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 Know the structure of an atom:

- 2.1.1.1 Negative electrons occupy most of the space in the atom.
- 2.1.1.2 Neutrons and positive protons make up the nucleus of the atom.
- 2.1.1.3 Protons and neutrons are almost two thousand times heavier than an electron.
- 2.1.1.4 The electric force between the nucleus and electrons hold the atom together.

2.1.2 Know that the number of electrons in an atom determines whether the atom is electrically neutral or an ion:

- 2.1.2.1 Electrically neutral atoms contain equal numbers of protons and electrons.
- 2.1.2.2 A positively charged atom has lost one or more electrons.
- 2.1.2.3 A negatively charged atom has gained one or more electrons.

2.1.3 Understand atomic physics.

2.2 Students understand chemical reactions.

2.3 Students understand the sources and properties of energy.

2.3.1 Understand energy as the ability to cause change.

- 2.3.1.1 Investigate and analyze energy storage and transfer mechanisms:Gravitational potential energy
  - 2.3.1.1.1 Elastic potential energy
  - 2.3.1.1.2 Thermal energy
  - 2.3.1.1.3 Kinetic energy
- 2.3.1.2 Analyze, evaluate, and apply the principle of conservation of energy.

2.3.2 Understand wave motion and the wave nature of sound and light.

- 2.3.2.1 Analyze, investigate, and evaluate the relationship among the characteristics of waves: wavelength, frequency, period, amplitude.
- 2.3.2.2 Describe the behavior of waves in various media.
- 2.3.2.3 Analyze the behavior of waves at boundaries between media.
  - 2.3.2.3.1 Kinetic energy (energy of motion)
  - 2.3.2.3.2 Potential energy (depends on relative position)
  - 2.3.2.3.3 Energy contained by a field (electromagnetic waves)

2.3.2.4 Analyze, evaluate, and measure the transfer of energy by a force.
- 2.3.2.4.1 Work
- 2.3.2.4.2 Power

2.3.2.5 Design and conduct investigations of:
- 2.3.2.5.1 Mechanical energy
- 2.3.2.5.2 Power

2.4 Students understand forces and motion.

2.4.1 Understand kinematics and dynamics.

2.4.2 Understand Newton's Laws of Motion.

- 2.4.2.1 Determine that an object will continue in its state of motion unless acted upon by a net outside force (Newton's First Law of Motion, The Law of Inertia).
- 2.4.2.2 Assess, measure and calculate the conditions required to maintain a body in a state of static equilibrium.
- 2.4.2.3 Assess, measure, and calculate the relationship among the force acting on a body, the mass of the body, and the nature of the acceleration produced (Newton's Second Law of Motion).
- 2.4.2.4 Analyze and mathematically describe forces as interactions between bodies (Newton's Third Law of Motion).
- 2.4.2.5 Assess the independence of the vector components of forces.
- 2.4.2.6 Investigate, measure, and analyze the nature and magnitude of frictional forces.
- 2.4.2.7 Assess and calculate the nature and magnitude of gravitational forces (Newton's Law of Universal Gravitation).

2.4.3 Understand two dimensional motion - including circular motion - work and energy.

- 2.4.3.1 Analyze and evaluate projectile motion in a defined frame of reference.
- 2.4.3.2 Design and conduct investigations of two-dimensional motion of objects.
- 2.4.3.3 Analyze and evaluate independence of the vector components of projectile motion.
- 2.4.3.4 Evaluate, measure, and analyze circular motion.
- 2.4.3.5 Analyze and evaluate the nature of centripetal forces.
- 2.4.3.6 Investigate, evaluate and analyze the relationship among:
  - 2.4.3.6.1 Centripetal force
  - 2.4.3.6.2 Centripetal acceleration
  - 2.4.3.6.3 Mass
  - 2.4.3.6.4 Velocity
  - 2.4.3.6.5 Radius

2.4.4 Know that laws of motion can be used to determine the effects of forces on the motion of objects:

- 2.4.4.1 Objects change their motion only when a net force is applied
- 2.4.4.2 Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object; the magnitude of the change in motion can be calculated using the relationship F=ma, which is independent of the nature of the force.

2.4.5 Analyze velocity as a rate of change of position:

- 2.3.1.1 Average velocity.
- 2.3.1.2 Instantaneous velocity.

