**Unless otherwise specified, "descriptions" referenced in the evidence statements could include but are not limited to written, oral, pictorial, and kinesthetic descriptions.*

MS-PS3-1 Energy

Students who demonstrate understanding can:

MS-PS3-1. **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.]

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

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.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- 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.

Crosscutting Concepts

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.

Observable features of the student performance by the end of the course:		
1	Organizing data	
	a	Students use graphical displays to organize the following given data:
		i. Mass of the object.
		ii. Speed of the object.
		iii. Kinetic energy of the object.
	b	Students organize the data in a way that facilitates analysis and interpretation.
2	Identifying relationships	
	a	Using the graphical display, students identify that kinetic energy:
		i. Increases if either the mass or the speed of the object increases or if both increase.
		ii. Decreases if either the mass or the speed of the object decreases or if both decrease.
3	Interpreting data	
	a	Using the analyzed data, students describe*:
		i. The relationship between kinetic energy and mass as a linear proportional relationship ($KE \propto m$) in which:
		1. The kinetic energy doubles as the mass of the object doubles.
		2. The kinetic energy halves as the mass of the object halves.
		ii. The relationship between kinetic energy and speed as a nonlinear (square) proportional relationship ($KE \propto v2$) in which:
		1. The kinetic energy quadruples as the speed of the object doubles.
		2. The kinetic energy decreases by a factor of four as the speed of the object is cut in half.