Academic Standards for Science and Technology and Engineering Education

June 1, 2009 FINAL
Elementary Standards
(Grades 3, 5, 6, 8)

Pennsylvania Department of Education

These standards are offered as a voluntary resource for Pennsylvania's schools and await action by the State Board of Education.

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ELEMENTARY STANDARDS
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VIII. INTRODUCTION

Learning about science and technology is vitally important in today's increasingly complicated world. The rate of new discoveries and the development of increasingly sophisticated tools make science and technology rapidly changing subjects. As stated in Content Standard E of the National Science Education Standards, "the relationship between science and technology is so close that any presentation of science without developing an understanding of technology would portray an inaccurate picture of science."

In the near future, society will benefit from basic research discoveries that will lead to new tools, materials, and medical treatments. Learning about the world around us, by observing and experimenting, is the core of science and technology and is strongly reflected in Pennsylvania's Academic Standards for Science and Technology.

This document describes what students should know and be able to do in the following four standard categories:

- ◊ 3.1. Biological Sciences
- ◊ 3.2. Physical Sciences: Chemistry and Physics
- ◊ 3.3. Earth and Space Sciences
- ◊ 3.4. Technology and Engineering Education

These standards describe what students should know and be able to do at each grade level. In addition, these standards reflect the increasing complexity and sophistication that students are expected to achieve as they progress through school. Additionally, Science as Inquiry is logically embedded in the Science and Technology standards as inquiry is the process through which students develop a key understanding of sciences. Unifying Themes in the sciences capture the big ideas of science. Teachers shall expect that students know and apply the concepts and skills expressed at the preceding level. Consequently, previous learning is reinforced but not re-taught.

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To clarify the coding of the standards, an example of the numbering system follows:

- Biological Sciences (3.1) is a **standard category.**
  - Organisms and Cells (3.1.A) is an **organizing category** under Biological Sciences.
    - Common Characteristics of Life (3.1.A1) is a **strand** under Organisms and Cells.
      - **Standard statements** indicate grade level appropriate learning for which students should demonstrate proficiency. For example, "Describe the similarities and differences of physical characteristics in plants and animals" (3.1.**4**.A1) is a fourth grade standard statement.

1 Common Characteristics of Life	3.1.3.A1.	3.1.4.A1. Describe the similarities and differences of physical characteristics in plants and animals.	3.1.5.A1.	3.1.6.A1.	3.1.7.A1. Describe the similarities and differences of physical characteristics in diverse **organisms**.	3.1.8.A1.

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The following descriptors explain the intent of each standard category:

3.1. Biological Sciences	Biology of organisms and cells 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 how life has evolved. 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.
3.2. Physical Sciences: 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 relationships between properties and structure of matter. Laboratory investigations of chemical interactions provide a basis for students to understand atomic theory 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.
3.3. Earth and Space Sciences	The dynamics of earth science include the studies of forces of nature that build up and wear down the earth's surface. Dynamics include energy flow across the earth's surface and its role in weather and climate. Space science is concerned with the origin and evolution of the universe. The understanding of these concepts uses principles from physical sciences, geography and mathematics.
3.4. Technology and Engineering Education	Technology and Engineering Education is the use of accumulated knowledge to process resources to meet human needs and improve the quality of life. It includes developing, producing, using and assessing technologies. It is human innovation in action and involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities. Its goal is to provide technological literacy to all students, including all students who traditionally have not been served by technology and engineering programs.

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Science as Inquiry: Understanding of science content is enhanced when concepts are grounded in inquiry experiences. The use of scientific inquiry will help ensure that students develop a deep understanding of science content, processes, knowledge and understanding of scientific ideas, and the work of scientists; therefore, inquiry is embedded as a strand throughout all content areas. Teaching science as inquiry provides teachers with the opportunity to help all students in grades K-12 develop abilities necessary to understand and do scientific inquiry. These are very similar across grade bands and evolve in complexity as the grade level increases.

Grades K-4	Grades 5-7	Grades 8-10	Grades 11-12
• Distinguish between scientific fact and opinion. • Ask questions about objects, organisms, and events. • Understand that all scientific investigations involve asking and answering questions and comparing the answer with what is already known. • Plan and conduct a simple investigation and understand that different questions require different kinds of investigations. • Use simple equipment (tools and other technologies) to gather data and understand that this allows scientists to collect more information than relying only on their senses to gather information. • Use data/evidence to construct explanations and understand that scientists develop explanations based on their evidence and compare them with their current scientific knowledge. • Communicate procedures and explanations giving priority to evidence and understanding that scientists make their results public, describe their investigations so they can be reproduced, and review and ask questions about the work of other scientists.	• Understand how theories are developed. • Identify questions that can be answered through scientific investigations and evaluate the appropriateness of questions. • Design and conduct a scientific investigation and understand that current scientific knowledge guides scientific investigations. • Describe relationships using inference and prediction. • Use appropriate tools and technologies to gather, analyze, and interpret data and understand that it enhances accuracy and allows scientists to analyze and quantify results of investigations. • Develop descriptions, explanations, and models using evidence and understand that these emphasize evidence, have logically consistent arguments, and are based on scientific principles, models, and theories. • Analyze alternative explanations and understanding that science advances through legitimate skepticism. • Use mathematics in all aspects of scientific inquiry. • Understand that scientific investigations may result in new ideas for study, new methods, or procedures for an investigation or new technologies to improve data collection.	• Compare and contrast scientific theories. • Know that both direct and indirect observations are used by scientists to study the natural world and universe. • Identify questions and concepts that guide scientific investigations. • Formulate and revise explanations and models using logic and evidence. • Recognize and analyze alternative explanations and models. • Explain the importance of accuracy and precision in making valid measurements.	• Examine the status of existing theories. • Evaluate experimental information for relevance and adherence to science processes. • Judge that conclusions are consistent and logical with experimental conditions. • Interpret results of experimental research to predict new information, propose additional investigable questions, or advance a solution. • Communicate and defend a scientific argument.

Content Area Strand										
3.1.3.A9.	3.1.4.A9.	3.1.5.A9.	3.1.6.A9.	3.1.7.A9.	3.1.8.A9.	3.1.B.A9.	3.1.C.A9.	3.1.P.A9.	3.1.12.A9.
3.1.3.B6.	3.1.4.B6.	3.1.5.B6.	3.1.6.B6.	3.1.7.B6.	3.1.8.B6.	3.1.B.B6.	3.1.C.B6.	3.1.P.B6.	3.1.12.B6.
3.1.3.C4.	3.1.4.C4.	3.1.5.C4.	3.1.6.C4.	3.1.7.C4.	3.1.8.C4.	3.1.B.C4.	3.1.C.C4.	3.1.P.C4.	3.1.12.C4.
3.2.3.A6.	3.2.4.A6.	3.2.5.A6.	3.2.6.A6.	3.2.7.A6.	3.2.8.A6.	3.2.B.A6.	3.2.C.A6.	3.2.P.A6.	3.2.12.A6.
3.2.3.B7.	3.2.4.B7.	3.2.5.B7.	3.2.6.B7.	3.2.7.B7.	3.2.8.B7.	3.2.B.B7.	3.2.C.B7.	3.2.P.B7.	3.2.12.B7.
3.3.3.A8.	3.3.4.A8.	3.3.5.A8.	3.3.6.A8.	3.3.7.A8.	3.3.8.A8.	3.3.B.A8.	3.3.C.A8.	3.3.P.A8.	3.3.12.A8.
3.3.3.D3.	3.3.4.D3.	3.3.5.D3.	3.3.6.D3.	3.3.7.D3.	3.3.8.D3.	3.3.B.D3.	3.3.C.D3.	3.3.P.D3.	3.3.12.D3.

