can be absorbed and transported to cells.

1.2d During respiration, cells use oxygen to release the energy stored in food. The respiratory system supplies oxygen and removes carbon dioxide (gas exchange).

1.2e The excretory system functions in the disposal of dissolved waste molecules, the elimination of liquid and gaseous wastes, and the removal of excess heat energy.

1.2f The circulatory system moves substances to and from cells, where they are needed or produced, responding to changing demands.

1.2g Locomotion, necessary to escape danger, obtain food and shelter, and reproduce, is accomplished by the interaction of the skeletal and muscular systems, and coordinated by the nervous system.

1.2h The nervous and endocrine systems interact to control and coordinate the body's responses to changes in the environment, and to regulate growth, development, and reproduction. Hormones are chemicals produced by the endocrine system; hormones regulate many body functions.

1.2i The male and female reproductive systems are responsible for producing sex cells necessary for the production of offspring.

1.2j Disease breaks down the structures or functions of an organism. Some diseases are the result of failures of the system. Other diseases are the result of damage by infection from other organisms (germ theory). Specialized cells protect the body from infectious disease. The chemicals they produce identify and destroy microbes that enter the body.

Key Idea 2:

Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

Introduction: Every organism requires a set of instructions for specifying its traits. This information is found in the genes of cells. As organisms reproduce, these instructions are passed from one generation to the next.

PERFORMANCE INDICATOR 2.1

Describe sexual and asexual mechanisms for passing genetic materials from generation to generation.

Major Understandings:

2.1a Hereditary information is contained in genes. Genes are composed of DNA that makes up the chromosomes of cells.

2.1b Each gene carries a single unit of information. A single inherited trait of an individual can be determined by one pair or by many pairs of genes. A human cell contains thousands of different genes.

2.1c Each human cell contains a copy of all the genes needed to produce a human being.

2.1d In asexual reproduction, all the genes come from a single parent. Asexually produced offspring are genetically identical to the parent.

2.1e In sexual reproduction typically half of the genes come from each parent. Sexually produced offspring are not identical to either parent.

PERFORMANCE INDICATOR 2.2

Describe simple mechanisms related to the inheritance of some physical traits in offspring.

Major Understandings:

2.2a In all organisms, genetic traits are passed on from generation to generation.

2.2b Some genes are dominant and some are recessive. Some traits are inherited by mechanisms other than dominance and recessiveness.

2.2c The probability of traits being expressed can be determined using models of genetic inheritance. Some models of prediction are pedigree charts and Punnett squares.

Key Idea 3:

Individual organisms and species change over time.

Introduction: Evolution is the change in a species over time. Millions of diverse species are alive today. Generally this diversity of species developed through gradual processes of change occurring over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations (natural selection). Biological adaptations are differences in structures, behaviors, or physiology that enhance survival and reproductive success in a particular environment.

PERFORMANCE INDICATOR 3.1

Describe sources of variation in organisms and their structures and relate the variations to survival.

Major Understandings:

3.1a The processes of sexual reproduction and mutation have given rise to a variety of traits within a species.

3.1b Changes in environmental conditions can affect the survival of individual organisms with a particular trait. Small differences between parents and offspring can accumulate in successive generations so that descendants are very different from their ancestors. Individual organisms with certain traits are more likely to survive and have offspring than individuals without those traits.

3.1c Human activities such as selective breeding and advances in genetic engineering may affect the variations of species.

PERFORMANCE INDICATOR 3.2

Describe factors responsible for competition within species and the significance of that competition.

Major Understandings:

3.2a In all environments, organisms with similar needs may compete with one another for resources.

3.2b Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to permit its survival. Extinction of species is common. Fossils are evidence that a great variety of species existed in the past.

3.2c Many thousands of layers of sedimentary rock provide evidence for the long history of Earth and for the long history of changing lifeforms whose remains are found in the rocks. Recently deposited rock layers are more likely to contain fossils resembling existing species.

3.2d Although the time needed for change in a species is usually great, some species of insects and bacteria have undergone significant change in just a few years.

Key Idea 4:
The continuity of life is sustained through reproduction and development.

Introduction: The survival of a species depends on the ability of a living organism to produce offspring. Living things go through a life cycle involving both reproductive and developmental stages. Development follows an orderly sequence of events.

PERFORMANCE INDICATOR 4.1

Observe and describe the variations in reproductive patterns of organisms, including asexual and sexual reproduction.

