Escondido Union High School District

Chemistry

EUHSD Board Approval Date: 4/18/17

The EUHSD *Chemistry* curriculum document identifies what students should be able to know by grade level in a comprehensive standards-based course of study. The curriculum document is updated annually based on student academic achievement data, research and best practices, and input from stakeholders. The EUHSD curriculum document contains the following documents and/or information:

A. Course Description
B. Course Guidelines/Requirements - graduation credit information, transcript information, adopted materials, adopted technology, assessment outline
C. Instructional Materials References
D. Scope and Sequence Map with Essential Standards outlined by Unit
E. References to key essential design and implementation documents

A comprehensive course of study and/or program is designed so that all students have access to the rigorous curriculum necessary to graduate high school demonstrating college and career readiness skills. Student-Centered learning provides opportunity for collaboration, communication, and a robust learning environment and provides opportunities for all students to meet the goals of the district's Instructional Focus at the time of this writing: *"All students communicate their thinking, ideas and understanding by effectively using oral, written and/or non-verbal expression."*

Key design considerations in the transition to the new California Next Generation Science Standards is a focus on changes in pedagogy. The NGSS instructional shifts guide classroom teaching and learning and form the foundation of curriculum and instructional design. Specific references to the key NGSS Instructional shifts are outlined within the 2015/2016 California Science framework document.

The curriculum document is aligned to the California Next Generation Science Standards: http://www.cde.ca.gov/pd/ca/sc/ngssstandards.asp

Chemistry Course Description

The introductory course of *Chemistry* covers the composition of matter and the changes it undergoes. Through hands-on and minds-on performance tasks and key activities students develop an understanding of the fundamental core ideas, cross-cutting concepts, and science and engineering practices used in chemistry. Topics include: chemical bonding, periodicity, atomic and molecular theory, states of matter, conservation laws, organic chemistry, stoichiometry, thermodynamics, solution, chemical equilibria, reaction rates, and nuclear chemistry. Questions on physical and chemical phenomena motivate the laboratory inquiry that students conduct.

Course Requirements

Course Length: Year Long	**Grade Level:** 9-12
UC/CSU Requirement: Meets UC/CSU "d" requirements	**Graduation Requirement:** Meets the EUHSD Physical Science graduation requirement
Course Number (Semester A): (P) 3661 (SE) 5500	**Transcript Abbreviation (Semester A):** CHEMISTRY A (P) CHEMISTRY A (P) (SE)
Course Number (Semester B): (P) 3685 (SE) 5501	**Transcript Abbreviation (Semester B):** CHEMISTRY B (P) CHEMISTRY B (P) (SE)
Credits (Semester A): 5 Physical Science	**Credits (Semester B):** 5 Physical Science
Required Prerequisite/s: Completion or Concurrent Enrollment in Algebra 1 or Math 1 (Integrated)	**Recommended Prerequisite/s:** None
Board Approval Date (Curriculum): 4/18/17	**Board Approval Date (Materials):**
Core Instructional Material/s: *Chemistry* by Myers, Oldham & Tocci, Holt, Rhinehart & Winston Publishing ©2007, ISBN: 0-03-092204-6 *EUHSD Chemistry teachers will pilot and supplement instruction through a variety of NGSS related materials, until such time that publishers release CA NGSS aligned instructional resources.	**Supplemental Instructional Material/s:** A variety of supplemental instructional materials have been written into the Scope and Sequence and will be updated in developing Unit Plans.
Technology Resource/s: • Individual student computer • Probeware • Variety of classroom laboratory equipment (see specific units)	

Assessment/s:

- Each unit of instruction outlines key performance based tasks required in order to address specific CA NGSS skills.
- Specific unit plans will be developed and will contain key unit formative and summative NGSS aligned assessments.
- Assessment is ‘science’ and three dimensional learning must be assessed three dimensionally. To assess our students, we plan and conduct investigations about student learning and then analyze and interpret data to develop models of what students are thinking. These models allow us to predict the effect of additional teaching that addresses patterns we notice in student understanding and misunderstanding. Assessment allows us to progressively improve our teaching practice, spiraling upward.

Scope and Sequence Guide

The Scope and Sequence Guide is a California standards based document that delineates the standards based skills students are expected to know and do in order to meet College and Career Readiness expectations. Each unit of study in the Scope and Sequence document is designed to build upon the previous unit and/or prerequisite coursework in support of student mastery of specific standards based skills. The Scope and Sequence document provides the framework of understanding for key assignments, key assessments, and instructional resources and strategies that serve to assist students in meeting unit learning objectives. The document will be updated annually with input from all stakeholders.

In coursework requiring reading and writing, the following standards are not specifically stated in any one unit of study, but are the result of implementation throughout the curriculum as students participate in reading, writing, and speaking/listening standards based activities.

