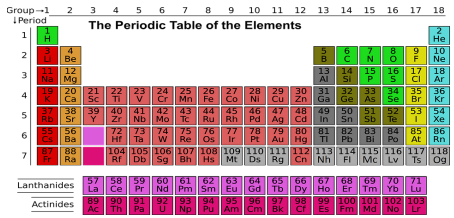
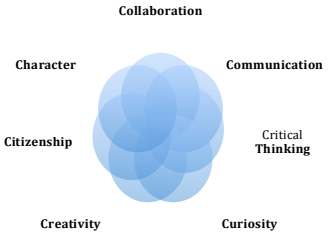
Content Area: Science	Course: Chemistry	Grade Level: 10-12
 	**R14 The Seven Cs of Learning** 	

Unit Titles	Length of Unit
• Structure and Properties of Matter	• 5-6 weeks
• Bonding and Chemical Reactions	• 5-6 weeks
• The Chemistry of Abiotic Systems	• 5-6 weeks
• Human Impact: The Chemistry of Sustainability	• 5-6 weeks
• Nuclear Chemistry	• 5-6 weeks

Strands	Course Level Expectations
Structure and Properties of Matter	• 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. • Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of the electrical forces between particles. • Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
Chemical Reactions	• 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. • Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. • Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which reaction occurs. • Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. • Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
Earth's Systems and Human Sustainability	• Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). • Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

	• Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. • Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. • Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. • Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. • Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate
Space Systems & Earth's History	• 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. • 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. • Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe • Communicate scientific ideas about the way stars, over their life cycle, produce elements • Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth' formation and early history

Unit Title	Structure and Properties of Matter	**Length of Unit**	5-6 weeks

Inquiry Questions (Engaging & Debatable)	● How does the structure of matter affect the properties and uses of materials?
Standards*	HS-PS1-1, HS-PS1-3, HS-PS1-8, HS-PS2-6, HS-ETS1-3, and HS-ETS1-4.
Unit Strands & Concepts	**DISCIPLINARY CORE IDEAS (DCI):** ● Structure & Properties of Matter ● Nuclear Processes ● Types of Interactions **Cross Cutting Concepts (CCC)** ● Structure & Function ● Patterns ● Energy & Matter
Key Vocabulary	Atoms, Electrons, Nucleus, Fission, Fusion, Radioactive Decay

*Standards based on Next Generation Science Standards (NGSS). For more information visit: https://www.nextgenscience.org

Unit Title	Structure an Properties o Matter	**Length of Unit**	5-6 weeks

Critical Content: My students will Know…	**Key Skills: My students will be able to (Do)…**
• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • 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. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. • 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 • Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.	• 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. • Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. • 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. • Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Assessments:	Performance Task(s) focused on demonstrating an understanding of the substructure of atoms through provide more mechanistic explanations of the properties of substances, the the periodic table as a tool to explain and predict the properties of elements, and phenomena involving nuclei.
Teacher Resources:	NGSS Frameworks, Region 14 Science Implementation Guide, Model Based Inquiry Investigations, NGSS Phenomenon Resources, Stem Teaching Tools

Unit Title	Bonding and Chemical Reactions	**Length of Unit**	5-6 weeks

Inquiry Questions (Engaging & Debatable)	● How do substances combine or change (react) to make new substances? ● How does one characterize and explain these reactions and make predictions about them?
Standards*	HS-PS1-2, HS-PS1-4, HS-PS1-5, HS-PS1-6, HS-PS1-7, HS-ETS1-2
Unit Strands & Concepts	**DISCIPLINARY CORE IDEAS (DCI):** ● Structure & Properties of Matter ● Chemical Reactions **Cross Cutting Concepts (CCC)** ● Stability and Change ● Patterns ● Energy & Matter
Key Vocabulary	Chemical Reaction, Le Chatelier's Principle, Mole, Catalyst, Law of Conservation of Mass

Unit Title	Bonding and Chemical Reactions	**Length of Unit**	5-6 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● 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. ● stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. ● Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. ● In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. ● 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.	● 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. ● Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. ● Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. ● Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. ● Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Assessments:	Performance Task(s) focused on demonstrating an understanding of chemical reactions, including rates of reactions and energy changes, in terms of the collisions of molecules and the rearrangements of atoms. Using this expanded knowledge of chemical reactions, students are able to explain important biological and geophysical phenomena.
Teacher Resources:	NGSS Frameworks, Region 14 Science Implementation Guide, Model Based Inquiry Investigations, NGSS Phenomenon Resources, Stem Teaching Tools