Major Understandings:

4.1a Some organisms reproduce asexually. Other organisms reproduce sexually. Some organisms can reproduce both sexually and asexually.

4.1b There are many methods of asexual reproduction, including division of a cell into two cells, or separation of part of an animal or plant from the parent, resulting in the growth of another individual.

4.1c Methods of sexual reproduction depend upon the species. All methods involve the merging of sex cells to begin the development of a new individual. In many species, including plants and humans, eggs and sperm are produced.

4.1d Fertilization and/or development in organisms may be internal or external.

PERFORMANCE INDICATOR 4.2

Explain the role of sperm and egg cells in sexual reproduction.

Major Understandings:

4.2a The male sex cell is the sperm. The female sex cell is the egg. The fertilization of an egg by a sperm results in a fertilized egg.

4.2b In sexual reproduction, sperm and egg each carry one-half of the genetic information for the new individual. Therefore, the fertilized egg contains genetic information from each parent.

PERFORMANCE INDICATOR 4.3

Observe and describe developmental patterns in selected plants and animals (e.g., insects, frogs, humans, seed-bearing plants).

Major Understandings:

4.3a Multicellular organisms exhibit complex changes in development, which begin after fertilization. The fertilized egg undergoes numerous cellular divisions that will result in a multicellular organism, with each cell having identical genetic information.

4.3b In humans, the fertilized egg grows into tissue which develops into organs and organ systems before birth.

4.3c Various body structures and functions change as an organism goes through its life cycle.

PERFORMANCE INDICATOR 4.3

continued

4.3d Patterns of development vary among animals. In some species the young resemble the adult, while in others they do not. Some insects and amphibians undergo metamorphosis as they mature.

4.3e Patterns of development vary among plants. In seed-bearing plants, seeds contain stored food for early development. Their later development into adulthood is characterized by varying patterns of growth from species to species.

4.3f As an individual organism ages, various body structures and functions change.

PERFORMANCE INDICATOR 4.4

Observe and describe cell division at the microscopic level and its macroscopic effects.

Major Understandings:

4.4a In multicellular organisms, cell division is responsible for growth, maintenance, and repair. In some one-celled organisms, cell division is a method of asexual reproduction.

4.4b In one type of cell division, chromosomes are duplicated and then separated into two identical and complete sets to be passed to each of the two resulting cells. In this type of cell division, the hereditary information is identical in all the cells that result.

4.4c Another type of cell division accounts for the production of egg and sperm cells in sexually reproducing organisms. The eggs and sperm resulting from this type of cell division contain one-half of the hereditary information.

4.4d Cancers are a result of abnormal cell division.

Key Idea 5:

Organisms maintain a dynamic equilibrium that sustains life.

Introduction: All organisms must be able to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment. Organisms respond to internal or environmental stimuli.

PERFORMANCE INDICATOR 5.1

Compare the way a variety of living specimens carry out basic life functions and maintain dynamic equilibrium.

Major Understandings:

5.1a Animals and plants have a great variety of body plans and internal structures that contribute to their ability to maintain a balanced condition.

5.1b An organism's overall body plan and its environment determine the way that the organism carries out the life processes.

PERFORMANCE INDICATOR 5.1

continued

5.1c All organisms require energy to survive. The amount of energy needed and the method for obtaining this energy vary among cells. Some cells use oxygen to release the energy stored in food.

5.1d The methods for obtaining nutrients vary among organisms. Producers, such as green plants, use light energy to make their food. Consumers, such as animals, take in energy-rich foods.

5.1e Herbivores obtain energy from plants. Carnivores obtain energy from animals. Omnivores obtain energy from both plants and animals. Decomposers, such as bacteria and fungi, obtain energy by consuming wastes and/or dead organisms.

5.1f Regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required for survival. Regulation includes a variety of nervous and hormonal feedback systems.

5.1g The survival of an organism depends on its ability to sense and respond to its external environment.

PERFORMANCE INDICATOR 5.2

Describe the importance of major nutrients, vitamins, and minerals in maintaining health and promoting growth, and explain the need for a constant input of energy for living organisms.

Major Understandings:

5.2a Food provides molecules that serve as fuel and building material for all organisms. All living things, including plants, must release energy from their food, using it to carry on their life processes.

5.2b Foods contain a variety of substances, which include carbohydrates, fats, vitamins, proteins, minerals, and water. Each substance is vital to the survival of the organism.