- *By the end of grade 11, students will read and comprehend literary nonfiction in the grades 11-CCR text completely band proficiently, with scaffolding as needed at the high range. (Reading Informational Text Standard 10)*
- *Students will write routinely over extending time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks and purposes. (Writing Standard 10)*
- *"To be college and career ready, students must have ample opportunities to take part in a variety of rich and structured conversations – as part of a whole class, in small groups, and with a partner – build around important content in various domains. They must be able to contribute appropriately to conversations, make comparisons and contrasts, and analyze and synthesize a multitude of ideas according to the standards of evidence appropriate to a particular discipline." (Standards for ELA Anchor Standards for Speaking/Listening)*

Chemistry Scope and Sequence
Unit 1 – What is Matter?
Length: 8 Weeks

Unit Description: In this unit, students investigate the origins of matter in the universe and the structure of the atom. Students explore evidence of how stars are the source of nearly all the chemical elements in our known universe that provide the necessary ingredients for life. Nuclear processes within stars (i.e., fusion) combine lighter elements into heavier elements. These elements make up our planet earth. Not only do these elements make up our planet, they are the building blocks for all living and nonliving systems. Through a series of investigations, students discover how atomic structure impacts the type of matter on planet Earth and how it changes because of the stability of the nucleus.			
Essential Question/s: • Where do atoms come from? • How are atoms different from one another? • How do the differences in subatomic particles for atoms affect how they change over time?			
PE = Performance Expectations (White) **DCI = Disciplinary Core Ideas** **Scientific and Engineering Practices (SEP)** **Cross Cutting Concepts (CCC)** **PE 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.** [Clarification Statement: Emphasis is on the astronomical evidence of the red shift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).] **DCI PS4.B:** Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2) **DCI ESS1.A:** The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-2), (HS-ESS1-3)	**Learning Objectives:** **Students will be able to:** • Develop an understanding of key content terminology for appropriate use and reference. • Use the WWW and other resources to research a topic. • Identify and communicate the relationships between the life cycle of the stars, the production of elements, and the conservation of the number of protons plus neutrons in stars. • Evaluate claims made about the age of the Earth and how it formed based on evidence from meteorites, other planets, and isotopes on Earth. • Develop models to explain changes to atomic structure from fusion, fission, and radioactive decay.	**Key Unit Performance Tasks/Activities:** • **1-1 Atomic Structure:** Students use computer simulations of atoms as a modeling tool to identify and describe the components of an atom and the relationships between subatomic particles. Students use data from the simulations to write an explanation about how the number and type of subatomic particles affects the identity, charge, mass, and nuclear stability for an atom. • **1-2 Light and Matter:** Students observe different spectral tubes and organize the data to construct a claim about the relationship between the type of element and the absorption lines. Students will use this relationship to plan and conduct an investigation to determine the identity of an unknown element using a flame test. Students use data from the flame test to write an argument, supported by evidence and reasoning, about the identity of the unknown element. Last, students use combined information from relevant texts and their flame test data to explain how the phenomenon of photon emission is used by astronomers as evidence that stars produce elements through the process of nuclear fusion. Students do this by annotating provided texts to create a model of the	**Unit Assessments:** • 1-1 Atomic Structure: Written explanation • 1-2 Light and Matter: Written Claim; Flame Test Lab Report; Written explanation of the source of light from stars • 1-3 Nuclear in Your Life: Annotated Bibliography; Student created model • 1-4 Moon Rocks: Lab Report; Research Proposal

<u>DCI ESS1.A</u>: 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. (HS-ESS1-2),(HS-ESS1-3) **<u>PE ESS1-3</u>: Communicate scientific ideas about the way stars, over their life cycle, produce elements.** [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.] **<u>PE PS1-8</u>: 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.** [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.] **<u>DCI PS1.C</u>:** 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. (HS-PS1-8) **<u>DCI PS1.C</u>:** Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6) **<u>PE PS4-4</u>: Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** [Clarification Statement: Emphasis is on the idea that photons	• Describe the scale of energy released in a nuclear change versus other types of reactions. • Use evidence from published materials to support claims regarding the effect of different wavelengths of electromagnetic radiation on matter. At least one claim must be about how electromagnetic radiation affects living tissue. • Analyze data to determine that an atom has a dense positively charged nucleus. • Develop a model to explain the structure of an atom with information from the periodic table. • Use the model of an atom to explain the differences between atoms of the same element in terms of charge and mass. • Use measurements of the ratio of parent to daughter atoms produced in radioactive decay as a means to determine the age of rocks or other carbon sources.	life cycle of our sun that includes information on how nuclear fusion changes over time. • **<u>1-3 Nuclear in Your Life</u>:** Students choose a topic of personal relevance to them that involves nuclear changes (e.g., San Onofre nuclear power plant, smoke detectors, or fusion power plant research). Students generate an essential question on a phenomenon that comes from this topic. Next, students conduct research and create an annotated bibliography to answer this essential question. Last, students produce an annotated model that describes the nuclear and energy changes associated with their nuclear phenomenon and how they compare to other common nuclear and chemical changes. • **<u>1-4 Moon Rocks</u>:** Students observe the rate of change for a chemical reaction between Crystal Violet and Sodium Hydroxide. Students develop a model that describes the disappearance of Crystal Violet in the chemical reaction. Students use this model and their observations of radioactive decay in a computer simulation to explain the phenomenon of half-life for radioactive isotopes. Last, students use the phenomenon to write a research proposal on what evidence they would need to collect to investigate whether the Earth is older than the Moon.	

associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.] [Assessment Boundary: Assessment is limited to qualitative descriptions.] **DCI PS1.C:** 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. (HS-PS1-8) **DCI PS1.C:** Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. (secondary to HS-ESS1-5),(secondary to HS-ESS1-6) **PE 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.** [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.] **DCI PS3.D:** Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. (secondary to HS-ESS1-1) **DCI ESS1.A:** The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)			

<u>PE ETS1-3</u>: 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. **<u>Scientific and Engineering Practices (SEP)</u>:** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts (CCC)</u>:** • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Systems and system models • Energy and matter: Flows, cycles, and conservation • Structure and function • Stability and change			

<u>Meeting the Needs of ELs</u>:
 	
• Utilize the student information system to acquire the language levels of EUHSD English Learners.
• In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf
• In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf
	<u>Unit Resources</u>:
	
	• Probeware
	• Computer Access
	• Basic Lab Equipment and Materials: Spectrophotometer or Colorimeter, gas discharge lamps and tubes, Bunsen burners, spectroscopes, Crystal Violet, Sodium Hydroxide.
	• Computer Simulation Links
	  o https://phet.colorado.edu/en/simulation/rutherford-scattering
	  o https://phet.colorado.edu/en/simulation/build-an-atom
	  o https://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass
	  o https://phet.colorado.edu/en/simulation/radioactive-dating-game
	  o https://phet.colorado.edu/en/simulation/legacy/discharge-lamps

	- https://phet.colorado.edu/en/simulation/legacy/alpha-decay - https://phet.colorado.edu/en/simulation/legacy/beta-decay - https://phet.colorado.edu/en/simulation/legacy/nuclear-fission - https://phet.colorado.edu/sims/html/molecules-and-light/latest/molecules-and-light_en.html - Research Articles (teachers may supplement with other topic alike articles) - Stars and Light Reading: How Astronomers Use Spectra to Learn About the Sun and Other Stars - Reading for discussion: - Supernova speech from Battlestar Galactica - Star Life Cycle Resources: http://aspire.cosmic-ray.org/Labs/StarLife/ - Nucleosynthesis Resources: https://www.sciencedaily.com/releases/2012/05/120508094346.htm - Sunburn Resources: https://www.scientificamerican.com/article/what-happens-when-you-get/# - https://researchnews.osu.edu/archive/dnaburn.htm - Escondido Volcanoes (Geomorphological history of North County) - Radiometric Dating by USGS - Clocks in the Rocks - Exemplar student work products: - https://drive.google.com/file/d/0B8YR7slQhXZYU29mYnpDUkxYSWc/view (teacher resource) - Student Exemplar #1 - Student Exemplar #2

Chemistry Scope and Sequence
Unit 2 – The Periodic Table
Length: 3 Weeks

Unit Description: Students use their knowledge of phenomena from the previous unit to explore how elements have different chemical properties. Observations of electromagnetic radiation emitted from atoms are used to make inferences about the electron configurations of elements and their associated chemical properties. Students use evidence of chemical properties of elements to assemble a periodic table that allows them to predict properties of unfamiliar elements.			
Essential Question/s: • Why do certain elements, such as Lithium and Sodium, react in similar ways? • How can the periodic table be used to predict the behavior of elements? • Why do elements chemically react?			
PE = Performance Expectations (White) **DCI = Disciplinary Core Ideas** **Scientific and Engineering Practices (SEP)** **Cross Cutting Concepts (CCC)** **PE 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.** [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.] **DCI PS1.A:** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1) **PE 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.** [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.]	**Learning Objectives:** **Students will be able to…** • Develop an understanding of key content terminology for appropriate use and reference. • Use the WWW and other resources to research a topic. • Describe the relationship between the wavelength of photons emitted from an atom and the energy state of electrons. • Construct a periodic table based on the patterns of chemical and physical properties of elements. • Explain the relationship between outer electron states of elements (i.e., valence electrons) and the arrangement of groups on the periodic table. • Develop and use a model to explain the patterns of behavior of elements (i.e., reactivity, electronegativity, and atomic size) based on the attraction and repulsion between the nucleus and layers of electrons.	**Unit Assignments:** • **2-1 Planet X:** Students read about a scenario where they are stranded on Planet X and must grow food on this planet. Unfortunately, one of the key elements required for plant life is missing and must be replaced by one of the unfamiliar elements on this planet. Students analyze data sets from assays run on soil to make a prediction about which elements are best for replacement. Next, students perform laboratory tests to identify additional chemical and physical properties on the possible elements. Last, students write an argument in the form of a report about why one element over others will work as the most suitable replacement to support the growth of food on the planet. Students must use the periodic table as a model of valence electrons for elements to justify why they are making their particular selection. • **2-2 Statue of Liberty:** Students synthesize information across texts to determine why the Statue of Liberty is a green color. Next, students use their model for how elements are arranged on the periodic table to plan and conduct an investigation to determine whether there are more appropriate metals that can be used than copper for the statue. Using evidence from metal reactivity tests and their model for atomic size and electronegativity on the periodic table, students construct a written argument about what the best metal is to be used on the outside of statues.	**Unit Assessments:** • 2-1 Planet X: Laboratory Report • 2-2 Statue of Liberty: Laboratory Report

[Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] **<u>DCI PS1.B</u>:** 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. (HS-PS1-2), (HS-PS1-7) **<u>DCI PS1.A</u>:** 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. (HS-PS1-1), (HS-PS1-2) **<u>Scientific and Engineering Practices (SEP)</u>:** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts (CCC)</u>:** • Patterns • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Systems and system models • Structure and function • Stability and change	• Use valence electrons and electronegativity to predict the number and types of bonds formed (i.e., ionic and covalent) by an element and between elements. • Describe the causal relationship between the observable macroscopic patterns of reactivity of elements (e.g., alkali metals in water) in the periodic table and their patterns of valence electrons, atomic size, and electronegativity. • Predict the number and charges of stable ions that form from atoms in a group on the periodic table.		

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<td><u>Meeting the Needs of ELs</u>:

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In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf

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<td><u>Unit Resources</u>:

Probeware
Computer Access
Basic Lab Equipment: well plates, pH paper or pH probe, conductivity probe, various metals, hydrochloric acid.
Computer simulation links:
https://phet.colorado.edu/en/simulation/legacy/hydrogen-atom
Research Articles (teachers may supplement with other topic alike articles)
Statue of Liberty and Copper Reading:
https://www.copper.org/education/liberty/liberty_reclothed1.html

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Chemistry Scope and Sequence
Unit 3 - Bonding
Length: 6 Weeks

Unit Description: Our last unit was about how atoms behave based on where their electrons are located. In this unit, we want to know how the "behavior" of certain elements determines how atoms connect together in chemical bonds. There are two major types of bonds, ionic and covalent. Ionic bonds form salt crystals. Covalent bonds form molecules. Molecules have intermolecular forces that enable them to work together and give rise to bulk properties that explain both living and nonliving phenomena.

Essential Question/s:

- How do covalent and ionic bonds differ?
- Why do molecules behave the way they do?
- How do different types of intra- and intermolecular forces affect our lives?

PE = Performance Expectations (White) DCI = Disciplinary Core Ideas Scientific and Engineering Practices (SEP) Cross Cutting Concepts (CCC)	Learning Objectives:	Unit Assignments:	Unit Assessments:
PE 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.] **PE PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.]	**Students will be able to…** • Develop an understanding of key content terminology for appropriate use and reference. • Use the WWW and other resources to research a topic. • Use Lewis dots as models of valence electrons to explain why elements form specific types of chemical bonds. • Draw and label a transfer of electrons between a metal and a nonmetal. • Draw Lewis structures as a model to predict how chemical bonds form between atoms. • Plan and carry out an investigation to determine the relative macroscopic properties of ionic and covalent compounds (e.g., solubility, conductivity, and state of matter). • Use the difference in electronegativity between atoms to describe the metallic character of a chemical bond (i.e., ionic, polar covalent, or non-polar covalent).	• **3-1 Molecular Geometry:** Students pour a fine stream of water and place a charged balloon next to the stream. Students record observations that are used to generate scientific questions relevant to investigating the phenomenon. Next, students use 3 dimensional models of molecules to make a prediction about how using molecules different from water might impact the phenomenon. Using Lewis structures, students draw a visual that explains the observations they record about different solutions and how they are affected by a charge. Last, students are asked to organize data on bulk properties (e.g., melting point, boiling point, vapor pressure, or surface tension) for different types of molecules and are asked to write an explanation for the relationships they can infer between molecular geometry, polarity, strength of intermolecular forces, and the data. • **3-2 Chromatography:** In this lab, students use their 3-dimensional models of molecules to predict the effect of different solvents on the process of chromatography. They investigate the relationship between the polarity of the solvent and its capacity to separate out different	• 3-1 Molecular Geometry: Scientific Questions, Laboratory Report • 3-2: Chromatography: Laboratory Report • 3-3 Cheese – Laboratory Report

