Course: *Chemistry* **Unit #:** *3: Chemical Reactions in Our World*	**Year of Implementation:** 2021-2022
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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
https://www.state.nj.us/education/cccs/2020/
https://www.nj.gov/education/cccs/2016/science/

Unit Standards:

Science and Engineering Practices

- Practice 1 Asking Questions and Defining Problems
- Practice 2 Developing and Using Models
- Practice 3 Planning and Carrying Out Investigations
- Practice 4 Analyzing and Interpreting Data
- Practice 5 Using Mathematics and Computational Thinking
- Practice 6 Constructing Explanations and Designing Solutions

Performance Expectations:

- HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties
- HS-PS1-5. 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-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Disciplinary Core Ideas:
PS1.B: CHEMICAL REACTIONS

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy.
- 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.
- 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.

NJSLS Career Readiness, Life Literacies, and Key Skills
The content of this unit will contribute to a student's ability to meet the following standards.

Creativity and Innovation

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas

Critical Thinking and Problem-solving

- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Information and Media Literacy

- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions

Technology Literacy

- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.3: Analyze the effectiveness of the process and quality of collaborative environments.

Transfer Goal: Students will be able to independently use their learning to model interactions at the molecular level, specifically collisions of molecules and the rearrangement of atoms, in order to explain the changes and phenomena which they observe in their everyday life.

Department Goals:

Students will:

- construct, interpret, and refine models (scientific and mathematical) to explain the physical and natural world.
- effectively communicate scientific ideas and evidence-based arguments to an appropriate audience through written and oral means.
- evaluate for their validity arguments that rely on scientific reasoning presented in the popular press or other informational sources.

<u>*Enduring Understandings*</u>	<u>*Essential Questions*</u>
Students will understand that. . . *EU 1* when a chemical reaction occurs, atoms combine or rearrange, but matter and energy are always conserved.	*EU 1* ● How are new substances created? ● How can a chemical equation allow one to quantitatively predict the amounts of products or reactants in a reaction? ● What type of evidence could we use to demonstrate that matter and energy are conserved when substances react?
EU 2 modeling is useful in explaining and communicating particle-level interactions and macroscopic properties of substances.	*EU 2* ● How do we study the different ways in which atoms and molecules interact when we cannot see them? ● What is the best way to communicate knowledge about atoms and molecules that is gathered from experiments?
EU 3 chemists analyze data to find patterns in order to predict how chemicals will react.	*EU 3* ● What are the patterns that we observe when we combine atoms and molecules? ● How can we use data and information from the periodic table, activity series, etc. to predict the outcome of a reaction?

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<td>EU 4
the rates of reactions and their degree of equilibrium can help determine their usefulness in the world.</td>
<td>EU 4
What advantage would we gain from the ability to manipulate the speed of a reaction and what factors are involved?
How might we manipulate a reaction to produce more of a desired substance?</td>
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<td><u>Knowledge</u>
Students will know . . .

EU 1
substances react to become more stable and lower in energy (PS1.A)
the products of a chemical reaction result from the exchange of valence electrons and the rearrangement of atoms. (PS1.B)
when a physical or chemical change occurs, matter and energy are always conserved (HS-PS1-7).
EU 2
macroscopic observations of reactions are rooted in rearrangements of atoms at the microscopic level and occur in predictable ways. (PS1.B, SEP 2)
EU 3</td>
<td><u>Skills</u>
Students will be able to. . .

EU 1
model a reaction on the molecular level (SEP 2)
interpret an energy diagram or use bond energy data to support Law of Conservation of Energy (HS-PS1-4)
use data to support the Law of Conservation of Mass (HS-PS1-7)
predict the amount of product formed in a chemical reaction and then conduct an investigation to test these calculations (HS-PS1-7, SEP 5)
EU 2
generate questions about physical and chemical properties, reactions, and other observations to clarify or refine models of reactions. (SEP 1, 2)
EU 3</td>
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- the periodic table can provide useful information about the reactivity of substances based on their position and relationship to one another on the table (PS1.A) - other data, such as an activity series or a solubility chart can be useful in predicting whether a reaction will occur and what substances are involved in the transformation.(PS1.B) *EU 4* - the balance between a reaction and the reverse reaction determines the numbers of all types of molecules present (PS1.B) - changes in experimental conditions (temp., pressure, concentration) can be utilized to produce more molecules of a particular substance as needed. (PS1.B) - manipulation of experimental conditions that change the amount of collisions or force of collisions can be used to speed up or slow down a chemical reaction for a particular purpose.(PS1.B)	- use the periodic table and other data to predict results of chemical reactions. (PS1.C, SEP 2) *EU 4* - apply scientific principles and evidence to explain how the rate of a reaction can be controlled or changed. This can be applied to a real-world goal (preserving food, increasing the absorption of pharmaceuticals, etc.) (HS-PS1-5) - refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. (HS-PS1-6)

Stage Two - Assessment

<u>Other Evidence:</u>

- *Student-created models of reactions that create new substances*
- *Quizzes/ Tests on:*
    - *Writing and balancing equations as well as modeling the reaction on the microscopic level*
    - *Moles and Stoichiometric calculations*
    - *Oxidation numbers and reactivity patterns*
    - *Manipulating equilibrium of reversible reactions*
- *Student responses to the various iterations of models*
- *Evaluation of claims, evidence and reasoning in explanations of phenomena and of lab results*
- *Lab reports and student answers to lab-related questions*

Stage Three - Instruction

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: 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.**

***Bolded activities are hyperlinked to a resource folder.**

Unit 3: Reactions

How do we know a reaction has occurred? What important reactions take place around us? Why do things react?

