Willingboro Public Schools

"Where Excellence is the Expectation"

Chemistry

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From New Jersey Student Learning Standards

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Overview	Content Standards	Core Ideas
Unit 1 **Fundamentals**	HS.Structure and Properties of Matter ● HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. ● HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. ● HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. ● HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	● Scientific Inquiry ● What Chemistry is About ● Matter and Energy ● Matter and the Elements ● Molecules and Compounds ● Mixtures and Solutions ● Temperature ● Heat and Thermal Energy ● Phase Changes ● Understanding Chemical Changes ● Chemical Reactions ● Chemical Reactions in the Lab
Unit 2 **Core Concepts Part 1 (Chapters 5-9)**	HS.Energy ● HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. ● HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). ● HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. ● HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). ● HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	● The Atom Has a Structure ● The Quantum Atom ● Electron Configuration ● Light and Spectroscopy ● The Periodic Table ● Properties of Groups of Elements ● Valence ● What is a Chemical Bond? ● Valence Electrons and Bonding Patterns ● Molecular Geometry and Lewis Dot Structure ● Ionic Compounds ● Molecular Compounds ● Intermolecular Forces ● Formula Masses ● Solutes, Solvents, and Water ● Concentration and Solubility ● Properties of Solutions
	HS Chemical Reactions	● Chemical Equations ● Methods for Balancing Chemical Equations

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Overview	Content Standards	Core Ideas
Unit 3 **Core Concepts Part 2 (Chapters 10-14)**	● HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. ● HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. ● HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. ● HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. ● HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	● Types of Chemical Reactions ● Chemical Reactions and Energy ● Analyzing a Chemical Reaction ● Percent Yield and Concentration ● Limiting Reactants ● Solving Stoichiometric Problems ● Reaction Rates ● Chemical Equilibrium ● Chemical Pathways ● Catalysts ● The Chemical Nature of Acids and Bases ● The pH Scale ● Acid-Base Equilibrium ● Acid-Base Reactions ● Pressure and Kinetic Theory ● The Gas Laws ● Stoichiometry and Gases
Unit 4 **Applications**	**All core science standards were covered prior to Unit 4: Applications.** ● HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. ● HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. ● HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. ● HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	● Electrochemistry and Electricity ● Oxidation-Reduction (Redox) Reactions ● Balancing Redox Equations ● Electrochemical Cells ● The Properties of Solids ● The Microstructure of Solids ● Metals and Alloys ● Physical Properties of Liquids ● Carbon Molecules ● Functional Groups ● Organic Reactions ● Fats and Carbohydrates ● Photosynthesis and Respiration ● Proteins ● DNA and the Molecular Reproduction ● Chemistry of the Atmosphere **(Climate Change Mandate)** ● Chemistry of the Oceans ● Chemistry of the Land ● Nuclear Equations ● Nuclear Reactions: Radioactivity ● Rate of Radioactive Decay ● Nuclear Energy

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Overview	Content Standards	Core Ideas
		• Biological Effects of Radiation • The Sun and the Stars • The Planets • The Possibility of Life Elsewhere
Suggested Open Educational Resources	• American Association of Chemistry Teachers • 20 SEL Activities for High School • High School Chemistry Education Resources • Concord High School Chemistry Resources • Lab-Aids	

Unit 1: Fundamentals

Overview

Chemistry is an introductory course preparing the student for further studies in chemistry in college. It is directed toward explaining the composition of matter. Emphasis is placed on chemical principles and their application, problem solving, and the development of laboratory skills. Chemical principles will be used to explain aspects of forensic science, medicine, energy production, and environmental issues. Topics that will be explored include atomic and molecular structure, physical and chemical changes, and bonding and reactivity.

Essential Questions

- How do scientists know when they have the right explanation?
- How did scientists "discover" the atom, when they couldn't see it?
- How important are observations?
- What are some techniques that chemists use to measure volume?
- Why is volume important in chemistry?
- How do careful volume measurements contribute to good results?
- How is mass measured in chemistry?
- Can liquids be measured on a balance or just solid substances?
- How carefully can mass be measured?
- How can we convert one type of unit to another?
- What is dimensional analysis?
- How do I know which way to use my conversion factor?
- What are mixtures?
- Can mixtures be separated?
- Can we determine what is in a mixture?
- What information does the chemical formula provide us with?
- How do we represent the number of each element in a chemical formula?
- Does the way a chemical formula is written give us information about that molecule?
- When do scientists use parts per million to measure the concentration of a substance?
- How can scientists measure such small amounts, like parts per million?
- Do such small amounts actually matter?
- What is density?
- If different substances occupy the same volume do they contain the same
- amount of matter?
- How do you measure density?
- How are heat and temperature related to each other?
- When substances mix at different temperatures, what happens?
- How can the flow of heat be measured?
- What is specific heat?

Enduring Understandings

- Chemistry is the science of matter and its changes. Water is an important chemical, in part because many other chemicals can dissolve in it. Water facilitates many chemical reactions essential to life. Mass, volume, density and pressure are basic measurements of matter.
- The primary goal of science is to discover the natural laws by which nature operates. Inquiry is the process of learning through asking questions then the questions. Good scientific evidence is both objective and repeatable.
- Depending on the type of matter and its internal thermal energy, matter can be solid, liquid, gas or plasma. Energy, a measure of a system's ability to cannot be created or destroyed (1st law of thermodynamics) but it can be converted from one form to another.
- Everyday matter is either a pure substance or a mixture of pure substances. Matter can be described by its physical and chemical properties. Elements
- are the fundamental "pure substances" from which all other matter is formed. Each of the 118 known elements are listed in the periodic table. Each element corresponds to a unique atom. One mole of an element contains 6.02×1023 atoms.
- Most matter is in the form of molecules and compounds, particles composed of elements chemically bonded together. There are trillions of different possible combinations of the elements. Chemical formulas describe the elements present in a molecule or compound; structural diagrams show how the elements are connected.
- Mixtures can be homogeneous or heterogeneous. Solutions are homogeneous mixtures composed of solute(s) dissolved in a solvent. Concentration describes the ratio of solute to solvent. Molarity is the number of moles of solute per liter of solvent. One mole of an ideal gas has a volume of 22.7 liters at T = 0°C and P = 100 kPa. Gas mixtures follow Dalton's law of partial pressures.
- Atoms and molecules are in constant motion. Temperature is a measurement of the average kinetic energy of the molecules in contact with the thermometer. Absolute zero (0 K, –273.15°C) is the lowest possible temperature,

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• Why do some substances change temperature more rapidly than others? • How can two substances, equal in mass and temperature, contain different amount of heat? • What is thermal equilibrium? • How does a substance reach thermal equilibrium? • When does the flow of heat stop? • What is the heat of fusion? • What happens when ice melts? • Why does the temperature stay constant while ice melts? • What causes water to change from one phase to another? • Does it take a lot of heat to change ice to steam? • Why does the temperature stay constant while ice melts and water boils? • How do we know when a chemical reaction is happening? • What are the various ways by which we can tell that a chemical reaction is happening? • Can we "see" a chemical change? • What physical changes indicate the presence of a chemical change? • What are the reactants for my chemical reaction? • Can we predict one or more of the products formed in a chemical reaction? • How can we write a chemical reaction that represents the experiment we just performed? •	corresponding to the lowest possible molecular motion. Heat, or thermal energy, is the total energy of motion in a sample of matter. • Heat, or thermal energy, is commonly measured in joules, calories and BTUs. As stated in the 2nd law of thermodynamics, heat spontaneously travels from areas of higher temperature to adjoining areas of lower temperature until the temperatures of both areas are equal and thermal equilibrium is reached. Specific heat is the amount of energy required to increase the temperature of 1 g of a material by 1°C. Heat flows more readily through materials that are thermal conductors. • A phase change occurs when a material changes between solid, liquid, and gas states.Every material has a specific temperature at which phase changes occur, called its melting and boiling points. The heat of fusion (vaporization) is the amount of energy required to convert 1g of a material from solid to liquid (liquid to gas). The surrounding pressure alters the temperatures at which phase changes occur. • Physical changes, which involve intermolecular forces, do not change molecular structure, whereas chemical changes, which involve interatomic forces, do. Electric charge is a fundamental property of matter. All atoms have protons in the nucleus surrounded by a "cloud" of negatively charged electrons. Chemical bonds between atoms form because of interactions among electrons. • Bonded atoms have less total energy than they would have if they were unbonded. Chemical reactions can be described by chemical equations, which indicate both the reactant and the product chemicals. Because mass is conserved in a chemical reaction, chemical equations that describe a reaction must be balanced. All reactions involve energy. Exothermic reactions release energy to the surroundings while endothermic reactions absorb energy from the surroundings. • Many reactions occur between chemicals dissolved in water. Precipitates are insoluble products of aqueous reactions. Oxidation and reduction are important aspects of many chemical reactions. Aqueous solutions can be acidic, basic (alkaline), or neutral. Reactions between acids and bases produce salts and water.

