Theme

"Protecting Our Planet through Chemistry"

STEM Innovation Academy Unit 2 Plan

Subject: Chemistry **Unit Title:** Unit 2- The Chemistry of Solutions and the Mole **Grade:** 10th	**Teacher:** Ms. Dy-Anni Austin **Duration:** 24-80 min blocks

Summary of Unit

In this unit of study, students use investigations, simulations, and models to makes sense of the structure of pure substances and mixtures to provide more mechanistic explanations of their properties. 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 science and engineering practices like *developing and using models*, *planning and conducting investigations*, *using mathematical thinking*, and *constructing explanations and designing solutions* to demonstrate proficiency with the core ideas.

Stage 1- Desired Results

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.]

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.]

Enduring Understandings: *Students will understand that…*	**Essential Questions:**
• Substances have unique chemical and physical properties • Physical properties and changes can be readily observed and are reversible • Chemical properties and changes occur in the presence of a chemical reaction, result in the formation of new substances and are not readily reversible. • Matter can be subdivided into pure substances and mixtures. • Pure substances include elements and compounds. Mixtures include homogeneous and heterogeneous mixtures • The chemical and physical properties of pure substances in a mixture are conserved and can be used to separate the components of a mixture through separation techniques.	• What are the descriptions for how atoms combine to form new substances by transferring electrons (ionic compounds) or by sharing electrons (molecular compounds)? • How does the Periodic Table provide for the charge of a metal or a nonmetal, in an ionic compound? • How can conversions be made among particles, mass, and moles of any substance? • How does the accumulation of metal and nonmetal ions used to increase agricultural productivity become a significant source of water pollution? • What are the physical conditions that affect solution formation, and what is the effect of each physical condition? • What are definitions for the five terms for concentration?

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• Chromatography can be used to separate the components of a homogenous mixture through polarity.
• Chemical symbols, formulas, and equations are understood internationally, and are written based upon universally accepted guidelines.
• The unit of measurement on which chemists rely to predict quantities in chemical reactions is the mole.
• The relative amounts of solute and solvent in a solution are described by Molarity, Molality, mass and volume percent.
• State and explain the significance of Avogadro's hypothesis.
• Understand and apply Dalton's Law of Partial pressures.
• Understand Avogadro's hypothesis as it applies to gases.
• The structure of the water molecule and the presence of hydrogen bonds in water are responsible for unique chemical and physical properties, which dictate many aspects of our world.
  • The significance of polarity, electrolytes and physical conditions, such as temperature, particle size and agitation, affect solution formation and the nature of the solvation process.
  • The relative amounts of solute and solvent in a solution are described by Molarity, Molality, Mass Volume Percent, and Percent Composition.	

Learning Objectives/Knowledge: *Students will know how to….*

Properties of Matter

- Differentiate between physical and chemical properties of matter.
- Identify the presence of a chemical reaction through a series of observations.
- Describe methods of separating substances based on these physical and chemical properties.
- Compare and contrast pure substances and mixtures.
- Identify elements on the periodic table.

The Mole

- Define Avogadro's number as one mole equals 6.02×10^{23} particles (atoms or molecules).
- Define gram atomic mass, gram molecular mass, gram formula mass, and molar mass from the chemical formula and a table of atomic masses.
- Relate mass, moles, volume, and number of particles for a given amount of a substance, at standard temperature and pressure.
- Use percent composition to determine empirical and molecular formulas.
- Show that different compounds composed of the same two elements obey the Law of Multiple Proportions, using experimental data.
- Show that different samples of the same compound obey the Law of Definite Proportions, using experimental data.

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Stoichiometry

- Interpret a chemical equation for mole relationships of mass, particles, or volume.
- Define and apply the concepts of theoretical, actual, and percent yield.
- Explain how the release of sulfur dioxide into the atmosphere can form acid rain, and how acid rain affects water sources, organisms, and human made structures.
- Describe the availability, current uses, and environmental issues related to the use of fossil and nuclear fuels to produce electricity.

