EL DORADO UNION HIGH SCHOOL DISTRICT
EDUCATIONAL SERVICES

Course of Study Information Page

COURSE TITLE **Chemistry**	
DISTRICT COURSE NUMBER **(#0318)**	4-DIGIT STATE COURSE CODE (COMPLETED BY SILT) **2607**
Rationale:	Chemistry in the Community (ChemA) is a practical, hands-on chemistry course. It's purpose is to provide students with knowledge and skills for scientific practices, cross-cutting relationships, and core knowledge for life-long learning.
Course Description that will be in the Course Directory:	Chemical principals will be applied to inquiry, investigation, and application to real-world and global challenges.
How Does this Course align with or meet State and District content standards?	See attached Table of Contents
NCLB Core Subjects:	*Select up to two that apply:* ☐ Arts ☐ Civics and Government ☐ Not Core Subject ☐ Economics ☐ History ☐ English ☒ Mathematics ☐ Foreign Language ☐ Reading / Language Arts ☐ Geography ☒ Science
CDE CALPADS Course Descriptors: (See Page 2 for Definitions)	CTE TECH PREP COURSE INDICATORS ☐ Tech Prep (32) (Higher Ed) ☐ Tech Prep & ROP(33) (Higher Ed) ☐ ROP (30) ☒ N/A CTE COURSE CONTENT CODE ☐ CTE Introductory (01) ☐ CTE Concentrator (02) ☐ CTE Completer (03) ☐ Voc Subject _____ ☒ N/A INSTRUCTIONAL LEVEL CODE ☐ Remedial (35) ☐ Honors UC-Certified (39) ☐ Honors Non UC-Certified (34) ☐ College (40) ☒ N/A
Length of Course:	☒ Year ☐ Semester
Grade Level(s):	☐ 9 ☒ 10 ☒ 11 ☒ 12
Credit:	☒ Number of credits: **10** ☒ Meets graduation requirements (subject **Physical Science**) ☐ Request for UC "a–g" requirements CSU/UC requirement _____ ☒ College Prep
Prerequisites:	Minimum competency- Completion of Algebra I and Biology with a grade of C or better. Completion of Geometry &/or concurrent enrollment in Algebra II is recommended.
Department(s):	Science
District Sites:	ORHS, PHS, EDHS, UMHS
Board of Trustees COS Adoption Date:	6/10/2014
Textbooks / Instructional Materials:	Inspire Chemistry, McGraw Hill, Copyright 2020, 978-0-07-692580-3

Funding Source:	General Fund
Board of Trustees Textbook Adoption Date:	05/17/2022

Definitions

CALPADS	California Longitudinal Pupil Achievement Data System
CTE Technical Prep	A course within a CTE technical career pathway or program that has been articulated with a postsecondary education or through an apprenticeship program of at least 2 years following secondary instruction.
Instructional Level Code	Represents a nonstandard instructional level at which the content of a specific course is either above or below a 'standard' course instructional level. These levels may be identified by the actual level of instruction or identified by equating the course content and level of instruction with a state or nationally recognized advanced course of study, such as IB or AP.
Instructional Level Honors, UC Certified	Includes all AP courses.
Instructional Level Honors, non UC Certified	Requires Board approval.
Instructional Level College	Includes ACE courses. Equivalent to college course and content, but not an AP course. Not related to section, but to course.

EL DORADO UNION HIGH SCHOOL DISTRICT

EDUCATIONAL SERVICES

Course Title: Chemistry A (#0318)

TABLE OF CONTENTS

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: I. Materials - Structure & Properties of Matter

ESSENTIAL QUESTION(S): Can scientists organize the seemingly chaotic world of matter?
Can the Earth provide enough natural resources to meet the chemical needs of humans?

UNIT OUTLINE:

- **I.A Building Blocks of Chemistry** – Properties, symbols, formulas, equations
- **I.B Periodic Trends** – Grouping elements, subatomic particles, ions & ionic compounds, metal reactivity
- **I.C Minerals and Moles** – Metal resources, percent composition, molar mass, redox, electroplating
- **I.D Conservation and Chemical Equation** – Writing and balancing equations, Reduce, Reuse, Recycle, Replace

NGSS DISCIPLINARY CORE IDEA (DCI**)**: *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, made of protons and neutrons, surrounded by electrons. (*HS-PS1-1*)
- The periodic table orders elements 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*)
- Large-scale structure & interactions of matter are determined by electrical forces within & between atoms. (*HS-PS1-3*),*(HS-PS2-6)*
- 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*)

PS1.B: Chemical Reactions

- 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*)

PS2.B: Types of Interactions

- 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-PS1-1),(HS-PS1-3),(HS-PS2-6*)

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

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. [Reactivity of metals, types and numbers of bonds, numbers of bonds formed, and reactions with oxygen.] **(ChemCom.UnitI.B.1-9)**

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. [Examples: reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen] **(ChemCom Unit I.B.10 – 15)**

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. [Strengths of forces between particles - ions, atoms, molecules, and networked materials, melting and boiling point, vapor pressure, and surface tension**(ChemCom Unit I.A.1)**

