Science Standards Review- Executive Summary

This is an executive summary of the complete Science Standards Review that was done in May 2018. The complete standards review can be found on the Arizonans Against Common Core website.

Arizona Science Standards are Developmentally Inappropriate in Kindergarten-5th Grade

The Science Standards were not reviewed by any well-known developmental psychologist like Jean Piaget, for example, to determine if students can perform the task they are being asked to do. Before he studied the minds of children, it was thought that children have the capability to think and reason like adults. However, after the Piaget theory –which is used by child psychologists around the world- this mindset changed about children. Below is a basic chart explaining the cognitive development of children and what type of demands their minds can accept in their corresponding ages:

Piaget's Theory

Stage	Age Range	Description
Sensorimotor	0-2 years	Coordination of senses with motor response, sensory curiosity about the world. Language used for demands and cataloguing. Object permanence developed
Preoperational	2-7 years	Symbolic thinking, use of proper syntax and grammar to express full concepts. Imagination and intuition are strong, but complex abstract thought still difficult. Conservation developed.
Concrete Operational	7-11 years	Concepts attached to concrete situations. Time, space, and quantity are understood and can be applied, but not as independent concepts
Formal Operations	11+	Theoretical, hypothetical, and counterfactual thinking. Abstract logic and reasoning. Strategy and planning become possible. Concepts learned in one context can be applied to another.

The Psychology Notes Headquarter - http://www.PsychologyNotesHQ.com

Children below age 11 years old cannot think abstractly, strategize, persevere or apply one concept to another. A large number of the March 2018 Draft Science Standards do not meet the criteria for clarity and appropriate cognitive demand. These same problems were called out throughout in the 2016 Mathematics Standards Comments document- especially in the Standards for Mathematical Practice- which *still* remain in the 2018 March draft Science Standards. These "Standards for Mathematical practice" are referenced in the "Connection to the Arizona Mathematics Standards" in the March 2018 draft Science Standards, by grade level. These standards need to be removed in grades where they are developmentally inappropriate especially below 11 years old as referenced in "Piaget's Theory" table above. Children under 11 years old cannot think "abstractly, persevere when solving problems, or analyze strategically."

Science has not changed! What *has* changed is the progressives in this country, and around the world, and *how* they want all of us to "teach science" in the classroom. These supposed "big ideas" that were the basis for these Science Standards, and the Next Generation Science Standards, are "bad ideas," and are nothing more than the

progressives push to change *how* our children are being taught and it is *adding* to the "deliberate dumbing down of America" that we continue to see with Common Core in English Language Arts and Mathematics through our current Arizona K-12 Standards.

What developmental psychologist(s) were used in developing the March 2018 draft Science Standards? Was this developmental psychologist(s) consulted on the "assumed minutes per week" of instructional time necessary for students to learn these standards by grade level from K-8 and High School?

Kindergarten- 5th Grade Connections to Other Academic Disciplines

Connection to the Arizona English Language Arts (ELA) Standards for Kindergarten- "Use age-appropriate scientific text and biographies to develop instruction surrounding the Reading Standards for Informational Text, the Reading Standards for Foundational Skills, and the Writing Standards." Who determines this when the current Arizona K-12 ELA standards are already developmentally inappropriate?

Connection to the Arizona Mathematics Standards for Mathematical Standards for Kindergarten- 5th grade

- Standards for Mathematical Practice- Developmentally inappropriate for this age!

Distribution of K-2 Standards

- **L4- "The theory of evolution seeks to make clear the unity and diversity of living and extinct organisms."** (K.L4U2.7, 1.L4U2.10 and 1.L4U4.11) Students should hear about the controversy in the highest levels of science over neo-Darwinian evolution. By examining both sides, asking questions and analyzing concepts, students will learn science more effectively. In 2017, Texas' streamlined biology standards on evolution and these standards provide a wonderful model of this.

