

<b>Grade &amp; Course:</b> 9-12 Chemistry		<b>Topic:</b> Reactions and Stoichiometry	<b>Duration:</b> 9 weeks
<p><b>Georgia Standards and Content:</b>  <b>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.</b>  <b>a.</b> 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>b.</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).  <b>c.</b> Use mathematics and computational thinking to apply concepts of the mole and Avogadro's number to conceptualize and calculate <ul style="list-style-type: none"> <li>percent composition</li> <li>empirical/molecular formulas</li> <li>mass, moles, and molecules relationships</li> <li>molar volumes of gases</li> </ul> <b>d.</b> 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.)  <b>e.</b> Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.</p>			
<b>Narrative / Background Information</b>			
<p><b>Prior Student Knowledge: (REFLECTION – PRIOR TO TEACHING THE UNIT)</b>  <b>S8P1. Obtain, evaluate, and communicate information about the structure and properties of matter.</b>  <b>f.</b> 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</p>			
<p><b>Year-Long Anchoring Phenomena: (LEARNING PROCESS)</b>  Changes to the measurement of chemicals added to Flint Michigan's water supply created dangerous levels of lead contamination in the drinking water.</p>			
<p><b>Unit Phenomenon (LEARNING PROCESS)</b>  Airbags utilize the chemical decomposition of sodium azide (<math>\text{NaN}_3</math>) which breaks down into elemental sodium (Na) and nitrogen gas (<math>\text{N}_2</math>).</p>			
<p><b>MYP Inquiry Statement:</b>  Conservation principles help predict and explain change.</p>			
<p><b>MYP Global Context:</b>  Personal and Cultural Expression</p>			
<p><b>Approaches to Learning Skills:</b></p> <ul style="list-style-type: none"> <li>Self Management skills: Managing state of mind</li> <li>Thinking skills: Practise observing carefully in order to recognize problems</li> </ul>	<p><b>Disciplinary Core Ideas: (KNOWLEDGE &amp; SKILLS)</b></p> <ul style="list-style-type: none"> <li>Chemical Reactions</li> <li>Parts of a Chemical Reaction</li> <li>Indicators of a Reaction</li> <li>Types of Reactions <ul style="list-style-type: none"> <li>Synthesis</li> <li>Decomposition</li> <li>Single Replacement</li> <li>Double Replacement</li> </ul> </li> </ul>	<p><b>Crosscutting Concepts: (KNOWLEDGE &amp; SKILLS)</b></p> <ul style="list-style-type: none"> <li>Systems and System Models</li> <li>Stability and Change</li> <li>Scale, Proportion, and Quantity</li> </ul>	<p><b>MYP Key and Related Concepts:</b></p> <ul style="list-style-type: none"> <li>Key Concepts: Systems, Change</li> <li>Related Concepts: Models, Balance,</li> </ul>

	<ul style="list-style-type: none"> <li>• Combustion</li> <li>● Chemical Equations <ul style="list-style-type: none"> <li>• Law of Conservation</li> <li>• Balancing Equations</li> <li>• Reaction Stoichiometry</li> <li>• Limiting Reactants</li> <li>• Excess Reactant</li> </ul> </li> <li>● Mole Conversions <ul style="list-style-type: none"> <li>• Moles to Moles</li> <li>• Mass to Moles</li> <li>• Moles to Mass</li> <li>• Mass to Mass</li> <li>• Molar Volume</li> <li>• Mole Ratio</li> <li>• Percent Yield</li> <li>• Percent Composition</li> <li>• Empirical Formulas</li> <li>• Molecular Formulas</li> </ul> </li> <li>● Significant Figures</li> </ul>	Interaction, Transfer
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**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)?

MYP Objectives		Summative assessment	
<ul style="list-style-type: none"> <li>• MYP Criterion C (iv): evaluate the validity of the method</li> </ul>		Relationship between summative assessment task(s) and statement of inquiry: Students will perform tasks and respond to assessment items that will gauge their mastery of reactions and stoichiometry as required by the Georgia Standards of Excellence. Mastery of these concepts is necessary to move forward in our study of chemistry.	
Learning Activities and Experiences	Inquiry & Obtain: (LEARNING PROCESS)	Evaluate: (LEARNING PROCESS)	Communicate: (LEARNING PROCESS)
<b>Weeks 1 to 2:</b> <b>Georgia Standard(s) of Excellence:</b> SC3(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, and molar volumes of gases.			
<b>Lesson 1</b> <b>(Moles and Avogadro)</b>  SC3(c)	Engage - compare dozen and similar units to the concept of a mole  Explore - concept of a mole, converting between number of particles (atoms/molecules/formula units) and moles	Explain - practice with mole-particle conversions  Elaborate - derivation of Avogadro's number	Evaluate - Ticket out the Door or similar (mole-particle conversions)
<b>Lesson 2</b> <b>(Molar Mass and Molar Volume)</b>  SC3(c)	Engage - connect concept of mole to mass and volume  Explore - calculating molar mass  Explore - mole conversions involving molar mass, molar volume, and particles	Explain - practice with all types of mole conversions  Elaborate - mixing units (more advanced dimensional analysis)	Evaluate - Ticket out the Door or similar (mole-mass, mole-volume, and mole-particle conversions)
<b>Lesson 3</b> <b>(Percent Composition)</b>  SC3(c)	Engage - how to visualize and quantify composition of a mixture (for example, Chex mix)  Explore - calculating percent	Explain - practice with percent composition calculations  Elaborate - combustion analysis	Evaluate - Ticket out the Door or similar (percent composition calculations)

