



Alignment Document
State of New York and Aventa Learning Chemistry

Chemistry
2005-2007 Benchmark Blueprint

Discipline	Standards	Key Ideas	Benchmarks	Unit Name	Course Topic Description
C Chemistry	C.1 Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.	C.1.1 Abstraction and symbolic representation are used to communicate mathematically.	C.1.M1.1 Use algebraic and geometric representations to describe and compare data.	Solids, Liquids, Gases Thermodynamics	Understanding Gas Laws Thermodynamics
			C.1.M1.1.a organize, graph, and analyze data gathered from laboratory activities or other sources	Solids, Liquids, Gases	Understanding Gas Laws
			C.1.M1.1.a.1 identify independent and dependent variables	The Scientific Method	Scientific Method
			C.1.M1.1.a.2 create appropriate axes with labels and scale		
			C.1.M1.1.a.3 identify graph points clearly		
			C.1.M1.1.b measure and record experimental data and use data in calculations	Labs covered throughout the course	
			C.1.M1.1.b.1 choose appropriate measurement scales and use units in recording	Labs covered throughout the course	
			C.1.M1.1.b.2 show mathematical work, stating	Solids, Liquids, Gases	Understanding Gas Laws

			formula and steps for solution	Thermodynamics	Thermodynamics
			C.1.M1.1.b.3 estimate answers		
			C.1.M1.1.b.4 use appropriate equations and significant digits	Solids, Liquids, Gases Thermodynamics The Scientific Method	Understanding Gas Laws Thermodynamics Accuracy and Precision
			C.1.M1.1.b.5 show uncertainty in measurement by the use of significant figures	The Scientific Method	Accuracy and Precision
			C.1.M1.1.b.6 identify relationships within variables from data tables		
			C.1.M1.1.b.7 calculate percent error	Labs covered throughout the course	
			C.1.M1.1.c recognize and convert various scales of measurement	The Scientific Method The Scientific Method	Qualitative versus Quantitative Energy
			C.1.M1.1.c.1 temperature - Celsius ($^{\circ}\text{C}$), Kelvin (K)	The Scientific Method	Energy
			C.1.M1.1.c.2 length - kilometers (km), meters (m), centimeters (cm), millimeters (mm)	The Scientific Method	Qualitative versus Quantitative
			C.1.M1.1.c.3 mass - grams (g), kilograms (kg)	The Scientific Method	Qualitative versus Quantitative
			C.1.M1.1.c.4 pressure - kilopascal (kPa), atmosphere (atm)	Solids, Liquids, Gases	Properties of Gases
			C.1.M1.1.d use knowledge of geometric arrangements to predict particle		

			properties or behavior		
		C.1.2 Deductive and inductive reasoning are used to reach mathematical conclusions.	C.1.M2.1 Use deductive reasoning to construct and evaluate conjectures and arguments, recognizing that patterns and relationships in mathematics assist them in arriving at these conjectures and arguments.		
			C.1.M2.1.a interpret a graph constructed from experimentally obtained data		
			C.1.M2.1.a.1 identify relationships - direct, inverse	Solids, Liquids, Gases	Understanding The Gas Laws
			C.1.M2.1.a.2 apply data showing trends to predict information		
		C.1.3 Critical thinking skills are used in the solution of mathematical problems.	C.1.M3.1 Apply algebraic and geometric concepts and skills to the solution of problems.		
			C.1.M3.1.a state assumptions which apply to the use of a particular mathematical equation and evaluate these assumptions to see if they have been met		
			C.1.M3.1.b evaluate the appropriateness of an answer, based on given data	The Scientific Method	Accuracy and Precision

		<p>C.1.1 The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.</p>	<p>C.1.S1.1 Elaborate on basic scientific and personal explanations of natural phenomena, and develop extended visual models and mathematical formulations to represent thinking.</p>		
			<p>C.1.S1.1.a use theories and/ or models to represent and explain observations</p>	Solids, Liquids, Gases	Properties of Gases
			<p>C.1.S1.1.b use theories and/ or principles to make predictions about natural phenomena</p>	Solids, Liquids, Gases	Properties of Gases
			<p>C.1.S1.1.c develop models to explain observations</p>		
			<p>C.1.S1.2 Hone ideas through reasoning, library research, and discussion with others, including experts.</p>		
			<p>C.1.S1.2.a locate data from published sources to support/ defend/ explain patterns observed in natural phenomena</p>		
			<p>C.1.S1.3 Work towards reconciling competing explanations, clarifying points of agreement and disagreement.</p>		
			<p>C.1.S1.3.a evaluate the merits of various scientific theories and indicate why one theory was accepted</p>	Atoms/Period Table	Atom

