3-D Performance Assessment

Performance Expectation: **HS-PS1-4**

Grade Level: **High School**

Title	**Total Bond Energy Change in Chemical Reactions**		
Designed by		Course(s)	**Chemistry**

Performance Expectation	**HS-PS1-4**: Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. **Clarification Statement**: Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved. **Assessment Boundary**: Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.

Science and Engineering Practice	**Developing and Using Models** • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
Disciplinary Core Ideas	**PS1.A: Structure and Properties of Matter** • A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **PS1.B: Chemical Reactions** • Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
Crosscutting Concept	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Student Performance	1. Components of the model 2. Relationships 3. Connections

Performance Assessment

Phenomenon

On Tuesday during a frigid baseball game, the pitcher of the high school team was sitting in the dugout waiting for his turn to pitch again. The coach provided the pitcher with hand warmers which he placed on his throwing arm to keep it warm between innings.

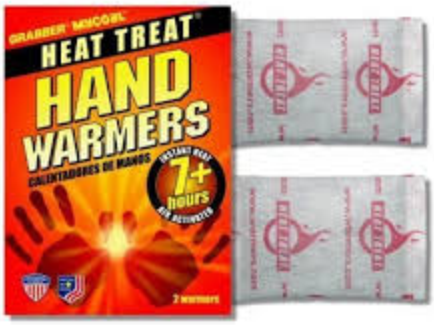
Stimulus

Below is information related to a hand warmer:

Chemical reaction:

$4Fe + 3O_2 \rightarrow 2 Fe_2O_3 + 1648\ kJ$

Hand warmer used and instructions:



Directions for using hand warmer:

- Open outer package and expose packet to air. No shaking necessary. For best results, use Hand Warmer in an enclosed area with air such as a pocket or glove.
- Reaches average temperature of 135 degrees Fahrenheit. Max temperature of 158 degrees Fahrenheit.
- Warmers will heat up immediately when activated, but will take up to 20 minutes to fully activate.
- Warmers usually last about 7 hours

Prompt

From the above situation, develop an energy and matter model that depicts changes that occur during the activation of a hand warmer.

- Identify the components of the system and the surroundings.
- Identify the energy transfer between system and the surroundings.
- Use the relationship established to explain the formation and breaking of bonds to predict the total bond energy change in the chemical reaction.

Assessment Rubric* - Question 1				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance				
Sample student responses				

Assessment Rubric* - Question 2				
	Emerging	Developing	Approaching Proficiency	Excelling
Description of performance				
Sample student responses				

*Assessment rubric adapted from the Stanford NGSS Assessment Project http://snapgse.stanford.edu/

[1]Wiggins, G. P. (1993). Assessing student performance. San Francisco: Jossey-Bass Publishers.