2.4.6 Analyze acceleration as rate of change in velocity.

2.4.7 Using graphical and mathematical tools, design and conduct investigations of linear motion and the relationships among:
- 2.3.1.3 Position
- 2.3.1.4 Average velocity
- 2.3.1.5 Instantaneous velocity
- 2.3.1.6 Acceleration
- 2.3.1.7 Time

2.4.8 Understand impulse and momentum.
- 2.4.8.1 Assess the vector nature of momentum and its relation to the mass and velocity of an object.
- 2.4.8.2 Compare and contrast impulse and momentum.
- 2.4.8.3 Analyze the factors required to produce a change in momentum.
- 2.4.8.4 Analyze one-dimensional interactions between objects and recognize that the total momentum is conserved in both collision and recoil situations.
- 2.4.8.5 Assess real world applications of the impulse and momentum, including but not limited to, sports and transportation.

2.4.9 Understand oscillatory motion and mechanical waves.

2.5 Students understand waves and optics.

2.5.1 Understand wave motion and the wave nature of sound and light.
- 2.5.1.1 Analyze, investigate, and evaluate the relationship among the characteristics of waves: wavelength, frequency, period, amplitude.
- 2.5.1.2 Describe the behavior of waves in various media
- 2.5.1.3 Analyze the behavior of waves at boundaries between media.
- 2.5.1.4 Understand Reflection, including the Law of Reflection.
- 2.5.1.5 Analyze the relationship between the phenomena of interference and the principle of superposition.
- 2.5.1.6 Know that waves (e.g. Sound, seismic, water, light) have energy and can transfer energy when they interact with matter
- 2.5.1.7 Analyze the frequency and wavelength of sound produced by a moving source (the Doppler Effect).

2.6 Students understand electricity and magnetism.

2.6.1 Understand static electricity and direct current electrical circuits.
- 2.6.1.1 Analyze the nature of electrical charges.
- 2.6.1.2 Investigate the electrical charging of objects due to transfer of charge
- 2.6.1.3 Investigate the conservation of electric charge.
- 2.6.1.4 Analyze the relationship among force, charge and distance summarized in Coulomb's law.
- 2.6.1.5 Analyze and measure the relationship among potential difference, current, and resistance in a direct current circuit s.
- 2.6.1.6 Analyze and measure the relationship among current, voltage, and resistance in circuits.
  - 2.6.1.6.1 Series.
  - 2.6.1.6.2 Parallel.
  - 2.6.1.6.3 Series-parallel combinations.
  - 2.6.1.6.4 Analyze and measure the nature of power in an electrical circuit.

2.6.2 Understand magnetic forces and fields.

2.6.3 Understand electromagnetic radiation.

2.6.4 Know that waves (e.g., sound, seismic, water, light) have energy and can transfer energy when they interact with matter.

2.6.5 Know the range of the electromagnetic spectrum.

2.6.6 Know that magnetic forces are very closely related to electric forces and can be thought of as different aspects of a single electromagnetic force:

2.6.6.1 Moving electric charges produce magnetic forces and moving magnets produce electric forces.

2.6.6.2 The interplay of these forces is the basis for electric motors, generators, radio, television, and many other modern technologies.

2.6.7 Know that nuclear forces are much stronger than electromagnetic forces, which are vastly stronger than gravitational forces, and the strength of nuclear forces explains why great amounts of energy are released from the nuclear reactions in atomic or hydrogen bombs, and in the sun and other stars.

2.6.8 Know that the strength of the gravitational force between two masses is proportional to the masses and inversely proportional o the square of the distance between them.

2.6.9 Know that the strength of the electric force between two charged objects is proportional to the charges (opposite charges attract whereas like charges repel) and, as with gravitation, inversely proportional to the square of the distance between them.

2.6.10 Know that electromagnetic forces exist within and between atoms:

2.6.10.1 Electric forces between oppositely charges electrons and protons hold atoms and molecules together, and are involved in all chemical reactions

2.6.10.2 Electric forces hold solid and liquid materials together and act between objects when they are in contact.

2.6.11 Know how different kinds of materials respond to electric forces:

2.6.11.1 As insulators, semiconductors, conductors, superconductors.

2.6.12 Know that materials that contain equal proportions of positive and negative charges are electrically neutral, but a very small excess or deficit of negative charges in a material produces noticeable electric forces.

Standard 3: Earth and Space Science

No standards apply.

Standard 4: Nature of Science

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, Probeware, 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 relate 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 (e.g., 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 Comprehend that creativity, imagination, and a good knowledge base are all required in the work of science and engineering

4.5 Students understand the connections among 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