3.1. Biological Sciences						
3.1.A. Organisms and Cells						
	3.1.3.A. GRADE 3	**3.1.4.A. GRADE 4**	**3.1.5.A. GRADE 5**	**3.1.6.A. GRADE 6**	**3.1.7.A. GRADE 7**	**3.1.8.A. GRADE 8**
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:						
1 Common Characteristics of Life	3.1.3.A1. Describe characteristics of living things that help to identify and classify them.	3.1.4.A1. Classify plants and animals according to the physical characteristics that they share.	3.1.5.A1. Intentionally Blank	3.1.6.A1. Describe the similarities and differences of major physical characteristics in plants, animals, fungi, protists, and bacteria.	3.1.7.A1. Describe the similarities and differences of physical characteristics in diverse **organisms**.	3.1.8.A1. Intentionally Blank
2 Energy Flow	3.1.3.A2. Describe the basic needs of living things and their dependence on light, food, air, water, and shelter.	3.1.4.A2. Describe the different resources that plants and animals need to live.	3.1.5.A2. Describe how life on earth depends on energy from the sun.	3.1.6.A2. Describe how energy derived from the sun is used by plants to produce sugars (**photosynthesis**) and is transferred within a food chain from producers (plants) to consumers to decomposers.	3.1.7.A2. Describes how organisms obtain and use energy throughout their lives.	3.1.8.A2. Intentionally Blank

3.1. Biological Sciences						
3.1.A. Organisms and Cells						
	3.1.3.A. GRADE 3	**3.1.4.A. GRADE 4**	**3.1.5.A. GRADE 5**	**3.1.6.A. GRADE 6**	**3.1.7.A. GRADE 7**	**3.1.8.A. GRADE 8**
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:						
3 Life Cycles	3.1.3.A3. Illustrate how plants and animals go through predictable life cycles that include birth, growth, development, reproduction, and death.	3.1.4.A3. Identify differences in the **life cycles** of plants and animals.	3.1.5.A3. Compare and contrast the similarities and differences in life cycles of different organisms.	3.1.6.A3. Intentionally Blank	3.1.7.A3. Explain why the **life cycles** of different **organisms** have varied lengths.	3.1.8.A3. Intentionally Blank
4 Cell Cycles	3.1.3.A4. Intentionally Blank	3.1.4.A4. Intentionally Blank	3.1.5.A4. Intentionally Blank	3.1.6.A4. Recognize that all organisms are composed of cells and that many organisms are **unicellular** and must carry out all life functions in one cell.	3.1.7.A4. Explain how cells arise from pre-existing cells.	3.1.8.A4. Intentionally Blank
5 Form and Function	3.1.3.A5. Identify the structures in plants that are responsible for food production, support, water transport, reproduction, growth, and protection.	3.1.4.A5. Describe common functions living things share to help them function in a specific environment.	3.1.5.A5. Explain the concept of a cell as the basic unit of life. Compare and contrast plant and animal cells.	3.1.6.A5. Describe basic structures that plants and animals have that contribute to their ability to make or find food and reproduce.	3.1.7.A5. Explain how the cell is the basic structural and functional unit of living things.	3.1.8.A5. Intentionally Blank

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3.1. Biological Sciences

3.1.A. Organisms and Cells

	3.1.3.A. GRADE 3	3.1.4.A. GRADE 4	3.1.5.A. GRADE 5	3.1.6.A. GRADE 6	3.1.7.A. GRADE 7	3.1.8.A. GRADE 8
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:						
6 Organization	3.1.3.A6. Intentionally Blank	3.1.4.A6. Intentionally Blank	3.1.5.A6. Intentionally Blank	3.1.6.A6. Identify examples of **unicellular** and **multicellular organisms**.	3.1.7.A6. Identify the levels of organization from cell to organism.	3.1.8.A6. Intentionally Blank
7 Molecular Basis of Life	3.1.3.A7. Intentionally Blank	3.1.4.A7. Intentionally Blank	3.1.5.A7. Intentionally Blank	3.1.6.A7. Intentionally Blank	3.1.7.A7. Compare life processes (e.g. growth, **digestion**) at the organism level with life processes at the cellular level.	3.1.8.A7. Intentionally Blank
8 Unifying Themes	3.1.3.A8. Intentionally Blank	3.1.4.A8. MODELS Construct and interpret **models** and diagrams of various animal and plant **life cycles**.	3.1.5.A8. Intentionally Blank	3.1.6.A8. SCALE Explain why the details of most cells are visible only through a microscope.	3.1.7.A8. MODELS Apply the appropriate **models** to show interactions among **organisms** in an environment.	3.1.8.A8. CHANGE AND CONSTANCY Explain mechanisms organisms use to adapt to their environment.
9 Science as Inquiry	3.1.3.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.4.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.5.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.6.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.7.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.8.A9. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.1. Biological Sciences						
3.1.B. Genetics						
	3.1.3.B. GRADE 3	**3.1.4.B. GRADE 4**	**3.1.5.B. GRADE 5**	**3.1.6.B. GRADE 6**	**3.1.7.B. GRADE 7**	**3.1.8.B. GRADE 8**
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:						
1 Heredity	3.1.3.B1. Understand that plants and animals closely resemble their parents.	3.1.4.B1. Describe features that are observable in both parents and their offspring.	3.1.5.B1. Differentiate between inherited and acquired characteristics of plants and animals.	3.1.6.B1. Intentionally Blank	3.1.7.B1. Explain how **genetic** instructions influence inherited traits. Identify **Mendelian patterns of inheritance.**	3.1.8.B1. Intentionally Blank
2 Reproduction	3.1.3.B2. Intentionally Blank	3.1.4.B2. Recognize that reproduction is necessary for the continuation of life.	3.1.5.B2. Intentionally Blank	3.1.6.B2. Intentionally Blank	3.1.7.B2. Compare **sexual reproduction** with **asexual reproduction**.	3.1.8.B2. Intentionally Blank
3 Molecular Basis of Life	3.1.3.B3. Intentionally Blank	3.1.4.B3. Intentionally Blank	3.1.5.B3. Intentionally Blank	3.1.6.B3. Intentionally Blank	3.1.7.B3. Intentionally Blank	3.1.8.B3. Intentionally Blank
4 Biotechnology	3.1.3.B4. Intentionally Blank	3.1.4.B4. Intentionally Blank	3.1.5.B4. Intentionally Blank	3.1.6.B4. Intentionally Blank	3.1.7.B4. Describe how selective breeding and **biotechnology** can alter the **genetic** composition of **organisms**.	3.1.8.B4. Intentionally Blank

3.1. Biological Sciences						
3.1.B. Genetics						
	3.1.3.B. GRADE 3	**3.1.4.B. GRADE 4**	**3.1.5.B. GRADE 5**	**3.1.6.B. GRADE 6**	**3.1.7.B. GRADE 7**	**3.1.8.B. GRADE 8**
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:						
5 Unifying Themes	3.1.3.B5. PATTERNS Identify characteristics that appear in both parents and offspring.	3.1.4 B5. PATTERNS Identify observable patterns in the physical characteristics of plants or groups of animals.	3.1.5.B5. Intentionally Blank	3.1.6.B5. Intentionally Blank	3.1.7 B5. PATTERNS Compare and contrast observable patterns in the physical characteristics across **families**, **strains** and **species**.	3.1.8.B5. Intentionally Blank
6 Science as Inquiry	3.1.3.B6. See *Science as Inquiry* in the Introduction for grade level indicators.(As indicated on page 8)	3.1.4 B6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.5.B6. See *Science as Inquiry* in the Introduction for grade level indicators.(As indicated on page 8)	3.1.6.B6. See *Science as Inquiry* in the Introduction for grade level indicators.(As indicated on page 8)	3.1.7 B6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.8.B6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.1. Biological Sciences						
3.1.C. Evolution						
	3.1.3.C. GRADE 3	**3.1.4.C. GRADE 4**	**3.1.5.C. GRADE 5**	**3.1.6.C. GRADE 6**	**3.1.7.C. GRADE 7**	**3.1.8.C. GRADE 8**
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:						
1 Natural Selection	3.1.3.C1. Recognize that plants survive through adaptations, such as stem growth towards light and root growth downward in response to gravity. Recognize that many plants and animals can survive harsh environments because of seasonal behaviors (e.g. hibernation, migration, trees shedding leaves).	3.1.4.C1. Identify different characteristics of plants and animals that help some populations survive and reproduce in greater numbers. Describe how environmental changes can cause **extinction** in plants and animals.	3.1.5.C1. Describe how organisms meet some of their needs in an environment by using behaviors (patterns of activities) in response to information (stimuli) received from the environment.	3.1.6.C1. Differentiate between instinctive and learned animal behaviors that relate to survival.	3.1.7.C1. Describe how **natural selection** is an underlying factor in a population's ability to adapt to changes.	3.1.8.C1. Explain how reproductive success coupled with advantageous traits over many generations contributes to **natural selection**.