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Unit 1: Fundamentals

Performance Expectations/Core Ideas

- HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
- HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
- HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Core Ideas

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.
- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

Student Learning Objectives

Students will be able to:

- Make objective observations
- Understand the importance of good observations
- Evaluate the accuracy of their hypotheses
- Measure volume by reading the meniscus
- Understand how important careful volume measurements are
- Evaluate how much bleach is required to remove the color from a dye solution
- Measure the mass of liquids precisely by reading a digital scale
- Understand how to zero or tare the balance
- Observe the effect liquid detergent has on oil and water
- Calculate percent concentration (by mass)
- Understand how unit conversions are used
- Feel comfortable converting from one unit to another using the dimensional analysis cards
- Set up a unit conversion and cancel unwanted units
- Identify a mixture containing sand, salt, and sugar, by knowing some specific information about their chemical and physical properties

- Understand that mixtures can be separated
- Determine the percent concentration of one of their mixtures.
- Write the chemical formula for a molecule
- Interpret the information provided by the chemical formula
- Understand that just a few elements can create many different unique molecules
- Make dilutions and calculate the new concentrations of solutions
- Measure the absorbance of a solution in the Lab-Master
- Graph and evaluate their diluted solutions to find the concentration in parts per million
- Explain what a part per million means
- Explain why substances have different densities
- Measure volume by water displacement
- Calculate the densities of substances
- Compare densities to assess the composition of coins
- Explain how heat flows
- Understand that temperature is related to molecular motion
- Calculate the mixture temperature and compare it to the experimental mixture temperature
- Explain the concept of specific heat
- Understand that the composition of matter influences a substance's ability to change temperature and hold energy
- Calculate the specific heat of steel
- Explain how heat flows
- Understand that temperature is related to molecular motion
- Graph time vs. temperature data and understand when thermal equilibrium is reached
- Understand how the rate of heat flow changes over time
- Understand what happens to water molecules during a phase change
- Graph time vs. temperature data and understand what the plateau represents
- Calculate the heat of fusion
- Understand what happens to water molecules during a phase change
- Graph time vs. temperature data and understand what different areas of the graph represent
- Understand why it requires more energy to boil water than it does to melt it
- Have descriptive knowledge of chemical change
- Understand some characteristics of chemical change
- Be able to identify some types of chemical change
- Remember the different physical changes that indicate a chemical change
- Recognize these changes in the lab during an actual experiment
- Write the reactants for an experiment
- Understand how to predict some of the products formed in a chemical reaction
- Be able to identify some types of chemical changes

Integrated Accommodations and Modifications		
Special Education Students	**English Language Learners**	**At Risk**

• Utilize modifications & accommodations delineated in the student's IEP • Provide additional manipulatives to support instruction • Allow for alternative strategies to solve algorithms or tasks • Provide the steps needed to complete the task • Model frequently • Provide repetition and practice. • Use visuals to demonstrate/model the processes • Restate, reread, and clarify directions/questions • Ask students to restate information, directions, and assignments. • Provide copy of class notes • Distribute study guide for classroom tests. • Provide preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Provide regular parent/ school communication • Allow extended time to complete assignment • Establish procedures for accommodations / modifications for assessments • Allow student to take/complete tests in an alternate setting as needed	WIDA Can Do Descriptors https://wida.wisc.edu/teach/can-do/descriptors • Modify Assignments • Use testing and portfolio assessment • Utilize Native Language Translation (peer, online assistive technology, translation device, bilingual dictionary) • Repeat, rephrase, paraphrase key concepts and directions • Allow for extended time for assignment completion as needed • Highlight key vocabulary • Define essential vocabulary in context • Use graphic organizers, visuals, manipulatives and other concrete materials • Use gestures, facial expressions and body language • Read aloud • Build on what students already know and prior experience	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Provide preferential seating to be mutually determined by the student and teacher • Allow the use of a computer to complete assignments. • Establish expectations for correct spelling on assignments • Provide extra textbooks for home. • Provide Peer Support • Increase one on one time

Gifted and Talented Students	504 Plan
• Utilize advanced, accelerated, or compacted content • Provide assignments that emphasize higher- level thinking skills. • Allow for individual student interest • Gear assignments to development in areas of affect, creativity, cognition, and research skills • Allow for a variety in types of resources • Provide problem-based assignments with planned scope and sequence • Utilize inquiry-based instruction • Adjust the pace of lessons • Utilize Choice Boards • Provide Problem-Based Learning • Establish flexible Grouping	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Break long assignments into smaller parts • Assist student in setting short term goals • Allow for preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Model and reinforce organizational systems (i.e. color-coding) • Write out homework assignments, check student's recording of assignments

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Interdisciplinary Connections	Computer Science and Design Thinking
Math ● HSS.IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population. ● HSS.IC.B.5: Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. ● HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ● HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. ● HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. ● HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. ● HSA-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ● HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. **English Language Arts** Reading ● RST.9-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. Writing ● WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. ● WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. ● WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. ● WHST.9-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas,	**Computer Science and Design Thinking Practices** 1. ☐ Fostering an Inclusive Computing and Design Culture 2. ☑ Collaborating Around Computing and Design 3. ☐ Recognizing and Defining Computational Problems 4. ☐ Developing and Using Abstractions 5. ☐ Creating Computational Artifacts 6. ☐ Testing and Refining Computational Artifacts 7. ☑ Communicating About Computing and Design **Computer Science and Design Thinking Standards** ● 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process. ● 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. ● 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. **Core Ideas** ● Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information. ● The accuracy of predictions or inferences made from a computer model is affected by the amount, quality, and diversity of data. ● The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.

avoiding plagiarism and overreliance on any one source and following a standard format for citation. ● WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.	

Career Readiness, Life Literacies and Key Skills
Career Readiness, Life Literacies and Key Skills Practices ● Act as a responsible and contributing community member and employee. ● Consider the environmental, social and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity, increase collaboration and communicate effectively. ● Work productively in teams while using cultural/global competence. ● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a). ● 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8). ● 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1) ● 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3). ● 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a). ● 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society (e.g., 6.1.12.CivicsPD.16.a). ● 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources. ● 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.). ● 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
SEL Competencies
● **Self - Awareness** ● **Self - Management** ● **Social Awareness** ● **Responsible Decision Making** ● **Relationship Skills**

Formative Assessment Plan	Summative Assessment Plan
Formative assessment informs instruction and is ongoing throughout a unit to determine how students are progressing against the standards.	*Summative assessment is an opportunity for students to demonstrate mastery of the skills taught during a particular unit.* ● **Investigations:** ○ **Inquiry and Scientific Evidence**

Teachers are encouraged to incorporate Formative Assessments into all lessons. During instruction, teachers will collect ongoing information on students' mastery of content through a variety of methods: • Questioning: using Socratic method, probing questions, a hierarchical system in complexity (Bloom's Taxonomy) • Exit tickets, rotational activities (stations), quizzes, and small group activities • Classwork, homework, group work • Pre-Assessments, teacher's observation, class discussion, and journal • Journal Writing • Daily Verbal Assessments	○ **Mass in Chemistry** ○ **Dimensional Analysis** ○ **Volume and Chemistry** ○ **Mixtures** ○ **Density** ○ **The Chemical Formula** ○ **One in a Million** ○ **Heat and Temperature** ○ **Specific Heat** ○ **Heat Flow and Thermal Equilibrium** ○ **Heat of Fusion** ○ **Phases Changes of Water** ○ **Indicators of Chemical Reactions** ○ **Chemical Changes** • **Other Summative Assessments:** Teachers are encouraged to design and their own assessments (topic/module tests and quizzes) individually and/or with their department or grade-level partners, as per Uniform Grading Profile.

Targeted Academic Vocabulary
Matter, measurement, volume, liter, milliliter, graduated cylinder, conversion factor, mass, weight, gram, balance, density, pressure, significant figures, precision, accuracy, dimensional analysis, theory, hypothesis, objective, variable, repeatability, evidence, deduction, conclusions, uncertainty, scientific method, Phases (or states) of matter, solid, liquid, gas, plasma, energy, law of conservation of energy, Substance, mixture, volume, pure, chemical property, chemical change, physical property, macroscopic, microscopic, atom, element, chemical symbol, periodic table, mole, Avogadro's number, Chemical formula, subscript, structural diagram, bonds, molecule, compound, formula mass, ionic compound, ions, moles, Homogeneous, heterogeneous, solution, solute, solvent, concentration, molarity, solubility, insoluble, dissolve, pressure, Dalton's law of partial pressures, STP, Heat, temperature, molecular motion, kinetic energy, random, Fahrenheit, Celsius, Kelvin, thermometer, thermistor, thermo-couple, absolute zero, Thermal energy, system, surroundings, thermal energy, joule, calorie, BTU, system, surroundings, 2nd law of thermodynamics, thermal equilibrium, 1st law of thermodynamics (energy conservation), specific heat, conduction, thermal insulator, thermal conductor, Phase change, melting point, boiling point, heat of fusion, heat of vaporization, evaporation, condensation, latent heat, triple point, relative humidity, dew point, Chemical change, physical change, interatomic forces, intermolecular forces, electric charge, electron, proton, electron cloud, chemical bond, enthalpy of formation, covalent bond, ionic bond, reactivity, Chemical reactions, chemical equations, reactant, product, conservation of mass, balanced equation, coefficient, exothermic, endothermic, surroundings, activation, energy, Aqueous, precipitate, salt, oxidation, reduction, ion, acid, base, neutral, pH

Resources:
• Geo Science Seven: Flame Lab Burners • Chemistry Land-Chemical & Physical Changes • The Science Channel • Dino Dig

- Crime Scene Investigators: Apply Carbon 14
- You Tube: Photoelectric Effect
- Explain That Stuff: Photoelectric Cells
- Chemistry Land: Properties of Ionic and Covalent Compounds
- Chemistry In Nazi Germany (acs.org) **(Holocaust Law)**
- Teaching Tolerance | National Geographic Society **(Holocaust Law)**
- 6 Important LGBTQ Scientists Who Left a Mark on STEM Fields (osc.org) **(LBGTQ+)**
- Atomic Structure | PBS LearningMedia
- Atomic Structure of an Alloy | PBS LearningMedia

Pacing Guide
Can be found within Lab-Aids.

