

**Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project**

**Grade 8 Science**

**Unit** **1 Task 3 Specification Tool & Verification of Alignment**

**Forces and Energy**

**September 2023**

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 SIPS Grade 8 Unit 1 Task 3 Specification & Verification of Alignment

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| **Grade: 8** | **Unit: 1** | **Task Number: 3** | **Task Title: Roller Coaster Thrills** |
| **NGSS Performance Expectations** |
| **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.]**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.*] |
| **Phenomena or Phenomena-rooted Design Problem** |
| * Distance traveled after objects of different masses roll down a ramp (i.e., rollercoasters) and the relationships of kinetic energy and gravitational potential energy.
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| **Scenario/Context/Situation/Boundaries** |
| * The scenario includes a situation involving a roller coaster at an amusement park that leads students to an examination of gravitational potential energy when comparing two systems.
* Students are asked to make logical and conceptual connections between data and explanations related to gravitational interactions and masses of interacting objects.
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| **Variable Features to Shift Complexity or Focus** |
| * Phenomenon addressed.
* Format of "real-world" phenomenon under investigation: image, data, text, combination.
* Domain-specific vocabulary.
* Type and number of system(s) or model(s).
* Components within a system or model.
* Type and range of measurement units.
 |
| **General Description of Task / Chain of Sensemaking**  |
| * Students are asked to use a model representing two systems to determine the energy system with the most gravitational potential energy and provide an explanation. **[Prompt 1: MS-PS2-4 & MS-PS3-1, KSA1]**
* Students explain why the gravitational force of attraction between two objects is not observable and support their explanation with information about masses of objects and gravitational force. **[Prompt 2: MS-PS2-4, KSA1]**
* Students identify proportional relationships of kinetic energy and the speed of rolling ball on inclined planes of different heights using provided data. **[Prompt 3: MS-PS3-1, KSA7]**
* Students use data comparing two roller coasters to state a claim and determine which ride would be more thrilling or faster as it reaches the bottom of the tallest drop. **[Prompt 4, Part A: MS-PS2-4 & MS-PS3-1, KSA2]**
* Students support the claim with quantitative evidence and the relationships between kinetic energy and gravitational potential energy. **[Prompt 4, Part B: MS-PS3-1, KSA9]**
 |
| **Targeted PE-related KSAs**  |
| **KSA1:** Support a claim with evidence related to the idea that gravitational interactions are attractive and depend on the masses of interacting objects.**KSA7:** Identify proportional relationships of kinetic energy and the speed of an object using data.**KSA9:** Construct and interpret a graphical display to compare the relationship between kinetic energy and mass to the relationship between speed and kinetic energy. |
| **Cross-performance Expectations Related KSAs to Target** |
| **MS-PS2-4 & MS-PS3-1, KSA1:** Use a model to predict how kinetic energy of an object will change as a result of changes in the mass and speed of an object.**MS-PS2-4 & MS-PS3-1, KSA2**: Construct an argument about how the mass and speed of a moving object affect its kinetic energy. |
| **Student Demonstrations of Learning**  |
| * Uses system models accurately to appropriately describe forces within systems that represent the observable phenomena.
* Constructs a sound argument related to the rate of change between mass and kinetic energy, and/or speed and kinetic energy (e.g., the kinetic energy doubles as the mass of the object doubles, yet the kinetic energy quadruples as the speed of the object doubles).
* Correctly identifies proportional relationships of kinetic energy and the mass of an object by analyzing data.
* Correctly identifies the proportional relationships of kinetic energy and the speed of an object by analyzing data.
* Constructs a sound argument related to the rate of change between mass and kinetic energy, and/or speed and kinetic energy (e.g., the kinetic energy doubles as the mass of the object doubles, yet the kinetic energy quadruples as the speed of the object doubles).
 |
| **Work Products** |
| * Selected response.
* Constructed response.
 |
| **Application of Universal Design for Learning-based Guidelines to Promote Accessibility (**[**https://udlguidelines.cast.org/**](https://udlguidelines.cast.org/) **)**  |
| **Means of Engagement** | **Multiple Means of Representation** | **Multiple Means of Action & Expression** |
| * Context or content.
* Age appropriate.
* Appropriate for different groups.
* Makes sense of complex ideas in creative ways.
* Vary the degree of challenge or complexity within prompts.
 | * Provide visual diagrams and charts.
* Make explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams.
* Activating relevant prior knowledge.
* Bridge concepts with relevant analogies and metaphors.
* Highlight or emphasize key elements in text, graphics, diagrams, and formulas.
* Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships.
* Give explicit prompts for each step in a sequential process.
 | * Solve problems using a variety of strategies.
* Sentence starters.
* Embed prompts to “show and explain your work”.
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| **SIPS Assessments Complexity Framework Components**  |
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| **Prompt** | **A.1** Degree and nature of sense-making about phenomena or problems | **B.1** Complexity of the presentation | **B.2** Cognitive demand of response development | **B.3** Cognitive demand of response production |
|  | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High | Low | Moderate | High |
| **1 Parts A & B** |  | **X** |  |  | **X** |  |  | **X** |  | **X** |  |  |
| **1 Part C** |  | **X** |  | **X** |  |  | **X** |  |  |  | **X** |  |
| **2** |  | **X** |  | **X** |  |  |  | **X** |  |  | **X** |  |
| **3**  |  | **X** |  |  |  | **X** |  | **X** |  |  | **X** |  |
| **4** |  | **X** |  |  | **X** |  |  |  | **X** |  | **X** |  |