Arizona Science Standards use the same Framework as the Next Generation Science Standards (NGSS)

The same framework the working groups used to develop the March 2018 draft Science Standards, "Working with Big Ideas of Science Education" and "A Framework for K-12 Science Education," were the basis for developing the Next Generation Science Standards (NGSS). So, saying these standards do not resemble NGSS is just a false statement. Twenty-six states rallied together to review these 2 documents, and Arizona was one of them under former Superintendent John Huppenthal, and these states were told to review the draft NGSS science standards that were primarily written by Achieve, Inc. This is eerily familiar to what happened with Common Core in 2010 but under the National Governor's Association. The "Three Dimensions" you call out in in the "Introduction"- Science & Engineering Practice, Crosscutting Concepts and Core Ideas- are the same three ideas called out in NGSS (same verbiage!). There is no hiding or denying that these ideas are the same in this March 2018 draft Science Standards as NGSS!

Two experts were called by California and Massachusetts to review their Science Standards in 2012 when they adopted NGSS- Ze'ev Wurman and Paul R. Gross. This is what they had to say about NGSS: "The [NGSS] standards are so generic. They often lack actual content that has been in the past standards," said Ze'ev Wurman in a Boston Herald article. Paul R. Gross stated, "The new standards leave out much important science that has worked perfectly for our students in the recent past….to follow the newest wrinkle in school pedagogy, every standard becomes a performance test, not necessarily on the history, the facts, and *big ideas* of science, but primarily on the students' ability to satisfy somebody's idea of *their* 'explanation,' or 'modeling,' or 'collecting

evidence' skills and the like." Fordham Institute rated NGSS a "C" rating and Arizona's 2005 Science Standards a "D" rating, BTW. We continue to see the same problem with the Common Core Standards today in our state- "primarily [asking] students to prove their ability to satisfy somebody's idea of *their* 'explanation,' or 'modeling,' or 'collecting evidence' skills and the like." These March 2018 draft Science Standards are *very* generic and lack the "big ideas of science" which have been successful for decades. "According to the National Science Foundation's (NSF) Science and Engineering Indicators 2018 report released [in January], the United States is the global leader in science and technology (S&T)" So, *why* do we need to teach science in a new way using these supposed "Big Ideas" like eliminating the Scientific Method which has been rigorous in Science application for decades? Science *has not* changed, just the way progressives in this country want to "teach science."

Arizona Science Standards are Delayed

Arizona Standards are very generic and often delayed on when science topics are introduced, especially in Kindergarten through 5th grade. For example, see these comparisons below of Arizona's Third Grade through Fifth Grade Science Standards vs. the 2013 Next Generation Science Standards for Physical Science, Earth and Space Science, and Life Science.

Arizona Physical Science Standards vs. NGSS

3.P2U2.2	**1-PS4-1 (In 1st grade!)**
Collect data and construct arguments based on evidence to explain how sound waves affect objects at varying distances and parts of the human ear.	**Plan and conduct investigation to provide evidence that vibrating materials can make sound and that sounds can make materials vibrate.** Sounds can make matter vibrate, and vibrating matter can make sound. (1-PS4.A)

Arizona Earth and Space Science Standards vs. NGSS

3.E1U1.4	**K-PS3-1 (In Kindergarten!)**
Construct an explanation describing how the Sun is the primary source of energy for the Earth.	**Make observations to determine the effect of sunlight on Earth's surface.**

Arizona Life Science Standards vs. NGSS

3.L1U2.6	**1-LS1-1 (In 1st grade!)**
Develop and use models to explain that plants and animals have internal and external structures that serve various functions that aid in growth, survival, behavior, and reproduction.	**Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1.A)

Arizona Physical Science Standards vs. NGSS

4.P4U2.2	3-PS2-3 (In 3rd grade!)
Develop and use a model that demonstrates how energy is moved from place to place through electric and magnetic currents.	**Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other**. Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2.B)

Arizona Physical Science Standards vs. NGSS

5.P4U1.6	3-PS2-3 (In 3rd grade!)
Analyze and interpret data to determine whether energy is present and can be transferred whenever there are moving objects.	**Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.** Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2.B)

Arizona Science Standards have Missing Content- Compare to other State Standards!