			over another		
		<p>C.1.2 Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proofed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.</p>	<p>C.1.S2.1 Devise ways of making observations to test proposed explanations.</p>	Labs covered throughout the course	
			<p>C.1.S2.1.a design and/ or carry out experiments, using scientific methodology to test proposed calculations</p>	Labs covered throughout the course	
			<p>C.1.S2.2 Refine research ideas through library investigations, including information retrieval and reviews of the literature, and through peer feedback obtained from review and discussion.</p>		
			<p>C.1.S2.2.a use library investigations, retrieved information, and literature reviews to improve the experimental design of an experiment</p>		
			<p>C.1.S2.3 Develop and present proposals including formal hypotheses to test explanations, i.e.; they predict what should be observed under specific conditions if their explanation is true.</p>	Labs covered throughout the course	
			<p>C.1.S2.3.a develop research proposals in the form of "if X is true and a particular test Y is done, then prediction Z will occur"</p>		

			<p>C.1.S2.4 Carry out a research plan for testing explanations, including selecting and developing techniques, acquiring and building apparatus, and recording observations as necessary.</p>		
			<p>C.1.S2.4.a determine safety procedures to accompany a research plan</p>		
		<p>C.1.3 The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.</p>	<p>C.1.S3.1 Use various means of representing and organizing observations (e.g., diagrams, tables, charts, graphs, equations, and matrices) and insightfully interpret the organized data.</p>		
			<p>C.1.S3.1.a organize observations in a data table, analyze the data for trends or patterns, and interpret the trends or patterns, using scientific concepts</p>	Labs covered throughout the course	
			<p>C.1.S3.2 Apply statistical analysis techniques when appropriate to test if chance alone explains the result.</p>		
			<p>C.1.S3.3 Assess correspondence between the predicted result contained in the hypothesis and the actual result, and</p>	Labs covered throughout the course	

			reach a conclusion as to whether or not the explanation on which the prediction is supported.		
			C.1.S3.3.a evaluate experimental methodology for inherent sources of error and analyze the possible effect on the result	Labs covered throughout the course	
			C.1.S3.3.b compare the experimental result to the expected result; calculate the percent error as appropriate	Labs covered throughout the course	
			C.1.S3.4 Using results of the test and through public discussion, revise the explanation and contemplate additional research.		
			C.1.S3.5 Develop a written report for public scrutiny that describes the proposed explanation, including a literature review, the research carried out, its results, and suggestions for further research.		
		C.1.1 Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop	C.1.1.1 If students are asked to do a design project, then:		
			C.1.T1.1.a Initiate and carry out a thorough investigation of an unfamiliar situation and		

		<p>technological solutions to problems within given constraints.</p>	<p>identify needs and opportunities for technological invention or innovation.</p>		
			<p>C.1.T1.1.b Identify, locate, and use a wide range of information resources, and document through notes and sketches how findings relate to the problem.</p>		
			<p>C.1.T1.1.c Generate creative solutions, break ideas into significant functional elements, and explore possible refinements; predict possible outcomes, using mathematical and functional modeling techniques; choose the optimal solution to the problem, clearly documenting ideas against design criteria and constraints; and explain how human understandings, economics, ergonomics, and environmental considerations have influenced the solution.</p>		
			<p>C.1.T1.1.d Develop work schedules and working plans which include optimal use and cost of materials, processes, time, and expertise; construct a</p>		

			model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship).		
			C.1.T1.1.e Devise a test of the solution according to the design criteria and perform the test; record, portray, and logically evaluate performance test results through quantitative, graphic, and verbal means. Use a variety of creative verbal and graphic techniques effectively and persuasively to present conclusions, predict impact and new problems, and suggest and pursue modifications.		
	C.2 Students will access, generate, process, and transfer information using appropriate technologies.	C.2.1 Information technology is used to retrieve, process, and communicate information as a tool to enhance learning. Examples include:	C.2.1.1 use the Internet as a source to retrieve information for classroom use, e.g., Periodic Table, acid rain	Scientific Method	Scientific Method
		C.2.2 Knowledge of the impacts and limitations of information systems is essential to its effectiveness and ethical use. Examples include:	C.2.2.1 critically assess the value of information with or without benefit of scientific backing and supporting data, and evaluate the effect such information could have on public judgment or opinion, e.g., environmental issues		