5.2c Metabolism is the sum of all chemical reactions in an organism. Metabolism can be influenced by hormones, exercise, diet, and aging.

5.2d Energy in foods is measured in Calories. The total caloric value of each type of food varies. The number of Calories a person requires varies from person to person.

5.2e In order to maintain a balanced state, all organisms have a minimum daily intake of each type of nutrient based on species, size, age, sex, activity, etc. An imbalance in any of the nutrients might result in weight gain, weight loss, or a diseased state.

5.2f Contraction of infectious disease, and personal behaviors such as use of toxic substances and some dietary habits, may interfere with one's dynamic equilibrium. During pregnancy these conditions may also affect the development of the child. Some effects of these conditions are immediate; others may not appear for many years.

Key Idea 6:

Plants and animals depend on each other and their physical environment.

Introduction: An environmentally aware citizen should have an understanding of the natural world. All organisms interact with one another and are dependent upon their physical environment. Energy and matter flow from one organism to another. Matter is recycled in ecosystems. Energy enters ecosystems as sunlight, and is eventually lost from the community to the environment, mostly as heat.

PERFORMANCE INDICATOR 6.1

Describe the flow of energy and matter through food chains and food webs.

Major Understandings:

6.1a Energy flows through ecosystems in one direction, usually from the Sun, through producers to consumers and then to decomposers. This process may be visualized with food chains or energy pyramids.

6.1b Food webs identify feeding relationships among producers, consumers, and decomposers in an ecosystem.

6.1c Matter is transferred from one organism to another and between organisms and their physical environment. Water, nitrogen, carbon dioxide, and oxygen are examples of substances cycled between the living and nonliving environment.

PERFORMANCE INDICATOR 6.2

Provide evidence that green plants make food and explain the significance of this process to other organisms.

Major Understandings:

6.2a Photosynthesis is carried on by green plants and other organisms containing chlorophyll. In this process, the Sun's energy is converted into and stored as chemical energy in the form of a sugar. The quantity of sugar molecules increases in green plants during photosynthesis in the presence of sunlight.

6.2b The major source of atmospheric oxygen is photosynthesis. Carbon dioxide is removed from the atmosphere and oxygen is released during photosynthesis.

6.2c Green plants are the producers of food which is used directly or indirectly by consumers.

Key Idea 7:

Human decisions and activities have had a profound impact on the physical and living environment.

Introduction: The number of organisms an ecosystem can support depends on the resources available and physical factors: quantity of light, air, and water; range of temperatures; soil composition. To ensure the survival of our planet, people have a responsibility to consider the impact of their actions on the environment.

PERFORMANCE INDICATOR 7.1

Describe how living things, including humans, depend upon the living and nonliving environment for their survival.

Major Understandings:

7.1a A population consists of all individuals of a species that are found together at a given place and time. Populations living in one place form a community. The community and the physical factors with which it interacts compose an ecosystem.

7.1b Given adequate resources and no disease or predators, populations (including humans) increase. Lack of resources, habitat destruction, and other factors such as predation and climate limit the growth of certain populations in the ecosystem.

7.1c In all environments, organisms interact with one another in many ways. Relationships among organisms may be competitive, harmful, or beneficial. Some species have adapted to be dependent upon each other with the result that neither could survive without the other.

7.1d Some microorganisms are essential to the survival of other living things.

7.1e The environment may contain dangerous levels of substances (pollutants) that are harmful to organisms. Therefore, the good health of environments and individuals requires the monitoring of soil, air, and water, and taking steps to keep them safe.

PERFORMANCE INDICATOR 7.2

Describe the effects of environmental changes on humans and other populations.

Major Understandings:

7.2a In ecosystems, balance is the result of interactions between community members and their environment.

7.2b The environment may be altered through the activities of organisms. Alterations are sometimes abrupt. Some species may replace others over time, resulting in long-term gradual changes (ecological succession).

7.2c Overpopulation by any species impacts the environment due to the increased use of resources. Human activities can bring about environmental degradation through resource acquisition, urban growth, land-use decisions, waste disposal, etc.

7.2d Since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion. The survival of living things on our planet depends on the conservation and protection of Earth's resources.

STANDARD 4: The Physical Setting

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:

The Earth and celestial phenomena can be described by principles of relative motion and perspective.