Solutions

- Describe the hydrogen bonding that occurs in water, on the bases of the structure of the polar water molecule, and electronegativity.
- Use the concept of hydrogen bonding to explain the high surface tension, high boiling point, high specific heat, and high heat of vaporization of water.
- Define the terms; solution, aqueous solution, solute and solvent.
- List and explain the factors that affect the rate of dissolving.
- Understand how the concentration of a solution may be quantitatively described.
- Use the rule of ―like dissolves like‖ to predict the solubility of one substance in another.
- Characterize colloids and suspensions and explain how they differ from solutions.
- Describe the procedure for preparing a dilute solution of known concentration from a more concentrated solution.
- Distinguish among weak electrolytes, strong electrolytes and nonelectrolytes.
- Use the concept of colligative properties to predict boiling points or freezing points of given solutions.

Stage 2 – Assessment Evidence

Performance Tasks:

- **Goal:** Students will create a calibration curve from experimental spectrophotometric data in order to determine the percent copper in a brass screw purchased from a local hardware store.
- **Role**: Researcher/Analytical Chemist
- **Audience**: Teacher
- **Situation**: "You are an Analytical Chemist hired by a screw manufacturing company, "Screws N' Things". As part of the research and development department, it is your job to suggest improvements to the brass screws manufactured by your company. Your department just found out that your most successful competitor, "Better Screws", just released a new and improved brass screw that is a best seller. You suspect that "Better Screws" has changed the amount of copper they add to their brass screws. In order to test your hypothesis, you decide to determine the concentration of copper in the brass screws manufactured by the competition."
- **Product**: Write up a formal laboratory report to share your findings with the teacher.
- **Standards**: Your work will be judged using a laboratory report rubric.

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	Far Below Expectations 0 points	Below Expectations 1 to 2 points	Meets or Exceeds Expectations 3 points
1. Heading, Neatness, & Organization	The lab report fails to meet two or more of the expectations for neatness, organization, name, title, and date.	The lab report fails to meet one of the expectations for neatness, organization, name, title, and date.	1. The lab report is clearly typed. 2. The sections are in correct order, clearly labeled, and presented in a professional manner 3. No spelling/grammatical errors in the report (scientific words will get the greatest focus)
2. Objective(s)	Objectives are missing, or only loosely related to the lab being performed.	The objectives address the procedural aspects of the lab, but do not accurately summarize the theoretical foundation of the experiment.	Objectives accurately describe the purpose for doing the lab.
3. Concept(s)	Concepts are missing, or only loosely related to the lab being performed.	The concepts address the procedural aspects of the lab, but do not accurately summarize the theoretical foundation of the experiment.	Concepts (theories, laws) illustrated in the lab are thoroughly explained using clear examples.
4. Materials Used	Materials list is missing.	Materials list is incomplete.	All materials used are listed.
5. Safety	MSDS links missing.	MSDS links incomplete.	Links to all MSDS included.
6. Procedure	Procedure (lab handout) is missing entirely.	Procedure (lab handout) has missing parts.	Procedure is included with the report.
7. Data and Calculations	The data section is missing.	The data section is incomplete.	1. All data from experiments in included. 2. Data is neatly organized (in tables or graphs where appropriate), and is easy to interpret. 3. All data is correct with regard to significant figures and labels/units. (Calculations only need to be included for one trial)
8. Analysis [5 points]	The student does not answer the questions or makes significant errors to making the answers incomprehensible. **[0 to 1 point]**	The student makes multiple errors or incorrect statements in answers. **[2 to 3 points]**	All analysis questions are answered fully and correctly. **[4 to 5 points]**
9. Discussion & Conclusion [9 points]	Discussion & Conclusion is missing, or is in conflict with the student's experimental results. **[0 to 3 points]**	Discussion & Conclusion is present, and does not conflict with the student's experimental findings, but fails to fully address reasons for error. **[4 to 7 points]**	The Discussion & Conclusion succinctly describes what can be concluded from the **experimental results, possible sources of error,** and also **describes what would be expected** if the experimental data were different. **[8 to 9 points]**

