SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Chemistry

New Jersey
Student Learning Standards
SCIENCE

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 1: Overview
Unit 1: Structures and Properties of Matter
Content Area: Chemistry
Pacing: 30 Instructional Days
Essential Question
How can the substructures of atoms explain the observable properties of substances?
Student Learning Objectives (Performance Expectations)
HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
HS-PS1-3 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-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
Unit Summary
In this unit of study, students use investigations, simulations, and models to makes sense of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Students are able to use the periodic table as a tool to explain and predict the properties of elements. Students are expected to communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. The crosscutting concepts of structure and function, patterns, energy and matter, and stability and change are called out as the framework for understanding the disciplinary core ideas. Students use developing and using models, planning and conducting investigations, using mathematical thinking, and constructing explanations and designing solutions. Students are also expected to use the science and engineering practices to demonstrate proficiency with the core ideas.
Technical Terms
Periodic Table of Elements, electrons, atoms, bonds, ions, Dmitri Mendeleev, nucleus, protons, neutrons, Atomic Radii, Ionization Energy, Electronegativity and Electron Affinity, atomic number, macroscopic level, Law of Conservation of Matter, particles, intermolecular forces, melting point and boiling point, vapor pressure, surface tension, polar, Ionic Properties, Molecular Properties, conductivity, malleability
Formative Assessment Measures
Part A: How can a periodic table tell me about the subatomic structure of a substance?
<u>Students who understand the concepts are able to:</u> Use the periodic table as a model to provide evidence for relative properties of elements at different scales based on the patterns of electrons in the outermost energy level of atoms in main group elements. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms in

main group elements.

Part B: How can I use the periodic table to predict if I need to duck before mixing two elements?

Students who understand the concepts are able to:

Use valid and reliable evidence (obtained from students' own investigations, models, theories, simulations, and peer review) showing the outermost electron states of atoms, trends in the periodic table, and patterns of chemical properties to construct and revise an explanation for the outcome of a simple chemical reaction.

Use the assumption that theories and laws that describe the outcome of simple chemical reactions operate today as they did in the past and will continue to do so in the future.

Observe patterns in the outermost electron states of atoms, trends in the periodic table, and chemical properties.

Use the conservation of atoms and the chemical properties of the elements involved to describe and predict the outcome of a chemical reaction.

Part C: How can I use the properties of something (in bulk quantities) to predict what is happening with the subatomic particles?

Students who understand the concepts are able to:

Plan and conduct an investigation individually and collaboratively to produce data that can serve as the basis for evidence for comparing the structure of substances at the bulk scale to infer the strength of electrical forces between particles. In the investigation design, decide on types, how much, and accuracy of data needed to produce reliable measurements; consider limitations on the precision of the data (e.g., number of trials, cost, risk, time); and refine the design accordingly.

Use patterns in the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

Part D: I want to do the right thing, what is the greener choice for grocery bags (paper or plastic/reusable vs. disposable); cold drink containers (plastic, glass, or aluminum); or hot drink containers (paper, Styrofoam, or ceramic)?

Students who understand the concepts are able to:

Communicate scientific and technical information about why the molecular - level structure is important in the functioning of designed materials.

Evaluate a solution to a complex real-world problem based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoffs considerations to determine why the molecular level structure is important in the functioning of designed materials.

Use mathematical models and/or computer simulations to show why the molecular level structure is important in the functioning of designed materials.

Communicate scientific and technical information about the attractive and repulsive forces that determine the functioning of the material.

Use mathematical models and/or computer simulations to show the attractive and repulsive forces that determine the functioning of the material.

Examine in detail the properties of designed materials, the structure of the components of designed materials, and the connections of the components to reveal the function.

Use models (e.g., physical, mathematical, computer models) to simulate systems of designed materials and interactions--including energy, matter, and information flows--within and between designed materials at different scales.

Interdisciplinary Connections

NJSLS- ELA	NJSLS- Mathematics
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)	MP.2 Reason abstractly and quantitatively. (HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-ETS1-3),(HS-ETS1-4) HSN-Q.A.1 Use units as a way to understand problems and to guide the solution

<table>
<tr><td colspan="2">WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HSPS1-2)
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),(HS-ETS1-3)
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3),(HS-ETS1-3)
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)</td><td colspan="2">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)</td></tr>
<tr><td>Core Instructional Materials</td><td colspan="3">Can include: Textbooks Series, Lab Materials, etc.</td></tr>
<tr><td>21st Century Life and Careers</td><td colspan="3">CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12</td></tr>
<tr><td>Technology Standards</td><td colspan="3">8.1.12.A.2,8.1.12.A.4,8.1.12.A.5, 8.1.12.E.1,8.2.12.D.1</td></tr>
<tr><td colspan="4">Modifications</td></tr>
<tr><td>English Language Learners</td><td>Special Education</td><td>At-Risk</td><td>Gifted and Talented</td></tr>
<tr><td>Scaffolding
Word walls
Sentence/paragraph frames
Bilingual dictionaries/translation
Think alouds
Read alouds</td><td>Word walls
Visual aides
Graphic organizers
Multimedia
Leveled readers
Assistive technology</td><td>Teacher tutoring
Peer tutoring
Study guides
Graphic organizers
Extended time
Parent communication</td><td>Curriculum compacting
Challenge assignments
Enrichment activities
Tiered activities
Independent research/inquiry
Collaborative teamwork</td></tr>
</table>

Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling Cognates	Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Modified assignments Counseling	Higher level questioning Critical/Analytical thinking tasks Self-directed activities

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS1-1 Matter and its Interactions		
HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.		
Clarification Statement: Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.		
Assessment Boundary: Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.		
Evidence Statements: HS-PS1-1		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Use a model to predict the relationships between systems or between components of a system.	**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. 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.	**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.
Connections to other DCIs in this grade: HS.LS1.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B		
NJSLS- ELA: RST.9-10.7		
NJSLS- Math: N/A		

5E Model	
HS-PS1-1: Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	
Engage Anticipatory Set	Bohr's Model and Valence Electrons The students explore the atom using the NGSS Practices of Developing and Using Models. http://betterlesson.com/lesson/614383/bohr-s-model-and-valence-electrons Build An Atom This could be used as both an engage and an exploration depending on the task. Ask students to build any atom. Refer to the location of the atom they built. They may draw the atom they build. Write one or more patterns that you observed. http://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Exploration Student Inquiry	Mendeleev Periodic Table Lab http://www.nwasco.k12.or.us/cms/lib04/OR01001464/Centricity/Domain/97/Mendeleev%20Periodic%20Table%20Lab%20Assignment.pdf Exploring the Periodic Table http://betterlesson.com/lesson/629234/exploring-the-periodic-table Flame Test Lab The purpose is to observe the characteristic colors produced by certain metallic ions when vaporized in a flame and then to identify an unknown metallic ion by means of its flame test. http://www.barbertonschools.org/Downloads/flame_test_lab.doc. Electron Configuration The purpose is to observe the characteristic colors produced by certain metallic ions when vaporized in a flame and then to identify an unknown metallic ion by means of its flame test. http://betterlesson.com/lesson/631736/electron-configuration Electron Configuration- Part 1 Students will be able to explain how electrons are located in energy levels and how to determine the number of valence electrons for atoms through completing an inquiry-style paper. http://betterlesson.com/lesson/619481/electron-configuration-part-i Electron Configuration- Part 2 Students will be able to write electron configurations for elements including orbital box diagrams and shorthand notation by taking notes, watching videos, and doing an activity. http://betterlesson.com/lesson/619482/electron-configuration-part-ii
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.A: Structure and Properties of Matter Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. 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.
Elaboration Extension Activity	Periodic Table Scavenger Hunt Students are using the periodic table to determine the number of particles in atoms, as well as the type of element represented. http://betterlesson.com/lesson/629268/periodic-table-scavenger-hunt Virtual Investigation http://www.mhhe.com/biosci/genbio/virtual_labs/periodic_table/main.html Graphing Periodic Trends

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

	Using the data from this interactive website, students will use Google Sheets or Excel to create graphs showing the periodic trends of Atomic Radii,Ionization Energy, Electronegativity and Electron Affinity vs atomic number using data from the following website. Students can construct explanations for the graphs showing the periodic trends. http://www.ptable.com/#Property/State	
Evaluation Assessment Tasks		Assessm Reflecti

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS1-2 Matter and its Interactions		
HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.		
Clarification Statement: Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen.		
Assessment Boundary: Assessment is limited to chemical reactions involving main group elements and combustion reactions.		
Evidence Statements: HS-PS1-2		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. 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.	**PS1.A: Structure and Properties of Matter** 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. **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.	**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.
Connections to other DCIs in this grade-band: HS.LS1.C ; HS.ESS2.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B		
NJSLS- ELA: WHST.9-12.2, WHST.9-12.5		
NJSLS- Math: HSN-Q.A.1, HSN-Q.A.3		

5E Model	
HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.	
Engage Anticipatory Set	How Elements Form Compounds This is a video excerpt showing how sodium reacts with chlorine to form salt. It is accompanied by discussion questions for engagement http://nj.pbslearningmedia.org/resource/nvhe.sci.chemistry.compounds/how-elements-form-compounds/

	What Makes an Element Reactive? This video demonstrates how electron configuration affects the reactivity of an element. It is accompanied by discussion questions for engagement. http://nj.pbslearningmedia.org/resource/nvhe.sci.chemistry.reactive/what-makes-an-element-reactive/ Gummy Bear Experiment The following video provides a demonstration of a spontaneous exothermic reaction will take place between a gummy bear and molten potassium chlorate. This demonstration can either be viewed or fully executed in the classroom. https://www.youtube.com/watch?v=7Xu2YZzufTM
Exploration Student Inquiry	#Trendi In this l includir http://b Periodic In this a perforn https:// Types o During number reactan decomp http://v Types o http://b http://be http://be Corrosi In this l
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.A: Structure and Properties of Matter 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.