The universe is comprised of a wide array of objects, a few of which can be seen by the unaided eye. Others can only be observed with scientific instruments. These celestial objects, distinct from Earth, are in motion relative to Earth and each other. Measurements of these motions vary with the perspective of the observer. Cyclical changes on Earth are caused by interactions among objects in the universe.

PERFORMANCE INDICATOR 1.1

Explain daily, monthly, and seasonal changes on Earth.

Major Understandings:

1.1a Earth's Sun is an average-sized star. The Sun is more than a million times greater in volume than Earth.

1.1b Other stars are like the Sun but are so far away that they look like points of light. Distances between stars are vast compared to distances within our solar system.

1.1c The Sun and the planets that revolve around it are the major bodies in the solar system. Other members include comets, moons, and asteroids. Earth's orbit is nearly circular.

1.1d Gravity is the force that keeps planets in orbit around the Sun and the Moon in orbit around the Earth.

1.1e Most objects in the solar system have a regular and predictable motion. These motions explain such phenomena as a day, a year, phases of the Moon, eclipses, tides, meteor showers, and comets.

1.1f The latitude/longitude coordinate system and our system of time are based on celestial observations.

1.1g Moons are seen by reflected light. Our Moon orbits Earth, while Earth orbits the Sun. The Moon's phases as observed from Earth are the result of seeing different portions of the lighted area of the Moon's surface. The phases repeat in a cyclic pattern in about one month.

1.1h The apparent motions of the Sun, Moon, planets, and stars across the sky can be explained by Earth's rotation and revolution. Earth's rotation causes the length of one day to be approximately 24 hours. This rotation also causes the Sun and Moon to appear to rise along the eastern horizon and to set along the western horizon. Earth's revolution around the Sun defines the length of the year as 365 1/4 days.

1.1i The tilt of Earth's axis of rotation and the revolution of Earth around the Sun cause seasons on Earth. The length of daylight varies depending on latitude and season.

1.1j The shape of Earth, the other planets, and stars is nearly spherical.

Key Idea 2:

Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Students should develop an understanding of Earth as a set of closely coupled systems. The concept of systems provides a framework in which students can investigate three major interacting components: lithosphere, hydrosphere, and atmosphere. Processes act within and among the three components on a wide range of time scales to bring about continuous change in Earth's crust, oceans, and atmosphere.

PERFORMANCE INDICATOR 2.1

Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.

Major Understandings:

2.1a Nearly all the atmosphere is confined to a thin shell surrounding Earth. The atmosphere is a mixture of gases, including nitrogen and oxygen with small amounts of water vapor, carbon dioxide, and other trace gases. The atmosphere is stratified into layers, each having distinct properties. Nearly all weather occurs in the lowest layer of the atmosphere.

2.1b As altitude increases, air pressure decreases.

2.1c The rock at Earth's surface forms a nearly continuous shell around Earth called the lithosphere.

2.1d The majority of the lithosphere is covered by a relatively thin layer of water called the hydrosphere.

2.1e Rocks are composed of minerals. Only a few rock-forming minerals make up most of the rocks of Earth. Minerals are identified on the basis of physical properties such as streak, hardness, and reaction to acid.

2.1f Fossils are usually found in sedimentary rocks. Fossils can be used to study past climates and environments.

2.1g The dynamic processes that wear away Earth's surface include weathering and erosion.

2.1h The process of weathering breaks down rocks to form sediment. Soil consists of sediment, organic material, water, and air.

2.1i Erosion is the transport of sediment. Gravity is the driving force behind erosion. Gravity can act directly or through agents such as moving water, wind, and glaciers.

2.1j Water circulates through the atmosphere, lithosphere, and hydrosphere in what is known as the water cycle.

PERFORMANCE INDICATOR 2.2

Describe volcano and earthquake patterns, the rock cycle, and weather and climate changes.

Major Understandings:

2.2a The interior of Earth is hot. Heat flow and movement of material within Earth cause sections of Earth's crust to move. This may result in earthquakes, volcanic eruption, and the creation of mountains and ocean basins.

2.2b Analysis of earthquake wave data (vibrational disturbances) leads to the conclusion that there are layers within Earth. These layers—the crust, mantle, outer core, and inner core—have distinct properties.

2.2c Folded, tilted, faulted, and displaced rock layers suggest past crustal movement.

2.2d Continents fitting together like puzzle parts and fossil correlations provided initial evidence that continents were once together.

