Unit 2 - Atomic Structure, Nuclear Chemistry, & Luminescence

Content Area: **Science**
Course(s):
Time Period: **Marking Period 1**
Length: **15 days**
Status: **Published**

Summary

At the heart of chemistry is the atom-- the smallest possible pure substance. In this unit, students will learn about the history of the atomic theory, from its origins to the modern understanding, including all of the scientists and the models they developed. This unit can be split into three distinct parts: atomic structure, nuclear chemistry, and luminescence. In atomic structure, the behavior and properties of the electron will be studied in great detail, focusing on the subatomic particles known as protons, neutrons, and electrons. In nuclear chemistry, the nucleus of the atom-- home to the protons and neutrons-- can be analyzed by observing how it changes through radioactive decay, as well as fission and fusion. In luminescence, the nature and the behavior of the electron will be studied through investigating the wave nature and particle nature of light and observing absorption and emission of energy in the form of electromagnetic radiation and photons.

Revised July 2026

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.
P.3	Consider the environmental, social and economic impacts of decisions.
P.4	Demonstrate creativity and innovation.
P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
9.4.12.CT	Critical Thinking and Problem-solving
P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
MA.A-SSE.B	Write expressions in equivalent forms to solve problems
P.9	Work productively in teams while using cultural/global competence.
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.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
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.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
LA.RST.9-10.5	Analyze the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
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.
9.4.12.GCA	Global and Cultural Awareness
LA.RST.9-10.10	By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.
9.4.12.IML	Information and Media Literacy
MA.A-CED.A	Create equations that describe numbers or relationships
LA.WHST.9-10.1.A	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
LA.WHST.9-10.1.B	Develop claim(s) and counterclaims using sound reasoning, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
LA.WHST.9-10.1.D	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
LA.WHST.9-10.1.E	Provide a concluding paragraph or section that supports the argument presented.
LA.WHST.9-10.2.A	Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
LA.WHST.9-10.2.C	Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
LA.WHST.9-10.2.D	Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
LA.WHST.9-10.2.E	Establish and maintain a style and tone appropriate to the audience and purpose (e.g., formal and objective for academic writing) while attending to the norms and conventions of the discipline in which they are writing.
LA.WHST.9-10.2.F	Provide a concluding paragraph or section that supports the argument presented.
9.4.12.TL	Technology Literacy
LA.WHST.9-10.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
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.
HS-PS4-1	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
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.
HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.

Essential Questions/Enduring Understandings

Essential Questions

- How can atomic models prove what happens at the atomic level if we cannot see the atoms and molecules?
- What is the modern description of an atom, how was it developed, and how might it still change?
- How can an atom's nucleus be stable if it only contains positively and neutrally charged subatomic particles?
- How does the electron influence/relate to the behavior of light (photons)?
- How is the frequency related to other characteristics of the electromagnetic spectrum, including speed, wavelength, and energy?

Enduring Understandings

- Atomic models evolve over time to best describe observations of atoms as well as predict behaviors or properties of atoms that may not have been observed yet.
- The arrangement of particles in the nucleus determines the stability of the atom but the arrangement of electrons around the nucleus determines its chemical reactivity.
- Light behaves as both a wave and a particle.

Objectives

Students Will Know

- Students will know the previous atomic models and be skilled at utilizing the modern model to understand the behavior of the atom.
- Students will know how to identify isotopes and be skilled at calculating average atomic masses of elements.
- Students will know the difference between nuclear fusion and fission.
- Students will know how light behaves both as a wave and a particle.

Students Will Be Skilled At

- Students will be skilled at half-life calculations and developing graphs based on data.

- Students will be skilled at calculating the frequency, energy, or wavelength of light using Planck's constant and the speed of light.

Learning Plan

- Preview essential questions and connect them to the concepts we will cover in the unit.
- Compare and contrast atomic models as they are developed over the course of history.
- Analyze the main ways of writing isotopes (hyphen notation or nuclear symbols) to identify the information contained within.
- Study nuclear reactions (fusion and fission) as well as natural radioactive decay.
- Analyze the nuclei of isotopes to determine what factor(s) may impact their stability (even or odd protons/neutrons).
- Emulate the Gold Foil Experiment to calculate the diameter of a target without using a ruler.
- Analyze the atomic spectra of select elements as a means of identifying them.
- Perform calculations to determine the frequency, wavelength, or energy of light.

Assessment

Summative Assessment

- Unit Quizzes
- Unit Tests
- Lab Reports

Formative Assessment

- Do Now Questions
- Exit Ticket Questions
- Whole Class Discussion Participation
- Small Group Discussion Participation
- Individual Student Questions/Responses
- Independent Tasks
    - Differentiate between historic and modern atomic models including prior models may have had correct.
    - Identify and write isotopes for the elements as well as determining the number of protons, neutrons, and electrons within.
    - Write and identify nuclear reactions as examples of fission or fusion.
    - Analyze atomic spectra and apply that analysis towards identifying samples using the

technique.
    - Calculate the wavelength, frequency, or energy of light using Planck's constant and the speed of light.
- Lab Experiments

Benchmark Assessment

- CP Chemistry Midterm Exam

Alternative Assessment

- Use available isotope data to calculate average atomic masses of the elements.
- Perform the Gold Foil Experiment in order to determine the diameter of a target.
- Analyze isotope information to identify a property that can be linked to their stability.
- Develop a half-life graph based on data obtained in an experiment.

Materials

- SAVVAS Experience Chemistry 2021 Textbook Volumes 1 & 2
- Guided notes
- Teacher handouts
- Supplementary worksheets
- Lab Handouts (Half-Life of Pennies Lab, Rutherford's Gold Foil Lab, Visible Spectra Lab, Flame Test Lab, NOTE: Supplies for each lab included on handout.)
- Simulations:
    - "Build an Atom" [https://phet.colorado.edu/en/simulation/build-an-atom] (up to Ne)
    - "Isotopes and Atomic Mass" [https://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass],
    - "Radioactive Dating Game"[https://phet.colorado.edu/en/simulation/radioactive-dating-game],
    - "Collisions" [https://app.playmada.com/Collisions/] Atoms (as some of the stuff is related to electron configuration/size of atoms it may be more appropriate here than in Unit 1)
    - "Discharge Lamps" [https://phet.colorado.edu/sims/cheerpj/discharge-lamps/latest/discharge-lamps.html?simulation=discharge-lamps])
- Safety Supplies (specifics to when they are required included in lab handouts)