BLOOMFIELD BOARD OF EDUCATION
Administration Offices
155 Broad Street
Bloomfield, NJ 07003

Action Chemistry
Curriculum Guide
Grade 11-12
2017

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Conforms to the Next Generation Science Standards and NJSLS Standards

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Content Area Standards

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Technological Literacy

8.1 Educational Technology

All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.

A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
• Understand and use technology systems. • Select and use applications effectively and productively.
HS 8.1.12.A.1 Create a personal digital portfolio which reflects personal and academic interests, achievements, and career aspirations by using a variety of digital tools and resources. 8.1.12.A.2 Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review. 8.1.12.A.3 Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.

8.1.12.A.4 Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results. 8.1.12.A.5 Create a report from a relational database consisting of at least two tables and describe the process, and explain the report results.

B. Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
• Apply existing knowledge to generate new ideas, products, or processes. • Create original works as a means of personal or group expression.
HS 8.1.12.B.2 Apply previous content knowledge by creating and piloting a digital learning game or tutorial.

C. Communication and Collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
• Interact, collaborate, and publish with peers, experts, or others by employing a variety of digital environments and media. • Communicate information and ideas to multiple audiences using a variety of media and formats. • Develop cultural understanding and global awareness by engaging with learners of other cultures. • Contribute to project teams to produce original works or solve problems.
HS 8.1.12.C.1 Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.

D. Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior.
• Advocate and practice safe, legal, and responsible use of information and technology. • Demonstrate personal responsibility for lifelong learning. • Exhibit leadership for digital citizenship.
HS 8.1.12.D.1 Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work. 8.1.12.D.2 Evaluate consequences of unauthorized electronic access (e.g., hacking) and disclosure, and on dissemination of personal information. 8.1.12.D.3 Compare and contrast policies on filtering and censorship both locally and globally. 8.1.12.D.4 Research and understand the positive and negative impact of one’s digital footprint. 8.1.12.D.5 Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.

E: Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
• Plan strategies to guide inquiry • Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media. • Evaluate and select information sources and digital tools based on the appropriateness for specific tasks.
HS 8.1.12.E.1 Produce a position statement about a real world problem by developing a systematic plan of investigation with peers and experts synthesizing information from multiple sources. 8.1.12.E.2 Research and evaluate the impact on society of the unethical use of digital tools and present your research to peers.

F: Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
● Identify and define authentic problems and significant questions for investigation. ● Plan and manage activities to develop a solution or complete a project. ● Collect and analyze data to identify solutions and/or make informed decisions. ● Use multiple processes and diverse perspectives to explore alternative solutions
HS 8.1.12.F.1 Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.

8.2 Technology Education, Engineering, Design, and Computational Thinking-Programming

All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

A. The Nature of Technology: Creativity and Innovation Technology systems impact every aspect of the world in which we live.
● The characteristics and scope of technology. ● The core concepts of technology. ● The relationships among technologies and the connections between technology and other fields of study.
HS 8.2.12.A.1 Propose an innovation to meet future demands supported by an analysis of the potential full costs, benefits, trade-offs and risks, related to the use of the innovation. 8.2.12.A.2 Analyze a current technology and the resources used, to identify the trade-offs in terms of availability, cost, desirability and waste. 8.2.12.A.3 Research and present information on an existing technological product that has been repurposed for a different function.

B. Technology and Society: Knowledge and understanding of human, cultural and societal values are fundamental when designing technological systems and products in the global society.
• The cultural, social, economic and political effects of technology. • The effects of technology on the environment. • The role of society in the development and use of technology. • The influence of technology on history.
HS 8.2.12.B.1 Research and analyze the impact of the design constraints (specifications and limits) for a product or technology driven by a cultural, social, economic or political need and publish for review. 8.2.12.B.2 Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation and maintenance of a chosen product. 8.2.12.B.3 Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs. 8.2.12.B.4 Investigate a technology used in a given period of history, e.g., stone age, industrial revolution or information age, and identify their impact and how they may have changed to meet human needs and wants. 8.2.12.B.5 Research the historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product, and present the competing viewpoints to peers for review.

C. Design: The design process is a systematic approach to solving problems.
• The attributes of design. • The application of engineering design. • The role of troubleshooting, research and development, invention and innovation and experimentation in problem solving.
HS

8.2.12.C.1 Explain how open source technologies follow the design process. 8.2.12.C.2 Analyze a product and how it has changed or might change over time to meet human needs and wants. 8.2.12.C.3 Analyze a product or system for factors such as safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, and human factors engineering (ergonomics). 8.2.12.C.4 Explain and identify interdependent systems and their functions. 8.2.12.C.5 Create scaled engineering drawings of products both manually and digitally with materials and measurements labeled. 8.2.12.C.6 Research an existing product, reverse engineer and redesign it to improve form and function. 8.2.12.C.7 Use a design process to devise a technological product or system that addresses a global problem, provide research, identify trade-offs and constraints, and document the process through drawings that include data and materials.

D. Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.
• Apply the design process. • Use and maintain technological products and systems. • Assess the impact of products and systems.
HS 8.2.12.D.1 Design and create a prototype to solve a real world problem using a design process, identify constraints addressed during the creation of the prototype, identify trade-offs made, and present the solution for peer review. 8.2.12.D.2 Write a feasibility study of a product to include: economic, market, technical, financial, and management factors, and provide recommendations for implementation. 8.2.12.D.3 Determine and use the appropriate resources (e.g., CNC (Computer Numerical Control) equipment, 3D printers, CAD software) in the design, development and creation of a technological product or system.

8.2.12.D.4 Assess the impacts of emerging technologies on developing countries. 8.2.12.D.5 Explain how material processing impacts the quality of engineered and fabricated products. 8.2.12.D.6 Synthesize data, analyze trends and draw conclusions regarding the effect of a technology on the individual, society, or the environment and publish conclusions.

E. Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
• Computational thinking and computer programming as tools used in design and engineering.
HS 8.2.12.E.1 Demonstrate an understanding of the problem-solving capacity of computers in our world. 8.2.12.E.2 Analyze the relationships between internal and external computer components. 8.2.12.E.3 Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games). 8.2.12.E.4 Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types and conditional statements).

