

06 - Chemical Quantities and the Mole Concept

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **8 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 apply the mole concept to convert between the mass and number of particles (atoms, molecules, or formula units) of a substance.
- Calculate the percent composition of a compound based on the masses or quantities of its elements.
- Use the concept of molar mass to convert between mass and moles of a substance.
- Solve problems involving the determination of empirical and molecular formulas based on experimental data and percent composition.
- Analyze and interpret data, tables, and experimental results to calculate chemical composition and quantities.
- Communicate numerical calculations and results using appropriate units and significant figures.
- Recognize and apply the concept of molar volume in the context of gases and gas stoichiometry.
- Relate the mole concept to real-life applications, such as the calculation of amounts of substances in industrial processes or environmental analysis.
- Analyze and interpret data, graphs, and diagrams related to chemical quantities and composition.
- Communicate scientific ideas and findings effectively using appropriate terminology and mathematical representations.

Essential Questions:

- How can mathematics be applied as a tool to model chemical quantities, composition, and relationships?
- How can the relative atomic mass of an element be determined, and how does it relate to the concept of the mole?
- What is the mole concept, and how does it allow us to relate the mass of a single atom to the mass of a

large quantity in grams?

- Why does one mole of any gas, at standard temperature and pressure, occupy the same volume (22.4 L)?
- How can the percent composition of a compound be calculated, and what does it reveal about the relative amounts of each element?
- How can mathematical representations support the claim of conservation of atoms and mass during a chemical reaction?

Enduring Understandings:

- Mathematics is a valuable tool for modeling objects, events, and relationships in the natural and designed world, including chemical quantities and composition.
- The relative atomic mass of an element can be determined from large amounts of the substance, providing a basis for understanding the mole concept.
- The mole concept provides a bridge between the macroscopic and microscopic worlds by relating the mass of a substance to the number of particles (atoms, molecules, or formula units) it contains.
- The mole concept is a fundamental concept in chemistry that allows for the quantitative understanding of chemical reactions and compositions.
- One mole of any gas, at standard temperature and pressure, will occupy the same volume (22.4 L).
- The percent composition of a compound can be calculated to determine the relative amounts of each element present.
- Mathematical representations can be used to support the claim that atoms and mass are conserved during a chemical reaction.

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:

- Mathematics is a tool used to model objects, events, and relationships, in the natural and designed world.
- The relative atomic mass of an element can be determined from large amounts of the substance.
- The mass of a single atom, in a.m.u., relates to the mass of a large quantity in grams, using the mole concept.
- One mole of any gas at standard temperature and pressure will occupy the same volume (22.4 L).
- The percent composition (by mass) can be used to determine the molecular formula (# of atoms in the compound).

Procedural Knowledge

Students will be able to:

- 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.
- Use scientific knowledge to generate a 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.

EVIDENCE OF LEARNING

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

Formative Assessments

- POGIL Activities:
 - Relative Mass and the Mole
 - Mole Ratios
- Labs
 - Empirical Formula Determination
 - Formula of a Hydrate
- Group practice
 - Particle Conversions
 - Molar Mass Conversions (1-step and 2-step)
 - Volume Conversions
 - Percent Composition
 - Empirical Formulas
 - Molecular Formulas
- 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
- Molar Conversions Quiz
- Empirical Formula Determination 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.