

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

Students who demonstrate understanding can:

- MS-PS2-4. 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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><b>Engaging in Argument from Evidence</b> 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.</p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p>-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS2.B: Types of Interactions</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.</li> </ul>

Observable features of the student performance by the end of the course:	
1	Supported claims
a	Students make a claim to be supported about a given phenomenon. In their claim, students include the following idea: Gravitational interactions are attractive and depend on the masses of interacting objects.
2	Identifying scientific evidence
a	Students identify and describe* the given evidence that supports the claim, including:
i.	The masses of objects in the relevant system(s).
ii.	The relative magnitude and direction of the forces between objects in the relevant system(s).
3	Evaluating and critiquing the evidence
a	Students evaluate the evidence and identify its strengths and weaknesses, including:
i.	Types of sources.
ii.	Sufficiency, including validity and reliability, of the evidence to make and defend the claim.
iii.	Any alternative interpretations of the evidence, and why the evidence supports the given claim as opposed to any other claims.
4	Reasoning and synthesis
a	Students use reasoning to connect the appropriate evidence about the forces on objects and construct the argument that gravitational forces are attractive and mass dependent. Students describe* the following chain of reasoning:
i.	Systems of objects can be modeled as a set of masses interacting via gravitational forces.
ii.	In systems of objects, larger masses experience and exert proportionally larger gravitational forces.

	iii. In every case for which evidence exists, gravitational force is attractive.
b	To support the claim, students present their oral or written argument concerning the direction of gravitational forces and the role of the mass of the interacting objects.