Standard 1: Life Science

No standards apply.

Standard 2: Physical Science

As a basis for understanding Physical Science, students will develop the following knowledge, skills and understandings:

2.1 Students understand the structure and properties of matter.

2.1.1 Matter can be classified between pure substances (elements and compounds) and mixtures (heterogeneous and homogenous).

- 2.1.1.1 Differentiate between solutions (homogenous mixtures) and suspensions; including colloids.
- 2.1.1.2 Separate, purify, and identify pure substance through the process of filtration, chromatography, distillation, and reverse osmosis.
- 2.1.1.3 Use element symbols to devise chemical formulas.

2.1.2 Early and Modern Atomic Theories have impacted current atomic models.

- 2.1.2.1 Understand Dalton's Atomic Theory and the major contributions leading up to his theory.
- 2.1.2.2 Use experimental basis to account for Thomson's discovery of the electron and Rutherford's discovery of the nucleus.
- 2.1.2.3 Understand the experimental basis for the development of the quantum theory of the Bohr and Modern Atomic Models.

2.1.3 Rutherford-Bohr models incorporate protons, neutrons, and electrons in their appropriate locations.

- 2.1.3.1 Relate the size and mass of the nucleus to the size and mass of the atom.
- 2.1.3.2 Know the relationship between atomic number (Z), atomic mass number (A), and the existence of isotopes.
- 2.1.3.3 Know that most elements have two or more isotopes (having little effect on how the atom chemically interacts with others) effecting the mass and stability of the nucleus.
- 2.1.3.4 Connect the charge of sub atomic particles to the electric force holding the atom together.
- 2.1.3.5 Calculate the number of electrons in an atom therefore determining whether the atom is electrically neutral or an ion.

2.1.4 Modern atomic structure can be derived using information off the periodic table, quantum analysis, and probability.

- 2.1.4.1 The quantum energy levels of atoms can be used to derive their structure and as a "fingerprint" for identification.
- 2.1.4.2 Determine valence configurations for atoms and relate the position of an element in the periodic table to its reactivity with other elements in the table.

2.1.5 The Periodic Table shows how periodicity of the physical and chemical properties of the elements relates to atomic structure.

- 2.1.5.1 Understand the history and development of the periodic table; starting with Mendeleev's vision.
- 2.1.5.2 Compare and contrast families, groups, periods, and/or series of elements on the periodic table.
- 2.1.5.3 Use the periodic table to identify representative and transition elements, metals, nonmetals, metalloids, the alkali metals, alkaline earth metals, halogens, and noble gases.
- 2.1.5.4 Know the nature and properties of ionic and covalent bonding between atoms and predict, using the periodic table, the general nature of bonding between atoms.

2.1.6 Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules.

2.1.6.1 Know that salt crystals are repeating patterns (lattices) of cations and anions held together by electrostatic attractions.

2.1.7 The chemical nomenclature system is used to descriptively name binary ionic, binary covalent, polyatomic, and acidic compounds.

2.1.8 Nuclear Processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fissions, and nuclear fusion.

2.1.8.1 Know that protons and neutrons in the nucleus are held together by nuclear forces that overcome proton-proton repulsions.

2.1.8.2 Identify the three most common forms of radioactive decay (alpha, beta, & gamma).

2.1.8.3 Know that the energy release in fission and fusion reactions is several magnitudes greater than energy releases in chemical and physical processes.

2.1.9 Students understand organic chemistry.

2.1.9.1 The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life.

2.1.9.2 Recognize the difference between carbon compounds that are classified as organic and those that are classified inorganic.

2.1.9.3 Distinguish monomers for some common polymers.

2.1.9.4 Alkanes, alkenes and alkynes differ in their properties and reactivities.

2.1.9.5 Organic functional groups have specific reactive characteristics.

2.2 Students understand chemical reactions.

2.2.1 Chemical reactions are processes in which reactants are re-arranged into products (different combinations of atoms).