We would suggest the working groups who developed the Arizona's Science Standards to compare their standards to other states who have excelled in the National Assessment for Education progress, year-after-year, like Massachusetts. Massachusetts continues to out-perform other states on their NAEP assessments scores. The 2006 Massachusetts Science/Technology Standards are referenced below for PreK-2nd grade, 3rd-6th grade, 6th-8th grade and for High School. Massachusetts standards also include a Technology and Engineering section which will prepare students for a career in Science, Technology, Engineering and Mathematics (STEM).

From the 2006 Massachusetts Science/Technology Standards (PreK-2nd grade):

- "**In grades PreK–2**, scientific investigations can center on student questions, observations, and communication about what they observe. For example, students might plant a bean seed following simple directions written on a chart. Then they can write down what happens over time in their own words."

Grades PreK–2

- Ask questions about objects, organisms, and events in the environment.
- Tell about *why and what would happen if*?
- Make predictions based on observed patterns.
- Name and use simple equipment and tools (e.g., rulers, meter sticks, thermometers, hand lenses, and balances) to gather data and extend the senses.
- Record observations and data with pictures, numbers, or written statements.
- Discuss observations with others.

Earth and Space Science

- "In **grades PreK–2**, students are naturally interested in everything around them. This curiosity leads them to observe, collect, and record information about the earth and about objects visible in the sky. Teachers should encourage their students' observations without feeling compelled to offer precise scientific reasons for these phenomena. Young children bring these experiences to school and learn to extend and focus their explorations. In the process, they learn to work with tools like magnifiers and simple measuring devices."

  "Learning standards for grades PreK–2 fall under the following four subtopics: *Earth's Materials; The Weather; The Sun as a Source of Light and Heat;* and *Periodic Phenomena."*

Life Science (Biology)

- "As Piaget noted, young children tend to describe anything that moves as *alive.* For purposes of working with students in **grades PreK–2**, who do not yet understand the continuity of life (e.g., from seed to seedling to tree to log), *living* can be defined as anything that is alive or has ever been alive (e.g., muskrat, flower, roadkill, log) and *nonliving* can be defined as anything that is not now and has never been alive (e.g., rock, mountain, glass, wristwatch). Over time, students refine their intuitive understanding. They begin to include in their definition of *living* such behaviors as eating, growing, and reproducing. They learn to use their senses to observe and then describe the natural world. Noticing differences and similarities, and grouping organisms based on common features are skills developed in the life science curriculum at this grade span. For a more in-depth discussion of this issue, please refer to the *National Science Education Standards*."

  "Learning standards for PreK–2 fall under the following four subtopics: *Characteristics of Living Things; Heredity; Evolution and Biodiversity;* and *Living Things and Their Environment."*

Physical Sciences (Chemistry and Physics)

- "In **grades PreK–2**, students' curiosity is engaged when they observe physical processes and sort objects by different criteria. During these activities, students learn basic concepts about how things are alike or different. As they push, pull, and transform objects by acting upon them, the students see the results of their actions and begin to understand how part of their world works. They continue to build understanding by telling stories about what they did and what they found out."

  "Learning standards for PreK–2 fall under the following three subtopics: *Observable Properties of Objects; States of Matter;* and *Position and Motion of Objects."*

Technology/Engineering

- "Even before entering **grades PreK–2**, students are experienced technology users. Their natural curiosity about how things work is clear to any adult who has ever watched a child doggedly work to improve the design of a paper airplane, or to take apart a toy to explore its insides. They are also natural engineers and inventors, builders of sandcastles at the beach and forts under furniture. Most students in grades PreK–2 are fascinated with technology. While learning the safe uses of tools and materials that underlie engineering solutions, PreK–2 students are encouraged to manipulate materials that enhance their three-dimensional visualization skills–an essential component of the ability to design. They identify and describe characteristics of natural and humanmade materials and their possible uses and identify uses of basic tools and materials (e.g., glue, scissors, tape, ruler, paper, toothpicks, straws, spools). In addition, PreK–2 students learn to identify tools and simple machines used for specific purposes (e.g., ramp, wheel, pulley, lever). They also learn to describe how human beings use parts of the body as tools."

