NGSS UNIT OVERVIEW

CHEMICAL REACTIONS

Performance Expectation MS-PS1-2: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Performance Expectation MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Performance Expectation MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Performance Expectation MS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Performance Expectation MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
1. **Investigation: Producing Circuit Boards** Students analyze and interpret data to compare the initial and final substances when a copper-coated circuit board is etched. This begins a series of activities that reveal patterns of changes indicating that chemical reactions have taken place.	MS-PS1.A MS-PS1.B	Analyzing and Interpreting Data Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns	ELA/Literacy: RST.6-8.1 RST.6-8.9
2. **Laboratory: Evidence of Chemical Change** Students carry out an investigation and analyze the results to identify evidence that may indicate that a chemical change has taken place. In later activities, the patterns they observe at the macroscopic level will be explained in terms of changes at the atomic/molecular level.	MS-PS1.A MS-PS1.B	Planning and Carrying Out Investigations Analyzing and Interpreting Data Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns	ELA/Literacy: RST.6-8.3
3. **Reading: Physical Changes and Chemical Reactions** Students read about observable (macroscopic) and atomic/molecular-level patterns of changes in physical and chemical properties and how they can be signs of chemical reactions. They also read about how to use logical reasoning to avoid mistaking physical changes for chemical changes. They integrate ideas in the reading with their observations of chemical changes in the previous investigation, and analyze and interpret several examples to determine whether a change is physical or chemical.	MS-PS1.A MS-PS1.B	Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns	ELA/Literacy: RST.6-8.1 RST.6-8.4 RST.6-8.7 WH.6-8.9

CHEMICAL REACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
4. **Modeling: Chemical Reactions at the Molecular Scale** Students use molecular models to explore the kinds and numbers of each kind of atom, as well as the arrangements of atoms, in the reactants and products of several chemical reactions. The patterns they observe demonstrate the concept of conservation of atoms in chemical reactions, as well as the relationship between changes at the atomic/molecular scale and changes in the observable properties of substances.	MS-PS1.B	Developing and Using Models Connections to Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	Energy and Matter Scale, Proportion, and Quantity Structure and Function	ELA/Literacy: RST.6-8.3
5. **Talking it Over: Physical or Chemical Change?** Students analyze and interpret information on the observable properties of substances before and after a change to determine whether the change is a physical change or a chemical reaction. This activity provides an assessment opportunity for Performance Expectation MS-PS1-2.	MS-PS1.A MS-PS1.B	Analyzing and Interpreting Data Systems and System Models Connections to Nature of Science: Scientific Knowledge Is Based on Empirical Evidence	Patterns	ELA/Literacy: RST.6-8.1 SL.8.1
6. **Laboratory: Comparing the Masses of Reactants and Products** Students investigate conservation of mass on a macroscopic scale. Students analyze and interpret data from two reactions to determine how the total mass of the products of a chemical reaction compares to the total mass of the reactants.	MS-PS1.B	Analyzing and Interpreting Data Connections to Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	Energy and Matter Systems and System Models Scale, Proportion, and Quantity	ELA/Literacy: RST.6-8.3
7. **Modeling: Explaining Conservation of Mass** Students use a combination of molecular modeling and mathematical computation to describe the atomic/molecular basis for mass conservation in chemical reactions. They are introduced to the law of conservation of mass and the relevance of this law to various natural phenomena. This activity provides an assessment opportunity for Performance Expectation MS-PS1-5.	MS-PS1.B	Developing and Using Models Systems and System Models Connections to the Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	Energy and Matter Systems and System Models Scale, Proportion, and Quantity	

CHEMICAL REACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
8. **Investigation: Chemical Batteries** Students investigate how chemical energy can be transformed via a chemical process into electrical energy. After building a prototype wet cell, students brainstorm improvements and build, test, and evaluate new prototypes to meet a set of predetermined criteria within specified constraints.	MS-PS1.B MS-ETS1.B MS-ETS1.C	Constructing Explanations and Designing Solutions	Energy and Matter	ELA/Literacy: RST.6-8.3
9. **Laboratory: Thermal Energy and Reactions** Students explore chemical reactions that absorb or release thermal energy. Through classroom discussion, students are introduced to the crosscutting concept that energy and matter are conserved but can transfer within a system between reactants, products, and the environment. They are also introduced to the idea that the absorption or release of energy is caused by the rearrangement of atoms during a reaction. Some rearrangements require energy; others release it.	MS-PS1.B MS-PS3.A	Analyzing and Interpreting Data	Energy and Matter	ELA/Literacy: RST.6-8.3
10. **Design: Developing a Prototype** Students undertake a design challenge to construct and test a hand warmer device that uses the thermal energy released from an iron exothermic reaction. When testing their designs, students analyze their results and brainstorm ideas for further modification.	MS-PS1.B MS-ETS1.B MS-ETS1.C MS-PS3.A	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Energy and Matter	
11. **Design: Refining the Design** Students use the thermal energy release from combining iron, calcium chloride, and water to design a hand warmer. Students redesign, construct, test, and evaluate their hand warmer designs from the "Developing a Prototype" activity. A new criterion is introduced— students must consider how to control the start of the chemical reaction in their design modifications. This activity provides an assessment opportunity for Performance Expectation MS-PS1-6.	MS-PS1.B MS-ETS1.B MS-ETS1.C MS-PS3.A	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions	Energy and Matter	

CHEMICAL REACTIONS (continued)

Activity Description	Disciplinary Core Ideas	Science and Engineering Practices	Crosscutting Concepts	Common Core State Standards
12. **Laboratory: Recovering Copper** Students investigate the use of reactions with three metals for reducing copper waste and reclaiming copper from the used copper etching solution produced in the first activity of the unit. Students use data from their investigation and text sources to develop an evidence- based argument for which metal is the best choice for recovering copper from the waste solution.	MS-PS1.A MS-PS1.B	Analyzing and Interpreting Data Planning and Carrying Out Investigations Engaging in Argument from Evidence	Patterns Energy and Matter	ELA/Literacy: WHST.6-8.1
13. **Laboratory: Another Approach to Recovering Copper** Students close the unit by applying what they have learned in previous activities to conduct a final investigation to figure out which precipitation reaction works best to remove copper from wastewater. Students analyze and interpret their data from this activity and previous activities to develop their evidence-based argument for the best choice of reactions.	MS-PS1.A MS-PS1.B	Analyzing and Interpreting Data Planning and Carrying Out Investigations Engaging in Argument from Evidence	Patterns Energy and Matter	ELA/Literacy: WHST.6-8.1