

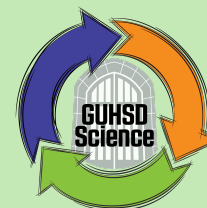


Chemical Reactions Resource Guide

Curated by the GUHSD OER Chemistry Team

Lead: Savannah Addy

Team: Shelby Crush, Christie Hoover, Rosanna Lupien, Stephanie Palechek, Andrea Peirce, Janet Pendleton, Nathan Samuels, Denise Yoak, David Youngblood, Karen Bowers, Annika Goodin, Franz Ruiz



Unit Overview

NGSS Performance Expectations	Concepts	Guiding Questions
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. HS-PS2-4: Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects. HS-PS3-5: Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	Students use their model of the inner working of the atom to explain whether energy is stored or released during interactions between atoms.	- Why do some combinations of elements react and others do not? - How do organisms harness energy from the chemical bonds in their food? - What holds atoms together to make molecules? - What patterns can help us determine the similarities and differences of chemical reactions? - How do the collisions of molecules affect the rearrangement of atoms?

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<u>Developing and Using Models</u> - Develop a model based on evidence to illustrate the relationships between systems or between components of a system. <u>Using Mathematics and Computational Thinking</u> - Use mathematical representations of phenomena to describe explanations.	<u>PS1.A: Structure and Properties of Matter</u> - 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. <u>PS1.B: Chemical Reactions</u> - 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. <u>PS2.B: Types of Interactions</u> - Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. - Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. <u>PS3.C: Relationship Between Energy and Forces</u> - When two objects interacting through a field change relative position, the energy stored in the field is changed.	<u>Patterns</u> - 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. <u>Energy and Matter</u> - 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. <u>Cause and Effect</u> - 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.

Framework Background

"Chemical Reactions" help students formulate an answer to the questions: "How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?" Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Using this expanded knowledge of chemical reactions, students are better able to understand a variety of important biological and geophysical phenomena, from cellular metabolism to reactions that form minerals and prepared to be critical consumers of information, so that they can engage in public discussion using evidence-based argumentation not only around science-related issues but across a broad range of topics. Students are also able to apply an understanding of the process of optimization in engineering design to chemical reaction systems. The crosscutting concepts of patterns, energy and matter, and stability and change are called out as organizing concepts for these disciplinary core ideas. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, using mathematical thinking, constructing explanations, and designing solutions; and to use these practices to demonstrate understanding of the core ideas. (NGSS Lead States 2013)

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Section 3.1: Chemical Equations and Reactions

[Chemical Reactions 5E Lesson](#) (Chemistry OER Team)

CK-12 Core Content Reading

YOU DO NOT NEED AN ACCOUNT TO ACCESS

CK-12 READINGS

- [Chemical Reaction](#)
- [Chemical Change](#)
- [Chemical Symbols and Formulas](#)
- [Reactants and Products](#)
- [Chemical Properties and Chemical Reactions](#)
- [Writing Chemical Equations](#)
- [Balancing Equations](#)
- [Word Equations](#)
- [Combination Reactions](#)
- [Synthesis Reaction](#)
- [Decomposition Reactions](#)
- [Single Replacement Reactions](#)
- [Activity Series](#)
- [Double Replacement Reactions](#)
- [Combustion Reaction](#)
- [Law of Conservation of Mass](#) (spiral from IS 1)

Readings & Articles

- Chemicool: [How Important are Chemical Reactions](#)
- [Reactants and Products Actively Learn Article](#)
- [Recognizing Chemical Reactions](#)
- [Links to Real Examples of Compounds](#)

Videos & Animations

- [Precipitation Reactions](#)
- [Types of Chemical Reactions](#)
- [Balancing Chemical Reactions](#)
- [Basics of Chemical Reactions Animation](#)
- [Chemical Reactions in Daily Life \(short\)](#)
- [6 Chemical Reactions That Changed History](#)
 - An [EdPuzzle](#) version
- [Sodium Reactions](#)
- [Collision Theory](#)

Simulations & Interactives

- PhET: [Balancing Chemical Equations](#)
 - [Student Handout](#), [Distance Learning Adaptation](#) 
- PhET: [Reactants, Products, & Leftover](#)
- PhET: [Balancing Chemical Equations](#)

Phenomena & Data

- [Why onions make you cry](#)
- [Combustion demo](#)
- [Decomposition Reaction - Elephant's Toothpaste](#)
- [Case Study of Lead](#) and [Testing Lead in Water](#)

