09 - Gas Laws and the Behavior of Gases

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **9 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 gases, including pressure, volume, temperature, and the number of moles.
- Apply Boyle's Law, Charles's Law, and the Combined Gas Law to analyze and predict the changes in gas properties.
- Use the Ideal Gas Law equation (PV = nRT) to solve problems involving gases at various conditions.
- Understand and explain the principles of the kinetic molecular theory as it relates to gas behavior.
- Conduct experiments and collect data to verify gas laws and principles.
- Analyze and interpret data and graphs related to gas behavior and properties.
- Apply gas laws and principles to real-world applications, such as gas storage, weather phenomena, and gas behavior in biological systems.
- Communicate scientific ideas and findings related to gas laws and the behavior of gases effectively, using appropriate terminology and units.
- Apply critical thinking skills to evaluate and analyze gas-related scenarios and problems.
- Recognize the limitations and deviations of the Ideal Gas Law under certain conditions, such as high pressures or low temperatures.

Essential Questions:

- How can the behavior of gases be described and predicted using gas laws?
- What are the key properties of gases, and how do pressure, volume, temperature, and the number of moles relate to each other?
- How do Boyle's Law, Charles's Law, and the Combined Gas Law explain the relationships between gas properties?

- What is the Ideal Gas Law, and how does it provide a comprehensive equation for gases?
- How does the kinetic molecular theory help explain the behavior of gases at the microscopic level?

Enduring Understandings:

- Gases occupy space and have properties that can be described and predicted using the principles of gas laws.
- The behavior of gases can be explained by concepts such as pressure, volume, temperature, and the number of moles.
- Gas laws, including Boyle's Law, Charles's Law, and the Combined Gas Law, describe the relationships between these properties.
- The Ideal Gas Law provides a comprehensive equation that relates the pressure, volume, temperature, and number of moles of a gas.
- The kinetic molecular theory helps explain the microscopic behavior of gases and provides insights into gas properties and behavior.

CONTENT AREA STANDARDS

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.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

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 kinetic molecular theory describes the motion of particles in a gas.
- The pressure of a contained gas is the result of the collisions of particles with the walls of the container, and is expressed in several units.
- The average velocity of gas particles is directly proportional to the temperature (in Kelvin)
- Most of the volume of a gas is empty space, which can either be compressed or allowed to expand into a larger container.
- The ideal gas law describes the relationships between pressure, volume, temperature, and the amount (moles) of a gas.
- When gases react with each other, their amounts and the amount of product can be predicted with stoichiometry [Honors]

Procedural Knowledge

Students will be able to:

- Use scientific knowledge to generate the design solution
    - Restate the original complex problem into a finite set of two or more sub-problems (in writing or as a diagram or flow chart).
    - For at least one of the sub-problems, propose two or more solutions that are based on student-generated data and/or scientific information from other sources.
    - Describe how solutions to the sub-problems are interconnected to solve all or part of the larger problem.
- 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:
    - Gas Variables
- Labs
    - Boyle's Law (Syringe)
    - Charles' Law (Flask)
    - The Molar Mass of Butane
    - Volume of H_2
- Group practice
    - Boyle's Law Calculations
    - Charles' Law Calculations
    - Gay-Lussac and Combined Gas Law Calculations
    - Ideal Gas Law Calculations
    - Real vs. Ideal Gases
- 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
- Gas Law Quiz
- Gas Laws and Calculations Test
- Boyle's and Charles' Law 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.