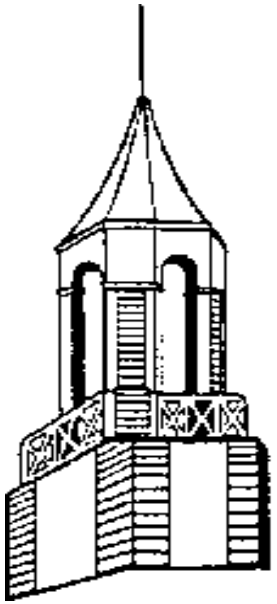
SCIENCE
COURSE OF STUDY
2007



CHAGRIN FALLS EXEMPTED VILLAGE SCHOOLS
400 East Washington Street
Chagrin Falls, Ohio 44022

THE SCIENCE COURSE OF STUDY

has been approved

by the

Chagrin Falls Board of Education

on

May 7, 2007

Resolution #07-032

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SCIENCE EDUCATION TABLE OF CONTENTS

PHILOSOPHY OF THE CHAGRIN FALLS EXEMPTED VILLAGE SCHOOLS

Education is a lifelong process. We, the Chagrin Falls Board of Education, as the elected body being legally responsible for the public school portion of that education, subscribe to the following philosophy:

We recognize an obligation to organize and administer the educational program in a manner compatible with a democratic society. We recognize that the unique responsibility of the schools is to pass along a fund of knowledge; and in order to meet this goal, to provide enriched conditions which foster academic excellence and individual growth. We recognize that all persons in our school community have rights and responsibilities that are inherent within that society. We believe that our school system should educate toward responsibility and responsiveness.

We recognize that students differ in their physical, intellectual, emotional, and social growth and in the way they develop these aspects. We believe that the school must play a primary role in the students' education and that educational goals grow out of the needs of individuals.

We believe that students bring together different abilities, talents, and backgrounds. Intellectual growth will flourish in an environment of trust, respect, and teamwork. The school should strive to heighten the students' appreciation of the cultural and individual diversity within the human family.

We believe that students need the freedom to question and should be encouraged to use independent, reflective, and critical thinking. They should have the opportunity to exercise independent judgment by making decisions about their education in addition to following standardized requirements.

We believe that students should understand their relationship to the community, the country, and to the world. Our schools should provide meaningful opportunities for students to become familiar with, and react to, a segment of society outside of their own community.

We believe the education received in Chagrin Falls should fit the students' needs for supporting themselves in the future by preparing for further academic study and vocational opportunities.

We believe objectives and procedures of all educational programs are dynamic rather than static and must change to meet new conditions in an ever-changing world. We should consider changes in the educational program because of their demonstrated worth.

CHAGRIN FALLS EXEMPTED VILLAGE SCHOOLS DISTRICT GOALS

The Chagrin Falls Board of Education is committed to quality education as its top priority. The mission of the Chagrin Falls Schools is to provide a comprehensive range of learning opportunities through which students, staff and community, in partnership, can develop each student's knowledge, confidence and responsibility leading to individual success and lifelong learning.

The Board defines a quality education as one that prepares the student to compete effectively in any chosen endeavor. Consideration will be given to the academic, social, cultural, physical, practical and emotional development of students in an integrated effort to equip them with a set of functional life skills.

The Chagrin Falls Board of Education will establish district goals, set policy, monitor progress, and prioritize its instructional, human, and financial resources to ensure accomplishment of its educational mission and defines the following goals:

- Establish standards for student achievement in the areas of:
  - Achievement relative to ability;
  - Identification and achievement of personal goals and feelings of positive self-worth in each student;
  - Development of an understanding of the world, its people and the student's role and responsibilities toward others;
  - Development of well-rounded individuals;
  - Development and implementation of marketing strategies to assure district competitiveness in the areas of college acceptance and other post-secondary options;
  - Academic and social behaviors that support student achievement;
  - Technology.
- Establish standards of teacher effectiveness in the areas of:
  - Professional and personal growth;
  - Development and implementation of stimulating lessons;
  - Development and use of articulate and correct language in all phases of student and employee communication;
  - Instruction encompassing higher-level thinking and problem-solving skills for all students;
  - Integration of curricula;
  - Identification of individual learning styles and adaptation of teaching methods in order to reach all students.

- Establish a plan and allocate sufficient resources to provide support services for the educational mission, including:
  - A safe environment;
  - An efficient transportation system;
  - Healthy and appetizing food service;
  - Professional development of classified employees;
  - Up-to-date instructional equipment and supplies;
  - Specialized services to meet individual student requirements.
- Establish a long-term facility plan to ensure:
  - Facilities that will enhance the educational program;
  - Maintenance and preservation of the community's investment in district facilities, grounds and equipment.
- Establish working relationships and communication networks within the community to ensure:
  - Identification of citizen, Board, parent, and student educational goals;
  - Commitment of citizens, Board, parents and students to ongoing support of the educational mission of the schools.
- Establish standards for administrator effectiveness in the areas of:
  - Fiscal management;
  - Personnel recruitment and development;
  - Policy development;
  - Curriculum development and coordination;
  - Implementation of district goals;
  - Appropriate educational offerings for all students;
  - Effective communications with all sectors of the school community.

PHILOSOPHY AND GUIDING ASSUMPTIONS OF SCIENCE INSTRUCTION

Science for All

The Ohio Department of Education believes that Ohio's academic content standards are for all students. Clearly defined standards delineate what all children, college- and career-bound, should know and be able to do as they progress through the grade levels. Well-defined standards ensure that parents, teachers and administrators will be able to monitor students' development. Students, as stakeholders in their own learning, will be capable of tracking their own learning.

No individual or group should be excluded from the opportunity to learn, and all students are presumed capable of learning. Every Ohio student, regardless of race, gender, ethnicity, socioeconomic status, limited English proficiency, disability or giftedness, shall have access to a challenging, standards-based curriculum.

The knowledge and skills defined in Ohio's academic content standards are within the reach of all students. Students, however, develop at different rates. All children learn and experience success given time and opportunity, but the degree to which the standards are met and the time it takes to reach the standards will vary from student to student.

Students with disabilities shall have Individualized Education Programs (IEP's) aligned with the standards. Students with disabilities are first and foremost students of the general curriculum, yet they may require specific supports and/or services to progress in the curriculum. These supports and services are not intended to compromise the content standards. Rather, they provide students with disabilities the opportunity to maximize their strengths, and participate and progress in the standards-based curriculum.

Students who can exceed the grade-level indicators and benchmarks set forth in the standards must be afforded the opportunity and be encouraged to do so. Students who are gifted may require special services or activities in order to fully develop their intellectual, creative, artistic and academic capabilities or to excel in a specific content area. Again, the point of departure is the standards-based curriculum.

Students with limited English proficiency (LEP) may also need specific supports and adaptive instructional delivery in order to achieve Ohio's academic content standards. An instructional delivery plan for a student with LEP needs to take into account the student's level of English language proficiency as well as his or her cultural experiences.

All children should be provided adjustments when necessary in order to address their individual needs. Identifying and nurturing the talents of all students will enable all children to reach the standards.

Ohio's science content standards serve as a basis for what all students should know and be able to do by the time they graduate from high school. The vision for the broad learning goals of Ohio's science academic content standards provides for a scientifically literate citizen. These standards, benchmarks and grade-level indicators are intended to provide Ohio's educators with a set of common expectations upon which to base science curriculum.

Philosophy of Ohio's Science Academic Content Standards

The intent of Ohio's science academic content standards is to:

- Help students develop an understanding of the unity and diversity of the natural (empirical) world;
- Foster an understanding of the nature of science, the development of science processes, the principles of science, and the connections between the physical, life, and Earth and space sciences;
- Prepare students to use appropriate scientific processes and principles in making personal decisions;
- Enable students to engage intelligently in public discourse about matters of scientific and technological concern; and
- Increase their future economic productivity through the use of scientific knowledge, understanding and skills in their careers.

Assumptions for Science Content Standards

Ohio's academic content standards:

- Set high expectations and provide strong support for science achievement by all students;
- Represent scientific knowledge and skills needed to make a successful transition to post-secondary education, the workplace and daily life
  Reflect sound application of research on how students learn science concepts and processes;
- Align with the national science education standards documents;
- Provide balance among conceptual understanding, procedural knowledge and skills, and application and problem-solving
- Address scientific content knowledge and processes including technological design, scientific ways of knowing, inquiry, communication, representation, and connections across the domains of science;
- Apply scientific knowledge and processes to individual and societal issues;
- Focus on important scientific concepts that are well-articulated through benchmarks and grade-level indicators;
- Represent rigorous progression across grades and in-depth study within each grade;
- Incorporate use of technology by all students in learning science and developing an understanding about the nature of science and technology including technological design;
- Serve as the basis for classroom and statewide assessments;
- Emphasize the nature, connections and historical development of scientific knowledge in the physical, life, and Earth and space sciences.

INTRODUCTION TO THE OHIO SCIENCE ACADEMIC CONTENT STANDARDS

The Ohio science academic content standards provide all students in the kindergarten through 12th grade program with a set of clear and rigorous expectations. The science standards focus on what all Ohio students need to know and be able to do for scientific literate citizenship, regardless of age, gender, cultural or ethnic background, disabilities or aspirations in science.

The science standards include science concepts, processes and ways of thinking. All Ohio students can apply these skills and understandings to make informed personal decisions, to accurately communicate with a variety of audiences, to become lifelong learners, and to make successful transitions to postsecondary education and the work force. The standards also include expectations for all Ohio students to safely and effectively use technological tools for learning and doing science. The Ohio science academic content standards are described below:

Earth and Space Sciences (ES)
Students demonstrate an understanding about how Earth systems and processes interact in the geosphere resulting in the habitability of Earth. This includes demonstrating an understanding of the composition of the universe, the solar system and Earth. In addition, it includes understanding the properties and the interconnected nature of Earth's systems, processes that shape Earth and Earth's history. Students also demonstrate an understanding of how the concepts and principles of energy, matter, motion and forces explain Earth systems, the solar system and the universe. Finally, they grasp an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with Earth and space sciences.

Life Sciences (LS)
Students demonstrate an understanding of how living systems function and how they interact with the physical environment. This includes an understanding of the cycling of matter and flow of energy in living systems. An understanding of the characteristics, structure and function of cells, organisms and living systems will be developed. Students will also develop a deeper understanding of the principles of heredity, biological evolution, and the diversity and interdependence of life. Students demonstrate an understanding of different historical perspectives, scientific approaches and emerging scientific issues associated with the life sciences.

Physical Sciences (PS)
Students demonstrate an understanding of the composition of physical systems and the concepts and principles that describe and predict physical interactions and events in the natural world. This includes demonstrating an understanding of the structure and properties of matter, the properties of materials and objects, chemical reactions and the conservation of matter. In addition, it includes understanding the nature, transfer and conservation of energy; motion and the forces affecting motion; and the nature of waves and interactions of matter and energy. Students demonstrate an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with the physical sciences.

Science and Technology (ST)
Students recognize that science and technology are interconnected and that using technology involves assessment of the benefits, risks and costs. Students should build scientific and technological knowledge, as well as the skill required to design and construct devices. In addition, they should develop the processes to solve problems and understand that problems may be solved in several ways.

Scientific Inquiry (SI)
Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and make predictions. They are able to reflect on scientific practices as they develop plans of action to create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Scientific Ways of Knowing (SK)
Students realize that the current body of scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. This includes demonstrating an understanding that scientific knowledge grows and advances as new evidence is discovered to support or modify existing theories, as well as to encourage the development of new theories. Students are able to reflect on ethical scientific practices and demonstrate an understanding of how the current body of scientific knowledge reflects the historical and cultural contributions of women and men who provide us with a more reliable and comprehensive understanding of the natural world.

The Ohio science standards identify essential expectations for students: concepts, principles, theories and processes of science. The science standards describe broad areas of content such as the interdependence of organisms, the interactions of matter and energy, objects in the sky, and the nature of scientific knowledge. The six standards address essential knowledge and skills in science that people may use in solving problems creatively, thinking critically, working cooperatively in teams, using technology effectively and valuing lifelong learning.

The Ohio science academic content standards provide teaching and learning opportunities that include accurate and technically-precise scientific information, scientific inquiry, technological design, communication and understanding of science concepts, analysis of data, and application of concepts.

Students' success in meeting the expectations of the standards depends on teaching and learning as an active inquiry process. This means that all teachers need the opportunity to teach science as something in which students are actively engaged. When participating in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge and communicate their ideas to others. This includes engaging all students' with relevant, real-world activities that develop students' knowledge, communication skills and scientific process skills.

The science standards enhance development of students' understanding of science concepts by combining scientific inquiry and technology studies with mathematical reasoning/analysis and language skills. Scientific literacy enables students to use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society. Science instruction can also integrate knowledge and skills from disciplines such as mathematics, English language arts, social studies and other disciplines to develop conceptual frameworks that lead to broader understandings.

The following terms and definitions are used in this document:

Standard: An overarching goal or theme in science. The standard statement describes, in broad terms, what students should know and be able to do as a result of the kindergarten through 12th grade program.

Benchmark: A specific statement of what all students should know and be able to do at a specified time in their schooling. Benchmarks are used to measure a student's progress toward meeting the standard. Science benchmarks are defined for grade bands K-2, 3-5, 6-8, 9-10, and 11-12.

Grade-Level: A specific statement of the knowledge and/or skills that a student is expected to demonstrate at each grade

Indicator: These indicators serve as checkpoints that monitor progress toward the benchmarks.

SCOPE AND SEQUENCE FOR SCIENCE K-12

Kindergarten
Kindergarten provides students with the opportunity to develop the scientific skills of wondering, questioning, investigating and communicating to enable them to begin to develop a sense of the world. Kindergartners learn through discovery about changes on Earth, in the sky, plants, animals, their habitats and non-living things in their local community. Through hands-on exploration, students learn the characteristics of objects, tools, materials, how they move, and whether or not they are natural or man-made. Students explore the different ways people learn about science and interact with living things and the environment to promote respect for nature. To complete this year, students show knowledge of scientific concepts through demonstration of verbal and non-verbal skills and activities.

Grade One
Science instruction in the first grade builds upon the science skills developed in kindergarten and from the child's life experiences. Students have increasing opportunities to explore how living things change, how they interact with their environment and how they acquire food. Students discover that many objects are made of different parts and characteristics. Students learn ways objects change, move, the materials of which they are composed and their physical properties. Students recognize and realize that natural resources are limited and can be extended by recycling or decreasing use. First-graders explore ways people learn about science through questioning, comparing, investigating and observing to conclude year one.

Grade Two
Second-graders continue to relate science concepts and skills to their life experiences. They compare similarities and differences between people, animals and plants. Living system functions and the interactions they have with their physical environment are explained. Focus is placed upon habits, and the interdependence and survival of plants and animals in Ohio. Weather changes both short term and long term are observed, described and measured. Second-graders discover how cycles are present in their everyday lives through investigations of Earth and sky, sound and light, and plants and animals. Students recognize the purpose, process and effects of technology, simple equipment and instruments used in learning about science. Students develop an awareness of repeated scientific investigations

Grade Three
The scientific skills of observation, measuring and classification serve as focal points for the third grade. Students learn to read and interpret simple tables and graphs, conduct safe investigations in which they collect and analyze data, and communicate the results. Third-graders explore the properties and composition of rocks and soils and the interaction of forces and motion. They also compare the life cycles of animals, classifications of animals according to their characteristics, descriptions of their habitat and adaptations to their environment. Students examine results of technology and explore careers in science, as well as scientific contributions from a diversity of cultures.

Grade Four
Fourth-graders continue to safely conduct investigations, choose appropriate tools, measure, collect, formulate conclusions and communicate findings. They draw inferences from simple experiments and study the physical and chemical changes of matter. Properties of materials and the discovery of new materials formed by combining two or more materials are explored. Students expand the study of life cycles of plants by examining characteristics, growth and functions. Students gather information on the weather and its patterns and how weather impacts the Earth's surface, land, air and water. They explore how utilizing technology affects human lives and how technology and inventions change to meet people's needs.

Grade Five
Earth and space sciences are investigated in more detail in grade five. Earth's characteristics, resources and location in the solar system are identified and their implications explored. Students also learn about the interrelationship of organisms and ecosystems and simple food chains and food webs. Energy and energy transfer through an electrical current are addressed. Fifth-graders describe and illustrate the design process and describe the positive and negative impacts of human activity and technology on the environment. Students observe, measure and collect data when conducting a scientific investigation; students use this information to formulate inferences and conclusions; and students develop skills to communicate the results.

Grade Six
Students in grade six continue to conduct investigations and begin to apply mathematical skills in evaluating and analyzing variables of data. They identify basic skills of the scientific inquiry process, such as how thinking scientifically is helpful in daily life and how technological advances affect the quality of life. Students research how men and women of other countries and cultures contribute to science. Sixth-grade students identify rocks, their distinct properties and formation and characteristic properties of the minerals that form them. They learn to recognize that a cell continually divides to create new cells, reproduction of cells occur, similar cells have special functions, and characteristics of an organism are a result of inherited traits. Students acquire knowledge of the uses, properties and chemical processes of the small particles that compose matter. They learn the renewable and nonrenewable sources of energy as part of the grade six indicators.

Grades Seven-Eight
Students learn to describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere. They continue to develop skills of scientific inquiry, explain how matter can change forms and describe how energy is potential or kinetic and takes many forms. Students apply math skills to evaluate and analyze variables and data from investigations as they draw conclusions from scientific evidence. Students are able to recognize that technology can create environmental and economic conflicts, affect the quality of life, and that science and technology cannot answer all questions and cannot solve all human problems. Students access knowledge to explain how energy entering the ecosystems, such as sunlight, supports the life of organisms through photosynthesis and the transfer of energy through the interactions of organisms and the environment. Students explore space and plate tectonics as they continue to draw conclusions from scientific evidence that support theories related to the change of Earth's surface. They acquire knowledge to describe how positions and motions of objects in the universe cause predictable and cyclic events. Students explain that the universe is composed of vast amounts of matter and that it is held together by gravitational force. They explore equipment to study the universe - telescopes, probes, satellites and spacecraft. Motion of objects, effects of forces on objects, and how waves (sound, water and earthquake) transfer energy are explored. Students will be able to explain how extinction of a species occurs when the environment changes and its adaptive characteristics are insufficient to allow survival. Students design a solution to a problem or design and build a product, given certain constraints. Technological influences on the quality of life are also explored in these grade levels.

Grade Nine
The ninth-grade year addresses physical science and related principles in Earth and space sciences. Physical science concepts include the nature of matter and energy; identifiable physical properties of substances; and properties of forces that act on objects. Ninth-graders learn about forces and motions, structures and properties of atoms, how atoms react with each other to form other substances, and how molecules react with each other or other atoms. Earth and space science topics include processes that move and shape Earth, Earth's interaction with the solar system, and gravitational forces and weather. Students continue to develop a deeper understanding of the processes of scientific inquiry and how these processes use evidence to support conclusions based on logical reasoning. Students investigate ways in which science and technologies combine to meet human needs and solve human problems. Ninth-graders trace the historical development of s

Grade 10
The 10th grade year emphasizes the concepts, principles and theories that enable people to understand the living environment. Students study life science concepts such as cells and their structure and function, the genetic and molecular bases of inheritance, biological evolution, and the diversity and interdependence of life. Students explain the Earth's history using geologic evidence, identifying the Earth's resources, and exploring processes that shape the Earth. The flow of energy and the cycling of matter through biological and ecological systems are addressed in the 10th grade. Embedded throughout this study are the basic science processes of inquiry, modeling investigations and the nature of science. Students learn to trace the historical development of scientific theories, ideas, ethical guidelines in science, the interdependence of science and technology, and the study of emerging issues to become scientifically literate citizens.

Grade 11
In grade 11 students draw on their previous experience and connect Earth, space, life and physical sciences into a coherent study of the environment. Emphasis is placed on the interactions between humans and Earth, ecosystems, biological evolution, populations and diversity. Students also explore matter and energy relationships. The human interactions with science and technology are discussed, as well as how man has modified current ecosystems and natural systems. Students have the opportunity to use basic science processes of inquiry, scientific investigation, and the nature of science to examine past events, current situations, and to develop and revise scientific predictions, ideas or theories.

Grade 12
Grade 12 focuses on advanced topics in biological and physical sciences. Biological topic clusters include cell specialization, biotechnology, DNA and evolutionary theory. In the physical sciences, students study equilibrium of systems, electromagnetic radiation, isotopes, radioactive decay, concepts of forces and motion as applied to large and small objects and energy levels. Integrated with these topics are historical perspectives, the process of inquiry, nature of science, ethical practices and use of appropriate technology. Twelfth-graders learn to apply principles of forces and motion to mathematically analyze, describe and predict the net effects of forces and motion of objects or systems. Students explore science research, scientific literature, and the relationship of science and society.

SCIENCE ASSESSMENT POLICY

The Role of Assessment
A strong, effective, aligned educational system has three parts: Standards, Curriculum and Instruction, and Assessments that align with the standards. Ohio has developed and adopted clear and rigorous academic content standards for its students. Educators, students, and the public need to know if students meet these standards. Assessment represents a student's demonstration of understanding; it provides evidence of what students know and are able to do. A comprehensive and thoughtful assessment system also provides needed information for instructional planning and decision-making.

Ohio's comprehensive assessment system includes several types of assessments:

- Achievement Tests
- Diagnostic Tests
- Classroom Assessments
- National and International Assessments

Each type of assessment provides invaluable information to Ohio's educators, parents, students and communities. While each piece supports the others, each also serves its own unique purpose:

Achievement Tests
Achievement tests provide the broadest picture of student performance. Ohio's achievement assessments, including the Ohio Graduation Test (OGT), are administered at specified grades and are based on the Ohio academic content standards benchmarks. Statewide assessments measure student achievement and provide guidance for making program decisions and for decisions related to the allocation of resources at the state and local level.

Diagnostic Assessments
Diagnostic assessments are administered annually and are designed to give teachers and parents detailed information as to the strengths and weaknesses of individual students. They provide teachers with important information for instructional planning.

Classroom Assessments
One of the most important components in implementing an aligned standard-based system is ongoing classroom assessment. Teachers constantly assess student performance on an ongoing basis, using both informal and formal measures. Listening to and questioning students are forms of classroom assessment, as are performance assessments, such as writing a research report or solving mathematical problems. Teachers use classroom assessments to evaluate students' performance and progress and to plan instruction intervention that is tailored to student's needs. Classroom assessments provide insights to the on-going performance of students. One benefit of classroom assessment is that the feedback is frequent and immediate. Another benefit is that teachers can plan and use assessment in a way that best suits their students' needs. Teachers can design and administer entry-level assessments to determine students' prerequisite skills. They can monitor students' progress frequently to adjust the pace of instruction appropriately and develop and use summative assessments to assess their instructional methods and their students' achievement.

National and International Assessments
Through participation in national and international assessment opportunities, such as NAEP and TIMSS, Ohio is able to compare the achievement of its students against that of students in other states and other nations. In this way, Ohio ensures that its standards are sufficiently rigorous and world-class.

The Best Preparation for All Types of Assessment
In Ohio's aligned system, teachers who develop classroom assessments based on the academic content standards grave-level indicators will know that they are evaluating students against a common reference point shared by all Ohio teachers.

When teachers design instructional plans based on the grade-level indicators, they will be preparing students for the statewide diagnostic and achievement test. Teachers will not have to take time out from instruction to prepare students for assessments. Standards-based instruction will prepare students for the assessments. In this way Ohio's aligned system will support schools, teachers, and parents in ensuring that all students meet the rigorous demands of the new century.

Ohio's Comprehensive Assessment System

Assessment Types	Basis for Content	Purpose
Achievement Test, including the Ohio Graduation Tests and grade/discipline specific tests	Ohio's Academic Content Standards	• Measure student achievement. • Demonstrate evidence of continuous improvement at the state and local level. • Provide data for Ohio's accountability system.
Diagnostic Assessment	Ohio's Academic Content Standards	• Monitoring student progress. • Make instructional decisions such as intervention, enrichment. • Provide information to students, parents and teachers.
Classroom Assessment	Ohio's Academic Content Standards Local Course of Study	• Measure process as well as product of student understanding and knowledge. • Inform teachers and students about progress. • Provide information for instructional planning.
National & International Assessment	National & International Standards	• Compare Ohio achievement against that of other states and nations.

INTERVENTION SERVICES

Individual students may need remediation, reinforcement, or extended learning situations to assist them with specific Indicators. As a result, two important assumptions need to be remembered: 1) intervention must always be tied to assessment, and 2) intervention is a shared responsibility. Assessment may be formal or informal, but it should always indicate to teachers whether intervention is necessary. This does not mean that a single assessment will necessarily indicate the need for intervention, nor will a single assessment indicate the type of intervention that should be provided. Rather, intervention programs need to be based on the full range of assessments that are included in a district's standards-based education program.

Intervention is a shared responsibility. In the broadest sense, intervention is the responsibility of all individuals who are involved with student achievement. Ideally, these structures involve students, teachers, parents, and building/district administrators. Minimally, intervention should be structured through three successive levels – the classroom, the building, and the district. At the core of classroom intervention is effective instruction aimed at each student. In general, this requires that instruction be focused as much upon the process of learning as upon what is learned.

Classroom Level Instruction

The primary responsibility for providing intervention, nevertheless, rests with the classroom teacher. The teacher must identify the need for intervention, design the instructional form it will take, and implement the action. Intervention in the classroom can take place during a lesson, after a lesson, at the end of a unit, or at the end (or beginning) of a grade level. However, the most effective intervention point occurs during the initial instruction.

There are many instruction/intervention patterns, and four of the most commonly observed patterns are characterized by (1) whole-group instruction, followed by remediation or extension for individual students, (2) whole-group instruction followed by collaborative group work, (3) group problem-solving strategies, and 4) one-to-one teacher-student interaction.

Building Level Intervention

When the intervention strategies provided in the classroom are not sufficient to meet the needs of an individual student, it is sometimes necessary to provide alternatives. These alternatives may include interclass grouping, the establishment of a resource or intervention room, tutorial programs, and a formal intervention assistance team established at the building level.

District Level Intervention

Students who continue to have needs for involvement in classroom and building level intervention programs need to be placed in district programs. These programs might include a highly individualized summer school program, a before- or after-school program during the regular school year, and in the case of secondary school students, a required remedial academic course or post-secondary enroll

INTERVENTION SERVICES MODEL (ADAPTED FROM OHIO DEPARTMENT OF EDUCATION, 1994)

Level	Resources	Records	***Activities***
CLASSROOM • Intraclass grouping • Alternative instruction	• Courses of study, performance objectives, appropriate instructional material	• Student folder/portfolio should contain records of performance objectives mastered and allow for documentation of intervention provided	1. Adjust instruction to learning styles 2. Modify materials 3. Personalize instruction 4. Use direct teaching 5. Use cooperative learning 6. Use learning contracts/teacher-student goal setting 7. Use diagnostic/prescriptive teaching 8. Conduct student conferences 9. Provide time in a resource room 10. Develop instructional plan with student 11. Provide independent activities coded to specific objectives 12. Use flexible grouping 13. Provide tutoring • Peer tutoring • Volunteer tutoring • Parent tutoring • Cross-age tutoring • Cross-grade tutoring 14. Use outside resource personnel/speakers 15. Involve parents in the intervention and implementation plan 16. Use diagnostic self-report 17. Conduct personal interview
BUILDING • Interclass grouping	• Student folder/portfolio, course of study, performance objectives, appropriate instruction materials	• ***Continue to update student folder, including evidence of student work***	
• Resource/intervention room	• Student folder/portfolio, , documentation of resource/intervention effort, course of study, performance objectives, appropriate instructional materials	• Continue to update student folder	
• Tutorial program	• Performance objectives, appropriate instructional materials	• Complete record of intervention effort given to professional overseeing tutoring for recording in student folder	
• Intervention Assistance Team		• Update student folder and document intervention plan decided upon by the team	
DISTRICTS • Summer school	• Courses of study, student folders/portfolio, performance objectives, appropriate instructional materials, documentation of intervention effort	• Provide a list of performance objectives mastered and evidence of growth to professional responsible for recording student progress	
• In-term extra hours programs (with teachers)	• Performance objectives not mastered, appropriate instructional materials, documentation of intervention effort	• Student folder/portfolio • Update student folder	
• Required remedial academic course	• Courses of study, student folder, performance objectives, appropriate instructional materials		

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

KINDERGARTEN

SCIENCE
KINDERGARTEN

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **<u>Science and Technology</u>** **✶ Explain why people, when building or making something, need to determine what it will be made of and how it will affect other people and the environment. (ST-A)** **✶ Explain that to construct something requires planning, communication, problem solving and tools. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Ask a testable question. (SI-A)** **✶ Design and conduct a simple investigation to explore a question. (SI-B)** **✶ Gather and communicate information from careful observations and simple investigation through a variety of methods. (SI-C)**	**By the end of Kindergarten, the student will:** **<u>Understanding Technology</u>** **✶ Explore that objects can be sorted as "natural" or "man-made." (ST-A-K-1)** **✶ Explore that some materials can be used over and over again (e.g., plastic or glass containers, cardboard boxes and tubes). (ST-A-K-2)** **<u>Abilities To Do Technological Design</u>** **✶ Explore that each kind of tool has an intended use, which can be helpful or harmful (e.g., scissors can be used to cut paper but they can also hurt you). (ST-B-K-3)** **<u>Doing Scientific Inquiry</u>** **✶ Ask "what if" questions. (SI-A-K-1)** **✶ Explore and pursue student-generated "what if" questions. (SI-A-K-2)** **✶ Use appropriate safety procedures when completing scientific investigations. (SI-B-K-3)** **✶ Use the five senses to make observations about the natural world. (SI-B-K-4)** **✶ Draw pictures that correctly portray features of the item being described. (SI-C-K-5)** **✶ Recognize that numbers can be used to count a collection of things. (SI-C-K-6)** **✶ Use appropriate tools and simple equipment/instruments to safely**	

SCIENCE
KINDERGARTEN

Scientific Ways of Knowing ✶ **Recognize that there are different ways to carry out scientific investigations. Realize that investigations can be repeated under the same conditions with similar results and may have different explanations. (SK-A)** ✶ **Recognize the importance of respect for all living things. (SK-B)** ✶ **Recognize that diverse groups of people contribute to our understanding of the natural world. (SK-C)**	**gather scientific data (e.g., magnifiers and other appropriate tools). (SI-B-K-7)** ✶ **Measure the lengths of objects using non-standard methods of measurement (e.g., teddy bear counters and pennies). (SI-C-K-8)** ✶ **Make pictographs and use them to describe observations and draw conclusions. (SI-C-K-9)** ✶ **Make new observations when people give different descriptions for the same thing. (SI-B-K-10)** **Nature of Science** ✶ **Recognize that scientific investigations involve asking open-ended questions. (How? What if?) (SK-A-K-1)** ✶ **Recognize that people are more likely to accept your ideas if you can give good reasons for them. (SK-A-K-2)** **Ethical Practices** ✶ **Interact with living things and the environment in ways that promote respect. (SK-B-K-3)** **Science and Society** ✶ **Demonstrate ways science is practiced by people everyday (children and adults). (SK-C-K-4)**	

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CARE AND OBSERVATION OF ANIMALS
Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Explain that living things cause changes on Earth. (ES-B)** **Life Sciences** ✶ **Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). (LS-A)** ✶ **Explain how organisms function and interact with their physical environment. (LS-B)** ✶ **Describe similarities and differences that exist among individuals of the same kind of plants and animals. (LS-C)**	**By the end of Kindergarten, the student will:** **Processes That Shape Earth** ✶ **Explore that animals and plants cause changes to their surroundings. (ES-B-K-2)** **Characteristics and Structure of Life** ✶ **Explore differences between living and non-living things (e.g., plant-rock). (LS-A-K-1)** ✶ **Discover that stories (e.g., cartoons, movies, comics) sometimes give plants and animals characteristics they really do not have (e.g., talking flowers). (LS-A-K-2)** **Heredity** ✶ **Describe how plants and animals usually resemble their parents. (LS-C-K-3)** ✶ **Investigate variations that exist among individuals of the same kind of plant or animal. (LS-C-K-4)** **Diversity and Interdependence of Life** ✶ **Investigate observable features of plants and animals that help them live in different kinds of places. (LS-B-K-5)** ✶ **Investigate the habitats of many different kinds of local plants and animals and some of the ways in which animals depend on plants and each other in our community. (LS-B-K-6)** **Sub-Objectives to Meet Indicators:** • Recognize characteristics that can identify a thing as living:	**Suggested Pacing Guide** • August and September (Emphasis on Living/Nonliving and Life Cycles of Animals) • April, May, June (Emphasis on Habitats) **Suggested Materials** • Teacher Resource: Ohio Kindergarten-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Literature: Squirrels All Year Long (Newbridge), one big book and guide per teacher • Literature: Where Do the Animals Live? (Newbridge), one big book and guide per teacher • Literature: Animals and Their Babies (Newbridge), one big book and guide per teacher • Literature: A Butterfly Is Born (Newbridge), one big book and guide per teacher • Literature: Is It Alive? (Newbridge), one big book and guide per teacher • Literature: Discovery Links-We Need Water (Newbridge), copies per teacher • Literature: Living Things Need Water (National Geographic), copies per teacher

	◦ Ability to grow and change ◦ Ability to react to its environment ◦ Need for food or another source of energy ◦ Take in gases for respiration (e.g., breathing, etc.) ◦ Ability to reproduce ◦ Made up of cells (taught at grades 3-4) • Identify a living organism's need for: ◦ Source of food or energy ◦ Water ◦ Gases to take in (e.g., breathing, etc.) ◦ Environment that will allow for survival (e.g., protection, light, temperature, etc.) • Differentiate between animals by their physical properties (e.g., weight, size, color, texture, etc.). • Sort and classify animals into categories according to ways in which animals move, foods they eat, coverings, environment, etc. • Compare and contrast indoor animals (e.g., mice, spiders, fleas, cats, lice, canaries, goldfish, etc.) and outdoor animals (e.g., foxes, worms, owls, deer, moles, etc.). • Identify and describe domestic and wild animals (e.g., cow, horse, cat, dog, mouse, platypus, tiger, sloth, anteater, chimpanzee, etc.). • Observe animal growth from a baby to an adult, noting the ways that animals grow and develop (e.g., through pictures, movies, field trips, classroom animals, etc.). • Explore how animals adapt to changing conditions both indoors and outdoors (e.g., light, weather, temperature, seasons, etc.).	• Literature: Look Once, Look Again Series (Creative Teaching Press), copies per teacher including the following titles ◦ At the Farm ◦ In a Tree ◦ In the Forest ◦ In the Garden ◦ At the Zoo ◦ Among the Flowers ◦ At the Seashore ◦ Underfoot ◦ At the Pond ◦ In the Desert ◦ In the Meadow ◦ In the Park **Suggested Teaching Strategies** • Activity: A Cup of Worms (AIMS Education Foundation) • Activity: A Walk in the Park (AIMS Education Foundation) • Activity: Causing Changes (AIMS Education Foundation) • Activity: Living and Nonliving Things (AIMS Education Foundation) • Activity: Living or Nonliving? (AIMS Education Foundation) • Activity: Living/Nonliving • Activity: Meet the Guppy Family (AIMS Education Foundation) • Activity: Paste-Up Habitats (AIMS Education Foundation) • Activity: See the Difference (AIMS Education Foundation)

		• Activity: Spider Spoofs and Proofs (AIMS Education Foundation) • Activity: Spot the Difference (AIMS Education Foundation) • Activity: Watch a Chicken Grow • Activity: Where Can Animals Live? (AIMS Education Foundation) • Activity: Where Do I Live? • Activity: Who's Been Here? (AIMS Education Foundation) • Activity: Who's My Mom (AIMS Education Foundation) • Learning Center: Scientific Classification Center (Lakeshore)

SCIENCE
KINDERGARTEN

CARE AND OBSERVATION OF PLANTS
Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES

By the end of the K-2 program, the student will:
 	
Earth and Space Sciences
✶ **Explain that living things cause changes on Earth. (ES-B)**
 	
Life Sciences
✶ **Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). (LS-A)**
✶ **Explain how organisms function and interact with their physical environment. (LS-B)**
✶ **Describe similarities and differences that exist among individuals of the same kind of plants and animals. (LS-C)**
	By the end of Kindergarten, the student will:
	
	Processes That Shape Earth
	✶ **Explore that animals and plants cause changes to their surroundings. (ES-B-K-2)**
	
	Characteristics and Structure of Life
	✶ **Explore differences between living and non-living things (e.g., plant-rock). (LS-A-K-1)**
	✶ **Discover that stories (e.g., cartoons, movies, comics) sometimes give plants and animals characteristics they really do not have (e.g., talking flowers). (LS-A-K-2)**
	
	Heredity
	✶ **Describe how plants and animals usually resemble their parents. (LS-C-K-3)**
	✶ **Investigate variations that exist among individuals of the same kind of plant or animal. (LS-C-K-4)**
	
	Diversity and Interdependence of Life
	✶ **Investigate observable features of plants and animals that help them live in different kinds of places. (LS-B-K-5)**
	✶ **Investigate the habitats of many different kinds of local plants and animals and some of the ways in which animals depend on plants and each other in our community. (LS-B-K-6)**
	
	Sub-Objectives to Meet Indicators:
	• Recognize characteristics that can identify a thing as living:
		Suggested Pacing Guide
		• October
		
