Unit 9 - Environmental & Applied Chemistry

Content Area: **Science**
Course(s):
Time Period: **Marking Period 4**
Length: **25 days**
Status: **Published**

Summary

Describing the role energy plays in the chemical process is known as thermochemistry. Studying thermochemistry and its relation to the environment allows scientists to understand natural chemical processes and the ways human activities interfere (positively or negatively) with them. “Green” chemistry is an example of how chemists can take tried-and-true processes and attempt to limit the generation of waste pre- and post-production. In this unit, students will investigate the role of energy to describe exothermic and endothermic processes and the preference nature has. Students can apply this concept alongside other concepts they have learned to investigate complex topics from manufacturing and industrial chemistry to acid rain, climate change and greenhouse gases, since understanding these topics requires the foundations in concepts such as reactions, thermochemistry, and equilibrium.

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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.
P.3	Consider the environmental, social and economic impacts of decisions.
P.4	Demonstrate creativity and innovation.
P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
9.4.12.CT	Critical Thinking and Problem-solving
P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
P.9	Work productively in teams while using cultural/global competence.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
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.
LA.RST.9-10.2	Determine the central ideas, themes, or conclusions of a text; trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
LA.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual

	form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
LA.RST.9-10.8	Determine if the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9.4.12.GCA	Global and Cultural Awareness
LA.RST.9-10.9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
LA.RST.9-10.10	By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.
9.4.12.IML	Information and Media Literacy
LA.WHST.9-10.1.D	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
LA.WHST.9-10.1.E	Provide a concluding paragraph or section that supports the argument presented.
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.
LA.WHST.9-10.2.A	Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
LA.WHST.9-10.2.C	Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
LA.WHST.9-10.2.D	Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
LA.WHST.9-10.2.E	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
9.4.12.TL	Technology Literacy
LA.WHST.9-10.2.F	Provide a concluding paragraph or section that supports the argument presented.
HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-4	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-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.
HS-ESS2-5	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
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.
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 (i.e., climate change).
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.

Learning Plan

- Preview essential questions and connect them to the concepts we will cover in the unit.
- Investigate rates by analyzing how quickly solutions can be made with water at various temperatures.
- Analyze chemical reaction rates in the "Alka-Seltzer" lab adding other factors like surface area and pressure.
- Re-analyze phase diagrams (Unit 1) with the focus on what role "heat" had.
- Model the principles of heat flow using the "qmcat" equation.
- Determine the specific heat of metals using simple "coffee cup" calorimeters.
- Design (or redesign) a calorimeter to investigate the heat from a chemical reaction (Marshmallow Calorimetry Lab) and/or solvation process (Enthalpy of Solutions Lab).
- Compare and contrast enthalpy with entropy and how both can be used to predict whether a process will occur.
- Compare and contrast the composition of the atmosphere and ocean (or other system) from points in the geological and recent past to the present.
- Identify events, natural or human, that caused a significant change in the composition of the atmosphere, ocean, or other system.
- Define the "spheres" of the earth and diagram how various substances move through them over time.
- Identify resources used by civilizations and the impact the use of those resources had on the local, regional, or global environment.
- Research and track current conditions using available data from air/water quality monitors or more specified resources (i.e. stratospheric ozone) in order to make predictions.
- Evaluate examples of human activity to identify systems that were in equilibrium and how human activity altered it.
- Investigate the effects of greenhouse gases and acid rain on the atmosphere.
- Analyze data trends to make predictions regarding global warming and climate change.
- Analyze experiments to determine their "green"-ness and make proposals to improve ones that are not "green."

Essential Questions/Enduring Understandings

Essential Questions

- What is the "driving force" behind all chemical reactions?
- What are the principles of energy flow?
- How can calorimetry be used to determine the identity of unknown substances?
- What major chemical processes or cycles occur in the environment that, if disrupted, affect life on earth?
- How can human activity impact natural chemical processes in both positive and negative manners?
- How do "green" chemistry principles ensure that current methodologies account for potential environmental impact?

Enduring Understandings

- Enthalpy (energy), entropy (randomness), and temperature all play an intertwined role in chemical reactions.
- Calorimeters apply the principles of heat flow in order to measure the amount of heat involved in a chemical reaction or process
- The earth is a complex system composed of countless smaller ones all of which are connected in a manner that changing one will affect another (equilibrium).
- Chemistry in the environment is not strictly an anthropogenic topic but human actions can alter natural chemical processes positively and negatively.

