Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 8 Science
Unit 2 End of Unit Assessment Unpacking Tools
Gravity and Motion of Objects in the Solar System
August 2023

The SIPS Grade 8 Science Unit 2 End of Unit Assessment Unpacking Tools, Gravity and Motion of Objects in the Solar System was developed with funding from the U.S. Department of Education under the Competitive Grants for State Assessments Program, CFDA 84.368A. The contents of this paper do not represent the policy of the U.S. Department of Education, and no assumption of endorsement by the Federal government should be made.

SIPS Grade 8 Unit 2 End of Unit Assessment Unpacking Tools

NGSS Performance Expectation: 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.]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models** Develop and use a model to describe phenomena.	**ESS1.A: The Universe and its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. **ESS1.B: Earth and the Solar System** This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.	**CCC: Patterns** Patterns can be used to identify cause-and-effect relationships.

Key Aspects	• Identify relevant components of a model.
	• Describe relationships between the components of a model.
	• Develop and/or use a model to predict and/or describe phenomena.
	• Develop a model to describe unobservable mechanisms.
	• Identify limitations to a model.
	• Students indicate the accuracy of size and distance (scale) relationships within the model, including any scale limitations within the model.
		• Lunar phases
		  ○ The visible proportion of the illuminated part of the moon (as viewed from Earth) changes over the course of a month as the location of the moon relative to Earth and the sun changes.
		  ○ The moon appears to become more fully illuminated until "full" and then less fully illuminated until dark, or "new," in a pattern of change that corresponds to what proportion of the illuminated part of the moon is visible from Earth.
		• Eclipses of the sun and moon
		  ○ Solar energy is prevented from reaching the Earth during a solar eclipse because the moon is located between the sun and Earth.
		  ○ Solar energy is prevented from reaching the moon (and thus reflecting off of the moon to Earth) during a lunar eclipse
			• Patterns can be used to identify cause-and-effect relationships.
			• Graphs, charts, and images can be used to identify patterns in data.
			• Patterns of change can be used to make predictions.
			• Patterns can be used as evidence to support an explanation.

		because Earth is located between the sun and the moon. ○ Because the moon's orbital plane is tilted with respect to the plane of the Earth's orbit around the sun, for a majority of time during an Earth month, the moon is not in a position to block solar energy from reaching Earth, and Earth is not in a position to block solar energy from reaching the moon. ● Seasons ○ Because the Earth's axis is tilted, the most direct and intense solar energy occurs over the summer months, and the least direct and intense solar energy occurs over the winter months. ○ The change in season at a given place on Earth is directly related to the orientation of the tilted Earth and the position of Earth in its orbit around the sun because of the change in the directness and intensity of the solar energy at that place over the course of the year. ○ Summer occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted toward the sun. Summer occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted toward the sun. ○ Winter occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted away from the sun. Winter occurs in the Southern Hemisphere at times in the Earth's orbit when the southern axis of Earth is tilted away from the sun.		
Prior Knowledge	● Use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).	● The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns.	**Relationships to SEPs:**	● Models can be used to support an explanation of phenomena that exhibit cyclic patterns.

	● Use models to describe and/or predict phenomena.	○ Day and night ○ Daily changes in the length and direction of shadows ○ Different positions of the sun, moon, and stars at different times of the day, month, and year ● Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**2) Developing and Using Models and** **4) Analyze and Interpret Data**	● Patterns can be modeled. ● Patterns are understandable through measurement and data analysis. ● Analyze and interpret data on lunar phases and/or eclipses to determine cyclic patterns. ● Patterns are also helpful when interpreting data, which may supply valuable evidence in support of an explanation or a particular solution to a problem.

NGSS Performance Expectation: 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.]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Developing and Using Models** Develop and use a model to describe phenomena.	**ESS1.A: The Universe and Its Stars** Earth and its solar system are part of the Milky Way galaxy which is one of many galaxies in the universe. **ESS1.B: Earth and the Solar System** The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.	**CCC: Systems and System Models** Models can be used to represent systems and their interactions.
Key Aspects	• Identify relevant components of a model. • Describe relationships between the components of a model. • Develop and/or use a model to predict and/or describe phenomena. • Develop a model to describe unobservable mechanisms. • Identify limitations to a model. • Students indicate the accuracy of size and distance (scale) relationships within the model, including any scale limitations within the model.	• Gravity plays a role in the motions within galaxies and the solar system. • Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them. • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. • Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system. • Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation. • The sun's gravity keeps all planets in a predictable orbit around it.	• Models are important for testing solutions. • A model of a system under study can be a useful tool not only for gaining understanding of the system but also for conveying it to others. • Models can be used to represent the relationships among parts, or subsystems, of a system as well as how they interact with one another to communicate an engineering design.

