

# PHENOMENA, DRIVING QUESTIONS AND SEPUP STORYLINE

## SOLAR SYSTEM AND BEYOND

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**Unit Issue:** Choose a proposed space mission based on which missions have the most potential for technological advancements and better scientific understanding.

**Anchoring Phenomenon:** There are a variety of objects in space and they move over time. Technology plays a critical role in learning more about these objects. Examples explored include the fact that objects in space can be categorized based on their characteristics and apparent motion, phases of the moon, seasons and changes in the day/night cycle, solar and lunar eclipses, evidence gathered from telescopes and other instruments as well as from piloted and unpiloted space missions. Students generate and answer questions such as: What causes the patterns of motion of objects in space? What causes a solar or lunar eclipse? How can we use technology, either from Earth or space missions, to understand space objects and how they appear to move through space?

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	SEPUP Storyline
Space is vast and mysterious.	How can we learn more about space?	<p>What have we learned from missions to space? (Activity 1)</p> <p>Which mission to Titan should we fund, and why? (Activity 17)</p>	1, 17	Astronomers learn about objects in space by making observations. While we are able to learn a lot about space just from making observations with Earth-based technologies, sending spacecraft to collect data from out in space has been invaluable to helping us better understand our universe.
The Moon appears to change its shape over time.	How can we use observations and models to understand the Moon phases?	<p>How can we predict changes in the Moon's appearance? (Activity 2)</p> <p>What causes the cycle of the Moon's phases that we observe from Earth? (Activity 3)</p> <p>How does the Moon's orbit around Earth cause the Moon's phases to repeat around every 29 days? (Activity 4)</p> <p>Why don't we see lunar and solar eclipses more often? (Activity 5)</p>	2, 3, 4, 5	The earliest astronomers did not have any specialized technologies to help them observe the universe, but even they were able to observe and recognize naturally occurring astronomical patterns that allowed them to predict phenomena such as full moons and lunar eclipses. Without even traveling off of Earth's surface, we too can observe how the Moon's phases change over time and model why these phases have the appearances we observe from Earth. These observations can help us understand that the Moon orbits Earth and that its orbital plane around Earth is tilted relative to Earth's orbital plane around the Sun, such that only at very specific times do the Sun, Earth, Moon align correctly to create solar or lunar eclipses.

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## SOLAR SYSTEM AND BEYOND (continued)

Investigative Phenomena	Driving Questions	Guiding Questions	Activities	SEPUP Storyline
<p>The Sun has a different path through the sky during different seasons.</p>	<p>Why does the Sun's path through the sky change over the year, and how does that change relate to seasons?</p>	<p>What do you observe about the length of daylight and the position of the Sun in the sky over the course of a year? (Activity 6)</p> <p>What does Earth's orbit around the Sun have to do with seasons? (Activity 7)</p> <p>Why does Earth's tilt cause different places on Earth to receive different amounts of energy from the Sun? (Activity 8)</p> <p>Why does Earth have seasons? (Activity 9)</p>	<p>6, 7, 8, 9</p>	<p>While it is easy to observe if you are watching the sky carefully, many people don't notice that the Sun's path through the sky changes over the course of the year. These changes correspond to the amount of daylight hours people experience at different places on Earth. To help understand why this is, we can model how Earth rotates on its axis while it orbits the Sun. By doing this, we can observe that Earth's axis is tilted relative to its orbital plane around the Sun. This tilt not only changes the Sun's apparent path through the sky over the course of the year, but it is also responsible for the differential heating of Earth's surfaces over that same period, which is what causes the seasons. If the Earth had no tilt, there would be no seasons.</p>

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<p>There are other objects in the sky besides the Moon and the Sun.</p>	<p>What are the other objects in our universe, and how far away are they?</p>	<p>What types of objects are found in space? (Activity 10)</p> <p>How can a scale model help us understand distances between objects in our Solar System? (Activity 11)</p> <p>How can you make a scale model showing the sizes of all of the planets? (Activity 12)</p> <p>What features make each planet in our Solar System unique? (Activity 13)</p>	<p>10, 11, 12, 13</p>	<p>With an understanding of the Sun–Earth–Moon system, we can look out farther in our Solar System and see that there are other objects that appear to move relative to the background stars. Some of these objects are planets, some are asteroids, and some are moons of other planets. Advances in technology over time have allowed us to look more closely at these other bodies, especially those in our Solar System. Using mathematical techniques with these technologies has allowed scientists to determine how far away these planets are and how big they are. To get a better sense of the size and scale of these planets, we can analyze our collected data to make representations of the scale properties of these planets. We can look at both their sizes and their distances scaled down to more-understandable scales, thus allowing us to get a better sense of the magnitude of space.</p>

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<p>While many objects look the same from night to night, some objects appear to move.</p>	<p>What determines how objects move in space?</p>	<p>What determines the amount of gravitational force between objects? (Activity 14)</p> <p>How does gravity affect the motion of objects in space? (Activity 15)</p> <p>How can models help us understand the role of gravity in the motion of space objects? (Activity 16)</p>	<p>14, 15, 16</p>	<p>If we continue to watch the planets from night to night and year to year, we will notice that their movements follow certain patterns. What causes these predictable motions within our Solar System? Gravity! Anything with mass attracts other things to it because of its gravitational field. This gravitational field changes based on how massive the objects are and how far away they are from each other. More massive objects produce stronger gravitational fields, and if an object moves closer to another object, the gravitational pull between the two objects increases. This property not only allows planets to stay in motion around the Sun, but it is also responsible for the formation of our entire Solar System. Our Solar System is one of many in our Galaxy, the Milky Way. In fact, all of the individual stars we see in the night sky are in our Galaxy. A galaxy is a group of stars gravitationally orbiting a massive center. The motion of stars within our Galaxy and planets within our Solar System can be modeled and predicted through an understanding of gravity. Humans have been able to learn all of this because of technologies developed over the centuries and missions launched by space-interested agencies. So the question is left to students: What mission do they think should be funded to help us better understand our universe?</p>