21st Century Life and Careers

Career Ready Practices

CRP1. Act as a responsible and contributing citizen and employee.
CRP2. Apply appropriate academic and technical skills.
CRP3. Attend to personal health and financial well-being.
CRP4. Communicate clearly and effectively and with reason.

CRP5. Consider the environmental, social and economic impacts of decisions.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9. Model integrity, ethical leadership and effective management.
CRP10. Plan education and career paths aligned to personal goals.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Course Description

Action Chemistry is a science course centered on thematic investigations that focus students on the impact of chemistry in their lives. The course begins with a study of the structures and properties of matter, then moves on to thermodynamics and the unique properties of water. From there, students will inquire about the nature of chemical reactions and bonding. With these fundamental understandings, students will cycle back to studying these concepts in the context of biology, earth science, and the environment.

Through their study, students will build an understanding of the structure of matter, how it can and cannot change, and the role of energy in bringing about these transformations. In studying these fundamental ideas, students will develop skills in asking and refining questions, identifying and analyzing patterns in data, explaining phenomena, and designing solutions to problems. They will explore how chemistry intersects with societal as well as their own personal needs and gain an understanding of the integrated nature of the various science disciplines..

As a result of their work in this introductory course, students will continue development in scientific thinking and practice. They will be better equipped to engage with science in their everyday lives, whether it be as a general citizen of the world or through continued progress to a career in the STEM (Science, Technology, Engineering, and Mathematics) fields. They will do this through the curriculum’s integration of the skills, knowledge, and expertise of Technology Literacy standards and through unit engineering design challenges. Students will be utilizing technology to model phenomena and develop their understandings as well as collaborate with peers to create solutions to real world problems.

Adopted Text(s)

Include textbook(s) formally adopted by Board resolution.

Adopted Resources

- Defined STEM Project Based Learning

Additional Resources

SmartBoard Notebook or Interactive LCD files; Web 2.0 Resources such as ChemThink, PhET interactive simulations, Concord Consortium, PBS NOVA streaming video; Defined STEM lessons; Data Sets from NASA, NOAA, and other national science archives

Unit 1

Unit #1:	Structures and Properties of Matter
Suggested Timeframe:	30 Instructional Days
Subject/Topic:	Atomic Structure / Periodic Trends / Physical and Chemical Properties / Conservation of Mass
DESIRED RESULTS	
Enduring Understandings:	● The physical and chemical characteristics of an atom are determined by its structure. ● The number of protons determine the elemental identity of an atom. ● The number of electrons determine the attraction and repulsion between atoms and explains the properties, transformations of matter, and the forces between objects. ● The pattern in the number of electrons in the outermost shell (valence electrons) determine the extent of chemical similarity among different elements and is represented in the periodic table.
Essential Questions:	● Why are the world's resources limited? ● Why can we not change unwanted materials like lead into desirable materials like gold? ● How can the substructures of atoms explain the observable properties of substances?
All Students Will Know and Be Able To. . .	● Use the periodic table to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. (HS-PS1-1) ● 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. (HS-PS1-2) ● 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. (HS-PS1-3) ● Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. (HS-PS2-6) ● Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible

	social, cultural, and environmental impacts. (HS-ETS1-3) • Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS-ETS1-4)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3) **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) • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources	**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) • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),*(secondary to HS-PS2-6)* **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),(HS-PS1-7) **PS2.B: Types of Interactions** • 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. *(secondary to HS-PS1-1),(secondary to HS-PS1-3)*,(HS-PS2-6) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to	**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-PS1-3) **Structure and Function** • Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-PS2-6) **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4) --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3) **Obtaining, Evaluating, and Communicating Information** ● Communicate scientific and technical information (e.g. about 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-PS2-6) **Using Mathematics and Computational Thinking** ● Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)	take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)	

Connections to other DCIs in this grade-band:
HS.PS3.A (HS-PS1-8); **HS.PS3.B** (HS-PS1-8); **HS.PS3.C** (HS-PS1-8); **HS.PS3.D** (HS-PS1-8); **HS.LS1.C** (HS-PS1-1); **HS.ESS1.A** (HS-PS1-8); **HS.ESS1.C** (HS-PS1-8);**HS.ESS2.C**(HS-PS1-3)

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-PS1-1),(HS-PS1-3),(HS-PS1-8),(HS-PS2-6); **MS.PS1.B** (HS-PS1-1),(HS-PS1-8); **MS.PS2.B** (HS-PS1-3),(HS-PS2-6); **MS.ESS2.A** (HS-PS1-8)

Common Core State Standards Connections:
ELA/Literacy -

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)*
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-PS1-3)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. *(HS-PS1-2)*
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),(HS-ETS1-3)
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3)
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. *(HS-PS1-3)*
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

Mathematics - **MP.2**	Reason abstractly and quantitatively. (HS-ETS1-3),(HS-ETS1-4)
MP.4	Model with mathematics. *(HS-PS1-8)*
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-PS1-3)*,(HS-PS1-8),*(HS-PS2-6)*

Critical Vocabulary	matter, microscopic, macroscopic, energy, hypothesis, variable, control, theory, mass, volume, substance, physical property, chemical property, solid, liquid, gas, vapor, physical change, atom, electron, proton, neutron, nucleus, atomic number, mass number, atomic mass, isotope, periodic table, period, group, energy level, atomic orbital, atomic emission spectrum, ground state, metal, nonmetal, metalloid, noble gas, transition metal, electronegativity, alloy, melting point

EVIDENCE OF STUDENT LEARNING	
Formative Performance Task:	(Defined STEM) Materials Engineering: Composites Analyst ● Your task is to research the atomic composition of traditional building materials such as steel and compare it to a composite material such as carbon fiber. ● Using a multimedia presentation, you will explain what advantageous physical and chemical properties result from the structure of composite materials and justify for their use in a construction project.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. ● Salt versus Sugar Lab
Formal Evidence of	Rubrics

Learning & Progress:	Exit Cards Presentations Written Responses Quizzes Tests Research Projects Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Reading Assessments (Oral, etc.) Pre-Assessments Journals Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection
LEARNING PLAN	
Required Activities:	**Introduction to Safety in the Lab** • Safety Scavenger Hunt (engage/explore) • Videos on operation of safety equipment (explain) **Prior Knowledge Review** • Matter Webquest (elaborate/evaluate) **Introduction to the Atom** • Cosmic Voyage video and Gas emission spectrum demo (engage)