		Suggested Materials
		• Teacher Resource: Ohio Kindergarten-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher
		• Literature: Growing Pumpkins (Newbridge), one big book and guide per teacher
		• Literature: Is It Alive? (Newbridge), one big book and guide per teacher
		• Literature: Seeds Get Around (Newbridge), one big book and guide per teacher
		• Literature: An Apple A Day (Newbridge), one big book and guide per teacher
		• Literature: Living Things Need Water (National Geographic), copies per teacher
		• Literature: First Step Series (Lerner Publications Company), copies per teacher including the following titles
		  ◦ Flowers
		  ◦ Roots
		  ◦ Stems
		  ◦ Leaves
		• Literature: The Carrot Seed (Scholastic), copies per teacher

SCIENCE
KINDERGARTEN

	° Ability to grow and change ° Ability to react to its environment ° Need for food or another source of energy ° Take in gases for respiration (e.g., breathing, etc.) ° Ability to reproduce ° Made up of cells (taught at grades 3-4) • Identify a living organism's need for: ° Source of food or energy ° Water ° Gases to take in (e.g., breathing, etc.) ° Environment that will allow for survival (e.g., protection, light, temperature, etc.) • Construct a planter to observe plant growth (e.g., terrarium, Ziploc bags, film canisters, etc.). • Observe the growth of a root system using a clear container (e.g., cup, film container, etc.). • Follow directions to care for plants from seed to mature organisms, including planting, feeding, and watering. • Estimate the size and growth of a plant. • Compare and contrast several plants varying in size, using nonstandard units (e.g., bigger, smaller, taller, etc.). • Describe various kinds of plants (e.g., carrot, lettuce, cabbage, tomato, pea, bean, etc.). • Examine sprouting, growth, flowering, dying, and decay of plants. • Order a series of pictures of plant growth in stages from seed to flowering. • Explore the impact of different variables on plants (e.g., heat, light, water, salt, fertilizer, etc.). • Observe plants and describe changes in them over time (e.g., through pictures, drawings, audio-taped reflections, etc.).	**Suggested Teaching Strategies** • Activity: A Snap of Time (AIMS Education Foundation) • Activity: A Sunflower Story • Activity: Apple Awareness • Activity: Concept • Activity: Digital Diaries (AIMS Education Foundation) • Activity: Find the Family (AIMS Education Foundation) • Activity: Flower-Parts Puzzle • Activity: Golden House (AIMS Education Foundation) • Activity: Kindergarten Science-Life Science, Plants • Activity: Light for Life • Activity: Literature Connections • Activity: Living and Nonliving Things (AIMS Education Foundation) • Activity: Living or Nonliving? (AIMS Education Foundation) • Activity: Living/Nonliving • Activity: Making a Little Book • Activity: Making Vegetable Soup • Activity: My Sweet Potato Book • Activity: Paste-Up Habitats (AIMS Education Foundation) • Activity: Pumpkin Changes Journal • Activity: Rainbow Art • Activity: Season-O (AIMS Education Foundation) • Activity: Seed Sort • Activity: Seed Sowing

		• Activity: Seeds • Activity: Sunflower House • Activity: Super Seeds (AIMS Education Foundation) • Activity: Tie a Yellow Ribbon (AIMS Education Foundation) • Activity: Trees • Activity: Who's Been Here? (AIMS Education Foundation) • Activity: Your Garden • Field Trip: Patterson's Fruit Farm • Learning Center: Plants Instant Learning Center • Learning Center: Scientific Classification Center (Lakeshore) • Worksheet: From Seed to Tree • Worksheet: Parts of a Tree • Worksheet: Plants with Pizzazz

SCIENCE
KINDERGARTEN

WEATHER

Earth and Space Sciences Standard (ES)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Observe, describe and measure changes in the weather, both long term and short term. (ES-C)**	**By the end of Kindergarten, the student will:** **Processes That Shape Earth** ✶ **Explore that sometimes change is too fast to see and sometimes change is too slow to see. (ES-C-K-3)** ✶ **Observe and describe day-to-day weather changes (e.g., today is hot, yesterday we had rain). (ES-C-K-4)** ✶ **Observe and describe seasonal changes in weather. (ES-C-K-5)** **Sub-Objectives to Meet Indicators:** • Make a graph of weather observations over a period of time (e.g., sunny days, cloudy days, hot days, rainy days, windy days, etc.). • Clarify observations and evaluate predictions of weather by investigating current data (e.g., T.V. weather reports, telephone time and temperature, newspapers, etc.). • Observe weather and dress according to weather conditions. • Observe seasonal changes over time due to temperature, light, sunshine, rainfall, etc. • Describe changes in the environment as seasons change (e.g., winter-cold, snow, ice, clouds, etc.).	**Suggested Pacing Guide** • November and December **Suggested Materials** • Teacher Resource: Ohio Kindergarten-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Literature: The Four Seasons (Newbridge), one big book and guide per teacher • Literature: Our Sun, Our Weather (Newbridge), one big book and guide per teacher • Literature: Squirrels All Year Long (Newbridge), one big book and guide per teacher • Literature: Who Cares About the Weather? (Newbridge), one big book and guide per teacher **Suggested Teaching Strategies** • Activity: Calendar Connections (AIMS Education Foundation) • Activity: Cats in Hats • Activity: Charting Winter Weather • Activity: Dress for the Weather (AIMS Education Foundation) • Activity: Feeling Heat

		• Activity: Just Right (AIMS Education Foundation) • Activity: Measuring Temperature • Activity: My Weather Book • Activity: Rainbow Science • Activity: Recipe for a Snowman • Activity: Season-O (AIMS Education Foundation) • Activity: Spring • Activity: Temperature Told-Hot and Cold (AIMS Education Foundation) • Activity: Watch It Melt! • Activity: Weather Changes Day to Day (AIMS Education Foundation) • Activity: Which Way Is It Blowing? • Learning Center: Theme Box-Seasons and Weather (Lakeshore) • Worksheet: How Does A Thermometer Work? • Worksheet: Observe the Weather • Worksheet: Trees • Worksheet: Weather Words • Worksheet: What Are the Four Seasons Called? • Worksheet: What Should You Wear?

SCIENCE
KINDERGARTEN

FIVE SENSES: PHYSICAL PROPERTIES
Physical Sciences Standard (PS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Physical Sciences** ✶ **Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change. (PS-A)**	**By the end of Kindergarten, the student will:** **Nature of Matter** ✶ **Demonstrate that objects are made of parts (e.g., toys, chairs). (PS-A-K-1)** ✶ **Examine and describe objects according to the materials that make up the object (e.g., wood, metal, plastic and cloth). (PS-A-K-2)** ✶ **Describe and sort objects by one or more properties (e.g., size, color and shape). (PS-A-K-3)** **Sub-Objectives to Meet Indicators:** • Explore the five senses through inquiry (e.g., smell kits, feely bags, blindfolded taste tests, recorded sounds, etc.). • Use instruments to enhance observations (e.g., hand lenses, magnifying glasses, binoculars, microscopes, etc.). • Identify the five senses and explore their uses. • Explore physical properties of living and nonliving things: ° Color ° Temperature ° Magnetic/Nonmagnetic ° Size ° Weight/Mass ° Luster/Shininess ° Shape ° Float/Sink ° Malleability/Flexibility ° Texture • Measure in nonstandard units (e.g., light/heavy, small/big, tall/short,	**Suggested Pacing Guide** • January and February **Suggested Materials** • Teacher Resource: Ohio Kindergarten-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Literature: See, Hear, Touch, Taste, Smell (Newbridge), one big book and guide per teacher • Literature: Sink or Float? (Newbridge), one big book and guide per teacher • Literature: The Mystery of Magnets (Newbridge), one big book and guide per teacher **Suggested Teaching Strategies** • Activity: Backpack Bounty (AIMS Education Foundation) • Activity: Bag of Beads (AIMS Education Foundation) • Activity: Did You Ever See a Table? (AIMS Education Foundation) • Activity: Eye Color Graph • Activity: Fit for a Bear (AIMS Education Foundation) • Activity: Hearing Science

	paper clips, unifix cubes, etc.). • Experience and describe objects in sensory terms (e.g., texture, smell, taste, loudness, etc.).	• Activity: Kaleidoscope Knowledge • Activity: Light Learning • Activity: Magnet Manipulation • Activity: Magnets Rock! • Activity: Magnifying Glass • Activity: Many Materials (AIMS Education Foundation) • Activity: My Favorite Things Book • Activity: Ocean Observation • Activity: Quart Quandary • Activity: Rainbow Around My Room (AIMS Education Foundation) • Activity: Rainbow Science • Activity: Shape Search (AIMS Education Foundation) • Activity: Take Aparts (AIMS Education Foundation) • Activity: Texture Rough, Texture Smooth (AIMS Education Foundation) • Activity: Volume Viewing • Activity: Will It Bend? • Activity: You Can Smell • Activity: You Can Touch • Learning Center: Listening Lotto (Lakeshore) • Learning Center: Theme Box-Five Senses (Lakeshore)

SCIENCE
KINDERGARTEN

DAY AND NIGHT

Earth and Space Sciences Standard (ES)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Observe constant and changing patterns of objects in the day and night sky. (ES-A)**	**By the end of Kindergarten, the student will:** **The Universe** ✶ **Observe that the Sun can be seen only in the daytime, but the Moon can be seen sometimes at night and sometimes during the day. (ES-A-K-1)** **Sub-Objectives to Meet Indicators:** • Observe and describe familiar patterns and cycles (e.g., day and night, passage of time, etc.). • Construct and/or observe simple models of the sun, moon, and earth (e.g., sky tent, StarLab, pictures, drawings, mobiles, etc.). • Discuss day/night using a globe/sphere and light source (e.g., ball and flashlight or lamp, etc.).	**Suggested Pacing Guide** • March **Suggested Materials** • Teacher Resource: Ohio Kindergarten-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Literature: What Is a Cycle? (Newbridge), one big book and guide per teacher • Literature: Our Sun, Our Weather (Newbridge), one big book and guide per teacher • Literature: Out in Space (Newbridge), one big book and guide per teacher • Literature: Light and Shadow (Newbridge), copies per teacher • Literature: Day and Night (Newbridge), copies per teacher • Literature: So That's How the Moon Changes Shape! (Harcourt Brace), copies per teacher **Suggested Teaching Strategies** • Activity: Nighttime/Daytime Animals • Activity: Animals at Night • Activity: Finding Patterns and Relationships • Activity: Globe Grabbing

		• Activity: Making Shadows • Activity: Moon Phase Fun • Activity: Moon Phases • Activity: Our Place in Space • Activity: Shady Sensations (AIMS Education Foundation) • Activity: Shedding Light on Shadows • Activity: Sun on Floor in Middle • Activity: The Sun • Activity: The Sun and the Moon (Book) (AIMS Education Foundation) • Activity: What Is the Source of the Moon's Light • Activity: What Shines? • Activity: Where is the Sun? (AIMS Education Foundation) • Activity: Where Will the Light Go? • Activity: Why Do We Have Night? • Poetry: Moon Chant • Poetry: The Night • Poetry: Why Does the Moon Shine? • Worksheet: Day and Night • Worksheet: Sunlight Makes Shadows • Worksheet: The Sun Is the Star Nearest the Earth • Worksheet: We See Sunlight in the Daytime • Worksheet: Which Star is the Closest One?

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 1

SCIENCE
GRADE 1

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Science and Technology** ✶ **Explain why people, when building or making something, need to determine what it will be made of and how it will affect other people and the environment. (ST-A)** ✶ **Explain that to construct something requires planning, communication, problem solving and tools. (ST-B)** **Scientific Inquiry** ✶ **Ask a testable question. (SI-A)** ✶ **Design and conduct a simple investigation to explore a question. (SI-B)** ✶ **Gather and communicate information from careful observations and simple investigation through a**	**By the end of First Grade, the student will:** **Understanding Technology** ✶ **Explore that some kinds of materials are better suited than others for making something new (e.g., building materials used in the *Three Little Pigs*). (ST-A-1-1)** ✶ **Explain that when trying to build something or get something to work better, it helps to follow directions and ask someone who has done it before. (ST-B-1-2)** **Abilities To Do Technological Design** ✶ **Investigate that tools are used to help make things and some things cannot be made without tools. (ST-B-1-6)** ✶ **Explore that several steps are usually needed to make things (e.g., building with blocks). (ST-B-1-7)** ✶ **Investigate that when parts are put together they can do things that they could not do by themselves (e.g., blocks, gears and wheels). (ST-B-1-8)** **Doing Scientific Inquiry** ✶ **Ask "what happens when" questions. (SI-A-1-1)** ✶ **Explore and pursue student-generated "what happens when" questions. (SI-A-1-2)** ✶ **Use appropriate safety procedures when completing scientific investigations. (SI-B-1-3)** ✶ **Work in a small group to complete an investigation and then share findings with others. (SI-C-1-4)**	**Suggested Materials** • Literature: Design It, Build It (Newbridge), one big book and guide per teacher

SCIENCE
GRADE 1

variety of methods. (SI-C) **<u>Scientific Ways of Knowing</u>** **✶ Recognize that there are different ways to carry out scientific investigations. Realize that investigations can be repeated under the same conditions with similar results and may have different explanations. (SK-A)** **✶ Recognize that diverse groups of people contribute to our understanding of the natural world. (SK-C)**	**✶ Create individual conclusions about group findings. (SI-C-1-5)** **✶ Use appropriate tools and simple equipment/instruments to safely gather scientific data (e.g., magnifiers, timers, simple balances and other appropriate tools). (SI-B-1-6)** **✶ Make estimates to compare familiar lengths, weights and time intervals. (SI-C-1-7)** **✶ Use oral, written and pictorial representation to communicate work. (SI-C-1-8)** **✶ Describe things as accurately as possible and compare with the observations of others. (SI-C-1-9)** **<u>Nature of Science</u>** **✶ Discover that when a science investigation is done the same way multiple times, one can expect to get very similar results each time it is performed. (SK-A-1-1)** **✶ Demonstrate good explanations based on evidence from investigations and observations. (SK-A-1-2)** **<u>Science and Society</u>** **✶ Explain that everybody can do science, invent things and have scientific ideas no matter where they live. (SK-C-1-3)**	

SCIENCE
GRADE 1

CHARACTERISTICS OF PLANTS
Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Explain that living things cause changes on Earth. (ES-B)** **Life Sciences** ✶ **Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). (LS-A)** ✶ **Explain how organisms function and interact with their physical environment. (LS-B)**	**By the end of First Grade, the student will:** **Processes That Shape the Earth** ✶ **Explain that all organisms cause changes in the environment where they live; the changes can be very noticeable or slightly noticeable, fast or slow (e.g., spread of grass cover slowing soil erosion, tree roots slowly breaking sidewalks). (ES-B-1-3)** **Characteristics and Structure of Life** ✶ **Explore that organisms, including people, have basic needs, which include air, water, food, living space and shelter. (LS-A-1-1)** ✶ **Explain that food comes from sources other than grocery stores (e.g., farm crops, farm animals, oceans, lakes and forests). (LS-B-1-2)** **Diversity and Interdependence of Life** ✶ **Investigate that animals eat plants and/or other animals for food and may also use plants or other animals for shelter and nesting. (LS-A-1-4)** ✶ **Recognize that seasonal changes can influence the health, survival or activities of organisms. (LS-B-1-5)** **Sub-Objectives to Meet Indicators:** • Recognize characteristics that can identify a thing as living: ° Ability to grow and change ° Ability to react to its environment ° Need for food or another source of energy ° Take in gases for respiration (e.g., breathing, etc.) ° Ability to reproduce	**Suggested Materials** • Literature: Life in a Tree (Newbridge), one big book and guide per teacher

	° Made up of cells (taught at grades 3-4) • Identify a living organism's need for: ° Source of food or energy ° Water ° Gases to take in (e.g., breathing, etc.) ° Environment that will allow for survival (e.g., protection, light temperature, etc.) • Recognize the parts of a plant and their functions by growing plants (e.g., roots, seeds, leaves, stems, flowers, etc.). • Alter conditions for growing plants to determine their effects on seed/plant growth (e.g., less water, fertilizer, no sun, etc.). • Make measurements of plants and graph their rates of change over time. • Create a list of conditions for keeping something alive, taking into account growing conditions as well as resources needed. • Classify plants according to their physical properties (e.g., size, shape, color, texture, etc.). • Describe categories of plants (e.g., fruits, vegetables, trees, herbs, houseplants, etc.). • Compare and contrast outdoor and indoor plants. • Describe the changes in plants through the various seasons.	

SCIENCE
GRADE 1

CHARACTERISTICS OF ANIMALS

Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Explain that living things cause changes on Earth. (ES-B)** **Life Sciences** ✶ **Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). (LS-A)** ✶ **Explain how organisms function and interact with their physical environment. (LS-B)** ✶ **Describe similarities and differences that exist among individuals of the same kind of plants and animals. (LS-C)**	**By the end of First Grade, the student will:** **Processes That Shape the Earth** ✶ **Explain that all organisms cause changes in the environment where they live; the changes can be very noticeable or slightly noticeable, fast or slow (e.g., spread of grass cover slowing soil erosion, tree roots slowly breaking sidewalks). (ES-B-1-3)** **Characteristics and Structure of Life** ✶ **Explore that organisms, including people, have basic needs which include air, water, food, living space and shelter. (LS-A-1-1)** ✶ **Explain that food comes from sources other than grocery stores (e.g., farm crops, farm animals, oceans, lakes and forests). (LS-B-1-2)** ✶ **Explore that humans and other animals have body parts that help to seek, find and take in food when they are hungry (e.g., sharp teeth, flat teeth, good nose, sharp vision). (LS-B-1-3)** **Diversity and Interdependence of Life** ✶ **Investigate that animals eat plants and/or other animals for food and may also use plants or other animals for shelter and nesting. (LS-A-1-4)** ✶ **Recognize that seasonal changes can influence the health, survival or activities of organisms. (LS-B-1-5)** **Sub-Objectives to Meet Indicators:** • Recognize characteristics that can identify a thing as living: ° Ability to grow and change	**Suggested Materials** • Literature: Predators and Prey (Newbridge), one big book and guide per teacher • Literature: Animals in Hiding (Newbridge), one big book and guide per teacher • Literature: Life in a Tree (Newbridge), one big book and guide per teacher • Literature: Animal's Eyes and Ears (Benchmark Education), six little books per teacher

	° Ability to react to its environment ° Need for food or another source of energy ° Take in gases for respiration (e.g., breathing, etc.) ° Ability to reproduce ° Made up of cells (taught at grades 3-4) • Identify a living organism's need for: ° Source of food or energy ° Water ° Gases to take in (e.g., breathing, etc.) ° Environment that will allow for survival (e.g., protection, light, temperature, etc.) • Explore similarities and differences between various categories of animals (e.g., insects, birds, mammals, fish, amphibians, reptiles, zoo, wild, domesticated, etc.). • Classify animals by types of home, environment, basic needs, etc. • Compare and contrast animals according to their physical properties (e.g., size, color, shape, texture, weight, etc.). • Observe animal growth from a baby to an adult, noting ways animals grow and develop. • Classify animals according to physical characteristics (e.g., by body coverings, habitats, legs, adaptive features, wings, etc.). • Identify animals that use camouflage as an adaptation to survive (e.g., chameleons, snowshoe rabbits, stick bugs, etc.).	

SCIENCE
GRADE 1

STATES OF MATTER
Physical Sciences Standard (PS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Physical Sciences** ✶ **Discover that many objects are made of parts that have different characteristics. Describe these characteristics and recognize ways an object may change. (PS-A)**	**By the end of First Grade, the student will:** **Nature of Matter** ✶ **Classify objects according to the materials they are made of and their physical properties. (PS-A-1-1)** ✶ **Investigate that water can change from liquid to solid or solid to liquid. (PS-A-1-2)** ✶ **Explore and observe that things can be done to materials to change their properties (e.g., heating, freezing, mixing, cutting, wetting, dissolving, bending and exposing to light). (PS-A-1-3)** ✶ **Explore changes that greatly change the properties of an object (e.g., burning paper) and changes that leave the properties largely unchanged (e.g., tearing paper). (PS-A-1-4)** **Sub-Objectives to Meet Indicators:** • Use the senses to investigate the physical properties of objects: ° Color ° Temperature ° Magnetic/Nonmagnetic ° Size ° Weight/Mass ° Shape ° Texture ° Float/Sink ° Luster/Shininess ° Malleability/Flexibility • Determine the material(s) that objects are made from (e.g., plastic, metal, glass, paper, wood, etc.). • Separate and sort objects according to the materials from which they are made.	**Suggested Materials** • Kit: FOSS-Solids and Liquids (Delta Education), previously adopted in the district and stored in the science room • Teacher Resource: What Is the World Made Of?-All About Solids, Liquids, and Gases (Books Galore), one copy per teacher • Literature: A World of Change (Newbridge), one big book and guide per teacher • Literature: Amazing Water (Newbridge), one big book and guide per teacher • Literature: What Is Matter? (Newbridge), one big book and guide per teacher • Literature: Properties of Materials (Newbridge), one big book and guide per teacher • Literature: Bubbles, Bubbles Everywhere (Newbridge), one big book and guide per teacher • Literature: Discovery Links-Water Changes (Newbridge), copies per teacher • Literature: Discovery World-Just Add Water (Rigby), copies per teacher • Literature: Discovery World-Materials and Their Uses (Rigby), copies per teacher • Literature: Discovery World-Wood and

	• Observe properties of gases (e.g., take up space, have volume, have weight, exert pressure, etc.). • Observe properties of liquids (e.g., take the shape of their containers, are fluids, etc.). • Observe properties of solids (e.g., have their own shape, etc.). • Compare and contrast solids, liquids and gases. • Identify examples of solids, liquids and gases. • Use the senses to describe physical changes of solids, liquids and gases (e.g., cooking foods, freezing and melting of ice, evaporating water, observing dry ice, etc.).	Other Materials (Rigby), copies per teacher • Literature: Windows on Literacy-Water (National Geographic), copies per teacher • Literature: Water's Way (Macmillan-McGraw Hill), copies per teacher

SCIENCE
GRADE 1

NATURAL RESOURCES: AIR, WATER AND SOIL
Earth and Space Sciences Standard (ES)
Physical Sciences (PS)
Science and Technology Standard (ST)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Explain that living things cause changes on Earth. (ES-B)** ✶ **Describe what resources are and recognize some are limited but can be extended through recycling or decreased use. (ES-D)** **Physical Sciences** ✶ **Recognize sources of energy and their uses. (PS-C)** **Science and Technology** ✶ **Explain why people, when building or making something, need to determine what it will be made of and how it will affect other people and the environment. (ST-A)**	**By the end of First Grade, the student will:** **Earth Systems** ✶ **Identify that resources are things that we get from the living (e.g., forests) and nonliving (e.g., minerals, water) environment and that resources are necessary to meet the needs and wants of a population. (ES-D-1-1)** ✶ **Explain that the supply of many resources is limited but the supply can be extended through careful use, decreased use, reusing and/or recycling. (ES-D-1-2)** **Processes That Shape the Earth** ✶ **Explain that all organisms cause changes in the environment where they live; the changes can be very noticeable or slightly noticeable, fast or slow (e.g., spread of grass cover slowing soil erosion, tree roots slowly breaking sidewalks). (ES-B-1-3)** **Nature of Energy** ✶ **Explore how energy makes things work (e.g., batteries in a toy and electricity turning fan blades). (PS-C-1-7)** ✶ **Recognize that the sun is an energy source that warms the land, air and water. (PS-C-1-8)** ✶ **Describe that energy can be obtained from many sources in many ways (e.g., food, gasoline, electricity or batteries). (PS-C-1-9)** **Science and Technology** ✶ **Identify some materials that can be saved for community recycling**	**Suggested Materials** • Literature: Where Does All The Garbage Go? (Newbridge), one big book and guide per teacher • Literature: Kids for the Earth (Newbridge), one big book and guide per teacher • Literature: Energy (Newbridge), one big book and guide per teacher • Literature: How We Use Electricity (Newbridge), one big book and guide per teacher • Literature: Rocks & Soil (Newbridge), one big book and guide per teacher

	projects (e.g., newspapers, glass and aluminum). (ST-A-1-3) ✶ **Explore ways people use energy to cook their food and warm their homes (e.g., wood, coal, natural gas and electricity). (ST-A-1-4)** ✶ **Identify how people can save energy by turning things off when they are not using them (e.g., lights and motors). (ST-A-1-5)** **<u>Sub-Objectives to Meet Indicators:</u>** • Identify a living organism's need for: ° Source of food or energy ° Water ° Gases to take in ° Environment that will allow for survival (e.g., protection, light, temperature, natural defenses, shelter) • Compare and contrast the three most important natural resources on the earth, i.e., air, water and soil. • Explore and describe environmental problems caused by air, water and soil pollution (e.g., acid rain, air pollution by transportation, erosion/weathering, littering, insecticidal/pesticidal runoff, deforestation, draining swamps, forest fires, oil spills, seasonal change, construction, etc.). • Identify and predict the effects of air, water, and soil pollution on the basic needs of living things and the possible endangerment or extinction of organisms. • Discuss positive and negative ways humans affect the environment (e.g., insecticides, recycling, etc.). • Explore ways living things respond to a change in the environment (e.g., deforestation, draining swamps, forest fires, oil spills, pesticidal runoff, seasonal change, construction, etc.). • List ways resources are recycled, renewed, and reused (e.g., paper, plastic, glass, etc.).	

SCIENCE
GRADE 1

THE WAY THINGS MOVE
Physical Sciences Standard (PS)

K-2 BENCHMARKS	GRADE-LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **<u>Physical Sciences</u>** ✶ **Recognize that light, sound and objects move in different ways. (PS-B)**	**By the end of Kindergarten, the student will:** **<u>Forces and Motion</u>** ✶ **Explore that things can be made to move in many different ways such as straight, zigzag, up and down, round and round, back and forth, or fast and slow. (PS-B-K-4)** ✶ **Investigate ways to change how something is moving (e.g., push, pull). (PS-B-K-5)** ✶ **Explore the effects some objects have on others even when the two objects might not touch (e.g., magnets). (PS-B-1-5)** ✶ **Investigate a variety of ways to make things move and what causes them to change speed, direction and/or stop. (Review from Kindergarten-PS-B-1-6)** **<u>Sub-Objectives to Meet Indicators:</u>** • Describe ways to change how something is moving (i.e., direction and/or speed) by giving objects pushes or pulls (i.e., forces). • Experiment with friction and identify it as a force that acts against motion when two surfaces are touching (e.g., objects moving on carpet, grass, tile, sidewalks, sandpaper, etc.). • Describe and compare and contrast how objects move in different ways. • Recognize relationships between mass and force, including: ° Things only move when something moves them. ° Things keep moving until something stops them. ° The harder something is pushed, the faster it goes. ° The more massive something is, the harder it is to move. • Explain or predict the motion of an object (e.g., where it will end up).	**<u>Suggested Materials</u>** • Kit: FOSS-Balance and Motion (Delta Education), previously adopted in the district and stored in the science room • Literature: <u>Push and Pull</u> (Newbridge), one big book and guide per teacher • Literature: <u>Balance and Motion</u> (Newbridge), one big book and guide per teacher

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 2

SCIENCE
GRADE 2

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

K-2 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **<u>Science and Technology</u>** **✶ Explain why people, when building or making something, need to determine what it will be made of and how it will affect other people and the environment. (ST-A)** **✶ Explain that to construct something requires planning, communication, problem solving and tools. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Ask a testable question. (SI-A)** **✶ Design and conduct a simple investigation to explore a question. (SI-B)** **✶ Gather and communicate information from careful observations and simple investigation through a**	**By the end of Second Grade, the student will:** **<u>Understanding Technology</u>** **✶ Explain that developing and using technology involves benefits and risks. (ST-A-2-1)** **✶ Investigate why people make new products or invent new ways to meet their individual wants and needs. (ST-A-2-2)** **✶ Predict how building or trying something new might affect other people and the environment. (ST-A-2-3)** **<u>Abilities To Do Technological Design</u>** **✶ Communicate orally, pictorially, or in written form the design process used to make something. (ST-B-2-4)** **<u>Doing Scientific Inquiry</u>** **✶ Ask "how can I/we" questions. (SI-A-2-1)** **✶ Ask "how do you know" questions (not "why" questions) in appropriate situations and attempt to give reasonable answers when others ask questions. (SI-A-2-2)** **✶ Explore and pursue student-generated "how" questions. (SI-A-2-3)** **✶ Use appropriate safety procedures when completing scientific investigations. (SI-B-2-4)** **✶ Use evidence to develop explanations of scientific investigations. (What do you think? How do you know?) (SI-C-2-5)** **✶ Recognize that explanations are generated in response to observations, events and phenomena. (SI-C-2-6)** **✶ Use appropriate tools and simple equipment/instruments to safely**	

variety of methods. (SI-C) **<u>Scientific Ways of Knowing</u>** **✶ Recognize that there are different ways to carry out scientific investigations. Realize that investigations can be repeated under the same conditions with similar results and may have different explanations. (SK-A)** **✶ Recognize the importance of respect for all living things. (SK-B)** **✶ Recognize that diverse groups of people contribute to our understanding of the natural world. (SK-C)**	**gather scientific data (e.g., magnifiers, non-breakable thermometers, timers, rulers, balances, calculators and other appropriate tools). (SI-B-2-7)** **✶ Measure properties of objects using tools such as rulers, balances and thermometers. (SI-B-2-8)** **✶ Use whole numbers to order, count, identify, measure and describe things and experiences. (SI-C-2-9)** **✶ Share explanations with others to provide opportunities to ask questions, examine evidence and suggest alternative explanations. (SI-C-2-10)** **<u>Nature of Science</u>** **✶ Describe that scientific investigations generally work the same way under the same conditions. (SK-A-2-1)** **✶ Explain why scientists review and ask questions about the results of other scientists' work. (SK-C-2-2)** **<u>Ethical Practices</u>** **✶ Describe ways in which using the solution to a problem might affect other people and the environment. (SK-B-2-3)** **<u>Science and Society</u>** **✶ Demonstrate that in science it is helpful to work with a team and share findings with others. (SK-C-2-4)**	

SCIENCE
GRADE 2

SOURCES OF LIGHT AND SOUND
Physical Sciences Standard (PS)

K-2 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Physical Sciences** ✶ **Recognize that light, sound and objects move in different ways. (PS-B)** ✶ **Recognize sources of energy and their uses. (PS-C)**	**By the end of Second Grade, the student will:** **Forces and Motion** ✶ **Explore how things make sound (e.g., rubber bands, tuning fork and strings). (PS-B-2-1)** ✶ **Explore and describe sounds (e.g., high, low, soft and loud) produced by vibrating objects. (PS-C-2-2)** ✶ **Explore with flashlights and shadows that light travels in a straight line until it strikes an object. (PS-B-2-3)** **Sub-Objectives to Meet Indicators:** • Investigate properties of light and sound: ° Light travels in a straight line until it strikes an object can be reflected/absorbed/refracted is made up of color is a source of heat ° Sound can be reflected/absorbed loudness pitch • Identify man-made and natural sources of light and sound: ° Light Natural-sun, lightning bugs, stars, lightning, etc. Man-made-fires, candles, matches, etc. ° Sound Natural-children's voices, echoes, dogs barking, etc. Man-made-alarms, telephones, cars, etc. • Recognize the effects of light and sound on the environment (e.g., noise	**Suggested Materials** • Textbook: Harcourt Science, Ohio Edition (Harcourt), including ° Ohio Student Edition, 30 copies per teacher ° Ohio Teacher Edition Collection, one set per teacher (plus one for special education) ° Ohio Reading Support and Homework Book, Student Edition, one copy per teacher ° Ohio Reading Support and Homework Book, Teacher Edition, one copy per teacher ° Ohio Lab Manual, Student Edition, one copy per teacher ° Ohio Lab Manual, Teacher Edition, one copy per teacher ° Ohio Audiotext Collection, one set per teacher (to share with special education) ° Ohio Assessment Guide, one copy per teacher ° Ohio Teaching Transparencies, one set per teacher ° Ohio Leveled Reader Package, one set per teacher

	and light pollution, warning signals, information from T.V. and radio, etc.). • Measure light and sound qualitatively (e.g., loud, soft, bright, etc.). • Demonstrate that sound is produced by vibrating objects and that pitch can be varied by changing the rate of vibration. • Infer that the sun is the world's most important source of heat and light. • Investigate the sun's heat being produced and conducted from one object to another (e.g., tinted windows, dark clothing, solar cookers, etc.). • Predict what will happen when light is reflected by a mirror, refracted by a lens, or absorbed by an object. • Demonstrate that light travels in a straight line until it strikes an object where it will refract (bend) or be absorbed.	° Ohio Teaching Resources Book, one copy per teacher ° Picture Cards, one set per teacher • Teacher Resource: Ohio Grade 2-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Teacher Resource: Primarily Physics (AIMS Education Foundation), one copy per teacher • Kit: teacher-created, supplies to teach activities from Primarily Physics (AIMS Education Foundation), one kit per teacher (Sheridan WorldWise, Inc.) • Literature: Sound and Light (Heinemann), one copy per teacher

SCIENCE
GRADE 2

LIFE CYCLES IN OHIO HABITATS
Life Sciences Standard (LS)

K-2 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **<u>Life Sciences</u>** **✶ Discover that there are living things, non-living things and pretend things, and describe the basic needs of living things (organisms). (LS-A)** **✶ Explain how organisms function and interact with their physical environment. (LS-B)** **✶ Describe similarities and differences that exist among individuals of the same kinds of plants and animals. (LS-C)**	**By the end of Second Grade, the student will:** **<u>Characteristics and Structure of Life</u>** **✶ Explain that animals, including people, need air, water, food, living space and shelter; and plants need air, water, nutrients (e.g., minerals), living space and light to survive. (LS-A-2-1)** **✶ Identify that there are many distinct environments that support different kinds of organisms. (LS-B-2-2)** **✶ Explain why organisms can survive only in environments that meet their needs (e.g., organisms that once lived on earth have disappeared for different reasons such as natural forces or human-caused effects). (LS-B-2-3)** **✶ Investigate the different structures of plants and animals that help them live in different environments (e.g., lungs, gills, leaves and roots). (LS-B-2-6)** **<u>Heredity</u>** **✶ Compare similarities and differences among individuals of the same kind of plants and animals, including people. (LS-C-2-4)** **<u>Diversity and Interdependence of Life</u>** **✶ Explain that food is a basic need of plants and animals (e.g., plants need sunlight to make food and to grow, animals eat plants and/or other animals for food, food chain) and is important because it is a source of energy (e.g., energy used to play, ride bicycles, read, etc.). (LS-A-2-5)** **✶ Compare the habitats of many different kinds of Ohio plants and animals and some of the ways animals depend on plants and each other. (LS-B-2-7)**	**<u>Suggested Materials</u>** • Textbook: Harcourt Science, Ohio Edition (Harcourt), including ° Ohio Student Edition, 30 copies per teacher ° Ohio Teacher Edition Collection, one set per teacher (plus one for special education) ° Ohio Reading Support and Homework Book, Student Edition, one copy per teacher ° Ohio Reading Support and Homework Book, Teacher Edition, one copy per teacher ° Ohio Lab Manual, Student Edition, one copy per teacher ° Ohio Lab Manual, Teacher Edition, one copy per teacher ° Ohio Audiotext Collection, one set per teacher (to share with special education) ° Ohio Teaching Transparencies, one set per teacher ° Ohio Leveled Reader Package, one set per teacher ° Ohio Teaching Resources Book, one copy per teacher

SCIENCE
GRADE 2

	✶ **Compare the activities of Ohio's common animals (e.g., squirrels, chipmunks, deer, butterflies, bees, ants, bats and frogs) during the different seasons by describing changes in their behaviors and body covering. (LS-B-2-8)**
	✶ **Compare Ohio plants during the different seasons by describing changes in their appearance. (LS-B-2-9)**
	
	Sub-Objectives to Meet Indicators:
	• Recognize characteristics that can identify a thing as living:
	  ° Ability to grow and change
	  ° Ability to react to its environment
	  ° Need for food or another source of energy
	  ° Take in gases for respiration (e.g., breathing, etc.)
	  ° Ability to reproduce
	  ° Made up of cells (taught in grades 3-4)
	• Classify things as living or nonliving.
	• Identify a living organism's need for:
	  ° Source of food or energy
	  ° Water
	  ° Gases to take in (e.g., breathing, etc.)
	  ° Environment that will allow for survival (e.g., protection, light, temperature, natural defenses, shelter)
	• Observe plants and animals to determine their needs and how they adapt physically and behaviorally to changes in the weather or the environment (e.g., dinosaur extinction due to weather changes, migration, hibernation, body covering changes in color, etc.).
	• Observe the life cycles of organisms through pictures or with real plants and animals (e.g., butterflies, lima beans, radishes, mealworms, frogs, etc.).
	• Describe life cycles of various organisms and observe characteristics at different stages of growth and development.
	• Compare and contrast cocoons and chrysalises.
	• Identify the life cycle phases for:
	  ° Three Stage/Incomplete Metamorphosis-egg, nymph, adult (e.g., grasshoppers, termites, mayflies, dragonflies, cockroaches, crickets, stoneflies, damselflies, frogs, etc.)
		° Picture Cards, one set per teacher
		• Teacher Resource: Ohio Grade 2-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher
		• Teacher Resource: Ohio Plants and Animals (Heinemann), one copy per teacher
		• Website for Fishes of Ohio: http://www.ohiodnr.com/dnap/rivfish/rivfish.html
		• Website for Ohio Fish Identification: http://www.ohiodnr.com/wildlife/fishing/fishid/default.htm
		• Website for Ohio Animal Fact Sheets: http://www.ohiodnr.com/publications/lifehistory.htm
		• Website for Ohio Butterflies: http://www.ohiodnr.com/wildlife/resources/lepid/species/photos.htm
		• Website for Ohio Birds: http://www.ohiodnr.com/publications/ohiobirds/default.htm
		• Website for Ohio Bird Beak Identification: http://www.ohiodnr.com/wildlife/kids/bbeaks.htm
		• Website for Ohio Reptiles: http://www.ohiodnr.com/wildlife/resources/reptiles/reptiles.html
		• Website for Ohio Amphibians: http://www.ohiodnr.com/publications/amphibians/default.htm
		• Website for Ohio Wetlands Habitat: http://www.ohiodnr.com/wildlife/kids/weth

	° Four Stage/Complete Metamorphosis-egg, larva, pupa, adult (e.g., honeybees, butterflies, moths, flies, beetles, etc.)	ab.htm • Website for Ohio Food Web: http://www.ohiodnr.com/wildlife/kids/lifeweb.htm • Website for Ohio Trees: http://www.ohiodnr.com/forestry/Education/ohiotrees/treesindex.htm • Website for Ohio Wildflowers: http://www.ohiodnr.com/publications/wildflowers.htm • Websites for Ohio Endangered Species: http://www.ohiodnr.com/endangered/endangered4.htm and http://www.ohiodnr.com/wildlife/kids/wildrsrch.htm

SCIENCE
GRADE 2

SUN, MOON AND STARS
Earth and Space Sciences Standard (ES)

K-2 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Observe constant and changing patterns of objects in the day and night sky. (ES-A)**	**By the end of K-2 Grade, the student will:** **The Universe** ✶ **Recognize that there are more stars in the sky than anyone can easily count. (ES-A-2-1)** ✶ **Observe and describe how the sun, moon and stars all appear to move slowly across the sky. (ES-A-2-2)** ✶ **Observe and describe how the moon appears a little different every day but looks nearly the same again about every four weeks. (ES-A-2-3)** **Sub-Objectives to Meet Indicators:** • Create a model of the sun, moon and earth system (e.g., using a globe/sphere and a light source, StarLab, etc.). • Demonstrate how the earth revolves around the sun. • Identify the sun as the brightest star and is located in the center of our solar system. • Investigate and record the direction of a person's shadow at different times during the day. • Observe patterns that stars make in the night sky, i.e. constellations (e.g., using pictures, StarLab, etc.). • Investigate what causes day and night and the changing seasons.	**Suggested Materials** • Textbook: Harcourt Science, Ohio Edition (Harcourt), including ° Ohio Student Edition, 30 copies per teacher ° Ohio Teacher Edition Collection, one set per teacher (plus one for special education) ° Ohio Reading Support and Homework Book, Student Edition, one copy per teacher ° Ohio Reading Support and Homework Book, Teacher Edition, one copy per teacher ° Ohio Lab Manual, Student Edition, one copy per teacher ° Ohio Lab Manual, Teacher Edition, one copy per teacher ° Ohio Audiotext Collection, one set per teacher (to share with special education) ° Ohio Assessment Guide, one copy per teacher ° Ohio Teaching Transparencies, one set per teacher ° Ohio Leveled Reader Package, one set per teacher

		° Ohio Teaching Resources Book, one copy per teacher ° Picture Cards, one set per teacher • Teacher Resource: Ohio Grade 2-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Kit: Science Companion-Our Solar System (Pearson Scott Foresman), including ° Teacher Lesson Manual, one copy per teacher ° Student Science Notebooks, 30 copies per teacher ° Student Science Notebook Teacher Guide, one copy per teacher ° Teacher Masters, one copy per teacher ° ExploraGear Activity Materials, one kit per teacher ° Assessment Book, one copy per teacher • Kit: teacher-created, additional supplies needed to teach activities from Science Companion-Our Solar System (Pearson Scott Foresman), one kit per teacher (Sheridan WorldWise, Inc.)

