

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.01.a Chemistry	Atomic and Molecular Structure	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.	Students know how to relate the position of an element in the periodic table to its atomic number and atomic mass.	311	protons/neutrons/electrons	132	atomic number determines what element that atom is
				311	location/size/charge of subatomic particles	133	using the periodic table
				315	atomic number discussed	133	identify atomic number
				315	atoms of same element have same atomic number	133	identify mass number
				316	mass number discussed	133	identify element symbol and name
				320	groups of elements	133	protons and neutrons
				321	studying the periodic table	133	location of electrons in atom
				322	atomic mass on the periodic table	136	building and studying the periodic table
				322	mass number on the periodic table	136	mass number
				322	atomic number on the periodic table	136	atomic number
				322	chemical symbols and element names	137	build atomic models
				322	metals nonmetals and metalloids	137	importance of atomic number
						140	review subatomic particles

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ChemHS.01.b Chemistry	Atomic and Molecular Structure	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.	Students know how to use the periodic table to identify metals, semimetals, non-metals, and halogens.	320 332	groups of elements metals nonmetals and metalloids	133 using the periodic table

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>	<b>Volume 2 Investigation Manual Page</b>		
ChemHS.01.c Chemistry	Atomic and Molecular Structure	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.	Students know how to use the periodic table to identify alkali metals, alkaline earth metals and transition metals, trends in ionization energy, electronegativity, and the relative sizes of ions and atoms.	321	groups of elements and valence shells	136	ions
				324	use the periodic table to predict chemical formulas	141	build model of Na and Cl atoms and explain why they bond to form a molecule
				324	which element is more likely to combine with other elements?	141	when an atom ionizes
				329	periodic table columns and valence electrons	141	modeling a chemical bond
				330	bonding and periodic table position	142	arrangement of electrons and groups of elements
				332	periodic table and electronegativities	143	ionic compounds
				335	periodic table and oxidation numbers		
				335	chemical bonding and the periodic table		
				404	water is a polar molecule		
				405	hydrogen bonding in water		
				406	hydrogen bonding and properties of water		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.01.d Chemistry	Atomic and Molecular Structure	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.	Students know how to use the periodic table to determine the number of electrons available for bonding.	320	groups of elements	133	using the periodic table
				324	use the periodic table to predict chemical formulas	136	ions
				324	which element is more likely to combine with other elements?	140	find the number of electrons in outermost level
				330	Lewis dot diagrams	141	when an atom ionizes
				335	chemical bonding and the periodic table	141	modeling a chemical bond
				388	showing valence electrons in a diagram	143	ionic compounds
				404	water is a polar molecule		
				405	hydrogen bonding in water		
				406	hydrogen bonding and properties of water		
ChemHS.01.e Chemistry	Atomic and Molecular Structure	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.	Students know the nucleus of the atom is much smaller than the atom yet contains most of its mass.	311	protons/neutrons/electrons	130	investigate Rutherford's gold foil experiment
				311	location/size/charge of subatomic particles	132	building atom models
				313	development of atomic theory	133	protons and neutrons
				318	proton/electron attraction	133	location of electrons in atom
				324	research and create a poster to illustrate development of atomic model	136	model stable and neutral atoms
						137	build atomic models
		140	review subatomic particles				

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ChemHS.01.f Chemistry	Atomic and Molecular Structure	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.	Students know how to use the periodic table to identify the lanthanide, actinide, and transactinide elements and know that the transuranium elements were synthesized and identified in laboratory experiments through the use of nuclear accelerators.	312 321 332 363 393 393 457	Dalton's contributions Mendeleev's periodic table Linus Pauling and electronegativities Antoine Lavoisier Marie and Pierre Curie accomplishments of Marie Curie Joseph Black	

**Correlation to California Science Content Standards**  
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**Student Text and Investigation Manual**

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ChemHS.01.g Chemistry	Atomic and Molecular Structure	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.	Students know how to relate the position of an element in the periodic table to its quantum electron configuration and to its reactivity with other elements in the table.	321	groups of elements and valence shells	136	ions
				329	periodic table columns and valence electrons	140	find the number of electrons in outermost level
				330	ionic bonds	141	build model of Na and Cl atoms and explain why they bond to form a molecule
				330	bonding and periodic table position		
				331	covalent bonds	141	when an atom ionizes
				332	periodic table and electronegativities	142	arrangement of electrons and groups of elements
				332	distinguishing between ionic and covalent bonds	143	classify ionic compounds
				335	periodic table and oxidation numbers	143	predict chemical formulas
				336	writing a chemical formula	144	show ratios in which elements combine to form a compound
				338	summary of chemical formula writing rules	145	determine empirical formula
				343	mole quantities		
				388	showing valence electrons in a diagram		
				404	water is a polar molecule		
				405	hydrogen bonding in water		
				406	hydrogen bonding and properties of water		
				409	dissolving an ionic compound		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
				410 solute dissolution depends on chemical bonds	
ChemHS.01.h Chemistry	Atomic and Molecular Structure	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.	Students know the experimental basis for Thomson's discovery of the electron, Rutherford's nuclear atom, Millikan's oil drop experiment and Einstein's explanation of the photoelectric effect.	313 development of atomic theory 324 research and create a poster to illustrate development of atomic model 370 research Lavoisier's contributions 400 research the Clean Air Act of 1970 and 1990 448 research local water supply history	130 investigate Rutherford's gold foil experiment

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.01.i Chemistry	Atomic and Molecular Structure	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.	Students know the experimental basis for the development of the quantum theory of atomic structure and the historical importance of the Bohr model of the atom.	312 313 321 324 332 363 388 393 393 457	Dalton's contributions development of atomic theory Mendeleev's periodic table research and create a poster to illustrate development of atomic model Linus Pauling and electronegativities Antoine Lavoisier showing valence electrons in a diagram Marie and Pierre Curie accomplishments of Marie Curie Joseph Black	130 140	investigate Rutherford's gold foil experiment find the number of electrons in outermost level
ChemHS.01.j Chemistry	Atomic and Molecular Structure	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.	Students know that spectral lines are results of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by using Planck's relationship ( $E=h\nu$ ).	234	electrons and energy levels and light emission	134 265	what does atomic structure have to do with light and color? an element's spectral lines correspond to specific wavelengths of light

