

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

Students who demonstrate understanding can:

- 3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.** [Clarification Statement: Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from both sides will not produce any motion at all.] [Assessment Boundary: Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.]

The performance expectation above was 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>Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</p> <ul style="list-style-type: none"> Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. <p style="text-align: center;">----- Connections to Nature of Science</p> <p>Scientific Investigations Use a Variety of Methods</p> <ul style="list-style-type: none"> Science investigations use a variety of methods, tools, and techniques. 	<p>PS2.A: Forces and Motion</p> <ul style="list-style-type: none"> Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) <p>PS2.B: Types of Interactions</p> <ul style="list-style-type: none"> Objects in contact exert forces on each other. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships are routinely identified.

Observable features of the student performance by the end of the grade:									
1	Identifying the phenomenon under investigation								
	a Students identify and describe* the phenomenon under investigation, which includes the effects of different forces on an object's motion (e.g., starting, stopping, or changing direction).								
	b Students describe* the purpose of the investigation, which includes producing data to serve as the basis for evidence for how balanced and unbalanced forces determine an object's motion.								
2	Identifying the evidence to address the purpose of the investigation								
	a Students collaboratively develop an investigation plan. In the investigation plan, students describe* the data to be collected, including: <table border="1" style="width: 100%; margin-left: 20px;"> <tr> <td colspan="2">i. The change in motion of an object at rest after:</td> </tr> <tr> <td style="width: 20px;">1.</td> <td>Different strengths and directions of balanced forces (forces that sum to zero) are applied to the object.</td> </tr> <tr> <td>2.</td> <td>Different strengths and directions of unbalanced forces (forces that do not sum to zero) are applied to the object (e.g., strong force on the right, weak force on the left).</td> </tr> <tr> <td colspan="2">ii. What causes the forces on the object.</td> </tr> </table>	i. The change in motion of an object at rest after:		1.	Different strengths and directions of balanced forces (forces that sum to zero) are applied to the object.	2.	Different strengths and directions of unbalanced forces (forces that do not sum to zero) are applied to the object (e.g., strong force on the right, weak force on the left).	ii. What causes the forces on the object.	
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ii. What causes the forces on the object.									
	b Students individually describe* how the evidence to be collected will be relevant to determining the effects of balanced and unbalanced forces on an object's motion.								
3	Planning the investigation								
	a In the collaboratively developed investigation plan, students describe* how the motion of the object will be observed and recorded, including defining the following features: <table border="1" style="width: 100%; margin-left: 20px;"> <tr> <td colspan="2">i. The object whose motion will be investigated.</td> </tr> </table>	i. The object whose motion will be investigated.							
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		ii. The objects in contact that exert forces on each other.
		iii. Changing one variable at a time (e.g., control strength and vary the direction, or control direction and vary the strength).
		iv. The number of trials that will be conducted in the investigation to produce sufficient data.
	b	Students individually describe* how their investigation plan will allow them to address the purpose of the investigation.
4	Collecting the data	
	a	Students collaboratively collect and record data according to the investigation plan they developed, including data from observations and/or measurements of:
		i. An object at rest and the identification of the forces acting on the object.
		ii. An object in motion and the identification of the forces acting on the object.