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Grade Level(s):	
Intended Audience:	DISCIPLINE CHEMISTRY; DISCIPLINE INVESTIGATION AND EXPERIMENTATION

**Standards Map - Basic Comprehensive Program  
Grades Nine Through Twelve - Science**

Pursuant to the State Board approved, *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve*  
Standards that all students are expected to achieve in the course of their studies are unmarked.  
Standards that all students should have the opportunity to learn are marked with an asterisk (\*).

Grade	Standard #	Text of Standard	PUBLISHER CITATIONS**			Meets Standard		FOR LEA USE ONLY Local Education Agency Evaluator Notes
			Introduced	Practiced	Taught to Mastery	Y	N	
<b>DISCIPLINE</b>		<b>CHEMISTRY</b>						
		<b>Atomic and Molecular Structure</b> 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. As a basis for understanding this concept:						
9-12	1a	Students know how to relate the position of an element in the periodic table to its atomic number and atomic mass.	SE: 98-99, 102-104	SE: 99, 102-104	SE: 113			
9-12	1b	Students know how to use the periodic table to identify metals, semimetals, non-metals, and halogens.	SE: 155-158	SE: 170-171 TWE: 158	SE: 158, 174 TWE: 281			
9-12	1c	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.	SE: 155-158, 163-169 TWE: 166-167	SE: 165, 288 TWE: 167	SE: 169, 174-175 TWE: 169			
9-12	1d	Students know how to use the periodic table to determine the number of electrons available for bonding.	SE: 159-161	SE: 162 TWE: 162	SE: 162, 174-175			

\*\* For more information, see Notes.  
Science 9-12th Grade Standards Map -- Approved by the State Board of Education on Feb. 6, 2002.

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			Introduced	Practiced	Taught to Mastery	Y	N	
9-12	1e	Students know the nucleus of the atom is much smaller than the atom yet contains most of its mass.	SE: 95, 97	SE: 953	SE: 112			
9-12	1f*	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.	SE: 156-158, 197, 201, 815-816		SE: 158, 201, 820			
9-12	1g*	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.	SE: 159-162, 167-168 TWE: 166-167	SE: 162, 170-171, 288 TWE: 162, 168	SE: 162, 174-175 TWE: 161			
9-12	1h*	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.	SE: 92-97, 123-124 TWE: 92-95	SE: 124 TWE: 97, 123	SE: 97, 112, 126, 146			
9-12	1i*	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.	SE: 127-134 TWE: 131	SE: 130 TWE: 128	SE: 134, 146 TWE: 133			
9-12	1j*	Students know that spectral lines are the result 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 ( $E = h\nu$ ).	SE: 122-126, 127-128	SE: 124, 125, 130, 142-143 TWE: 128	SE: 126, 147 TWE: 130			

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		<b>Chemical Bonds</b> 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. As a basis for understanding this concept:						
9-12	2a	Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.	SE: 215-217, 228-229, 241-247 TWE: 228, 244, 248-249	SE: 217, 232-233 TWE: 215, 245	SE: 220, 231, 236-237, 247, 272 TWE: 217, 231, 247			
9-12	2b	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.	SE: 242-246, 698, 710, 776-777, 781-782, 784-785	TWE: 243, 783	SE: 247, 272 TWE: 245, 247			
9-12	2c	Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.	SE: 217-218		SE: 220			
9-12	2d	Students know the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.	SE: 58-59, 396-397	TWE: 59	SE: 403 TWE: 397			
9-12	2e	Students know how to draw Lewis dot structures.	SE: 140, 160, 243-244, 252-258	SE: 141, 244, 253-258 TWE: 141, 212, 247, 254, 257, 258	SE: 141, 147, 247, 258, 273			
9-12	2f*	Students know how to predict the shape of simple molecules and their polarity from Lewis dot structures.	SE: 259-261, 264-266	SE: 261, 262, 266 TWE: 261, 262	SE: 262, 267, 273-274 TWE: 265			
9-12	2g*	Students know how electronegativity and ionization energy relate to bond formation.	SE: 167-169, 263-266	TWE: 168, 263	SE: 267, 273			