SCIENCE
GRADE 2

WEATHER

Earth and Space Sciences Standard (ES)

K-2 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the K-2 program, the student will: **Earth and Space Sciences** ✶ **Observe, describe and measure changes in the weather, both long term and short term. (ES-C)**	**By the end of K-2 Grade, the student will:** **Earth Systems** ✶ **Observe and describe that some weather changes occur throughout the day and some changes occur in a repeating seasonal pattern. (ES-C-2-4)** ✶ **Describe weather by measurable quantities such as temperature and precipitation. (ES-C-2-5)** **Sub-Objectives to Meet Indicators:** • Use weather instruments to predict weather conditions (e.g., weathervanes, rain gauges, thermometers). • Describe weather by measurable quantities, such as temperature, wind direction and speed, and precipitation. • Graph daily weather. • Observe and describe changes in weather through sequencing a set of pictures (e.g., seasonal change, water cycle). • Describe and record how weather affects choices of activities in their daily lives.	**Suggested Materials** • Textbook: Harcourt Science, Ohio Edition (Harcourt), including ° Ohio Student Edition, 30 copies per teacher ° Ohio Teacher Edition Collection, one set per teacher (plus one for special education) ° Ohio Reading Support and Homework Book, Student Edition, one copy per teacher ° Ohio Reading Support and Homework Book, Teacher Edition, one copy per teacher ° Ohio Lab Manual, Student Edition, one copy per teacher ° Ohio Lab Manual, Teacher Edition, one copy per teacher ° Ohio Audiotext Collection, one set per teacher (to share with special education) ° Ohio Assessment Guide, one copy per teacher ° Ohio Teaching Transparencies, one set per teacher ° Ohio Leveled Reader Package, one set per teacher

		° Ohio Teaching Resources Book, one copy per teacher ° Picture Cards, one set per teacher • Teacher Resource: Ohio Grade 2-Earth & Space, Life and Physical Science (AIMS Education Foundation), one copy per teacher • Kit: Science Companion-Weather (Pearson Scott Foresman), including ° Teacher Lesson Manual, one copy per teacher ° Student Science Notebooks, 30 copies per teacher ° Student Science Notebook Teacher Guide, one copy per teacher ° Teacher Masters, one copy per teacher ° ExploraGear Activity Materials, one kit per teacher ° Assessment Book, one copy per teacher • Kit: teacher-created, additional supplies needed to teach activities from Science Companion-Weather (Pearson Scott Foresman), one kit per teacher (Sheridan WorldWise, Inc.) • Literature: A True Book-Seasons (Books Galore), one copy per teacher

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 3

SCIENCE
GRADE 3

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **<u>Science and Technology</u>** **✶ Describe how technology affects human life. (ST-A)** **✶ Describe and illustrate the design process. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Use appropriate instruments safely to observe, measure and collect data when conducting a scientific investigation. (SI-A)** **✶ Organize and evaluate observations, measurements and other data to formulate inferences and conclusions. (SI-B)** **✶ Develop, design and safely conduct scientific investigations and communicate the results. (SI-C)** **<u>Scientific Ways of Knowing</u>** **✶ Describe different types of investigations and use results**	**By the end of Third Grade, the student will:** **<u>Understanding Technology</u>** **✶ Describe how technology can extend human abilities (e.g., to move things and to extend senses). (ST-A-3-1)** **✶ Describe ways that using technology can have helpful and/or harmful results. (ST-A-3-2)** **✶ Investigate ways that the results of technology may affect the individual, family and community. (ST-A-3-3)** **<u>Abilities To Do Technological Design</u>** **✶ Use a simple design process to solve a problem (e.g., identify a problem, identify possible solutions and design a solution). (ST-B-3-4)** **✶ Describe possible solutions to a design problem (e.g., how to hold down paper in the wind). (ST-B-3-5)** **<u>Doing Scientific Inquiry</u>** **✶ Select the appropriate tools and use relevant safety procedures to measure and record length and weight in metric and English units. (SI-A-3-1)** **✶ Discuss observations and measurements made by other people. (SI-B-3-2)** **✶ Read and interpret simple tables and graphs produced by self/others. (SI-B-3-3)** **✶ Identify and apply science safety procedures. (SI-C-3-4)** **✶ Record and organize observations (e.g., journals, charts and tables). (SI-B-3-5)**	

and data from investigations to provide the evidence to support explanations and conclusions. (SK-B) **✶ Explain the importance of keeping records of observations and investigations that are accurate and understandable. (SK-C)** **✶ Explain that men and women of diverse countries and cultures participate in careers in all fields of science. (SK-D)**	**✶ Communicate scientific findings to others through a variety of methods (e.g., pictures, written, oral and recorded observations). (SI-C-3-6)** **<u>Nature of Science</u>** **✶ Describe different kinds of investigations that scientists use depending on the questions they are trying to answer. (SK-B-3-1)** **<u>Ethical Practices</u>** **✶ Keep records of investigations and observations and do not change the records that are different from someone else's work. (SK-C-3-2)** **<u>Science and Society</u>** **✶ Explore through stories how men and women have contributed to the development of science. (SK-D-3-3)** **✶ Identify various careers in science. (SK-D-3-4)** **✶ Discuss how both men and women find science rewarding as a career and in their everyday lives. (SK-D-3-5)**	

SCIENCE
GRADE 3

ROCKS AND SOIL

Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Earth and Space Sciences** ✶ **Describe Earth's resources including rocks, soil, water, air, animals and plants and the ways in which they can be conserved. (ES-C)** **Life Sciences** ✶ **Compare changes in an organism's ecosystem/ habitat that affect its survival. (LS-C)**	**By the end of Third Grade, the student will:** **Earth Systems** ✶ **Compare distinct properties of rocks (e.g., color, layering and texture). (ES-C-3-1)** ✶ **Observe and investigate that rocks are often found in layers. (ES-C-3-2)** ✶ **Describe that smaller rocks come from the breakdown of larger rocks through the actions of plants and weather. (ES-C-3-3)** ✶ **Observe and describe the composition of soil (e.g., small pieces of rock and decomposed pieces of plants and animals, and products of plants and animals). (ES-C-3-4)** ✶ **Investigate the properties of soil (e.g., color, texture, capacity to retain water, ability to support plant growth). (ES-C-3-5)** ✶ **Investigate that soils are often found in layers and can be different from place to place. (ES-C-3-6)** **Diversity and Interdependence of Life** ✶ **Observe and explore how fossils provide evidence about animals that lived long ago and the nature of the environment at that time. (LS-C-3-5)** **Sub-Objectives to Meet Indicators:** • Differentiate between rocks and minerals, including: ° Rocks are aggregates of minerals and they may also contain organic matter. ° Rocks have different properties (e.g., color, layering, texture, etc.). ° Rocks reflect the way they were formed and the minerals in them.	**Suggested Materials** • Textbook Module: Harcourt Science, Earth's Land, Unit C (Harcourt), including ° Student Edition, 30 copies per teacher ° Earth Science Teacher's Edition, one copy per teacher (plus one for special education) ° Take-Home Book, one copy per teacher ° Workbook, Teacher's Edition, one copy per teacher ° Assessment Guide, one copy per teacher ° Teaching Resources, one copy per teacher • Teacher Resource: Dig In! Hands-on Soil Investigations (National Science Teachers Association), one copy per teacher • Teacher Resource: Ohio Grade 3-Earth Systems (AIMS Education Foundation), one copy per teacher • Kit: teacher-created, supplies to teach soil activities from Ohio Grade 3-Earth Systems (AIMS Education Foundation), one kit per teacher (Sheridan WorldWise, Inc.)

	◦ Minerals are composed of only one substance, and that substance is the same in all samples of the mineral. • Examine the properties of rocks and minerals, including: ◦ Color ◦ Texture ◦ Smell ◦ Luster ◦ Transparency ◦ Hardness ◦ Shape ◦ Reaction to magnets ◦ Cleavage • Demonstrate that rocks can be broken down into small particles (i.e., weathering) to form soil. • Identify the properties of soil, including: ◦ Soil contains particles of different sizes. ◦ Different soils absorb water at different rates. ◦ Soil affects plant and root growth. • Examine the composition of soil, including: ◦ Air is present in soil. ◦ Soil may contain animals, plants, and their remains. ◦ Over time, dead plants become part of soil. ◦ Sand, clay, and humus are the three basic components of soil. • Compare and contrast the soil characteristics that differ from place to place (e.g., beaches, playgrounds, homes, differences between regions of the United States, etc.). • Explain why different types of soil exist (e.g., different kinds of remains of plants and animals, chemicals in the soil, weather and climate in the area, etc.). • Create examples of soil layering. • Illustrate profiles of soil layering.	• Kit: STC-Rocks and Minerals (Carolina Biological Supply Company), one kit with teacher's manual per two teachers • Literature: What Is Soil? (The Wright Group), 60 copies per building

SCIENCE
GRADE 3

ENVIRONMENTS AND ADAPTATIONS OF ANIMALS
Life Sciences Standard (LS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Life Sciences** ✶ **Differentiate between the life cycles of different plants and animals. (LS-A)** ✶ **Analyze plant and animal structures and functions needed for survival and describe the flow of energy through a system that all organisms use to survive. (LS-B)** ✶ **Compare changes in an organism's ecosystem/ habitat that affect its survival. (LS-C)**	**By the end of Third Grade, the student will:** **Heredity** ✶ **Compare the life cycles of different animals including birth to adulthood, reproduction and death (e.g., egg-tadpole-frog, egg-caterpillar-chrysalis-butterfly). (Review from Second Grade-LS-A-3-1)** **Diversity and Interdependence of Life** ✶ **Relate animal structures to their specific survival functions (e.g., obtaining food, escaping or hiding from enemies). (LS-B-3-2)** ✶ **Classify animals according to their characteristics (e.g., body coverings and body structure). (LS-B-3-3)** ✶ **Use examples to explain that extinct organisms may resemble organisms that are alive today. (LS-C-3-4)** ✶ **Observe and explore how fossils provide evidence about animals that lived long ago and the nature of the environment at that time. (LS-C-3-5)** ✶ **Describe how changes in an organism's habitat are sometimes beneficial and sometimes harmful. (LS-C-3-6)** **Sub-Objectives to Meet Indicators:** • Recognize characteristics that can identify a thing as living: ° Ability to grow and change ° Ability to react to its environment ° Need for food or another source of energy ° Take in gases for respiration ° Ability to reproduce	**Suggested Materials** • Textbook Module: Life Science, Module A (Pearson Scott Foresman), including ° Student Edition, 30 copies per teacher ° Volume 1, Teacher's Edition Package, one per teacher (plus one for special education) ° Assessment Book, one copy per teacher ° Every Student Learns Teacher's Guide, one copy per teacher ° Quick Study, one copy per teacher ° Activity Book Teacher's Guide, one copy per teacher ° Workbook Teacher's Guide, one copy per teacher • Teacher Resource: Ohio Grade 3-Life Science (AIMS Education Foundation), one copy per teacher • Kit: teacher-created, supplies to teach activities from Ohio Grade 3-Life Science (AIMS Education Foundation), one kit per teacher (Sheridan WorldWise, Inc.) • Literature: Go Facts Set 8, including ° Teaching Guide, one copy per teacher ° Birds, 6 little books per teacher or 42 little books per building

	° Made up of cells • Identify a living organism's need for: ° Source of food or energy ° Water ° Gases to take in ° Environment that will allow for survival (e.g., protection, light, temperature, etc.) • Clarify the components of animal habitats (i.e., food, water, shelter, and space in a suitable arrangement/amount). • Compare and contrast the various habitats/biomes (e.g., deserts, marshes, oceans, rainforests, farms, savannas, etc.) and how they support the basic needs of organisms for survival. • Identify the physical adaptations of animals (e.g., coloration, body covering, types of teeth, types of feet, types of beaks, camouflage, etc.). • Identify behavioral adaptations of animals (e.g., migration, hibernation, protection from predators, mimicry, etc.). • Describe how a certain characteristic or behavior helps an organism meet its basic needs and identify what basic needs are being met by these characteristics or behaviors. • Distinguish between absolutely necessary conditions for growth or survival from conditions that are not necessary. • Compare and contrast how organisms, at a population or individual level, react to major environmental changes that are daily or seasonal and regular (e.g., temperature, food availability, pollution, seasonal change, deforestation, construction, wildlife poaching, etc.). • Compare and contrast how certain conditions can lead to an animal's endangerment or extinction.	° Insects, 6 little books per teacher or 42 little books per building ° Mammals, 6 little books per teacher or 42 little books per building ° Reptiles, 6 little books per teacher or 42 little books per building

SCIENCE
GRADE 3

FORCES AND MOTION
Physical Sciences Standard (PS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Physical Sciences** ✶ **Describe the forces that directly affect objects and their motion. (PS-C)**	**By the end of Third Grade, the student will:** **Forces and Motion** ✶ **Describe an object's position by locating it relative to another object or the background. (PS-C-3-1)** ✶ **Describe an object's motion by tracing and measuring its position over time. (PS-C-3-2)** ✶ **Identify contact/non-contact forces that affect motion of an object (e.g., gravity, magnetism and collision). (PS-C-3-3)** ✶ **Predict the changes when an object experiences a force (e.g., a push or pull, weight and friction). (PS-C-3-4)** **Sub-Objectives to Meet Indicators:** • Define force operationally (through experimentation) as a push or pull. • Describe forces qualitatively (e.g., weaker, stronger, etc.) and quantitatively (e.g., spring scales, rulers, balances, timers, etc.). • Recognize how real-world devices can be used to reduce effort or force related to motion (e.g., simple machines, complex machines, etc.). • Observe that objects at rest will tend to stay at rest unless forces act upon them and that objects in motion tend to stay in motion unless forces act upon them, i.e. inertia. • Recognize relationships between mass and force, including: ° Things only move when something moves them. ° Things keep moving until something stops them. ° The harder something is pushed, the faster it goes. ° The more massive something is, the harder it is to move. • Explore forces that affect motion, including: ° Friction (e.g., air resistance, etc.) ° Gravity	**Suggested Materials** • Textbook Module: Harcourt Science, Exploring Energy and Forces, Unit F (Harcourt), including ° Student Edition, 30 copies per teacher ° Earth Science Teacher's Edition, one copy per teacher (plus one for special education) ° Take-Home Book, one copy per teacher ° Workbook, Teacher's Edition, one copy per teacher ° Assessment Guide, one copy per teacher ° Teaching Resources, one copy per teacher • Teacher Resource: Ohio Grade 3-Physical Science (AIMS Education Foundation), one copy per teacher • Kit: teacher-created, supplies to teach activities from Ohio Grade 3-Physical Science (AIMS Education Foundation), one kit per teacher (Sheridan WorldWise, Inc.)

	° Magnetism ° Air Pressure • Compare and contrast physical characteristics that are associated with causing or reducing friction (e.g., surfaces, lubricants, wheels, etc.). • Investigate real-world examples of motion that can be observed, determining why objects move or stop moving.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 4

SCIENCE
GRADE 4

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRETEGIES/RESOURCES
By the end of the 3-5 program the student will: **<u>Science and Technology</u>** **✶ Describe how technology affects human life. (ST-A)** **✶ Describe and illustrate the design process. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Use appropriate instruments safely to observe, measure and collect data when conducting a scientific investigation. (SI-A)** **✶ Organize and evaluate observations, measurements and other data to formulate inferences and conclusions. (SI-B)** **✶ Develop, design and safely conduct scientific investigations and communicate the results. (SI-C)** **<u>Scientific Ways of Knowing</u>** **✶ Distinguish between fact and opinion and explain how**	**By the end of Fourth Grade, the student will:** **<u>Understanding Technology</u>** **✶ Explain how technology from different areas (e.g., transportation, communication, nutrition, healthcare, agriculture, entertainment and manufacturing) has improved human lives. (ST-A-4-1)** **✶ Investigate how technology and inventions change to meet peoples' needs and wants. (ST-A-4-2)** **<u>Abilities To Do Technological Design</u>** **✶ Describe, illustrate and evaluate the design process used to solve a problem. (ST-B-4-3)** **<u>Doing Scientific Inquiry</u>** **✶ Select the appropriate tools and use relevant safety procedures to measure and record length, weight, volume, temperature and area in metric and English units. (SI-A-4-1)** **✶ Analyze a series of events and/or simple daily or seasonal cycles, describe the patterns and infer the next likely occurrence. (SI-B-4-2)** **✶ Develop, design and conduct safe, simple investigations or experiments to answer questions. (SI-C-4-3)** **✶ Explain the importance of keeping conditions the same in an experiment. (SI-C-4-4)** **✶ Describe how comparisons may not be fair when some conditions are not kept the same between experiments. (SI-C-4-5)** **✶ Formulate instructions and communicate data in a manner that allows others to understand and repeat an investigation or**	

ideas and conclusions change as new knowledge is gained. (SK-A) **✶ Describe different types of investigations and use results and data from investigations to provide the evidence to support explanations and conclusions. (SK-B)** **✶ Explain the importance of keeping records of observations and investigations that are accurate and understandable. (SK-C)**	**experiment. (SI-C-4-6)** **<u>Nature of Science</u>** **✶ Differentiate fact from opinion and explain that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed. (SK-A-4-1)** **✶ Record the results and data from an investigation and make a reasonable explanation. (SK-C-4-2)** **✶ Explain discrepancies in an investigation using evidence to support findings. (SK-B-4-3)** **<u>Ethical Practices</u>** **✶ Explain why keeping records of observations and investigations are important. (SK-C-4-4)**	

SCIENCE
GRADE 4

EARTH'S CHANGING SURFACE
Earth and Space Sciences Standard (ES)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRETEGIES/RESOURCES
By the end of the K-5 program, the student will: **Earth and Space Sciences** ✶ **Summarize the processes that shape Earth's surface and describe evidence of those processes. (ES-B)**	**By the end of Fourth Grade, the student will:** **Earth Systems** ✶ **Describe how wind, water and ice shape and reshape Earth's land surface by eroding rock and soil in some areas and depositing them in other areas producing characteristic landforms (e.g., dunes, deltas and glacial moraines). (ES-B-4-8)** ✶ **Identify and describe how freezing, thawing and plant growth reshape the land surface by causing the weathering of rock. (ES-B-4-9)** ✶ **Describe evidence of changes on Earth's surface in terms of slow processes (e.g., erosion, weathering, mountain building and deposition) and rapid processes (e.g., volcanic eruptions, earthquakes and landslides). (ES-B-4-10)** **Sub-Objectives to Meet Indicators:** • Diagram and describe the characteristics of the layers of the earth. • Compare and contrast how sedimentary, metamorphic, and igneous rocks are formed, i.e., the rock cycle. (Partially Reviewed from Third Grade) • Compare and contrast physical (e.g., roots, freezing/thawing, etc.) and chemical weathering (e.g., acid rain, oxidation/rusting, etc.). • Compare and contrast the causes of changes in the earth's surface; including: ° Wind ° Water ° Glaciers ° Gravity ° Plant or animal activity (e.g., farming, overgrazing, earthworm activity, plant roots, etc.)	**Suggested Materials** • Textbook Module: Earth Science, Module B (Pearson Scott Foresman), including ° Student Edition, 210 copies per building ° Volume 1, Teacher's Edition Package, one per science teacher (plus one for special education) ° Assessment Book, one copy per science teacher ° Every Student Learns Teacher's Guide, one copy per science teacher ° Quick Study, one copy per science teacher ° Activity Book Teacher's Guide, one copy per science teacher ° Workbook Teacher's Guide, one copy per science teacher • Kit: Science Companion-Earth's Changing Surface (Pearson Scott Foresman), including ° Teacher Lesson Manual, one copy per science teacher ° Student Science Notebooks, 30 copies per science teacher ° Student Science Notebook Teacher Guide, one copy per science teacher

	• Identify evidence of changes in the earth's surface from analyzing:
	  ° "Before and after" illustrations of the earth's surface
	  ° Descriptions of events that would cause erosion, deposition, change in position, or other changes
	• Explore the impact of human activity on the earth (e.g., housing/commercial land development, strip mining, deforestation, farming, acid rain, soil pollution, insecticides/pesticides in the food chain, etc.).
	• Recognize relationships between human activity and the environment, in terms of:
	  ° Pollution (air, water, soil)
	  ° Conservation of resources (including plant and animal species)
	  ° Erosion
	  ° Agricultural activities
		° Teacher Masters, one copy per science teacher
		° ExploraGear Activity Materials, one kit per science teacher
		° Assessment Book, one copy per science teacher
		• Literature: Shaping the Earth's Surface Series (National Geographic), including
		° Teaching Guide, two copies per science teacher
		° Wind, 16 copies per science teacher or 64 copies per building
		° Water, 16 copies per science teacher or 64 copies per building
		° Ice, 16 copies per science teacher or 64 copies per building
		° Earthquakes and Volcanoes, 16 copies per science teacher or 64 copies per building

SCIENCE
GRADE 4

MATTER: PHYSICAL AND CHEMICAL CHANGE
Physical Sciences Standard (PS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Physical Sciences** ✶ **Compare the characteristics of simple physical and chemical changes. (PS-A)** ✶ **Identify and describe the physical properties of matter in its various states. (PS-B)** ✶ **Summarize the way changes in temperature can be produced and thermal energy transferred. (PS-D)**	**By the end of Fourth Grade, the student will:** **Nature of Matter** ✶ **Identify characteristics of a simple physical change (e.g., heating or cooling can change water from one state to another and the change is reversible). (PS-A-4-1)** ✶ **Identify characteristics of a simple chemical change. When a new material is made by combining two or more materials, it has chemical properties that are different from the original materials (e.g., burning paper, vinegar and baking soda). (PS-A-4-2)** ✶ **Describe objects by the properties of the materials from which they are made and that these properties can be used to separate or sort a group of objects (e.g., paper, glass, plastic and metal). (PS-B-4-3)** ✶ **Explain that matter has different states (e.g., solid, liquid and gas) and that each state has distinct physical properties. (PS-B-4-4)** **Nature of Energy** ✶ **Compare ways the temperature of an object can be changed (e.g., rubbing, heating and bending of metal). (PS-D-4-5)** **Sub-Objectives to Meet Indicators:** • Identify properties of gases (e.g., take up space, have volume, have weight, exert pressure, etc.). • Identify properties of liquids (e.g., take the shape of their containers, are fluids, etc.). • Identify properties of solids (e.g., have their own shape, etc.). • Prepare and use a key to classify various kinds of matter (e.g., physical properties of solids, liquids, and gases, etc.). • Conduct experiments that illustrate physical and chemical changes in	**Suggested Materials** • Textbook Module: Properties of Matter Unit B (Houghton-Mifflin), including ° Student Edition, 210 copies per building ° Teaching Guide, one copy per science teacher (plus one for special education) ° Unitized Teacher's Resource Book, Unit B, one copy per science teacher ° Marie Curie, one copy per science teacher ° Activity Video, one copy per science teacher • Teacher Resource: Ohio Grade 4-Physical Science (AIMS Education Foundation), one copy per science teacher • Kit: teacher-created, supplies to teach activities from Ohio Grade 4-Physical Science (AIMS Education Foundation), one kit per science teacher (Sheridan WorldWise, Inc.)

	matter.
	• Infer characteristics of physical and chemical changes from experiments/inquiry investigations.
	• Determine the following characteristics of simple physical changes through experimentation:
	  ° May change in size
	  ° May change in shape (configuration)
	  ° May change in the state of matter of a substance
	  ° Do not involve permanent changes in properties of a material
	  ° Does not produce or become a new substance
	• Determine the following characteristics of chemical changes through experimentation:
	  ° Difficult to reverse
	  ° Involve permanent change in the properties of the substance
	  ° Often give off heat on their own
	• Describe the energy flow or force that can cause a physical change (e.g., breaking a substance, melting with heat, dissolving in a liquid, freezing water, etc.).
	• Identify properties of the different states of matter (gases, liquids and solids) that indicate physical and chemical change.
	• Explore real-world examples of physical changes (e.g., evaporation, condensation, melting, change in volume due to temperature, etc.).
	• Explore real-world examples of chemical changes (e.g., burning, cooking, digestion, rusting, rotting, etc.).	

SCIENCE
GRADE 4

ENVIRONMENTS AND ADAPTATIONS OF PLANTS
Life Sciences Standard (LS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Life Sciences** ✶ **Differentiate between the life cycles of different plants and animals. (LS-A)** ✶ **Analyze plant and animal structures and functions needed for survival and describe the flow of energy through a system that all organisms use to survive. (LS-B)** ✶ **Compare changes in an organism's ecosystem/habitat that affect its survival. (LS-C)**	**By the end of Fourth Grade, the student will:** **Heredity** ✶ **Compare the life cycles of different plants including germination, maturity, reproduction and death. (LS-A-4-1)** ✶ **Describe how organisms interact with one another in various ways (e.g., many plants depend on animals for carrying pollen or dispersing seeds). (LS-A-4-5)** **Diversity and Interdependence of Life** ✶ **Relate plant structures to their specific functions (e.g., growth, survival and reproduction). (LS-B-4-2)** ✶ **Classify common plants according to their characteristics (e.g., tree leaves, flowers, seeds, roots and stems). (LS-B-4-3)** ✶ **Observe and explore that fossils provide evidence about plants that lived long ago and the nature of the environment at that time. (LS-C-4-4)** **Sub-Objectives to Meet Indicators:** • Recognize characteristics that can identify a thing as living: ° Ability to grow and change ° Ability to react to its environment ° Need for food or another source of energy ° Take in gases for respiration ° Ability to reproduce ° Made up of cells • Identify a living organism's need for: ° Source of food or energy ° Water	**Suggested Materials** • Textbook Module: Characteristics of Living Things, Unit A (Macmillan/McGraw-Hill), including ° Student Edition, 210 copies per building ° Life Science, Teacher's Edition, one copy per science teacher (plus one for special education) ° Reading in Science Resources Blackline Masters, one copy per science teacher ° Activity Resources Blackline Masters, one copy per science teacher ° Assessment Books Blackline Masters w/Answer Key, one copy per science teacher ° Test Preparation and Practice Blackline Masters, one copy per science teacher ° School to Home Activities Blackline Masters, one copy per science teacher ° Cross Curricular Projects Blackline Masters, one copy per science teacher ° Transparency Books, one set per science teacher ° Teacher Works CD-Rom, one copy

	° Gases to take in ° Environment that will allow for survival (e.g., protection, light, temperature, etc.) • Clarify the components of plant habitats (i.e., food, water, shelter, and space in a suitable arrangement/amount). • Diagram plant structures, including: ° Stems ° Roots ° Leaves ° Stamens ° Trunks ° Filaments ° Pistils ° Flowers ° Ovaries ° Sepals ° Petals • Describe the reproductive process of plants, i.e. pollination, including: ° Flowering plants must be pollinated in order to produce seeds. ° Many plants are pollinated by bees. ° A flower's pollen sticks to a bee, but some runs off when the bee feeds at other flowers. ° One seed produces one plant; but one plant can produce many seeds. • Investigate the physical adaptations of plants (e.g., coloration, covering, capacity for water, leaf size and structure, poisons, etc.). • Investigate the behavioral adaptations of plants (e.g., losing leaves during seasons, dormancy, cactus roots spreading out to receive water, phototropism, etc.). • Describe how a certain characteristics or behaviors help a plant meet its basic needs and identify what basic needs are being met by these characteristics or behaviors. • Distinguish between absolutely necessary conditions for growth or survival from conditions that are not necessary. • Compare and contrast how certain conditions can prevent organisms from surviving.	per science teacher ° Pupil Edition on Audio CD, one copy per building for special education ° Mindjogger Video, one copy per science teacher ° Test Generator CD-Rom, one copy per science teacher ° Science Explore Activity Videos, one set per science teacher • Teacher Resource: Ohio Grade 4-Life Science (AIMS Education Foundation), one copy per science teacher • Kit: teacher-created, supplies to teach activities from Ohio Grade 4-Life Science (AIMS Education Foundation), one kit per science teacher (Sheridan WorldWise, Inc.)

	• Compare and contrast how organisms, at a population level or an individual level, react to major environmental changes that are daily or seasonal and regular (e.g., temperature, nutrient availability, water availability, soil quality, seasonal change, etc.).	

SCIENCE
GRADE 4

WEATHER PREDICTION
Earth and Space Sciences Standard (ES)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRETEGIES/RESOURCES
By the end of the 3-5 program the student will: **Earth and Space Sciences** ✶ **Analyze weather and changes that occur over a period of time. (ES-D)**	**By the end of Fourth Grade, the student will:** **Earth Systems** ✶ **Explain that air surrounds us, takes up space, moves around us as wind, and may be measured using barometric pressure. (ES-A-4-1)** ✶ **Identify how water exists in the air in different forms (e.g., in clouds, fog, rain, snow and hail). (ES-D-4-2)** ✶ **Investigate how water changes from one state to another (e.g., freezing, melting, condensation and evaporation). (ES-D-4-3)** ✶ **Describe weather by measurable quantities such as temperature, wind direction, wind speed, precipitation and barometric pressure. (ES-D-4-4)** ✶ **Record local weather information on a calendar or map and describe changes over a period of time (e.g., barometric pressure, temperature, precipitation symbols and cloud conditions). (ES-D-4-5)** ✶ **Trace how weather patterns generally move from west to east in the United States. (ES-D-4-6)** ✶ **Describe the weather which accompanies cumulus, cumulonimbus, cirrus and stratus clouds. (ES-D-4-7)** **Sub-Objectives to Meet Indicators:** • Make measurements using standard units (e.g., degrees Celsius, degrees Fahrenheit, inches of rain, inches of snow, etc.) through the use of weather instruments (e.g., barometers, anemometers, weathervanes, rain gauges, thermometers, etc.). • Record weather data through charts, graphs, computer programs, etc. • Investigate relationships between air pressure, temperature, and volume that correspond to weather changes, as well as other daily life occurrences. • Describe the water cycle (i.e., evaporation, condensation, and	**Suggested Materials** • Textbook Module-Earth Science, Module B (Pearson Scott Foresman), including ° Student Edition, 210 copies per building ° Volume 1, Teacher's Edition Package, one per science teacher (plus one for special education) ° Assessment Book, one copy per science teacher ° Every Student Learns Teacher's Guide, one copy per science teacher ° Quick Study, one copy per teacher ° Activity Book Teacher's Guide, one copy per science teacher ° Workbook Teacher's Guide, one copy per science teacher • Kit: Weather Instruments (Delta Education), one kit with teacher's manual per science teacher

	precipitation). • Determine the effect of air temperature in and below clouds on what form precipitation will take (i.e., snow, hail, sleet, and rain). • Associate high-pressure systems with clear skies (symbol "H" on a weather map means "high pressure" which indicates "clear skies"). • Associate low-pressure systems with cloudy or stormy skies (symbol "L" on a weather means "low pressure" which indicates "stormy skies"). • Recognize relationships between colliding warm and cold fronts and how they cause storms, precipitation, or cloudy skies. • Determine the relationship between latitude and general temperature or weather patterns (e.g., changing seasons in different states, weather near equator versus Arctic zone, etc.). • Interpret weather maps and reports from daily newspapers using a key (i.e., weather symbols). • Describe general west-to-east movement of weather in the continental United States. • Interpret information from a weather map and key (i.e., weather symbols), consistently observed phenomena, or from stated conditions (e.g., time, temperature, etc.) to make observations and predictions about the weather. • Classify severe weather conditions (e.g., floods, tornadoes, lightning, hurricanes, etc.) and communicate safety precautions to be implemented during these storms.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 5

SCIENCE
GRADE 5

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **<u>Science and Technology</u>** **✶ Describe how technology affects human life. (ST-A)** **✶ Describe and illustrate the design process. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Use appropriate instruments safely to observe, measure and collect data when conducting a scientific investigation. (SI-A)** **✶ Organize and evaluate observations, measurements and other data to formulate inferences and conclusions. (SI-B)** **✶ Develop, design and safely conduct scientific investigations and communicate the results. (SI-C)** **<u>Scientific Ways of Knowing</u>** **✶ Distinguish between fact and**	**By the end of Fifth Grade, the student will:** **<u>Understanding Technology</u>** **✶ Investigate positive and negative impacts of human activity and technology on the environment. (ST-A-5-1)** **<u>Abilities To Do Technological Design</u>** **✶ Revise an existing design used to solve a problem based on peer review. (ST-B-5-2)** **✶ Explain how the solution to one problem may create other problems. (ST-B-5-3)** **<u>Doing Scientific Inquiry</u>** **✶ Select and safely use the appropriate tools to collect data when conducting investigations and communicating findings to others (e.g., thermometers, timers, balances, spring scales, magnifiers, microscopes and other appropriate tools). (SI-A-5-1)** **✶ Evaluate observations and measurements made by other people and identify reasons for any discrepancies. (SI-B-5-2)** **✶ Use evidence and observations to explain and communicate the results of investigations. (SI-B-5-3)** **✶ Identify one or two variables in a simple experiment. (SI-C-5-4).** **✶ Identify potential hazards and/or precautions involved in an investigation. (SI-C-5-5)** **✶ Explain why results of an experiment are sometimes different (e.g., because of unexpected differences in what is being investigated, unrealized differences in the methods used or in the circumstances in**	

opinion and explain how ideas and conclusions change as new knowledge is gained. (SK-A) **✶ Describe different types of investigations and use results and data from investigations to provide the evidence to support explanations and conclusions. (SK-B)** **✶ Explain the importance of keeping records of observations and investigations that are accurate and understandable. (SK-C)** **✶ Explain that men and women of diverse countries and cultures participate in careers in all fields of science. (SK-D)**	**which the investigation was carried out, and because of errors in observations). (SI-C-5-6)** **<u>Nature of Science</u>** **✶ Summarize how conclusions and ideas change as new knowledge is gained. (SK-A-5-1)** **✶ Develop descriptions, explanations and models using evidence to defend/support findings. (SK-B-5-2)** **✶ Explain why an experiment must be repeated by different people or at different times or places and yield consistent results before the results are accepted. (SK-B-5-3)** **✶ Identify how scientists use different kinds of ongoing investigations depending on the questions they are trying to answer (e.g., observations of things or events in nature, data collection and controlled experiments). (SK-B-5-4)** **<u>Ethical Practices</u>** **✶ Keep records of investigations and observations that are understandable weeks or months later. (SK-C-5-5)** **<u>Science and Society</u>** **✶ Identify a variety of scientific and technological work that people of all ages, backgrounds and groups perform. (SK-D-5-6)**	

SCIENCE
GRADE 5

ENERGY: SOUND AND LIGHT
Physical Sciences Standard (PS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Physical Sciences** ✶ **Describe the properties of light and sound energy. (PS-F)**	**By the end of Fifth Grade, the student will:** **Nature of Energy** ✶ **Explore and summarize observations of the transmission, bending (refraction) and reflection of light. (PS-F-5-5)** ✶ **Describe and summarize observations of the transmission, reflection, and absorption of sound. (PS-F-5-6)** ✶ **Describe that changing the rate of vibration can vary the pitch of a sound. (PS-F-5-7)** **Sub-Objectives to Meet Indicators:** **Sound** • Produce a variety of sounds by banging, plucking or blowing a variety of objects. • Infer that the loudness of a sound relates directly to the amount of energy used in producing a sound. • Produce examples of high-pitched and low-pitched sounds (e.g., vibrating columns of air, etc.). • Demonstrate that fast vibrations cause high-pitched sounds and low-pitched sounds are caused by slow vibrations. • Explore the "Doppler Effect" (i.e., when a vibrating object approaches and then moves away, its pitch changes). • Explore resonance (i.e., when an object causes another object of the same natural frequency to vibrate). • Observe reflection and absorption of sound waves (e.g., in water, ultrasound, SONAR, acoustical tiles, carpet, drapes, etc.). • Identify the characteristics and properties of sound waves (e.g., wavelength, amplitude, frequency, periods, compressions, hertz, pitch, etc.).	**Suggested Materials** • Textbook Module: Sound and Light, Unit F (Houghton-Mifflin), previously adopted in the district and stored in the science classrooms • Teacher Resource: Ohio Grade 5-Physical Science (AIMS Education Foundation), one copy per teacher • Kit: Lenses and Mirrors (Delta Education), one kit with teacher's manual per teacher • Kit: Sound (Delta Education), one kit with teacher's manual per teacher • Kit: Color and Light (Delta Education), one kit with teacher's manual per teacher **Suggested Strategies** • Enrichment-ear and eye, how we hear and see • Enrichment-optical illusions

	Light • Compare and contrast transverse (light) waves and longitudinal (sound) waves. • Demonstrate that sound and light can be absorbed. • Determine that observing an object requires light to travel from a light source to an object and then travel from the object to the eye of the observer. • Experiment with shadows or pinhole images to verify that light travels in a straight line. • Conduct experiments to demonstrate that as light spreads out from its source, it decreases in intensity. • Identify examples of transparent, translucent, and opaque materials and describe how light is refracted differently through each type of material. • Explore objects through convex (converging) and concave (diverging) lenses to determine differences between the images. • Define operationally that when light is reflected, its angle of incidence is equal to its angle of reflection. • Recognize the relationship between wavelength and frequency (i.e., inversely related) and their relationship to wave speed (i.e., wave speed = wavelength x frequency). • Interpret the electromagnetic spectrum to determine relationships among frequency, wavelength, and kinds of rays (e.g., radio, T.V., microwaves, visible light, gamma, short-wave radio, x-rays, etc.). • Describe light and sound in quantitative (e.g., hertz, decibels, etc.) and qualitative measures (e.g., bright, dark, loud, etc.).	