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

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ChemHS.02.a Chemistry	Chemical Bonds	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.	Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging to form ionic bonds.	321	groups of elements and valence shells	136	ions
				324	use the periodic table to predict chemical formulas	141	build model of Na and Cl atoms and explain why they bond to form a molecule
				324	which element is more likely to combine with other elements?	141	when an atom ionizes
				329	periodic table columns and valence electrons	141	modeling a chemical bond
				330	bonding and periodic table position	142	arrangement of electrons and groups of elements
				332	periodic table and electronegativities	143	ionic compounds
				335	periodic table and oxidation numbers		
				335	chemical bonding and the periodic table		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

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ChemHS.02.b Chemistry	Chemical Bonds	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.	Students know chemical bonds between atoms in molecules such as , H <sub>2</sub> , CH <sub>4</sub> , NH <sub>3</sub> , H <sub>2</sub> CCH <sub>2</sub> , N <sub>2</sub> , Cl <sub>2</sub> and many large biological molecules are covalent.	321	groups of elements and valence shells	141	build model of Na and Cl atoms and explain why they bond to form a molecule
				329	periodic table columns and valence electrons	142	arrangement of electrons and groups of elements
				330	bonding and periodic table position	143	ionic compounds
				332	periodic table and electronegativities	162	carbon reactions and the environment
				335	periodic table and oxidation numbers	162	structure of fossil fuels
				364	carbon chains	162	importance of fossil fuels
				394	photosynthesis and carbon reactions		
				395	fossil fuels and carbon reactions		
ChemHS.02.c Chemistry	Chemical Bonds	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.	Students know salt crystals such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.	389	strong nuclear force	136	ions
				389	forces in the nucleus	136	strong force
				389	electromagnetic force	141	whan an atom ionizes
						143	ionic compounds

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***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.02.e Chemistry	Chemical Bonds	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.	Students know how to draft Lewis dot structure	330	Lewis dot diagrams		
ChemHS.02.g Chemistry	Chemical Bonds	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.	Students know how electronegativity and ionization energy relate to bond formation.	311 311 324 324 335	protons/neutrons/electrons location/size/charge of subatomic particles use the periodic table to predict chemical formulas which element is more likely to combine with other elements? chemical bonding and the periodic table	133 133 136 137 140 141 141	protons and neutrons location of electrons in atom ions build atomic models review subatomic particles when an atom ionizes modeling a chemical bond

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.03.a Chemistry	Conservation of Matter and Stoichiometry	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.	Students know how to describe chemical reactions by writing balanced equations.	371	which of the equations is balanced?	149	balance these equations
ChemHS.04.a Chemistry	Gases and Their Properties	The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gasses.	Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.	299 300	Charles' law Boyle's law		
ChemHS.04.b Chemistry	Gases and Their Properties	The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gasses.	Students know the random motion of molecules explain the diffusion of gases.	284 405	states of matter and arrangement of molecules molecular structure of ice	118 118	investigate melting molecules in a liquid

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***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>	<b>Volume 2 Investigation Manual Page</b>
ChemHS.04.c Chemistry	Gases and Their Properties	The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gasses.	Students know how to apply the gas laws to relations between the pressure, temperature and volume of any amount of an ideal gas or any mixture of ideal gases.	299 Charles' law 300 Boyle's law	
ChemHS.04.g Chemistry	Gases and Their Properties	The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gasses.	Students know the kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.	451 temperature is a measure of average kinetic energy	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.05.a Chemistry	Acids and Bases	Acids, bases, and salts are three classes of compounds that form ions in water solution.	Students know the observable properties of acids, bases and salt solution.	417	acids and bases compared/contrasted	176	investigate acids and bases
				417	define and compare acids and bases	176	measure pH of everyday solutions
				418	formulas and reactions of acids and bases	181	testing pH of tap water samples
				420	defining and determining pH	184	determining pH of water as carbon dioxide dissolves
				420	pH and pH scale		
				420	concentration of hydronium ions determines pH and strength of acids and bases		
				421	table of pH of common substances		
				421	pH of substances you use or consume		
				422	examples of acid and base chemistry		
				422	pH and blood		
				437	concentration of ions and pH		
437	pH of acid rain						

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

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ChemHS.05.b Chemistry	Acids and Bases	Acids, bases, and salts are three classes of compounds that form ions in water solution.	Students know acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.	417	properties of acids	176	investigate acids and bases
				417	H and OH ions		
				417	acids and bases compared/contrasted		
				417	define and compare acids and bases		
				418	properties of bases		
				418	formulas and reactions of acids and bases		
				420	concentration of hydronium ions determines pH and strength of acids and bases		
				422	examples of acid and base chemistry		
				422	pH and blood		
				437	concentration of ions and pH		
437	pH of acid rain	176	measure pH of everyday solutions				

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.05.d Chemistry	Acids and Bases	Acids, bases, and salts are three classes of compounds that form ions in water solution.	Students know how to use the pH scale to characterize acid and base solutions.	417	acids and bases compared/contrasted	176	investigate acids and bases
				417	define and compare acids and bases	176	measure pH of everyday solutions
				418	formulas and reactions of acids and bases	181	testing pH of tap water samples
				420	defining and determining pH	184	determining pH of water as carbon dioxide dissolves
				420	pH and pH scale		
				420	concentration of hydronium ions determines pH and strength of acids and bases		
				421	table of pH of common substances		
				421	pH of substances you use or consume		
				422	examples of acid and base chemistry		
				422	pH and blood		
				437	concentration of ions and pH		
				437	pH of acid rain		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.06.a Chemistry	Solutions	Solutions are homogenous mixtures of two or more substances.	Students know the definitions of solute and solvent.	403	why water is a nearly universal solvent	170	design experiments to explore dissolving rate
				403	water structure and its function as a solvent	170	solubility and temperature
				403	a water molecule is v-shaped	172	investigate solubility of sugar
				407	solute and solvent defined	175	solubility and pressure
				407	definitions of solution and solute and solvent	181	water quality testing
				409	why water is called the universal solvent	181	water quality testing
				409	polar solutes		
				412	effect of nature of solvent on solubility		
				412	solubility value		
				412	effect of temperature on solubility		
				413	temperature-solubility graphs		
				414	effect of temperature on solubility of gasses		
				414	effect of pressure on solubility of gasses		
				414	pressure and the solubility of gases		
				415	saturated and supersaturated solutions		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
				416 SCUBA diving and effects of pressure on gasses in the bloodstream	
ChemHS.06.b Chemistry	Solutions	Solutions are homogenous mixtures of two or more substances.	Students know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.		170 design experiments to explore dissolving rate
ChemHS.06.c Chemistry	Solutions	Solutions are homogenous mixtures of two or more substances.	Students know temperature, pressure and surface area affect the dissolving process.	403 why water is a nearly universal solvent 409 polar solutes 412 solubility value 412 effect of nature of solvent on solubility 412 effect of temperature on solubility 413 temperature-solubility graphs 414 pressure and the solubility of gases 414 effect of pressure on solubility of gasses 414 effect of temperature on solubility of gasses 416 SCUBA diving and effects of pressure on gasses in the bloodstream	170 solubility and temperature 172 investigate solubility of sugar 175 solubility and pressure 181 water quality testing 181 water quality testing

