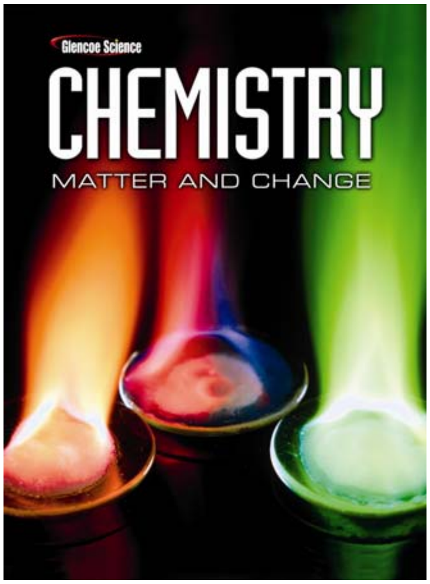
McGraw Hill Glencoe

High School Science Content
Expectations/Chemistry
Core Skills



CHEMISTRY

MATTER AND CHANGE

STANDARDS		PAGE REFERENCES
	STANDARD C1: INQUIRY, REFLECTION, AND SOCIAL IMPLICATIONS *Students will understand the nature of science and demonstrate an ability to practice scientific reasoning by applying it to the design, execution, and evaluation of scientific investigations. Students will demonstrate their understanding that scientific knowledge is gathered through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to, experimentation. They will be able to distinguish between types of scientific knowledge (e.g., hypotheses, laws, theories) and become aware of areas of active research in contrast to conclusions that are part of established scientific consensus. They will use their scientific knowledge to assess the costs, risks, and benefits of technological systems as they make personal choices and participate in public policy decisions. These insights will help them analyze the role science plays in society, technology, and potential career opportunities.*	
	C1.1 Scientific Inquiry Science is a way of understanding nature. Scientific research may begin by generating new scientific questions that can be answered through replicable scientific investigations that are logically developed and conducted systematically. Scientific conclusions and explanations result from careful analysis of empirical evidence and the use of logical reasoning. Some questions in science are addressed through indirect rather than direct observation, evaluating the consistency of new evidence with results predicted by models of natural processes. Results from investigations are communicated in reports that are scrutinized through a peer review process.	
C1.1f	Predict what would happen if the variables, methods, or timing of an investigation were changed.	**Student Edition:** 14-15, 57-58 *Chemlab* 24, 126 *Inquiry Extension* 164, 432, 584, 850 *Problem-Solving Lab* 50, 72, 531

Codes used for Teacher Wraparound Edition pages are the initial caps of headings on that page.

STANDARDS		PAGE REFERENCES
C1.1g	Based on empirical evidence, explain and critique the reasoning used to draw a scientific conclusion or explanation	**Student Edition:** 35-38, 44-46, 50-54, 55-58, 141-143, 379-384, 523-528 *Chemlab* 60, 92, 550 *MiniLab* 39, 683
C1.1h	Design and conduct a systematic scientific investigation that tests a hypothesis. Draw conclusions from data presented in charts or tables.	**Student Edition:** 12-15, 55-58 *Chemistry & Health* 59 *Data Analysis Lab* 21 *Inquiry Extension* 92, 164, 390, 432, 584, 698 *Math Handbook* 959-963
C1.1i	Distinguish between scientific explanations that are regarded as current scientific consensus and the emerging questions that active researchers investigate.	**Student Edition:** 5-8, 16 *Chemistry & Health* 389 *Data Analysis Lab* 216, 387, 724 *Problem-Solving Lab* 444, 622, 668 *Problem-Solving Strategy* 160, 374, 696
	C1.2 Scientific Reflection and Social Implications The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.	
C1.2f	Critique solutions to problems, given criteria and scientific constraints.	**Student Edition:** 36-38, 333-340, 380-383 *Data Analysis Lab* 216, 768, 805 *Launch Lab* 281 *MiniLab* 39 *Problem-Solving Lab* 50, 622, 668
C1.2g	Identify scientific tradeoffs in design decisions and choose among alternative solutions.	**Student Edition:** 141-145, 151-152, 880-882, 885-889 *Chemistry & Health* 59, 389 *MiniLab* 227 *Writing in Chemistry* 549, 583, 775