SCIENCE
GRADE 5

ENERGY: ELECTRICAL AND THERMAL
Physical Sciences Standard (PS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **<u>Physical Sciences</u>** ✶ **Summarize the way changes in temperature can be produced and thermal energy transferred. (PS-D)** ✶ **Trace how electrical energy flows through a simple electrical circuit and describe how the electrical energy can produce thermal energy, light, sound and magnetic forces. (PS-E)**	**By the end of Fifth Grade, the student will:** **<u>Nature of Energy</u>** ✶ **Define temperature as the measure of thermal energy and describe the way it is measured. (PS-D-5-1)** ✶ **Trace how thermal energy can transfer from one object to another by conduction. (PS-D-5-2)** ✶ **Describe that electrical current in a circuit can produce thermal energy, light, sound and/or magnetic forces. (PS-E-5-3)** ✶ **Trace how electrical current travels by creating a simple electric circuit that will light a bulb. (PS-E-5-4)** **<u>Sub-Objectives to Meet Indicators:</u>** **Thermal Energy** • Explain the term heat and explore its relationship to the movement of particles of matter. • Differentiate between heat and temperature. • Compare the ways the temperature of an object can be raised (e.g., rubbing, burning, bending, cutting, etc.). • Describe how a warmer object can warm a cooler one by contact or at a distance through the three methods of heat transfer (i.e., conduction, convection, and radiation). • Explain how some materials conduct heat much better than others (e.g., metal, wood, glass, water, etc.) do. • Compare and contrast a variety of types of insulators (e.g., plastic, wood, glass, rubber, air, etc.).	**<u>Suggested Materials</u>** • Textbook Module: Interactions of Matter and Energy, Unit E (Macmillan McGraw-Hill), including ° Student Edition, 35 copies per teacher ° Physical Science Teacher's Edition, one copy per teacher ° Reading in Science Resources Blackline Masters, one copy per teacher ° Activity Resources Blackline Masters, one copy per teacher ° Assessment Books Blackline Masters with Answer Key, one copy per teacher ° Test Preparation and Practice Blackline Masters, one copy per teacher ° School to Home Activities Blackline Masters, one copy per teacher ° Cross Curricular Projects Blackline Masters, one copy per science teacher ° Transparency Books, one set per teacher ° Teacher Works CD-Rom, one copy per teacher ° Pupil Edition on Audio CD, one copy

	Electricity and Electromagnetism • Identify the parts of an atom and their functions (i.e., electron, proton and neutron). • Describe how objects gain static charges (i.e., static electricity). • Construct, draw, and label open and closed circuits (e.g., battery, bulb and wire, etc.) with or without switches. • Identify solids and solutions as insulators and conductors. • Construct, draw, and label parallel and series circuits. • Distinguish between safe and unsafe practices when dealing with electricity. • Design and construct simple electrical devices (e.g., filament light bulbs, flashlights, sockets, motors, etc.). • Design and construct an electromagnet. • Analyze the environmental impact of electrical production and usage.	per building for special education ° Mindjogger Video, one copy per teacher ° Test Generator CD-Rom, one copy per teacher ° Science Explore Activity Videos, one set per teacher • Teacher Resource: Ohio Grade 5-Physical Science (AIMS Education Foundation), one copy per teacher • Kit: Electrical Circuits (Delta Education), one kit with teacher's manual per teacher

SCIENCE
GRADE 5

FOOD CHAINS AND FOOD WEBS
Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Earth and Space Sciences** ✶ **Describe Earth's resources including rocks, soil, water, air, animals and plants and the ways in which they can be conserved. (ES-C)** **Life Sciences** ✶ **Analyze plant and animal structures and functions needed for survival and describe the flow of energy through a system that all organisms use to survive. (LS-B)** ✶ **Compare changes in an organism's ecosystem/habitat that affect its survival. (LS-C)**	**By the end of Fifth Grade, the student will:** **Earth Systems** ✶ **Explain how the supply of many non-renewable resources is limited and can be extended through reducing, reusing and recycling but cannot be extended indefinitely. (ES-C-5-5)** ✶ **Investigate ways Earth's renewable resources (e.g., fresh water, air, wildlife and trees) can be maintained. (ES-C-5-6)** **Diversity and Interdependence of Life** ✶ **Describe the role of producers in the transfer of energy entering ecosystems as sunlight to chemical energy through photosynthesis. (LS-B-5-1)** ✶ **Explain how almost all kinds of animals' food can be traced back to plants. (LS-B-5-2)** ✶ **Trace the organization of simple food chains and food webs (e.g., producers, herbivores, carnivores, omnivores and decomposers). (LS-B-5-3)** ✶ **Summarize that organisms can survive only in ecosystems in which their needs can be met (e.g., food, water, shelter, air, carrying capacity and waste disposal). The world has different ecosystems and distinct ecosystems support the lives of different types of organisms. (LS-C-5-4)** ✶ **Support how an organism's patterns of behavior are related to the nature of that organism's ecosystem, including the kinds and numbers of other organisms present, the availability of food and resources, and the changing physical characteristics of the ecosystem. (LS-C-5-5)**	**Suggested Materials** • Textbook Module: Populations and Ecosystems, Unit D (Houghton-Mifflin), previously adopted in the district and stored in the science classrooms

	✶ **Analyze how organisms, including humans, cause changes in their ecosystems and how these changes can be beneficial, neutral or detrimental (e.g., beaver ponds, earthworm burrows, grasshoppers eating plants, people planting and cutting trees and people introducing a new species). (LS-C-5-6)** **<u>Sub-Objectives to Meet Indicators:</u>** • Identify ways in which living things meet their needs, including the following physical characteristics and behaviors by which organisms meet basic needs: ° Energy and/or nutrients for growth ° Water ° Shelter and protection or escape from other organisms ° Thermoregulation or reactions (e.g., migration, hibernation, etc.) to climate or other environmental stresses. ° Elimination of wastes ° Reproduction ° Growth and maturation • Describe the physical and behavioral adaptations of plants and animals (e.g., camouflage, migration/hibernation/dormancy, protection from predators, types of teeth, types of beaks, types of claws/talons/webbed feet, seasonal change, etc.). • Diagram and analyze food chains, food webs and energy pyramids to trace the energy transfer among organisms, beginning with photosynthesis. • Identify and explain the roles and relationships of primary producers, producers, consumers, decomposers, predators, prey, parasites, hosts, and scavengers in the environment (e.g. owls as predators, worms as decomposers, plants as producers, etc.) in a food chain, food web, or small ecosystem. • Identify the relative amount (most, least) of energy from producers that is available to an organism or group of organisms in a food chain, food web and energy pyramid. • Interpret diagrams to recognize that arrows are drawn from organisms that are eaten to the organisms that eat them in illustrations of food chains and food webs (e.g., plants ➔mouse ➔owl➔, etc.).	

	• Account for the conservation of energy in living systems, as in simple physical systems, due to:
	  ° Organisms lose energy as heat.
	  ° Organisms gain energy, directly or indirectly, from the sun.
	  ° Energy can be stored in chemical bonds and passed on as organisms consume food (e.g., photosynthesis, etc.).
	  ° Energy is transformed every time energy is transferred.
	• Identify processes in the carbon and nitrogen cycles:
	  ° Respiration
	  ° Photosynthesis
	  ° Decomposition
	• Describe organisms or pathways through which the carbon and nitrogen cycles take place.
	• Compare and contrast physical or biological factors that affect the carbon and nitrogen cycles.
	• Recognize relationships between where organisms get the nutrients or gases they need in the cycles and how they make them available to other organisms.
	• Analyze the cycling of resources as "an accounting of things as they change form", similar to the conservation of mass or energy.
	• Predict what can account for changes in matter or the way resources can and cannot be recycled, including:
	  ° Cycling of resources
	  ° Plants' importance to carbon, nitrogen and water cycling
	  ° Environmental results of deforestation
	• Investigate environmental changes and conditions, both natural and manmade that will result in adaptations of living things to avoid endangerment or extinction (e.g., paving, pollution, spraying, developing industries on farmland, insecticidal/pesticidal runoff, deforestation, land development, storms, forest fires, floods, responses to seasonal change, etc.) related to food chains/webs and energy pyramids.
	• Describe how changing one component of a biological system affects others (e.g., food, water, shelter, space, etc.).	

SCIENCE
GRADE 5

CYCLES OF THE EARTH, SUN AND MOON
Earth and Space Sciences Standard (ES)

3-5 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 3-5 program, the student will: **Earth and Space Sciences** **✶ Explain the characteristics, cycles and patterns involving Earth and its place in the Solar System. (ES-A)**	**By the end of Fifth Grade, the student will:** **The Universe** **✶ Describe how night and day are caused by Earth's rotation. (ES-A-5-1)** **✶ Explain that Earth is one of several planets to orbit the sun, and that the moon orbits Earth. (ES-A-5-2)** **✶ Describe the characteristics of Earth and its orbit about the sun (e.g., three-fourths of Earth's surface covered by a layer of water [some of it frozen], the entire planet surrounded by a thin blanket of air, elliptical orbit, tilted axis and spherical planet). (ES-A-5-3)** **✶ Explain that stars are like the Sun, some being smaller and some larger, but so far away that they look like points of light. (ES-A-5-4)** **Sub-Objectives to Meet Indicators:** • Diagram arrangements of the earth, sun and moon that produce: ° Solar and lunar eclipses ° A new moon ° High and/or low tides ° Seasons ° Phases of the moon (crescent to full) • Infer the relationship between the: ° Earth's tilt and the seasons ° Hemispherical location and seasonal temperatures or cycles (e.g., amount of sunlight, daylight savings time, changing daylight/darkness hours, etc.). • Describe the revolution of the earth around the sun and the moon around the earth. • Illustrate phases of the moon and describe their relationship to the moon's position near the earth. • Create models of the earth, sun and moon cycles and discuss the reinforcement of concepts or limitations of these models.	**Suggested Materials** • Textbook Module-Space and Technology Science, Module D (Pearson Scott Foresman), including ° Student Edition, 35 copies per teacher ° Volume 2, Teacher's Edition Package, one per teacher (plus one for special education) ° Assessment Book, one copy per teacher ° Every Student Learns Teacher's Guide, one copy per teacher ° Quick Study, one copy per teacher ° Activity Book Teacher's Guide, one copy per teacher ° Workbook Teacher's Guide, one copy per teacher • Kit: Earth, Moon and Sun (Delta Education), one kit with teacher's manual per teacher

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADE 6

SCIENCE
GRADE 6

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing (SK)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Science and Technology</u>** **✶ Give examples of how technological advances, influenced by scientific knowledge, affect the quality of life. (ST-A)** **✶ Design a solution or product taking into account needs and constraints (e.g., cost, time, trade-offs, properties of materials, safety and aesthetics). (ST-B)** **<u>Scientific Inquiry</u>** **✶ Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools. (SI-A)** **✶ Analyze and interpret data from scientific investigations**	**By the end of Sixth Grade, the student will:** **<u>Understanding Technology</u>** **✶ Explain how technology influences the quality of life. (ST-A-6-1)** **✶ Explain how decisions about the use of products and systems can result in desirable or undesirable consequences (e.g., social and environmental). (ST-A-6-2)** **✶ Describe how automation (e.g., robots) has changed manufacturing including manual labor being replaced by highly-skilled jobs. (ST-A-6-3)** **✶ Explain how the usefulness of manufactured parts of an object depends on how well their properties allow them to fit and interact with other materials. (ST-A-6-4)** **<u>Abilities To Do Technological Design</u>** **✶ Design and build a product or create a solution to a problem given one constraint (e.g., limits of cost and time for design and production, supply of materials and environmental effects). (ST-B-6-5)** **<u>Doing Scientific Inquiry</u>** **✶ Explain that there are not fixed procedures for guiding scientific investigations; however, the nature of an investigation determines the procedures needed. (SI-A-6-1)** **✶ Choose the appropriate tools or instruments and use relevant safety procedures to complete scientific investigations. (SI-A-6-2)** **✶ Distinguish between observation and inference. (SI-B-6-3)** **✶ Explain that a single example can never prove that something is**	

using appropriate mathematical skills in order to draw valid conclusions. (SI-B) **<u>Scientific Ways of Knowing</u>** **✶ Use skills of scientific inquiry processes (e.g., hypothesis, record keeping, description and explanation). (SK-A)** **✶ Give examples of how thinking scientifically is helpful in daily life. (SK-C)**	**always correct, but sometimes a single example can disprove something. (SI-B-6-4)** **<u>Nature of Science</u>** **✶ Identify that hypotheses are valuable even when they are not supported. (SK-A-6-1)** **<u>Ethical Practices</u>** **✶ Describe why it is important to keep clear, thorough and accurate records. (SK-A-6-2)** **<u>Science and Society</u>** **✶ Identify ways scientific thinking is helpful in a variety of everyday settings. (SK-C-6-3)** **✶ Describe how the pursuit of scientific knowledge is beneficial for any career and for daily life. (SK-C-6-4)** **✶ Research how men and women of all countries and cultures have contributed to the development of science. (SK-C-6-5)**	

SCIENCE
GRADE 6

MATTER: CHEMICAL REACTIONS
Physical Sciences Standard (PS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Physical Sciences</u>** ✶ **Relate uses, properties and chemical processes to the behavior and/or arrangement of the small particles that compose matter. (PS-A)**	**By the end of Sixth Grade, the student will:** **<u>Nature of Matter</u>** ✶ **Explain that equal volumes of different substances usually have different masses. (PS-A-6-1)** ✶ **Describe that in a chemical change new substances are formed with different properties than the original substance (e.g., rusting, burning). (PS-A-6-2)** ✶ **Describe that in a physical change (e.g., state, shape and size) the chemical properties of a substance remain unchanged. (PS-A-6-3)** ✶ **Describe that chemical and physical changes occur all around us (e.g., in the human body, cooking and industry). (PS-A-6-4)** **<u>Sub-Objectives to Meet Indicators:</u>** • Identify information about an atom from the Periodic Table of Elements, including: ° Name of the element ° Symbol ° Atomic number ° Atomic mass ° Metal/Nonmetal ° Number of protons and neutrons • Diagram an atom of an element using the Periodic Table of Elements. • Describe various atomic models throughout history (e.g., electron cloud model, Bohr's model, etc.). • Compare and contrast elements, mixtures, and compounds. • Identify properties of matter, including: ° Color ° Temperature	**<u>Suggested Materials</u>** • Textbook Module: Introduction to Matter, Module K (Holt, Rinehart and Winston, 2007), including ° Student Edition w/Live Ink, 35 copies per teacher ° Teacher's Edition, one copy per teacher (plus one for special education) ° Premier Online Edition, 6 Year Subscription ° Interactive Textbook, one copy per teacher ° Interactive Textbook Answer Key, one copy per teacher ° Chapter Resources, one copy per teacher ° Guided Reading Audio CD Program, one copy per teacher (to share with special education) ° One-Stop Planner with Test Generator and State-Specific Resources, one copy per teacher ° Physical Science Brain Food Video Quizzes on DVD, one copy per teacher ° Virtual Investigations CD-ROM, one

	° Magnetic/Nonmagnetic ° Size ° Weight/Mass ° Luster/Shininess ° Shape ° Texture ° Float/Sink ° Malleability/Flexibility ° Density • Describe the states of matter and model their molecular structure (e.g., lots of molecules moving slowly/solid, etc.). • Create a list of characteristics of simple physical changes, including: ° Observable change in size ° Observable change in shape/configuration ° Change in state of matter of a substance ° Does not produce or become a new substance ° Do not involve permanent changes in properties of a material • Create a list of characteristics of simple chemical changes, including: ° Difficult to reverse ° Often give off heat on their own ° Result in a permanent change in substances' properties • Compare and contrast simple physical changes versus chemical changes. • Identify examples of changes before and after an event to determine whether a change is chemical or physical (e.g., cold packs, heat packs, physical changes caused by water, chemical changes involving water and other elements, etc.). • Measure and/or describe the rate or nature of physical and/or chemical changes that are taking place. • Measure pH of acids and bases. • Compare and contrast acids, bases, and salts. • Conduct experiments to neutralize a substance from an acid to a base. • Compare and contrast solutions, saturated solutions, and suspensions.	copy per teacher ° Lab Generator CD-ROM, one copy per teacher ° Physical Science Lab Videos on DVD, one set per teacher ° Visual Concepts CD-Rom, one copy per teacher ° Ohio Test Preparation Workbook, one copy per teacher • Teacher Resource: Properties of Matter, Teacher's Edition (Frey Scientific), one copy per teacher

SCIENCE
GRADE 6

FORMS AND SOURCES OF ENERGY
Physical Sciences Standard (PS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Physical Sciences** ✶ **Describe renewable and nonrenewable sources of energy (e.g., solar, wind, fossil fuels, biomass, hydroelectricity, geothermal and nuclear energy) and the management of these sources. (PS-C)**	**By the end of Sixth Grade, the student will:** **Nature of Energy** ✶ **Explain that the energy found in nonrenewable resources such as fossil fuels (e.g., oil, coal and natural gas) originally came from the sun and may renew slowly over millions of years. (PS-C-6-5)** ✶ **Explain that energy derived from renewable resources such as wind and water is assumed to be available indefinitely. (PS-C-6-6)** ✶ **Describe how electric energy can be produced from a variety of sources (e.g., sun, wind and coal). (PS-C-6-7)** ✶ **Describe how renewable and nonrenewable energy resources can be managed (e.g., fossil fuels, trees and water). (PS-C-6-8)** ✶ **Describe how electric energy can be produced from a variety of sources (e.g., sun, wind, coal). (Introduction Before Sixth Grade-PS-C-6-7)** **Sub-Objectives to Meet Indicators:** **Energy Transformation and Conservation** • Compare and contrast potential and kinetic energy. • Cite examples (situations) of various types of energy being conserved or transformed from one specific form to another. • Investigate how energy and matter are conserved in everyday situations. • Compare and contrast the main forms of energy: ° Electrical ° Mechanical ° Chemical ° Thermal (Heat) ° Nuclear	**Suggested Materials** • Textbook Module: Environmental Science, Module E (Holt, Rinehart and Winston, 2007), including ° Student Edition w/Live Ink, 35 copies per science teacher ° Teacher's Edition, one copy per teacher (plus one for special education) ° Premier Online Edition, 6 Year Subscription ° Interactive Textbook, one copy per teacher ° Interactive Textbook Answer Key, one copy per teacher ° Chapter Resources, one copy per teacher ° Guided Reading Audio CD Program, one copy per teacher (to share with special education) ° One-Stop Planner with Test Generator and State-Specific Resources, one copy per teacher ° Life Science Brain Food Video Quizzes on DVD, one copy per teacher ° Virtual Investigations CD-ROM, one

	° Radiant (e.g., light, solar, etc.) ° Acoustic (e.g., sound) **Energy Sources** • Investigate the availability and use of natural resources and energy sources (i.e., solar, wind, biomass, propane, natural gas, petroleum, hydropower, nuclear, and geothermal). • Compare and contrast fossil fuels (i.e., coal, petroleum, natural gas, and propane). • Differentiate between renewable and nonrenewable resources and strategies for managing and conserving them (e.g., recycling, reusing, etc.). • Compare and contrast the trade-offs (risks and benefits) represented as humans act to consume and/or conserve natural resources, while differentiating this analysis from how social pressure and advertising may impact actions.	copy per teacher ° Lab Generator CD-ROM, one copy per teacher ° Life Science Lab Videos on DVD, one set per teacher ° Visual Concepts CD-Rom, one copy per teacher ° Ohio Test Preparation Workbook, one copy per teacher • Teacher Resource: The NEED Project, one copy per teacher ° Energy in the Balance, one copy per teacher ° Great Energy Debate Game, one copy per teacher ° Great Energy Rock Performances, one copy per teacher ° Mission Possible: Energy Trade-offs, one copy per teacher ° Energy On Stage, one copy per teacher ° Energy Carnival, Grades 4-12, one copy per teacher ° Energy Jeopardy, one copy per teacher ° Mystery World Tour, one copy per teacher

SCIENCE
GRADE 6

BIODIVERSITY IN ECOSYSTEMS
Physical Sciences Standard (PS)
Life Sciences Standard (LS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Life Sciences</u>** **✶ Explain that the basic functions of organisms are carried out in cells and groups of specialized cells form tissues and organs; the combination of these cells make up multicellular organisms that have a variety of body plans and internal structures. (LS-A)** **✶ Describe the characteristics of an organism in terms of a combination of inherited traits and recognize reproduction as a characteristic of living organisms essential to the continuation of the species. (LS-B)** **✶ Explain how energy entering the ecosystems as sunlight supports the life of organisms through photosynthesis and the transfer of energy through the interactions of organisms**	**By the end of Sixth Grade, the student will:** **<u>Characteristics and Structure of Life</u>** **✶ Explain that many of the basic functions of organisms are carried out by or within cells and are similar in all organisms. (LS-A-6-1)** **✶ Explain that multicellular organisms have a variety of specialized cells, tissues, organs and organ systems that perform specialized functions. (LS-A-6-2)** **✶ Identify how plant cells differ from animal cells (e.g., cell wall and chloroplasts). (LS-A-6-3)** **<u>Heredity</u>** **✶ Recognize that an individual organism does not live forever; therefore reproduction is necessary for the continuation of every species and traits are passed on to the next generation through reproduction. (LS-B-6-4)** **✶ Describe that in asexual reproduction all the inherited traits come from a single parent. (LS-B-6-5)** **✶ Describe that in sexual reproduction an egg and sperm unite and some traits come from each parent, so the offspring is never identical to either of its parents. (LS-B-6-6)** **✶ Recognize the likenesses between parents and offspring (e.g., eye color, flower color) are inherited. Other likenesses, such as table manners are learned. (LS-B-6-7)** **<u>Diversity and Interdependence of Life</u>** **✶ Describe how organisms may interact with one another. (LS-C-6-8)** **<u>Sub-Objectives to Meet Indicators:</u>** **Genetics and Heredity**	**<u>Suggested Materials</u>** • Textbook Module: Continuity of Life, Unit A (Houghton-Mifflin, 2007), including ° Student Edition, 35 copies per teacher ° Life Science Teacher's Edition, one per teacher (plus one for special education) ° Unit Resources with Review and Assessment Blackline Masters, one copy per teacher ° Teaching Transparencies, one set per teacher ° Reading and Concept Transparencies, one set per teacher ° Study Guide "A" Extra Support Blackline Masters, one copy per teacher ° Study Guide "B" Extra Support Blackline Masters, one copy per teacher ° Building Vocabulary Book Blackline Masters, one copy per teacher ° Independent Chapter Inquiry Book Blackline Masters for Challenge, one copy per teacher ° Interactive Reading Support Book Blackline Masters, one copy per

and the environment. (LS-C)	• Explain how organisms are made of cells (i.e., many organisms are made of a single cell; others, including plants and animals, are made of many cells), which are the fundamental units of life, whose details are usually only visible through a microscope. • Identify different body tissues and organs and determine that they are made up of different kinds of cells (e.g., fat, smooth muscle, skeletal muscle, heart, intestine, etc.). • Explain that living organisms have distinct structures and body systems that serve specific functions in growth, survival, and reproduction (e.g., various body structures for walking, flying, or swimming). • Describe changes that occur during mitosis and meiosis. • List examples of physical traits. • List examples of human traits that are not based on physical appearance. • Distinguish between traits that are genetic and traits that are environmentally controlled. • Distinguish between dominant and recessive traits. • Describe Mendel's experiments with pea plants. • Explain the difference between genotype and phenotype. • Discuss and describe human genetic disorders. **Adaptation and Extinction** • Identify human actions that affect the environment (e.g., insect control, paving, exhaust systems, construction, deforestation, acid rain, CFC's, pesticidal/insecticidal runoff, factory pollution, mining, etc.). • Describe and analyze how human actions or activities can affect the earth's ecosystems and its plant and animal species in terms of: ° Air, water, and soil pollution ° Conservation of natural resources, including preservation of land and species of plants and animals ° Change or maintenance of habitats for particular plant or animal species ° Erosion ° Soil fertility ° Use and/or production of different forms of energy	teacher ° Investigate Activity Blackline Masters, one copy per teacher ° Student Edition Audio CD-ROM, one copy per building for special education ° National Geographic Life Content Video, one copy per teacher • Teacher Resource: Genetics and Heredity, Teacher's Edition (Frey Scientific), one copy per science teacher

SCIENCE
GRADE 6

PATTERNS IN ROCKS AND SOIL
Earth and Space Sciences Standard (ES)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Earth and Space Sciences** ✶ **Identify that the lithosphere contains rocks and minerals and that minerals make up rocks. Describe how rocks and minerals are formed and/or classified. (ES-D)**	**By the end of Sixth Grade, the student will:** **Earth Systems** ✶ **Describe the rock cycle and explain that there are sedimentary, igneous and metamorphic rocks that have distinct properties (e.g., color, texture) and are formed in different ways. (ES-D-6-1)** ✶ **Explain that rocks are made of one or more minerals. (ES-D-6-2)** ✶ **Identify minerals by their characteristic properties. (ES-D-6-3)** **Sub-Objectives to Meet Indicators:** • Examine the properties of rocks and minerals, including: ° Color ° Texture ° Smell ° Luster ° Transparency ° Hardness ° Shape ° Reaction to magnets ° Cleavage • Identify the relative hardness of a mineral using scratch tests and Moh's Scale of Hardness. • Describe in comparative terms (e.g., oldest, youngest, etc.) the age of disturbed or undisturbed rock layers. • Compare and contrast characteristics and/or patterns caused by various natural phenomena (e.g., glaciers, earthquakes, rivers, wind, erosion weathering etc.). • Identify land features from a contour map. • Analyze data about rock or soil types.	**Suggested Materials** • Textbook: Investigating Earth Systems-Rocks and Landforms (It's About Time, Herff Jones Education Division, 2001), including ° Student Edition, 35 copies per teacher ° Teacher's Edition, one copy per science teacher

	• Create a dichotomous key to classify rocks as igneous, sedimentary or metamorphic according to the way they were formed.
	• Determine the water-holding capacities of a variety of rocks.
	• Summarize how the following factors affect the development of different soil types:
	  ° Climate
	  ° Plants and animals
	  ° Land surface features
	  ° Time
	  ° Type of parent material (origin of soil)
	• Compare and contrast physical and chemical weathering.
	• Investigate the variables that influence erosion and deposition of materials.
	• Make predictions about changes in local landforms due to erosion and weathering, according to:
	  ° Steepness of slope
	  ° Time
	  ° Amount of water	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

GRADES 7 AND 8

SCIENCE
GRADES SEVEN AND EIGHT

SEVENTH GRADE

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.

Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Science and Technology</u>** **✶ Give examples of how technological advances, influenced by scientific knowledge, affect the quality of life. (ST-A)** **✶ Design a solution or product taking into account needs and constraints (e.g., cost, time, trade-offs, properties of materials, safety and aesthetics). (ST-B)** **<u>Scientific Inquiry</u>** **✶ Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools. (SI-A)** **✶ Analyze and interpret data**	**By the end of Seventh Grade, the student will:** **<u>Understanding Technology</u>** **✶ Explain how needs, attitudes and values influence the direction of technological development in various cultures. (ST-A-7-1)** **✶ Describe how decisions to develop and use technologies often put environmental and economic concerns in direct competition with each other. (ST-A-7-2)** **✶ Recognize that science can only answer some questions and technology can only solve some human problems. (ST-A-7-3)** **<u>Abilities To Do Technological Design</u>** **✶ Design and build a product or create a solution to a problem given two constraints (e.g., limits of cost and time for design and production or supply of materials and environmental effects). (ST-B-7-4)** **<u>Doing Scientific Inquiry</u>** **✶ Explain that variables and controls can affect the results of an investigation and that ideally one variable should be tested at a time; however it is not always possible to control all variables. (SI-A-7-1)** **✶ Identify simple independent and dependent variables. (SI-A-7-2)** **✶ Formulate and identify questions to guide scientific investigations that connect to science concepts and can be answered through scientific investigations. (SI-A-7-3)** **✶ Choose the appropriate tools and instruments and use relevant safety procedures to complete scientific investigations. (SI-A-7-4)**	

from scientific investigations using appropriate mathematical skills in order to draw valid conclusions. (SI-B) **<u>Scientific Ways of Knowing</u>** **✶ Explain the importance of reproducibility and reduction of bias in scientific methods. (SW-B)** **✶ Give examples of how thinking scientifically is helpful in daily life. (SW-C)**	**✶ Analyze alternative scientific explanations and predictions and recognize that there may be more than one good way to interpret a given set of data. (SI-B-7-5)** **✶ Identify faulty reasoning and statements that go beyond the evidence or misinterpret the evidence. (SI-B-7-6)** **✶ Use graphs, tables and charts to study physical phenomena and infer mathematical relationships between variables (e.g., speed and density). (SI-B-7-7)** **<u>Ethical Practices</u>** **✶ Show that the reproducibility of results is essential to reduce bias in scientific investigations. (SW-B-7-1)** **✶ Describe how repetition of an experiment may reduce bias. (SW-B-7-2)** **<u>Science and Society</u>** **✶ Describe how the work of science requires a variety of human abilities and qualities that are helpful in daily life (e.g., reasoning, creativity, skepticism and openness). (SW-C-7-3)** **<u>Sub-Objectives to Meet Indicators:</u>** • Measure length, mass, temperature, density, weight, etc. • Identify and utilize lab equipment, including beakers, graduated cylinders, thermometers, tongs, test tube racks, strippers, microscopes, stereoscopes, gas jets, electric scales, etc. • Demonstrate lab safety and safety rules. • Describe the steps of the Scientific Method.	