Formal Lab Report (See Above Rubric, Submitted via Turnitin.com)

Total Score

_____/35

Other Evidence:

Before	During	After
KWL – Students will list what they know and what they want to know about the Chemistry of Solutions. **Brainstorming** – Students will discuss what they know about the Chemistry of Solutions by breaking down the word and coming up with various meanings. **Quick Writes (Do Now)** – Before each lesson students will be asked to write their thoughts and questions for the day pertaining to the objectives. **Pretest** – Students may be given an assessment to understand their knowledge on the unit before any instruction is given.	**Journals** – Students will complete daily journal reflections and take notes when necessary. **Lab Investigations** – Students will complete one or more lab investigation(s) exploring and applying Scientific Inquiry, Literacy, and Numeracy. **Daily Assignments** – Students will be given problem solving based assignments and calculation problems. **Observations** – Students will write down any observations in their journals as witnessed in class or during their labs. **Think-Pair-Share** – Students will work in pairs to discuss vocabulary and concepts and reinforce understanding. **Quizzes –** Give short quizzes or Exit Tickets - to show mastery of concepts needed before moving to the next concept.	**Unit Test** – Students will be given a test after the unit has been completed and Authentic Assessments have been given **Authentic Assessment**- students will be presented with a real word problem that they must solve as a small group by performing research on scientific concepts, gathering evidence through experimentation, developing models using chart paper, and writing scientific explanations using a template. **Power Point Project** – Students may also create a Power Point Presentation (as a group) of this unit. This will include various concepts, experimental data, vocabulary, and applications in the "real world".

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Student Self-Assessment and Reflection:
Students will write down their questions and or comments pertaining to the day's events, including any observations they made during the lab and/or scientific demonstrations into their journals. Students will compare the quality of their Do Now responses to their exit ticket responses to gauge their level of understanding and comfort with the material.

Stage 3 – Learning Plan

Differentiated Instruction (by student readiness):

Tiers 2-3: Students who have scored a 3 or below (approaching expectations) on the ELA and Math NJSLAs

1. Scaffolding
2. Group work
3. Peer tutoring
4. One on one discussions
5. Office hour appointments
6. Laboratory Investigations
7. Authentic Assessment
8. Group Power Point Presentation
9. Unit Test

Tier 1: for students who have scored a 4 or 5 (met or exceeded expectations) on the ELA and Math NJSLAs

1. One on one discussions
2. Office hour appointments
3. Laboratory Investigations
4. Authentic Assessment
5. Group Power Point Presentation
6. Unit Test

Learning Activities:

1. Physical and Chemical Properties WebQuest Parts 1 & 2
2. White Solid Analysis and Identification Lab, Questions, and Reflection
3. M&M Paper Chromatography Lab, Questions, and Reflection
4. "Paper Chromatography" Chemmatters Article and 3-2-1-Contact! Questions
5. Quiz Question: Compare and contrast paper chromatography and gel electrophoresis
6. Separation Techniques Resource Packet and Separation Techniques Chem Flyer
7. "The Measure of a Mole" Chemmatters Article and 3-2-1-Contact! Questions
8. 2B: The Chemical Formula Lab Investigation and Reflection
9. Intro to Stoichiometry WS
10. Mole Maze Worksheet (with original work shown)
11. Quiz: Stoichiometry Mixed Mole Conversions Escape Room
12. Stoichiometry- Percent Composition, and Empirical/Molecular Formula WS
13. Quiz: Percent Composition, and Empirical/Molecular Formula WS
14. "Empirical Formula of a Hydrate" Lab Questions and Reflection
15. "Making Sense of Milk" Chemmatters Article and 3-2-1-Contact! Questions
16. "Clean and Green" Chemmaters Article and 3-2-1-Contact! Questions
17. "Solubility Curve of Salts VLab" Questions and Reflection
18. "The Sweet Science of Candy Making" Chemmaters Article and 3-2-1-Contact! Questions
19. "Rock Candy/Borax Ornaments" Crystallization in Action Resource Packet and Model
20. "Kool-Aid Concentrations: Introduction to Molarity" Lab Questions and Reflection
21. Concentration of Solutions (Molarity, Molality, Percent Concentration, and Mole Fraction) Practice Problems
22. "Salting Roads" Chemmaters Article and 3-2-1-Contact! Questions
23. "2C: One in a Million" Lab Questions and Reflection

Extensions: What activities truly support this as an honors level class? Use the last three stages of Bloom's Taxonomy to address this section including 4-analyze- drawing connections among idea, 5- evaluate- justify a

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stance or decision, 6- create- producing original work.