STANDARDS		PAGE REFERENCES
C1.2h	Describe the distinctions between scientific theories, laws, hypotheses, and observations.	**Student Edition:** 12-13, 15-16, 77-79, 87-90, 517, 599 *Inquiry Extension* 92, 164, 390, 432, 584, 698 *Launch Lab* 101
C1.2i	Explain the progression of ideas and explanations that lead to science theories that are part of the current scientific consensus or core knowledge.	**Student Edition:** 84-90, 102-114, 117-120, 136-143, 146-152, 161, 174-181, 210-217, 240-247, 258-259, 265-270, 333-340, 402-403, 425-430, 744-749
C1.2j	Apply science principles or scientific data to anticipate effects of technological design decisions.	**Student Edition:** 724-727, 880-882, 886-890 *Chemistry & Health* 163, 465 *Data Analysis Lab* 216, 269, 387, 805 *How It Works* 549, 733 *In the Field* 505 *Problem-Solving Lab* 622
C1.2k	Analyze how science and society interact from a historical, political, economic, or social perspective.	**Student Edition:** 5-8, 20-21, 880-884 *Chemistry & Health* 59, 389, 623 *Chemlab* 698, 892 *Data Analysis Lab* 21, 387, 805 *Everyday Chemistry* 229, 431, 815 *In the Field* 389, 465

STANDARD C2: FORMS OF ENERGY

Students recognize the many forms of energy and understand that energy is central to predicting and explaining how and why chemical reactions occur. The chemical topics of bonding, gas behavior, kinetics, enthalpy, entropy, free energy, and nuclear stability are addressed in this standard.

Chemistry students relate temperature to the average kinetic energy of the molecules and use the kinetic molecular theory to describe and explain the behavior of gases and the rates of chemical reactions. They understand nuclear stability in terms of reaching a state of minimum potential energy.

P2.p1 Potential Energy *(prerequisite)*

Three forms of potential energy are gravitational, elastic, and chemical. Objects can have elastic potential energy due to their compression or chemical potential energy due to the arrangement of the atoms. *(prerequisite)*

STANDARDS		PAGE REFERENCES
	C2.1x Chemical Potential Energy Potential energy is stored whenever work must be done to change the distance between two objects. The attraction between the two objects may be gravitational, electrostatic, magnetic, or strong force. Chemical potential energy is the result of electrostatic attractions between atoms.	
C2.1a	Explain the changes in potential energy (due to electrostatic interactions) as a chemical bond forms and use this to explain why bond breaking always requires energy.	**Student Edition:** 247, 525-528, 529, 564-565, 571-573
C2.1b	Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).	**Student Edition:** 247, 525-528, 529, 537-541, 564-565, 571-573 *Connection to Biology* 532 *Launch Lab* 475
C2.1c	Compare qualitatively the energy changes associated with melting various types of solids in terms of the types of forces between the particles in the solid.	**Student Edition:** 214-217, 226, 269-270 *MiniLab* 242
	C2.2 Molecules in Motion Molecules that compose matter are in constant motion (translational, rotational, vibrational). Energy may be transferred from one object to another during collisions between molecules.	
	C2.2x Molecular Entropy As temperature increases, the average kinetic energy and the entropy of the molecules in a sample increases.	
C2.2c	Explain changes in pressure, volume, and temperature for gases using the kinetic molecular model.	**Student Edition:** 402-410, 442-451, 454-456 *Chemlab* 466 *Launch Lab* 441
C2.2d	Explain convection and the difference in transfer of thermal energy for solids, liquids, and gases using evidence that molecules are in constant motion.	**Student Edition:** 226, 402-405, 422
C2.2e	Compare the entropy of solids, liquids, and gases.	**Student Edition:** 544-545
C2.2f	Compare the average kinetic energy of the molecules in a metal object and a wood object at room temperature.	**Student Edition:** 411, 422-424

