MIDLAND PARK PUBLIC SCHOOLS
Midland Park, New Jersey
CURRICULUM

Chemistry

Prepared by:
Deborah Marks

Superintendent of Schools:
Marie C. Cirasella, Ed.D.
Director of Curriculum, Instruction & Assessment:
Melissa Quackenbush

Approved by the Midland Park Board of Education on August 16, 2016

HS Chemistry Curriculum Overview

High School Chemistry is taught in five units throughout the school year. The curriculum is a hands-on, open-ended and sequential process of investigating the composition of matter and the physical and chemical changes it undergoes. High School Chemistry is a laboratory science course in which students investigate the composition of matter and the physical and chemical changes it undergoes. Students use science process skills to study the fundamental structure of atoms, the way atoms combine to form compounds, and the interactions between matter and energy. Students will investigate chemical bonding and how the kinetic molecular theory and intermolecular forces explain the physical and chemical characteristics of matter. Additional aspects of chemical reactions including limiting reactants, percent yield, equilibrium, reaction rates, and thermochemistry are considered. Aspects of physical science; life science; earth & space science; and engineering, technology & applications of science are taught throughout the year. A guided inquiry program gives students the opportunity to explore topics and concepts though investigations. Participating in this hands-on program helps students:

1. To foster a life-long enjoyment of learning science.
2. To observe science in the world around them.
3. To meet the science standards for New Jersey Public Schools.

Suggested Course Sequence*:

Unit 1: Structure and Properties of Matter: 45 days
Unit 2: The Chemistry of Abiotic Systems: 35 days
Unit 3: Bonding and Chemical Reactions: 35 days
Unit 4: Compounds; Acids and Bases: 25
Unit 5: Nuclear Chemistry: 40 days

Pre-Requisites: Biology, Algebra I

**The number of instructional days is an estimate based on the information available at this time. 1 day equals approximately 48 minutes of seat time. Teachers are strongly encouraged to review the entire unit of study carefully and collaboratively to determine whether adjustments to this estimate need to be made.*

Content Area: High School Chemistry
Unit Title: Structure and Properties of Matter
Grade Level: 10
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. **Interdisciplinary Connections:** Math, Art, History, Biology, English **21st Century Themes and Skills:** CRP2. Apply appropriate academic and technical skills. CRP4. Communicate clearly and effectively and with reason. CRP6. Demonstrate creativity and innovation. CRP7. Employ valid and reliable research strategies. CRP8. Utilize critical thinking to make sense of problems and persevere in solving them. CRP11. Use technology to enhance productivity. CRP12. Work productively in teams while using cultural global competence.

Standards (Content and Technology):	
CPI#:	**Statement:**
Next Generation Science Standards	
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
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.
2014 New Jersey Core Curriculum Content Standards - Technology	
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
8.2.12.C.4	Explain and identify interdependent systems and their functions.

8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Unit Essential Question(s):	**Unit Enduring Understandings:**
• How can a periodic table tell me about the subatomic structure of a substance? • How can I use the periodic table to predict if I need to duck before mixing two elements? • How can I use the properties of something (in bulk quantities) to predict what is happening with the subatomic particles? • 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)?	• Different patterns may be observed at each of the scales at which a system is studied, and these patterns can provide evidence for causality in explanations of phenomena. • Each atom has a charged substructure. • An atom's nucleus is made of protons and neutrons and is surrounded by electrons. • The periodic table orders elements horizontally by number of protons in the nucleus of each element's atoms and places elements with similar chemical properties in columns. • The repeating patterns of this table reflect patterns of outer electron states. • Patterns of electrons in the outermost energy level of atoms can provide evidence for the relative properties of elements at different scales. • 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. • 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. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. • When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, aesthetics, and to consider social, cultural, and environmental impacts. • 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. • Models (e.g., physical, mathematical, computer models) can be used to simulate why the

	molecular-level structure is important in the functioning of designed materials.

Unit Learning Targets/Objectives:

Students will

• 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.

• 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.

• 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.

• 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.