	• PhET Build an Atom to identify the parts and investigate properties of atoms (explore) • Lecture / Video (JJ Thomson cathode ray experiment) (explain) • Return to Build an Atom simulation (calculating mass number and atomic mass) (elaborate) • Guided Practice (atomic mass and number calculations) (elaborate and evaluate) • Model review (engage) • Rutherford experiment simulation (explore) • Lecture and guided practice (Bohr model drawings/interpretations) (explain and elaborate) • Wintergreen lifesavers demo (engage) • Colors of the rainbow flame test lab (explore) • Guided Fireworks reading (elaborate) • POGIL models on electrons (explore/explain) • Atom basics stations review (elaborate) **The Periodic Table** • Mendeleev simulator (engage/explore) • Periodic table KLEWS chart (engage) • Periodic table webquest (explain) • Hunting the elements video (explain) • Color coding the periodic table activity (explain) • Jigsaw notes on origin of chemical elements (elaborate) **Periodic Trends** • Periodic trends graphing activity or here (explore) • Reactivity of metals demonstration (elaborate) • Bulk property (evaporation) of alcohol and structure (elaborate) • Modified NGSS salt versus sugar lab (elaborate/evaluate)
Required Resources:	• Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Introduction to the Atom** • PBS Atom Builder Activity • Quantum Mechanics and Split Peas Lab • Seeing the Light Spectra Lab

	The Periodic Table • Element Brochure • Periodic Table Element Windsock Project • Universal Periodic Table Activity **Periodic Trends** • Metal, Nonmetal, or Metalloid Lab • Periodic Trends Lab
Suggested Resources:	• Online tutorial resources at ChemThink
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.

Unit 2

Unit #2:	The Chemistry of Abiotic Systems
Suggested Timeframe:	20 Days
Subject/Topic:	Thermodynamics / Physical and Chemical Properties of Water
DESIRED RESULTS	
Enduring Understandings:	• Energy and matter are neither created nor destroyed, just rearranged into different forms that may be useful to humankind. • Uncontrolled systems always move toward a more stable state, where energy is more uniformly distributed. • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties (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) are central to the planet's dynamics. • All forms of energy production and other resource extraction have associated economic, social, and geopolitical costs and risks. The calculus of costs and risks can be changed by new technologies and social regulations. • Modeling can be used to simulate systems and interactions (including energy, matter, and information flows) by defining the inputs and outputs within and between systems at different scales. • Analysis of costs and benefits is a critical aspect of the use of scientific knowledge, and it is further influenced by ethics, values, and sociocultural contexts.
Essential Questions:	• How can the flow of thermal energy be manipulated for useful ends? • Why are scientists concerned with finding evidence of water in outer space? Why is water so special? • How do ancient carbon atoms drive economic decisions in the modern world?
All Students Will Know and Be Able To. . .	• 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). (HS-PS3-4)

	• Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (HS-ESS2-5) • Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. (HS-ESS3-2) • Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (HS-ETS1-3)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS3-4),(HS-ESS2-5) **Engaging in Argument from Evidence** • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). (HS-ESS3-2) **Constructing Explanations and Designing Solutions** • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	**PS3.B: Conservation of Energy and Energy Transfer** • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1),(HS-PS3-4) • 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). (HS-PS3-4) **PS3.D: Energy in Chemical Processes** • Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3),(HS-PS3-4) **ESS3.A: Natural Resources** • 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. (HS-ESS3-2) **ESS2.C: The Roles of Water in Earth's Surface Processes** • The abundance of liquid water on Earth's surface and its unique combination of	**Systems and System Models** • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-PS3-4) **Structure and Function** • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Analysis of costs and benefits is a critical aspect of decisions about technology. • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3) ---

	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. (HS-ESS2-5) **ETS1.A: Defining and Delimiting Engineering Problems** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. **ETS1.B: Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** ● Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. (HS-ESS3-2) ● Science knowledge indicates what can happen in natural systems—not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2) ● Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)
Connections to other DCIs in this grade-band: ***HS.PS1.A*** *(HS-PS3-2);* ***HS.PS1.B*** *(HS-PS3-1),(HS-PS3-2);* ***HS.PS2.B*** *(HS-PS3-2),(HS-PS3-5);* ***HS.LS2.B*** *(HS-PS3-1);* ***HS.ESS1.A*** *(HS-PS3-1),(HS-PS3-4) ;* ***HS.ESS2.A****(HS-PS3-1),(HS-PS3-2),(HS-PS3-4);* ***HS.ESS2.D*** *(HS-PS3-4);* ***HS.ESS3.A*** *(HS-PS3-3)*		

Articulation of DCIs across grade-bands:
***MS.PS1.A** (HS-PS3-2); **MS.PS2.B** (HS-PS3-2),(HS-PS3-5); **MS.PS3.A** (HS-PS3-1),(HS-PS3-2),(HS-PS3-3); **MS.PS3.B** (HS-PS3-1),(HS-PS3-3),(HS-PS3-4); **MS.PS3.C**(HS-PS3-2),(HS-PS3-5); **MS.ESS2.A** (HS-PS3-1),(HS-PS3-3)*

Common Core State Standards Connections:
ELA/Literacy -

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-PS3-4),(HS-ESS3-2)
RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. *(HS-ETS1-3)*
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ESS3-2),(HS-PS3-4),(HS-ETS1-3)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. *(HS-ETS1-3)*
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS3-4),(HS-ESS2-5)
WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS3-4)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. *(HS-PS3-4)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-PS3-4),(HS-ESS3-2),(HS-ETS1-3)
MP.4	Model with mathematics. *(HS-PS3-4)*,(HS-ETS1-3)

Critical Vocabulary	chemical change, mixture, homogeneous mixture, heterogeneous mixture, solution, hydrogen bonds, acid, base, neutralization, temperature, kinetic energy, kinetic theory, collision, pressure, vaporization, evaporation, phase, phase change, surface tension, surfactant, aqueous solution, solvent, solute, electrolyte, nonelectrolyte, suspension, colloid, emulsion, solubility, concentration, dilution, heat, thermal energy, conservation of energy, system, surroundings, endothermic process, exothermic process, specific heat

