

CHEMISTRY COLLEGE PREPARATORY

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **Sample Time Period**
Length: **1 Academic Year**
Status: **Not Published**

Title Page, Table of Contents, Statement of purpose

CHEMISTRY COLLEGE PREPARATORY (CP)

SAYREVILLE WAR MEMORIAL HIGH SCHOOL

5 CREDITS/ 6 CREDITS

Full Year

Statement of Purpose.....

Unit 1: (Introduction to Chemistry).....

Unit 2: (Structure and Properties of Matter).....

Unit 3: (Bonding and Chemical Reactions).....

Unit 4: (Energy of Chemical Systems).....

Unit 5: (Applied Chemistry).....

Statement of Purpose

Chemistry College Preparatory (CP) is designed to give student developing skills to function as independent, critical thinkers in order to apply their understanding of chemical theory and concepts to model real world situations. Students will engage in scientific discourse and identify and research areas of technological and environmental concern. Students will learn how to apply appropriate scientific techniques and principles in making responsible decisions. The coursework is designed for the development of student-centered and inquiry-based lessons with the infusion of science literacy.

Summary of the Course: College Preparatory Chemistry provides students the opportunity to acquire a solid foundation of chemical principles and concepts. The year is devoted to topics in inorganic chemistry, including a foundation based on formula writing, the balancing of equations, stoichiometry, acids and bases, and gas laws. In conjunction with the course content, a laboratory sequence is offered. This sequence parallels the content and affords the opportunity to experience first-hand, not only the analyses and problem solving discussed in class, but also the chemical techniques associated with the course. The weekly two-period lab

class (CP 6) focuses on furthering the development of laboratory skills and problem solving through experimentation and student-centered, hands-on activities. Success in this course requires students to have a foundation in Algebra. All learning styles are addressed through instructional methods and assessments that incorporate scientific reading, writing, and computation.

In order to demonstrate a cohesive and complete implementation plan the following general suggestions are provided:

- The use of various formative assessments are encouraged in order to provide an ongoing method of determining the current level of understanding the students have of the material presented.
- Homework, when assigned should be relevant and reflective of the current teaching taking place in the classroom.
- Organizational strategies should be in place that allow the students the ability to take the information gained in the classroom and put in in terms that are relevant to them.
- Instruction should be differentiated to allow students the best opportunity to learn.
- Assessments should be varied and assess topics of instruction delivered in class.
- Modifications to the curriculum should be included that address students with Individualized Educational Plans (IEP), English Language Learners (ELL), and those requiring other modifications (504 plans).

Unit 1: Introduction to Chemistry

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **1st Semester**
Length: **6 Weeks**
Status: **Not Published**

Summary of the Unit

This unit introduces students to the requisite knowledge and laboratory techniques that must be known to be successful in the course. Students will have an understanding of the study of chemistry, the specialized analytical techniques utilized in a chemistry laboratory, and some ways in which matter can be categorized for further study.

Enduring Understandings

- Following safety procedures, using personal protective equipment, and selecting the appropriate equipment or tools will reduce the risk of injury
- Planning, organizing, and analyzing data are essential components of solving problems.
- Chemistry is the study of matter and all changes it undergoes.
- Everyday occurrences of changes in matter are related to energy transfer.
- Substances are classified based on their properties, which is directly related to their atomic makeup.

Essential Questions

- What does "Safety First" mean and how do we apply it in the chemistry laboratory?
- How do we organize and analyze empirical data?
- What is chemistry and why is it important in our daily life?
- What ways do we classify substances and what dictates their classification?

Summative Assessment and/or Summative Criteria

The tools used to assess the following criteria for mastery will be, but are not limited to: Quarterly exam, topic quizzes, chapter tests, projects, worksheets, and laboratory experiments.

- Students will be able to use their learning of safety and lab procedures to make informed decisions when selecting and using equipment or tools
- Students will be able to transfer their learning of the scientific method and data analysis to solve problems and identify sources of error

- Students will be able to use their learning to analyze and communicate how the main components of chemistry, matter and energy transfer, affect all components of their lives

Resources

Board approved textbook(s) and accompanying resources

Digital textbook access resources

Teacher resource binder

Student generated resources

Digital media and simulations including but not limited to the following:

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks/Assessments	Standards
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<p>What is Chemistry? (3 Days)</p>	<ul style="list-style-type: none"> • Identify five traditional areas of study in chemistry • Relate pure chemistry to applied chemistry • Identify areas of research affected by chemistry and discuss practical applications 	<ul style="list-style-type: none"> • Discuss chemical fields and why it is studied • Differentiate between pure and applied chemistry using prompts • View media on some areas of chemical research and identify whether they are studying macroscopic or microscopic views of chemical research 	<ul style="list-style-type: none"> • Research a career in a chemical field and give a presentation or create a poster with findings • Research a current event article in chemistry and write a short summary for presentation 	<p>HS-PS1-3</p>
<p>The Scientific Method and Laboratory Safety (6 Days)</p>	<ul style="list-style-type: none"> • Explain the importance of safety in science. • Identify laboratory equipment and its uses • Apply the knowledge of how laboratory equipment is used in the laboratory. • Implement safe laboratory procedures • Utilize the steps of the scientific method to solve practical problems inside and outside of the laboratory 	<ul style="list-style-type: none"> • Review Scientific Method using various scenarios • View Lab Safety Media • Identify unsafe lab procedures in visual and/or printed media 	<ul style="list-style-type: none"> • LAB Activity --Create classroom map and identify locations of safety equipment, identify lab equipment and its use, and complete simple measurements using lab equipment • Apply knowledge of laboratory safety procedures and equipment to complete lab safety quiz • LAB Activity -- Apply scientific method to draw conclusions in a "Whodunit" using forensic techniques and write lab report with conclusion using given format 	<p>HS-PS1-3</p>
<p>Measurement, Data Collection, and Analysis (10 Days)</p>	<ul style="list-style-type: none"> • Convert scientific units of measurement • Justify the importance of significant figures in measurement • Identify the 	<p>Graphing Data</p> <ul style="list-style-type: none"> • Students display various types of data using different types of graphs and analyze the data findings • Students find their 	<ul style="list-style-type: none"> • LAB – Introduction to Measurement – Apply knowledge of measurement, significant figures, and error to accurately measure in a laboratory setting 	<p>HS-PS1-3</p>

