VII. TABLE OF CONTENTS

VIII. INTRODUCTION

This document describes what students should know and be able to do in the following eight areas:

- 3.1. Unifying Themes of Science
- 3.2. Inquiry and Design
- 3.3. Biological Sciences
- 3.4. Physical Science, Chemistry and Physics
- 3.5. Earth Sciences
- 3.6. Technology Education
- 3.7. Technological Devices
- 3.8. Science, Technology and Human Endeavors

These standards describe what students should know and be able to do by the end of fourth, seventh, tenth and twelfth grade. In addition, these standards reflect the increasing complexity and sophistication that students are expected to achieve as they progress through school.

This document avoids repetition, making an obvious progression across grade levels less explicit. Teachers shall expect that students know and can apply the concepts and skills expressed at the preceding level. Consequently, previous learning is reinforced but not retaught.

Standards are arranged by categories, for example, 3.5 Earth Science. Under each category are standard statements that are preceded by a capital letter; for example, in 3.1 Unifying Themes, grade 10.B, ''Describe concepts of models as a way to predict and understand science and technology.'' Following the standard statements are bulleted standard descriptors, which explain the nature and scope of the standard. Descriptors specify the nature of the standard and the level of complexity needed in meeting that standard in a proficient manner. Descriptors serve to benchmark the standard statement. Curriculum, instruction and assessment should focus on meeting the standard statement. Technology

education, computer applications and science are separate curricular areas. Meeting standards should be approached as a collaborative effort among all curricular areas.

The following descriptors explain the intent of each standard category:

3.1. Unifying Themes	**Unifying themes of science and technology provide big ideas that integrate with significant concepts. There are only a few fundamental concepts and processes that form the framework upon which science and technology knowledges are organized—motion and forces, energy, structure of matter, change over time and machines. These themes create the context through which the content of the disciplines can be taught and are emphasized in each standard.**
3.2. Inquiry and Design	The nature of science and technology is characterized by applying process knowledge that enables students to become independent learners. These skills include observing, classifying, inferring, predicting, measuring, computing, estimating, communicating, using space/time relationships, defining operationally, raising questions, formulating hypotheses, testing and experimenting, designing controlled experiments, recognizing variables, manipulating variables, interpreting data, formulating models, designing models, and producing solutions. Everyone can use them to solve real-life problems. These process skills are developed across the grade levels and differ in the degree of sophistication, quantitative nature and application to the content.
3.3. Biological Sciences	Biology concerns living things, their appearance, different types of life, the scope of their similarities and differences, where they live and how they live. Living things are made of the same components as all other matter, involve the same kinds of transformations of energy and move using the same basic kinds of forces as described in chemistry and physics standards. Through the study of the diversity of life, students learn to understand how life has changed over a long period of time. This great variety of life forms continues to change even today as genetic instructions within cells are passed from generation to generation, yet the amazing integrity of most species remain.
3.4. Physical Science Chemistry and Physics	Physics and chemistry involve the study of objects and their properties. Students examine changes to materials during mixing, freezing, heating and dissolving and then learn how to observe and measure results. In chemistry students study the relationship between matter, atomic structure and its activity. Laboratory investigations of the properties of substances and their changes through a range of chemical interactions provide a basis for students to understand atomic theory and a variety of reaction types and their applications in business, agriculture and medicine. Physics deepens the understanding of the structure and properties of materials and includes atoms, waves, light, electricity, magnetism and the role of energy, forces and motion.
	The dynamics of earth science include the studies of forces of nature that build the earth and wear down the earth. The understanding of

3.5. Earth Sciences	these concepts uses principles from physical sciences, geography and mathematics.
3.6. Technology Education	Technology education is the use of accumulated knowledge to process resources to meet human needs and improve the quality of life. Students develop the ability to select and correctly use materials, tools, techniques and processes to answer questions, understand explanations and solve problems encountered in real life situations. These overriding themes require students to design, create, use, evaluate and modify systems of Biotechnologies, Information Technologies, and Physical Technologies.
3.7. Technological Devices	Students use tools to observe, measure, move and make things. New technological tools and techniques make it possible to enact far-reaching changes in our world. Technology enhances the students' abilities to identify problems and determine solutions. Computers play an integral role in every day life by extending our abilities to collect, analyze and communicate information and ideas.
3.8. Science, Technology and Human Endeavors	Scientific knowledge and societal needs often create a demand for new technology. Conversely, new technology advances scientific knowledge. Both influence society through the impact of their products and processes.

What Is Science? Any study of science includes the search for understanding the natural world and facts, principles, theories and laws that have been verified by the scientific community and are used to explain and predict natural phenomena and events.

Acquiring scientific knowledge involves constructing hypotheses using observation and knowledge in the content area in order to formulate useful questions that provoke scientific inquiry. As a result of repeated, rigorous testing over time and applying multiple perspectives to a problem, consistent information emerges. A theory describes this verifiable event or phenomena. Theories are powerful elements in science and are used to predict other events. As theories lose their ability to predict, they are modified, expanded or generalized or incorporated into a broader theory.