2.2e The Theory of Plate Tectonics explains how the "solid" lithosphere consists of a series of plates that "float" on the partially molten section of the mantle. Convection cells within the mantle may be the driving force for the movement of the plates.

2.2f Plates may collide, move apart, or slide past one another. Most volcanic activity and mountain building occur at the boundaries of these plates, often resulting in earthquakes.

2.2g Rocks are classified according to their method of formation. The three classes of rocks are sedimentary, metamorphic, and igneous. Most rocks show characteristics that give clues to their formation conditions.

2.2h The rock cycle model shows how types of rock or rock material may be transformed from one type of rock to another.

2.2i Weather describes the conditions of the atmosphere at a given location for a short period of time.

2.2j Climate is the characteristic weather that prevails from season to season and year to year.

2.2k The uneven heating of Earth's surface is the cause of weather.

2.2l Air masses form when air remains nearly stationary over a large section of Earth's surface and takes on the conditions of temperature and humidity from that location. Weather conditions at a location are determined primarily by temperature, humidity, and pressure of air masses over that location.

2.2m Most local weather condition changes are caused by movement of air masses.

2.2n The movement of air masses is determined by prevailing winds and upper air currents.

2.2o Fronts are boundaries between air masses. Precipitation is likely to occur at these boundaries.

2.2p High-pressure systems generally bring fair weather. Low-pressure systems usually bring cloudy, unstable conditions. The general movement of highs and lows is from west to east across the United States.

PERFORMANCE INDICATOR 2.2

continued

2.2q Hazardous weather conditions include thunderstorms, tornadoes, hurricanes, ice storms, and blizzards. Humans can prepare for and respond to these conditions if given sufficient warning.

2.2r Substances enter the atmosphere naturally and from human activity. Some of these substances include dust from volcanic eruptions and greenhouse gases such as carbon dioxide, methane, and water vapor. These substances can affect weather, climate, and living things.

Key Idea 3:

Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

Objects in the universe are composed of matter. Matter is anything that takes up space and has mass. Matter is classified as a substance or a mixture of substances. Knowledge of the structure of matter is essential to students' understanding of the living and physical environments. Matter is composed of elements which are made of small particles called atoms. All living and nonliving material is composed of these elements or combinations of these elements.

PERFORMANCE INDICATOR 3.1

Observe and describe properties of materials, such as density, conductivity, and solubility.

Major Understandings:

3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.

3.1b Solubility can be affected by the nature of the solute and solvent, temperature, and pressure. The rate of solution can be affected by the size of the particles, stirring, temperature, and the amount of solute already dissolved.

3.1c The motion of particles helps to explain the phases (states) of matter as well as changes from one phase to another. The phase in which matter exists depends on the attractive forces among its particles.

3.1d Gases have neither a determined shape nor a definite volume. Gases assume the shape and volume of a closed container.

3.1e A liquid has definite volume, but takes the shape of a container.

3.1f A solid has definite shape and volume. Particles resist a change in position.

3.1g Characteristic properties can be used to identify different materials, and separate a mixture of substances into its components. For example, iron can be removed from a mixture by means of a magnet. An insoluble substance can be separated from a soluble substance by such processes as filtration, settling, and evaporation.

3.1h Density can be described as the amount of matter that is in a given amount of space. If two objects have equal volume, but one has more mass, the one with more mass is denser.

3.1i Buoyancy is determined by comparative densities.

PERFORMANCE INDICATOR 3.2

Distinguish between chemical and physical changes.

Major Understandings:

3.2a During a physical change a substance keeps its chemical composition and properties. Examples of physical changes include freezing, melting, condensation, boiling, evaporation, tearing, and crushing.

3.2b Mixtures are physical combinations of materials and can be separated by physical means.

3.2c During a chemical change, substances react in characteristic ways to form new substances with different physical and chemical properties. Examples of chemical changes include burning of wood, cooking of an egg, rusting of iron, and souring of milk.

3.2d Substances are often placed in categories if they react in similar ways. Examples include metals, nonmetals, and noble gases.

3.2e The Law of Conservation of Mass states that during an ordinary chemical reaction matter cannot be created or destroyed. In chemical reactions, the total mass of the reactants equals the total mass of the products.

PERFORMANCE INDICATOR 3.3

Develop mental models to explain common chemical reactions and changes in states of matter.

Major Understandings:

3.3a All matter is made up of atoms. Atoms are far too small to see with a light microscope.

