

**SANTA ROSA CITY SCHOOLS  
HIGH SCHOOL SCIENCE CONTENT AND PERFORMANCE STANDARDS  
PHYSICAL SCIENCE**

***Motion and Force:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.1 The motion of objects is generally predictable using Newton’s laws.</b></p> <p>9.1.2 Define Newton’s first law and conduct investigations and calculate results demonstrating the effects of forces on the motion of objects.</p> <p>9.1.3 Demonstrate the relationship between force/mass/acceleration to solve one dimensional motion problems involving constant forces (Newton’s second law, <math>[F=ma]</math>)</p> <p>9.1.4 Investigate and calculate results demonstrating the effects of Newton’s third law.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Calculating the average speed of a runner running 400km in 45 seconds.</li> <li>▪ Solving for Force = mass x acceleration: What is the force needed to accelerate a 3000kg car to 2 meters/sec<sup>2</sup> if a Newton = 1kg x1m/sec<sup>2</sup>.</li> <li>▪ Calculate the acceleration of any object near the surface of the earth at 9.8 meters/sec<sup>2</sup>: If a rock were dropped off a bridge, what would the velocity be after 3 seconds?</li> </ul>
<b>Important to Know and Do</b>	
9.1.1 Solve problems involving constant speed and average speed.	
<b>Worth Being Familiar With</b>	
9.1.5 Demonstrate the relationship between the universal law of gravitation and the force of gravity on an object at the surface of the earth.	

***Conservation of Energy and Momentum:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.2 The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.</b></p> <p>9.2.1 Demonstrate the difference between kinetic and potential energy.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Calculating kinetic energy using the</li> </ul>

<b>Important to Know and Do</b>	<p>formula <math>KE = (1/2 mv^2)</math>.</p> <ul style="list-style-type: none"> <li>Calculate changes in gravitational potential energy near the earth using the formula (change in potential energy) <math>PE = mgh</math> (change in elevation).</li> <li>Solving the following problem: Using the formula Kinetic energy = <math>\frac{1}{2}</math> mass x speed <sup>2</sup>: When the brakes of a car going 90 km/h are locked, how much farther will it skid than if the breaks lock at 30 km/h?</li> <li>Solving the following problem: How much work is done when a 75-N bowling ball is lifted 1 meter?</li> <li>Explore to discover what can be done to keep an egg from cracking when dropped from a one-story building and defining how that energy of motion will change.</li> </ul>
<b>Worth Being Familiar With</b>	
9.2.2 Solve problems involving conservation of energy in simple systems such as falling objects.	

***Heat and Thermodynamics:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.2 Energy cannot be created or destroyed; however, in many processes, energy is lost to the environment as heat, that is, as disordered motion of atoms.</b></p> <p>9.3.2 Demonstrate temperature and heat flow as seen by the motion of molecules.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>Discussing the structures of a thermos determine the different types of heat transfer (conduction, convection and radiation).</li> <li>Determining the difference in the amount of random motion when a balloon is heated in a pan of boiling water and the circumference is measured and, then, put into a pan of iced water and measure.</li> <li>Experimenting to answer the following questions: If a fast marble hits a set of slow marbles, does the fast marble usually speed up or slow down? If a gram of</li> </ul>
<b>Important to Know and Do</b>	
9.3.1 Demonstrate that heat flow and work are two forms of energy that transfer between systems.	

<b>Worth Being Familiar With</b>	<p>hot water is added to 25 grams of cool water, what will happen to the beaker of water and to the original gram of water? How do these questions relate to the direction of heat flow?</p> <ul style="list-style-type: none"> <li>Explaining the relationship between the second law of thermodynamics and entropy.</li> </ul>
9.3.3 Define and give an example of the Second Law of Thermodynamics.	

