

MS-PS1-6 Matter and its Interactions

California Science Test—Item Content Specifications

# MS-PS1-6 Matter and its Interactions

Students who demonstrate understanding can:

Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [*Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*]

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 knowledge, principles, and theories.  Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. | PS1.B: Chemical Reactions   1. Some chemical reactions release energy, others store energy.   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. *(secondary to MS-PS1-6)*  ETS1.C: Optimizing the Design Solution  3. Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary to MS-PS1-6)*  4. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary to MS-PS1-6)* | 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

6E.2 Ability to evaluate and/or refine solutions to 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.1.2 Ability to generate multiple solutions for a design problem that meet design criteria and constraints

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

6E.2.1 Ability to compare or critique competing design solutions based on design criteria

6E.2.2 Ability to evaluate and/or refine (optimize) design solutions based on scientific knowledge or evidence

6E.2.3 Ability to optimize performance of a design by prioritizing criteria and considering trade-offs to test, revise, and retest

### Disciplinary Core Idea Assessment Targets

#### PS1.B.6

* Identify the release or absorption of thermal energy based on the chemical processes taking place
* Consider the unique, energy-related chemical properties of the inputs and outputs of a system

#### ETS.1.B.6

* Use relevant scientific principles to describe multiple design solutions that may be viable given the constraints and criteria to address the problem
* Use relevant scientific principles to create an evaluation plan that can test design solutions with respect to how well they meet certain criteria (e.g., the transfer of thermal energy) and constraints (e.g., amount and cost of materials, safety, and operating time)

#### ETS.1.C.3

* Identify the features of a design solution that perform best with respect to how well they meet a certain criteria or constraint
* Optimize a design solution by incorporating the best features of multiple design solutions into one design

#### ETS.1.C.4

* Understand that design is an iterative process that involves the systematic evaluation of multiple design solutions

### 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 a description of a problem (including criteria and constraints) that can be solved by a device that involves the transfer of thermal energy caused by chemical processes:

* Selects features to include in an initial design solution (6E.1.1, PS1.B.6, ETS1.B.6, and CCC5)

Task provides both a description of a problem that can be solved by a device that involves the storage, release, or transfer of thermal energy and representations of potential design solutions:

* Identifies initial design solution(s) that meet the provided criteria and constraints (6E.1.2, PS1.B.6, ETS1.B.6, and CCC5)
* Uses scientific principles to select and justify the most effective design (6E.2.2, PS1.B.6, ETS1.C.3, and CCC5)

Task provides both a description of a problem (including criteria and constraints) that can be solved by a device that involves the storage, release, or transfer of thermal energy and a design solution:

* Identifies the scientific concepts underlying the performance of the device (6E.1.4, PS1.B.6, ETS1.B.6, and CCC5)
* Identifies the tradeoffs in the design solution (6E.2.1, PS1.B.6, ETS1.C.3, and CCC5)

Task provides 1) a description of a problem that can be solved by a device that involves the storage, release, or transfer of thermal energy, 2) multiple design solutions, and 3) a list of prioritized criteria:

* Selects the design solution that best meets the prioritized criteria (6E.2.1, PS1.B.6, ETS1.C.3, and CCC5)

Task provides 1) a description of a problem that can be solved by a device that involves the storage, release, or transfer of thermal energy, 2) multiple design solutions, 3) relevant data/evidence for each design solution, and 4) a list of prioritized criteria:

* Uses the data evidence to select and justify the best design solution based on the prioritized criteria (6E.2.1, PS1.B.6, ETS1.C.4, and CCC5)

Task provides 1) a description of a problem (including prioritized criteria) that can be solved by a device that involves the storage, release, or transfer of thermal energy, 2) a design solution, and 3) data from testing the prototype device:

* Uses the data to identify design improvements with respect to the prioritized criteria (6E.2.3, PS1.B.6, ETS1.C.4, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Reactions that absorb or release significant amounts of heat (e.g., in instant hot or cold packs)
* Energy transfer to materials that have large specific heat capacities
* A device that works by combustion of methane (natural gas) or butane
* Efficiency of different exothermic or endothermic chemical reactions

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Design only requires developing good ideas and does not include the realization and evaluation of the ideas.
* Once a solution comes to mind, there is no need to develop alternate solutions.
* Engineering design is a linear process.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

MS-PS1-6 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/MS-PS1-6 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-PS1-6%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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