03 - Electrons and Periodic Trends

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **14 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:

- Explain the concept of electron clouds and the probabilistic nature of electron location within orbitals.
- Describe the organization of electrons into quantized energy levels and sublevels based on the periodic table.
- Construct and interpret electron configurations using orbital notations, electron dot diagrams, and the periodic table.
- Investigate and explain the relationship between the arrangement of electrons and the physical and chemical properties of elements.
- Apply the principles of quantum mechanics to justify and predict trends in atomic radius, ionization energy, electron affinity, and electronegativity.
- Analyze the emission spectra of elements and interpret the colors (wavelengths) of light emitted by excited atoms.
- Recognize and explain the relationship between the emission spectra and the energy levels of electrons within atoms.
- Utilize electron configurations and periodic trends to predict and explain the formation of ions and chemical bonding.
- Engage in hands-on experiments and models to explore the principles of electron configurations, periodic trends, and emission spectra.
- Demonstrate critical thinking skills by analyzing and evaluating experimental data, scientific claims, and real-life applications related to electron configurations and periodic trends.
- Communicate scientific ideas and findings effectively using appropriate terminology, diagrams, and representations.

Essential Questions:

- How do electron configurations and orbital arrangements determine the properties and position of elements in the periodic table?
- What is the significance of the quantum model in explaining the behavior of electrons and the formation of electron configurations?
- How does the emission of light by excited elements support the concept of quantized energy levels?

Enduring Understandings:

- Electrons reside in orbitals within quantized energy levels, and their arrangement determines the properties and position of an element in the periodic table.
- The quantum model of the atom explains the behavior of electrons and provides a basis for understanding electron configurations and periodic trends.
- The emission of light by excited elements provides evidence for the quantized nature of energy levels.

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-PS1-2	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.
SCI.9-12.HS-PS4-3	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.
SCI.9-12.HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
SCI.9-12.HS-PS2-4	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

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.
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.
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.
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.

STUDENT LEARNING TARGETS

Refer to the 'Declarative Knowledge' and 'Procedural Knowledge sections.

Declarative Knowledge

Students will understand that:

- Electrons reside in clouds or orbitals, where their exact position is not known, only the probability of finding them in a certain region.
- Those orbitals are arranged in quantized energy levels, which can contain one or more sublevels.
- The number of electrons in those sublevels determines many properties of the element and its position on the periodic table.
- Electron configurations, orbital notations, and dot diagrams can all be used to express the arrangement of electrons around the atom.
- The colors (i.e. wavelengths) of light emitted by the excitation of an element provide evidence for the quantum model of the atom.
- Several trends in the physical/ chemical properties of elements can be justified using the quantum model and periodic table.

Procedural Knowledge

Students will be able to:

- Show that the product of the frequency and the wavelength of a particular type of wave in a given medium is constant, and identify this relationship as the wave speed according to the mathematical relationship $v = f\lambda$.

- Use the data to show that the wave speed for a particular type of wave changes as the medium through which the wave travels changes.

- Predict the relative change in the wavelength of a wave when it moves from one medium to another (thus different wave speeds using the mathematical relationship $v = f\lambda$). Students express the relative change in terms of cause (different media) and effect (different wavelengths but same frequency).

- Identify and describe the components of the model that are relevant to 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)

  - The number of protons in each element.

- Students 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 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).
- Describe that the ratio between electric forces between objects with a given charge and mass is a pattern that is independent of distance, given mathematical models.
- Identify the given explanation that is to be supported by the claims, evidence, and reasoning to be evaluated, and that includes the following idea: Electromagnetic radiation can be described either by a wave model or a particle model and for some situations one model is more useful than the other.

EVIDENCE OF LEARNING

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

Formative Assessments

- POGIL Activities:
  - Electron Energy and Light
  - Electron Configurations
  - Coulombic Attraction
  - Cracking the Periodic Table
  - Periodic Trends
- Labs
  - Flame Test
  - Spectral Emissions
  - Bohr Model Simulation
  - In The Family (Periodic Trends)
  - Solubility Trends Within a Group
- Group practice
  - Electron Configurations
  - Writing Electron Configurations and Orbital Notations
  - Noble Gas Abbreviations and Configurations for Ions

    - Quantum Numbers
    - History of the Periodic Table
    - Periodic Trends: Atomic Radius, Ionization Energy, Ionic Radius, and Electronegativity
- 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

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.