Knowledge of what science is incorporates carefully developed and integrated components:

• **Nature of science**—the ways in which scientists search for answers to questions and explanations of observations about the natural world; includes process knowledge of observing, classifying, inferring, predicting, measuring, hypothesizing, experimenting and interpreting data

• **Unifying themes of science**—concepts, generalizations and principles that result from and lead to inquiry

• **Knowledge**—facts, principles, theories and laws verifiable through scientific inquiry by the world community of scientists; includes physics, chemistry, earth science and biological sciences

• **Inquiry**—an intellectual process of logic that includes verification of answers to questions about and explanations for natural objects, events and phenomena

• **Process skills**—Recognition by students how knowledge is acquired and applied in science by observing, classifying, inferring, predicting, measuring, computing, estimating, communicating, using space/time relationships, defining operationally, formulating hypotheses, testing and experimenting, designing controlled experiments, recognizing variables, manipulating variables, interpreting data, formulating models, designing models and producing solutions.

• **Problem solving**—application of concepts to problems of human adaptation to the environment that often leads to recognition of new problems; has social implications and leads to personal decision-making and action; a process which forms the link for interactions between scientific and technological results or findings; involves operational definitions, recognizing variables, formulating models and asking questions

• **Scientific thinking**—the disposition to suspend judgment, not make decisions and not take action until results, explanations or answers have been tested and verified with information.

What Is Technology Education? It is the means by which we teach technology. Technology is a body of knowledge separate from but related to the sciences, with specific content, curriculum and specific certification requirements. Technology is the application of tools, materials, processes and systems by humans to solve problems and provide benefits to humankind. We use technology in an attempt to improve our environment. These improvements may relate to survival needs (e.g., food, shelter, defense) or they may relate to human aspirations (e.g., knowledge, art, control). They can include unexpected benefits, unexpected costs and unexpected risks.

Technology education involves a broad spectrum of knowledge and activities. Effective technology education combines knowledge of content, process and skills to provide students with a holistic approach to learning. Technology education offers unique opportunities to apply numerous academic concepts through practical, hands-on applications. Instructional technology, on the other hand, deals specifically with use of computers and different software to solve problems and communicate effectively. Knowledge of content, process and skills should be used together to effectively engage students and promote a complete understanding of the sciences, related technologies and their interrelationship. The relationship between science and technology is one where science builds principles or theories and technology provides the practical application of those principles or theories.

Knowledge of content, process and skills in technology involves learning processes that include these components:

• Methods of designing and developing solutions

• Standards for selecting and using appropriate materials, tools and processes

• Experimental and design specifications for testing and evaluating solutions

• Criteria for judging the performance and impact of the solutions

• Evaluating the impact of modifying a system to improve performance.

Technology education can be divided into three main systems that include biotechnological, informational, and physical technologies:

Biotechnological Systems
Bioconversion
Bioprocessing
Environment
Ergonomics
Engineering/Design Systems
Research and Development

Informational Systems
Computer-Aided Drafting/Design (CADD)
Drafting & Design
Desktop Publishing
Electronic Communications
Engineering/ Design Systems
Graphic Communications
Communications Systems
Multimedia Technology
Networking Systems
Research and Development
Video and Television Production
World Wide Web Design & Publishing

Physical Systems
Automation/Robotics
Computer-Aided and Integrated Manufacturing (CAM/CIM)
Construction
Electronic Circuits/ Control Systems
Energy Systems
Architecture and Community Planning
Engineering/Design Systems
Enterprise Organization & Operation
Manufacturing Material Processes
Research and Development
Transportation

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .			
Know that natural and human-made objects are made up of parts. • Identify and describe what parts make up a system. • Identify system parts that are natural and human-made (e.g., ball point pen, simple electrical circuits, plant	Explain the parts of a simple system and their relationship to each other. • Describe a system as a group of related parts that work together to achieve a desired result (e.g., digestive	Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems. • Identify the function of subsystems within a larger system (e.g., role of thermostat in an engine, pressure switch). • Describe the interrelationships among inputs,	Apply concepts of systems, subsystems, feedback and control to solve complex technological problems. • Apply knowledge of control systems concept by designing and modeling control systems that solve specific problems.

A.	anatomy). • Describe the purpose of analyzing systems. • Know that technologies include physical technology systems (e.g., construction, manufacturing, transportation), informational systems and biochemical-related systems.	A.	system). • Explain the importance of order in a system. • Distinguish between system inputs, system processes and system outputs. • Distinguish between open loop and closed loop systems. • Apply systems analysis to solve problems.	A.	processes, outputs, feedback and control in specific systems. • Explain the concept of system redesign and apply it to improve technological systems. • Apply the universal systems model to illustrate specific solutions and troubleshoot specific problems. • Analyze and describe the effectiveness of systems to solve specific problems.	A.	• Apply systems analysis to predict results. • Analyze and describe the function, interaction and relationship among subsystems and the system itself. • Compare and contrast several systems that could be applied to solve a single problem. • Evaluate the causes of a system's inefficiency.

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
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B.	Know models as useful simplifications of objects or processes. • Identify different types of models. • Identify and apply models as tools for prediction and insight. • Apply appropriate simple modeling tools and techniques.	B.	Describe the use of models as an application of scientific or technological concepts. • Identify and describe different types of models and their functions. • Apply models to predict specific results and observations (e.g., population growth, effects of infectious organisms). • Explain systems	B.	Describe concepts of models as a way to predict and understand science and technology. • Distinguish between different types of models and modeling techniques and apply their appropriate use in specific applications (e.g., kinetic gas theory, DNA). • Examine the advantages of using models to demonstrate processes and	B.	Apply concepts of models as a method to predict and understand science and technology. • Evaluate technological processes by collecting data and applying mathematical models (e.g., process control). • Apply knowledge of complex physical models to interpret data and apply mathematical

	• Identify theories that serve as models (e.g., molecules).		by outlining a system's relevant parts and its purpose and/or designing a model that illustrates its function.		outcomes (e.g., blue print analysis, structural stability). • Apply mathematical models to science and technology.		models. • Appraise the importance of computer models in interpreting science and technological systems.

