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

Content Area: **Science**
Course(s):
Time Period: **MP1**
Length: **45 days**
Status: **Published**

NJSLS - Science

9-12.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.
9-12.HS-ESS1-3	Communicate scientific ideas about the way stars, over their life cycle, produce elements.
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.
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.
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.

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' invasions, models, theories, simulations, and 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 paerns of this table reflect paerns 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 decay of unstable nuclei, involve the 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 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 paerns 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 a BOE-approved September 2020 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 - What will students know?

- Atoms are the building blocks of matter with a positively charged nucleus containing both protons and neutrons,
- 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 a 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 me of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron and the process releases electromagnetic energy.

Skills - What will students be able to do?

- Explain the arrangement of elements on the periodic table including the relationship to the properties of an element as well as the total number 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 several 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 the surface allowing radiation to travel to the Earth.

Activities - How will we teach the content and skills?

- Calculate the number of protons, neutrons, and electrons in a given element or isotope of an element on the periodic 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 makes an isotope radioactive. [Link] E. Students will read a short article “Where Atoms Come

From: We Are All Star Stuff" to introduce how elements are formed in stars.

Evidence/Assessments - How will we know what students have learned?

- **Assessments can be reviewed for each course in this folder.**

- Students will take an assessment to evaluate their understanding of the structure of an atom, properties of elements, isotopes, and types and shapes of orbitals.
- Students will take an assessment to evaluate their 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?" acvity. [Link]
- Students will be assessed by completing the literacy acvity titled "Fission VS Fusion Reading." [Link]
- Chemistry Unit 1 Benchmark

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 same 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 me. • Nuclear fusion within stars produces elements and releases energy	• Substances are made from different types of atoms, which combine in various ways. • Scientific models continue to evolve over me. • The sun is the nearest star to the Earth and produces solar energy.	• Students will complete a self-guided POGIL acvity on the structure of the atom and isotopes and radiation. • Students will complete the Founders of Chemistry acvity as well as the History of the Periodic Table acvity. [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

Dynamic Periodic Table [Link]

POGIL: Process-Oriented Guided Inquiry Learning [Link]

PhET Simulations [Link]

American Association of Chemistry Teachers [Link]

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 project 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 (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
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 (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
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 (e.g., NJSLSA.SL5).

Interdisciplinary Connections