3.1. Biological Sciences

3.1.C. Evolution

	3.1.3.C. GRADE 3	3.1.4.C. GRADE 4	3.1.5.C. GRADE 5	3.1.6.C. GRADE 6	3.1.7.C. GRADE 7	3.1.8.C. GRADE 8
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:						
2 Adaptation	3.1.3.C2. Describe animal characteristics that are necessary for survival.	3.1.4.C2. Describe plant and animal adaptations that are important to survival.	3.1.5.C2. Give examples of how inherited characteristics (e.g., shape of beak, length of neck, location of eyes, shape of teeth) may change over time as adaptations to changes in the environment that enable organisms to survive.	3.1.6.C2. Intentionally Blank	3.1.7.C2. Explain why the **extinction** of a **species** may occur when the environment changes. Explain that **mutations** can alter a gene and are the original source of new variations in a population.	3.1.8.C2. Intentionally Blank
3 Unifying Themes	3.1.3.C3. <u>CONSTANCY AND CHANGE</u> Recognize that fossils provide us with information about living things that inhabited the Earth long ago	3.1.4.C3. <u>CONSTANCY AND CHANGE</u> Compare fossils to one another and to currently living organisms according to their anatomical similarities and differences.	3.1.5.C3. Intentionally Blank	3.1.6.C3. Intentionally Blank	3.1.7.C3. <u>CONSTANCY AND CHANGE</u> Identify evidence drawn from **geology**, fossils, and comparative anatomy that provides the basis for the **theory of evolution**.	3.1.8.C3. Intentionally Blank
4 Science as Inquiry	3.1.3.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.4.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.5.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.6.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.7.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.1.8.C4. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.2. Physical Sciences: Chemistry and Physics						
3.2.A. Chemistry						
	3.2.3.A. GRADE 3	**3.2.4.A. GRADE 4**	**3.2.5.A. GRADE 5**	**3.2.6.A. GRADE 6**	**3.2.7.A. GRADE 7**	**3.2.8.A. GRADE 8**
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:						
1 Properties of Matter	3.2.3.A1. Differentiate between properties of objects such as size, shape, and weight and properties of materials that make up the objects such as color, texture, and hardness. Differentiate between the three states of matter, classifying a substance as a solid, liquid, or gas.	3.2.4.A1. Identify and classify objects based on their observable and measurable physical properties. Compare and contrast solids, liquids, and gases based on their properties.	3.2.5.A1. Describe how water can be changed from one state to another by adding or taking away heat.	3.2.6.A1. Distinguish the differences in properties of solids, liquids, and gases. Differentiate between volume and mass. Investigate that equal volumes of different substances usually have different masses.	3.2.7.A1. Differentiate between **elements**, **compounds**, and **mixtures**. Identify groups of **elements** that have similar properties. Explain how materials are characterized by having a specific amount of mass in each unit of volume (**density**).	3.2.8.A1. Differentiate between mass and weight.
2 Structure of Matter	3.2.3.A2. Recognize that all objects and materials in the world are made of matter.	3.2.4.A2. Demonstrate that materials are composed of parts that are too small to be seen without magnification.	3.2.5.A2. Intentionally Blank	3.2.6.A2. Compare and contrast pure substances with mixtures.	3.2.7.A2. Identify **atoms** as the basic building blocks of matter and that elements are composed of one type of atom.	3.2.8.A2. Identify characteristics of elements derived from the **periodic table**.

3.2. Physical Sciences: Chemistry and Physics						
3.2.A. Chemistry						
	3.2.3.A. GRADE 3	**3.2.4.A. GRADE 4**	**3.2.5.A. GRADE 5**	**3.2.6.A. GRADE 6**	**3.2.7.A. GRADE 7**	**3.2.8.A. GRADE 8**
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:						
3 Matter & Energy	3.2.3.A3. Demonstrate how heating and cooling may cause changes in the properties of materials including phase changes.	3.2.4.A3. Demonstrate the conservation of **mass** during physical changes such as melting or freezing.	3.2.5.A3. Intentionally Blank	3.2.6.A3. Explain and give examples of how **mass** is conserved in a closed **system.**	3.2.7.A3. Explain how energy transfer can affect the chemical and physical properties of matter.	3.2.8.A3. Explain how changes in matter are accompanied by changes in energy.
4 Reactions	3.2.3.A4. Use basic reactions to demonstrate observable changes in properties of matter (e.g., burning, cooking).	3.2.4.A4. Recognize that combining two or more substances may make new materials with different properties.	3.2.5.A4. Intentionally Blank	3.2.6.A4. Differentiate between physical changes and chemical changes.	3.2.7.A4. Describe how reactants change into products in simple chemical reactions.	3.2.8.A4. Compare and contrast physical and chemical changes in terms of products.
5 Unifying Themes	3.2.3.A5. CONSTANCY AND CHANGE Recognize that everything is made of matter.	3.2.4.A5. MODELS Use models to demonstrate the physical change as water goes from liquid to ice and from liquid to vapor.	3.2.5.A5. Intentionally Blank	3.2.6.A5. CONSTANCY AND CHANGE Identify characteristic properties of matter that can be used to separate one substance from the other.	3.2.7.A5. Intentionally Blank	3.2.8.A5. Intentionally Blank

3.2. Physical Sciences: Chemistry and Physics						
3.2.A. Chemistry						
	3.2.3.A. GRADE 3	**3.2.4.A. GRADE 4**	**3.2.5.A. GRADE 5**	**3.2.6.A. GRADE 6**	**3.2.7.A. GRADE 7**	**3.2.8.A. GRADE 8**
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:						
6 Science as Inquiry	3.2.3.A6. See *Science as Inquiry* in the Introduction for grade level indicators (As indicated on page 8)	3.2.4.A6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.5.A6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.6.A6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.7.A6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.8.A6. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.2. Physical Sciences: Chemistry and Physics						
3.2.B. Physics						
	3.2.3.B. GRADE 3	**3.2.4.B. GRADE 4**	**3.2.5.B. GRADE 5**	**3.2.6.B. GRADE 6**	**3.2.7.B. GRADE 7**	**3.2.8.B. GRADE 8**
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:						
1 Force & Motion of Particles and Rigid Bodies	3.2.3.B1. Explain how movement can be described in many ways.	3.2.4.B1. Explain how an object's change in motion can be observed and measured.	3.2.5.B1. Explain how mass of an object resists change to motion.	3.2.6.B1. Explain how changes in motion require a force.	3.2.7.B1. Describe how unbalanced forces acting on an object change its **velocity**. Analyze how observations of displacement, **velocity**, and acceleration provide necessary and sufficient evidence for the existence of forces.	3.2.8.B1. Explain how **inertia** is a measure of an object's **mass**. Explain how momentum is related to the forces acting on an object.
2 Energy Storage and Transformations: Conservation Laws	3.2.3.B2 Explore energy's ability to cause motion or create change. Explore how energy can be found in moving objects, light, sound, and heat.	3.2.4.B2. Identify types of energy and their ability to be stored and changed from one form to another.	3.2.5.B2. Examine how energy can be transferred from one form to another.	3.2.6.B2. Describe energy as a property of objects associated with heat, light, electricity, magnetism, mechanical motion, and sound. Differentiate between potential and kinetic energy.	3.2.7.B2. Describe how energy can be changed from one form to another (transformed) as it moves through a **system** or transferred from one system to another system.	3.2.8.B2. Identify situations where kinetic energy is transformed into potential energy, and vice versa.