			C.2.2.2 discuss the use of the peer-review process in the scientific community and explain its value in maintaining the integrity of scientific publication, e.g., "cold fusion"		
C.4 Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.	C.4.3 Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.	C.4.3.1 Explain the properties of materials in terms of the arrangement and properties of the atoms that compose them.		Atoms/Period Table Atoms/Period Table Atoms/Period Table Ionic Compounds	History of The Periodic Table Trends In Periodic Table Group Names Ionic and Covalent Compounds
			C.4.3.1.a The modern model of the atom has evolved over a long period of time through the work of many scientists.	Atoms/Period Table	History of The Periodic Table
			C.4.3.1.b Each atom has a nucleus, with an overall positive charge, surrounded by negatively charged electrons.	Atoms/Period Table	Atom
			C.4.3.1.c Subatomic particles contained in the nucleus include protons and neutrons.	Atoms/Period Table	Atom
			C.4.3.1.d The proton is positively charged, and the neutron has no charge. The electron is negatively charged.	Atoms/Period Table	Atom
			C.4.3.1.e Protons and	Atoms/Period Table	Atom

			electrons have equal but opposite charges. The number of protons equals the number of electrons in an atom.		
			C.4.3.1.f The mass of each proton and each neutron is approximately equal to one atomic mass unit. An electron is much less massive than a proton or a neutron.	Atoms/Period Table	Atom
			C.4.3.1.g The number of protons in an atom (atomic number) identifies the element. The sum of the protons and neutrons in an atom (mass number) identifies an isotope. Common notations that represent isotopes include: ^{14}C , ^{14}C , carbon-14, C-14. 6	Atoms/Period Table	Atomic Number, Mass Number, and Isotopes
			C.4.3.1.h In the wave-mechanical model (electron cloud model) the electrons are in orbitals, which are defined as the regions of the most probable electron location (ground state).	Atoms/Period Table	Quantum theory
			C.4.3.1.i Each electron in an atom has its own distinct amount of energy.	Atoms/Period Table	Quantum theory
			C.4.3.1.j When an electron in an atom gains a specific amount of energy, the	Atoms/Period Table	Quantum theory

			electron is at a higher energy state (excited state).		
			C.4.3.1.k When an electron returns from a higher energy state to a lower energy state, a specific amount of energy is emitted. This emitted energy can be used to identify an element.	Atoms/Period Table	Quantum theory
			C.4.3.1.l The outermost electrons in an atom are called the valence electrons. In general, the number of valence electrons affects the chemical properties of an element.	Atoms/Period Table	Group Names
			C.4.3.1.m Atoms of an element that contain the same number of protons but a different number of neutrons are called isotopes of that element.	Atoms/Period Table	Atomic Number, Mass Number, and Isotopes
			C.4.3.1.n The average atomic mass of an element is the weighted average of the masses of its naturally occurring isotopes.	Atoms/Period Table	Atomic Number, Mass Number, and Isotopes
			C.4.3.1.o Stability of an isotope is based on the ratio of neutrons and protons in its nucleus. Although most nuclei are stable, some are unstable	Nuclear Chemistry	Nuclear Chemistry

			and spontaneously decay, emitting radiation.		
			C.4.3.1.p Spontaneous decay can involve the release of alpha particles, beta particles, positrons, and/ or gamma radiation from the nucleus of an unstable isotope. These emissions differ in mass, charge, ionizing power, and penetrating power.	Nuclear Chemistry	Nuclear Reactions
			C.4.3.1.q Matter is classified as a pure substance or as a mixture of substances.	Chemistry Fundamentals	Classification of Matter
			C.4.3.1.r A pure substance (element or compound) has a constant composition and constant properties throughout a given sample, and from sample to sample.	Chemistry Fundamentals	Classification of Matter
			C.4.3.1.s Mixtures are composed of two or more different substances that can be separated by physical means. When different substances are mixed together, a homogeneous or heterogeneous mixture is formed.	Chemistry Fundamentals	Classification of Matter
			C.4.3.1.t The proportions of components in a mixture can be varied. Each	Chemistry Fundamentals	Classification of Matter

			component in a mixture retains its original properties.		
			C.4.3.1.u Elements are substances that are composed of atoms that have the same atomic number. Elements cannot be broken down by chemical change.	Atoms/Period Table	Atomic Number, Mass Number, and Isotopes
			C.4.3.1.v Elements can be classified by their properties and located on the Periodic Table as metals, nonmetals, metalloids (B, Si, Ge, As, Sb, Te), and noble gases.	Atoms/Period Table	History of The Periodic Table
			C.4.3.1.w Elements can be differentiated by physical properties. Physical properties of substances, such as density, conductivity, malleability, solubility, and hardness, differ among elements.	Chemistry Fundamentals Chemistry Fundamentals	Physical Change Chemical Versus Physical Properties
			C.4.3.1.x Elements can also be differentiated by chemical properties. Chemical properties describe how an element behaves during a chemical reaction.	Chemistry Fundamentals Chemistry Fundamentals	Chemical Change Chemical Versus Physical Properties
			C.4.3.1.y The placement or location of an element on the Periodic Table gives an indication of the physical	Atoms/Period Table Atoms/Period Table	Atomic Number, Mass Number, and Isotopes Trends in Periodic Table