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Communicate the proportional relationships between masses of atoms in reactants and

products. Use the mole to convert from atomic to macroscopic scale

HS-PS3-5. Develop models of two objects interacting through electric or fields, their forces, & energy changes; Drawings, diagrams, and text shows what happens when two charges of opposite polarity are near each other, how the change in energy is related to the change in energy of the field.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiments:***

Investigating Chemistry through Inquiry

Experiment #2: "Baking Soda and vinegar Investigations"
Experiment 4: "Conductivity of an Aqueous Solution"
Experiment #5: "Identifying a Pure Substance"
Experiment 12: "Colligative Properties of Solutions"
Experiment #22: "Reaction Rates"

Lab Manual: Organic Chemistry

Experiment #8: "Investigating Gas Chromatography" (*Atomic size and Intermolecular Forces*)
Experiment #10: "Understanding Intermolecular Forces using Gas Chromatographs"

Vernier Probeware & Sensors – 8 Lab Quest II Receiver, 8 Temperature Probes, 8 Conductivity Meters, 8 Gas Pressure Sensors, Mini GC Plus Gas Chromatograph.

- ***ChemCom Labs [American Chemical Society(ACS)] include:***

HS-PS1-1. Lab I.A.10: "Metal or Nonmetal."
Lab I.B.12: "Relative Reactivities of Metals,"
Lab I.C.12: "Copper Plating"
Lab I.D.7 Striking it Rich (copper into brass)
Lab II.B.2 "Converting Copper,"

HS-PS1-6. Lab V.B.2: **"**Le Chatelier's Principle"

Other Suggested Projects & Activities:

HS-PS1-1. Lab: "Alkaline Earth Elements," Lab: "Bohr Models with Fruit Loops," Worksheet: "Family Feud, YouTubeVideo: "Dogs Teaching Chemistry"

HS-PS1-2. Paper Model of Water and Soap Molecule,

HS-PS1-3. Lab: "Graphing Trends of the Periodic Table," Worksheet: "Solubility of Common Solutes, "Labs utilizing "Magnetic Model Kits," Demo: "Surface Tension of Soapy Water," Lab: "Chromatography of Magic Markers,"

HS-PS1-4. Models include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.

HS-PS1-6. Design chemical reaction systems; describe the connection between changes made at the macroscopic and molecular level. Designs include different ways to increase product formation including adding reactants or removing products. " Lab: "Making Gloop," Lab: "Viscosity in a Glass Tube."

HS-PS1-4. Model the release / absorption of energy - with molecular-level drawings, diagrams of reactions, graphing relative energies of reactants and products, representations showing energy is conserved.

HS-PS1-7. Suggested Worksheets: "Keeping Track of Atoms," "Accounting for Atoms," "Balancing Equations"
Smartboard Activity: Use the cloning feature to add molecules for each side of the equation

Teacher Demonstration: Use an equal arm balance to show molecules can be balanced in an equation.

ASSESSMENT: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas.*

Assessments: Labs, tests, quizzes, worksheets, creating models.
Suggested online resources: Quizlet – games, quizzes, vocabulary development <http://quizlet.com>

Assessment Boundaries:

- **HS-PS1-1. Periodic properties of elements & electrons.** Limited to trends of main group elements, not quantitative.
- **HS-PS1-2. Simple chemical reactions -outermost electrons, periodic trends, and chemical properties.** Limited to combustion reactions and reactions involving main group elements.
- **HS-PS1-3. Structure of substances from the strength of electrical forces.** Does not include Raoult's law calculations of vapor pressure.
- **HS-PS1-4. Energy of reaction depends on bond energy.** Does not include calculating the total bond energy.
- **HS-PS1-5. Temperature / concentration on reaction rate. S**imple reactions with two reactants; evidence from

temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

- **HS-PS1-6. Increasing amount of products** Emphasis: **c**hange one variable at a time, not calculating equilibrium constants and/or concentrations.
- **HS-PS1-7. Conservation of mass in chemical reactions.** Includes simple chemical reactions, emphasizing mathematical thinking, not memorization.
- **HS-PS3-5.** Assessment is limited to systems containing two objects.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (*HS-PS1-1*),(*HS-PS1-2*),(*HS-PS1-3*),(*HS-PS1-5*)

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (*HS-PS1-8*)
- The total amount of energy and matter in closed systems is conserved. (*HS-PS1-7*)
- Changes of energy and matter can be described in terms of energy and matter flowing in, out, and within that system. (*HS-PS1-4*)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (*HS-PS1-6*)

Nature of Science -Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes the universe is a vast single system in which basic laws are consistent. (*HS-PS1-7*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Developing and Using Models

- Construct and interpret Potential Energy Diagrams showing the relationships between energy of reactants and products in a chemical reaction. (*HS-PS1-4*).
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS1-4)* (*HS-PS1-1*).