	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.
Elaboration Extension Activity	The Signs of Chemical Reactions Lab http://alki.vansd.org/dgray/Assignments/Chemical%20Reactions/Evidence%20of%20Chemical%20Reactions%20Lab.doc.
Evaluation Assessment Tasks	Assessment Task: Trends of the Periodic Table https://betterlesson.com/lesson/resource/3131431/periodic-trends-ws?from=lessonsection_narrative

CHEMISTRY		
HS-PS1-3 Matter and its Interactions		
HS-PS1-3 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.		
Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension.		
Assessment Boundary: Assessment does not include Raoult's law calculations of vapor pressure.		
Evidence Statements: HS-PS1-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. 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.	**PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.	**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.
Connections to other DCIs in this grade-band: MS.LS2.A ; MS.LS4.D ; MS.ESS3.A ; MS.ESS3.C		
Articulation of DCIs across grade-bands: HS.PS1.A ; HS.LS2.A ; HS.LS4.D ; HS.ESS3.A		
NJSLS- ELA: RST.6-8.1, WHST.6-8.8		
NJSLS- Math: N/A		

5E Model	
HS-PS1-3 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.	
Engage Anticipatory Set	Properties of Ionic and Covalent Substances Lab In this lab, students we will examine certain physical properties of three compounds to try to determine if they are ionic or covalent, and if they are covalent if they are polar or nonpolar. http://www.myips.org/cms/lib8/IN01906626/Centricity/Domain/8123/Properties_of_Ionic_and_Covalent_Substances_Lab.pdf

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Exploration Student Inquiry	Introduction to Bonding In this multi-day lab, students will be able to use electronegativity values to decide if a bond is ionic or molecular, and describe differences in physical characteristics for substances with each type of bond. Includes Ionic vs. Molecular Properties Lab. http://betterlesson.com/lesson/633250/introduction-to-bonding Boiling Point Lab In this lab, students will determine what happens to the properties of liquids as they reach the boiling point. http://www.chsd.us/~tthompson/assignments/trimester3/Physical%20Science/boiling%20point%20lab.pdf
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.A: Structure and Properties of Matter The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
Elaboration Extension Activity	Candy Compounds http://schoolwires.henry.k12.ga.us/cms/lib08/GA01000549/Centricity/Domain/7044/Chem%20Candy%20Lab.pdf
Evaluation Assessment Tasks	Assessment Task A: Lab Reflection After conducting the investigation, students will reflect on the accuracy and precision of data, as well as limitations of the investigations and make suggestions for refinement.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS2-6 Motion and Stability: Forces and Interactions		
HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.		
Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.		
Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.		
Evidence Statements: HS-PS2-6		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. 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).	**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.	**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.
Connections to other DCIs in this grade-band: N/A		
Articulation of DCIs across grade-bands: MS.PS2.B		
NJSLS- ELA: RST.11-12.1, WHST.11-12.2		
NJSLS- Math: HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3		

5E Model	
HS-PS2-6: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.	
Engage Anticipatory Set	Atomic Structure of an Alloy In this video excerpt from NOVA: "Hunting the Elements," New York Times technology columnist David Pogue visits The Verdin Company, a manufacturer of bells, to learn about bronze. Find out how copper is typically alloyed with tin to make bronze—a metal alloy widely used in tools and weapons during the Bronze Age and still in use today. Learn how to make a bell and why bronze is still the manufacturer's material of choice. Explore how the atomic structure of a metal determines its properties, such as

	conductivity and malleability, and how combining metals can create a new material with different properties. http://nj.pbslearningmedia.org/resource/nvhe.sci.chemistry.alloy/atomic-structure-of-an-alloy/ Article- Graphene: The Next Wonder Material? http://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/archive-2012-2013/graphene.html?_ga=1.111599428.1330968908.1461338522
Exploration Student Inquiry	What Makes a Good Conductor? http://www.fofweb.com/onfiles/seof/chemistry_experiments/4-08.pdf Fun Look at Material Science In this activity, students are introduced to the multidisciplinary field of material science. Through a class demo and PowerPoint® presentation, they learn the basic classes of materials (metals, ceramics, polymers, composites) and how they differ from one another, considering concepts such as stress, strain, ductile, brittle, deformation and fracture. Practical examples help students understand how the materials are applied, and further information about specific research illustrates how materials and material science are useful in space exploration. A worksheet and quiz are provided. https://www.teachengineering.org/view_lesson.php?url=collection/uoh_/lessons/uoh_matlsci/uoh_matlsci_lesson01.xml
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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.
Elaboration Extension Activity	Additional Activities http://www.ck12.org/ngss/high-school-physical-sciences/motion-and-stability:-forces-and-interactions
Evaluation Assessment Tasks	Assessment Task A: Written Explanation Students will describe how electromagnetic forces on the atomic and molecular scale result in contact forces on the macroscopic scale.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 2: Overview

Unit 2: The Chemistry of Abiotic Systems & Energy of Chemical Systems

Content Area: Chemistry

Pacing: 30 Instructional Days

Essential Question

Why are we so lucky that water has the physical properties that it does? How do ancient carbon atoms drive economic decisions in the modern world?

Student Learning Objectives (Performance Expectations)

HS-PS3-4: 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-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ETS1-3: 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.

Unit Summary

In this unit of study, students develop and use models, plan and carry out investigations, analyze and interpret data, and engage in argument from evidence to make sense of energy as a quantitative property of a system—a property that depends on the motion and interactions of matter and radiation within that system. They will also use the findings of investigations to provide a mechanistic explanation for the core idea that total change of energy in any system is always equal to the total energy transferred into or out of the system. Additionally, students develop an understanding that energy, at both the macroscopic and the atomic scales, can be accounted for as motions of particles or as energy associated with the configurations (relative positions) of particles. Students apply their understanding of energy to explain the role that water plays in affecting weather. Students examine the ways that human activities cause feedback that create changes to other systems. Students are expected to demonstrate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, engaging in argument from evidence, and using these practices to demonstrate understanding of core ideas. Students also develop possible solutions for major global problems. They begin by breaking these problems into smaller problems that can be tackled with engineering methods. To evaluate potential solutions, students are expected not only to consider a wide range of criteria, but also to recognize that criteria need to be prioritized.

Technical Terms

Chemical reaction, electron states of atom, sodium, chlorine, carbon, oxygen, hydrogen, elements, protons,electronegativity, ionization energy, atomic size, Law of Conservation of Matter, Five General Types of Reaction (combination, decombination, combustion, single replacement, , displacement, double replacement, ionic)

Formative Assessment Measures

Part A: Does thermal energy always transfer or transform in predictable ways?

Students who understand the concepts are able to:

Plan and conduct an investigation individually or collaboratively to produce data on transfer of thermal energy in a closed system that can serve as a basis for evidence of uniform energy distribution among components of a system when two components of different temperatures are combined. Use models to describe a system and define its boundaries, initial conditions, inputs, and outputs. Design an investigation to produce data on transfer of thermal energy in a closed system that can serve as a basis for evidence of uniform energy distribution among components of a system when two components of different temperatures are combined, considering types, how much, and the accuracy of data needed to produce reliable measurements. Consider the limitations of the precision of the data collected and refine the design accordingly
Part B: What makes water's properties essential to life on our planet? or Why do we look for water on other planets? or What makes water so special?
<u>Students who understand the concepts are able to:</u> Plan and conduct an investigation individually and collaboratively of the properties of water and its effects on Earth materials and surface processes. Use models to describe a hydrological system and define its boundaries, initial conditions, inputs, and outputs. Design an investigation considering the types, how much, and accuracy of data needed to produce reliable measurements. Consider the limitations on the precision of the data collected and refine the design accordingly.
Part C: What is the best energy source for a home? How would I meet the energy needs of the house of the future?
<u>Students who understand the concepts are able to:</u> Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost benefit ratios, scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, and ethical considerations). Use models to evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost–benefit ratios, scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, and ethical considerations).

Interdisciplinary Connections

NJSLS- ELA	NJSLS- Mathematics
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.	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)

(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), (HSESS2-5) 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. WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS3-4)	

Core Instructional Materials	Can include: Textbooks Series, Lab Materials, etc.
21st Century Life and Careers	CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12
Technology Standards	8.1.12.A.2,8.1.12.A.4,8.1.12.A.5, 8.1.12.C.1, 8.1.12.D.1, 8.1.12.E.1

Modifications

English Language Learners	Special Education	At-Risk	Gifted and Talented
Scaffolding Word walls Sentence/paragraph frames Bilingual dictionaries/translation Think alouds Read alouds Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling Cognates	Word walls Visual aides Graphic organizers Multimedia Leveled readers Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Teacher tutoring Peer tutoring Study guides Graphic organizers Extended time Parent communication Modified assignments Counseling	Curriculum compacting Challenge assignments Enrichment activities Tiered activities Independent research/inquiry Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS3-4 Energy		
HS-PS3-4: 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).		
Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.		
Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.		
Evidence Statements: HS-PS3-4		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. 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.	**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. 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). **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.	**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.
Connections to other DCIs in this grade-band: HS.ESS2.A		
Articulation of DCIs across grade-bands: MS.PS3.B		
NJSLS- ELA: RST.11-12.1, WHST.9-12.7, WHST.11-12.8		
NJSLS- Math: MP.2, MP.4		
5E Model		
HS-PS3-4: 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).		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Engage Anticipatory Set	Conduction: The Effect of Wall Thickness on Heat Conduction Using this interactive model, students will compare the flow of heat through materials of differing thicknesses. https://concord.org/stem-resources/conduction-effect-wall-thickness-heat-conduction
Exploration Student Inquiry	Hands on Activity: To Heat or Not to Heat https://www.teachengineering.org/view_activity.php?url=collection/wsu_/activities/wsu_heat_activity/wsu_heat_activity.xml Energy Forms and Changes https://phet.colorado.edu/en/simulation/legacy/energy-forms-and-changes In this online simulation, students will explore how heating and cooling iron, brick, and water adds or removes energy. They will see how energy is transferred between objects, build their own system with energy sources, changers, and users and track and visualize how energy flows and changes through your system. Heat, Temperature and Calorimetry In this lesson, students will differentiate between heat energy and temperature and apply this knowledge to calorimetry. http://betterlesson.com/lesson/640677/heat-temperature-and-calorimetry Calorimetry Lab In this lesson, students will track energy changes in an open calorimeter when mixing water of different temperatures. http://betterlesson.com/lesson/640678/calorimetry-lab
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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. 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). 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.
Elaboration Extension Activity	Soda Can Calorimeter This activity will introduce the concept of calorimetry and investigate the caloric content of snack foods https://www.flinnsci.com/media/510570/soda_can.pdf Additional Activities http://www.ck12.org/ngss/high-school-physical-sciences/energy
Evaluation Assessment Tasks	Assessment Task A: Throughout the exploration activities, teachers should assess students' planning of their investigations. Assessment Task B: Calorimetry Lab: Analysis Questions

