

HS-PS1-4 Matter and its Interactions

California Science Test—Item Content Specifications

# **HS-PS1-4 Matter and its Interactions**

Students who demonstrate understanding can:

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*.]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Developing and Using ModelsModeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.Develop a model based on evidence to illustrate the relationships between systems or between components of a system. | PS1.A: Structure and Properties of Matter16. 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 Reactions7. 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. | Energy and MatterChanges of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

2.1 Ability to develop models

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

2.1.1 Ability to determine components of a scientific event, system, or design solution

2.1.2 Ability to determine the relationships among multiple components of a scientific event, system, or design solution

2.1.3 Ability to determine scope, scale, and grain-size of models, as appropriate for their intended use

2.1.4 Ability to represent mechanisms, relationships, and connections to illustrate, explain, or predict a scientific event

### Disciplinary Core Idea Assessment Targets

#### PS1.A.16

* Recognize that a stable molecule has less energy than the same set of atoms separated, thus energy is required to break the molecule apart

#### PS1.B.7

* Identify and describe the relevant chemical components of a reaction, including the bonds broken in the reactants and bonds formed in the products during the reaction
* Recognize that breaking bonds requires the input of energy and forming bonds releases energy
* Describe that the reactants and products have different potential energies or total bond energies as a result of the different arrangement of atoms, resulting in a net energy change in the chemical system
* Describe that a net energy change in the system is accompanied by a transfer of an equal amount of energy from the system to the surroundings or from the surroundings to the system
* Describe that the total energy of the system and the surroundings is conserved
* Describe that energy transfer occurs through molecular collisions (e.g., the transformation of potential energy of the chemical system to kinetic energy in the surroundings [or vice versa])

### Crosscutting Concept Assessment Target(s)

CCC5 Describe changes in matter and energy in a system in terms of the energy and matter that flows into, out of, and within the system

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides information about energy changes in a chemical system and a list of relevant and irrelevant components to model the system:

* Selects the relevant components to illustrate the energy changes in the chemical system (2.1.1, PS1.B.7, and CCC5)

Task provides information about energy changes in a chemical system and an incomplete model of the system (e.g., molecular-level drawing, diagram of a reaction, potential energy diagram):

* Selects the components or labels to complete the model to illustrate or explain the energy changes in the chemical system (2.1.1, PS1.B.7, and CCC5)

Task provides information about energy changes in a chemical system and a list of models:

* Selects the appropriate model to illustrate the energy changes in the chemical system (2.1.2, PS1.B.7, and CCC5)

Task provides a model and/or information about energy changes in the chemical system and a list of correct and incorrect representations or descriptions of the mechanisms and behaviors underlying the energy changes:

* Selects the representations or descriptions of the mechanisms and behaviors (2.1.3, PS1.B.7, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* A potential energy diagram that best represents a specific endothermic or exothermic reaction based on an observed temperature change in the surroundings
* A demonstration of changes in energy when concentrations of reactants are increased or decreased
* A comparison of the total reactant bond energy with the total product bond energy based on a description of a reaction and temperature changes in the surroundings (e.g., combustion of butane or decomposition of hydrogen peroxide)

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Energy is released when bonds are broken and absorbed when bonds are formed.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS1-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS1-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS1-4%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

Posted by the California Department of Education, March 2021 (updated February 2024)