SCIENCE
GRADES SEVEN AND EIGHT

SEVENTH GRADE
PLATE TECTONICS
Earth and Space Sciences Standard (ES)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Earth and Space Sciences** **✶ Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution). (ES-C)** **✶ Describe the processes that contribute to the continuous changing of Earth's surface (e.g., earthquakes, volcanic eruptions, erosion, mountain building and lithospheric plate movements). (ES-E)**	**By the end of the Seventh Grade, the student will:** **Earth Systems** **✶ Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air). (ES-C-7-1)** **✶ Describe the interior structure of Earth and Earth's crust as divided into tectonic plates riding on top of the slow moving currents of magma in the mantle. (ES-E-8-9)** **✶ Explain that most major geological events (e.g., earthquakes, volcanic eruptions, hot spots and mountain building) result from plate motion. (ES-E-8-10)** **✶ Use models to analyze the size and shape of Earth, its surface and its interior (e.g., globes, topographic maps, satellite images). (ES-E-8-11)** **✶ Explain that some processes involved in the rock cycle are directly related to thermal energy and forces in the mantle that drive plate motions. (ES-E-8-12)** **✶ Describe how landforms are created through a combination of destructive (e.g., weathering and erosion) and constructive processes (e.g., crustal deformation, volcanic eruptions and deposition of sediment). (ES-E-8-13)** **✶ Explain that folding, faulting and uplifting can rearrange the rock layers so the youngest is not always found on top. (ES-E-8-14)** **✶ Illustrate how the three primary types of plate boundaries (transform, divergent and convergent) cause different landforms (e.g., mountains, volcanoes and ocean trenches). (ES-E-8-15)** **Sub-Objectives to Meet Indicators:**	**Suggested Materials** • Textbook Module: Inside the Restless Earth, Module F (Holt, Rinehart and Winston, 2007), including ° Student Edition w/Live Ink, 200 copies per building ° Teacher's Edition, one copy per teacher (plus two for special education) ° Premier Online Edition, 6 Year Subscription ° Interactive Textbook, one copy per teacher ° Interactive Textbook Answer Key, one copy per teacher ° Chapter Resources, one copy per teacher ° Guided Reading Audio CD Program, one copy per teacher (to share with special education) ° One-Stop Planner with Test Generator and State-Specific Resources, one copy per teacher ° Earth Science Brain Food Video Quizzes on DVD, one copy per teacher

	• Describe convection currents in magma. • Analyze the theory of plate tectonics through investigation of the break-up of Pangaea. • Create a sketch or map of the stages of the break-up of Pangaea. • Investigate relationships between volcanoes and earthquakes to land formation and land deformation. • Create maps and diagrams of the various landforms (e.g., mountains, valleys, plateaus, etc.). • Create a sketch of the various layers of the earth. • Compare and contrast the processes of plate tectonics (e.g., volcanism, earthquakes, rifting, mountain building, etc.). • Implement maps, diagrams, models, and common situations to determine how earth-changing processes are reflected through changes in the earth's surface (e.g., earthquakes, volcanic eruptions, erosion, landforms, glacial movement, etc.).	° Virtual Investigations CD-ROM, one copy per teacher ° Lab Generator CD-ROM, one copy per teacher ° Physical Science Lab Videos on DVD, one set per teacher ° Visual Concepts CD-Rom, one copy per teacher ° Ohio Test Preparation Workbook, one copy per teacher

SCIENCE
GRADES SEVEN AND EIGHT

SEVENTH GRADE
WEATHER AND CLIMATE
Earth and Space Sciences Standard (ES)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Earth and Space Sciences** ✶ **Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution). (ES-C)**	**By the end of the Seventh Grade, the student will:** **Earth Systems** ✶ **Explain the biogeochemical cycles which move materials between the lithosphere (land), hydrosphere (water) and atmosphere (air). (ES-C-7-1)** ✶ **Describe the water cycle and explain the transfer of energy between the atmosphere and hydrosphere. (ES-C-7-3)** ✶ **Make simple weather predictions based on the changing cloud types associated with frontal systems. (ES-C-7-5)** ✶ **Determine how weather observations and measurements are combined to produce weather maps and that data for a specific location at one point in time can be displayed in a station model. (ES-C-7-6)** ✶ **Read a weather map to interpret local, regional and national weather. (ES-C-7-7)** ✶ **Describe the connection between the water cycle and weather-related phenomenon (e.g., tornadoes, floods, droughts, and hurricanes). (ES-C-7-9)** **Sub-Objectives to Meet Indicators:** • Diagram and illustrate earth cycles, including water and weather cycles. • Explain the effects of ocean currents on global weather. • Compare and contrast convection currents in land, water and air. • Create a sketch of the layers of the atmosphere. • Provided with the appropriate key, identify various kinds of clouds and their relationship to types of weather. • Given various weather maps, identify weather symbols and predict weather patterns.	**Suggested Materials** • Textbook Module: Investigating Earth Systems-Climate and Weather (It's About Time, Herff Jones Education Division, 2001) ° Student Edition, 200 copies per building ° Teacher's Edition, one copy per teacher

SCIENCE
GRADES SEVEN AND EIGHT

SEVENTH GRADE
THE UNIVERSE
Earth and Space Sciences Standard (ES)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Earth and Space Sciences** ✶ **Describe how the positions and motions of the objects in the universe cause predictable and cyclic events. (ES-A)** ✶ **Explain that the universe is composed of vast amounts of matter, most of which is at incomprehensible distances and held together by gravitational force. Describe how the universe is studied by the use of equipment such as telescopes, probes, satellites and spacecraft. (ES-B)**	**By the end of the Seventh Grade, the student will:** **The Universe** ✶ **Describe how objects in the Solar System are in regular and predictable motions that explain such phenomena as days, years, seasons, eclipses, tides and moon cycles. (ES-A-8-1)** ✶ **Explain that gravitational force is the dominant force determining motions in the Solar System and in particular keeps the planets in orbit around the Sun. (ES-A-8-2)** ✶ **Compare the orbits and composition of comets and asteroids with that of Earth. (ES-A-8-3)** ✶ **Describe the effect that asteroids or meteoroids have when moving through space and sometimes entering planetary atmospheres (e.g., meteor-"shooting star" and meteorite). (ES-B-8-4)** ✶ **Explain that the universe consists of billions of galaxies that are classified by shape. (ES-B-8-5)** ✶ **Explain interstellar distances are measured in light years (e.g., the nearest star beyond the sun is 4.3 light years away). (ES-B-8-6)** ✶ **Examine the life cycle of a star and predict the next likely stage of a star. (ES-B-8-7)** ✶ **Name and describe tools used to study the universe (e.g., telescopes, probes, satellites and spacecraft). (ES-B-8-8)** **Sub-Objectives to Meet Indicators:** • Demonstrate, through the use of models, distances among objects and their motions within the solar system. • Simulate sun, earth and moon phenomena and arrangements through models.	**Suggested Materials** • Textbook Module: Investigating Earth Systems-Astronomy (It's About Time, Herff Jones Education Division, 2006) ° Student Edition, 200 copies per building ° Teacher's Edition, one copy per teacher

	• Recognize relationships among seasonal change, time, tilt of the earth's axis, time of rotation and revolution, and orbital shape. • Investigate daylight, sunrise and sunset. • Describe the effects of the tilt of the earth's axis on seasons, climate, solstices, and equinoxes. • Observe and record the phases of the moon over time. • Use a model of the moon and earth to explain the effects of the moon on tidal patterns. • Illustrate and explain lunar and solar eclipses.	

SCIENCE
GRADES SEVEN AND EIGHT

SEVENTH GRADE
DIVERSITY OF LIFE
Earth and Space Sciences Standard (ES)
Life Sciences Standard (LS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Earth and Space Sciences</u>** **✶ Describe interactions of matter and energy throughout the lithosphere, hydrosphere and atmosphere (e.g., water cycle, weather and pollution). (ES-C)** **<u>Life Sciences</u>** **✶ Explain that the basic functions of organisms are carried out in cells and groups of specialized cells form tissues and organs; the combination of these cells make up multicellular organisms that have a variety of body plans and internal structures. (LS-A)** **✶ Describe the characteristics of an organism in terms of a combination of inherited traits and recognize reproduction as a**	**By the end of the Seventh/Eighth Grade, the student will:** **<u>Earth Systems</u>** **✶ Explain that Earth's capacity to absorb and recycle materials naturally (e.g., smoke, smog and sewage) can change the environmental quality depending on the length of time involved (e.g., global warming). (ES-C-7-2)** **✶ Analyze data on the availability of fresh water that is essential for life and for most industrial and agricultural processes. Describe how rivers, lakes and groundwater can be depleted or polluted becoming less hospitable to life and even becoming unavailable or unsuitable for life. (ES-C-7-4)** **✶ Describe how temperature and precipitation determine climatic zones (biomes) (e.g., desert, grasslands, forests, tundra and alpine). (ES-C-7-8)** **<u>Characteristics and Structure of Life</u>** **✶ Investigate the great variety of body plans and internal structures found in multicellular organisms. (LS-A-7-1)** **<u>Diversity and Interdependence of Life</u>** **✶ Investigate how organisms or populations may interact with one another through symbiotic relationships and how some species have become so adapted to each other that neither could survive without the other (e.g., predator-prey, parasitism, mutualism and commensalism). (LS-C-7-2)** **✶ Explain how the number of organisms an ecosystem can support**	**<u>Suggested Materials</u>** • Textbook Module: Science Explorer-Environmental Science (Prentice-Hall, 2007), including ° Student Edition, 200 copies per teacher ° Interactive Text CD-ROM with 6 Year Online Access, 200 copies per building ° Teacher's Edition, one copy per teacher (plus two for special education) ° Lesson Plans, one copy per teacher ° Section Summaries, one copy per teacher ° Guided Reading & Study Worksheets, Levels A and B, one copy per teacher ° Review Worksheets, one copy per teacher ° Enrich Worksheets, one copy per teacher ° Performance Assessment, one copy per teacher ° Chapter and Book Tests, Levels A and B, one copy per teacher

characteristic of living organisms essential to the continuation of the species. (LS-B) ✶ **Explain how energy entering the ecosystems as sunlight supports the life of organisms through photosynthesis and the transfer of energy through the interactions of organisms and the environment. (LS-C)** ✶ **Explain how extinction of a species occurs when the environment changes and its adaptive characteristics are insufficient to allow survival (as seen in evidence of the fossil record). (LS-D)**	**depends on adequate biotic (living) resources (e.g., plants, animals) and abiotic (non-living) resources (e.g., light, water and soil). (LS-C-7-3)** ✶ **Investigate how overpopulation impacts an ecosystem. (LS-D-7-4)** ✶ **Explain that some environmental changes occur slowly while others occur rapidly (e.g., forest and pond succession, fires and decomposition). (LS-D-7-5)** ✶ **Summarize the ways that natural occurrences and human activity affect the transfer of energy in Earth's ecosystems (e.g., fire, hurricanes, roads and oil spills). (LS-C-7-6)** ✶ **Explain that photosynthetic cells convert solar energy into chemical energy that is used to carry on life functions or is transferred to consumers and used to carry on their life functions. (LS-C-7-7)** **<u>Evolutionary Theory</u>** ✶ **Investigate the great diversity among organisms. (LS-B-7-8)** **<u>Sub-Objectives to Meet Indicators:</u>** • Compare and contrast the differences among primary and secondary producers, consumers, and decomposers in food chains, food webs and energy pyramids. • Illustrate and label diagrams of land and water food webs. • Illustrate energy gain directly or indirectly from the sun, energy stored in chemical bonds in food, energy transformed as organisms consume food, and energy diminishing in usefulness when lost as heat. • Trace the energy transformation food chains, food webs, and energy pyramids, illustrating the way it is always conserved. • Compare and contrast living and nonliving environmental changes and their effects on ecosystems, including: ° Changes in biotic factors (e.g., rainfall, temperature, light availability, etc.) ° Weather catastrophes on the local or global scale, such as flood or drought ° Air, water and soil pollution ° Competition among species for resources	° Laboratory Manual Worksheets, one copy per teacher ° Lab and Chapter Project Support, one copy per teacher ° Transparency Planner, one copy per teacher ° Color Transparencies, one set per teacher ° Answer Keys, one copy per teacher ° Discovery Channel School Video, one copy per teacher ° Lab Activity Video, one copy per teacher ° TeacherEXPRESS CD-ROM, one copy per teacher ° Prentice Hall PresentationEXPRESS CD-ROM, one copy per teacher

	° Species introductions ° Biological magnification ° Extinction of species • Describe changes in populations that are due to: ° Mutations ° Relationships between species (e.g., symbiosis, commensalism, parasitism, predator-prey, etc.) ° Natural selection/survival of the fittest species (e.g., Peppered Moth's change of color over time, etc.) ° Extinction (e.g., dinosaurs, etc.) ° Climate and environmental changes ° Competition for resources.	

SCIENCE
GRADES SEVEN AND EIGHT

EIGHTH GRADE

NATURE OF SCIENCE-These scientific process skills should be integrated into the following grade level content units.

Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Science and Technology</u>** **✶ Give examples of how technological advances, influenced by scientific knowledge, affect the quality of life. (ST-A)** **✶ Design a solution or product taking into account needs and constraints (e.g., cost, time, trade-offs, properties of materials, safety and aesthetics). (ST-B)** **<u>Scientific Inquiry</u>** **✶ Explain that there are differing sets of procedures for guiding scientific investigations and procedures are determined by the nature of the investigation, safety considerations and appropriate tools. (SI-A)** **✶ Analyze and interpret data**	**By the end of Eighth Grade, the student will:** **<u>Understanding Technology</u>** **✶ Examine how science and technology have advanced through the contributions of many different people, cultures and times in history. (ST-A-8-1)** **✶ Examine how choices regarding the use of technology are influenced by constraints caused by various unavoidable factors (e.g., geographic location, limited resources, social, political and economic considerations). (ST-A-8-2)** **<u>Abilities To Do Technological Design</u>** **✶ Design and build a product or create a solution to a problem given more than two constraints (e.g., limits of cost and time for design and production, supply of materials and environmental effects). (ST-B-8-3)** **✶ Evaluate the overall effectiveness of a product design or solution. (ST-B-8-4)** **<u>Doing Scientific Inquiry</u>** **✶ Choose the appropriate tools or instruments and use relevant safety procedures to complete scientific investigations. (SI-A-8-1)** **✶ Describe the concepts of sample size and control and explain how these affect scientific investigations. (SI-A-8-2)** **✶ Read, construct and interpret data in various forms produced by self and others in both written and oral form (e.g., tables, charts, maps,**	

from scientific investigations using appropriate mathematical skills in order to draw valid conclusions. (SI-B) **<u>Scientific Ways of Knowing</u>** **✶ Use skills of scientific inquiry processes (e.g., hypothesis, record keeping, description and explanation). (SW-A)** **✶ Explain the importance of reproducibility and reduction of bias in scientific methods. (SW-B)**	**graphs, diagrams and symbols). (SI-B-8-3)** **✶ Apply appropriate math skills to interpret quantitative data (e.g., mean, median and mode). (SI-B-8-4)** **<u>Nature of Science</u>** **✶ Identify the difference between description (e.g., observation and summary) and explanation (e.g., inference, prediction, significance and importance). (SW-A-8-1)** **<u>Ethical Practices</u>** **✶ Explain why it is important to examine data objectively and not let bias affect observations. (SW-B-8-2)** **<u>Sub-Objectives to Meet Indicators:</u>** • Measure length, mass, temperature, density, weight, etc.	

SCIENCE
GRADES SEVEN AND EIGHT

EIGHTH GRADE
HEREDITY
Life Sciences Standard (LS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **Life Sciences** ✶ **Describe the characteristics of an organism in terms of a combination of inherited traits and recognize reproduction as a characteristic of living organisms essential to the continuation of the species. (LS-B)** ✶ **Explain how extinction of a species occurs when the environment changes and its adaptive characteristics are insufficient to allow survival (as seen in evidence of the fossil record). (LS-D)**	**By the end of the Eighth Grade, the student will:** **Heredity** ✶ **Describe that asexual reproduction limits the spread of detrimental characteristics through a species and allows for genetic continuity. (LS-B-8-1)** ✶ **Recognize that in sexual reproduction new combinations of traits are produced which may increase or decrease an organism's chances for survival. (LS-B-8-2)** **Evolutionary Theory** ✶ **Explain how variations in structure, behavior or physiology allow some organisms to enhance their reproductive success and survival in a particular environment. (LS-B-8-3)** ✶ **Explain that diversity of species is developed through gradual processes over many generations (e.g., fossil record). (LS-D-8-4)** ✶ **Investigate how an organism adapted to a particular environment may become extinct if the environment, as shown by the fossil record, changes. (LS-D-8-5)** **Sub-Objectives to Meet Indicators:** • Identify the cell as the basic unit of life. • Observe cellular characteristics with a microscope. • Identify and describe the levels of organization (i.e., cells, tissues, organs, and organ systems). • Investigate how a cell takes in nutrients to provide energy for the cell to grow and reproduce (e.g., asexual reproduction, phases of mitosis, diffusion, osmosis, active transport, etc.).	**Suggested Materials** • Textbook Module: Cells, Heredity and Classification, Module C (Holt, Rinehart and Winston, 2007), including ° Student Edition w/Live Ink, 200 copies per building ° Teacher's Edition, one copy per teacher (plus two for special education) ° Premier Online Edition, 6 Year Subscription ° Interactive Textbook, one copy per teacher ° Interactive Textbook Answer Key, one copy per teacher ° Chapter Resources, one copy per teacher ° Guided Reading Audio CD Program, one copy per teacher to share with special education ° One-Stop Planner with Test Generator and State-Specific Resources, one copy per teacher ° Life Science Brain Food Video Quizzes on DVD, one copy per teacher

	• Create a model of the process of cellular division (i.e., mitosis). • Define operationally, through experimentation, the basic nature of DNA, chromosomes and genes. • Recognize relationships between the work of Gregor Mendel and the laws of genetics. • Compare and contrast dominant and recessive traits of an organism. • Describe the Law of Segregation (i.e., meiosis). • Compare and contrast the difference between phenotypes and genotypes. • Investigate the Law of Independent Assortment to predict the results of genetic crosses (e.g., probability activities, Punnett squares, pedigrees, etc.). • Discuss ways in which genetic engineering has contributed to medicine and agriculture (e.g., genetic disorders, cloning, engineered wheat and beans, stem cell research, etc.).	° Virtual Investigations CD-ROM, one copy per teacher ° Lab Generator CD-ROM, one copy per teacher ° Life Science Lab Videos on DVD, one set per teacher ° Visual Concepts CD-Rom, one copy per teacher ° Ohio Test Preparation Workbook, one copy per teacher

SCIENCE
GRADES SEVEN AND EIGHT

EIGHTH GRADE
WAVES
Physical Sciences Standard (PS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Physical Sciences</u>** ✶ **Relate uses, properties and chemical processes to the behavior and/or arrangement of the small particles that compose matter. (PS-A)** ✶ **Describe that energy takes many forms, some forms represent kinetic energy and some forms represent potential energy; and during energy transformations the total amount of energy remains constant. (PS-D)**	**By the end of the Eighth Grade, the student will:** **<u>Nature of Energy</u>** ✶ **Investigate how matter can change forms but the total amount of matter remains constant. (PS-A-7-1)** ✶ **Identify different forms of energy (e.g., electrical, mechanical, chemical, thermal, nuclear, radiant and acoustic). (PS-D-7-3)** ✶ **Explain how energy can change forms but the total amount of energy remains constant. (PS-D-7-4)** ✶ **Trace energy transformation in a simple closed system (e.g., a flashlight). (PS-D-7-5)** ✶ **Demonstrate that waves transfer energy. (PS-D-8-4)** ✶ **Demonstrate that vibrations in materials may produce waves that spread away from the source in all directions (e.g., earthquake waves and sound waves). (PS-D-8-5)** **<u>Sub-Objectives to Meet Indicators:</u>** • Compare and contrast the behavior and properties of electromagnetic (light) and mechanical (sound) waves. • Compare and contrast how different forms of wave energy are produced, transferred, and detected (i.e., the nature of wave motion). • Define operationally through experimentation: ° Frequency ° Pitch ° Wavelength ° Amplitude (loudness) ° Speed ° Energy	**<u>Suggested Materials</u>** • Textbook Module: Waves, Sound and Light (McDougal Littell, 2005), including ° Student Edition, 200 copies per building ° eEdition Plus Online Student Edition, 200 copies per building ° McDougal Littell Website and ClassZone Access, available at www.mcdougallittel.com ° Lab Manual, Student Edition, 200 copies per building ° Note-taking/Reading Study Guide, 200 copies per building ° Teacher Edition, one copy per teacher (plus two for special education) ° Teacher's Resource Package (includes Unit Resource Book, Unit Assessment Book and Unit Transparency Book), one set per teacher ° Program Wide Resources (includes Visual Glossary, Scientific American Frontiers Video Guide, Process and Lab Skills Teacher Edition, Problem Solving and Critical Thinking

	° Refraction ° Reflection • Design experiments to demonstrate the interaction of waves with various phases of matter (i.e., solids, liquids and gases). • Predict the path of reflected or refracted waves. • Demonstrate the relationship between frequency and pitch to the Doppler Effect. • Compare and contrast the risks and benefits of the use of electromagnetic (e.g., x-rays, microwaves, etc.) or sound waves in everyday settings. • Recognize relationships between light and sound and why we are able to see and hear. • Explore light and sound in everyday, relevant situations (e.g., simple optical devices, acoustical systems, waves in/on water, music, noise, etc.). **Transformations of Energy (As Applied to Waves)** • Demonstrate, through experimentation, the transformation and conservation of various forms of energy, including thermal, acoustic, nuclear, radiant, chemical, mechanical, and electrical energy. • Apply the Laws of Conservation of Matter and Energy to everyday situations.	Teacher Edition), one set per teacher ° Scientific American Frontiers Video Program (DVD) Kit, one copy per teacher ° HowStuffWorks Express Magazine, one copy per teacher ° City Science, one copy per teacher ° Understanding Technological Design, one copy per teacher ° Test Generator CD-ROM, one copy per teacher ° eEdition CD-ROM, thirty copies per building ° PowerPoint Presentations CD-ROM, one copy per teacher ° Lab Generator CD-ROM, one copy per teacher ° Audio Readings in English CD, one copy per teacher ° Content Review CD-ROM, one copy per teacher ° Science Toolkit, one copy per teacher

SCIENCE
GRADES SEVEN AND EIGHT

EIGHTH GRADE
FORCES AND MOTION
Physical Sciences Standard (PS)

6-8 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 6-8 program, the student will: **<u>Physical Sciences</u>** ✶ **Relate uses, properties and chemical processes to the behavior and/or arrangement of the small particles that compose matter. (PS-A)** ✶ **In simple cases, describe the motion of objects and conceptually describe the effects of forces on an object. (PS-B)** ✶ **Describe that energy takes many forms, some forms represent kinetic energy and some forms represent potential energy; and during energy transformations the total amount of energy remains constant. (PS-D)**	**By the end of the Eighth Grade, the student will:** **<u>Nature of Energy</u>** ✶ **Investigate how matter can change forms but the total amount of matter remains constant. (PS-A-7-1)** ✶ **Describe how an object can have potential energy due to its position or chemical composition and can have kinetic energy due to its motion. (PS-D-7-2)** ✶ **Identify different forms of energy (e.g., electrical, mechanical, chemical, thermal, nuclear, radiant and acoustic). (PS-D-7-3)** ✶ **Explain how energy can change forms but the total amount of energy remains constant. (PS-D-7-4)** ✶ **Trace energy transformation in a simple closed system (e.g., a flashlight). (PS-D-7-5)** **<u>Forces and Motion</u>** ✶ **Describe how the change in the position (motion) of an object is always judged and described in comparison to a reference point. (PS-B-8-1)** ✶ **Explain that motion describes the change in the position of an object (characterized by a speed and direction) as time changes. (PS-B-8-2)** ✶ **Explain that an unbalanced force acting on an object changes that object's speed and/or direction. (PS-B-8-3)** **<u>Sub-Objectives to Meet Indicators:</u>** • Distinguish between speed and velocity. • Interpret a distance over time graph. • Compare and contrast acceleration and deceleration.	**<u>Suggested Materials</u>** • Textbook Module: Science Explorer-Motion, Forces and Energy (Prentice-Hall, 2007), including ° Student Edition, 200 copies per teacher ° Interactive Text CD-ROM with 6 Year Online Access, 200 copies per building ° Teacher's Edition, one copy per teacher (plus two for special education) ° Lesson Plans, one copy per teacher ° Section Summaries, one copy per teacher ° Guided Reading & Study Worksheets, Levels A and B, one copy per teacher ° Review Worksheets, one copy per teacher ° Enrich Worksheets, one copy per teacher ° Performance Assessment, one copy per teacher ° Chapter and Book Tests, Levels A and B, one copy per teacher ° Laboratory Manual Worksheets, one

	• Recognize the relationship between velocity and mass to calculate momentum.
	• Define operationally (through experimentation) Newton's Laws of Motion:
	  ° 1st Law – A body at rest will remain at rest unless an unbalanced force acts on it. A body in motion will remain in motion and in a straight line at a steady speed unless an unbalanced force acts on it.
	  ° 2nd Law – When an unbalanced force acts on a mass, it produces an acceleration in the direction of the force that is directly proportional to the force and inversely proportional to the mass (F = ma).
	  ° 3rd Law – If one object applies a force to another, the second object applies an equal and opposite force to the first object. For every action there is an equal and opposite reaction.
	• Discuss the development of the Universal Gravitational Law; i.e., objects will fall at 9.8 meters/second squared.
	• Predict the effects of forces on objects (e.g., friction, gravity, magnetism, fluid forces, etc.)
	
	Transformations of Energy (as Applied to Forces and Motion)
	• Infer the relationship between friction and heat.
	• Demonstrate, through experimentation, the transformation and conservation of various forms of energy, including thermal, acoustic, nuclear, radiant, chemical, mechanical, and electrical energy.
	• Apply the Laws of Conservation of Matter and Energy to everyday situations.
		copy per teacher
		° Lab and Chapter Project Support, one copy per teacher
		° Transparency Planner, one copy per teacher
		° Color Transparencies, one set per teacher
		° Answer Keys, one copy per teacher
		° Discovery Channel School Video, one copy per teacher
		° Lab Activity Video, one copy per teacher
		° TeacherEXPRESS CD-ROM, one copy per teacher
		° Prentice Hall PresentationEXPRESS CD-ROM, one copy per teacher

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

NATURE OF SCIENCE GRADES 9 - 10

SCIENCE
NATURE OF SCIENCE GRADES 9 - 10

NINTH/TENTH GRADES
NATURE OF SCIENCE-These scientific process skills should be integrated into OGT Requirement courses.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

9-10 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 9-10 program, the student will: **<u>Science and Technology</u>** **✶ Explain the ways in which the processes of technological design respond to the needs of society. (ST-A)** **✶ Explain that science and technology are interdependent; each drives the other. (ST-B)** **<u>Scientific Inquiry</u>** **✶ Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of these investigations. (SI-A)** **<u>Scientific Ways of Knowing</u>** **✶ Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to**	**By the end of Ninth/Tenth Grades, the student will:** **<u>Understanding Technology</u>** **✶ Describe means of comparing the benefits with the risks of technology and how science can inform public policy. (ST-B-9-1)** **✶ Cite examples of ways that scientific inquiry is driven by the desire to understand the natural world and how technology is driven by the need to meet human needs and solve human problems. (ST-B-10-1)** **✶ Describe examples of scientific advances and emerging technologies and how they may impact society. (ST-B-10-2)** **<u>Abilities To Do Technological Design</u>** **✶ Identify a problem or need, propose designs and choose among alternative solutions for the problem. (ST-A-9-2)** **✶ Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined. (ST-A-9-3)** **✶ Explain that when evaluating a design for a device or process, thought should be given to how it will be manufactured, operated, maintained, replaced and disposed of in addition to who will sell, operate and take care of it. Explain how the costs associated with these considerations may introduce additional constraints on the design. (ST-A-10-3)** **<u>Doing Scientific Inquiry</u>** **✶ Distinguish between observations and inferences given a scientific situation. (SI-A-9-1)** **✶ Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, Material Safety**	

modification and limited to the natural world. (SK-A) **✶ Explain how scientific inquiry is guided by knowledge, observations, ideas and questions. (SK-B)** **✶ Describe the ethical practices and guidelines in which science operates. (SK-C)** **✶ Recognize that scientific literacy is part of being a knowledgeable citizen. (SK-D**	**Data Sheets [MSDS], eyewash, goggles and ventilation). (SI-A-9-2)** **✶ Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts. (SI-A-9-3)** **✶ Decide what degree of precision based on the data is adequate and round off the results of calculator operations to the proper number of significant figures to reasonably reflect those of the inputs. (SI-A-9-4)** **✶ Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology. (SI-A-9-5)** **✶ Draw logical conclusions based on scientific knowledge and evidence from investigations. (SI-A-9-6)** **✶ Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, MSDS, eyewash, goggles and ventilation). (SI-A-10-1)** **✶ Present scientific findings using clear language, accurate data, appropriate graphs, tables, maps and available technology. (SI-A-10-2)** **✶ Use mathematical models to predict and analyze natural phenomena. (SI-A-10-3)** **✶ Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic and evidence (data) from investigations. (SI-A-10-4)** **✶ Explain how new scientific data can cause any existing scientific explanation to be supported, revised or rejected. (SI-A-10-5)** **<u>Nature of Science</u>** **✶ Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose – to better understand a portion of our universe. (SK-A-9-1)** **✶ Illustrate that the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigations. (SK-C-9-2)**	

	✶ **Demonstrate that reliable scientific evidence improves the ability of scientists to offer accurate predictions. (SK-A-9-3)** ✶ **Discuss science as a dynamic body of knowledge that can lead to the development of entirely new disciplines. (SK-A-10-1)** ✶ **Describe that scientists may disagree about explanations of phenomena, about interpretation of data or about the value of rival theories, but they do agree that questioning, response to criticism and open communication are integral to the process of science. (SK-A-10-2)** ✶ **Recognize that science is a systematic method of continuing investigation, based on observation, hypothesis testing, measurement, experimentation, and theory building, which leads to more adequate explanations of natural phenomena. (SK-A-10-3)** **<u>Ethical Practices</u>** ✶ **Explain how support of ethical practices in science (e.g., individual observations and confirmations, accurate reporting, peer review and publication) are required to reduce bias. (SK-C-9-4)** ✶ **Recognize that ethical considerations limit what scientists can do. (SK-A-10-4)** ✶ **Recognize that research involving voluntary human subjects should be conducted only with the informed consent of the subjects and follow rigid guidelines and/or laws. (SK-C-10-5)** ✶ **Recognize that animal-based research must be conducted according to currently accepted professional standards and laws. (SK-C-10-6)** **<u>Scientific Theories</u>** ✶ **Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing. (SK-B-9-5)** ✶ **Explain that inquiry fuels observation and experimentation that produce data that are the foundation of scientific disciplines. Theories are explanations of these data. (SK-B-9-6)** ✶ **Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge. (SK-B-9-7)**	

	Science and Society ✶ **Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientists, their daily work and their efforts to advance scientific knowledge in their area of study. (SK-D-9-8)** ✶ **Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue. (SK-D-9-9)** ✶ **Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue. (SK-D-10-7)**	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

EARTH, SPACE AND PHYSICAL SCIENCE

SCIENCE
EARTH, SPACE AND PHYSICAL SCIENCE

NINTH GRADE
EARTH, SPACE AND PHYSICAL SCIENCE
Earth and Space Sciences Standard (ES)
Physical Sciences Standard (PS)

9-10 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 9-10 program, the student will: **<u>Earth and Space Sciences</u>** **✶ Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in the composition and scale of the physical universe. (ES-A)** **✶ Explain that many processes occur in patterns within the Earth's systems. (ES-B)** **✶ Explain the 4.5 billion-year-history of Earth and the 4 billion-year-history of life on Earth based on observable scientific evidence in the geologic record. (ES-C)** **✶ Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources. (ES-D)** **✶ Explain the processes that move and shape Earth's surface. (ES-E)**	**By the end of Ninth/Tenth Grade, the student will:** **<u>The Universe</u>** **✶ Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium. (ES-A-9-1)** **✶ Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago. (ES-A-9-2)** **✶ Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the solar system. (ES-C-9-3)** **<u>Earth Systems</u>** **✶ Explain the relationships of the oceans to the lithosphere and atmosphere (e.g., transfer of energy, ocean currents and landforms). (ES-B-9-4)** **✶ Summarize the relationship between the climatic zone and the resultant biomes. (This includes explaining the nature of the rainfall and temperature of the mid-latitude climatic zone that supports the deciduous forest.) (ES-B-10-1)** **✶ Explain climate and weather patterns associated with certain geographic locations and features (e.g., tornado alley, tropical hurricanes and lake effect snow). (ES-B-10-2)** **✶ Explain how geologic time can be estimated by multiple methods (e.g., rock sequences, fossil correlation and radiometric dating). (ES-C-10-3)**	**<u>Suggested Materials</u>** • Textbook: Holt Science Spectrum: Physical Science (Holt, Rinehart and Winston, 2008), including ° Student Edition, 50 copies per building ° Teacher's Edition, 2 copies per building ° Interactive Online Edition, 6 Year Subscription ° Chapter Resources, two copies per building ° Chapter Resources CD-ROM, two copies per building ° Interactive Reader, two copies per building ° Interactive Reader Answer Key, two copies per building ° Teacher's One-Stop Planner, two copies per building ° Lab Generator CD-ROM, two copies per building ° Math Skills Workbook, two copies per building ° Study Guide, two copies per building ° Guided Reading Audio CD Program,

SCIENCE
EARTH, SPACE AND PHYSICAL SCIENCE

✶ **Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences. (ES-F)** **<u>Physical Sciences</u>** ✶ **Describe that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explain the structure and properties of atoms. (PS-A)** ✶ **Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances. (PS-B)** ✶ **Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance. (PS-C)** ✶ **Explain the movement of objects by applying Newton's three laws of**	✶ **Describe how organisms on Earth contributed to the dramatic change in oxygen content of Earth's early atmosphere. (ES-C-10-4)** ✶ **Explain how the acquisition and use of resources, urban growth and waste disposal can accelerate natural change and impact the quality of life. (ES-D-10-5)** ✶ **Describe ways that human activity can alter biogeochemical cycles (e.g., carbon and nitrogen cycles) as well as food webs and energy pyramids (e.g., pest control, legume rotation crops vs. chemical fertilizers). (ES-D-10-6)** **<u>Processes that Shape Earth</u>** ✶ **Explain how the slow movement of material within Earth results from:** **a. thermal energy transfer (conduction and convection) from the deep interior;** **b. the action of gravitational forces on regions of different density. (ES-E-9-5)** ✶ **Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding). (ES-E-9-6)** ✶ **Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating). (ES-E-9-7)** **<u>Historical Perspectives and Scientific Revolutions</u>** ✶ **Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory). (ES-F-9-8)** ✶ **Describe advances and issues in earth and space science that have important long-lasting effects on science and society (e.g., geologic time scales, global warming, depletion of resources and exponential population growth). (ES-F-10-7)**	two copies per building ° Lab Videos on DVD, two copies per teacher ° Mindpoint Quiz Show, two copies per teacher ° Teaching Transparencies, two copies per building ° Teaching Transparencies CD-ROM, two copies per building ° Visual Concepts CD-ROM, two copies per building ° Virtual Investigations CD-ROM, two copies per building ° Strategies for English Language Learners, two copies per building ° Program Introduction Resource File, two copies per building ° NOVA Videos, two sets per building ° Ohio Test Preparation Workbook, two copies per building • Textbook: Holt Earth Science (Holt, Rinehart and Winston, 2008), including ° Student Edition, 50 copies per building ° Teacher's Edition, three copies per building ° Interactive Online Edition, 6 Year Subscription ° Chapter Resources CD-ROM, two copies per building ° Directed Reading Workbook, two copies per building ° Study Guide, two copies per building ° Lab Generator CD-ROM, two copies per building

motion. (PS-D) **✶ Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored). (PS-E)** **✶ Explain how energy may change form or be redistributed but the total quantity of energy is conserved. (PS-F)** **✶ Demonstrate that waves (e.g., sound, seismic, water and light) have energy and waves can transfer energy when they interact with matter. (PS-G)** **✶ Trace the historical development of scientific theories and ideas, and describe emerging issues in the study of physical sciences. (PS-H)**	**<u>Nature of Matter</u>** **✶ Recognize that all atoms of the same element contain the same number of protons, and elements with the same number of protons may or may not have the same mass. Those with different masses (different numbers of neutrons) are called isotopes. (PS-A-9-1)** **✶ Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral. (PS-A-9-2)** **✶ Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation. (PS-F-9-3)** **✶ Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations. (PS-A-9-4)** **✶ Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons. (PS-A-9-5)** **✶ Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals and water). (PS-B-9-6)** **✶ Show how atoms may be bonded together by losing, graining or sharing electrons and that in a chemical reaction, the number, type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations). (PS-B-9-7)** **✶ Demonstrate that the pH scale (0-14) is used to measure acidity and classify solutions as acidic, basic, or neutral substances. (PS-B-9-8)** **✶ Investigate the properties of pure substances and mixtures (e.g. density, conductivity, hardness, properties of alloys, superconductors and semiconductors). (PS-C-9-9)** **✶ Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity. (PS-C-9-10)**	° Teacher's One-Stop Planner CD-ROM, two copies per building ° Teaching Transparencies CD-ROM, two copies per building ° Teaching Transparencies and Worksheets with Answer Key, two copies per building ° Brain Food Video Quizzes on DVD, two copies per building ° Visual Concepts CD-ROM, two copies per building ° Chapter Summaries Audio CD-ROM, two copies per building ° Earth Science Brain Food Video Quizzes, two copies per building ° Mindpoint Quiz Show CD-ROM, two copies per building

	Nature of Energy ✶ **Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion, and during changes of state the temperature remains constant. (PS-F-9-11)** ✶ **Explain how an object's kinetic energy depends on its mass and its speed ($KE = 1/2mv^2$). (PS-E-9-12)** ✶ **Demonstrate that near Earth's surface an object's gravitational potential energy depends upon its weight (*mg* where *m* is the object's mass and *g* is the acceleration due to gravity) and height (*h*) above a reference surface (*PE = mgh*). (PS-E-9-13)** ✶ **Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.) (PS-F-9-14)** ✶ **Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy. (PS-F-9-15)** ✶ **Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs, hot packs and the burning of fossil fuels). (PS-F-9-16)** ✶ **Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation). (PS-F-9-17)** ✶ **Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays). (PS-G-9-18)** ✶ **Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic**	

	waves can be propagated without a medium. (PS-G-9-19) **✶ Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material. (PS-G-9-20)** **<u>Forces and Motion</u>** **✶ Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time. (PS-D-9-21)** **✶ Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it. (PS-D-9-22)** **✶ Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F_{net} = ma. Note that weight is the gravitational force on a mass.) (PS-D-9-23)** **✶ Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object. (PS-D-9-24)** **✶ Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight). (PS-D-9-25)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory and Newtonian mechanics). (PS-H-9-26)** **✶ Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy,**	

	nanotechnology, plastics and ceramics and communication technology). (PS-H-9-27) **<u>Sub-Objectives to Meet Indicators:</u>** **Measurement** • Identify and utilize the metric units for measuring length, volume, mass, temperature, time, area, and force. • Describe the relationship between metric and English units. • Apply the prefixes milli, centi, deci, deka, hecto, and kilo to the metric units of length, mass and volume. • Utilize the factor-label method to convert measurements from one unit to another unit. • Measure length using a meter stick. • Measure liquid volumes using a graduated cylinder. • Measure temperature using a thermometer. • Interpret data from a data table or a graph. • Enter data into a computer graphing program and generate a graph displaying the data. • Mathematically show how to calculate the density of various objects. • Explain density and explain why objects of the same size have different densities. • Relate the density of various objects to water (e.g., more/less dense than water). • Exhibit an understanding of and practice lab safety rules. • Identify and use science equipment in a safe and proper manner, including beakers, graduated cylinders, Bunsen burners, Erlenmeyer flasks, test tubes, test tube holders, electronic balances, triple beam balances, and ring stands. • Explain the differences among the terms average speed, velocity and acceleration and calculate them mathematically. **Motion** • Graph motion showing changes in distance as a function of time. • Predict the influence that motion will have on other objects.	

	• Explore the factors that influence motion (e.g., friction, lubrication, etc). • Utilize the slow movement of Earth's plates to calculate speed. • Describe what happens to the motion of an object as it accelerates. • Calculate the acceleration of an object and graph changing speed and distance of an accelerating object. **Forces** • Explain how balanced and unbalanced forces are related to motion. • Explain Newton's First Law of Motion related to inertia. • Recognize different kinds of forces. • Define, apply and use the metric unit of force, the Newton. • Explain Newton's Second Law of Motion relative to how force and mass are related to acceleration. • Solve for force mathematically using the formula F = m x a. • Distinguish between mass and weight. • Cite examples of the effects of gravity. • Explain the Universal Law of Gravitation. • Describe the effects of gravity and air resistance on an object in free fall. • Explain Newton's Third Law of Motion. • Calculate momentum and explain the Law of Conservation of Momentum. **Work and Machines (Enrichment ONLY!)** • Identify when work is done on an object. • Define work, efficiency and mechanical advantage and solve for them mathematically. • Explain what machines do and how they make work easier. • Identify the simple machines, understand how they work and give examples of each. • Cite examples of compound machines. • Explain how the human body is composed of simple machines. **Energy and Power** • Relate work and energy.	