<u>PE ESS2-5</u>: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).] **<u>DCI ESS2.C</u>:** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) **<u>PE LS1-6</u>: 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.** [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.] **<u>DCI LS1.C</u>:** As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7) **<u>DCI LS1.C</u>:** The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to	• Use models to explain the relationship between molecular shape, polarity, and intermolecular forces. • Identify and communicate the evidence that supports how intermolecular forces have an effect on the bulk properties of materials (e.g., state of matter, solubility, stickiness, conductivity, material strength, and vapor pressure). • Plan and conduct an investigation to determine how intermolecular forces affect bulk properties, such as: melting point, boiling point, vapor pressure, and surface tension. • Use the kinetic molecular theory to explain how intermolecular forces and kinetic energy of particles affects the state of matter for a substance. • Construct an explanation to show that the carbon, hydrogen, and oxygen atoms from ingested sugar molecules are the same atoms found in amino acids and other large carbon-based molecules in living systems. • Explain the phenomena of ice being less dense than water using molecular models of the intermolecular forces. • Use the density and polarity of water to explain mechanical and chemical weathering of rocks.	mixtures. Students will use evidence from this experiment to select the most appropriate solvent for separating out a colored dye mixture (e.g., the exterior of brown M&Ms). They will evaluate the effectiveness of their chosen solvent in a written laboratory report. • **<u>3-3 Cheese:</u>** Students research the origins of cheese and how intermolecular forces affect the formation of curds from milk. Using their research, students generate a testable of questions on cheese production. Students use these questions to plan and conduct an investigation into the most efficient way to produce cheese. Students write an argument about how their chosen variable affects curd production. Last, students create a visual explanation for how the atoms bonded together that make up the proteins in cheese get used by humans for necessary biological functions (e.g., protein synthesis and DNA).	

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. (HS-LS1-6) **<u>PE PS1-3</u>: 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.** [Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.] [Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.] **<u>DCI: PS2.B</u>:** 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. (HS-PS2-6), (secondary to HS-PS1-1), (secondary to HS-PS1-3) **<u>DCI: PS1.A</u>:** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),(secondary to HS-PS2-6) **<u>PE ETS1-2</u>: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.** **<u>Scientific and Engineering Practices (SEP)</u>:** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence			

• Obtaining, evaluating, and communicating information **Cross Cutting Concepts (CCC):** • Patterns • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Structure and function • Stability and change			

Meeting the Needs of ELs:
 	
• Utilize the student information system to acquire the language levels of EUHSD English Learners.
• In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf
• In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf
		Unit Resources:
		
		• Probeware
		• Computer Access
		• Basic Lab Equipment: burets, balloons, chromatography paper, conical tubes, pipets, pipet pumps, incubator, shaker tables, DNA models, and a Vacuum pump system.
		• Computer Simulation Links
		  o https://phet.colorado.edu/en/simulation/balloons-and-static-electricity
		  o https://phet.colorado.edu/en/simulation/molecule-shapes
		  o https://phet.colorado.edu/en/simulation/legacy/molecule-polarity
		  o https://phet.colorado.edu/en/simulation/states-of-matter
		  o https://phet.colorado.edu/en/simulation/legacy/build-a-molecule
		  o https://phet.colorado.edu/en/simulation/legacy/soluble-salts
		  o https://phet.colorado.edu/en/simulation/legacy/sugar-and-salt-solutions
		• Research Articles (teachers may supplement with other topic alike articles)
		  o Cheese reading:
		    ▪ https://www.wired.com/2014/03/everythingyoudidntknowyouwantedtoknow-about-the-science-of-cheese/
		    ▪ http://biotechlearn.org.nz/focus_stories/cheesemaking/the_science_of_cheese	

Chemistry Scope and Sequence
Unit 4 – Chemical Reactions and Stoichiometry
Length: 5 Weeks

<table>
<tr><td colspan="4"><u>Unit Description</u>: In this unit, students build on a deep conceptual understanding on how and why chemical reactions produce specific products. They plan and conduct investigations to better model the outcomes of chemical reactions. Students apply their models of chemical reactions to design solutions to real world problems, such as Airbag inflation for vehicles and antacids.</td></tr>
<tr><td colspan="4"><u>Essential Question/s:</u>
• How do we model chemical reactions to better optimize their use for societal needs?
• What models can we use to predict the outcomes of chemical reactions?
• What variables affect how much product is produced in a chemical reaction?</td></tr>
<tr>
<td><u>PE = Performance Expectations (White)</u>
<u>DCI = Disciplinary Core Ideas</u>
<u>Scientific and Engineering Practices (SEP)</u>
<u>Cross Cutting Concepts (CCC)</u>

<u>PE PS1-2</u>: 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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

<u>PE PS1-7</u>: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.] [Assessment Boundary:</td>
<td><u>Learning Objectives</u>:

Students will be able to…
• Develop an understanding of key content terminology for appropriate use and reference.
• Use the WWW and other resources to research a topic.
• Use observations of a phenomena to classify a change as chemical or physical.
• Use a chemical equation as a model to explain that in a chemical reaction, the total number of atoms of each element in the reactant and products is the same.
• Use a chemical equation and the periodic table as models to explain the number and types of bonds broken and formed in a chemical reaction.
• Use moles to simplify describing the amounts of components in a chemical system.
• Calculate the mass (and moles or atoms) for any component of a reaction, given any other component.</td>
<td><u>Unit Assignments</u>:

• <u>4-1 Copper's Friends:</u> In this lab, students will use what they learned from previous investigations in the bonding to unit to predict how copper chemically reacts with a number of different compounds. Students are provided with copper (II) nitrate and react it with sodium hydroxide and hydrochloric acid over a series of chemical reactions. Using evidence from the chemical reactions and their models of Lewis structures and chemical equations, they predict the products produced in each chemical reaction. Students will write a tutorial on how to systematically identify the products of chemical reactions based on the starting products and observations from the reaction.
• <u>4-2 Precipitates:</u> Students obtain information on how seashells are made through a reading that then leads them into the laboratory to make seashells. In the laboratory, they explore different precipitation reactions to see what additional types of seashells might be made by living organisms. Using data from precipitation reactions, students develop a model to explain which ions are coming together to produce precipitates. Students use the model to construct a solution to the problem of identifying an unknown solution. They plan a method to use patterns of precipitation to identify the ions in the unknown</td>
<td><u>Unit Assessments</u>:

• 4-1 Copper's Friends: Laboratory Report and Written Tutorial
• 4-2 Precipitates: Laboratory Report and Model of Solubility
• 4-3 Counting by Mass: Laboratory Report
• 4-4 Airbag: Laboratory Report
• 4-5 Antacids: Laboratory Report</td>
</tr>
</table>

Assessment does not include complex chemical reactions.] **DCI ETS1.C:** 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. HS-ETS1-2, secondary to HS-PS1-6, HS-PS2-3) **PE 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.** **Scientific and Engineering Practices (SEP):** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information **Cross Cutting Concepts (CCC):** • Patterns • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Systems and system models • Energy and matter: Flows, cycles, and conservation • Structure and function • Stability and change	• Use mathematical representations (e.g., numerical calculations, graphs, or other pictorial descriptions of quantitative information) to predict changes in mass (and the number of moles or atoms) to the reactants and products of a chemical reaction. • Use the phenomena of limiting and excess reactants to design a solution for optimizing the amount of reactants required to produce a specific yield of product in a chemical reaction.	solution. They use evidence from their experiment to determine the identity of an unknown solution. • **4-3 Counting by Mass:** Students are asked to use computational thinking to count by weighing. Students will be given a piece of chalk and be asked to write their name. Students then must explain their calculations on how they determined the number of particles used to write their name by mass. • **4-4 Airbag:** Students are tasked with inflating an airbag using a weak acid and sodium hydrogen carbonate. They plan and conduct an investigation to determine the optimal ratio of reactants to produce the largest balloon. Using the size of inflated balloons as evidence, students write an argument in support of the proper ratio of reactants to inflate an airbag in a car. • **4-5 Antacids:** Students plan and conduct an investigation into the type of antacid that is most effective for neutralizing stomach acid. Students conduct text based research into the chemical properties of stomach acid and antacids. Using this background, they perform titrations using hydrochloric acid and different brands of antacids. Using the data from these titrations, students perform stoichiometric calculations to determine the efficiency of each antacid. Students write an argument in a laboratory report about which one is the most cost effective to help prevent heartburn.	

<u>Meeting the Needs of ELs</u>:	**<u>Unit Resources</u>:**
• Utilize the student information system to acquire the language levels of EUHSD English Learners. • In 2012, the CA Department of Education adopted new language level proficiency descriptors and new EL state standards. Visit the following website to learn more about those new descriptors and corresponding standards: http://www.cde.ca.gov/sp/el/er/documents/eldstndspublication14.pdf • In 2014, the CA Department of Education adopted new ELA-ELD Framework, with specific strategies designed to meet the needs of EL students. Visit the following URL to learn more about the new frameworks: http://www.cde.ca.gov/ci/rl/cf/documents/elaeldfwchapter11.pdf	• Probeware • Computer Access • Basic Lab Equipment: Test tubes, hot plates, well plates, chalk, balloons, flasks, burets • Computer Simulation Links: o https://phet.colorado.edu/en/simulation/legacy/sugar-and-salt-solutions o https://phet.colorado.edu/en/simulation/legacy/soluble-salts o https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers o https://phet.colorado.edu/en/simulation/acid-base-solutions o https://phet.colorado.edu/en/simulation/ph-scale o https://phet.colorado.edu/en/simulation/concentration o https://phet.colorado.edu/en/simulation/balancing-chemical-equations • Research Articles (teachers may supplement with other topic alike articles) o Seashell Reading: https://www.scientificamerican.com/article/how-are-seashells-created/

Chemistry Scope and Sequence
Unit 5 – Kinetics and Equilibrium
Length: 4 Weeks

<table>
<tr><td colspan="4"><u>Unit Description</u>: In Unit 5, students build on a deep conceptual understanding on how and why chemical reactions proceed in particular directions at specific rates. They plan and conduct investigations to better model chemical systems that have a human impact on a global scale. Students act as engineers and focus on the relationship between the atmosphere and Earth's ocean where carbon dioxide from the combustion of fossil fuels is having a dramatic impact on ocean life.</td></tr>
<tr><td colspan="4"><u>Essential Question/s:</u>
How do we manipulate the rate of a chemical reaction?
How do variables affect the direction of chemical reactions?
How are chemical reactions in living and nonliving systems on our planet responsible for the increase in carbon dioxide concentrations on our planet?</td></tr>
<tr>
<td><u>PE = Performance Expectations (White)</u>
<u>DCI = Disciplinary Core Ideas</u>
<u>Scientific and Engineering Practices (SEP)</u>
<u>Cross Cutting Concepts (CCC)</u>

<u>PE PS1-5</u>: 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. [Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.] [Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.]

