Advanced Chemistry

[Implement start year (2013-2014)]

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Unit 1: Structure and Properties of Matter - *Students will be able to independently use their learning to…*

Make sense of the macroscopic details of the world around them using symbolic and molecular-level reasoning to explain what they see.

Stage 1 – Desired Results

Established Goals

2009 NJCCC Standard(s), Strand(s)/CPI #
(http://www.state.nj.us/education/cccs/)

5.1.12.A.1
Mathematical, physical, and computational tools are used to search for and explain core scientific concepts and principles.
5.1.12.A.2
Interpretation and manipulation of evidence-based models are used to build and critique arguments/explanations.
5.1.12.B.3
Empirical evidence is used to construct and defend arguments.
5.2.12.A.1
Electrons, protons, and neutrons are parts of the atom and have measurable properties, including mass and, in the case of protons and electrons, charge. The nuclei of atoms are composed of protons and neutrons. A kind of force that is only evident at nuclear distances holds the particles of the nucleus together against the electrical repulsion between the protons.
5.2.12.A.2
Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged, and by the strength of the forces of attraction between the atoms, ions, or molecules.
5.2.12.A.5
Solids, liquids, and gases may dissolve to form solutions. When combining a solute and solvent to prepare a solution, exceeding a particular

21st Century Themes
(www.21stcenturyskills.org)

_X_ Global Awareness
___Financial, Economic, Business and Entrepreneurial Literacy
___Civic Literacy
___Health Literacy
_X_Environmental Literacy

21st Century Skills

Learning and Innovation Skills:
___Creativity and Innovation
_X_Critical Thinking and Problem Solving
_X_Communication and Collaboration

Information, Media and Technology Skills:
___Information Literacy
___Media Literacy
___ICT (Information, Communications and Technology) Literacy

Life and Career Skills:
___Flexibility and Adaptability
_X_Initiative and Self-Direction
_X_Social and Cross-Cultural Skills
_X_Productivity and Accountability
_X_Leadership and Responsibility

concentration of solute will lead to precipitation of the solute from the solution. Dynamic equilibrium occurs in saturated solutions. Concentration of solutions can be calculated in terms of molarity, molality, and percent by mass. 5.2.12.B.1 An atom's electron configuration, particularly of the outermost electrons, determines how the atom interacts with other atoms. Chemical bonds are the interactions between atoms that hold them together in molecules or between oppositely charged ions 5.2.12.C.1 Gas particles move independently and are far apart relative to each other. The behavior of gases can be explained by the kinetic molecular theory. The kinetic molecular theory can be used to explain the relationship between pressure and volume, volume and temperature, pressure and temperature, and the number of particles in a gas sample. There is a natural tendency for a system to move in the direction of disorder or entropy. 5.2.12.C.2 Heating increases the energy of the atoms composing elements and the molecules or ions composing compounds. As the kinetic energy of the atoms, molecules, or ions increases, the temperature of the matter increases. Heating a pure solid increases the vibrational energy of its atoms, molecules, or ions. When the vibrational energy of the molecules of a pure substance becomes great enough, the solid melts. 5.2.12.B.3 The conservation of atoms in chemical reactions leads to the ability to calculate the mass of products and reactants using the mole concept. **Common Core Curriculum Standards for Math and English** (http://www.corestandards.org/) RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11-12 texts and topics*. 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. WHST.11-12.1 Write arguments focused on discipline-specific content.	

WHST.11-12.7 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.	
Enduring Understandings: *Students will understand that . . .* *EU 1* Models (mathematical, graphical, or visual) are constructed based upon experimental data to explain the physical and chemical properties of matter. *EU 2* Nuclear reactions, because of their fundamental differences from chemical reactions, have unique applications in society which are oftentimes controversial. *EU 3* Atoms combine to form compounds in predictable and energetically favorable ways. *EU 4* Differences in the physical properties of solids, liquids, and gases are explained by the ways in which the atoms, ions, or molecules of the substances are arranged and by the strength of the forces of attraction between them. *EU 5* The strength and nature of the interactions between solute and solvent particles impacts the formation of a solution and its properties.	**Essential Questions:** *EU 1* • How can you explain what you cannot see? *EU 2* • Is Nuclear Energy safe to use? *EU 3* • Are there limits to the number of different compounds that can exist? *EU 4* • To what extent does the motion of particles affect the properties of matter? *EU 5* • Is salt still salt when it is dissolved in water?

Knowledge: *Students will know . . .*	**Skills:** *Students will be able to . . .*
EU 1 Atomic Structure • Bohr Model and relationships between light, energy, and electrons • Quantum mechanical model (exists, based on probability, electron configurations)	*EU 1* • Apply mathematical equations to model the hydrogen atom • Write electron configurations • Predict the chemical behavior of elements based on their position on the periodic table.
EU 2 Fundamental differences between nuclear processes and chemical reactions including: • How conservation of mass and energy is applied • Outer electrons versus changes to the nucleus • Transmutation of atoms into other atoms • Interconversion between mass and energy • Energy changes involved in nuclear processes as compared to chemical processes	*EU 2* • Write nuclear equations and predict products of nuclear processes • Analyze the role of nuclear chemistry in society
EU 3 Bonding • Atomic properties based on structure (trends) • Energy changes associated with bonds, including graph of PE vs. nuclear distance • Types of bonds (continuum of bond classification) • Organic/Inorganic Nomenclature • Molecular geometry (Lewis structures, VSEPR theory, Hybridization) • Resonance	*EU 3* • Write Lewis Structures and predict the molecular geometry for molecules • Write chemical names and formulas for compounds
EU 4 States of Matter • Kinetic Molecular Theory and energy as applied to solids/liquids/gases/plasma • Intermolecular forces • Applications of solid bonding (including allotropes, network-covalent, etc.)	*EU 4* • Identify the intermolecular forces found in a substance and use this information to classify the type of solid/crystal