	• Explain the difference between and calculate potential and kinetic energy. • Describe different forms of energy. • Identify and describe conversions from one type of energy to another. • Explain the Law of Conservation of Energy. • Identify the source of energy stored in fossil fuels. • Explain how energy is converted when fossil fuels are used. • Explain and calculate power. • Compare and contrast energy and power. **Light and Optics** • Describe sources of light. • Describe the arrangement of electromagnetic waves on the electromagnetic spectrum. • Contrast electromagnetic waves with other types of waves. • Describe the relationship between wavelength and frequency of waves on the electromagnetic spectrum. • Identify the difference between opaque, transparent and translucent materials. • Explain how humans see color. • Explain how various light sources work (e.g., incandescent, fluorescent, etc.). • Describe and experiment with reflection, refraction and diffraction. • Identify, distinguish between, and experiment with plane, concave and convex mirrors. • Identify and experiment with convex and concave lenses. • Explain how lenses are used to correct vision. • Identify the use of lenses and mirrors in a variety of equipment (e.g., cameras, telescopes, microscopes, etc.). • Explain the difference between coherent and incoherent light (e.g., lasers, etc.). **Universe** • Compare and contrast several theories on the origin of the universe.	

	• Identify factors that keep the planets in their orbits. • Describe the main characteristics of the planets. • Describe characteristics of comets and asteroids. • Identify where meteoroids come from in the atmosphere. • Describe the origin and evolution of stars. • List major characteristics of galaxies. • Explain the major theories on the formation of the solar system. • Identify the effects of Earth's rotation and revolution (e.g., seasons, etc.). • Explain what causes the phases of the moon. • Compare and contrast the causes of solar and lunar eclipses. • Explain what causes tides. • Trace the history of space exploration and its impact on society. **Earth's Waters and Cycles** • Explain how people and other living things use water. • Identify the distribution of Earth's saltwater and freshwater sources. • Describe the physical and chemical properties of water. • Describe how water dissolves other polar substances. • Identify the three states in which water exists on earth. • Describe the Earth's water cycle and ways in which living things depend on the water cycle. • Describe how glaciers form and why icebergs are dangerous to ships. • Compare and contrast springs and geysers and describe how water moves through underground layers of soil and rock. • Explain what an aquifer is and how people obtain water from it. • Describe what water pollution is and list some sources of pollution. • Explain how runoff affects ponds and streams. • Explain how moving water can produce electricity. • Identify ways in which hydroelectric power is a good source of energy. • Describe the impact of dams. • Describe characteristics of ocean waves and explain how they form. • Explain how waves change near the shore and explain what a tsunami is. • Identify the effects of waves on beaches and coastlines.	

	• List factors that cause tides and the daily and monthly tide cycles. • Describe how people can use the energy of tides. • Describe how ocean conditions change with depth. • Identify the forces that cause surface currents and deep currents in the ocean and how they affect climate on land. • Describe features of the ocean floor. **Matter** • List and describe several properties of matter. • Differentiate between elements, compounds, mixtures, colloids, and suspensions. • Differentiate between homogeneous mixtures and heterogeneous mixtures. • Using mass and volume calculate the density of various objects and compare these densities to water. • Trace the history of atomic theory and the relative size of the atom. • Compare and contrast the three states of matter at the particle level. • Relate pressure, volume and temperature changes to gases and graph the relationship between them. • Compare and contrast chemical and physical properties. • Categorize various regions of the periodic table based on common properties. **Chemical Reactions** • Relate the basics of carbon chemistry to industry and everyday uses. • List the four indicators of a chemical change and recognize the difference between a chemical change and a physical change. • Write and interpret simple chemical formulas. • Balance simple chemical equations using coefficients. • Distinguish among the five types of chemical reactions. • Contrast exothermic and endothermic reactions. • List and describe factors that affect the rate of a chemical change. • Calculate the number of protons, neutrons and electrons in an atom. • Trace the history of atomic theory and the models associated with each	

	theory. • Distinguish between ionic and covalent bonds. • Distinguish between polar and nonpolar substances and explain how each affects solubility. • Correctly apply solution vocabulary to the description of various types of solutions. **Acids/Bases** • List and describe the properties of acids and bases. • Describe what happens to an acid or base in water. • Explain how the pH scale is based on a factor of ten and explain how pH is assigned. • Classify acids or bases as strong or weak. • Predict the products of simple acid/base reactions. **Nuclear Reactions** • List characteristics of atoms that make them radioactive. • List the steps of radioactive decay. • Explain the term isotope. • Explain how radioactive tracers are used in medicine and industry. • Calculate the half-life of a radioactive substance. **The Atmosphere** • Describe the gaseous composition of the atmosphere. • Identify factors that contribute to measures of air quality. • Define pressure and explain variances in air pressure in various elevations. • Describe the layers of the atmosphere and the importance of each. • Relate all energy sources as originating from the sun. • Explain the three methods of heat transfer and how winds are related to these. • Describe the various forms of water in the atmosphere and their effect on the environment.	

	Changes in the Atmosphere • Describe characteristics of the types of precipitation. • List characteristics of air masses and fronts. • Identify characteristics of common types of storms. • List factors that can lead to flooding and the environmental effects of such an event. • Predict weather using modern forecasting methods.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

BIOLOGY

SCIENCE
BIOLOGY

NINTH/TENTH GRADE
BIOLOGY
Life Sciences Standard (LS)

9-10 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 9-10 program, the student will: **<u>Life Sciences</u>** **✶ Explain that cells are the basic unit of structure and function of living organisms that once life originated all cells come from pre-existing cells, and that there are a variety of cell types. (LS-A)** **✶ Explain the characteristics of life as indicated by cellular processes and describe the process of cell division and development. (LS-B)** **✶ Explain the genetic mechanisms and molecular basis of inheritance. (LS-C)** **✶ Explain the flow of energy and the cycling of matter through biological and ecological systems (cellular, organismal and ecological). (LS-D)** **✶ Explain how evolutionary relationships contribute to an understanding of the unity and diversity of life.**	**By the end of Ninth/Tenth Grade, the student will:** **<u>Characteristics and Structure of Life</u>** **✶ Explain that living cells** **a. are composed of a small number of key chemical elements (carbon, hydrogen, oxygen, nitrogen, phosphorus and sulfur)** **b. are the basic unit of structure and function of all living things** **c. come from pre-existing cells after life originated, and** **d. are different from viruses. (LS-A-10-1)** **✶ Compare the structure, function and interrelatedness of cell organelles in eukaryotic cells (e.g., nucleus, chromosome, mitochondria, cell membrane, cell wall, chloroplast, cilia, flagella) and prokaryotic cells. (LS-A-10-2)** **✶ Explain the characteristics of life as indicated by cellular processes including** **a. homeostasis** **b. energy transfers and transformation** **c. transportation of molecules** **d. disposal of wastes** **e. synthesis of new molecules (LS-B-10-3)** **✶ Summarize the general processes of cell division and differentiation, and explain why specialized cells are useful to organisms and explain that complex multicellular organisms are formed as highly organized arrangements of differentiated cells. (LS-B-10-4)** **<u>Heredity</u>** **✶ Illustrate the relationship of the structure and function of DNA to protein synthesis and the characteristics of an organism. (LS-C-10-5)** **✶ Explain that a unit of hereditary information is called a gene, and**	**<u>Suggested Materials</u>** • Textbook: Biology (Prentice-Hall, 2007), including ° Student Edition, 220 copies per building ° Interactive Textbook CD-ROM with StudentEXPRESS 6 Year Online Access, 220 copies per building ° Teacher Edition, six copies per building ° Teacher Online Access Pack, six copies per building ° Teaching Resources, six copies per building ° Chapter Tests, Unit Tests and Final Exams, Levels A and B, six copies per building ° Transparencies Plus, six copies per building ° Teacher Express CD-ROM, six copies per building ° ExamView Test Bank and Assessment Suite, six copies per building ° Presentation Express CD-ROM, six copies per building ° Audio CD-Rom, one copy per

(LS-E) **✶ Explain the structure and function of ecosystems and relate how ecosystems change over time. (LS-F)** **✶ Describe how human activities can impact the status of natural systems. (LS-G)** **✶ Describe a foundation of biological evolution as the change in gene frequency of a population over time. Explain the historical and current scientific developments, mechanisms and processes of biological evolution. (LS-H)** **✶ Explain how natural selection and other evolutionary mechanisms account for the unity and diversity of past and present life forms. (LS-I)** **✶ Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of life sciences. (LS-J)**	**genes may occur in different forms called alleles (e.g., gene for pea plant height has two alleles, tall and short). (LS-C-10-6)** **✶ Describe that spontaneous changes in DNA are mutations, which are a source of genetic variation. When mutations occur in sex cells, they may be passed on to future generations; mutations that occur in body cells may affect the functioning of that cell or the organism in which that cell is found. (LS-C-10-7)** **✶ Use the concepts of Mendelian and non-Mendelian genetics (e.g., segregation, independent assortment, dominant and recessive traits, sex-linked traits and jumping genes) to explain inheritance. (LS-C-10-8)** **<u>Diversity and Interdependence of Life</u>** **✶ Describe how matter cycles and energy flows through different levels of organization in living systems and between living systems and the physical environment. Explain how some energy is stored and much is dissipated into the environment as thermal energy (e.g., food webs and energy pyramids). (LS-D-10-9)** **✶ Describe how cells and organisms acquire and release energy (photosynthesis, chemosynthesis, cellular respiration and fermentation). (LS-D-10-10)** **✶ Explain that living organisms use matter and energy to synthesize a variety of organic molecules (e.g., proteins, carbohydrates, lipids and nucleic acids) and to drive life processes (e.g., growth, reacting to the environment, reproduction and movement). (LS-D-10-11)** **✶ Describe that biological classification represents how organisms are related with species being the most fundamental unit of the classification system. Relate how biologists arrange organisms into a hierarchy of groups and subgroups based on similarities and differences that reflect their evolutionary relationships. (LS-E-10-12)** **✶ Explain that the variation of organisms within a species increases the likelihood that at least some members of a species will survive under gradually changing environmental conditions. (LS-E-10-13)** **✶ Relate diversity and adaptation to structures and their functions in living organisms (e.g., adaptive radiation). (LS-E-10-14)** **✶ Explain how living things interact with biotic and abiotic components**	building for special education

	of the environment (e.g., predation, competition, natural disasters and weather). (LS-F-10-15) **✶ Relate how distribution and abundance of organisms and populations in ecosystems are limited by the ability of the ecosystem to recycle materials and the availability of matter, space and energy. (LS-F-10-16)** **✶ Conclude that ecosystems tend to have cyclic fluctuations around a state of approximate equilibrium that can change when climate changes, when one or more new species appear as a result of immigration or when one or more species disappear. (LS-F-10-17)** **✶ Describe ways that human activities can deliberately or inadvertently alter the equilibrium in ecosystems. Explain how changes in technology/biotechnology can cause significant changes, either positive or negative, in environmental quality and carrying capacity. (LS-G-10-18)** **✶ Illustrate how uses of resources at local, state, regional, national, and global levels have affected the quality of life (e.g., energy production, sustainable vs. nonsustainable agriculture). (LS-G-10-19)** **<u>Evolutionary Theory</u>** **✶ Recognize that a change in gene frequency (genetic composition) in a population over time is a foundation of biological evolution. (LS-H-10-20)** **✶ Explain that natural selection provides the following mechanism for evolution; undirected variation in inherited characteristics exist within every species. These characteristics may give individuals an advantage or disadvantage compared to others in surviving and reproducing. The advantaged offspring are more likely to survive and reproduce. Therefore, the proportion of individuals that have advantageous characteristics will increase. When an environment changes, the survival value of some inherited characteristics may change. (LS-H-10-21)** **✶ Describe historical scientific developments that occurred in evolutionary thought (e.g., Lamarck and Darwin, Mendelian Genetics and modern synthesis). (LS-H-10-22)** **✶ Analyze how natural selection and other evolutionary mechanisms**	

	(e.g., genetic drift, immigration, emigration, mutation) and their consequences provide a scientific explanation for the diversity and unity of past life forms, as depicted in the fossil record, and present life forms. (LS-I-10-24) **✶ Explain that life on Earth is thought to have begun as simple, one celled organisms approximately 4 billion years ago. During most of the history of Earth only single celled microorganisms existed, but once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved. (LS-I-10-25)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived. These ideas are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., biological evolution, germ theory, biotechnology and discovering germs). (LS-J-10-26)** **✶ Describe advances in life sciences that have important long-lasting effects on science and society (e.g., biological evolution, germ theory, biotechnology and discovering germs). (LS-J-10-27)** **✶ Analyze and investigate emerging scientific issues (e.g., genetically modified food, stem cell research, genetic research and cloning). (LS-J-10-28)** **<u>Sub-Objectives to Meet Indicators:</u>** **Taxonomy** • Explain the fundamentals of biological classification using Linnean principles. • Relate the significance of the scientific name as it applies to the hierarchy of taxonomy. • Identify the differences among the major phyla in each kingdom (e.g., Monera, Protista, Fungi, and Plants). • Relate morphology to classification. • Compare and contrast the various morphological forms and physiological types of bacteria.	

	• Recognize the prevalence and ubiquity of bacterial organisms. • Distinguish between aerobic and anaerobic bacteria. • Observe the rate at which bacteria are able to reproduce. • Consider cases of modern microbiological technology (e.g., recombinant DNA, etc.). • Describe virus particles as being on the edge of life. • Describe viral reproduction within its host. **Biochemistry** • Diagram the basic structure of the atom. • Write simple chemical formulas using the periodic table. • Differentiate between various types of chemical reactions. • Compare and contrast reactants and products in chemical changes. • Use indicators to qualitatively analyze various chemical substances for chemical composition. • Distinguish between acids and bases in terms of pH. • Differentiate between various types of bonds including ionic, covalent, single, double, and triple bonding. • Describe the basics of carbon chemistry. • Compare and contrast the functional groups of organic compounds and demonstrate how they are combined to form complex substances. • Construct various hydrocarbons using models and computer simulations. • Distinguish among and recognize carbohydrates, proteins, lipids, and their functions in living organisms. • Compare, contrast and give examples of the processes of dehydration synthesis and hydrolysis. • Interpret the results of tests for various organic nutrients. • Recognize the role of an enzyme to the metabolism of a biological organism. **Cytology** • Recognize the work of famous biologists in the history of cell biology. • Describe the plasma membrane and demonstrate its various functions. • Identify various mechanisms for cellular transport and distinguish between active and passive transport.	

	• Identify the various levels of organization in living systems. • Distinguish between prokaryotic cells and eukaryotic cells. • Distinguish among the organelles in the modern plant and animal cell and consider how structure complements function. • Distinguish between the light dependent and light independent reactions of photosynthesis. • Recognize the importance of the visible spectrum to photosynthesis. • Describe the role of chloroplasts and chlorophyll in the process of photosynthesis. • Qualitatively separate the pigments of a green leaf and research its characteristics. • Distinguish between internal and external cellular respiration. • Distinguish between anaerobic and aerobic respiration. • Compare and contrast endergonic and exergonic reactions in biological organisms. • Interpret the basic steps of cellular respiration. • Define and demonstrate fermentation. • Outline the ATP cycle and discuss its relationship to cellular respiration. • Demonstrate and observe mitotic apparatus and the sequence of events of mitosis. • Define and identify meristematic tissue. • Explain how mitosis usually results in genetic continuity. • Differentiate between the diploid and monoploid number of chromosomes in a cell. • Recognize that in diploid cells, chromosome pairs are homologous. • Compare and contrast the types and number of chromosomes in sperms, eggs and zygotes. • Describe meiosis as the process which produces sex cells having the monoploid number chromosomes. • Compare the contrast spermatogenesis and oogenesis. • Explain how the process of meiosis provides for variation among offspring. **Genetics and Evolution** • Explain how the process of meiosis is the basis for transfer of genetic	

	information. • Define crossing-over and demonstrate how it further increases genetic variation. • State the laws of probability and how they apply to genetics. • Describe the relationship between the terms DNA, genes and chromosomes. • Explain Mendelian genetics, including Mendel's Laws. • Explain non-Mendelian genetics, i.e., codominance. • Compare and contrast the terms phenotype and genotype. • Compare and contrast regular dominance to incomplete and codominance. • Solve problems that involve multiple alleles. • Recognize the chromosome theory of inheritance. • Define independent assortment and solve problems using dihybrid crosses. • Describe the two sex chromosomes and solve problems. • Explain the significance of a karyotype. • Describe non-disjunction of chromosomes and the effect of this condition. • Compare the structure of DNA to RNA, and discuss the differences in their functions. • Demonstrate DNA replication. • Contrast transcription and translation, and relate each to the process of protein synthesis. • Describe genetic disorders. • Discuss current advances in the understanding and utilization of DNA. • Explain the significance of evolution. • Discuss the importance of geographic isolation, barriers and adaptive radiation to the process of speciation. • Relate the fossil record and geologic time to our current concept of evolution. **Physiology** • Discuss the relationship of structure to function. • Explain how organs make up organ systems. • Relate how fertilized eggs become multicellular embryos and how the three basic tissue layers form.	

	• Compare and contrast the following systems, including skeletal, digestive, nervous, circulatory, excretory, and endocrine. • Discuss closed versus open circulation. • Describe the function of the kidney. • Identify regions of the brain and the functions of each. • Compare the control aspects of the nervous and endocrine systems and describe how they overlap to a degree. • Compare the various hormones, their source and function. • Describe plant "organs", including root, stem and leaf. • Describe photosynthesis and relate the process to leaf structure. • Compare and contrast the various means of plant reproduction and compare these means to animal reproductive methods. • Describe alternation of generation in plants. • Explain plant tropisms. • Discuss the role of plant hormones and compare to animal hormones. • Explain plant growth and the role of meristematic tissue. **Ecology** • Explain the components of an ecosystem. • Describe biotic and abiotic factors in an ecosystem. • Explain the role of sunlight in an ecosystem. • Compare trophic (feeding) levels and the interactions of producers, consumers and decomposers. • Describe food chains and food webs. • Explain the models of the pyramids of energy, biomass and numbers. • Compare biological associations such as mutualism and commensalism. • Explain how abiotic factors influence organisms. • Describe the major ecological cycles. • Interpret biological accumulation of pesticides. • Survey a forest community. • Define ecological succession as a series of changes in a community. • Compare and contrast primary and secondary succession. • Compare the biomes of North America. • Describe human influence on an ecosystem.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

NATURE OF SCIENCE GRADES 11-12

SCIENCE
NATURE OF SCIENCE GRADES 11-12

ELEVENTH/TWELFTH GRADES
NATURE OF SCIENCE-These scientific process skills should be integrated into High School Elective courses.
Science and Technology Standard (ST)
Scientific Inquiry Standard (SI)
Scientific Ways of Knowing Standard (SK)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will: **<u>Science and Technology</u>** **✶ Predict how human choices today will determine the quality and quantity of life on Earth. (ST-A)** **<u>Scientific Inquiry</u>** **✶ Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data. (SI-A)** **<u>Scientific Ways of Knowing</u>** **✶ Explain how scientific evidence is used to develop and revise scientific predictions, ideas or theories. (SK-A)** **✶ Explain how ethical considerations shape**	**By the end of Eleventh/Twelfth Grades, the student will:** **<u>Understanding Technology</u>** **✶ Identify that science and technology are essential social enterprises but alone they can only indicate what can happen, not what should happen. Realize the latter involves human decisions about the use of knowledge. (ST-A-11-1)** **✶ Predict how decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment and/or humans. (ST-A-11-2)** **✶ Explore and explain any given technology that may have a different value for different groups of people and at different points in time (e.g., new varieties of farm plants and animals have been engineered by manipulating their genetic instructions to reproduce new characteristics). (ST-A-11-3)** **✶ Explain why basic concepts and principles of science and technology should be a part of active debate about the economics, policies, politics and ethics of various science-related and technology-related challenges. (ST-A-11-4)** **✶ Investigate that all fuels (e.g., fossil, solar and nuclear) have advantages and disadvantages; therefore society must consider the trade-offs among them (e.g., economic costs and environmental impact). (ST-A-11-5)** **✶ Research sources of energy beyond traditional fuels and the advantages, disadvantages and trade-offs society must consider when using alternative sources (e.g., biomass, solar, hybrid engines, wind**	

SCIENCE
NATURE OF SCIENCE GRADES 11-12

scientific endeavors. (SK-B) **✶ Explain how societal issues and considerations affect the progress of science and technology. (SK-C)**	**and fuel cells). (ST-A-11-6)** **✶ Explain how science often advances with the introduction of new technologies and how solving technological problems often results in new scientific knowledge. (ST-A-12-1)** **✶ Describe how new technologies often extend the current levels of scientific understanding and introduce new areas of research. (ST-A-12-2)** **✶ Research how scientific inquiry is driven by the desire to understand the natural world and how technological design is driven by the need to meet human needs and solve human problems. (ST-A-12-3)** **✶ Explain why basic concepts and principles of science and technology should be a part of active debate about the economics, policies, politics and ethics of various science-related and technology-related challenges. (ST-A-12-4)** **<u>Doing Scientific Inquiry</u>** **✶ Formulate testable hypotheses. Develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation. (SI-A-11-1)** **✶ Evaluate assumptions that have been used in reaching scientific conclusions. (SI-A-11-2)** **✶ Design and carry out scientific inquiry (investigation), communicate and critique results through peer review. (SI-A-11-3)** **✶ Explain why the methods of an investigation are based on the questions being asked. (SI-A-11-4)** **✶ Summarize data and construct a reasonable argument based on those data and other known information. (SI-A-11-5)** **✶ Formulate testable hypotheses. Develop and explain the appropriate procedures, controls and variables (dependent and independent) in scientific experimentation. (SI-A-12-1)** **✶ Derive simple mathematical relationships that have predictive power from experimental data (e.g., derive an equation from a graph and vice versa, determine whether a linear or exponential relationship exists among the data in a table). (SI-A-12-2)** **✶ Research and apply appropriate safety precautions when designing**	

	and/or conducting scientific investigations (e.g., OSHA, MSDS, eyewash, goggles and ventilation). (SI-A-12-3) **✶ Create and clarify the method, procedures, controls and variables in complex scientific investigations. (SI-A-12-4)** **✶ Use appropriate summary statistics to analyze and describe data. (SI-A-12-5)** **<u>Nature of Science</u>** **✶ Analyze a set of data to derive a hypothesis and apply that hypothesis to a similar phenomenon (e.g., biome data). (SK-A-11-1)** **✶ Apply scientific inquiry to evaluate results of scientific investigations, observations, theoretical models and the explanations proposed by other scientists. (SK-A-11-2)** **✶ Demonstrate that scientific explanations adhere to established criteria, for example a proposed explanation must be logically consistent, it must abide by the rules of evidence and it must be open to questions and modifications. (SK-A-11-3)** **✶ Explain why scientists can assume that the universe is a vast single system in which the basic rules are the same everywhere. (SK-A-11-4)** **✶ Give examples that show how science is a social endeavor in which scientists share their knowledge with the expectation that it will be challenged continuously by the scientific community and others. (SK-A-12-1)** **✶ Evaluate scientific investigations by reviewing current scientific knowledge and the experimental procedures used, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence and suggesting alternative explanations for the same observations. (SK-A-12-2)** **✶ Select a scientific model, concept or theory and explain how it has been revised over time based on new knowledge, perceptions or technology. (SK-A-12-3)** **✶ Analyze a set of data to derive a principle and then apply that principle to a similar phenomenon (e.g., predator/prey relationships and properties of semiconductors). (SK-A-12-4)** **✶ Describe how individuals and teams contribute to science and**	

	engineering at different levels of complexity (e.g., an individual may conduct basic field studies, hundreds of people may work together on major scientific questions or technical problems). (SK-A-12-5) **<u>Ethical Practices</u>** **✶ Recognize that bias affects outcomes. People tend to ignore evidence that challenges their beliefs but accept evidence that supports their beliefs. Scientists attempt to avoid bias in their work. (SK-B-11-5)** **✶ Describe the strongly held traditions of science that serve to keep scientists within the bounds of ethical professional behavior. (SK-B-11-6)** **✶ Explain that scientists may develop and apply ethical tests to evaluate the consequences of their research when appropriate. (SK-C-12-6)** **<u>Scientific Theories</u>** **✶ Explain how theories are judged by how well they fit with other theories, the range of included observations, how well they explain observations and how effective they are in predicting new findings. (SK-A-11-7)** **<u>Science and Society</u>** **✶ Explain that the decision to develop a new technology is influenced by societal opinions and demands and by cost benefit considerations. (SK-C-11-8)** **✶ Explain how natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society as well as cause risks. (SK-C-11-9)** **✶ Describe costs and trade-offs of various hazards-ranging from those with minor risk to a few people, to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations. (SK-C-11-10)** **✶ Research the role of science and technology in careers that students plan to pursue. (SK-11-11)**	

	✶ **Describe the current and historical contributions of diverse peoples and cultures to science and technology and the scarcity and inaccessibility of information on some of these contributions. (SK-C-12-7)** ✶ **Recognize that individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs and benefits and consideration of who benefits and who suffers, who pays and gains, and what the risks are and who bears them. (SK-C-12-8)** ✶ **Recognize the appropriateness and value of basic questions "What can happen?" "What are the odds?" and "How do scientists and engineers know what will happen?" (SK-C-12-9)** ✶ **Recognize that social issues and challenges can affect progress in science and technology (e.g., funding priorities for specific health problems serve as examples of ways that social issues influence science and technology). (SK-C-12-10)** ✶ **Research how advances in scientific knowledge have impacted society on a local, national or global level. (SK-C-12-11)**	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

CHEMISTRY

SCIENCE
CHEMISTRY

HIGH SCHOOL ELECTIVE
CHEMISTRY
Physical Sciences Standard (PS)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will, **Physical Sciences** ✶ **Explain how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena. (PS-A)** ✶ **Recognize that some atomic nuclei are unstable and will spontaneously break down. (PS-B)** ✶ **Describe how atoms and molecules can gain or lose energy only in discrete amounts. (PS-C)** ✶ **Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems. (PS-D)** ✶ **Summarize the historical development of scientific theories and ideas within the study of physical sciences. (PS-E)**	**By the end of Eleventh/Twelfth Grades, the student will:** **Nature of Matter** ✶ **Explain that elements with the same number of protons may or may not have the same mass and those with different masses (different numbers of neutrons) are called isotopes. Some of these are radioactive. (PS-A-11-1)** ✶ **Explain that humans have used unique bonding of carbon atoms to make a variety of molecules (e.g., plastics). (PS-E-11-2)** ✶ **Explain how atoms join with one another in various combinations in distinct molecules or in repeating crystal patterns. (PS-A-12-1)** ✶ **Describe how a physical, chemical or ecological system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small. Large disturbances may cause it to escape that equilibrium and eventually settle into some other state of equilibrium. (PS-A-12-2)** ✶ **Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe). (PS-D-12-3)** **Forces and Motion** ✶ **Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use). (PS-C-11-3)** ✶ **Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces that would make it fly apart. (PS-D-12-6)** ✶ **Recognize that nuclear forces are much stronger than electromagnetic**	**Suggested Materials** • Textbook: Holt Chemistry (Holt, Rinehart, and Winston, 2004), previously adopted in the district and stored in the science classrooms **Suggested Pacing Guide: First Semester** • Chapter 1-1, 2, 3 • Chapter 2-1, 2, 3 • Chapter 3-1, 2, 3 • Chapter 4-1, 2, 3, 4 • Chapter 5-1, 2, 3 • Chapter 6-1 • Chapter 13-3 • Chapter 6-2, 3 (only p. 212) • Chapter 3-4 • Chapter 7-1, 2, 3 (skip pp. 242-247) • Chapter 8-1, 2, 3, 4 (skip) • Chapter 17-1 • Chapter 9 (skip) • Chapter 10 (skip) • Chapter 11 (skip) **Suggested Pacing Guide: Second Semester** • Chapter 12-1, 2, 3 (skip pp. 436-437) • Chapter 13-1 (optional), 2

	forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars). (PS-D-12-7) **<u>Nature of Energy</u>** **✶ Explain the characteristics of isotopes. The nucleus of radioactive isotopes is unstable and spontaneously decays emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. (PS-B-12-10)** **✶ Use the predictability of decay rates and the concept of half-life to explain how radioactive substances can be used in estimating the age of materials. (PS-B-12-11)** **✶ Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules. (PS-C-12-12)** **✶ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-C-12-13)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-E-12-14)** **✶ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-E-12-15)** **<u>Sub-Objectives to Meet Indicators:</u>**	• Chapter 14 (skip) • Chapter 15-1, 2, 3, 4 (skip) • Chapter 16 (skip) • Chapter 17-1, 2 (skip), 3 (skip), 4 (skip) • Chapter 18-1, 2, 3 • Chapter 19 (skip) • Chapter 20 (skip)

SCIENCE
CHEMISTRY

	Scientific Method • Demonstrate an understanding that chemistry occurs all around us. • Use the proper scientific method to make predictions, determine the next steps to be taken in an experiment, and organize and report scientific information in its correct form. • Exhibit proper safety and lab techniques. **Data Analysis and Interpretation** • Properly collect, convert, calculate, interpret, and analyze data. • Convert data into different graphic representations and analyze accordingly. • Use dimensional analysis (i.e., factor labeling) to solve problems and make SI conversions. **Stoichiometry** • Calculate molar mass. • Calculate percent composition of a compound or determine the empirical formula of a binary compound given the masses of the two elements. • Calculate percent of water in a hydrated compound or determine the formula of a hydrate. • Use stoichiometry to calculate solutions to problems involving conversions from moles to moles, moles to grams, grams to moles, and grams to grams. • Calculate percent error. **Matter and Energy** • Distinguish among elements, compounds, homogeneous mixtures, and heterogeneous mixtures. • Compare and contrast physical and chemical changes. • Distinguish between matter and energy and their properties, including endothermic and exothermic reactions. • Apply the Laws of Conservation of Mass and Energy to chemical changes. • Compare and contrast energy transfer by conduction, convection and radiation. **Atomic Theory** • Describe the modern model of atomic theory.	

	• Interpret information available about each element from the periodic table. • Compare and contrast the characteristics of a solids, liquids and gases. • Describe the Kinetic Theory of Matter related to the properties of solids, liquids and gases. • Interpret changes in temperature and changes in state of a substance in terms of the Kinetic Theory of Matter. • Interpret graphs that illustrate changes in states of matter. **How Elements React** • Describe changes in energy as an electron moves between different energy levels within an atom. • Illustrate valence electrons by Lewis electron dot structures. • Demonstrate how and why atoms achieve chemical stability by bonding. **Compounds** • Determine the properties of compounds from those of the elements of which they are composed. • Interpret the information in a chemical formula. • Model the two basic types of compound formation (i.e., ionic and covalent) at the atomic level. • Compare, using examples, the effects of ionic and covalent bonding on the physical properties of a compound. • Apply ionic charge to writing formulas for ionic compounds. • Apply formulas to name ionic compounds. • Apply formulas to name molecular compounds. • Describe the role of electrons in covalent bonding. • Compare and contrast the characteristics of ionic, covalent, and polar-covalent bonds. **Reactions** • Demonstrate how chemical equations describe chemical reactions. • Illustrate how to balance chemical equations by changing coefficients. • Distinguish among types of chemical reactions. • Use reference information to predict if single or double replacement reactions will occur (e.g., using reactivity tables, solubility tables, etc.).	

	Periodicity • Predict trends and similarities in properties of elements by using the periodic table (e.g., atomic radii, ionization energy, etc.). • Recognize the relationship between an element's valence electron structure and its position on the periodic table. • Use the periodic table to identify and compare the properties of metals, non-metals or metalloids. • Distinguish among the s, p, d, and f blocks on the periodic table and relate them to an element's electron configuration. • Predict the electron configuration of an atom using the periodic table. • Explain how the stability of an atom is related to its electron configuration and number of valence electrons. **Physical Characteristics of Gases** • List the assumptions of the Kinetic-Molecular Theory of Matter and describe how the theory explains properties of matter. • Differentiate between relative temperature and absolute temperature and between relative pressure and absolute pressure. • Describe how pressure is measured and convert units of pressure. • Calculate volume-pressure changes using Boyle's Law. • Calculate volume-temperature changes using Charles' Law. • Calculate pressure-temperature changes using Gay-Lussac's Law. • Calculate volume-pressure-temperatures changes using the combined gas law. • Calculate total and partial pressure using Dalton's Law. • Describe Avogadro's Law and recognize its relationship to standard molar volume of a gas. • Using the Ideal Gas Law, calculate pressure, volume, temperature, or amount of gas when the other three quantities are known. **Solutions** • Compare and contrast the properties of suspensions, colloids, and solutions. • Differentiate between electrolytes and nonelectrolytes as solutes. • Use polar and nonpolar substances to demonstrate "like dissolves like". • Describe the effects of temperature and pressure on solubility.	

	• Calculate molarity of a solution. • Distinguish between strong and weak electrolytes. **Acids, Bases and Salts** • Compare and contrast acids, bases and salts. • Write acid-base neutralization equations. • Perform acid-base titrations to determine the concentration of an acid or base, given the known concentration of one or the other. • Use the pH scale to express relative concentrations of hydrogen and hydroxide ions. • Describe how acid-base indicators work. **Redox Chemistry** • Explain oxidation and reduction. • Explain what oxidation numbers are and how they are assigned. • Explain what is meant by the activity series of metals. • Describe some applications of redox reactions. **Nuclear Chemistry** • Compare and contrast major radiation types. • Write nuclear equations for decay, fission, fusion and capture reactions. • Explain the term half-life and how it is involved in radioactive dating. **Qualitative Analysis** • Use a published scheme to determine the presence of important cations and anions in an aqueous solution.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

HONORS CHEMISTRY

SCIENCE
HONORS CHEMISTRY

HIGH SCHOOL ELECTIVE
HONORS CHEMISTRY
Physical Sciences Standard (PS)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
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	gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars). (PS-D-12-7) **<u>Nature of Energy</u>** **✶ Explain the characteristics of isotopes. The nucleus of radioactive isotopes is unstable and spontaneously decays emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. (PS-B-12-10)** **✶ Use the predictability of decay rates and the concept of half-life to explain how radioactive substances can be used in estimating the age of materials. (PS-B-12-11)** **✶ Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules. (PS-C-12-12)** **✶ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-C-12-13)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-E-12-14)** **✶ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-E-12-15)** **<u>Sub-Objectives to Meet Indicators:</u>**	° CBL Laboratory Manual, Teacher Edition, four copies per building ° ChemLab and MiniLab Worksheets, four copies per building ° Study Guide for Content Mastery, Teacher Edition, four copies per building ° Laboratory Management and Safety in the Science Classroom, four copies per building ° ExamView Assessment Suite CD-ROM, four copies per building ° TeacherWorks CD-ROM, four copies per building ° Interactive Chalkboard CD-ROM, four copies per building

	The Nature of Chemistry • Practice basic safety rules when working in the chemistry laboratory. • Identify the metric units of measurement used in chemistry. • Explain what causes uncertainty in measurements and compare accuracy and precision. • Explain how to use significant digits and scientific notation. • Calculate percent error. • Define and calculate density and compare the densities of various substances to water. • Use dimensional analysis to solve problems. • State the Laws of Conservation of Energy and Matter. • Compare the Fahrenheit, Celsius and Kelvin temperature scales and convert between and among them. • Extrapolate absolute zero and explain its significance. • Name and describe the three states of matter. • Compare and contrast physical and chemical properties of matter. • Explain the difference between an element and a compound. • Compare heterogeneous and homogeneous mixtures and describe several techniques for separating mixtures. **Structure of Matter** • Explain the term atom and describe and calculate the three subatomic particles of the atom. • Identify the postulates of Dalton's atomic theory. • Explain how isotopes are related to atomic mass. • Define radioactivity and describe the changes that accompany nuclear reactions. • Describe a wave in terms of its frequency, wavelength, speed, and amplitude. • Identify the major regions of the electromagnetic spectrum. • Explain what is meant by a quantum of energy. • Relate the energy of radiation to its frequency. • Distinguish between a continuous spectrum and a line spectrum. • State the main ideas in Bohr's model of the atom.	

