# Physical Science

| State Standard Number | State Standard Area/Description | Unit Name | Course Topic Description |
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| 1.9-12 SYS | Systems | | |
| 0 | Predictability and Feedback | | |
| 1.9-12 SYSA | Feedback is a process in which the output of a system provides information used to regulate the operation of the system. Positive feedback increases the disturbance to a system. Negative feedback reduces the disturbance to a system. | | |
| 1.9-12 SYSA.1 | Give examples of a positive feedback system and explain its regulatory mechanism (e.g., global warming causes Earth's ice caps to melt, reflecting less energy to space, increasing temperatures). | | |
| 1.9-12 SYSA.2 | Give examples of a negative feedback system and explain its regulatory mechanism (e.g., when a human body overheats, it produces sweat that cools the body by evaporation). | | |
| 1.9-12 SYSB | Systems thinking can be especially useful in analyzing complex situations. To be useful, a system needs to be specified as clearly as possible. | | |
| 1.9-12 SYSB.1 | Determine if a systems approach will be helpful in answering a question or solving a problem. | | |
| 1.9-12 SYSB.2 | Represent the system with a diagram specifying components, boundaries, flows, and feedbacks. | | |
| 1.9-12 SYSB.3 | Describe relevant subsystems and the larger system that contains the system being analyzed. | | |
| 1.9-12 SYSB.4 | Determine how the system functions with respect to other systems. | | |

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| 1.9-12 SYSC | In complex systems, entirely new and unpredictable properties may emerge. Consequently, modeling a complex system in sufficient detail to make reliable predictions may not be possible. | | |
| 1.9-12 SYSC.1 | Create a simplified model of a complex system. Trace the possible consequences of a change in one part of the system and explain how the simplified model may not be adequate to reliably predict consequences. | | |
| 1.9-12 SYSD | Systems can be changing or in equilibrium. | | |
| 1.9-12 SYSD.1 | Analyze whether or not a system (e.g., population) is changing or in equilibrium. | | |
| 1.9-12 SYSD.2 | Determine whether a state of equilibrium is static or dynamic (e.g., inflows equal outflows). | | |
| 2.9-12 INQ | Inquiry | | |
| 0 | Conducting Analyses and Thinking Logically | | |

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| 2.9-12 INQA | Scientists generate and evaluate questions to investigate the natural world. | | |
| 2.9-12 INQA.1 | Generate and evaluate a question that can be answered through a scientific investigation. Critique questions generated by others and explain whether or not the questions are scientific. | Scientific Nature | Section B<br>Questions and Hypotheses |
| 2.9-12 INQB | Scientific progress requires the use of various methods appropriate for answering different kinds of research questions, a thoughtful plan for gathering data needed to answer the question, and care in collecting, analyzing, and displaying the data. | | |
| 2.9-12 INQB.1 | Plan and conduct a scientific investigation, choosing a method appropriate to the question being asked. | Scientific Inquiry | Section E<br>Unit Project : Scientific Inquiry |
| 2.9-12 INQB.2 | Collect, analyze, and display data using calculators, computers, or other technical devices when available. | Scientific Inquiry | Section C<br>Scientific Inquiry Unit Project, Part 3 |
| 2.9-12 INQC | Conclusions must be logical, based on evidence, and consistent with prior established knowledge. | | |
| 2.9-12 INQC.1 | Draw conclusions supported by evidence from the investigation and consistent with established scientific knowledge. | Scientific Inquiry | Section D<br>Unit Project: Scientific Inquiry, Part 4 |
| 2.9-12 INQC.2 | Analyze alternative explanations and decide which best fits the data. | | |