Unit Title	The Chemistry of Abiotic Systems	**Length of Unit**	5-6 weeks

Inquiry Questions (Engaging & Debatable)	● How do the properties and movements of water shape Earth's surface and affect its systems? ● How is energy transferred and conserved in a system?
Standards*	HS-PS3-4, HS-ESS3-2, HS-ESS2-5, HS-ETS1-3
Unit Strands & Concepts	**DISCIPLINARY CORE IDEAS (DCI):** ● Conservation of Energy and Energy Transfer ● The Roles of Water in Earth's Surface Processes ● Natural Resources ● Energy in Chemical Processes **Cross Cutting Concepts (CCC)** ● Structure and Function ● Systems and System Models
Key Vocabulary	Thermal Energy, Viscosity, Hydrologic Cycle, Rock Cycle, Chemical Weathering, Recrystallization

Unit Title	The Chemistry of Abiotic Systems	**Length of Unit**	5-6 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
• Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. • All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.	• Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics) • Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. • Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

Assessments:	Performance Task(s) focused on demonstrating an understanding of the role that water plays in affecting weather as well as the ways that human activities cause feedbacks that create changes to other systems.
Teacher Resources:	NGSS Frameworks, Region 14 Science Implementation Guide, Model Based Inquiry Investigations, NGSS Phenomenon Resources, Stem Teaching Tools

Unit Title	Human Impact: The Chemistry of Sustainability	**Length of Unit**	5-6 weeks

Inquiry Questions (Engaging & Debatable)	● What regulates weather and climate? ● What are the effects of human activity on Earth's climate?
Standards*	HS-ESS2-4, HS-ESS2-6, HS-ESS3-5, HS-ESS3-6, HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4
Unit Strands & Concepts	**DISCIPLINARY CORE IDEAS (DCI):** ● Weather and Climate ● Earth and the Solar System ● Earth Materials and Systems ● Global Climate Change **Cross Cutting Concepts (CCC)** ● Energy and Matter ● Cause and Effect ● Stability and Change ● Systems and System Models
Key Vocabulary	Hydrosphere, Atmosphere, Geosphere, Biosphere, Cryosphere, Photosynthetic Biomass

Unit Title	Human Impact: The Chemistry of Sustainability	**Length of Unit**	5-6 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. ● Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. ● The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. ● Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. ● Current models predict that, although future regional climate changes	● Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere ● Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. ● Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. ● Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. ● Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	

Assessments:	Performance Task(s) focused on demonstrating an understanding of the system interactions that control weather and climate, the many factors that drive climate change over a wide range of time scales. The complex and significant interdependencies between humans and the rest of Earth's systems through the impacts of natural hazards, our dependencies on natural resources, and the environmental impacts of human activities.
Teacher Resources:	NGSS Frameworks, Region 14 Science Implementation Guide, Model Based Inquiry Investigations, NGSS Phenomenon Resources, Stem Teaching Tools

Unit Title	Nuclear Chemistry	**Length of Unit**	5-6 weeks

Inquiry Questions (Engaging & Debatable)	What is the universe? What goes on in stars?
Standards*	HS-PS1-8, HS-ESS1-1, HS-ESS1-2, HS-ESS1-3, HS-ESS1-6
Unit Strands & Concepts	**DISCIPLINARY CORE IDEAS (DCI):** ● Nuclear Processes ● The Universe and its Stars ● Energy in Chemical Processes and Everyday Life ● Electromagnetic Radiation ● The History of Planet Earth **Cross Cutting Concepts (CCC)** ● Energy and Matter ● Scale, Proportion, and Quantity ● Stability and Change
Key Vocabulary	Fission, Fusion, Radioactive Decay, Nucleosynthesis, Supernova

Unit Title	Nuclear Chemistry	Length of Unit	5-6 weeks

Critical Content: **My students will Know…**	**Key Skills:** **My students will be able to (Do)…**
● 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 ● The star called the sun is changing and will burn out over a lifespan of approximately 1 billion years ● Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. ● The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. ● The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. ● Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter	● 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. ● 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. ● Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe ● Communicate scientific ideas about the way stars, over their life cycle, produce elements ● Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history

than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode ● Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. ● Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history	

Assessments:	Performance Task(s) focused on demonstrating an understanding of how the matter of our world formed during the Big Bang and within the cores of stars, the formation and abundance of the elements, how short-term changes in the behavior of our sun directly affect humans, theories of the formation of the solar system and universe, radioactivity, the release of energy from the sun and other stars, and the generation of nuclear power.
Teacher Resources:	NGSS Frameworks, Region 14 Science Implementation Guide, Model Based Inquiry Investigations, NGSS Phenomenon Resources, Stem Teaching Tools