PERFORMANCE EXPECTATION	
MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]	
Disciplinary Core Ideas (DCIs)	
PS3.A: Definitions of Energy ● Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. **PS3.B: Conservation of Energy and Energy Transfer** ● Energy is spontaneously transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation.	● Temperature measures energy levels ● Temperature changes do not equal adding "coldness" or "hotness" ● Particles of matter are always in motion ● States of matter are determined by certain characteristics ● Energy moves and is transferred from high to low (hot to cold) until equilibrium ● Different matter types are going to react to energy changes different (water - specific heat) ● All things are made of matter ● Identify heat - thermal energy ● Total change of energy in a system is always equal to the total energy going in or out.
Science and Engineering Practices (SEPs)	
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ● Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.	**Lesson 5 - Construct an explanation:** ● **Apply ideas and/or evidence to construct revise or use an explanation for phenomena.** **Scaffolds:** **What is a claim and how to answer a claim** **Sentence stems state 2 data points from the data table** **Design that we are testing needs to be around temperature or thermal energy transfer which appears at the end of the 7.2 storyline** ● **Apply scientific ideas or principles to design construct or test a design** ● **Undertake a design project** ● **Optimize performance of a design**

Cross-Cutting Concepts (CCCs)	
Energy and Matter • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).	**Transfer of energy in lessons 1 - 5** **6 - 11 - Add matter. Explain how matter can be transferred in a chemical reaction.**

PERFORMANCE EXPECTATION	
MS-PS1-1 **Develop models to describe the atomic composition of simple molecules and extended structures.** [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [***Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required***.]	
Disciplinary Core Ideas (DCIs)	
PS1.A: Structure and Properties of Matter **Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).**	• All substances are made of Atoms • Different combinations of Atoms makes different Molecules • Molecules can be different sizes but keep the same unique characteristics • Solo structure vs repeating structures *
Science and Engineering Practices (SEPs)	
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. **Develop a model to predict and/or describe**	**Focus using models to describe phenomena of atoms coming together to make simple and extended molecules** **Model used to describe atomic structure and chemical changes**

phenomena.	**The model used is a simulation**
Cross-Cutting Concepts (CCCs)	
Scale, Proportion, and Quantity ● Time, space, and energy **phenomena can be observed at various scales using models to study systems that are too large or too small.**	**Phenomena that can be observed at one scale may not be observable at another scale.** ● **Legos as representation of atoms too small to see**

Evidence Statement:

Observable features of the student performance by the end of the course:				
1	Components of the model			
	a	Students develop models of atomic composition of simple molecules and extended structures that vary in complexity. In the models, students identify the relevant components, including:		
		i.	Individual atoms.	
		ii.	Molecules.	
		iii.	Extended structures with repeating subunits.	
		iv.	Substances (e.g., solids, liquids, and gases at the macro level).	
2	Relationships			
	a	In the model, students describe* relationships between components, including:		
		i.	Individual atoms, from two to thousands, combine to form molecules, which can be made up of the same type or different types of atom.	
		ii.	Some molecules can connect to each other.	
		iii.	In some molecules, the same atoms of different elements repeat; in other molecules, the same atom of a single element repeats.	
3	Connections			
	a	Students use models to describe* that:		
		i.	Pure substances are made up of a bulk quantity of individual atoms or molecules. Each pure substance is made up of one of the following:	
			1.	Individual atoms of the same type that are connected to form extended structures.
			2.	Individual atoms of different types that repeat to form extended structures (e.g., sodium chloride).
			3.	Individual atoms that are not attracted to each other (e.g., helium).
			4.	Molecules of different types of atoms that are not attracted to each other (e.g., carbon dioxide).
			5.	Molecules of different types of atoms that are attracted to each other to form extended structures (e.g., sugar, nylon).
			6.	Molecules of the same type of atom that are not attracted to each other (e.g., oxygen).
		ii.	Students use the models to describe* how the behavior of bulk substances depends on their structures at atomic and molecular levels, which are too small to see.	

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.** [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [*Assessment boundary: Assessment is limited to analysis of the following properties:* ***density, melting point, boiling point, solubility, flammability, and odor.***]	
Disciplinary Core Ideas (DCIs)	
PS1.A: Structure and Properties of Matter **Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.** **PS1.B: Chemical Reactions** **Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.**	● Physical and chemical properties ○ Each pure substance or element has its own characteristic chemical composition ○ Physical properties can help identify ○ Conditions could include liquid, solid, gas or temperature of environment ● Pure substance vs a mixture http://www.middleschoolchemistry.com/lessonplans/chapter5/lesson9 ● Mixing two different things how do I know there was a change - physical or chemical changes ● Substances react chemically in characteristic ways
Science and Engineering Practices (SEPs)	
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● **Analyze and interpret data to determine similarities and differences in findings.**	**Analyze and interpret data to determine similarities and differences in findings.** ● **Used as a way to determine if a chemical change/reaction has occurred** ● **Comparing products to reactants** **Students analyze data on the physical and chemical properties of the different white powders** **Students analyze their own data from mixing the white powders (Ammonium Nitrate and Calcium Chloride) to determine a chemical reaction due to a temperature change after solids and liquids are mixed.** **Design challenge:** **Consider limitations of data analysis (e.g.,**

	measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).
	• **Collecting data to optimize engineering design solution**
	• **Limitations on collecting of data could impact overall design product based on given solution criterion and constraints**
	
	Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.
	• **Optimal range for proposed design solution**
	  ○ **Amount of reactants or products**
	  ○ **Amount of energy released or absorbed**
	  ○ **Characteristics depending on chosen phenomenon**

Cross-Cutting Concepts (CCCs)	
Scale, Proportion, and Quantity • Time, space, and energy **phenomena can be observed at various scales using models to study systems that are too large or too small.** ~~**Energy and Matter**~~ • ~~Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)~~ • ~~The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)~~	**Phenomena that can be observed at one scale may not be observable at another scale.** • **Legos as representation of atoms too small to see** **The transfer of energy can be tracked as energy flows through a designed or natural system.** **Matter is conserved because atoms are conserved in physical and chemical processes.**

Evidence Statement:

Observable features of the student performance by the end of the course:		
1	Organizing data	
	a	Students organize given data about the characteristic physical and chemical properties (e.g., density, melting point, boiling point, solubility, flammability, odor) of pure substances before and after they interact.
	b	Students organize the given data in a way that facilitates analysis and interpretation.
2	Identifying relationships	
	a	Students analyze the data to identify patterns (i.e., similarities and differences), including the changes in physical and chemical properties of each substance before and after the interaction (e.g., before the interaction, a substance burns, while after the interaction, the resulting substance does not burn).
3	Interpreting data	
	a	Students use the analyzed data to determine whether a chemical reaction has occurred.
	b	Students support their interpretation of the data by describing* that the change in properties of substances is related to the rearrangement of atoms in the reactants and products in a chemical reaction (e.g., when a reaction has occurred, atoms from the substances present before the interaction must have been rearranged into new configurations, resulting in the properties of new substances).

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.*** [Clarification Statement: Emphasis is on the design, controlling the transfer of energy of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [*Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*]	
Disciplinary Core Ideas (DCIs)	
PS1.B: Chemical Reactions Some chemical reactions release energy, others store energy.	• Some chemical reactions release energy and some store energy • Understanding of cycling of matter and physical energies depend on physical and chemical processes • Amount, time, and temperature
Science and Engineering Practices (SEPs)	
Constructing Explanations and Designing Solutions **Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.** • **Undertake a design project, engaging in the design cycle, to construct and/or**	**Design criteria and constraints is dependant upon chemical reaction needed for chosen phenomena** **NO CER for designing solutions** **See below for ETS unpacking for what designing a solution entails**

implement a solution that meets specific design criteria and constraints.	
Cross-Cutting Concepts (CCCs)	
<u>Energy and Matter</u> • <u>Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)</u> • <u>The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)</u>	**The transfer of energy can be tracked as energy flows through a designed or natural system.** **Matter is conserved because atoms are conserved in physical and chemical processes.**

Observable features of the student performance by the end of the course:			
1	Using scientific knowledge to generate design solutions		
	a	Given a problem to solve that requires either heating or cooling, students design and construct a solution (i.e., a device). In their designs, students:	
		i.	Identify the components within the system related to the design solution, including:
			1. The components within the system to or from which energy will be transferred to solve the problem.
			2. The chemical reaction(s) and the substances that will be used to either release or absorb thermal energy via the device.
		ii.	Describe* how the transfer of thermal energy between the device and other components within the system will be tracked and used to solve the given problem.
2	Describing* criteria and constraints, including quantification when appropriate		
	a	Students describe* the given criteria, including:	
		i.	Features of the given problem that are to be solved by the device.
		ii.	The absorption or release of thermal energy by the device via a chemical reaction.
	b	Students describe* the given constraints, which may include:	
		i.	Amount and cost of materials.
		ii.	Safety.
		iii.	Amount of time during which the device must function.
3	Evaluating potential solutions		
	a	Students test the solution for its ability to solve the problem via the release or absorption of thermal energy to or from the system.	
	b	Students use the results of their tests to systematically determine how well the design solution meets the criteria and constraints, and which characteristics of the design solution performed the best.	
4	Modifying the design solution		
	a	Students modify the design of the device based on the results of iterative testing, and improve the design relative to the criteria and constraints.	

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

<table>
<tr><th colspan="2">Disciplinary Core Ideas (DCIs)</th></tr>
<tr><td>ETS1.B: Developing Possible Solutions
• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.
• Models of all kinds are important for testing solutions.</td><td>• A solution needs to be tested and then modified to improve the solution
• Tested and solution based on criteria
• Can be combined to make a better solution
• Simulations can be used for making predictions</td></tr>
<tr><td>ETS1.C: Optimizing the Design Solution
• The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.</td><td>• Systematic processes for evaluating solutions
• Comparing different designs could involve running them through the same kinds of tests
• Each test can provide useful information for redesign process and incorporated into new design
• Once solution is determined, important to describe that solution, explain how it was developed, and describe the features that make it successful

Model is used as either component of testing solution or used within the communication of solution
• Model showing chemical reaction as a component of solution communication needed here</td></tr>
<tr><th colspan="2">Science and Engineering Practices (SEPs)</th></tr>
<tr><td>Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
• Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.</td><td>Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
• Done in unit 6.2

Inputs and outputs will be chemical products and reactants</td></tr>
<tr><th colspan="2">Cross-Cutting Concepts (CCCs)</th></tr>
<tr><td>NONE</td><td></td></tr>
</table>