Formative Assessments:

- Conferences
- Observations
- Question and Answer Sessions
- First Drafts / Quizzes
- Journals

Summative/Benchmark Assessment(s):

- Chapter/Unit tests
- Projects
- Performances
- Final copies

Resources/Materials (copy hyperlinks for digital resources):

Buthelezi, Thandi, Laurel Dingrando, Nicholas Hainen, Cheryl Wistrom, and Dinah Zike. *Glencoe Chemistry: Matter and Change*. Bothell, WA: McGraw-Hill Education, 2013. Print.

Modifications:

- Special Education Students
  - Allow errors
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer questions, and permit drawing, as an explanation
  - Consult with Case Managers and follow IEP accommodations/modifications
- English Language Learners
  - Assign a buddy, same language or English speaking
  - Allow errors in speaking
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer question
- At-Risk Students
  - Provide extended time to complete tasks
  - Consult with Guidance Counselors and follow I&RS procedures/action plans
- Gifted and Talented Students
  - Provide extension activities
  - Build on students' intrinsic motivations
  - Higher Level mathematical computations

Lesson Name/Topic	**Lesson Objective(s)**	**Time frame (day(s) to complete)**
Atomic Scale of Structure of Matter	Use a variety of models to understand the structure of an atom	3 days
Valence Electrons	Write electron configurations for main group elements, paying attention to patterns of electrons in the outermost energy level	2 days
Power of the Periodic Table	Annotate the periodic table to determine its arrangement horizontally by number of protons in the atom's nucleus and its vertical arrangement by the placement of elements with similar chemical properties in columns	4 days
Translation of the Periodic Table	Translate information about patterns in the periodic table into words that describe the importance of the outermost electrons in atoms	2 days
Chemical Reactions	Observe simple reactions in a closed system and measure the mass before and after the	5 days

	reaction as well as count atoms in reactants and products in chemical formulas	
Law of Conservation of Mass	Construct chemical formulas involving main group elements in order to model that atoms are conserved in chemical reactions (the Law of Conservation of Mass)	3 days
Types of Chemical Reactions	Describe and predict simple chemical reactions, including combustion, involving main group elements. Students should use units when modeling the outcome of chemical reactions	3 days
Writing Chemical Reactions	Write a rigorous explanation of the outcome of simple chemical reactions	2 days
Investigating Properties	Investigate melting point, boiling point, vapor pressure, and surface tension	2 days
Forces between particles	Investigate how the strength of forces between particles is dependent on particle type (ions, atoms, molecules, networked materials [allotropes])	2 days
Types of Solids	Examine crystal structures and amorphous structures	1 day
Heating and Cooling Curves	Collect data to create cooling and heating curves.	3 days
Form and Function at Molecular Level	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials, the focus should be on attractive and repulsive forces.	3 days
Real World Applications	Consider the properties of various materials (e.g. Molar mass, solubility, and bonding) to decide what materials to use for what purposes, inputs and outputs measured for their real-world problem. Students must consider the properties of various materials (e.g. Molar mass, solubility,	5 days

	bonding) to decide which materials to use for which purposes	
Environmental Impact	Evaluate the Life Cycle Analysis, LCA, process and communicate a solution to a real-world problem, such as the environmental impact of different types of grocery bags (paper or plastic/reusable vs. disposable), cold drink containers (plastic, glass, or aluminum), or hot drink containers (paper, Styrofoam, or ceramic).	5 days

Teacher Notes:

Additional Resources

Build an Atom: This simulation allows students to create different illustrations of atoms and provides evidence that protons determine the identity of the element.
Periodic Table Trends: This is a virtual investigation of the periodic trends.
Path to Periodic Table: This investigation provides students with the opportunity to make sense of how and why the periodic table is organized the way that it is. Students will re-create the thought process that Dmitri Mendeleev and Julius Lothar Meyer went through to devise their early periodic tables.
Castle of Mendeleev: Students engage in a fantasy world that requires them to make claims, based on evidence, regarding the identity of unknown materials.
Shall We Dance? – Classifying Types of Chemical Reactions: Students identify and differentiate between four types of chemical reactions: synthesis, decomposition, single replacement and double replacement. Students also develop models for chemical reactions and identify the limitations of the models using evidence.