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| 2.9-12 INQD | The methods and procedures that scientists use to obtain evidence must be clearly reported to enhance opportunities for further investigation. | | |
| 2.9-12 INQD.1 | Write a detailed laboratory report that includes: the question that motivated the study, a justification for the kind of investigation chosen, hypotheses (if any), a description of what was done, a summary of data in tables and graphs, and a conclusion, based on the evidence, that responds to the question. | Scientific Inquiry | Section E<br>Unit Project : Scientific Inquiry |
| 2.9-12 INQE | The essence of scientific investigation involves the development of a theory or conceptual model that can generate testable predictions. | | |
| 2.9-12 INQE.1 | Formulate one or more hypotheses based on a model or theory of a causal relationship. Demonstrate creativity and critical thinking to formulate and evaluate the hypotheses. | Scientific Inquiry | Sectoion A<br>Unit Project: Scientific Inquiry Guidelines |
| 2.9-12 INQF | Science is a human endeavor that involves logical reasoning and creativity and entails the testing, revision, and occasional discarding of theories as new evidence comes to light. | | |
| 2.9-12 INQF.1 | Evaluate an investigation to determine if it was a valid means of answering the question, and whether or not the results were reliable. | Scientific Inquiry | Section E<br>Unit Project : Scientific Inquiry |
| 2.9-12 INQF.2 | Describe the development of a scientific theory that illustrates logical reasoning, creativity, testing, revision, and replacement of prior ideas in light of new evidence. | Scientific Nature | Section E<br>Acceptance of Plate Tectonic Theory |
| 2.9-12 INQG | Public communication among scientists is an essential aspect of research. Scientists evaluate the validity of one another's investigations, check the reliability | | |

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| | of results, and explain inconsistencies in findings. | | |
| 2.9-12 INQG.1 | Participate in a scientific discussion about their own investigations and those performed by others. | Scientific Inquiry | Section E Discussion: Communicating About Your Experiment |
| 2.9-12 INQG.2 | Respond to questions and criticisms, and if appropriate, revise explanations based on these discussions. | Scientific Inquiry | Section E Discussion: Communicating About Your Experiment |
| 2.9-12 INQH | Scientists carefully evaluate sources of information for reliability before using that information. When referring to the ideas or findings of others, they cite their sources of information. | | |
| 2.9-12 INQH.1 | Provide appropriate citations for all ideas, findings, and information used in any and all written reports. | | |
| 2.9-12 INQH.2 | Explain the consequences for failure to provide appropriate citations. | Scientific Inquiry | Section E Communicating Results |
| 3.9-12 APP | Application | | |
| 0 | Science, Technology, and Society | | |

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| 3.9-12 APPA | Science affects society and cultures by influencing the way many people think about themselves, others, and the environment. Society also affects science by its prevailing views about what is important to study and by deciding what research will be funded. | | |
| 3.9-12 APPA.1 | Describe ways that scientific ideas have influenced society or the development of differing cultures. | Scientific Nature | Section A<br>Science and Society |
| 3.9-12 APPA.2 | List questions that scientists investigate that are stimulated by the needs of society (e.g., medical research, global climate change). | Scientific Nature | Section A<br>Science and Society |
| 3.9-12 APPB | The technological design process begins by defining a problem in terms of criteria and constraints, conducting research, and generating several different solutions. | | |
| 3.9-12 APPB.1 | Work collaboratively with other students to generate ideas for solving a problem. Identify criteria and constraints, research the problem, and generate several possible solutions. | | |
| 3.9-12 APPC | Choosing the best solution involves comparing alternatives with respect to criteria and constraints, then building and testing a mode or other representation of the final design. | | |
| 3.9-12 APPC.1 | Choose the best solution for a problem, create a model or drawing of the final design, and devise a way to test it. Redesign the solution, if necessary, then present it to peers. | | |

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| 3.9-12 APPD | The ability to solve problems is greatly enhanced by use of mathematics and information technologies. | | |
| 3.9-12 APPD.1 | Use proportional reasoning, functions, graphing, and estimation to solve problems. | | |
| 3.9-12 APPD.2 | Use computers, probes, and software when available to collect, display, and analyze data. | | |
| 3.9-12 APPE | Perfect solutions do not exist. All technological solutions involve trade-offs in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended, others not. | | |
| 3.9-12 APPE.1 | Analyze a societal issue that may be addressed through science and/or technology. Compare alternative solutions by considering trade-offs and unintended consequences (e.g., removing dams to increase salmon spawning). | Scientific Nature | Section A<br>Tradeoffs |
| 3.9-12 APPF | It is important for all citizens to apply science and technology to critical issues that influence society. | | |
| 3.9-12 APPF.1 | Critically analyze scientific information in current events to make personal choices or to understand public-policy decisions. | | |
| 4.9-11 PS | Physical Science | | |