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .			
C. Illustrate patterns that regularly occur and reoccur in nature. • Identify observable patterns (e.g., growth patterns in plants, crystal shapes in minerals, climate, structural patterns in bird feathers). • Use knowledge of natural patterns to predict next occurrences (e.g., seasons, leaf patterns, lunar phases).	C. Identify patterns as repeated processes or recurring elements in science and technology. • Identify different forms of patterns and use them to group and classify specific objects. • Identify repeating structure patterns. • Identify and describe patterns that occur in physical systems (e.g., construction, manufacturing, transportation), informational systems and biochemical-related systems.	C. Apply patterns as repeated processes or recurring elements in science and technology. • Examine and describe recurring patterns that form the basis of biological classification, chemical periodicity, geological order and astronomical order. • Examine and describe stationary physical patterns. • Examine and describe physical patterns in motion.	C. Assess and apply patterns in science and technology. • Assess and apply recurring patterns in natural and technological systems. • Compare and contrast structure and function relationships as they relate to patterns. • Assess patterns in nature using mathematical formulas.

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .			
Know that scale is			Analyze scale as

D.	an important attribute of natural and human made objects, events and phenomena. • Identify the use of scale as it relates to the measurement of distance, volume and mass. • Describe scale as a ratio (e.g., map scales). • Explain the importance of scale in producing models and apply it to a model.	D.	Explain scale as a way of relating concepts and ideas to one another by some measure. • Apply various applications of size and dimensions of scale to scientific, mathematical, and technological applications. • Describe scale as a form of ratio and apply to a life situation.	D.	Apply scale as a way of relating concepts and ideas to one another by some measure. • Apply dimensional analysis and scale as a ratio. • Convert one scale to another.	D.	a way of relating concepts and ideas to one another by some measure. • Compare and contrast various forms of dimensional analysis. • Assess the use of several units of measurement to the same problem. • Analyze and apply appropriate measurement scales when collecting data.

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .			

E.	Recognize change in natural and physical systems. • Recognize change as fundamental to science and technology concepts. • Examine and explain change by using time and measurement. • Describe relative motion.	E.	Identify change as a variable in describing natural and physical systems. • Describe fundamental science and technology concepts that could solve practical problems. • Explain how ratio is used to describe change. • Describe the	E.	Describe patterns of change in nature, physical and man made systems. • Describe how fundamental science and technology concepts are used to solve practical problems (e.g., momentum, Newton's laws of universal gravitation, tectonics, conservation of mass and energy, cell theory, theory of evolution, atomic theory, theory of relativity, Pasteur's germ theory, relativity, heliocentric theory, gas laws, feedback	E.	Evaluate change in nature, physical systems and man made systems. • Evaluate fundamental science and technology concepts and their development over time (e.g., DNA, cellular respiration, unified field theory, energy measurement, automation, miniaturization, Copernican and Ptolemaic universe theories). • Analyze how models, systems and technologies have changed over time

	• Describe the change to objects caused by heat, cold, light or chemicals.		effect of making a change in one part of a system on the system as a whole.		systems). • Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously).		(e.g., germ theory, theory of evolution, solar system, cause of fire). • Explain how correlation of variables does not necessarily imply causation.

3.1. Unifying Themes			
3.1.4. GRADE 4	**3.1.7. GRADE 7**	**3.1.10. GRADE 10**	**3.1.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to . . .			
		• Describe the effects of error in measurements. • Describe changes to matter caused by heat, cold, light or chemicals using a rate function.	• Evaluate the patterns of change within a technology (e.g., changes in engineering in the automotive industry).

3.2. Inquiry and Design			
3.2.4. GRADE 4	**3.2.7. GRADE 7**	**3.2.10. GRADE 10**	**3.2.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
Identify and use the nature of scientific and technological knowledge. • Distinguish between a scientific fact and a belief.	Explain and apply scientific and technological knowledge. • Distinguish between a scientific theory and a belief. • Answer ''What if'' questions based on observation, inference or prior	Apply knowledge and understanding about the nature of scientific and technological knowledge. • Compare and contrast scientific theories and beliefs.	Evaluate the nature of scientific and technological knowledge. • Know and use the ongoing scientific processes to continually improve and better understand how things work.

