Coherence and Alignment Among Science Curriculum, Instruction, and Assessment (CASCIA) Project

Grade 8 Unit 2: Gravity and Motion of Objects in the Solar System

Interpretive Guidance and Instructional Strategies for Educators

March 2025

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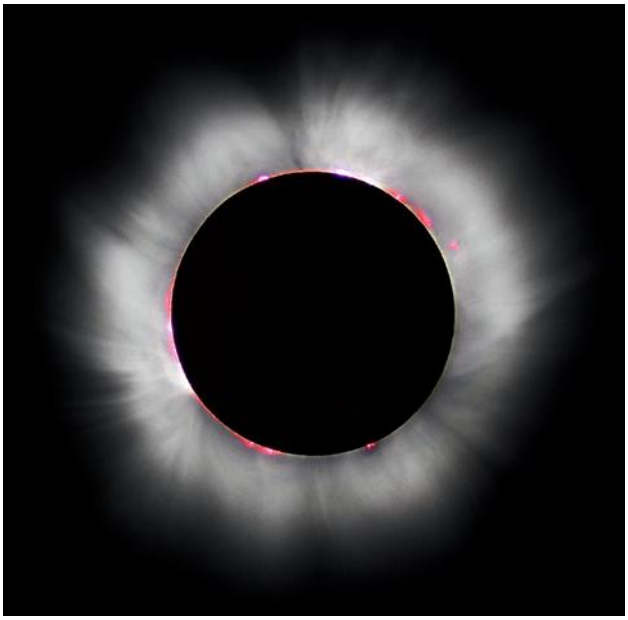
Purpose

The purpose of this document is to help educators understand their students' performance on the Grade 8 Unit 2 Science Assessment and to provide instructional strategies and resources for planning and adjusting instruction to help students learn, whether it involves reteaching previously addressed concepts and skills from the prior instructional unit or planning additional learning opportunities, interventions, or extensions in the next unit.



Credit: "Total solar eclipse" by Luc Viatour
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Unit Overview

By engaging in this unit, students deepen their knowledge of Earth's place in the universe, the force of gravity between objects with mass, and the role of gravitational force in keeping planetary objects in orbit. Students develop their experience and skills in developing and using models and analyzing and interpreting data to investigate the characteristics of objects in the solar system, explain patterns of the apparent motion of the sun, moon, and stars, and construct and support evidence-based arguments about the connections between gravitational forces and orbital motion.

Instructions for Educators

1. Based on your analysis of student work from the assessment, in combination with additional assessment evidence gathered over the course of the instructional unit, consider themes or trends in your students' performance. Refer to your students' scores on the Classroom Roster Report to determine the degree to which students in your classroom require additional instructional support based on their instructional needs levels—red, yellow, or green—for each performance category.
2. For each performance category, use the provided interpretive guidance (i.e., *What These Results Mean*, *Next Instructional Steps*, and *Example Scored and Annotated Student Work* located in the Grade 8 Unit 2 EOU Assessment Scoring Guide) to understand what your students likely know and are able to do and to consider next instructional steps based on their instructional needs levels. Scored and annotated student work samples are provided for each performance category to demonstrate the evidence students might demonstrate in response to each prompt for each possible score point. The student responses represent the full range of score points possible for each prompt based on the scoring rubric.
3. For each performance category, use the *Instructional Strategies and Resources* organized by Universal Design for Learning (UDL) principle to support the design and delivery of accessible instruction and learning opportunities for all students based on their performance on the Grade 8 Unit 2 Assessment and their recommended instructional needs. These instructional recommendations can be selected and used to intentionally plan instruction and learning opportunities for students across the range of instructional needs levels (i.e., red, yellow, green).

Universal Design For Learning

The instructional strategies and resources provided in this document are organized by the Universal Design for Learning (UDL) principles. UDL is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn." (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles, Multiple Means of Engagement, Multiple Means of Representation, and Multiple Means of Action & Expression as ways to focus on variety and flexibility in instructional practices.

 Multiple Means of Engagement	*The WHY of Learning* - provide options for recruiting student interest, sustaining effort, and promoting motivation
 Multiple Means of Representation	*The WHAT of Learning* - provide options for displaying information, including alternatives for auditory and visual information, use multi-media, clarify vocabulary and symbols, support comprehending text, and guide information processing and visualization
 Multiple Means of Action & Expression	*The HOW of Learning* – vary the methods for student responses and collection of evidence of their learning, optimize access to tools and technologies, use multiple tools for construction and composing responses, facilitate managing information and resources, and enhance student capacity for monitoring progress

By examining instruction and instructional materials through the lens of each of these principles, we can identify and thus reduce or remove barriers to diverse learners to promote accessible and equitable teaching and learning opportunities. Application of UDL guidelines and principles allows all students to engage with and be provided with multiple means of representing instructional content and expressing what they know and can do which is similarly the purpose of the use of accommodations for students receiving special education, students who have a 504 plan, and emerging Bilinguals.