3.2. Physical Sciences: Chemistry and Physics						
3.2.B. Physics						
	3.2.3.B. GRADE 3	**3.2.4.B. GRADE 4**	**3.2.5.B. GRADE 5**	**3.2.6.B. GRADE 6**	**3.2.7.B. GRADE 7**	**3.2.8.B. GRADE 8**
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:						
3 Heat/Heat Transfer	3.2.3.B3. Explore temperature changes that result from the addition or removal of heat.	3.2.4.B3. Understand that objects that emit light often emit heat.	3.2.5.B3. Demonstrate how heat energy is usually a byproduct of an energy transformation.	3.2.6.B3. Give examples of how heat moves in predictable ways, normally flowing from warmer objects to cooler ones until they reach the same temperature. Explain the effect of heat on particle motion by describing what happens to particles during a phase change.	3.2.7.B3. Differentiate among **convection**, **conduction,** and **radiation**. Explain why heat energy consists of the random motion and vibrations of the particles of matter.	3.2.8.B3. Explain how changes in temperature are accompanied by changes in kinetic energy.
4 Electrical and Magnetic Energy	3.2.3.B4. Identify and classify objects and materials that are conductors or insulators of electricity. Identify and classify objects and materials as magnetic or non-magnetic.	3.2.4.B4. Apply knowledge of basic electrical circuits to the design and construction of simple direct **current** circuits. Compare and contrast series and parallel circuits. Demonstrate that magnets have poles that repel and attract each other.	3.2.5.B4. Demonstrate how electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced. Demonstrate how electromagnets can be made and used.	3.2.6.B4. Describe how electric current produces magnetic forces and how moving magnets produce electric current. Derive Ohm's Law through investigation of voltage, current, and resistance.	3.2.7.B4. Explain how electrical current is produced by the flow of electrons. Explain and demonstrate how electric current produces magnetic forces and how moving magnets produce electric current.	3.2.8.B4. Compare and contrast atomic properties of conductors and insulators.

3.2. Physical Sciences: Chemistry and Physics						
3.2.B. Physics						
	3.2.3.B. GRADE 3	**3.2.4.B. GRADE 4**	**3.2.5.B. GRADE 5**	**3.2.6.B. GRADE 6**	**3.2.7.B. GRADE 7**	**3.2.8.B. GRADE 8**
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:						
5 Nature of Waves (Sound and Light Energy)	3.2.3.B5. Recognize that light travels in a straight line until it strikes an object or travels from one material to another	3.2.4.B5. Demonstrate how vibrating objects make sound and sound can make things vibrate. Demonstrate how light can be reflected, refracted, or absorbed by an object.	3.2.5.B5. Compare the characteristics of sound as it is transmitted through different materials. Relate the rate of vibration to the pitch of the sound.	3.2.6.B5. Intentionally Blank	3.2.7.B5. Demonstrate that visible light is a mixture of many different colors. Explain the construct of the electromagnetic spectrum. Describe how sound and light energy are transmitted by waves.	3.2.8.B5. Intentionally Blank
6 Unifying Themes	3.2.3.B6. ENERGY Recognize that light from the sun is an important source of energy for living and nonliving systems and some source of energy is needed for all organisms to stay alive and grow.	3.2.4.B6. ENERGY Give examples of how energy can be transformed from one form to another.	3.2.5.B6. Intentionally Blank	3.2.6.B6. ENERGY Demonstrate that heat moves in predictable ways from warmer objects to cooler ones. SCALE Investigate that materials may be composed of parts too small to be seen without magnification.	3.2.7.B6. ENERGY Demonstrate that heat is often produced as energy is transformed through a **system**. ENERGY Demonstrate how the transfer of heat energy causes temperature changes.	3.2.8.B6. PATTERNS Explain how physics principles underlie everyday phenomena and important technologies.

3.2. Physical Sciences: Chemistry and Physics						
3.2.B. Physics						
	3.2.3.B. GRADE 3	**3.2.4.B. GRADE 4**	**3.2.5.B. GRADE 5**	**3.2.6.B. GRADE 6**	**3.2.7.B. GRADE 7**	**3.2.8.B. GRADE 8**
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:						
7 Science as Inquiry	3.2.3.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.4.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.5.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.6.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.7.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.2.8.B7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.3. Earth and Space Sciences						
3.3.A. Earth Structure, Processes and Cycles						
	3.3.3.A. GRADE 3	**3.3.4.A. GRADE 4**	**3.3.5.A. GRADE 5**	**3.3.6.A. GRADE 6**	**3.3.7.A. GRADE 7**	**3.3.8.A. GRADE 8**
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:						
1 Earth Features and the Processes that Change It	3.3.3.A1. Explain and give examples of the ways in which **soil** is formed.	3.3.4.A1. Describe basic landforms. Identify the layers of the earth. Recognize that the surface of the earth changes due to slow processes and rapid processes.	3.3.5.A1. Describe how landforms are the result of a combination of destructive forces such as erosion and constructive erosion, deposition of sediment, etc.	3.3.6.A1. Recognize and interpret various mapping representations of Earth's common features.	3.3.7.A1. Define basic features of the **rock cycle.** Describe the layers of the earth. Differentiate among the mechanisms by which heat is transferred through the Earth's **system**.	3.3.8.A1. Distinguish between physical and chemical weathering. Compare and contrast the types of energy that drive Earth's systems.
2 Earth's Resources/Materials	3.3.3.A2. Identify the physical properties of minerals and demonstrate how minerals can be tested for these different physical properties.	3.3.4.A2. Identify basic properties and uses of Earth's materials including rocks, soils, water, and gases of the **atmosphere.**	3.3.5.A2. Describe the usefulness of Earth's physical resources as raw materials for the human made world.	3.3.6.A2. Examine how soil fertility, composition, resistance to erosion, and texture are affected by many factors.	3.3.7.A2. Explain land use in relation to soil type and **topography**.	3.3.8.A2. Describe renewable and nonrenewable energy resources.

3.3. Earth and Space Sciences						
3.3.A. Earth Structure, Processes and Cycles						
	3.3.3.A. GRADE 3	**3.3.4.A. GRADE 4**	**3.3.5.A. GRADE 5**	**3.3.6.A. GRADE 6**	**3.3.7.A. GRADE 7**	**3.3.8.A. GRADE 8**
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:						
3 Earth's History	3.3.3.A3. Intentionally Blank	3.3.4.A3. Recognize that fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.	3.3.5.A3. Explain how geological processes observed today such as erosion, movement of lithospheric plates, and changes in the composition of the atmosphere are similar to those in the past.	3.3.6.A3. Intentionally Blank	3.3.7.A3. Explain and give examples of how physical evidence, such as fossils and surface features of glaciation support theories that the Earth has evolved over **geologic time.** Compare geologic processes over time.	3.3.8.A3. Explain how matter on earth is conserved throughout the geological processes over time.
4 Water	3.3.3.A4. Connect the various forms of precipitation to the weather in a particular place and time.	3.3.4.A4. Recognize Earth's different water resources, including both fresh and saltwater. Describe phase changes in the forms of water on Earth.	3.3.5.A4. Explain the basic components of the water cycle.	3.3.6.A4. Describe how water on earth cycles in different forms and in different locations, including underground and in the atmosphere.	3.3.7.A4. Differentiate among Earth's water **systems**. Describe the motions of tides and identify their causes.	3.3.8.A4. Explain how the oceans form one interconnected circulation system powered by wind, tides, the Earth's rotation, and water density differences.

3.3. Earth and Space Sciences						
3.3.A. Earth Structure, Processes and Cycles						
	3.3.3.A. GRADE 3	**3.3.4.A. GRADE 4**	**3.3.5.A. GRADE 5**	**3.3.6.A. GRADE 6**	**3.3.7.A. GRADE 7**	**3.3.8.A. GRADE 8**
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:						
5 Weather and Climate	3.3.3.A5. Explain how air temperature, moisture, wind speed and direction, and precipitation make up the weather in a particular place and time.	3.3.4.A5. Describe basic weather elements. Identify weather patterns over time.	3.3.5.A5. Differentiate between weather and climate. Explain how the cycling of water, both in and out of the atmosphere, has an effect on climate.	3.3.6.A5. Describe the composition and layers of the **atmosphere.** Explain the effects of oceans on climate. Describe how global patterns such as the jet stream and water currents influence local weather in measurable terms such as temperature, wind direction and speed, and precipitation.	3.3.7.A5. Describe basic elements of **meteorology**. Explain the relationship between the energy provided by the sun and the temperature differences among water, land and **atmosphere.**	3.3.8.A5. Explain how the curvature of the earth contributes to climate. Compare and contrast water vapor, clouds, and humidity.

