Educational Resources from *Phenomenon Science Education*

Student Proficiency Goals for Performance Expectation **HS-PS1-4**

Information about Performance Expectation HS-PS1-4

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 Limits.

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 Idea (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.

Disciplinary Core Idea (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.

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<table>
<tr><th colspan="2">Student Proficiency Goals for Performance Expectation HS-PS1-4</th></tr>
<tr><td colspan="2">SEP (Developing and Using Models):

• Students use evidence to identify and assign roles for the components required for their models.
• Students use evidence to identify the systems that their models are required to illustrate.
• Students develop models that can address phenomena related to the release or absorption of energy during a chemical reaction.
• Students develop models that can illustrate the changes in total bond energy during chemical reactions.
• Students use their models to illustrate the release or absorption of energy during chemical reactions.
• Students use their models to illustrate the changes in total bond energy during chemical reactions.</td></tr>
<tr><td>DCI (PS1.A Structure and Properties of Matter):

• Students know that molecules represent a lower energy state than unbonded atoms.
• Students know that the process of breaking bonds to separate atoms in a molecule requires energy to be added to the system.
• Students know that energy is released from the system when bonds are formed between atoms, resulting in molecules at a lower energy state.

(continued on the next page)</td><td>CCC (Energy and Matter):

• Students consider the flow of energy into, within, and out of systems of chemical reactions.
• Students consider the flow of matter into, within, and out of systems of chemical reactions.
• Students consider that total energy is conserved, meaning no energy is lost or gained, during a chemical reaction.
• Students consider that total matter is conserved, meaning no matter is lost or gained, during a chemical reaction.</td></tr>
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DCI (PS1.B Chemical Reactions):	
• Students know that chemical reactions depend on collisions among reactant particles. • Students know that atoms are rearranged into new particles in chemical reactions. • Students know that the total energy absorbed or released in a chemical reaction depends on the energy required to break bonds and the energy released when new bonds are made. • Students know that the energy released or absorbed during a chemical reaction is measured by temperature, which represents changes in the total kinetic energy of the particles within the system.	