			and chemical properties of that element. The elements on the Periodic Table are arranged in order of increasing atomic number.		
			C.4.3.1.z For Groups 1, 2, and 13-18 on the Periodic Table, elements within the same group have the same number of valence electrons (helium is an exception) and therefore similar chemical properties.	Atoms/Period Table	Group Names
			C.4.3.1.aa The succession of elements within the same group demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	Atoms/Period Table	Trends in Periodic Table
			C.4.3.1.ab The succession of elements across the same period demonstrates characteristic trends: differences in atomic radius, ionic radius, electronegativity, first ionization energy, metallic/nonmetallic properties.	Atoms/Period Table	Trends in Periodic Table
			C.4.3.1.ac A compound is a substance composed of two or more different elements that are chemically combined in a	Ionic Compounds	Ionic and Covalent Compounds

			<p>fixed proportion. A chemical compound can be broken down by chemical means. A chemical compound can be represented by a specific chemical formula and assigned a name based on the IUPAC system.</p>		
			<p>C.4.3.1.ad Compounds can be differentiated by their physical and chemical properties.</p>		
			<p>C.4.3.1.ae Types of chemical formulas include empirical, molecular, and structural.</p>	Mole/Chemical Composition	The Mole and Chemical Composition
			<p>C.4.3.1.af Organic compounds contain carbon atoms, which bond to one another in chains, rings, and networks to form a variety of structures. Organic compounds can be named using the IUPAC system.</p>		
			<p>C.4.3.1.ag Hydrocarbons are compounds that contain only carbon and hydrogen. Saturated hydrocarbons contain only single carbon-carbon bonds. Unsaturated hydrocarbons contain at least one multiple carbon-carbon bond.</p>		

			C.4.3.1.ah Organic acids, alcohols, esters, aldehydes, ketones, ethers, halides, amines, amides, and amino acids are categories of organic compounds that differ in their structures. Functional groups impart distinctive physical and chemical properties to organic compounds.		
			C.4.3.1.ai Isomers of organic compounds have the same molecular formula, but different structures and properties.		
			C.4.3.1.aj The structure and arrangement of particles and their interactions determine the physical state of a substance at a given temperature and pressure.	Solids, Liquids, Gases	Properties of Gases
			C.4.3.1.ak The three phases of matter (solids, liquids, and gases) have different properties.	Solids, Liquids, Gases Solids, Liquids, Gases	Properties of Gases Solids, Liquids, Gases: Introduction
			C.4.3.1.al Entropy is a measure of the randomness or disorder of a system. A system with greater disorder has greater entropy.	Thermodynamics	Conservation of Energy-Calorimetry
			C.4.3.1.am Systems in nature tend to undergo	Thermodynamics	Conservation of Energy-Calorimetry

			changes toward lower energy and higher entropy.		
			C.4.3.1.an Differences in properties such as density, particle size, molecular polarity, boiling and freezing points, and solubility permit physical separation of the components of the mixture.	Water, Solutions	Properties of Solutions
			C.4.3.1.ao A solution is a homogeneous mixture of a solute dissolved in a solvent. The solubility of a solute in a given amount of solvent is dependent on the temperature, the pressure, and the chemical natures of the solute and solvent.	Water, Solutions	Properties of Solutions
				Water, Solutions	The Solution Process
			C.4.3.1.ap The concentration of a solution may be expressed in molarity (M), percent by volume, percent by mass, or parts per million (ppm).		
			C.4.3.1.aq The addition of a nonvolatile solute to a solvent causes the boiling point of the solvent to increase and the freezing point of the solvent to decrease. The greater the concentration of solute particles, the greater the effect.	Water, Solutions	Colligative Properties
			C.4.3.1.ar An electrolyte is	Water, Solutions	Properties of Solutions

