

HS-PS2-1 Motion and Stability: Forces and Interactions

California Science Test—Item Content Specifications

# HS-PS2-1 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

[Clarification Statement: Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [*Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.*]

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 |
| --- | --- | --- |
| Analyzing and Interpreting DataAnalyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.Connections to Nature of ScienceScience Models, Laws, Mechanisms, and Theories Explain Natural PhenomenaTheories and laws provide explanations in science.Laws are statements or descriptions of the relationships among observable phenomena. | PS2.A: Forces and Motion1. Newton’s second law accurately predicts changes in the motion of macroscopic objects.
 | Cause and EffectEmpirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. |

## 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.

4.1.1 Ability to record information and represent data in tables and graphical displays

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

#### PS2.A.8

* Organize data, graphs, charts, or vector drawings representing the net force and acceleration for an object with constant mass
* Recognize that, for the same net force, objects with a larger mass experience a smaller acceleration
* Recognize that, for an object with a constant mass, a larger net force exerted onto the object results in a larger acceleration
* Identify that the force of gravity exerted onto a free-falling object produces a constant acceleration because the net force/mass ratio is the same for all objects in a specific local gravitational field
* Analyze data as empirical evidence describing the relationship between net force, acceleration, and mass
* Recognize the cause-effect relationship in that the net force exerted onto an object causes the object to experience accelerated motion using the expression *Fnet = ma*

### Crosscutting Concept Assessment Target(s)

CCC2 Identify empirical evidence to differentiate between cause and correlation and make claims about specific causes and effects

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a description of a physical situation involving an object being accelerated:

* Identifies from a list the correct information and data corresponding to the physical situation (4.1.1, PS2.A.8, and CCC2)

Task provides a simulation of a physical situation involving an object being accelerated. As the object accelerates, the simulation provides information/data of time, position, and velocity:

* Identifies the free-body diagrams and/or motion diagrams corresponding to the presented physical situation (4.1.3, PS2.A.8, and CCC2)

Task provides graphs or a data table of position, velocity, and force as a function of time:

* Describes the relationship between net force and acceleration, and/or net force and mass, and/or mass and acceleration (4.2.1, PS2.A.8, and CCC2)

Task provides a data set of acceleration, mass, and net force:

* Identifies the relationship between net force and acceleration, and/or net force and mass, and/or mass and acceleration (4.2.2, PS2.A.8, and CCC2)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Motion diagrams or graphs (e.g., position-time, velocity-time, and acceleration-time graphs)
* Data regarding changes in position, time, instantaneous velocities, and/or acceleration (e.g., free-falling objects)
* Data regarding mass and acceleration of a two-cart system or a cart and pulley system

## Common Misconceptions

Note that the list in this section is not exhaustive.

* The forces exerted on an object are unbalanced when the object moves with constant velocity.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS2-1 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS2-1 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS2-1%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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