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						Y	N	
9-12	2h*	Students know how to identify solids and liquids held together by Van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/melting point temperatures.	SE: 266, 393-395	SE: 267, 410-411, 766-767 TWE: 266	SE: 395, 414 TWE: 394, 395			
		<b>Conservation of Matter and Stoichiometry</b> 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. As a basis for understanding this concept:						
9-12	3a	Students know how to describe chemical reactions by writing balanced equations.	SE: 278-283	SE: 282, 285, 286, 289, 291, 301 TWE: 279, 281, 283	SE: 283, 304-305 TWE: 282, 287			
9-12	3b	Students know the quantity one mole is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.	SE: 310					
9-12	3c	Students know one mole equals $6.02 \times 10^{23}$ particles (atoms or molecules).	SE: 310-312, 316-319, 325-327	SE: 312, 318, 326 TWE: 319	SE: 312, 327, 346, 348 TWE: 310, 312, 317, 327			
9-12	3d	Students know how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.	SE: 313-319, 322-327, 430-433	SE: 314, 316, 318, 322-324, 326, 433 TWE: 315, 316, 322	SE: 319, 327, 347-348, 449 TWE: 317, 318, 323, 324, 325, 327			
9-12	3e	Students know how to calculate the masses of reactants and products in a chemical reaction from the mass of one of the reactants or products and the relevant atomic masses.	SE: 361-363	SE: 362 TWE: 362	SE: 363, 380 TWE: 363			

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9-12	3f*	Students know how to calculate percent yield in a chemical reaction.	SE: 370-373 TWE: 370	SE: 372, 375 TWE: 373	SE: 373, 378, 381 TWE: 371, 373			
9-12	3g*	Students know how to identify reactions that involve oxidation and reduction and how to balance oxidation-reduction reactions.	SE: 635-643, 644-649 TWE: 645	SE: 635, 638, 640, 642, 646, 647, 649, 654-655 TWE: 636, 644	SE: 643, 649, 658-660 TWE: 643, 648, 649			
		<b>Gases and their Properties</b> The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:						
9-12	4a	Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.	SE: 388-389, 420		SE: 392			
9-12	4b	Students know the random motion of molecules explains the diffusion of gases.	SE: 387	TWE: 392	SE: 414			
9-12	4c	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.	SE: 421-427, 428-430 TWE: 420-421, 425	SE: 422, 424, 425, 427, 430	SE: 427, 433, 448-449 TWE: 427, 430			
9-12	4d	Students know the values and meanings of standard temperature and pressure (STP).	SE: 431		SE: 448			
9-12	4e	Students know how to convert between the Celsius and Kelvin temperature scales.	SE: 30, 424-427, 429	SE: 425, 427, 430	SE: 50 TWE: 30			
9-12	4f	Students know there is no temperature lower than 0 Kelvin.	SE: 423					
9-12	4g*	Students know the kinetic theory of gases relates the absolute temperature of a gas to the average kinetic energy of its molecules or atoms.	SE: 385-386, 419-420	SE: 411, 533 TWE: 391	SE: 414			
9-12	4h*	Students know how to solve problems by using the ideal gas law in the form $PV = nRT$ .	SE: 434-438	SE: 437, 438, 439, 444-445 TWE: 435	SE: 449 TWE: 439			

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9-12	4i*	Students know how to apply Dalton's law of partial pressures to describe the composition of gases and Graham's law to predict diffusion of gases.	SE: 387-388, 391-392	SE: 388, 392 TWE: 387	SE: 392, 415			
		<b>Acids and Bases</b> Acids, bases, and salts are three classes of compounds that form ions in water solutions. As a basis for understanding this concept:						
9-12	5a	Students know the observable properties of acids, bases, and salt solutions.	SE: 595-596, 621-622 TWE: 596, 602	SE: 622	SE: 601, 625, 630-631			
9-12	5b	Students know acids are hydrogen-ion-donating and bases are hydrogen-ion-accepting substances.	SE: 598-599	SE: 599 TWE: 600	SE: 601, 630			
9-12	5c	Students know strong acids and bases fully dissociate and weak acids and bases partially dissociate.	SE: 602-607	SE: 604 TWE: 605	SE: 607, 630 TWE: 605			
9-12	5d	Students know how to use the pH scale to characterize acid and base solutions.	SE: 610-616 TWE: 612	TWE: 611, 620	SE: 631-632 TWE: 614, 615			
9-12	5e*	Students know the Arrhenius, Brønsted-Lowry, and Lewis acid-base definitions.	SE: 597-599, 603-604	TWE: 600	SE: 601, 607, 630, 632 TWE: 599			
9-12	5f*	Students know how to calculate pH from the hydrogen-ion concentration.	SE: 610-611 TWE: 610	SE: 611 TWE: 615	SE: 616 TWE: 631			
9-12	5g*	Students know buffers stabilize pH in acid-base reactions.	SE: 622-625 TWE: 622-623	SE: 624	SE: 625, 631 TWE: 623, 625			
		<b>Solutions</b> Solutions are homogenous mixtures of two or more substances. As a basis for understanding this concept:						
9-12	6a	Students know the definitions of solute and solvent.	SE: 292, 453-454	TWE: 455	SE: 484			

