Academic Standards for Science and Technology

APPENDIX B

Academic Standards for Science and Technology

and

Environment and Ecology

Pennsylvania Department of Education

Academic Standards for Science and Technology

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VII. TABLE OF CONTENTS

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VIII. INTRODUCTION

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

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 taught.

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.

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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 movement, use 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 in 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

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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.

3.5. Earth Sciences The dynamics of earth science include the studies of forces of nature that build the earth and wear down the earth. The understanding of 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.

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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.
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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.

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

Biotechnological Systems	Informational Systems	Physical Systems
Bioconversion	Computer-Aided Drafting / Design (CADD)	Automation / Robotics
Bioprocessing	Drafting & Design	Computer-Aided and Integrated Manufacturing (CAM/CIM)
Environment	Desktop Publishing	Construction
Ergonomics	Electronic Communications	Electronic Circuits / Control Systems
Engineering / Design Systems	Engineering / Design Systems	Energy Systems
Research and Development	Graphic Communications	Architecture and Community Planning
	Communications Systems	Engineering / Design Systems
	Multimedia Technology	Enterprise Organization & Operation
	Networking Systems	Manufacturing
	Research and Development	Material Processes
	Video and Television Production	Research and Development
	World Wide Web Design & Publishing	Transportation

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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 . . .			
A. 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 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. 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 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. 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, 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 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. • 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.
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. • Identify theories that serve as models (e.g., molecules).	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).	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 outcomes (e.g., blue print analysis, structural stability).	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 models.

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	• Explain systems by outlining a system's relevant parts and its purpose and/or designing a model that illustrates its function.	• Apply mathematical models to science and technology.	• Appraise the importance of computer models in interpreting science and technological systems.
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.
D. Know that scale is 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. Analyze scale as 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.
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.	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,	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,

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• Describe the change to objects caused by heat, cold, light or chemicals.	• Describe the effect of making a change in one part of a system on the system as a whole.	cell theory, theory of evolution, atomic theory, theory of relativity, Pasteur's germ theory, relativity, heliocentric theory, gas laws, feedback systems). • Recognize that stable systems often involve underlying dynamic changes (e.g., a chemical reaction at equilibrium has molecules reforming continuously). • Describe the effects of error in measurements. • Describe changes to matter caused by heat, cold, light or chemicals using a rate function.	miniaturization, Copernican and Ptolemaic universe theories). • Analyze how models, systems and technologies have changed over time (e.g., germ theory, theory of evolution, solar system, cause of fire). • Explain how correlation of variables does not necessarily imply causation. • Evaluate the patterns of change within a technology (e.g., changes in engineering in the automotive industry).

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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 . . .			
A. Identify and use the nature of scientific and technological knowledge. • Distinguish between a scientific fact and a belief. • Provide clear explanations that account for observations and results. • Relate how new information can change existing perceptions.	A. 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 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. Apply knowledge and understanding about the nature of scientific and technological knowledge. • Compare and contrast scientific theories and beliefs. • 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. Evaluate the nature of scientific and technological knowledge. • Know and use the ongoing scientific processes to continually improve and better understand how things work. • 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, defining operationally.	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.

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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.
D. Recognize and use the technological design process to solve problems. • Recognize and 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. Know and use the technological design process to solve problems. • Define different types of problems. • Define all aspects of the problem, 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. Identify and apply the technological design process to solve problems. • Examine the problem, rank all necessary 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. Analyze and use the technological design process to solve problems. • Assess all aspects of the problem, prioritize the necessary information and formulate 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.

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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; appendages, type of covering, body segments) and that similarities and differences are related to environmental habitat. • Describe basic needs of plants and animals.	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 dichotomous key to identify plants and animals. • Account for adaptations among organisms that live in a particular environment.	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 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.	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 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 structures or functions of an organism.	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 biochemistry and physiology of life.