Performance Category 1: Model Relationships Among Objects in Earth's Solar System

Interpretive Guidance for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Red (0-6 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (7-10 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (11-13 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • Present **incomplete and/or inaccurate** representations of the role of gravity and inertia in the motions of planets within the solar system and/or of the cyclic pattern of the lunar phases. • Present **incomplete and/or inaccurate** scale representations (values are incorrect with respect to each other) of a system that includes Earth. • Use a model to develop **incomplete and largely inaccurate** explanations of the position and motions of objects within a galaxy and/or solar system.	**This student is likely able to:** • Present **clear and complete** representations with **minor errors** of the role of gravity and inertia in the motions of planets within the solar system and/or the cyclic pattern of the lunar phases. • Present **partially accurate** scale representations of a system that includes Earth with **minor calculation errors**. • Use a model to develop **incomplete but accurate** explanations of the position and motions of objects within a galaxy and/or solar system.	**This student is likely able to:** • Present **clear, complete, and accurate** representations of the role of gravity and inertia in the motions of planets within the solar system and/or the cyclic pattern of the lunar phases. • Present **accurate** scale representations of a system that includes Earth with **few calculation errors**. • Use the model to develop **thorough and accurate** explanations of astronomical and other observations of cyclical patterns (e.g., eclipses, tides, seasons).

Instructional Strategies and Resources for Performance Category 1:
Model Relationships Among Objects in Earth's Solar System

Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)

Red (0-6 score points earned)	Yellow (7-10 score points earned)	Green (11-13 score points earned)
➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Select and label components of a model to identify the effect gravity has on the direction of motions of objects within the solar system. • Select the most accurate and complete model of the cyclic pattern of the lunar phases from a range of models. • Select the most accurate and complete explanation of the motions of objects within a galaxy and/or solar system.	**Provide opportunities for the student to:** • From a given model, develop a complete and accurate explanation of the role of gravity and inertia in the motions of planets within the solar system and/or the cyclic pattern of the lunar phases. • Interpret data to determine the scale properties of objects within our solar system to visualize the relative sizes of objects in the system and distances between objects. • Identify and use multiple representations of the position and motions of objects within a galaxy and/or solar system.	**Provide opportunities for the student to:** • With and without using models, compare and refine explanations of a wide range of macro-phenomena, focusing on generating explanations and predictions about the behavior of a scientific phenomenon related to the Earth-sun-moon system. • Compare and refine models of a wide range of macro-phenomena to describe the role of gravity in the motions within galaxies and the solar system.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System

Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	***Modeling through Discourse*** Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse where they build on others' ideas to optimize the use of a range of models to show relationships among objects, forces, and cycles in the solar system. Opportunities for scientific discourse should be situated in the authentic, interest-driven, science-based development of models. ***Culturally Responsive Modeling*** Foster model-development practices that are culturally responsive, drawing from and respecting students' cultural resources, backgrounds, and personal experiences. Provide a range of ways for students to engage in cooperative learning (e.g., think-pair-share, jigsaw, round robin) with diverse groupings of students.	• Talk Activities Flowchart – This flowchart can help structure activities so that students' talk is more equitable, scientific, and focused on sensemaking in support of a classroom culture based on curiosity and learning. [https://stemteachingtools.org/sp/talk-flowchart] • STEM Teaching Tools – Practice Brief 55 – This article explains why making cultural diversity visible in STEM education is crucial. [https://stemteachingtools.org/brief/55] • STEM Teaching Tools – Practice Brief 48 – This article discusses how teachers can use tools to scaffold student science talk and includes Talk Resource Tools to foster shifts in science classroom talk. [https://stemteachingtools.org/brief/48] • 5 Tips to Make Your Science Classroom More Culturally Responsive – This Edutopia article includes suggestions on how science teachers can encourage students to explore their individual cultural heritages. [https://www.edutopia.org/article/5-tips-creating-culturally-responsive-science-curriculum/] • Ten Culturally Responsive Teaching Strategies for the Science Classroom – This *Education Week* article describes ten straightforward ways in which teachers can be culturally responsive while teaching science.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://www.edweek.org/teaching-learning/opinion-ten-culturally-responsive-teaching-strategies-for-the-science-classroom/2021/02]
	*Modeling and Critiquing Scientific Models* Use spoken and written examples to model how to evaluate and refine models comparing predictions with the real world and encourage students to adjust and refine the model by identifying strengths and weaknesses in the model to explain the relationship between objects in our solar system.	• Synchronous Rotation of the Moon – This 2:19 minute video shows two non-examples before modeling the actual synchronous rotation of the moon. [https://www.youtube.com/watch?v=OZIB_leg75Q&t=72s] • Solar System Size and Distance – This NASA video accurately compares the planets' sizes and distances in the solar system. [https://www.jpl.nasa.gov/edu/learn/video/solar-system-size-and-distance/] • Models: Bringing Real-World Phenomena to School – This article demonstrates how teachers can use real-world phenomena to highlight the importance and limits of scientific models. [https://smithsonianstc.com/models-bringing-real-world-phenomena-to-school-whitepaper/] • Can Poor Science Models Still Be Useful for Teaching Science? – This article uses an example of a toy solar system model to show teachers how to guide students in analyzing the flaws of such models. Students exhibit scientific literacy and their understanding of the content by questioning what is presented to them.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://www.fizzicseducation.com.au/articles/can-poor-science-models-still-be-useful-for-teaching-science/] • How to Make a Good Scientific Model – This brief article offers a simple way to begin critiquing student models. It includes a "Good Model" checklist. [https://knowledge.carolina.com/discipline/earth-environmental/how-to-make-a-good-scientific-model/]
	***Promoting Engagement through Interactive, Collaborative Games*** Use interactive games and collaborative formats to reinforce disciplinary core ideas related to science ideas about a phenomenon demonstrating the role of gravity and inertia in the motions of planets within the solar system and/or the cyclic pattern of the lunar phases.	• Orbital Order – This interactive game quizzes students on the distances and rotations of individual planets and then has them place them in order. Correct answers are given when a question is answered incorrectly. [https://www.abcya.com/games/orbital_order]
	***Vocabulary*** Provide varied opportunities for students to learn and apply vocabulary in diverse situations and contexts. Vocabulary retention improves when academic terminology is layered on conceptual understanding. To maximize vocabulary building, support students in building conceptual understanding and then apply the academic terminology using the strategies outlined below.	• Teaching Science Vocabulary with *The Shape of the Moon's Orbit* – This NASA lesson uses the phenomenon of the moon's orbit to build a deeper understanding of science vocabulary. It offers a framework that can be applied to other lessons. [https://ibex.princeton.edu/sites/g/files/toruqf1596/files/shape_of_moons_orbit.pdf] • Science Word Walls: A Must Have in Your Classroom – This webpage offers tips for science word walls as well as editable

