### 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*:

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>PS3.A: Definitions of Energy</strong></td>
<td><strong>Scale, Proportion, and Quantity</strong></td>
</tr>
<tr>
<td>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.</td>
<td>● 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.</td>
<td>● 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.</td>
</tr>
<tr>
<td>● Construct and interpret graphical displays of data to identify linear and nonlinear relationships.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Observable features of the student performance by the end of the course:

<table>
<thead>
<tr>
<th>1. Organizing data</th>
<th>2. Identifying relationships</th>
<th>3. Interpreting data</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Students use graphical displays to organize the following given data:</td>
<td>a. Using the graphical display, students identify that kinetic energy:</td>
<td>a. Using the analyzed data, students describe:</td>
</tr>
<tr>
<td>i. Mass of the object.</td>
<td>i. Increases if either the mass or the speed of the object increases or if both increase.</td>
<td>i. The relationship between kinetic energy and mass as a linear proportional relationship (KE ∝ m) in which:</td>
</tr>
<tr>
<td>ii. Speed of the object.</td>
<td>ii. Decreases if either the mass or the speed of the object decreases or if both decrease.</td>
<td>1. The kinetic energy doubles as the mass of the object doubles.</td>
</tr>
<tr>
<td>iii. Kinetic energy of the object.</td>
<td></td>
<td>2. The kinetic energy halves as the mass of the object halves.</td>
</tr>
<tr>
<td>b. Students organize the data in a way that facilitates analysis and interpretation.</td>
<td></td>
<td>i. The relationship between kinetic energy and speed as a nonlinear (square) proportional relationship (KE ∝ v^2) in which:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1. The kinetic energy quadruples as the speed of the object doubles.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. The kinetic energy decreases by a factor of four as the speed of the object is cut in half.</td>
</tr>
</tbody>
</table>