3.3. Earth and Space Sciences

3.3.A. Earth Structure, Processes and Cycles

	3.3.3.A. GRADE 3	3.3.4.A. GRADE 4	3.3.5.A. GRADE 5	3.3.6.A. GRADE 6	3.3.7.A. GRADE 7	3.3.8.A. GRADE 8
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:						
6 Unifying Themes	3.3.3.A6. Intentionally Blank	3.3.4.A6. MODELS/SCALE Identify basic landforms using models and simple maps. CONSTANCY/ CHANGE Identify simple changes in the earth **system** as air, water, soil and rock interact. SCALE Explain how basic weather elements are measured.	3.3.5.A6. Intentionally Blank	3.3.6.A6. MODELS/SCALES Describe the scales involved in characterizing Earth and its atmosphere. MODELS/SCALES Create models of Earth's common physical features.	3.3.7.A6. MODELS/SCALES Locate significant geologic structures using various mapping representations. CONSTANCY/ CHANGE Describe changes in atmospheric conditions associated with various weather patterns. CONSTANCY/ CHANGE SCALE Describe **geologic time** as it relates to earth processes.	3.3.8.A6. CHANGES Explain changes in earth systems in terms of energy transformation and transport. MODELS Explain how satellite images, models, and maps are used to identify Earth's resources.
7 Science as Inquiry	3.3.3.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.4.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.5.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.6.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.7.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.8.A7. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.3. Earth and Space Sciences						
3.3.B. Origin and Evolution of the Universe						
3.3.3.B. GRADE 3		**3.3.4.B. GRADE 4**	**3.3.5.B. GRADE 5**	**3.3.6.B. GRADE 6**	**3.3.7.B. GRADE 7**	**3.3.8.B. GRADE 8**
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:						
1 Composition and Structure	3.3.3.B1. Relate the rotation of the earth and day/night, to the apparent movement of the sun, moon, and stars across the sky. Describe the changes that occur in the observable shape of the moon over the course of a month.	3.3.4.B1. Identify planets in our **solar system** and their basic characteristics. Describe the earth's place in the **solar system** that includes the sun (a star), planets, and many moons. Recognize that the universe contains many billions of galaxies and that each **galaxy** contains many billions of stars.	3.3.5.B1. Provide evidence that the earth revolves around (orbits) the sun in a year's time and that the earth rotates on its axis once approximately every 24 hours.	3.3.6.B1. Compare and contrast the size, composition, and surface features of the planets that comprise the solar system as well as the objects orbiting them. Recognize the role of gravity as a force that pulls all things on or near the earth toward the center of the earth and in the formation of the solar system and the motions of objects in the solar system. Explain why the planets orbit the sun in nearly circular paths. Describe how the planets change their position relative to the background of the stars	3.3.7.B1. Explain how **gravity** is the major force in the formation of the planets, stars, and the **solar system**. Describe **gravity** as a major force in determining the motions of planets, stars, and the **solar system.** Compare and contrast properties and conditions of objects in the **solar system** to those on Earth.	3.3.8.B1. Explain how light, measured remotely, can be used to classify objects in the universe.

3.3. Earth and Space Sciences						
3.3.B. Origin and Evolution of the Universe						
	3.3.3.B. GRADE 3	**3.3.4.B. GRADE 4**	**3.3.5.B. GRADE 5**	**3.3.6.B. GRADE 6**	**3.3.7.B. GRADE 7**	**3.3.8.B. GRADE 8**
Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to:						
				Explain how the tilt of the earth and its revolution around the sun cause an uneven heating of the earth which in turn causes the seasons and weather patterns.		
2 Unifying Themes	3.3.3.B2. Intentionally Blank	3.3.4.B2. SCALES Know the basic characteristics and uses of telescopes. PATTERNS/PHASES Identify major lunar phases. PATTERNS Explain time (days, seasons) using **solar system** motions.	3.3.5.B2. Intentionally Blank	3.3.6.B2. MODELS Use models to demonstrate that earth has different seasons and weather patterns. MODELS Use models to demonstrate that the phases of the moon are a result of its orbit around Earth.	3.3.7.B2. SCALE AND MEASUREMENT Identify a variety of instruments used to gather evidence about the universe. PATTERNS Describe repeating patterns in the Sun-Earth-Moon **system** and the positions of stars. SCALE Relate planetary size and distance in our **solar system** using an appropriate scale model.	3.3.8.B2. SCALE AND MEASUREMENT Explain measurements and evidence indicating the age of the universe.

3.3. Earth and Space Sciences						
3.3.B. Origin and Evolution of the Universe						
	3.3.3.B. GRADE 3	**3.3.4.B. GRADE 4**	**3.3.5.B. GRADE 5**	**3.3.6.B. GRADE 6**	**3.3.7.B. GRADE 7**	**3.3.8.B. GRADE 8**
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:						
3 Science as Inquiry	3.3.3.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.4.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.5.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.6.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page8)	3.3.7.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)	3.3.8.B3. See *Science as Inquiry* in the Introduction for grade level indicators. (As indicated on page 8)

3.4. Technology and Engineering Education						
3.4.A. The Scope of Technology						
	3.4.3.A. GRADE 3	**3.4.4.A. GRADE 4**	**3.4.5.A. GRADE 5**	**3.4.6.A. GRADE 6**	**3.4.7.A. GRADE 7**	**3.4.8.A. GRADE 8**
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:						
1 Characteristics Of Technology	3.4.3.A1. Identify how the natural made world and the human made world are different.	3.4.4.A1. Understand that tools, materials, and skills are used to make things and carry out tasks.	3.4.5.A1. Explain how people use tools and techniques to help them do things.	3.4.6.A1. Identify how creative thinking and economic and cultural influences shape technological development.	3.4.7.A1. Explain how **technology** is closely linked to creativity, which has resulted in **innovation** and invention.	3.4.8.A1. Analyze the development of **technology** based on affordability or urgency.
2 Core Concepts of Technology	3.4.3.A2. Identify that some systems are found in nature and some systems are made by humans.	3.4.4.A2. Understand that systems have parts and components that work together.	3.4.5.A2. Understand that a **subsystem** is a **system** that operates as part of a larger **system**.	3.4.6.A2. Describe how systems thinking involves considering how every part relates to others.	3.4.7.A2. Explain how different **technologies** involve different sets of processes.	3.4.8.A2. Explain how controls are steps that people perform using information about the **system** that causes **systems** to change.
3 Technology Connections	3.4.3.A3. Identify how the study of technology uses many of the same ideas and skills as many other subjects.	3.4.4.A3. Describe how various relationships exist between **technology** and other fields.	3.4.5.A3. Describe how **technologies** are often combined.	3.4.6.A3. Explain how knowledge from other fields of study (**STEM**) integrate to create new technologies.	3.4.7.A3. Explain how knowledge gained from other fields of study has a direct effect on the development of technological products and **systems**.	3.4.8.A3. Compare how a product, **system,** or environment developed for one setting may be applied to another setting.

3.4. Technology and Engineering Education						
3.4.B. Technology and Society						
	3.4.3.B. GRADE 3	**3.4.4.B. GRADE 4**	**3.4.5.B. GRADE 5**	**3.4.6.B. GRADE 6**	**3.4.7.B. GRADE 7**	**3.4.8.B. GRADE 8**
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:						
1 Effects of Technology	3.4.3.B1. Describe how using **technology** can be good or bad.	3.4.4.B1. Describe how **technology** affects humans in various ways.	3.4.5.B1. Explain how the use of **technology** can have unintended consequences.	3.4.6.B1. Describe how economic, political, and cultural issues are influenced by the development and use of **technology**.	3.4.7.B1. Explain how the use of **technology** can have consequences that affect humans in many ways.	3.4.8.B1. Evaluate the societal implications of the management of waste produced by **technology**.
2 Technology and Environment	3.4.3.B2. Explain how materials are re-used or recycled.	3.4.4.B2. Explain how the use of **technology** affects the environment in good and bad ways.	3.4.5.B2. Describe how waste may be appropriately recycled or disposed of to prevent unnecessary harm to the environment.	3.4.6.B2. Describe how **technologies** can be used to repair damage caused by natural disasters and to break down waste from the use of various products and **systems**.	3.4.7.B2. Explain how decisions to develop and use **technologies** may be influenced by environmental and economic concerns.	3.4.8.B2. Compare and contrast decisions to develop and use **technologies** as related to environmental and economic concerns.
3 Society and Development of Technology	3.4.3.B3. Identify and define products made to meet individual needs versus wants.	3.4.4.B3. Explain why new **technologies** are developed and old ones are improved in terms of needs and wants.	3.4.5.B3. Describe how community concerns support or limit technological developments.	3.4.6.B3. Interpret how societal and cultural priorities are reflected in technological devices.	3.4.7.B3. Describe how **invention** and **innovation** lead to changes in society and the creation of new needs and wants.	3.4.8.B3. Explain how throughout history, new **technologies** have resulted from the demands, values, and interests of individuals, businesses, industries, and societies.

