



Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 1 Instructionally-embedded Assessment Task Specification Tool:

“Designing Solutions to a Problem Involving a Collision”

Forces and Energy

April 2023

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SIPS Grade 8 Unit 1 Instructionally-embedded Assessment Task Specification Tool

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|----------------|---------------|--------------------------------|---|
| Grade 8 | Unit 1 | Instructional Segment 4 | Task Title: Designing Solutions to a Problem Involving a Collision |
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Unit 1: Forces and Energy

Anchor Phenomenon

In this unit, the anchor phenomenon is about collisions. These compelling situations can be used as a starting point for a discussion about collisions in various situations, the effects of those collisions on an object's motion, and the factors that affect the forces and corresponding changes in motion. There are several possible anchoring phenomena that the teacher may want to consider. Some examples are:

- The teacher may start with an image (or video) of a soccer ball colliding with a player's face. Video of ball/face collision: <https://youtu.be/On1CsbTwlDs?t=155>.
- The Artemis Mission and Orion Spacecraft: The Orion spacecraft is used as part of the Artemis missions, seeking to return a human to the moon. This will require landing on both the moon and Earth and bringing an object down to Earth so that it collides safely. Information on the NASA mission, including images and videos: <https://www.nasa.gov/exploration/systems/orion/index.html> and <https://www.nasa.gov/artemis/videos>.
- Motor vehicle safety/accidents. Crash tests and automobile safety equipment help keep people safe in the event of an accident. For example: <https://www.youtube.com/watch?v=VEHC2iJ3Ufg> or <https://www.youtube.com/watch?v=fPF4fBGnk0U>.

Problematization/Investigative Strategy for the Unit

The unit opening will focus on students experiencing and discussing a phenomenon that sparks their interest and curiosity. To do so, the class engages with an "anchor phenomenon" and generates questions based on that phenomenon, posting their questions to the "driving question board." Some of the questions added to the driving question board can be used by the teacher to transition into Instructional Segment 1 by framing the lessons (and segment) as a means by which to investigate and answer some of the questions that students generate based on the anchor phenomenon.

Throughout the unit (e.g., at the conclusion of each instructional segment) the teacher returns to the driving question board and has students reflect on their recent learning, and which questions they can now answer based on their learning in the prior segment. Following this reflection, the teacher uses the driving question board again, this time identifying remaining unanswered (or partially answered) questions that can motivate the activities and investigations that will be the focus of the next instructional segment.

Segment 4 Overview

Students engage in the practice of designing and carrying out investigations to examine the effect and the size of gravitational forces on the motion of objects and the effect of distance on the magnitude of gravitational forces. Students develop models to represent how the variables of distance and mass impact the motion of objects. Students construct explanations and models and engage in arguments from evidence about gravitational interactions. Students use their models, data, and scientific knowledge when refining and presenting their design solutions to the problem of collisions and an egg-drop challenge.

| Lesson Title | Lesson Description |
|---|---|
| Applying Understanding of Forces and Kinetic Energy to a Design Project | <p>In the lesson, "Applying Understanding of Forces and Kinetic Energy to a Design Project," students are presented with the engineering challenge of protecting an "egg-stronaut" as it returns to Earth. Students are presented with the engineering problem: protecting the egg as it collides with the Earth. This is the classic egg-drop engineering activity. To start, the teacher should provide some information about the challenge and design constraints. These constraints could include the materials, the size, the weight, the cost, or other constraints that make sense. From there, students work in small groups on the engineering process to design a prototype, which they share with the class for feedback.</p> <p><u>What Students Figure Out:</u></p> <p>a. Solutions to a design problem uses available information sources that provide information on constraints and criteria. (CCC: Influence of Science, Engineering, and Technology on Society and the Natural World).</p> |

| Formal Assessment Title | Assessment Description |
|--|--|
| Designing Solutions to a Problem Involving a Collision | <p>The teacher introduces the assessment by presenting a problem involving the motion of two colliding objects.</p> <p>Next, the teacher can opt to show students the video located at https://www.youtube.com/watch?v=3Cl3VEyseLc to support student engagement.</p> <p>At the end of the task, students are directed to explain the fact that not all of the water balloons popped during the world's largest water balloon fight.</p> |

| NGSS PE(s) Code(s) & Description(s) |
|--|
| MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. |
| AG(s) Code(s) & Description(s) |
| A1. Design a solution to a problem that utilizes the fact that when two objects interact, they exert a force on each other in opposite directions. |
| A3. Create a model to show the direction of the forces exerted by two interacting objects on each other is opposite. |
| A4. Construct an explanation that describes the relationship between force and motion to describe phenomena. |
| A6. Apply Newton's Third Law to explain a situation involving the motion of two colliding objects. (MS-PS2-1) |