Planning and Carrying Out Investigations

- Making the Case for Currency – Students will plan and conduct an investigation individually and collaboratively to design and produce a new coin made from a natural resource that is plentiful, inexpensive, with useful properties. Students will produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations, then refine the design accordingly. (*HS-PS1-3*)

Using Mathematics and Computational Thinking

- Create balanced chemical equations to demonstrate the Law of Conservation of Matter. (*HS-PS1-7*)
- Use mathematical representations of phenomena to support claims. (*HS-PS1-7*)

Constructing Explanations and Designing Solutions

- Design models explaining temperature/kinetic molecular theory and concentration effects on reaction rates. (*HS-PS1-5*)
- Gather evidence to demonstrate Le Chatlier's Principle by showing how an equilibrium system will respond with variations such as changing reactant concentration, temperature, and addition of catalysts (HS-PS1-6).
- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (*HS-PS1-5*)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and 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. (HS-PS1-2)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS1-6*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.* After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, "Bozeman Science, Khan Academy, YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: II. Air: Designing Scientific Investigations

ESSENTIAL QUESTION(S): Will the air that we breathe today be safe for posterity?
Does the interaction of matter and energy in the atmosphere affect life on Earth?
Are humans an invasive species?

UNIT OUTLINE:

II.A Properties of Gases – Pressure, temperature, volume, gas laws,
II.B Physical Behavior of Gases – Kinetic molecular theory, ideal gas law, phase changes
II.C Interactions of Matter and Energy in Atmosphere – Structure of Atmosphere, collision theory, stoichiometry, electromagnetic spectrum.
II.D Human Impact on Air Quality – Air pollution, acid rain, Ph

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS3.A: Definitions of Energy (*ChemCom Unit II.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*)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (*HS-PS3-2*) (*HS-PS3-3*)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (*HS-PS3-2*)

PS3.B: Conservation of Energy and Energy Transfer (*ChemCom Unit II.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*)
- 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*)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (*HS-PS3-1*)
- The availability of energy limits what can occur in any system. (*HS-PS3-1*)
- 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*)

PS4.B: Electromagnetic Radiation (*ChemCom Unit II.C*)

- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features. (*HS-PS4-3*)
- When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. (*HS-PS4-4*)

ESS2.D: Weather and Climate (*ChemCom Unit II.D*)

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(sa HS-ESS3-6)*

ESS2.D: Weather and Climate (*ChemCom Unit II.C*)

- The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (*HS-ESS2-4*)
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide & released oxygen. (*HS-ESS2-6*),(*HS-ESS2-7*)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations & thus affect climate. (*HS-ESS2-6*),(*HS-ESS2-4*)

ESS3.D: Global Climate Change (*ChemCom Unit II.D*)

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (*HS-ESS3-5*)
- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (*HS-ESS3-6*)

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

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. Explain the meaning of mathematical expressions used in the model.

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* Both qualitative and quantitative evaluations of devices such as wind turbines, solar cells, solar ovens, and generators, renewable energy forms and efficiency.

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). Analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually such as mixing liquids at different initial temperatures or adding objects at different temperatures to water.

HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.

HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. 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.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.* Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate; Causes of climate change, changes in human activity, solar output, changes in atmospheric composition.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. Cycling of carbon through the ocean, atmosphere, soil, and biosphere (humans), provide the foundation for living organisms.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. Evidence for data and climate models are for climate changes (precipitation and temperature) and their associated impacts on sea level, glacial ice volumes, or atmosphere and ocean composition.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. Earth systems include hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. Human Impacts from increased atmospheric carbon dioxide results in an increased photosynthetic biomass, ocean acidification, with resulting impacts on sea organism health and marine populations.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual - Chemistry with Vernier

  Experiment # *6: "Boyle's Law: Pressure Volume Relationships in Gases"*
  Experiment #*7: "Pressure-Temperature Relationship in Gases"*

  Lab Manual: Organic Chemistry
  Experiment #5: "Separating Organic Compounds by Acid-Base Extraction
  Experiment #8: "Investigating Gas Chromatography" (*Atomic size and Intermolecular Forces*)
  Experiment #10: "Understanding Intermolecular Forces using Gas Chromatographs"

  Lab Manual: Investigating Chemistry through Inquiry
  Experiment #20: "Investigating Voltaic Cells"

Vernier Probeware & Sensors – 8 Lab Quest II Receiver, 4 Mini GC Plus Gas Chromatograph, 8 Voltage Sensors, 8 Gas Pressure Sensors, 8 Temperature Probes, Melt Station.

