Unit 09: Thermochemistry and Chemical Kinetics

Content Area: **Science**
Course(s):
Time Period: **Marking Period 4**
Length: **1-2 Weeks**
Status: **Published**

Brief Summary of Unit

Thermochemistry, the study of the heat flow that accompanies chemical reactions, as well as Reaction Rates, will be presented in this unit. The direction and sign of heat flow, as well as the calculations needed to determine its magnitude, will be addressed. Problem-solving using a calorimeter, both coffee cup and bomb, will be discussed. Enthalpy will be introduced and utilized in different aspects such as reaction stoichiometry, Hess' Law, and its relationship with entropy and Gibbs' free energy. The study of reaction rates will be presented and related to energy diagrams. The main emphasis of chemical kinetics will be on factors that influence reaction rates and the relationship of reaction rates among reactants and products in a balanced chemical equation.

Revised June 2022

Standards

	With a growth mindset, failure is an important part of success.
LA.K-12.NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
	Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.
9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.
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.
LA.K-12.NJSLSA.R8	Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LA.K-12.NJSLSA.W4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
LA.K-12.NJSLSA.W6	Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
LA.K-12.NJSLSA.W8	Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
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.
PS3.A	Definitions of Energy
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.
PS3.D	Energy in Chemical Processes
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).
PS3.B	Conservation of Energy and Energy Transfer
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.

Essential Questions

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What are the principles of heat flow?

How is thermodynamics used to predict the occurrence of chemical reactions?

What factors control the speed of a reaction?

Enduring Understandings

Heat/energy is conserved.

Increased entropy of a system is favored in nature.

The speed/rate of a process/reaction is governed by the interactions between particles/molecules.

Students Will Know/Students Will be Skilled At

Students will know the principles of heat flow.

Students will know what is specific heat and how the formula for specific heat can be used in problem-solving.

Students will know the qualitative and quantitively properties of enthalpy.

Students will be skilled at applying Hess' law.

Students will know what entropy is and how it is predicted.

Students will know Gibb's free energy is related to the spontaneity of a reaction.

Students will know what factors control the speed of a reaction in terms of the collision theory.

Students will know what a reaction rate is and how it's determined.

Students will know how reaction rates of reactants and products are related.

Students will know what factors affect the rate of a reaction.

Students will be skilled at interpreting energy diagrams.

Learning Plan

Preview the essential questions and connect them to learning throughout the unit.

Discuss heat and the principles of heat flow.

Discuss specific heat and model problem solving using $q=mc\Delta T$.

Define a state property and explain its significance in the quantitive relationships that exist for enthalpy.

Model how enthalpy can be solved through stoichiometry and Hess' Law.

Discuss entropy, Gibb's free energy, and how to determine the driving force behind a spontaneous process/reaction.

Model how to solve problems utilizing $\Delta G = \Delta H - T\Delta S$

Define reaction rate and present how the rate is expressed using concentrations.

Model the relationship between the rates of reactants and products.

Discuss collision theory and factors that affect the rate.

Model how to construct and interpret energy diagrams.

Labs/Activities:

The following PhET simulations can be utilized: specific heat capacity.

Specific Heat of a Metal Lab

Heat of Solution Lab (Hot or Cold packs)

Energy content of food Lab

Factors that affect the rate of a reaction (inquiry Lab)

Evidence/Performance Tasks

Formative

Explaining the role of heat in chemical and physical processes.

Quantitative data analysis in calorimeter experiments.

Predicting spontaneity given enthalpy, entropy, and temperature.

Determining the rates of reactants and products from a balanced chemical equation.

Explaining factors that affect the rate of a reaction in terms of collision theory.

Interpreting energy diagrams.

Self Assessment problems during class.

Completed problems in CHEMFILE: MINI GUIDE TO PROBLEM SOLVING HOLT 1999

Assigned homework problems in CHEMISTRY 11 ED. CHANG MCGRAW HILL 2013

Summative

Unit Quiz and Test

Benchmark

Final Exam

Alternative

Lab Report for Energy content of food, Heat of Solution Lab, or Factors that affect Reaction Rates Inquiry Lab.

Materials

CHEMISTRY 11 ED. CHANG MCGRAW HILL 2013

CHEMFILE: MINI GUIDE TO PROBLEM SOLVING HOLT 1999

Approved Textbook Link

In addition to general lab and safety equipment as noted in lab handouts:

sodium hydroxide

hydrochloric acid

potassium nitrate

calcium chloride

acetic acid

alka seltzer tablets

Suggestions Strategies for Modifications

FOR SPECIAL EDUCATION STUDENTS , ELL, AT RISK AND STUDENTS GIFTED STUDENTS

https://docs.google.com/spreadsheets/d/1pQwsQoD_QLot65BTdHFEHN5dXIiqS54iQ5iDL8C4q6o/edit?usp=sharing