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.06.f Chemistry	Solutions	Solutions are homogenous mixtures of two or more substances.	Students know how molecules in a solution are separated or purified by the methods of chromatography and distillation.	278	mixtures can be separated by physical means	114	separating a homogeneous mixture
ChemHS.07.a Chemistry	Chemical Thermodynamics	Energy is exchanged or transformed in all chemical reactions and physical changes of matter.	Students know how to describe temperature and heat flow in terms of the motion of molecules or atoms).	451	temperature is a measure of average kinetic energy	119	investigate temperature and energy transfer in melting process
				453	comparing temperature in Fahrenheit and Celsius scales	186	develop a way to convert between Fahrenheit and Celsius temperature scales
				454	changes in temperature are directly related to changes in energy	188	investigate the increase of temperature of water as thermal energy is added
				455	description and use of BTUs		
				460	thermal equilibrium		
				468	use of "R value"		
CHEMHS.07.b Chemistry	Chemical Thermodynamics	Energy is exchanged or transformed in all chemical reactions and physical changes of matter.	Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.	381	exothermic reactions and MREs	158	investigate energy changes in chemical reactions
				382	endothermic reactions and cold packs	158	measure energy changes in 3 different reactions

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.07.c Chemistry	Chemical Thermodynamics	Energy is exchanged or transformed in all chemical reactions and physical changes of matter.	Students know energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.	284	changes of state	119	create a temperature vs. time graph of phase change
				406	hydrogen bonding and the gaseous state of water	119	energy and phase changes
				498	phases changes in the atmosphere	204	investigating latent heat and thermal buffering
						204	compare the shape of the water line and the ice line on the temperature/time graph
ChemHS.07.d Chemistry	Chemical Thermodynamics	Energy is exchanged or transformed in all chemical reactions and physical changes of matter.	Students know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.	456	specific heat	205	investigating how the high specific heat of water helps regulate Earth's temperature
				456	definition of specific heat		
				458	water's specific heat helps regulate Earth's temperature		
				459	heat equation		
ChemHS.10.a Chemistry	Organic Chemistry and Biochemistry	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.	Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.	333	plastics	162	structure of fossil fuels
				394	photosynthesis and carbon reactions	162	importance of fossil fuels
				395	fossil fuels and carbon reactions		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ChemHS.10.b Chemistry	Organic Chemistry and Biochemistry	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.	Students know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.	364	carbon chains	162	carbon reactions and the environment
ChemHS.11.a Chemistry	Nuclear Processes	Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion.	Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.	318 389 389 389	proton/electron attraction strong nuclear force forces in the nucleus electromagnetic force	132 136 136	building atom models strong force model stable and neutral atoms
ChemHS.11.c Chemistry	Nuclear Processes	Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion.	Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.	316 393 393 400	isotopes explained radioisotopes in science and medicine carbon dating research pros and cons of nuclear technology	133 136 160 161	exploring isotopes understanding isotopes radioactive decay research pros and cons of uses for radioactive elements

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.01.a Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know how the difference and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.	472	comparison of Earth's atmosphere to other planets	256	simulate an object in orbit and investigate how orbital period varies within distance
				612	Johannes Kepler	258	setting up a scale model of the solar system
				612	orbits of planets around the sun	259	determining scale distances for the planets
				613	Kepler's elliptically shaped orbits	260	determining scale sizes of the planets
				613	explanation and illustration of the solar system		
				614	relative sizes and distances within the solar system		
				615	what makes Earth capable of supporting life		
				619	asteroids and comets		
				620	meteors and meteorites and the Kuiper Belt		
				641	the existence of other planetary systems		
				641	how the solar system was formed		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page		Volume 2 Investigation Manual Page
ESHS.01.b Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.	641	how the solar system was formed	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.01.c Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today	481	global warming	225	determining the relative ages of rock formations
				483	global temperature changing over time	226	sequencing events in a geologic cross-section
				522	relative dating	228	reading a bathymetric map
				523	interpreting rock formations	229	using a geologic hazard map of frequent earthquakes
				528	Earth's surface is changing	230	predicting plate movement over 50 million years and the resultant land features
				528	predicting what Earth might look like in 50 million years	240	estimating the effects of meteor impacts on Earth
				534	land features resulting from divergent plate boundaries	241	identifying which geologic features on Earth were caused by meteors
				535	resulting land features from subduction		
				536	land features resulting from transform plate boundaries		
				540	where earthquakes occur		
				541	earthquake hazard map		
				547	predict separation of North America and Europe in 75 million years		
				548	predict effects of divergent plate boundaries on Great Rift Valley		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
				555 formation of Hawaiian Islands due to volcanic activity	
				558 volcanoes shape the Earth	
				563 mountain-building	
				563 constructive process of mountain building	
				564 changes in land features due to erosion	
				564 the destructive process of erosion	
				565 wind erosion	
				566 effect of glaciers on land	
				567 geologic hazard maps	
				569 studying moon rocks on Earth	
				580 using a geologic hazard map	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.01.d Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the evidence indicating that the planets are much closer to Earth than the stars are.	591	characteristics of the universe	258	setting up a scale model of the solar system
				613	explanation and illustration of the solar system	259	determining scale distances for the planets
				614	relative sizes and distances within the solar system	260	determining scale sizes of the planets
				633	what is a star?		
				642	what is a galaxy?		
				652	research and describe astronomical objects		
ESHS.01.e Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.	638	the life cycle of stars	255	observe and describe the appearance of the moon and Jupiter and its moons
				639	death of small to medium stars results in white dwarfs and planetary nebula and black dwarfs	264	using spectroscopy to analyze the light emitted by stars and identify most common elements
				639	description and illustration of the life cycle of stars		
				640	death of massive stars results in supernovas and neutron stars and black holes		
				640	death of massive stars		
				640	birth of elements		
640	elements formed by nuclear fusion in stars						