	<p>appropriate SI unit to use in measurement in a laboratory setting (H,C,B)</p> <ul style="list-style-type: none"> Analyze data and interpret its meaning, identifying any sources of error Display data using the appropriate graph Appropriately measure quantities using the correct equipment/tools and units 	<p>own data online, display using an appropriate graph, and analyze the data</p>		
<p>Classification of Matter (8 Days)</p>	<ul style="list-style-type: none"> Identify classifications of matter (element, compound, homogenous vs. heterogeneous mixtures) Differentiate samples of matter for the purpose of classification Separate matter based on differences in their physical and chemical properties Distinguish physical changes 	<ul style="list-style-type: none"> View media on types of mixtures and separation techniques Given a prompt, classify mixtures as homogenous or heterogeneous Given examples of mixtures, explain how they would be separated Create a graphic organizer differentiating elements, compounds, heterogeneous, and homogeneous mixtures Highlight important elements on a periodic table and create flashcards with their 	<ul style="list-style-type: none"> Separation of Mixtures Lab <p>Students design and carry out a procedure to separate a complex mixture</p> <ul style="list-style-type: none"> Chemical & Physical Changes Lab <p>Students carry out a large number of procedures in the lab and identify whether they resulted in a chemical or physical change and explain the rationale for their decision.</p> <ul style="list-style-type: none"> Classify substances as elements or compounds and differentiate them from mixtures by completing worksheet Apply knowledge of Chemical Symbols to complete assessment 	<p>HS-PS1-3</p>

		names and symbols		
States of Matter Due to Energy Transfer (6 Days)	<ul style="list-style-type: none"> • Differentiate among three states of matter • Describe the assumptions of the kinetic theory • Justify evaporation in terms of kinetic energy • Assess how equilibrium conditions are represented in a phase diagram 	<ul style="list-style-type: none"> • Apply prior knowledge to compare and contrast the states of matter and list the main properties of each in terms of particle movement and arrangement • Read and discuss the assumptions of the kinetic theory as it applies to gases, liquids, and solids • Review phase changes • Look at phase diagram of water and identify specific points and phase changes • Determine examples of substances that have the ability to sublime 	<ul style="list-style-type: none"> • Complete a blank graphic organizer comparing and contrasting the states of matter • Apply the knowledge of kinetic theory to relate how the properties of a gas, liquid, or solid make it different than the other states of matter • Justify an explanation as to how Newton's cradle demonstrates elastic collisions in a gas showing conservation of energy • Analyze phase diagram of a substance and point out triple point, solid, liquid, and gas phases, melting/freezing point, boiling/condensing point, and critical point 	<p>HS-PS1-3</p> <p>HS-PS2-3</p>

9-12.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.

9-12.HS-PS2-3

Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

Suggested Modifications for Special Education, ELL and Gifted Students

*Consistent with individual plans, when appropriate.

Students with individual learning styles can be assisted through adjustments in assessment standards and time restraints, one-to-one teacher support, extended testing time, and use of visual and auditory teaching methods. This wide variety of assessments, strategies, and hands-on evaluations complement the individual learning experience. Additional strategies are as follows:

- Restructure lessons using Universal Design for Learning (UDL) principals

(<http://www.cast.org/our-work/about-udl.html#.VXmoXcfD UA>)

- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide English Language Learners students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Suggested Technological Innovations/Use

- Internet for up-to-date resources such as journal articles (ex. Newsela, Actively Learn) and simulations (ex. YouTube, Discovery Education, CK12, PheT)
- Education focused websites, like Google Platform, to provide group forums to discuss topics
- Online programs (ex. such as Kahoot, EdPuzzle, Quizziz, PearDeck) to assess and/or poll students before, during, and after unit lesson

TECH.8.1.12.C.CS1

Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media.

TECH.8.1.12.E.CS2

Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.

TECH.8.1.12.A.4

Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Cross Curricular/21st Century Connections

Mathematics

- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities representing periodic trends for main group elements based on patterns of

electrons in the outermost energy level of atoms.

- Determine and interpret the scale and origin in graphs and data
- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities

Engineering

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Language Arts Literacy

- Cite specific textual evidence comparing the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- Develop evidence comparing the structure of substances at the bulk scale and the strength of electrical forces between particles.

MA.K-12.2	Reason abstractly and quantitatively.
LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
MA.N-Q.A	Reason quantitatively and use units to solve problems.
LA.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
MA.K-12.4	Model with mathematics.
MA.N-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.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
SCI.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.
SCI.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.
LA.WHST.11-12.1	Write arguments focused on discipline-specific content.
LA.RL.11-12.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
MA.K-12.1	Make sense of problems and persevere in solving them.