	composition by mass of a compound		
<b>Lesson 4 (Empirical and Molecular Formulas)</b>  <b>SC3(c)</b>	Engage - importance and significance of different types of chemical formulas  Explore - determining empirical formula from percent composition by mass  Explore - determining molecular formula from empirical formula and molecular mass	Explain - Mole Airlines group activity (common learning experience)  Explain - practice with empirical and molecular formulas  Elaborate - combustion analysis	Evaluate - CFA Quiz on SC3(c) - Moles and Formulas
<b>Weeks 3 to 6:</b> <b>Georgia Standard(s) of Excellence:</b> SC3(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. SC3(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).			
<b>Lesson 5 (Indicators and Types of Chemical Reactions)</b>  <b>SC3(b)</b>	Engage - introduction to the five types of reactions  Explore - introduction to reactions and their indicators  Explore - five types of reactions (synthesis, decomposition, single replacement, double replacement, and combustion)	Explain - practice with classifying reactions and suggesting indicators of a given reaction description  Elaborate - further exploration of indicators and their causes	Evaluate - Evidence and Types of Reactions Stations Investigation (common learning experience)
<b>Lesson 6 (Balancing Chemical Equations)</b>  <b>SC3(a)</b>	Engage - what is a balanced equation? (PhET simulation)  Explore - writing and balancing chemical reactions using computational thinking	Explain - practice with balancing chemical equations  Elaborate - complex examples including combustion	Evaluate - Ticket out the Door or similar (balancing)
<b>Lesson 7 (Predicting Products)</b>  <b>SC3(a)</b>	Engage - revisit patterns from the five types of reactions  Explore - predicting products of the five types of reactions, including use of activity series info (graphic organizer)	Explain - practice predicting products and then balancing the overall equation  Elaborate - solubility rules for double replacement reactions	Evaluate - CFA Quiz on SC3(a) and SC3(b) - Reactions  <b>Evaluate - CSA Test on Moles and Reactions ("UNIT 3A")</b>
<b>Weeks 7 to 9:</b> <b>Georgia Standard(s) of Excellence:</b> SC3(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. SC3(e) - Plan and carry out an investigation to demonstrate the conceptual principle of limiting reactants.			
<b>Lesson 8 (Significant Figures and Mole Ratios)</b>  <b>SC3(d)</b>	Engage - introduction to concepts of ratios and limiting reactants using Cookie Chemistry (common)  Explore - significant figures and their use in basic arithmetic	Explain - practice counting and using significant figures  Elaborate - significant figures in other operations	Evaluate - Ticket out the Door or similar

<b>Lesson 9 (Reaction Stoichiometry - Mole-Mole and Mole Mass)</b>  <b>SC3(d)</b>	Engage - mole ratios and defining stoichiometry  Explore - mole-mole reaction stoichiometry, then mole-mass & mass-mole using the Gradual Release of Responsibility model	Explain/Elaborate - practice with mole-mole, mole-mass, and mass-mole reaction stoichiometry problems	Evaluate - Ticket out the Door or similar
<b>Lesson 10 (Reaction Stoichiometry - Mass-Mass)</b>  <b>SC3(d)</b>	Engage - recap of reaction stoichiometry utilizing the Unit Phenomenon of airbags  Explore - mass-mass reaction stoichiometry using the Gradual Release of Responsibility model	Explain/Elaborate - practice with mass-mass reaction stoichiometry problems	Evaluate - Ticket out the Door or similar  Evaluate - CFA Quiz on SC3(d) - Reaction Stoichiometry
<b>Lesson 11 (Limiting Reactants)</b>  <b>SC3(e)</b>	Engage - balloon exploration demo (vinegar and baking soda) (common opener)  Explore - limiting reactant concepts	Explain - practice with limiting reactants  Elaborate - limiting reactant calculations and percentage yield	Evaluate - S'more Stoichiometry Activity (common learning experience)  <b>Evaluate - CSA Test on Stoichiometry ("UNIT 3B")</b>

**Resources (hyperlink to model lessons and/or resources):**

Discovery Education Science Techbook

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

Prior to teaching the unit	During teaching	After teaching the unit