A.	• Provide clear explanations that account for observations and results. • Relate how new information can change existing perceptions.	A.	knowledge or experience. • Explain how skepticism about an accepted scientific explanation led to a new understanding. • Explain how new information may change existing theories and practice.	A.	• Know that science uses both direct and indirect observation means to study the world and the universe. • Integrate new information into existing theories and explain implied results.	A.	• Critically evaluate the status of existing theories (e.g., germ theory of disease, wave theory of light, classification of subatomic particles, theory of evolution, epidemiology of AIDS).
B.	Describe objects in the world using the five senses. • Recognize observational descriptors from each of the five senses (e.g., see-blue, feel-rough). • Use observations to develop a descriptive vocabulary.	B.	Apply process knowledge to make and interpret observations. • Measure materials using a variety of scales. • Describe relationships by making inferences and predictions. • Communicate, use space/time relationships, define operationally, raise questions, formulate hypotheses, test and experiment. • Design controlled experiments, recognize variables, and manipulate variables. • Interpret data, formulate models, design models, and produce solutions.	B.	Apply process knowledge and organize scientific and technological phenomena in varied ways. • Describe materials using precise quantitative and qualitative skills based on observations. • Develop appropriate scientific experiments: raising questions, formulating hypotheses, testing, controlled experiments, recognizing variables, manipulating variables, interpreting data, and producing solutions. • Use process skills to make inferences and predictions using collected information and to communicate, using space/time relationships,	B.	Evaluate experimental information for appropriateness and adherence to relevant science processes. • Evaluate experimental data correctly within experimental limits. • Judge that conclusions are consistent and logical with experimental conditions. • Interpret results of experimental research to predict new information or improve a solution.

				defining operationally.			
C.	Recognize and use the elements of scientific inquiry to solve problems. • Generate questions about objects, organisms and/or events that can be answered through scientific investigations. • Design an investigation. • Conduct an experiment. • State a conclusion that is consistent with the information.	C.	Identify and use the elements of scientific inquiry to solve problems. • Generate questions about objects, organisms and/or events that can be answered through scientific investigations. • Evaluate the appropriateness of questions. • Design an investigation with limited variables to investigate a question. • Conduct a two-part experiment. • Judge the significance of experimental information in answering the question. • Communicate appropriate conclusions from the experiment.	C.	Apply the elements of scientific inquiry to solve problems. • Generate questions about objects, organisms and/or events that can be answered through scientific investigations. • Evaluate the appropriateness of questions. • Design an investigation with adequate control and limited variables to investigate a question. • Conduct a multiple step experiment. • Organize experimental information using a variety of analytic methods. • Judge the significance of experimental information in answering the question. • Suggest additional steps that might be done experimentally.	C.	Apply the elements of scientific inquiry to solve multi-step problems. • Generate questions about objects, organisms and/or events that can be answered through scientific investigations. • Evaluate the appropriateness of questions. • Design an investigation with adequate control and limited variables to investigate a question. • Organize experimental information using analytic and descriptive techniques. • Evaluate the significance of experimental information in answering the question. • Project additional questions from a research study that could be studied.
	Recognize and use the technological design process to solve problems. • Recognize and		Know and use the technological design process to solve problems. • Define different types of problems. • Define all aspects of the problem,		Identify and apply the technological design process to solve problems. • Examine the problem, rank all necessary		Analyze and use the technological design process to solve problems. • Assess all aspects of the problem, prioritize the necessary information and formulate

D.	explain basic problems. • Identify possible solutions and their course of action. • Try a solution. • Describe the solution, identify its impacts and modify if necessary. • Show the steps taken and the results.	D.	necessary information and questions that must be answered. • Propose the best solution. • Design and propose alternative methods to achieve solutions. • Apply a solution. • Explain the results, present improvements, identify and infer the impacts of the solution.	D.	information and all questions that must be answered. • Propose and analyze a solution. • Implement the solution. • Evaluate the solution, test, redesign and improve as necessary. • Communicate the process and evaluate and present the impacts of the solution.	D.	questions that must be answered. • Propose, develop and appraise the best solution and develop alternative solutions. • Implement and assess the solution. • Evaluate and assess the solution, redesign and improve as necessary. • Communicate and assess the process and evaluate and present the impacts of the solution.

3.3. Biological Sciences			
3.3.4. GRADE 4	**3.3.7. GRADE 7**	**3.3.10. GRADE 10**	**3.3.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
A. Know the similarities and differences of living things. • Identify life processes of living things (e.g., growth, digestion, react to environment). • Know that some organisms have similar external characteristics (e.g., anatomical characteristics;	A. Describe the similarities and differences that characterize diverse living things. • Describe how the structures of living things help them function in unique ways. • Explain how to use a	A. Explain the structural and functional similarities and differences found among living things. • Identify and characterize major life forms according to their placement in existing classification groups. • Explain the relationship	A. Explain the relationship between structure and function at all levels of organization. • Identify and explain interactions among organisms (e.g., mutually beneficial, harmful relationships). • Explain and analyze the relationship between structure and function at the

	appendages, type of covering, body segments) and that similarities and differences are related to environmental habitat. • Describe basic needs of plants and animals.		dichotomous key to identify plants and animals. • Account for adaptations among organisms that live in a particular environment.		between structure and function at the molecular and cellular levels. • Describe organizing schemes of classification keys. • Identify and characterize major life forms by kingdom, phyla, class and order.		molecular, cellular and organ-system level. • Describe and explain structural and functional relationships in each of the five (or six) kingdoms. • Explain significant biological diversity found in each of the biomes.
B.	Know that living things are made up of parts that have specific functions. • Identify examples of unicellular and multicellular organisms. • Determine how different parts of a living thing work together to make the organism function.	B.	Describe the cell as the basic structural and functional unit of living things. • Identify the levels of organization from cell to organism. • Compare life processes at the organism level with life processes at the cell level. • Explain that cells and organisms have particular structures that underlie their functions. • Describe and distinguish among cell cycles, reproductive cycles and life cycles. • Explain disease effects on	B.	Describe and explain the chemical and structural basis of living organisms. • Describe the relationship between the structure of organic molecules and the function they serve in living organisms. • Identify the specialized structures and regions of the cell and the functions of each. • Explain how cells store and use information to guide their functions. • Explain cell functions and processes in terms of chemical reactions and energy changes.	B.	Analyze the chemical and structural basis of living organisms. • Identify and describe factors affecting metabolic function (e.g., temperature, acidity, hormones). • Evaluate metabolic activities using experimental knowledge of enzymes. • Evaluate relationships between structure and functions of different anatomical parts given their structure. • Describe potential impact of genome research on the