"Learning standards for PreK–2 fall under the following two subtopics: *Materials and Tools;* and *Engineering Design."*

From the 2006 Massachusetts Science/Technology Standards (3rd-5th grade):

- "**In grades 3–5**, students can plan and carry out investigations as a class, in small groups, or independently, often over a period of several class lessons. The teacher should first model the process of selecting a question that can be answered, formulating a hypothesis, planning the steps of an experiment, and determining the most objective way to test the hypothesis. Students should incorporate mathematical skills of measuring and graphing to communicate their findings."

Grades 3–5

- Ask questions and make predictions that can be tested.
- Select and use appropriate tools and technology (e.g., calculators, computers, balances, scales, meter sticks, graduated cylinders) in order to extend observations.
- Keep accurate records while conducting simple investigations or experiments.
- Conduct multiple trials to test a prediction. Compare the result of an investigation or experiment with the prediction.
- Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
- Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

Earth and Space Science

- "In **grades 3–5**, students explore properties of geological materials and how they change. They conduct tests to classify materials by observed properties, make and record sequential observations, note patterns and variations, and look for factors that cause change. Students observe weather phenomena and describe them quantitatively using simple tools. They study the water cycle, including the forms and locations of water. The focus is on having students generate questions, investigate possible solutions, make predictions, and evaluate their conclusions."

"Learning standards for grades 3–5 fall under the following six subtopics: *Rocks and Their Properties; Soil; Weather; The Water Cycle; Earth's History;* and *The Earth in the Solar System."*

Life Science (Biology)

- "In **grades 3–5**, students expand the range of observations they make of the living world. In particular, students in these grades record details of the life cycles of plants and animals and explore how organisms are adapted to their habitats. Students move beyond using their senses to gather information. They begin to use measuring devices to gather quantitative data that they record, examine, interpret, and communicate. They are introduced to the power of empirical evidence as they design ways of exploring questions that arise from their observations."

"Learning standards for grades 3–5 fall under the following four subtopics: *Characteristics of Plants and Animals; Structures and Functions; Adaptations of Living Things;* and *Energy and Living Things."*

Physical Sciences (Chemistry and Physics)

- "In **grades 3–5**, students' growth in their understanding of ordinary things allows them to make the intellectual connections necessary to understand how the physical world works. Students are able to design simple comparative tests, carry out the tests, collect and record data, analyze results, and communicate their findings to others."

"Learning standards for grades 3–5 fall under the following three subtopics: *Properties of Objects and Materials; States of Matter;* and *Forms of Energy* (including electrical, magnetic, sound, and light)."

Technology/Engineering

- "Students in **grades 3–5** learn how appropriate materials, tools, and machines extend our ability to solve problems and invent. They identify materials used to accomplish a design task based on the materials' specific properties, and explain which materials and tools are appropriate to construct a given prototype. They achieve a higher level of engineering design skill by recognizing a need or problem, learning different ways that the problem can be represented, and working with a variety of materials and tools to create a product or system to address the problem."

"Learning standards for grades 3–5 fall under the following two subtopics: *Materials and Tools;* and *Engineering Design."*

From the 2006 Massachusetts Science/Technology Standards (6th-8th grade):

- "**In grades 6–8**, teacher guidance remains important but allows for more variation in student approach. Students at this level are ready to formalize their understanding of what an experiment requires by controlling variables to ensure a fair test. Their work becomes more quantitative, and they learn the importance of carrying out several measurements to minimize sources of error. Because students at this level use a greater range of tools and equipment, they must learn safe laboratory practices (see Appendix IV). At the conclusion of their investigations, students in these grades can be expected to prepare reports of their questions, procedures, and conclusions."

Grades 6–8

- Formulate a testable hypothesis.
- Design and conduct an experiment specifying variables to be changed, controlled, and measured.
- Select appropriate tools and technology (e.g., calculators, computers, thermometers, meter sticks, balances, graduated cylinders, and microscopes), and make quantitative observations.
- Present and explain data and findings using multiple representations, including tables, graphs, mathematical and physical models, and demonstrations.
- Draw conclusions based on data or evidence presented in tables or graphs and make inferences based on patterns or trends in the data.
- Communicate procedures and results using appropriate science and technology terminology.
- Offer explanations of procedures, and critique and revise them.