EVIDENCE OF STUDENT LEARNING

Formative Performance Task:	(Defined STEM) Industrial Engineer/Inventor: Solar Power • Your task is to justify and design a solar powered appliance for home use. • You will describe the costs and benefits of traditional versus alternative energy sources in the home, then advocate for and design a piece of technology in line with the argument being put forward. • You will use technology to create an oral presentation, electronic billboard, technical report, scientific drawing, or model that highlights and explains your design.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. • Write a scientific explanation (example graphic organizer, pg. 4) for an Absolute Zero Lab experiment.
Formal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Written Responses Quizzes Tests Research Projects Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Reading Assessments (Oral, etc.) Pre-Assessments

	Journals Checklists Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection
LEARNING PLAN	

Required Activities:	**Thermodynamic Processes**
	• States of matter and thermal energy review (engage/explore)
	• Endothermic or exothermic lab (engage/explore)
	• Design an experiment to quantify the effect of varying material concentration on how endothermic or exothermic a process will be (explore/explain)
	    ○ Data analysis
	    ○ Discussion
	    ○ Proposed changes for future experiments
	• Modeling heat transfer (explain/elaborate)
	
	Properties of Water
	• Properties of water stations activity (engage/explore)
	• pH mini-lab (explore)
	• Specific heat of water inquiry investigation, pg. S5-S6 (explore)
	• Surface tension and viscosity of different liquids activity (explore)
	• Guided notes on properties of water (explain)
	• PhET molecule polarity (explain/elaborate)
	• National Data Buoy – data analysis (elaborate)
	• Chemical weathering by water inquiry (elaborate)

Required Resources:	• Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Thermodynamic Processes**

	• Descent into the Ice Lab • The Balloon and the Bottle Lab • Melting and Freezing Lab **Properties of Water** • Water Surface Tension Lab • Analysis of Water Lab • Molecule Polarity and Solubility Lab • Design an Experiment to test Solubility
Suggested Resources:	• Concord STEM Resources • PhET simulations • National Oceanic and Atmospheric Administration website
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.

Unit 3

Unit #3:	Bonding and Chemical Reactions
Suggested Timeframe:	30 Days
Subject/Topic:	Conservation of Matter and Energy / Chemical Reactions / Kinetic Theory / Bonding / Equilibrium
DESIRED RESULTS	
Enduring Understandings:	● The fact that atoms are conserved, together with the knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. ● The total amount of energy and matter in closed systems, specifically chemical reaction systems, is conserved. ● A stable molecule has less energy than the same set of atoms separated; at least this much energy must be provided in order to take the molecule apart. ● Changes of energy and matter in a chemical reaction system can be described in terms of collisions of molecules and the rearrangements of atoms into new molecules, with subsequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. ● 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. ● Patterns in the effects of changing the temperature or concentration of the reacting particles can be used to provide evidence for causality in the rate at which a reaction occurs. ● In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecule-s present. ● Explanations can be constructed explaining how chemical reaction systems can change and remain stable
Essential Questions:	● How can we predict the effects of one chemical species interacting with another? ● Why do two materials like sugar and salt appear somewhat similar yet have such vastly distinct

	properties? ● Do all chemical reactions truly end? How can this fact be exploited for society?
All Students Will Know and Be Able To. . .	● Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. (HS-PS1-7) ● 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. (HS-PS1-4) ● 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. (HS-PS1-5) ● Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. (HS-PS1-6) ● Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ● Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS1-4),(HS-PS1-8) ● Use a model to predict the relationships between systems or between components of a system. (HS-PS1-1) **Planning and Carrying Out Investigations** ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)	**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) ● The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. (HS-PS1-3),*(secondary to HS-PS2-6)* ● A 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. (HS-PS1-4) **PS1.B: Chemical Reactions**	**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),(HS-PS1-3),(HS-PS 1-5) **Energy and Matter** ● In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8) ● The total amount of energy and matter in closed systems is conserved. (HS-PS1-7) ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS1-4) **Stability and Change** ● Much of science deals with constructing explanations of how things change and how they remain stable. (HS-PS1-6)

Using Mathematics and Computational Thinking • Use mathematical representations of phenomena to support claims. (HS-PS1-7) **Constructing Explanations and Designing Solutions** • Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5) • 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) • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS1-6) **Asking Questions and Defining Problems** • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4) **Constructing Explanations and Designing Solutions** • Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)	• 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. (HS-PS1-4),(HS-PS1-5) • 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. (HS-PS1-6) • 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),(HS-PS1-7) **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) **PS2.B: Types of Interactions** • 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. *(secondary to HS-PS1-1),(secondary to HS-PS1-3)* **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be	-- ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS1-7)

• Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	

Connections to other DCIs in this grade-band:
HS.PS3.A (HS-PS1-4),(HS-PS1-5),(HS-PS1-8); **HS.PS3.B** (HS-PS1-4),(HS-PS1-6),(HS-PS1-7),(HS-PS1-8); **HS.PS3.C** (HS-PS1-8); **HS.PS3.D** (HS-PS1-4),(HS-PS1-8);**HS.LS1.C** (HS-PS1-1),(HS-PS1-2),(HS-PS1-4),(HS-PS1-7); **HS.LS2.B** (HS-PS1-7); **HS.ESS1.A** (HS-PS1-8); **HS.ESS1.C** (HS-PS1-8); **HS.ESS2.C** (HS-PS1-2),(HS-PS1-3)

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-PS1-1),(HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8); **MS.PS1.B** (HS-PS1-1),(HS-PS1-2),(HS-PS1-4),(HS-PS1-5),(HS-PS1-6),(HS-PS1-7),(HS-PS1-8); **MS.PS2.B** (HS-PS1-3),(HS-PS1-4),(HS-PS1-5); **MS.PS3.A** (HS-PS1-5); **MS.PS3.B** (HS-PS1-5); **MS.PS3.D** (HS-PS1-4); **MS.LS1.C** (HS-PS1-4),(HS-PS1-7); **MS.LS2.B** (HS-PS1-7); **MS.ESS2.A** (HS-PS1-7),(HS-PS1-8)