			structures or functions of an organism.				biochemistry and physiology of life.
C.	Know that characteristics are inherited and, thus, offspring closely resemble their parents. • Identify characteristics for animal and plant survival in different climates. • Identify physical characteristics that appear in both parents and offspring and differ between families, strains or species.	C.	Know that every organism has a set of genetic instructions that determines its inherited traits. • Identify and explain inheritable characteristics. • Identify that the gene is the basic unit of inheritance. • Identify basic patterns of inheritance (e.g., dominance, recessive, codominance). • Describe how traits are inherited. • Distinguish how different living things reproduce (e.g., vegetative budding, sexual). • Recognize that mutations can alter a gene. • Describe how selective breeding, natural selection and genetic technologies can change genetic makeup of organisms.	C.	Describe how genetic information is inherited and expressed. • Compare and contrast the function of mitosis and meiosis. • Describe mutations' effects on a trait's expression. • Distinguish different reproductive patterns in living things (e.g., budding, spores, fission). • Compare random and selective breeding practices and their results (e.g., antibiotic resistant bacteria). • Explain the relationship among DNA, genes and chromosomes. • Explain different types of inheritance (e.g., multiple allele, sex-influenced traits). • Describe the role of DNA in protein synthesis as it relates to gene expression.	C.	Explain gene inheritance and expression at the molecular level. • Analyze gene expression at the molecular level. • Describe the roles of nucleic acids in cellular reproduction and protein synthesis. • Describe genetic engineering techniques, applications and impacts. • Explain birth defects from the standpoint of embryological development and/or changes in genetic makeup.
					Explain the mechanisms of the theory of		

D.	Identify changes in living things over time. • Compare extinct life forms with living organisms.	D.	Explain basic concepts of natural selection. • Identify adaptations that allow organisms to survive in their environment. • Describe how an environmental change can affect the survival of organisms and entire species. • Know that differences in individuals of the same species may give some advantage in surviving and reproducing. • Recognize that populations of organisms can increase rapidly. • Describe the role that fossils play in studying the past. • Explain how biologic extinction is a natural process.	D.	evolution. • Analyze data from fossil records, similarities in anatomy and physiology, embryological studies and DNA studies that are relevent to the theory of evolution. • Explain the role of mutations and gene recombination in changing a population of organisms. • Compare modern day descendents of extinct species and propose possible scientific accounts for their present appearance. • Describe the factors (e.g., isolation, differential reproduction) affecting gene frequency in a population over time and their consequences.	D.	Analyze the theory of evolution. • Examine human history by describing the progression from early hominids to modern humans. • Apply the concept of natural selection as a central concept in illustrating evolution theory.

3.3. Biological Sciences			
3.3.4. GRADE 4	**3.3.7. GRADE 7**	**3.3.10. GRADE 10**	**3.3.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
		• Describe and differentiate between the roles of natural selection and	

	genetic drift. • Describe changes that illustrate major events in the earth's development based on a time line. • Explain why natural selection can act only on inherited traits. • Apply the concept of natural selection to illustrate and account for a species' survival, extinction or change over time.	

Ecosystem Standards are in the Environment and Ecology Standard Category (4.6).

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
A. Recognize basic concepts about the structure and properties of matter. • Describe properties of matter (e.g., hardness, reactions to simple chemical tests). • Know that combining two or more substances can make new materials with different properties. • Know different material characteristics (e.g., texture, state of matter,	A. Describe concepts about the structure and properties of matter. • Identify elements as basic building blocks of matter that cannot be broken down chemically. • Distinguish compounds from mixtures. • Describe and conduct experiments that identify chemical and physical properties. • Describe reactants and products of	A. Explain concepts about the structure and properties of matter. • Know that atoms are composed of even smaller sub-atomic structures whose properties are measurable. • Explain the repeating pattern of chemical properties by using the repeating patterns of atomic structure within the periodic table. • Predict the behavior of gases through the use of Boyle's, Charles' or the ideal gas law, in everyday situations. • Describe phases of matter according to the Kinetic Molecular Theory.	A. Apply concepts about the structure and properties of matter. • Apply rules of systematic nomenclature and formula writing to chemical substances. • Classify and describe, in equation form, types of chemical and nuclear reactions. • Explain how radioactive isotopes that are subject to decay can be used to estimate the age of materials. • Explain how the forces that bind solids, liquids and gases affect their properties.

	solubility).		simple chemical reactions.		• Explain the formation of compounds and their resulting properties using bonding theories (ionic and covalent).		• Characterize and identify important classes of compounds (e.g., acids, bases, salts).

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
		• Recognize formulas for simple inorganic compounds. • Describe various types of chemical reactions by applying the laws of conservation of mass and energy. • Apply knowledge of mixtures to appropriate separation techniques. • Understand that carbon can form several types of compounds.	• Apply the conservation of energy concept to fields as diverse as mechanics, nuclear particles and studies of the origin of the universe. • Apply the predictability of nuclear decay to estimate the age of materials that contain radioactive isotopes. • Quantify the properties of matter (e.g., density, solubility coefficients) by applying mathematical formulas.