Click links below to access additional resources used to design this unit:
https://phet.colorado.edu/en/simulations/category/chemistry
http://www.rsc.org/resources-tools/education-resources/

Content Area: High School Chemistry

Unit Title: The Chemistry of Abiotic Systems

Grade Level: 10

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.

Interdisciplinary Connections:
Math, Art, History, Biology, English

21st Century Themes and Skills:
CRP2. Apply appropriate academic and technical skills.
CRP4. Communicate clearly and effectively and with reason.
CRP6. Demonstrate creativity and innovation.
CRP7. Employ valid and reliable research strategies.
CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
CRP11. Use technology to enhance productivity.
CRP12. Work productively in teams while using cultural global competence.

Standards (Content and Technology):

CPI#:	**Statement:**
Next Generation Science Standards	
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 tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
2014 New Jersey Core Curriculum Content Standards - Technology	
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
8.2.12.C.4	Explain and identify interdependent systems and their functions.
8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Unit Essential Question(s):	**Unit Enduring Understandings:**
• Does thermal energy always transfer or transform in predictable ways? • 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? • How would I meet the energy needs of the house of the future? • What is the best energy source for a home?	• 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. • Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. • Uncontrolled systems always move toward more stable states—that is, toward a more uniform energy distribution. • Although energy cannot be destroyed, it can be converted into less useful forms—for example, to thermal energy in the surrounding environment. • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. • The functions and properties of water and water systems can be inferred from the overall structure, the way the components are shaped and used, and the molecular substructure. • These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks. • All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. • Models can be used to simulate systems and interactions, including energy, matter, and information flows, within and between systems at different scales. • Engineers continuously modify design solutions to increase benefits while decreasing costs and risks. • Analysis of costs and benefits is a critical aspect of decisions about technology. • Scientific 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.

	• New technologies can have deep impacts on society and the environment, including some that were not anticipated. • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. • Many decisions are made not using science alone, but instead relying on social and cultural contexts to resolve issues.

Unit Learning Targets/Objectives:
Students will

- 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
- 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).

Formative Assessments:

- Conferences
- Observations
- Question and Answer Sessions
- First Drafts / Quizzes
- Journals

Summative/Benchmark Assessment(s):

- Chapter/Unit tests
- Projects
- Performances
- Final copies

Resources/Materials (copy hyperlinks for digital resources):
Buthelezi, Thandi, Laurel Dingrando, Nicholas Hainen, Cheryl Wistrom, and Dinah Zike. *Glencoe Chemistry: Matter and Change*. Bothell, WA: McGraw-Hill Education, 2013. Print.

Modifications:

- Special Education Students
  - Allow errors
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer questions, and permit drawing, as an explanation
  - Consult with Case Managers and follow IEP accommodations/modifications
- English Language Learners
  - Assign a buddy, same language or English speaking
  - Allow errors in speaking
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer question
- At-Risk Students
  - Provide extended time to complete tasks
  - Consult with Guidance Counselors and follow I&RS procedures/action plans
- Gifted and Talented Students
  - Provide extension activities
  - Build on students' intrinsic motivations
  - Higher Level mathematical computations

Lesson Name/Topic	**Lesson Objective(s)**	**Time frame (day(s) to complete)**
Investigations of thermal energy transfer	Investigate and describe a system focusing specifically on thermal energy transfer in a closed system	1 week
Energy distribution in a system	Collect relevant data from several sources, including their own investigations, and synthesize their findings into a coherent understanding	1 week
Calorimeters	Create computational or mathematical models to calculate the change in the energy in one component of a system when the change in energy of the other component(s) and energy flows in and out of the systems are known	5 days
Energy distribution	Collect data to show that energy is transported from one place to another or transferred between systems, and that uncontrolled systems always move toward more stable states with more uniform energy distribution	1 week

Energy Transformation	Observe during investigations that energy can be converted into less useful forms, such as thermal energy released to the surrounding environment	4 days
Mechanical and chemical investigations of water	Investigate 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	5 days
Water on Earth	Determine how the properties of water affect Earth materials and surface processes	3 days
Resources	Use cost–benefit ratios to evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources	3 days