Unit 2: Core Concepts (Chapters 5 - 9)

Overview
Chemistry is an introductory course preparing the student for further studies in chemistry in college. It is directed toward explaining the composition of matter. Emphasis is placed on chemical principles and their application, problem solving, and the development of laboratory skills. Chemical principles will be used to explain aspects of forensic science, medicine, energy production, and environmental issues. Topics that will be explored include atomic and molecular structure, physical and chemical changes, and bonding and reactivity.

Essential Questions	**Enduring Understandings**
• What particles are found in atoms, and where? • How can you determine the number of protons, neutrons and electrons in an atom. • What particles distinguish one atom from another and one isotope from another? • How is color measured? • How is light measured? • What is the difference between transmission and absorption? • What makes an object appear a certain color? • How is color used to identify elements? • Why does each element have a characteristic spectrum? • What is the difference between emission and absorption spectra? • How are atomic properties used to identify elements? • How can you figure out an element's particular isotope? • How are atomic properties used to identify elements? • How can you figure out an element's particular isotope? • How do we determine the valence of an atom?	• All matter is made of atoms of the 92 naturally occurring elements. Atoms are made from smaller particles called protons, neutrons, and electrons. The beautiful variety of nature arises from how the three particles come together in rich and complex ways. • When electrons are confined in an atom they are arranged in a pattern that minimizes their energy. Quantum theory describes the science in the microscopic world of atoms and electrons. In this world the particles are spread out like a wave. Electrons are arranged in a pattern according to energy levels. • Electrons are arranged in space and energy around the atom by following a set of rules. These rules are based on quantum theory. To find the electron configuration we follow an established order that tells us the orbitals and the order that they are filled. Each element emits a characteristic spectrum. Chemists refer to the emission spectrum as the "fingerprint" of an element Atoms both emit and absorb light at the energies corresponding to their energy levels.

● Why does only the outer shell of electrons determine chemical properties? ● How can we predict how atoms will bond based on valence? ● How do Lewis dot diagrams help us to understand bonding? ● How does a Lewis dot structure describe a molecule? ● Why do molecules form the way they do? ● Are molecules flat? ● What does a Lewis structure tell us about molecular shape? ● What are some common 3-D molecular shapes? ● What is a hydrate? ● How can the formula of a hydrate be determined? ● What does the chemical formula of a hydrate mean? ● How are binary ionic compounds named? ● How are binary molecular compounds named? ● How can a compound be named from its chemical formula? ● How is density measured? ● How can density be used to determine concentration? ● How can you figure out how much of a solvent is in a solute? ● What is Beer's Law? ● How can we use Beer's Law to figure out the concentration of a solution? ● How can we construct a calibration curve to help measure solutions of unknown concentration? ● What is the heat of a solution? ● How can we measure it? ● What are some different ways to measure it? ● What is a coffee-cup calorimeter? Why is it useful? How is it used?	● The periodic table contains, and is arranged according to, essential characteristics of the 117 confirmed elements. Large quantities of 10 elements, called macronutrients, are required for life. Trace elements are also required but only in very small, trace amounts. Elements in each row of the periodic table are arranged according to periodic properties such as atomic number, electronegativity, and ionization energy. ● Elements in each column, or group, of the periodic table have similar properties such as valence electrons and bonding characteristics. Atoms bond by sharing, donating, or accepting electrons from other atoms so that each atom has only completely filled energy levels. ● Valence electrons are those electrons in an atom's highest energy level. Only valence electrons form chemical bonds. Lewis dot diagrams depict an atom's valence electrons. ● Polarization, an electrically induced distortion of an atom's structure, is involved in bond formation. Covalent bonds occur when electrons are shared; ionic bonds occur when electrons are transferred. The properties of electronegativity and ionization energy help predict what type of bond will form between two atoms. Polar molecules exhibit unequal ● In a molecule, each unpaired valence electron forms one covalent bond. When ions form, each transferred valence electron results in the gain or loss of one unit of positive charge. Ionic substances are often comprised of oppositely charged ions in a regular, repeated, crystalline pattern. Atoms and molecules with unpaired electrons are reactive. ● Chemical formulas do not tell you the 3-D structure of the molecule. Isomers are molecules with the same formula but different structures. Atoms can form single, double and triple bonds. VSEPR theory allows us to predict bond angles and basic molecular shapes. ● Ionic substances tend to be brittle solids at room temperature, have high melting points, and conduct electricity when melted or dissolved. These properties arise because of bonding patterns. A polyatomic ion is a small molecule with a non-neutral charge. ● The highly variable properties of molecular compounds arise from the structure and interatomic bonding of the individual molecules and various intermolecular forces. Hydrocarbons are an important class of medium-sized molecules. Many molecules essential for life are very large organic molecules called polymers that are composed of smaller repeated units called monomers. ● Intermolecular attractions help explain why some molecular substances are solids at room temperature while others are liquids or gases. There are two broad categories of intermolecular attractions: dipole-dipole and London dispersion. Hydrogen bonding is a strong type of dipole-dipole attraction. One way to identify compounds is by mass percent of each element. Empirical

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	formulas give the lowest ratio of elements. Molecular formulas are often multiples of empirical formulas. ● Water has some unusual properties including high boiling point, high surface tension, and an ability to dissolve many substances. These properties arise because water is a small, polar molecule that can form hydrogen bonds. Aqueous solutions have water as a solvent, help facilitate many chemical reactions, and are essential to life ● The concentration of a solution is commonly measured in g/L, mass % (or ppm), and molarity of the solute(s). Solubility is the amount of solute that can dissolve in a given amount of solvent (at a given temperature and pressure). For liquid and solid solutes, solubility and dissolving rates tend to increase as temperature increases. The solubility of gases decreases as temperature increases and increases as pressure increases. ● Higher concentration and/or temperature generally results in a faster reaction rate. Enthalpy is the heat energy of a physical or chemical change and can be measured by calorimetry. Colligative properties, such as depressed melting point and increased boiling point, depend upon the number of solute particles in a solution, not the type of particles. Electrolytes are aqueous solutions that contain ions and conduct electricity.

Unit 2: Core Concepts

Content Standards

- HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
- HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

Core Ideas

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can

Unit 2: Core Concepts

Content Standards

be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.
- Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).
- When two objects interacting through a field change relative position, the energy stored in the field is changed.
- Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.
- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

Student Learning Objectives

Students will be able to:

- Know the subatomic particles, and describe their locations in the atom
- Determine the number of protons and neutrons in an atom
- Know the differences between atoms and isotopes?
- Know the difference between transmission and absorption
- Explain why objects appear certain colors
- Know how to use absorbance to measure amounts of different colors
- Know the difference between emission and absorption spectra
- Know that each element has a characteristic spectrum
- Know how to use spectroscopy
- Identify an element based on some combination of its atomic mass, number, symbol, isotope or properties
- Figure out an atom's isotope by knowing something about the relation between the number of protons and neutrons
- Identify an element based on some combination of its atomic mass, number, symbol,isotope or properties
- Figure out an atom's isotope by knowing something about the relation between the number of protons and neutrons
- Determine the valence of an atom by building it, or by using the periodic table and some simple rules
- Figure out how an atom will likely bond with others based on its valence
- Understand what a Lewis dot structure represents
- Make a molecular model from a Lewis dot structure
- Make a Lewis dot structure from a molecular model

- Understand that a chemical formula may describe more than one molecular arrangement
- Understand that molecules are actually three-dimensional
- Make a molecular model from a Lewis structure
- Associate a 3-D shape with a simple Lewis structure
- Understand that lone pairs on the central atom are important to the shape of a molecule
- Calculate the percent by mass of water in their hydrate
- Calculate the number of moles of water associated with their hydrate
- Write the chemical formula for their hydrate—copper (II) sulfate pentahydrate
- Name binary ionic and binary molecular compounds
- Predict chemical names based on the chemical formula
- Write the chemical formula for a compound from the corresponding name
- Determine the density of an object by measuring its mass and volume
- Create a density curve based on standardized solutions
- Figure out how much solvent is in a solution by using this density curve
- Know Beer's Law, and why it is useful
- Use Beer's Law to determine the concentration of a solution by way of its optical absorbance
- Construct a calibration curve of absorbance vs. concentration, and use it to figure out the concentration of an unknown solution
- Explain the heat of solution
- Measure the heat of solution by direct (temperature) methods, and indirectly by measuring the temperature change in a reaction
- Explain why a coffee-cup calorimeter is useful, and use it to measure the heat of solution
-

Integrated Accommodations and Modifications		
Special Education Students	**English Language Learners**	**At Risk**
• Utilize modifications & accommodations delineated in the student's IEP • Provide additional manipulatives to support instruction • Allow for alternative strategies to solve algorithms or tasks • Provide the steps needed to complete the task • Model frequently • Provide repetition and practice. • Use visuals to demonstrate/model the processes • Restate, reread, and clarify directions/questions • Ask students to restate information, directions, and assignments. • Provide copy of class notes • Distribute study guide for classroom tests.	WIDA Can Do Descriptors https://wida.wisc.edu/teach/can-do/descriptors • Modify Assignments • Use testing and portfolio assessment • Utilize Native Language Translation (peer, online assistive technology, translation device, bilingual dictionary) • Repeat, rephrase, paraphrase key concepts and directions • Allow for extended time for assignment completion as needed • Highlight key vocabulary • Define essential vocabulary in context • Use graphic organizers, visuals, manipulatives and other concrete materials	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Provide preferential seating to be mutually determined by the student and teacher • Allow the use of a computer to complete assignments. • Establish expectations for correct spelling on assignments • Provide extra textbooks for home. • Provide Peer Support • Increase one on one time

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• Provide preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Provide regular parent/ school communication • Allow extended time to complete assignment • Establish procedures for accommodations / modifications for assessments • Allow student to take/complete tests in an alternate setting as needed	• Use gestures, facial expressions and body language • Read aloud • Build on what students already know and prior experience	

Gifted and Talented Students	504 Plan
• Utilize advanced, accelerated, or compacted content • Provide assignments that emphasize higher- level thinking skills. • Allow for individual student interest • Gear assignments to development in areas of affect, creativity, cognition, and research skills • Allow for a variety in types of resources • Provide problem-based assignments with planned scope and sequence • Utilize inquiry-based instruction • Adjust the pace of lessons • Utilize Choice Boards • Provide Problem-Based Learning • Establish flexible Grouping	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Break long assignments into smaller parts • Assist student in setting short term goals • Allow for preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Model and reinforce organizational systems (i.e. color-coding) • Write out homework assignments, check student's recording of assignments
Interdisciplinary Connections	**Computer Science and Design Thinking**

Math

- HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

English Language Arts

Reading

- RST.9-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.