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.01.f Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.	522	relative dating	225	determining the relative ages of rock formations
				523	interpreting rock formations	226	sequencing events in a geologic cross-section
				524	extinction of the dinosaurs due to giant meteor hitting Earth		
				569	studying moon rocks on Earth		
				619	how an asteroid event may have caused the extinction of dinosaurs		
ESHS.01.g Earth Science	Earth's Place in the Universe	Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time.	Students know the evidence for the existence of planets orbiting other stars.	641	the existence of other planetary systems		
ESHS.02.a Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.	612	Johannes Kepler	256	simulate an object in orbit and investigate how orbital period varies within distance
				612	orbits of planets around the sun		
				613	Kepler's elliptically shaped orbits		
				619	asteroids and comets		
				620	meteors and meteorites and the Kuiper Belt		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.02.b Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe.	615 624 625	classifying the planets features and diagram of the sun features and emissions of the sun	
ESHS.02.c Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know the evidence indicating that all elements with an atomic number greater than that of lithium have been formed by nuclear fusion stars.	640 640	death of massive stars birth of elements	
ESHS.02.d Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data reveal those differences.	594 595 596 597 598 634	history of the telescope types and uses of telescopes types and uses of telescopes satellites as tools of astronomy spacecraft as tools of astronomy the use of spectroscopy to analyze stars	264 understand why spectroscopy is an important tool of astronomers 268 measuring apparent brightness to calculate the distance to stars and galaxies

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.02.e Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know accelerators boost subatomic particles to energy levels that simulate conditions in the stars and in the early history of the universe before stars formed.	594 595 596 597 598 634	history of the telescope types and uses of telescopes types and uses of telescopes satellites as tools of astronomy spacecraft as tools of astronomy the use of spectroscopy to analyze stars	264  268	understand why spectroscopy is an important tool of astronomers  measuring apparent brightness to calculate the distance to stars and galaxies
ESHS.02.f Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know the evidence indicating that the color, brightness, and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.	639 640	death of small to medium stars results in white dwarfs and planetary nebula and black dwarfs death of massive stars results in supernovas and neutron stars and black holes	264	using spectroscopy to analyze the light emitted by stars and identify most common elements
ESHS.02.g Earth Science	Earth's Place in the Universe	Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time.	Students know how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.	648 649	evidence for the Big Bang theory evidence for the Big Bang theory		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.03.a Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.	530 531	sea-floor spreading and mid-ocean ridges magnetic patterns on the sea floor	228 listing which kind of plate boundary is associated with each geologic feature
ESHS.03.b Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know the principal structures that form at the three different kinds of plate boundaries.	533 534 535 536	describing plate boundaries divergent plate boundaries convergent plate boundaries transform plate boundaries	229 identifying tectonic plates and plate boundaries
ESHS.03.c Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.	554 559 561	properties of volcanically formed rock types of volcanic rock describing volcanic rock	237 examining the magma chemistry of volcanoes and how it relates to a volcano's location
ESHS.03.d Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.	537 539	causes and descriptions of earthquakes earthquakes rating scales	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.03.e Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.	554 555 556	types and shapes of volcanoes shield volcanoes stratovolcanoes	236	understanding the Volcanic Explosivity Index
ESHS.03.f Earth Science	Dynamic Earth Processes	Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface.	Students know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.	555 556	formation of shield volcanoes due to hot spots formation of stratovolcanoes due to subduction	237	finding a pattern of volcanoes related to the locations of plate boundaries
ESHS.04.a Earth Science	Energy in the Earth System	Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.	Students know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.	480 481 485 525 526 552	distribution of incoming solar radiation Earth's "energy budget" Earth's internal energy formation of Earth's layers description of Earth's layers formation of magma in Earth's mantle		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.04.b Earth Science	Energy in the Earth System	Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.	Students know the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.	480 481	distribution of incoming solar radiation Earth's "energy budget"	
ESHS.04.c Earth Science	Energy in the Earth System	Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.	Students know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.	481	greenhouse effect and greenhouse gasses	185 effect of ocean on carbon dioxide levels in the atmosphere 202 investigate the temperature effects of greenhouse gases
ESHS.04.d Earth Science	Energy in the Earth System	Energy enters the Earth system primarily as solar radiation and eventually escapes as heat.	Students know the differing greenhouse conditions on Earth, Mars, and Venus; the origins of those conditions; and the climatic consequences of each.	481 485 615	greenhouse conditions on Earth research the density of Venus' and Mars' atmospheres greenhouse conditions on Venus	
ESHS.05.a Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.	493	convection currents in the atmosphere	213 exploring how temperature-dependent layering creates currents

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.05.b Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.	494 504	the Coriolis effect rotation of air masses due to Coriolis effect	
ESHS.05.c Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know the origin and effects of temperature inversions.	437 438 443 496 504	acid rain causes and health effects of acid rain impact of increased CO2 on oceans descriptions of ocean currents and their effects on climate temperature inversion	182 the effects of acid rain on organisms in aquatic environments 207 research how large bodies of water affect climate 215 understanding the Atlantic gyre
ESHS.05.d Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic of distribution of marine organisms.	441 442 508	sources of salts in the ocean composition of seawater causes and effects of the El Nino Southern Oscillation	212 investigate how the ocean's salinity affects its density

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.05.e Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know rain forests and deserts on Earth are distributed in bands at specific latitudes.	509	descriptions and distribution of desert biomes	
				511	descriptions and distribution of tropical rainforest biomes	
ESHS.05.f Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know the interaction of wind patterns, ocean currents, and mountain ranges results in the global pattern of latitudinal bands of rain forests and deserts.	510	different types of deserts and how they are formed	223 research a particular biome
				511	how tropical rainforests are formed	
ESHS.05.g Earth Science	Energy in the Earth System	Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.	Students know features of the ENSO (El Nino southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.	508	causes and effects of the El Nino Southern Oscillation	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>	<b>Volume 2 Investigation Manual Page</b>
ESHS.06.a Earth Science	Energy in the Earth System	Climate is the long-term average of a region's weather and depends on many factors.	Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.	480 transfer of energy in and out of Earth's atmosphere	
ESHS.06.b Earth Science	Energy in the Earth System	Climate is the long-term average of a region's weather and depends on many factors.	Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.	491 Earth's temperature varies with latitude 496 effects of the Gulf Stream on climate of Great Britain 510 effect of cold ocean currents on formation of fog desserts 511 effect of warm ocean currents on formation of tropical rainforest 513 effect of large bodies of water on climate 515 alpine tundra occurs at high altitudes	207 research how large bodies of water affect climate
ESHS.06.c Earth Science	Energy in the Earth System	Climate is the long-term average of a region's weather and depends on many factors.	Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.	483 global temperature changing over time 528 Earth's surface is changing	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
ESHS.06.d Earth Science	Energy in the Earth System	Climate is the long-term average of a region's weather and depends on many factors.	Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.	485	computer modeling to predict greenhouse effects		
ESHS.07.a Earth Science	Biogeochemical Cycles	Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.	Students know the carbon cycle of photosynthesis and respiration and the nitrogen cycle.	364	carbon chains	162	carbon reactions and the environment
				436	nitrates and the nitrogen cycle	178	actions to take to improve water quality
				437	effects of acid rain on natural environments		
				471	nitrogen cycle diagrammed		
				471	nitrogen cycle		
				472	the carbon cycle explained		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