Unit 2: Structure and Properties of Matter

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **1st Semester**
Length: **5 Weeks**
Status: **Not Published**

Summary of the Unit

In this unit of study, students use investigations, simulations, and models to make sense of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Students will be able to explain the placement of elements on the periodic table and predict patterns in chemical and physical properties. Students will be able to transfer their learning of the current atomic model to analyze the relative structure of atoms. Students are able to use the periodic table as a tool to explain and predict the properties of elements. Students are expected to communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. The crosscutting concepts of structure and function, patterns, energy and matter, and stability and change are called out as the framework for understanding the disciplinary core ideas. Students use developing and using models, planning and conducting investigations, using mathematical thinking, and constructing explanations and designing solutions. Students are also expected to use the science and engineering practices to demonstrate proficiency with the core ideas.

Enduring Understandings

- In the universe, atoms are the fundamental building blocks of all matter
- Electron movement can be explained by the duality of particles and waves
- Modern atomic theory suggests that electrons may be located in regions of high probability
- The placement of elements on the periodic table is based on specific properties and characteristics of elements, which follow a noticeable pattern when organized in order of increasing atomic number.

Essential Questions

- What does the subatomic structure of a substance tell me about its properties?
- What do the properties of a substance tell me about its subatomic makeup?
- What does an element's placement on the periodic table tell me about its subatomic structure and chemical and physical properties?

Summative Assessment and/or Summative Criteria

The tools used to assess the following criteria for mastery will be, but are not limited to: Quarterly exam, topic quizzes, chapter tests, projects, worksheets, and laboratory experiments.

- Given an element from the periodic table, students will be able to predict atomic structure and electron arrangement
- Students will be able to explain the placement of elements on the periodic table and predict patterns in chemical and physical properties

Resources

Board approved textbook(s) and accompanying resources

Digital textbook access resources

Teacher resource binder

Student generated resources

Digital media and simulations including but not limited to the following:

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>

Unit Plan

Topic/Selection on Timeframe	General Objectives	Instructional Activities	Benchmarks/Assessments	Standards
Chemical and Physical Properties (3 Days)	<ul style="list-style-type: none"> • Define physical property and list several common physical properties of substances • Identify properties of matter as extensive or intensive 	<ul style="list-style-type: none"> • Classify properties of matter as intensive or extensive 	<ul style="list-style-type: none"> • Analyze an object in the room by listing its physical properties and stating whether each property is extensive or intensive 	HS-PS1-2
Atomic Structure and Models (15 Days)	<ul style="list-style-type: none"> • Solve for non-routine problems on isotopes, calculating numbers of subatomic particles • Formulate electron configurations and Aufbau diagrams by applying the Aufbau principle, Hund's rule, and the Pauli exclusion principle • Apply concepts about the properties of the elements to 	<ul style="list-style-type: none"> • Beanium LAB: Calculate the atomic mass of a fictional element by analyzing its isotope make-up • Drawing Diagrams: Students draw Aufbau diagrams and write electron configurations (long-hand & noble gas core) 	<ul style="list-style-type: none"> • Argue the inaccuracies of Dalton's Atomic Theory and previous models of the atom • Judge whether an electron configuration is possible given the rules that govern configuration and, if not, explain why it is incorrect • Common Assessment in which the students demonstrate their mastery of the general objectives 	HS-PS1-1 HS-PS1-8 HS-PS3-5

	<p>the electron configurations and orbital filling diagrams</p> <ul style="list-style-type: none"> • Prove how the modern theory of the atom incorporates all the discoveries of the atom 			
<p>Periodic Table (8 Days)</p>	<ul style="list-style-type: none"> • Connect the placement of elements on the periodic table to each other and prove the various trends • Analyze patterns in the periodic trends of atomic size, ionization energy, and electronegativity • Determine the identity of missing elements based upon the properties of other elements in the group • Construct a periodic table based 	<ul style="list-style-type: none"> • Create a graphic organizer color-coding the groups and three broad classes of elements • Define all periodic trends • Create a graphic organizer with a blank periodic table illustrating the periodic trends 	<ul style="list-style-type: none"> • Project – Rubric (Element research) • Explain the evolution of the periodic table by comparing and contrasting the old and modern periodic tables • LAB – Properties of Elements – Analyze properties of elements to determine and compare and contrast the main properties of metals, nonmetals, and metalloids to be assessed by a post-lab question worksheet • Operation Periodic Table Lab <p>Students create a periodic table from a list of fictional elements</p> <ul style="list-style-type: none"> • Graphing Periodic Trends Lab <p>Students research and use Google sheets to graph values for atomic size, ionization energy, and electronegativity</p>	<p>HS-PS1-1</p> <p>HS-PS1-3</p> <p>HS-PS2-6</p>

	upon chemical and physical properties and prove the reason for the placement of the elements			
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SCI.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.
SCI.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.
SCI.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.
SCI.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.

Suggested Modifications for Special Education, ELL and Gifted Students

- Restructure lessons using Universal Design for Learning (UDL) principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.

- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide English Language Learners students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Suggested Technological Innovations/Use

- Internet for up-to-date resources such as journal articles (ex. Newsela, Actively Learn) and simulations (ex. YouTube, Discovery Education, CK12, PheT)
- Education focused websites, like Google Platform, to provide group forums to discuss topics
- Online programs (ex. such as Kahoot, EdPuzzle, Quizziz, PearDeck) to assess and/or poll students before, during, and after unit lesson

TECH.8.1.12.C.1	Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.
TECH.8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.
TECH.8.1.12.B.2	Apply previous content knowledge by creating and piloting a digital learning game or tutorial.

