

HS-PS3-1 Energy

California Science Test—Item Content Specifications

# HS-PS3-1 Energy

Students who demonstrate understanding can:

Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

[Clarification Statement: Emphasis is on explaining the meaning of mathematical expressions used in the model.] [*Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.*]

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 |
| --- | --- | --- |
| Using Mathematics and Computational ThinkingMathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis; a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms; and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.Create a computational model or simulation of a phenomenon, designed device, process, or system. | PS3.A: Definitions of Energy1. Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.

PS3.B: Conservation of Energy and Energy Transfer1. Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.

Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.The availability of energy limits what can occur in any system. | Systems and System ModelsModels can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.Connections to Nature of ScienceScientific Knowledge Assumes an Order and Consistency in Natural SystemsScience assumes the universe is a vast single system in which basic laws are consistent. |

## 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.

5.1 Ability to develop mathematical and/or computational models (e.g., graphical representation in a simulation)

### 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.

5.1.1 Ability to generate mathematical representations to describe characteristics and patterns of a scientific phenomenon and/or a design solution

5.1.2 Ability to use units of measurement, diagrams, and graphs to record and organize data gathered directly or provided from scientific investigations

### Disciplinary Core Idea Assessment Targets

#### PS3.A.9

* Identify the boundaries and initial energy configuration of a system to be modeled
* Identify the components of the total energy in a system
* Describe the energy flow into and out of the system and the conversion of energy within the system

#### PS3.B.8

* Create a computational model in which total energy is conserved

#### PS3.B.9

* Create a computational model for the transfer of energy within a system

#### PS3.B.10

* Use algebraic descriptions of the initial and final energy states of a system based on the principle of conservation of energy
* Use a computational model to predict the maximum possible change in the energy of one component of the system for a given set of energy flows
* Identify and describe the limitations of a computational model describing energy flows in a system

#### PS3.B.11

* Explain that the availability of energy impacts a system

### Crosscutting Concept Assessment Target(s)

CCC4 Use models to predict the behavior of a system, taking into consideration that predictions have limited precision and reliability due to the assumptions and approximations inherent in models

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a qualitative description of a system of interacting objects:

* Creates a mathematical representation to determine the components of energy in a system (5.1.1, PS3.A.9, and CCC4)

Task provides a system in which total energy is conserved and can be transferred between components within the system:

* Provides a mathematical description of the interactions between components to model the energy configuration of the system (5.1.1, PS3.B.10, and CCC4)

Task provides a description of a closed system in which energy is conserved:

* Creates graphs or tables that compare initial and final energy states of the system (5.1.2, PS3.B.8, and CCC4)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* An Earth-object system
* A thermodynamic system
* A device that converts electric energy to mechanical energy
* A power plant that converts various forms of energy to electric energy
* Potential and kinetic energy of a bead on a ring

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Mathematical models are only used to calculate values, not to describe relationships.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS3-1 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS3-1 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS3-1%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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