STANDARDS		PAGE REFERENCES
	C2.3x Breaking Chemical Bonds For molecules to react, they must collide with enough energy (activation energy) to break old chemical bonds before their atoms can be rearranged to form new substances.	
C2.3a	Explain how the rate of a given chemical reaction is dependent on the temperature and the activation energy.	**Student Edition:** 560-565, 570-573 *Chemistry & Health* 583 *MiniLab* 571
C2.3b	Draw and analyze a diagram to show the activation energy for an exothermic reaction that is very slow at room temperature.	**Student Edition:** 534-535, 564-565, 570
	C2.4x Electron Movement For each element, the arrangement of electrons surrounding the nucleus is unique. These electrons are found in different energy levels and can only move from a lower energy level (closer to nucleus) to a higher energy level (farther from nucleus) by absorbing energy in discrete packets. The energy content of the packets is directly proportional to the frequency of the radiation. These electron transitions will produce unique absorption spectra for each element. When the electron returns from an excited (high energy state) to a lower energy state, energy is emitted in only certain wavelengths of light, producing an emission spectra.	
C2.4a	Describe energy changes in flame tests of common elements in terms of the (characteristic) electron transitions.	**Student Edition:** 144-145, 146-148 *Chemlab* 164 *Elements Handbook* 907, 911, 923 *MiniLab* 144 *Problem-Solving Lab* 150
C2.4b	Contrast the mechanism of energy changes and the appearance of absorption and emission spectra.	**Student Edition:** 144-148 *Chemlab* 164 *Elements Handbook* 923 *Problem-Solving Lab* 150
C2.4c	Explain why an atom can absorb only certain wavelengths of light.	**Student Edition:** 146-148 *Chemlab* 164 *Connection to Astronomy* 145
C2.4d	Compare various wavelengths of light (visible and nonvisible) in terms of frequency and relative energy.	**Student Edition:** 5, 138-140, 144-148, 863-864 *Problem-Solving Lab* 150

STANDARDS		PAGE REFERENCES
	C2.5x Nuclear Stability Nuclear stability is related to a decrease in potential energy when the nucleus forms from protons and neutrons. If the neutron/proton ratio is unstable, the element will undergo radioactive decay. The rate of decay is characteristic of each isotope; the time for half the parent nuclei to decay is called the half-life. Comparison of the parent/daughter nuclei can be used to determine the age of a sample. Heavier elements are formed from the fusion of lighter elements in the stars.	
C2.5a	Determine the age of materials using the ratio of stable and unstable isotopes of a particular type.	**Student Edition:** 873-874
	STANDARDC3: ENERGY TRANSFER AND CONSERVATION *Students apply the First and Second Laws of Thermodynamics to explain and predict most chemical phenomena.* *Chemistry students use the term enthalpy to describe the transfer of energy between reactants and products in simple calorimetry experiments performed in class and will recognize Hess's Law as an application of the conservation of energy.* *Students understand the tremendous energy released in nuclear reactions is a result of small amounts of matter being converted to energy.*	
	P3.p1 Conservation of Energy *(prerequisite)* When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. *(prerequisite)*	
	C3.1x Hess's Law For chemical reactions where the state and amounts of reactants and products are known, the amount of energy transferred will be the same regardless of the chemical pathway. This relationship is called Hess's law.	
C3.1a	Calculate the Δ**H** for a given reaction using Hess's Law.	**Student Edition:** 534-540
C3.1b	Draw enthalpy diagrams for exothermic and endothermic reactions.	**Student Edition:** 527-530, 534-535
C3.1c	Calculate the Δ**H** for a chemical reaction using simple coffee cup calorimetry.	**Student Edition:** 523-525 *MiniLab* 526
C3.1d	Calculate the amount of heat produced for a given mass of reactant from a balanced chemical equation.	**Student Edition:** 526-528, 529-533, 534-536
	P3.p2 Energy Transfer *(prerequisite)* Nuclear reactions take place in the sun. In plants, light from the sun is transferred to oxygen and carbon compounds, which, in combination, have chemical potential energy (photosynthesis). *(prerequisite)*	