Cross Curricular/21st Century Connections

Mathematics

- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities representing periodic trends for main group elements based on patterns of electrons in the outermost energy level of atoms.
- Determine and interpret the scale and origin in graphs and data
- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities

Engineering

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-

generated sources of evidence, prioritized criteria, and tradeoff considerations.

Language Arts Literacy

- Translate information from the periodic table about the patterns of electrons in the outermost energy level of atoms into words that describe the relative properties of elements.
- Develop and strengthen explanations for the outcome of a simple chemical reaction by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties of elements.

MA.K-12.2	Reason abstractly and quantitatively.
LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
LA.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
MA.K-12.5	Use appropriate tools strategically.
9-12.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.
9-12.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.
9-12.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.
MA.K-12.7	Look for and make use of structure.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

Unit 3: Bonding and Chemical Reactions

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **1st Semester**
Length: **10 Weeks**
Status: **Not Published**

Summary of the Unit

In this unit, students will develop an understanding that the total amount of energy and matter in a closed system (including chemical reaction systems) is conserved and that changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. Using this knowledge, and knowledge of the chemical properties of elements, students should be able to describe and predict simple chemical reactions in terms of mass and energy. Students will be able to utilize learning of atomic structure to predict the formation and characteristics of ionic, covalent, and metallic compounds, in addition to utilizing their learning of elements and compounds to determine the amounts of reactants and products in chemical reactions.

Enduring Understandings

- The formation of chemical bonds can be explained by the atom's ability to satisfy the Octet Rule and achieve stability.
- The type of chemical bond an element forms can be linked to its valence electrons and its location on the periodic table.
- A compound's structure and shape can be determined through an understanding of the interactions between valence electrons while intermolecular forces determine its properties
- Chemical equations are used to represent chemical reactions and show that mass can neither be created nor destroyed.
- There are different types of chemical reactions that can be observed in everyday life
- Mass and mole ratios between different compounds in a reaction can answer quantitative questions concerning reactants and products.

Essential Questions

- Where do atoms go during a chemical reaction?
- How are ionic, covalent, and metallic bonds formed, and how are they characterized?

- How are the names and formulas of ionic and covalent compounds written?
- How can we quantify something that we can't see? How do we know that we are right?
- Why must the mass of reactants equal the mass of products in a chemical reaction?

Summative Assessment and/or Summative Criteria

- Differentiate between ionic, covalent, and metallic bonds, predict bond formation, and accurately represent a compound using chemical formulas, proper nomenclature, and shape
- Construct Lewis structures and predict molecular shape
- Compare and contrast intermolecular forces and determine when they are present
- Develop a logical argument as to how delocalized electrons explain various properties of metals
- Apply the law of conservation of mass to write balanced chemical equations
- Cite evidence of a chemical reaction
- Classify chemical reactions and predict products, writing balanced chemical equations

Resources

Board approved textbooks, Teacher resource binder, Student generated resources, Internet web resources (including, but not limited to):

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>

- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks/Assessments	Standards
Ionic Bonds (14 Days)	<ul style="list-style-type: none"> • Utilize learning of atomic structure to predict the formation and characteristics of ionic and metallic bonds • Differentiate between ionic, covalent, and metallic bonds in terms of valence electrons, and be able to analyze a list of formulas or names • Predict oxidation numbers based on location on periodic table • Apply concepts of ionic bonding to effectively represent compounds using chemical formulas and names (including binary and 	<ul style="list-style-type: none"> • On an existing graphic organizer of the periodic table, write in the number of valence electrons over A groups • Draw Lewis structure to illustrate valence electrons and bonding • Apply criss-cross method for writing formulas of ionic compounds 	<ul style="list-style-type: none"> • Complete a practice worksheet identifying the number of valence electrons an atom has and predicting what ion it will form, if any • Compare/contrast properties of ionic and covalent compounds • Write formula and name ionic and acid/base compounds • LAB – Ionic Compounds – students write formulas for and name products of a series of double replacement reactions 	HS-PS1-1 HS-PS1-2 HS-PS1-3 HS-PS1-4 HS-PS1-6 HS-PS1-7 HS-PS2-8

	<p>oxyacids)</p> <ul style="list-style-type: none"> • Develop a logical argument as to how delocalized electrons explain various properties of metals • Differentiate between the three bond types, predict bond formation, and accurately represent a compound using a chemical formula, proper nomenclature, and shape 			
<p>Covalent Bonding (12 Days)</p>	<ul style="list-style-type: none"> • Utilize learning of atomic structure to predict the formation and characteristics of covalent bonds • Differentiate between ionic, covalent, and metallic bonds in terms of valence electrons, and be able to analyze a list of formulas or names • Apply concepts of covalent bonding to effectively represent compounds using chemical formulas and 	<ul style="list-style-type: none"> • Draw Lewis structure to illustrate valence electrons, bonding, shape, and exceptions to the octet rule • Molecular Modeling lab – ball and stick and/or computer 3-D modeling • Chart differences in polarity based on electronegativity 	<ul style="list-style-type: none"> • Compare/contrast properties of covalent compounds • Write formula and name molecular compounds • Predict molecular shapes on VSEPR practice worksheet • LAB – VSEPR Origami Lab – draw Lewis structures for a variety of compounds and identify their shape according to VSEPR Theory 	<p>HS-PS1-1</p> <p>HS-PS1-2</p> <p>HS-PS1-3</p> <p>HS-PS1-4</p> <p>HS-PS1-6</p> <p>HS-PS1-7</p> <p>HS-PS2-8</p>