**Waves:**

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.4 Waves have characteristic properties that do not depend on the type of wave.</b></p> <p>9.4.1 Demonstrate that waves carry energy from one place to another.</p> <p>9.4.4 Explain the difference between radio waves, light and x-rays, wavelength bands in the electromagnetic spectrum.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>Using information about seismic and water waves to demonstrate that energy is carried by the waves.</li> <li>Using a variety of materials (slinky, long spring, rope), to demonstrate how longitudinal waves differ from transverse waves.</li> <li>Calculating and demonstrating that speed waves move through different medium.</li> <li>Demonstrating an understanding of diffraction of white light into individual electromagnetic frequencies using a prism.</li> </ul>
<b>Important to Know and Do</b>	
<p>9.4.2 Identify the difference between transverse and longitudinal waves.</p> <p>9.4.3 Show that sound wave speed is dependent on the properties of the medium in which it propagates.</p>	
<b>Worth Being Familiar With</b>	

***Electronic and Magnetic Phenomena:***

<p style="text-align: center;"><b>Enduring Understanding</b></p>	<p style="text-align: center;"><b>EXAMPLES/ILLUSTRATIONS</b></p>
<p><b>9.5 Electric and magnetic phenomena are related and have many practical applications.</b></p> <p>9.5.3 Demonstrate that magnetic materials and electric currents are sources of magnetic fields and experience forces due to magnetic fields of other sources.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Using an electroscope to demonstrate an electric force.</li> <li>▪ Creating an electric field and testing its effect on magnetism.</li> <li>▪ Demonstrating the presence of an electric field by using a charged electric coil and compass.</li> </ul>
<p style="text-align: center;"><b>Important to Know and Do</b></p>	
<p>9.5.2 Recognize that charged particles are sources of electric fields and experience forces due to the electric fields from other charges.</p>	
<p style="text-align: center;"><b>Worth Being Familiar With</b></p>	
<p>9.5.1 Define the properties of transistors and the role transistors play in electric circuits.</p> <p>9.5.4 Explain the direction of a magnetic field and test its effect on magnetism flowing in a straight wire or coil.</p>	

***Atomic and Molecular Structure:***

Enduring Understanding	EXAMPLES/ILLUSTRATIONS
<p><b>9.6 The Periodic Table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure.</b></p> <p>9.6.1 Relate the position of an element in the Periodic Table to its atomic number and atomic mass.</p> <p>9.6.3 Use the Periodic Table to determine the number of electrons available for bonding.</p> <p>9.6.4 Explain that the nucleus is much smaller in size than the atom yet contains most of its mass.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Identifying and grouping elements by similar properties.</li> <li>▪ Color coding the Periodic Table to easily identify and find the different classes of elements.</li> <li>▪ Identifying the number of valence electrons using the Periodic Table.</li> <li>▪ Illustrating different elements by labeling the number of valence electrons.</li> <li>▪ Studying and diagramming Rutherford's gold foil experiment to determine the structure of the atom.</li> <li>▪ Calculating the mass number based on the number of protons and neutrons.</li> </ul>
Important to Know and Do	
<p>9.6.2 Identify metals, nonmetals, and metalloids on the Periodic Table.</p>	
Worth Being Familiar With	

***Chemical Bonds:***

Enduring Understanding	EXAMPLES/ILLUSTRATIONS
<p><b>9.7 The enormous variety of biological, chemical and physical properties of matter result from the ability of atoms to form bonds. This ability results from the electrostatic forces between electrons and protons, and between atoms and molecules.</b></p> <p>9.7.1 Demonstrate how atoms combine to form molecules by sharing electrons to form covalent or metallic bonds, or by exchanging electron to form ionic bonds.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Diagramming the electron transfer between a metal (magnesium) and a non-metal (Chlorine) and balancing the charges to form an ionic compound.</li> <li>▪ Diagramming H<sub>2</sub>O and NH<sub>3</sub> and answering the question: How many</li> </ul>

<b>Important to Know and Do</b>	electrons are shared in each diagram to complete the valence energy level? ▪ Using the periodic table, drawing various Lewis dot structures using only the valence electrons.
9.7.2 Draw and explain Lewis or electron dot structures.	
<b>Worth Being Familiar With</b>	

*Conservation of Matter and Stoichiometry:*

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
	Students may demonstrate these performance standards by:
<b>Important to Know and Do</b>	▪ Balancing the following equations by using the coefficients only: $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
<b>9.8 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.</b>  9.8.1 Balance a given chemical equation.	▪ Determining if the following reaction is balanced: $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
<b>Worth Being Familiar With</b>	