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ESHS.07.b Earth Science	Biogeochemical Cycles	Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.	Students know the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.	414	178 predict the quality of surface water to be tested and justify your answer  178 actions to take to improve water quality	
				436		effect of electrical generating facilities on dissolved oxygen in water
				437		nitrates and the nitrogen cycle
				443		effects of acid rain on natural environments
				471		impact of increased CO <sub>2</sub> in oceans
				471		nitrogen cycle diagrammed
				472		nitrogen cycle
				479		the carbon cycle explained
				482		effects of CFC's on the ozone layer
				515		effects of burning fossil fuels
ESHS.07.c Earth Science	Biogeochemical Cycles	Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.	Students know the movement of matter among reservoirs is driven by Earth's internal and external sources of energy.	485	Earth's internal energy	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

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ESHS.07.d Earth Science	Biogeochemical Cycles	Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles.	Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.	414	effect of electrical generating facilities on dissolved oxygen in water	178	predict the quality of surface water to be tested and justify your answer
				443	impact of increased CO <sub>2</sub> in oceans		
				479	effects of CFC's on the ozone layer		
				482	effects of burning fossil fuels		
				515	permafrost		
ESHS.08.a Earth Science	Structure and Composition of the Atmosphere	Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.	Students know the thermal structure and chemical composition of the atmosphere.	471	composition of Earth's atmosphere	198	detecting ozone which is a protective atmosphere gas against high energy radiation
				473	definition of atmospheric pressure		
				475	how atmospheric pressure changes with altitude		
				476	graph showing atmospheric pressure vs. altitude		
				477	ozone layer		
				479	ozone depletion		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>
ESHS.08.b Earth Science	Structure and Composition of the Atmosphere	Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.	Students know how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen.	483	global temperature changing over time	
				528	Earth's surface is changing	
ESHS.08.c Earth Science	Structure and Composition of the Atmosphere	Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life.	Students know 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.	481	featured in ancillary component greenhouse effect and greenhouse gasses	featured in ancillary component 185 effect of ocean on carbon dioxide levels in the atmosphere 202 investigate the temperature effects of greenhouse gases
ESHS.09.a Earth Science	California Geology	The geology of California underlies the state's wealth of natural resources as well as its natural hazards.	Students know the resources of major economic importance in California and their relation to California's geology.	542	featured in ancillary component using seismic waves for oil and gas exploration	featured in ancillary component
				560	mineral deposits and diamonds	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>	<b>Volume 2 Investigation Manual Page</b>
ESHS.09.b Earth Science	California Geology	The geology of California underlies the state's wealth of natural resources as well as its natural hazards.	Students know the principal natural hazards in different California regions and the geologic basis of those hazards.	<p>featured in ancillary component</p> <p>537 earthquakes and plate tectonics</p> <p>552 geologic basis for volcanic eruptions</p> <p>552 formation of magma in Earth's mantle</p> <p>553 where volcanic activity occurs</p> <p>555 geologic basis for shield volcanoes</p> <p>556 geologic basis for stratovolcanoes</p> <p>557 geologic bases for cinder cone volcanoes</p>	featured in ancillary component
ESHS.09.c Earth Science	California Geology	The geology of California underlies the state's wealth of natural resources as well as its natural hazards.	Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.	<p>featured in ancillary component</p> <p>533 activity of Earth's crust at plate boundaries</p> <p>534 balance of creating and consuming Earth's crust</p> <p>562 constructive and destructive processes</p> <p>576 the rock cycle</p>	featured in ancillary component

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>	<b>Volume 2 Investigation Manual Page</b>
ESHS.09.d Earth Science	California Geology	The geology of California underlies the state's wealth of natural resources as well as its natural hazards.	Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.	<p>featured in ancillary component</p> <p>540 where earthquakes occur</p> <p>541 earthquake hazard map</p> <p>567 geologic hazard maps</p> <p>580 using a geologic hazard map</p>	<p>featured in ancillary component</p> <p>228 reading a bathymetric map</p> <p>229 using a geologic hazard map of frequent earthquakes</p>

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
InqHS.01.a Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.	5 measuring distance 12 importance of reliable and accurate data collection 630 use the data to answer the questions 630 what evidence was used to predict the existence of the Kuiper Belt? 652 analysis with a spectrometer (#4)	data tables and graphs can be created on computer or graphing calculator 4 difference between precise and accurate data 5 measuring metric and english lengths 6 electronic timer and release technique 6 measure time 7 record time interval 9 collect speed data 14 record three different time intervals 16 measure force 17 record times 24 collect weight data 25 collect force data 27 write down the number of weights you use 36 collect precise speed and height data 44 measure voltage 46 measure current 48 measure resistance 75 collect mass and amplitude data

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					87 measure wavelength
					116 measure mass
					117 measure volume
					150 record data as you perform experiment
					171 collect time data and record observations
					182 observing daphnia and recording movements and behavior
					182 making detailed observations
					184 collecting pH readings while adding carbon dioxide
					186 measure temperature
					186 collecting temperature data
					189 collecting time and temperature data
					193 collecting and recording time and temperature data
					206 collecting temperature and time data
					210 collecting qualitative data of light intensity at scale distance from the sun
					217 collecting wet and dry bulb temperature readings

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					249 using your sundial to collect accurate data 253 calibrating your telescope

