PHENOMENA, DRIVING QUESTIONS AND STORYLINE

SOLAR SYSTEM AND BEYOND

This unit explores the related anchoring phenomena: There are a variety of objects in space, there are patterns of changes in the positions of these objects in the sky, and technology has played a critical role in obtaining evidence 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?

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
Space is vast and mysterious.	How can we learn more about space?	What have we learned from missions to space? (Activity 1)	1, 17	MS-ESS1-3	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.
		Which mission to Titan should we fund, and why? (Activity 17)			
The Moon appears to change its shape over time.	How can we use observations and models to understand the Moon phases?	How can we predict changes in the Moon's appearance? (Activity 2)	2, 3, 4, 5	MS-ESS1-1	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.
		What causes the cycle of the Moon's phases that we observe from Earth? (Activity 3)			
		How does the Moon's orbit around Earth cause the Moon's phases to repeat around every 29 days? (Activity 4)			
		Why don't we see lunar and solar eclipses more often? (Activity 5)			

PHENOMENA, DRIVING QUESTIONS AND STORYLINE

SOLAR SYSTEM AND BEYOND (continued)

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
There are other objects in the sky besides the Moon and the Sun.	What are the other objects in our universe, and how far away are they?	What types of objects are found in space? (Activity 10)	10, 11,12, 13	MS-ESS1-3	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.
		How can a scale model help us understand distances between objects in our Solar System? (Activity 11)			
		How can you make a scale model showing the sizes of all of the planets? (Activity 12)			
		What features make each planet in our Solar System unique? (Activity 13)			

PHENOMENA, DRIVING QUESTIONS AND STORYLINE

SOLAR SYSTEM AND BEYOND (continued)

Phenomenon	Driving Questions	Guiding Questions	Activities	PE	Storyline/Flow (How an activity leads to subsequent activities)
While many objects look the same from night to night, some objects appear to move.	What determines how objects move in space?	What determines the amount of gravitational force between objects? (Activity 14) How does gravity affect the motions of objects in space? (Activity 15) How can models help us understand the role of gravity in the motion of space objects? (Activity 16)	14, 15, 16	MS-ESS1-2	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?