Teacher Notes:

Additional Resources

Concord Consortium: Virtual Simulations: *http://concord.org/*

International Technology and Engineering Educators Association: *http://www.iteaconnect.org/*

National Earth Science Teachers Association: *http://www.nestanet.org/php/index.php*

National Science Digital Library: *https://nsdl.oercommons.org/*

Click links below to access additional resources used to design this unit:
https://phet.colorado.edu/en/simulations/category/chemistry
http://www.rsc.org/resources-tools/education-resources/

Content Area: High School Chemistry
Unit Title: Bonding and Chemical Reactions
Grade Level: 10
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. **Interdisciplinary Connections:** Math, Art, History, Biology, English **21st Century Themes and Skills:** CRP2. Apply appropriate academic and technical skills. CRP4. Communicate clearly and effectively and with reason. CRP6. Demonstrate creativity and innovation. CRP7. Employ valid and reliable research strategies. CRP8. Utilize critical thinking to make sense of problems and persevere in solving them. CRP11. Use technology to enhance productivity. CRP12. Work productively in teams while using cultural global competence.

Standards (Content and Technology):	
CPI#:	**Statement:**
Next Generation Science Standards	
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.
2014 New Jersey Core Curriculum Content Standards - Technology	
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
8.2.12.C.4	Explain and identify interdependent systems and their functions.
8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Unit Essential Question(s):	**Unit Enduring Understandings:**
• Where do the atoms go during a chemical reaction?	

• What is different inside a heat pack and a cold pack? • Is it possible to change the rate of a reaction or cause two elements to react that do not normally want to? • What can we do to make the products of a reaction stable?	• The fact that atoms are conserved, together with the knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. • The total amount of energy and matter in closed systems is conserved. • The total amount of energy and matter in a chemical reaction system is conserved. • Changes of energy and matter in a chemical reaction system can be described in terms of energy and matter flows into, out of, and within that system. • Changes of energy and matter in a chemical reaction system can be described in terms of collisions of molecules and the rearrangements of atoms into new molecules, with subsequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. • A stable molecule has less energy than the same set of atoms separated; at least this much energy must be provided in order to take the molecule apart. • 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. • Patterns in the effects of changing the temperature or concentration of the reacting particles can be used to provide evidence for causality in the rate at which a reaction occurs. • Much of science deals with constructing explanations of how things change and how they remain stable. • 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.

	• 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 may be needed. • Explanations can be constructed explaining how chemical reaction systems can change and remain stable.

Unit Learning Targets/Objectives:

Students will

- 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.
- Explain the idea that a stable molecule has less energy than the same set of atoms separated.
- 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.
- 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.
- 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.

Formative Assessments:
- Conferences
- Observations
- Question and Answer Sessions
- First Drafts / Quizzes
- Journals

Summative/Benchmark Assessment(s):
- Chapter/Unit tests
- Projects
- Performances
- Final copies

Resources/Materials (copy hyperlinks for digital resources):
Buthelezi, Thandi, Laurel Dingrando, Nicholas Hainen, Cheryl Wistrom, and Dinah Zike. *Glencoe Chemistry: Matter and Change.* Bothell, WA: McGraw-Hill Education, 2013. Print.

Modifications:
- Special Education Students
  - Allow errors
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer questions, and permit drawing, as an explanation
  - Consult with Case Managers and follow IEP accommodations/modifications
- English Language Learners
  - Assign a buddy, same language or English speaking
  - Allow errors in speaking
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer question
- At-Risk Students
  - Provide extended time to complete tasks
  - Consult with Guidance Counselors and follow I&RS procedures/action plans
- Gifted and Talented Students
  - Provide extension activities
  - Build on students' intrinsic motivations
  - Higher Level mathematical computations