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***

	• Build understanding of domain-specific vocabulary using a multi-sensory approach or having students participate in simulations.
	• Make connections between vocabulary and real-life or future opportunities.
	  ○ Explain, describe, give real-world examples, or provide concrete representations of vocabulary words rather than formal definitions. Vocabulary.com (see Resources) provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students.
	  ○ Build a vocabulary word wall for students to add and reference during instruction and self-guided activities or tasks.
	  ○ Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge.
	• Read books or watch videos related to vocabulary words and concepts.
	• Sort words, photographs, or concrete representations into categories. Text Project (see Resources) provides free Word Pictures for educators to use. It includes Word
		templates and pre-made word cards. [https://beakersandink.com/word-wall/]
		• STEM Teaching Tools – Practice Brief 66 – This article discusses how to support emerging multilingual learners as they develop language that interprets and explains phenomena. [https://stemteachingtools.org/brief/66]
		• Vocabulary.com – This site provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. [https://www.vocabulary.com/]
		• Text Project – Word Pictures – This site provides word pictures that are free for educators to use. It includes word pictures for core vocabulary and various content areas, including science and social studies. [https://textproject.org/archive/textproject-word-pictures/]
		• The Science Penguin – This website provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary terms. [http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html]
		• Interactive Word Walls Enliven Vocab Learning – This article with teaching strategies supports students' use of a word wall to build understanding of key vocabulary.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	Pictures for core vocabulary and various content areas, including science and social studies. • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge. • Define domain-specific vocabulary using both domain-specific and common terms. • Embedded visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.). • Have students create their glossary of terms.	[https://www.middleweb.com/37209/interactive-word-walls-enliven-vocab-learning/]
	***Presenting Information in Different Modalities*** Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas related to a scientific phenomenon involving the Earth-sun-moon system.	• Visualizing Our Solar System – This interactive webpage allows students to zoom, pan, and jump to objects in the solar system. [https://aptv.pbslearningmedia.org/resource/buac68-sci-visualizesolarsystem/visualizing-our-solar-system/] • Gravity and Orbits – This interactive simulation allows students to view the Earth-sun-moon system while selecting variables. Velocity vectors show the path that objects would take without gravity. [https://phet.colorado.edu/sims/html/gravity-and-orbits/latest/gravity-and-orbits_en.html] • How Does Gravity Govern Motion in the Universe – This online text explains the importance of gravity and inertia in the universe. It includes activities and questions.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://grade8science.com/3-4-4-how-does-gravity-govern-motion-in-the-universe/] • Space Math: Scale of the Solar System – This lesson offers practice problems on the scale of the solar system. The problems are grouped by topic and could be divided between groups of students. Click the word "View" to access the entire pdf. [https://aptv.pbslearningmedia.org/resource/buac68-sci-scalesolarsystem/scale-of-the-solar-system/]
	***Maximizing Transfer of Information*** Provide information in a manner that guides learners and supports generalization and transfer of knowledge about objects in Earth's solar system by employing explicit strategies such as accessing prior knowledge, embedding in familiar contexts, using mnemonic devices, applying to new situations, and using graphic organizers.	• Learning by Inquiry – This website offers methods to activate prior knowledge by using a constructivist mindset to help learners integrate new information. [https://www.learningbyinquiry.com/simple-strategies-to-activate-students-prior-knowledge/] • Increasing the Value of Graphic Organizers – This *Edutopia* article explains the importance of allowing students to take ownership of learning by creating their own graphic organizers. [https://www.edutopia.org/article/increasing-value-graphic-organizers/] • 10 Strategies and Tools to Activate Knowledge – This article by *The Teaching Factor* offers ten strategies and modalities for accessing students' prior knowledge. [https://theteachingfactor.wordpress.com/2021/08/24/10-strategies-and-tools-to-activate-knowledge/]