Writing

- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Computer Science and Design Thinking Practices

1. ☐ Fostering an Inclusive Computing and Design Culture
2. ☑ Collaborating Around Computing and Design
3. ☐ Recognizing and Defining Computational Problems
4. ☐ Developing and Using Abstractions
5. ☐ Creating Computational Artifacts
6. ☐ Testing and Refining Computational Artifacts
7. ☑ Communicating About Computing and Design

Computer Science and Design Thinking Standards

- 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
- 8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

Core Ideas

- Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems.
- Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.

Career Readiness, Life Literacies and Key Skills

Career Readiness, Life Literacies and Key Skills Practices

- Act as a responsible and contributing community members and employee
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Use technology to enhance productivity increase collaboration and communicate effectively.
- Work productively in teams while using cultural/global competence.

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
- 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem (e.g., 7.1.AL.IPERS.6).

SEL Competencies

- **Self - Awareness**
- **Self - Management**
- **Social Awareness**
- **Responsible Decision Making**
- **Relationship Skills**

District/School Formative Assessment Plan	District/School Summative Assessment Plan
Formative assessment informs instruction and is ongoing throughout a unit to determine how students are progressing against the standards. Teachers are encouraged to incorporate Formative Assessments into all lessons. During instruction, teachers will collect ongoing information on students' mastery of content through a variety of methods: • Questioning: using Socratic method, probing questions, a hierarchical system in complexity (Bloom's Taxonomy) • Exit tickets, rotational activities (stations), quizzes, and small group activities • Classwork, homework, group work • Pre-Assessments, teacher's observation, class discussion, and journal • Journal Writing • Daily Verbal Assessments	*Summative assessment is an opportunity for students to demonstrate mastery of the skills taught during a particular unit.* • **Investigations:** ○ **Inside the Atom** ○ **Spectrophotometry** ○ **Spectroscopy** ○ **Periodic Table Riddles** ○ **Periodic Table Fill in the Blank** ○ **Valence** ○ **Lewis Structures** ○ **The Geometry of Molecules** ○ **Naming Chemical Compounds** ○ **The Formula of a Hydrated Salt** ○ **Density and Concentration**

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	○ **Solutions and Beer's Law** ○ **Solution Calorimetry** ● **Other Summative Assessments:** Teachers are encouraged to design and their own assessments (topic/module tests and quizzes) individually and/or with their department or grade-level partners, as per Uniform Grading Profile.

Targeted Academic Vocabulary

Proton, neutron, electron, nucleus, mass number, atomic number, isotope, atomic mass unit (amu), ion, transmission, absorption, spectroscopy, color, spectrum, emission spectrum, absorption spectrum, spectroscopy, spectrum, emission spectrum, absorption spectrum, spectroscopy, atomic mass, atomic number, macronutrient, trace element, trace amount, periodic table, periodic properties, electronegativity, ionization energy, orbital, transition metal, noble, gas, alkali metal, alkali earth metal, atomic radius, valence, electron shell, electron configuration, bonding, Lewis dot diagrams, Lewis dot structure, covalent bond, non-polar covalent, polar covalent, polarization, molecular model, valence electrons, ionization energy, electronegativity, polar molecule, valence electrons, ions, octet rule, electron configuration, ionic crystal, paired and unpaired electrons, free radical, antioxidant, VSEPR, region of electron density, lone pair, trigonal planar, tetrahedral, tetrahedron, trigonal pyramidal, bent, Ionic, covalent network, molecular, metallic, brittle, electric current, ion, crystal, chemical formula, polyatomic ion, transition metal, molecular compound, hydrocarbons, monomer, polymer, network covalent, organic molecule Van der Waals attraction, dipole-dipole, London dispersion, hydrogen bonding, surface tension, molar mass, percent composition, empirical formula, molecular formula, solvent, solute, dissolve, polar, hydration, boiling point, surface tension, tap water, distilled water, deionized water, aqueous, polar solvent, nonpolar solvent, Mass, volume, solute, solvent, concentration, molarity, solubility, dilute, concentrated, saturated, aqueous equilibrium, surface area, temperature, pressure, supersaturated, Reaction rate, enthalpy, calorimetry, colligative property, molality, entropy, electrolytes

Resources:

- PHET Simulation Labs
- The Periodic Table
- Virtual Periodic table
- 5 LGBT Scientists Who Changed the World | Latest Science News and Articles | Discovery **(LBGTQ+)**
- Slayton Evans Memorial Lectureship – Department of Chemistry (unc.edu) **(Amistad Law)**
- Newsela - Chemistry group offers seat at periodic table to 4 new elements
- Newsela | 2/7: National Periodic Table Day
- Newsela | Periodic Table
- Periodic Table of the Elements | PBS LearningMedia
- Ionic Bonding and Ionic Compounds Unit
- Golden rain - ionic bonding demo
- Agents of global warming – Climate Change: Vital Signs of the Planet (nasa.gov) **(Climate Change)**
- Periodical | Finding Chemistry Connections in Climate Change | AACT (teachchemistry.org) **(Climate Change)**
- Organizing Atoms and Electrons | Chemistry: Unit 4 | PBS LearningMedia
- Chapter 6: From Frog Legs to Electrolytes | Raw to Ready: Komatsu | PBS LearningMedia
- Newsela - Report shows that teens are drinking less soda, but more sports drinks
- Ionic compound tutorial - American Chemical Society (acs.org)
- Romiya Glover | Chemistry | PBS LearningMedia **(Diversity, Equity and Inclusion/ Amistad Law)**

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- Covalent bonding and molecular compounds Unit
- The Periodic Table and the Formulation of Compounds | Chemistry: Unit 4 | PBS LearningMedia
- Molecular Shapes | PBS LearningMedia
- Molecular Evidence for Evolutionary Relationships | PBS LearningMedia

Pacing Guide

Can be found within LabAids.

Unit 3: Core Concepts (Chapter 10-14)

Overview

Chemistry is an introductory course preparing the student for further studies in chemistry in college. It is directed toward explaining the composition of matter. Emphasis is placed on chemical principles and their application, problem solving, and the development of laboratory skills. Chemical principles will be used to explain aspects of forensic science, medicine, energy production, and environmental issues. Topics that will be explored include atomic and molecular structure, physical and chemical changes, and bonding and reactivity.

Essential Questions	Enduring Understandings
• What happens when aqueous salt solutions are mixed? • How can a solid form when two aqueous solutions are mixed? • What kind of chemical change occurs during a precipitate reaction? • Are there some simple methods that can be used to help identify products in a chemical reaction? • What are some of the common products produced during certain types of chemical change? • How can I write a chemical equation that represents what I observed? • How can the ΔH of a chemical reaction in solution be determined? • How is coffee-cup calorimetry used to measure the heat change in a chemical reaction? • When can Hess's Law be applied to determine a ΔH value? • What is stoichiometry? • How can we use stoichiometry to figure out how much of a product was formed? • How can we use stoichiometry to design efficient chemical reactions? • How can stoichiometry be used to design reactions? • Can stoichiometry accurately predict the amount of product formed by a • reaction in the lab? • How do we measure the efficiency of a reaction? • How is the percentage yield of a reaction determined? • How can you determine the effect of temperature on a reaction rate?	• Chemical equations describe chemical reactions by indicating the chemical formulas of the reactant and the product chemicals. Because matter must be conserved, chemical equations must be balanced. There is a series of steps to follow that makes the process of balancing equations easier. • Four common classifications of chemical reactions are: combination (synthesis), decomposition, single replacement, and double replacement. • Precipitates form when an aqueous reaction forms an insoluble product. • Breaking and forming bonds during a chemical equation involve energy. Exothermic reactions release energy, whereas endothermic reactions absorb • energy. Enthalpy, ΔH, is the energy absorbed (positive) or released (negative) during a reaction. Spontaneous reactions have very small energy barriers and do not require an external energy input. • Stoichiometry can tell us how much of each reactant is used up and how much of each product is formed. The coefficients in balanced equations can be thought of as mole amounts, but not as mass amounts. Molar masses can then be used to determine the mass of each chemical involved. • Actual chemical reactions often produce less than stoichiometry predicts for ideal conditions. Percent yield is the ratio of the amount of actual product to the amount of theoretical product. In many reactions, one of the reactants, the limiting reactant, is used up before the other(s). The other reactant(s) are excess

- How does temperature affect cellular respiration?
- Is there an optimum temperature at which yeast carry out their life processes?
- How can we study the speed of a chemical reaction?
- How does a change in reactant concentration affect the reaction rate?
- Does a change in reactant concentration always affect the reaction speed?
- Does Le Châtelier's Principle really predict the behavior of a chemical system?
- How can we detect which way a chemical reaction proceeds?
- Will a reaction "shift" if there is a change in concentration of a reactant?
- Can a change in the temperature of the surroundings cause one side of a chemical reaction to be favored?
- What does a pH measurement actually tell us?
- How can the pH of a solution be calculated from concentration data?
- How can I determine the pH of a solution using the spectrophotometer?
- How much acetic acid is in commercial vinegar?
- How can a titration be used to accurately determine mole amounts of an acid?
- What is an equivalence point?
- Is the amount of acetic acid advertised on the label of commercial vinegar accurate?
- How do antacids work?
- What are the chemicals in antacid tablets? How do these chemicals react with the acid in our stomach?
- Are some brands of antacids more effective than others?
- How much vitamin C is in fresh squeezed orange juice?
- What types of foods contain the most vitamin C content?
- Are vitamin C tablets a good source of vitamin C?
- What chemical reactions are involved in measuring the amount of vitamin C?
- What is the ideal gas law? How can we use it to our advantage?
- How can we measure properties of a gas without letting it escape?
- How can we use these measurements to figure out the molar mass of a gas?
- How heavy is air?
- How can we measure the weight of air?
- What happens to the density of a gas as the pressure is increased?
- Why don't we feel the enormous weight of the atmosphere all the time?