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
Know basic energy types, sources and conversions. • Identify energy forms and examples (e.g., sunlight, heat, stored, motion). • Know the	Relate energy sources and transfers to heat and temperature. • Identify and describe sound changes in	Analyze energy sources and transfers of heat. • Determine the efficiency of chemical systems by applying mathematical	Apply and analyze energy sources and conversions and their relationship to heat and temperature. • Determine the

	concept of the flow of energy by measuring flow through an object or system. • Describe static electricity in terms of attraction, repulsion and sparks. • Apply knowledge of the basic electrical		moving objects. • Know that the sun is a major source of energy that emits wavelengths of visible light, infrared and ultraviolet radiation. • Explain the conversion of one form of		formulas. • Use knowledge of chemical reactions to generate an electrical current. • Evaluate energy changes in chemical reactions. • Use knowledge of conservation of		heat involved in illustrative chemical reactions. • Evaluate mathematical formulas that calculate the efficiency of specific chemical and mechanical systems. • Use knowledge of oxidation and
B.	circuits to design and construction simple direct current circuits. • Classify materials as conductors and nonconductors. • Know and demonstrate the basic properties of heat by producing it in a variety of ways.	B.	energy to another by applying knowledge of each form of energy. • Explain the parts and functions in an electrical circuit.	B.	energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion). • Explain resistance, current and electro-motive force (Ohm's Law).	B.	reduction to balance complex reactions. • Apply appropriate thermodynamic concepts (e.g., conservation, entropy) to solve problems relating to energy and heat.

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
• Know the characteristics of light (e.g., reflection, refraction, absorption) and use them to produce heat, color or a virtual image.			

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .TrC.			
		Distinguish among	Apply the

Observe and describe different types of force and motion. • Identify characteristics of sound (pitch, loudness and echoes). • Recognize forces that attract or repel other objects and demonstrate them. • Describe various types of motions. • Compare the relative movement of objects and describe types of motion that are evident. • Describe the position of an object by locating it relative to another object or the background (e.g., geographic direction, left, up).	C.	Identify and explain the principles of force and motion. • Describe the motion of an object based on its position, direction and speed. • Classify fluid power systems according to fluid used or mode of power transmission (e.g., air, oil). • Explain various motions using models. • Explain how convex and concave mirrors and lens change light images. • Explain how sound and light travel in waves of differing speeds, sizes and frequencies.	C.	the principles of force and motion. • Identify the relationship of electricity and magnetism as two aspects of a single electromagnetic force. • Identify elements of simple machines in compound machines. • Explain fluid power systems through the design and construction of appropriate models. • Describe sound effects (e.g., Doppler effect, amplitude, frequency, reflection, refraction, absorption, sonar, seismic). • Describe light effects (e.g., Doppler effect, dispersion, absorption, emission spectra, polarization, interference). • Describe and measure the motion of sound, light and other objects.	C.	principles of motion and force. • Evaluate wave properties of frequency, wavelength and speed as applied to sound and light through different media. • Propose and produce modifications to specific mechanical power systems that will improve their efficiency. • Analyze the principles of translational motion, velocity and acceleration as they relate to free fall and projectile motion. • Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque. • Interpret a model that illustrates circular motion and acceleration.

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
		• Know Newton's laws of motion (including inertia, action and reaction) and	• Describe inertia,

	gravity and apply them to solve problems related to forces and mass. • Determine the efficiency of mechanical systems by applying mathematical formulas.	motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
D. Describe the composition and structure of the universe and the earth's place in it. • Recognize earth's place in the solar system. • Explain and illustrate the causes of seasonal changes. • Identify planets in our solar system and their general characteristics. • Describe the solar system motions and use them to explain time (e.g., days, seasons), major lunar phases and eclipses.	D. Describe essential ideas about the composition and structure of the universe and the earth's place in it. • Compare various planets' characteristics. • Describe basic star types and identify the sun as a star type. • Describe and differentiate comets, asteroids and meteors. • Identify gravity as the force that keeps planets in orbit around the sun and governs the rest of the movement of the solar system and the universe. • Illustrate how the position of stars and constellations change in relation to the Earth during an evening and from	D. Explain essential ideas about the composition and structure of the universe. • Compare the basic structures of the universe (e.g., galaxy types, nova, black holes, neutron stars). • Describe the structure and life cycle of star, using the Hertzsprung-Russell diagram. • Describe the nuclear processes involved in energy production in a star. • Explain the ''red-shift'' and Hubble's use of it to determine stellar distance and movement. • Compare absolute versus apparent star	D. Analyze the essential ideas about the composition and structure of the universe. • Analyze the Big Bang Theory's use of gravitation and nuclear reaction to explain a possible origin of the universe. • Compare the use of visual, radio and x-ray telescopes to collect data regarding the structure and evolution of the universe. • Correlate the use of the special theory of

			month to month. • Identify equipment and instruments that explore the universe.		magnitude and their relation to stellar distance. • Explain the impact of the Copernican and Newtonian thinking on man's view of the universe.		relativity and the life of a star.