2.2.1.1 Identify synthesis, decomposition, single replacement, double replacement, precipitation, acid-base, and oxidation-reduction reactions.

2.2.1.2 Classify relevant chemicals into Acids and Bases based on their electrolytes.

2.2.1.3 Distinguish among acid-base constituents of Arrhenius, Brønsted-Lowry, and Lewis.

2.2.2 The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants; stoichiometry.

2.2.3 Chemical Equilibrium is a dynamic process at the molecular level.

2.2.3.1 Apply Le Chatelier's Principle and relate shifts in physical and chemical systems at equilibrium to the stresses applied.

2.3 Students understand the sources and properties of energy - in structure, reactions, phases, and solutions.

2.3.1 Energy cannot be created nor destroyed; including work and power.

2.3.1.1 Define mechanical energy as the sum of potential and kinetic energy.

2.3.1.2 Determine, quantitatively, the relationships among the kinetic, gravitational potential and total mechanical energies of a mass at any point between maximum potential energy and maximum kinetic energy.

2.3.1.3 Recall work as a measure of the mechanical energy transferred and power as the rate of doing work.

2.3.1.4 Describe power qualitatively and quantitatively.

2.3.1.5 Describe, qualitatively, the change in mechanical energy in a system that is not isolated.

2.3.2 In many natural processes, energy is transferred to the environment as heat.

2.3.3 Energy can be considered either potential, kinetic, or contained by a field (electromagnetic fields).

2.3.3.1 Understand how electric forces hold atoms and molecules together.

2.3.4 Energy is exchanged or transformed in all chemical reactions and physical changes of matter.
- 2.3.4.1 Understand chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules such as concentration, temperature and pressure.
- 2.3.4.2 Explain the role of activation energy in chemical reactions.
- 2.3.4.3 Explain the role of a catalyst in chemical reactions.

2.3.5 The kinetic Molecular Theory describes the motion of atoms and molecules; specifically temperature and heat.
- 2.3.5.1 Distinguish between exothermic and endothermic processes.
- 2.3.5.2 Understand radical reactions and their role in natural and human processes, i.e., ozone, greenhouse gases, burning fossil fuels, forming polymers.

2.3.6 Phase diagrams interpret changes of state under different conditions.
- 2.3.6.1 Relate vapor pressure and temperature.

2.3.7 The kinetic Molecular Theory explains the properties of gases.
- 2.3.7.1 Know the random motion of gas particles and their collisions with a surface create observable pressure on that surface.
- 2.3.7.2 Know the values and understand the meanings of standard temperature and pressure (STP).
- 2.3.7.3 Apply the gas laws (including the Boyle's Law and Charle's Law) to relations between the pressure, temperature, and volume of a gas sample.
- 2.3.7.4 Understand how the kinetic molecular theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.

2.3.8 Solutions are homogenous mixtures of two or more substances.
- 2.3.8.1 Describe the dissolving process at the molecular level using concepts of solute and solvent.
- 2.3.8.2 Understand how structural, temperature, pressure and surface area affect the dissolving process.

2.3.9 Natural and technological systems use physical, chemical, and nuclear change to produce nuclear energy.

2.4 Students understand forces and motion.

2.4.1 Motion is defined using distance, time, and a frame of reference.
- 2.4.1.1 Know and understand the difference between distance and displacement.
- 2.4.1.2 Know and understand the difference between average and instantaneous speed/velocity.
- 2.4.1.3 Interpret motion graphs; distance vs. time and velocity vs. time.
- 2.4.1.4 Draw and interpret vector quantities; including addition and subtraction.
- 2.4.1.5 Understand acceleration is a change in velocity.

2.4.2 Newton's Laws predict the motion of most objects.
- 2.4.2.1 Explain the effects of balanced and unbalanced forces on velocity.
- 2.4.2.2 Explain that a nonzero net force causes a change in velocity.
- 2.4.2.3 Apply Newton's first law of motion to explain, qualitatively, an object's state of rest or uniform motion.
- 2.4.2.4 apply Newton's second law of motion to explain, qualitatively, the relationships among net force, mass and acceleration.
- 2.4.2.5 Apply Newton's third law of motion to explain, qualitatively, the interaction between two objects, recognizing that the two forces, equal in magnitude and opposite in direction, do not act on the same object.
- 2.4.2.6 Describe the different types of forces.