EU 5 Solutions • Qualitative properties of solutions • formation • energetic • saturation • solubility (including curves) • Quantitative properties of solutions • molarity, molality, mole fraction, • solubility	*EU 5* • Read and interpret graphical representations of solubility • Calculate molarity

Stage 2 – Assessment Evidence

Recommended Performance Tasks: *Each unit must have at least 1 Performance Task. Consider the GRASPS form.*

- Two friends in your school are having an argument about whether intermolecular forces are the same things as bonds. One friend says "Of course they are bonds, just look at the name, 'hydrogen bond'." The other friend says "Forces aren't the same thing as bonds because they aren't permanent." Using your understanding of the chemical bond, construct an argument for the editorial section of your school newspaper to solve the disagreement. Your argument should address both sides, but should take a stance that is either supporting or refuting the statement. (EU3, EU4)

AND

- Student is a lab technician for a company that tests blood and urine samples. A professional athlete has recently been indicted on charges of using illegal performance enhancing drugs (PED). The judge has requested your testimony that both shows and explains the data in a way that the jury will understand. The student who analyzed her blood is responsible for preparing the testimony. The testimony should contain only factual information that can be concluded from the lab test that was done. [Mass Spectrometer and chromatography data will be provided to the student and it will be their task to create the testimony for the judge.] (EU1, EU5)

AND

- Your town is trying to decide which method of energy production to invest in the future. The town council has asked our local chemistry class to research different types of energy production via chemical or nuclear means and make a recommendation to the council. Students in the class take on roles (power plant manager, mayor of town, concerned citizen, etc…) and write a position paper to be read at the town council meeting supporting the use of one type of energy production. (EU2)

  OR

- Students are given the following prompt: You are a home owner in a small town in New Jersey that has high unemployment. A private energy company has proposed building a nuclear power plant five miles upstream from your town. Write a 2-3 minute speech to give at the town council meeting or a 1-2 page letter to your town council to express and defend your opinion regarding the building of the plant using chemical arguments. (EU2)

Other Recommended Evidence: *Tests, Quizzes, Prompts, Self-assessment, Observations, Dialogues, etc.*

- Quizzes on nuclear reactions, electron configurations, Lewis Structures, concentration, and solubility curves
- Tests on Atomic Structure, Bonding, States of Matter, and Solutions
- Formative assessment using individual contributions to class discussions and independent brief written responses (like "Ticket to Leave", etc…)
- Laboratory notebooks or reports may be used for assessment of the above listed lab skills and content

Stage 3 – Learning Plan

Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: *Consider the WHERETO elements. Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.*

Learning Activities:

a. Discussion of how studies of light led to an understanding of the behavior of electrons in an atom (A)
b. Quantitative Spectroscopy and the Hydrogen Atom (M)
c. Students explore the effects of different types of electron transitions using fluorescence and phosphorescence as a model (M)
d. POGIL series on Photoelectron Spectroscopy, as related to justification of electron configurations (M)
e. Students research spectroscopy uses in the real world and then explain a specific application such as how it can be used to determine the elemental composition of stars (M/T)
f. Periodic trends lab: approximating an atomic radius via trending (T)
g. Students read article "Why Orbitals Do Not Exist" and debate the value of the quantum mechanical description of the electron. (A/M)
h. Teacher led summary of systematic chemical nomenclature (A)
i. Students complete practice problems: naming and writing formulas for compounds (M)
j. Teacher demonstrations of chemical bonding models (A/M)
k. POGILs on Coulomb's law in relation to bonding
l. Students build models of chemicals which approximate the 3-D shape of the molecules (M)
m. Students use models of chemicals to determine molecular polarity (M/T)
n. POGIL on Hybrid Orbitals
o. Students draw energy diagrams for hybridized orbitals (M/T)
p. Students draw their own organic structure(s) given a set of criteria and then another student can name the structure(s) (M/T)
q. Analysis of Maleic/fumaric acid (M/T)
r. Students brainstorm the difference between structure and properties of the various states of matter (A/M)
s. Determination of the Molar Mass and/or Molar Volume of a volatile liquid (M)
t. Students investigate the difference between graphite/diamond/buckminsterfullerene in terms of chemical structure and usage (M)
u. Create a solubility curve for a solute based on experimentally derived data at different temps (rationalize different shapes of curves for different solutes) (M)

v. Students apply knowledge of solution properties to analyze a practical phenomenon (i.e. sugar in drinks, miscibility of liquids & solubility) (T)
w. Students can predict the absorbance of different vitamins in the blood and/or fat in the human body based on their structure. (T)
x. Gravimetric determination of an unknown chloride compound (T)
y. Students perform independent practice problems such as calculating solution concentrations (M/T)
z. Students investigate real-world applications such as Doppler Shift, Nanochemistry, & Materials Science (T)