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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, co-dominance). • 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.
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. Explain the mechanisms of the theory of evolution. • analyze data from fossil records, similarities in anatomy and physiology, embryological studies and DNA studies that are relevant to the theory of evolution. • Explain the role of mutations and gene recombination in changing a population of organisms. • Compare modern day descendants of extinct species and propose possible scientific accounts for their present appearance. • describe the factors (e.g., isolation, differential	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.

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		reproduction) affecting gene frequency in a population over time and their consequences. • 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).

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

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B. Know basic energy types, sources and conversions. • Identify energy forms and examples (e.g., sunlight, heat, stored, motion). • Know 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 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. • Know the characteristics of light (e.g., reflection, refraction, absorption) and use them to produce heat, color or a virtual image.	B. Relate energy sources and transfers to heat and temperature. • Identify and describe sound changes in 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 energy to another by applying knowledge of each form of energy. • Explain the parts and functions in an electrical circuit.	B. Analyze energy sources and transfers of heat. • Determine the efficiency of chemical systems by applying mathematical formulas. • Use knowledge of chemical reactions to generate an electrical current. • Evaluate energy changes in chemical reactions. • Use knowledge of conservation of energy and momentum to explain common phenomena (e.g., refrigeration system, rocket propulsion). • Explain resistance, current and electro-motive force (Ohm's Law).	B. Apply and analyze energy sources and conversions and their relationship to heat and temperature. • Determine the heat involved in illustrative chemical reactions. • Evaluate mathematical formulas that calculate the efficiency of specific chemical and mechanical systems. • Use knowledge of oxidation and reduction to balance complex reactions • Apply appropriate thermodynamic concepts (e.g., conservation, entropy) to solve problems relating to energy and heat.
C. 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. Distinguish among 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).	C. Apply the 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.

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		• Describe light effects (e.g., Doppler effect, dispersion, absorption, emission spectra, polarization, interference). • Describe and measure the motion of sound, light and other objects. • Know Newton's laws of motion (including inertia, action and reaction) and gravity and apply them to solve problems related to forces and mass. • Determine the efficiency of mechanical systems by applying mathematical formulas.	• Analyze the principles of rotational motion to solve problems relating to angular momentum, and torque. • Interpret a model that illustrates circular motion and acceleration. • Describe inertia, motion, equilibrium, and action/reaction concepts through words, models and mathematical symbols.
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 positions of stars and constellations change in relation to the Earth during an evening and from month to month. • Identify equipment and instruments that explore the universe. • Identify the accomplishments and contributions provided by selected past and present scientists in the field of astronomy.	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 magnitude and their relation to stellar distance. • Explain the impact of the Copernican and Newtonian thinking on man's view of the universe. • Identify and analyze the findings of several space instruments in regard to the extent and composition of the	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 relativity and the life of a star.

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	• Identify and articulate space program efforts to investigate possibilities of living in space and on other planets.	solar system and universe.	

Refer to Technology Standard Category 3.6 for applied uses of these concepts and principles.

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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 . . .			
A. Know basic landforms and earth history. • Describe earth processes (e.g., rusting, 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).	A. Describe earth features and processes. • Describe major layers of the earth. • Describe the processes involved in the creation of 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. • 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.	A. Relate earth features and processes that change the earth. • Illustrate and explain plate tectonics as the mechanism of continental movement and sea 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. • Correlate rock units with general geologic time periods in the history of the earth. • Describe and identify major types of rocks and minerals.	A. Analyze and evaluate earth features and processes that change the earth. • 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.

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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.
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. Describe basic elements of meteorology. • Explain weather forecasts by interpreting weather data and symbols. • 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. Analyze atmospheric energy transfers. • Describe how 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.

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D. Recognize the earth's different water resources. • Know that approximately three-fourths of the earth is covered by water. • identify and describe types of fresh and salt-water 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. Explain the behavior and impact of the earth's water systems. • Explain the water cycle using the processes of evaporation and 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. 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 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. Analyze the principles and history of hydrology. • Analyze the operation and effectiveness of a 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.