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Build Fluencies with Graduated Levels of Support for Practice and Performance* Provide differentiated models of the Earth-sun-moon system as well as scaffolds, supported opportunities, and degrees of freedom for more independence to students of varying ability levels.	• Phases of the Moon – This interactive webpage offers graphic depictions of the Earth-sun-moon system, including the lunar cycle. [https://view.genial.ly/622a65aed4fc6d00128fb359] • Phases of the Moon, Part II – This webpage contains seven interactive activities with graphics, animations, click-and-drag matching, and quick reviews about the cycle of changes of the moon as seen from Earth. [https://aptv.pbslearningmedia.org/resource/buac19-68-sci-ess-phasesmoon2/phases-of-the-moon-part-2/] • Lunar Phases – This brief online tutorial on the phases of the moon includes a 3:15 minute *History Channel* video, "The Universe: Phases of the Moon" as well as review questions. [https://flexbooks.ck12.org/cbook/ck-12-middle-school-earth-science-flexbook-2.0/section/3.11/primary/lesson/lunar-phases-ms-es/]
	*Scaffolds for Communicating through Models* Provide scaffolds for developing models to explain phenomena related to objects in Earth's solar system (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural for students.	• Moon Phases Graphic Organizer – This graphic organizer provides the framework for students to make a paper model of the phases of the moon. Follow-up questions are included. [https://www.bookunitsteacher.com/blog/march2015/lunarphases.pdf] • Developing and Using Models – This article from *MPRES Toolkit for Teachers Conceptual Change* includes a "Developing and Using Models" video from *Bozeman Science*, links to activities

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		and guiding questions. [http://www.mtscienceducation.org/toolkit-home/scientific-engineering-practices/developing-and-using-models/] • National Science Foundation – Tools for Ambitious Science Teaching – This website discusses a tool that provides scaffolds for writing that support learners in constructing explanations with evidence. These take the form of sentence frames, guides for how to help English learners practice final explanations, norms for whole-class discussion that are developed by students, roles that students can take in small group activities, and others. [https://ambitiousscienceteaching.org/orientation-ambitious-science-teaching/] • Model Teaching – CER Checklist and Graphic Organizer – This site introduces Claim-Evidence-Reasoning (CER), downloadable resources, and writing templates. [https://www.modelteaching.com/education-articles/writing-instruction/claim-evidence-reasoning-cer]
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their models and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs.	• Student Project: Make a Scale Solar System – This webpage by NASA's Jet Propulsion Laboratory offers ten projects where students construct their scale model of the solar system by learning how to calculate scale distances, the relative sizes of planets, or both. An educator guide is included.

Instructional Strategies and Resources for Performance Category 1: Model Relationships Among Objects in Earth's Solar System *Task 1, Prompt 1 (4 points); Task 1, Prompt 3, Parts A & B (3 points); Task 2, Prompt 2, Part A (3 points); Task 3, Prompt 3, Part A (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	• Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	[https://www.jpl.nasa.gov/edu/learn/project/make-a-scale-solar-system/] • 10 Great Ways for Students to Research and Present Information – This article includes a few unique methods of presentation, such as "wax museum" and "pyramids" [https://lovinglanguagearts.com/10-great-ways-for-students-to-research-and-present-information/] • Science Notebook Corner – This website offers a variety of topics relating to students using science notebooks for lab reports, journaling, drawing, planning, and creative writing. [https://aptv.pbslearningmedia.org/collection/science-notebook-corner/] • Venngage Infographic Maker – This free, user-friendly infographic-building website allows students to create visually appealing displays to present their projects. [https://venngage.com/blog/infographics-maker?utm_source=google&utm_medium=cpc&utm_campaign=&utm_content=&utm_term=infographic%20maker&match=e&campaignid=19558960020&adgroupid=143879091486&gad=1&gclid=CjwKCAjws9ipBhB1EiwAccEi1HuNZdgWNz4MdFj26NlUeiZMHVMp994nWi-pG7DVaMZCbJxCgBjIOxoChWMQAvD_BwE]

Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe

Interpretive Guidance for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Red (0-7 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (8-13 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (14-16 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • **Attempt to interpret** provided data in a graph. • Provide some evidence to support an **incomplete or inaccurate** explanation of the spatial and temporal relationships in the Earth-sun-moon system, including seasonal patterns of Earth and the cyclic pattern of the lunar phases. • **Attempt** to describe a relationship or pattern in the data when making inferences based on properties of objects within a solar system. • **Attempt** to develop an explanation of the formation of Earth's solar system with **major conceptual errors**.	**This student is likely able to:** • Accurately interpret **some** provided data in a graph, using **simple** mathematical thinking, as necessary. • Provide **adequate evidence** to support a **reasonable** explanation of the spatial and temporal relationships in the Earth-sun-moon system, including seasonal patterns of Earth and the cyclic pattern of the lunar phases. • Describe the relationship between variables and identify patterns (qualitative or quantitative) among variables represented in the data, but analyses include **some minor errors**.	**This student is likely able to:** • **Accurately interpret** provided data in a graph and **demonstrate mathematical thinking** in their explanation. • Provide **complete and accurate** evidence of the spatial and temporal relationships in the Earth-sun-moon system. • Describe the relationship between variables and identify patterns (qualitative or quantitative) among variables represented in the data with **minimal errors.** • Describe the events leading to the formation of Earth's solar system with **few conceptual errors**. • Demonstrate **complete and accurate** understanding of similarities and differences among solar system objects and **accurately**

• Demonstrate **limited** understanding of similarities and differences among solar system objects (e.g., using patterns of features when using a model to compare inner and outer planets).	• Describe **some aspects** of the events leading to the formation of Earth's solar system with **some conceptual errors**. • Demonstrate **partial** understanding of similarities and differences among solar system objects and **apply some of these concepts** to compare inner planets' conditions (e.g., surface temperature) to outer planets.	explain the pattern found regarding the comparison of surface temperatures of planets and their location in a solar system.