3.3b Atoms and molecules are perpetually in motion. The greater the temperature, the greater the motion.

3.3c Atoms may join together in well-defined molecules or may be arranged in regular geometric patterns.

3.3d Interactions among atoms and/or molecules result in chemical reactions.

3.3e The atoms of any one element are different from the atoms of other elements.

3.3f There are more than 100 elements. Elements combine in a multitude of ways to produce compounds that account for all living and nonliving substances. Few elements are found in their pure form.

3.3g The periodic table is one useful model for classifying elements. The periodic table can be used to predict properties of elements (metals, nonmetals, noble gases).

Key Idea 4:
Energy exists in many forms, and when these forms change energy is conserved.

Introduction: An underlying principle of all energy use is the Law of Conservation of Energy. Simply stated, energy cannot be created or destroyed.

Energy can be transformed, one form to another. These transformations produce heat energy. Heat is a calculated value which includes the temperature of the material, the mass of the material, and the type of the material. Temperature is a direct measurement of the average kinetic energy of the particles in a sample of material. It should be noted that temperature is not a measurement of heat.

PERFORMANCE INDICATOR 4.1

Describe the sources and identify the transformations of energy observed in everyday life.

Major Understandings:

4.1a The Sun is a major source of energy for Earth. Other sources of energy include nuclear and geothermal energy.

4.1b Fossil fuels contain stored solar energy and are considered nonrenewable resources. They are a major source of energy in the United States. Solar energy, wind, moving water, and biomass are some examples of renewable energy resources.

4.1c Most activities in everyday life involve one form of energy being transformed into another. For example, the chemical energy in gasoline is transformed into mechanical energy in an automobile engine. Energy, in the form of heat, is almost always one of the products of energy transformations.

4.1d Different forms of energy include heat, light, electrical, mechanical, sound, nuclear, and chemical. Energy is transformed in many ways.

4.1e Energy can be considered to be either kinetic energy, which is the energy of motion, or potential energy, which depends on relative position.

PERFORMANCE INDICATOR 4.2

Observe and describe heating and cooling events.

Major Understandings:

4.2a Heat moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature.

4.2b Heat can be transferred through matter by the collisions of atoms and/or molecules (conduction) or through space (radiation). In a liquid or gas, currents will facilitate the transfer of heat (convection).

4.2c During a phase change, heat energy is absorbed or released. Energy is absorbed when a solid changes to a liquid and when a liquid changes to a gas. Energy is released when a gas changes to a liquid and when a liquid changes to a solid.

4.2d Most substances expand when heated and contract when cooled. Water is an exception, expanding when changing to ice.

4.2e Temperature affects the solubility of some substances in water.

PERFORMANCE INDICATOR 4.3

Observe and describe energy changes as related to chemical reactions.

Major Understandings:

4.3a In chemical reactions, energy is transferred into or out of a system. Light, electricity, or mechanical motion may be involved in such transfers in addition to heat.

PERFORMANCE INDICATOR 4.4

Observe and describe the properties of sound, light, magnetism, and electricity.

Major Understandings:

4.4a Different forms of electromagnetic energy have different wavelengths. Some examples of electromagnetic energy are microwaves, infrared light, visible light, ultraviolet light, X-rays, and gamma rays.

4.4b Light passes through some materials, sometimes refracting in the process. Materials absorb and reflect light, and may transmit light. To see an object, light from that object, emitted by or reflected from it, must enter the eye.

4.4c Vibrations in materials set up wave-like disturbances that spread away from the source. Sound waves are an example. Vibrational waves move at different speeds in different materials. Sound cannot travel in a vacuum.

4.4d Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy.

4.4e Electrical circuits provide a means of transferring electrical energy.

4.4f Without touching them, material that has been electrically charged attracts uncharged material, and may either attract or repel other charged material.

4.4g Without direct contact, a magnet attracts certain materials and either attracts or repels other magnets. The attractive force of a magnet is greatest at its poles.

PERFORMANCE INDICATOR 4.5

Describe situations that support the principle of conservation of energy.

Major Understandings:

4.5a Energy cannot be created or destroyed, but only changed from one form into another.

4.5b Energy can change from one form to another, although in the process some energy is always converted to heat. Some systems transform energy with less loss of heat than others.

Key Idea 5:
Energy and matter interact through forces that result in changes in motion.