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 . . .			
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. Explain 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. • explain the impact that agricultural science has had on biotechnology.	A. Apply biotechnologies that relate to propagating, 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. • describe specific examples that reflect the impact that agricultural science has had on biotechnology.	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. • 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.

B. 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, television, fiber optics). • Identify graphic reproduction methods. • Describe appropriate image generating techniques (e.g., photography, video). • Demonstrate the ability to communicate an idea by applying basic sketching and drawing techniques.	B. 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 graphic object designed and produced to communicate a thought or concept. • Apply basic technical drawing techniques to communicate an idea or solution to a problem. • Apply the appropriate method of communications technology to communicate a thought.	B. 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 specific problem. • Apply and analyze advanced communication techniques to produce an image that effectively conveys a message (e.g., desktop publishing, audio and/or video production). • Illustrate an understanding of a computer network system by modeling, constructing or assembling its components.	B. 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 evaluate a message designed and produced using still, motion and animated communication techniques. • Describe the operation of fiber optic, microwave and satellite informational systems. • Apply various graphic and electronic information techniques to solve real world problems (e.g., data organization and analysis, forecasting, interpolation).
C. Know physical technologies of structural design, analysis and engineering, finance, production, marketing, research and design. • Identify and group a variety of construction tasks. • Identify the major construction systems present in a specific local building. • Identify specific construction systems that depend on each other in order to complete a project. • Know skills used in construction. • Identify examples of manufactured goods present in the home and school.	C. Explain physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design. • Use knowledge of material effectiveness to solve specific construction problems (e.g., steel vs. wood bridges). • Differentiate among the different types of construction applications (e.g., microwave tower, power plants, aircrafts).	C. Apply physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design to real world problems. • Describe and classify common construction by their characteristics and composition. • Compare and contrast specific construction systems that depend on each other in order to complete a project. • Evaluate material failure common to specific applications.	C. Analyze physical technologies of structural design, analysis and engineering, personnel relations, financial affairs, structural production, marketing, research and design to real world problems. • Apply knowledge of construction technology by designing, planning and applying all the necessary resources to successfully solve a construction problem. • Compare resource options in solving a specific manufacturing problem.

• Identify basic resources needed to produce a manufactured item. • Identify basic component operations in a specific manufacturing enterprise (e.g., cutting, shaping, attaching). • Identify waste and pollution resulting from a manufacturing enterprise. • Explain and demonstrate the concept of manufacturing (e.g., assemble a set of papers or ball point pens sequentially, mass produce an object). • Identify transportation technologies of propelling, structuring, suspending, guiding, controlling and supporting. • Identify and experiment with simple machines used in transportation systems. • Explain how improved transportation systems have changed society.	• Explain basic material processes that manufactured objects undergo during production. (e.g., separating, forming, combining). • Evaluate a construction activity by specifying task analyses and necessary resources. • Explain the relationships among the basic resources needed in the production process for a specific manufactured object. • Explain the difference between design engineering and production engineering processes. • Analyze manufacturing steps that affect waste and pollutants. • Explain transportation technologies of propelling, structuring, suspending, guiding, controlling and supporting. • Identify and explain the workings of several mechanical power systems. • Model and explain examples of vehicular propulsion, control, guidance, structure and suspension systems. • Explain the limitations of land, marine, air and space transportation systems.	• Demonstrate knowledge of various construction systems by building or interpreting models. • Select and apply the necessary resources to successfully conduct a manufacturing enterprise. • Apply concepts of design engineering and production engineering in the organization and application of a manufacturing activity. • Apply the concepts of manufacturing by redesigning an enterprise to improve productivity or reduce or eliminate waste and/or pollution. • Evaluate the interrelationship of various transportation systems in the community. • Analyze the impacts that transportation systems have on a community.	• Analyze and apply complex skills needed to process materials in complex manufacturing enterprises. • Apply advanced information collection and communication techniques to successfully convey solutions to specific construction problems. • Assess the importance of capital on specific construction applications. • Analyze the positive and negative qualities of several different types of materials as they would relate to specific construction applications. • Analyze transportation technologies of propelling, structuring, suspending, guiding, controlling and supporting. • Analyze the concepts of vehicular propulsion, guidance, control, suspension and structural systems while designing and producing specific complex transportation systems.