CHEMISTRY		
HS-ESS2-5 Earth's Systems		
HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.		
Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids.		
Assessment Boundary: N/A		
Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids.		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. 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.	**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 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.	**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 other DCIs in this grade-band: HS.PS1.A ; HS.PS1.B ; HS.PS3.B ; HS.ESS3.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS4.B ; MS.ESS2.A ; MS.ESS2.C ; MS.ESS2.D		

NJSLS- ELA: WHST.9-12.7	
NJSLS- Math: HSN.Q.A.3	
5E Model	
HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	
Engage Anticipatory Set	Ausable Chasm, NY: Flood Video Students will be asked to watch a video on the flooding of the Ausable Chasm and investigate how water played a role in its formation. https://www.youtube.com/watch?v=XpdlNhRNNIY Largest Crystals in the World: Giant Crystal Cave, Mexico Students will be shown pictures of the Giant Crystal Caves in Mexico and will be asked to develop a theory as to how these caves formed. How did water cause crystals to form? Where did the material to form these crystals come from? How might the flooding of these caves endanger the existence of these crystals? If you entered the caves what do you predict the environment would be like? What would you experience inside the cave? http://www.tourismontheedge.com/get-extreme/largest-crystals-in-the-world-giant-crystal-cave-mexico
Exploration Student Inquiry	Making a Cave This activity simulates the way that dissolution, a chemical weathering process, leads to the formation of caves. http://www.earthsciweek.org/classroom-activities/making-cave Streamflow Lab https://skyschool.arizona.edu/skyschoolwiki/index.php?title=Streamflow_lesson_plan
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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 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.
Elaboration Extension Activity	Landforms from Stream Erosion and Deposition The following site provides reading materials, videos and study guides on this topic. http://www.ck12.org/earth-science/Landforms-from-Stream-Erosion-and-Deposition/?by=ck12&difficulty=all#text
Evaluation Assessment Tasks	Assessment Task A: Throughout the exploration activities, Making a Cave and Streamflow Lab, teachers should assess students' planning of their investigations. Assessment Task B: Landforms from Erosion and Deposition Study Guide

	Concept Check Questions: http://www.ck12.org/earth-science/Landforms-from-Stream-Erosion-and-Deposition/studyguide/Landforms-from-Erosion-and-Deposition-Study-Guide/?referrer=concept_details Compare the effects of different types of erosion. Why does erosion occur and how does it affect humans? How are landforms formed by different types of erosion?

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ESS3-2 Earth and Human Activity		
HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.		
Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.		
Assessment Boundary: N/A		
A4=HYPERLINK("http://www.nextgenscience.org/sites/ngss/files/HS-ESS3-2_Evidence%20Statements%20Jan%202015.pdf","Evidence Statements: HS-ESS3-2")		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. 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).	**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. **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. (secondary)	**Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology. **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. 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. Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues.
Connections to other DCIs in this grade-band: HS.PS3.B ; HS.PS3.D ; HS.LS2.A ; HS.LS2.B ; HS.LS4.D ; HS.ESS2.A		
Articulation of DCIs across grade-bands: MS.PS3.D ; MS.LS2.A ; MS.LS2.B ; MS.LS4.D ; MS.ESS3.A ; MS.ESS3.C		
NJSLS- ELA: RST.11-12.1, RST.11-12.8		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

NJSLS- Math: MP.2	
5E Model	
HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	
Engage Anticipatory Set	One Fracking Minute This animation provides an overview of hydraulic fracturing http://www.marketplace.org/2012/12/07/sustainability/crude-economy/one-fracking-minute-animated-explainer-hydraulic-fracturing
Exploration Student Inquiry	Comparing Energy Resources: Pros and Cons Students will be able to compare the pros and cons of various energy resources and determine which resource is the best option to both meet our future energy needs and minimize our environmental impact. http://betterlesson.com/lesson/640507/comparing-energy-resources-pros-and-cons
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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. 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. (secondary)
Elaboration Extension Activity	Earth, Science Week- Additional Activities http://www.earthsciweek.org/classroom-activities/ngss
Evaluation Assessment Tasks	Assessment Task A: Comparing Energy Resources: Pros and Cons- Writing Component Which Energy Resource is Best? Consider the pros and cons of each energy resource. Which resource(s) do you think societies should use to meet their future energy needs?

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ETS1-3 Engineering Design		
HS-ETS1-3: 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.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**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.	**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.
Connections to other DCIs in this grade-band: Earth and Space Science: HS-ESS3-2, HS-ESS3-4 Life Science: HS-LS2-7, HS-LS4-6		
Articulation of DCIs across grade-bands: MS.ETS1.A ; MS.ETS1.B		
NJSLS- ELA: RST.11-12.7, RST.11-12.8, RST.11-12.9		
NJSLS- Math: MP.2, MP.4		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 3: Overview
Unit 3: Bonding and Chemical Reactions
Content Area: Chemistry
Pacing: 30 Instructional Days
Essential Question
How can one explain the structure, properties, and interactions of matter?
Student Learning Objectives (Performance Expectations)
HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
HS-PS1-4: 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-PS1-5: 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-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
Unit Summary
In this unit of study, students develop and using models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they develop an understanding of the substructure of atoms and to provide more mechanistic explanations of the properties of substances. Chemical reactions, including rates of reactions and energy changes, can be understood by students at this level in terms of the collisions of molecules and the rearrangements of atoms. Students also apply an understanding of the process of optimization and engineering design to chemical reaction systems. The crosscutting concepts of patterns, energy and matter, and stability and change are the organizing concepts for these disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models, planning and conducting investigations, using mathematical thinking, and constructing explanations and designing solutions.
Technical Terms
reactants, macroscopic scale, linear and nonlinear functions, trigonometric functions, exponentials, logarithms, equilibrium, particles, kinetic energy, absorption of energy, Endothermic and Exothermic Reactions, calcium carbonate, hydrochloric acid, Le Chatelier’s Principle, Law of conservation of mass
Formative Assessment Measures
Part A: Where do the atoms go during a chemical reaction?
Students who understand the concepts are able to: Use mathematical representations of chemical reaction systems to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Use mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and products and the translation of these

relationships to the macroscopic scale, using the mole as the conversion from the atomic to the macroscopic scale.
Use the fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, to describe and predict chemical reactions.
Describe changes of energy and matter in a chemical reaction system in terms of energy and matter flows into, out of, and within that system.

Part B: What is different inside a heat pack and a cold pack?

Students who understand the concepts are able to:
Explain the idea that a stable molecule has less energy than the same set of atoms separated. Describe changes of energy and matter in a chemical reaction system in terms of energy and matter flows into, out of, and within that system.
Describe chemical processes, their rates, and whether or not they store or release energy 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.
Develop a model based on evidence to illustrate the relationship between the release or absorption of energy from a chemical reaction system and the changes in total bond energy.

Part C: Is it possible to change the rate of a reaction or cause two elements to react that do not normally want to?

Students who understand the concepts are able to:
Use the number and energy of collisions between molecules (particles) to explain the effects of changing the temperature or concentration of the reacting articles on the rate at which a reaction occurs.
Use patterns in the effects of changing the temperature or concentration of the reactant particles to provide evidence for causality in the rate at which a reaction occurs.
Apply scientific principles and multiple and independent student-generated sources of evidence to provide an explanation of the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

Part D: What can we do to make the products of a reaction stable?

Students who understand the concepts are able to:
Construct explanations for how chemical reaction systems change and how they remain stable.
Design a solution to specify a change in conditions that would produce increased amounts of products at equilibrium in a chemical system based on scientific knowledge, student-generated sources of evidence, prioritized
criteria, and tradeoff considerations.
Break down and prioritize criteria for increasing amounts of products in a chemical system at equilibrium.
Refine the design of a solution to specify a change in conditions that would produce increased amounts of products at equilibrium in a chemical system based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Interdisciplinary Connections

NJSLS- ELA	NJSLS- Mathematics
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)	MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7),(HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4)

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-PS1-5) 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.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HSPS1-5) 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-PS1-6) 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)	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-PS1-4),(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) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-4),(HS-PS1-5),(HS-PS1-7)

Core Instructional Materials	Can include: Textbooks Series, Lab Materials, etc.
21st Century Life and Careers	CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12
Technology Standards	8.1.12.A.2,8.1.12.A.4,8.1.12.C.1, 8.1.12.D.1, 8.1.12.E.1

Modifications

English Language Learners	Special Education	At-Risk	Gifted and Talented
Scaffolding Word walls Sentence/paragraph frames Bilingual	Word walls Visual aides Graphic organizers Multimedia	Teacher tutoring Peer tutoring Study guides Graphic organizers	Curriculum compacting Challenge assignments Enrichment activities Tiered activities

dictionaries/translation Think alouds Read alouds Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling Cognates	Leveled readers Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Extended time Parent communication Modified assignments Counseling	Independent research/inquiry Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY

HS-PS1-7 Matter and its Interactions

HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale. Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.

Assessment Boundary: Assessment does not include complex chemical reactions.

Evidence Statements:HS-PS1-7

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena to support claims.	**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.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved. **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.