- ***ChemCom Labs [American Chemical Society(ACS)] include:***
  Lab II.A.1: "Properties of Gases"
  Lab II.A.9: "Exploring Temperature-Volume Relationships"
  Lab II.B.2: " Modeling Matter: "Understanding Kinetic Molecular Theory (KMT)"
  Lab II.C.8 "Generating and Analyzing CO_2"
  Lab II.D.2: "Detecting Pollutants in Air"
  Lab II.D.9: "Effects of Acid Rain"

Other Projects & Activities:

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessments: Simple qualitative models, such as pictures or diagrams, to demonstrate chemical concepts and processes.
Labs, tests, quizzes, worksheets, models. Suggested online resources: Quizlet – games, quizzes, vocabulary development http://quizlet.com

Assessment Boundary:
HS-PS3-1. Basic algebraic expressions or computations; thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.
HS-PS3-2. Investigations based on materials and tools provided to students.
HS-PS3-3. Quantitative evaluations are limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.
HS-PS4-4. Qualitative descriptions.
HS-PS4-5. Qualitative information. Assessments do not include band theory.
HS-ESS3-5. One example of a climate change and its associated impacts.
HS-ESS3-6. Limited to using the published results of scientific computational models.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (*HS-ESS2-4*)
- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (*HS-PS4-4*)
- Systems can be designed to cause a desired effect. (*HS-PS4-5*)

Energy and Matter
- 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. (*HS-PS3-3*)
- The total amount of energy and matter in closed systems is conserved. (*HS-ESS2-6*)
- Energy drives the cycling of matter within and between systems. (*HS-ESS2-3*)

Stability and Change
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (*HS-ESS2-1*)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (*HS-PS3-4*)
- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (*HS-PS3-1*)
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (*HS-PS4-3*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Analyzing and Interpreting Data

- Analyze data using computational models in order to make valid and reliable scientific claims. (*HS-ESS3-5*)

Constructing Explanations and Designing Solutions

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS3-3*)
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources with 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. (*HS-ESS3-1)*

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-ESS2-1*),(*HS-ESS2-3*),(*HS-ESS2-6*)
- Use a model to provide mechanistic accounts of phenomena. (*HS-ESS2-4*)

Engaging in Argument from Evidence

- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (*HS-PS4-3*)
- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). *(HS-ESS3-2*)

Obtaining, Evaluating, and Communicating Information

- Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible. (*HS-PS4-4*)
- Communicate technical information or 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). (*HS-PS4-5*)

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (*HS-PS3-4*) (*HS-ESS2-5*)

Scientific Investigations Use a Variety of Methods

- Science investigations use diverse methods & not always the same set of procedures to obtain data. (*HS-ESS3-5*)
- New technologies advance scientific knowledge. (*HS-ESS3-5*)
- Science knowledge is based on empirical evidence. (*HS-ESS3-5*)

Using Mathematics and Computational Thinking

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (*HS-PS3-1*)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (*HS-ESS3-6*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*

After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, “Bozeman Science, Khan Academy, and YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: III. Petroleum: Breaking and Making Bonds

ESSENTIAL QUESTION(S): Is petroleum the best resource for building molecules and burning fuel?
Can knowledge of chemistry help consumers make informed choices about petroleum use?

UNIT OUTLINE:

III. A What is Petroleum? - Hydrocarbon properties (viscosity, boiling points, phase changes), carbon footprint, distillation, intermolecular forces, isomerism,

III. B Petroleum: A Building Material Source – polymerization, petrochemicals, condensation polymers

III. C Petroleum: An Energy Source – Energy, fossil fuels, combustion, heat of combustion, molar heat of combustion, atmospheric CO_2, greenhouse gases, global climate change

III. D Alternatives to Petroleum – Energy efficiency, altering fuels, oxygenated fuels, biodiesel, alternative fuel vehicles

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS1.B: Chemical Reactions

- 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*)
- 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*)

PS3.A: Definitions of Energy (*ChemCom Unit III.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*)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. (*HS-PS3-2*) (*HS-PS3-3*)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as either motions of particles or energy stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (*HS-PS3-2*)

PS3.B: Conservation of Energy and Energy Transfer (*ChemCom Unit III.C*)

- 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*)
- 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*)
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (*HS-PS3-1*)
- The availability of energy limits what can occur in any system. (*HS-PS3-1*)
- 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*)

PS3.D: Energy in Chemical Processes (*ChemCom Unit III.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*)

- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. *(HS-PS4-5)*

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. A chemical reaction is a system that affects energy changes.

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, particularly the number and energy of collisions between molecules.

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, particularly explain the meaning of mathematical expressions.

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or stored energy. Conversion of kinetic to thermal energy and/or potential energy. Models include diagrams, drawings, descriptions, and computer simulations.

HS-PS3-3. Design, build, and refine a renewable energy device (ex. wind turbines, solar cells, solar ovens, generators) that works within given constraints to convert one form of energy to another.

HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). Analyzing qualitative and quantitative data to describe the energy changes. Investigations include mixing liquids at different initial temperatures or adding objects at different temperatures.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. 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 the cycling of carbon through the ocean, atmosphere, soil, and humans.

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. Evidence for both data and climate model outputs, are for climate changes and their associated impacts.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. Earth systems (hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere) and the impacts from a human activity on atmospheric carbon dioxide, increased photosynthetic biomass, and acidification.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual - Chemistry with Vernier

  Experiment # *2: "*Freezing & Melting of Water"

  Lab Manual: Organic Chemistry
  Experiment #1: "Determining Melting Temperatures"
  Experiment #3: "Determination of a Boiling Point - Simple and Fractional Distillation"
  Experiment #6: "Understanding Polarimetry"
  Experiment #9: "Fractional Distillation of Esters"
  Experiment #11: "Investigating Thermodynamics of Substituted Hydrocarbons"

  Lab Manual: Investigating Chemistry through Inquiry
  Experiment #7: " Investigating the energy Content of Fuels"
  Experiment #8: "Evaporation and Intermolecular Attraction of Alkanes and Alcohols"
  Experiment #9: "Enthalpy Changes"

Vernier Probeware & Sensors – 8 Lab Quest II Receivers, 8 Temperature Probes, 8 Melt Stations, 8 Wide-Range Temperature Probes, 8 Polarimeters, 4 Mini GC Plus Gas Chromatographs.