	<p>names</p> <ul style="list-style-type: none"> • Compare and contrast different intermolecular forces and recognize in which compounds they are present • Construct Lewis structures and predict molecular shape • Differentiate between the three bond types, predict bond formation, and accurately represent a compound using a chemical formula, proper nomenclature, and shape 			
<p>Chemical Equations and Reactions (14 Days)</p>	<ul style="list-style-type: none"> • Use the fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, to describe and predict chemical reactions. • Utilize knowledge of elements and compounds to determine the amounts of reactants and products in chemical 	<ul style="list-style-type: none"> • Review law of mass conservation • Analyze a balanced chemical equation to determine the relationship of particles within the chemical reaction 	<ul style="list-style-type: none"> • LAB – Who’s Counting? Atoms, Mass, and Moles – Discover, by analogy, how chemists count atoms and molecules • Lab – Balancing Equations: Perform chemical reactions between known reactants and balance the equations of the reactions • Lab – Classification of Reactions: Analyze the reactants of a given equation and determine the classification (B) in order to correctly derive the products of the 	<p>HS-PS1-1 HS-PS1-7</p>

	reactions		<p>reaction</p> <ul style="list-style-type: none"> •Classify reaction type based on reactant side of equation and predict products to compose a complete balanced chemical equation •Determine from unbalanced chemical equations, how a substance violates the law of mass conservation 	
The Mole and Stoichiometry (15 Days)	<ul style="list-style-type: none"> • Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction • Use mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and products and the translation of these relationships to the macroscopic scale, using the mole as the conversion from the atomic to the macroscopic scale. 	<ul style="list-style-type: none"> • Calculate atomic masses of compounds, both guided and individual practice • Convert between moles, mass, STP, and particles of a substance •Review law of mass conservation •Analyze a balanced chemical equation to determine the relationship of particles within the chemical reaction •Calculate stoichiometric quantities using mole ratios 	<ul style="list-style-type: none"> •LAB – The Mole – Calculate the number of moles and molecules in a given amount of material in the room •Lab – Mole Ratios: Determine the number of moles of reactants and products in the reaction of copper and silver nitrate and calculate their mole ratio 	<p>HS-PS1-1</p> <p>HS-PS1-7</p>

<ul style="list-style-type: none"> • Utilize knowledge of elements and compounds to determine the amounts of reactants and products in chemical reactions 			
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Suggested Modifications for Special Education, ELL and Gifted Students

*Consistent with individual plans, when appropriate.

Students with individual learning styles can be assisted through adjustments in assessment standards and time restraints, one-to-one teacher support, extended testing time, and use of visual and auditory teaching methods. This wide variety of assessments, strategies, and hands-on evaluations complement the individual learning experience. Additional strategies are as follows:

- Restructure lessons using Universal Design for Learning (UDL) principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.
- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.

- Provide English Language Learners students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Suggested Technological Innovations/Use

- Internet for up-to-date resources such as journal articles (ex. Newsela, Actively Learn) and simulations (ex. YouTube, Discovery Education, CK12, PheT)
- Education focused websites, like Google Platform, to provide group forums to discuss topics
- Online programs (ex. such as Kahoot, EdPuzzle, Quizziz, PearDeck) to assess and/or poll students before, during, and after unit lesson

TECH.8.1.12.C

Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

TECH.8.1.12.A.4

Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Cross Curricular/21st Century Connections

Mathematics

- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities representing periodic trends for main group elements based on patterns of electrons in the outermost energy level of atoms.
- Determine and interpret the scale and origin in graphs and data
- Determine a level of accuracy appropriate to limitations on measurement when reporting quantities based on experimental evidence

Engineering

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Language Arts Literacy

- Write 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 of elements using well-chosen, relevant, and sufficient facts; extended definitions; and concrete details from students' own investigations, models, theories, simulations, and peer review.

- Develop and strengthen explanations for the outcome of a simple chemical reaction by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties of elements.
- Draw evidence from informational texts about the outermost electron states of atoms, trends in the periodic table, and patterns of chemical properties of elements to construct a rigorous explanation of the outcome of a simple chemical reaction.
- Cite specific textual evidence comparing the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- Conduct short as well as more sustained research projects to compare the structure of substances at the bulk scale and use this research to infer the strength of electrical forces between particles.
- Gather applicable information from multiple reliable sources to support the claim that electrical forces between particles can be used to explain the structure of substances at the bulk scale.
- Develop evidence comparing the structure of substances at the bulk scale and the strength of electrical forces between particles.

LA.RST.11-12.1	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.
MA.K-12.2	Reason abstractly and quantitatively.
LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
LA.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
MA.K-12.5	Use appropriate tools strategically.
LA.RH.11-12.1	Accurately cite strong and thorough textual evidence, (e.g., via discussion, written response, etc.), to support analysis of primary and secondary sources, connecting insights gained from specific details to develop an understanding of the text as a whole.
MA.K-12.6	Attend to precision.
LA.WHST.11-12.1	Write arguments focused on discipline-specific content.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
MA.K-12.1	Make sense of problems and persevere in solving them.

Unit 4: Energy of Chemical Systems

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **2nd Semester**
Length: **7 Weeks**
Status: **Not Published**

Summary of the Unit

In this unit of study, students construct explanations for the role of energy in chemical reactions. They apply mathematical concepts to develop evidence to support explanations of the interactions reactants and products and develop models to communicate these explanations. Students are expected to develop and use models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they demonstrate proficiency with the disciplinary core ideas. Specifically, students will be able to use their learning of the Kinetic Molecular Theory to explain and predict the behavior of gas under experimental conditions, identify a substance as an acid or a base using multiple evidences and evaluate the function based on the specific properties, and investigate the factors that affect reaction rates.