**Gases and their Properties**

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
	Students may demonstrate these performance standards by:
	▪ Using a thermometer to verify that an

<b>Important to Know and Do</b>	<p>increase in temperature proves an increase in collision of molecules.</p> <ul style="list-style-type: none"> <li>Opening a highly volatile gaseous sample and timing how much time it takes to diffuse to another area of the room.</li> </ul>
<p><b>9.9 The Kinetic Molecular Theory describes the motion of atoms and molecules and explains the properties of gases.</b></p> <p>9.9.1 Model random motion and collision with a surface to create the observable pressure on that surface.</p> <p>9.9.2 Demonstrate how random motion of molecules explains the diffusion of gases.</p>	
<b>Worth Being Familiar With</b>	

*Acids and Bases:*

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<b>Important to Know and Do</b>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>Classifying compounds according to the results of chemical tests of various acids, bases and salts.</li> <li>Demonstrating ionization through conductivity tests.</li> <li>Illustrating and creating a pH scale to test various compounds.</li> </ul>
<p><b>9.10 Acids, bases and salts are three classes of compounds that form ions in water solutions.</b></p> <p>9.10.1 Describe the properties of acids, bases and salt solutions.</p> <p>9.10.2 Demonstrate understanding and use of the pH scale to test various compounds.</p>	
<b>Worth Being Familiar With</b>	

**Solutions:**

<b>Enduring Understandings</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<b>Important to Know and Do</b>	Students may demonstrate these performance standards by: <ul style="list-style-type: none"> <li>▪ Proving, through the use of the Tyndall Effect, the presence of a solution.</li> <li>▪ Illustrating the process of dissociation through the use of the molecular motion and kinetic energy theory.</li> <li>▪ Designing experiments showing knowledge of the effects of temperature, pressure and surface area on the dissolving process.</li> </ul>
9.11 <b>Solutions are homogenous mixtures of two or more substances.</b>	
<b>Worth Being Familiar With</b>	
9.11.1 Define solute, solvent and solution. 9.11.2 Describe and illustrate the process involving the solute/solvent interaction to produce a solution. 9.11.3 Demonstrate the effects of temperature, pressure and surface area on the dissolving process.	

**Chemical Thermodynamics:**

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
9.12 <b>Energy is exchanged or transformed in all chemical reactions and physical change of matter.</b> 9.12.1 Demonstrate temperature and heat flow as seen by the motion of molecules.	Students may demonstrate these performance standards by: <ul style="list-style-type: none"> <li>▪ Using vials of water at different temperatures to note the movement of drops of food coloring to indicate molecular movement.</li> <li>▪ Combining appropriate materials to create reactions that generate heat energy or absorb heat energy.</li> <li>▪ Using a simple calorimeter, calculating the energy released as various simple foods are burned as fuel to raise the temperature of water.</li> </ul>
<b>Important to Know and Do</b>	
9.12.2 Measure temperature change in chemical reactions to determine whether the result is endothermic or exothermic. 9.12.3 Calculate the change in energy in the form of calories as a material reacts.	

**Worth Being Familiar With**

*Earth's Place in the Universe:*

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.13.1 Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time.</b></p> <p>9.13.1.1 Know how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system and that evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas.</p> <p>9.13.1.2 Explain through geological studies that early Earth was very different from present day Earth.</p> <p>9.13.1.3 Demonstrate an awareness of the proximity of the planets in relation to the stars.</p> <p>9.13.1.4 Explain the fundamental reactions in nuclear fusion of hydrogen to helium.</p> <p><b>9.13.2 Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe.</b></p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Analyzing data of composition of structures in the solar system.</li> <li>▪ Investigating data of geological samples by:               <ol style="list-style-type: none"> <li>a. Modeling through the theory of Pangaea.</li> <li>b. Comparing and contrasting various samples of minerals and rocks.</li> </ol> </li> <li>▪ Creating a model that demonstrates the proximity of planets in relationship to each other and to the stars.</li> <li>▪ Analyzing astronomical scientific measurements and determining the proximity of planets and stars.</li> <li>▪ Analyzing various spectral compositions of gases and elements found on earth.</li> <li>▪ Evaluating various images of the moon and other planets.</li> <li>▪ Comparing evidence in changes in life forms and the geological time line.</li> <li>▪ Examining and analyzing data that identifies the location of the solar system.</li> <li>▪ Examining and analyzing data on the composition of galaxies.</li> <li>▪ Examining and analyzing data collected through x-ray and radio telescopes.</li> <li>▪ Comparing information on the</li> </ul>
<b>Important to Know and Do</b>	
<p>9.13.2.3 Recognize the formation of the planets and moons surface through dramatic asteroid impacts and mass extinction of life on Earth.</p> <p>9.13.2.2 Identify the composition of galaxies.</p> <p>9.13.2.3 Contrast the various star life cycles.</p>	