Connections to other DCIs in this grade-band: HS.LS1.C ; HS.LS2.B ; HS.PS3.B

Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.LS1.C ; MS.LS2.B ; MS.ESS2.A

NJSLS- ELA: N/A

NJSLS- Math: MP.2, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3

5E Model

HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Engage Anticipatory Set	Balancing Chemical Equations - Use mathematics and visual representations to balance chemical equations. https://phet.colorado.edu/en/simulation/legacy/balancing-chemical-equations http://phet.colorado.edu/en/simulation/balancing-chemical-equations Reactions and Rates - See that atoms are conserved in an equilibrium situation where there are unreacted particles. https://phet.colorado.edu/en/simulation/legacy/reactions-and-rates

	Reactants, Products, and Leftovers https://phet.colorado.edu/en/simulation/legacy/reactants-products-and-leftovers
Exploration Student Inquiry	Stoichiometry Lab http://misterguch.brinkster.net/MLX039.doc. Limiting Reactants Lab http://my-ecoach.com/online/resources/3709/Stoichiometry_of_Smores_Lab1.pdf
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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. 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.
Elaboration Extension Activity	Related Worksheets Limiting Reactants: http://chemwiki.ucdavis.edu/Worksheets/Worksheets%3A_General_Chemistry/Worksheet%3A_Limiting_Reagents_2 Moles: http://chemwiki.ucdavis.edu/Worksheets/Worksheets%3A_General_Chemistry/Worksheet%3A_Moles General Science: http://chemwiki.ucdavis.edu/Worksheets/Worksheets%3A_General_Chemistry
Evaluation Assessment Tasks	Assessment Task A: Stoichiometry Lab Post Lab Questions http://misterguch.brinkster.net/MLX039.doc. Assessment Task B: Limiting Reactants Lab Analysis Questions http://my-ecoach.com/online/resources/3709/Stoichiometry_of_Smores_Lab1.pdf

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS1-4 Matter and its Interactions		
HS-PS1-4: 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.		
Clarification Statement: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.		
Assessment Boundary: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.		
Evidence Statements: HS-PS1-4		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**PS1.A: Structure and Properties of Matter** 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. **PS1.B: Chemical Reactions** 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.	**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.
Connections to other DCIs in this grade-band: HS.PS3.A ; HS.PS3.B ; HS.PS3.D ; HS.LS1.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.PS2.B ; MS.PS3.D ; MS.LS1.C		
NJSLS- ELA: SL.11-12.5		
NJSLS- Math: MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3		

5E Model	
HS-PS1-4: 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.	
Engage Anticipatory Set	Energy Forms and Changes http://phet.colorado.edu/en/simulation/energy-forms-and-changes Enthalpy: Crash Course https://www.youtube.com/watch?v=SV7U4yAXL5I

Exploration Student Inquiry	Endothermic and Exothermic Reaction Lab http://www.sciencegeek.net/Chemistry/chempdfs/EndoExo.pdf Endothermic and Exothermic Reaction Lab/Graphing Activity http://www.myips.org/cms/lib8/IN01906626/Centricity/Domain/8123/General%20Chemistry%20Unit%205%20Energetics_Jan%202010.pdf Endothermic and Exothermic Reaction Lab http://extension.uga.edu/k12/science-behind-our-food/lesson-plans/endothermicexothermicreactions.pdf
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.A: Structure and Properties of Matter 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. PS1.B: Chemical Reactions 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.
Elaboration Extension Activity	Reversible Reactions https://phet.colorado.edu/en/simulation/reversible-reactions Endothermic and Exothermic Reactions http://www.cfep.uci.edu/cspi/docs/lessons_secondary/Endo%20vs%20Exo%20Lab.pdf
Evaluation Assessment Tasks	Assessment Task A: Student models can include molecular level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products and representations showing energy is conserved. Exploration activities above include these various models.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS1-5 Matter and its Interactions		
HS-PS1-5: 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.		
Clarification Statement: Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.		
Assessment Boundary: Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.		
Evidence Statements: HS-PS1-5		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**PS1.B: Chemical Reactions** 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** 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.
Connections to other DCIs in this grade-band: HS.PS3.A		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.PS2.B ; MS.PS3.A ; MS.PS3.B		
NJSLS- ELA: RST.11-12.1, WHST.9-12.2		
NJSLS- Math: MP.2, HSN-Q.A.1, HSN-Q.A.3		

5E Model	
HS-PS1-5: 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.	
Engage Anticipatory Set	Rates of Reaction: Part 2 https://www.youtube.com/watch?v=ExHV_cFWYSM Concentration Simulation https://phet.colorado.edu/sims/html/concentration/latest/concentration_en.html Dissolving Salts in Water Simulation http://www.pbslearningmedia.org/resource/lsps07.sci.phys.matter.dissolvesalt/dissolving-salts-in-water/

Exploration Student Inquiry	Reaction Rate Experimental Design http://betterlesson.com/lesson/638411/reaction-rate-experimental-design?from=cc_lesson_title In this lesson students will conduct a brief mini-lab to reconnect to the idea that molecules are moving. They will then work on designing an experiment that measures the reaction rate between calcium carbonate and hydrochloric acid when either temperature, concentration, or surface area are manipulated.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.B: Chemical Reactions 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.
Elaboration Extension Activity	Bond Energy Calculation http://www.springboro.org/userfiles/722/Classes/5769/Bond%20Energy%20Practice%20Sheet%20with%20Key.pdf Elephant Toothpaste Lab http://looseinthelabscience.com/downloads/ElephantToothpaste2011.pdf
Evaluation Assessment Tasks	Assessment Task A: Rates of Reaction Lab-Discussion Questions https://sjesci.wikispaces.com/file/view/Rate+of+reaction.pdf

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY

HS-PS1-6 Matter and its Interactions

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Clarification Statement: Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products.

Assessment Boundary: Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.

Evidence Statements: HS-PS1-6

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**PS1.B: Chemical Reactions** 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. 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. (secondary)	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

Connections to other DCIs in this grade-band: HS.PS3.B

Articulation of DCIs across grade-bands: MS.PS1.B

NJSLS- ELA: WHST.9-12.7

NJSLS- Math: N/A

5E Model

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

Engage Anticipatory Set	Reactions & Rates http://phet.colorado.edu/en/simulation/reactions-and-rates Explore what makes a reaction happen by colliding atoms and molecules. Design experiments with different reactions, concentrations, and temperatures. When are reactions reversible? What affects the rate of a reaction? Change concentrations, energy of reactions, temperatures, types of reactions and see changing concentrations

Exploration Student Inquiry	CHM152LL: Le Chatelier's Principle http://web.gccaz.edu/~lisys52871/LeChat.pdf In this experiment you will observe shifts in equilibrium systems when conditions, such as the concentration and temperature, are changed. You will explain the observed color changes of four reactions in terms of Le Chatelier's principle.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS1.B: Chemical Reactions 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. 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. (secondary)
Elaboration Extension Activity	Iodine Clock Reaction https://www.youtube.com/watch?v=_qhYDuJt8fI Student will watch the clock reaction and will then be tasked with the following activity 1) Create a graphical representation of the reaction observed. Make sure to account for the various products and reactants in the reaction. 2) Modify your graphical representation to account for the change in the reaction rate over time. 3) Predict how the graph would be different if there were more intermediate stages for the reaction (i.e. more colors the reaction could go through) 4) Set up individual graphs for relative concentrations of each of the products and reactants produced in the experiment. Make sure your graph accounts for the Law of conservation of mass.
Evaluation Assessment Tasks	Assessment Task A: Le Chatelier's Principle Lab-Discussion Questions & Molecular Level Drawings http://web.gccaz.edu/~lisys52871/LeChat.pdf

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ETS1-2 Engineering Design		
HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-2		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**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.	
Connections to other DCIs in this grade-band: Physical Science: HS-PS1-6, HS-PS2-3		
Articulation of DCIs across grade-bands: MS.ETS1.A ; MS.ETS1.B ; MS.ETS1.C		
NJSLS- ELA: N/A		
NJSLS- Math: MP.4		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 4: Overview
Unit 4: Matter and Energy in Living Systems
Content Area: Chemistry
Pacing: 20 Instructional Days
Essential Question
How do organisms obtain and use the energy they need to live and grow?
Student Learning Objectives (Performance Expectations)
HS-LS1-7: 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-LS1-6: 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.
Unit Summary
In this unit of study, students construct explanations for the role of energy in the cycling of matter in organisms. They apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration and develop models to communicate these explanations. The crosscutting concept of matter and energy provides students with insights into the structures and processes of organisms. Students are expected to develop and use models, plan and conduct investigations, use mathematical thinking, and construct explanations and design solutions as they demonstrate proficiency with the disciplinary core ideas.
Technical Terms
cellular respiration, bonds, molecules, compounds, photosynthesis, glucose, oxygen, carbon, hydrogen, sugar molecules, organic compounds, carbohydrates, dehydration synthesis, hydrocarbon, amino acids, respiration
Formative Assessment Measures
Part A: How does photosynthesis transform light energy into stored chemical energy?
Students who understand the concepts are able to: Provide a mechanistic explanation for how photosynthesis transforms light energy into stored chemical energy. Use their understanding of energy flow and conservation of energy to illustrate the inputs and outputs of matter and the transformation of energy in photosynthesis.
Part B: How does cellular respiration result in a net transfer of energy?
Students who understand the concepts are able to: Construct an evidence-based 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. Use their understanding of energy flow and conservation of energy to illustrate the inputs and outputs of the process of cellular respiration.
Part C: How do elements of a sugar molecule combine with other elements and what molecules are formed?

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Students who understand the concepts are able to:

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) 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.

Construct and revise an explanation, based on valid and reliable evidence from a variety of sources (including models, theories, simulations, peer review) and on 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, 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.

Use evidence from models and simulations to support explanations 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.