Lesson Name/Topic	Lesson Objective(s)	Time frame (day(s) to complete)
Mole concept and Stoichiometry	Show proportional relationships between masses of reactants and products	2 days
Balancing Equations	Use balanced equations to show mass relationships between reactants and products	2 days
Dimensional analysis	Gain an understanding of the use of dimensional analysis to perform mass to mole conversions that demonstrate how mass is	4 days

	conserved during chemical reactions	
Conservation of Energy	Demonstrate understanding of the conservation of energy within a system by emphasizing the key idea that a stable molecule has less energy than the same set of atoms when separated	3 days
Molecular-level drawings	Analyze molecular-level drawings and tables showing energies in compounds with multiple bonds to show that energy is conserved in a chemical reaction.	3 days
Endo vs Exothermic	Determine whether reactions are endothermic and exothermic, constructing explanations in terms of energy changes	3 days
Le Chatelier's principle	Study the effect on reaction rates of changing the temperature and/or concentration of a reactant	3 days
Equilibrium	Explore the concept of equilibrium through investigations, which may include manipulations of variables such as temperature and concentration	1 week
Rate of Reactions	Develop an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs and on equilibrium	5 days
Engineering application	Design a solution to specify a change in conditions that would produce increased amounts of products at equilibrium in order to produce the greatest amount of product from a reaction system	1 week

Teacher Notes:

Additional Resources
www.harpercollege.edu/tm-ps/chm/100/dgodambe/thedisk/equil/equil.htm
Science NetLinks: *http://www.aaas.org/program/science-netlinks*
North American Association for Environmental Education: *http://www.naaee.net/*

Click links below to access additional resources used to design this unit:
https://phet.colorado.edu/en/simulations/category/chemistry
http://www.rsc.org/resources-tools/education-resources/

Content Area: High School Chemistry
Unit Title: Ionic and Covalent Compounds; Acids and Bases
Grade Level: 10
Unit Summary: Atoms in ionic compounds are held together by chemical bonds formed by the attraction of oppositely charged ions. Ions are formed when atoms gain or lose valence electrons to achieve a stable octet electron configuration (noble gas electron configuration). Oppositely charged ions attract each other, forming electrically neutral ionic compounds. In written names and formulas for ionic compounds, the cation appears first, followed by the anion. Metals form crystal lattices and can be modeled as cations surrounded by a "sea" of freely moving valence electrons. Atoms in covalent compounds are held together by chemical bonds formed by the sharing of valence electrons. Atoms gain stability when they share electrons and form covalent bonds. Specific rules are used when naming binary covalent compounds and binary acids and oxyacids. Structural formulas show the relative positions of atoms within a molecule. The VSEPR theory is used to determine molecular shape. A chemical bond's character is related to each atom's attraction for the electrons in the bond. **Interdisciplinary Connections:** Math, Art, History, Biology, English **21st Century Themes and Skills:** CRP2. Apply appropriate academic and technical skills. CRP4. Communicate clearly and effectively and with reason. CRP6. Demonstrate creativity and innovation. CRP7. Employ valid and reliable research strategies. CRP8. Utilize critical thinking to make sense of problems and persevere in solving them. CRP11. Use technology to enhance productivity. CRP12. Work productively in teams while using cultural global competence.

Standards (Content and Technology):	
CPI#:	**Statement:**
Next Generation Science Standards	
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-PS1-3	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-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-PS2-6	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials
2014 New Jersey Core Curriculum Content Standards - Technology	
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
8.2.12.C.4	Explain and identify interdependent systems and their functions.
8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Unit Essential Question(s):	**Unit Enduring Understandings:**
• Why do bonds form?	

• What are the major similarities and differences between ionic and covalent bonds? • How do shape, electronegativity, and polarity relate to one another? • How can the shape, bond angles, and polarity be predicted using VSEPR theory? • How does metallic bonding structure affect the properties of a metal? • How does crystal lattice structure affect the properties of an ionic compound? • What are the rules for ionic, covalent, and acid naming and formula writing?	• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. • Much of science deals with constructing explanations of how things change and how they remain stable. • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. • 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.