3.7. Technological Devices			
3.7.4. **GRADE 4**	3.7.7. **GRADE 7**	3.7.10. **GRADE 10**	3.7.12. **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. Explore the use of basic tools, simple materials and techniques to safely solve problems. • Describe the scientific principles on which various tools are based. • Group tools and machines by their function. • Select and safely apply appropriate tools and materials to solve simple problems.	A. Describe the safe and appropriate use of tools, materials and techniques to answer questions and solve problems. • Identify uses of tools, machines, materials, information, people, money, energy and time that meet specific design criteria. • Describe safe procedures for using tools and materials. • Assess materials for appropriateness of use.	A. Identify and safely use a variety of tools, basic machines, materials and techniques to solve problems and answer questions. • Select and safely apply appropriate tools, materials and processes necessary to solve complex problems. • Apply advanced tool and equipment manipulation techniques to solve problems.	A. Apply advanced tools, materials and techniques to answer complex questions. • Demonstrate the safe use of complex tools and machines within their specifications. • Select and safely apply appropriate tools, materials and processes necessary to solve complex problems that could result in more than one solution. • Evaluate and use technological resources to solve complex multi-step problems.
B. Select appropriate instruments to study materials. • Develop simple skills to measure, record, cut and fasten. • Explain appropriate instrument selection for specific tasks.	B. Use appropriate instruments and apparatus to study materials. • Select appropriate instruments to measure the size, weight, shape and temperature of living and non-living objects. • Apply knowledge of different measurement systems to measure and record objects' properties.	B. Apply appropriate instruments and apparatus to examine a variety of objects and processes. • Describe and use appropriate instruments to gather and analyze data. • Compare and contrast different scientific measurement systems; select the best measurement system for a specific situation. • Explain the need to estimate measurements within error of various instruments. • Apply accurate measurement knowledge to solve everyday problems. • Describe and demonstrate the	B. Evaluate appropriate instruments and apparatus to accurately measure materials and processes. • Apply and evaluate the use of appropriate instruments to accurately measure scientific and technologic phenomena within the error limits of the equipment. • Evaluate the appropriate use of different measurement scales (macro and micro). • Evaluate the utility and advantages of a variety of absolute and relative measurement scales for their appropriate application.

