

# UNIT 05 Energetics

Content Area: **Science**  
 Course(s): **IB Chemistry, SL**  
 Time Period: **Second Marking period**  
 Length: **2 Week**  
 Status: **Published**

## Unit Overview

---

Fundamental principle—conservation of energy is a fundamental principle of science.

Making careful observations—measurable energy transfers between systems and surroundings.

## STAGE 1- DESIRED RESULTS

### 2020 New Jersey Student Learning Standards- Science

---

|                   |   |
|-------------------|---|
| 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-PS3-1 | 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-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). |

## Cross Cutting Concepts

---

### 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-PS-3)

### Energy and Matter

In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)

### 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)

## **Science and Engineering Practices**

---

### **Developing and Using Models**

Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (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**

Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

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)

### **Obtaining, Evaluating, and Communicating Information**

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.

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)

## **Essential Questions**

---

How do you explain the first law of thermodynamics?

How does the energy change when bonds are broken and when bonds are formed?

How does one calculate the enthalpy changes in chemical reactions?

## Enduring Understanding

---

- Heat is a form of energy.
- Temperature is a measure of the average kinetic energy of the particles.
- Total energy is conserved in chemical reactions.
- Chemical reactions that involve transfer of heat between the system and the surroundings are described as endothermic or exothermic.
- The enthalpy change ( $\Delta H$ ) for chemical reactions is indicated in  $\text{kJ mol}^{-1}$ .
- $\Delta H$  values are usually expressed under standard conditions, given by  $\Delta H^\circ$ , including standard states.
- The enthalpy change for a reaction that is carried out in a series of steps is equal to the sum of the enthalpy changes for the individual steps.
- Bond-forming releases energy and bond-breaking requires energy.
- Average bond enthalpy is the energy needed to break one mol of a bond in a gaseous molecule averaged over similar compound.

## Students will know...

---

Energy

Enthalpy

Exothermic Reaction

Endothermic Reaction

Conservation of Energy

Average bond enthalpy

Hess's Law

Enthalpy of formation

enthalpy of combustion

Specific heat

- Heat is a form of energy.
- Temperature is a measure of the average kinetic energy of the particles.
- Total energy is conserved in chemical reactions.
- Chemical reactions that involve transfer of heat between the system and the surroundings are described as endothermic or exothermic.
- The enthalpy change ( $\Delta H$ ) for chemical reactions is indicated in  $\text{kJ mol}^{-1}$ .
- $\Delta H$  values are usually expressed under standard conditions, given by  $\Delta H^\circ$ , including standard states.
- The enthalpy change for a reaction that is carried out in a series of steps is equal to the sum of the enthalpy changes for the individual steps.

- Bond-forming releases energy and bond-breaking requires energy.
- Average bond enthalpy is the energy needed to break one mol of a bond in a gaseous molecule averaged over similar compounds.
- **Misconception:**
- Students think that energy is released as you break bonds as well.
- Defining entropy as "disorder" and considering visual disorder and entropy as synonymous;
- Inaccurate connection of entropy to the number of inter-molecular interactions;
- Inaccurate connection of entropy of a system and the accompanying entropy changes in its surroundings;
- Entropy of the whole system decreases or does not change when a spontaneous change occurs in an isolated system; and
- Entropy of carbon dioxide is bigger than that of propane or the same at the same temperature.

### **Students will be able to...**

---

- Calculate the heat change when the temperature of a pure substance is changed using  $q=mc\Delta T$ .
- A calorimetry experiment for an enthalpy of reaction should be covered and the results evaluated.
- Apply Hess's Law to calculate enthalpy changes.
- Calculate  $\Delta H$  reactions using enthalpy of formation data.
- Determine the enthalpy change of a reaction that is the sum of multiple reactions with known enthalpy changes.
- Calculate the enthalpy changes from known bond enthalpy values and comparison of these to experimentally measured values.
- Sketch and evaluate potential energy profiles in determining whether reactants or products are more stable and if the reaction is exothermic or endothermic.
- Discuss the bond strength in ozone relative to oxygen in its importance to the atmosphere.

## **STAGE 2- EVIDENCE OF LEARNING**

---

### **Formative Assessment**

---

- 3- Minute Pause
- A-B-C Summaries
- Analogy Prompt
- Choral Response
- Debriefing
- Exit Card / Ticket
- Hand Signals

- Idea Spinner
- Index Card Summaries
- Inside-Outside Circle Discussion (Fishbowl)
- Journal Entry
- Misconception Check
- Observation
- One Minute Essay
- One Word Summary
- Portfolio Check
- Questions & Answers
- Quiz
- Self-Assessment
- Student Conference
- Think-Pair-Share
- Web or Concept Map

### **Authentic Assessments**

---

- Calculation of the heat change when the temperature of a pure substance is changed using  $q=mc\Delta T$ . ( Lab activity)
- A calorimetry experiment for an enthalpy of reaction should be covered and the results evaluated.
- Application of Hess's Law to calculate enthalpy changes. (Lab)
- Determination of the enthalpy change of a reaction that is the sum of multiple reactions with known enthalpy changes.
- Calculation of the enthalpy changes from known bond enthalpy values and comparison of these to experimentally measured values.
- Sketching and evaluation of potential energy profiles in determining whether reactants or products are more stable and if the reaction is exothermic or endothermic.
- Discussion of the bond strength in ozone relative to oxygen in its importance to the atmosphere.