Common Core State Standards Connections:
ELA/Literacy -

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)*
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-PS1-3),(HS-PS1-5)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1-2),*(HS-PS1-5)*

RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),*(HS-ETS1-3)*
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ETS1-1),*(HS-ETS1-3)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),*(HS-ETS1-3)*
WHST.9-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3),*(HS-PS1-6)*
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-PS1-4)*
Mathematics - **MP.2**	Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
MP.4	Model with mathematics. *(HS-PS1-4),(HS-PS1-8)*
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-PS1-3),(HS-PS1-4),(HS-PS1-5)*,(HS-PS1-7),(HS-PS1-8)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-4),*(HS-PS1-7)*,(HS-PS1-8)
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. *(HS-PS1-2),(HS-PS1-3),(HS-PS1-4),(HS-PS1-5),(HS-PS1-7),(HS-PS1-8)*

Critical Vocabulary	chemical change, compound, reactant, product, precipitate, conservation of mass, valence electron, cation, anion, electron dot diagram, Lewis structure, chemical formula, chemical equation, balanced chemical equation, coefficient, ionic bond, formula unit, coordination number, ionic compound, metallic bond, covalent bond, molecular compound, molecule, diatomic molecule, molecular formula, double covalent bond, triple covalent bond, monoatomic ion, polyatomic ion, octet rule, polarity, nonpolar covalent bond, polar covalent bond, polar molecule, dipole, dipole interactions, dispersion forces, activation energy, catalyst, combination/synthesis reaction, decomposition reaction, single-replacement/single-displacement reaction, double-replacement/double-displacement reaction, activity series, combustion reaction, limiting reagent, chemical equilibrium, rate, reversible reaction, Le Chatelier's principle

EVIDENCE OF STUDENT LEARNING	
Formative Performance Task:	Process Engineering Design Challenge: Optimizing Chemical Reaction Yields • You will design a process or device to improve yields for a given chemical reaction. • Using technology, you will create a mockup of your process or yield (presentation, flow diagram poster, etc) and explain the mechanism of action along with the costs and benefits of your design.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. • Determine an unknown chemical reactant in a Chemical Reactions Lab and justify the claim with an explanation of the reaction mechanism.
Formal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Written Responses Quizzes Tests Research Projects Portfolios Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards

	Presentations Reading Assessments (Oral, etc.) Pre-Assessments Portfolios Journals Checklists Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection
LEARNING PLAN	
Required Activities:	**Conservation of Matter and Energy** • Gummy bear "sacrifice" demonstration (engage) • Writing chemical equations guided practice (explain) • PhET Balancing Equations or Gizmo (explore) • Black Snake sulfuric acid demonstration on physical and chemical changes (explore) • Conservation of Mass lab (explore/explain) **Chemical Reactions** • Evidence of a Chemical Reaction Lab (engage/explore) • Evidence of Chemical Reactions guided notes (explain) • Types of Chemical Reactions Lab (engage/explore) • Types of Chemical Reactions guided notes and practice (explain) **Kinetic Theory and Bonding** • Kinetic theory: Collision theory Gizmo (engage/explore) • Guided notes on collision theory (explain) • Kinetic theory: Modeling the Effect of temperature on bonding and activation energy (explain/explore) • Breaking a molecular bond simulation (explore) • Brainpop video on chemical bonding (engage)

	• Ionic bonding Gizmos simulation or Concord chemical bonds simulation (explore) • Lewis dot diagram direct instruction (explain) • Covalent bonding Gizmos simulation or Concord chemical bonds simulation (explore) • Bonding guided notes on valence electrons (explain) **Rates of Reactions** • Designing an experiment to change the rate of a reaction (engage/explore) • Reaction rate jigsaw activity on temperature, surface area, concentration (explain) • Reaction rate demonstrations and catalyst (elaborate) **Chemical Equilibrium** • Blue bottle (methylene blue) equilibrium demonstration (engage) • Equilibrium water activity (explore) • PhET reversible reactions simulation (explore) • Equilibrium guided notes (explain) • LeChatelier principle notes and guided practice (explain/elaborate) • LeChatelier Lab (elaborate)
Required Resources:	• Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Conservation of Matter and Energy** • Chembalancer Activity • Matter and Energy Demonstrations **Chemical Reactions** • Chemical Reaction Demonstrations • Chemical Reactions Lab **Kinetic Theory and Bonding** • Kinetic Molecular Theory of Popcorn Activity' • Ionic or Covalent Lab • Properties of Ionic and Covalent Compounds Lab **Rates of Reactions**

	• Sudsy Kinetics Demonstration • Iodine Clock Lab • Enzyme Salad Lab **Chemical Equilibrium** • Acid-Base Titration Lab
Suggested Resources:	• Concord STEM Resources • PhET simulations
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.

Unit 4

Unit #4:	Matter and Energy Transformations in Living Systems
Suggested Timeframe:	20 Days
Subject/Topic:	Photosynthesis / Respiration / Polymerization
DESIRED RESULTS	
Enduring Understandings:	• The process of photosynthesis converts light energy to stored energy by converting carbon dioxide plus water into sugars plus released oxygen. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products; energy is transferred from one system of interacting molecules to another based on these recombinations. • Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles; the process also releases the energy needed to maintain body temperature. • Sugar molecules contain carbon, hydrogen, and oxygen. Their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (proteins, DNA) used to form new cells or to repair/replace existing cells. • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.
Essential Questions:	• How do organisms obtain and use energy they need to live and grow? • How do organisms grow themselves with the food that they consume?
All Students Will Know and Be Able To. . .	• Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. (HS-LS1-5) • Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. (HS-LS1-7)

	• Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. (HS-LS1-6)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5),(HS-LS1-7) **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-LS1-6)	**LS1.A: Structure and Function** • Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1) • All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)* • Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2) • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3) **LS1.B: Growth and Development of Organisms** • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6) • Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

	daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4) **LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5) • The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6) • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6),(HS-LS1-7) • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)	
Connections to other DCIs in this grade-band: ***HS.PS1.B*** *(HS-LS1-5),(HS-LS1-6),(HS-LS1-7);* ***HS.PS2.B*** *(HS-LS1-7);* ***HS.LS3.A*** *(HS-LS1-1);* ***HS.PS3.B*** *(HS-LS1-5),(HS-LS1-7)*		
Articulation of DCIs across grade-bands: ***MS.PS1.A*** *(HS-LS1-6);* ***MS.PS1.B*** *(HS-LS1-5),(HS-LS1-6),(HS-LS1-7);* ***MS.PS3.D*** *(HS-LS1-5),(HS-LS1-6),(HS-LS1-7);* ***MS.LS1.A*** *(HS-LS1-1),(HS-LS1-2),(HS-LS1-3),(HS-LS1-4);* ***MS.LS1.B*** *(HS-LS1-4);* ***MS.LS1.C*** *(HS-LS1-5),(HS-LS1-6),(HS-LS1-7);* ***MS.LS2.B*** *(HS-LS1-5),(HS-LS1-7);* ***MS.ESS2.E*** *(HS-LS1-6);* ***MS.LS3.A*** *(HS-LS1-1),(HS-LS1-4);* ***MS.LS3.B*** *(HS-LS1-1)*		
Common Core State Standards Connections: *ELA/Literacy -*		

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-LS1-1),(HS-LS1-6)
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-LS1-1),(HS-LS1-6)
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-LS1-6)
WHST.9-12.9	Draw evidence from informational texts to support analysis, reflection, and research. (HS-LS1-1),(HS-LS1-6)
SL.11-12.5	Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. *(HS-LS1-2),(HS-LS1-4),(HS-LS1-5),(HS-LS1-7)*
Mathematics -	
MP.4	Model with mathematics. *(HS-LS1-4)*
HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. *(HS-LS1-4)*
HSF-BF.A.1	Write a function that describes a relationship between two quantities. *(HS-LS1-4)*

Critical Vocabulary	hydrocarbon, photosynthesis, cellular respiration, polymer, functional group, monomer, carbohydrate, monosaccharide, polysaccharide, amino acid, protein, nucleic acid, nucleotide

EVIDENCE OF STUDENT LEARNING	
Formative Performance Task:	(Defined STEM) Microbiologist: Biofuels Consultant ● Your task is to advise an international energy company transitioning to alternative fuels on the feasibility of using cyanobacteria and algae for the creation of biofuels ● You will use technology to create an oral presentation, news report, diagram, research summary, or mathematical model to explain the costs and benefits of the biofuels as well as propose an alternative fuels solution to the company.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of

	study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. ● Complete an Alcoholic Fermentation Bio-Engineering Design Challenge
Formal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Written Responses Quizzes Tests Research Projects Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Reading Assessments (Oral, etc.) Pre-Assessments Journals Checklists Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection

LEARNING PLAN	
Required Activities:	**Energy Conversion – Photosynthesis** ● Floating Spinach photosynthesis inquiry activity (engage/explore) ● Photosynthesis webquest or guided notes (explore/explain) ● Elodea oxygen bubbles Lab (elaborate) ● Design an experiment to test the effect of different lights (pg. 89) on plant growth (elaborate) **Energy Transfer – Cellular Respiration** ● Respiration of water snails demonstration (engage) ● Designing an experiment – respiration in plants (explore) ● Cellular respiration interactive and guided notes (explain) **Organic Building Blocks – Carbohydrate Formation, Amino Acid Polymerization, DNA Formation** ● Breakfast breakdown - log (engage) ● Research organic molecules found in breakfast and organic molecules in the body (explore) ● Organic building blocks guided notes (explain) ● Compare structure of precursor molecules with biological molecules using molview (elaborate)
Required Resources:	● Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Energy Conversion – Photosynthesis** ● Floating Leaf Disk Photosynthesis Activity ● Photosynthesis Modeling Activity **Energy Transfer – Cellular Respiration** ● Visualizing Photosynthesis and Cellular Respiration Lab **Organic Building Blocks – Carbohydrate Formation, Amino Acid Polymerization, DNA Formation** ● Where Does a Plant's Mass Come From? Activity ● Food, Energy, and Body Weight Activity
Suggested	● NOVA Photosynthesis Video Resources

Resources:	• Molview molecule viewer
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.

Unit 5

Unit #5:	Nuclear Chemistry
Suggested Timeframe:	30 Days
Subject/Topic:	Fusion / Fission / Nuclear Decay / Big Bang / Radiometric Dating
DESIRED RESULTS	
Enduring Understandings:	• Nuclear processes, including fusion, fission, and radioactive decay of unstable nuclei, involve release or absorption of energy. • In nuclear processes, atoms are not conserved, but the total number of protons and neutrons is conserved • The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. 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. • The star called the Sun is changing and will burn out over a lifespan of approximately 10 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 fills the universe. • 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.
Essential Questions:	• Why doesn't all radiation harm living things? • How are elements produced?

	• How can we figure out how long the Sun will last? • How do we know there was a Big Bang?
All Students Will Know and Be Able To. . .	• 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-PS1-8) • Communicate scientific ideas about the way stars, over their life cycle, produce elements. (HS-ESS1-3) • 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. (HS-ESS1-1) • 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. (HS-ESS1-2) • 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. (HS-ESS1-6)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.(HS-PS1-8),(HS-ESS1-1) **Constructing Explanations and Designing Solutions** • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, 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-ESS1-2) • Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)	**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) • Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials. *(secondary to HS-ESS1-5),(secondary to HS-ESS1-6)* **PS3.D: Energy in Chemical Processes and Everyday Life** • Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. *(secondary to HS-ESS1-1)* **PS4.B: Electromagnetic Radiation** • Atoms of each element emit and absorb characteristic frequencies of light. These	**Energy and Matter** • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. (HS-PS1-8), (HS-ESS1-3) • Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems. (HS-ESS1-2) **Scale, Proportion, and Quantity** • The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-ESS1-1) • Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-ESS1-4) **Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS1-6)