		operation and use of advanced instrumentation in evaluating material and chemical properties (e.g., scanning electron microscope, nuclear magnetic resonance machines).	
Computer literacy, including the use of hardware and software in standard statements C, D, and E, should be integrated across all content areas.			
C. Identify basic computer operations and concepts. • Identify the major parts necessary for a computer to input and output data. • Explain and demonstrate the basic use of input and output devices (e.g., keyboard, monitor, printer, mouse). • Explain and demonstrate the use of external and internal storage devices (e.g., disk drive, CD drive).	C. Explain and demonstrate basic computer operations and concepts. • Know specialized computer applications used in the community. • Describe the function of advanced input and output devices (e.g., scanners, video images, plotters, projectors) and demonstrate their use. • Demonstrate age appropriate keyboarding skills and techniques.	C. Apply basic computer operations and concepts. • Identify solutions to basic hardware and software problems. • Apply knowledge of advanced input devices. • Apply knowledge of hardware setup. • Describe the process for basic software installation and demonstrate it. • Analyze and solve basic operating systems problems. • Apply touch keyboarding skills and techniques at expectable speed and accuracy. • Demonstrate the ability to perform basic software installation.	C. Evaluate computer operations and concepts as to their effectiveness to solve specific problems. • Describe and demonstrate atypical software installation. • Analyze and solve hardware and advanced software problems. • Assess and apply multiple input and output devices to solve specific problems.
D. Use basic computer software. • Apply operating system skills to perform basic computer tasks. • Apply basic word processing skills. • Identify and use simple graphic and presentation graphic materials generated by the computer. • Apply specific instructional software.	D. Apply computer software to solve specific problems. • Identify software designed to meet specific needs (e.g., Computer Aided Drafting, design software, tutorial, financial, presentation software). • Identify and solve basic software problems relevant to specific software applications. • Identify basic multimedia applications.	D. Utilize computer software to solve specific problems. • Identify legal restrictions in the use of software and the output of data. • Apply advanced graphic manipulation and desktop publishing techniques. • Apply basic multimedia applications. • Apply advanced word processing, database and spreadsheet skills.	D. Evaluate the effectiveness of computer software to solve specific problems. • Evaluate the effectiveness of software to produce an output and demonstrate the process. • Design and apply advanced multimedia techniques. • Analyze, select and apply the appropriate software to solve complex problems. • Evaluate the effectiveness of the

	applications. • Demonstrate a basic knowledge of desktop publishing applications. • Apply intermediate skills in utilizing word processing, database and spreadsheet software. • Apply basic graphic manipulation techniques.	• Describe and demonstrate how two or more software applications can be used to produce an output. • Select and apply software designed to meet specific needs.	computer as a presentation tool. • Analyze the legal responsibilities of computer users.
E. Identify basic computer communications systems. • Apply a web browser. • Apply basic electronic mail functions. • Use on-line searches to answer age appropriate questions.	E. Explain basic computer communications systems. • Describe the organization and functions of the basic parts that make up the World Wide Web. • Apply advanced electronic mail functions. • Apply basic on-line research techniques to solve a specific problem.	E. Apply basic computer communications systems. • Identify and explain various types of on-line services. • Identify and explain the function of the parts of a basic network. • Describe and apply the components of a web page and their function. • Explain and demonstrate file transfer within and out side of a computer network. • Identify, describe and complete advanced on-line research.	E. Assess the effectiveness of computer communications systems. • Assess the effectiveness of a computer based communications system. • Transfer files among different computer platforms. • Analyze the effectiveness of on-line information resources to meet the needs for collaboration, research, publications, communications and productivity. • Apply knowledge of protocol standards to solve connectivity problems.

3.8. Science, Technology and Human Endeavors			
3.8.4. **GRADE 4**	3.8.7. **GRADE 7**	3.8.10. **GRADE 10**	3.8.12. **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 that people select, create and use science and technology and that they are limited by social and physical restraints. • Identify and describe positive and negative impacts that influence or result from new tools and techniques. • Identify how physical technology (e.g., construction, manufacturing, transportation), informational technology and biotechnology are used to meet human needs. • Describe how scientific discoveries and technological advancements are related. • Identify interrelationships among technology, people and their world. • Apply the technological design process to solve a simple problem.	A. Explain how sciences and technologies are limited in their effects and influences on society. • Identify and describe the unavoidable constraints of technological design. • Identify changes in society as a result of a technological development. • Identify and explain improvements in transportation, health, sanitation and communications as a result of advancements in science and technology and how they effect our lives.	A. Analyze the relationship between societal demands and scientific and technological enterprises. • Identify past and current tradeoffs between increased production, environmental harm and social values (e.g., increased energy needs, power plants, automobiles). • Compare technologies that are applied and accepted differently in various cultures (e.g., factory farming, nuclear power). • Describe and evaluate social change as a result of technological developments. • Assess the social impacts of a specific international environmental problem by designing a solution that applies the appropriate technologies and resources.	A. Synthesize and evaluate the interactions and constraints of science and technology on society. • Compare and contrast how scientific and technological knowledge is both shared and protected. • Evaluate technological developments that have changed the way humans do work and discuss their impacts (e.g., genetically engineered crops). • Evaluate socially proposed limitations of scientific research and technological application.
B. Know how human ingenuity and technological resources satisfy specific human needs and improve the quality of life. • Identify and distinguish between human needs and improving the quality of life. • Identify and distinguish between natural and human-made resources.	B. Explain how human ingenuity and technological resources satisfy specific human needs and improve the quality of life. • Identify interrelationships between systems and resources. • Identify and describe the resources necessary to solve a selected problem in a community and improve the quality of life.	B. Analyze how human ingenuity and technological resources satisfy specific human needs and improve the quality of life. • Identify several problems and opportunities that exist in your community, apply various problem-solving methods to design and evaluate possible solutions. • Analyze a recently invented item,	B. Apply the use of ingenuity and technological resources to solve specific societal needs and improve the quality of life. • Apply appropriate tools, materials and processes to solve complex problems. • Use knowledge of human abilities to design or modify technologies that extend and enhance human