Enduring Understandings

- The behavior of gases is dependent on Kinetic Molecular Theory and can be predicted by mathematical relationships between pressure, temperature, volume, and molar quantities.
- Concentration of a solution is an important chemical quantity and maximum concentration, or solubility, is affected by many different factors
- Everyday substances can be analyzed both qualitatively and quantitatively to determine if they are an acid or a base
- Energy is conserved during all chemical and physical processes
- All reactions work towards equilibrium
- Reaction rates are influenced by several factors

Essential Questions

- How does Kinetic Molecular theory explain the behavior of all matters, including gases?
- What factors affect solubility of a solution?
- What are the qualitative and quantitative differences between acids and bases?
- How is energy involved in endothermic and exothermic processes?

- How does collision theory affect reaction rate?

Summative Assessment and/or Summative Criteria

- Explain and Predict Behavior of Gases under experimental conditions
- Prove solubility of a substance
- Identify a substance as an acid or a base using multiple evidences and evaluate the function based on specific properties
- Relate the law of conservation of energy to chemical and physical process, both in the lab and everyday life

Resources

Board approved textbooks, Teacher resource binder, Student generated resources, Internet web resources (including, but not limited to):

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>
- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks/Assessments	Standards
Kinematics of Gases (15 Days)	<ul style="list-style-type: none"> Analyze data and graph representing the relationships between pressure, volume, and temperature of a gas Explain how the Kinetic Molecular Theory and the behavior of gases are related to the changes observed in pressure, volume, and temperature Understand the link between temperatures and CO₂ concentrations in the atmosphere 	<ul style="list-style-type: none"> Presentation on the gas laws and relationships of variables Demo – Collapsing Can: Demonstrate the relationship of pressure and temperature Calculate missing variable utilizing algebraic expressions of gas laws with guidance Analyze and graph data of concentration/volume of gas vs. temperature 	<ul style="list-style-type: none"> Lab – Alka Seltzer and the Ideal Gas Law: Measure and calculate, indirectly, the molar mass of carbon dioxide produced utilizing the ideal gas law Calculate missing variables utilizing algebraic expressions of gas laws independently Justify why the true volume of a gas cannot be determined Construct graph of CO₂ data vs temperature to illustrate greenhouse gas affect on global warming 	HS-PS3-1 HS-PS1-5 HS-ESS1-3.8.1 HS.ESS2-2 HS.ESS2-4.ESS2.D.2
Solutions (15 Days)	<ul style="list-style-type: none"> Differentiate between concentrated and dilute solutions and calculate concentration 	<ul style="list-style-type: none"> Discuss units and algebraic expression associated with determining concentration of a solution Illustrate how diluting a 	<ul style="list-style-type: none"> Lab – Preparing Solutions: Create a solution of specified molarity based on calculation of moles of solute needed Calculate molarity of solutions with 	HS-PS3-1 HS-PS1-5

	<ul style="list-style-type: none"> • Explain how to make solutions and then make them in the lab • Prove that a laboratory substance is an acid or a base based on multiple indicators such as formula of the compound, pH calculations, chemical and physical properties of the compound, and analysis with litmus and/or pH paper 	<p>solution changes the number of moles of a substance</p> <ul style="list-style-type: none"> • View media on how a solution is made and the factors that affect solubility • Create a graphic organizer comparing and contrasting properties of acids and bases, pH values, $[OH^-]$ and $[H^+]$, and examples • View media on the strength of acids and bases • Predict the products of a neutralization reaction and the pH of the products 	<p>known mass and/or moles and volume</p> <ul style="list-style-type: none"> • Calculate molarity of a solution once diluted • Differentiate how percent by mass, percent by volume, and molarity of a solution measure • Complete a problem set/worksheet applying information on the pH scale • LAB – pH of Markers lab – Measure the pH of household items using indicators and determine their pOH, $[H^+]$, and $[OH^-]$ 	
Thermochemistry – the Energy of Phase Changes & Reactions (6 Days)	<ul style="list-style-type: none"> • Calculate the amount of heat absorbed or released while heating an object • Calculate enthalpy of a reaction • Relate the 	<ul style="list-style-type: none"> • View demo of an endothermic and exothermic reaction • List and discuss the variables and units for determining the amount of energy 	<ul style="list-style-type: none"> • Plan and conduct an investigation individually or collaboratively to produce data on transfer of thermal energy in a closed system that can serve as a basis for evidence of uniform energy distribution among 	HS-PS3-1

	<p>law of the conservation of energy to chemical and physical processes in everyday life</p>	<p>absorbed or released in a chemical reaction</p> <ul style="list-style-type: none"> Utilize the equation for heat transfer and manipulate to solve for missing variable View a calorimeter and discuss how it works 	<p>components of a system when two components of different temperatures are combined.</p> <ul style="list-style-type: none"> Compose a list of examples of everyday chemical reactions that are endothermic or exothermic Calculate missing quantity in specific heat equation if other variables are known LAB – Measuring Heat of Reaction: Calculate the heat transferred in a chemical reaction Diagram a calorimeter and label the parts and their function 	
<p>Reaction Rates and Equilibrium (3 Days)</p>	<ul style="list-style-type: none"> Describe how factors such as concentration, temperature, surface area, and agitation affect the rate of a reaction Describe how a catalyst affects the 	<ul style="list-style-type: none"> Create a graphic organizer that identifies the four factors that influence reaction rate and how 	<ul style="list-style-type: none"> Predict what would happen to the reaction rate given a specific scenario LAB – Rates of Reactions – Manipulate the factors that influence reaction rates 	<p>HS-PS1-2 HS-PS1-7</p>

	rate of a reaction		
9-12.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.		
9-12.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.		
9-12.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.		
9-12.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.		
9-12.HS-ESS1-3.8.1	Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).		
9-12.HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.		
9-12.HS-ESS2-4.ESS2.D.2	Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.		

