MYP/3D Science Unit Planner

Marietta City Schools

Grade & Course: 9-12 Chemistry	**Topic:** Reactions and Stoichiometry	**Duration:** 9 weeks

Georgia Standards and Content:

SC3. Obtain, evaluate, and communicate information about how the Law of Conservation of Matter is used to determine chemical composition in compounds and chemical reactions.

a. Use mathematics and computational thinking to balance chemical reactions (i.e., synthesis, decomposition, single replacement, double replacement, and combustion) and construct 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.

b. Plan and carry out an investigation to determine that a new chemical has been formed by identifying indicators of a chemical reaction (e.g., precipitate formation, gas evolution, color change, water production, and changes in energy to the system).

c. Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate • percent composition

- empirical/molecular formulas
- mass, moles, and molecules relationships
- molar volumes of gases

d. Use mathematics and computational thinking to identify and solve different types of reaction stoichiometry problems (i.e., mass to moles, mass to mass, moles to moles, and percent yield) using significant figures. (Clarification statement: For elements c and d emphasis is on use of mole ratios to compare quantities of reactants or products and on assessing students' use of mathematical thinking and not on memorization and rote application of problem-solving techniques.)

e. Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.

Narrative / Background Information

Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)

S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.

f. Construct an explanation based on evidence to describe conservation of matter in a chemical reaction including the resulting differences between products and reactants. (Clarification statement: Evidence could include models such as balanced chemical equations

Year-Long Anchoring Phenomena: (LEARNING PROCESS)

Changes to the measurement of chemicals added to Flint Michigan's water supply created dangerous levels of lead contamination in the drinking water.

Unit Phenomena (LEARNING PROCESS)

Airbags utilize the chemical decomposition of sodium azide (NaN3) which breaks down into elemental sodium (Na) and nitrogen gas (N2). Using the correct amount of sodium azide is important so that the airbag inflates to the correct volume due to the production of the correct volume of nitrogen gas which can be calculated using stoichiometry.

–OR–

In baking, precise measurement of ingredients is crucial. By understanding that matter is conserved, bakers ensure that all ingredients (matter) are accounted for, leading to consistent results.

MYP Inquiry Statement:

Mass is preserved in chemical reactions and provides a tool to predict and understand the quantity of reactants and products in a given reaction.

MYP Global Context:

Globalization and Sustainability

Approaches to Learning Skills:	**Disciplinary Core Ideas: (KNOWLEDGE & SKILLS)**	**Crosscutting Concepts: (KNOWLEDGE & SKILLS)**
• Communication skills • Social skills • Self Management skills • Research skills • Thinking skills	• Chemical Reactions • Parts of a Chemical Reaction • Indicators of a Reaction • Types of Reactions	Systems and System Models Stability and Change Scale, Proportion, and Quantity

	• Chemical Equations • Mole Conversions • Significant Figures	**MYP Key and Related Concepts:** Key Concept: System, Change Related Change: Patterns, Form, Consequences, Interaction

Possible Preconceptions/Misconceptions: (REFLECTION – PRIOR TO TEACHING THE UNIT)

- Matter can be created or destroyed in chemical reactions.
- Mass changes in open systems.
- Atoms change into other types of atoms during chemical reactions.
- Balanced equations mean that the reactants and products are identical.
- Mass is lost during phase changes.
- Coefficients in chemical equations indicate the mass of substances.

Key Vocabulary: (KNOWLEDGE & SKILLS)

- Law of Conservation of Matter
- Single Replacement (Displacement)
- Percent Composition
- Chemical Reaction
- Double Replacement (Displacement)
- Empirical Formula
- Reactant
- Combustion
- Molecular Formula
- Product
- Precipitate
- Stoichiometry
- Synthesis
- Mole
- Significant Figures
- Decomposition
- Avogadro's Number
- Mole Ratio
- Theoretical Yield
- Coefficient
- Subscript
- Limiting Reactant
- Excess Reactant
- Percent Yield

Inquiry Questions:

Factual -
What is the Law of Conservation of Matter, and how does it apply to chemical reactions?
What is the role of energy changes (e.g., heat, light) in identifying a chemical reaction?
How is Avogadro's number used to convert between moles and molecules?

Conceptual -
Why is it important to use mole ratios in stoichiometric calculations, and how do these ratios relate to the Law of Conservation of Matter?
What are the implications of a reaction having an excess of one reactant, and how does it affect the outcome of the reaction?

