

# Unit 7: Chemical Equilibrium

Content Area: **Science**  
Course(s):  
Time Period: **Marking Period 4**  
Length: **15 Days**  
Status: **Published**

## Summary

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Introductory chemical reactions often proceed in the forward direction; however, many chemical processes from simple acid-base to complex biochemistry exist in equilibrium. This means instead of an arrow pointing forward ( $\rightarrow$ ) there is a pair of arrows  $\leftrightarrow$ . In this unit, students will encounter systems at equilibrium and what happens when that equilibrium is tested or “stressed.” The chemistry of acids and bases (and other solutions) is often in equilibrium and these substances can be investigated beyond what students may already know (i.e. pH).

Revised July 2021

MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
LA.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
LA.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
LA.RST.9-10.6	Determine the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.
LA.WHST.9-10.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
SCI.HS-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
LA.WHST.9-10.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
SCI.HS-PS1-6	Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
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.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.
TECH.8.1.12	Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.2.12	Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
TECH.9.4.12.CT	Critical Thinking and Problem-solving
TECH.9.4.12.TL	Technology Literacy
TECH.9.4.12.GCA	Global and Cultural Awareness
TECH.9.4.12.IML	Information and Media Literacy

## Essential Questions / Enduring Understandings

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### Essential Questions

What occurs for a chemical process to exist at equilibrium?

How can chemical processes be “stressed” and what happens when they are?

How is the pH midpoint represented by an equilibrium process?

### Enduring Understandings

Equilibrium is a point where two competing processes (forward and reverse) occur at equal rates.

Systems can be stressed by changes in temperature, pressure, and addition/removal of reagents.

pH is scaled logarithmically so a change of 1 on the scale represents a solution becoming 10x more or less acidic.

## Objectives

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Students will know how to recognize a system at equilibrium.

Students will know the difference between strong and weak acids or bases.

Students will know the primary definitions of acids and bases.

Students will know how the temperature and pressure affect the solubility of solutes (or equilibrium of a solution).

Students will know how to calculate the concentration of a solution (molarity/molality).

Students will know how the properties of a solution (i.e. boiling point) are affected by concentration (molality).

Students will be skilled at predicting the result when a system at equilibrium is “stressed.”

Students will be skilled at calculating the pH of a solution.

Students will be skilled at recognizing equations including strong or weak acids and bases.

## **Learning Plan**

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Preview essential questions and connect them to the concepts we will cover in the unit.

Identify natural systems (chemical or other) that are in equilibrium and predict what would happen if “stressed.”

Define chemical equilibrium and the manners in which a chemical process at equilibrium can be stressed (limit future assessment to what can be demonstrated in class).

Differentiate between strong and weak acids and bases.

Calculate the pH of a solution and determine the percent acidity change for a 0.1 and 1.0 change in pH level.

Utilize chemical equations, pH, and the concept of equilibrium to identify strong and weak acids and bases.

Define acids and bases according to their behavior as described by Arrhenius, Bronsted, and Lewis.

Prepare solutions of specific molar or molal concentrations (i.e. for use during a lab).

Investigate how temperature affects the solubility of substances (or pressure on gases) and/or equilibrium of a solution.

Predict and experimentally determine the change in boiling point when a solute is dissolved in water.

## **Assessment**

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### **Formative Assessment**

Define equilibrium and distinguish between equations of processes at equilibrium or not.

Identify strong and weak acids and bases by properties and when viewing equations.

Define acids and bases according to three characteristics (Arrhenius, Bronsted, Lewis).

Calculate the pH of a solution.

Determine how temperature and pressure affect the solubility of a substance (or equilibrium of solution).

### **Benchmark Assessment**

## Final Exam

### Alternative Assessment

Prepare solutions of specific molar or molal concentrations.

Evaluate the change in boiling point of water with the addition of a solute.

Identify “stresses” and predict the shift in equilibrium if stress is applied to a system.

### Summative Assessment

Unit Quizzes

Unit Tests

## Materials

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Guided notes or teacher handouts

Lab Handouts (Boiling Point Elevation Lab, Ka of Acetic Acid Lab, Titration of Vinegar Lab, NOTE: Supplies for each lab included on handout.)

Simulations:

“Collisions” [<https://app.playmada.com/Collisions/>] Acids/Bases, Equilibrium

“Virtual Titration Experiment” [<https://virtual.edu.rsc.org/titration/experiment/2>]

“pH Scale: Basics” [<https://phet.colorado.edu/en/simulation/ph-scale-basics>]

“pH Scale” [<https://phet.colorado.edu/en/simulation/ph-scale>]

“Acid-Base Solutions” [<https://phet.colorado.edu/en/simulation/acid-base-solutions>]

“Molarity” [<https://phet.colorado.edu/en/simulation/molarity>]

“Concentration” [<https://phet.colorado.edu/en/simulation/concentration>]

## Integrated Accommodations and Modifications Spec Ed., ELL, At-Risk, G&T, Career

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## Education, 504s

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<https://docs.google.com/spreadsheets/d/1CvoX6NXdGUPrTPcEqPOsnWbqpDLS4Ego1W1eaIrGYTo/>