Interpretive Guidance for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Red (0-7 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (8-13 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (14-16 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Select the most accurate and complete graph of a phenomenon and interpret a trendline. • Present a phenomenon related to the Earth-Moon-Sun system and a driving question or hypothesis to support or refute using evidence. • Match conclusions or an explanation that a model is trying to convey. • Collaboratively critique and revise incomplete or inaccurate models and/or explanations of similarities and differences among solar system objects by describing patterns of features of those objects (e.g., distance from the sun, diameter, surface features, structure, and composition).	**Provide opportunities for the student to:** • From a given graph or data set, develop a complete and accurate explanation of a phenomenon resulting from the patterns found in multiple representations of data to draw conclusions relating to characteristics of different categories of solar system objects based on their features, composition, and locations within the solar system. • From a list of conclusions related to a phenomenon related to the Earth-Moon-Sun system, identify the most accurate explanations based on the evidence. • Evaluate the strength of a provided model and/or explanation identifying characteristics of different categories of solar system objects based on their features,	**Provide opportunities for the student to:** • Compare and refine models of a wide range of phenomena due to various interacting forces (i.e., gravity) and relationships (e.g., Earth-moon-sun-system) to describe objects and events in Earth's solar system and universe. • Develop and use graphs or tables to make comparisons between the size and gravitational pull of the planets and their moons. • Identify a revision that improves the model's explanatory or predictive power. • Research a novel phenomenon related to relative energy (gravitational potential or kinetic), generate a model comparing systems, and annotate the relationship between variables.

• Collaboratively discuss and order the components and sequences of events to form a correct explanation of the formation of Earth's solar system.	composition, and locations within the solar system. • Independently model systems (e.g., selecting from a list of components to sequence events) to form a correct explanation of the phenomenon (e.g., the formation of Earth's solar system).	

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
	*Argumentation through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse, building on each other's ideas to coordinate claims, evidence, and reasoning in a scientific argument. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations. *Culturally Responsive Argumentation* Foster culturally responsive argumentation, drawing from and respecting students' cultural resources, backgrounds, and personal experiences. Provide a range of ways for students to engage in cooperative learning (e.g., think-pair-share, jigsaw, round robin) with diverse groupings of students.	• Talk Activities that can Scaffold Argumentation and Talk Activities Flowchart – This tool highlights those talk formats and explains when, how, and why to use each talk format in support of student investigations. PDF is available in Spanish. [http://stemteachingtools.org/brief/35] • Smithsonian Science Education Center: Techniques for Encouraging a Culture of Argumentation in Your Classroom – This article discusses avenues for creating a culture of argumentation in a science classroom. [https://ssec.si.edu/stemvisions-blog/techniques-encouraging-culture-argumentation-your-classroom] • Why Summer Days Have More Daylight – Watch the video and have students gather data to support an argument that summer days have more daylight. Students can work through the interactive pages to gather evidence to support the claim that summer days have more daylight. [https://lsintspl3.wgbh.org/en-us/lesson/buac20-il-daylightsummerwinter/?as_guest=True&next=https://nebraskapublicmedia.pbslearningmedia.org/resource/buac20-35-sci-ess-daylightsummerwinter-il/why-summer-days-have-more-daylight-interactive-lesson/]
	*Modeling and Critiquing Scientific Arguments* Use spoken and written examples to model scientific arguments and encourage students to critique and challenge	• Student-Friendly Video on Scientific Argumentation – This brief, animated video explains scientific argumentation in simple terms. Non-examples are also provided.

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
	scientific arguments by identifying strengths and weaknesses in reasoning and evidence.	[https://concord.org/blog/student-friendly-video-on-scientific-argumentation/] • Argumentation and Practical Work – This website provides examples of how practical work in the classroom can be used alongside argumentation. Section 5 of this document (page 14) offers an example of how students can critique arguments. [https://www.nuffieldfoundation.org/sites/default/files/files/Argumentation%20Introduction.pdf] • Seasons on Earth and Mars Interactive – Highlight page 4 of the interactive, showing the axial tilts for planets in the solar system. Ask students to choose one planet and develop an argument for whether that planet has seasons or not. Jigsaw students into groups with the same planet, then switch so that different planets are paired up. Prompt students to critique each argument. [https://contrib.pbslearningmedia.org/WGBH/buac18/buac18-int-seasonsearthmars/index.html] • How the Inner Solar System Formed – Watch the video to collect evidence for how the inner solar system formed. Continued in the Multiple Means of Expression section. [https://nebraskapublicmedia.pbslearningmedia.org/resource/flbe12.sci.ess.eiu.planetform/how-the-inner-solar-system-formed/]

