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

The SIPS Grade 8 Science Unit 1 Task 3 Specification Tool & Verification of Alignment was developed with funding from the U.S. Department of Education under the Competitive Grants for State Assessments Program, CFDA 84.368A. The contents of this paper do not represent the policy of the U.S. Department of Education, and no assumption of endorsement by the Federal government should be made.

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

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.

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.

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/)

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”.

SIPS Assessments Complexity Framework Components

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**	

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).

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)**

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)**

Task Notes

SIPS Assessments Complexity Framework

	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