- ***ChemCom (ACS) Labs:***
  Lab III.A.1 "Properties of Petroleum"
  Lab III.A.5: "Separation by Distillation"
  Lab III.B.10: "Condensation (Esters)"
  Lab III.C.1: " Comparing Fuels"
  Lab III.C.4: "Combustion"
  Lab III.D.8: "Synthesizing and Evaluating Biodiesel Fuel"

Other Suggested Projects & Activities:

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessment: Simple qualitative models, such as pictures or diagrams, to demonstrate chemical concepts and processes.
Labs, tests, quizzes, worksheets, models. Suggested online resources: Quizlet – games, quizzes, vocabulary development <http://quizlet.com>

Assessment Boundary:

HS-PS3-1. Basic algebraic expressions or computations - thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.
HS-PS3-3. Quantitative evaluations are limited to total output for a given input as well as devices constructed with materials provided to students.
HS-PS3-4. Investigations based on materials and tools provided to students.
HS-ESS2-4. Climate changes include changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.
HS-ESS2-7. A comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems is not necessary.
HS-ESS3-5. One example of a climate change and its associated impacts
HS-ESS3-6. Students will use the published results of scientific computational models.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

ESS2.D: Weather and Climate

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)*

ESS3.D: Global Climate Change

- Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (*HS-ESS3-5*)

ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (*HS-ESS3-1*)
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (*HS-ESS3-2*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Constructing Explanations and Designing Solutions

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (*HS-PS1-5*)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and 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. (*HS-PS1-2*)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS1-6*)

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS3-1*)

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS1-4*)
- Use a model to predict the relationships between systems or between components of a system. (*HS-PS1-1*)
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS3-2*),(*HS-PS3-5*)

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (*HS-PS3-4*) (*HS-PS1-3*)

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to support claims. (*HS-PS1-7*)
- Create a computational model or simulation of a phenomenon, designed device, process, or system. (*HS-PS3-1*)

Project Ideas:

- **"The Case of Sick Sally"** Students investigate the source of air pollution causing Sally to be ill. Project based on the real-life case of an active EDUHSD board member. Published by Intel Innovations in Education.
- **Making Perfume** - Use distillation process to create essential oils for students to make perfumes. (sa Vernier Lab 8: Fractional Distillation)
- **Role play** – Students take on the role of newscaster where (s)he interviews an elderly person. Questioning includes their energy consumption, fuel sources, past living conditions. Students will compare and contrast their past experiences with the present. Students then project to the future given catastrophic scenarios.

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*

After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, "Bozeman Science, Khan Academy, YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: IV. Water: Exploring Solutions

ESSENTIAL QUESTION(S): Does local and global water quality affect your quality of life?
Are human activities substantial enough to permanently impact the Earth's hydrosphere?

UNIT OUTLINE:

IV. A Sources, Uses, and Properties of Water – Supply, demand, uses, and properties of water, mixtures & solutions
IV. B Looking at Water and Its Contaminates – Solution concentration and solubility of ionic and molecular compounds.
IV. C Reactions in Solution – Precipitation reactions, net ionic equations, pH of acids, bases, &buffers, solution concentration
IV. D Water Purification and Treatment

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS1.A: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (*HS-PS1-1*)
- 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*)
- 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)*
- 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*)

PS1.B: Chemical Reactions

- 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*)
- 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*)
- 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*)

ESS2.C: The Roles of Water in Earth's Surface Processes

- 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*)

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*
Students who demonstrate understanding can:

HS-PS1-1. (*ChemCom Unit IV.B*) 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. Predicted properties include: reactivity of metals, types & number of bonds, and main group elements.

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. Reactions include sodium and chlorine, carbon and oxygen, carbon and hydrogen, or main group elements, and combustion reactions.

HS-PS1-3. (*ChemCom Unit IV.A.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. Includes: intermolecular forces such as ions, atoms, molecules, and networked materials (graphite). Bulk properties include: melting point and boiling point, vapor pressure, and surface tension.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. Chemical reactions affect energy change. Models include molecular-level drawings and diagrams of reactions, graphs of relative energies of reactants and products, and representations showing energy is conserved.

HS-PS1-5. Apply scientific principles and evidence to explain the effects of temperature or concentration on rate of reactions. Focuses student reasoning on number and energy of collisions between molecules

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium (Le Chatelier's Principle).

HS-PS1-7. (*ChemCom Unit IV.B.5-7*) 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 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.