3.4. Physical Science, Chemistry and Physics			
3.4.4. GRADE 4	**3.4.7. GRADE 7**	**3.4.10. GRADE 10**	**3.4.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
	• Identify the accomplishments and contributions provided by selected past and present scientists in the field of astronomy. • Identify and articulate space program efforts to investigate possibilities of living in space and on other planets.	• Identify and analyze the findings of several space instruments in regard to the extent and composition of the solar system and universe.	
Refer to Technology Standard Category 3.6 for applied uses of these concepts and principles.			

3.5. Earth Sciences			
3.5.4. GRADE 4	**3.5.7. GRADE 7**	**3.5.10. GRADE 10**	**3.5.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
Know basic landforms and earth history. • Describe earth processes (e.g., rusting,	Describe earth features and processes. • Describe major layers of the earth. • Describe the processes involved in the creation of	Relate earth features and processes that change the earth. • Illustrate and explain plate tectonics as the mechanism of continental movement and sea	Analyze and evaluate earth features and processes that change the earth.

	weathering, erosion) that have affected selected physical features in students' neighborhoods. • Identify various earth structures (e.g., mountains, faults, drainage basins) through the use of models. • Identify the composition of soil as weathered rock and decomposed organic remains. • Describe fossils and the type of environment they lived in (e.g., tropical, aquatic, desert).		geologic features (e.g., folding, faulting, volcanism, sedimentation) and that these processes seen today (e.g., erosion, weathering crustal plate movement) are similar to those in the past. • Describe the processes that formed Pennsylvania geologic structures and resources including mountains, glacial formations, water gaps and ridges. • Explain how the rock cycle affected rock formations in the state of Pennsylvania.		floor changes. • Compare examples of change to the earth's surface over time as they related to continental movement and ocean basin formation (e.g., Delaware, Susquehanna, Ohio Rivers system formations, dynamics). • Interpret topographic maps to identify and describe significant geologic history/structures in Pennsylvania. • Evaluate and interpret geologic history using geologic maps. • Explain several methods of dating earth materials and structures.		• Apply knowledge of geophysical processes to explain the formation and degradation of earth structures (e.g., mineral deposition, cave formations, soil composition). • Interpret geological evidence supporting evolution. • Apply knowledge of radioactive decay to assess the age of various earth features and objects.

3.5. Earth Sciences			
3.5.4. GRADE 4	**3.5.7. GRADE 7**	**3.5.10. GRADE 10**	**3.5.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
	• Distinguish between examples of rapid surface changes (e.g., landslides, earthquakes) and slow surface changes (e.g., weathering). • Identify living plants and animals that are similar to fossil forms.	• Correlate rock units with general geologic time periods in the history of the earth. • Describe and identify major types of rocks and minerals.	

3.5. Earth Sciences			

3.5.4. GRADE 4		3.5.7. GRADE 7		3.5.10. GRADE 10		3.5.12. GRADE 12	
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .							
B.	Know types and uses of earth materials. • Identify uses of various earth materials (e.g., buildings, highways, fuels, growing plants). • Identify and sort earth materials according to a classification key (e.g., soil/rock type).	B.	Recognize earth resources and how they affect everyday life. • Identify and locate significant earth resources (e.g., rock types, oil, gas, coal deposits) in Pennsylvania. • Explain the processes involved in the formation of oil and coal in Pennsylvania. • Explain the value and uses of different earth resources (e.g., selected minerals, ores, fuel sources, agricultural uses). • Compare the locations of human settlements as related to available resources.	B.	Explain sources and uses of earth resources. • Compare the locations of strategic minerals and earth resources in the world with their geologic history using maps and global information systems. • Demonstrate the effects of sedimentation and erosion before and after a conservation plan is implemented. • Evaluate the impact of geologic activities/hazards (e.g., earthquakes, sinkholes, landslides). • Evaluate land use (e.g., agricultural, recreational, residential, commercial) in Pennsylvania based upon soil characteristics.	B.	Analyze the availability, location and extraction of earth resources. • Describe how the location of earth's major resources has affected a country's strategic decisions. • Compare locations of earth features and country boundaries. • Analyze the impact of resources (e.g., coal deposits, rivers) on the life of Pennsylvania's settlements and cities.
			Describe basic elements of meteorology. • Explain weather forecasts by interpreting weather data and symbols.				Analyze atmospheric energy transfers. • Describe how

C.	Know basic weather elements. • Identify cloud types. • Identify weather patterns from data charts (including temperature, wind direction and speed, precipitation) and graphs of the data. • Explain how the different seasons effect plants, animals, food availability and daily human life.	C.	• Explain the oceans' impact on local weather and the climate of a region. • Identify how cloud types, wind directions and barometric pressure changes are associated with weather patterns in different regions of the country. • Explain and illustrate the processes of cloud formation and precipitation. • Describe and illustrate the major layers of the earth's atmosphere. • Identify different air masses and global wind patterns and how they relate to the weather patterns in different regions of the U.S.	C.	Interpret meteorological data. • Analyze information from meteorological instruments and online sources to predict weather patterns. • Describe weather and climate patterns on global levels. • Evaluate specific adaptations plants and animals have made that enable them to survive in different climates.	C.	weather and climate involve the transfer of energy in and out of the atmosphere. • Explain how unequal heating of the air, ocean and land produces wind and ocean currents. • Analyze the energy transformations that occur during the greenhouse effect and predict the long-term effects of increased pollutant levels in the atmosphere. • Analyze the mechanisms that drive a weather phenomena (e.g., El Nino, hurricane, tornado) using the correlation of three methods of heat energy transfer.
	Recognize the earth's different water resources. • Know that approximately three-fourths of the earth is covered by water.		Explain the behavior and impact of the earth's water systems. • Explain the water cycle using the processes of evaporation and		Assess the value of water as a resource. • Compare specific sources of potable water (e.g., wells, public systems, rivers) used by people in Pennsylvania. • Identify the		Analyze the principles and history of hydrology. • Analyze the operation and effectiveness of a