2.4.3 Explain qualitatively static, kinetic, and rolling forces of friction acting on an object.

2.4.4 Students understand gravitational effects extend throughout the universe.
- 2.4.4.1 Identify the gravitational force as one of the fundamental forces in nature.
- 2.4.4.2 Describe qualitatively Newton's law of universal gravitation.
- 2.4.4.3 Define the term "field" as a concept that replaces "action at a distance" and apply the concept to describe gravitational effects.
- 2.4.4.4 Predict, quantitatively, differences in the weight of objects on different planets.

2.4.5 Students will be able to explain circular motion using Newton's laws of motion.
- 2.4.5.1 Explain, qualitatively, uniform circular motion in terms of Newton's laws of motion.
- 2.4.5.2 Explain, quantitatively, planetary and natural and artificial satellite motion, using circular motion to approximate elliptical orbits.

2.4.6 Students will understand momentum and impulse.
- 2.4.6.1 Explain how momentum is conserved when objects interact in an isolated system.
- 2.4.6.2 Define momentum as a vector quantity equal to the product of the mass and the velocity of an object.
- 2.4.6.3 Explain, quantitatively, the concepts of impulse and change in momentum, using Newton's laws of motion.
- 2.4.6.4 Explain, qualitatively, that momentum is conserved in an isolated system.
- 2.4.6.5 Explain, qualitatively, that momentum is conserved in one- and two-dimensional interactions in an isolated system.
- 2.4.6.6 Define, compare and contrast elastic and inelastic collisions, using quantitative examples, in terms of conservation of kinetic energy.

2.4.7 Simple Machines manipulate work and power through mechanical advantage.
- 2.4.7.1 Identify the different types of simple machines while stating their purpose.
- 2.4.7.2 Identify and describe input/output distance and input/output force.
- 2.4.7.3 Describe qualitatively and quantitatively mechanical advantage.
- 2.4.7.4 Identify the difference between actual and ideal mechanical advantage.
- 2.4.7.5 Describe qualitatively and quantitatively efficiency in a machine.
- 2.4.7.6 Identify compound machines within the real world; classifying their parts.

2.4.8 Fluids exert force in the form of pressure.
- 2.4.8.1 Define and identify fluids.
- 2.4.8.2 Define pressure as a force distributed over an area; acting from all directions within a fluid.
- 2.4.8.3 Know the relationship between pressure and depth of a fluid.
- 2.4.8.4 Describe Pascal's Principle.
- 2.4.8.5 Apply Pascal's Principle to hydraulic systems.
- 2.4.8.6 Know Bernoulli's Principle; connecting it to real life examples.
- 2.4.8.7 Understand that all fluids exert a buoyant force; Archimedes Principle.
- 2.4.8.8 Know how density relates to buoyancy.

2.5 Students understand waves and optics.

2.5.1 Waves have characteristic properties that do not depend on the type of wave (mechanical and electromagnetic).

2.5.2 Optics can be explained using wave theory.

2.5.3 Explain the nature and behavior of EMR, using the wave model.
- 2.5.3.1 Compare and contrast the constituents of the electromagnetic spectrum on the basis of frequency and wavelength.
- 2.5.3.2 Understand that all electromagnetic waves travel at the speed of light.
- 2.5.3.3 Describe, qualitatively, diffraction, interference and polarization.
- 2.5.3.4 Compare and contrast the visible spectra produced by diffraction gratings and triangular prisms.

2.6 Students understand electricity and magnetism.

2.6.1 Students will understand the behavior of electrical charges, using the laws that govern electrical interactions.
2.6.2 Students will be able to describe electrical phenomena, using the electrical field theory.
2.6.3 Student will be able to understand the properties of electric and magnetic fields.

