04 - Chemical Bonding

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:

- Use the periodic table to predict the relative properties of elements based on the patterns of electrons in their outermost energy level.
- Construct and revise explanations for the outcomes of simple chemical reactions by considering the outermost electron states of atoms, periodic trends, and knowledge of chemical properties.
- Plan and conduct investigations to compare the structure of substances at the bulk scale and infer the strength of electrical forces between particles.
- Develop models to illustrate the release or absorption of energy in chemical reactions and how it relates to changes in total bond energy.
- Analyze and interpret data to support explanations of chemical bonding and the formation of compounds.
- Apply knowledge of chemical bonding to predict the types of bonds (ionic, covalent, metallic) and their properties in various substances.
- Demonstrate an understanding of the relationship between chemical bonding and the physical and chemical properties of substances.
- Engage in hands-on experiments and activities to explore and investigate chemical bonding.
- Use scientific language, diagrams, and representations to communicate explanations and findings related to chemical bonding.
- Apply critical thinking and problem-solving skills to analyze and evaluate experimental data, scientific claims, and real-life applications related to chemical bonding.

Essential Questions:

- How can we use the periodic table to predict the properties of elements based on the patterns of electrons in their outermost energy levels?

- How can we explain and predict the outcomes of chemical reactions based on the outermost electron states, periodic trends, and chemical properties?
- How can we gather evidence about the strength of electrical forces between particles by comparing the structure of substances at the bulk scale?
- How does the release or absorption of energy in a chemical reaction relate to changes in total bond energy?

Enduring Understandings:

- The periodic table can be used as a model to predict the properties of elements based on the arrangement of electrons in their outermost energy levels.
- Chemical reactions and the resulting substances can be explained and predicted by considering the outermost electron states, periodic trends, and patterns of chemical properties.
- The strength of electrical forces between particles in a substance can be inferred by comparing the structure of substances at the bulk scale.
- The release or absorption of energy in a chemical reaction is dependent on changes in total bond energy.

CONTENT AREA STANDARDS

SCI.9-12.HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
SCI.9-12.HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
SCI.9-12.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
SCI.9-12.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

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.
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 world is generally not composed of isolated atoms; rather, atoms bond to one another to form molecules and hence chemical compounds.
- There are several ways that atoms can form a compound, and each process involves the flow of energy.
- The outermost electrons of an atom determine their reactivity and the nature of the chemical bonds they tend to form.
- Not all chemical bonds are created equal: some are weak and some very strong, a difference that depends primarily on the interactions of electrons between atoms.
- Covalent bonds can form from the sharing of one (or more) pair(s) of electrons.
- Electronegativity differences are the reason for ionic, polar covalent, and nonpolar covalent bonding. [Honors]
- The shape of a molecule is determined by the number of bonds and nonbonding pairs (VSEPR theory).
- The polarity of a molecule is determined by its shape and the electronegativity difference of each bond. [Honors]

Procedural Knowledge

Students will be able to:

- Identify and describe the components of the model that are relevant for their predictions, including:
    - Elements and their arrangement in the periodic table;
    - A positively-charged nucleus composed of both protons and neutrons, surrounded by negatively-charged electrons;
    - Electrons in the outermost energy level of atoms (i.e., valence electrons); and
    - The number of protons in each element.
- Construct an explanation of the outcome of the given reaction, including:
    - The idea that the total number of atoms of each element in the reactant and products is the same;
    - The numbers and types of bonds (i.e., ionic, covalent) that each atom forms, as determined by the outermost (valence) electron states and the electronegativity;
    - The outermost (valence) electron state of the atoms that make up both the reactants and the products of the reaction is based on their position in the periodic table; and
    - A discussion of how the patterns of attraction allow the prediction of the type of reaction that

occurs (e.g., formation of ionic compounds, combustion of hydrocarbons).

- Identify and describe the evidence to construct the explanation, including:
    - Identification of the products and reactants, including their chemical formulas and the arrangement of their outermost (valence) electrons;
    - Identification that the number and types of atoms are the same both before and after a reaction;
    - Identification of the numbers and types of bonds (i.e., ionic, covalent) in both the reactants and the products;
    - The patterns of reactivity at the macroscopic level as determined by using the periodic table; and
    - The outermost (valence) electron configuration and the relative electronegativity of the atoms that make up both the reactants and the products of the reaction based on their position in the periodic table.
- Use evidence to develop a model in which they identify and describe the relevant components, including:
    - The chemical reaction, the system, and the surroundings under study;
    - The bonds that are broken during the course of the reaction;
    - The bonds that are formed during the course of the reaction;
    - The energy transfer between the systems and their components or the system and surroundings;
    - The transformation of potential energy from the chemical system interactions to kinetic energy in the surroundings (or vice versa) by molecular collisions;
    - The relative potential energies of the reactants and the products.

EVIDENCE OF LEARNING

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

Formative Assessments

- POGIL Activities:
    - Molecular Geometry
- Labs
    - Ball and Stick Models
    - Chromatography
- Group practice
    - Basics of Bonding
    - Lewis Dot Structures
    - Properties of Ionic Compounds
    - Properties of Covalent Compounds
    - Molecular Geometry (VSEPR)
    - Polar and Nonpolar Molecules
- Performance Scale/ Student Tracking Chart
- Whiteboards
- Exit Tickets
- Homework

Summative Assessments

- Lewis Dot Structures Quiz
- Bonding Test
- Chromatography Lab Report

- 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

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.