Labs

- [Law of Conservation Lab in a Bottle](#)
 - [Conclusion Questions for the Law of Conservation Lab](#)
- [Copper Cycle](#)
- [Activity Series \(ADI format\)](#)
- [PASCO Conservation of Matter Lab](#)
- [PASCO Modeling Chemistry Lab](#)
- [Balancing Equations](#)
- [Chemical Reactions Walk Around](#), [Distance Learning Adaptation](#) 
- [Reaction types](#)
- [Atomic Shifts in Chemical Reactions](#)
- [Chemical Reactions Card Sort](#), [Distance Learning Adaptation](#) 

Engineering Ideas

- Race Car Project: [Assignment](#), [presentation](#)

Other Activities

- [Grab Bag Modeling Types of Reactions](#)
- [Marshmallow Modeling Law of Conservation](#)
- [Discovering Types of Chemical Reactions Slides](#) (to be used with Mario reactions below)
- [Mario Reactions Sorting](#) (directions in slides above)
- [Chemical Reaction Models Worksheet](#)

	Other Resource Collections • NGSS Storyline: Why do some things get colder (or hotter) when they react? • Matter Storyline • Student vs scientific views- overview with further resources • Framework for 3 Course Model: Explanation of Bond Energy	Assessment Options & Performance Tasks • Law of Conservation Lab Test • Assessment Rubric for LP for HS-PS1-7
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Section 3.2: Energy in Chemical Reactions

CK-12 Core Content Reading

YOU DO NOT NEED AN ACCOUNT TO ACCESS CK-12 READINGS

- [Chemical Potential Energy](#)
- [Heat](#)
- [Exothermic Reaction](#)
- [Endothermic Reaction](#)
- [Coulomb's Law](#)
- [Collision Theory](#)
- [Activation Energy](#)
- [Potential Energy Diagrams](#)

Readings & Articles

- [Why Cold Doesn't Exist](#)
- [ACS History of Nitrogen](#)
- [Energy from Fossil Fuels](#); Western Oregon University
- [Fireflies and flashes](#) (activation energy application)
- [Solubility and Coulomb's Law Reading](#)
- [Solubility and Coulomb's Law Questions](#)

Videos & Animations

- [The Energy in Chemical Reactions](#) (28")
 - [Transcript](#) (Annenberg Learner course)
- [Endothermic & Exothermic Crash Course](#)
- [Endothermic & Exothermic](#) Bozeman
- [Fuse School animation on Endo & Exo](#)
- CK-12: [Potential energy Diagrams](#)
- [Bond Energy](#)
- [Collision Theory](#)
- [Collision Theory Animation](#) (CK12)
- [Breaking Bonds](#) (Video Clip)

Simulations & Interactives

- Concord: [Energy in an Explosion](#) (unit of study)
- Concord: [Energy of Bond Formation](#)
- Concord: [Measuring Heat Transfer](#)
- Concord: [Energy Between H₂ and O₂ molecules](#)
- Concord: [Energy Between H and O atoms](#)
- Concord: [Breaking Bonds](#)
- Concord: [Making and Breaking Bonds the effect of Temperature](#)
- ACS [Energy Change in Chemical Reactions](#)
- MERLOT: [Chemical Reactions](#)
- PhET: [Coulomb's Law](#)

Labs

- [Dissolving Lab: temperature drop](#) (then students plan own investigation to determine physical vs. chemical)
- [Temperature Change of Dissolving Reactions](#)
- [Dissolving salts in water: virtual lab](#) with [Student Worksheet](#)
- [Build Hot and Cold Packs](#)
- [Modeling Chemical Bond Energy Using Magnets Part 1](#)
- [Modeling Chemical Bond Energy Using Magnets Part 2](#)

Project Ideas

- [Design & test for the best instant hand warmers.](#)

Engineering Ideas

- [To Heat or Not to Heat Challenge](#)

Other Activities

- [Fun Carbon dioxide ice cream lab](#)
- [Bond Energy Poster](#)
- [Potential Energy v Time Graph](#)
- [Models of Energy Change in Chemical Reactions](#)
- [Lattice Energies Data Table](#)
- [Using bond energies to calculate change in enthalpy and predict exo v. endo](#)

Assessment Options & Performance Tasks

- [Sub-zero test](#)
- [Inner Orbit HS-PS1-4 Assessment](#)