Debatable -
Should the Law of Conservation of Matter be considered an absolute rule in chemistry, or are there exceptions in modern physics (such as in nuclear reactions)?
Can energy changes in a reaction be considered a reliable indicator of a chemical reaction, given that some physical changes also involve energy changes (e.g., phase changes)?

Unit Objectives:

Learning Activities and Experiences	Inquiry & Obtain: (LEARNING PROCESS)	Evaluate: (LEARNING PROCESS)	Communicate: (LEARNING PROCESS)
Week 1:	**Engage** *The Law of Conservation of Matter* ● a video or demonstration of a chemical reaction of burning a candle. **Explore** ● a hands-on activity where they measure the mass of reactants before and after a chemical reaction of vinegar and baking soda in a sealed bag.	**Evaluate** Formative: Exit ticket: explain the Law of Conservation of Matter and how it applies to one of the reactions: (a) rusting of iron, (b) combustion of fuels	**Explain** Explaining the Law of Conservation of Matter ● Students research real-world examples (e.g., rusting of iron, combustion of fuels) and explain how the law applies in these contexts. ● Students will work in pairs to create posters based on their research.
Week 2:	**Engage** *Chemical Reaction Indicators* ● Show a brief time-lapse video of iron rusting or a reaction that produces color change. ● What evidence can we use to know that a chemical reaction occurred? **Explore** ● Chemical Reaction Stations.	**Evaluate** Formative: Students design their own investigation to test for indicators of a chemical reaction	**Explain** ● Review the indicators of a chemical reaction: precipitate formation, gas evolution, color change, temperature change, and energy production.
Week 3:	**Engage** *Types of Chemical Reactions* ● Show a video montage or live demonstrations of different types of chemical reactions. ● How do these reactions differ from one another? ● What are some similarities you noticed? **Explore** ● Stations for each type of reaction. ● Students rotate through each station,	**Evaluate** Formative: Which type of reaction do you think is the most important in everyday life and why?	**Explain** ● Explain the five types of chemical reactions in detail, emphasizing the reactants and products involved in each reaction:

<table>
<tr><td></td><td>performing the reactions and recording observations. They should note evidence of each type of reaction</td><td></td><td></td></tr>
<tr><td>Week 4:</td><td>Engage
Mole Relationships
What do you think is bigger: one mole of atoms or one dozen eggs?
Why do we use the mole as a counting unit in chemistry
Explore
Using beans or marbles, to calculate the number of particles in a given sample using Avogadro's number</td><td>Evaluate
Formative: students calculate how many water molecules in a drop of water and how many sodium ions in a pinch of salt.</td><td>Explain
Explaining
Avogadro's number and how it relates to the mole. Show students how to use the formula to calculate the number of particles.
Walk through a sample calculation with students.
Students revise their answers for the Explore activity.</td></tr>
<tr><td>Week 5:</td><td>Engage
Formulas
Display a common household item such as table salt, sugar.
What do these everyday items have in common, and how can we represent their composition with a formula?
Explore
Students will build these compounds (H_2O, CO_2, and NaCl) and record their chemical formulas based on the atoms they used.</td><td>Evaluate
Formative: Give students the following compounds (methane (CH_4), sulfuric acid (H_2SO_4), and glucose ($C_6H_{12}O_6$) and have them write the chemical formulas.</td><td>Explain
Explaining the differences in the following types of formulas
Formulas
Percent Composition
Empirical Formula
Molecular Formula</td></tr>
<tr><td>Week 6:</td><td>Engage
Significant Figures
Mystery Numbers: Write several numbers on the board (e.g., 0.00456, 1200, 3.00, 500.0). Ask students to guess how many significant figures each number contains.
Lead a discussion:</td><td>Evaluate
Formative:
Divide students into small groups and assign each group a real-world scenario where significant figures are critical (e.g., pharmaceuticals, environmental science). Have them</td><td>Explain
Continue from Explore activity —After measurements, have students share their findings. Discuss any discrepancies in their measurements and how significant figures play a role in expressing precision.
Define significant figures and explain the rules for determining them:</td></tr>
</table>

