Lindenwold Public Schools

Unit 1: Where do all the different elements come from?

45 Instructional Days

New Jersey Student Learning Standards Science

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. [Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.] [Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.]

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. [Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.] [Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.]

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. [Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.] [Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.]

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. [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.] [Assessment Boundary: Assessment does not include details of the atomic and sub-atomic processes involved with the sun's nuclear fusion.]

Lindenwold Public Schools

HS- ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements. [Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.] [Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.]

Science and Engineering Practices

Developing and Using Models

- Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1)
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-8), (HS-ESS1-1)

Obtaining, Evaluating, and Communicating Information

- Communicate scientific ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-ESS1-3)

Constructing Explanations and Designing Solutions

- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)

Disciplinary Core Ideas

PS1.A Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. (HS-PS1-1)
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. (HS-PS1-1), (HS-PS1-2)

PS1.B Chemical Reactions

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. (HS-PS1-2)

PS1.C: Nuclear Processes

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process. (HS-PS1-8)

ESS1.A: The Universe and Its Stars

- The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1)
- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. (HS-ESS1-3)
- Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-3)

Crosscutting Concepts

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS1-1), (HS-PS1-2)

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1)

Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-ESS1-3)

Rationale and Transfer Goals :

This unit introduces students to the elements of the periodic table and the theme that all elements are made through nuclear processes. Students will begin by reviewing that atoms are composed of electrons, protons and neutrons, but then apply the understanding that an increase in atomic number corresponds to an increase in the number of protons in an element's nucleus. Along with developing an

understanding of the organization of the periodic table, valence electrons, as well as physical and chemical properties of elements; students will also be introduced to the nuclear processes involved in creating elements including fission, fusion and radioactive decay.

Enduring Understandings:

- All matter is composed of atoms.
- Atoms have a positively charged nucleus containing protons and neutrons, with electrons located outside the nucleus in quantized energy levels.
- Properties of elements exhibit observable periodic trends.
- Elements originate in stars, including the sun.
- Nuclear fusion in stars creates heavier elements from lighter ones.
- Radioactive elements have unstable nuclei.

Essential Questions:

- Where do all the different elements come from?
- What is an atom and what is its structure? [Anchor]
- What is the relationship between the elements and their position on the periodic table? [Anchor]
- How are elements created in stars? [Anchor]
- What is radiation and what makes an element radioactive? [Anchor]

Content/Objectives		Instructional Actions	
Content ***What students will know***	**Skills** ***What students will be able to do***	**Activities/Strategies** ***How we teach content and skills***	**Evidence (Assessments)** ***How we know students have learned***
• Atoms are the building blocks of matter with a positively charged nucleus containing both protons and neutrons,	• Explain the arrangement of elements on the periodic table including relationship to properties of an element as well as	• Calculate the number of protons, neutrons, and electrons in a given element or isotope of an element on the periodic	• Students will take an assessment to evaluate understanding of the structure of an atom, properties of elements,

surrounded by negatively charged electrons in quantized energy levels (orbitals). ● Elements in the seven main groups of the periodic table form predictable ions through the gain or loss of electrons. Noble Gases (Group 8) do not form ions. Ions are formed through the loss of valence electrons. ● The organization of the periodic table allows for prediction of bond type between different elements. ● The relationships between components underlying the nuclear processes of fission, fusion, and three distinct types of radioactive decay. ● Hydrogen and helium formed at the time of the Big Bang, nuclear	total numbers of protons, neutrons and electrons for a neutral atom, ion, or isotope. ● Use the periodic table to predict the types of ions formed by groups 1-7 based on number of valence electrons and explain why group 8 does not form ions. ● Students will be able to predict whether a given element will form ionic or covalent bonds. ● Students will be able to explain nuclear processes, and understand that atoms are not conserved, but the total number of protons plus neutrons is conserved. ● Students will be able to explain that by the process of nuclear fusion, hydrogen gas is converted to helium gas and energy flows out of the core to	table using the atomic number, mass number, and dynamic periodic table resource. ● Use the Aufbau Principle to write the proper electron configurations for elements on the periodic table including exceptions to the principle (Cr, Cu, etc) View orbital simulation [Link] complete electrons and orbitals activity [Link] C. Students will complete an ionic and covalent bonding simulation to make predictions about types of bonds formed between elements on the periodic table. D & E. Students will complete an activity along with an online phET simulation to make predictions about what	isotopes and types and shapes of orbitals. ● Students will take an assessment to evaluate understanding of the formation of ions as well as proper electron configurations, physical and chemical properties of elements as well as types of bonds formed. ● Students will be assessed by completing the “Why Are Some Isotopes Radioactive?” activity. [Link] ● Students will be assessed by completing the literacy activity titled “Fission VS Fusion Reading.” [Link] ● Chemistry Unit 1 Benchmark

fusion within stars produces all atomic nuclei lighter than and including iron and the process releases electromagnetic energy.	the surface allowing radiation to travel to the Earth.	makes an isotope radioactive. [Link] E. Students will read a short article "Where Atoms Come From: We Are All Star Stuff" to introduce the how elements are formed in stars.	

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• All matter is composed of atoms containing protons, neutrons and electrons. Isotopes are atoms with the name number of protons, but different numbers of neutrons. Unstable atomic nuclei lose energy through radiation. • Both the current model of the structure of an atom and the organization of the periodic table evolved over time. • Nuclear fusion within stars produces elements and releases energy.	• Substances are made from different types of atoms, which combine with one another in various ways. • Scientific models continue to evolve over time. • The sun is the nearest star to the Earth and produces solar energy.	• Students will complete a self guided POGIL activity on the structure of the atom and isotopes and radiation. • Students will complete the Founders of Chemistry activity as well as the History of the Periodic Table activity. [Link] • Students will provide an explanation of the process of nuclear fusion that occurs in the sun's core to produce energy. [Link]

Key resources:

Lindenwold Public Schools

Dynamic Periodic Table [Link]

POGIL: Process Oriented Guided Inquiry Learning [Link]

PhET Simulations [Link]

American Association of Chemistry Teachers [Link]

21st Century Life & Careers:

9.2.12.CAP.2: Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.

9.2.12.CAP.3: Investigate how continuing education contributes to one's career and personal growth.

9.2.12.CAP.4: Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.

Career Readiness, Life Literacies, & Key Skills:

9.4.12.CT.3: Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

9.4.12.CT.4: Participate in online strategy and planning sessions for course-based, school-based, or other projects and determine the strategies that contribute to effective outcomes.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience.

9.4.12.IML.5: Evaluate, synthesize, and apply information on climate change from various sources appropriately.

9.4.12.IML.6: Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity.

InterDisciplinary Connections/Companion Standards:

NJSLS-Math

HSN-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. (HS-PS1-2), (HS-PS1-8), (HS-ESS1-1)

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-8), (HS-ESS1-1)

HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-2), (HS-PS1-8), (HS-ESS1-1)

HSA-SSE.A.1 Interpret expressions that represent a quantity in terms of its context. (HS-ESS1-1)

HSA-CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HS-ESS1-1)

HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-ESS1-1)

NJSLS-ELA

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. (HS-PS1-1)

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2), (HS-ESS1-3)

WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (HS-PS1-2)

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-ESS1-1)

SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. (HS-ESS1-3)

Companion Standards for ELA in Science and Technical Subjects: Reading

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.

RST.11-12.1. 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.

Companion Standards for ELA in Science and Technical Subjects: Writing

WHST.11-12.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.