<u>PE ESS2-6</u>: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. [Clarification Statement: **The carbon cycle is a property of the Earth system that arises from interactions among the hydrosphere, atmosphere, geosphere, and biosphere. Emphasis is on modeling biogeochemical cycles that include</td>
<td><u>Learning Objectives</u>:

Students will be able to…
Develop an understanding of key content terminology for appropriate use and reference.
Use the WWW and other resources to research a topic.
Construct an explanation that as the kinetic energy of colliding particles increases and the number of collisions increase, the reaction rate increases.
Describe the quantitative relationship between solute, solvent, and concentration for a solution.
Prepare a solution at a specific concentration.
Plan and conduct an investigation into the relationship between the concentration of hydrogen ions within a solution and decreasing ocean pH.
Plan and conduct an investigation to show that as concentration increases, so does the rate of a chemical reaction.
Use evidence from a data set to explain the typical pattern that as temperature increases, so does the reaction rate.</td>
<td><u>Unit Assignments</u>:
<u>5-1 The Power of pH:</u> What is pH and how does carbon dioxide released from the burning of fossil fuels increase the acidity of the ocean? Students explore the answers to these questions in this two-part lab investigation. Students first investigate the power of pH by creating their own pH scale through a serial dilution of hydrochloric acid and sodium hydroxide. Students then compare the pH of fresh-water and sea-water and add carbon dioxide to determine how pH is affected. Finally, the effect of ocean acidification on marine life is inferred through observations of chemical reactions between calcium carbonate precipitates and hydrochloric acid.
<u>5-2 - Clock Reaction:</u> Students observe the properties of the iodine clock reaction and generate testable questions on how to set the time of the "clock." Students use these questions to plan and conduct an investigation on how the concentration and temperature of reactants affects the rate of the iodine clock reaction. Students write an argument about how these variables affect the rate of a chemical reaction.
<u>5-3 Baking Bread:</u> If carbon dioxide is not produced fast enough when baking bread, it will become flat and dense. Students investigate how the concentration and temperature of a reactant can affect the rate of a chemical reaction that will improve the quality of bread. Students</td>
<td><u>Unit Assessments</u>:
5-1 The Power of pH: Laboratory Report
5-2 Clock Reaction: Laboratory Report
5-3 Baking Bread: Laboratory Report
5-4 Haber Process: Academic Summary, Laboratory Report</td>
</tr>
</table>

the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.] **<u>DCI ESS2.D</u>:** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7) **<u>DCI ESS2.D:</u>** Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6), (HS-ESS2-4) **<u>DCI PS3.D</u>:** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5) **<u>DCI LS2.B</u>:** Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5) **<u>PE PS1-6</u>: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. *** [Clarification Statement: Emphasis is on the application of Le Chatlier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.] [Assessment Boundary: Assessment is limited to specifying the change in only one variable	• Explain that a system at equilibrium includes the idea that both the forward and backward reactions are occurring at the same rate, which results in an appearance of stability at the macroscopic level. • Describe how, at a molecular level, a stress involving a change in concentration to one component of an equilibrium system affects other components. • Apply LeChatlier's principle to explain the relationship between the increase in carbon dioxide of carbon dioxide in the atmosphere on the acidity of the ocean. • Refine a chemical system to optimize the amount of specific product produced by manipulating the concentration and/or temperature of the system. Examples of constraints to be considered are cost, energy required to produce a product, hazardous nature and chemical properties of reactants and products, and availability of resources. • Identify and describe the physical system and societal needs for the problem of carbon dioxide emission. • Specify the qualitative and quantitative criteria and constraints for acceptable solutions to the problem of increased carbon dioxide concentrations.	design a gas collection apparatus to collect data on the amount of carbon dioxide gas produced from a chemical reaction between sodium bicarbonate and acetic acid. Using experimental evidence, students write a molecular explanation of the relationship between the concentration of acetic acid and the volume of carbon dioxide gas produced. • **<u>5-4 Haber Process:</u>** Students obtain information about the hunger crisis that affected Europe in the early 20th century due to the lack of naturally fixed nitrogen to deploy as a fertilizer in agricultural fields. Next, they read about Fritz Haber and the chemical process involving LeChatelier's principle to create artificial fertilizer and how the same process is used to make explosives. Using this text based research, students debate the ethical implications of the Haber chemical system and its impacts on global challenges throughout the 20th century. Last, students conduct an experiment on a similar chemical system to explain the shifts between iron(III) and iron(II) thiocyanate. Students develop a molecular model of the common ion effect to explain how the direction of a chemical reaction is affected by the addition of reactants or products to a chemical system.	

at a time. Assessment does not include calculating equilibrium constants and concentrations.] **<u>DCI PS1.B</u>:** 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. (HS-PS1-6) **<u>PE ETS1-1</u>: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.** **<u>Scientific and Engineering Practices (SEP)</u>:** • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence • Obtaining, evaluating, and communicating information **<u>Cross Cutting Concepts (CCC)</u>:** • Patterns • Cause and effect: Mechanism and explanation • Scale, proportion, and quantity • Systems and system models • Energy and matter: Flows, cycles, and conservation • Structure and function • Stability and change			