STANDARDS		PAGE REFERENCES
	C3.2x Enthalpy Chemical reactions involve breaking bonds in reactants (endothermic) and forming new bonds in the products (exothermic). The enthalpy change for a chemical reaction will depend on the relative strengths of the bonds in the reactants and products.	
C3.2a	Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.	**Student Edition:** 846-847 *Connection to Biology* 532
C3.2b	Describe the relative strength of single, double, and triple covalent bonds between nitrogen atoms.	**Student Edition:** 242-246
	C3.3 Heating Impacts Heating increases the kinetic (translational, rotational, and vibrational) energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic (translational) energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a sample of a crystalline solid increases the kinetic (vibrational) energy of the atoms, molecules, or ions. When the kinetic (vibrational) energy becomes great enough, the crystalline structure breaks down, and the solid melts.	
	C3.3x Bond Energy Chemical bonds possess potential (vibrational and rotational) energy.	
C3.3c	Explain why it is necessary for a molecule to absorb energy in order to break a chemical bond.	**Student Edition:** 247, 564-565, 571-573
	C3.4 Endothermic and Exothermic Reactions Chemical interactions either release energy to the environment (exothermic) or absorb energy from the environment (endothermic).	
	C3.4x Enthalpy and Entropy All chemical reactions involve rearrangement of the atoms. In an exothermic reaction, the products have less energy than the reactants. There are two natural driving forces: (1) toward minimum energy (enthalpy) and (2) toward maximum disorder (entropy).	
C3.4c	Write chemical equations including the heat term as a part of equation or using **ΔH** notation.	**Student Edition:** 529-533, 534-540
C3.4d	Draw enthalpy diagrams for reactants and products in endothermic and exothermic reactions.	**Student Edition:** 526-528, 529, 532-533, 535-540
C3.4e	Predict if a chemical reaction is spontaneous given the enthalpy (ΔH) and entropy (ΔS) changes for the reaction using Gibb's Free Energy, $\Delta G = \Delta H - T\Delta S$ (Note: mathematical computation of ΔG is not required.)	**Student Edition:** 546-548

STANDARDS		PAGE REFERENCES
C3.4f	Explain why some endothermic reactions are spontaneous at room temperature.	**Student Edition:** 546-548
C3.4g	Explain why gases are less soluble in warm water than cold water.	**Student Edition:** 426-427, 492, 495
	C3.5x Mass Defect Nuclear reactions involve energy changes many times the magnitude of chemical changes. In chemical reactions matter is conserved, but in nuclear reactions a small loss in mass (mass defect) will account for the tremendous release of energy. The energy released in nuclear reactions can be calculated from the mass defect using **$E = mc^2$**.	
C3.5a	Explain why matter is not conserved in nuclear reactions.	**Student Edition:** 877-880 *Problem-Solving Strategy* 878
	STANDARD C4: PROPERTIES OF MATTER *Compounds, elements, and mixtures are categories used to organize matter. Students organize materials into these categories based on their chemical and physical behavior. Students understand the structure of the atom to make predictions about the physical and chemical properties of various elements and the types of compounds those elements will form. An understanding of the organization the Periodic Table in terms of the outer electron configuration is one of the most important tools for the chemist and student to use in prediction and explanation of the structure and behavior of atoms.*	
	P4.p1 Kinetic Molecular Theory *(prerequisite)* Properties of solids, liquids, and gases are explained by a model of matter that is composed of tiny particles in motion. *(prerequisite)*	
	P4.p2 Elements, Compounds, and Mixtures *(prerequisite)* Elements are a class of substances composed of a single kind of atom. Compounds are composed of two or more different elements chemically combined. Mixtures are composed of two or more different elements and/or compounds physically combined. Each element and compound has physical and chemical properties, such as boiling point, density, color, and conductivity, which are independent of the amount of the sample. *(prerequisite)*	
	C4.1x Molecular and Empirical Formulae Compounds have a fixed percent elemental composition. For a compound, the empirical formula can be calculated from the percent composition or the mass of each element. To determine the molecular formula from the empirical formula, the molar mass of the substance must also be known.	
C4.1a	Calculate the percent by weight of each element in a compound based on the compound formula.	**Student Edition:** 342-343
C4.1b	Calculate the empirical formula of a compound based on the percent by weight of each element in the compound.	**Student Edition:** 344-345
C4.1c	Use the empirical formula and molecular weight of a compound to determine the molecular formula.	**Student Edition:** 346-349