			a substance which, when dissolved in water, forms a solution capable of conducting an electric current. The ability of a solution to conduct an electric current depends on the concentration of ions.		
			C.4.3.1.as The acidity or alkalinity of an aqueous solution can be measured by its pH value. The relative level of acidity or alkalinity of these solutions can be shown by using indicators.	Water, Solutions Water, Solutions	Properties of Acids and Bases Measuring Acidity-pH
			C.4.3.1.at On the pH scale, each decrease of one unit of pH represents a tenfold increase in hydronium ion concentration.	Water, Solutions	Measuring Acidity-pH
			C.4.3.1.au Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.	Water, Solutions	Properties of Acids and Bases
			C.4.3.1.av Arrhenius acids yield $H^+(aq)$, hydrogen ion as the only positive ion in an aqueous solution. The hydrogen ion may also be written as $H_3O^+(aq)$, hydronium ion.	Water, Solutions	Properties of Acids and Bases
			C.4.3.1.aw Arrhenius bases yield $OH^-(aq)$,	Water, Solutions	Properties of Acids and Bases

			hydroxide ion as the only negative ion in an aqueous solution.		
			C.4.3.1.ax In the process of neutralization, an Arrhenius acid and an Arrhenius base react to form a salt and water.	Water, Solutions	Properties of Acids and Bases
			C.4.3.1.ay There are alternate acid-base theories. One theory states that an acid is an H ⁺ donor and a base is an H ⁺ acceptor.	Water, Solutions	Properties of Acids and Bases
			C.4.3.1.az Titration is a laboratory process in which a volume of a solution of known concentration is used to determine the concentration of another solution.		
			C.4.3.2 Use atomic and molecular models to explain common chemical reactions.	Chemical Reactions	What is a Chemical Reaction
			C.4.3.2.a A physical change results in the rearrangement of existing particles in a substance. A chemical change results in the formation of different substances with changed properties.	Chemistry Fundamentals Chemistry Fundamentals	Physical Change Chemical Change
			C.4.3.2.b Types of chemical reactions include synthesis, decomposition,	Chemical Reactions	Physical Change: Intro

		single replacement, and double replacement.		
		C.4.3.2.c Types of organic reactions include addition, substitution, polymerization, esterification, fermentation, saponification, and combustion.		
		C.4.3.2.d An oxidation-reduction (redox) reaction involves the transfer of electrons (e^-).		
		C.4.3.2.e Reduction is the gain of electrons.		
		C.4.3.2.f A half-reaction can be written to represent reduction.		
		C.4.3.2.g Oxidation is the loss of electrons.		
		C.4.3.2.h A half-reaction can be written to represent oxidation.		
		C.4.3.2.i Oxidation numbers (states) can be assigned to atoms and ions. Changes in oxidation numbers indicate that oxidation and reduction have occurred.		
		C.4.3.2.j An electrochemical cell can be either voltaic or electrolytic. In an electrochemical cell, oxidation occurs at the anode and reduction at the		

			cathode.		
			C.4.3.2.k A voltaic cell spontaneously converts chemical energy to electrical energy.		
			C.4.3.2.l An electrolytic cell requires electrical energy to produce a chemical change. This process is known as electrolysis.		
			C.4.3.3 Apply the principle of conservation of mass to chemical reactions.	Chemical Reactions	Stoichiometry
			C.4.3.3.a In all chemical reactions there is a conservation of mass, energy, and charge.	Chemical Reactions Thermodynamics Thermodynamics	What is a Chemical Reaction Thermodynamics Conservation of Energy-Calorimetry
			C.4.3.3.b In a redox reaction the number of electrons lost is equal to the number of electrons gained.		
			C.4.3.3.c A balanced chemical equation represents conservation of atoms. The coefficients in a balanced chemical equation can be used to determine mole ratios in the reaction.	Chemical Reactions Chemical Reactions	What is a Chemical reaction Stoichiometry
			C.4.3.3.d The empirical formula of a compound is the simplest whole-number	Mole/Chemical Composition	The Mole and Chemical Composition

			ratio of atoms of the elements in a compound. It may be different from the molecular formula, which is the actual ratio of atoms in a molecule of that compound.		
			C.4.3.3.e The formula mass of a substance is the sum of the atomic masses of its atoms. The molar mass (gram-formula mass) of a substance equals one mole of that substance.	Mole/Chemical Composition	The Mole and Chemical Composition
			C.4.3.3.f The percent composition by mass of each element in a compound can be calculated mathematically.	Mole/Chemical Composition	The Mole and Chemical Composition
			C.4.3.4 Use kinetic molecular theory (KMT) to explain rates of reactions and the relationships among temperature, pressure, and volume of a substance.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.a The concept of an ideal gas is a model to explain the behavior of gases. A real gas is most like an ideal gas when the real gas is at low pressure and high temperature.	Solids, Liquids, and Gases	Understanding The Gas Laws
			C.4.3.4.b Kinetic molecular theory (KMT) for an ideal gas states that all gas	Solids, Liquids, and Gases	Properties of Gases

