Academic Standards for Science and Technology

Pennsylvania Department of Education

Academic Standards for Science and Technology

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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
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- ◊ 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.

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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 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.

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

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)

Electronic Circuits / Control Systems
Energy Systems
Architecture and Community Planning
Engineering / Design Systems
Enterprise Organization & Operation

Material Processes
Research and Development

Construction

ransportation

Manufacturing

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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.

	• 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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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.

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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	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.

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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	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).

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.

Biomes: 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.

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.

Scale: 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).

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.