	• Describe atomic orbitals in terms of their shape, size, orientation and energy. • Determine the electron configurations of several elements using the principles of orbital energy, orbital capacity and electron spin. • Discuss the contributions of various scientists to the creation of the modern periodic table. • Explain why elements in a group have similar properties. • Identify the four regions of the periodic table (i.e., s, p, d, and f). • Explain how the Periodic Law is used to identify the four periodic trends and explain how each trend reflects the electron configurations of the elements. **Chemical Formulas and Bonding** • Describe the characteristics of ionic and covalent bonds. • Explain the octet rule. • Differentiate between polar and nonpolar covalent bonds. • Write names for ionic compounds, molecular compounds and acids. • Describe the VSEPR theory in terms of electron cloud arrangement and molecular geometry (e.g., linear, trigonal planar, tetrahedral, etc.). • Identify the common shapes of small molecules. • Explain what determines the polarity of a molecule. • List four pieces of evidence that indicate chemical changes. • Write balanced chemical equations. • Classify chemical reactions. **Stoichiometry** • Describe the importance of a mole through its definition. • Identify and use Avogadro's number in calculations. • Calculate molar mass and explain how it relates the mass of a substance to the number of particles in that substance. • Convert among the number of particles, moles and mass of a substance. • Describe molar volume and use it to solve problems. • Find the percentage composition of a given formula. • Use percentage composition information to calculate the empirical and	

	molecular formulas of an unknown sample. • Solve stoichiometry problems involving two substances in a balanced equation. • Determine the limited reactant of a chemical reaction. • Compare and contrast ideal and real gases. • Relate gas density to temperature and molar mass. **Physical Characteristics of Gases** • List the assumptions of the Kinetic-Molecular Theory of Matter and describe how the theory explains properties of matter. • Differentiate between relative temperature and absolute temperature and between relative pressure and absolute pressure. • Describe how pressure is measured and convert units of pressure. • Calculate volume-pressure changes using Boyle's Law. • Calculate volume-temperature changes using Charles' Law. • Calculate pressure-temperature changes using Gay-Lussac's Law. • Calculate volume-pressure-temperatures changes using the combined gas law. • Calculate total and partial pressure using Dalton's Law. • Describe Avogadro's Law and recognize its relationship to standard molar volume of a gas. • Using the Ideal Gas Law, calculate pressure, volume, temperature, or amount of gas when the other three quantities are known. • Interpret graphs that illustrate vaporization, condensation, boiling, freezing, melting, and sublimations. **Solutions** • Compare and contrast the properties of suspensions, colloids, and solutions. • Differentiate between electrolytes and nonelectrolytes as solutes. • Use polar and nonpolar substances to demonstrate "like dissolves like". • Describe the effects of temperature and pressure on solubility. • Calculate molarity of a solution. • Distinguish between strong and weak electrolytes.	

	Chemical Equilibrium • Describe the properties of and identify types of solutions. • Measure the concentration of solutions in terms of molarity and normality. • Differentiate among saturated, unsaturated and supersaturated solutions. • Define solubility and describe the factors that affect solubility and the rate of solubility. • Define chemical equilibrium in terms of reversible reactions and explain how it is achieved. • Calculate and analyze the extent of a reaction from its equilibrium constant. • Describe how changes in concentration, pressure, and temperature affect a reaction at equilibrium. • Write net ionic equations to describe the formation of an aqueous solution. **Acids and Bases** • Explain the Bronsted-Lowry definition of acids and bases. • Identify the common physical and chemical properties of acids and bases. • Use experimental data to calculate dissociation constant and explain their significance in terms of acids and bases. • Name acids using the nomenclature system. • Identify the ion concentrations in pure water. • Describe the pH scale. • Convert between H_3O^+, OH^- and pH. • Identify a buffer and explain how it works. • Complete an acid-base titration and calculate the concentration of the unknown. • Explain how indicators are used in titrations and how they are chosen. **Redox Chemistry** • Explain oxidation and reduction. • Explain the difference between and identify oxidizing agents and reducing agents. • Explain what oxidation numbers are and how they are assigned. • Recognize whether or not a reaction is a redox reaction based upon	

	oxidation numbers. • Explain what is meant by the activity series of metals. • Describe some applications of redox reactions. • Balance redox equations. **Kinetics, Thermodynamics and Heat** • Explain how energy is involved in chemical reactions. • Define activation energy and describe an activated complex. • List the factors that affect reaction rates. • Distinguish between exothermic and endothermic reactions. • Compare and contrast heat and temperature. • Compare and contrast energy transfer by conduction, convection and radiation. **Nuclear Chemistry** • Compare and contrast major radiation types. • Write nuclear equations for decay, fission, fusion and capture reactions. • Explain the term half-life and how it is involved in radioactive dating. **Qualitative Analysis** • Use a published scheme to determine the presence of important cations and anions in an aqueous solution.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

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ADVANCED PLACEMENT CHEMISTRY

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ADVANCED PLACEMENT CHEMISTRY
Physical Sciences Standard (PS)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will, **<u>Physical Sciences</u>** **✶ Explain how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena. (PS-A)** **✶ Recognize that some atomic nuclei are unstable and will spontaneously break down. (PS-B)** **✶ Describe how atoms and molecules can gain or lose energy only in discrete amounts. (PS-C)** **✶ Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems. (PS-D)** **✶ Summarize the historical development of scientific theories and ideas within the study of physical sciences. (PS-E)**	**By the end of Eleventh/Twelfth Grades, the student will:** **<u>Nature of Matter</u>** **✶ Explain that elements with the same number of protons may or may not have the same mass and those with different masses (different numbers of neutrons) are called isotopes. Some of these are radioactive. (PS-A-11-1)** **✶ Explain that humans have used unique bonding of carbon atoms to make a variety of molecules (e.g., plastics). (PS-E-11-2)** **✶ Explain how atoms join with one another in various combinations in distinct molecules or in repeating crystal patterns. (PS-A-12-1)** **✶ Describe how a physical, chemical or ecological system in equilibrium may return to the same state of equilibrium if the disturbances it experiences are small. Large disturbances may cause it to escape that equilibrium and eventually settle into some other state of equilibrium. (PS-A-12-2)** **✶ Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe). (PS-A-12-3)** **✶ Recognize that at low temperatures some materials become superconducting and offer little or no resistance to the flow of electrons. (PS-A-12-4)** **<u>Forces and Motion</u>** **✶ Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use). (PS-C-11-3)** **✶ Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces**	**<u>Suggested Materials</u>** • Textbook: Chemistry, 7th Edition (Houghton-Mifflin/McDougal Littell, 2007), including ° Student Edition with Student CD-ROM and AP Workbook, 30 copies per building ° Instructor's Annotated Edition, one copy per building ° Instructor's Complete Solutions Manual, one copy per building ° Lab Manual, one copy per building ° AP Teacher Resource Guide, one copy per building ° Test Bank, one copy per building ° Instructor Media Guide, one copy per building ° Instructor's Media Integration Guide, one copy per teacher ° Houghton-Mifflin ClassPresent CD-ROM, one copy per teacher ° Houghton-Mifflin ClassPrep with Houghton-Mifflin Testing CD-ROM, one copy per teacher ° Study Guide, one copy per building

	that would make it fly apart. (PS-D-12-6) **✶ Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g., from atomic and hydrogen bombs and in the sun and other stars). (PS-D-12-7)** **<u>Nature of Energy</u>** **✶ Explain the characteristics of isotopes. The nucleus of radioactive isotopes is unstable and spontaneously decays emitting particles and/or wavelike radiation. It cannot be predicted exactly when, if ever, an unstable nucleus will decay, but a large group of identical nuclei decay at a predictable rate. (PS-B-12-10)** **✶ Use the predictability of decay rates and the concept of half-life to explain how radioactive substances can be used in estimating the age of materials. (PS-B-12-11)** **✶ Describe how different atomic energy levels are associated with the electron configurations of atoms and electron configurations (and/or conformations) of molecules. (PS-C-12-12)** **✶ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-C-12-13)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-E-12-14)** **✶ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-E-12-15)**	

	Sub-Objectives to Meet Indicators: **Measurement, Atoms, Molecules and Ions** • Describe and illustrate the laws of conservation of mass, definite proportions and multiple proportions. • Describe Dalton's theory of atoms and Rutherford's alpha scattering experiment. • Utilize the relationship between atomic number, mass number and net charge to determine the number of electrons, protons and neutrons in an atom or ion. • Recognize isotopes and the difference between mass number for an isotope and the average atomic mass for an element. • Write chemical names and chemical formulas for important inorganic molecules. **Stoichiometry and Chemical Reactions** • Determine empirical and molecular formulas given mass or mass percent data and the molar mass. • Calculate molarities of solutions given the mass of solute and volume of solution being prepared. • Perform calculations involving the dilution of a more concentrated stock solution. • Perform mass-mass and volume of an aqueous solution-mass problems. • Solve limiting reactant problems determining both the amount of product produced and the amount of excess reactant involved. • Recognize and write in proper AP reaction format precipitation, acid-base neutralization, redox, and combustion reactions. **Thermochemistry** • Define enthalpy and illustrate enthalpy changes using a reaction diagram and the significance of enthalpy being a state property. • State that absolute enthalpy is extremely difficult to measure and how a change in enthalpy can be readily measured using calorimetry. • State the relationship between relative enthalpy and relative chemical stability.	

	• Write standard molar enthalpy of formation and enthalpy of combustion equations. • Utilize Hess's Law, standard enthalpy of formation data and bond dissociation energies to calculate ΔH for a reaction. **Electronic Structure of Atoms** • Discuss the wave/particle dichotomy for light and electrons. • Relate value of wavelength, frequency and energy per photon using appropriate equations. • Recognize patterns in the electromagnetic spectrum by wavelength, frequency and energy per photon. • Describe the contributions of Rutherford, Bohr, Heisenberg, and de Broglie to our modern theory of the atom. • Describe electron atomic orbitals in terms of radial probability, 90% probability boundaries and relative electron densities. • Describe the physical manifestations of the four quantum numbers. • Recognize electron configurations as being ground state or excited state. • Recognize patterns in electron configuration to determine electron configurations for s-block and p-block elements and their common ions. **Periodic Properties** • Recognize and explain patterns in first ionization energy, atomic radii, electron affinity, and ionic radii. • Explain patterns in effective nuclear charge. **Chemical Bonding/Shapes of Molecules and Polyatomic Ions** • Evaluate the dominant bond character between atoms in a chemical bond based upon differences in electro-negativity. • Draw Lewis electron dot structures for molecules, ionic formulas units and polyatomic ions. • Utilize formal charge to assess validity of possible electron dot representations. • Describe and recognize the difference between bond polarity and molecular polarity. • Utilize electron dot structures and the Valence Shell Electron Repulsion	

	Theory (VSEPR) to predict the following: arrangement of the electron clouds, shapes of the molecule or ion, hybridization of the central atom, bond angles, molecular polarity and the oxidation state of each atom. • Illustrate the concept of resonance by representing and interpreting various resonance structures. **Gas Behavior** • Utilize the Kinetic Molecular Theory as a microscopic model to explain the macroscopic behavior of gases. • Recognize and apply the following gas laws: Boyle's Law, Charles's Law, Dalton's Law of Partial Pressures, Combined Gas Law, and the Ideal Gas Law. • Perform volume-volume and mass-volume problems utilizing a balanced chemical equation. • Calculate the molar mass (molecular weight) from gas density and vice versa. • State the relationship between partial pressures and total pressures and between partial pressures and mole fraction of a gas sample. • State and apply the relationship between temperature and the average kinetic energy of the molecules. • Describe the conditions under which real gases deviate significantly from ideal behavior and when it is appropriate to utilize van der Waals Equation. **Liquids, Solids and Properties of Solutions** • Generally describe and illustrate models of the interparticle forces in molecular solids, metallic solids, and covalent network solids: LDF, dipole-dipole, hydrogen bonding, covalent bonding, electrostatic attraction, and shared pool of electrons. • Utilize models of the interparticle forces in molecular solids, metallic solids and covalent network solids to explain macroscopic behavior. • Define vapor pressure and state the relationship between vapor pressure the boiling point of a liquid. • Discuss and interpret the features of phase diagrams. • Describe and perform calculations involving the following units for	

	expressing solution concentration: molarity, mass percent, volume percent, and molality. • Describe how molecular structure, pressure and temperature affect the solubility of a solute in a particular solvent. • Apply Raoult's Law in examining colligative properties of solutions, which contain a nonvolatile solute or a volatile solute in a volatile solvent. **Chemical Kinetics** • Define reaction rate and state how reaction rates can be calculated from experimental data. • Discuss factors, which influence the rate of a reaction in terms of the collision model. • Construct reaction diagrams, which illustrate the activation energies, enthalpy changes, and the effect of a catalyst on a reaction system. • Compare the contrast homogeneous catalysis with heterogeneous catalysis. • Determine the order of a reaction and the (differential) rate law by the method of initial rates. • Graphically determine the order of a reaction and the (integrated) rate law by the method of initial rates given the appropriate data. • Calculate the value for the rate constant including proper units. • Discuss the concepts of reaction mechanism and rate-determining and evaluate proposed mechanisms in terms of their plausibility. **Chemical Equilibrium** • Discuss and explain the conditions necessary for the establishment of chemical equilibrium. • Utilize the law of mass action to construct equilibrium expressions and calculate equilibrium constants from experimental data. • Demonstrate an understanding of how condensed phases are treated in constructing an equilibrium expression. • Utilize Le Chatelier's Principle to predict the effect of an imposed change in concentration, temperature, or volume on a system, which is at equilibrium.	

	Electrolytes and Applications of Aqueous Equilibrium • Assign oxidation numbers to individual elements, recognize oxidation-reduction reactions and label oxidizing and reducing agents. • Utilize the half-reaction method for balancing redox equations. • Utilize the concept of normality to perform calculations involving redox titrations. • Define cell potential and distinguish between galvanic and electrolytic cells. • Describe how standard reduction potentials are assigned in the context of the standard hydrogen electrode. • Distinguish between kinetic chemical stability and thermodynamic chemical stability. • Incorporate entropy and enthalpy factors to make qualitative judgments about the thermodynamic driving forces in a specific chemical reaction. • Quantify the relationship between cell potential and cell concentrations. • Perform free energy calculations using either standard molar free energy of formation or enthalpy and entropy values. • Calculate equilibrium constants from cell potentials and vice versa. • Define equilibrium in terms of minimum free energy and show how the value of K_{eq} is related to ΔG. **Nuclear Chemistry** • Classify the major types of radioactive decay and write appropriate nuclear equations for each type. • Evaluate the various nuclear radiations in terms of energy, penetrating ability, damage to living tissue, and response to a magnetic field.	

STANDARDS-BASED

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PHYSICS

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	(PS-D-12-7) ✶ **Describe how the observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect). If either is moving towards the other, the observed wavelength is shorter; if either is moving away, the observed wavelength is longer (e.g., weather radar, bat echoes and police radar). (PS-D-12-8)** ✶ **Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force if proportional to the masses and weakens rapidly with increasing distance between them. (PS-D-12-9)** **Nature of Energy** ✶ **Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-C-12-13)** **Historical Perspectives and Scientific Revolutions** ✶ **Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-E-12-14)** ✶ **Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-E-12-15)** **Sub-Objectives to Meet Indicators:** **Mechanics: Kinematics** • Define displacement, time interval, motion, average speed, uniform speed, instantaneous speed, average acceleration, and instantaneous acceleration. • Distinguish between position and displacement along a straight line. • Plot a position-time graph and show that the slope is speed. • Plot velocity-time graph and show that the slope is acceleration.	

	• Show that the area under a velocity-time graph is displacement. • Solve motion problems involving displacement, time, velocity, and acceleration. • Solve problems using correct metric units and scientific notation. • Describe the motion of objects in free fall near the earth's surface. • Solve problems for distance, time or speed of objects having uniform accelerated motion, such as in free fall. • Determine experimentally if an object is moving with uniform speed. • Experimentally determine the acceleration due to gravity at the earth's surface. • Perform investigations, labs and demonstrations with computer data collection devices and current software. **Mechanics: Newton's Laws of Motion** • Differentiate between a vector quantity and a scalar quantity. • Represent vector measurements graphically. • Add and subtract two or more vector quantities by a scale drawing. • Resolve a given vector into its rectangular components and vice-versa. • Apply the Pythagorean Theorem and basic trigonometric functions to vector addition and subtraction. • Explain Newton's Law of Motion. • Determine Newton's Second Law of Motion experimentally. • Describe the relationships between units of force, weight and acceleration. • Recognize that force and acceleration are vector quantities. • Recognize and explain the difference between force, weight and mass. • Compare and contrast gravitational and inertial mass. • Perform investigations, labs and demonstrations with computer data collection devices and current software. • Determine the net force on objects considering inclined planes and friction. **Mechanics: Motion in Two Dimensions** • Recognize that forces of motion that are perpendicular to each other will act independently.	

	• Resolve the paradox of falling and horizontally projected objects hitting the ground at the same time. • Solve projectile problems for height, range and time in flight given velocity and angle. • Determine period, frequency, centripetal force, and centripetal acceleration. • Explain circular motion in terms of centripetal force and acceleration. • Recognize that in simple harmonic motion, the force varies with the displacement from equilibrium. • Explain Kepler's Three Laws. • Describe Newton's Law of Gravitation in words and in formula form. • Calculate the force of gravity between any two objects. • Solve satellite problems by equating centripetal forces to gravitational force. • Perform investigations, labs and demonstrations with computer data collection devices and current software. • Determine the total energy of an oscillating system and know the points where PE and KE are maximum and minimum. **Mechanics: Momentum and its Conservation** • Differentiate between impulse and momentum. • Recognize that impulse and momentum are vector quantities. • Explain the relationship between impulse and momentum. • Apply the law of conservation of one and two dimensional collisions. • Describe the many contributions made to physics by Newton. • Perform investigations, labs and demonstrations with computer data collection devices and current software. **Mechanics: Work, Energy and Power** • Articulate the connection between work and power. • Explain the terms potential energy, kinetic energy, work, and power. • Compare and contrast elastic and inelastic interactions. • List and identify the different forms of potential energy. • Perform investigations, labs, and demonstrations with computer data	

	collection devices and current software. • Discuss career opportunities in physics-related fields. **Heat, Kinetic Theory and Thermodynamics**: **Temperature and Heat** • Differentiate between heat and temperature. • Define calorie, specific heat, heat of fusion, and heat of vaporization. • Calculate the amount of heat involved when a substance changes temperature. • Solve problems by applying the principle of conservation of heat energy using the law of heat exchange. • Determine experimentally the heat of fusion. • Demonstrate the mechanical equivalence of heat. **Waves and Optics: Nature of Light** • Explain luminous, non-luminous, transparent, and opaque rays, beams and pencils. • Describe the reflection of different colors of light from various colored objects. • Diagram and explain the formation of shadows. • Recognize that objects or images can be located by following sight lines to their actual or apparent origin. • Describe how illuminance varies directly with the source intensity and inversely with the square of the distance from the source. • Perform investigation, labs and demonstrations with computer data collection devices and current software. **Waves and Optics: Reflection and Refraction** • Discover experimentally the laws of reflection. • Identify and define real and virtual images. • Diagram the formation of images in plane and curved mirrors. • Derive the lens equation. • Solve problems relating to image size and distance, object size and the distance focal lengths of mirrors. • Differentiate among reflection, refraction and diffraction. • Identify in a diagram the normal, the angle of incidence, the angle of	

	reflection, and the law of reflection. • Explain Snell's Law. • Solve problems involving Snell's Law. • Define and explain critical angle and total internal reflection and cite conditions necessary for their occurrence. • Describe examples and applications of total internal reflection. • Explain the dispersion of colors by a prism in terms of different indexes of refraction for colors. • Relate the color of light to its frequency and wavelength. • Differentiate between converging and diverging lenses. • Describe image location, nature and size in curved lenses both qualitatively and using ray diagrams. • Derive the lens equation from ray diagrams. • Solve equation involving image size or location and focal length using the lens equation. • Describe the six cases of lenses relative to image, object size and location, and list applications for each. **Waves and Optics: Waves, Motion and Sound** • Describe wave, wavelength, frequency, period, and amplitude. • Distinguish between transverse and longitudinal waves. • Differentiate between a pulse and a wave. • Relate period and frequency. • Describe the behavior of waves on a slinky. • Explain the principle of superposition and illustrate by diagrams. • Relate the behavior of waves when they reach a junction to two different springs. • Study the behavior of waves in a ripple tank relative to reflection, refraction, and interference. • Diagram the diffraction and interference of waves in a ripple tank. • Solve problems using the wave equation. • Compare the behavior of waves to the behavior of light. • Describe the nature of sound waves. • Solve problems involving standing waves in resonating air columns.	

	Waves and Optics: Interference and Diffraction • Measure the wavelength of light from an interference pattern. • Describe and explain single and double slit interference patterns. • Explain the interference patterns of light in thin films. • Discuss the diffraction of light through small openings. • Explain the interference of waves in terms of path differences. • Solve problems using Young's Equation. • Explain the effect of shifting phase in the interference pattern. • Compare the behavior of light relative to the waves and particle theories. • Discuss career opportunities in physics-related fields. **Electricity and Magnetism: Currents** • Explain potential difference, resistance, and current, and identify their units. • Explain Ohm's Law in symbols and units. • Solve problems for power using power formulas. • State the factors that affect the resistance of a wire. • Distinguish between resistance, current and voltage in series and parallel circuits. • Explain the meaning of the various electric symbols. • Explain how fuses and circuit breakers work. • Describe how voltmeters and ammeters are connected in circuits. • Investigate circuits with current computer simulation software. **Electricity and Magnetism: Electromagnetism** • Discuss the effects of stationary charges, charges in motion and accelerated charges. • Explain briefly the generation of electromagnetic radiation. • Recognize and state the basic properties of all electro-magnetic radiations. • Identify the direct source for each part of the electromagnetic spectrum. • Discuss career opportunities in physics-related fields. **Modern Physics: Atomic and Nuclear Physics** • Compare the properties of alpha, beta and gamma radiations.	

	• Explain the concepts of isotopes. • Recognize the radioactive decay series. • Define half-life and solve simple problems using the concept. • List three factors affecting nuclear stability and explain how nuclear emissions will increase the stability of the nucleus. • Write nuclear equations for naturally occurring alpha and beta particle emissions. • Distinguish between nuclear fusion and fission. • Write balance nuclear equations for induced transmutations, for fission, and fusion reactions. • Discuss and explain the main components of a nuclear reactor. • Discuss career opportunities in physics-related fields.	

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11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will, **<u>Physical Sciences</u>** **✶ Explain how variations in the arrangement and motion of atoms and molecules form the basis of a variety of biological, chemical and physical phenomena. (PS-A)** **✶ Describe how atoms and molecules can gain or lose energy only in discrete amounts. (PS-C)** **✶ Apply principles of forces and motion to mathematically analyze, describe and predict the net effects on objects or systems. (PS-D)** **✶ Summarize the historical development of scientific theories and ideas within the study of physical sciences. (PS-E)**	**By the end of Eleventh/Twelfth Grades, the student will:** **<u>Nature of Matter</u>** **✶ Explain how all matter tends toward more disorganized states and describe real world examples (e.g., erosion of rocks and expansion of the universe). (PS-D-12-3)** **✶ Recognize that at low temperatures some materials become superconducting and offer little or no resistance to the flow of electrons. (PS-A-12-4)** **<u>Forces and Motion</u>** **✶ Describe real world examples showing that all energy transformations tend toward disorganized states (e.g., fossil fuel combustion, food pyramids and electrical use). (PS-C-11-3)** **✶ Explain how electric motors and generators work (e.g., relate that electricity and magnetism are two aspects of a single electromagnetic force). Investigate that electric charges in motion produce magnetic fields and a changing magnetic field creates and electric field). (PS-D-11-4)** **✶ Use and apply the laws of motion to analyze, describe and predict the effects of forces on the motions of objects mathematically. (PS-D-12-5)** **✶ Recognize that the nuclear forces that hold the nucleus of an atom together, at nuclear distances, are stronger than the electric forces that would make it fly apart. (PS-D-12-6)** **✶ Recognize that nuclear forces are much stronger than electromagnetic forces, and electromagnetic forces are vastly stronger than gravitational forces. The strength of the nuclear forces explains why greater amounts of energy are released from nuclear reactions (e.g.,**	**<u>Suggested Materials</u>** • Textbook: College Physics (with PhysicsNOW) (Thomson Brooks/Cole, 2006), including ° Student Edition, 70 copies per building ° ExamView, one copy per building ° Instructor's Solutions Manual Volume 1, one copy per building ° Instructor's Solutions Manual Volume 2, one copy per building ° Multimedia Manager Instructor's Resource CD-ROM, Volume 1, one copy per building ° Multimedia Manager Instructor's Resource CD-ROM, Volume 2, one copy per building ° Overhead Transparencies, Volume 1, one copy per building ° Overhead Transparencies, Volume 2, one copy per building ° PhysicsNOW Website Access ° Student Solutions Manual with Study Guide, Volume 1, one copy per building ° Student Solutions Manual with Study

	from atomic and hydrogen bombs and in the sun and other stars). (PS-D-12-7) **✶ Describe how the observed wavelength of a wave depends upon the relative motion of the source and the observer (Doppler effect). If either is moving towards the other, the observed wavelength is shorter; if either is moving away, the observed wavelength is longer (e.g., weather radar, bat echoes and police radar). (PS-D-12-8)** **✶ Describe how gravitational forces act between all masses and always create a force of attraction. Recognize that the strength of the force if proportional to the masses and weakens rapidly with increasing distance between them. (PS-D-12-9)** **<u>Nature of Energy</u>** **✶ Explain how atoms and molecules can gain or lose energy in particular discrete amounts (quanta or packets); therefore they can only absorb or emit light at the wavelengths corresponding to these amounts. (PS-C-12-13)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., nuclear energy, quantum theory and theory of relativity). (PS-E-12-14)** **✶ Describe concepts/ideas in physical sciences that have important, long-lasting effects on science and society (e.g., quantum theory, theory of relativity, age of the universe). (PS-E-12-15)** **<u>Sub-Objectives to Meet Indicators:</u>** **Mechanics: Kinematics** • Compare and contrast displacement, time interval, motion, average speed, uniform speed, instantaneous speed, average acceleration, and instantaneous acceleration.	Guide, Volume 2, one copy per building ° Test Bank, Volume 1, one copy per building ° Test Bank, Volume 2, one copy per building ° Turning Point Clickers, 30 per building ° AP Binder, one copy per building

	• Distinguish between position and displacement along a straight line. • Plot a position-time graph and show that the slope is speed. • Plot velocity-time graph and show that the slope is acceleration. • Show that the area under a velocity-time graph is displacement. • Demonstrate an ability to solve motion problems involving displacement, time, velocity, and acceleration. • Solve problems using correct metric units and scientific notation. • Describe the motion of objects in free fall near the earth's surface. • Solve problems for distance, time or speed of objects having uniform accelerated motion, such as in free fall. • Determine experimentally if an object is moving with uniform speed. • Experimentally determine the acceleration due to gravity at the earth's surface. • Perform investigations, labs and demonstrations with computer data collection devices and current software. **Mechanics: Newton's Laws of Motion** • Differentiate between a vector quantity and a scalar quantity. • Represent vector measurements graphically. • Add and subtract two or more vector quantities by a scale drawing. • Resolve a given vector into its rectangular components and vice-versa. • Apply the Pythagorean Theorem and basic trigonometric functions to vector addition and subtraction. • Explain Newton's Law of Motion. • Determine Newton's Second Law of Motion experimentally. • Describe the relationships between units of force, weight and acceleration. • Recognize that force and acceleration are vector quantities. • Recognize and explain the difference between force, weight and mass. • Compare gravitational and inertial mass. • Perform investigations, labs and demonstrations with computer data collection devices and current software. • Determine the net force on objects considering inclined planes and friction.	

	Mechanics: Motion in Two Dimensions • Recognize that forces of motion that are perpendicular to each other will act independently. • Resolve the paradox of falling and horizontally projected objects hitting the ground at the same time. • Solve projectile problems for height, range and time in flight given velocity and angle. • Determine period, frequency, centripetal force, and centripetal acceleration. • Explain circular motion in terms of centripetal force and acceleration. • Recognize that in simple harmonic motion, the force varies with the displacement from equilibrium. • Explain Kepler's Three Laws. • Write Newton's Universal Law of Gravitation in words and in formula form. • Calculate the force of gravity between any two objects. • Solve satellite problems by equating centripetal forces to gravitational force. • Perform investigations, labs and demonstrations with computer data collection devices and current software. • Determine the total energy of an oscillating system and know the points where PE and KE are maximum and minimum. **Mechanics: Momentum and its Conservation** • Differentiate between impulse and momentum. • Recognize that impulse and momentum are vector quantities. • Explain the relationship between impulse and momentum. • Apply the law of conservation of one and two-dimensional collisions. • Describe the many contributions made to physics by Newton. • Perform investigations, labs and demonstrations with computer data collection devices and current software. **Mechanics: Work, Energy, and Power** • Articulate the connection between work and power.	

	• Explain the terms: potential energy, kinetic energy, work, and power. • Compare and contrast elastic and inelastic interactions. • List and identify the different forms of potential energy. • Determine the gravitational potential energy of objects near the earth's surface. • Determine the kinetic energy of objects. • Solve problems involving the conservation of energy. • Perform investigations, labs and demonstrations with computer data collection devices and current software. • Discuss career opportunities in physics-related fields. **Heat, Kinetic Theory, and Thermodynamics: Temperature and Heat** • Differentiate between heat and temperature. • Define calorie, specific heat, heat of fusion, and heat of vaporization. • Calculate the amount of heat involved when a substance changes temperature. • Solve problems by applying the principle of conservation of heat energy using the law of heat exchange. • Determine experimentally the heat of fusion. • Demonstrate the mechanical equivalence of heat. **Heat, Kinetic Theory, and Thermodynamics: Kinetic Theory and Thermodynamics** • State the First Law of Thermodynamics, distinguishing heat from both work and thermal energy • State the Second Law of Thermodynamics; define entropy. • List the assumptions of the kinetic theory and the definition of an ideal gas. • State Boyle's Law and demonstrate an ability to use the law in solving problems. • State Charles' Law and solve problems. • Describe the formation of the Ideal Gas Law. • Explain the distinction between a real and ideal gas. • Discuss career opportunities in physics-related fields.	

	Waves and Optics: Nature of Light • Define luminous, non-luminous, transparent, and opaque rays, beams and pencils. • Describe the reflection of different colors of light from various colored objects. • Diagram and explain the formation of shadows. • Recognize that objects or images can be located by following sight lines to their actual or apparent origin. • Explain that luminance varies directly with the source intensity and inversely with the square of the distance from the source. • Perform investigation, labs, and demonstrations with computer data collection devices and current software. **Waves and Optics: Reflection and Refraction** • Discover experimentally the laws of reflection. • Identify and define real and virtual images. • Diagram the formation of images in plane and curved mirrors. • Derive the lens equation. • Solve problems relating to image size and distance, object size and the distance focal lengths of mirrors. • Differentiate among reflection, refraction and diffraction. • Identify in a diagram: the normal, the angle of incidence, the angle of reflection, and the law of reflection. • Explain and solve problems involving Snell's Law. • Define and explain critical angle and total internal reflection and cite conditions necessary for their occurrence. • Describe examples and applications of total internal reflection. • Explain the dispersion of colors by a prism in terms of different indexes of refraction for colors. • Relate the color of light to its frequency and wavelength. • Differentiate between converging and diverging lenses. • Describe image location, nature and size in curved lenses both qualitatively and using ray diagrams.	

	• Derive the lens equation from diagrams of rays. • Solve equation involving image size or location and focal length using the lens equation. • Describe the six cases of lenses relative to image, object size, and location, and list applications for each. **Waves and Optics: Waves, Motion, and Sound** • Compare and contrast wave, wavelength, frequency, period, and amplitude. • Distinguish between transverse and longitudinal waves. • Differentiate between a pulse and a wave. • Relate period and frequency. • Describe the behavior of waves (e.g., using a Slinky, etc.). • Explain the principle of superposition and illustrate by diagrams. • Relate the behavior of waves when they reach a junction to two different springs. • Describe the behavior of waves in a ripple tank relative to reflection, refraction and interference. • Diagram the diffraction and interference of waves in a ripple tank. • Solve problems using the wave equation. • Compare the behavior of waves to the behavior of light. • Describe the nature of sound waves. • Solve problems involving standing waves in resonating air columns. **Waves and Optics: Interference and Diffraction** • Measure the wavelength of light from an interference pattern. • Describe and explain single and double slit interference patterns. • Explain the interference patterns of light in thin films. • Discuss the diffraction of light through small openings. • Explain the interference of waves in terms of path differences. • Solve problems using Young's Equation. • Explain the effect of shifting phase in the interference pattern. • Compare the behavior of light relative to the waves and particle theories. • Discuss career opportunities in physics-related fields.	

	Electricity and Magnetism: Magnetism • Explain magnetic field lines. • Draw the lines of force between magnets arranged N-N and N-S. • Predict attraction and repulsion for a given alignment of magnet poles. • Describe magnetic domains. • Describe the concept of a magnetic field. • Describe similarities and differences in magnetic and electric phenomena. • Define magnetic field lines. • Predict the resulting field produced by two or more interacting fields. **Electricity and Magnetism: Static Electricity** • Identify the force relationship between like and unlike charges. • Describe charging by induction and conduction. • Define insulator and conductor. • Explain why a charged object can attract materials with no charge. • Discuss the mechanisms of charge transport in gases, solutions and metals. • State the principle of charge conservation. • Describe the difference between a neutral object and a charged object. • Explain the operation of an electroscope. • Solve problems involving Coulomb's Law. **Electricity and Magnetism: Electric Fields and Currents** • Sketch electric fields around positive and negative point charges, between parallel plates. • State the five properties of electric fields. • Explain Millikan's oil drop experiment. • Define potential difference, resistance and current related to their corresponding units. • Determine the electric potential energy per unit of positive charge. • Calculate the magnitude and direction of an electric field. • State the difference between volt and electronvolt. • State Ohm's Law in symbols and units. • Solve problems for power using power formulas.	

	• Predict the direction of electric fields about a wire carrying a current. • Predict the direction of magnetic polarity of a coil of wire. • Predict the mutual force on two current-carrying wires. • Solve problems for the force on a wire or force on a moving charge, when placed in a magnetic field. • State the factors that affect the resistance of a wire. • Describe the magnetic production of electricity. • Explain Lenz's Law. • Describe the construction of AC and DC generators. • Predict the direction of induced currents in a wire moving through a magnetic field. • Describe the construction and operation of a DC motor. • Distinguish between resistance, current and voltage in series and parallel circuits. • Explain the function and use of a voltmeter, ammeter and galvanometer. • Explain the meaning of the various electric symbols. • Explain the reasons why AC current is used in the country. • Diagram and explain how transformers and the induction coil works. • Explain how fuses and circuit breakers work. • State how voltmeters and ammeters are connected in circuits. • Investigate circuits with current computer simulation software. **Electricity and Magnetism: Electromagnetism** • Discuss the effects of stationary charges, charges in motion and accelerated charges. • Explain briefly the generation of electromagnetic radiation. • Recognize and state the basic properties of all electromagnetic radiations. • State the direct source for each part of the electromagnetic spectrum. • Discuss career opportunities in physics-related fields. **Modern Physics: Atomic Structure** • Summarize the main aspects of atomic models from Dalton to the current model. • Describe the production of cathode rays, state their properties, and tell	

	what they are. • Solve problems for the mass of charged particles using the principle of the mass-spectrograph. • Define and explain the photoelectric effect. • Describe photoelectric predictions based on the photoelectric effect. • List the experimental facts of the P-E effect. • Discuss and explain Einstein's interpretation of the photoelectric effect. • Explain the significance of Compton's experiment. • Discuss the principles on which the modern atom is based. • Apply the relationship between the energy and frequency of a photon. • Calculate the wavelength of some particle according to DeBroglie. **Modern Physics: Atomic and Nuclear Physics** • Compare the properties of alpha, beta and gamma radiations. • Explain the concepts of isotopes. • Recognize the radioactive decay series. • Define half-life and solve simple problems using the concept. • List three factors affecting nuclear stability and explain how nuclear emissions will increase the stability of the nucleus. • Write nuclear equations for naturally occurring alpha and beta particle emissions. • Distinguish between nuclear fusion and fission. • Write balanced nuclear equations for induced transmutations, fission and fusion reactions. • Discuss and explain the main components of a nuclear reactor. • Discuss career opportunities in physics-related fields.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

APPLIED BIOLOGY

SCIENCE
APPLIED BIOLOGY

HIGH SCHOOL ELECTIVE
APPLIED BIOLOGY
Life Sciences Standard (LS)
Earth and Space Sciences Standard (ES)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will: **Life Sciences** ✶ **Explain how processes at the cellular level affect the functions and characteristics of an organism. (LS-A)** ✶ **Explain how humans are connected to and impact natural systems. (LS-B)** ✶ **Explain how the molecular basis of life and the principles of genetics determine inheritance. (LS-C)** ✶ **Explain the interconnectedness of the components of a natural system. (LS-E)** ✶ **Explain how human choices today will affect the quality and quantity of life on earth. (LS-F)** ✶ **Summarize the historical development of scientific theories and ideas within the study of life sciences. (LS-G)**	**By the end of Eleventh/Twelfth Grades, the student will:** **Characteristics and Structure of Life** ✶ **Describe how the maintenance of a relatively stable internal environment is required for the continuation of life, and explain how stability is challenged by changing physical, chemical and environmental conditions as well as the presence of pathogens. (LS-A-11-1)** ✶ **Recognize that information stored in DNA provides the instructions for assembling protein molecules used by the cells that determine the characteristics of the organism. (LS-A-12-1)** ✶ **Explain why specialized cells/structures are useful to plants and animals (e.g., stoma, phloem, xylem, blood, nerve, muscle, egg and sperm). (LS-A-12-2)** ✶ **Investigate the impact on the structure and stability of ecosystems due to changes in their biotic and abiotic components as a result of human activity. (LS-B-11-5)** **Heredity** ✶ **Examine the inheritance of traits through one or more genes and how a single gene can influence more than one trait. (LS-C-12-5)** ✶ **Explain how developmental differentiation is regulated through the expression of different genes. (LS-C-12-6)** **Diversity and Interdependence of Life** ✶ **Predict some possible impacts on an ecosystem with the introduction of a non-native species. (LS-E-11-6)**	**Suggested Materials** • Textbook: Essential Biology with Physiology, 2nd Edition (Prentice-Hall, 2007), including ° Student Edition, 60 copies per building ° Teacher Online Access Pack, two copies per building ° Instructor's Guide to Text/Media, two copies per building ° Media Manager CD's, two sets per building ° Printed Test Bank, two copies per building ° Computerized Test Bank/Test Bank CD-ROM, two copies per building ° Color Transparencies, two copies per building ° Study Guide, two copies per building

	✶ **Show how populations can increase through linear or exponential growth with corresponding effects on resource use and environmental pollution. (LS-E-11-7)** ✶ **Recognize that populations can reach or temporarily exceed the carrying capacity of a given environment. Show that the limitation is not just the availability of space but the number of organisms in relation to resources and the capacity of earth systems to support life. (LS-E-11-8)** ✶ **Give examples of how human activity can accelerate rates of natural change and can have unforeseen consequences. (LS-F-11-9)** ✶ **Explain how environmental factors can influence heredity or development of organisms. (LS-E-11-10)** ✶ **Investigate issues of environmental quality at local, regional, national and global levels such as population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economics, politics and different ways humans view the earth. (LS-F-11-11)** ✶ **Relate diversity and adaptation to structures and functions of living organisms at various levels of organization. (LS-E-12-7)** ✶ **Based on the structure and stability of ecosystems and their nonliving components, predict the biotic and abiotic changes in such systems when disturbed (e.g., introduction of non-native species, climatic change, etc.). (LS-E-12-8)** **Historical Perspectives and Scientific Revolutions** ✶ **Describe advances in life sciences that have important, long-lasting effects on science and society (e.g., biotechnology). (LS-G-12-12)** **Sub-Objectives to Meet Indicators:** **Anatomy and Physiology** • Identify the various body planes (e.g., coronal, sagittal, transverse, etc.) and directional terms (e.g., proximal, distal, anterior, posterior, etc.). • Distinguish among the four tissue types. • Utilizing a microscope, identify the four major layers of tissues.	

