Unit 09: Applications of Thermodynamics

Content Area:
Course(s):
Time Period: **Year**
Length: **180**
Status: **Published**

Unit 9

Unit Title:	Applications of Thermodynamics
Suggested Duration:	**Three weeks**

Interdisciplinary Connections

Interdisciplinary Connections
Reading and Writing Companion Standards for History, Social Studies, Science and Technical Subjects ▪ Grades 9-10 ▪ Grades 11-12 **Math Practices**: https://www.nj.gov/education/standards/math/Index.shtml **Science Practices**: https://www.nj.gov/education/standards/science/Index.shtml Find and paste appropriate Companion Standards or Practices 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 SAMR Model: 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

Course Skills

ENE-4.A Identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.
ENE-4.B Calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process.
ENE-4.C Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of ΔGo
ENE-4.D Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate.
ENE-5.A Explain whether a process is thermodynamically favored using the relationships between K, ΔGo , and T.
ENE-5.B Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes.
ENE-6.A Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell.
ENE-6.B Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half-reactions within the cell.
ENE-6.C Explain the relationship between deviations from standard cell conditions and changes in the cell potential.
ENE-6.D Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.

STAGE I Desired Results

STAGE I Desired Results
Objective (Transfer)

This unit allows students to connect principles and calculations across Units 5–8. The thermodynamics of a chemical reaction is connected to both the structural aspects of the reaction and the macroscopic outcomes of the reaction. All changes in matter involve some form of energy change. One key determinant of chemical transformations is the change in potential energy that results from changes in electrostatic forces. Chemical systems undergo three main processes that change their energy: heating/cooling, phase transitions, and chemical reactions. Applying the laws of thermodynamics will allow students to describe the essential role of energy and explain and predict the direction of changes in matter.

Mastery	
Big Ideas/Understandings **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 How does water flow uphill? How is the favorability of a chemical or physical transformation determined? How is electrical energy generated using chemical reactions?
Acquisition	
Students will know . . . *See "essential knowledge" in each topic of College Board CED for Unit 9*	*Students will be skilled at . . .* To achieve success in AP Chemistry and in Unit 9 specifically, students must connect principles and calculations across the areas of kinetics, thermodynamics, equilibrium, and electrochemistry to explain and support claims about what is happening in chemical systems. Sometimes support of such claims comes from students being able to estimate an approximate value of a required characteristic of a chemical system rather than use a routine application of an algorithm. Students are introduced to entropy as a factor that is necessary to explain why some endothermic reactions occur in spite of the lower energy that products may have in exothermic changes. Students will use particulate representations and graphical distribution of kinetic energy to describe the increase in entropy with increasing temperature. In addition, students will explore how to use Gibbs free energy for determining the thermodynamic favorability by considering the change in both enthalpy and entropy. Students will use the concepts of thermodynamics to generate more comprehensive claims about what is

	happening in a galvanic or electrolytic cell.

STAGE II Assessment Evidence

STAGE II Assessment Evidence	
Common Summative Assessments	Common Formative Assessments
Tests Quizzes Laboratory Reports and analyses	Exit Slips Quizzes Homework Problems Participation in class discussions and in performance of lab experiments Laboratory notebook AP Classroom Unit checks
Modifications	
How are the evaluations/assessments modified/accelerated? (i.e.: alternate assessment). All courses follow a balanced assessment system with Practice, Assessments, Evaluations.	

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.

STAGE III Learning Plan

STAGE III Learning Plan
Organize plan by weeks
9.1 Introduction to Entropy 9.2 Absolute Entropy and Entropy Change 9.3 Gibbs Free Energy 9.4 Thermodynamic and Kinetic Control 9.5 Free Energy and Equilibrium 9.6 Coupled Reactions

9.7 Galvanic (Voltaic) and Electrolytic Cells
9.8 Cell Potential and Free Energy
9.9 Cell Potential Under Nonstandard Conditions
9.10 Electrolysis and Faraday'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

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 Core Idea and Performance Expectation from NJDOE link above.	