Unit Phenomenon: **Elephant Toothpaste Demonstration**

1. Generate questions (M, EU2):
   - After being presented with the phenomenon, students individually develop questions "What do you know? What do you wonder?" (SEP)
2. Small groups - (M, EU2)
   - What do you think? What is happening?
   - Draw a model to represent your thinking.
   - What kind of information would you need in order to test your initial model?
3. Explore: Students conduct experiments or teacher demos experiments of physical and chemical changes. (A/M, EU2, EU1)
   - Discussion: What is physical change and what is chemical change? How do we know? What indicates a chemical reaction has occurred? (A/M)
   - Cooking connections:
     i. Students watch a video of a cooking demonstration and identify all the changes as physical or chemical (M/T) (https://www.youtube.com/watch?v=CHbrXX23cto)
     ii. Chemistry of Baking Cookies Article (M) https://www.thoughtco.com/chemistry-baking-cookies-4140220
4. **Baggie Chemistry Mini-lab** (M/T, EU1, EU2, EU3)
5. Phenomena: Burning of Steel Wool (EU1) https://www.youtube.com/watch?v=TsnLmgWXw-E&feature=youtu.be
   - Think/Pair/Share: Explain using Law of Conservation of Mass (A/M)
6. Molecular Level diagrams: what happens in a chemical reaction? (EU2, EU3)

- Students investigate simple chemical reactions and practice diagramming basic processes (rusting, patina formation, combustion, etc.) (M/T)
- Revisit original model and revise based upon new information; revise, amend or include more details. (M)

7. Teacher-led discussion on symbols and chemical equations (A, EU1)
8. Balancing Reactions POGIL (A/M, EU1)
9. Online Balancing Equations Practice (A/M, EU1) http://funbasedlearning.com/chemistry/chemBalancer/default.htm
10. Chemical Evidence: How do we know what forms? (EU2, EU3)
    - **Phenomena: Candle Snuffer**
    - Students conduct experiments with gas tests for O_2, H_2, CO_2 (M)
    - **ChemMatters: The Hindenberg** (M/T)
    - Teacher-led discussion of characteristic colors, solubility charts, etc. (A)
    - Revisit original models and amend, revise based on new information (T)
11. Reaction Patterns Exploration: Students conduct experiments or teacher demos experiments of different patterns of chemical reactions (T, EU3, EU2)
    - Teacher-led discussion of chemical reaction patterns (Honors may choose to predict products, but other levels should focus mainly on recognizing different patterns).
    - **Reaction Types Lab with Gas Tests (T)**
    - **Double or Single Replacement Reaction Lab (T)**
12. Reaction Rates (EU4)
    - Phenomenon: **Sudsy Kinetics** (Repeat Elephant Toothpaste with 3%, 10%, and 30% hydrogen peroxide)
        i. Revisit Elephant toothpaste, but now from a kinetic perspective. Pose question: How will different concentrations of hydrogen peroxide affect the reaction and why? (M/T)
    - Ted Ed Video on Factors Affecting Reaction Rates https://www.youtube.com/watch?v=OttRV5ykP7A (M/A)
    - Teacher demos of rates examples: Mg in 1.0M vs. 6.0M HCl, Alka-seltzer in water (whole vs. smashed up, in Erlenmeyer with balloons), H_2O_2 with MnO_2 (M)
    - Think-Pair-Share: Fill in chart with reaction, prediction, observations, and explanation (A/M)
    - Iodine Clock Reaction Demo (optional) (M/T)
    - **Chem Matters Article: Sugar, An Unusual Explosive** (M)
    - Revisit original models and amend, revise based on new information (T)
13. Quantifying reactions: Brainstorm: How do we measure quantities for reactions?

14. Revisit the mole to mass connection from Unit 2 (EU1)
    - Mole Conversion Practice Worksheet (grams, liters, molecules) (M/T)
15. Stoichiometry Phenomena: More does not always make more (EU1) (M)
    https://thewonderofscience.com/phenomenon/2017/10/8/ps1-matter-and-its-interactions

16. Stoichiometry conversion practice (grams, moles, molecules, liters) (A)
17. **Real World Stoichiometry Dilemma Activity** (complete activity in small groups) (T, EU1)
18. POGIL What Happens if I Run Out of Ingredients (Reactants) (T, EU1)
    - **Cookie Stoichiometry Activity** (M)
    - **S'mores Stoichiomtry Activity** (A/M)
19. Teacher-guided problem-solving: Limiting Reagents (A/M, EU1, EU2)
20. Limiting Reagent/Excess Reagent Practice (M/T, EU1)
21. **Target Mole Lab Activity** or Copper (II) sulfate and Magnesium reaction Lab (T, EU1)
    - Students conduct a lab in which they measure out all reactants, conduct the experiment, separate and weigh products and then calculate theoretical, actual, and percent yield and evaluate data.
22. Revisit original models and amend, revise based on new information (T)
    - Discuss: What did we learn about the elephant toothpaste reaction and how can we control/use this information to design a reaction, predict products and apply to solve a problem?