Evidence Statement(s)

- Apply Newton’s third law of motion to justify and identify the best design and to provide justification for the selection based on the application of Newton’s third law of motion when provided a description of a physical situation involving a collision between two objects and a list of multiple designs with given criteria.
 - Refer to the system model to identify how objects are interacting to design the system model.
 - Construct a system model to analyze Newton’s third law forces in a collision (force directions).
 - Determine the effect of speed within a collision.
 - Identify the action-reaction force pair during the collision of two objects and the statement regarding the magnitude of the action-reaction forces involved in the collision.
 - Use the appropriate scientific principle (e.g., action-reaction forces) that supports the effectiveness of the design solution to a problem involving the motion of two objects.
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Phenomenon or Phenomenon-rooted Design Problem

- Water balloon drop – related to the engineering challenge of protecting an “egg-stronaut” as it returns to Earth.
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General Scenario Description

Students are introduced to a scenario related to the world’s largest water balloon fight. Students explore Newton’s third law as it relates to action-reaction force pairs in a collision between two objects. Students consider force pairs and the magnitude of forces to explain why not all the water balloons popped during the water balloon fight.

Chain of Sensemaking

- Students explore practical examples of the collision of two objects under different conditions.
 - Students describe Newton’s third law as it relates to the collision between two objects.
 - Students create a model to represent systems and their interactions.
 - Students describe the elements of their model and the scientific principle (e.g., action-reaction forces) that supports their explanation of physical situations.
 - Students reflect upon the opening description of the water balloon fight, describe the action-reaction force pairs during collisions, and explain the fact that some balloons do not burst due to the magnitude of the action-reaction forces involved in the collision.
 - Students identify the criteria and constraints they can apply to a design solution to the water balloon problem.
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Work Products

- Completed model
- Constructed response

Application of Universal Design for Learning-based Guidelines to Promote Accessibility (<https://udlguidelines.cast.org/>)

| Multiple Means of Engagement | Multiple Means of Representation | Multiple Means of Action & Expression |
|--|---|---|
| <input type="checkbox"/> Context or content | <input checked="" type="checkbox"/> Provide visual diagrams and charts | <input checked="" type="checkbox"/> Solve problems using a variety of strategies |
| <input checked="" type="checkbox"/> Age appropriate | <input type="checkbox"/> Make explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams | <input checked="" type="checkbox"/> Sentence starters |
| <input checked="" type="checkbox"/> Appropriate for different groups | <input checked="" type="checkbox"/> Activate relevant prior knowledge | <input checked="" type="checkbox"/> Embed prompts to “show and explain your work” |
| <input checked="" type="checkbox"/> Makes sense of complex ideas in creative ways | <input checked="" type="checkbox"/> Bridge concepts with relevant and simple analogies and limited use of metaphors | |
| <input type="checkbox"/> Vary the degree of challenge or complexity within prompts | <input type="checkbox"/> Highlight or emphasize key elements in text, graphics, diagrams, formulas | |
| | <input type="checkbox"/> Use outlines, graphic organizers, unit organizer routines, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships | |
| | <input checked="" type="checkbox"/> Give explicit prompts for each step in a sequential process | |

Targeted PE(s) Code(s) and Alternate Conception(s)

- **NGSS PE: MS PS2-1.** Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.
 - **Common Alternate Conceptions**
 - Action-reaction forces cancel each other

Unit 3 Vocabulary

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|-------------|------------------------|----------------------|
| • Motion | • Elasticity | • Newton’s Third Law |
| • Force | • Collision | • System |
| • Magnitude | • Action-reaction pair | • Speed |