Unit Learning Targets/Objectives:

Students will

- Describe the formation of an ionic bond.
- Describe the formation of an anion or cation from its neutral atom.
- Determine the correct ratio of cations to anions needed to form a neutral ionic compound.
- Identify the properties of an ionic compound, including melting point, boiling point, lattice energy, and hardness.
- Understand that ionic compounds conduct electricity if they are in an aqueous or molten state.
- Explain the electron sea model and the role that delocalized electrons play in determining the physical properties of metals (malleable, conductors of electricity/heat, luster, and ductile).
- Understand that alloys are a mixture of elements that have metallic properties.
- Distinguish between the term electrolyte and nonelectrolyte.
- Describe the formation of a covalent bond.
- Explain the differences between single, double and triple bonds based on number of electrons shared (length and strength).
- Determine the polarity of molecules based on their shape if they have the same terminal ends.
- Write formulas for binary molecular compounds.
- Distinguish among ionic, molecular, and metallic substances given their properties.
- Distinguish between ionic compounds and binary molecular compounds.
- Apply electronegativity values to predict bond type (nonpolar covalent, mostly covalent, polar covalent, and ionic).
- Name binary acids and oxyacids.
- Distinguish the properties of acids and bases.

Formative Assessments:

- Conferences
- Observations
- Question and Answer Sessions
- First Drafts / Quizzes
- Journals

Summative/Benchmark Assessment(s):

- Chapter/Unit tests
- Projects
- Performances
- Final copies

Resources/Materials (copy hyperlinks for digital resources):
Buthelezi, Thandi, Laurel Dingrando, Nicholas Hainen, Cheryl Wistrom, and Dinah Zike. *Glencoe Chemistry: Matter and Change*. Bothell, WA: McGraw-Hill Education, 2013. Print.

Modifications:

- Special Education Students
  - Allow errors
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer questions, and permit drawing, as an explanation
  - Consult with Case Managers and follow IEP accommodations/modifications
- English Language Learners
  - Assign a buddy, same language or English speaking
  - Allow errors in speaking
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer question
- At-Risk Students
  - Provide extended time to complete tasks
  - Consult with Guidance Counselors and follow I&RS procedures/action plans
- Gifted and Talented Students
  - Provide extension activities
  - Build on students' intrinsic motivations
  - Higher Level mathematical computations

Lesson Name/Topic	Lesson Objective(s)	Time frame (day(s) to complete)
Cations and anions	Identify and Name ions	2 days
Ionic Compounds	Name and describe formation of various ionic compounds	2 days
Properties and uses	Identify the properties of an ionic compound, including melting point, boiling point, lattice energy, and hardness	4 days

	and relate to the uses of various ionic compounds	
Covalent Compounds	Explain how shape, electronegativity, and polarity relate to one another	3 days
Formulas	Write formulas for binary molecular compounds	2 days
Bond type	Apply electronegativity values to predict bond type	2 days
Naming Acids	Name binary acids and oxyacids.	2 days
Properties of Acids,Bases	Distinguish the properties of acids and bases	3 days
Uses of Acids and Bases	Identify and model the uses of acidic and basic compounds in biological functions, industrial uses and other real life applications	1 week

Teacher Notes:

Additional Resources
http://www.periodni.com/solcalc-chemical_compounds.html
http://www.compoundchem.com/

Click links below to access additional resources used to design this unit:
https://phet.colorado.edu/en/simulations/category/chemistry
http://www.rsc.org/resources-tools/education-resources/

Content Area: High School Chemistry
Unit Title: Nuclear Chemistry
Grade Level: 10
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. **Interdisciplinary Connections:** Math, Art, History, Biology, English **21st Century Themes and Skills:** CRP2. Apply appropriate academic and technical skills. CRP4. Communicate clearly and effectively and with reason. CRP6. Demonstrate creativity and innovation. CRP7. Employ valid and reliable research strategies. CRP8. Utilize critical thinking to make sense of problems and persevere in solving them. CRP11. Use technology to enhance productivity. CRP12. Work productively in teams while using cultural global competence.

Standards (Content and Technology):	
CPI#:	**Statement:**
Next Generation Science Standards	
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
2014 New Jersey Core Curriculum Content Standards - Technology	
8.1.12.F.1	Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.
8.2.12.C.4	Explain and identify interdependent systems and their functions.
8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.