Interdisciplinary Connections

NJSLS- ELA	NJSLS- Mathematics
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-LS1-6) 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-LS1-4),(HS-LS1-5),(HS-LS1-7) WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (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-LS1-6)	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)

Core Instructional Materials	Can include: Textbooks Series, Lab Materials, etc.
21st Century Life and Careers	CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12
Technology Standards	8.1.12.A.2,8.1.12.A.4,8.1.12.C.1, 8.1.12.D.1, 8.1.12.E.1

Modifications

English Language Learners	Special Education	At-Risk	Gifted and Talented
Scaffolding Word walls Sentence/paragraph frames Bilingual dictionaries/translation Think alouds	Word walls Visual aides Graphic organizers Multimedia Leveled readers	Teacher tutoring Peer tutoring Study guides Graphic organizers Extended time	Curriculum compacting Challenge assignments Enrichment activities Tiered activities Independent research/inquiry

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Read alouds Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling Cognates	Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Parent communication Modified assignments Counseling	Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

CHEMISTRY		
HS-LS1-7: From Molecules to Organisms: Structures and Processes		
HS-LS1-7: 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		
Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.		
Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.		
Evidence Statements: HS-LS1-7		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.C: Organization for Matter and Energy Flow in Organisms** As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. 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.	**Energy and Matter** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.
Connections to other DCIs in this grade-band: HS.PS1.B ; HS.PS2.B ; HS.PS3.B		
Articulation of DCIs across grade-bands: MS.PS1.B ; MS.PS3.D ; MS.LS1.C ; MS.LS2.B		
NJSLS- ELA: SL.11-12.5		
NJSLS- Math: N/A		
5E Model		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

HS-LS1-7: 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	
Engage Anticipatory Set	ATP & Respiration: Crash Course Video https://www.youtube.com/watch?v=00jbG_cfGuQ
Exploration Student Inquiry	How Do Organisms Use Energy? http://serendip.brynmawr.edu/exchange/files/how%20organisms%20use%20energy%20SHO.docx Students will read through the notes/worksheet and answer questions. Photosynthesis Chemistry Models http://www.ngsslifescience.com/science.php?/biology/lessonplans/C455 The activity can be done in reverse to show how glucose and oxygen are broken down*
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): LS1.C: Organization for Matter and Energy Flow in Organisms As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. 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.
Elaboration Extension Activity	Food, Energy and Body Weight This analysis and discussion activity reinforces student understanding of cellular respiration and helps students to understand the relationships between food, energy, physical activity, and changes in body weight. The first attached file has the Student Handout and the second attached file has the Teacher Notes. The Teacher Notes provide background information and instructional suggestions and explain how this activity is aligned with the Next Generation Science Standards instructional suggestions and explain how this activity is aligned with the Next Generation Science Standards http://serendip.brynmawr.edu/exchange/files/FoodEnergyWtTN_0.docx
Evaluation Assessment Tasks	Assessment Task A: Driving Question Response Response should include the relationships between these components: Carbon dioxide and water are produced from sugar and oxygen by the process of cellular respiration The process of cellular respiration releases energy because the energy released when the bonds that are formed in CO2 and water is greater than the energy required to break the bonds of sugar and oxygen.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-LS2-3: Ecosystems: Interactions, Energy, and Dynamics		
HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.		
Clarification Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.		
Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.		
Evidence Statements: HS-LS2-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. 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. **Connections to Nature of Science** **Scientific Knowledge is Open to Revision in Light of New Evidence** Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.	**Energy and Matter** Energy drives the cycling of matter within and between systems.
Connections to other DCIs in this grade-band: HS.PS1.B ; HS.PS3.B ; HS.PS3.D ; HS.ESS2.A		
Articulation of DCIs across grade-bands: MS.PS1.B ; MS.PS3.D ; MS.LS1.C ; MS.LS2.B		
NJSLS- ELA: RST.11-12.1, WHST.9-12.5		
NJSLS- Math: N/A		
5E Model		
HS-LS2-3: Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.		

Engage Anticipatory Set	Anaerobic vs Aerobic Respiration https://www.youtube.com/watch?v=EkjR04SHuV0
Exploration Student Inquiry	Aerobic vs. Anaerobic Respiration http://www.d.umn.edu/gk12/FellowTeacherTeams/2010-11teams/CabinRoss-JacobOjard/CellularRespiration.pdf In this lab activity, students will: Describe the basic ideas and components of the respiration process in cells. Compare and contrast aerobic and anaerobic respiration. Develop a hypothesis about how to determine when sugar is provided for respiration in making dough. Observe/measure results of the experiment (how much did the dough rise?) Analyze results to make a conclusion.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): LS2.B: Cycles of Matter and Energy Transfer in Ecosystems Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
Elaboration Extension Activity	Anaerobic and Aerobic Respiration http://www.ck12.org/biology/Anaerobic-and-Aerobic-Respiration/lesson/Anaerobic-and-Aerobic-Respiration-BIO/?referrer=featured_content
Evaluation Assessment Tasks	Assessment Task: Constructed Explanation Lab Response Questions: How are aerobic and anaerobic respiration the same? How are they different? Which process is more efficient at producing energy? How could we measure the efficiency of each process? Given new data or information, students revise their explanation and justify the revision

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

<table>
<tr><th colspan="3">CHEMISTRY</th></tr>
<tr><td colspan="3">HS-LS1-5: From Molecules to Organisms: Structures and Processes</td></tr>
<tr><td colspan="3">HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</td></tr>
<tr><td colspan="3">Clarification Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.</td></tr>
<tr><td colspan="3">Assessment Boundary: Assessment does not include specific biochemical steps.</td></tr>
<tr><td colspan="3">Evidence Statements: HS-LS1-5</td></tr>
<tr><th>Science & Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Cross-Cutting Concepts</th></tr>
<tr><td>Developing and Using Models
Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
Use a model based on evidence to illustrate the relationships between systems or between components of a system.</td><td>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.</td><td>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.</td></tr>
<tr><td colspan="3">Connections to other DCIs in this grade-band: HS.PS1.B ; HS.PS3.B</td></tr>
<tr><td colspan="3">Articulation of DCIs across grade-bands: MS.PS1.B ; MS.PS3.D ; MS.LS1.C ; MS.LS2.B</td></tr>
<tr><td colspan="3">NJSLS- ELA: SL.11-12.5</td></tr>
<tr><td colspan="3">NJSLS- Math: N/A</td></tr>
<tr><th colspan="3">5E Model</th></tr>
<tr><td colspan="3">HS-LS1-5: Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</td></tr>
<tr><td>Engage
Anticipatory Set</td><td colspan="2">Photosynthesis
https://www.youtube.com/watch?v=g78utcLQrJ4</td></tr>
<tr><td>Exploration
Student Inquiry</td><td colspan="2">Putting The Energy Into Photosynthesis
http://betterlesson.com/lesson/634381/putting-the-energy-into-photosynthesis
In this lesson, students will design an an illustrated model to represent the chemical equation of photosynthesis that demonstrates the transformation of light energy into chemical energy.
Shedding Light On Photosynthesis
http://betterlesson.com/lesson/633523/shedding-light-on-photosynthesis
In this lesson, students will describe the discoveries that promoted our understanding of photosynthesis, recite the equation, and</td></tr>
</table>

	discuss the importance of the chemical reactions that occur to allow photosynthesis to occur.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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.
Elaboration Extension Activity	Related Activities https://www.opened.com/search?standard=HS.LS1.5
Evaluation Assessment Tasks	Assessment Task: Students use the given model to illustrate: 1. The transfer of matter and flow of energy between the organism and its environment during photosynthesis 2. Photosynthesis as resulting in the storage of energy in the difference between the energies of the chemical bonds of the inputs (carbon dioxide and water) and outputs (sugar and oxygen).

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-LS1-6- From Molecules to Organisms: Structures and Processes		
HS-LS1-6: 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.		
Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.		
Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.		
Evidence Statements: HS-LS1-6		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. 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.	**LS1.C: Organization for Matter and Energy Flow in Organisms** 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. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.	**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.
Connections to other DCIs in this grade-band: HS.PS1.B		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.PS3.D ; MS.LS1.C ; MS.ESS2.E		
NJSLS- ELA: RST.11-12.1, WHST.9-12.2, WHST.9-12.5, WHST.9-12.9		
NJSLS- Math: N/A		

5E Model	
HS-LS1-6: 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.	
Engage Anticipatory Set	Organic Chemistry Primer: Video https://www.youtube.com/watch?v=GBfWyJeayAA Teachers may select portions of the video to show.

