

Level	Satellites and Society	
High School		
Time Required	Lesson Summary	
150 min (3 – 50 min. class periods). Please add an extra day if you are going to try to detect satellite signals.	This lesson begins by introducing students to how satellites are involved in worldwide communication. Students will first learn about the basics of satellites, including the different sizes and orbits. Then the class will focus on investigating specific satellites. Finally, students will read about how satellites may interfere with other spectrum users. The lesson will conclude with a discussion on the topic.	
Standards		
NGSS HS – PS4-5 Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy Influence of Engineering, Technology, and Science on Society and the Natural World. Modern civilization depends on major technological systems.		
Vocabulary	Objectives	
Apogee Perigee	<ul style="list-style-type: none">Students will be able to discuss how satellites use radio waves to transmit data and communicationsStudents will describe the different categories of satellites and identify the ways they disrupt other users of the electromagnetic spectrum	
Materials		
Student computers Student handouts (one per person) If you do not have student computers available you can project your computer screen onto a screen or the wall. Do the satellite activities together as a class. You can print the research pages out for students in advance. To save on paper create a class set of materials and remind students to not write on these papers.		

Pre-Requisites	
Students should have knowledge of electromagnetic waves, the electromagnetic spectrum, and how the RTL-SDR dongle works	
Safety Considerations	
None	
Pacing Notes	
<p>This activity is expected to take 3 – 50 minute class periods. However, if you want to take your class outside to detect a satellite please add an extra class period.</p> <p>Day 1: Prior knowledge discussion about satellites, short video, investigating local satellites, satellite size reading, and satellite orbit reading.</p> <p>Day 2: Current satellite investigation</p> <p>Day 3: Satellite interference research and discussions.</p>	
Before the Lesson	
<p>Print the student handouts</p> <p>Download the software in chapters 1, 2 and 4 of the Windows technical guide.</p> <p>Practice scanning for satellites. Use https://www.n2yo.com or https://www.heavens-above.com (both last accessed on Sept. 9, 2022) to determine when satellites will be passing your area. The monopole antenna included in your kit is not the best antenna for this task, however, it will be able to detect the signal if you are careful. You need to know when the satellite is supposed to be going overhead (use your satellite list from above) and you need to be outside. If your antenna has an unobstructed view of the sky and is tuned to the correct frequency it should be able to receive a signal. The signal you receive may not be particularly strong but should be identifiable.</p>	
Assessments	Classroom Instructions
Pre-Activity Assessments	Introduction
You will assess student understanding of this video during the discussion.	While you are taking attendance and taking care of other administrative tasks play this video on satellite communication for the students. Students will learn about the history of satellite communication by watching a short video

	https://www.youtube.com/watch?v=zqkVq4kGgZg
Activity Embedded Assessments	Activities
<p>The number of students who volunteer to contribute to the conversation and the depth of their contribution will reflect how well the class understood the video.</p> <p>If most students are not engaged in the discussion. Replay short segments of the video and conduct a discussion on the information provided in that clip.</p> <p>Continue this process until you have worked your way through the entire video.</p> <div> <p>Please note: There are two options for activity 2. Choose the option that is best for your location.</p> </div>	<p>I. Class discussion about devices that use satellites for communication</p> <p>Say: In the video you saw a short history of satellite communication. Ask: Why were satellites first used for communication? Ask: Are they still used for that today? Ask: What other uses for satellites did the video mention? Ask: Are satellites still used for those things? Ask: Can you think of anything else satellites are used for today that was not mentioned in the video?</p> <p>Allow as many students as possible to contribute to the conversation. Allow students to speak to other students instead of the conversation focusing on you. Encourage students to use phrases such as “Adding on to what student X said satellites are also able to . . . “</p> <p>2. Scan for satellites in your area. (optional) Use the instructions in chapter 5 of the technical guide to scan for satellites. Please read the <i>Before the Lesson</i> section which contains important information about reception. In addition, please realize that satellites only travel over your location at set times. Therefore, it is possible that no satellite will be traveling above you during your class time. If this is true for you attempt to scan for satellites outside of class time. Record the signal from the satellite with a screen recording program. If you don’t have a screen recording program installed on your computer there are many versions available for free download from the internet.</p> <p>If you were able to get a signal from a satellite have the students look it up and provide the following information:</p> <ol style="list-style-type: none"> Owner Purpose <p>2. (Alternative) Investigate local satellites If you weren’t able to get a signal from a satellite the students should learn about the satellites that travel over your location.</p>

Ask: How can you convert from the unit in the article to something more familiar?

Ask: What is your initial response to seeing all those satellites orbiting the Earth?

Project of the webpages listed in the Before Class section on the screen. Explain to students that these satellites travel over your location. Take the time to go through a couple of the entries. Talk about when the satellite will be present and where in the sky it will be found.