STANDARDS		PAGE REFERENCES
	C4.2 Nomenclature All compounds have unique names that are determined systematically.	
	C4.2x Nomenclature All molecular and ionic compounds have unique names that are determined systematically.	
C4.2c	Given a formula, name the compound.	**Student Edition:** 222-224, 248-252, 351, 756, 793
C4.2d	Given the name, write the formula of ionic and molecular compounds.	**Student Edition:** 218-221, 251-252
C4.2e	Given the formula for a simple hydrocarbon, draw and name the isomers.	**Student Edition:** 750-754, 759-763, 765-769
	C4.3 Properties of Substances Differences in the physical and chemical properties of substances are explained by the arrangement of the atoms, ions, or molecules of the substances and by the strength of the forces of attraction between the atoms, ions, or molecules.	
	C4.3x Solids Solids can be classified as metallic, ionic, covalent, or network covalent. These different types of solids have different properties that depend on the particles and forces found in the solid.	
C4.3c	Compare the relative strengths of forces between molecules based on the melting point and boiling point of the substances.	**Student Edition:** 269-270, 414, 426, 789 *MiniLab* 242
C4.3d	Compare the strength of the forces of attraction between molecules of different elements. (For example, at room temperature, chlorine is a gas and iodine is a solid.)	**Student Edition:** 226, 414, 789 *Elements Handbook* 906, 910, 922, 926, 932, 936, 940, 944
C4.3e	Predict whether the forces of attraction in a solid are primarily metallic, covalent, network covalent, or ionic based upon the elements' location on the periodic table.	**Student Edition:** 177-181, 265-266, 411
C4.3f	Identify the elements necessary for hydrogen bonding (N, O, F).	**Student Edition:** 411-414
C4.3g	Given the structural formula of a compound, indicate all the intermolecular forces present (dispersion, dipolar, hydrogen bonding).	**Student Edition:** 411-414, 418-419
C4.3h	Explain properties of various solids such as malleability, conductivity, and melting point in terms of the solid's structure and bonding.	**Student Edition:** 216-226 *MiniLab* 242

STANDARDS		PAGE REFERENCES
C4.3i	Explain why ionic solids have higher melting points than covalent solids. (For example, NaF has a melting point of 995°C, while water has a melting point of 0° C.)	**Student Edition:** 216-217 *MiniLab* 242
	C4.4x Molecular Polarity The forces between molecules depend on the net polarity of the molecule as determined by shape of the molecule and the polarity of the bonds.	
C4.4a	Explain why at room temperature different compounds can exist in different phases.	**Student Edition:** 73, 76-77, 411-414, 428-429
C4.4b	Identify if a molecule is polar or nonpolar given a structural formula for the compound.	**Student Edition:** 267-269
	C4.5x Ideal Gas Law The forces in gases are explained by the ideal gas law.	
C4.5a	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-volume relationship in gases.	**Student Edition:** 442-443, 449-451, 454-455 *Problem-Solving Lab* 444 *Problem-Solving Strategy* 458
C4.5b	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the pressure-temperature relationship in gases.	**Student Edition:** 447-448, 449-451, 454-455 *Chemlab* 466 *Problem-Solving Strategy* 458
C4.5c	Provide macroscopic examples, atomic and molecular explanations, and mathematical representations (graphs and equations) for the temperature-volume relationship in gases.	**Student Edition:** 444-446, 449-451, 454-455 *Launch Lab* 441 *Problem-Solving Strategy* 458
	C4.6x Moles The mole is the standard unit for counting atomic and molecular particles in terms of common mass units.	
C4.6a	Calculate the number of moles of any compound or element given the mass of the substance.	**Student Edition:** 325-332, 337
C4.6b	Calculate the number of particles of any compound or element given the mass of the substance.	**Student Edition:** 338-340 *Everyday Chemistry* 355

STANDARDS		PAGE REFERENCES
	C4.7x Solutions The physical properties of a solution are determined by the concentration of solute.	
C4.7a	Investigate the difference in the boiling point or freezing point of pure water and a salt solution.	**Student Edition:** 500-503 *MiniLab* 502
C4.7b	Compare the density of pure water to that of a sugar solution.	**Student Edition:** 414, 478-479
	C4.8 Atomic Structure Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.	
	C4.8x Electron Configuration Electrons are arranged in main energy levels with sublevels that specify particular shapes and geometry. Orbitals represent a region of space in which an electron may be found with a high level of probability. Each defined orbital can hold two electrons, each with a specific spin orientation. The specific assignment of an electron to an orbital is determined by a set of 4 quantum numbers. Each element and, therefore, each position in the periodic table is defined by a unique set of quantum numbers.	
C4.8e	Write the complete electron configuration of elements in the first four rows of the periodic table.	**Student Edition:** 158-159, 182-186 *Elements Handbook* 902-915, 916-921, 922-945
C4.8f	Write kernel structures for main group elements.	**Student Edition:** 159, 182-186 *Elements Handbook* 902-915, 922-945
C4.8g	Predict oxidation states and bonding capacity for main group elements using their electron structure.	**Student Edition:** 182-183, 206-209, 219, 243-244, 265-270, 686-688 *Elements Handbook* 902-915, 922-945
C4.8h	Describe the shape and orientation of *s* and *p* orbitals.	**Student Edition:** 153-154, 262-264
C4.8i	Describe the fact that the electron location cannot be exactly determined at any given time.	**Student Edition:** 151-152
	C4.9 Periodic Table In the periodic table, elements are arranged in order of increasing number of protons (called the atomic number). Vertical groups in the periodic table (families) have similar physical and chemical properties due to the same outer electron structures.	