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9-12	6b	Students know how to describe the dissolving process at the molecular level by using the concept of random molecular motion.	SE: 455-456, 458	TWE: 455	SE: 461			
9-12	6c	Students know temperature, pressure, and surface area affect the dissolving process.	SE: 456, 458-461 TWE: 458-459	SE: 461 TWE: 457	SE: 461, 484, 486 TWE: 461			
9-12	6d	Students know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.	SE: 462-470 TWE: 468	SE: 463-465, 469, 470 TWE: 465, 466	SE: 470, 484-485 TWE: 470			
9-12	6e*	Students know the relationship between the molality of a solute in a solution and the solution's depressed freezing point or elevated boiling point.	SE: 472-475 TWE: 472	SE: 473, 474 TWE: 474	SE: 475, 485-486 TWE: 475			
9-12	6f*	Students know how molecules in a solution are separated or purified by the methods of chromatography and distillation.	SE: 69	SE: 68, 268-269	SE: 69, 82-83 TWE: 725			
		<b>Chemical Thermodynamics</b> Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:						
9-12	7a	Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).	SE: 386, 404-408	SE: 411, 533 TWE: 405	SE: 409, 414 TWE: 406			
9-12	7b	Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.	SE: 219, 247, 498-500 TWE: 508	SE: 520-521 TWE: 499	SE: 500, 524 TWE: 538			
9-12	7c	Students know energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.	SE: 404-408, 502-503	SE: 503, 505 TWE: 505	SE: 409, 505 TWE: 406, 408			
9-12	7d	Students know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.	SE: 492-495, 496-498, 502-505	SE: 495, 498, 503, 504, 505, 520-521 TWE: 493	SE: 495, 500, 505, 525 TWE: 497			

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9-12	7e*	Students know how to apply Hess's law to calculate enthalpy change in a reaction.	SE: 506-508 TWE: 506	SE: 508	SE: 512, 525			
9-12	7f*	Students know how to use the Gibbs free energy equation to determine whether a reaction would be spontaneous.	SE: 517-519	SE: 519	SE: 519, 524, 526 TWE: 517, 519			
		<b>Reaction Rates</b> Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules. As a basis for understanding this concept:						
9-12	8a	Students know the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.	SE: 529-531 TWE: 530	SE: 531 TWE: 530	SE: 535, 554-555 TWE: 531			
9-12	8b	Students know how reaction rates depend on such factors as concentration, temperature, and pressure.	SE: 536-538 TWE: 536-537	SE: 539, 550-551	SE: 541, 554 TWE: 541			
9-12	8c	Students know the role a catalyst plays in increasing the reaction rate.	SE: 539-541, 757	SE: 529 TWE: 540	SE: 541, 554 TWE: 538, 541			
9-12	8d*	Students know the definition and role of activation energy in a chemical reaction.	SE: 533-534, 540	TWE: 535	SE: 554-555 TWE: 534			

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		<b>Chemical Equilibrium</b> Chemical equilibrium is a dynamic process at the molecular level. As a basis for understanding this concept:						
9-12	9a	Students know how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.	SE: 569-574, 588 TWE: 570	SE: 573 TWE: 574	SE: 574, 590-591 TWE: 571, 574			
9-12	9b	Students know equilibrium is established when forward and reverse reaction rates are equal.	SE: 561-563 TWE: 561, 562		SE: 568, 593			
9-12	9c*	Students know how to write and calculate an equilibrium constant expression for a reaction.	SE: 563-568	SE: 565, 567, 568 TWE: 566	SE: 568, 590-591 TWE: 568			
		<b>Organic Chemistry and Biochemistry</b> 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. As a basis for understanding this concept:						
9-12	10a	Students know large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits.	761-764, 775-778, 782-783, 788-791 TWE: 761, 762-763, 789	SE: 790 TWE: 764, 765, 788	SE: 765, 771, 780, 783, 801			
9-12	10b	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.	SE: 244, 245, 698-701, 706, 710, 717-721, 722-724, 737-738, 761-764 TWE: 719	SE: 720, 721 TWE: 245, 701, 717, 720, 738	SE: 732 TWE: 721			
9-12	10c	Students know amino acids are the building blocks of proteins.	SE: 775-778		SE: 780, 800, 801			