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. Mechanical and chemical investigations with water and a variety of solid materials provide the connections between the hydrologic cycle and the rock cycle- stream transportation and deposition, erosion, soil moisture, frost wedging, chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting point.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual - Chemistry with Vernier

  Experiment #12: "Effect of Temperature on Solubility of a Salt"
  Experiment #13: Properties of Solutions: Electrolytes and Non-Electrolytes"

  Lab Manual: Organic Chemistry
  Experiment #2: "Recrystallization of Benzoic Acid and Aspirin"

  Lab Manual: Investigating Chemistry through Inquiry
  Experiment # 1: "Physical Properties of Water"
  Experiment #10: "Reaction Stoichiometry"
  Experiment #15: "Acid-Base Properties of Household Products"
  Experiment #17: "Acid-Base Titrations"

Vernier Probeware & Sensors – 8 Lab Quest II Receiver, 8 Temperature Probes, 8 Conductivity Meters, 8 Melt Stations, 8 pH Meters.

- ***ChemCom Labs:***
  Lab IVLab.A.3: "Properties of Water"
  Lab IV.B: "What Substances Dissolve in Water?"
  Lab IV.B.7: " Measuring Solution Concentration"
  Lab IV.C.1: "Combining Solutions"
  Lab IV.C.13: "Acids, Bases, & Buffers"
  Lab IV.D.2: "Foul Water"

Suggested Projects & Activities:
"FISH KILL- Finding the Solution:" Students roll-play members of a small community who's economic livelihood depends on the fishing industry that is threatened by an untimely "fish kill."

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessment: Simple qualitative models, such as pictures or diagrams, to demonstrate chemical concepts and processes.

Labs, tests, quizzes, worksheets, models. Suggested online resources: Quizlet – games, quizzes, vocabulary development <http://quizlet.com>

Assessment Boundary:

HS-PS1-1. Main group elements.
HS-PS1-2. Limited to chemical reactions of group elements and combustion reactions
HS-PS1-3. Does not include Raoult's law calculations of vapor pressure.
HS-PS1-4. Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.]
HS-PS1-5. Focus on number and energy of collisions between molecules, simple reactions with two reactants; evidence from temperature, concentration, and rate data; and relationships between rate and temperature.
HS-PS1-6. **L**imited to specifying the change in only one variable at a time, not equilibrium constants and concentrations.
HS-PS1-7. **Assess** mathematical thinking, not memorization and rote application of problem-solving techniques.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (*HS-PS1-1),(HS-PS1-2),(HS-PS1-3),(HS-PS1-5*)

Energy and Matter

- The total amount of energy and matter in closed systems is conserved. (*HS-PS1-7*)
- 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. (*HS-PS1-4*)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (*HS-PS1-6*)
- Science assumes the universe is a vast single system in which basic laws are consistent. (*HS-PS1-7*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of* ***core ideas.***

Constructing Explanations and Designing Solutions

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (*HS-PS1-5*)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and 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. (*HS-PS1-2*)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS1-6*)

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS1-4),(HS-PS1-8*)
- Use a model to predict the relationships between systems or between components of a system. (*HS-PS1-1*)

Planning and Carrying Out Investigations

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (*HS-PS1-3*)

Using Mathematics and Computational Thinking

- Use mathematical representations of phenomena to support claims. (*HS-PS1-7*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*

After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, "Bozeman Science, Khan Academy, YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: V. Industry: Applying Chemical Reactions

ESSENTIAL QUESTION(S): Is the chemical industry obliged to produce useful products, create jobs, mitigate environmental impacts, and protect public health?
Is Green Chemistry a passing fad or a systemic change for the future?

UNIT OUTLINE:

- **V. A Providing Nutrients for Agriculture** – Fertilizer, Nitrogen Cycle, Nitrogen-Fixing, oxidation-Reduction
- **V. B Industrial Production of Ammonia** – LeChatelier's Principle, Chemical Equilibrium, Ammonia Synthesis, Green Chemistry
- **V. C Generating Electrical Energy from Chemical Reactions** – Electrochemistry, Forms of Energy, Voltaic & Fuel Cells, Equilibrium
- **V. D Industrial Production of Batteries** – Electrochemical Cell Potential/Voltage, Primary & Secondary Batteries, Battery Recycling

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS1.B: Chemical Reactions

- 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*)
- 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*)
- 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*)

PS3.D: Energy in Chemical Processes

- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy. *(HS-PS4-5)*

ETS1: Engineering Design

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(HS-ETS1.1 -4)*

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. A chemical reaction is a system that affects energy change. Models include molecular-level drawings, diagrams of reactions, graphs of relative energies of reactants and products, and representations showing energy is conserved.

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. Focus on number and energy of collisions between molecules

HS-PS1-6. Design a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. Use Le Chatlier's Principle to describe connection between macroscopic and molecular level changes. Increase product formation by adding reactants or removing products.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual: Organic Chemistry
  Experiment #23: "Synthesis of Fluorescein"
  Experiment #24: "Synthesis of methyl Orange and Its Application to Textiles"
  Experiment #26: using a Gas Chromatograph: Identification of Unknown Compounds"

Vernier Probeware & Sensors – 8 Lab Quest II Receivers, 8 Wide-Range Temperature Probes, 2 Spectrometers.

