Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 1 Task 1 Specification Tool & Verification of Alignment

Forces and Energy

September 2023

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

Grade: 8	Unit: 1	Task Number: 1	Task Title: Storing Grocery Carts

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-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's first law) and unbalanced forces in a system, qualitative comparisons of forces, mass, and changes in motion (Newton's second law), frame of reference, and specification of units.] [*Assessment Boundary: Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*]

Phenomena or Phenomena-rooted Design Problem

- Design a solution to a problem involving the motion of two colliding objects.

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 make logical and conceptual connections between evidence and explanations.

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.
- Use or purpose of the model.

General Description of Task/Chain of Sensemaking

- Students develop a model to identify action-reaction pairs of forces and the objects/components involved in a physical situation involving a collision between two objects. **[Prompt 1, Part A: MS-PS2-1, KSA1]**
- Students are asked to apply scientific concepts, principles, theories, and big ideas to construct an explanation of a real-world collision between two objects. **[Prompt 1, Part B: MS-PS2-2, KSA2]**
- Students are asked to evaluate designs for collisions and provide an explanation using the provided criteria and constraints of the solution. **[Prompt 2, Parts A & B: MS-PS2-1, KSA2]**
- Students identify the scientific principle (e.g., action-reaction forces) that supports the effectiveness of the design**. [Prompt 2, Part C: MS-PS2-1, KSA6]**
- Students describe the relative magnitude and direction of the forces exerted onto a system and whether or not they balance each other. **[Prompt 2, Part D: MS-PS2-2, KSA4]**

Targeted PE-related KSAs

MS-PS2-1, KSA1: Develop a model to represent the motion of objects in colliding systems and their interactions (e.g., inputs, processes, and outputs, as well as energy and matter flows within systems).

MS-PS2-2, KSA2: Explain how the change in motion of an object (i.e., changes over time and forces at different scales) is due to balanced or unbalanced forces acting on the object.

MS-PS2-1, KSA2: Describe a design approach as a possible solution to a problem involving the motion of two colliding objects.

MS-PS2-1, KSA6: Apply Newton's third law to identify the scientific principle (e.g., action-reaction forces) that supports the effectiveness of the design.

MS-PS2-4, KSA4: Make logical and conceptual connections between evidence and explanations of stability and change in an object's motion.

Cross-performance Expectations Related KSAs to Target

NA

Student Demonstrations of Learning

- Model accurately represents the observable phenomena.
- Develops and/or uses a model to determine a design solution to a problem.
- Identifies a solution that is most likely to be successful.
- Determines how well the design solution meets the criteria and constraints, based upon an understanding of Newton's third law.
- Analyzes and interprets data to determine how a design best minimizes collision force.

Work Products

- Complete a model.
- Interpretation of models.
- 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 Part A	**X**			**X**				**X**		**X**		
1 Part B	**X**			**X**				**X**		**X**		
2 Part A		**X**			**X**			**X**			**X**	
2 Part B		**X**			**X**			**X**			**X**	
2 Parts C & D		**X**			**X**				**X**			**X**

Rubric Considerations

- Accuracy of the model.
- Sophistication of the explanations.

Assessment Boundaries

- Assessment is limited to vertical or horizontal interactions in one dimension.
- Assessment is limited to forces and changes in motion in one dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.

Common Alternate Conceptions

- **MS-PS2-1**
  - Action-reaction forces cancel each other.
- **MS-PS2-2**
  - Different types of motion—rest, constant velocity, and constant acceleration—are the same.
  - If speed increases, then acceleration must be increasing as well.
  - Contact/field forces and net forces are the same.
  - Forces must be exerted on a system for the system to maintain motion.

- If the sum of all forces adds to zero, then the object must be at rest.
- If the sum of all forces adds to zero, then the object cannot move.
- Any force on an object must be in the direction of movement.
- Individual forces, not their sum, determine the motion of an object.
- If an object is moving, the sum of all forces cannot equal zero.
- Constant speed, not constant acceleration, results from constant force.
- An object can have a force within it that keeps it moving.

Possible Technical Terms for Task

- balanced force, unbalanced force, collision, Newton's third law of motion, action-reaction force pairs, momentum

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)**
- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **(MS-PS2-1), (MS-PS2-2)**

Writing History/Social Studies, Science and Technical Subjects

- **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. **(MS-PS2-1), (MS-PS2-2)**

Common Core State Standards for Mathematics

Mathematical Practices

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

Mathematics

- **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. **(MS-PS2-1)**
- **6.EE.A.2** Write, read, and evaluate expressions in which letters stand for numbers. **(MS-PS2-1), (MS-PS2-2)**
- **7.EE.B.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. **(MS-PS2-1), (MS-PS2-2)**

- **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem and construct simple equations and inequalities to solve problems by reasoning about the quantities. **(MS-PS2-1), (MS-PS2-2)**

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 concretely 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