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
InqHS.01.b Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Identify and communicate sources of unavoidable experimental error.	11 controlling variables in experiments 12 importance of reliable and accurate data collection 19 did you run a controlled experiment? 20 what factors could explain the variability in their data? 485 what percentage comes from this source? (problem 4) 543 determining distance to an epicenter 547 what explains the difference in density? (#5) 605 how big is Earth?	4 difference between precise and accurate data 6 electronic timer and release technique 7 record time interval 7 what variables should be controlled? 9 collect speed data 11 calculate % error 17 record times 24 collect weight data 36 collect precise speed and height data 75 collect mass and amplitude data 76 calculate % error 129 control the height of the liquid 169 what does the word control mean? 169 why was plain water tested? 171 collect time data and record observations 182 making detailed observations

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					184 collecting pH readings while adding carbon dioxide 186 collecting temperature data 189 collecting time and temperature data 193 collecting and recording time and temperature data 197 calculating error between your barometer and a commercial barometer 199 importance of good record keeping in order to avoid error 249 using your sundial to collect accurate data 253 calibrating your telescope

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.c Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.	11	controlling variables in experiments	7	what variables should be controlled?
				19	did you run a controlled experiment?	11	calculate % error
				20	what factors could explain the variability in their data?	76	calculate % error
				485	what percentage comes from this source? (problem 4)	129	control the height of the liquid
				543	determining distance to an epicenter	169	why was plain water tested?
				547	what explains the difference in density? (#5)	169	what does the word control mean?
				605	how big is Earth?	197	calculating error between your barometer and a commercial barometer
						199	importance of good record keeping in order to avoid error

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.d Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Formulate explanations by using logic and evidence.	20	finding variability in data	18	use data to describe relationship between force and motion
				28	identifying cause and effect relationships	19	use data to infer correct relationship between variables
				41	identify cause and effect	21	construct reasonable explanation based on data
				79	look at force data and decide the usefulness of a machine	21	determine effect of increasing mass
				438	what causes acid rain	30	interpret block and tackle data
				456	determining effect of changing mass on temperature changes	35	study data and determine importance of height on speed of marble
				460	thermal equilibrium	45	analyze data and explain a rule
				497	factors that shape the weather	141	build models of Na and Cl and use them to explain bonding
				608	relationship between orbital speed and distance between two objects	157	add new rules to list based on findings
						182	making hypotheses and testing them against observations
						185	analyzing the results of the buffered acid experiment
						190	effect of changing mass on data

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					<p>193 explaining efficiency of heat transfer based on data</p> <p>197 identifying relationships between air pressure and weather</p> <p>197 evaluating your aneroid barometer design</p> <p>206 identifying relationship between percent of Earth covered in water and temperature range</p> <p>224 reconstruct a series of events from clues</p> <p>224 sequencing events</p> <p>235 concluding which conditions affect the timing and duration and intensity of an earthquake based on observation</p> <p>235 interpreting how the drumming affects the intensity of the earthquake in the model</p> <p>241 justify which scenario was most likely</p> <p>256 investigation discovering relationship between orbital speed and distance</p>

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.e Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.	42	interpreting distance/time graph	25	create a mathematical model
				459	heat equation	27	find math rule for lever equilibrium
				590	astronomic numbers expressed in scientific notation	28	derive a math formula
				592	calculating light year using scientific notation	187	find equation for trend line
				601	converting numbers to scientific notation	257	inverse square law
				606	determining Earth's mass using scientific notation	268	discovering the mathematical relationship between apparent brightness and distance
				645	inverse square law	271	calculating solar brightness units (SBU) from kilometers in scientific notation

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page		Volume 2 Investigation Manual Page	
InqHS.01.f Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Distinguish between hypothesis and theory as scientific terms.	9	steps in the scientific method	7	variables in an experiment
				10	forming a hypothesis	7	perform your own experiment
				10	process of reviewing hypothesis explained	7	compare results with hypothesis
				19	design your own experiment	10	conduct car/ramp experiment
				448	forming a hypothesis and testing through experimentation (#5)	16	investigate Newton's 2nd law
				448	describe steps you would take to determine whether pH affects frog population	34	investigate motion on a rollercoaster
				521	relative dating and modern geology based on Steno's theories	35	what evidence is there in support of your hypothesis?
				524	Kelvin's calculations of Earth's age	39	analyze energy transformations in different scenarios
				528	theory of plate tectonics	39	critique group's explanation of energy transformations
				529	critiquing Wegener's theories of continental drift	39	review energy theory in context of everyday scenarios
				530	proving hypotheses for sea-floor spreading	75	plan three experiments to determine which variable affects the period of a pendulum
				563	Darwin's theories of the Andes formation	75	perform self-designed experiment
				566	what causes ice ages		
				580	form a hypothesis (#7)		
				602	identify question, hypothesis, procedure, and results (#1)		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
				611 theories of origin of the moon	77 show how energy loss data could be applied to designing a real clock
				612 early theories of the solar system	77 compare law of conservation of energy to motion of pendulum
				647 Big Bang theory	151 do the data support the hypothesis
					151 review your hypothesis
					170 which factor will produce fastest dissolving rate?
					170 devise hypothesis and explain
					171 did you prove or disprove your hypothesis?
					171 what was happening at molecular level?
					182 simulating the effect of acid rain on daphnia
					182 formulate hypothesis
					188 conducting investigation of efficiency of immersion heater
					193 conducting experiments on heat transfer
					205 investigating how specific heat of water regulates Earth's temperature

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					208 formulate a hypothesis about why the seasons occur  237 develop a research plan for studying volcanoes

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.g Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the usefulness and limitations of models and theories as scientific representations of reality.	23	why make models?	13	graph distance vs. time
				24	scientific models	15	construct a quantitative graphical model
				24	making a graph	25	create a mathematical model
				24	what is a scientific model?	27	find math rule for lever equilibrium
				26	creating graphs	28	derive a math formula
				41	make a graph	37	organize data into a graph of speed vs. height
				42	interpreting distance/time graph	51	graph voltage vs. current
				459	heat equation	121	graph mass vs. volume
				485	computer modeling to predict greenhouse effects	147	organize observations into a category table
				494	modeling air currents	151	does your experiment agree with law of conservation of mass?
				518	create a model (#1)	185	constructing a graph of drops of acid vs pH
				524	model of Earth's history	187	construct a graphical model
				533	modeling plate boundaries	187	find equation for trend line
				576	rock cycle model	189	construct a temperature vs. time graph
				614	solar system modeling	197	constructing a graph from atmospheric pressure data
				624	model of the sun's anatomy	202	modeling the effect of greenhouse gases on Earth's temperature
				645	inverse square law		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					203 graphing water and ice temperature readings 206 constructing a graph of time vs. temperature 212 modeling underwater rivers and waterfalls and springs 231 evaluating your completed bathymetric map 232 construct a model that simulates an earthquake 247 evaluate your ability to interpret rock formations 257 inverse square law 258 setting up a scale model of the solar system 268 discovering the mathematical relationship between apparent brightness and distance