	Students should construct a diagram (draw and write) that addresses the question "How do we get our energy to live, move and grow?" Collect evidence to support the scientific idea about the composition and flow of matter. Students should create a "Food Log" that contains the food they eat during the week and classified into organic compound categories (proteins, lipids, carbohydrates.)
Exploration Student Inquiry	Conceptualizing Carbohydrates http://betterlesson.com/lesson/628470/conceptualizing-carbohydrates In this lesson, students will create a model of the dehydration synthesis chemical reaction and develop a detailed narration to describe this process. Show pictures of the structure of a carbohydrate, a protein, and a lipid. Ask students to identify what all of these molecules (that make up foods) have in common. Students should research the building blocks of each class of organic compound and could continue with building simple organic monomer models from glucose and oxygen models. Construct explanations for how the bonds and atoms are rearranged to form the carbon-based molecules. Students should include pictures of their models as evidence.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): LS1.C: Organization for Matter and Energy Flow in Organisms 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. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
Elaboration Extension Activity	For a final assessment, begin by asking students probing questions to connect photosynthesis; cellular respiration; systems; and matter, energy, and life. Ask students to revisit their initial diagram (from anticipatory set) and add to it pictures, words, and arrows to convey their understanding of the flow of energy and matter through a living organism. Their final diagram should include food, large molecules (protein, carbohydrates, lipids) and their components, digestion, cellular respiration, and how "food" is converted to energy in a living organism.
Evaluation Assessment Tasks	Assessment Task A: Conceptualizing Carbohydrates- One Minute Report In this explanation, students should use reasoning to show: The atoms in sugar molecules can provide most of the atoms that comprise amino acids and other complex carbon-based molecules. The energy released in respiration can be used to drive chemical reactions between sugars and other substances, and the products of those reactions can include amino acids and other complex carbon-based molecules. The matters flows in cellular processes are the results of the rearrangements of primarily the atoms in sugar molecules because those are the molecules whose reactions release the energy needed for cell processes.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 5: Overview
Unit 5: Nuclear Chemistry
Content Area: Chemistry
Pacing: 30 Instructional Days
Essential Question
What happens in stars?
Student Learning Objectives (Performance Expectations)
HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.
HS-ESS1-1: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
HS-ESS1-2: 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-ESS1-6: 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.
Unit Summary
In this unit of study, energy and matter are studied further by investigating the processes of nuclear fusion and fission that govern the formation, evolution, and workings of the solar system in the universe. Some concepts studied are fundamental to science and demonstrate scale, proportion, and quantity, such as understanding how the matter of the world formed during the Big Bang and within the cores of stars over the cycle of their lives. In addition, an important aspect of Earth and space sciences involves understanding the concept of stability and change while making inferences about events in Earth's history based on a data record that is increasingly incomplete the farther one goes back in time. A mathematical analysis of radiometric dating is used to comprehend how absolute ages are obtained for the geologic record. The crosscutting concepts of energy and matter; scale, proportion, and quantity; and stability and change are called out as organizing concepts for this unit. Students are expected to demonstrate proficiency in developing and using models; constructing explanations and designing solutions; using mathematical and computational thinking; and obtaining, evaluating, and communicating information; and they are expected to use these practices to demonstrate understanding of the core ideas.
Technical Terms
nucleus, transformation, fission, fusion, radioactive decay, Polonium atoms, radiation, absorption of energy, nucleosynthesis, Big Bang Theory, electromagnetic energy, protons, neutrons, supernova explosions, radiation, solar flares, light spectra, galaxies, meteorites, plate tactonics, erosion
Formative Assessment Measures
Part A: Why is fusion considered the Holy Grail for the production of electricity? Why aren't all forms of radiation harmful to living things?
Students who understand the concepts are able to: Develop models based on evidence 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. Use simple qualitative models based on evidence to illustrate the scale of energy released in nuclear processes relative to other kinds of transformations. Develop models based on evidence to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of alpha, beta, and gamma radioactive decays.
Part B
<u>Students who understand the concepts are able to:</u>
Communicate scientific ideas in multiple formats (including orally, graphically, textually, and mathematically) about the way stars, over their life cycles, produce elements. Communicate scientific ideas about the way nucleosynthesis, and therefore the different elements it creates, vary as a function of the mass of a star and the stage of its lifetime. Communicate scientific ideas about how in nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
Part C: Is the life span of a star predictable?
<u>Students who understand the concepts are able to:</u> 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 in releasing energy that eventually reaches Earth in the form of radiation. Develop a model based on evidence to illustrate the relationships between nuclear fusion in the sun's core and radiation that reaches Earth.
Part D: If there was nobody there to Tweet about it, how do we know that there was a Big Bang?
<u>Students who understand the concepts are able to:</u> 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. Construct an explanation of the Big Bang theory based on the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars). Construct an explanation based on valid and reliable evidence that energy in the universe cannot be created or destroyed, only moved between one place and another place, between objects and/or fields, or between systems.
Part E: How can chemistry help us to figure out ancient events?
<u>Students who understand the concepts are able to:</u> 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. Use available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Apply scientific reasoning to link evidence from ancient Earth materials, meteorites, and other planetary surfaces to claims about Earth’s formation and early history, and assess the extent to which the reasoning and data support the explanation or conclusion. Use available evidence within the solar system to construct explanations for how Earth has changed and how it remains stable.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Interdisciplinary Connections	
NJSLS- ELA	**NJSLS- Mathematics**
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. (HSESS1-3),(HS-ESS1-2) 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)	MP.2 Reason abstractly and quantitatively. (HS-ESS1-1), (HS-ESS1-2), (HS-ESS1-3) ,(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)

Core Instructional Materials	Can include: Textbooks Series, Lab Materials, etc.
21st Century Life and Careers	CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12
Technology Standards	8.1.12.A.2,8.1.12.A.4,8.1.12.C.1, 8.1.12.D.1, 8.1.12.E.1

Modifications			
English Language Learners	**Special Education**	**At-Risk**	**Gifted and Talented**
Scaffolding Word walls Sentence/paragraph frames Bilingual dictionaries/translation Think alouds Read alouds Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling	Word walls Visual aides Graphic organizers Multimedia Leveled readers Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter	Teacher tutoring Peer tutoring Study guides Graphic organizers Extended time Parent communication Modified assignments Counseling	Curriculum compacting Challenge assignments Enrichment activities Tiered activities Independent research/inquiry Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

Cognates	Color contrast		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-PS1-8 Matter and its Interactions		
HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.		
Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.		
Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.		
Evidence Statements: HS-PS1-8		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**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.	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
Connections to other DCIs in this grade-band: HS.PS3.A ; HS.PS3.B ; HS.PS3.C ; HS.PS3.D ; HS.ESS1.A ; HS.ESS1.C ; HS.ESS3.A ; HS.ESS3.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS1.B ; MS.ESS2.A		
NJSLS- ELA: N/A		
NJSLS- Math: MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3		

5E Model	
HS-PS1-8: Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.	
Engage Anticipatory Set	Alpha Decay https://phet.colorado.edu/en/simulation/legacy/alpha-decay Students will be observing the changes that happen to the Polonium atoms as they are exposed to radiation. 1) What happens to the mass number of each atom? 2) What is being added to each atom? What is being given off by each atom? 3) Does every atom react? Why or why not?
Exploration Student Inquiry	Nuclear Fission Inquiry Lab Worksheets: https://phet.colorado.edu/en/contributions/view/3335

	Simulation: https://phet.colorado.edu/en/simulation/legacy/nuclear-fission Students will be covering a series of activities where they will be examining various applications of nuclear reactions and nuclear chain reactions.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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.
Elaboration Extension Activity	Feasibility of Nuclear Power https://www.youtube.com/watch?v=JMaEjEWL6PU http://www.world-nuclear.org/getmedia/ab488e1b-ba74-4a3e-8561-fb96297f37dc/world-electricity-production.png.aspx Students will be doing research and collecting data in an attempt to answer the question, "Is nuclear power worth the risk?"
Evaluation Assessment Tasks	Assessment Task A: Nuclear Fission Lab Responses and Model Drawings

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ESS1-3 Earth's Place in the Universe		
HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.		
Clarification Statement: Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime.		
Assessment Boundary: Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.		
Evidence Statements: HS-ESS1-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.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).	**ESS1.A: The Universe and Its Stars** 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.	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.
Connections to other DCIs in this grade-band: HS.PS1.A ; HS.PS1.C		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.ESS1.A		
CCSS- ELA: WHST.9-12.2, SL.11-12.4		
CCSS- Math: MP.2		

5E Model	
HS-ESS1-3: Communicate scientific ideas about the way stars, over their life cycle, produce elements.	
Engage Anticipatory Set	How Elements Are Made https://www.opened.com/video/how-elements-are-made/5763719
Exploration Student Inquiry	The Life Cycle of Stars http://betterlesson.com/lesson/640537/the-life-cycle-of-stars?from=cc_lesson_title In this lesson, students explore what makes a star a star, and examine how different stars in the universe are different sizes, colors, and temperatures - categorizing each of those along the way. How Elements Are Formed http://sciencelearn.org.nz/Contexts/Just-Elemental/Science-Ideas-and-Concepts/How-elements-are-formed

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

	Students would be able to read the following article and answer posed questions. Star Death and Creation of the Elements https://www.youtube.com/watch?v=DEw6X2BhIy8 This video from BBC 2 summarizes the way elements are created by the collapse of stars in the Universe.
Explanation Concepts and Practices	In these Teache Student Topics t ESS1.A: The stu distanc Other t than an achieve
Elaboration Extension Activity	Stars and Elements https://www.khanacademy.org/partner-content/big-history-project/stars-and-elements Using the different sections of this website, students could be assigned to work through the different tabs to gain a greater knowledge on the creation of the elements.
Evaluation Assessment Tasks	Assessment Task A: Students will use at least two different formats to describe the following: 1. Helium and a small amount of other like nuclei were formed from high-energy collisions starting from protons and neutrons in the early universe before any stars existed. 2. More massive elements, up to iron, are produced in the cores of stars by a chain of processes of nuclear fusion, which also releases energy. 3. Supernova explosions of massive stars are the mechanism by which elements more massive than iron are produced. 4. There is a correlation between a star's mass and stage of development and the types of elements it can create during its lifetime. 5. Electromagnetic emission and absorption spectra are used to determine a star's composition, motion and distance to Earth.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ESS1-1 Earth's Place in the Universe		
HS-ESS1-1: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.		
Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun's radiation varies due to sudden solar flares ("space weather"), the 11-year sunspot cycle, and non-cyclic variations over centuries.		
Assessment Boundary: Assessment does not include details of the atomic and subatomic processes involved with the sun's nuclear fusion.		
Evidence Statements: HS-ESS1-1		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**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. **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)	**Scale, Proportion, and Quantity** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.
Connections to other DCIs in this grade-band: HS.PS1.C ; HS.PS3.A		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS4.B ; MS.ESS1.A ; MS.ESS2.A ; MS.ESS2.D		
NJSLS- ELA: RST.11-12.1		
NJSLS- Math: MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSA-SSE.A.1, HSA-CED.A.2, HSA-CED.A.4		

5E Model	
HS-ESS1-1: Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.	
Engage Anticipatory Set	How the Universe Works: Extreme Stars https://www.youtube.com/watch?v=DCl-4wYNPEM
Exploration Student Inquiry	The Sun and Its Core http://www.blackrocksolar.org/wp-content/uploads/2014/09/H.S.-The-Sun-and-its-Core-Teacher-Guide-Part-1-of-3.pdf