Meeting the Needs of ELs:	Unit Resources:	
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Chemistry Scope and Sequence
Unit 6 – Thermodynamics
Length: 9 Weeks

<table>
<tr><td colspan="4"><u>Unit Description</u>: In this unit, students develop models based on evidence from experimental investigations about how energy flows within and between systems. They will use their models on how energy flows to better engineer systems involving food and beverages. In these investigations, students will be analyzing the limitations of their models and the experimental errors that affect the validity of their claims. They will use their models to better understand how living and nonliving systems harness transformations of energy.</td></tr>
<tr><td colspan="4"><u>Essential Question/s:</u>
What is energy, how is it measured, and how does it flow within and between systems?
What mechanisms allow us to utilize the energy of our foods and fuels?
How can energy be harnessed to perform useful tasks in living and nonliving systems?</td></tr>
<tr><td><u>PE = Performance Expectations (White)</u>
<u>DCI = Disciplinary Core Ideas</u>
<u>Scientific and Engineering Practices (SEP)</u>
<u>Cross Cutting Concepts (CCC)</u>

<u>PE PS3-4</u>: 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). [Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.]

<u>DCI PS3.B</u>: 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). (HS-PS3-4)</td>
<td><u>Learning Objectives</u>:

Students will be able to…
Develop an understanding of key content terminology for appropriate use and reference.
Use the WWW and other resources to research a topic.
Develop models to describe the transformation between different forms of energy in living and nonliving systems (e.g., photosynthesis or cooking food on a grill)
Use evidence from an experimental investigation to build a model that explains how energy transfers between the systems components or between the system and surroundings.
Use a model to describe how the components in a chemical system (i.e., bonds broken and bonds formed) affects the transformation of potential energy to kinetic energy</td>
<td><u>Unit Assignments</u>:
<u>6-1 Thermos:</u> Students must design a thermos to keep a beverage warm for as long as possible for the lowest cost. Students will be given a list of materials and their associated costs. Plan and conduct an investigation to test the effectiveness of holding in heat. Students must organize the data to calculate the amount of heat lost and evaluate how effective their thermos design was compared to a professionally manufactured thermos. Students must present an argument behind why their thermos is worthy of investment to begin manufacturing for the thermos market.
<u>6-2 Cooking:</u> Students must evaluate different materials for cooking based on data they collect on their specific heat. Students plan and conduct the investigation to determine which of a number of provided metals has the highest specific heat capacity. Students use this data to argue which metal will be best for cooking on a stovetop.
<u>6-3 Calorimetry of Foods:</u> Students design an experiment to compare the caloric content of two different types of Cheetos. Using data from their experiment, students argue which Cheetos has the highest chemical energy content. In their argument, they explain the limitations of their computational</td>
<td><u>Unit Assessments</u>:
6-1 Thermos: Laboratory Report
6-2 Cooking: Laboratory Report
6-3 Calorimetry of Foods: Laboratory Report, Model of Energy Flow</td></tr>
</table>

DCI PS3.D: Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) **PE 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.** [Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.] **DCI PS3.B**: 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. (HS-PS3-1) **DCI PS3.A**: 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. (HS-PS3-1), (HS-PS3-2) **DCI PS3.B**: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1), (HS-PS3-4) **DCI PS3.B**: The availability of energy limits what can occur in any system. (HS-PS3-1) **PE PS1-4: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system**	in the surroundings by molecular collisions. • Use a computational model and the principle of the conservation of energy to calculate changes in the energy of one component of the system when changes in the energy of the other components and the energy flows are known. • Plan and conduct an investigation to calculate the amount of chemical energy in food and/or fuels. • Plan and conduct a calorimetry based investigation that involves specific heat capacity to calculate how much thermal energy is transferred in physical and chemical changes. • Identify and describe the limitations of calorimetry based investigations based on the assumptions that were made in creating the algebraic descriptions of energy changes and flows in the system.	models and experimental errors. Next, students relate the heat energy released from burning the Cheetos to data they collect on a chemical reaction between acetic acid and sodium bicarbonate. Students must develop a model to explain how the energy transfer in these chemical reactions is affected by the changes in total bond energy.	

depends upon the changes in total bond energy. [Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.] [Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.] **DCI PS1.A:** Stable forms of matter are those in which the electric and magnetic field energy is minimized. 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. (HS-PS1-4) **DCI PS1.B:** 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. (HS-PS1-4),(HS-PS1-5) PE 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.** PE 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.**			

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Scientific and Engineering Practices (SEP):

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Cross Cutting Concepts (CCC):

- Patterns
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter: Flows, cycles, and conservation
- Structure and function
- Stability and change

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Meeting the Needs of ELs:

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Unit Resources:

- Probeware
- Computer Access
- Basic Lab Equipment: Coffee cup calorimeters, thermometers, specific heat metal set, ring stand.
- Computer Simulation Links
    - https://phet.colorado.edu/en/simulation/legacy/greenhouse
    - https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes

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