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)	characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary to HS-ESS1-2)* **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-ESS1-2),(HS-ESS1-3) ● 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. (HS-ESS1-2) ● 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-ESS1-2),(HS-ESS1-3) ***ESS1.B: Earth and the Solar System*** ● *Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)* ***ESS1.C: The History of Planet Earth*** ● *Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)* ● *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*	- ***Connections to Engineering,Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** ● Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-2),(HS-ESS1-4) - ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-ESS1-2) ● Science assumes the universe is a vast single system in which basic laws are consistent. (HS-ESS1-2)

	meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)	
Connections to other DCIs in this grade-band: ***HS.PS1.A** (HS-ESS1-2),(HS-ESS1-3); **HS.PS1.C** (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3); **HS.PS2.A** (HS-ESS1-6); **HS.PS2.B** (HS-ESS1-4),(HS-ESS1-6); **HS.PS3.A**(HS-ESS1-1),(HS-ESS1-2); **HS.PS3.B** (HS-ESS1-2),(HS-ESS1-5); **HS.PS4.A** (HS-ESS1-2)*		
Articulation of DCIs across grade-bands: ***MS.PS1.A** (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3); **MS.PS2.A** (HS-ESS1-4); **MS.PS2.B** (HS-ESS1-4),(HS-ESS1-6); **MS.PS4.B** (HS-ESS1-1),(HS-ESS1-2); **MS.ESS1.A**(HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4); **MS.ESS1.B** (HS-ESS2-4), (HS-ESS2-6); **MS.ESS1.C** (HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.A** (HS-ESS1-1),(HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.B** (HS-ESS1-5),(HS-ESS1-6); **MS.ESS2.D** (HS-ESS1-1)*		

Common Core State Standards Connections:

ELA/Literacy -

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)*
WHST.9-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-ESS1-2),*(HS-ESS1-3)*
SL.11-12.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(HS-ESS1-3)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-3),(HS-ESS1-4),(HS-PS1-8)
MP.4	Model with mathematics. (HS-ESS1-1)
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-ESS1-1),(HS-ESS1-2)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-1),*(HS-ESS1-2)*
HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1),(HS-ESS1-2)
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),(HS-ESS1-2)*
HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *(HS-ESS1-1),(HS-ESS1-2)*

Critical Vocabulary	wavelength, frequency, electromagnetic radiation, spectrum, radiation, radioactivity, alpha particle, beta particle, gamma ray, nuclear decay, positron, half-life, fission, fusion, radiometric dating, ionizing radiation, star, Big Bang, redshift, blueshift, Doppler Effect, isotope

EVIDENCE OF STUDENT LEARNING	
Formative Performance Task:	Astronomer • Your task is to delineate and justify the life cycle of a celestial body using multiple forms of evidence from radiation. • You will use technology to create a multimedia timeline for a chosen celestial body that explains how scientists have determined the age of the star or planet and demonstrates the progression of matter and energy in the body over time.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. • Life Cycle of a Star Project
Formal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Written Responses Essays

	Quizzes Tests Research Projects Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Reading Assessments (Oral, etc.) Pre-Assessments Journals Checklists Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection
LEARNING PLAN	
Required Activities:	**Fusion, Fission, and Nuclear Decay** ● Nuclear survey and discussion (engage) ● PhET: Introduction to Isotopes and Stability simulation (explore) ● Brainpop: Radioactivity and guided notes on radioactivity (explain) ● Building a Cloud Chamber: Identifying Radiation Lab (elaborate) ● Modeling Alpha and Beta Decay using a Gizmo or through PhET simulations (alpha and beta) (explore) ● Particle decay guided practice (explain) ● Nuclear Fission simulation (elaborate) **Stars and the Formation of Elements** ● Alpha Fusion modeling activity (explore)

	• Valley of Stability, heavy element modeling activity (explore) • Formation of Elements guided notes (explain) **The Finite Life of a Star** • Cosmos "Sisters of the Sun" (engage) • Star in a Box simulation (explore) • Star Life Cycle activity (explain) **The Big Bang** • BrainPop "The Big Bang" and Big Bang Theory Doppler Effect video (engage) • Doppler Effect demonstration or here (pg. 45) (explore) • Big Bang guided notes (explain) • Redshift graphing activity (elaborate) **Chemistry and Time** • Cosmos "The Clean Room" (engage) • Geologic Time webquest (explore) • Half-Life and Radiometric Dating guided notes (explain) • Radiometric Dating inquiry activity (elaborate)
Required Resources:	• Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Fusion, Fission, and Nuclear Decay** • Half-Life Lab • Penetrating Power Experiment **Stars and the Formation of Elements** • Cosmic Shuffle Activity (pg. 16) **The Finite Life of a Star** • Star Life Cycle Activity **The Big Bang** • Big Bang Balloon Activity

	Chemistry and Time • PhET Radioactive Dating Game simulation
Suggested Resources:	• NASA website • PhET simulations
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.

Unit 6

Unit #6:	Human Impact: The Chemistry of Sustainability
Suggested Timeframe:	30 Days
Subject/Topic:	Climate and Energy / The Carbon Cycle
DESIRED RESULTS	
Enduring Understandings:	● The foundation for Earth's global climate systems is the electromagnetic radiation from the Sun, as well as its reflections, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. ● 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. ● Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. ● Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. ● The total amount of carbon cycling among and between the hydrosphere, atmosphere, geosphere, and biosphere is conserved.
Essential Questions:	● How do Earth's geochemical processes and human activities affect each other? ● How do we know if climate change is real? If so, how do we know climate change is caused by human activity? ● How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere?

All Students Will Know and Be Able To. . .	• Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (HS-ESS2-4) • Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. (HS-ESS2-6) • Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. (HS-ETS1-1) • Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. (HS-ETS1-2) • Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.. (HS-ETS1-3) • Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. (HS-ETS1-4)

Established Goals:

The Student Learning Objective above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-1),(HS-ESS2-3),(HS-ESS2-6) • Use a model to provide mechanistic accounts of phenomena. (HS-ESS2-4) **Asking Questions and Defining Problems** • Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1) **Using Mathematics and Computational Thinking** • Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)	**ESS1.B: Earth and the Solar System** • 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. *(secondary to HS-ESS2-4)* **ESS2.A: Earth Materials and Systems** • 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	**Cause and Effect** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS2-4) **Energy and Matter** • The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6) • Energy drives the cycling of matter within and between systems. (HS-ESS2-3) **Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4) - ***Connections to Engineering, Technology, and Applications of Science***