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| 4.9-11 PS1 | Newton's Laws | | |
| 4.9-11 PS1A | Average velocity is defined as a change in position with respect to time. Velocity includes both speed and direction. | | |
| 4.9-11 PS1A.1 | Calculate the average velocity of a moving object, given the object's change in position and time. (v = x2-x1/ t2-t1) | | |
| 4.9-11 PS1A.2 | Explain how two objects moving at the same speed can have different velocities. | Energy in Motion | Section A<br>Velocity |
| 4.9-11 PS1B | Average acceleration is defined as a change in velocity with respect to time. Acceleration indicates a change in speed and/or a change in direction. | | |
| 4.9-11 PS1B.1 | Calculate the average acceleration of an object, given the object's change in velocity with respect to time. (a = v2-v1/ t2-t1) | Energy in Motion | Section A<br>Acceleration |
| 4.9-11 PS1B.2 | Explain how an object moving at constant speed can be accelerating. | Energy in Motion | Section A<br>Acceleration |
| 4.9-11 PS1C | An object at rest will remain at rest unless acted on by an unbalanced force. An object in motion at constant velocity will continue at the same velocity unless acted on by an unbalanced force. (Newton's First Law of Motion, the Law of Inertia) | | |

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| 4.9-11 PS1C.1 | Given specific scenarios, compare the motion of an object acted on by balanced forces with the motion of an object acted on by unbalanced forces. | Energy in Motion | Section B<br>Balanced and Unbalanced Forces<br>Section C<br>Newton's First Law of Motion<br>Inertia and Momentum |
| 4.9-11 PS1D | A net force will cause an object to accelerate or change direction. A less massive object will speed up more quickly than a more massive object subjected to the same force. (Newton's Second Law of Motion, F=ma) | | |
| 4.9-11 PS1D.1 | Predict how objects of different masses will accelerate when subjected to the same force. | Energy in Motion | Section C<br>Newton's Second Law of Motion |
| 4.9-11 PS1D.2 | Calculate the acceleration of an object, given the object's mass and the net force on the object, using Newton's Second law of Motion (F=ma). | Energy in Motion | Section C<br>Newton's Second Law of Motion |
| 4.9-11 PS1E | Whenever one object exerts a force on another object, a force of equal magnitude is exerted on the first object in the opposite direction. (Newton's Third Law of Motion) | | |
| 4.9-11 PS1E.1 | Illustrate with everyday examples that for every action there is an equal and opposite reaction (e.g., a person exerts the same force on the Earth as the Earth exerts on the person). | Energy in Motion | Section C<br>Newton's Third Law of Motion |
| 4.9-11 PS1F | Gravitation is a universal attractive force by which objects with mass attract one another. The gravitational force between two objects is proportional to their masses and inversely proportional to the square of the distance between the objects. (Newton's Law of Universal Gravitation) | | |

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| 4.9-11 PS1F.1 | Predict how the gravitational force between two bodies would differ for bodies of different masses or different distances apart. | Energy in Motion | Section B<br>Gravity |
| 4.9-11 PS1F.2 | Explain how the weight of an object can change while its mass remains constant. | Energy in Motion | Section B<br>Gravity, Mass and Weight |
| 4.9-11 PS1G | Electrical force is a force of nature, independent of gravity that exists between charged objects. Opposite charges attract while like charges repel. | | |
| 4.9-11 PS1G.1 | Predict whether two charged objects will attract or repel each other, and explain why. | Electricity and Magnetism | Section A<br>Coulomb's Law |
| 4.9-11 PS1H | Electricity and magnetism are two aspects of a single electromagnetic force. Moving electric charges produce magnetic forces, and moving magnets produce electric forces. | | |
| 4.9-11 PS1H.1 | Demonstrate and explain that an electric current flowing in a wire will create a magnetic field around the wire (electromagnetic effect). | Electricity and Magnetism | Section C<br>Electric Currents and Magnetic Fields |
| 4.9-11 PS1H.2 | Demonstrate and explain that moving a magnet near a wire will cause an electric current to flow in the wire (the generator effect). | Electricity and Magnetism | Section D<br>Faraday's Experiment |
| 4.9-11 PS2 | Chemical Reactions | | |