- reactants because they are still present after the reaction has gone to completion. Stoichiometry can be used to determine the limiting reactant and the product yield.
- Reaction rates are affected by concentration, temperature, surface area, and cat-
- alysts. Reaction rates tend to decrease with time. Collision theory helps explain reaction rates. For a reaction to proceed, the reactant(s) must have sufficient energy to form an activated complex.
- Because reactions are reversible, the endpoint of many reactions is known as equilibrium, where the rates of the forward and reverse reactions are equal. Equilibrium is a dynamic state and does not imply that there are equal amounts of reactants and products. Le Châtelier's principle describes how equilibrium changes when conditions, such as temperature, concentration and pressure, change.
- Reactions follow a chemical pathway or reaction mechanism made up of a series of elementary steps. An intermediate is a chemical formed during one elementary step only to be consumed in a later step.
- Catalysts speed up reactions by providing a pathway with a lower activation energy. Enzymes are catalysts used by organisms and are essential to life. Catalysts play important roles (both positive and negative) in industry and the environment.
- Neutral liquids, such as pure water, have equal amounts of H+ and OH– ions. An acid solution has excess H+ ions and a base solution has excess OH– ions. Acidic and basic solutions have distinct properties and react to form water and salts. A strong acid or base, such as HCl or NaOH, dissociates completely.
- Pure water is neutral, has [H+] = [OH–] = 1 × 10–7 M, for which pH = 7. Acids have pH < 7 ([H+] > 1 × 10–7) and bases have pH > 7 ([H+] < 1 × 10–7). pH = log[H+]. A pH indicator turns a distinct color at a specific pH.
- Dilute aqueous solutions obey the equilibrium rule [H+] × [OH–]= 1 × 10–14. This results in an ion product constant (Kw) = 1 × 10–14 at 25°C. [H+] in a weak acid (or base) also obeys an equilibrium relationship, quantified by a specific Ka or Kb for each acid or base.
- Neutralization is a reaction between an acid and a base that creates salt and water, and results in a solution with a pH closer to 7. Complete neutralization results in a pH = 7. Titrations are precise neutralizations that use indicators to determine the exact pH. Buffers resist small changes in pH.
- The kinetic molecular theory provides an explanation for the unique properties of gases. The kinetic theory of pressure explains why increasing gas temperature and/or density results in increased pressure. The energy of molecular motion in a gas is given by Boltzmann's constant Gas pressure (P) depends on the strength and frequency of molecular impacts which depends on

	the volume of the container (V), the amount of gas molecules in the container (n), and the temperature of the gas (T). Boyle's law, Charles law, the combined gas law, and the ideal gas law mathematically define the relationships among P, T, V, and n. ● Stoichiometry can be used to determine the quantity of a gas consumed or produced during a reaction.

Unit 3: Core Concepts (Chapter 10-14)

Content Standards

- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
- HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Core Ideas

- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

Student Learning Objectives

Students will be able to:

- Describe what happens when a precipitate is formed from two aqueous solutions
- Make predictions about the solubilities of some common ions in solution
- Write a complete ionic equation for a double replacement reaction

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- Determine the identity of an unknown salt solution based on experimental observations
- Write down the reactants and predict some of the products for a chemical reaction
- Begin to understand that some reaction types produce common products
- Become familiar with some common tests for basic solutions
- Know common tests for carbon dioxide gas, hydrogen gas, and water vapor
- Calculate the ΔH of chemical reactions occurring in solution, using their own data
- Apply Hess's Law and understand how it works
- Use coffee-cup calorimetry methods to measure the ΔH for a chemical change
- Explain that stoichiometry is the process of balancing a chemical reaction
- Use stoichiometry to figure out how much of a product was formed
- Use stoichiometry to balance a reaction, and then figure out how much of each reactant is needed to produce the theoretical yield in a reaction
- Explain how stoichiometric relationships work in a balanced equation
- Use stoichiometry to balance a reaction and determine how much of each reactant to add
- Compare theoretical predictions with experimental data for a stoichiometrically balanced reaction
- Measure the percent yield of a reaction
- Determine the best temperature range for yeast to carry out cellular respiration
- Explain how temperature affects chemical reactions such as cellular respiration
- Graph and evaluate experimental data
- Explain how a change in reactant concentration affects the rate of reaction
- Describe one method for measuring the rate of a reaction
- Graph and explain the significance of their data
- Explain how an increase in reactant concentration causes a chemical reaction to shift and create more product
- Explain how a decrease in reactant concentration causes a chemical reaction to shift to create more reactant
- Describe how a change in temperature effects the equilibrium position of a chemical reaction
- Write a chemical reaction that describes the behavior of an equilibrium system
- Explain the difference between the hydrogen ion concentration, in a solution with a pH of 2 and a solution with a pH of 3
- Describe what pH measures
- Graph experimental data and explain how the spectrophotometer can be used as a tool to find an unknown pH
- Describe the significance of the equivalence point
- Explain how the titration process can be used to determine the mole amounts of an acid or base in solution
- Demonstrate the laboratory skills associated with a simple titration
- Calculate the percent by mass of acetic acid in commercial vinegar
- Describe the chemical reaction that occurs when a particular brand of antacid tablet reacts with stomach acid
- Measure the neutralizing power of one brand of antacid in millimoles per gram of tablet
- Explain how the process of back titration works
- Explain the importance of each chemical reaction involved in the measurement of vitamin C
- Describe how the starch indicator works
- Measure the mole amount of vitamin C using a simple titration process
- Calculate the amount of vitamin C in tablets and juices
- Understand the ideal gas law, and how it can be used as an equation of state to find missing properties of an ideal gas
- How to measure the properties of a gas (temperature, pressure, volume) without letting it escape to the environment

- Use the above measurements to determine other properties of the gas
- Know the density of air, and understand that it is significant
- Understand techniques for measuring the weight of a gas
- Explain what happens to a gas as the pressure is changed
- Explain that we do feel the weight of all the air above us in the form of air pressure

Integrated Accommodations and Modifications		
Special Education Students	**English Language Learners**	**At Risk**
• Utilize modifications & accommodations delineated in the student's IEP • Provide additional manipulatives to support instruction • Allow for alternative strategies to solve algorithms or tasks • Provide the steps needed to complete the task • Model frequently • Provide repetition and practice. • Use visuals to demonstrate/model the processes • Restate, reread, and clarify directions/questions • Ask students to restate information, directions, and assignments. • Provide copy of class notes • Distribute study guide for classroom tests. • Provide preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Provide regular parent/ school communication • Allow extended time to complete assignment • Establish procedures for accommodations / modifications for assessments • Allow student to take/complete tests in an alternate setting as needed	WIDA Can Do Descriptors https://wida.wisc.edu/teach/can-do/descriptors • Modify Assignments • Use testing and portfolio assessment • Utilize Native Language Translation (peer, online assistive technology, translation device, bilingual dictionary) • Repeat, rephrase, paraphrase key concepts and directions • Allow for extended time for assignment completion as needed • Highlight key vocabulary • Define essential vocabulary in context • Use graphic organizers, visuals, manipulatives and other concrete materials • Use gestures, facial expressions and body language • Read aloud • Build on what students already know and prior experience	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Provide preferential seating to be mutually determined by the student and teacher • Allow the use of a computer to complete assignments. • Establish expectations for correct spelling on assignments • Provide extra textbooks for home. • Provide Peer Support • Increase one on one time

Gifted and Talented Students	**504 Plan**
• Utilize advanced, accelerated, or compacted content • Provide assignments that emphasize higher- level thinking skills. • Allow for individual student interest • Gear assignments to development in areas of affect, creativity, cognition, and research skills • Allow for a variety in types of resources	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes

• Provide problem-based assignments with planned scope and sequence • Utilize inquiry-based instruction • Adjust the pace of lessons • Utilize Choice Boards • Provide Problem-Based Learning • Establish flexible Grouping	• Break long assignments into smaller parts • Assist student in setting short term goals • Allow for preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Model and reinforce organizational systems (i.e. color-coding) • Write out homework assignments, check student's recording of assignments
Interdisciplinary Connections	**Computer Science and Design Thinking**
Math • HSF-BF.A.1: Write a function that describes a relationship between two quantities. • HSS.IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population. • HSS.IC.B.5: Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. **English Language Arts** Reading • RST.9-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. Writing • WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. • WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • WHST.9-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.	**Computer Science and Design Thinking Practices** 1. □ Fostering an Inclusive Computing and Design Culture 2. ☑ Collaborating Around Computing and Design 3. □ Recognizing and Defining Computational Problems 4. □ Developing and Using Abstractions 5. □ Creating Computational Artifacts 6. □ Testing and Refining Computational Artifacts 7. ☑ Communicating About Computing and Design **Computer Science and Design Thinking Standards** • 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. • 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. • 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. • 8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process. **Core Ideas** • The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities. • Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information. • The accuracy of predictions or inferences made from a computer model is affected by the amount, quality, and diversity of data.

• WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. Speaking and Listening • SL.9-10.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.	

Career Readiness, Life Literacies and Key Skills
Career Readiness, Life Literacies and Key Skills Practices • Act as a responsible and contributing community members and employee • Consider the environmental, social and economic impacts of decisions. • Demonstrate creativity and innovation. • Utilize critical thinking to make sense of problems and persevere in solving them. • Use technology to enhance productivity increase collaboration and communicate effectively. • Work productively in teams while using cultural/global competence. • 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a). • 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8). • 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1) • 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3). • 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a). • 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society (e.g., 6.1.12.CivicsPD.16.a). • 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources. • 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.). • 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
SEL Competencies
• **Self - Awareness** • **Self - Management** • **Social Awareness** • **Responsible Decision Making** • **Relationship Skills**

District/School Formative Assessment Plan	**District/School Summative Assessment Plan**
Formative assessment informs instruction and is ongoing throughout a unit to determine how students are progressing against the standards.	*Summative assessment is an opportunity for students to demonstrate mastery of the skills taught during a particular unit.* • **Investigations:**

Teachers are encouraged to incorporate Formative Assessments into all lessons. During instruction, teachers will collect ongoing information on students' mastery of content through a variety of methods: • Questioning: using Socratic method, probing questions, a hierarchical system in complexity (Bloom's Taxonomy) • Exit tickets, rotational activities (stations), quizzes, and small group activities • Classwork, homework, group work • Pre-Assessments, teacher's observation, class discussion, and journal • Journal Writing • Daily Verbal Assessments	○ **Chemical Reactions** ○ **Solubility Rules** ○ **Calorimetry: Hess's Law** ○ **Stoichiometry** ○ **Stoichiometry: Quantitative Precipitate** ○ **Respiration and Temperature** ○ **Reaction Rate and Concentration** ○ **Le Châtelier's Principle** ○ **The pH Scale** ○ **Titration of Vinegar** ○ **Commercial Antacids** ○ **Determining the Amount of Vitamin C** ○ **Density of Air** ○ **Determination of the Molar Mass of Butane** • **Other Summative Assessments:** Teachers are encouraged to design and their own assessments (topic/module tests and quizzes) individually and/or with their department or grade-level partners, as per Uniform Grading Profile.

Targeted Academic Vocabulary
Chemical equation, chemical formula, reactant, product, subscript, coefficient, conservation of mass, balanced equation, unbalanced equation Reactants, products, coefficient, free element Combination (synthesis), decomposition, single replacement, double replacement, precipitate, insoluble, polymer, polymerization, exothermic, endothermic, enthalpy (ΔH), thermochemical equation, photosynthesis, energy diagram, energy barrier, spontaneous reaction, Hess's Law, Stoichiometry, unbalanced chemical reaction, balanced chemical, reaction, products, reactants, mole ratio, Percent yield, actual yield, theoretical yield, ratio, concentration, Limiting reactant, excess reactant, Haber-Bosch process, temperature, activation energy, reaction, rate, average rate, collision theory, reaction profile, activation, energy, activated complex, reversible, chemical equilibrium, dynamic, closed system, equilibrium position, Le Châtelier's principle, law of mass action, equilibrium expression, equilibrium constant (Keq), Chemical pathway, reaction mechanism, elementary step, intermediate, unimolecular, bimolecular, rate determining step, Catalyst, catalysis, enzyme, Dissociate, hydrogen ion, hydroxide ion, hydronium ion, acid, base, acidic, basic, neutral, salt, strong acid/base, weak acid/base, alkaline, Arrhenius theory, Bronsted-Lowry definition, amphoteric, pH, pH scale, hydrogen ion concentration, logarithm, exponent, pH indicator, Equilibrium relationship, ion product, constant, Kw, Ka, Kb, net ionic equation, polyprotic, Neutralization, reaction, titration, equivalence point, neutralized, salts, buffer, conjugate acids and bases, common ion, buffer capacity, Gas, kinetic molecular theory, Brownian motion, pressure, pascal, atmospheric pressure, barometer, kinetic theory of pressure, diffusion, Boltzmann's constant, Temperature, pressure, volume, Boyle's law, Charles law, the combined gas law, ideal gas, ideal gas law, ideal gas constant, Molar mass, mole ratio, ideal gas law

Resources:
• Mole Calculations Unit • Global warming/climate change: an easy calculation - EDN **(Climate Change)** • Study Shows Cost of Climate Harm Rich Nations Have Caused | Time **(Climate Change)**

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- Unit 6, Segment C: Percent Composition and Empirical Formulas | Chemistry Matters | PBS LearningMedia
- Mole calculations - Formula mass and mole calculations - GCSE Chemistry (Single Science) Revision - BBC Bitesize
- Unit 6, Segment B: The Mole | Chemistry Matters | PBS LearningMedia
- Unit 12, Segment F: The Mole and Stoichiometry Review | Chemistry Matters | PBS LearningMedia
- Stoichiometry and Moles | Chemistry: Unit 6 | PBS LearningMedia
- Stoichiometry Unit
- Stoichiometry Lab
- Newsela - How this scientist used chemistry to design better rocket fuel **(Diversity, Equity and Inclusion)**
- Unit 12, Segment F: The Mole and Stoichiometry Review | Chemistry Matters | PBS LearningMedia
- Stoichiometry and Moles | Chemistry: Unit 6 | PBS LearningMedia
- Unit 6, Segment D: Stoichiometric Calculations | Chemistry Matters | PBS LearningMedia
- Good Thinking! — Chemical Reactions in Action | PBS LearningMedia
- Gases unit
- Molar mass unit
- Real Gases | Crash Course Chemistry | PBS LearningMedia
- Unit 9, Segment F: Air Bag Lab | Chemistry Matters | PBS LearningMedia
- NJCTL - Acid Base Unit
- Properties of Acid Base lab
- Acidic Seas | PBS LearningMedia **(Climate Change)**
- Acids and Bases | Chemistry: Unit 10 | PBS LearningMedia
- Unit 7, Segment G: Acids and Bases Part I | Chemistry Matters | PBS LearningMedia
- Unit 7, Segment H: Acids and Bases Part II | Chemistry Matters | PBS LearningMedia
- Fizzy Fun and Exploring Acid-Base Chemistry | Cooking Up Science with Miss America | PBS LearningMedia

Pacing Guide

Can be found within LabAids.

Unit 4: Applications

Overview

All core science standards were covered prior to Unit 4: Applications.

Chemistry is an introductory course preparing the student for further studies in chemistry in college. It is directed toward explaining the composition of matter. Emphasis is placed on chemical principles and their application, problem solving, and the development of laboratory skills. Chemical principles will be used to explain aspects of forensic science, medicine, energy production, and environmental issues. Topics that will be explored include atomic and molecular structure, physical and chemical changes, and bonding and reactivity.

Essential Questions	Enduring Understandings

- Can a lemon be used to generate electricity?
- What factors are important in making an LED light up?
- How much voltage does a lemon battery yield?
- What are the chemical reactions associated with a lemon battery?
- How can a electrochemical cell generate electricity?
- What chemical reaction occurs at each electrode?
- Why is the salt bridge important?
- What happens over time in an electrochemical cell?
- Which metal is the most easily oxidized?
- Which metallic ion is the most easily reduced?
- How can I write a chemical equation that represents what I observed?
- What are the half-reactions associated with each chemical change between the metal and the metal ion(s)?
- How can we electroplate one metal onto another metal surface?
- What chemical reaction occurs at each electrode?
- What gas is produced?
- How does electrolysis work?
- What is surface tension?
- How can we observe the surface tension of a liquid?
- How can we measure the surface tension of a liquid?
- How can objects denser than water appear to "float" on top?
- How can we change the surface tension of a liquid?
- What is viscosity?
- How can we measure viscosity?
- How does bonding in a liquid affect viscosity?
- How does the concentration of a solute affect viscosity?
- Do oil and water mix under some circumstances?
- How does oil behave when mixed with water?
- What happens to things placed on the surface of an oil spill?
- What are some of the methods for cleaning up an oil spill?
- What molecules in spices are responsible for their aromas?
- How can aromatic hydrocarbon molecules be separated from spices?
- How does the process of distillation work?
- How much protein does milk contain?
- Does milk contain sugar (carbohydrates)?
- Is milk mostly composed of water?
- How much energy is in a cup of non-fat milk?
- What effect does pineapple have on gelatin?
- Do all types of pineapples have the same effect on gelatin?
- Does heat affect the way the enzyme works?