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
	*Presenting Information in Different Modalities* Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas related to Earth's place in the solar system.	• Why Do We Have Seasons Interactive – Allow students to explore the interactive and gather evidence to support an argument about Earth's tilt and its effect on seasons. [https://contrib.pbslearningmedia.org/WGBH/npls13/npls13_int_seasons/index.html] • Formation of Our Solar System SlideShow – Use the slideshow notes to explain the formation of the solar system. Ask students to gather evidence for the role of gravity and the patterns they notice in planets during the discussion. [https://www.lpi.usra.edu/education/resources/s_system/solar_sys_formation.ppt]
	*Activate Prior Knowledge* Ask questions and provide resources that connect current learning to learning that may or may not have occurred in 5th grade. Provide relevant background information for students when prior learning does not exist.	• Observe Sunrise and Sunset – Watch the video to help students remember motions of the Earth-sun-moon system throughout a calendar year. Prompt students to observe the differences between daylight in the summer vs. winter. [https://nebraskapublicmedia.pbslearningmedia.org/resource/buac18-35-sci-ess-daylightsunpath/daylight-hours-and-the-suns-apparent-path/] • Sun and Shadows Game – Give students a few minutes to interact with the shadows game to activate learning done in 5th grade. Prompt students to connect to current learning to explain why shadows are longer and shorter during the day and how the tilt of the Earth causes seasons.

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
		[https://contrib.pbslearningmedia.org/WGBH/buac18/buac18-int-ruffshadowgame/index.html]
	*Maximize Generalization and Transfer* Provide transfer scenarios that ask students to use evidence to support an argument.	• Using Phenomena in NGSS Lessons and Units – This STEM Teaching Tool describes the benefits of seating learning in phenomena. Phenomena-driven instruction helps increase students' ability to transfer learning to new scenarios. [https://stemteachingtools.org/brief/42] • What is a gravitational wave? – This resource explains how gravitational waves form and affect space. Ask students to compare gravitational waves and regular gravity. Take students a step further by asking them how the early solar system would have been affected if it had been hit repeatedly by gravitational waves. [https://spaceplace.nasa.gov/gravitational-waves/en/]
	*Scaffolds for Communicating through Argumentation* Provide scaffolds for argumentative writing and discussions to justify or describe a phenomenon or support a design solution (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural.	• Bozeman Science: Engaging in Argumentation – In this video, Paul Andersen explains how to have your students engage in argumentation in the science classroom. [https://www.youtube.com/watch?v=L96LiRDWgmI] • Stem Teaching Tool – Practice Brief 25: Equitable Argumentation – This article describes how supporting multiple modes of expression can increase how students communicate their arguments. [https://stemteachingtools.org/brief/25]

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
		• Moon Phases Graphic Organizer – Use the graphic organizer to help students visualize the phases of the moon, then ask students to argue from evidence to explain how many days each moon phase is visible in the sky. [https://www.bookunitsteacher.com/blog/march2015/lunarphases.pdf] • Evolution of our Solar System – Use the pictures to have small groups order the events in the formation of the solar system. Probe students to explain why they ordered the pictures the way they did and how gravity played a role in the events in the timeline. [https://www.lpi.usra.edu/education/timeline/activity/]
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their arguments and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc.	• Lunar Phase Interactive – Allow students to use the interactive to develop a poster model of the lunar phases, which should include the orientation of the sun, moon, and Earth as seen from space and what the moon looks like from Earth's perspective. [https://contrib.pbslearningmedia.org/WGBH/buac19/buac19-int-moonphaseint/index.html] • How the Inner Solar System Formed – Use the evidence from the video to create a cartoon about how the inner solar system formed. [https://nebraskapublicmedia.pbslearningmedia.org/resource/f

Instructional Strategies and Resources for Performance Category 2: Support Arguments About Earth's Place in the Solar System and Universe *Task 1, Prompt 3, Part C (2 points); Task 2, Prompt 1 (7 points); Task 2, Prompt 2, Part B (2 points); Task 3, Prompt 3, Part B (2 points); Task 3, Prompt 4 (3 points)*		
Instructional Strategies and Resources		
	Instructional Strategies	***Resources***
	Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	lbe12.sci.ess.eiu.planetform/how-the-inner-solar-system-formed/] • Solar System Temperatures – Use the evidence from the infographic to create a visual explanation that compares the distance from the sun and surface temperature for at least two planets that aren't Earth. [https://science.nasa.gov/resource/solar-system-temperatures/]

Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System

Interpretive Guidance for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Red (0-4 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (5-10 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (11-13 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • Provide some quantitative data to support an **incomplete or inaccurate** explanation of the relationships among objects in our solar system. • **Attempt** to describe a relationship or pattern among variables in the data with **major conceptual or procedural errors**. • **Attempt to apply** provided data related to properties of objects within the solar system when comparing the inner planets to the outer planets.	**This student is likely able to:** • Provide **adequate** quantitative data to support a **reasonable** explanation of relative distances between the planets and their orbital paths around the sun in terms of time and distance. • Describe the relationship between variables and identify patterns (qualitative or quantitative) among variables represented in the data, but analyses include **some minor errors**. • Accurately apply **some** provided data, using **simple** mathematical thinking, as necessary to make conclusions based on properties of objects within the solar system.	**This student is likely able to:** • Provide **thorough** quantitative data to support a **complete and accurate** explanation of the relationship of relative distances between the planets and their orbital paths around the sun in terms of time and distance. • **Mathematically describe** the relationship between variables and **identify patterns** (qualitative or quantitative) among variables represented in the data to make inferences based on properties of objects within the solar system. • **Accurately use** provided data, applying appropriate scale and proportion about the relationships of mass and gravitational force related to objects in the solar system, **using mathematical thinking** as necessary.

