15 - Nuclear Decay and Radiation

Content Area: **Science**
Course(s):
Time Period: **Full Year**
Length: **6 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 describe nuclear decay, including alpha decay, beta decay, and gamma decay.
- Explain the properties, interactions, and ionizing abilities of alpha particles, beta particles, and gamma rays.
- Calculate and interpret half-life values for radioactive substances.
- Use half-life values to predict the remaining quantity of a radioactive substance or the time required for a given quantity to decay.
- Relate the concepts of nuclear decay and half-life to real-world applications, such as medical imaging, nuclear power, and carbon dating.
- Understand the risks and safety precautions associated with handling radioactive materials.
- Analyze and interpret data and graphs related to nuclear decay and half-life.
- Communicate scientific ideas and findings effectively, using appropriate terminology and models.
- Recognize the importance of ethical considerations and responsible use of radioactive materials in scientific research and applications.
- Apply critical thinking skills to evaluate and analyze scenarios involving nuclear decay, radiation, and half-life.

Essential Questions:

- What is nuclear decay, and how does it lead to the emission of different types of radiation?
- What are the properties and interactions of alpha particles, beta particles, and gamma rays?
- How is the concept of half-life used to describe the rate of radioactive decay and predict the remaining amount of a radioactive substance?
- What are some real-world applications of radioactive isotopes, and how are they used in medicine,

energy production, and artifact dating?
- What safety considerations and precautions should be taken when working with radioactive materials?

Enduring Understandings:

- Nuclei of unstable atoms undergo radioactive decay, transforming into more stable nuclei and emitting radiation in the process.
- Different types of radiation, including alpha particles, beta particles, and gamma rays, have distinct properties and interactions with matter.
- Radioactive decay follows a predictable pattern characterized by half-life, which is the time it takes for half of a radioactive substance to decay.
- Radioactive isotopes have practical applications in various fields, such as medicine, energy production, and dating artifacts.
- Understanding nuclear decay, radiation, and half-life is essential for assessing risks and ensuring safety in handling radioactive materials.

CONTENT AREA STANDARDS

SCI.9-12.HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
SCI.9-12.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.

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:

- The features and sources of alpha, beta, and gamma radiation, and the differences between nuclear fusion and fission.
- Nuclear chemistry deals with radioactivity, nuclear processes, and nuclear properties.
- Nuclear reactions produce tremendous amounts of energy and lead to the formation of elements.

Procedural Knowledge

Students will be able to:

- Develop models in which they identify and describe the relevant components of the models, including:
    - Identification of an element by the number of protons;
    - The number of protons and neutrons in the nucleus before and after the decay;
    - The identity of the emitted particles (i.e., alpha, beta — both electrons and positrons, and gamma); and
    - The scale of energy changes associated with nuclear processes, relative to the scale of energy changes associated with chemical processes.
- Use evidence to develop a model in which they identify and describe the relevant components, including:
    - Hydrogen as the sun’s fuel;
    - Helium and energy as the products of fusion processes in the sun; and
    - That the sun, like all stars, has a life span based primarily on its initial mass, and that the sun’s lifespan is about 10 billion years.

EVIDENCE OF LEARNING

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

Formative Assessments

- Labs
    - Half-Life Modeling

- Group practice
    - Half-Life Determination and Calculations
    - Forms of Nuclear Decay and Radiation
- 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
- Half-Life and Nuclear Decay Quiz

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.