STANDARDS		PAGE REFERENCES
	C4.9x Electron Energy Levels The rows in the periodic table represent the main electron energy levels of the atom. Within each main energy level are sublevels that represent an orbital shape and orientation.	
C4.9b	Identify metals, non-metals, and metalloids using the periodic table.	**Student Edition:** 177-181, 226 *Chemlab* 196
C4.9c	Predict general trends in atomic radius, first ionization energy, and electonegativity of the elements using the periodic table.	**Student Edition:** 187-188, 191-194, 265-266 *Elements Handbook* 906-907, 910-911, 922-923, 926-927, 932-933, 936-937, 940-941, 944
	C4.10 Neutral Atoms, Ions, and Isotopes A neutral atom of any element will contain the same number of protons and electrons. Ions are charged particles with an unequal number of protons and electrons. Isotopes are atoms of the same element with different numbers of neutrons and essentially the same chemical and physical properties.	
	C4.10x Average Atomic Mass The atomic mass listed on the periodic table is an average mass for all the different isotopes that exist, taking into account the percent and mass of each different isotope.	
C4.10c	Calculate the average atomic mass of an element given the percent abundance and mass of the individual isotopes.	**Student Edition:** 119-121 *Chemlab* 126 *MiniLab* 120
C4.10d	Predict which isotope will have the greatest abundance given the possible isotopes for an element and the average atomic mass in the periodic table.	**Student Edition:** 117, 120
C4.10e	Write the symbol for an isotope, A/Z *X*, where *Z* is the atomic number, *A* is the mass number, and *X* is the symbol for the element.	**Student Edition:** 115, 117
	STANDARD C5: CHANGES IN MATTER *Students will analyze a chemical change phenomenon from the point of view of what is the same and what is not the same.*	
	P5.p1 Conservation of Matter *(prerequisite)* Changes of state are explained by a model of matter composed of tiny particles that are in motion. When substances undergo changes of state, neither atoms nor molecules themselves are changed in structure. Mass is conserved when substances undergo changes of state. *(prerequisite)*	

STANDARDS		PAGE REFERENCES
	C5.r1x Rates of Reactions *(recommended)* The rate of a chemical reaction will depend upon (1) concentration of reacting species, (2) temperature of reaction, (3) pressure if reactants are gases, and (4) nature of the reactants. A model of matter composed of tiny particles that are in constant motion is used to explain rates of chemical reactions. (recommended)	
	C5.2 Chemical Changes Chemical changes can occur when two substances, elements, or compounds interact and produce one or more different substances whose physical and chemical properties are different from the interacting substances. When substances undergo chemical change, the number of atoms in the reactants is the same as the number of atoms in the products. This can be shown through simple balancing of chemical equations. Mass is conserved when substances undergo chemical change. The total mass of the interacting substances (reactants) is the same as the total mass of the substances produced (products).	
	C5.2x Balancing Equations A balanced chemical equation will allow one to predict the amount of product formed.	
C5.2d	Calculate the mass of a particular compound formed from the masses of starting materials.	**Student Edition:** 373-377, 380-383 *MiniLab* 378
C5.2e	Identify the limiting reagent when given the masses of more than one reactant.	**Student Edition:** 379-380, 382
C5.2f	Predict volumes of product gases using initial volumes of gases at the same temperature and pressure.	**Student Edition:** 460-464 *Real-World Chemistry* 461
C5.2g	Calculate the number of atoms present in a given mass of element.	**Student Edition:** 329-330, 338-339
	C5.3x Equilibrium Most chemical reactions reach a state of dynamic equilibrium where the rates of the forward and reverse reactions are equal.	
C5.3a	Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	**Student Edition:** 606-610, 612-617 *MiniLab* 611
C5.3b	Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).	**Student Edition:** 606-610, 618-619 *MiniLab* 611
C5.3c	Predict the extent reactants are converted to products using the value of the equilibrium constant.	**Student Edition:** 606-611, 612-613