			particles:		
			C.4.3.4.b.1 are in random, constant, straight-line motion.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.b.2 are separated by great distances relative to their size; the volume of the gas particles is considered negligible.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.b.3 have no attractive forces between them.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.b.4 have collisions that may result in a transfer of energy between gas particles, but the total energy of the system remains constant.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.c Kinetic molecular theory describes the relationships of pressure, volume, temperature, velocity, and frequency and force of collisions among gas molecules.	Solids, Liquids, and Gases	Properties of Gases
			C.4.3.4.d Collision theory states that a reaction is most likely to occur if reactant particles collide with the proper energy and orientation.	Reactions Rates An	Reaction Rates and Collision Theory
			C.4.3.4.e Equal volumes of gases at the same temperature and pressure contain an equal number of particles.	Solids, Liquids, and Gases	Understanding the Gas Laws

			C.4.3.4.f The rate of a chemical reaction depends on several factors: temperature, concentration, nature of the reactants, surface area, and the presence of a catalyst.	Reactions Rates An	Kinetics
			C.4.3.4.g A catalyst provides an alternate reaction pathway, which has a lower activation energy than an uncatalyzed reaction.	Reactions Rates An	Kinetics
			C.4.3.4.h Some chemical and physical changes can reach equilibrium.		
			C.4.3.4.i At equilibrium the rate of the forward reaction equals the rate of the reverse reaction. The measurable quantities of reactants and products remain constant at equilibrium.		
			C.4.3.4.j LeChatelier's principle can be used to predict the effect of stress (change in pressure, volume, concentration, and temperature) on a system at equilibrium.		
		C.4.4 Energy exists in many forms, and when these forms change energy is conserved.	C.4.4.1 Observe and describe transmission of various forms of energy.	Thermodynamics	Thermodynamics
		C.4.5 Energy and matter	C.4.4.1.a Energy can exist in different forms, such as		

		interact through forces that result in changes in motion.	chemical, electrical, electromagnetic, thermal, mechanical, nuclear.		
			C.4.4.1.b Chemical and physical changes can be exothermic or endothermic.	Thermodynamics	Thermodynamics
			C.4.4.1.c Energy released or absorbed during a chemical reaction can be represented by a potential energy diagram.		
			C.4.4.1.d Energy released or absorbed during a chemical reaction (heat of reaction) is equal to the difference between the potential energy of the products and potential energy of the reactants.	Thermodynamics	Conservation of Energy - Calorimetry
			C.4.4.2 Explain heat in terms of kinetic molecular theory.	Solids, Liquids, and Gases	Understanding The Gas Laws
			C.4.4.2.a Heat is a transfer of energy (usually thermal energy) from a body of higher temperature to a body of lower temperature. Thermal energy is the energy associated with the random motion of atoms and molecules.	Thermodynamics	Thermodynamics
			C.4.4.2.b Temperature is a measurement of the average kinetic energy of the particles in a sample of material. Temperature is	Thermodynamics	Thermodynamics

			not a form of energy.		
			C.4.4.2.c The concepts of kinetic and potential energy can be used to explain physical processes that include: fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition.	Thermodynamics	Conservation of Energy - Calorimetry
			C.4.4.4 Explain the benefits and risks of radioactivity.	Nuclear Chemistry	Nuclear Chemistry
			C.4.4.4.a Each radioactive isotope has a specific mode and rate of decay (half-life).	Nuclear Chemistry	Fission and Fusion
			C.4.4.4.b Nuclear reactions include natural and artificial transmutation, fission, and fusion.	Nuclear Chemistry	Fission and Fusion
			C.4.4.4.c Nuclear reactions can be represented by equations that include symbols which represent atomic nuclei (with mass number and atomic number), subatomic particles (with mass number and charge), and/or emissions such as gamma radiation.	Nuclear Chemistry	Nuclear Reactions
			C.4.4.4.d Radioactive isotopes have many beneficial uses. Radioactive isotopes are	Nuclear Chemistry	Fission and Fusion