1. Separation Techniques Resource Packet and Separation Techniques Chem Flyer: students draw connections among ideas by analyzing reading material in order to create an original and informative flyer describing the usefulness of a specific separation technique to chemists and beyond.
2. (Rock Candy/Borax Ornaments) Crystallization in Action Resource Packet and Model: students draw connections among ideas by analyzing the crystallization resource packet, evaluating the results of a crystallization experiment by making rock candy or borax crystal ornaments, and developing a model to explain the chemistry behind this phenomenon.
3.

Vocabulary:

Substance, mixture, volume, pure, chemical property, chemical change, physical property, macroscopic, microscopic, atom, element, chemical symbol, periodic table, mole, Avogadro's number, Chemical formula, subscript, structural diagram, bonds, molecule, compound, formula mass, ionic compound, ions, moles, homogeneous, heterogeneous, solution, solute, solvent, concentration, molarity, solubility, insoluble, dissolve, pressure, and STP

Literacy and Math Connections:

RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed
visually or mathematically (e.g., in an equation) into words. (HS-PS1-1)
RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or
inconsistencies in the account. (HS-PS1-3),(HS-PS2-6)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS2-6)
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. (HSPS1-3)
WHST.11-12.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations
of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding
plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3)
WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3)
Mathematics –
MP.4 Model with mathematics. (HS-PS1-8)
HSN-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose
and interpret the scale and the origin in graphs and data displays. (HS-PS1-3),(HS-PS1-8),(HS-PS2-6)
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-8),(HS-PS2-6)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3),(HS-PS1-8),(HS-PS2-6)

Expert/Field Experiences:

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An expert will be invited if available and field experience will be scheduled.

Capstone Project:

Task: In a cost-effective and creative manner, your company is to produce two pounds of packaged, quality soap that meets and appeals to the consumers' demands of a specified soap market.

Background Information: We (the class) are an existing company based in Orange, New Jersey, that plans to enter the market of producing bar soap for families in "The Oranges". Our marketing division in Trenton, New Jersey, has provided us with an initial analysis of the Orange community. Assuming that we can take over 20% of the Orange "family" market, that each family would purchase seventy five 140 g-bars per year, and that we stick to a basic recipe of lard, lye, and water, we could make a minimum profit of 10% per bar sold. From our research division in Newark, New Jersey, we have obtained an initial small-scale basic recipe that makes approximately 21 grams of soap. This recipe will serve as our foundation for producing the two-pound prototype. Prior to the project, we will become familiar with the process of saponification by using the recipe to make initial soap samples, in addition, a soap expert will inform us of the chemistry behind saponification and take our questions.

Project Objectives:

1. Improve communication skills
    a. Operate productively and positively in a scientific community.
    b. Define a target audience and communicate appropriately to same.
    c. Formulate concise, objective oriented memos.
2. Experience an applicable scientist endeavor
    a. Understand what scientists do and how mangers, accountants, and marketers affect what scientists do.
    b. Learn one chemical process for producing a desired product.
3. Become familiar with the corporate world
    a. Experience how different teams interact to accomplish a desired goal.
    b. Learn how to function under time, monetary, and regulatory constraints.

Connection to End of Year Project:

Students will be tasked as a class to formulate, synthesize, package, and market two pounds of high-quality soap. Successful customer packaged goods companies have both a Research and Development (R&D) department and Quality Control (QC) department. This unit emphasizes both components of product production through exposure to separation techniques, concentration quantification using analytical instrumentation, graphical analysis, and communication of results through a lab report.