Interpretive Guidance for Performance Category 3:
Analyze Data to Describe Interactions Among Objects in Earth's Solar System

Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)

Red (0-4 score points earned)	Yellow (5-10 score points earned)	Green (11-13 score points earned)
➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Use provided data sets and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to identify and describe patterns related to objects and events in the solar system. • Identify the correct statement from a list of statements written in simple, non-academic terms about the relationship between gravitational force and mass as related to objects in the solar system based on data from a graph or table. • Identify patterns related to cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky.	**Provide opportunities for the student to:** • Analyze provided data sets and various graphical displays related to a given phenomenon using written or oral procedural supports as needed to describe patterns related to objects and events in the solar system. • Identify the correct statement from a list of statements written in grade-level academic terms about the relationship between gravitational force and mass as related to objects in the solar system within the context of the given phenomenon based on data from a graph or table. • Use patterns to identify cause and effect relationships and use graphs and charts to identify patterns in data.	**Provide opportunities for the student to:** • Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships related to objects and events in the solar system. • Generate a statement written in grade-level academic terms about the relationship between gravitational force and mass as related to objects in the solar system within the context of the given phenomenon based on data in a graph or a table. • Use patterns in large data sets at different scales to identify temporal and spatial relationships related to objects in the solar system.

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Data Analysis Through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse where they build on ideas to optimize the use of a range of tools for tabulation, graphical representation, visualization, and statistical analysis to analyze and interpret data. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations.	Use any resources about generating scientific discourse with any resources about planetary data to design a collaborative opportunity for students to engage with real data about celestial interactions. ***Discussion Tools:*** • Fostering Student-Driven Scientific Discourse – This article briefly explains student discourse, listing the reasons for its use in science, classroom norms, and types of classroom discourse. [https://www.discoveryeducation.com/info/scientific-discourse/] • The Dialog Toolkit – This toolkit provides self-facilitated ways for students to engage with stimuli. Students can use the strategies listed to start engaging with the provided data. [https://pz.harvard.edu/sites/default/files/DigDil%20and%20OOEL%20Dialogue%20Toolkit.pdf] ***Data Sources:*** • Exoplanet Types – This video and article explore exoplanets and their various types. Build conceptual understanding before diving into comparative data. [https://exoplanets.nasa.gov/what-is-an-exoplanet/planet-types/overview/] • Exploring Exoplanets with Kepler – Use this NASA-provided lesson plan to engage in comparative planetary data analysis to show further the direct relationship between the orbital period and the distance from the sun. As is, this activity can be used as

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		an extension for students scoring green and can easily be modified and scaffolded for students scoring yellow or red. [https://www.jpl.nasa.gov/edu/teach/activity/exploring-exoplanets-with-kepler/] • NASA Planetary Data Chart – Use planetary data to compare exoplanet data to planetary data in our solar system. [https://nssdc.gsfc.nasa.gov/planetary/factsheet/]
	*Critiquing and Refining Data Interpretation* Use spoken and written examples to model scientific interpretation of data, including significant features and observable patterns and/or relationships between variables, by identifying strengths and weaknesses such as sources of error.	• Interpreting Data and Looking for Relationships – This video shows a high school teacher engaging students in multidimensional learning using a digital media resource for ideas about engaging students in interpreting data representation and building consensus. The teacher models scientific interpretation and allows students to look for and explain the patterns. [https://aptv.pbslearningmedia.org/resource/buac21-pd-sci-tommy/in-the-science-classroom-interpreting-data-and-looking-for-patterns/]
	*Determining Relevant Data Needed for Particular Conclusions* Foster data interpretation and inform inferences by highlighting the utility and relevance of learning and demonstrating relevance through authentic, meaningful activities.	Use any resources about determining relevant data with any resources about planetary data to design a collaborative opportunity for students to engage in real data about celestial interactions. ***Determining Relevance of Evidence*** • Argumentation Evidence Card Sort – Activity to support students' critical thinking, productive argumentative talk, and ability to argue evidence while sorting it, and to provide a

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		platform that gets students actively involved in a way that promotes respect and safety. [http://energyteacher.org/wp-content/uploads/2018/11/Argumentation.pdf] ***Data Sources*** • Habitable Zone – Use this NASA data to determine the usefulness of raw data in supporting or refuting conclusions. How can analyzing data help us find potentially habitable planets? What kind of data do we need? How do the orbital period and the distance from the sun help us find if a planet is in the habitable zone of a particular sun? [https://exoplanets.nasa.gov/search-for-life/habitable-zone/] • Atmospheres on Exoplanets – Use this NASA data to determine the usefulness of raw data in supporting or refuting conclusions. How does a planet's density or gravitational pull help us ascertain an exoplanet's atmosphere? What other data besides density and gravitational force is needed to determine if the atmosphere can support life? [https://exoplanets.nasa.gov/news/1522/other-skies-other-suns-the-search-for-exoplanet-atmospheres/]