<b>Worth Being Familiar With</b>	Doppler effect and spectral analysis.
9.13.2.1 Demonstrate knowledge of the location of our solar system in the Milky Way Galaxy.	

***Dynamic Earth Processes:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<p><b>9.13 Plate tectonics operating over geological time has changed the pattern of land, sea, and mountains on the Earth's surface.</b></p> <p>9.14.1 Illustrate evidence of plate tectonics by studying features of the ocean floor.</p> <p>9.14.2 Relate differences of principal structures that form at plate boundaries.</p> <p>9.14.4 Explain how and why earthquakes occur and how they are measured by intensity and magnitude.</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Examining data of evidence of ocean floor composition and diagramming the features of sea floor topography.</li> <li>▪ Constructing a model showing continental drift.</li> <li>▪ Analyzing various rock samples based on origins (igneous, sedimentary and metamorphic).</li> <li>▪ Design and evaluate information showing the origin and intensity of earthquakes.</li> <li>▪ Collecting and organizing information to determine epicenters using seismology graphs.</li> <li>▪ Compare and contrast types of volcanoes.</li> <li>▪ Examine Ah-ah and Pa-hoe-hoe lava flows.</li> </ul>
<b>Important to Know and Do</b>	
9.14.4 Analyze the composition of the properties of rocks based on physical and chemical conditions and formations (rock cycle).	
<b>Worth Being Familiar With</b>	
9.14.3 Define two kinds of volcanoes, one with violent eruptions producing steep slopes and the other with voluminous lava flows producing gentle slopes.	

***Energy in the Earth System:***

<p style="text-align: center;"><b>Enduring Understanding</b></p>	<p style="text-align: center;"><b>EXAMPLES/ILLUSTRATIONS</b></p>
<p><b>9.15 Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.</b></p> <p>9.15.1 Heating of Earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.</p> <p>9.15.2 Climate is the long term average of a region’s weather and depends on many factors.</p> <p>9.15.1.2 Illustrate comprehension of incoming solar energy in terms of reflection, absorption and photosynthesis.</p> <p>9.15.2.1 Explain how differential heating of the Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.</p> <p>9.15.3.1 Illustrate the difference between weather and climate and the transfer of energy in and out of the atmosphere.</p> <p>9.15.3.2 Demonstrate the impact on climate of latitude, elevation, topography as well as the proximity to large bodies of water and cold or warm ocean currents.</p> <p>9.15.3.4 Demonstrate how the Earth’s climate has changed over time, corresponding to changes in the Earth’s geography, atmospheric composition and/or other factors (i.e., solar radiation, plate movement, etc.).</p>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Constructing experiments to measure effects of energy absorbed and reflected using photosynthesis.</li> <li>▪ Discussing and modeling global warming and the effects of various air pollutants.</li> <li>▪ Constructing diagrams and models showing atmospheric air currents (i.e., Corrals effect and global wind patterns).</li> <li>▪ Graphing and tracking hurricane weather patterns and interpreting cause and effect.</li> <li>▪ Explaining necessary atmospheric conditions to produce weather phenomena (i.e., tornadoes).</li> </ul>
<p style="text-align: center;"><b>Important to Know and Do</b></p>	<ul style="list-style-type: none"> <li>▪ Comparing and contrasting the various layers of the earth’s atmosphere and the effects of temperature and pressure.</li> </ul>
<p>9.15.1.1 Understand how the relative amount of incoming solar energy is compared with the Earth’s internal energy and the energy used by society.</p> <p>9.15.3.3 Compare and contrast the different atmospheric gases that absorb the earth’s thermal radiation and the mechanism and significance of the Greenhouse effect.</p> <p>9.15.2.2 Investigate the relationship between rotation of the Earth and the circular motion of ocean currents and air in pressure centers.</p> <p>9.15.2.4 Analyze the properties of ocean water such as temperature and salinity that can be used to explain the layered structure of oceans, generation of horizontal and vertical ocean currents and the geographic distribution of marine organisms.</p> <p>9.15.2.5 Compare and contrast the distribution of rain forests and deserts on Earth in bands at specific latitudes.</p>	<ul style="list-style-type: none"> <li>▪ Synthesizing the data on temperature, salinity and currents to explain geographic distribution of Marine organisms.</li> <li>▪ Diagramming a global map showing distribution of rain forests based on specific latitudes.</li> <li>▪ Writing an essay explaining about weather and climate.</li> </ul>