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| 4.9-11 PS2A | Atoms are composed of protons, neutrons, and electrons. The nucleus of an atom takes up very little of the atom's volume but makes up almost all of the mass. The nucleus contains protons and neutrons, which are much more massive than the electrons surrounding the nucleus. Protons have a positive charge, electrons are negative in charge, and neutrons have no net charge. | | |
| 4.9-11 PS2A.1 | Describe the relative charges, masses, and locations of the protons, neutrons, and electrons in an atom of an element. | Elements, Compounds and Mixtures | Section A<br>The Nuclear Atom |
| 4.9-11 PS2B | Atoms of the same element have the same number of protons. The number and arrangement of electrons determines how the atom interacts with other atoms to form molecules and ionic arrays. | | |
| 4.9-11 PS2B.1 | Given the number and arrangement of electrons in the outermost shell of an atom, predict the chemical properties of the element. | Elements, Compounds and Mixtures | Section C<br>Tutorial: It's All About the Electrons |
| 4.9-11 PS2C | When elements are listed in order according to the number of protons, repeating patterns of physical and chemical properties identify families of elements with similar properties. This Periodic Table is a consequence of the repeating pattern of outermost electrons. | | |
| 4.9-11 PS2C.1 | Given the number of protons, identify the element using a Periodic Table. | Elements, Compounds and Mixtures | Section B<br>Characterizing Elements |
| 4.9-11 PS2C.2 | Explain the arrangement of the elements on the Periodic Table, including the significant relationships among elements in a given column or row. | Elements, Compounds and Mixtures | Section B<br>The Periodic Table<br>Patterns on the Periodic Table |

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| 4.9-11 PS2D | Ions are produced when atoms or molecules lose or gain electrons, thereby gaining a positive or negative electrical charge. Ions of opposite charge are attracted to each other, forming ionic bonds. Chemical formulas for ionic compounds represent the proportion of ion of each element in the ionic array. | | |
| 4.9-11 PS2D.1 | Explain how ions and ionic bonds are formed (e.g., sodium atoms lose an electron and chlorine atoms gain an electron, then the charged ions are attracted to each other and form bonds). | Elements, Compounds and Mixtures | Section C<br>Ionic Bonds |
| 4.9-11 PS2D.2 | Explain the meaning of a chemical formula for an ionic array (e.g., NaCl). | Elements, Compounds and Mixtures | Section C<br>Ionic Bonds (continued) |
| 4.9-11 PS2E | Molecular compounds are composed of two or more elements bonded together in a fixed proportion by sharing electrons between atoms, forming covalent bonds. Such compounds consist of well-defined molecules. Formulas of covalent compounds represent the types and number of atoms of each element in each molecule. | | |
| 4.9-11 PS2E.1 | Give examples to illustrate that molecules are groups of two or more atoms bonded together (e.g., a molecule of water is formed when one oxygen atom shares electrons with two hydrogen atoms). | Elements, Compounds and Mixtures | Section B<br>Molecules |
| 4.9-11 PS2E.2 | Explain the meaning of a chemical formula for a molecule (e.g., CH4 or H2O). | Chemical Reactions | Section A<br>Chemical Symbols in Reaction Equations |
| 4.9-11 PS2F | All forms of life are composed of large molecules that contain carbon. Carbon atoms bond to one another and other elements by sharing electrons, forming covalent | | |

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| | bonds. Stable molecules of carbon have four covalent bonds per carbon atom. | | |
| 4.9-11 PS2F.1 | Demonstrate how carbon atoms form four covalent bonds to make large molecules. Identify the functions of these molecules (e.g., plant and animal tissue, polymers, sources of food and nutrition, fossil fuels). | | |
| 4.9-11 PS2G | Chemical reactions change the arrangement of atoms in the molecules of substances. Chemical reactions release or acquire energy from their surroundings and result in the formation of new substances. | | |
| 4.9-11 PS2G.1 | Describe at least three chemical reactions of particular importance to humans (e.g., burning of fossil fuels, photosynthesis, rusting of metals). | Chemical Reactions | Section A<br>Changes to Matter |
| 4.9-11 PS2G.2 | Use a chemical equation to illustrate how the atoms in molecules are arranged before and after a reaction. | Chemical Reactions | Section A<br>Chemical Symbols in Reaction Equations |
| 4.9-11 PS2G.3 | Give examples of chemical reactions that either release or acquire energy and result in the formation of new substances (e.g., burning of fossil fuels releases large amounts of energy in the form of heat). | Chemical Reactions | Section A<br>Energy Gains and Losses |
| 4.9-11 PS2H | Solutions are mixtures in which particles of one substance are evenly distributed through another substance. Liquids are limited in the amount of dissolved solid or gas that they can contain. Aqueous solutions can be described by relative quantities of the dissolved substances and acidity or alkalinity (pH). | | |

