

MS-PS3-3 Energy

California Science Test—Item Content Specifications

# MS-PS3-3 Energy

Students who demonstrate understanding can:

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

[Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [*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 |
| --- | --- | --- |
| Constructing Explanations and Designing Solutions  Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.  Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. | PS3.A: Definitions of Energy  3. 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  7. Energy is spontaneously transferred out of hotter regions or objects and into colder ones.  ETS1.A: Defining and Delimiting an Engineering Problem  5. The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. *(secondary to MS-PS3-3)*  ETS1.B: Developing Possible Solutions  6. A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. *(secondary to MS-PS3-3)* | Energy and Matter  The transfer of energy can be tracked as energy flows through a designed or natural 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.

6E.1 Ability to solve design problems

### 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.

6E.1.1 Ability to solve design problems by engaging in a systematic, iterative process that results in structures or processes, or the plans for structures or processes

6E.1.3 Ability to solve a design problem by constructing a device or generating a design solution

6E.1.4 Ability to apply relevant scientific knowledge and/or evidence in designing solutions

### Disciplinary Core Idea Assessment Targets

#### PS3.A.3

* Recognize that temperature of an object relates to average kinetic energy of the particles that make up the substance
* Understand that for a given sample of material, a higher temperature corresponds to higher energy and a lower temperature corresponds to lower energy

#### PS3.B.7

* Identify that thermal energy spontaneously transfers only from hotter objects or regions to colder objects or regions
* Identify materials or properties of materials that will allow the transfer of thermal energy versus ones that will not

#### ETS1.A.5

* Describe the criteria that will be considered while designing a device to minimize or maximize energy transfer
* Identify constraints in the design process such as materials, safety, time, and cost
* Design or test a device or process to minimize/maximize thermal energy transfer

#### ETS1.B.6

* Identify the components relevant to testing ideas about the problem being solved including criteria and constraints
* Test a proposed solution
* Modify a solution based on test results
* Use relevant scientific principles to describe multiple design solutions that may be viable given the constraints and criteria to address the problem

### Crosscutting Concept Assessment Target(s)

CCC5 Identify that the transfer of energy can be tracked as energy flows through a designed or natural system

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides student with an interactive virtual environment or simulation that allows the layering of materials to insulate a container with given constraints:

* Observes patterns and determines which materials are most effective, while adhering to cost and weight constraints (6E.1.1, ETS1.A.5, and CCC5)

Task provides student with a design problem to maximize or minimize thermal energy transfer:

* Creates or selects a diagram for a solution using given materials that meet the requirements and achieves the desired goal (6E.1.3, ETS1.B.6, and CCC5)

Task provides student with a design problem to minimize thermal energy transfer:

* Selects correct diagram of a solution by recognizing which design has the lowest temperature and provides the most insulation (6E.1.3, PS3.A.3, and CCC5)

Task provides description of an apparatus or container meant to maximize or minimize thermal energy transfer, including criteria and constraints with annotations of the materials used:

* Selects the correct explanation for the choice of material used based on science concepts (6E.1.4, PS3.B.7, and CCC5)

## 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.

* Analysis of house insulation methods
* Effectiveness of insulated cups and containers
* Basic tests of thermal conductivity (i.e., by measuring temperature differences) for various materials
* Cold-weather clothing
* Selecting optimal material(s) to use in a device that maximizes or minimizes thermal energy transfer

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Cold flows in the opposite direction as heat.
* Temperature and heat are the same thing.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

MS-PS3-3 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/MS-PS3-3 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-PS3-3%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>

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