

HS-PS3-3 Energy

California Science Test—Item Content Specifications

# HS-PS3-3 Energy

Students who demonstrate understanding can:

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

[Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [*Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials 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 |
| --- | --- | --- |
| Constructing Explanations and Designing Solutions  Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  Design, evaluate, and/or refine a solution to a complex real-world problem based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. | PS3.A: Definitions of Energy  10. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.  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.  ETS1.A: Defining and Delimiting an Engineering Problem  Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. *(secondary to HS-PS3-3)* | Energy and Matter  Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.  Connections to Engineering, Technology, and Applications of Science  Influence of Science, Engineering and Technology on Society and the Natural World  Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. |

## 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.1.2 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

### Disciplinary Core Idea Assessment Targets

#### PS3.A.10

* Identify the forms of energy that are being converted from one form to another in a designed system

#### PS3.D.7

* Identify appropriate energy conversion principles that best suit a design solution
* Identify which forms of energy are appropriate inputs to a designed system and which forms are appropriate outputs from a designed system
* Identify losses (or potential losses) of energy from a designed solution/system to the surrounding environment

#### ETS1.A.6

* Describe criteria for a device that converts energy from one form to another
* Identify and describe constraints and tradeoffs that should be considered in design
* Use appropriate scientific reasoning to choose materials and structure of a device
* Quantify the degree to which a design solution meets the wants and needs of stakeholders
* Identify appropriate scientific principles that apply to a designed solution and which may be useful in refining that solution

### Crosscutting Concept Assessment Target(s)

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

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a simulation where a student chooses different parameters or features for building a device capable of transforming energy from one form to another for a stated purpose:

* Identifies relationships between features of a design that were altered and changes to outcomes (including efficiency of transfer, material cost, losses of energy to the environment, etc.) (6E.1.1, PS3.D.7, and CCC5)

Task provides an existing design for transforming energy from one form to another with data on current performance as well as the desire of certain stakeholders (e.g., residents, politicians, businesses) to improve performance in certain dimensions:

* Identifies (or generates) viable refinements to aspects of the design that better help the designed solution reach the goals of the stakeholders (6E.1.2, PS3.D.7, ETS1.A.6, and CCC5)
* Identifies aspects of the design that are in need of refinement to satisfy the provided constraints (e.g., a certain part leaks too much energy into the environment) (6E.1.2, PS3.D.7, ETS1.A.6, and CCC5)

Task provides an existing design for transforming energy from one form to another with various aspects of the design modeled, outlined, or graphed in ways that focus on underlying physical principles:

* Identifies which kinds of energy transfer (e.g., chemical to thermal) are taking place between different parts of the device (6E.1.4, PS3.A.10, and CCC5)
* Identifies relevant scientific principles (such as conservation of energy, various laws of thermodynamics, Newton’s laws, etc.) involved in the functioning of various parts of the device (6E.1.4, PS3.D.7, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Conversion of mechanical energy into electrical or thermal energy
* Conversion of electrical or chemical energy into mechanical or thermal energy
* Conversion of gravitational or elastic potential energy into kinetic energy
* Reduction of material cost or energy input requirements
* Reduction of energy losses to the environment

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Energy can be lost, created, or destroyed.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

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