<b>Worth Being Familiar With</b>	<ul style="list-style-type: none"> <li>▪ Constructing models depicting topography.</li> <li>▪ Constructing a geological timeline.</li> <li>▪ Constructing a Pangaea model.</li> </ul>
9.15.2.3 Recognize the origin and effects of temperature inversions.	

***Biochemical Cycles:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<b>9.16 Each element on Earth moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of biochemical cycles.</b>	Students may demonstrate these performance standards by: <ul style="list-style-type: none"> <li>▪ Observing the turbidity of soil and its effect on plants and animals.</li> <li>▪ Diagramming and modeling the carbon and nitrogen cycle.</li> <li>▪ Explaining the development of fossil fuels.</li> </ul>
<b>Important to Know and Do</b>	
9.16.1 Demonstrate the global carbon cycle in terms of the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, and fossil fuels, and the movement of carbon among these reservoirs.	
<b>Worth Being Familiar With</b>	
9.16.2 Explain why the movement of matter among reservoirs is driven by the Earth's internal and external sources of energy.	

***Structures and Composition of the Atmosphere:***

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<b>9.17 Life has changed Earth's atmosphere and changes in the atmosphere affect conditions for life.</b>	Students may demonstrate these performance standards by: <ul style="list-style-type: none"> <li>▪ Graphing the different layers of the atmosphere in relation to altitude and</li> </ul>
9.17.1a Investigate the chemical composition of the atmosphere.	

<b>Important to Know and Do</b>	<p>temperature.</p> <ul style="list-style-type: none"> <li>▪ Writing an essay on changes in the earth’s atmosphere through the process of outgassing.</li> <li>▪ Discussing why the ozone layer has been impacted by humans and projecting the results of this practice.</li> </ul>
<p>9.17.2 Explain how the composition of the Earth’s atmosphere has evolved over geologic time including outgassing, the origin of atmospheric oxygen, and variations in carbon dioxide concentration.</p> <p>9.17.3 Investigate the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation and how it varies both naturally and in response to human activities.</p>	
<b>Worth Being Familiar With</b>	
9.17.1b Investigate the thermal structure of the atmosphere.	

**California Geology:**

<b>Enduring Understanding</b>	<b>EXAMPLES/ILLUSTRATIONS</b>
<b>Important to Know and Do</b>	<p>Students may demonstrate these performance standards by:</p> <ul style="list-style-type: none"> <li>▪ Diagramming and plotting the location of major deposits of geological resources on a map of California.</li> <li>▪ Labeling and defining major earthquake faults and their locations.</li> <li>▪ Constructing models of different fault types and explaining their movement and hazard potential.</li> <li>▪ Diagramming a map of California water systems, natural and man-made.</li> </ul>
<b>Worth Being Familiar With</b>	
<p>9.18 The geology of California underlies the state’s wealth of natural resources as well as its natural hazards.</p> <p>9.18.1 Identify the resources of major economic importance in California and their relation to California’s geology.</p> <p>9.18.2 Identify the principal natural hazards in different California regions, and the geological basis of those hazards.</p> <p>9.18.3 Explain the importance of water to society, the origins of California’s fresh water, and the relationship between supply and need.</p>	