MS-PS1-6 Matter and its Interactions

Students who demonstrate understanding can:

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 to the environment, and modification of a device using factors such as type and concentration 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.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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 implement a solution that meets specific design criteria and constraints.

Disciplinary Core Ideas

PS1.B: Chemical Reactions

- Some chemical reactions release energy, others store energy.

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. *(secondary)*

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary)*
- 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. *(secondary)*

Crosscutting Concepts

Energy and Matter

- The transfer of energy can be tracked as energy flows through a designed or natural system.

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.