natural and human-made resources. • Describe a technological invention and the resources that were used to develop it.	• identify and explain specific examples of how agricultural science has met human needs and has improved the quality of life.	describing the human need that prompted its invention and the current and potential social impacts of the specific invention. • Apply knowledge of oceanography, meteorology, geology and human anatomy to explain important considerations that need to be made for construction of homes, buildings and businesses in the United States. • Assess the impacts that agricultural science has had on meeting human needs and improving the quality of life.	abilities. • Apply appropriate tools, materials and processes to physical, informational or biotechnological systems to identify and recommend solutions to international problems. • apply knowledge of agricultural science to develop a solution that will improve on a human need or want.
C. Know the pros and cons of possible solutions to scientific and technological problems in society. • Compare the positive and negative expected and unexpected impacts of technological change. • Identify and discuss examples of technological change in the community that have both positive and negative impacts.	C. Identify the pros and cons of applying technological and scientific solutions to address problems and the effect upon society. • Describe the positive and negative expected and unexpected effects of specific technological developments. • Describe ways technology extends and enhances human abilities.	C. Evaluate possibilities consequences and impacts of scientific and technological solutions. • Relate scientific and technological advancements in terms of cause and effect. • Describe and evaluate the impacts that financial considerations have had on specific scientific and technological applications. • Compare and contrast potential solutions to technological, social, economic and environmental problems. • Analyze the impacts on society of accepting or rejecting scientific and technological advances.	C. Evaluate the consequences and impacts of scientific and technological solutions. • Propose solutions to specific scientific and technological applications, identifying possible financial considerations. • Analyze scientific and technological solutions through the use of risk/benefit analysis. • Analyze and communicate the positive or negative impacts that a recent technological invention had on society. • Evaluate and describe potential impacts from emerging technologies and the consequences of not keeping abreast of technological advancements (e.g., assessment alternatives, risks, benefits, costs, economic impacts, constraints).

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IX. GLOSSARY

Allele: Any of a set of possible forms of a gene.

Biochemical conversion: The changing of organic matter into other chemical forms.

Biomass conversion: The changing of organic matter that has been produced by photosynthesis into useful liquid, gas or fuel.

Biomedical technology: The application of health care theories to develop methods, products and tools to maintain or improve homeostasis.

Biome: A community of living organisms of a single major ecological region.

Biotechnology: The ways that humans apply biological concepts to produce products and provide services.

Carbon chemistry: The science of the composition, structure, properties and reactions of carbon based matter, especially of atomic and molecular systems; sometimes referred to as organic chemistry.

Construction technology: The ways that humans build structures on sites.

Desalinization: To remove salts and other chemicals from sea or saline water.

Dichotomous: Divided or dividing into two parts or classifications.