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9-12	10d*	Students know the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds, simple hydrocarbons with double and triple bonds, and simple molecules that contain a benzene ring.	SE: 699-705, 711-715, 723-724 TWE: 703	SE: 705, 714 TWE: 701, 724, 748	SE: 705, 716, 732-734			
9-12	10e*	Students know how to identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.	SE: 743-746, 747-751	SE: 751 TWE: 747, 749	SE: 746, 753, 770-771 TWE: 745, 746, 753			
9-12	10f*	Students know the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins.	SE: 776-777	TWE: 776	SE: 780, 800			
		<b>Nuclear Processes</b> 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. As a basis for understanding this concept:						
9-12	11a	Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.	SE: 810		SE: 814, 836			
9-12	11b	Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E = mc^2$ ) is small but significant in nuclear reactions.	SE: 821-822	TWE: 821	SE: 826			
9-12	11c	Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.	SE: 105-106, 807, 810-811	TWE: 100, 107, 812	SE: 814, 836 TWE: 814			
9-12	11d	Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.	SE: 106-107, 807-809, 813-814	SE: 814 TWE: 106, 107, 809	SE: 107, 112, 809, 814, 837			
9-12	11e	Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.	SE: 808-809, 829-831	SE: 830, 964	SE: 809 TWE: 809			

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9-12	11f*	Students know how to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.	SE: 817-819 TWE: 817	SE: 819 TWE: 818, 819	SE: 820, 837 TWE: 820			
9-12	11g*	Students know protons and neutrons have substructures and consist of particles called quarks.	SE: 97	TWE: 817				
<b>DISCIPLINE</b>		<b>INVESTIGATION AND EXPERIMENTATION</b> 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 their own questions and perform investigations. Students will:						
9-12	1a	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.	SE: 43-45, 903-907	SE: 164, 478, 480-481, 688-689, 796-797, 832-833, 862-863 TWE: 497, 620, 819	SE: 45, 51-52 TWE: 45			
9-12	1b	Identify and communicate sources of unavoidable experimental error.	SE: 38-39	SE: 47, 155, 343, 445, 521, 833 TWE: 41				
9-12	1c	Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.		SE: 109, 233, 269, 301, 375, 481, 551, 729 TWE: 38, 504				
9-12	1d	Formulate explanations by using logic and evidence.		SE: 125, 155, 191, 219, 233, 288, 473, 573, 848, 860				

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9-12	1e	Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.	SE: 542-545, 610-614, 817-819, 910-911	SE: 130, 545, 611, 614, 819, 830, 911 TWE: 544, 610	SE: 631-632, 820			
9-12	1f	Distinguish between hypothesis and theory as scientific terms.	SE: 11, 13	TWE: 12	SE: 22 TWE: 13			
9-12	1g	Recognize the usefulness and limitations of models and theories as scientific representations of reality.	SE: 131, 699 TWE: 129					
9-12	1h	Read and interpret topographic and geologic maps.		SE: 846 TWE: 856				
9-12	1i	Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).	SE: 163-169, 817-821, 850-851, 858-861	SE: 164, 819 TWE: 167, 850, 856	SE: 169, 837, 861			
9-12	1j	Recognize the issues of statistical variability and the need for controlled tests.	SE: 12	SE: 18-19, 478, 767 TWE: 13	SE: 22			
9-12	1k	Recognize the cumulative nature of scientific evidence.	SE: 3-6, 87-97, 151-154, 806, 846	TWE: 97, 133, 325, 432				
9-12	1l	Analyze situations and solve problems that require combining and applying concepts from more than one area of science.	SE: 131, 152, 226, 264, 457, 563, 637, 684, 739, 851	SE: 143, 309, 445, 624 TWE: 405, 430				
9-12	1m	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, and land and water use decisions in California.	SE: 825, 845-846, 853, 859-860 TWE: 847	SE: 20, 80, 110, 482, 627, 834, 860 TWE: 824, 851, 853				

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9-12	1n	Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).	SE: 89-90, 92-96, 127-128, 151-153	TWE: 89, 93, 156				

Publisher Notes/Additional Comments (note to publishers: please include grade level/standard when listing comments):