3.4. Technology and Engineering Education						
3.4.B. Technology and Society						
	3.4.3.B. GRADE 3	**3.4.4.B. GRADE 4**	**3.4.5.B. GRADE 5**	**3.4.6.B. GRADE 6**	**3.4.7.B. GRADE 7**	**3.4.8.B. GRADE 8**
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:						
4 Technology and History	3.4.3.B4. Illustrate how people have made tools to provide food, clothing, and shelter.	3.4.4.B4. Describe how the history of civilization is linked closely to technological development.	3.4.5.B4. Identify how the way people live and work has changed history in terms of technology.	3.4.6.B4. Demonstrate how new technologies are developed based on people's needs, wants, values, and/ or interests.	3.4.7.B4. Explain how many **inventions** and **innovations** have evolved by using deliberate and methodical processes of tests and refinements.	3.4.8.B4. Explain how societal and cultural priorities and values are reflected in technological devices.

3.4. Technology and Engineering Education						
3.4.C. Technology and Engineering Design						
	3.4.3.C. GRADE 3	**3.4.4.C. GRADE 4**	**3.4.5.C. GRADE 5**	**3.4.6.C. GRADE 6**	**3.4.7.C. GRADE 7**	**3.4.8.C. GRADE 8**
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:						
1 Design Attributes	3.4.3.C1. Recognize **design** is a creative process and everyone can design solutions to problems.	3.4.4.C1. Understand that there is no perfect **design**.	3.4.5.C1. Explain how the **design** process is a purposeful method of planning practical solutions to problems.	3.4.6.C1. Recognize that requirements for a **design** include such factors as the desired elements and features of a product or **system** or the limits that are placed on the design.	3.4.7.C1. Describe how **design**, as a creative planning process, leads to useful products and **systems**.	3.4.8.C1. Evaluate the criteria and constraints of a design.
2 Engineering Design	3.4.3.C2. Explain why the **design** process requires creativity and consideration of all ideas.	3.4.4.C2. Describe the **engineering design process**: Define a problem. Generate ideas. Select a solution and test it. Make the item. Evaluate the item. Communicate the solution with others. Present the results.	3.4.5.C2. Describe how design, as a dynamic process of steps, can be performed in different sequences and repeated.	3.4.6.C2. Show how models are used to communicate and test design ideas and processes.	3.4.7.C2. Explain how modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.	3.4.8.C2. Explore the design process as a collaborative endeavor in which each person in the group presents his or her ideas in an open forum.

3.4. Technology and Engineering Education						
3.4.C. Technology and Engineering Design						
	3.4.3.C. GRADE 3	**3.4.4.C. GRADE 4**	**3.4.5.C. GRADE 5**	**3.4.6.C. GRADE 6**	**3.4.7.C. GRADE 7**	**3.4.8.C. GRADE 8**
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:						
3 Research & Development, Invention & Innovation, Experimentation / Problem Solving and Troubleshooting	3.4.3.C3. Recognize that all products and **systems** are subject to failure; many products and systems can be fixed.	3.4.4.C3. Explain how asking questions and making observations help a person understand how things work and can be repaired.	3.4.5.C3. Identify how **invention** and **innovation** are creative ways to turn ideas into real things.	3.4.6.C3. Explain why some technological problems are best solved through experimentation.	3.4.7.C3. Describe how troubleshooting as a problem-solving method may identify the cause of a malfunction in a technological **system**.	3.4.8.C3. Analyze how a multi-disciplinary **(STEM)** approach to problem solving will yield greater results.

3.4. Technology and Engineering Education						
3.4.D. Abilities for a Technological World						
	3.4.3.D. GRADE 3	**3.4.4.D. GRADE 4**	**3.4.5.D. GRADE 5**	**3.4.6.D. GRADE 6**	**3.4.7.D. GRADE 7**	**3.4.8.D. GRADE 8**
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:						
1 Applying the Design Process	3.4.3.D1. Identify people's needs and wants and define some problems that can be solved through the design process.	3.4.4.D1. Investigate how things are made and how they can be improved.	3.4.5.D1. Identify ways to improve a design solution.	3.4.6.D1. Apply a design process to solve problems beyond the laboratory classroom.	3.4.7.D1. Identify and collect information about everyday problems that can be solved by **technology** and generate ideas and requirements for solving a problem.	3.4.8.D1. Test and evaluate the solutions for a design problem.
2 Using and Maintaining Technological Systems	3.4.3.D2. Observe, analyze and document how simple **systems** work.	3.4.4.D2. Recognize and use everyday symbols (e.g. icons, simple electrical symbols measurement) to communicate key ideas. Identify and use simple hand tools (e.g., hammer, scale) correctly and safely.	3.4.5.D2. Use information provided in manuals, protocols, or by experienced people to see and understand how things work.	3.4.6.D2. Use computers appropriately to access and organize and apply information.	3.4.7.D2. Select and safely use appropriate tools, products and **systems** for specific tasks.	3.4.8.D2. Operate and maintain systems in order to achieve a given purpose.

3.4. Technology and Engineering Education						
3.4.D. Abilities for a Technological World						
	3.4.3.D. GRADE 3	**3.4.4.D. GRADE 4**	**3.4.5.D. GRADE 5**	**3.4.6.D. GRADE 6**	**3.4.7.D. GRADE 7**	**3.4.8.D. GRADE 8**
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:						
3 Assessing Impact of Products and Systems	3.4.3.D3. Collect information about everyday products and systems by asking questions.	3.4.4.D3. Investigate and assess the influence of a specific **technology** or **system** on the individual, family, community, and environment.	3.4.5.D3. Determine if the human use of a product or system creates positive or negative results.	3.4.6.D3. Design and use instruments to evaluate data.	3.4.7.D3. Use data collected to analyze and interpret trends in order to identify the positive or negative effects of a **technology**.	3.4.8.D3. Interpret and evaluate the accuracy of the information obtained and determine its usefulness.

3.4. Technology and Engineering Education						
3.4.E. The Designed World						
	3.4.3.E. GRADE 3	**3.4.4.E. GRADE 4**	**3.4.5.E. GRADE 5**	**3.4.6.E. GRADE 6**	**3.4.7.E. GRADE 7**	**3.4.8.E. GRADE 8**
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:						
1 Medical Technologies	3.4.3.E1. Identify the technologies that support and improve quality of life.	3.4.4.E1. Identify tools and devices that have been designed to provide information about a healthy lifestyle.	3.4.5.E1. Identify how technological advances have made it possible to create new devices and to repair or replace certain parts of the human body.	3.4.6.E1. Describe how advances and **innovation**s in medical **technologies** are used to improve health care.	3.4.7.E1. Investigate recent advancements in medical technologies and their impact on quality of life.	3.4.8.E1. Analyze what technologies are used in genetic engineering and predict how it may change the future of medicine.
2 Agricultural and Related Biotechnologies	3.4.3.E2. Identify some processes used in agriculture that require different procedures, products, or systems.	3.4.4.E2. Identify the **technologies** in agriculture that make it possible for food to be available year round.	3.4.5.E2. Understand that there are many different tools necessary to maintain an ecosystem, whether natural or man-made.	3.4.6.E2. Identify how emerging agricultural technologies have an effect on ecosystem dynamics and human/ animal food resources.	3.4.7.E2. Examine specialized equipment and practices used to improve the production of food, fiber, fuel, and other useful products and in the care of animals.	3.4.8.E2. Describe how biotechnology applies the principles of biology to create commercial products or processes.
3 Energy and Power Technologies	3.4.3.E3. Recognize that tools, machines, products, and systems use energy in order to do work.	3.4.4.E3. Identify types of energy and the importance of energy conservation.	3.4.5.E3. Explain how tools, machines, products, and systems use energy in order to do work.	3.4.6.E3. Investigate that power is the rate at which energy is converted from one form to another or transferred from one place to another.	3.4.7.E3. Examine the efficiency of energy use in our environment	3.4.8.E3. Examine power systems are used to drive and provide propulsion to other technological products or systems.