	• Describe the skin as an organ and describe its role in the proper functioning of a human being. • Identify and elaborate on the accessory structures of the skin (glands, hair, and nails). • Identify the organizational structure of the skeletal system and bones. • Identify and label the bones of the axial skeleton and the appendicular skeleton. • Compare and contrast the three principle kinds of joints and be able to associate the joint types with examples in the human body. • Distinguish among the different types of muscle tissue. • Identify the various physical components of the central nervous system (e.g., brain, spinal cord, etc.). • Recognize the relationship of the A.N.S. to proper functioning of the body. • Recognize the relationship between the functions of the circulatory system and proper health. • Identify and characterize the structures of the heart. • Trace the flow of blood through the heart. • Distinguish between the different types of blood vessels and their functions. • Differentiate between components of the blood regarding structure, function, and origin. • Identify the major lymphatic structures. • Trace the steps involved in gas exchange. • Label a diagram of the digestive system • Trace the digestion of a simple meal from ingestion to elimination. **Diversity of Life** • Describe the major events involved in the process of protein synthesis. • Describe the importance of DNA to cell reproduction. • Explain the physiology of DNA and how it relates to the cell. • Explain the role of RNA in protein synthesis and cell reproduction. • Explain the physiology of RNA and how it relates to the cell. • Explain the difference between RNA and DNA.	

	• Describe the importance of the amino acids to living things. • Explain the major events involved in the process of protein synthesis. • Identify and explain the major events involved in the process of meiosis. • Describe the relationships among protein, DNA and chromosomes. • Explain the role that chromosomes play in human reproduction. • Explain and distinguish between different types of chromosomal disorders. • Identify and explain the different types of mutations that occur in cells. • Compare and contrast the terms allele, locus, genotype, phenotype, dominant, recessive, homozygous, and heterozygous. • Apply Mendel's principles to solve genetics problems involving monohybrid and dihybrid crosses (e.g., Punnett squares, mathematical expressions, etc.). • Analyze data from a test cross. • Compare and contrast different types of inheritance. • Discuss the implications of the Human Genome project. • Explore the modern trends and practical applications of biotechnology and genetic engineering. **Environmental Science** • Explore various populations and their interactions with the environment. • Identify examples of domestic, industrial and agricultural point and nonpoint sources of pollution. • Describe effects of pollutants on various systems. • Discuss the causes and effects of groundwater contamination. • Discuss and investigate practices and alternatives to solid waste management. • Research ecological issues to develop a position on problems (e.g., air quality, water pollution and its cost, urban sprawl, zebra mussels in the Great Lakes, etc.).	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

ADVANCED PLACEMENT BIOLOGY

SCIENCE
ADVANCED PLACEMENT BIOLOGY

HIGH SCHOOL ELECTIVE
ADVANCED PLACEMENT BIOLOGY
Life Sciences Standard (LS)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will: **Life Sciences** **✶ Explain how processes at the cellular level affect the functions and characteristics of an organism. (LS-A)** **✶ Explain how humans are connected to and impact natural systems. (LS-B)** **✶ Explain how the molecular basis of life and the principles of genetics determine inheritance. (LS-C)** **✶ Relate how biotic and abiotic global changes have occurred in the past and will continue to do so in the future. (LS-D)** **✶ Explain the interconnectedness of the components of a natural system. (LS-E)** **✶ Explain how human choices today will affect the quality and quantity of life on earth. (LS-F)**	**By the end of Eleventh/Twelfth Grades, the student will:** **Characteristics and Structure of Life** **✶ Describe how the maintenance of a relatively stable internal environment is required for the continuation of life, and explain how stability is challenged by changing physical, chemical and environmental conditions as well as the presence of pathogens. (LS-A-11-1)** **✶ Recognize that chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Some of this energy is released as thermal energy. (LS-A-11-2)** **✶ Relate how birth rates, fertility rates and death rates are affected by various environmental factors. (LS-B-11-3)** **✶ Examine the contributing factors of human population growth that impact natural systems such as levels of education, children in the labor force, education and employment of women, infant mortality rates, costs of raising children, birth control methods, and cultural norms. (LS-B-11-4)** **✶ Investigate the impact on the structure and stability of ecosystems due to changes in their biotic and abiotic components as a result of human activity. (LS-B-11-5)** **✶ Recognize that information stored in DNA provides the instructions for assembling protein molecules used by the cells that determine the characteristics of the organism. (LS-A-12-1)** **✶ Explain why specialized cells/structures are useful to plants and animals (e.g., stoma, phloem, xylem, blood, nerve, muscle, egg and sperm). (LS-A-12-2)** **✶ Explain that the sun is essentially the primary source of energy for life. Plants capture energy by absorbing light and using it to form strong**	**Suggested Materials** • Textbook: Biology, 7th Edition (Prentice-Hall, 2005), including ◦ Student Edition, 48 copies per building ◦ Teacher Online Access Pack, one copy per building ◦ Instructor's Guide to Text and Media, one copy per building ◦ AP Printed Test Bank, one copy per building ◦ AP ExamView Test Bank, one copy per building ◦ Transparencies, one copy per building ◦ Study Guide, one copy per building

✶ **Summarize the historical development of scientific theories and ideas within the study of life sciences. (LS-G)**	**(covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. (LS-A-12-3)** ✶ **Explain that carbon-containing molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes. (LS-A-12-4)** **<u>Heredity</u>** ✶ **Examine the inheritance of traits through one or more genes and how a single gene can influence more than one trait. (LS-C-12-5)** ✶ **Explain how developmental differentiation is regulated through the expression of different genes. (LS-C-12-6)** **<u>Diversity and Interdependence of Life</u>** ✶ **Predict some possible impacts on an ecosystem with the introduction of a non-native species. (LS-E-11-6)** ✶ **Show how populations can increase through linear or exponential growth with corresponding effects on resource use and environmental pollution. (LS-E-11-7)** ✶ **Recognize that populations can reach or temporarily exceed the carrying capacity of a given environment. Show that the limitation is not just the availability of space but the number of organisms in relation to resources and the capacity of earth systems to support life. (LS-E-11-8)** ✶ **Give examples of how human activity can accelerate rates of natural change and can have unforeseen consequences. (LS-E-11-9)** ✶ **Explain how environmental factors can influence heredity or development of organisms. (LS-E-11-10)** ✶ **Investigate issues of environmental quality at local, regional, national and global levels such as population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economics, politics and different ways humans view the earth. (LS-F-11-11)** ✶ **Relate diversity and adaptation to structures and functions of living organisms at various levels of organization. (LS-E-12-7)** ✶ **Based on the structure and stability of ecosystems and their nonliving**	

	components, predict the biotic and abiotic changes in such systems when disturbed (e.g., introduction of non-native species, climatic change, etc.). (LS-E-12-8) **✶ Explain why and how living systems require a continuous input of energy to maintain their chemical and physical organization. Explain that with death and the cessation of energy input, living systems rapidly disintegrate toward more disorganized states. (LS-E-12-9)** **<u>Evolutionary Theory</u>** **✶ Recognize that ecosystems change when significant climate changes occur or when one or more new species appear as a result of immigration or speciation. (LS-D-11-12)** **✶ Describe how the process of evolution has changed the physical world over geologic time. (LS-D-11-13)** **✶ Describe how geologic time can be estimated by observing rock sequences and using fossils to correlate the sequences at various locations. Recognize that current methods include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed. (LS-D-11-14)** **✶ Explain additional components of the evolution theory, including genetic drift, immigration, emigration and mutation. (LS-D-12-10)** **<u>Historical Perspectives and Scientific Revolutions</u>** **✶ Trace the historical development of a biological theory or idea (e.g., genetics, cytology and germ theory). (LS-G-12-11)** **✶ Describe advances in life sciences that have important, long-lasting effects on science and society (e.g., biotechnology). (LS-G-12-12)** **<u>Sub-Objectives to Meet Indicators:</u>** **Molecules and Cells: Biological Chemistry** • Diagram the basic structure of the atom. • Identify the biologically significant elements. • Interpret simple chemical formulas, structural formulas and equations. • Distinguish between inorganic and organic compounds, and identify biologically important inorganic compounds.	

	• Discuss the properties of water molecules and their importance to living things. • Compare acids and bases. • Use the pH scale to describe the hydrogen ion concentration in living systems and to describe the role of buffers. • Compare the major groups of organic compounds (i.e., carbohydrates, lipids, proteins, and nucleic acids) with respect to their chemical composition and function. • Distinguish between the types of chemical bonds that join atoms to form ionic and covalent compounds and give the characteristics of each type. • Compare and summarize the role of enzymes as chemical regulators and describe how they work. • Identify factors such as pH and temperature that influence enzymatic activity. • Compare the action and effects of coenzymes and cofactors. **Molecules and Cells: Cells** • Discuss the importance of the plasma membrane to the cell, describing the various functions it performs. • Describe the currently accepted model for the structure of the plasma membrane. • Describe the function of membrane proteins. • Describe the cell wall and its function. • Contrast the physical and the physiological processes by which materials are transported across cell membranes. • Justify that the cell is considered the basic unit of life and state the cell theory. • Contrast prokaryotic and eukaryotic cells; contrast plant and animal cells. • Describe and list functions of the principal cell organelles. • Identify the stages in the cell cycle and describe the main events of each. • Describe the events occurring in each stage of mitosis with emphasis on the behavior of chromosomes. • Describe in detail the procedure of cytokinesis. **Molecules and Cells: Energy Transformations** • Contrast potential and kinetic energy and identify different forms in which energy can exist.	

	• Apply the First and Second Laws of Thermodynamics to living organisms and to the ecosphere. • Describe the energy dynamics of a reaction that is in equilibrium. • Distinguish between endergonic and exergonic reactions, and explain how they may be coupled so that the Second Law of Thermodynamics is not violated. • Relate the chemical structure of ATP to its role in cellular metabolism. • Write a summary reaction for cellular respiration, giving the origin and fate of each substance involved. • Describe the four phases of cellular respiration and indicate where the reactions of each phase take place in the cell. • Describe chemiosmotic phosphorylation, explaining how a gradient of protons is established across the inner mitochondrial membrane and the process by which the proton gradient drives ATP synthesis. • Indicate how the products of protein and fat metabolism feed into the same metabolic pathways that oxidize glucose. • Contrast aerobic and anaerobic pathways used by cells to extract energy from nutrients in terms of ATP energy formation, final hydrogen acceptor and end products. • Write a summary reaction for photosynthesis explaining the origin and fate of each substance involved. • Explain the properties of light, both as a wave and as a particle. • Describe the internal structure of a chloroplast. • Summarize the events of the light-dependent reactions of photosynthesis, including the role of light in the activation of chlorophyll. • Distinguish between the overall pattern of cyclic and non-cyclic photophosphorylation. • Describe how proton gradients allow the formation of ATP according to the chemiosmotic theory. • Summarize the events of the light-independent reactions of photosynthesis. • Compare the contrast CAM, C3 and C4 photosynthetic pathways. **Genetics and Evolution: Molecular Genetics** • Describe or diagram the basic chemical structure of a nucleic strand.	

	• Distinguish chemically between DNA and the varieties of RNA. • Summarize the process of DNA replication. • Define and describe the process of protein synthesis, including transcription and translation. • Describe the function of transfer RNA, messenger RNA and of ribosomal RNA. • Discuss the occurrence of introns and exons, and discuss their possible rolls. • Indicate the significance of genetic proofreading mechanisms. • Describe the role of mutations and their affect on protein structure and function. • Describe various mechanisms of prokaryotic gene regulation including the lac and trp operon systems. • Compare the structure of the eukaryotic chromosome with that of the prokaryotic chromosome. • Describe the various levels of gene regulation in eukaryotes. • Describe the genetic structure of a virus and discuss several ways they can reproduce. • Describe the genetic structure of the bacterial genome. • Discuss several methods for genetic recombination among bacteria. • Outline important concepts in DNA technology including DNA cloning, recombinant DNA and vectors. • Discuss practical applications for DNA technology including industrial, pharmaceutical, forensic, environmental, and agricultural applications. • Discuss how DNA technology raises important safety and ethical questions. **Genetics and Evolution: Heredity** • Distinguish between haploid and diploid, and define homologous chromosomes. • Summarize the significance of meiosis in sexual reproduction. • Contrast the events of mitosis and meiosis. • Summarize the characteristics of selected chromosomal disorders. • Review Mendel's laws and explain their application to genetics. • Explain the basic terms relating to genetic inheritance, i.e., gene, dominance, recessiveness, codominance, chromosome, homozygous, heterozygous, allele,	

	homologous, locus, genotype, and phenotype. • Relate the inheritance of genetic traits to the behavior of chromosomes in meiosis. • Solve simple problems in genetics involving monohybrid and dihybrid crosses by applying the laws of genetic recombination. • Describe the inheritance of sex-linked genes. • Solve simple problems in genetics involving incomplete dominance, polygenes and multiple alleles. • Summarize the concepts of homologous chromosomes and allelic pairs. • Recognize a state of genetic linkage and given an example, be able to solve simple genetic problems involving sex linkage. • Summarize the characteristics of selected genetic diseases. **Genetics and Evolution: Evolution** • Outline the historical development of the theory of evolution. • Explain natural selection as envisioned by Darwin. • Compare the types of evidence for evolution that are obtained from the following fields: comparative anatomy, developmental biology, paleontology, biogeography, biochemistry, and molecular biology. • Define and give examples of homologous and analogous organs. • Distinguish between the gene pool of a population and the genotype of an individual. • State the Hardy-Weinberg Law and discuss its significance in population genetics. • Explain how each of the following alters the gene frequencies in populations: mutation, genetic drift, gene flow and natural selection. • Distinguish between stabilizing selection, directional selection, and disruptive selection, and describe how each play a role in evolution. • Define a species and explain the limitations of the definition provided. • Explain the significance of biological isolating mechanisms. • Distinguish between allopatric and sympatric speciation and give an example of each. • Explain macroevolution and differentiate between the terms microevolution, speciation and macroevolution.	

	• Distinguish between gradualism and punctuated equilibrium as the two paces of evolution. • Explain extinction and discuss its biological ramifications. • Describe the environmental conditions on early earth before life forms were evident. • Outline the major steps that are thought to have occurred in the origin of living cells. **Organisms and Populations: Principles of Classification** • Identify taxonomy as the science of classifying organisms. • Describe the system of binomial nomenclature introduced by Linnaeus. • List and explain factors that are used in classifying organisms: homologous structures, biochemical similarities, comparative embryology, and genetics. • Describe the six-kingdom system of classification. • Describe three alternative schemes of classification and discuss the significance of each. • Offer at least two justifications for the use of scientific names and classifications of organisms. • Determine in which kingdom an organism belongs and summarize the basic characteristics of each kingdom. **Organisms and Populations: The Diversity of Life** • Describe the distinguishing characteristics of monerans. • Summarize the ecological importance of the bacteria and of the cyanobacteria. • Characterize the common features of the kingdom Protista. • Summarize the current theories on the origin of eukaryotic cells and multicellularity among the protists. • List the distinguishing characteristics of the kingdom Fungi. • Summarize the special ecological roles of lichens and mycorrhizae. • Discuss the environmental challenges faced by land plants and relate adaptations that evolved to meet these challenges. • Summarize the features that distinguish bryophytes from green algae. • Discuss the advancements the ferns and fern allies have over the mosses and liverworts.	

	• Diagram a generalized plant life cycle, clearly showing alternation of generations. • Compare seeds with spores and discuss the advantages of plants that reproduce primarily by seeds rather than spores. • Summarize the features that distinguish gymnosperms from the ferns. • Contrast dicots with monocots. • Discuss the evolutionary advancements of the angiosperms. • Develop a definition of an animal using the characteristics common to animals. • Justify classification and proposed relationships of the animal phyla on the basis of symmetry, type of body cavity and pattern of embryonic development (i.e., protostomes and deuterostomes). • Contrast the animal phyla based on distinguishing characteristics. • Describe the course of vertebrate evolution according to contemporary evolutionary theory. • Identify adaptations that enabled vertebrates to succeed on land. **Organisms and Populations: Plant Structure and Function** • Describe the importance of root systems and shoot systems to plants, and explain how they work. • Distinguish between the three major types of plant cells with regard to structure and function. • Distinguish between the three major tissue systems of a plant with regard to structure and function. • Describe the role of meristems in both primary and secondary growth. • Compare and contrast leaf, root and stem anatomy of monocot and dicot plants. • Explain how the structure of the leaf is related to its primary function of photosynthesis. **Organisms and Populations: Transport in Plants** • Describe the transport of water and solutes in a plant on the cellular, organ and whole-plant level. • Explain the process by which roots absorb water and minerals from the soil.	

	• Explain the ascent of xylem sap according to the transpiration cohesion model. • Outline the physiological changes that accompany stomatal opening and closing. • Explain the translocation of phloem sap according to the bulk-flow mechanism. **Organisms and Populations: Plant Nutrition** • Describe the essential elements required for plant growth. • Examine the symptoms of mineral deficiency in plant growth. • Discuss the role of soil bacteria in making nitrogen available to plants. • Describe how predation and symbiosis are evolutionary adaptations that enhance plant nutrition. **Organisms and Populations: Plant Reproduction and Development** • Distinguish between the sporophyte and gametophyte generations in the alternate life cycle of plants. • Distinguish between pollination and fertilization. • Describe the development of a plant embryo from the first mitotic division to an embryonic plant with rudimentary organs. • Identify various seed structures and recall a function of each. • Describe variations in the process of germination including the fate of the radicle, shoot tip, hypocotyls, epicotyl, and cotyledons. • Distinguish between sexual reproduction and vegetative reproduction. • Compare and contrast complete and incomplete, perfect and imperfect flowers. **Organisms and Populations: Control Systems in Plants** • Outline key research experiments that led to the discovery of why plants grow toward light. • Define the five classes of hormones, describe their major functions and recall where they are produced in the plant. • Define tropism and list three stimuli that induce tropisms and a consequent change of plant shape. • Discuss the role of turgor movements in plants. • Discuss the role of biological clocks in plants and other eukaryotes.	

	• Define photoperiodism and discuss its role in the control of flowering in plants. • Describe numerous control systems that enable plants to cope with environmental stress. **Organisms and Populations: Animal Structure and Function** • Discuss the functions of various animal tissues and organs and correlate structure with function. • Describe the importance of metabolic rate and describe how it relates to body size. • Describe how homeostatic mechanisms can regulate an animal's internal environment. **Organisms and Populations: Animal Nutrition** • Discuss several feeding mechanisms among animals. • Describe the major steps involved in food processing. • Explain the major steps involved in food digestion. • Explore the mammalian digestive system, and discuss the functions of the major organs. • Review the importance of food including biosynthesis and essential nutrients. **Organisms and Populations: Circulation and Gas Exchange** • Compare the circulatory systems of invertebrates and vertebrates. • Discuss the function of the mammalian heart. • Describe how the lymphatic system returns fluid to the blood and aids in body defense. • Describe the major components found in human blood. • Explore how gas exchange supplies oxygen for cellular respiration and disposes of carbon dioxide. • Discuss several mechanisms for gas exchange in animals including skin, gills, tracheae, and lungs. **Organisms and Populations: The Body's Defenses** • Discuss several nonspecific immune mechanisms and describe how they provide general barriers to infection.	

	• Explain how clonal selection of lymphocytes is the cellular basis for immunological specificity and diversity. • Discuss how memory cells function in secondary immunity. • Describe how molecular markers on cell surfaces function in self/non-self recognition. • Explore the humoral and cell-mediated immune responses. • Describe how abnormal immune function can lead to disease. **Organisms and Populations: Chemical Systems in Animals** • Compare several types of chemical signals in animals. • Compare and contrast the function of the two classes of hormones. • Explore the relationship between the endocrine and nervous system. • Describe the importance of the hypothalamus and pituitary glands in the function of the vertebrate endocrine system. • Discuss various glands and provide a function for the hormone they secrete. **Organisms and Populations: Nervous System** • Describe how the nervous system performs three overlapping functions of sensory input, integration and motor output. • Describe the various types of nervous cells. • Illustrate how a neuron fires, including membrane potential and action potential. • Describe the types of synapses and explain how they function in communication. • Compare the invertebrate and vertebrate nervous system and outline the structure of each. • Review the anatomy of the brain and describe how it functions. **Organisms and Populations: Controlling the Internal Environment** • Discuss various homeostatic mechanisms that protect an animal's internal environment. • Define osmoregulation and provide several examples of how this works in different animals. • Describe how the mammalian kidney functions in homeostasis.	

	• Discuss the different types of nitrogenous wastes produced by animals. • Discuss thermoregulation in different animal species. • Describe the differences between ectotherms and endotherms. **Organisms and Populations: Animal Reproduction and Development** • Describe the differences between sexual and asexual reproduction. • Review the diverse reproductive systems that have evolved in the animal kingdom. • Review embryonic and fetal development as stages occurring during pregnancy. • Describe the stages of embryonic development including cell division, differentiation and morphogenesis. • Define the processes of gastrulation and organogenesis. • Discuss the importance of amniote embryos. **Organisms and Populations: Ecology** • Define community and ecosystem and give the salient characteristics of each. • Characterize producers, consumers and decomposers, and give the function of each category of organism in a community. • Summarize the concept of limiting factors and describe their relationship to the ecological niche. • Describe the main factors that produce population change. • List the main determinants of the earth's climate. • Summarize the nature of the ecological threat posed by the atmospheric accumulation of carbon dioxide and methane as the threat resulting from the depletion of the ozone layer. • Briefly describe the principal land biomes of the earth, citing the climatic factors that influence their characteristics. • Describe the ways in which aquatic habitats differ most significantly from land habitats. • Describe the marine life zones and their ecological significance. • Review the development and impact of modern human lifestyles upon the ecosystems of the earth. • Describe several problems associated with pesticide use.	

	• Describe the biogeochemical cycle found in an ecosystem. • Describe how spacing and density are important to an ecosystem. • Discuss how a population might grow incorporating the concept of carrying capacity. • Describe density-dependent and density-independent factors of population growth. • Describe the possible outcomes of interspecific and intraspecific competition. • Discuss animal behavior, i.e., what an animal does and how an animal does it.	

STANDARDS-BASED

SCIENCE COURSE OF STUDY

2007

ADVANCED PLACEMENT ENVIRONMENTAL SCIENCE

SCIENCE
ADVANCED PLACEMENT ENVIRONMENTAL SCIENCE

HIGH SCHOOL ELECTIVE
AP ENVIRONMENTAL SCIENCE
Life Sciences Standard (LS)
Earth and Space Sciences Standard (ES)

11-12 BENCHMARKS	GRADE LEVEL INDICATORS AND SUB-OBJECTIVES	TEACHING STRATEGIES/RESOURCES
By the end of the 11-12 program, the student will: **<u>Life Sciences</u>** ✶ **Explain how processes at the cellular level affect the functions and characteristics of an organism. (LS-A)** ✶ **Explain how humans are connected to and impact natural systems. (LS-B)** ✶ **Relate how biotic and abiotic global changes have occurred in the past and will continue to do so in the future. (LS-D)** ✶ **Explain the interconnectedness of the components of a natural system. (LS-E)** ✶ **Explain how human choices today will affect the quality and quantity of life on earth. (LS-F)** ✶ **Summarize the historical development of scientific theories and ideas within the study of life sciences. (LS-G)**	**By the end of Eleventh/Twelfth Grades, the student will:** **<u>Characteristics and Structure of Life</u>** ✶ **Describe how the maintenance of a relatively stable internal environment is required for the continuation of life, and explain how stability is challenged by changing physical, chemical and environmental conditions as well as the presence of pathogens. (LS-A-11-1)** ✶ **Relate how birth rates, fertility rates and death rates are affected by various environmental factors. (LS-B-11-3)** ✶ **Examine the contributing factors of human population growth that impact natural systems such as levels of education, children in the labor force, education and employment of women, infant mortality rates, costs of raising children, birth control methods, and cultural norms. (LS-B-11-4)** ✶ **Investigate the impact on the structure and stability of ecosystems due to changes in their biotic and abiotic components as a result of human activity. (LS-B-11-5)** ✶ **Explain that the sun is essentially the primary source of energy for life. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between the atoms of carbon-containing (organic) molecules. (LS-A-12-3)** ✶ **Explain that carbon-containing molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes. (LS-A-12-4)**	**<u>Suggested Materials</u>** • Textbook: Environment, 5th Edition (Peoples Education, 2005), including ° Student Edition with WileyPlus (1 Year Access), 55 copies per building ° Instructor's Resource CD, three copies per building ° Instructor's Companion Website Access ° Student Companion Website Access ° Laboratory Investigations: AP Environmental Science Teacher's Edition, three copies per building

SCIENCE
ADVANCED PLACEMENT ENVIRONMENTAL SCIENCE

Earth and Space Sciences ✶ **Describe how Earth is made up of a series of interconnected systems and how a change in one system affects other systems. (ES-B)** ✶ **Explain that humans are an integral part of the Earth's system and the choices humans make today impact natural systems in the future. (ES-C)** ✶ **Summarize the historical development of scientific theories and ideas and describe emerging issues in the study of Earth and space sciences. (ES-D)**	**Diversity and Interdependence of Life** ✶ **Predict some possible impacts on an ecosystem with the introduction of a non-native species. (LS-E-11-6)** ✶ **Show how populations can increase through linear or exponential growth with corresponding effects on resource use and environmental pollution. (LS-E-11-7)** ✶ **Recognize that populations can reach or temporarily exceed the carrying capacity of a given environment. Show that the limitation is not just the availability of space but the number of organisms in relation to resources and the capacity of earth systems to support life. (LS-E-11-8)** ✶ **Give examples of how human activity can accelerate rates of natural change and can have unforeseen consequences. (LS-E-11-9)** ✶ **Explain how environmental factors can influence heredity or development of organisms. (LS-E-11-10)** ✶ **Investigate issues of environmental quality at local, regional, national and global levels such as population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economics, politics and different ways humans view the earth. (LS-F-11-11)** ✶ **Relate diversity and adaptation to structures and functions of living organisms at various levels of organization. (LS-E-12-7)** ✶ **Based on the structure and stability of ecosystems and their nonliving components, predict the biotic and abiotic changes in such systems when disturbed (e.g., introduction of non-native species, climatic change, etc.). (LS-E-12-8)** ✶ **Explain why and how living systems require a continuous input of energy to maintain their chemical and physical organization. Explain that with death and the cessation of energy input, living systems rapidly disintegrate toward more disorganized states. (LS-E-12-9)** **Evolutionary Theory** ✶ **Recognize that ecosystems change when significant climate changes occur or when one or more new species appear as a result of immigration or speciation. (LS-D-11-12)**	

	Historical Perspectives and Scientific Revolutions ✶ **Trace the historical development of a biological theory or idea (e.g., genetics, cytology and germ theory). (LS-G-12-11)** ✶ **Describe advances in life sciences that have important, long-lasting effects on science and society (e.g., biotechnology). (LS-g-12-12)** **Earth Systems** ✶ **Describe the normal adjustments of Earth, which may be hazardous for humans. Recognize that humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in Earth's solid crust. Realize that as societies have grown, become stable and come to value aspects of the environment, vulnerability to natural processes of change has increased. (ES-B-11-8)** ✶ **Explain the effects of biomass and human activity on climate (e.g., climatic change and global warming). (ES-C-11-9)** ✶ **Analyze how materials from human societies (e.g., radioactive waste and air pollution) affect both physical and chemical cycles of Earth. (ES-C-11-11)** ✶ **Explain ways in which humans have had a major effect on other species (e.g., the influence of humans on other organisms occurs through land use, which decreases space available to other species and pollution, which changes the chemical composition of air, soil and water). (ES-C-11-12)** ✶ **Explain how human behavior affects the basic processes of natural ecosystems and the quality of the atmosphere, hydrosphere and lithosphere. (ES-C-11-13)** ✶ **Conclude that Earth has finite resources and explain that humans deplete some resources faster than they can be renewed. (ES-C-11-14)** ✶ **Describe how scientists estimate how much of a given resource is available on Earth. (ES-B-12-6)** **Historical Perspectives and Scientific Revolutions** ✶ **Use historical examples to show how new ideas are limited by the context in which they are conceived; are often rejected by the social**	

	establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., global warming, Heliocentric Theory and Theory of Continental Drift). (ES-11-15) ✶ **Describe advances in Earth and space science that have important long-lasting effects on science and society (e.g., global warming, Heliocentric Theory and Plate Tectonics Theory). (ES-11-16)** **<u>Sub-Objectives to Meet Indicators:</u>** **The Earth's Systems: The Flow of Energy and the Cycling of Matter Through the Biosphere** • Classify the forms and quality of energy. • Use energy units and measurements of energy to assess the flow of energy through the biosphere. • Categorize sources and sinks and explain the processes involved to convert them from available to unavailable sources of materials. • Diagram the water cycle. • Trace an atom of carbon through the biosphere. • Differentiate between the cycling of major and trace elements. **The Solid Earth and the Atmosphere** • Construct a timeline that includes the Earth's history, the geological time scale and the biological time scale. • Investigate the Earth's dynamics including plate tectonics, volcanism, the rock cycle, and soil formation with respect to the past and present data. • Explain the atmospheric history including its origin, evolution, composition, and structure. • Predict the weather and define the climate of a given locale based on data collected from the weather service using knowledge of atmospheric dynamics. **Dynamics of a Biosphere That Enhance or Endanger Species Survival** • Demonstrate how organisms adapt to their environment. • Analyze the effects of exponential growth and the carrying capacity on the	

	makeup of populations and communities. • Demonstrate the way that ecosystems change due to natural selection and extinction. **Population and Resource Utilization** • Calculate population changes. • Use demographics such as birth rates and death rates to predict population size. • Analyze patterns of resource utilization locally, nationally and globally. • Predict the human carrying capacity locally and extrapolate it to encompass the globe. • Evaluate the effect of cultural and economic influences on population demographics of a given place at a given time. **Water as a Human Resource** • Explain how fresh water is used as a natural resource. • Relate the use of the oceans for industry and fisheries to the oceans' role as a natural resource. **Uses and Abuses of Our Land** • Categorize soil samples as types of soil. • Explain the role that erosion plays in the management of soil. • Describe the ways that land is put to residential and commercial use. • Analyze the agricultural and forestry uses of land as to their overall impact on soil preservation. • Distinguish between recreational and wilderness land areas and the laws that govern them. **Biological Organisms as a Natural Resource** • Illustrate the biological importance of natural areas. • Analyze the importance of genetic diversity to the welfare of a species. • Demonstrate the importance of food and other agricultural products to environmental well-being.	

	Energy Sources • Analyze the conventional sources of energy as to their efficiency, cost and environmental effect. • Determine the effectiveness and practicality of alternative sources of energy. **Air, Water, Soil, and Solid Waste Pollution** • Investigate the effects of major pollutants on the environment, including a discussion of types of pollutants (e.g., SO_2, NO_x, etc.) and pesticides, measurements and associated units (e.g., ppm, pH, Bg/L, etc.) and point and non-point sources (i.e., domestic, industrial and agricultural). • Determine the effects of pollutants on aquatic systems, vegetation, natural features, building, and structures, and wildlife. • Propose methods for pollution reduction, remediation and control. • Categorize pollutants as to types, sources and amounts. • Scrutinize the current disposal methods and their limitations. • Propose alternatives to eliminate the use of some specific pollutants **Impact of Environmental Quality or Lack Thereof on Human Health** • Categorize chemical and biological agents as to the environmental damage that they cause. • Explain the mechanisms that result in the effects, both acute and chronic, and the dose-response relationships with respect to environmental agents that impact human health. • Evaluate the relative risks of environmental agents and the appropriate response to the particular level of risk. **Causes and Effects of First-order Interactions That Affect Global Change** • Examine the various atmospheric changes due to CO_2, CH_4 and stratospheric O_3. • Relate the changes in ocean surface temperatures, currents and sea level to global change events. • Analyze the effect of habitat destruction, loss of biodiversity and	

	introduced exotics on the biodiversity locally and globally. **Higher Order Interactions That Affect Global Change** • Discuss the effects of rising CO_2 levels on photosynthesis and other global changes. • Illustrate the effect of changes in ocean currents on climate and biological communities. • Relate increased levels of ultraviolet light to evidence of cell damage. **Environmental Decision-making** • Scrutinize an environmental decision from the viewpoint of economic forces such as cost-benefit analysis, marginal cost, ownership, and externalized cost indicating how these forces affect the decision-making process. • Evaluate the importance of cultural and aesthetic considerations in decision-making. • Explain what is meant by environmental ethics and the role it plays in policy-making. • Categorize the various environmental laws and regulations (i.e., international, national and regional) according to whether they are detrimental, beneficial or neutral to the environment. **Future Choices for Environmental Quality** • Explain what is meant by conservation. • Describe what is meant by preservation. • Illustrate methods of restoration. • Evaluate methods of remediation. • Generalize what is meant on all levels by sustainability and discuss its feasibility and importance. **Scientific Analysis of Environmental Issues** • Use appropriate scientific apparatus and technology for collection of field data. • Practice and improve the ability to work collaboratively to obtain and	

	share scientific data. • Gain experience at setting up and using data tables for the orderly recording of observations and measurements. • Develop the ability to create end interpret appropriate graphical presentations of recorded numerical data. • Estimate and approximate quantities that are derived from computations and numerical calculations. • Utilize both linear and logarithmic scales, and exponential and decimal notation. • Practice the application of best-fit curves or apply other standard statistical techniques (standard deviation, standard error, etc.). • Use discipline-appropriate language to clearly communicate scientific ideas via lab reports, scientific papers, oral reports, etc. • Read and interpret appropriate scientific articles and reports. • Design appropriate and testable explanatory models. • Acquire an understanding of the logic of the scientific method, and the meanings of and distinctions between proving, disproving, and failing to disprove a scientific model. • Explore examples that illustrate that science relies on reproducible observations of nature. • Recognize that the most valuable data are those, which conflict with prediction, for they lead to improved hypotheses.	

CURRICULUM STUDY CYCLE - 2006-2011

Content Area	2006 – 2007	2007 – 2008	2008 – 2009	2009 - 2010	2010-2011
English Language Arts	5	1	2	3	4
Music	5	1	2	3	4
Foreign Language	4	5	1	2	3
Family/Consumer Science	4	5	1	2	3
Science	3	4	5	1	2
Gifted & Talented	3	4	5	1	2
Guidance	3	4	5	1	2
Art	3	4	5	1	2
Social Studies	2	3	4	5	1
Technology	2	3	4	5	1
Business	2	3	4	5	1
Library	2	3	4	5	1
Mathematics	1	2	3	4	5
Health	1	2	3	4	5
Physical Education	1	2	3	4	5

KEY

1 – **Study Group** – Research best practices, study state and national standards and post secondary
2 – **Action Research** – Evaluate current instructional practices in light of research based practices
3 – **Curriculum Writing** – Develop the course of study and grade level assessment calendar
4 – **Lesson Study** – Implement curriculum and newly adopted materials, develop and establish assessments
5 – **Lesson Study** - Implement curriculum and newly adopted materials, develop and refine assessments