



Stackable Instructionally- embedded Portable Science (SIPS) Assessments Project

Grade 8 Science

Unit 2 Task 1 Specification Tool & Verification of Alignment

Gravity and Motion of Objects in the Solar System

September 2023

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

Grade: 8

Unit: 2

Task Number: 1

Task Title: Orbiting Around

NGSS Performance Expectations

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.]*

Phenomena or Phenomena-rooted Design Problem

- The orbital nature of two objects interacting via gravity and inertia.
- Compare size (as diameter or mass), number, or characteristics (e.g., average distance from a planet, orbital period) of moons, asteroids, and comets.

Scenario/Context/Situation/Boundaries

- Scenario includes a situation in which students are to model gravity as the attractive force that keeps solar systems together.
- Students are asked to use the patterns found in data at varying scales to draw conclusions and identify characteristics of different categories of solar system objects based on their locations within the solar system.
- 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.

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- 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.
 - Measurement tools and units.
 - Mathematical representations.
 - Representation of data.
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General Description of Task/Chain of Sensemaking

- Students are asked to complete a model of the role of gravity and inertia in the motions of planets within the solar system. **[Prompt 1: MS-ESS1-2, KSA1]**
 - Students are asked to explain how to use patterns found in data to describe the order of the planets from the Sun outward and use patterns when comparing the inner planets to the outer planets. **[Prompt 2: MS-ESS1-3, KSA2]**
 - Students are asked to develop a scale to be used to create a model of a system that includes Earth, the moon, and a near-Earth object. **[Prompt 3, Part A: MS-ESS1-3, KSA5]**
 - Students develop an explanation of the limitations of using scale relationships to represent distances and objects in the solar system. **[Prompt 3, Part B: MS-ESS1-2 & MS-ESS1-3, KSA1]**
 - Students interpret a graph displaying a data set to describe the relationship between asteroid diameters and the number of asteroids in Earth's solar system. **[Prompt 3, Part C: MS-ESS1-3, KSA4]**
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Targeted PE-related KSAs

MS-ESS1-2, KSA1: Describe how a model shows the role of gravity in the motions of objects within a galaxy and/or solar system.

MS-ESS1-3, KSA2: Analyze data, applying appropriate scale and proportion, about objects in the solar system.

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

MS-ESS1-3, KSA4: Draw conclusions about the similarities and differences among solar system objects based on data.

Cross-performance Expectations Related KSAs to Target

MS-ESS1-2 & MS-ESS1-3, KSA1: Use a model to collect evidence to reason qualitatively or quantitatively about scale relationships represented in a model of objects in the solar system.

Student Demonstrations of Learning

- Accurately describes the interactions with a system shown in a model.
- Model accurately represents the gravitational interactions within a system.
- Compares and contrasts properties of objects within the solar system (i.e., size, distances, layers, surface features, orbital radius, density).
- Draws appropriate conclusions about similarities and/or differences among objects in the solar system.
- Draws appropriate conclusions about similarities and/or differences among objects in the solar system.

Work Products

- Draw a model to describe the phenomena.
- Interpretation of data.
- 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
<ul style="list-style-type: none">• 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.	<ul style="list-style-type: none">• 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.	<ul style="list-style-type: none">• 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		
2 Parts A & B		X			X			X			X	
3 Parts A & B			X		X				X			X
3 Part C		X		X				X			X	

Rubric Considerations

- Correctness and/or appropriateness of the scale model.
- Accuracy of the data and data representations.
- Sophistication of the explanations.

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 recalling facts about the properties of the planets and other solar system bodies.

Common Misconceptions

- **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 without 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.
- Larger diameter equals more density.

Possible Technical Terms for Task

- gravity, inertia, near-Earth Object, planets, moons, orbit, solar system, asteroid

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)**
- **SL.8.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. **(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-ESS1-2)**

Mathematics

- **6.RP.A.1** Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. **(MS-ESS1-2, MS-ESS1-3)**
- **7.RP.A.2** Recognize and represent proportional relationships between quantities. **(MS-ESS1-2, MS-ESS1-3)**
- **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or depending on the purpose at hand, any number in a specified set. **(MS-ESS1-2)**
- **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-ESS1-2)**

Task Notes

SIPS Assessments Complexity Framework

Component	Complexity		
	Low	Moderate	High
Connections to Curriculum and Instruction	<p>A.1 Degree and nature of sense-making about phenomena or problems</p> <ul style="list-style-type: none"> Requires one or two dimensions One dimension may have a greater degree of emphasis than another Requires previously learned ideas or concepts 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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	<p>B.1 Complexity of the presentation</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
	<p>B.2 Cognitive demand of response development</p> <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
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