Earth and Space Science

- "In **grades 6–8**, students gain sophistication and experience in using models, satellite images, and maps to represent and interpret processes and features. In the early part of this grade span, students continue to investigate geological materials' properties and methods of origin. As their experiments become more quantitative, students should begin to recognize that many of the earth's natural events occur because of processes such as heat transfer.

- Students in these grades should recognize the interacting nature of the earth's four major systems: the geosphere, hydrosphere, atmosphere, and biosphere. They should begin to see how the earth's movement affects both the living and nonliving components of the world. Attention shifts from the properties of particular objects toward an understanding of the place of the earth in the solar system and changes in the earth's composition and topography over time. Middle school students grapple with the importance and methods of obtaining direct and indirect evidence to support current thinking. They recognize that new technologies and observations change our explanations about how things in the natural world behave."

Life Science (Biology)

- "In **grades 6–8**, the emphasis changes from observation and description of individual organisms to the development of a more connected view of biological systems. Students in these grades begin to study biology at the microscopic level, without delving into the biochemistry of cells. They learn that organisms are composed of cells and that some organisms are unicellular and must therefore carry out all of the necessary processes for life within that single cell. Other organisms, including human beings, are multicellular, with cells working together. Students should observe that the cells of a multicellular organism can be physically very different from each other and should relate that fact to the specific role that each cell has in the organism (specialization). For example, cells of the eye or the skin or the tongue look different and do different things. Students in these grades also examine the hierarchical organization of multicellular organisms and the roles and relationships that organisms occupy in an ecosystem. As is outlined in the *National Science Education Standards*, students in grades 6–8 should be exposed in a general way to the systems of the human body but are not expected to develop a detailed understanding at this grade level. They should develop the understanding that the human body has organs, each of which has a specific function of its own, and that these organs together create systems that interact with each other to maintain life."

- "At the macroscopic level, students focus on the interactions that occur within ecosystems. They explore the interdependence of living things, specifically the dependence of life on photosynthetic organisms such as plants, which in turn depend upon the sun as their source of energy. Students use mathematics to calculate rates of growth, derive averages and ranges, and represent data graphically to describe and interpret ecological concepts.

  Learning standards for grades 6–8 fall under the following eight subtopics: *Classification of Organisms; Structure and Function of Cells; Systems in Living Things; Reproduction and Heredity; Evolution and Biodiversity; Living Things and Their Environment; Energy and Living Things;* and *Changes in Ecosystems Over Time."*

Physical Sciences (Chemistry and Physics)

- "In **grades 6–8**, students still need concrete, physical-world experiences to help them develop concepts associated with motion, mass, volume, and energy. As they learn to make accurate measurements using a variety of instruments, their experiments become more quantitative and their physical models more precise. Students in these grades are able to graph one measurement in relation to another, such as temperature change over time. They may collect data by using microcomputer- or calculator-based laboratories (MBL or CBL) and can learn to make sense immediately of graphical and other abstract representations essential to scientific understanding."

"Learning standards for grades 6–8 fall under the following five subtopics: *Properties of Matter; Elements, Compounds, and Mixtures; Motion of Objects; Forms of Energy;* and *Heat Energy."*

Technology/Engineering

- "In **grades 6–8**, students pursue engineering questions and technological solutions that emphasize research and problem solving. They identify and understand the five elements of a technology system (goal, inputs, processes, outputs, and feedback). They acquire basic safety skills in the use of hand tools, power tools, and machines. They explore engineering design; materials, tools, and machines; and communication, manufacturing, construction, transportation, and bioengineering technologies. Starting in grades 6–8 and extending through grade 10, the topics of power and energy are incorporated into the study of most areas of technology. Grades 6–8 students use knowledge acquired in their mathematics and science curricula to understand engineering. They achieve a more advanced level of skill in engineering design by learning to conceptualize a problem, design prototypes in three dimensions, and use hand and power tools to construct their prototypes, test their prototypes, and make modifications as necessary. The culmination of the engineering design experience is the development and delivery of an engineering presentation. Because of the hands-on, active nature of the technology/engineering environment, it is strongly recommended that it be taught by teachers who are certified in technology education, and who are very familiar with the safe use of tools and machines."