			used in medicine and industrial chemistry for radioactive dating, tracing chemical and biological processes, industrial measurement, nuclear power, and detection and treatment of diseases.		
			C.4.4.4.e There are inherent risks associated with radioactivity and the use of radioactive isotopes. Risks can include biological exposure, long-term storage and disposal, and nuclear accidents.	Nuclear Chemistry	Fission and Fusion
			C.4.4.4.f There are benefits and risks associated with fission and fusion reactions.	Nuclear Chemistry	Fission and Fusion
			C.4.5.2 Explain chemical bonding in terms of the behavior of electrons.	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.a Chemical bonds are formed when valence electrons are:		
			C.4.5.2.a.1 transferred from one atom to another (ionic)	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.a.2 shared between atoms (covalent)	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.a.3 mobile within a metal (metallic)	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.b Atoms attain a stable valence electron configuration by bonding with other atoms. Noble	Ionic Compounds	Ionic and Covalent Compounds

			gases have stable valence configurations and tend not to bond.		
			C.4.5.2.c When an atom gains one or more electrons, it becomes a negative ion and its radius increases. When an atom loses one or more electrons, it becomes a positive ion and its radius decreases.		
			C.4.5.2.d Electron-dot diagrams (Lewis structures) can represent the valence electron arrangement in elements, compounds, and ions.	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.e In a multiple covalent bond, more than one pair of electrons are shared between two atoms. Unsaturated organic compounds contain at least one double or triple bond.	Ionic Compounds	Ionic and Covalent Compounds
			C.4.5.2.f Some elements exist in two or more forms in the same phase. These forms differ in their molecular or crystal structure, and hence in their properties.		
			C.4.5.2.g Two major categories of compounds are ionic and molecular (covalent) compounds.	Ionic Compounds	Ionic and Covalent Compounds

			<p>C.4.5.2.h Metals tend to react with nonmetals to form ionic compounds. Nonmetals tend to react with other nonmetals to form molecular (covalent) compounds. Ionic compounds containing polyatomic ions have both ionic and covalent bonding.</p>	Ionic Compounds	Ionic and Covalent Compounds
			<p>C.4.5.2.i When a bond is broken, energy is absorbed. When a bond is formed, energy is released.</p>	Thermodynamics	Conservation of Energy - Calorimetry
			<p>C.4.5.2.j Electronegativity indicates how strongly an atom of an element attracts electrons in a chemical bond. Electronegativity values are assigned according to arbitrary scales.</p>	Ionic Compounds	Ionic and Covalent Compounds
			<p>C.4.5.2.k The electronegativity difference between two bonded atoms is used to assess the degree of polarity in the bond.</p>	Ionic Compounds	Ionic and Covalent Compounds
			<p>C.4.5.2.l Molecular polarity can be determined by the shape of the molecule and distribution of charge. Symmetrical (nonpolar) molecules include CO₂, CH₄, and diatomic elements. Asymmetrical</p>		

			(polar) molecules include HCl, NH ₃ , and H ₂ O.		
			C.4.5.2.m Intermolecular forces created by the unequal distribution of charge result in varying degrees of attraction between molecules. Hydrogen bonding is an example of a strong intermolecular force.		
			C.4.5.2.n Physical properties of substances can be explained in terms of chemical bonds and intermolecular forces. These properties include conductivity, malleability, solubility, hardness, melting point, and boiling point.		
			C.4.5.3 Compare energy relationships within an atom's nucleus to those outside the nucleus.	Nuclear Chemistry	Nuclear Chemistry
			C.4.5.3.a A change in the nucleus of an atom that converts it from one element to another is called transmutation. This can occur naturally or can be induced by the bombardment of the nucleus with high-energy particles.	Nuclear Chemistry	Nuclear Reactions
			C.4.5.3.b Energy released in a nuclear reaction	Nuclear Chemistry	Fission and Fusion

			(fission or fusion) comes from the fractional amount of mass that is converted into energy. Nuclear changes convert matter into energy.		
			C.4.5.3.c Energy released during nuclear reactions is much greater than the energy released during chemical reactions.	Nuclear Chemistry	Fission and Fusion
C.6 Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.	C.6.1 Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions. Examples include:	C.6.1.1 use the concept of systems and surroundings to describe heat flow in a chemical or physical change, e.g., dissolving process		Thermodynamics	Conservation of Energy - Calorimetry
		C.6.2 Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.	C.6.2.1 Revise a model to create a more complete or improved representation of the system.		
			C.6.2.1.a show how models are revised in response to experimental evidence, e.g., atomic theory, Periodic Table	Atoms/Period Table	Atom
			C.6.2.2 Collect information about the behavior of a system and use modeling tools to represent the operation of the system.	Labs covered throughout the course	
			C.6.2.2.a show how information about a system	Solids, Liquids, Gases	Properties of Gases