- Electrochemistry describes the process by which chemical reactions generate electricity. Electric current can only exist when there are moveable electric charges, such as ions in solution or electrons in a wire, and when there is a difference in electrical potential energy between two points in a circuit.
- Oxidation–reduction (redox) reactions involve the transfer of electrons among elements. The oxidation number is a way to keep track of the electrons associated with each atom. In a redox reaction, the oxidation number of (some of) the element(s) will be different on each side of the equation. Most redox reactions need to be balanced using the oxidation number method. For redox reactions in aqueous solutions, it is useful to use two half-reactions
- An electrochemical cell contains separate oxidation and reduction reactions, and can be used to generate electric current. Redox reactions occur at separate electrodes that are part of a circuit connected by both an electrolyte and an electrically conductive bridge. Cell voltage (electromotive force) and energy can be calculated using half- reactions and the standard reduction potentials.
- Solids have measurable characteristics such as density, hardness, and strength that distinguish one solid from another. Molecules of a solid are bound into one of two microstructures: crystalline or amorphous. There are 14 unique, crystal structures. Natural crystals have defects. Many important properties of metals arise from their structure—a fixed lattice of positive ions surrounded by a "sea" of electrons.
- Alloys are mostly or all metal but contain at least one other element, homogeneously mixed and bound together by metallic bonds. Many unique properties of liquids arise because a liquid's intermolecular bonds are constantly forming and breaking. The existence of bonds allows liquids to hold together while the breaking of bonds allows them to flow.
- Organic compounds contain carbon. Carbon is unique in that it can form up to three covalent bonds with other carbon atoms and create networks. Simple hydrocarbon molecules are classified according to the number of carbon atoms and whether there are any double or triple bonds. Many hydrocarbons are fuels. Carbon molecules can be straight or branched, and contain ring structures.
- A functional group is a specific set of elements that can be attached to a basic hydrocarbon and add specific properties to the molecule.
- Organic compounds are involved in many important chemical reactions including combustion, dehydrogenation, hydrogenation, cracking, and polymerization. Polymers (long chain molecules) are both natural and synthetic.
- Organisms use fat and carbohydrate molecules for energy and for structural purposes. Cyclic monosaccharides, or sugar molecules, are the basis for all carbohydrates. Long chain, fatty acids are the basis for fats and oils.

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- Do all types of pineapples contain the bromelain enzyme?
- What do amino acid molecules look like?
- How are amino acid molecules joined to form a protein?
- How is a sequence of codons interpreted?
- What intermolecular forces of attraction result in a protein's shape?
- What causes a water molecule to change phase?
- How do water molecules in the vapor phase return to the liquid phase?
- Is the water cycle a chemical or a physical process?
- What effect does temperature have on the density of water?
- How does water move around in different areas of the ocean?
- Does the saltiness of the ocean have an effect on the ocean currents?
- What is a half-life? What does it measure?
- How much time will it take for half of a radioactive substance to decay? How about for three quarters to decay?
- What does a half life graph look like? Why does it look like that?
- How can one element change into another?
- What are the different types of radioactive decay? What is emitted in each?
- What is a radioactive decay chain?
- What is absorption spectroscopy?
- How can we tell what elements are in a star?
- How can we figure out the temperature of a star by looking at it?
- How can we use this information to figure out the approximate age of the star?
-

- Photosynthesis is a process that produces glucose molecules from H2O, CO2, and light energy. Photosynthesis depends on chlorophyll, NADPH, and ATP molecules.Cellular respiration, the reverse of photosynthesis, is a reaction between glucose and O2 that produces H2O, CO2, and energy.
- Proteins are large polymers of amino acids and are required for almost all chemical reactions that occur within organisms. Different sequences of amino acids form proteins with different structures and properties which perform different functions within an organism.
- DNA molecules, which store and transmit genetic information, are huge polymers made up of only four nucleotides. DNA's double helix structure can uncoil, unzip, and replicate. RNA molecules, which transmit information, are similar to DNA but much smaller.
- Earth's atmosphere is made of layers, with each layer having distinct properties, such as temperature and chemical composition. Different chemical reactions occur in the atmosphere which have a variety of effects on the conditions on Earth's surface.
- About 97% of Earth's water is in the oceans. The salinity of ocean water is about 3.5%. Chemical and physical interactions that occur within the oceans affect the water cycle, ocean currents, the carbon cycle, and climate.
- 98.5% of Earth's matter is made from only eight elements, most notably oxygen and silicon. Interactions involving chemicals found in rocks play important roles in the origin and continued existence of life.
- Unlike chemical reactions, nuclear reactions affect the nuclei of atoms. Chemical reactions form different compounds, whereas nuclear reactions form different elements. Like chemical reactions, nuclear reactions must be balanced.
- Nuclear reactions involve much more energy than chemical reactions. The two main types of nuclear reactions are spontaneous decay and bombardment. Decaying radioactive elements can emit energy in the form of gamma rays or alpha, beta, or positron particles.
- Each radioactive isotope decays at a fixed rate called its half-life. Radioactive decay can help determine the age of very old materials. Nuclear energy is energy released during a nuclear reaction. E = mc2 explains why nuclear reactions release so much energy. Fusion reactions release much more energy than fission reactions.
- Exposure to radiation can damage living tissue by removing outer electrons. This can break chemical bonds and alter the function of biological molecules.
- The elemental composition of the universe is very different than that on Earth. Stars the most massive visible objects in the universe contain mostly H and He. A star's energy results from fusion reactions. Fusion reactions within stars also produce other elements. Earth and the other three planets closest

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	to the Sun are rocky while the planets with more distant orbits are gas giants. All planets receive energy from the Sun and radiate energy into space. ● Unusual life forms exist on Earth in environments with extreme conditions, much different from those found on Earth's surface. The existence of these life forms indicates that organisms could exist elsewhere in our solar system.

Unit 4: Applications

Content Standards

Performance Expectations

- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Core Ideas

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

Student Learning Objectives

Students will be able to:

- Explain the importance of connecting the electrodes to the LED in the proper way
- Understand that electric current flows in one direction
- Describe what chemical reactions are creating the voltage in a lemon battery
- Explain that the type of the electrodes affects the voltage
- Explain the chemical reactions that generate voltage in an electrochemical cell

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- Understand the function of the salt bridge, and be able to describe the movement of the ions in the salt bridge
- Describe what happens at the anode and cathode as the oxidation–reduction reactions proceed
- Explain that chemicals can provide energy in a battery
- Explain which metal is the most easily oxidized
- Explain which metal ion is the most easily reduced
- Understand that oxidation and reduction occur together
- Describe what happens when a metal reacts with an aqueous solution of metal ions
- Write the half-reactions that correspond to each reaction they carried out
- Write the overall balanced oxidation reduction reaction for the reactions they observed
- Explain why copper is deposited at the cathode
- Understand the function of the battery, and how it provides the energy to allow a non-spontaneous reaction to occur
- Describe what happens at the anode and cathode as the oxidation–reduction reactions proceed
- Explain why the anode is positive (+) and the cathode is (–) in an electrolytic cell
- Explain the concept of surface tension
- Demonstrate examples of surface tension in common liquids such as water
- Design a qualitative experiment to measure the relative surface tensions of different liquids.
- Explain, using surface tension, how objects like paper clips and lizards can rest on top of the surface of water
- Explain how surfactants change the surface tension of a liquid
- Explain the concept of viscosity
- Design a simple experiment to measure relative viscosities of liquids
- Explain how the bonding between molecules in a liquid has a general effect on its viscosity
- Explain qualitatively how the concentration of a solute affects the viscosity of liquid
- Explain how oil behaves when mixed with water
- Understand what happens to oil after it is spilled on the surface of water
- Describe some effective clean up strategies for removing oil from water
- Explain how soap interacts with oil molecules
- Explain how the distillation process works to separate molecules in substances
- Understand that certain organic molecules contained in spices are responsible for their aromas
- Describe some of the similarities between aromatic molecules contained in spices
- Determine how much protein, carbohydrate and water a typical sample of non-fat milk contains
- Understand why proteins can be separated from milk by precipitation using an acid
- Describe what the primary components of milk are and why it is nutritious
- Explain how much energy is in one cup of non-fat milk
- Compare the control to the test samples to determine the effect pineapple has on the gelling process
- Understand why gelatin does not set or gel when fresh pineapple is added
- Describe the effect of heat on enzyme activity
- Explain the importance of enzymes in chemical change
- Use codon sequences to identify specific amino acids
- Describe how a peptide bond is formed
- Explain how some amino acid side chains (R groups) are polar, while others are nonpolar
- Assemble an amino acid chain using molecular models

- Describe how water molecules undergo changes in phase
- Explain how temperature affects the hydrogen bonds that hold water molecules together
- Explain how the water cycle works relative to their observations
- Describe how the density of water varies with temperature
- Explain how the saltiness of the ocean effects the density of the water
- Compare the melting of ice in salt water to the melting of ice in fresh water
- Explain why ice melts faster in fresh water
- Describe how differences in salinity can help give rise to ocean currents
- Explain what a half-life is and how it measures radioactive decay
- Calculate how much time it takes for a certain fraction of an isotope to decay based on its half-life
- Describe the shape of the half-life graph and why it appears so
- Explain how elements can change via radioactive decay
- List the different types of radioactive decay and say what particle is emitted in each
- Explain the concept of a radioactive decay chain, and give an example of how multiple radioactive decays can turn an unstable nucleus into a stable one
- Explain the concept of absorption spectroscopy, and why it works
- Determine the elements present in a star by looking at its absorption spectrum
- Figure out the temperature of a star by looking at its black-body spectrum
- Use the above information to determine in what stage of life the star is