"Learning standards for grades 6–8 fall under the following seven subtopics: *Materials, Tools, and Machines; Engineering Design; Communication Technologies; Manufacturing Technologies; Construction Technologies; Transportation Technologies;* and *Bioengineering Technologies."*

From the 2006 Massachusetts Science/Technology Standards (High School):

- "**In high school**, students develop greater independence in designing and carrying out experiments, most often working alone or in small groups. They come up with questions and hypotheses that build on what they have learned from secondary sources. They learn to critique and defend their findings, and to revise their explanations of phenomena as new findings emerge. Their facility with using a variety of physical and conceptual models increases. Students in the final two years of high school can be encouraged to carry out extended independent experiments that explore a scientific hypothesis in depth, sometimes with the assistance of a scientific mentor from outside the school setting."

- "Preparation for post-secondary opportunities is another reason to provide regular laboratory and fieldwork experiences in high school science and technology/engineering courses. The Massachusetts Board of Higher Education's *Admissions Standards for the Massachusetts State Colleges and University* (www.mass.edu\a_f) states that three science courses, including two courses with laboratory work, must be completed in order to fulfill the minimum science requirement for admission to the Commonwealth's four-year public institutions. All high school courses based on the standards presented in this document should include substantial laboratory and/or fieldwork to allow all students the opportunity to meet or exceed this requirement of the Massachusetts Board of Higher Education."

High School

"This *Framework* introduces four **Scientific Inquiry Skills** (SIS) standards that are included in each introductory high school course (except Technology/Engineering, where they are replaced by the steps of the Engineering Design Process):

SIS1. Make observations, raise questions, and formulate hypotheses.
SIS2. Design and conduct scientific investigations.
SIS3. Analyze and interpret results of scientific investigations.
SIS4. Communicate and apply the results of scientific investigations.

"In each course, each Scientific Inquiry Skills standard includes an example skill set that further defines and articulates the standard."

"Also new to the 2006 *Framework* are the lists of **mathematical skills** needed for a solid understanding of each high school science and technology/engineering course. Engaging in science and technology/engineering often involves the use of mathematics to analyze and support findings of investigations or the design process. Most mathematical skills listed are based on grade-appropriate standards outlined in the *Massachusetts Mathematics Curriculum Framework.* Any specialized mathematical skills not detailed in the *Mathematics Framework* are listed separately. Please note that these lists are provided only as examples and are not exhaustive; the lists do not represent all mathematical skills students might need in a typical course."

Earth and Space Science

- "At the **high school** level, students review geological, meteorological, oceanographic, and astronomical data to learn about Earth's matter, energy, processes, and cycles. Through these data they also learn about the origin and evolution of the universe. Students gain knowledge about Earth's internal and external energy sources, local weather and climate, and the dynamics of ocean currents. Students learn about the renewable and non-renewable energy resources of Earth and what impact these have on the environment. Through learning about Earth's processes and cycles, students gain a better understanding of nitrogen and carbon cycles, the rock cycle, and plate tectonics. Students also learn about the origin of the universe and how scientists are currently studying deep space and the solar system."

"High school learning standards fall under the following four subtopics: *Matter and Energy in the Earth System; Energy Resources in the Earth System; Earth Processes and Cycles;* and *The Origin and Evolution of the Universe."*

Life Science (Biology)

- "At the **high school** level, a solid understanding of the processes of life allows students to make scientifically informed decisions related to their health and to the health of the planet. Students in high school study life through cell biology and genetics (molecular level), vertebrate anatomy and physiology (tissue and organ levels), and ecology (organism and population levels)."