	• PhET: Atomic Interaction • PhET: Energy Forms and Changes Phenomena & Data • Reaction between barium hydroxide and ammonium chloride (Student Directions) (room temp. solids cool to freezing when mixed) • Reaction between pink lemonade powder, baking soda, and water (room temp. substances become colder) • Boiling Water to Snow at -20 • Block and Ice Investigation from CA Rollout Other Resource Collections • NGSS Storyline: Why do some things get colder (or hotter) when they react? • Why Clothes Stick Together • Hindenburg Storyline	
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All Unit Resources

3 Chemical Reactions	
CK-12 Core Content Resource (Reading)	Student Activities
YOU DO NOT NEED AN ACCOUNT TO ACCESS CK-12 READINGS • Activation Energy • Activity Series • Balancing Equations • Chemical Change • Chemical Potential Energy • Chemical Properties and Chemical Reactions • Chemical Reaction • Chemical Symbols and Formulas • Collision Theory • Combination Reactions • Combustion Reaction • Coulomb's Law • Decomposition Reactions • Double Replacement Reactions • Endothermic Reaction • Exothermic Reaction • Heat • Law of Conservation of Mass (spiral from IS 1) • Potential Energy Diagrams • Reactants and Products • Single Replacement Reactions • Synthesis Reaction • Word Equations • Writing Chemical Equations	Labs • Activity Series (ADI format) • Balancing Equations • Build Hot and Cold Packs • Copper Cycle • PASCO Conservation of Matter Lab • PASCO Modeling Chemistry Lab • Reaction types • Temperature Change of Dissolving Reactions Project Ideas • Design & test for the best instant hand warmers. Engineering Ideas • Potential Energy • Race Car Project: Assignment, presentation • To Heat or Not to Heat Challenge Other Activities • Bond Energy Poster • Fun Carbon dioxide ice cream lab • Models of Energy Change in Chemical Reactions • Potential Energy v Time Graph • POGIL Activity: Types of Chemical Reactions Assessment Options & Performance Tasks • Sub-zero test

Supplemental Content Resources

Readings & Articles

- [ACS History of Nitrogen](#)
- Chemicool [“How Important are Chemical Reactions](#)
- [Collision Theory Animation](#) (CK12)
- [Energy from Fossil Fuels](#); Western Oregon University
- [Fireflies and flashes](#) (activation energy application)
- [Links to Real Examples of Compounds](#)
- [Reactants and Products Actively Learn Article](#)
- [Recognizing Chemical Reactions](#)
- [Why Cold Doesn't Exist](#)

Videos & Animations

- [6 Chemical Reactions That Changed History](#) - *It's Okay to be Smart*
- [Balancing Chemical Reactions](#)
- [Basics of Chemical Reactions Animation](#)
- [Bond Energy](#)
- [Chemical Reactions in Daily Life \(short\)](#)
- [Endothermic & Exothermic Bozeman](#)
- [Endothermic & Exothermic Crash Course](#)
- [Fuse School animation on Endo & Exo](#)
- [Potential energy Diagrams](#)
- [Precipitation Reactions](#)
- [Sodium Reactions](#)
- [The Energy in Chemical Reactions](#) (28")
 - [Transcript](#) (Annenberg Learner course)
- [Types of Chemical Reactions](#) - Tyler DeWitt

Simulations & Interactives

- [ACS Energy Change in Chemical Reactions](#)
- [Energy Flow](#)
- [Energy of Bond Formation](#)
- [Chemical Reactions](#) - MERLOT Simulation Collection
- Concord: [Breaking Bonds](#)
- Concord: [Making and Breaking Bonds the effect of Temperature](#)
- PhET [Balancing Act](#)

- PhET: [Coulomb's Law](#)
- PhET: [Atomic Interaction](#)
- PhET [Balancing Chemical Reactions lab](#) (Doc) **Web Link**
- PhET [Reactants, Products, & Leftover](#)
- PLIX [Basic Reaction Types](#)
- PhET: [Energy Forms and Changes](#)
- PhET: [Balancing Chemical Equations](#)
- [Potential energy diagram simulation](#)

Phenomena & Data

- [Block and Ice Investigation](#) from CA Rollout
- [Boiling Water to Snow at -20](#)
- [Combustion demo](#)
- [Decomposition Reaction - Elephant's Toothpaste](#)
- [Why onions make you cry](#)

Other Resource Collections

- [Matter Storyline](#)
- [NGSS Storyline: Why do some things get colder or hotter?](#)
- [Student vs scientific views](#) - overview with further resources
- [Why Clothes Stick Together](#)