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.j Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the issues of statistical variability and the need for controlled tests.	11	control and experimental variables	7	doing a controlled experiment
				12	writing lab procedures	21	choose independent and dependent variables for graph
				26	independent and dependent variables	27	recognize variables
				547	average density (#5)	129	find average velocity
				618	average distance from the sun	170	write a procedure
						171	average dissolving rate
						190	effect of changing mass on collected data
						196	writing a procedure for constructing a pointer for an aneroid barometer
						211	determining whether distance from light source or axial tilt plays a more significant role in causing the seasons
						214	develop a procedure to create an underwater spring

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
InqHS.01.k Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Recognize the cumulative nature of scientific evidence.	73 473 504 648	impact of Da Vinci's work why do ears pop meteorologists use atmospheric pressure data to understand movement of weather systems evidence for Big Bang theory	6 215	asking questions and learning about natural world the food paradox of the oceans
InqHS.01.l Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Analyze situations and solve problems that require combining and applying concepts from more than one area of science.	548	describe the work of a geologist and paleontologist and seismologist	177 178	chemistry and photography water quality testing

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page		
InqHS.01.m Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources...	379	hydrogen-powered cars and the environment	52	the cost of using electrical appliances
				379	research environmental impact of fuel cells	163	too much CO <sub>2</sub>
				379	research economic impact of fuel cells	163	research how trees offset accumulation of CO <sub>2</sub>
				379	research fuel cells	163	research how trees offset accumulation of CO <sub>2</sub>
				391	impact of nuclear energy	201	research the causes of ozone in the lower atmosphere
				391	nuclear vs. fossil fuels	262	solar energy can be used to generate electricity without producing pollution
				395	fossil fuels		
				400	reducing pollution		
				400	economic impact of reducing air pollution		
				400	economic impact of pollution		
				400	problems caused by airborne pollutants		
				414	environmental impact of electrical generating facilities		
				433	the clean water act		
				436	effect of excess nitrates on environment		
				438	impact of using fossil fuels		
				439	catalytic converters and scrubbing reduce acid rain		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
				448 research economic impact of producing gases that cause acid rain	
				483 hydrogen powered cars	
				538 what we can learn from seismographs	
				544 understanding earthquakes allows engineers to design safer buildings	
				627 using photovoltaic cells	

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page		
InqHS.01.n Investigation and Experimentation	Standard	Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop questions and perform investigations.	Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent and that the theory is sometimes wrong.	19	which group did the best experiment?	6	predict which car will move fastest
				20	finding variability in data	7	test the effect of one other variable
				79	look at force data and decide the usefulness of a machine	9	devise a hypothesis
				11	calculate % error	18	evaluate graphs as to whether or not they show relationships between variables
				485	what percentage comes from this source? (problem 4)	18	use data to describe relationship between force and motion
				524	Kelvin's calculations of Earth's age	19	use data to infer correct relationship between variables
				543	determining distance to an epicenter	21	evaluate percent change for data collected
				547	what explains the difference in density? (#5)	27	think about the variables
				605	how big is Earth?	30	interpret block and tackle data
				34	where does the marble move the fastest?		
39	analyze energy transformations in different scenarios						
43	how did A and B tapes acquire different charge?						
75	evaluate statistical significance						

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					75 investigate variables that affect the period of a pendulum
					76 calculate % error
					77 compare law of conservation of energy to motion of pendulum
					141 build models of Na and Cl and use them to explain bonding
					151 explain how hypothesis compares to results
					151 perform the experiment you designed
					157 add new rules to list based on findings
					170 devise hypothesis and explain
					171 evaluate method based on data
					182 making hypotheses and testing them against observations
					185 analyzing the results of the buffered acid experiment
					193 explaining efficiency of heat transfer based on data
					197 evaluating your aneroid barometer design

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

Standard #: Subject	Topic	Standard	Benchmark	Volume 1 Student Text Page	Volume 2 Investigation Manual Page
					197 calculating error between your barometer and a commercial barometer 199 importance of good record keeping in order to avoid error 200 evaluating your qualitative ozone strips 208 testing hypothesis of why seasons occur against your observations in the investigation 224 reconstruct a series of events from clues 235 interpreting how the drumming affects the intensity of the earthquake in the model
PhysHS.01.a Physics	Motion and Forces	Newton's law predicts the motion of most objects.	Students know how to solve problems that involve constant speed and average speed.	14 how to calculate speed 20 find speed of bumblebee 20 calculate speed of car 24 accurate speed measurements 32 average speed vs. instantaneous 42 calculate speed from distance/time graph	9 collect data and calculate speed of car 10 calculate speed of the car 12 find speed of car at different positions 14 calculate speed of car at two places on the ramp 17 calculate speed of car 36 find speed of marble

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.01.b Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).	45	Newton's first law summarized	14	exploring acceleration on a ramp
				48	Newton's first law in detail	16	unbalanced forces and acceleration of car
				51	balanced and unbalanced forces		
PhysHS.01.c Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to apply the law $F=ma$ to solve one-dimensional motion problems that involve constant forces (Newton's second law).	45	Newton's second law summarized	16	thinking about force
				49	Newton's second law in detail	19	discover 2nd law of motion
				64	solving problems using $f=ma$		
PhysHS.01.d Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).	45	Newton's third law summarized	22	car and ramp and Newton's 3rd law
				59	Newton's third law in detail	23	using 3rd law to explain common phenomena

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.01.e Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.	52 52 54 55 606	gravity depends on mass the effect of gravity Newton's law of universal gravitation calculating gravitational force between objects Newton's law of universal gravitation	20 257	investigate effect of gravity on motion relating the relationship between orbital speed and distance to the equation of universal gravitation
PhysHS.01.m Physics	Motion and Force	Newton's law predicts the motion of most objects.	Students know how to solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation).	52 54 55 606	gravity depends on mass Newton's law of universal gravitation calculating gravitational force between objects Newton's law of universal gravitation	257	relating the relationship between orbital speed and distance to the equation of universal gravitation
PhysHS.02.a Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to calculate kinetic energy by using the formula $E=(1/2)mv^2$ .	91 537	following an energy transformation potential energy transformed to kinetic energy causes earthquakes	36 38	energy conservation and the roller coaster identify potential/kinetic energy conversions