	○ What factors did you consider when counting significant figures?" ○ "Why do you think significant figures are important in scientific measurements? **Explore** ● Hands-On Activity: Measurement Stations: ● Set up stations around the classroom with different measurement tools (rulers, graduated cylinders, scales). ● Have students measure various objects and record their measurements, emphasizing how to identify significant figures in their results.	prepare a short presentation on the importance of significant figures in that context ● Administer a short quiz with questions on identifying significant figures in given numbers, performing calculations with significant figures, and applying the rules learned in class.	○ Non-zero digits are always significant. ○ Any zeros between significant digits are significant. ○ Leading zeros are not significant. ○ Trailing zeros in a number with a decimal are significant. ○ Trailing zeros in a whole number without a decimal point are not significant. ● Provide examples of each rule and demonstrate how to identify significant figures in different contexts.
Week 7:	**Engage** *Moles Ratios* Present students with a basic cooking recipes ● Why do you think it's important to follow these ratios when cooking? ● How might this idea of ratios apply to chemical reactions? **Explore** ● Provide students with colored fuzzy balls (e.g., red for hydrogen, blue for oxygen) to model the reaction ● Have students physically combine the balls to represent the formation of water, reinforcing the mole ratio of 2:1:2 (reactants to	**Evaluate** Formative: ● Students will research a real-world chemical reaction (like combustion or fermentation) and present how mole ratios are applied in that context, emphasizing industrial or laboratory significance. ● Exit Ticket:Students will write a brief explanation of what mole ratios are, including an example from today's lesson.	**Explain** ● Explain what mole ratios are and how they are derived from balanced chemical equations. ● Discuss the significance of mole ratios in predicting product amounts and reactant needs. ● Present examples of balanced equations and identify the mole ratios.

	products). • Prepare cards with different chemical formulas (e.g., • O,NaCl) and their respective balanced equations. • Students work in pairs to match the formulas with the correct mole ratios based on the balanced equations.		
Week 8	**Engage** *Reaction Stoichiometry* • Present a real-life scenario such as baking cookies, where each ingredient must be in a specific ratio. • If you want to bake twice the number of cookies, how would you adjust the amount of ingredients? How does this relate to chemical reactions? **Explore** • Students will explore different balanced chemical equations. Using these equations, students will calculate the mass of the product that will be produced, the number of moles, the mass of the substance using its molar mass, and the theoretical yield of the product and compare it to the actual yield to find the percent yield.	**Evaluate** Formative:Calculating the following: - Moles to Moles - Mass to Moles - Moles to Mass - Mass to Mass - Percent Yield	**Explain** Explaining and modeling how to calculate: • Moles to Moles • Mass to Moles • Moles to Mass • Mass to Mass • Percent Yield
Week 9	**Engage** *Limiting Reactants* Present a simple analogy: making sandwiches. Display images of bread slices and sandwich ingredients, such as cheese and ham. Tell the class they have 10 slices of bread, 4 slices of cheese, and 5 slices of ham. • If each sandwich requires 2 slices of	**Evaluate** Formative:Group Problem-Solving: Divide students into small groups and provide each group with a different balanced chemical equation along with the initial quantities of reactants. • Combustion of Propane: • Given: 50 grams of	**Explain** • What happened to the amount of gas produced as more baking soda was added? • Why did the reaction stop even though you added more baking soda? • Define Limiting Reactant: The reactant that is completely consumed in a reaction, limiting the amount

	bread, 1 slice of cheese, and 1 slice of ham, how many sandwiches can we make? What ingredient runs out first? • In a chemical reaction, how do we figure out which reactant runs out first and stops the reaction from continuing? **Explore** • Have students conduct an experiment: Add different amounts of baking soda (in grams) to the same amount of vinegar in test tubes, then cover the test tubes with a balloon to capture the gas produced.	propane (C_3H_8) and 200 grams of oxygen (O_2). • Formation of Ammonia: • Given: 20 grams of nitrogen (N_2) and 10 grams of hydrogen (H_2).	of product formed. • Define Excess Reactant: The reactant that remains after the limiting reactant is used up. • Go over the steps to identify the limiting reactant in a reaction: • Write a balanced chemical equation. • Convert the masses of reactants to moles. • Use mole ratios to determine which reactant will be completely consumed first (the limiting reactant).

Resources (hyperlink to model lessons and/or resources):
Discovery Education Science Techbook (See Above)

Reflection: Considering the planning, process and impact of the inquiry

Prior to teaching the unit	During teaching	After teaching the unit