Introduction: Examples of objects in motion can be seen all around us. These motions result from an interaction of energy and matter. This interaction creates forces (pushes and pulls) that produce predictable patterns of change. Common forces would include gravity, magnetism, and electricity. Friction is a force that should always be considered in a discussion of motion.

When the forces acting on an object are unbalanced, changes in that object's motion occur. The changes could include a change in speed or a change in direction. When the forces are balanced, the motion of that object will remain unchanged. Understanding the laws that govern motion allows us to predict these changes in motion.

PERFORMANCE INDICATOR 5.1

Describe different patterns of motion of objects.

Major Understandings:

5.1a The motion of an object is always judged with respect to some other object or point. The idea of absolute motion or rest is misleading.

5.1b The motion of an object can be described by its position, direction of motion, and speed.

5.1c An object's motion is the result of the combined effect of all forces acting on the object. A moving object that is not subjected to a force will continue to move at a constant speed in a straight line. An object at rest will remain at rest.

5.1d Force is directly related to an object's mass and acceleration. The greater the force, the greater the change in motion.

5.1e For every action there is an equal and opposite reaction.

PERFORMANCE INDICATOR 5.2

Observe, describe, and compare effects of forces (gravity, electric current, and magnetism) on the motion of objects.

Major Understandings:

5.2a Every object exerts gravitational force on every other object. Gravitational force depends on how much mass the objects have and on how far apart they are. Gravity is one of the forces acting on orbiting objects and projectiles.

5.2b Electric currents and magnets can exert a force on each other.

5.2c Machines transfer mechanical energy from one object to another.

5.2d Friction is a force that opposes motion.

5.2e A machine can be made more efficient by reducing friction. Some common ways of reducing friction include lubricating or waxing surfaces.

5.2f Machines can change the direction or amount of force, or the distance or speed of force required to do work.

5.2g Simple machines include a lever, a pulley, a wheel and axle, and an inclined plane. A complex machine uses a combination of interacting simple machines, e.g., a bicycle.

APPENDIX A
INTERMEDIATE SCIENCE EXAMINATION DESCRIPTION

PURPOSE: To assess student achievement of Standards 1, 2, 4, 6, and 7 of the *Learning Standards for Mathematics, Science, and Technology* and, when appropriate, include aspects of the other six mathematics, science, and technology standards including analysis, inquiry, design, information systems, mathematics, technology, common themes, and interdisciplinary problem solving.

FORMAT: Questions will be content- and skills-based and may require students to graph, complete a data table, label diagrams or photographs, interpret a reading passage, make calculations, or write a response. As outlined in the Scientific Inquiry section of the *Learning Standards for Mathematics, Science, and Technology*, students may be asked to hypothesize, interpret, analyze, and evaluate data and apply their scientific knowledge and skills to real-world situations.

The three-hour written examination will include three parts. Students should be prepared to answer questions in selected-response (multiple choice) and constructed-response formats. In addition, prior to the written portion, there will be a laboratory performance test that will assess students' skills.

The specifics are as follows:

PART A Content-based, multiple choice questions assessing the student's ability to apply, analyze, synthesize, and evaluate core material primarily from Standard 4.
(approximately 25 - 35% of exam)

PART B Content- and skills-based questions, multiple choice and/or short constructed-response items assessing the student's ability to apply, analyze, synthesize, and evaluate material primarily from Standard 4 (content) and Standard 1 (inquiry).
(approximately 25 - 35% of exam)

PART C Content and its application will be assessed with extended constructed-response items. Material from Standards 1, 4, 6, and 7 (problem solving) primarily will be assessed by requiring students to apply their knowledge of science concepts and skills to address real-world situations.

Real-world situations (approximately three to five) may be taken from newspaper or magazine articles, scientific journals, or current events, for example. Students will be asked to apply scientific concepts, formulate hypotheses, make predictions, or use other scientific inquiry techniques in their responses to the questions posed.

Scoring rubrics will be used to assess responses.
(approximately 20 - 25% of exam)

PART D Laboratory performance test (prior to written examination)
Hands-on laboratory tasks linked to content and skills in Standards 1, 2, 4, 6, and 7.
(comprising 15% of exam)

APPENDIX B
EXAMPLES OF ACTIVITIES TO BUILD SKILLS TO SUPPORT STANDARDS 1 AND 4

Standard 1: Scientific Inquiry

Key Idea 1: **The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.**

- After being shown the disparity between the amount of solid waste that is recycled and the amount that could be recycled, students working in small groups are asked to explain why this disparity exists. They develop a set of possible explanations and select one for intensive study. After their explanation is critiqued by other groups, it is refined and submitted for assessment. The explanation is rated on clarity, plausibility, and appropriateness for intensive study using research methods.

