02 Chemical Bonding

Content Area:	**Science**
Course(s):	**Chemistry CP**
Time Period:	**Semester 1**
Length:	**10 weeks**
Status:	**Published**

Standards

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.
	Developing and Using Models
PS1.A	Structure and Properties of Matter
	Patterns
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.
PS1.B	Chemical Reactions
	Patterns
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.
	Planning and Carrying Out Investigations
PS2.B	Types of Interactions
HS-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
	Obtaining, Evaluating, and Communicating Information
PS1.A	Structure and Properties of Matter
	Structure and Function

Enduring Understandings

1. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with the same valence electron number in the same column.
2. The number of valence electrons in an element dictate its physical and chemical and physical properties as well as its reactivity.
3. Matter naturally seeks stability by minimizing energy, forming stable molecules through chemical bonds that require a specific binding energy to break.
4. Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.
5. The physical and chemical properties of different design materials influences how easily they are extracted, produced, and recycled which will have an environmental, political, and social impact.

Essential Questions

1. How does the physical arrangement of the periodic table reflect a predictable blueprint of subatomic patterns and element reactivity?

2. In what ways do the quantity and configuration of an atom's valence electrons independently dictate its physical properties, chemical identity, and capacity to interact with other matter?

3. How does nature's universal drive to minimize energy and maximize structural stability govern why and how individual atoms combine into complex, low-energy molecules?

4. How does the degree to which valence electrons are shared or transferred establish the unique physical limits and properties of ionic, covalent, and metallic substances?

5. How can the microscopic attraction and repulsion between electric charges at the atomic scale explain both the internal structure of matter and the physical contact forces we experience in our everyday macroscopic world?

6. How does the varying strength of electrostatic attractions between subatomic particles ultimately determine a substance's measurable physical limits, such as electrical conductivity, melting points, and malleability?

7. How do the inherent physical and chemical properties of consumer materials dictate the difficulty of their extraction, manufacturing, and ultimate recycling lifecycle?

8. How can a deep understanding of material properties be leveraged to engineer recycled alternatives and waste-management protocols that directly mitigate global environmental, political, and social stressors?

Knowledge and Skills

Knowledge

1. Students will critique the thermodynamic stability of elements based on their periodic placement, explaining why a filled valence shell makes helium safely unreactive for consumer use, whereas alkali metals react violently with water due to their low ionization energies.(PS1.A Structure and Properties of Matter)

2. Students will analyze how the nature of chemical bonds (ionic, covalent, metallic) dictates a substance's macroscopic physical properties, including electrical conductivity, melting points, and malleability. (PS1.A Structure and Properties of Matter)

3. Students will evaluate how molecular geometry, surface tension, and intermolecular forces (such as hydrogen bonding) explain physical interactions, from why water striders can walk on water to the devastating biological impacts of molecular chirality (e.g., Thalidomide). (PS2.B Type of Interactions)

4. Students will critique how identical atomic building blocks can rearrange into entirely different structural configurations (allotropes), explaining how carbon can form both ultra-hard network

covalent diamonds and soft, layered pencil lead. (PS2.B Type of Interactions)

5. Students will analyze the unique bonding capability of carbon to form stable, complex chains and rings that serve as the foundation for organic molecules, petroleum products, and biochemical structures. (PS2.B Type of Interactions)

Skills

1. Design a prototype organizational system for a novel set of data (e.g., periodic table of shapes, aliens, or consumer products) that mirrors Mendeleev's methodology, predicting the properties of "undiscovered" entries based on vertical and horizontal periodic trends.
2. Design and execute an investigation using conductivity meters and melting point analysis to classify unknown substances as ionic, molecular covalent, network covalent, or metallic based on empirical evidence.
3. Construct 3D molecular models using VSEPR theory to illustrate molecular geometry to predict polarity and observable macroscopic properties, such as viscosity, surface tension, density, cohesion, and adhesion for substances such as dish soap, vegetable oil, water, and rubbing alcohol.
4. Formulate a chemical nomenclature guide that translates complex molecular structural formulas found on food and cosmetic labels (e.g., everyday skin-care) into standardized IUPAC names, assessing their chemical safety and purpose.
5. Perform a comprehensive cost-benefit analysis comparing petroleum energy to alternative energy sources, generating a data-driven proposal that evaluates constraints like energy density, cost, infrastructure, and ecosystem degradation.
6. Construct a mathematical stoichiometry model using a limiting reactant framework (conceptually modeled by s'mores manufacturing) to predict theoretical yields, calculate percent error, and optimize chemical resource management.

Resources

Core Resources:

CK-12 Chemistry Intermediate

Supplemental Resources:

- Chemistry in the Community 4th Edition

- Density Lab
- Spectroscopy Webquest
- Halloweenium Lab
- http://www.teachchemistry.org/periodic-trends

- Edpuzzles: Including but not limited to: Eyes of Nye,
- Interactive Chemistry - Ionic Bonding Matchmaker
- PBS Learning Media - tutorials and interactive videos
- Pivot Interactives
    - Pivot Lab: Properties of Ionic and Covalent Bonded Substances

Assessments

https://docs.google.com/document/d/1wR7bQF-8AQoRrt0g4C3hKja0yjwDjC9_BiAmONWbTcI/edit?usp=sharing

Modifications

https://docs.google.com/document/d/1ODqaPP69YkcFiyG72fIT8XsUIe3K1VSG7nxuc4CpCec/edit?usp=sharing