		• Earth's gravity holds its moon in its orbit.		
Prior Knowledge	• Use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). • Use models to describe and/or predict phenomena.	• Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. • The sun is a star that appears larger and brighter than other stars because it is closer. • Stars range greatly in size and distance from Earth. • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. • Planets in the night sky change positions and are not always visible from Earth as they orbit the sun. • Stars appear in patterns called constellations, which can be used for navigation and appear to move together across the sky because of Earth's rotation. • All of the objects in the universe exhibit gravity to some degree. • Gravity holds Earth in orbit around the sun, and it holds the moon in orbit around Earth. • Both Earth and its moon exhibit gravity, but because Earth is larger, its force of gravity is greater.	**Relationships to SEPs:** **2) Developing and Using Models and** **7) Engaging in Argument from Evidence**	• Models can be used to describe relationships. • Models are used to represent a system (or parts of a system) under study. • Use evidence, data, or a model to support an argument. • Construct and present an argument with a model of an observable scientific process or system.

NGSS Performance Expectation: 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.]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Analyzing and Interpreting Data** Analyze and interpret data to determine similarities and differences in findings.	**ESS1.B: Earth and the Solar System** The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	**CCC: Scale, Proportion, and Quantity** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Key Aspects	• Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.
	  ○ Construct a graphical display of data sets to identify relationships.
	  ○ Analyze and Interpret graphical displays of data to identify linear relationships.
	  ○ Analyze and Interpret graphical displays of data to identify nonlinear relationships.
	• Use graphical displays of large data sets to identify temporal and spatial relationships.
	• Analyze and interpret data to determine similarities and differences in findings.
	• Construct and interpret a scatter plot or line graph for two quantitative variables.
	• Determine whether a linear relationship is negative or positive and whether the linear relationship appears strong or weak.
	• Construct and interpret a line graph to describe changes over time of a quantitative variable.
		• Objects in the solar system have scale properties.
		• Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.
		• The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.
		• Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large.
		• Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.
			• Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or small.
			• Proportional relationships among different types of quantities provide information about the magnitude of properties and processes.
			• Scientific relationships can be represented through the use of algebraic expressions and equations.
			• Phenomena that can be observed at one scale may not be observable at another scale.

Prior Knowledge	• Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.	• The sun is a star that appears larger and brighter than other stars because it is closer. • Stars range greatly in size and distance from Earth.	**Relationships to SEPs:** • Observable phenomena exist from very short to very long time periods.

	• Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	• The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. • Planets in the night sky change positions and are not always visible from Earth as they orbit the sun. • Stars appear in patterns called constellations, which can be used for navigation and appear to move together across the sky because of Earth's rotation.	**4) Analyzing and Interpreting Data and** **7) Engaging in Argument from Evidence**	• Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. • The concept of Scale, Proportion, and Quantity figures prominently in taking measurements of structures and phenomena, and these fundamental observations are usually obtained, analyzed, and interpreted quantitatively. • Understanding the relative magnitude of some properties or processes, is necessary to explain the relationships among different types of quantities. • Proportional relationships may be used as evidence to support an argument or claim.

NGSS Performance Expectation: 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 evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]

	Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Foundations	**SEP: Engaging in Argument from Evidence** Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**PS2.B: Types of Interactions** Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.	**CCC: Systems and System Models** Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems.
Key Aspects	• Construct scientific arguments. • Compare, evaluate, and critique competing arguments. • Identify evidence/data that supports a claim.	• Gravitational interactions are always attractive, require at least two interacting objects, and are directed toward the center of mass of the other object. • All gravitational interactions (gravitational forces) require a system of two or more objects. • For the same distance, the force between two objects increases or decreases directly with an increase or decrease in the mass of the interacting objects. • For the same masses, the force between two objects increases or decreases inversely with the distance between the two interacting objects. • Some effects of gravitational interactions may only be observable in interactions between very massive objects.	• Scientists and engineers use systems and system models to investigate natural and designed systems. • Use models to represent systems and their interactions, such as gravitational interactions between two masses. • Some phenomena (e.g., gravitational forces) can only be observed through the observation of simulations, the use of models, or the analysis of data. • Consideration of flows into and out of the system is a crucial element of system design. • Models can be valuable in predicting a system's behaviors.
Prior Knowledge	• Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	• Objects in contact exert forces on each other. • Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. • The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Relationships to SEPs:** **7) Engaging in Argument from Evidence and** **4) Analyzing and Interpreting Data** • Models such as force diagrams can be used to represent and identify the relative magnitude and direction of the force each object exerts on the other. • Data analysis serves to interpret quantitative measures of masses, distances, and

				gravitational forces based upon models. ● Models may be used to analyze relationships (e.g., linear or nonlinear) across or within systems (e.g., How does [subsystem A] relate to [subsystem B]?).