Key Idea 2: **Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.**

- Students develop a research plan for studying the accuracy of their explanation of the disparity between the amount of solid waste that is recycled and the amount that could be recycled. After their tentative plan is critiqued, they refine it and submit it for assessment.The research proposal is rated on clarity, feasibility, and soundness as a method of studying the explanation's accuracy. They carry out the plan, with teacher-suggested modifications. This work is rated by the teacher while it is in progress.

Key Idea 3: **The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.**

- Students carry out their plan, making appropriate observations and measurements. They analyze the data, reach conclusions regarding their explanation of the disparity between the amount of solid waste that is recycled and the amount that could be recycled, and prepare a tentative report which is critiqued by other groups, refined, and submitted for assessment. The report is rated on clarity, quality of presentation of data and analyses, and soundness of conclusions.

Standard 4: Science—Living Environment

Key Idea 1: **Living things are both similar to and different from each other and from nonliving things.**

- Students conduct a survey of the school grounds and develop appropriate classification keys to group plants and animals by shared characteristics.
- Students use spring-type clothespins to investigate muscle fatigue or rulers to determine the effect of amount of sleep on hand-eye coordination.

Key Idea 2: **Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.**

- Students contrast dominance and blending as models for explaining inheritance of traits.
- Students trace patterns of inheritance for selected human traits.

Key Idea 3: **Individual organisms and species change over time.**

- Students conduct a long-term investigation of plant or animal communities.
- Students investigate the acquired effects of industrialization on tree trunk color and those effects on different insect species.

Key Idea 4: **The continuity of life is sustained through reproduction and development.**

- Students apply a model of the genetic code as an analogue for the role of the genetic code in human populations.

Key Idea 5: **Organisms maintain a dynamic equilibrium that sustains life.**

- Students record and compare the behaviors of animals in their natural habitats and relate how these behaviors are important to the animals.
- Students design and conduct a survey of personal nutrition and exercise habits, and analyze and critique the results of that survey.

Key Idea 6: **Plants and animals depend on each other and their physical environment.**

- Students construct a food web for a community of organisms and explore how elimination of a particular part of a chain affects the rest of the chain and web.

Key Idea 7: **Human decisions and activities have had a profound impact on the physical and living environment.**

- Students conduct an extended investigation of a local environment affected by human actions (e.g., a pond, stream, forest, empty lot).

Standard 4: Science—Physical Setting

Key Idea 1: **The Earth and celestial phenomena can be described by principles of relative motion and perspective.**

- Students create models, drawings, or demonstrations describing the arrangement, interaction, and movement of the Earth, Moon, and Sun.
- Students plan and conduct an investigation of the night sky to describe the arrangement, interaction, and movement of celestial bodies.

Key Idea 2: **Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.**

- Students add heat to and subtract heat from water and graph the temperature changes, including the resulting phase changes.
- Students make a record of reported earthquakes and volcanoes and interpret the patterns formed worldwide.

Key Idea 3: **Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.**

- Students test and compare the properties (hardness, shape, color, etc.) of an array of materials.
- Students observe an ice cube as it begins to melt and construct an explanation for what happens, including sketches and written descriptions of their ideas.
- Students observe and measure characteristic properties, such as boiling and melting points, solubility, and simple chemical changes of pure substances, and use those properties to distinguish and separate one substance from another.

Key Idea 4: **Energy exists in many forms, and when these forms change energy is conserved.**

- Students design and construct devices to transform/transfer energy.
- Students conduct supervised explorations of chemical reactions for selected household products (not including ammonia and bleach products), such as hot and cold packs used to treat sports injuries.
- Students build an electromagnet and investigate the effects of using different types of core materials, varying thicknesses of wire, and different circuit types.

Key Idea 5: **Energy and matter interact through forces that result in changes in motion.**

- Students investigate physics in everyday life, such as at an amusement park or playground.
- Students use simple machines made of pulleys and levers to lift objects and describe how each machine transforms the force applied to it.
- Students build "Rube Goldberg" type devices and describe the energy transformations evident in them.