Unit 6 Patterns Chemistry - Stoichiometry

Unit 6: Stoichiometry - approx. 750 minutes or 8.5 class periods (90 minutes each)

Unit Resources

Unit walk through Unit 6 INB Vocabulary Unit 6 Printable Packet Rubrics Unit 6 Webinar	Whiteboard Meetings Teacher Notes CER Resource Posters + useful slides for classroom setup Links to Instructional Materials for All Unit 6 Tasks [English, Spanish, WCAG]

Stoichiometry - Uses mathematics and computational thinking to show that atoms and mass are conserved during chemical reactions.

Anchoring Phenomenon: Stoichiometry is used for chemical reactions and processes across many different industries (vehicle manufacturing and use, agriculture, rocketry, healthcare, culinary, etc.) in order to maximize products and minimize the waste of excess reactants.

Unit Essential Question: How can we calculate the exact amounts of reactants and products with no waste in a chemical reaction?

NGSS Performance Expectations with links to evidence statements

HS-PS1-7

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. [Clarification Statement: Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale.]

Practices: Mathematics and Computational Thinking **Crosscutting Concepts: Energy and Matter** **Disciplinary Core Ideas: Chemical Reactions**
Social, Emotional, Learning tip: Hey teachers! Consider building some positive classroom culture and community using these low stakes talk scripts.

Task Set # (Days)	Essential Question & Activities	Practice & Extension	SEPs CCCs DCIs	Evidence of Student Learning/ Assessment
Engage				
1 (30 mins)	**EQ:** Why do we do stoichiometry? **Phenomenon:** Different ratios of reactants can cause different outcomes. TS 1 Teacher notes Unit Opener (slides, template)		**SEP:** Use Mathematics and Computational Thinking. **CCC:** Energy and Matter **DCI:** Conservation of Mass	Student talk/sticky notes
Explore and Explain				
2 (180 mins)	**EQ:** How do we count atoms? **Phenomenon**: There are many different atoms in a car, we can count them by using the mole. TS 2 Teacher Notes • Mole Conversion Inquiry Lab (slides, template) • Practice problems "How many atoms in the car?" worksheet	Molar Mass Practice Problems (KEY) Mole Conversion Practice Problems (KEY)	**SEP:** Mathematical and Computational Thinking **CCC:** Energy and Matter **DCI:** Structure and Properties of Matter Chemical Reactions	Mole conversion worksheet Mole Conversion Inquiry Lab Template

3 (180 mins)	**EQ:** What is the ratio between compounds in a chemical reaction? **Phenomenon**: A chemical reaction has the best mole ratio between compounds. TS 3 Teacher notes • Mole Ratio Lab (slides, template) • Practice problems on mole ratio conversions	Mole Ratio Practice Mole Ratio: More Practice	**SEP:** Mathematical and Computational Thinking, Analyze and Interpret Data, Construct Explanations, Engage in Argument from Evidence **CCC:** Patterns and Scale, Proportions, Quantity **DCI:** Chemical Reactions, Mole Ratios	Lab template/ conclusion

4
 	
(180 mins)
	EQ: How do scientists determine how much reactant or product will be needed or made by a chemical reaction?
	
	Phenomenon: Calculating the exact amount of reactants and products needed for a reaction, maximizes the amount of product while eliminating waste.
	
	TS 4 Teacher notes
	
	• Stoichiometry
	  ○ Stoichiometry Slides
	  ○ Stoichiometry Intro Practice - digital or paper (KEY)
	  ○ Vehicle Stoichiometry Practice Problems - (KEY)
		Beginning Practice: Stoichiometry S'mores
		
		Additional Practice: AACT Chemical Reactions and Stoichiometry,
		
		Pollutants Stoichiometry Practice
		
		Challenge: % yield & Limiting Reactants Problems
		
		Arts Integration - Numberism - Create a picture of a compound or Chemical reaction
			SEP: Mathematical and Computational Thinking
			CCC: Energy and Matter
			DCI: Structure and Properties of Matter Chemical Reactions
				Practice Problems
				
				Formative Quiz (KEY)

		using numbers relevant them ● Presentation (Do slides 1-10; 47-61) ● Teacher Notes		
Elaborate and Evaluate				
5 (180 min)	**EQ:** How can we use chemical reactions to improve car safety? **Phenomenon**: Airbags rapidly fill with a gas **produced** by a controlled chemical reaction to protect the driver and passengers in a car in the event of a crash. Teacher Notes TS5 ● Airbag Engineering Project ● **OR** CK-12 Airbag Reaction Simulation (shorter/remote) End of Unit Exam		**SEP:** Designing Solutions **CCC:** Cause and Effect **DCI:** Chemical Reactions	Engineering Portfolio

Science and Engineering Practice Look Fors:

Practice	Grades 9-12 Science and Engineering Practice "Look Fors"
Practice 1a: Asking Questions	● Ask questions: ○ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. ○ that arise from examining models or a theory, to clarify and/or seek additional information and relationships. ○ to determine relationships, including quantitative relationships, between independent and dependent variables. ○ to clarify and refine a model, an explanation, or an engineering problem. ● Evaluate a question to determine if it is testable and relevant. ● Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory. ● Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability

	of a design
Practice 1b: Defining Problems	• Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical and/or environmental considerations.
Practice 2: Developing and Using Models	• Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria. • Design a test of a model to ascertain its reliability. • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.
Practice 3: Planning and Carrying Out Investigations	• Work as an individual or a team to produce data as evidence to revise models, support explanations or test solutions to problems. Students should consider confounding variables and evaluate design to ensure controls. • Critically analyze design of an experiment to decide the accuracy of data needed to produce reliable measurements and limitations of the data (number of trials, cost, risk, time etc.) • Select appropriate tools to collect, record, analyze and evaluate data. • Make directional hypotheses about dependent and independent variable relationships.
Practice 4: Analyzing and Interpreting Data	• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. • Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data. • Compare and contrast various types of data sets (e.g., self generated, archival) to examine consistency of measurements and observations. • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.
Practice 5: Using	• Create and/or revise a computational model or simulation of a phenomenon, designed device, process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world

Mathematics and Computational Thinking	● Use mathematical, computational, and/or algorithmic representation of phenomena or design solutions to describe and/or support claims and/or explanations. ● Apply techniques of algebra and functions to represent and solve scientific and engineering problems. For example, apply ratios, rates, percentages and unit conversions to problems involving quantities with derived or compound units.
Practice 6a: Constructing Explanations and Designing Solutions	● Make a claim regarding the relationship between independent and dependent variables. ● Construct and revise an explanation based on reliable and varied evidence to describe the natural world and its laws. ● Apply scientific ideas, principles and/or evidence to explain phenomena and solve design problems, taking into account possible unanticipated effects. ● Apply scientific reasoning to link evidence to claims and assess the extent to which the reasoning and data support the conclusion.
Practice 6b: Designing Solutions	● Design, evaluate and/or refine a solution to a complex real-world problem, based on scientific knowledge, evidence, criteria and tradeoff considerations.
Practice 7: Engaging in Argument from Evidence	● Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations, constraints, and ethical issues to determine the merits of arguments. ● Respectfully provide and/or recieve critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. ● Construct, use, and/or present oral and written claims and arguments or counter-arguments based on data and evidence about the natural world or effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. ● Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (economic, societal, environmental, ethical considerations).
Practice 8: Obtaining, Evaluating, and Communicating Information	● Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms. ● Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem. ● Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source. Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible. ● Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and

	mathematically).

Other Unit Resources