	Radiation and Climate http://betterlesson.com/lesson/638116/radiation-and-climate?from=cc_lesson_title In this lesson students continue to learn about earth's atmosphere in terms of how solar radiation interacts with gases.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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. 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)
Elaboration Extension Activity	Interior of the Sun: Discussion Questions http://www.ck12.org/earth-science/Interior-of-the-Sun/cthink/Interior-of-the-Sun-Discussion-Questions/
Evaluation Assessment Tasks	Assessment Task A: Nuclear Fusion Popcorn Model Students will use the model to: predict how the relative proportions of hydrogen to helium change as the sun ages. qualitatively describe the scale of the energy released by the fusion process as being much larger than the scale of the energy released by chemical processes explicitly identify that chemical process are unable to produce the amount of energy flowing out of the sun over long periods of time, thus requiring fusion processes as a mechanism for energy release in the sun.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

<table>
<tr><th colspan="3">CHEMISTRY</th></tr>
<tr><td colspan="3">HS-ESS1-2 Earth's Place in the Universe</td></tr>
<tr><td colspan="3">HS-ESS1-2: 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.</td></tr>
<tr><td colspan="3">Clarification Statement: Emphasis is on the astronomical evidence of the redshift of light from galaxies as an indication that the universe is currently expanding, the cosmic microwave background as the remnant radiation from the Big Bang, and the observed composition of ordinary matter of the universe, primarily found in stars and interstellar gases (from the spectra of electromagnetic radiation from stars), which matches that predicted by the Big Bang theory (3/4 hydrogen and 1/4 helium).</td></tr>
<tr><td colspan="3">Assessment Boundary: N/A</td></tr>
<tr><td colspan="3">Evidence Statements: HS-ESS1-2</td></tr>
<tr><th>Science & Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Cross-Cutting Concepts</th></tr>
<tr><td>Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
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.")
Connections to Nature of Science
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.</td><td>ESS1.A: The Universe and Its Stars
The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe.
Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
PS4.B: Electromagnetic Radiation
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. (secondary)</td><td>Energy and Matter
Energy cannot be created or destroyed–only moved between one place and another place, between objects and/or fields, or between systems.</td></tr>
<tr><td colspan="3">Connections to other DCIs in this grade-band: HS.PS1.A ; HS.PS1.C ; HS.PS3.A ; HS.PS3.B ; HS.PS4.A</td></tr>
</table>

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS4.B ; MS.ESS1.A	
NJSLS- ELA: RST.11-12.1, WHST.9-12.2	
NJSLS- Math: MP.2, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSA-SSE.A.1, HSA-CED.A.2, HSA-CED.A.4	
5E Model	
HS-ESS1-2: 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.	
Engage Anticipatory Set	The Big Bang Theory- Theme Song https://www.youtube.com/watch?v=X41bA4l-h0w The Big Bang- Stephen Hawking https://www.youtube.com/watch?v=gs-yWMuBNr4
Exploration Student Inquiry	The Big Bang http://betterlesson.com/lesson/641870/the-big-bang?from=cc_lesson_title In this lesson, we talk about the process of the Big Bang, how it led to the "start" of the universe, and most importantly, the two main pieces of evidence that scientists use to support the Big Bang - cosmic background radiation and red-shifting of distant galaxies.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ESS1.A: The Universe and Its Stars The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth. The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. PS4.B: Electromagnetic Radiation 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. (secondary)
Elaboration Extension Activity	Mars Dead or Alive: Welcome to Mars https://www.opened.com/video/mars-dead-or-alive-welcome-to-mars/204362 This video segment shows the range of emotions experienced by NASA scientists and technicians as they observe the landing and the beginning of a new era of space exploration. Is also includes clips from an animation showing the atmospheric entry and landing

	of a Mars rover.
Evaluation Assessment Tasks	Assessment Task A: Constructed Explanation Following the lesson, the students will construct an explanation describing the following chain of reasoning: 1. Redshifts indicate that an object is moving away from the observer, thus the observed redshift from most galaxies and the redshift vs. distance relationship is evidence that the universe is expanding. 2. The observed background cosmic radiation and the ratio of hydrogen to helium have been shown to be consistent with the universe that was very dense and hot a long time ago and that evolved through different stages at it expanded and cooled. 3. An expanding universe must have been smaller in the past and can be extrapolated back in time to a tiny size from which it expanded.

CHEMISTRY		
HS-ESS1-6 Earth's Place in the Universe		
HS-ESS1-6: 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.		
Clarification Statement: Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed along with the rest of the solar system 4.6 billion years ago. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.		
Assessment Boundary: N/A		
Evidence Statements: HS-ESS1-6		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	**ESS1.C: The History of Planet Earth** Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. PS1.C: Nuclear Processes Spontaneous radioactive decays follow a characteristic exponential decay law.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

Connections to Nature of Science **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory.	Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials.(secondary)	
Connections to other DCIs in this grade-band: HS.PS2.A ; HS.PS2.B		
Articulation of DCIs across grade-bands: MS.PS2.B ; MS.ESS1.B ; MS.ESS1.C ; MS.ESS2.A ; MS.ESS2.B		
CCSS- ELA: RST.11-12.1, RST.11-12.8		
CCSS- Math: MP.2, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3, HSF-IF.B.5, HSS-ID.B.6		

5E Model	
HS-ESS1-6: 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.	
Engage Anticipatory Set	Crash Course: Formation of Earth and Solar System https://www.opened.com/video/crash-course-formation-of-earth-and-solar-system/5767508 This Crash Course video focuses on the formation and development of the Earth. Students will learn about the Solar nebula, the birth of the sun, the formation of planets, and how the Earth and the rest of the solar system developed over the last 4.567 billion years.
Exploration Student Inquiry	Earth Formation https://www.opened.com/video/earth-formation-khan-academy/180397 A video about how the Earth is a the byproduct of a local supernova. Birth of the Moon https://www.opened.com/video/birth-of-the-moon/207963 Scientists have been reconstructing the history of the moon by scouring its surface, mapping its mountains and craters, and probing its interior. What are they learning about our own planet's beginnings? Radiometric Dating http://www.earth-time.org/Lesson_Plan.pdf Students will learn how scientists determine the ages of rocks using radioactive decay. They will be introduced to the concepts of

	half-life and decay rate, and use parent/daughter isotope ratios to calculate dates
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ESS1.C: The History of Planet Earth Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. PS1.C: Nuclear Processes 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)
Elaboration Extension Activity	Radioactivity and Half-Life http://betterlesson.com/lesson/635131/radioactivity-half-life?from=cc_lesson_title Students explore the methods and techniques involved in radioactive dating
Evaluation Assessment Tasks	Assessment Task: Constructed Explanation Students use reasoning to connect the evidence to construct the explanation of EArth's formation and early history.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Unit 6: Overview
Unit 6: Human Impact- The Chemistry of Sustainability
Content Area: Chemistry
Pacing: 30 Instructional Days
Essential Question
How do Earth's geochemical processes and human activities affect each other?
Student Learning Objectives (Performance Expectations)
HS-ESS2-4: 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-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2: 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-ETS1-3: 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-ETS1-4: 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-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
Unit Summary
In this unit of study, students use cause and effect to develop models and explanations for the ways that feedbacks among different Earth systems control the appearance of Earth's surface. Central to this is the tension between internal systems, which are largely responsible for creating land at Earth's surface (e.g., volcanism and mountain building), and the sun-driven surface systems that tear down the land through weathering and erosion. Students begin to examine the ways that human activities cause feedbacks that create changes to other systems. Students understand the system interactions that control weather and climate, with a major emphasis on the mechanisms and implications of climate change. Students model the flow of energy and matter between different components of the weather system and how this affects chemical cycles such as the carbon cycle. Engineering and technology figure prominently here, as students use mathematical thinking and the analysis of geoscience data to examine and construct solutions to the many challenges facing long-term human sustainability on Earth. Here students will use these geoscience data to explain climate change over a wide range of timescales, including over one to ten years: large volcanic eruption, ocean circulation; ten to hundreds of years: changes in human activity, ocean circulation, solar output; tens of thousands to hundreds of thousands of years: changes to Earth's orbit and the orientation of its axis; and tens of millions to hundreds of millions of years: long-term changes in atmospheric composition).
Technical Terms
Sustainability, human sustainability, volcanism, mountain building,weathering, erosion, geoscience data, atmospheric composition, solar output, system interactions, geochemical, hydrosphere, atmosphere, geosphere, biosphere, biogeochemical cycles

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Formative Assessment Measures
Part A: What happens if we change the chemical composition of our atmosphere?
Students who understand the concepts are 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. Use empirical evidence to differentiate between how variations in the flow of energy into and out of Earth's systems result in climate changes. Use multiple lines of evidence to support how variations in the flow of energy into and out of Earth's systems result in climate changes.
Part B: How does carbon cycle among the hydrosphere, atmosphere, geosphere, and biosphere?
Students who understand the concepts are able to: Develop a model based on evidence to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere, biogeochemical cycles Develop a model based on evidence to illustrate the biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere, providing the foundation for living organisms.