- "Organic evolution, a concept fundamental to understanding modern biology, unifies these diverse topics. Students learn that the DNA molecule is the functional unit of the evolutionary process, and that it dictates all of the physical traits that are inherited across generations. They learn that variation in traits also is inherited and that the unit of inheritance is the gene. Students learn that variation can give some individuals a selective advantage – perhaps due to morphological, physiological or behavioral traits – that allow them to survive better, and to be more competitive in a given environment. This understanding provides students with a framework for explaining why there are so many different kinds of organisms on Earth; why organisms of distantly related species share biochemical, anatomical, and functional characteristics; why species become extinct; and how different kinds of organisms are related to one another."

"Learning standards for Biology at the high school level fall under the following six subtopics: *The Chemistry of Life; Cell Biology; Genetics; Anatomy and Physiology; Evolution and Biodiversity;* and *Ecology."*

Physical Sciences (Chemistry and Physics)

- "In **high school Chemistry**, students learn about the properties of matter and how these properties help to organize elements on the periodic table. Students develop a better understanding of the structure of the atom. Students develop an understanding of chemical reactions, including the involvement of energy and sub-atomic particles, to better understand the nature of chemical changes. Students learn about chemical reactions that occur around us every day as they learn about chemical reactions such as oxidation-reduction, combustion, and decomposition. Students also gain a deeper understanding of acids and bases, rates of

reactions, and factors that affect those rates. From calculating stoichiometry problems and molar concentrations, students learn about proportionality and strengthen their mathematical skills."

"Learning standards for high school Chemistry fall under the following eight subtopics: *Properties of Matter; Atomic Structure and Nuclear Chemistry; Periodicity; Chemical Bonding; Chemical Reactions and Stoichiometry; States of Matter, Kinetic Molecular Theory, and Thermochemistry; Solutions, Rates of Reaction, and Equilibrium;* and *Acids and Bases and Oxidation-Reduction Reactions."*

- "In **high school Introductory Physics**, students recognize the nature and scope of physics, including its relationship to the other sciences. Students learn about basic topics such as motion, forces, energy, heat, waves, electricity, and magnetism. They learn about natural phenomena by using physical laws to calculate quantities such as velocity, acceleration, momentum, and energy."

- "Students of introductory physics learn about the relationships between motion and forces through Newton's laws of motion. They study the difference between vector and scalar quantities and learn how to solve basic problems involving these quantities. Students learn about conservation of energy and momentum and how these are applied to everyday situations. They learn about heat and how thermal energy is transferred throughout the different phases of matter. Students extend their knowledge of waves and how they carry energy. Students gain a better understanding of electric current, voltage, and resistance by learning about Ohm's law. They also gain knowledge about the electromagnetic spectrum in terms of wavelength and frequency."

"Learning standards for high school Introductory Physics fall under the following six subtopics: *Motion and Forces; Conservation of Energy and Momentum; Heat and Heat Transfer; Waves; Electromagnetism;* and *Electromagnetic Radiation."*

Technology/Engineering

- "In **high school,** students develop their ability to solve problems in technology/engineering using mathematical and scientific concepts. High school students are able to relate concepts and principles they have learned in science with knowledge gained in the study of technology/engineering. For example, a well-rounded understanding of energy and power equips students to tackle such issues as the ongoing problems associated with energy supply and energy conservation."

- "In a high school technology/engineering course, students pursue engineering questions and technological solutions that emphasize research and problem solving. They achieve a more advanced level of skill in engineering design by learning how to conceptualize a problem, develop possible solutions, design and build prototypes or models, test the prototypes or models, and make modifications as necessary. Throughout the process of engineering design, high school students are able to work safely with hand and/or power tools, various materials and equipment, and other resources. In high school, courses in technology/engineering should be taught by teachers who are certified in that discipline and who are familiar with the safe use of tools and machines."

"Learning standards for high school fall under the following seven subtopics: *Engineering Design; Construction Technologies; Energy and Power Technologies—Fluid Systems; Energy and Power Technologies—Thermal Systems; Energy and Power Technologies—Electrical Systems; Communication Technologies;* and *Manufacturing Technologies."*