

Exploring Satellite Motion and Technology

Companion Lesson to X-STEM All Access Episode “[Protecting and Securing Space](#)”

Grade/ Grade Band 9-12	Topic: Satellites in Space	
Brief Lesson Description: Space Force Captain Tasia Reed protects and secures outer space. She calls herself a traffic cop for space. In this lesson, students will explore the satellites orbiting Earth.		
Performance Expectation(s): HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.		
Specific Learning Outcomes: Students will be able to identify the types of satellites that orbit Earth. Students will be able to locate the positions of satellites in orbit using maps. Students will be able to describe how satellite technology is used in different industries.		
Narrative / Background Information		
Prior Student Knowledge: Students should be able to define and describe the motions of orbiting objects.		
Science & Engineering Practices: <u>Using Mathematics and Computational Thinking</u> Mathematics and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials, and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. <ul style="list-style-type: none"> Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4) 	Disciplinary Core Ideas: <u>ESS1.B: Earth and the Solar Systems</u> Kepler’s laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4)	Crosscutting Concepts: <u>Scale, Proportion, and Quantity</u> Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs exponential growth). (HS-ESS1-4) <u>Interdependence of Science, Engineering, and Technology</u> Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS1-4)
Possible Preconceptions/Misconceptions: Students may believe that satellites are stationary objects in the sky, however, satellites move and orbit the earth. Students may also believe that satellites are only used for communication. In this lesson, students will learn that there are many other applications for satellite technology, such as weather forecasting, scientific research, and military surveillance.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:		
<p>The lesson begins with students viewing Protecting and Securing Space with Captain Tasia Reed. After viewing the video, students write a reflection discussing how Capt Reed’s experiences relate to their lives.</p> <p>Next, ask students if they can name any types of satellites or industries that use satellite technology and record the responses on the board. (possible answers: weather, communication, navigation, scientific research, (moon-but we’re not studying that one today)).</p>		
EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions: Students will need access to laptops and the internet for this lesson.		
<p>Students are going to explore the different types of man-made satellites. Assign a type of satellite (identified during the ENGAGE section) to a small group of students to research. They should identify the following:</p> <ul style="list-style-type: none"> Purpose of the satellite Its history Achievements or discoveries it has made <p>The teacher may provide a resource list for students to use (see samples below) or have students address ELA Common Core Standard to</p>		

draw evidence from informational texts to support analysis, reflection, and research and determine which sites are credible for the project.

Sample Resource List– [NOAA](#), [Space.com](#), [Smithsonian](#), [NASA](#), [FAA](#), [GPS.gov](#), [Space Force](#), [Air Force](#)

Students share their findings with their classmates so that all students have notes for weather, communication, navigation, and scientific research satellites.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Explain to students that satellites are objects that orbit around another object in space, and we have been looking at and referring to artificial satellites launched into space by humans. There are two different regions of space where satellites can be placed into orbit around the Earth: Low Earth Orbit (LEO) and High Earth Orbit (HEO). Low Earth Orbit (LEO) is an orbit less than 2,000 Km above the Earth's surface. LEO satellites can complete one orbit in 90 minutes. LEO satellites have a shorter communication delay and require less power to transmit signals back to Earth. Ask students which type of satellites they believe would be LEO satellites. Then explain that LEO satellites are used for Earth observations, communications, and scientific research. Next, ask students to write down why these satellites should be in low earth orbit. (possible answers: does not require a lot of power, short time needed for signals to travel to-and-from the satellite to Earth, low cost, easy to launch, can capture more detailed pictures).

HEO satellites orbit 35,000+ Km above the Earth's surface. At this altitude, the satellite can orbit the Earth at the same rate as the Earth rotates, which is called a geostationary orbit. This means they remain in a fixed position relative to the Earth. HEO satellites have a longer communication delay and require more power to transmit signals back to the ground. Stop and ask students what they believe is an advantage for a satellite to be in high earth orbit. Then explain HEO satellites can be used for communications and weather observation, where a constant view of a particular region is required.

Discuss with students how satellite technology is used in different industries, such as telecommunications, weather forecasting, and navigation. Divide students into new groups to research one of the industries, noting:

- how satellites are used in that industry
- achievements/discoveries made with satellite technology
- how satellite technology impacts their daily lives

Vocabulary:

Satellite -objects that orbit around another object in space

Low Earth Orbit -encompasses Earth-centered orbits with an altitude of 2,000 Km or less

High Earth Orbit -when a satellite reaches exactly 42,164 Km from the center of the Earth

Geostationary orbit -a high earth orbit that permits satellites to match Earth's rotation

ELABORATE: Applications and Extensions:

Before starting this lesson's elaboration section, you will need to gather the following materials (per student): laptops/computers.

Share the following satellite tracking websites: [www.n2yo.com](#) , [www.satview.org](#) , or [www.in-the-sky.org](#). Demonstrate how to use the website to track the position of the satellites in orbit, show students how to search for a specific satellite, and view its current position on a map.

Have students explore the websites and locate at least 3 different types of satellites to track. Once the students have located the positions of the satellites, have them plot the position on a map of the Earth, labeling them and indicating their orbits.

Websites for maps: [NASA Viz](#), [USGS](#), [NOAA](#)

EVALUATE:

Formative Monitoring (Questioning / Discussion): Class participation and engagement in discussion, observation of students during activities

Summative Assessment (Quiz / Project / Report): Completion of maps and research assignments

Elaborate Further / Reflect: Enrichment: Students design their own satellite as a contractor with The UK Space Agency. Use the [SATELLITE BUILDER](#) website.

SOCIAL EMOTIONAL LEARNING ACTIVITY

CASEL Competency: SELF-MANAGEMENT

Self-management is about effectively managing your emotions, thoughts, and behaviors in different situations and achieving goals and aspirations. Capt Reed discusses how she wished she knew how to study before getting to college particularly because she was a good student in high school and didn't have to do much studying. In this lesson, students are going to learn about effective study strategies before making their own study plan.

Share the list of strategies with students: spaced practice, interleaving, elaboration, concrete examples, dual coding, and retrieval practice. Then show students the [How to Study Effectively for School or College](#) video and ask them to write an explanation for each strategy. You may need to pause the video and rewind it a couple of times. Lead a discussion about healthy study habits: time management, a distraction-free study environment, maintaining good health (getting enough sleep, exercising, nutritious meals) and asking students which strategies from the video they have tried, which ones they would like to try, and why they would like to try it.

Then ask students to create an individual study plan based on the strategies they selected. Have each student identify their academic goals and the steps they need to take to achieve them. Encourage students to be specific and realistic in their goals and strategies.

Allow students time to work on their study plans, referring to them repeatedly, offering guidance, and checking in on the progress towards their academic goals consistently.

Vocabulary

Spaced Practice -spacing out your study over time, not cramming the night before a big exam

Interleaving - switching up the topic you're studying

Elaboration -asking yourself questions, explaining what you know, and making connections

Examples -create concrete, specific examples that you understand ideas, making real-world connections

Dual Coding -combining verbal materials with visual information

Retrieval Practice -writing down everything you know about a topic; practice tests

INTERDISCIPLINARY CONNECTIONS/IDEAS

HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. (HS-ESS1-4)

MP.2 - Reason abstractly and quantitatively. (HS-ESS1-4)

Materials Required for This Lesson/Activity

Quantity	Description
Per student	Laptops



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