Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 2 Task 3 Specification Tool & Verification of Alignment

Gravity and Motion of Objects in the Solar System

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SIPS Grade 8 Unit 2 Task 3 Specification & Verification of Alignment

Grade: 8	Unit: 2	Task Number: 3	Task Title: Earth's Solar System

NGSS Performance Expectations

MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon and seasons. [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] *[Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]*

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models] *[Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]*

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 problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.]

Phenomena or Phenomena-rooted Design Problem

- Comparing properties of planets in Earth's solar system (i.e., gravitational pull, orbits of planets) and their position in the solar system using data and the sequence of events needed to explain the formation of Earth's solar system from a dust cloud (nebula).

Scenario/Context/Situation/Boundaries

- The scenario presents data related to the gravitational pull of planets in Earth's solar system.
- Students develop an argument that the 'weight' of an object on a planet increases with the magnitude of gravitational force using evidence from the data provided.
- Scenario includes a situation in which students are to use data to reach conclusions about the similarities and differences among solar system objects (e.g., rocky or gaseous planets).
- Scenario includes the use of evidence generated from a model representing a phenomenon related to a planet-sun system to support/refute a hypothesis based on the positions of the objects, relative to each other.
- The scenario includes a situation in which students are to explain the formation of Earth's solar system from a dust cloud (nebula).

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.
- Function of the model:
  - To explain a mechanism underlying a phenomenon.
  - To predict future outcomes.
  - To describe a phenomenon.
  - To generate data to inform how the world works.
- Mathematical representations.
- Representation of data.

General Description of Task/Chain of Sensemaking

- Students are asked to analyze data, applying appropriate scale and proportion, about the relationships of mass and gravitational force as related to objects in the solar system. **[Prompt 1, Parts A & B: MS-PS2-4, KSA5]**
- Students are asked to make a prediction regarding the relationship between the mass of objects interacting via gravitational forces. **[Prompt 1, Part C: MS-PS2-4, KSA6]**
- Students are asked to organize and interpret data to make inferences based on properties of objects within the solar system. **[Prompt 2: MS-ESS1-3, KSA5]**
- Students are asked to manipulate the components of a model to make predictions of the motions of objects within a galaxy and/or solar system. **[Prompt 3: MS-ESS1-1 & MS-ESS1-2, KSA1]**
- Students are asked to explain how relevant evidence/data supports or refutes a claim related to the components/sequences of events that resulted in the formation of our solar system from a dust cloud (nebula). **[Prompt 4: MS-ESS1-2 and MS-PS2-4, KSA1]**

Targeted PE-related KSAs

MS-PS2-4, KSA5: Identify proportional relationships of mass and gravitational force using data to construct an argument.

MS-PS2-4, KSA6: Use proportional relationships of mass and/or distance and gravitational force(s) using data to make a prediction.

MS-ESS1-3, KSA5: Organize and interpret data to observe patterns and make inferences about scale properties of objects within the solar system.

Cross-performance Expectations Related KSAs to Target

MS-ESS1-1 & MS-ESS1-2, KSA1: Manipulate the components of a model to make predictions of the motions of objects within a galaxy and/or solar system.

MS-ESS1-2 and MS-PS2-4, KSA1: Use reasoning to explain how relevant evidence/data supports or refutes a claim related to the components/sequences of events that resulted in the formation of our solar system from a dust cloud (nebula).

Student Demonstrations of Learning

- Correctly identifies evidence that supports a claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- Constructs a sound argument that mass increases the magnitude of gravitational force.
- Chooses appropriate data related to similarities and differences among objects.
- Compares and contrasts properties of objects within the solar system.
- Draws appropriate conclusions about similarities and/or differences among objects in the solar system.
- Accurately describes the pattern shown in the model.
- Appropriateness of the description of how the solar system formed.

Work Products

- Selected response.
- Constructed response.
- Interpretation of data.
- Written arguments supported by empirical evidence and scientific reasoning to support the claim.

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**	
1 Part C		**X**		**X**				**X**			**X**	
2		**X**			**X**			**X**			**X**	
3 Part A		**X**			**X**				**X**			**X**

3 Part B	**X**	**X**		**X**	**X**
4	**X**		**X**	**X**	**X**

Rubric Considerations

- Sophistication of the explanations.
- Correctness and/or appropriateness of the scale drawing.

Assessment Boundaries

- Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.
- Assessment does not include phenomena that cause cycles of ice ages and other gradual climate changes.
- Students do not need to know Earth’s exact tilt; sidereal and synodic periods; umbra and penumbra (the term “shadow” should be used); times of moonrise and moonset; precession; exact dates of equinoxes and solstices.
- Assessment does not include recalling facts about the properties of the planets and other solar system bodies.
- Assessment does not include the use of scientific notation.
- Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects.

Common Misconceptions

- **MS-ESS1-1**
  - The “dark side” (or far side) of the Moon does not receive light from the sun.
  - All objects within the solar system orbit on the same plane.
  - The distance between Earth and the sun is the primary cause of seasons.
- **MS-ESS1-2**
  - The Milky Way galaxy is at the center of the universe.
  - Earth and the solar system are at the center of the Milky Way.
  - The relative proximity of Earth to the sun causes seasons.
  - Celestial bodies are discrete bodies without pattern or hierarchy.
  - The solar system always existed in its current form.
  - Some, but not all, celestial objects have gravity.
- **MS-ESS1-3**

- A diagram of the solar system built to scale for distances from the sun can also present the relative sizes of the planets and the sun at the same scale.
    - Increased mass equals increased density.
    - A larger diameter equals more density.
- **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

- orbit, eclipse, galaxy, satellite, elliptical orbit, scale (and possible 'scale model'), Earth-sun-moon system, eclipse, universe, galaxy, accretion, density, gravitational pull, Milky Way, galaxy, orbital distance

Common Core State Standards for Literacy

ELA/Literacy

- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. **(MS-ESS1-3)**
- **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-ESS1-3)**
- **WHST.6-8.1** Write arguments focused on discipline-specific content. **(MS-PS2-4)**
- **SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. **(MS-ESS1-1, MS-ESS1-2)**

Common Core State Standards for Mathematics

Mathematical Practices

- **MP.2** Reason abstractly and quantitatively. **(MS-ESS1-3)**
- **MP.4** Model with mathematics. **(MS-ESS1-1, MS-ESS1-2)**

Mathematics

- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. **(MS-ESS1-1, MS-ESS1-2, MS-ESS1-3)**
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. **(MS-ESS1-1, MS-ESS1-2, MS-ESS1-3)**

- **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-ESS1-2)**

Task Notes

SIPS Assessments Complexity Framework Components

<table>
<tr><th rowspan="2"></th><th rowspan="2">Component</th><th colspan="3">Complexity</th></tr>
<tr><th>Low</th><th>Moderate</th><th>High</th></tr>
<tr><td>Connections to Curriculum and Instruction</td><td>A.1 Degree and nature of sense-making about phenomena or problems</td><td>• Requires one or two dimensions
• One dimension may have a greater degree of emphasis than another
• Requires previously learned ideas or concepts</td><td>• 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</td><td>• 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</td></tr>
<tr><td rowspan="2">Characteristics of the Tasks</td><td>B.1 Complexity of the presentation</td><td>• 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 presented in a concrete way with high level of certainty</td><td>• 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</td><td>• 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</td></tr>
<tr><td>B.2 Cognitive demand of response development</td><td>• 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</td><td>• 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</td><td>• 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</td></tr>
</table>

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