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| 4.9-11 PS2H.1 | Give examples of common solutions. Explain the differences among the processes of dissolving, melting, and reacting. | | |
| 4.9-11 PS2H.2 | Predict the result of adding increased amounts of a substance to an aqueous solution, in concentration and pH. | | |
| 4.9-11 PS2I | The rate of a physical or chemical change may be affected by factors such as temperature, surface area, and pressure. | | |
| 4.9-11 PS2I.1 | Predict the effect of a change in temperature, surface area, pressure, on the rate of a given physical or chemical change. | | |
| 4.9-11 PS2J | The number of neutrons in the nucleus of an atom determines the isotope of the element. Radioactive isotopes are unstable and emit particles and/or radiation. Though the timing of a single nuclear decay is unpredictable, a large group of nuclei decay at a predictable rate, making it possible to estimate the age of materials that contain radioactive isotopes. | | |
| 4.9-11 PS2J.1 | Given the atomic number and atomic mass number of an isotope, students draw and label a model of the isotope's atomic structure (number of protons, neutrons and electrons). | | |
| 4.9-11 PS2J.2 | Given data from a sample, use a decay curve for a radioactive isotope to find the age of the sample. Explain how the decay curve is derived. | Chemical Reactions | Section C<br>Nuclear Reactions: Radioactive Decay |

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| 4.9-11 PS2K | Nuclear reactions convert matter into energy, releasing large amounts of energy compared with chemical reactions. Fission is the splitting of a large nucleus into smaller pieces. Fusion is the joining of nuclei and is the process that generates energy in the Sun and other stars. | | |
| 4.9-11 PS2K.1 | Distinguish between nuclear fusion and nuclear fission by describing how each process transforms elements present before the reaction into elements present after the reaction. | Chemical Reactions | Section C<br>Nuclear Reactions: Fusion<br>Nuclear Reactions: Fission |
| 4.9-11 PS3 | Transformation and Conservation of Energy | | |
| 4.9-11 PS3A | Although energy can be transferred from one object to another and can be transformed from one form of energy to another form, the total energy in a closed system is constant and can neither be created nor destroyed. (Conservation of Energy) | | |
| 4.9-11 PS3A.1 | Describe a situation in which energy is transferred from one place to another and explain how energy is conserved. | Matter, Energy and Change | Section D<br>Case Study: Energy Transformations in a Car<br>The Law of Conservation of Energy |
| 4.9-11 PS3A.2 | Describe a situation in which energy is transformed from one form to another and explain how energy is conserved. | | |
| 4.9-11 PS3B | Kinetic energy is the energy of motion. The kinetic energy of an object is defined by the equation: Ek = ½ mv2 | | |

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| 4.9-11 PS3B.1 | Calculate the kinetic energy of an object, given the object's mass and velocity. | | |
| 4.9-11 PS3C | Gravitational potential energy is due to the separation of mutually attracting masses. Transformations can occur between gravitational potential energy and kinetic energy, but the total amount of energy remains constant. | | |
| 4.9-11 PS3C.1 | Give an example in which gravitational potential energy and kinetic energy are changed from one to the other (e.g., a child on a swing illustrates the alternating transformation of kinetic and gravitational potential energy). | Matter, Energy andChange | Section C<br>Kinetic and Potential Energy |
| 4.9-11 PS3D | Waves (including sound, seismic, light, and water waves) transfer energy when they interact with matter. Waves can have different wavelengths, frequencies, and amplitudes, and travel at different speeds. | | |
| 4.9-11 PS3D.1 | Demonstrate how energy can be transmitted by sending waves along a spring or rope. Characterize physical waves by frequency, wavelength, amplitude, and speed. | Waves | Section A<br>What is a Wave?<br>Frequency and Period<br>Amplitude and Energy<br>Wave Speed |
| 4.9-11 PS3D.2 | Apply these properties to the pitch and volume of sound waves and to the wavelength and magnitude of water waves. | | |
| 4.9-11 PS3E | Electromagnetic waves differ from physical waves because they do not require a medium and they all travel at the same speed in a vacuum. This is the maximum speed that any object or wave can travel. Forms of electromagnetic waves include X-rays, ultraviolet, visible light, infrared, and radio. | | |

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| 4.9-11 PS3E.1 | Illustrate the electromagnetic spectrum with a labeled diagram, showing how regions of the spectrum differ regarding wavelength, frequency, and energy, and how they are used (e.g., infrared in heat lamps, microwaves for heating foods, X-rays for medical imaging). | Waves | Section D<br>The Electromagnetic Spectrum |