08 - Stoichiometry

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **11 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 stoichiometry and explain its significance in understanding chemical reactions.
- Balance chemical equations and use them to determine mole-to-mole ratios between reactants and products.
- Perform stoichiometric calculations to predict the amounts of reactants consumed and products formed.
- Identify and calculate the limiting reactant in a chemical reaction.
- Calculate the theoretical yield of a product based on stoichiometric calculations.
- Determine percent yield by comparing the actual yield of a product to the theoretical yield.
- Apply stoichiometry to real-world contexts, such as industrial processes, environmental analysis, and pharmaceutical development.
- Analyze and interpret stoichiometric calculations and data to draw conclusions about chemical reactions.
- Communicate stoichiometric calculations and results effectively, using appropriate units and significant figures.
- Develop problem-solving skills and critical thinking through the application of stoichiometric principles.

Essential Questions:

- What is stoichiometry, and why is it important in chemistry?
- How do balanced chemical equations provide the foundation for stoichiometric calculations?
- What is a limiting reactant, and how does it influence the amount of product that can be formed?
- How can theoretical yield and percent yield be determined in a chemical reaction?

- In what ways can stoichiometry be applied in real-world scenarios and industries?

Enduring Understandings:

- Stoichiometry is a fundamental concept in chemistry that allows us to quantitatively analyze and predict the amounts of reactants and products in a chemical reaction.
- Balanced chemical equations provide the basis for stoichiometric calculations by establishing the mole-to-mole ratios between reactants and products.
- The concept of limiting reactants helps identify the reactant that limits the amount of product that can be formed in a chemical reaction.
- Theoretical yield represents the maximum amount of product that can be obtained based on stoichiometric calculations, while actual yield accounts for experimental limitations and can be used to determine percent yield.
- Stoichiometry has practical applications in various fields, including industrial processes, environmental analysis, and pharmaceutical development.

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-PS1-7	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:

- Chemical equations are balanced to satisfy the law of conservation of matter/mass.
- A balanced equation can be interpreted as a ratio of molecules, moles, or volume, but not mass.
- The mass of expected products can be predicted from the given mass of reactants.
- Often the amount of one reactant is limiting while the amount of another is in an excess amount.
- Not all reactions go to completion, leading to a lower than 100% yield.

Procedural Knowledge

Students will be able to:

- Use scientific knowledge to generate a design solution
    - Students 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, students 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 the mathematical representations to
    - Predict the relative number of atoms in the reactants versus the products at the atomic molecular scale;
    - Calculate the mass of any component of a reaction, given any other component.
- 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, a 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:
    - Limiting and Excess Reactants
    - Mole Ratios
- Labs
    - Copper/Silver Nitrate Reaction
    - Relating Moles to Coefficients
    - Limiting Reactants in Lead(II) Iodide Precipitation
    - Percent Yield Determination
- Group practice
    - Stoichiometric Conversions
        - Mole-to-Mole
        - Mass-to-Mass
        - Volume and Particles
    - Limiting Reactant Calculations
    - Excess Reactant Calculations
    - Percent Yield 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
- Mass-Mole Conversions Quiz
- Stoichiometry Test
- Limiting Reactants and Percent Yield 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.