3.4. Technology and Engineering Education						
3.4.E. The Designed World						
	3.4.3.E. GRADE 3	**3.4.4.E. GRADE 4**	**3.4.5.E. GRADE 5**	**3.4.6.E. GRADE 6**	**3.4.7.E. GRADE 7**	**3.4.8.E. GRADE 8**
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:						
4 Information and Communication Technologies	3.4.3.E4. Recognize that information and communication technology is the transfer of messages among people and/or machines over distances through the use of technology.	3.4.4.E4. Explain how information and communication systems allow information to be transferred from human to human.	3.4.5.E4. Describe how the use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.	3.4.6.E4. Illustrate how communication systems are made up of a source, encoder, transmitter, receiver, decoder, and destination. Examine how communications information technologies are used to help humans make decisions and solve problems.	3.4.7.E4. Illustrate how information can be acquired and sent through a variety of technological sources, including print and electronic media.	3.4.8.E4. Describe how the design of the message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.
5 Transportation Technologies	3.4.3.E5. Understand that transportation has many parts that work together to help people travel.	3.4.4.E5. Recognize that a transportation **system** has many parts that work together to help people travel and to move goods from place to place.	3.4.5.E5. Examine reasons why a transportation system may lose efficiency or fail (e.g., one part is missing or malfunctioning or if a subsystem is not working).	3.4.6.E5. Demonstrate how transporting people and goods involves a combination of individuals and sub-systems, such as structural, propulsion, suspension, guidance, control, and support.	3.4.7.E5. Explain how processes, such as receiving, holding, storing, loading, moving, unloading, delivering, evaluating, marketing, managing and communicating are necessary for the entire **system** to operate efficiently.	3.4.8.E5. Describe how governmental regulations influence the design, operation and efficiency of transportation systems.

3.4. Technology and Engineering Education						
3.4.E. The Designed World						
	3.4.3.E. GRADE 3	**3.4.4.E. GRADE 4**	**3.4.5.E. GRADE 5**	**3.4.6.E. GRADE 6**	**3.4.7.E. GRADE 7**	**3.4.8.E. GRADE 8**
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:						
6 Manufacturing Technologies	3.4.3.E6. Explain how manufacturing systems design and produce products in quantity.	3.4.4.E6. Identify key aspects of manufacturing processes (designing products, gathering resources and using tools to separate, form and combine materials in order to produce products).	3.4.5.E6. Examine how manufacturing technologies have become an integral part of the engineered world.	3.4.6.E6. Identify key aspects of manufacturing systems that use mechanical processes to change the form of natural materials (e.g., separating, forming, combining, conditioning).	3.4.7.E6. Examine the processes involved in extracting (e.g., harvesting, drilling, mining) raw materials from the earth for use in manufacturing processes.	3.4.8.E6. Analyze the steps involved in the manufacturing process (e.g., design, development, production, marketing and servicing of products and **systems)**.
7 Construction Technologies	3.4.3.E7. Recognize that people live, work, and go to school in buildings which are different types of structures.	3.4.4.E7. Understand that structures rest on foundations and that some structures are temporary, while others are permanent.	3.4.5.E7. Describe the importance of guidelines when planning a community.	3.4.6.E7. Explain how the type of structure determines the way the parts are put together.	3.4.7.E7. Examine subsystems found in the construction of a building.	3.4.8.E7. Analyze factors that determine structural design (e.g., building laws and codes, style, convenience, cost, climate, and function).

IX. GLOSSARY

Adaptation: A characteristic of an organism that has been favored by natural selection and increases its fitness.

Anatomical: Relating to the structure of the body.

Angular Momentum: The resistance of an object to changes of rotation.

Asexual Reproduction: Offspring produced from only one parent.

Atmosphere: The gaseous mass or envelope surrounding a celestial body, especially the one surrounding the Earth, and retained by the celestial body's gravitational field.

Atoms: The smallest unit of an element that retains the chemical properties of that element.

Biochemistry: The study of the body's chemical reactions.

Biomacromolecules: Carbon-containing polymers in living systems commonly referred to as the molecules of life.

Biosphere: The parts of the land, sea, and atmosphere in which organisms are able to live.

Biotechnology: Any technique that uses living organisms, or parts or organisms to make or modify products, improve plants or animals, or to develop microorganisms for specific uses.

Carbon Cycle: A cycle by which carbon is exchanged between the biosphere, pedosphere, geosphere, hydrosphere and atmosphere of the Earth.

Cell Cycle: The process by which cells duplicate themselves.

Colligative Properties: Properties of solutions that depend on the number of particles in a given volume of solvent and not on the mass of the particles.

Compounds: A substance consisting of two or more different elements chemically bonded together in a fixed proportion by mass.

Conduction: The transfer of heat through solids.

Convection: Transfer of heat by moving the molecules of a gas and/or liquid.

Coulomb's Law: Electrical charges attract or repel one another with a force proportional to the product of their charges and inversely proportional to the square of their separation distance.

Current: The flow of electrons through a conductor.

Density: The ratio of its mass (*m*) to its volume (*V*), a measure of how tightly the matter within it is packed together.

Design: An iterative decision-making process that produces plans by which resources are converted into products or systems that meet human needs and wants or solve problems.

Digestion: How the body breaks down eaten food into molecules.

DNA: The fundamental substance of which genes are composed. Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions directing the biological development of all cellular forms of life, and many viruses.

Electricity: The flow of electrons through a conductor or the additional or loss of electrons from a material.

Electrochemical Reactions: Any process either caused or accompanied by the passage of an electric current and involving in most cases the transfer of electrons between two substances—one a solid and the other a liquid.

Electromagnetic Force: The force that charged objects exert on one another.

Electromagnetic Spectrum: Electromagnetic waves can exhibit a distribution of frequencies ranging below radio wave to light beyond the visible.

Electron Orbital Transitions: The probability distribution of an electron in an atom or molecule.

Elements: A type of atom that is distinguished by its atomic number; i.e., by the number of protons in its nucleus. The term is also used to refer to a pure chemical substance composed of atoms with the same number of protons.

Endothermic: A process or reaction that absorbs energy in the form of heat.

Engineering The profession of or work performed by an engineer. Engineering involves the knowledge of the mathematical and natural sciences (biological and physical) gained by study, experience, and practice that are applied with judgment and creativity to develop ways to utilize the materials and forces of nature for the benefit of mankind.

Engineering Design Process: The seven step process or method used by engineers to solve a problem. (See 3.4.4.C2.)

Enzymes: Protein that catalyzes chemical reactions in cells.

Equilibrium: A condition in which all acting influences are cancelled by others, resulting in a stable, balanced or unchanging system.

Evolution: The change in genetic composition of a population over successive generations leading to the formation of a new species.

Exothermic: A process or reaction that releases energy usually in the form of heat, but it can also release energy in form of light (e.g. explosions), sound or electricity (e.g., a battery).

Extinction: The cessation of existence of a species.

Families: A taxonomic rank; a way of classifying organisms into groups based on similarities.

Food Chain: A relationship of who eats whom.

Food Web: A complex relationship where most organisms are eaten by more than one type of consumer.

Forensics: The use of DNA for identification. Some examples of DNA use are to establish paternity in child support cases; establish the presence of a suspect at a crime scene, and identify accident victims.

Frequency: The number of repeated wave cycles per second.

Galaxy: A massive, gravitationally bound system consisting of stars, an interstellar medium of gas and dust and dark matter.

Gamete: A sex cell containing one set of chromosomes, sperm or egg.

Gene Expression: The process by which inheritable information from a gene, such as the DNA sequence, is made into a functional gene product, such as protein or RNA.

Gene Recombination: The process by which a strand of genetic material (usually DNA but can also be RNA) is broken and then joined to a different DNA molecule.

Genetic Engineering: The technology entailing all processes of altering the genetic material of a cell to make it capable of performing the desired functions, such as mass-producing substances like insulin.

Genetic(s): The study of inheritance.

Genotypic: Referring to the actual genetic composition of an organism.

Geochemical Cycles: The Earth is a containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs in the solid earth, oceans, atmosphere and organisms.

Geologic Time: A chronologic schema to describe the timing and relationships between events that have occurred during the history of Earth.

Geology: The science and study of the solid matter that constitutes the Earth.