STANDARDS		PAGE REFERENCES
	C5.4 Phase Change/Diagrams Changes of state require a transfer of energy. Water has unusually high-energy changes associated with its changes of state.	
	C5.4x Changes of State All changes of state require energy. Changes in state that require energy involve breaking forces holding the particles together. The amount of energy will depend on the type of forces.	
C5.4c	Explain why both the melting point and boiling points for water are significantly higher than other small molecules of comparable mass (e.g., ammonia and methane).	**Student Edition:** 411-414, 415-424
C5.4d	Explain why freezing is an exothermic change of state.	**Student Edition:** 216-217, 428
C5.4e	Compare the melting point of covalent compounds based on the strength of IMFs (intermolecular forces).	**Student Edition:** 413-414, 422-423, 425-426
	C5.5 Chemical Bonds — Trends An atom's electron configuration, particularly of the outermost electrons, determines how the atom can interact with other atoms. The interactions between atoms that hold them together in molecules or between oppositely charged ions are called chemical bonds.	
	C5.5x Chemical Bonds Chemical bonds can be classified as ionic, covalent, and metallic. The properties of a compound depend on the types of bonds holding the atoms together.	
C5.5c	Draw Lewis structures for simple compounds.	**Student Edition:** 242-245, 253-259, 642
C5.5d	Compare the relative melting point, electrical and thermal conductivity and hardness for ionic, metallic, and covalent compounds.	**Student Edition:** 73-75, 180-181, 226, 270, 758 *MiniLab* 242
C5.5e	Relate the melting point, hardness, and electrical and thermal conductivity of a substance to its structure.	**Student Edition:** 73-75, 214-215, 226, 270, 758 *Launch Lab* 205 *MiniLab* 242
	C5.6x Reduction/Oxidation Reactions Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve electron transfer are known as oxidation/reduction (or "redox").	
C5.6a	Balance half-reactions and describe them as oxidations or reductions.	**Student Edition:** 689-696, 708-709, 712-716, 718-722, 724-727, 728-732 *Problem-Solving Strategy* 717

STANDARDS		PAGE REFERENCES
C5.6b	Predict single replacement reactions.	**Student Edition:** 293-295, 298, 712 *Launch Lab* 679 *Problem-Solving Lab* 294 *Real-World Chemistry* 295
C5.6c	Explain oxidation occurring when two different metals are in contact.	**Student Edition:** 724-727 *Chemlab* 734 *MiniLab* 726
C5.6d	Calculate the voltage for spontaneous redox reactions from the standard reduction potentials.	**Student Edition:** 710-716, 718-722 *Chemlab* 734 *Data Analysis Lab* 724 *Problem-Solving Strategy* 717
C5.6e	Identify the reactions occurring at the anode and cathode in an electrochemical cell.	**Student Edition:** 710-712, 718-722, 724-727 *Chemlab* 734 *Launch Lab* 707
	C5.7 Acids and Bases Acids and bases are important classes of chemicals that are recognized by easily observed properties in the laboratory. Acids and bases will neutralize each other. Acid formulas usually begin with hydrogen, and base formulas are a metal with a hydroxide ion. As the pH decreases, a solution becomes more acidic. A difference of one pH unit is a factor of 10 in hydrogen ion concentration.	
	C5.7x Brønsted-Lowry Chemical reactions are classified according to the fundamental molecular or submolecular changes that occur. Reactions that involve proton transfer are known as acid/base reactions.	
C5.7f	Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.	**Student Edition:** 659-661 *Problem-Solving Strategy* 663
C5.7g	Calculate the pH from the hydronium ion or hydroxide ion concentration.	**Student Edition:** 650-658
C5.7h	Explain why sulfur oxides and nitrogen oxides contribute to acid rain.	**Student Edition:** 643
	C5.8 Carbon Chemistry The chemistry of carbon is important. Carbon atoms can bond to one another in chains, rings, and branching networks to form a variety of structures, including synthetic polymers, oils, and the large molecules essential to life.	