### **Benchmark Assessments**

---

IB Topic 5 Test

### **STAGE 3- LEARNING PLAN**

---

## Instructional Map

---

- Enthalpy changes of combustion ( $\Delta H_c$ ) and formation ( $\Delta H_f$ ) should be covered.
- Consider reactions in aqueous solution and combustion reactions.
- Standard state refers to the normal, most pure stable state of a substance measured at 100 kPa. Temperature is not a part of the definition of standard state, but 298 K is commonly given as the temperature of interest.
- The specific heat capacity of water is provided in the data booklet in section 2.
- Students can assume the density and specific heat capacities of aqueous solutions are equal to those of water, but should be aware of this limitation.
- Heat losses to the environment and the heat capacity of the calorimeter in experiments should be considered, but the use of a bomb calorimeter is not required.
- An application of Hess's Law is  $\Delta H_{\text{reaction}} = \Sigma(\Delta H_f \text{ products}) - \Sigma(\Delta H_f \text{ reactants})$
- Average bond enthalpies are only valid for gases and calculations involving bond enthalpies may be inaccurate because they do not take into account intermolecular forces.

## Modification/Differentiation of Instruction

---

### Differentiation Strategies for Special Education Students

- Remove unnecessary material, words, etc., that can distract from the content
- Use of off-grade level materials
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Time allowed
- Level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Varied homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Ability to work at their own pace
- Present ideas using auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment
- Differentiated checklists and rubrics, if available and appropriate

### Differentiation Strategies for Gifted and Talented Students

- Increase the level of complexity
- Decrease scaffolding
- Variety of finished products
- Allow for greater independence
- Learning stations, interest groups
- Varied texts and supplementary materials
- Use of technology
- Flexibility in assignments
- Varied questioning strategies
- Encourage research
- Strategy and flexible groups based on formative assessment or student choice
- Acceleration within a unit of study
- Exposure to more advanced or complex concepts, abstractions, and materials
- Encourage students to move through content areas at their own pace
- After mastery of a unit, provide students with more advanced learning activities, not more of the same activity
- Present information using a thematic, broad-based, and integrative content, rather than just single-subject areas

### Differentiated Strategies for ELL Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials, including visuals
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language.
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Allow students to work at their own pace
- Presenting ideas through auditory, visual, kinesthetic, & tactile means

- Role play
- Provide graphic organizers, highlighted materials
- Strategy and flexible groups based on formative assessment

### Differentiation Strategies for At Risk Students

- Remove unnecessary materials, words, etc., that can distract from the content
- Provide appropriate scaffolding
- Limit the number of steps required for completion
- Gradually increase the level of independence required
- Tiered centers, assignments, lessons, or products
- Provide appropriate leveled reading materials
- Deliver the content in “chunks”
- Varied texts and supplementary materials
- Use technology, if available and appropriate
- Differentiate homework and products
- Varied questioning strategies
- Provide background knowledge
- Define key vocabulary, multiple-meaning words, and figurative language
- Use audio and visual supports, if available and appropriate
- Provide multiple learning opportunities to reinforce key concepts and vocabulary
- Meet with small groups to reteach idea/skill
- Provide cross-content application of concepts
- Presenting ideas through auditory, visual, kinesthetic, & tactile means
- Provide graphic organizers and/or highlighted materials
- Strategy and flexible groups based on formative assessment

### **504 Plans**

Students can qualify for 504 plans if they have physical or mental impairments that affect or limit any of their abilities to:

- walk, breathe, eat, or sleep
- communicate, see, hear, or speak
- read, concentrate, think, or learn
- stand, bend, lift, or work



Examples of accommodations in 504 plans include:

- preferential seating
- extended time on tests and assignments
- reduced homework or classwork
- verbal, visual, or technology aids
- modified textbooks or audio-video materials
- behavior management support
- adjusted class schedules or grading
- verbal testing
- excused lateness, absence, or missed classwork
- pre-approved nurse's office visits and accompaniment to visits
- occupational or physical therapy

## **Modification Strategies**

---

- Cooperative Grouping
- Extended Time
- Frequent Breaks
- Highlighted Text
- Interactive Notebook
- Modified Test
- Oral Directions
- Peer Tutoring
- Preferential Seating
- Re-direct
- Repeated Drill and Practice
- Shortened Assignment
- Teacher Notes
- Tutorials
- Use of Additional Reference Materials
- Use of Audio Resources

## **Differentiation Strategies**

---

## **High Preparation**

---

- Alternative Assessments

- Choice Boards
- Games and Tournaments
- Group Investigations
- Guided Reading
- Independent Research / Project
- Interest Groups
- Learning Contracts
- Leveled Rubrics
- Literature Circles
- Multiple Intelligence Options
- Multiple Texts
- Personal Agendas
- Project Based Learning (PBL)
- Stations / Centers
- Think-Tac-Toe
- Tiered Activities / Assignments
- Varying Graphic Organizers

## **Low Preparation**

---

- Choice of Book / Activity
- Cubing Activities
- Exploration by Interest (using interest inventories)
- Flexible Grouping
- Goal Setting With Student
- Homework Options
- Jigsaw
- Mini Workshops to Re-teach or Extend Skills
- Open-ended Activities
- Think-Pair-Share by Readiness, Interest, or Learning Style
- Use of Collaboration
- Use of Reading Buddies
- Varied Journal Prompts
- Varied Product Choice
- Varied Supplemental Materials
- Work Alone / Together

## **Horizontal Intergration- Interdisciplinary Connections**

---

See Appendix

## **Vertical Integration- Discipline Mapping**

---

Eighth grade Chemical Interactions

Tenth grade Chemistry

## **Additional Materials**

---

Pearson IB Chemistry, Catrin Brown & Mike Ford

[www.Ibchem.com](http://www.Ibchem.com)

Richard Thornley Video Lessons