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	***Clarifying Academic Vocabulary Through Engaging with Phenomena*** Give students practice using academic vocabulary in context by providing graphic symbols with student-generated definitions that students can easily access while engaging in learning experiences driven by making sense of phenomena.	• STEM Teaching Tools – Practice Brief 66 – Article supporting emerging multilingual learners as they develop language that interprets and explains phenomena. [https://stemteachingtools.org/brief/66] • STEM Teaching Tools – Word Catchers – Word Catchers help students, especially multilingual learners, develop and use science- and phenomena-related words and phrases that support their sensemaking. [https://stemteachingtools.org/assets/landscapes/WordCatchers.pdf] • Interactive Word Walls Enliven Vocab Learning – Article with teaching strategies to support students' use of a word wall to build understanding of key vocabulary [https://www.middleweb.com/37209/interactive-word-walls-enliven-vocab-learning/]
	***Maximize Transfer and Generalization by Engaging in Data Analysis Through Engineering*** Use engineering challenges to interpret data by highlighting patterns, critical features, big ideas, and relationships between objects.	• The Great Gravity Escape – Use this engineering challenge to support students in generalizing the relationship between mass and gravitational force and the relationship of relative distances between the planets and their orbital paths by applying data analysis to get a rocket out of Earth's orbit. [https://www.teachengineering.org/activities/view/cub_mars_lesson04_activity1] • Slingshot to the Outer Planets – Use this engineering challenge to support students in generalizing the relationship between mass and gravitational force and the relationship of relative

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		distances between the planets and their orbital paths by applying data analysis to the problem of getting a rocket out to the outer planets. [https://www.teachengineering.org/activities/view/cub_solar_lesson07_activity1] • An Inflated Impression of Mars – Use this engineering challenge to support students in generalizing the relationship between mass and gravitational force by engineering a community on Mars, a planet with different gravitational pull than Earth's. [https://www.teachengineering.org/activities/view/cub_mars_lesson01_activity1]
	***Communicating Conclusions of Data Analysis*** Provide scaffolds for analyzing and interpreting data to be used as evidence to support scientific conclusions to explain a phenomenon or support a design solution (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural for students.	Use any resources about generating scientific conclusions with any resources about planetary data to design a collaborative opportunity for students to engage in real data about celestial interactions. ***Data Interpretation Resources*** • National Science Foundation – Tools for Ambitious Science Teaching – This website discusses a tool that provides scaffolds for writing that support learners in constructing explanations with evidence. These take the form of sentence frames, guides for how to help English learners practice final explanations, norms for whole-class discussion that are developed by students, roles that students can take in small group activities, and others.

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://ambitiousscienceteaching.org/orientation-ambitious-science-teaching/] • Collecting and Analyzing Data – This website presents ways to use the science notebook to collect and analyze data, helping students make scientific meaning from results. [https://www.calacademy.org/educators/collecting-and-analyzing-data] ***Data Sources*** • Kepler-186f – Compare a planet similar to Earth by looking at data. Will it orbit its sun faster or slower than we do? How can you tell? Would you weigh more or less? Why? Would you be warmer or colder most of the time? How can you tell? How old would you be in Kepler-186f years? [https://exoplanets.nasa.gov/resources/198/kepler-186f-the-first-earth-size-planet-in-the-habitable-zone-artists-concept/] • Kepler-62f – Compare a planet similar to Earth by looking at data. Will it orbit its sun faster or slower than we do? How can you tell? Would you weigh more or less? Why? Would you be warmer or colder most of the time? How can you tell? How old would you be in Kepler-62f years? [https://exoplanets.nasa.gov/resources/122/kepler-62f-a-small-habitable-zone-world-artist-concept/] • NASA Planetary Data Chart – Use planetary data to compare exoplanet data to planetary data in our solar system. [https://nssdc.gsfc.nasa.gov/planetary/factsheet/]

Instructional Strategies and Resources for Performance Category 3: Analyze Data to Describe Interactions Among Objects in Earth's Solar System *Task 1, Prompt 2 (3 points); Task 3, Prompt 1, Parts A & B (5 points); Task 3, Prompt 1, Part C (2 points); Task 3, Prompt 2 (3 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Expressing Conclusions from Data Analysis in Multiple Modalities* Provide multiple, flexible options for students to communicate their results and present data evidence to support their conclusions and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	• Science Notebook Corner – This website offers a variety of topics relating to students using science notebooks for lab reports, journaling, drawing, planning, or creative writing. [https://aptv.pbslearningmedia.org/collection/science-notebook-corner/] • Infographic Maker – This presentation software allows students to create data and infographics to summarize learning with charts, graphs, and diagrams. [https://venngage.com/blog/infographics-maker?utm_source=google&utm_medium=cpc&utm_campaign=&utm_content=&utm_term=infographic%20maker&match=e&campaignid=19558960020&adgroupid=143879091486&gad=1&gclid=Cj0KCQjw9fqnBhDSARIsAHlcQYSnvSGACgz1oEBmzQLMma1B3UbfY5Ieynj1ZD6Y7st4Cmtmf7rpiVcaAlEYEALw_wcB] • Stop Motion Studio – This app supports student explanation through simple stop motion videos that show conceptual understandings with creativity. [https://www.cateater.com/]