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| **Rubric Considerations** |
| * Sophistication of the explanations.
* Correctness of the identification that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions.
* Correctness and/or appropriateness using evidence related to the idea that gravitational interactions are attractive and depend on the masses of interacting objects to support a claim.
 |
| **Assessment Boundaries** |
| * Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.
* Assessment is limited to the proportional relationships of kinetic energy to the mass of an object and kinetic energy to the speed of an object.
* Assessment does not require students to calculate slopes or determine functions of graphical displays.
* Assessment does not include a kinetic energy derivation (e.g., using algebra or calculus).
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| **Common Misconceptions** |
| * **MS-PS3-1**
	+ The material makeup of an object affects its kinetic energy.
	+ Kinetic energy depends on its direction of travel.
	+ Kinetic energy only depends on mass or speed.
	+ Kinetic energy equally depends on mass and speed.
	+ Speed is the only factor that determines the kinetic energy of a moving object.
	+ Faster-moving objects always have more kinetic energy than slower-moving objects.
* **MS-PS2-4**
	+ 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.
 |
| **Possible Technical Terms for Task**  |
| * motion, speed, velocity, acceleration, force, balanced force, unbalanced force, position, mass, gravity, kinetic energy, gravitational potential energy
 |
| **Common Core State Standards for Literacy** |
| **ELA/Literacy*** **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **[MS-PS3-1]**
* **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **[MS-PS3-1]**

**Writing History/Social Studies, Science and Technical Subjects*** **WHST.6-8.1** Write arguments focused on discipline-specific content. **(MS-PS2-4)**
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| **Common Core State Standards for Mathematics** |
| **Mathematical Practices*** **MP.2** Reason abstractly and quantitatively. **(MS-PS3-1)**
* **6.RP.A.1** Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. **(MS-PS3-1)**
* **6.RP.A.2 Understand** the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0 and use rate language in the context of a ratio relationship. **(MS-PS3-1)**
* **7.RP.A.2** Recognize and represent proportional relationships between quantities. **(MS-PS3-1)**
* **8.EE.A.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. **(MS-PS3-1)**
* **8.EE.A.2** Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. **(MS-PS3-1)**
* **8.F.A.3** Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. **(MS-PS3-1)**
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| **Task Notes** |

 SIPS Assessments Complexity Framework

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| **Component** | **Complexity** |
| **Low** | **Moderate** | **High** |
| **Connections to Curriculum and Instruction** | **A.1 Degree and nature of sense-making** **about phenomena or problems** | * Requires one or two dimensions
* One dimension may have a greater degree of emphasis than another
* Requires previously learned ideas or concepts
 | * Requires integration of two dimensions in the service of sense-making
* Requires integration of same or different combinations of dimensions as represented in the PE bundle
* Requires a combination of previously learned ideas or concepts and newly presented information
 | * Requires integration of three dimensions in the service of sense-making
* Requires integration of same or different combinations of dimensions as represented in the PE bundle
* Requires a combination of previously learned ideas or concepts and newly presented information
 |
| **Characteristics of the Tasks** | **B.1 Complexity of the presentation**  | * The amount and type of information provided in the scenario supports limited simple connections among ideas or concepts
* Provides few, simple graphics/data/models
* Includes definitions or examples
* Phenomenon or problem is presented in a concrete way with high level of certainty
 | * The amount and type of information provided in the scenario supports multiple evident connections among ideas or concepts
* Provides graphics/data/models
* Limited use of definitions or examples
* Phenomenon or problem presented with some level of uncertainty
 | * The amount and type of information provided in the scenario supports multiple and varied complex connections among ideas or concepts
* Provides complex graphics/data/models
* Phenomenon or problem presented with high-degree of uncertainty
 |
| **B.2 Cognitive demand of response development** | * Requires well-defined set of actions or procedures
* Requires a connection or retrieval of factual information
* Response requires a low level of sophistication with routinely encountered well-practiced applications
 | * Requires application of ideas and practices given cues and guidance
* Requires drawing relationships and connecting ideas and practices
* Response requires a moderate level of sophistication with typical but relatively complex representation of ideas and application of skills
 | * Requires selection and application of multiple complex ideas and practices
* Requires high degree of sense-making, reasoning, and/or transfer
* Response requires a high level of sophistication with non-routine or abstract representation of ideas and application of skills
 |
| **B.3 Cognitive demand of response production** | * Responses include selection from a small set of options presented as text (e.g., word, short phrase) or other formats (e.g., a simple graphic or process)
 | * Responses include one or more sentences or a paragraph, a moderately complex graphic, or multiple steps in a simple or moderately complex process
 | * Responses include multiple paragraphs, multiple graphics of at least moderate complexity, or multiple steps in a complex process
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