

14 - Acids, Bases, and the pH concept

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **7 Blocks***
Status: **Published**

General Overview, Course Description or Course Philosophy

Chemistry CP aims to provide students with a fundamental understanding of the composition, structure, properties, and transformations of matter. Through a combination of theoretical concepts, laboratory investigations, and real-world applications, students will explore the principles and laws that govern chemical reactions and interactions. The course emphasizes the development of scientific inquiry skills, critical thinking abilities, and the application of problem-solving strategies. Students will actively engage in the process of scientific discovery, asking questions, seeking answers, and making connections between theory and practical applications. Laboratory experiences will integrate with theoretical knowledge, fostering the development of practical skills, scientific inquiry, and responsible practices. Students will also explore the ethical considerations and societal implications of chemistry, promoting informed decision-making as responsible citizens. By the end of the course, students will have a deepened appreciation for the relevance of chemistry in everyday life and will be prepared for further study and careers in scientific fields.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Objectives:

- Define and describe acids and bases based on their characteristic properties, behavior in water, and chemical formulas.
- Use the pH scale to quantify the acidity or basicity of a solution and interpret pH values.
- Classify acids and bases as strong or weak based on their ionization or dissociation in water.
- Perform calculations related to pH, pOH, H⁺ and OH⁻ concentrations, and acid/base neutralization reactions.
- Relate the strength of an acid or base to its tendency to donate or accept protons (H⁺ ions).
- Understand and explain the concept of acid-base equilibrium and the role of conjugate acid-base pairs.
- Apply the principles of acids, bases, and pH to real-world scenarios, such as water quality analysis, antacid effectiveness, and buffer solutions.
- Conduct experiments and investigations to explore acid-base reactions and the effects of pH on indicators.
- Analyze and interpret data, graphs, and models related to acids, bases, and pH.
- Communicate scientific ideas and findings effectively, using appropriate terminology and units.

Essential Questions:

- What are acids and bases, and how do their properties and behaviors differ?
- How is the acidity or basicity of a solution quantitatively measured using the pH scale?
- What are the different methods for classifying acids and bases based on their chemical formulas and observable properties?
- How do acid-base reactions occur, and what products are formed as a result?
- In what ways are the concepts of acids, bases, and pH relevant and applicable in environmental

science, medicine, and chemical analysis?

Enduring Understandings:

- Acids and bases are two distinct types of compounds that exhibit characteristic properties and behaviors.
- The pH scale is a quantitative measure of the acidity or basicity of a solution, ranging from acidic (pH < 7) to neutral (pH = 7) to basic (pH > 7).
- Acids and bases can be classified based on their chemical formulas, observable properties, and behavior in water.
- Acid-base reactions involve the transfer of protons (H⁺ ions) from acids to bases, leading to the formation of water and a salt.
- Understanding acids, bases, and the pH concept is essential for various applications, such as environmental science, medicine, and chemical analysis.

CONTENT AREA STANDARDS

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|-------------------|---|
| SCI.9-12.HS-PS1-7 | Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. |
| SCI.9-12.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. |

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

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|-----------------|---|
| LA.RST.9-10.1 | Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions. |
| LA.RST.9-10.2 | Determine the central ideas, themes, or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. |
| LA.RST.9-10.7 | Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. |
| 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.3 | Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. |
| TECH.K-12.1.3.d | build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. |
| TECH.K-12.1.4.a | know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. |

STUDENT LEARNING TARGETS

Refer to the 'Declarative Knowledge' and 'Procedural Knowledge' sections.

Declarative Knowledge

Students will understand that:

- There are multiple definitions of acids and bases, each with distinct applications.
- Acids and bases are considered opposites in many ways and combine in neutralization reactions.
- The pH scale can be used to describe the strength or concentration of acids and bases.
- Acids can be monoprotic or polyprotic.
- Substances like water that can be both acidic and basic exhibit amphotericism.
- The volume or moles of an acid or base used in a neutralization reaction determines the amount of water produced [Honors]

Procedural Knowledge

Students will be able to:

- Identify and describe evidence to construct the explanation, including:
 - Evidence (e.g., from a table of data) of a pattern that increases in concentration (e.g., a change in one concentration while the other concentration is held constant) increase the reaction rate, and vice versa; and
 - Evidence of a pattern that increases in temperature usually increases the reaction rate, and vice versa.
- Use and describe the following chain of reasoning that integrates evidence, facts, and scientific principles to construct the explanation:
 - Molecules that collide can break bonds and form new bonds, producing new molecules.
 - The probability of bonds breaking in the collision depends on the kinetic energy of the collision being sufficient to break the bond since bond breaking requires energy.
 - Since temperature is a measure of average kinetic energy, a higher temperature means that molecular collisions will, on average, be more likely to break bonds and form new bonds.
 - At a fixed concentration, molecules that are moving faster also collide more frequently, so molecules with higher kinetic energy are likely to collide more often.
 - A high concentration means that there are more molecules in a given volume and thus more particle collisions per unit of time at the same temperature.
- Given a chemical reaction, use mathematical representations to
 - Predict the relative number of atoms in the reactants versus the products at the atomic-molecular scale; and
 - Calculate the mass of any component of a reaction, given any other component.

EVIDENCE OF LEARNING

Refer to the 'Formative Assessments' and 'Summative Assessments' sections.

Formative Assessments

- POGIL Activities:
 - Acids and Bases
 - Strong vs Weak Acids
 - Calculating pH
- Labs
 - Titrations
 - Stock Solution Dilutions
 - Colorimetric Analysis
- Group practice
 - Molarity
 - Acid/Base Calculations
 - pH Calculations
 - Titration Calculations
- Performance Scale/ Student Tracking Chart
- Whiteboards
- Exit Tickets
- Homework

Summative Assessments

- Benchmarks – departmental benchmark given at the end of MP1, MP2, and MP3 based on lab practices
- Alternative Assessments
 - Lab inquiries and investigations
 - Lab Practicals
 - Exploratory activities based on phenomenon
 - Gallery walks of student work
 - Creative Extension Projects
 - Build a model of a proposed solution
 - Let students design their own flashcards to test each other
 - Keynote presentations made by students on a topic

- Portfolio
- Determining pH Quiz
- Titration Calculation Lab Report

RESOURCES (Instructional, Supplemental, Intervention Materials)

[CK-12 Online Textbook](#)

POGIL Chemistry

Gizmos Simulations

PhET Simulations

Khan Academy

Bozeman Science

American Chemical Society

INTERDISCIPLINARY CONNECTIONS

ELA/Literacy

Mathematics

Technology

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.