Electronic communication: System for the transmission of information using electronic technology (e.g., digital cameras, cellular telephones, Internet, television, fiber optics)

Embryology: The branch of biology dealing with the development of living things from fertilized egg to its developed state.

Engineering: The application of scientific, physical, mechanical and mathematical principles to design processes, products and structures that improve the quality of life.

Enzyme: A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.

Ergonomical: Of or relating to the design of equipment or devices to fit the human body's control, position, movement and environment.

Evolution: A process of change that explains why what we see today is different from what existed in the past; it includes changes in the galaxies, stars, solar system, earth and life on earth. biological evolution is a change in hereditary characteristics of groups of organisms over the course of generations.

Fact: Information that has been objectively verified.

Geologic hazard: A naturally occurring or man-made condition or phenomenon that presents a risk or is a potential danger to life and property (e.g., landslides, floods, earthquakes, ground subsidence, coastal and beach erosion, faulting, dam leakage and failure, mining disasters, pollution and waste disposal, sinkholes).

Geologic map: A representation of a region on which is recorded earth information (e.g., the distribution, nature and age relationships of rock units and the occurrences of structural features, mineral deposits and fossil localities).

Hydrology: The scientific study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks and in the atmosphere.

Hypothesis: An assertion subject to verification or proof as a premise from which a conclusion is drawn.

Information technology: The technical means that humans create to store and transmit information.

Inquiry: A systematic process for using knowledge and skills to acquire and apply new knowledge.

Instructional technology: Any mechanical aid (including computer technology) used to assist in or enhance the process of teaching and learning.

Law: Summarizing statement of observed experimental facts that has been tested many times and is generally accepted as true.

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Manufacturing technology: The ways that humans produce goods and products.

Mitosis: The sequential differentiation and segregation of replicated chromosomes in a cell's nucleus that precedes complete cell division.

Model: A description, analogy or a representation of something that helps us understand it better (e.g., a physical model, a conceptual model, a mathematical model).

Nova: A variable star that suddenly increases in brightness to several times its normal magnitude and returns to its original appearance in a few weeks to several months or years.

Patterns: Repeated processes that are exhibited in a wide variety of ways; identifiable recurrences of the element and/or the form.

Physical technology: The ways that humans construct, manufacture and transport products.

Radioactive isotope: An atom that gives off nuclear radiation and has the same number of protons (atomic number) as another atom but a different number of neutrons.

Relationship between science and technology: Science builds principles or theories while technology is the practical application of those principles or theories. Relates concepts and ideas to one another by some measurement (e.g., quantitative, numeral, abstract, ideological); provides a measure of size and/or incremental change.

Science: Search for understanding the natural world using inquiry and experimentation.

System: A group of related objects that work together to achieve a desired result.

Open Loop system: A group of related objects that do not have feedback and cannot modify themselves.

Closed Loop system: A group of related objects that have feedback and can modify themselves.

Subsystem: A group of related objects that make up a larger system (e.g., automobiles have electrical systems, fuel systems).

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Technology education: The application of tools, materials, processes and systems to solve problems and extend human capabilities.

Technological design process: Recognizing the problem, proposing a solution, implementing the solution, evaluating the solution and communicating the problem, design and solution.

Theory: Systematically organized knowledge applicable in a relatively wide variety of circumstances; especially, a system of assumptions, accepted principles and rules of procedure devised to analyze, predict or otherwise explain the nature or behavior of a specified set of phenomena.

Theory of evolution: A theory that the various types of animals and plants have their origin in other preexisting types and that the distinguishable differences are due to modification in successive generations.

Topographic map: A representation of a region on a sufficient scale to show detail, selected man-made and natural features of a portion of the land surface including its relief and certain physical and cultural features; the portrayal of the position, relation, size, shape and elevation of the area.

Transportation systems: A group of related parts that function together to perform a major task in any form of transportation.

Transportation technology: The physical ways humans move materials, goods and people.

Tool: Any device used to extend human capability including computer-based tools.