D.	• Identify and describe types of fresh and saltwater bodies. • Identify examples of water in the form of solid, liquid and gas on or near the surface of the earth. • Explain and illustrate evaporation and condensation. • Recognize other resources available from water (e.g., energy, transportation, minerals, food).	D.	condensation. • Describe factors that affect evaporation and condensation. • Distinguish salt from fresh water (e.g., density, electrical conduction). • Compare the effect of water type (e.g., polluted, fresh, salt water) and the life contained in them. • Identify ocean and shoreline features (e.g., bays, inlets, spit, tidal marshes).	D.	components of a municipal/agricultural water supply system and a wastewater treatment system. • Relate aquatic life to water conditions (e.g., turbidity, temperature, salinity, dissolved oxygen, nitrogen levels, pressure). • Compare commercially important aquatic species in or near Pennsylvania. • Identify economic resources found in marine areas. • Assess the natural and man-made factors that affect the availability of clean water (e.g., rock and mineral deposits, man-made pollution).	D.	water purification and desalination system. • Evaluate the pros and cons of surface water appropriation for commercial and electrical use. • Analyze the historical development of water use in Pennsylvania (e.g., recovery of Lake Erie). • Compare the marine life and type of water found in the intertidal, neritic and bathyal zones.

3.5. Earth Sciences			
3.5.4. GRADE 4	**3.5.7. GRADE 7**	**3.5.10. GRADE 10**	**3.5.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
Refer to Environment and Ecology Standards Categories 4.1, 4.3, 4.8 for standards that deal with environmental impact of Earth structures and forces.			

3.6. Technology Education			
3.6.4. GRADE 4	**3.6.7. GRADE 7**	**3.6.10. GRADE 10**	**3.6.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
	Explain	Apply biotechnologies that relate to propagating,	

A.	Know that biotechnologies relate to propagating, growing, maintaining, adapting, treating and converting. • Identify agricultural and industrial production processes that involve plants and animals. • Identify waste management treatment processes. • Describe how knowledge of the human body influences or impacts ergonomic design. • Describe how biotechnology has impacted various aspects of daily life (e.g., health care, agriculture, waste treatment).	A.	biotechnologies that relate to related technologies of propagating, growing, maintaining, adapting, treating and converting. • Identify the environmental, societal and economic impacts that waste has in the environment. • Identify and explain the impact that a specific medical advancement has had on society. • Explain the factors that were taken into consideration when a specific object was designed. • Define and describe how fuels and energy can be generated through the process of biomass conversion. • Identify and group basic plant and animal production processes.	A.	growing, maintaining, adapting, treating and converting. • Apply knowledge of plant and animal production processes in designing an improvement to existing processes. • Apply knowledge of biomedical technology applications in designing a solution to a simple medical problem (e.g., wheel chair design, artificial arteries). • Apply knowledge of how biomedical technology affects waste products in designing a solution that will result in reduced waste. • Apply ergonomic engineering factors when devising a solution to a specific problem. • Describe various methods of biochemical conversion.	A.	Analyze biotechnologies that relate to propagating, growing, maintaining, adapting, treating and converting. • Analyze and solve a complex production process problem using biotechnologies (e.g., hydroponics, fish farming, crop propagation). • Analyze specific examples where engineering has impacted society in protection, personal health application or physical enhancement. • Appraise and evaluate the cause and effect and subsequent environmental, economic and societal impacts that result from biomass and biochemical conversion.

3.6. Technology Education			
3.6.4. GRADE 4	3.6.7. GRADE 7	3.6.10. GRADE 10	3.6.12. GRADE 12

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
	• Explain the impact that agricultural science has had on biotechnology.	• Describe specific examples that reflect the impact that agricultural science has had on biotechnology.	• Evaluate and apply biotechnical processes to complex plant and animal production methods. • Apply knowledge of biochemical-related technologies to propose alternatives to hazardous waste treatment. • Apply knowledge of agricultural science to solve or improve a biochemical related problem.

3.6. Technology Education			
3.6.4. GRADE 4	**3.6.7. GRADE 7**	**3.6.10. GRADE 10**	**3.6.12. GRADE 12**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to. . .			
Know that information technologies involve encoding, transmitting, receiving, storing, retrieving and decoding. • Identify electronic communication methods that exist in the community (e.g., digital cameras, telephone, internet,	Explain information technologies of encoding, transmitting, receiving, storing, retrieving and decoding. • Demonstrate the effectiveness of image generating technique to communicate a story (e.g., photography, video). • Analyze and evaluate the effectiveness of a	Apply knowledge of information technologies of encoding, transmitting, receiving, storing, retrieving and decoding. • Describe the proper use of graphic and electronic communication systems. • Apply a variety of advanced mechanical and electronic drafting methods to communicate a solution to a	Analyze knowledge of information technologies of processes encoding, transmitting, receiving, storing, retrieving and decoding. • Apply and analyze advanced information techniques to produce a complex image that effectively conveys a message (e.g., desktop publishing, audio and/or video production). • Analyze and