3. Satellite activities

This lesson is composed of several activities that will guide students to an understanding about satellites. The student page contains all of these activities. You can print it out as a single document or you can print each activity separately.

a. Satellite size activity

The first activity is a short reading about satellite sizes. It can be found at this web address <https://news.viasat.com/blog/scn/how-big-is-that-satellite-a-primer-on-satellite-categories> (last accessed on Sept. 9, 2022). After students have read the article allow them to work with a partner to convert the metric weights to English units. If you have the time you could extend this activity by having students build a model microsatellite out of paper. See the Extension Section for details.

b. Satellite orbits

Next, students are going to read about satellite orbits. You could have students read this to themselves, read with a partner or you could read it aloud as a class. Similarly, the questions could be done individually, in partners or as a class.

<https://earthobservatory.nasa.gov/features/OrbitsCatalog> (last accessed Sept. 9, 2022).

c. Current satellite investigation

During this activity each student will collect information from three data points. This information will be combined to create a class data set. You will then compare your findings with those of the webpage. This will give you the opportunity to talk about sampling and sampling error.

Everyone will go to this webpage <https://geoxc-apps.bd.esri.com/space/satellite-explorer/> (last accessed Sept. 9, 2022)

The first thing the students should do is explore the image. The image represents the orbital paths of every satellite in space. Give them a few minutes to write a paragraph that describes what they see.

	<p>Then students are going to investigate three of those satellites and collect some data. You need to have a way of ensuring students are investigating different satellites. Students could write their satellite name on the board before collecting the information. A better solution would be to have students record their satellite name on a Google doc. This would allow them to quickly check if another student already investigated that satellite.</p> <p>You also need to have a place where students can add their data to the class set. You could create a large table with the headings below on the board. Alternatively, you could create a Google doc and allow students to add their data to the class set.</p> <p>Table headings:</p> <table><tr><td>Satellite name</td><td>Purpose</td><td>Country</td><td>Orbital parameters</td></tr></table> <p>After the data has been collected have students work in small groups to transfer it to the three classification of satellite data tables. If you need to make this process go faster you could divide the class into thirds and have each section complete one of the tables. This information could then be shared with the rest of the class.</p> <p>End this activity by discussing sampling procedures and how that affects the results of a scientific investigation.</p>	Satellite name	Purpose	Country	Orbital parameters
Satellite name	Purpose	Country	Orbital parameters		
Post Activity Assessments	Closure				
	<p>Satellite Interference Research and Discussion</p> <p>Students should be placed in a group of three. Each of the students should select one of the following three topics: satellite interference with radio astronomy, satellite interference with weather forecasting, or satellite interference with stargazing. Each topic should be selected by a different student in the group. Each student should find one article on their topic and read it. After reading the students will write a brief 5-7 sentence summary paragraph.</p> <p>Small group discussion: Give the students approximately 15 minutes to discuss their articles as a small group.</p> <p>Large group discussion: Bring the class back together and discuss the articles as a</p>				

large group. Go through the topics one at a time allowing students to share what they found with the class. At the end have a discussion consisting of some of the following questions:

How can the needs of the satellite companies be balanced with the needs of the radio astronomers and the weather forecasters?

Should satellite companies be concerned about their impact on stargazing?

Do people have to be willing to give up components of their culture in order to have the newest technologies?

Accommodations

During the *Jigsaw Reading Activity* make sure students with reading difficulties are given the shortest article to read. Allow students who need additional assistance to either work in the school resource room or with a partner to complete the assignment.

Make any necessary adjustments to the *Student Research and Poster Development* activity to meet the needs of your students. You may want to identify web pages for students who struggle with reading in advance and direct those individuals to the selected pages.

Educator Resources

<https://in-the-sky.org>

has information about whether satellites are operational or not

<https://www.n2ya.com>

<https://www.heavens-above.com>

satellite encyclopedia

http://www.tbs-satellite.com/tse/online/sat_intelsat_604.html

Optional Extension Activities

You can find instructions for building a model microsatellite at this webpage https://s3-us-west-2.amazonaws.com/ardusatweb/Paper_Cubesat_Final.pdf (last accessed Sept. 9, 2022)

Acknowledgments

This is the eighth lesson in a nine-lesson series intended to increase student understanding of radio frequencies. You are welcome to just use this lesson but if you are interested in this topic consider checking out the others in the series.

Lesson One: Mechanical Waves

Lesson Two: Electromagnetic Waves

Lesson Three: Electromagnetic Spectrum

Lesson Four: Argumentation and Radio Waves

Lesson Five: Investigating Spectrum Users

Lesson Six: Aircraft and Newton's Second Law of Motion

Lesson Seven: Weather Forecasting and Radio Waves

Lesson Eight: Satellites and Society

Lesson Nine: Spectrum Management

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