Standard 3: Earth and Space Science

As a basis for understanding Earth and Space Science, students will develop the following knowledge, skills and understandings:

3.1 Students understand the composition and structure of the universe.

3.1.1 Know the heat energy inside the Earth and radiation from the Sun provides the energy for Earth's processes.

3.2 Students understand Earth's composition and structure.

3.2.1 Know that rocks are formed from minerals, our world is built from rocks, and rocks can change into other rocks over time through the rock cycle.
3.2.2 Understand the concept of plate tectonics and how this process over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis of this concept students should know:
- 3.3.2.1 Effects of the movement of crustal plates which produce earthquakes and volcanoes.
- 3.3.2.2 Features of the ocean floor (magnetic patterns, sea-floor topography) provide evidence of plate tectonics.
- 3.3.2.3 The principal structures that form at the three different kinds of plate boundaries.
- 3.3.2.4 The properties of basaltic vs. granite with regards to the composition of the plates.
- 3.3.2.5 The three different kinds of volcanoes and their characteristics.
- 3.3.2.6 Plate boundaries and the various types of earthquakes produced by plate movement along boundaries.

3.3 Students understand the composition and structure of the atmosphere.

3.3.1 Understand that life has changed Earth's atmosphere and changes in the atmosphere affect conditions for life. As a basis for this understanding students should know:
- 3.3.1.1 The thermal and chemical composition of the atmosphere.
- 3.3.1.2 The location of the ozone layer in the upper atmosphere; its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities.
- 3.3.1.3 Energy from the sun supplies the atmosphere's energy and ultimately provides the starting point for movement within the atmosphere.

3.4 Heating of the Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

3.4.1 Know that differential heating of the Earth results in circular patterns in the oceans and atmosphere that globally distribute heat.
3.4.2 Know the Coriolis Effect which is the relationship between the rotation of the Earth and the circular motions of ocean currents and air in pressure centers.
3.4.3 Know the properties of ocean water with regards to salinity and temperature, and how these properties can be used to explain vertical ocean currents.
3.4.4 Know how wind also drives the production of waves in the ocean and how waves affect the shape of coastal areas.

Standard 4: Nature of Science and Global Issues

As a basis for understanding the nature of science as it relates to scientific knowledge, scientific inquiry, and scientific enterprise and to address content in the other standards students will:

4.1 Apply proper scientific measures when solving problems.

4.1.1 Know and employ metric units when measuring and problem solving:
- 4.1.1.1 **Identify the seven major SI and laboratory metric units, i.e., meter, kilogram, second, ampere, Kelvin, mole, and candela.**
- 4.1.1.2 **Convert between prefixes nano to mega within the metric system.**
- 4.1.1.3 **Differentiate and convert between the two temperature scales; Celsius and Kelvin.**
- 4.1.1.4 **Contrive and solve derived values (volume and density) using correct SI units.**

4.1.2 Use problem solving strategies (including dimensional analysis) to solve mathematical problems.
- 4.1.2.1 **Identify the potentially important information given in a problem when choosing an appropriate solution.**
- 4.1.2.2 **Determine the true question and/or conceptual premise; applying appropriate units when applicable.**
- 4.1.2.3 **Properly manipulate conversion factors to dimensional analysis questions.**

4.1.3 Reason unavoidable sources of error when discussing accuracy and precision (uncertainty) of results; examples include human, instrumental, systematic, and random errors.
- 4.1.3.1 **Reason the number of significant digits, accuracy, and precision in problems and laboratory tools.**
- 4.1.3.2 **Answer mathematical operations using scientific notation.**

4.1.4 Demonstrate safety procedures within lab situations:
- 4.1.4.1 **Demonstrate proper lab safety.**
- 4.1.4.2 **Locate and explain how to properly use safety equipment in the lab.**

4.1.5 Use technology and mathematics (e.g. measurement, formulas, charts, graphs) to perform accurate scientific investigations and communications.
- 4.1.5.1 **Select and use appropriate lab tools, measuring devises, calculators, computers, probe ware, etc., correctly during investigations.**
- 4.1.5.2 **Utilize appropriate measurements, formulas, charts, graphs, etc. when analyzing laboratory data.**

4.2 Investigate the natural world using scientific inquiry.

4.2.1 Effectively contribute to a collaborative group; including accepting roles, following norms, and successfully communicating.