- ***ChemCom Labs:***
  Lab V.A.1: "Fertilizer Components" (Tests Include: $BaCl_2$, NO_3^-, NH_4, Fe^{3+}, K^+ , NaOH, Flame Tests)
  Lab V.B.2: "LeChatelier's Principle"
  Lab V.C.2: "Voltaic Cells & Half-Reactions"
  Lab V.D.1: "Building a Voltaic Pile"

Other Suggested Projects & Activities:
Modeling Matter – V.A.4: "The Nitrogen Cycle," V.C.6: "Visualizing Changes within Voltaic Cells," V.D.7: " Life Cycle of a Battery"

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessment: Labs, tests, quizzes, worksheets, models.
Suggested online resources: Quizlet – games, quizzes, vocabulary development <http://quizlet.com>

Assessment Boundary:
HS-PS1-4. Assessment does not include calculating the total bond energy.
HS-PS1-5. Assess simple reactions with two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.
HS-PS1-6. Specifically change one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Energy and Matter
- 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. (*HS-PS1-4*)

Influence of Science, Engineering, and Technology on Society and the Natural World
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (*HS-ETS1-1*) (*HS-ETS1-3*)

Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (*HS-PS1-5*)

Stability and Change
- Much of science deals with constructing explanations of how things change and how they remain stable. (*HS-PS1-6*)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (*HS-ETS1-4*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Asking Questions and Defining Problems

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (*HS-ETS1-1*)

Constructing Explanations and Designing Solutions

- Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (*HS-PS1-5*)
- Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-PS1-6*)
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-ETS1-2*)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (*HS-ETS1-3*)

Developing and Using Models

- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS1-4*)
- Use a model to predict the relationships between systems or between components of a system. (*HS-PS1-1*)

Using Mathematics and Computational Thinking

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (*HS-ETS1-4*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*

After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, “Bozeman Science, Khan Academy, YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: VI. Atoms: Nuclear Processes and Interactions

ESSENTIAL QUESTION: Is the notion of a Doomsday Clock an outdated model in foretelling world-wide nuclear threat?

UNIT OUTLINE:

VI. A The Nature of Atoms – Ionizing Energy, Radiation, Atomic Nuclei, Isotopes, Isotopic & Molar mass
VI. B Nuclear Radiation – Alpha, Beta, Gamma Radiation, Exposure to Ionizing Radiation, Radioactive Decay, Balancing Nuclear Equations, Radon, Cloud Chambers, Public Safety
VI. C Using Radioactivity – Half-Life, Carbon Dating, Medical Radioisotopes, Artificial Radioactivity, Transmutation
VI. D Nuclear Energy: Benefits and Burdens – Chain Reactions, Nuclear Fission / Power Plants, Nuclear Fusion, Nuclear Waste

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

PS1.C: Nuclear Processes

- 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*)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*HS-ETS1-3*)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation about how a given design will meet the public needs. (*HS-ETS1-4*)

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

HS - PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course goals. Explain how assignments support the Common Core Standards.*

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual – Nuclear Radiation with Vernier

  Experiment # 1: " Alpha, Beta, Gamma Radiation"
  Experiment #2: Distance and Radiation"
  Experiment #3: "Lifetime Measurement"

Experiment #5: “Background Radiation Sources”
Experiment #6: “Radiation Shielding”

Lab Manual: Investigating Chemistry through Inquiry
Experiment #25: “Nuclear Radiation”

Vernier Probeware & Sensors – 8 Lab Quest II Receiver, 8 Digital Radiation Monitors.

- ***ChemCom Labs:***
  Lab VI.A.1: “Exploring Ionizing Radiation”
  Lab VI.A.7: “Isotopic Pennies”
  Lab VI.B.4: “ Alpha, Beta, & Gamma Radiation”
  Lab VI.B.9: “Cloud Chambers”

- ***Other Suggested Projects & Activities:***
  Video: “Doomsday Clock”
  Lab: “M & M Half-Life”
  Building skills: VI.A.6: Interpreting Isotopic Notation,” VI.A.9: “Molar Mass & Isotopic Abundance,”VI.B.6: “Nuclear Balancing Act,” VI.C.3: “Applications of Half-Lives,” VI.C.7: “Nuclear-Bombardment Reactions,” VI.D.7 Disposal of High- & Low-Level Waste,”
  Making Decisions VI.B.10 Ensuring Public Safety”
  ChemQuandry: VI.C.4 “Radioisotopes in Medicine”

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessment: Simple qualitative models, such as pictures or diagrams, to demonstrate the scale of energy released in nuclear processes. Labs, tests, quizzes, worksheets, models. Suggested online resources: Quizlet – games, quizzes, vocabulary development <http://quizlet.com

Assessment Boundary: Limited to alpha, beta, and gamma radioactive decays, not quantitative calculation of energy released.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Energy and Matter
- The total amount of energy and matter in closed systems is conserved. (*HS-PS1-7*)
- 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. (*HS-PS1-4*)
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (*HS-PS1-8*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Developing and Using Models
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (*HS-PS1-4*),(*HS-PS1-8*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*
After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, “Bozeman Science, Khan Academy, YouTube Videos.