8.1.12.A.4	Construct a spreadsheet workbook with multiple worksheets, rename tabs to reflect the data on the worksheet, and use mathematical or logical functions, charts and data from all worksheets to convey the results.

Unit Essential Question(s):	**Unit Enduring Understandings:**
• Why is fusion considered the Holy Grail for the production of electricity? • Why aren't all forms of radiation harmful to living things? • How do stars produce elements? • Is the life span of a star predictable? • If there was nobody there to Tweet about it, how do we know that there was a Big Bang? • How can chemistry help us to figure out ancient events?	• Nuclear processes, including fusion, fission, and radioactive decay of unstable nuclei, involve release or absorption of energy. • In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved. • Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. • The significance of the energy transfer mechanisms that allow energy from nuclear fusion in the sun's core to reach Earth is dependent on the scale, proportion, and quantity at which it occurs. • 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 nonstellar 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. • 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. • Energy cannot be created or destroyed, only moved between one place and another place, between objects and/or fields, or between systems. • Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

	• Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and will continue to do so in the future. • Science assumes the universe is a vast single system in which basic laws are consistent. • 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. • 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, meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. • 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. • Much of science deals with constructing explanations of how things change and how they remain stable.

Unit Learning Targets/Objectives:
Students will

- 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.
- 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.
- 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.

- 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 red shift 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.
- 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.

Formative Assessments:

- Conferences
- Observations
- Question and Answer Sessions
- First Drafts / Quizzes
- Journals

Summative/Benchmark Assessment(s):

- Chapter/Unit tests
- Projects
- Performances
- Final copies

Resources/Materials (copy hyperlinks for digital resources):
Buthelezi, Thandi, Laurel Dingrando, Nicholas Hainen, Cheryl Wistrom, and Dinah Zike. *Glencoe Chemistry: Matter and Change*. Bothell, WA: McGraw-Hill Education, 2013. Print.

Modifications:

- Special Education Students
  - Allow errors
  - Rephrase questions, directions, and explanations
  - Allow extended time to answer questions, and permit drawing, as an explanation
  - Consult with Case Managers and follow IEP accommodations/modifications
- English Language Learners
  - Assign a buddy, same language or English speaking
  - Allow errors in speaking
- At-Risk Students
  - Provide extended time to complete tasks
  - Consult with Guidance Counselors and follow I&RS procedures/action plans
- Gifted and Talented Students
  - Provide extension activities
  - Build on students' intrinsic motivations
  - Higher Level mathematical computations

- o Rephrase questions, directions, and explanations
- o Allow extended time to answer question

Lesson Name/Topic	Lesson Objective(s)	Time frame (day(s) to complete)
Fission, Fusion and radioactive decay	Develop and use models to illustrate the processes of fission, fusion, and radioactive decay	6 days
Energy of Nuclear Chemistry	Explain the scale of energy released in nuclear processes relative to other kinds of transformations, such as chemical reactions	3 days
Radioactive decay Processes	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	3 days
Stellular Composition	Identify compositional elements of stars, their movements, and their distances from Earth	3 days
Light spectra and brightness	Develop an understanding of how analysis of light spectra gives us information about the composition of stars and interstellar gases	1 week
Nuclear Fusion	Illustrate the relationship between nuclear fusion in the sun's core and energy that reaches the Earth in the form of radiation	5 days
Chemistry and the Big Bang Theory	Apply the red shift/blue shift, wavelength relationships to energy, and universe expansion as pieces of evidence for the Big Bang Theory	1 week
Chemistry and the Earth's Age	Use examples of spontaneous radioactive decay as a tool to determine the ages of rocks or other materials	5 days
Earth's formation	Make claims about Earth's formation and early history supported by data while considering appropriate units, quantities and limitations on measurement	1 week

Teacher Notes:

Additional Resources

Click links below to access additional resources used to design this unit:

https://phet.colorado.edu/en/simulations/category/chemistry
http://www.rsc.org/resources-tools/education-resources/