Integrated Accommodations and Modifications		
Special Education Students	**English Language Learners**	**At Risk**
• Utilize modifications & accommodations delineated in the student's IEP • Provide additional manipulatives to support instruction • Allow for alternative strategies to solve algorithms or tasks • Provide the steps needed to complete the task • Model frequently • Provide repetition and practice. • Use visuals to demonstrate/model the processes • Restate, reread, and clarify directions/questions • Ask students to restate information, directions, and assignments. • Provide copy of class notes • Distribute study guide for classroom tests. • Provide preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Provide regular parent/ school communication	WIDA Can Do Descriptors https://wida.wisc.edu/teach/can-do/descriptors • Modify Assignments • Use testing and portfolio assessment • Utilize Native Language Translation (peer, online assistive technology, translation device, bilingual dictionary) • Repeat, rephrase, paraphrase key concepts and directions • Allow for extended time for assignment completion as needed • Highlight key vocabulary • Define essential vocabulary in context • Use graphic organizers, visuals, manipulatives and other concrete materials • Use gestures, facial expressions and body language • Read aloud	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Provide preferential seating to be mutually determined by the student and teacher • Allow the use of a computer to complete assignments. • Establish expectations for correct spelling on assignments • Provide extra textbooks for home. • Provide Peer Support • Increase one on one time

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• Allow extended time to complete assignment • Establish procedures for accommodations / modifications for assessments • Allow student to take/complete tests in an alternate setting as needed	• Build on what students already know and prior experience	

Gifted and Talented Students	504 Plan
• Utilize advanced, accelerated, or compacted content • Provide assignments that emphasize higher- level thinking skills. • Allow for individual student interest • Gear assignments to development in areas of affect, creativity, cognition, and research skills • Allow for a variety in types of resources • Provide problem-based assignments with planned scope and sequence • Utilize inquiry-based instruction • Adjust the pace of lessons • Utilize Choice Boards • Provide Problem-Based Learning • Establish flexible Grouping	• Pair visual prompts with verbal presentations • Ask students to restate information, directions, and assignments. • Provide repetition and and practice • Model skills / techniques to be mastered. • Provide extended time to complete class work • Provide copy of class notes • Break long assignments into smaller parts • Assist student in setting short term goals • Allow for preferential seating to be mutually determined by the student and teacher • Provide extra textbooks for home. • Model and reinforce organizational systems (i.e. color-coding) • Write out homework assignments, check student's recording of assignments

Interdisciplinary Connections	Computer Science and Design Thinking
English/Language Arts Reading • RST.9-12.1 Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. Writing • WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. • WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. • WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • WHST.9-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and	**Computer Science and Design Thinking Practices** 1. ☐ Fostering an Inclusive Computing and Design Culture 2. ☑ Collaborating Around Computing and Design 3. ☐ Recognizing and Defining Computational Problems 4. ☐ Developing and Using Abstractions 5. ☐ Creating Computational Artifacts 6. ☐ Testing and Refining Computational Artifacts 7. ☑ Communicating About Computing and Design **Computer Science and Design Thinking Standards** • 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. • 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. • 8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. ● WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. Speaking and Listening ● SL.9-10.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.	● 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. ● 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. **Core Ideas** ● Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information. ● Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information. ● The accuracy of predictions or inferences made from a computer model is affected by the amount, quality, and diversity of data. ● The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.

Career Readiness, Life Literacies and Key Skills
Career Readiness, Life Literacies and Key Skills Practices ● Act as a responsible and contributing community members and employee ● Consider the environmental, social and economic impacts of decisions. ● Demonstrate creativity and innovation. ● Utilize critical thinking to make sense of problems and persevere in solving them. ● Use technology to enhance productivity increase collaboration and communicate effectively. ● Work productively in teams while using cultural/global competence. ● 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a). ● 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8). ● 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1) ● 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3). ● 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a). ● 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society (e.g., 6.1.12.CivicsPD.16.a). ● 9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection. ● 9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3). ● 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.

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- 9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2)
- 9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).
- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specific task (e.g., W.11-12.6.).
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

SEL Competencies

- **Self - Awareness**
- **Self - Management**
- **Social Awareness**
- **Responsible Decision Making**
- **Relationship Skills**

District/School Formative Assessment Plan	**District/School Summative Assessment Plan**

Formative assessment informs instruction and is ongoing throughout a unit to determine how students are progressing against the standards.
 	
Teachers are encouraged to incorporate Formative Assessments into all lessons. During instruction, teachers will collect ongoing information on students' mastery of content through a variety of methods:
 	
• Questioning: using Socratic method, probing questions, a hierarchical system in complexity (Bloom's Taxonomy)
• Exit tickets, rotational activities (stations), quizzes, and small group activities
• Classwork, homework, group work
• Pre-Assessments, teacher's observation, class discussion, and journal
• Journal Writing
• Daily Verbal Assessments
	Summative assessment is an opportunity for students to demonstrate mastery of the skills taught during a particular unit.
	
	• **Investigations:**
	  ○ **The Lemon Battery**
	  ○ **Oxidation–Reduction Reactions of Metals and Metal Ions**
	  ○ **An Electrochemical Cell**
	  ○ **Electroplating**
	  ○ **Surface Tension and Surfactants**
	  ○ **Measuring Viscosity**
	  ○ **Oil Spills**
	  ○ **Distilling Aromatic Hydrocarbons**
	  ○ **Analysis of Milk**
	  ○ **Building an Amino Acid Chain**
	  ○ **Catalysis and Enzymes**
	  ○ **The Water Cycle**
	  ○ **Ocean Currents**
	  ○ **The Alchemical Race**
	  ○ **Half-Life Experiment: Coin Toss**
	  ○ **Astronomical Spectroscopy**

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	● **Other Summative Assessments:** Teachers are encouraged to design and their own assessments (topic/module tests and quizzes) individually and/or with their department or grade-level partners, as per Uniform Grading Profile.

Targeted Academic Vocabulary

Free radicals, antioxidants, coulomb, electric current, ampere, electroneutrality, electrical potential energy voltage, volt, resistance, ohm, Ohm's law, Oxidation, reduction, redox reaction, oxidation number, oxidizing, agent, reducing agent, Oxidation number method, half- reactions, spectator ions, standard reduction, potentials, Eo cell, spontaneous reaction, oxidation number, Electrode, anode, cathode, electrolyte, salt bridge, voltaic cell, galvanic cell, electrolytic cell, electromotive force (emf), standard reduction potential, spontaneous, non-spontaneous, Nernst equation, electrolysis, Density, hardness, Mohs hardness scale, tensile strength, brittle, ductile, Condensed matter, microstructure, crystalline, amorphous, crystal, glass, metallic, glass, crystal structure, Bravais lattice, point defect, dislocation, grain boundary, Metallic bond, thermal conductivity, electrical conductivity, alloy, binary alloy, alloying element, binary phase, diagram, eutectic, Intermolecular bonding, flow, cohesion, adhesion, meniscus, capillary action, viscosity, viscous, surface tension, surfactant, Organic compound, hydrocarbon, single bond, double bond, triple bond, saturated hydrocarbon, alkane, unsaturated hydrocarbon, alkene, alkyne, structural isomer, parent compound, R-group, petroleum, crude oil, stereoisomer, geometric isomer, optical isomer, aromatic, hydrocarbon, benzene ring, Functional group, alcohol, ether, aldehyde, ketone, carbonyl group, carbohydrate, carboxylic acid, amine, ester, Combustion, substitution reaction, dehydrogenation reaction, addition reaction, hydrogenation, partial hydrogenation, petroleum, cracking, polymer, monomer, polymerization, addition polymerization, condensation polymerization, amide linkage, Carbohydrate, simple carbohydrate, complex carbohydrate, monosaccharide, oligosaccharide, polysaccharide, fat, oil, triglyceride, phospho-lipid, micelle, Photosynthesis, chlorophyll, NADPH, ATP, Calvin cycle, electron transport chain, Protein, amino acid, chirality, peptide bond, catalyst, enzyme, muscle, primary structure, secondary structure, alpha helix, pleated sheet, tertiary structure substrate, active site, cytochrome protein, DNA, nucleotide, nitrogenous base, phosphate group, deoxyribose sugar, adenine, guanine, cytosine, thymine, double helix, RNA, uracil, gene, Troposphere, stratosphere, nitrogen, oxygen, argon, carbon dioxide, water vapor, acid rain, photodissociation, photoionization, global warming, Salinity, water cycle, transpiration, evaporation, precipitation, condensation, ocean current, climate, carbon cycle, Solar nebula, core, mantle, crust, silicates, magma, igneous rock, minerals, volcano, lava, geologist, rock cycle, sedimentary rock, metamorphic rock, nitrogen cycle, nitrogen fixation, phosphorus cycle, soil, Atomic number, neutron number, mass number, Nuclear reaction, decay, bombardment, radioactivity, radiation, inten-ity of radiation, inverse square law, alpha decay, alpha radiation, beta decay, beta radiation, gamma decay, positron, emission, Carbon-14, half-life, rate of decay, rate, constant, activity, radiometric dating, carbon dating, Nuclear energy, E = mc2, binding, energy, fission reaction, fission products, chain reaction, nuclear power plant, fusion reaction, fusion products, Ionization, ionizing radiation, nonionizing radiation, dose, rad, rem, Dark matter, plasma, ionization, Big Bang theory, nucleosynthesis, supernova, Solar system, rocky planet, gas planet, blackbody radiation, planetary energy balance, green-house effect, Chemosynthesis, thermophiles

Resources:

- How to Give Science Lessons a Real-World Boost
- Tips for Teaching Science to HS
- Recommendations for Teaching HS Chemistry
- Sources of Greenhouse Gases | PBS LearningMedia **(Climate Change)**
- Newsela - A warm blanket around the Earth **(Climate Change)**
- Newsela - Nitrous oxide, or "laughing gas," has serious effect on Earth **(Climate Change)**

Pacing Guide

Can be found within LabAids.