Suggested Modifications for Special Education, ELL and Gifted Students

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- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage

work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide English Language Learners students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Suggested Technological Innovations/Use

- Internet for up-to-date resources such as journal articles (ex. Newsela, Actively Learn) and simulations (ex. YouTube, Discovery Education, CK12, PheT)
- Education focused websites, like Google Platform, to provide group forums to discuss topics
- Online programs (ex. such as Kahoot, EdPuzzle, Quizziz, PearDeck) to assess and/or poll students before, during, and after unit lesson

TECH.8.1.12.C

Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

TECH.8.1.12.A.4

Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Cross Curricular/21st Century Connections

Language Arts Literacy

- Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- 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.

- Draw evidence from informational texts to support analysis, reflection, and research.
- 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.

Mathematics

- Model with mathematics.
- Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- Write a function that describes a relationship between two quantities.

MA.K-12.2	Reason abstractly and quantitatively.
LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
MA.N-Q.A	Reason quantitatively and use units to solve problems.
LA.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
MA.K-12.4	Model with mathematics.
LA.WHST.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.WHST.11-12.1	Write arguments focused on discipline-specific content.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
MA.K-12.1	Make sense of problems and persevere in solving them.

Unit 5: Applied Chemistry

Content Area: **Science**
Course(s): **Chemistry CP (6)**
Time Period: **2nd Semester**
Length: **5 Weeks**
Status: **Not Published**

Summary of the Unit

In this unit of study, students will study chemistry as it applies to other sciences. First, students will study biochemistry and construct explanations for the role of energy in the cycling of matter in organisms. They apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration and develop models to communicate these explanations. The crosscutting concept of matter and energy provides students with insights into the structures and processes of organisms. Students are expected to develop and use models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they demonstrate proficiency with the disciplinary core ideas. Next, energy and matter are studied further by investigating the processes of nuclear fusion and fission that govern the formation, evolution, and workings of the solar system in the universe. Some concepts studied are fundamental to science and demonstrate scale, proportion, and quantity, such as understanding how the matter of the world formed during the Big Bang.

Enduring Understandings

- The process of photosynthesis converts light energy to stored energy by converting carbon dioxide plus water into sugars plus released oxygen.
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within a system.
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.
- Sugar molecules contain carbon, hydrogen, and oxygen: Their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells.
- Nuclear processes, including fusion, fission, and radioactive decay of unstable nuclei, involve release or absorption of energy.
- The total number of neutrons plus protons does not change in any nuclear process. In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons

are conserved.

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Essential Questions

- How does photosynthesis transform light energy into stored chemical energy?
- How do elements of a sugar molecule combine with other elements and what molecules are formed?
- Why is fusion considered the Holy Grail for the production of electricity?
- How do stars produce elements?

Summative Assessment and/or Summative Criteria

The tools used to assess the following criteria for mastery will be, but are not limited to: Quarterly exam, topic quizzes, chapter tests, projects, worksheets, and laboratory experiments.

- Analyze current research in the area of biochemistry and/or nuclear chemistry and present topics for peer review

Resources

Board approved textbooks, Teacher resource binder, Student generated resources, Internet web resources (including, but not limited to the following sites):

- American Association for the Advancement of Science: <http://www.aaas.org/programs>
- American Chemical Society: <http://www.acs.org/content/acs/en/education.html>
- Concord Consortium: Virtual Simulations: <http://concord.org/>

- International Technology and Engineering Educators Association: <http://www.iteaconnect.org/>
- National Earth Science Teachers Association: <http://www.nestanet.org/php/index.php>
- National Science Digital Library: <https://nsdl.oercommons.org/>
- National Science Teachers Association: <http://ngss.nsta.org/Classroom-Resources.aspx>
- North American Association for Environmental Education: <http://www.naaee.net/>
- Phet: Interactive Simulations <https://phet.colorado.edu/>
- Science NetLinks: <http://www.aaas.org/program/science-netlinks>

Unit Plan

Topic/Selection Timeframe	General Objectives	Instructional Activities	Benchmarks/Assessments	Standards
Biochemistry - Macromolecules (6 Days)	<ul style="list-style-type: none"> • Illustrate the inputs and outputs of matter and the transformation of energy in photosynthesis. • Construct and revise an explanation, based on valid and reliable evidence from a variety of sources (including models, theories, simulations, peer review) and on the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, for how carbon, 	<ul style="list-style-type: none"> • Create graphic organizer that determines use and function of each type • View media on the structure and function carbohydrates, lipids, and amino acids • Demo – Saturated vs. Unsaturated Fats • Compare and contrast the 20 amino acids that exist • Determine how an amino 	<ul style="list-style-type: none"> • Categorize samples of macromolecules and their uses in the body • Diagram the backbone of an amino acid • Differentiate between the 20 amino acids based on "R" group 	<p>HS-LS1-5</p> <p>HS-LS1-7</p> <p>HS-LS1-6</p>

	hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon based molecules.	acid is useful in building protein		
Biochemistry – DNA and Genetic Research (4 Days)	Construct and revise an explanation, based on valid and reliable evidence from a variety of sources (including models, theories, simulations, peer review) and on the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon based molecules.	<ul style="list-style-type: none"> • Compare structure of DNA to RNA • Determine how a codon can translate into an amino acid using simulation 	<ul style="list-style-type: none"> • Combine the base pairs of nucleic acids to form a strand of genetic code • Determine the difference in structure and base pairs of DNA and RNA • Research disadvantage of incorrect and/or incomplete base pairing (genetic disease) • Create a peptide sequence of amino acids from a strand of genetic code 	<p>HS-LS1-5</p> <p>HS-LS1-7</p> <p>HS-LS1-6</p>
Nuclear Chemistry – Types of Radioactive Emission (5 Days)	<ul style="list-style-type: none"> • Develop models based on evidence to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of alpha, beta, and gamma radioactive decays. • Communicate scientific ideas 	<ul style="list-style-type: none"> • Organize information on the types of radiation products • Identify the devices used to detect radiation and correlate the advantages and/or disadvantages for each 	<ul style="list-style-type: none"> • Differentiate between the three main types of radiation • Evaluate the decay process (beta emission, electron capture, positron, emission, or alpha emission) based on the nuclear decay equation 	<p>HS-PS1-8</p> <p>HS-ESS1-3</p> <p>HS-ESS1-1</p> <p>HS-ESS1-2</p> <p>HS-ESS1-6</p>

	<p>about the way nucleosynthesis, and therefore the different elements it creates, vary as a function of the mass of a star and the stage of its lifetime.</p>			
<p>Nuclear Chemistry – Radioactive Decay Process (10 Days)</p>	<ul style="list-style-type: none"> • Develop models based on evidence 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. • Communicate scientific ideas in multiple formats (including orally, graphically, textually, and mathematically) about the way stars, over their life cycles, produce elements. • Communicate scientific ideas about the way nucleosynthesis, and therefore the different elements it creates, vary as a function of the mass of a star and the stage of 	<ul style="list-style-type: none"> • Discuss how an element can undergo transmutation and determine if all elements do • Simulation on nuclear chain reaction • Differentiate between fusion and fission processes 	<ul style="list-style-type: none"> • Calculate the amount of a substance that will remain over a specified period of time, given initial mass and half-life • Lab – Half-Life Simulation: Simulate radioactive decay by studying the probability of a random process – rolling dice • Assess and provide an example of a substance that demonstrates the two ways transmutation can occur • Explain how the nuclear energy is an example of a nuclear chain reaction • Justify how the energy produced from fusion reactions would suggest why it only occurs in the sun 	<p>HS-PS1-8</p> <p>HS-ESS1-3</p> <p>HS-ESS1-1</p> <p>HS-ESS1-2</p> <p>HS-ESS1-6</p>

	<p>its lifetime.</p> <ul style="list-style-type: none"> • Communicate scientific ideas about how in nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. 			
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9-12.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
9-12.HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
9-12.HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.
9-12.HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
9-12.HS-ESS1-2	Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
9-12.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
9-12.HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

Suggested Modifications for Special Education, ELL and Gifted Students

*Consistent with individual plans, when appropriate.

Students with individual learning styles can be assisted through adjustments in assessment standards and time restraints, one-to-one teacher support, extended testing time, and use of visual and auditory teaching methods. This wide variety of assessments, strategies, and hands-on evaluations complement the individual learning experience. Additional strategies are as follows:

- Restructure lessons using Universal Design for Learning (UDL) principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)
- Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

- Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling).
- Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).
- Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).
- Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings.
- Use project-based science learning to connect science with observable phenomena.
- Structure the learning around explaining or solving a social or community-based issue.
- Provide English Language Learners students with multiple literacy strategies.
- Collaborate with after-school programs or clubs to extend learning opportunities.

Suggested Technological Innovations/Use

- Internet for up-to-date resources such as journal articles (ex. Newsela, Actively Learn) and simulations (ex. YouTube, Discovery Education, CK12, PheT)
- Education focused websites, like Google Platform, to provide group forums to discuss topics
- Online programs (ex. such as Kahoot, EdPuzzle, Quizziz, PearDeck) to assess and/or poll students before, during, and after unit lesson

TECH.8.1.12.A

Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

TECH.8.1.12.C

Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

Cross Curricular/21st Century Connections

Language Arts/Literacy

- Make strategic use of digital media in presentations to enhance understanding of how photosynthesis transforms light energy into stored chemical energy.

- Use digital media in presentations to enhance understanding of the inputs and outputs of the process of cellular respiration.
- Cite specific textual evidence to support how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon-based molecules.
- Use evidence from multiple sources to clearly communicate an explanation for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon-based molecules.
- Revise an explanation for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon-based molecules by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant.
- Draw evidence from informational texts to describe how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large, carbon-based molecules.

Mathematics

- Reason abstractly and quantitatively.
- Model with mathematics.
- 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
- Define appropriate quantities for the purpose of descriptive modeling.
- Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- Interpret expressions that represent a quantity in terms of its context.
- Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales
- Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

Engineering

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

and technical texts, attending to precise details for explanations or descriptions.

MA.K-12.2

Reason abstractly and quantitatively.

LA.RST.11-12.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

MA.K-12.4

Model with mathematics.

LA.WHST.11-12.1

Write arguments focused on discipline-specific content.

LA.WHST.11-12.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

MA.K-12.1

Make sense of problems and persevere in solving them.