Unit 07: Equilibrium

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

Unit 7

Unit Title:	Equilibrium
Suggested Duration:	**Four 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

TRA-6.A Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations.
TRA-6.B Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions.
TRA-7.A Represent the reaction quotient Qc or Qp , for a reversible reaction, and the corresponding equilibrium expressions Kc = Qc or K p = Qp .
TRA-7.B Calculate Kc or K p based on experimental observations of concentrations or pressures at equilibrium.
TRA-7.C Explain the relationship between very large or very small values of K and the relative concentrations of chemical species at equilibrium.
TRA-7.D Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction.
TRA-7.E Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant.
TRA-7.F Represent a system undergoing a reversible reaction with a particulate model.
TRA-8.A Identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle.
TRA-8.B Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium.
SPQ-5.A Calculate the solubility of a salt based on the value of K sp for the salt.
SPQ-5.B Identify the solubility of a salt, and/or the value of K sp for the salt, based on the concentration of a common ion already present in solution.
SPQ-5.C Identify the qualitative effect of changes in pH on the solubility of a salt.
SPQ-5.D Explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.

STAGE I Desired Results

STAGE I Desired Results	
Objective (Transfer)	
Chemical equilibrium is a dynamic state in which opposing processes occur at the same rate. In this unit, students learn that any bond or intermolecular attraction that can be formed can be broken. These two processes are in a dynamic competition, sensitive to initial conditions and external perturbations. A change in conditions, such as addition of a chemical species, change in temperature, or change in volume, can cause the rate of the forward and reverse reactions to fall out of balance. Le Châtelier's principle provides a means to reason qualitatively about the direction of the shift in an equilibrium system resulting from various possible stresses. The expression for the equilibrium constant, K, is a mathematical expression that describes the equilibrium state associated with a chemical change. An analogous expression for the reaction quotient, Q, describes a chemical reaction at any point, enabling a comparison to the equilibrium state. Subsequent units will explore equilibrium constants that arise from acid-base chemistry.	
Mastery	
Big Ideas/Understandings	Essential Questions
BIG IDEA 1: SCALE, PROPORTION, AND QUANTITY (SPQ) Quantities in chemistry are expressed at both the macroscopic and atomic scale. Explanations, predictions, and other forms of argumentation in chemistry require understanding the meaning of these quantities, and the relationship between quantities at the same scale and across scales.	Why is a waterfall considered a spontaneous reaction? How can reactions occur in more than one direction? How is caffeine removed from coffee?
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	Why is food stored in a refrigerator?

events.	
Acquisition	
Students will know . . . *See "essential knowledge" in each topic of College Board CED for Unit 7*	*Students will be skilled at . . .* Building on practices from earlier units where students translated between representations of chemical systems, they will now construct equilibrium expressions from reaction equations. Students should also illustrate the dynamic nature of the chemical reaction through particulate level representations, portraying both the forward and reverse rates of the reaction equations. They will construct and describe graphs that represent a chemical system in equilibrium and connect them to their particulate-level representations and equilibrium expressions. In conjunction with their constructed equilibrium expressions, students will practice using experimental data to calculate the reaction quotient (Q) and equilibrium constant (K) for a reaction. Using Le Châtelier's principle, they will also support claims made about the dominant direction of a reaction once stresses like changes in concentration, pressure, volume, or temperature are introduced.

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 7.1 Introduction to Equilibrium 7.2 Direction of Reversible Reactions 7.3 Reaction Quotient and Equilibrium Constant 7.4 Calculating the Equilibrium Constant 7.5 Magnitude of the Equilibrium Constant 7.6 Properties of the Equilibrium Constant 7.7 Calculating Equilibrium Concentrations 7.8 Representations of Equilibrium 7.9 Introduction to Le Chatlier's Principle 7.10 Reaction Quotient and Le Chatlier's Principle 7.11 Introduction to Solubility 7.12 Common-Ion Effect 7.13 pH and Solubility 7.14 Free Energy of Dissolution
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.	