			is used to create a model, e.g., kinetic molecular theory (KMT)		
			C.6.2.3 Find and use mathematical models that behave in the same manner as the processes under investigation.		
			C.6.2.3.a show how mathematical models (equations) describe a process, e.g., combine.g.s law	Solids, Liquids, Gases	Understanding The Gas Laws
			C.6.2.4 Compare predictions to actual observations, using test models.	Labs covered throughout the course	
			C.6.2.4.a compare experimental results to a predicted value, e.g., percent error	Labs covered throughout the course	
		C.6.3 The grouping of magnitudes of size, time, frequency, and pressures or other units of measurement into a series of relative order provides a useful way to deal with the immense range and the changes in scale that affect the behavior and design of systems.	C.6.3.1 Describe the effects of changes in scale on the functioning of physical, biological, or designed information systems.		
			C.6.3.1.a show how microscale processes can resemble or differ from real-world processes, e.g., microscale chemistry		
			C.6.3.2 Extend the use of powers of ten notation to understanding the exponential function and	Water, Solutions	Measuring Acidity-pH

			performing operations with exponential factors.		
			C.6.3.2.a use powers often to represent a large range of values for a physical quantity, e.g., pH scale	Water, Solutions	Measuring Acidity-pH
		C.6.4 Equilibrium is a state of stability due either to a lack of change (static equilibrium) or a balance between opposing forces (dynamic equilibrium).	C.6.4.1 Describe specific instances of how disturbances might affect a system's equilibrium, from small disturbances that do not upset the equilibrium to larger disturbances (threshold level) that cause the system to become unstable.		
			C.6.4.1.a explain how a small change might not affect a system, e.g., activation energy	Reactions Rates An	Reaction Rates and Collision Theory
			C.6.4.2 Cite specific examples of how dynamic equilibrium is achieved by equality of change in opposing directions.		
			C.6.4.2.a explain how a system returns to equilibrium in response to a stress, e.g., LeChatelier's principle		
		C.6.5 Identifying patterns of change is necessary for making predictions about future behavior and conditions. Examples include:	C.6.5.1 use graphs to make predictions, e.g., half-life, solubility	Solids, Liquids, and Gases	Understanding The Gas Laws
			C.6.5.2 use graphs to identify patterns and interpret experimental data,	Thermodynamics	Conservation of Energy-Calorimetry

			e.g., heating and cooling curves		
	<p>C.7 Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.</p>	<p>C.7.1 The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/ society, consumer decision making, design, and inquiry into phenomena.</p>	<p>C.7.1.1 Analyze science/ technology/ society problems and issues on a community, national, or global scale and plan and carry out a remedial course of action.</p>		
			<p>C.7.1.1.a carry out a remedial course of action by communicating the plan to others, e.g., writing and sending "a letter to the editor"</p>		
			<p>C.7.1.2 Analyze and quantify consumer product data, understand environmental and economic impacts, develop a method for judging the value and efficacy of competing products, and discuss cost-benefit and risk-benefit trade-offs made in arriving at the optimal choice.</p>		
			<p>C.7.1.2.a compare and analyze specific consumer products, e.g., antacids, vitamin C</p>		
			<p>C.7.1.3 Design solutions to real-world problems on a community, national, or global scale, using a technological design</p>		

			process that integrates scientific investigation and rigorous mathematical analysis of the problem and of the solution.		
			C.7.1.3.a design a potential solution to a regional problem, e.g., suggest a plan to adjust the acidity of a lake in the Adirondacks		
			C.7.1.4 Explain and evaluate phenomena mathematically and scientifically by formulating a testable hypothesis, demonstrating the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment, applying and inquiring into the mathematical ideas relating to investigation of phenomena, and using (and if needed, designing) technological tools and procedures to assist in the investigation and in the communication of results.	Labs covered throughout the course	
			C.7.1.4.a design an experiment that requires the use of a mathematical concept to solve a scientific problem, e.g., an experiment to compare the density of different types of soda pop	Labs covered throughout the course	

		<p>C.7.2 Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.</p>	<p>C.7.2.1 If students are asked to do a project, then the project would require students to:</p> <p>C.7.2.1.a work effectively</p> <p>C.7.2.1.b gather and process information</p> <p>C.7.2.1.c generate and analyze ideas</p> <p>C.7.2.1.d observe common themes</p> <p>C.7.2.1.e realize ideas</p> <p>C.7.2.1.f present results</p>	<p>Labs covered throughout the course</p> <p>Labs covered throughout the course</p> <p>Labs covered throughout the course</p> <p>Labs covered throughout the course</p> <p>Labs covered throughout the course</p> <p>Labs covered throughout the course</p>	
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