

HS-PS3-4 Energy

California Science Test—Item Content Specifications

# HS-PS3-4 Energy

Students who demonstrate understanding can:

Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

[Clarification Statement: Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.] [*Assessment Boundary: Assessment is limited to investigations based on materials and tools provided to students.*]

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 |
| --- | --- | --- |
| Planning and Carrying Out Investigations  Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.  Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. | PS3.B: Conservation of Energy and Energy Transfer  9. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.  12. Uncontrolled systems always evolve toward more stable states—that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).  PS3.D: Energy in Chemical Processes  7. Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment. | Systems and System Models  When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. |

## 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.

3.2 Ability to develop, evaluate, and refine a plan for the investigation

3.3 Ability to collect the data for the investigation

### 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.

3.2.2 Ability to describe a detailed experimental procedure (e.g., number of trials, identify the control) and experimental setup

3.3.1 Ability to use appropriate tools for accurate and precise measurements

3.3.3 Ability to evaluate the quality of data to determine if the evidence meets the goals of the investigation

### Disciplinary Core Idea Assessment Targets

#### PS3.B.9

* Identify the evidence needed to support the transfer of thermal energy between systems

#### PS3.B.12

* Describe how the data supports the concept that systems initially at different temperatures eventually reach thermal equilibrium as a result of the natural tendency toward a more uniform energy distribution

#### PS3.D.7

* Develop an investigation plan and describe the data that will be collected to investigate the transfer of thermal energy
* Describe the evidence to be derived from the data collected in an investigation about thermal energy transfer

### Crosscutting Concept Assessment Target(s)

CCC4 Investigate or describe a system, defining the boundaries and initial conditions of the system, and analyze the system inputs and outputs using models

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a scenario for measuring the temperature of two systems in contact over time:

* Selects or describes correct experimental procedures appropriate to the target problem under investigation (3.2.2, PS3.D.7, and CCC4)

Task provides an apparatus for measuring the temperature of components in a closed system:

* Uses tools and techniques to collect data useful for investigating a scientific problem (3.3.1, PS3.D.7, and CCC4)
* Uses measuring tools to get accurate, precise measures required by the scientific investigation (3.3.1, PS3.D.7, and CCC4)

Task provides the results from an investigation of thermal energy transfer between components of a system:

* Determines if the evidence meets the goal of the investigation (3.3.3, PS3.D.7, and CCC4)
* Determines if the data is sufficient to answer the scientific question under investigation (3.3.3, PS3.D.7, and CCC4)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Thermal energy transfer between objects in a closed system
* Calorimetry to determine whether a reaction is exothermic or endothermic
* Two objects at different temperatures reaching thermal equilibrium

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Energy is lost during thermal energy transfer.
* Thermal energy cannot be measured.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS3-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS3-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS3-4%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>

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