

# Unit 06: Thermodynamics

Content Area:

Course(s):

Time Period: **Year**

Length: **180**

Status: **Published**

## Unit 6

|                            |                |
|----------------------------|----------------|
| <b>Unit Title:</b>         | Thermodynamics |
| <b>Suggested Duration:</b> | <b>4 weeks</b> |

## Interdisciplinary Connections

| Interdisciplinary Connections   |
|---|
| <b>Reading and Writing Companion Standards for History, Social Studies, Science and Technical Subjects</b> <ul style="list-style-type: none"><li>▪ <a href="#">Grades 9-10</a></li><li>▪ <a href="#">Grades 11-12</a></li></ul> |
| <b>Math Practices:</b><br><a href="https://www.nj.gov/education/standards/math/Index.shtml">https://www.nj.gov/education/standards/math/Index.shtml</a>   |
| <b>Science Practices:</b><br><a href="https://www.nj.gov/education/standards/science/Index.shtml">https://www.nj.gov/education/standards/science/Index.shtml</a>  |
| Find and paste appropriate <u>Companion Standards or Practices</u> here.  |

Mathematics—Metric conversions, solving for an unknown, interpreting graphs

Language Arts- Reading scientific documents for comprehension, writing conclusions, writing lab reports

Social Studies—Historical events leading to scientific discoveries and/or revisions

Foreign Language – Chemical nomenclature relates to the learning of any language

## Technology Integration

| Technology Integration  |
|---|
| Northern supports the integration of the <a href="#">SAMR Model</a> : a framework which extends learning through the use of technology. The installation of interactive boards, the purchase of softwares and subscriptions, and the investment in 1:1 laptops and various other instructional technologies are examples of Northern's commitment to enhancing students' learning and preparing the 21st century learner for college and careers. |

- *Use of Atomic Emission Spectroscopes*
- Vernier Computer-based probes and software
- ViewBoard for presentation of information and interactive activities
- United Streaming/Discovery Education
- Laptops/Computer Lab—web based project
- AP Classroom.

## Standard(s) Addressed

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ENE-2.A Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation.

ENE-2.B Represent a chemical or physical transformation with an energy diagram.

ENE-2.C Explain the relationship between the transfer of thermal energy and molecular collisions.

ENE-2.D Calculate the heat  $q$  absorbed or released by a system undergoing heating/ cooling based on the amount of the substance, the heat capacity, and the change in temperature.

ENE-2.E Explain changes in the heat  $q$  absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition

ENE-2.F Calculate the heat  $q$  absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.

ENE-3.A Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.

ENE-3.B Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation.

ENE-3.C Represent a chemical or physical process as a sequence of steps.

ENE-3.D Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.

## STAGE I Desired Results

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| <b>STAGE I Desired Results</b>   |
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| <b><i>Objective (Transfer)</i></b>   |
| <p><i>The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter. The availability or disposition of energy plays a role in virtually all observed chemical processes. Thermodynamics provides tools for understanding this key role, particularly the conservation of energy, including energy transfer in the forms of heat and work. Chemical bonding is central to chemistry. A key concept to know is that the breaking of a chemical bond inherently requires an energy input, and because bond formation is the reverse process, it will release energy. In subsequent units, the application of</i></p> |

*thermodynamics will determine the favorability of a reaction occurring.*

### **Mastery**

#### Big Ideas/Understanding

#### **BIG IDEA 3: TRANSFORMATIONS (TRA)**

At its heart, chemistry is about the rearrangement of matter. Understanding the details of these transformations requires reasoning at many levels as one must quantify what is occurring both macroscopically and at the atomic level during the process. This reasoning can be as simple as monitoring amounts of products made or as complex as visualizing the intermolecular forces among the species in a mixture. The rate of a transformation is also of interest, as particles must move and collide to initiate reaction events.

#### **BIG IDEA 4: ENERGY (ENE)**

Energy has two important roles in characterizing and controlling chemical systems. The first is accounting for the distribution of energy among the components of a system and the ways that heat exchanges, chemical reactions, and phase transitions redistribute this energy. The second is in considering the enthalpic and entropic driving forces for a chemical process. These are closely related to the dynamic equilibrium present in many chemical systems and the ways in which changes in experimental conditions alter the positions of these equilibria.

#### Essential Questions

Why is energy released when water becomes an ice cube?

How are chemical transformations that require bonds to break and form influenced by energy?

### **Acquisition**

*Students will know . . .*

[See essential knowledge in each topic of College Board for Unit 6](#)

*Students will be skilled at . . .*

The ability to link atomic- and particulate level phenomena and models to macroscopic phenomena is central to the study of chemistry. In previous units, students used representations, equations, and reasoning to demonstrate this ability. In Unit 6, students will develop justifications for claims made about the



- 6.2 Energy Diagrams
- 6.3 Heat Transfer and Thermal Equilibrium
- 6.4 Heat Capacity and Calorimetry
- 6.5 Energy of Phase Changes
- 6.6 Introduction to Enthalpy of Reaction
- 6.7 Bond Enthalpies
- 6.8 Enthalpy of Formation
- 6.9 Hess's Law

### Modifications

**How are the activities modified/differentiated? (i.e.: abridged text)**

Modifications on 504 plans may be submitted at ([SSD](#)), prior to testing. Both exclusion **statements** and **extensions** exist for each standard to accommodate different paces.

### Specific Resources for Unit

#### Specific Resources for Unit

Attached Affirmative Action Compliance Checklist

Selected College-Board practice problems

Chang, Raymond and Goldsby, Kenneth A. Chemistry, 13th Edition. New York, McGraw-Hill. 2019

The College Board. AP Chemistry Guided Inquiry Experiments: Applying the Science Practices. 2013.

Demmin, Peter and David Hostage. AP Chemistry, Fifth Edition. New York: D&S Marketing Systems, Inc., 2005

Vonderbrink, Sally. Laboratory Experiments for Advanced Placement Chemistry. Batavia: Flinn Scientific, 2001.

POGIL Activities for High School Chemistry, Batavia: Flinn Scientific, 2012, AP Classroom

### Diversity, Equity, & Inclusion

#### Diversity, Equity & Inclusion

Provide a brief description of how this unit addresses DE&I.

## Career Readiness (9.2), Life Literacies and Key Skills (9.4) Standards

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|--------------|--|
| WRK.K-12.P.1 | Act as a responsible and contributing community members and employee.                      |
| WRK.K-12.P.2 | Attend to financial well-being.  |
| WRK.K-12.P.3 | Consider the environmental, social and economic impacts of decisions.                      |
| WRK.K-12.P.4 | Demonstrate creativity and innovation.   |
| WRK.K-12.P.5 | Utilize critical thinking to make sense of problems and persevere in solving them.         |
| WRK.K-12.P.6 | Model integrity, ethical leadership and effective management.                              |
| WRK.K-12.P.7 | Plan education and career paths aligned to personal goals.                                 |
| WRK.K-12.P.8 | Use technology to enhance productivity increase collaboration and communicate effectively. |
| WRK.K-12.P.9 | Work productively in teams while using cultural/global competence.                         |

## Climate Change Education

| ClimateChange Education   |                          |
|---|--------------------------|
| Enduring Understandings/Core Ideas  | Performance Expectations |
| Math and ELA- Provide a brief description of a lesson or activity that relates to Climate Change. All other Content Team copy and paste the <u>Core Idea and Performance Expectation</u> from NJDOE link above. |                          |