

MS-PS3-1 Energy

California Science Test—Item Content Specifications

# MS-PS3-1 Energy

Students who demonstrate understanding can:

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

[Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Analyzing and Interpreting Data  Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.  Construct and interpret graphical displays of data to identify linear and nonlinear relationships. | PS3.A: Definitions of Energy   1. Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. | 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.

4.1 Ability to record and organize data

4.2 Ability to analyze data to identify relationships

### 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.

4.1.3 Ability to organize data in a way that facilitates analysis and interpretation

4.2.1 Ability to use empirical data to describe patterns and relationships

4.2.2 Ability to identify patterns (qualitative or quantitative) among variables represented in data

### Disciplinary Core Idea Assessment Targets

#### PS3.A.6

* Demonstrate through graphical displays that when the mass and/or the speed of an object increases, the kinetic energy increases
* Demonstrate through graphical displays that when the mass and/or the speed of an object decreases, the kinetic energy decreases
* Demonstrate through graphical displays that kinetic energy and mass have a linear proportional relationship
* Demonstrate through graphical displays that kinetic energy and speed have a proportional relationship that is nonlinear
* Draw comparisons between the rate of change between mass and kinetic energy, and speed and kinetic energy (i.e., the kinetic energy doubles as the mass of the object doubles, yet the kinetic energy quadruples as the speed of the object doubles)

### 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 data showing indentations made when objects of different masses or travelling at different speeds hit a barrier:

* Describes that the different masses make different indentations along the barrier upon impact (4.1.3, PS3.A.6, and CCC3)
* Graphs the relationship between mass/speed and the depth of the indentation (4.1.3, PS3.A.6, and CCC3)
* Uses their generated graph to identify a pattern between the masses or speeds of the object and the indentation along the barrier (4.1.3, PS3.A.6, and CCC3)

Task provides a graph of an increase in mass versus kinetic energy and/or a graph of an increase in speed versus kinetic energy:

* Describes the relationship shown by the graph as linear or non-linear (4.2.1, PS3.A.6, and CCC3)

Task provides an interactive model where the mass and speed of an object in motion can be varied, and the object’s kinetic energy is displayed:

* Describes that increasing the object’s mass results in a directly proportional increase of the object’s kinetic energy (4.2.2, PS3.A.6, and CCC3)
* Describes that increasing the object’s speed results in an increase of the object’s kinetic energy proportional to the square of its speed (4.2.2, PS3.A.6, and CCC3)

## Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive.*

* Damage done by objects of different masses moving at the same speed or objects of the same mass moving at different speeds
* Distances traveled after objects of different masses are rolled down a ramp or released from a catapult or some other source of kinetic energy
* Measuring an object’s speed and making inferences about its kinetic energy as the object moves along a path of known distance

## Common Misconceptions

Note that the list in this section is not exhaustive.

* The material make-up of an object affects its kinetic energy.
* Kinetic energy depends on its direction of travel.
* Kinetic energy only depends on mass or speed.
* Kinetic energy equally depends on mass and speed.
* Speed is the only factor that determines the kinetic energy of a moving object.
* Faster moving objects always have more kinetic energy than slower moving objects.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

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

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