Department: Science

Course Title: Chemistry in the Community **Course Number:** #0318

UNIT TITLE: VII. Food: Matter & Energy for Life

Essential Question: Brillat-Savarin's famous quote,"Dis-moi ce que tu manges, je te dirai ce que tu es," translates into, "Tell me what you eat and I will tell you what you are." Are we humans really "What we eat?"

UNIT OUTLINE:

VII. A Food as Energy – Energy Flow on Earth, energy Release & Storage
VII. B Carbohydrates and Fats – C,H, & O Atoms, (Un)Saturated Fats, Calories, Hydrogenation, Limiting Reactants
VII. C Proteins – Function and Structure, Diet, Enzymes, Amylase
VII. D Vitamins, Minerals, and Additives – Diet, Minerals, Food Additives such as dyes, Nitrites, Artificial Sweeteners

NGSS DISCIPLINARY CORE IDEAS (DCI): *List broad scientific concepts that help students to connect personally to societal issues and increase their depth of learning.*

Students who demonstrate understanding can:

PS1.B: Chemical Reactions - Limiting Reactants

- 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)

PS2.B: Types of Interactions

- 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)(HS-PS1-3)*

ETS1.A: Defining and Delimiting Engineering Problems

- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (*HS-ETS1-1*)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (*HS-ETS1-1*)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*HS-ETS1-3*)

PERFORMANCE EXPECTATIONS: *Student performance that demonstrates student has mastered the Disciplinary Core Idea (DCI).*

Students who demonstrate understanding can:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of materials such as long chained molecules, and pharmaceuticals that are designed to interact with specific receptors.

HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use math to communicate proportional relationships between masses of atoms in the reactants and the products, using the mole as the conversion and the translation of these relationships to the macroscopic scale for limiting reactants.

INSTRUCTIONAL STRATEGIES: *Indicate how the instructional strategies support the delivery of curriculum and course*

goals. Explain how assignments support the Common Core Standards.

Suggested Lab Activities:

- ***Vernier Lab Experiment:***
  Lab Manual - Chemistry with Vernier

  Experiment # 31: "Timed-Release Vitamin C Tablet"
  Experiment #34: "Determining the Quantity of Iron in a Vitamin Tablet"

  Lab Manual: Organic Chemistry
  Experiment #4: " Identifying Unknown analgesic by Melting Point Temperature and Thin-Layer Chromatography"
  Experiment #14: Observer Reaction Kinetics of Sucrose with Polarimetry"

  Lab Manual: Investigating Chemistry through Inquiry
  Experiment #6: Investigate the Energy Content of Food"

Vernier Probeware & Sensors – 8 Lab Quest II Receiver, 8 pH Meters, 8 colorimeters or Spectrometers, 8 Melt-Stations, 8 Mini Gas Chromatographs, 8 wide-Range Temperature Probes.8 Temperature Probes.

- ***ChemCom Labs:***
  Lab VII.A.3: "Energy Contained in a Snack (Potato Chip)"
  LabVII.B.11: "Analyzing Fats & Carbohydrates"
  Lab VII.C.5: "Enzymes"
  Lab VII.C.7 "Amylase Tests
  Lab VII.D.2: "Vitamins in the Diet"
  Lab VII.D.3 "Vitamin C"
  Lab VII.D.7: "Food Coloring Additives"

Other Suggested Projects & Activities:
Molecular Kits: "Modeling Carbohydrates, Fats, & Proteins"
Project FOG (Poster): Fats, Oils, & Grease

ASSESSMENTS: *Describe the Formative and Summative Assessments that will be used to demonstrate learning and mastery of the NGSS Core Ideas***.**

Assessment: Simple qualitative models, such as pictures or diagrams, to demonstrate chemical concepts and processes.
Labs, tests, quizzes, worksheets, models. Suggested online resources: Quizlet – games, quizzes, vocabulary development http://quizlet.com

Assessment Boundary:
HS-PS2-6. Provide molecular structures of specific designed materials.
HS-PS1-7. Assess student use of mathematical thinking for simple chemical reactions, not memorization and rote application.

CROSS-CUTTING CONCEPTS: *Core ideas have application across all domains of science.*

Structure and Function
- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (*HS-PS2-6*)

Energy and Matter – Limiting Reactants
- The total amount of matter in closed systems is conserved. (*HS-PS1-7*)

SCIENCE & ENGINEERING PRACTICES: *Describe how students will investigate and build models and theories of core ideas.*

Using Mathematics and Computational Thinking
- Use mathematical representations of phenomena to support claims. (*HS-PS1-7*)

Obtaining, Evaluating, and Communicating Information
- Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (*HS-PS2-6*)

INTERVENTIONS: *Describe methods used to support students who fail to master formative and summative assessments for each unit.*
After-school Tutoring, Homework Club, Study Group, Online Resources such as teacher notes & worksheets posted online, “Bozeman Science, Khan Academy, YouTube Videos.

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