

MS-PS2-4 Motion and Stability: Forces and Interactions

California Science Test—Item Content Specifications

# MS-PS2-4 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

[Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [*Assessment Boundary: Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.*]

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 |
| --- | --- | --- |
| Engaging in Argument from Evidence  Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.  Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.  Connections to Nature of Science  Scientific Knowledge is Based on Empirical Evidence  Science knowledge is based upon logical and conceptual connections between evidence and explanations. | PS2.B: Types of Interactions   1. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. | Systems and System Models  Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. |

## 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.

7.1 Ability to construct scientific arguments

7.2 Ability to compare, evaluate, and critique competing arguments

### 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.

7.1.1 Ability to identify evidence/data that supports a claim

7.1.2 Ability to develop scientific arguments that are supported by evidence/data

7.1.3 Ability to use reasoning to explain how relevant evidence/data supports or refutes the claim; the reasoning should reflect application of scientific concepts, principles, ideas, and models

7.2.1 Ability to evaluate arguments about a natural phenomenon based on scientific concepts, principles, and big ideas

### Disciplinary Core Idea Assessment Targets

#### PS2.B.6

* Identify the variables associated with gravitational interactions
* Identify that gravitational interactions are always attractive and occur at a distance and not through direct contact
* Recognize that all gravitational interactions (gravitational forces) require a system of two or more objects
* Describe that, for the same distance, the force between two objects increases or decreases directly with an increase or decrease in the mass of the interacting objects
* Describe that, for the same masses, the force between two objects increases or decreases inversely with the distance between the two interacting objects
* Describe why some effects of gravitational interactions, which apply universally, may only be observable in interactions between very massive objects
* Identify and represent, using models such as force diagrams, the relative magnitude and direction of the force each object exerts on the other
* Identify evidence that gravitational interactions are always attractive, require at least two interacting objects, and are directed towards the center of mass of the other object

### Crosscutting Concept Assessment Target(s)

CCC4 Use models to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides either data on masses, distances, and gravitational forces or a computer-simulated means of collecting data:

* Constructs a sound argument that increases to mass increase the magnitude of gravitational force that contains a claim, evidence from the data or simulation provided, and reasoning that links the evidence or data to the claim (7.1.1, PS2.B.6, and CCC4)

Task provides either data on masses, distances, and gravitational forces or a computer-simulated means of collecting said data. Task also provides a claim regarding the relationship between the mass of objects interacting via gravitational forces, the magnitude of that force, and its direction:

* Identifies pieces of evidence or data that support the claim (7.1.2, PS2.B.6, and CCC4)
* Selects appropriate reasoning based on relevant scientific concepts that explains why the data provided support the claim provided (7.1.3, PS2.B.6, and CCC4)

Task provides an argument (or several arguments) in need of refinement that makes a claim regarding the relationship and factors that determine the universal law of gravitation:

* Critiques the relevance of sources used, the reliability of the data, or the validity of the experimental context to be universally applicable (7.2.1, PS2.B.6, and CCC4)
* Challenges the evidence or reasoning of an argument by presenting new evidence from a related phenomenon (7.2.1, PS2.B.6, and CCC4)
* Synthesizes evidence from several arguments in order to shore up the weaknesses of any one argument (7.2.1, PS2.B.6, and CCC4)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Data or graphs showing that the strength of gravitational forces between two objects at a given distance increases as the mass of one or both objects increases
* Data or graphs showing that the strength of gravitational forces decreases as distance between two objects increases
* Simulations depicting the movement of two objects interacting via gravitational forces after altering the mass or relative distance between the objects
* Comparing data from orbital speeds of satellites around a massive object (like the Sun) to satellites around a less massive object (like a planet or the Moon)

## Common Misconceptions

Note that the list in this section is not exhaustive.

* The magnitudes of the gravitational forces exerted on interacting objects are not equal, with the smaller mass receiving a larger force and the larger mass receiving a smaller force.
* Gravitational force only applies to large objects such as planets and stars.
* There is no gravity in space.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

MS-PS2-4 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/MS-PS2-4 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS-PS2-4%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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