

MS-PS3-4 Energy

California Science Test—Item Content Specifications

# MS-PS3-4 Energy

Students who demonstrate understanding can:

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

[Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [*Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.*]

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 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.  Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.  Connections to Nature of Science  Scientific Knowledge is Based on Empirical Evidence  Science knowledge is based upon logical and conceptual connections between evidence and explanations | PS3.A: Definitions of Energy   1. Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.   PS3.B: Conservation of Energy and Energy Transfer   1. The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. | Scale, Proportion, and Quantity  Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. |

## 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

### 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.

3.2.1 Ability to decide how to observe and/or measure relevant variables, considering the level of accuracy and precision required and the kinds of instrumentation and techniques best suited to making such measurements

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

### Disciplinary Core Idea Assessment Targets

#### PS3.A.3

* Identify the variables needed to determine the total amount of energy in the system
* Explain how to measure the total amount of energy in a system based on these variables
* Define the dependent and independent variables that will be measured
* Explain the relationship between temperature and average kinetic energy of particles in matter

#### PS3.B.6

* Identify how certain variables (mass, type of container, etc.) will affect the amount of energy transfer
* Determine the best starting temperatures to allow an optimal amount of data points to be taken
* Decide how many data points need to be taken to get meaningful data

### Crosscutting Concept Assessment Target(s)

CCC3 Identify proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities that provide information about the magnitude of properties and processes

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a list of materials one would use to conduct an experiment involving temperature and thermal energy:

* Identifies the role of each item on the list and its appropriateness for the investigation (3.2.1, PS3.A.3, and CCC3)
* Explains, using this list, how the total energy of the system can be measured (3.2.1, PS3.A.3, and CCC3)
* Identifies the appropriate variables to measure that would reveal a pattern describing the phenomenon of thermal energy (3.2.1, PS3.A.3, and CCC3)
* Uses the results of the experiment to explain the relationship between temperature and average kinetic energy of particles in the matter (3.2.1, PS3.A.3, and CCC3)

Task provides a desired outcome of an experiment (e.g., measure the change in temperature or determine which substance will gain or lose more energy through heat):

* Selects the suitable equipment with which to achieve the desired results with minimal error or uncertainty (3.2.1, PS3.B.6, and CCC3)
* Identifies procedures that would result in better data (e.g., choosing a proper starting temperature) (3.2.1, PS3.B.6, and CCC3)
* Determines if the correct amount of meaningful data was collected verifying the desired outcome (3.2.1, PS3.B.6, and CCC3)

## California Environmental Principles and Concepts

* EP4: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* An experiment to measure the temperature change of samples of different materials with the same mass as they cool or heat in the environment
* An experiment to measure the temperature change of the same material with different masses when a specific amount of energy is added
* An investigation of two objects at different temperatures, including the time needed to reach thermal equilibrium
* An investigation involving measurements of temperature changes for equal volumes of a liquid in containers of different materials

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Heat and temperature are the same.
* Heat is a substance that flows in and out of matter, not a transfer of energy.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

MS-PS3-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/MS-PS3-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-PS3-4%20Evidence%20Statements%20June%202015%20asterisks.pdf)

California Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

California Education and the Environment Initiative <http://californiaeei.org/>

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>

Appendix 2: Connections to California Environmental Principles and Concepts <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

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