Gradualism: Evolution model stating that mutations and phenotypic changes leading to the formation of new species are gradual and explain the fossil record gaps as simply missing because fossils are hard to find.

Gravity: The fundamental force of attraction that all objects with mass have for each other.

Hydrogen Bonds: A special type of dipole-dipole force that exists between an electronegative atom and a hydrogen atom bonded to Nitrogen, Oxygen or Fluorine.

Hydrologic Cycle: Describes the continuous movement of water on, above and below the surface of the Earth.

Hydrosphere: The water on or surrounding the surface of the globe, including the water of the oceans and the water in the atmosphere.

Igneous: Rock produced under conditions involving intense heat, as rocks of volcanic origin or rocks crystallized from molten magma.

Inertia: The resistance an object has to a change in its state of motion.

Innovation: The introduction of something new or a new idea, method or device. An innovation can be clearly complex or seemingly simple. Innovation is the process of modifying an existing product, process, or system, or system to improve it.

Intermodalism: The use of more than one form of transportation.

Invention: Invention is the process of turning ideas and imagination into new products, processes, or systems.

Kinetic Molecular Theory: Explains the forces between molecules and the energy that they possess; explains macroscopic properties of gases, such as pressure, temperature or volume, by considering their molecular composition and motion.

Law of Superposition: A general law stating that in any sequence of sediments or rocks that has not been overturned, the youngest sediments or rocks are at the top of the sequence and the oldest are at the bottom.

Life Cycles: The lifetime of an organism from birth to death.

Lithosphere: The outer part of the Earth, consisting of the crust and upper mantle.

Lymphocytes: White blood cells.

Magnets: A material that attracts or repels the same material and attracts iron and steel.

Mass: How much matter there is in an object.

Meiosis A type of cell division consisting or two rounds of nuclear and cellular division.

Mendelian Patterns of Inheritance:	Predicting the inheritance of offspring traits.
Metamorphic:	Rock that was once one form of rock but has changed to another under the influence of heat, pressure or some other agent without passing through a liquid phase.
Meteorology:	The interdisciplinary scientific study of the atmosphere that focuses on weather processes and forecasting.
Mitosis:	Process by which one cell divides into two cells.
Mixtures:	A substance that is not the same from one sample to the next, and a mixture can be separated into its parts; Two or more substances that are mixed together but not chemically joined.
Model:	A visual, mathematical, or three-dimensional representation in detail of an object or design, often a different scale than the original. A model is often used to test ideas, make changes to a design, and to learn more about what would happen to a similar, real object.
Molar Mass:	The mass of one mole of a substance, chemical element or chemical compound.
Mole:	Avogadro's number of the constituent entities of that substance; Avogadro's number, approximately 6.02214×10^{23}, makes the weight of a mole in grams equal to the weight of an entity in daltons.
Molecular Biology:	The study of how genes work.
Molecules:	The smallest particle of a substance that retains the chemical and physical properties of the substance and is composed of two or more atoms; a group of like or different atoms held together by chemical forces.
Multicellular:	An organism made up of a multiple cells.
Mutations:	Permanent transmissible change in the genetic material.

Nanotechnology: Deals with materials and machines on an incredibly tiny scale -- less than one billionth of a meter. A nanometer (nm) is one-billionth of a meter, smaller than the wavelength of visible light and a hundred-thousandth the width of a human hair [source: Berkeley Lab]. Nanotechnology is an expected future manufacturing technology that will make most products lighter, stronger, cleaner, less expensive and more precise.

The arrangement of carbon molecules and the ability to roll atoms into carbon nano tubes can create products that are incredibly strong but lightweight.

Natural Selection: A process in nature in which organisms possessing certain genes that code for traits that make them better adjusted to an environment tend to survive, reproduce, increase in number or frequency, and therefore, are able to transmit and perpetuate these traits.

Neurons: Nerve cells.

Newton's Laws: Three laws that explain the motion of objects caused by forces.

Nuclear Processes: The splitting (fission) or merging together (fusion) of the nuclei of atom(s).

Nuclear Reactions: A process in which two nuclei or nuclear particles collide to produce products different from the initial particles.

Nucleic Acids: The bimolecular DNA and RNA.

Ohm's Law: Voltage is equal to the *current* times the *resistance*.

Organic Molecules: Molecules that use carbon as their chemical backbones.

Organisms: A living individual.

Period: The time in seconds for one wave cycle to occur.

Periodic Table: A tabular method of displaying the chemical elements; used to illustrate recurring trends in the properties of the elements. The layout of the table has been refined and extended over time, as new elements have been discovered and new theoretical models have been developed to explain chemical behavior.

Phenotypic: Referring to the observable expression of an organism's genes.

Photosynthesis: The process used by plants and others to use light energy to power chemical reaction converting carbon dioxide and water into sugars and starches.

Physiology: The study of the body's cells function.

Plate Tectonics: The branch of geology studying the folding and faulting of the earth's crust.

Polarity: Description of how equally bonding electrons are shared between atoms.

Protein Synthesis: The creation of proteins using DNA and RNA.

Prototype: A rudimentary working model of a product or information system, usually built for demonstration purposes or as part of the development process.

Punctuated Equilibrium: Evolution model stating that over long periods of time, mutations simply accumulate but do not cause any drastic phenotypic changes, followed by short periods where these mutations are suddenly expressed and new species formed. This would account for the lack of transitional fossils in many phylogenic branches.

Radiation: Transfer of heat through light.

Radioactive Decay: The process in which an unstable atomic nucleus loses energy by emitting radiation in the form of particles or electromagnetic waves.

Red Blood Cells: Blood cells that carry oxygen through the body.

Resistance: A material that cause a reduction in voltage between two points.

Rock Cycle: The process by which rocks are formed, altered, destroyed, and reformed by geological processes and which is recurrent, returning to a starting point.

Sedimentary: Rock that has formed through the deposition and solidification of sediment.

Seismic Events: The rupture of geological faults, huge amounts of gas migration, mainly methane deep within the earth, but also by volcanic activity, landslides, mine blasts and nuclear experiments.

Sexual Reproduction Reproduction by the union of a sperm and an egg.

Simple Harmonic Motion: A motion that repeats over identical time intervals.

Speciation: The evolutionary process by which new biological species arise.

Species: A group of organisms capable of interbreeding and producing fertile offspring.

Specific Heat: The measure of the heat energy required to increase the temperature of a unit quantity of a substance by a certain temperature interval.

STEM: Acronym for Science, Technology, Engineering and Math. Science, Technology, Engineering, and Mathematics, are collectively considered core technological underpinnings of an advanced society.

Stem Cells: Cells that can divide to different type of cells.

Strains: Groups sharing common ancestry with clear-cut physiological distinctions but usually not structural distinctions.

Subsystem: A set of elements, which is a system itself, and a part of a larger system.

System: A set of interacting or interdependent entities, real or abstract, forming an integrated whole. An open system usually interacts with some entities in their environment. A closed system is isolated from its environment.

Technology: Technology is how people modify the natural world to suit their own purposes... generally it refers to the diverse collection of processes and knowledge that people use to extend human abilities and to satisfy human needs and wants.

Technology Transfer: Technology transfer is the process of sharing of skills, knowledge, technologies, methods of manufacturing, samples of manufacturing and facilities among governments and other institutions to ensure that scientific and technological developments are accessible to a wider range of users who can then further develop and exploit the technology into new products, processes, applications, materials or services

Telemedicine: The use of telecommunications and information technologies for the provision of health care at a distance.

Theory of Evolution: Theory that explains the process of change in the inherited traits of a population of organisms from one generation to the next. There are two major mechanisms driving evolution: natural selection and genetic drift.

Topography: The three-dimensional arrangement of physical attributes (such as shape, height, and depth) of a land surface in a place or region; physical features that make up the topography of an area include mountains, valleys, plains, and bodies of water; human-made features such as roads, railroads and landfills are also often considered part of a region's topography.

Torque: A force applied at right angles to an object's center of rotation that cause rotation.

Unicellular: An organism made up of a single cell.

Velocity: The speed and direction of an object or wave.

Voltage: The difference of electrical potential between two points that cause current to flow.

VSEPR: A model which is used for predicting the shapes of individual molecules based upon their extent of electron-pair electrostatic repulsion.

Wavelength: The physical length of one cycle or period of a wave.