4.2.2 Design and conduct open ended scientific investigations; confirming scientific laws, theories, and models; or to explore new aspects of the natural world and new areas of science.

4.2.3 Devise investigations that:
- 4.2.3.1 **Identify a focused problem or research question.**
- 4.2.3.2 **Formulate testable hypotheses that is related to the research question; supporting it quantitatively when appropriate.**
- 4.2.3.3 **Select relevant independent and dependent variables.**
- 4.2.3.4 **Identify and clarify the method and controls; using appropriate apparatus.**
- 4.2.3.5 **Demonstrate competence in using laboratory equipment (seeking assistance when required); paying attention to safety issues.**
- 4.2.3.6 **Adapt to new and unforeseen circumstances while following instructions.**
- 4.2.3.7 **Employ methods that collect sufficient and relevant quantitative and/or qualitative data; using appropriate units.**
- 4.2.3.8 **Organize and display raw data for easier interpretation and analysis data.**
- 4.2.3.9 **Determine errors, their quantitative/qualitative effects they have on results, and calculate percent error when possible.**
- 4.2.3.10 **Formulate a conclusion based on interpretation of results with an explanation, and, where appropriate, compare results with literature values.**
- 4.2.3.11 **Receive critical response from others.**

4.2.4 Reason that when conditions of an investigation cannot be controlled, it may be necessary to discern patterns by observing a wide range of natural occurrences.

4.2.5 Know that conceptual principles and knowledge guide scientific inquiries; historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

4.2.6 Comprehend why scientists conduct investigations:

- 4.2.6.1 **To discover new aspects of the natural world.**
- 4.2.6.2 **To explain recently observed phenomena.**
- 4.2.6.3 **To test the conclusions of prior investigations.**
- 4.2.6.4 **To test predictions of current theories.**

4.2.7 Appreciate that investigations and public communication among scientists must meet specific criteria in order to be accepted as new knowledge and methods:

- 4.2.7.1 **Strive for certainty of proposed solutions using experimental standards.**
- 4.2.7.2 **Pursue arguments that are logical and do demonstrate connections between natural phenomena, investigations, and the historical body of scientific knowledge.**
- 4.2.7.3 **Convey explanations with logical structure and rules of evidence.**
- 4.2.7.4 **Show commitment to making public their methods, procedures, and conclusions.**
- 4.2.7.5 **Report methods and procedures used to obtain evidence to enhance opportunities for further research.**
- 4.2.7.6 **Understand the logical and empirical communication among scientists and the public leads to new accountable information.**
- 4.2.7.7 **Continually test, revise, and occasionally discard theories to allow for critical response from others.**
- 4.2.7.8 **Know that all current scientific knowledge in principle is subject to change as new evidence become available.**

4.2.8 Understand the Nature of Science Inquiry is driven by the desire to understand the natural world and seeks to answer questions that may or may not directly influence humans.

4.3 Evaluate the acquisition, development, and modification of scientific knowledge in the past, present, and future.

4.3.1 Know ways in which science distinguishes itself from other bodies of knowledge, through use of empirical standards and logical arguments.

