13 - Properties of Solutions

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **6 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 the properties of solutions, including solubility, miscibility, concentration, and saturation.
- Calculate and express the concentration of solutions using mass percent, mole fraction, and molarity.
- Explain the factors that influence solubility, such as temperature, pressure, and the nature of the solute and solvent.
- Define and understand colligative properties, including vapor pressure lowering, boiling point elevation, and freezing point depression.
- Apply mathematical relationships and formulas to calculate colligative properties of solutions.
- Predict the behavior of solutions and the changes in colligative properties based on changes in temperature, pressure, and solute concentration.
- Relate the understanding of solutions and colligative properties to practical applications, such as drug delivery, antifreeze solutions, and osmotic pressure in cells.
- Conduct experiments and collect data to investigate and demonstrate the properties of solutions and colligative properties.
- Analyze and interpret data, graphs, and models related to solutions and colligative properties.
- Communicate scientific ideas and findings effectively, using appropriate terminology and units.

Essential Questions:

- What are the properties of solutions, and how do they differ from those of the individual solute and solvent components?
- How can the concentration of a solution be expressed, and what factors affect the solubility of solutes in solvents?

- What are colligative properties, and how do they depend on the concentration of solute particles in a solution?
- How do changes in temperature, pressure, and solute concentration impact the behavior of solutions and their colligative properties?
- In what ways are the properties of solutions and colligative properties relevant and applicable in various scientific fields and everyday life?

Enduring Understandings:

- Solutions are homogeneous mixtures composed of a solute and a solvent, with properties that differ from those of the individual components.
- The concentration of a solution can be expressed in various ways, including mass percent, mole fraction, and molarity.
- The behavior of solutions is influenced by factors such as solubility, temperature, pressure, and the nature of the solute and solvent.
- Colligative properties of solutions, including vapor pressure lowering, boiling point elevation, and freezing point depression, depend on the concentration of solute particles rather than their identity.
- Understanding the properties of solutions and colligative properties has practical applications in fields such as medicine, environmental science, and industrial processes.

CONTENT AREA STANDARDS

SCI.9-12.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.
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)

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.
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.
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.

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.

STUDENT LEARNING TARGETS

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

Declarative Knowledge

Students will understand that:

- The process of a solute dissolving into a solvent depends on attractions between their molecules.
- The concentration of a solution can be described qualitatively (as dilute or concentrated) or quantitatively, using a variety of units.
- The maximum amount of a gas or solid in water varies with temperature, shown by graphs known as solubility curves.
- The properties of a solution differ from those of the pure solvent (freezing point depression and boiling point elevation).
- Molarity expresses the moles of solute dissolved per liter of solution, and can be used to calculate the volume needed to dilute a solution.
- The solubility of an ionic compound at a particular temperature can be calculated using equilibrium expressions. [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) increases 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.

- Identify and describe potential changes in a component of the given chemical reaction system that will increase the amounts of particular species at equilibrium. Students use evidence to describe the relative quantities of a product before and after changes to a given chemical reaction system (e.g., concentration increases, decreases, or stays the same), and will explicitly use Le Chatelier's principle, including:
    - How, at a molecular level, stress involving a change to one component of an equilibrium system affects other components;
    - That changing the concentration of one of the components of the equilibrium system will change the rate of the reaction (forward or backward) in which it is a reactant until the forward and backward rates are again equal; and
    - A description of a system at equilibrium that includes the idea that both the forward and backward reactions are occurring at the same rate, resulting in a system that appears stable at the macroscopic level.

EVIDENCE OF LEARNING

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

Formative Assessments

- POGIL Activities:
    - Saturated and Unsaturated Solutions
    - Solubility
    - Molarity
- Labs
    - Solubility vs. Temperature
    - Freezing Point Depression
- Group practice
    - Molarity Calculations
    - Properties of Solutions
    - Saturation Points
    - Boiling and Freezing Point
- 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
- Solutions and Molarity Test
- Freezing Point Depression 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.