Objectives

Students Will Know

- Students will know the factors that affect the rate of chemical reactions.
- Students will know know heat is the flow of energy from one object to another.
- Students will know the definitions and roles of enthalpy and entropy.
- Students will know how to find the activation energy of a process.
- Students will know the composition of the atmosphere and oceans.
- Students will know how specific substances (i.e. carbon, nitrogen, water, etc.) are cycled among the four spheres (hydrosphere, atmosphere, geosphere, and biosphere).
- Students will know how green chemistry will result in a positive change in the environment.
- Students will know the effects of human activity on earth's natural systems and what the system is

doing in response (equilibrium).

Students Will Be Skilled At

- Students will be skilled at analyzing data in order to calculate the specific heat of a material.
- Students will be skilled at designing and/or utilizing calorimeters to determine the amount of heat involved in a chemical/physical change.
- Students will be skilled at recognizing processes – chemical reactions or phase changes – as exothermic or endothermic.
- Students will be skilled at graphing the energy of a process in order to identify it as exothermic or endothermic.
- Students will be skilled at recognizing areas where green chemistry can be applied to modern methods.
- Students will be skilled at recognizing a positive or negative impact the use of resources has on local (or larger) environments.
- Students will be skilled at interpreting data to analyze past, present, or predict future conditions.

Assessment

Formative Assessment

- Do Now Questions
- Exit Ticket Questions
- Whole Class Discussion Participation
- Small Group Discussion Participation
- Individual Student Questions/Responses
- Independent Tasks
    - Determine the factors that affect the rate of a reaction and describe how they affect the rate.
    - Analyze phase diagrams with respect to thermodynamic concepts.
    - Calculate heat flow.
    - Describe how enthalpy and entropy can be used to predict the spontaneity of a chemical process.
    - Analyze data to determine composition of the atmosphere, ocean, or other system.
    - Identify changes in a system (atmosphere, ocean, other) as a result of natural or human-caused event.
    - Diagram the cycle(s) of a substance(s) through the earth's "spheres."
    - Develop guidelines that can be used to assess an experiment's "green"-ness.
- Lab Experiments

Summative Assessment

- Unit Quizzes
- Unit Tests
- Lab Reports

Benchmark Assessment

- CP Chemistry Final Exam

Alternative Assessment

- Interpret data from the "Alka-Seltzer" lab to propose how the new factors (not in the solutions activity) affect the rate.
- Utilize the heat flow equation and data obtained via experiment to determine the specific heat of metals.
- Design and build a calorimeter.
- Use a calorimeter to determine the enthalpy of a chemical process.
- Collect and graph data from real-time air/water quality monitors.
- Diagram a natural system at equilibrium and identify how human activity has altered the system.
- Research the resources used by civilization to measure the impact using that resource has on local, regional, or global environment.
- Investigate the rate of temperature change due to the greenhouse effect.

Materials

- SAVVAS Experience Chemistry 2021 Textbook Volumes 1 & 2
- Guided notes
- Teacher handouts
- Supplementary worksheets
- Lab Handouts (Alka-Seltzer Lab, Specific Heat of Metals Lab, Marshmallow Calorimetry Lab, Enthalpy of Solutions Lab, Teacher Discretion of previous labs for "green" analysis, NOTE: Supplies for each lab included on handout.)
- List of associated environmental/green chemistry videos (collaboration among teachers)
- Simulations:

    - “Energy Forms and Changes” [https://phet.colorado.edu/en/simulation/energy-forms-and-changes]
    - “Calorimetry Simulations” [https://media.pearsoncmg.com/bc/bc_0media_chem/chem_sim/calorimetry/Calor.php]
    - Rahway Air Quality Data (Real time) [https://aqicn.org/city/usa/newjersey/rahway-pm/]
    - Elizabeth Air Quality Data (Real time) [https://aqicn.org/city/usa/newjersey/elizabeth-trailer]
    - NOAA Ocean Monitor (Real time) [https://www.nodc.noaa.gov/oads/stewardship/data_assets.html]
    - "The Greenhouse Effect" [https://phet.colorado.edu/en/simulation/greenhouse])
- Safety Supplies (specifics to when they are required included in lab handouts)

Integrated Accommodation and Modifications, Special Education students, English Language Learners, At-Risk students, Gifted and Talented students, Career Education, and those with 504s

https://docs.google.com/spreadsheets/d/1mfe42JCam4Rlgd626vidMg54nDZ1ic055qKKGLvhcPg/edit?usp=sharing