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.02.c Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know how to solve problems involving conservation of energy in simple systems, such as falling objects.	88	potential and kinetic energy explained	36	energy conservation and the roller coaster
				90	conservation of energy explained	37	investigating conservation of energy with rollercoaster
				92	energy transformations and conservation	38	conservation of energy and energy transformations
				93	different forms of energy described		
				96	prove that energy is conserved		
PhysHS.02.e Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know momentum is separately conserved quantity different from energy.	60	law of conservation of momentum		
PhysHS.02.f Physics	Conservation of Energy and Momentum	The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects.	Students know an unbalanced force on an object produces a change in its momentum.	51	balanced and unbalanced forces	16	unbalanced forces and acceleration of car
				60	how to calculate momentum		
				64	calculate momentum		

**Correlation to California Science Content Standards  
 Foundations of Physical Science with Earth and Space Science  
 Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.03.a Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know heat flow and work are two forms of energy transfer between systems.	84	work input and output	31	work output vs. work input
				85	some input work is converted to heat	38	explore energy transformations
				91	energy conversions	119	investigate temperature and energy transfer in melting process
				92	where does "spent" energy go?	188	investigate the increase of temperature of water as thermal energy is added
				96	explain the "lost" energy	192	investigate convection in liquids
				454	changes in temperature are directly related to changes in energy		
				462	heat transfer through air		
				462	densely packed solids are good conductors of heat		
				463	convection currents and weather		
				463	warming hands over candle		
				464	convection currents in water		
				465	solid road surface emits radiation		
				465	transfer of heat by radiation		
				482	global warming and heat transfer by radiation		
				493	apply knowledge of heat transfer to different situations		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.03.c Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object energy of motion of the atoms and molecules...	454	temperature and thermal energy and heat	119	investigate temperature and energy transfer in melting process
				454	changes in temperature are directly related to changes in energy	188	relationship between heat and temperature
				455	examples of flow of heat	188	investigate heating water with an immersion heater
				456	specific heat	188	investigate the increase of temperature of water as thermal energy is added
				456	definition of specific heat		
				458	water's specific heat helps regulate Earth's temperature	205	investigating how the high specific heat of water helps regulate Earth's temperature
				459	heat equation		
				461	conduction and convection and radiation		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.03.g Physics	Heat and Thermodynamics	Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat.	Students know how to solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.	83	how to calculate work	31	calculate work done on block
				84	work input and output	31	work output vs. work input
				85	efficiency explained	191	find efficiency of water heater
				85	efficiency and bicycles	191	calculating work input and work output
				86	power explained	191	power of an immersion heater
				86	how to calculate power	263	calculate the power output of a photovoltaic cell
				96	calculate work done		
				97	find the efficiency of a machine		
				97	calculate work output from efficiency data		
				97	compare different amounts of work done		
				97	calculate work accomplished by a motor		
				97	calculate power of two different machines		
				97	analyze power of motor		
				97	calculate power		
				138	how to calculate electrical power		
PhysHS.04.a Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know waves carry energy from one place to another.	195	waves transmit energy		
				480	energy and radiation relationships		
				626	the sun's energy reaches Earth in the form of electromagnetic waves		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.04.b Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).	197 205 538	transverse and longitudinal waves standing waves on a string body waves	82 84	study wave pulses on elastic cord make different types of waves in a ripple tank
PhysHS.04.c Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to solve problems involving wavelength, frequency, and wave speed.	221	importance of wavelength of sound waves	83 86	find speed of a wave adjust frequency of a standing wave
PhysHS.04.d Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.	219 222 222 480	frequency of sound and pitch effect of temperature on speed of sound wave effect of medium on speed of sound wave electromagnetic radiation	90 94	what is sound and how do we hear it? does sound behave like other waves?
PhysHS.04.e Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately $3 \times 10^8$ m/s (186,000 miles/second).	237 237 479	visible light and the electromagnetic spectrum light waves and the electromagnetic spectrum ultraviolet and infrared light	134	investigating visible light with a spectrometer

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.04.f Physics	Waves	Waves have characteristic properties that do not depend on the type of wave.	Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.	201	waves and absorption	85	observing reflection in water waves
				201	waves and refraction	95	interference and sound waves
				201	waves and reflection	95	investigate interference with sound waves
				201	reflection in water waves and light waves	101	examine light through diffraction grating
				202	refraction and eyeglasses	102	polarization of a spring wave
				206	constructive and destructive interference	102	polarization of water waves
				210	can wave interference sink a ship?	103	polarization of light
				223	interference of sound waves	108	explore refraction with a prism
				225	consonance and dissonance and beats		
				240	polarization of light		
				261	refraction and lenses		
				648	the Doppler effect		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
**Student Text and Investigation Manual**

<b>Standard #: Subject</b>	<b>Topic</b>	<b>Standard</b>	<b>Benchmark</b>	<b>Volume 1 Student Text Page</b>		<b>Volume 2 Investigation Manual Page</b>	
PhysHS.05.a Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to predict the voltage or current in simple direct current(DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	101	concept of electric current	44	investigate concept of voltage
				102	concept of electric circuits	45	battery chemicals and electrical charge
				103	circuit diagrams	46	investigate concept of electric current
				113	battery uses chemical energy to produce electrical charge	56	build a parallel circuit
				114	voltage is related to potential energy	56	build a series circuit
				114	voltage and potential energy	57	compare brightness of bulbs in series vs. parallel
				115	how to measure voltage	58	build a series circuit and find total resistance
				145	series circuit defined	60	parallel circuit and Ohm's law
				145	parallel circuit defined	61	compare current and voltage and resistance in each type of circuit
				145	single path vs. branching paths		
				145	holiday lights as series or parallel		
				146	household wiring		
				147	current and voltage in series circuits		
				151	voltage and resistance in parallel circuits		
				155	analyze a parallel circuit		
				156	analyze a series circuit		

**Correlation to California Science Content Standards**  
***Foundations of Physical Science with Earth and Space Science***  
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PhysHS.05.b Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know how to solve problems involving Ohm's law.	131 132	Ohm's law explained using Ohm's law to analyze circuits	50	Ohm's law
PhysHS.05.c Physics	Electric and Magnetic Phenomena	Electric and magnetic phenomena are related and have many practical applications.	Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula $Power = IR$ .	123 136	understand the concept of electrical resistance potentiometer explained	48	measuring resistance