Constructing Explanations and Designing Solutions • Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)	ages) to very long-term tectonic cycles. (HS-ESS2-4) **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2)(HS-ESS2-4) • Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) • Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4) **ETS1.A: Defining and Delimiting Engineering Problems** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1) • Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1) **ETS1.B: Developing Possible Solutions** • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3) • Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of	**Influence of Science, Engineering, and Technology on Society and the Natural World** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)

	solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4) **ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. (HS-ETS1-2)	

Connections to other DCIs in this grade-band:
HS.PS1.A (HS-ESS2-5),(HS-ESS2-6); **HS.PS1.B** (HS-ESS2-5),(HS-ESS2-6); **HS.PS2.B** (HS-ESS2-1),(HS-ESS2-3); **HS.PS3.A** (HS-ESS2-4); **HS.PS3.B** (HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5); **HS.PS3.D** (HS-ESS2-3),(HS-ESS2-6); **HS.PS4.B** (HS-ESS2-2); **HS.LS1.C** (HS-ESS2-6); **HS.LS2.A** (HS-ESS2-7); **HS.LS2.B**(HS-ESS2-2),(HS-ESS2-6); **HS.LS2.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-7); **HS.LS4.A** (HS-ESS2-7); **HS.LS4.B** (HS-ESS2-7); **HS.LS4.C** (HS-ESS2-7); **HS.LS4.D**(HS-ESS2-2),(HS-ESS2-7); **HS.ESS1.C** (HS-ESS2-4); **HS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6); **HS.ESS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

Articulation of DCIs across grade-bands:
MS.PS1.A (HS-ESS2-3),(HS-ESS2-5),(HS-ESS2-6); **MS.PS1.B** (HS-ESS2-3); **MS.PS2.B** (HS-ESS2-1),(HS-ESS2-3); **MS.PS3.A** (HS-ESS2-3),(HS-ESS2-4); **MS.PS3.B**(HS-ESS2-3),(HS-ESS2-4); **MS.PS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.PS4.B** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6); **MS.LS1.C** (HS-ESS2-4); **MS.LS2.A** (HS-ESS2-7); **MS.LS2.B** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6); **MS.LS2.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-7); **MS.LS4.A** (HS-ESS2-7); **MS.LS4.B** (HS-ESS2-7); **MS.LS4.C** (HS-ESS2-2),(HS-ESS2-7); **MS.ESS1.C** (HS-ESS2-1),(HS-ESS2-7); **MS.ESS2.A** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.B** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-3),(HS-ESS2-4),(HS-ESS2-6); **MS.ESS2.C** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS2.D** (HS-ESS2-1),(HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-5); **MS.ESS3.C** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6),(HS-ESS2-7); **MS.ESS3.D** (HS-ESS2-2),(HS-ESS2-4),(HS-ESS2-6)

Common Core State Standards Connections:
ELA/Literacy -

RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),*(HS-ETS1-3)*
RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. *(HS-ETS1-1)*,(HS-ETS1-3)
RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),*(HS-ETS1-3)*

Mathematics -

MP.2	Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)
MP.4	Model with mathematics. (HS-ESS2-4),(HS-ESS2-6)
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-ESS2-4),(HS-ESS2-6)
HSN-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS2-4),*(HS-ESS2-6)*

HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS2-4),(HS-ESS2-6)

Critical Vocabulary	climate, sustainability, climate change, carbon sink, carbon source, hydrosphere, atmosphere, geosphere, biosphere

EVIDENCE OF STUDENT LEARNING	
Formative Performance Task:	Civil Engineer – Sustainable and Future-Proof Housing ● Your task is to design a sustainable housing unit that will be responsive to anticipated changes in sea level. ● Using technology, you will create a model or technical drawing that argues for the benefits of your chosen design while also acknowledging its costs.
Summative Performance Task:	A Summative Performance Task is a timed and graded performance assessment used to measure higher levels of learning and transfer of knowledge. It is generally a post-assessment administered at the end of a unit of study. These will be tests and labs that will assess the knowledge and levels of learning of the material throughout the unit Included below is a an example of summative assessments that may be used within the unit. ● Create a model of Climate Change using real data
Formal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Written Responses

	Essays Quizzes Tests Research Projects Portfolios Journals Checklists Examinations of Student Work
Informal Evidence of Learning & Progress:	Rubrics Exit Cards Presentations Reading Assessments (Oral, etc.) Pre-Assessments Portfolios Journals Checklists Peer Review Informal Observations/Dialogues Think A-louds Examinations of Student Work Self-Assessment /Reflection

LEARNING PLAN

Required Activities:	**Energy and Climate** ● Cosmos “The World Set Free” (engage) ● Sun-Earth Energy Modeling Activity (explore/explain) ● Examining the Vital Signs Climate Activity (explore) ● Science of Climate Research guided notes (explain) ● Data Analysis Activity: NASA carbon dioxide and sea level data (elaborate) ● Greenhouse Gas Resonance Modeling activity (elaborate) ● Warming Arctic webquest (explore/explain)

	• Eyes on the Earth simulation (explain/elaborate) • Climate Change discussion (elaborate) • Climate Change mitigation game (elaborate) **The Carbon Cycle** • Carbon Sinks and Sources demonstrations (engage) • Acidification of water demonstration (explore) • Moving through the Carbon Cycle activity (explore/explain) • Where do Trees get their Mass from? Video (explain) • Data Analysis: Vostok Ice Core samples (elaborate) • Pacala and Socolow's Wedges – Carbon Cycle Projection Simulation (elaborate)
Required Resources:	• Textbook: Prentice Hall Chemistry by Wibraham, Staley, Matta, and Waterman (Prentice Hall, 2008)
Suggested Activities:	**Energy and Climate** • Graphing Mauna Loa CO_2 Data • Modeling Historic Climate Change with ANDRILL (ANtarctic geolocial DRILLing) Data **The Carbon Cycle** • Carbon Cycle Jigsaw • Modeling the Carbon Cycle of the Anthropocene
Suggested Resources:	• NASA website • Stanford Climate Change Education • Climate Literacy & Energy Awareness Network
Strategies for Differentiation:	• Organize lesson materials and notes graphically and in chunks. • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with choices in accessing learning materials (readings, simulations, videos, podcasts). • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

	• Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Structure lesson using UDL principles.