4.3.2 Be aware that scientific explanations must meet certain criteria to be considered valid:

- 4.3.2.1 **Must be consistent with experimental and observational evidence about nature.**
- 4.3.2.2 **Make accurate predictions about systems being studied.**
- 4.3.2.3 **Be logical.**
- 4.3.2.4 **Respect rules of evidence.**
- 4.3.2.5 **Be open to criticism.**
- 4.3.2.6 **Report methods and procedures.**
- 4.3.2.7 **Make a commitment to making knowledge public.**

4.3.3 Reason how scientific knowledge changes and accumulates over time:

- 4.3.3.1 **Comprehend that all scientific knowledge is subject to change as new evidence becomes available.**
- 4.3.3.2 **Know that some scientific ideas are incomplete and opportunity exists in these areas for new advances.**
- 4.3.3.3 **Know that scientific knowledge is continually tested, revised, and occasionally discarded as new evidence is obtained.**

4.3.4 Accept and anticipate that from time to time, major shifts occur in the scientific view of how the world works, but usually the changes that take place in the body of scientific knowledge are usually small modifications of prior knowledge.

4.4 Examine how science and its enterprises impact society.

4.4.1 Compare and Contrast Science and Technology.

4.4.2 Reflect that, throughout history, diverse cultures have developed scientific ideas and solved human problems through technology.

4.4.3 Understand that individuals and teams contribute to scientific knowledge and understanding at different levels of complexity:
- 4.4.3.1 **Conducting basic field studies or improving advanced technology.**
- 4.4.3.2 **Creating New Technologies.**
- 4.4.3.3 **Solving technological problems.**
- 4.4.3.4 **Collaborating (sometimes between hundreds of people) on a major scientific question or technological problem.**

4.4.4 Comprehend the free and rapid interplay of theoretical ideas and experiments results in published scientific literature maintains crucial links between scientific fields.

4.4.5 Develop information and technology skills which are essential in modern scientific endeavors.

4.4.6 Appreciate that progress in Science/Technology can relate to social issues and challenges (eg. Funding priorities, health problems).

4.4.7 Understand that there are ethical traditions associated with the scientific enterprise:
- 4.4.7.1 Be committed to peer review.
- 4.4.7.2 Report truthfully about methods and outcomes of investigations.
- 4.4.7.3 Publish results of work with the expectation of peer review.
- 4.4.7.4 Scientists who violate these traditions are censored by their peers.

4.4.8 Consider that scientists and engineers can only conduct research on human subjects or stem cells if they have the consent of the subjects or governing bodies.

4.4.9 Accept that technology is often driven by the desire to help meet human needs, solve human problems, and fulfill human aspirations.

4.4.10 Be able to assess a proposal from a scientific enterprise; including questions about: alternatives, risks, costs, benefits, consideration of who benefits, who suffers, who pays, who gains, and who bears the risks.

4.4.11 Validate that credible technological resources come from professional presentations, journal publications, and data bases.

4.4.12 Understand that science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen.

4.4.13 Acknowledge science is interdependent on different fields of study in different disciplines.
- 4.4.13.1 **Scientists in different disciplines ask different questions, use different methods of investigation and accept different types of evidence to support their explanations.**
- 4.4.13.2 **Many scientific investigations require the contributions of individuals from different disciplines.**
- 4.4.13.3 **New disciplines of science (such as geophysics, biochemistry, and genomics) often emerge at the interface of older disciplines.**

4.4.14 Undergo searches for current areas where data, information, and understanding are incomplete; therefore providing the best opportunity for students to advance in the science related career opportunities.

4.4.15 Comprehends that creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

4.5 Students understand the connections between science, global issues and sustainable solutions.

As a basis for this, students will understand:

4.5.1 Climate Change (Global Warming)
4.5.2 Biodiversity and Ecosystem Losses
4.5.3 Fisheries Depletion
4.5.4 Deforestation
4.5.5 Water Deficits
4.5.6 Air, Water and Soil Pollution
4.5.7 Global Infectious Diseases
4.5.8 Natural Disaster Prevention and Mitigation
4.5.9 Human Population Dynamics
4.5.10 Unsustainable Land Use (unsustainable agriculture, livestock grazing, urban sprawl, landfills, hazardous waste, mining and mineral extraction)
4.5.11 Solid Waste Management (waste minimization, recycling, closed loop systems)

4.5.12 Energy Conservation, alternative energy, alternative fuels