10 - Thermochemistry

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **8 Blocks***
Status: **Published**

General Overview, Course Description or Course Philosophy

Chemistry CP aims to provide students with a fundamental understanding of the composition, structure, properties, and transformations of matter. Through a combination of theoretical concepts, laboratory investigations, and real-world applications, students will explore the principles and laws that govern chemical reactions and interactions. The course emphasizes the development of scientific inquiry skills, critical thinking abilities, and the application of problem-solving strategies. Students will actively engage in the process of scientific discovery, asking questions, seeking answers, and making connections between theory and practical applications. Laboratory experiences will integrate with theoretical knowledge, fostering the development of practical skills, scientific inquiry, and responsible practices. Students will also explore the ethical considerations and societal implications of chemistry, promoting informed decision-making as responsible citizens. By the end of the course, students will have a deepened appreciation for the relevance of chemistry in everyday life and will be prepared for further study and careers in scientific fields.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Objectives:

- Understand the relationship between energy and chemical reactions.
- Define and apply key terms and concepts related to thermochemistry, such as heat, temperature, enthalpy, entropy, and heat capacity.
- Explain and apply the laws of thermodynamics in the context of chemical reactions.
- Calculate and interpret changes in enthalpy (ΔH) for chemical reactions.
- Apply calorimetry principles to measure heat changes and determine the heat transfer in chemical reactions.
- Use Hess's Law to calculate ΔH for reactions based on known enthalpy changes of other reactions.
- Understand and apply bond enthalpies to calculate energy changes in chemical reactions.
- Predict the spontaneity of a reaction based on ΔH and ΔS values using Gibbs' free energy (ΔG) calculations.
- Analyze and interpret energy diagrams and reaction profiles to understand the energy changes in chemical reactions.
- Apply thermochemical principles to real-world situations, such as energy production, environmental impact, and food calorimetry.

Essential Questions:

- What is the relationship between energy and chemical reactions?
- How can we measure and quantify heat changes in chemical reactions?
- What are the fundamental laws and principles of thermodynamics, and how do they apply to chemical systems?
- How do we calculate and interpret changes in enthalpy for chemical reactions?

- What is calorimetry, and how can we use it to determine heat transfer in chemical reactions?
- How can we use Hess's Law to calculate ΔH for reactions based on known enthalpy changes of other reactions?
- How can bond enthalpies be used to estimate energy changes in chemical reactions?
- How can we predict the spontaneity of a reaction based on ΔH and ΔS values using Gibbs free energy calculations?
- How can energy diagrams and reaction profiles be used to understand the energy changes in chemical reactions?
- How do thermochemical principles apply to real-world scenarios, such as energy production, environmental impact, and food calorimetry?

Enduring Understandings:

- Energy is involved in all chemical reactions and can be quantified and measured.
- Thermodynamics provides a set of laws and principles that govern energy transfer and transformation in chemical systems.
- Enthalpy changes reflect the heat exchange in chemical reactions and can be calculated and interpreted.
- Calorimetry allows us to measure and determine the heat transfer in chemical reactions.
- Hess's Law enables us to calculate ΔH for reactions by manipulating known enthalpy changes of other reactions.
- Bond enthalpies provide a way to estimate energy changes in chemical reactions based on the strength of chemical bonds.
- Gibbs' free energy (ΔG) calculations allow us to predict the spontaneity of a reaction based on ΔH and ΔS values.
- Energy diagrams and reaction profiles provide visual representations of the energy changes in chemical reactions.
- Thermochemical principles have practical applications in various fields, including energy production, environmental science, and food science.

CONTENT AREA STANDARDS

SCI.9-12.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.
SCI.9-12.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
SCI.9-12.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).
SCI.9-12.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
SCI.9-12.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.
SCI.9-12.HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of

	changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

LA.RST.9-10.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
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.9-10.7	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.
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.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
TECH.K-12.1.3.d	build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
TECH.K-12.1.4.a	know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

STUDENT LEARNING TARGETS

Refer to the 'Declarative Knowledge' and 'Procedural Knowledge sections.

Declarative Knowledge

Students will understand that:

- Energy is involved in all chemical reactions and can be quantified and measured.
- Thermodynamics provides a set of laws and principles that govern energy transfer and transformation in chemical systems.
- Enthalpy changes reflect the heat exchange in chemical reactions and can be calculated and interpreted.
- Calorimetry allows us to measure and determine the heat transfer in chemical reactions.
- Hess's Law enables us to calculate ΔH for reactions by manipulating known enthalpy changes of other reactions.
- Bond enthalpies provide a way to estimate energy changes in chemical reactions based on the strength of chemical bonds.
- Gibbs' free energy (ΔG) calculations allow us to predict the spontaneity of a reaction based on ΔH and ΔS values.
- Energy diagrams and reaction profiles provide visual representations of the energy changes in chemical reactions.

- Thermochemical principles have practical applications in various fields, including energy production, environmental science, and food science.

Procedural Knowledge

Students will be able to:

- Define and differentiate between various thermodynamic terms, such as heat, temperature, enthalpy, and entropy.
- Explain the laws of thermodynamics and their implications in chemical reactions.
- Explain the difference between exothermic and endothermic processes.
- Describe and calculate changes in enthalpy (ΔH) for chemical reactions.
- Calculate heat transfer using the specific heat capacity equation.
- Understand and apply Hess's Law and the concept of enthalpy of formation.
- Describe the relationship between bond energies and the energy changes in chemical reactions.
- Explain the concept of spontaneity and predict whether a reaction will occur based on the sign of ΔH and ΔS.

EVIDENCE OF LEARNING

Refer to the 'Formative Assessments' and 'Summative Assessments' sections.

Formative Assessments

- POGIL Activities:
    - Calorimetry
    - Bond Energy
- Labs
    - Heat of Reactions (Hess' Law)
    - Constructing Heating and Cooling Curves for Lauric Acid
- Group practice
    - Calorimetry Calculations
    - Thermochemical Equations
    - Heating Curves
    - Hess' Law
- Performance Scale/ Student Tracking Chart
- Whiteboards
- Exit Tickets
- Homework

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3 based on lab practices
- Alternative Assessments
    - Lab inquiries and investigations
    - Lab Practicals
    - Exploratory activities based on phenomenon
    - Gallery walks of student work
    - Creative Extension Projects
    - Build a model of a proposed solution
    - Let students design their own flashcards to test each other
    - Keynote presentations made by students on a topic
    - Portfolio
- Hess' Law and Thermochemical Calculations Quiz
- Constructing Heating and Cooling Curves for Lauric Acid Lab Report

RESOURCES (Instructional, Supplemental, Intervention Materials)

CK-12 Online Textbook

POGIL Chemistry

Gizmos Simulations

PhET Simulations

Khan Academy

Bozeman Science

American Chemical Society

INTERDISCIPLINARY CONNECTIONS

ELA/Literacy

Mathematics

Technology

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.