Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 1 Task 2 Specification Tool & Verification of Alignment

Forces and Energy

September 2023

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SIPS Grade 8 Unit 1 Task 2 Specification & Verification of Alignment

Grade: 8	Unit: 1	Task Number: 2	Task Title: Barriers on the Highway

NGSS Performance Expectations

MS-PS2-1. Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects. [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [*Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension*.]

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.]

Phenomena or Phenomena-rooted Design Problem

- Design a solution to a problem involving the motion of two colliding objects to reduce damage in accidents.

Scenario/Context/Situation/Boundaries

- The scenario includes a situation in which students plan an investigation in order to apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
- Students are asked to use data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object and construct an explanation to make sense of a problem involving the motion of two colliding objects.

Variable Features to Shift Complexity or Focus

- Phenomenon addressed.
- Complexity of scientific concept(s) to be modeled.
- Format of "real-world" phenomenon under investigation: image, data, text, combination.
- Domain-specific vocabulary.
- Measurement tools and units.
- Type of units.

General Description of Task / Chain of Sensemaking

- Students are asked to describe the relationships between kinetic energy, mass, and velocity of different vehicles and the importance of a range of data to be collected before developing a design solution. **[Prompt 1: MS-PS2-1, KSA3]**
- Students are asked to construct a graphical display showing the relationship between kinetic energy and mass. **[Prompt 2, Part A: MS-PS3-1, KSA1]**
- Students identify the linear relationship between kinetic energy and mass based on their graph. **[Prompt 2, Parts B & C: MS-PS3-1, KSA3]**
- Students are asked to construct a graphical display showing the relationship between kinetic energy and speed. **[Prompt 3, Part A: MS-PS3-1, KSA2]**
- Students are asked to interpret a graphical display to compare the relationship between kinetic energy and mass to the relationship between speed and kinetic energy. **[Prompt 3, Parts B & C: MS-PS3-1, KSA9]**
- Students are asked to explain how the relationships among kinetic energy, mass, and velocity, and Newton's third law of motion are taken into account within a design approach to a problem involving the motion of two colliding objects. **[Prompt 4: MS-PS2-1, KSA3]**

Targeted PE-related KSAs

MS-PS2-1, KSA3: Explain how the relevant scientific ideas are taken into account within a design approach to a problem involving the motion of two colliding objects.

MS-PS3-1, KSA1: Construct a graphical display showing the relationship between kinetic energy and mass.

MS-PS3-1, KSA3: Interpret a graph to state that kinetic energy and mass have a linear relationship**.**

MS-PS3-1, KSA2: Construct a graphical display showing the relationship between kinetic energy and speed.

MS-PS3-1, 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

NA

Student Demonstrations of Learning

- Accurately constructs graphical displays of data.
- Accurately interprets graphic displays of data.
- Accurately and appropriately uses proportional relationships and data to make justifiable predictions and to explain phenomena.
- Accurately constructs and interprets graphical displays of phenomena to make comparisons.

- Analyzes and interprets data to determine a design that best minimizes collision force.

Work Products

- Graph quantities.
- 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	**X**			**X**				**X**			**X**	
2		**X**			**X**			**X**			**X**	
3		**X**			**X**			**X**			**X**	
4		**X**			**X**				**X**			**X**

Rubric Considerations

- Accuracy of the data and data representations
- Sophistication of the explanations
- Correctness of the identification of the relationship between kinetic energy and mass and the relationship between speed and kinetic energy.

Assessment Boundaries

- Assessment is limited to vertical or horizontal interactions in one dimension.
- 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 Alternate Conceptions

- **MS-PS2-1**
  - Action-reaction forces cancel each other.
- **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.

Possible Technical Terms for Task

- balanced force, unbalanced force, collision, Newton's third law of motion, action-reaction force pairs, momentum, kinetic energy, potential energy, velocity, speed, mass

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-PS2-1) (MS-PS3-1)**
- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **(MS-PS2-1)**
- **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)**

Common Core State Standards for Mathematics

Mathematical Practices

- **MP.2** Reason abstractly and quantitatively. **(MS-PS2-1), (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