Interdisciplinary Connections

NJSLS- ELA	NJSLS- Mathematics
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)	MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7),(HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4) MP.4 Model with mathematics. (HS-PS1-4), (HS-ETS1-1),(HS-ETS1-2),(HS-ETS1-3),(HS-ETS1-4) 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-PS1-4),(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) HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-4),(HS-PS1-5),(HS-PS1-7)

Core Instructional Materials	Can include: Textbooks Series, Lab Materials, etc.
21st Century Life and Careers	CRP 1, CRP 2, CRP 4, CRP 5, CRP 6, CRP 7, CRP 8 , CRP 9, CRP 11, CRP 12
Technology Standards	8.1.12.A.2,8.1.12.A.4,8.1.12.C.1, 8.1.12.D.1, 8.1.12.E.1

Modifications

English Language Learners	Special Education	At-Risk	Gifted and Talented
Scaffolding	Word walls	Teacher tutoring	Curriculum compacting
Word walls	Visual aides	Peer tutoring	Challenge assignments
Sentence/paragraph frames	Graphic organizers	Study guides	Enrichment activities
Bilingual dictionaries/translation	Multimedia	Graphic organizers	Tiered activities

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

Think alouds Read alouds Highlight key vocabulary Annotation guides Think-pair- share Visual aides Modeling Cognates	Leveled readers Assistive technology Notes/summaries Extended time Answer masking Answer eliminator Highlighter Color contrast	Extended time Parent communication Modified assignments Counseling	Independent research/inquiry Collaborative teamwork Higher level questioning Critical/Analytical thinking tasks Self-directed activities

CHEMISTRY

HS-ESS2-4 Earth's Systems

HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Clarification Statement: Examples of the causes of climate change differ by timescale, over 1-10 years: large volcanic eruption, ocean circulation; 10-100s of years: changes in human activity, ocean circulation, solar output; 10-100s of thousands of years: changes to Earth's orbit and the orientation of its axis; and 10-100s of millions of years: long-term changes in atmospheric composition.

Assessment Boundary: Assessment of the results of changes in climate is limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.

Evidence Statements: HS-ESS2-4

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Use a model to provide mechanistic accounts of phenomena. **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence Science arguments are strengthened by multiple lines of evidence**	**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) **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 ages) to very long-term tectonic cycles. **ESS2.D: Weather and Climate**	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

supporting a single explanation.	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.	

Connections to other DCIs in this grade-band: HS.PS3.A ; HS.PS3.B ; HS.LS2.C ; HS.ESS1.C ; HS.ESS3.C ; HS.ESS3.D

Articulation of DCIs across grade-bands: MS.PS3.A ; MS.PS3.B ; MS.PS3.D ; MS.PS4.B ; MS.LS1.C ; MS.LS2.B ; MS.LS2.C ; MS.ESS2.A ; MS.ESS2.B ; MS.ESS2.C ; MS.ESS2.D ; MS.ESS3.C ; MS.ESS3.D

NJSLS- ELA: SL.11-12.5

NJSLS- Math: MP.2, MP.4, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3

5E Model

HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

Engage Anticipatory Set	Climate Change: How Do We Know? http://climate.nasa.gov/evidence/
Exploration Student Inquiry	Earth's Energy Flows and Climate http://www.pbslearningmedia.org/resource/pcep15-sci-ess-energyflows/earths-energy-flows-and-climate/ In this lesson, students will learn how Earth's climate results from the ways that energy enters, circulates within, and flows out of the Earth system. Explore the flows of energy in regional locations and then at the global level to understand how the increased greenhouse effect causes global warming. From the given model in the lesson above, students will identify and describe the components of the model relevant for their mechanistic descriptions. Given models include at least one factor that affects the input of energy, at least one factor that affects the output of energy, and at least one factor that affects the storage and redistribution of energy. Factors are derived from the following list: - Changes in Earth's orbit and the orientation of its axis - Changes in the sun's energy output - Configuration of continents resulting from tectonic activity - Ocean circulation - Atmospheric composition (including amount of water vapor and CO_2) - Atmospheric circulation - Volcanic activity - Glaciation - Changes in extent or type of vegetation cover - Human activities From the given model, students identify the relevant different time scales on which the factors operate.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices.

	Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): 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) 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 ages) to very long-term tectonic cycles. 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.
Elaboration Extension Activity	Global Climate Change https://www3.epa.gov/climatechange/kids/resources/lesson-plans.html
Evaluation Assessment Tasks	Assessment Task A: Students use the given model to provide a mechanistic account of the relationship between energy flow in Earth's systems and changes in climate, including: 1. The specific cause and effect relationships between the factors and the effect on energy flow into and out of Earth's systems; and 2. The net effect of all of the competing factors in changing the climate.

CHEMISTRY		
HS-ETS1-1 Engineering Design		
HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-1		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and	**ETS1.A: Defining and Delimiting Engineering Problems** Criteria and constraints also include satisfying any	**Connections to Engineering, Technology, and Applications of Science**

evaluating empirically testable questions and design problems using models and simulations. Analyze complex real-world problems by specifying criteria and constraints for successful solutions.	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. 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.	**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.
Connections to other DCIs in this grade-band: HS-PS2-3, HS-PS3-3		
Articulation of DCIs across grade-bands: MS.ETS1.A		
NJSLS- ELA: RST.11-12.7, RST.11-12.8, RST.11-12.9		
NJSLS- Math: MP.2, MP.4		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ETS1-2 Engineering Design		
HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-2		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**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.	
Connections to other DCIs in this grade-band: HS-PS1-6, HS-PS2-3		
Articulation of DCIs across grade-bands: MS.ETS1.A ; MS.ETS1.B ; MS.ETS1.C		
NJSLS- ELA: N/A		
NJSLS- Math: MP.4		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ETS1-3 Engineering Design		
HS-ETS1-3: 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.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-3		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	**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.	**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.
Connections to other DCIs in this grade-band: Earth and Space Science: HS-ESS3-2, HS-ESS3-4 Life Science: HS-LS2-7, HS-LS4-6		
Articulation of DCIs across grade-bands: MS.ETS1.A ; MS.ETS1.B		
NJSLS- ELA: RST.11-12.7, RST.11-12.8, RST.11-12.9		
NJSLS- Math: MP.2, MP.4		

CHEMISTRY		
HS-ETS1-4 Engineering Design		
HS-ETS1-4: 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.		
Clarification Statement: N/A		
Assessment Boundary: N/A		
Evidence Statements: HS-ETS1-4		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.	**ETS1.B: Developing Possible Solutions** 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.	**Systems and Systems Models** 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.
Connections to other DCIs in this grade-band: HS-LS2-7, HS-LS4-6		
Articulation of DCIs across grade-bands: MS.ETS1.A ; MS.ETS1.B ; MS.ETS1.C		
NJSLS- ELA: N/A		
NJSLS- Math: MP.2, MP.4		

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ESS2-6 Earth's Systems		
HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.		
Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.		
Assessment Boundary: N/A		
Evidence Statements: HS-ESS2-6		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved.
Connections to other DCIs in this grade-band: HS.PS1.A ; HS.PS1.B ; HS.PS3.D ; HS.LS1.C ; HS.LS2.B ; HS.ESS3.C ; HS.ESS3.D		
Articulation of DCIs across grade-bands: MS.PS1.A ; MS.PS3.D ; MS.PS4.B ; MS.LS2.B ; MS.ESS2.A ; MS.ESS2.B ; MS.ESS2.C ; MS.ESS3.C ; MS.ESS3.D		
NJSLS- ELA: N/A		
NJSLS- Math: MP.2, MP.4, HSN-Q.A.1, HSN-Q.A.2, HSN-Q.A.3		

5E Model	
HS-ESS2-6: Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	
Engage Anticipatory Set	The Carbon Cycle http://www.sciencecourseware.org/eec/GlobalWarming/Tutorials/CarbonCycle/
Exploration Student Inquiry	Carbon and Climate http://carboncycle.aos.wisc.edu/ Using the interactive applet, students will develop quantitative models depicting future human emissions and future carbon sinks in the oceans and on the land.
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

	Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ESS2.D: Weather and Climate Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.
Elaboration Extension Activity	Understanding the Carbon Cycle: A Jigsaw Approach http://serc.carleton.edu/NAGTWorkshops/climatechange/activities/15162.html In this "jigsaw" exercise, each student is assigned one of five geochemical processes in the carbon cycle to research, fully understand, and then explain to others in groups of five. At the end of class all students will know about each of the five processes, and thus develop an integrated understanding of the entire carbon cycle.
Evaluation Assessment Tasks	Assessment Task: Student Model Students used the model to explicitly identify the conservation of matter as carbon cycles through various components of Earth's systems Students identify the limitations of the model in accounting for all of Earth's carbon.

SUBJECT: SCIENCE/CHEMISTRY

Cliffside Park Public Schools

GRADE: 9-12

BOE APPROVAL: August 2016

CHEMISTRY		
HS-ESS2-7 Earth Systems		
HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.		
Clarification Statement: Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples of include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.		
Assessment Boundary: Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.		
Evidence Statements: HS-ESS2-7		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Cross-Cutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Construct an oral and written argument or counter-arguments based on data and evidence.	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. **ESS2.E Biogeology** The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.
Connections to other DCIs in this grade-band: N/A		
Articulation of DCIs across grade-bands: MS.LS2.A ; MS.LS4.D ; MS.ESS2.A ; MS.ESS3.A ; MS.ESS3.B		
NJSLS- ELA: RST.11-12.1, WHST.9-12.2		
NJSLS- Math: MP.2, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3		

5E Model	
HS-ESS2-7: Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	
Engage Anticipatory Set	The Long-Term Co-Evolution of Life and the Planet http://www.lifeandplanet.net/

Exploration Student Inquiry	Coevolution of the Earth's Systems and Life on Earth: PowerPoint luckasavitch.weebly.com/uploads/3/7/3/8/37384789/samantha_gernat.pptx The Coevolution of Life and Environments: Article http://www.ib.usp.br/zoologia/evolution/papers/Knoll_%2002.pdf
Explanation Concepts and Practices	In these lessons Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): ESS2.D: Weather and Climate Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. ESS2.E Biogeology The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.
Elaboration Extension Activity	Coevolution Describes evolution of species in symbiotic relationships. http://www.ck12.org/biology/Coevolution/lesson/Coevolution-BIO/?referrer=featured_content
Evaluation Assessment Tasks	Assessment Task A: Student Argument Students use at least two examples to construct oral and written logical arguments. The examples: 1. Include that the evolution of photosynthetic organisms led to a drastic change in Earth's atmosphere and oceans in which the free oxygen produced caused worldwide deposition of iron oxide formations, increased weathering due to an oxidizing atmosphere and the evolution of animal life that depends on oxygen for respiration; 2. Identify causal links and feedback mechanisms between changes in the biosphere and changes in Earth's other systems.