

Lesson	<h1>Satellites and Society</h1>
8	
Time Required	Lesson Summary
150 min (3 – 50 min. class periods). Please add an extra day if you try to detect satellite signals.	This lesson introduces students to how satellites are involved in worldwide communication. Students will first learn about the basics of satellites, including their 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 Addressed	
<ul style="list-style-type: none"> ○ Next Generation Science Standards <ul style="list-style-type: none"> ○ HS – PS4-5 <ul style="list-style-type: none"> ▪ 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 <ul style="list-style-type: none"> ▪ Modern civilization depends on major technological systems. ○ Virginia standards <ul style="list-style-type: none"> ○ PH5.b Students will understand that the long wavelength, low-frequency portion of the electromagnetic spectrum is used for communication. ○ PH.5.b The students will investigate and understand that waves transmit energy and move in predictable patterns. Students will realize those wave interactions are part of everyday experiences and identify technological applications of the radio wave portion of the spectrum. ○ West Virginia standards <ul style="list-style-type: none"> ○ S. HS. P. 23 Students will 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. 	
Vocabulary	Objectives
<ol style="list-style-type: none"> 1. Apogee 2. Perigee 	<ul style="list-style-type: none"> ● Students will be able to discuss how satellites use radio waves to transmit data and communications. ● Students will describe the different categories of satellites and identify how they disrupt other electromagnetic spectrum users.

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 not to 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

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.

Day 1: Prior knowledge discussion about satellites, short video, investigating local satellites, satellite size reading, and satellite orbit reading.

Day 2: Current satellite investigation

Day 3: Satellite interference research and discussions.

Before the Lesson

Print the student handouts

Download the software in chapters 1, 2, and 4 of the Windows technical guide.

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. A monopole antenna in your kit is not the best for this task. However, it can 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 powerful, but it should be identifiable.

Assessments	Classroom Instructions
<i>Pre-Activity Assessments</i>	<i>Introduction</i>
<p>You will assess student understanding of this video during the discussion.</p>	<p>While 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=zkkVq4kGgZg</p>
<i>Activity Embedded Assessments</i>	<i>Activities</i>
<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 data-bbox="126 1514 418 1766" style="border: 1px solid black; padding: 5px;"> <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 discussion 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. In addition, please read the <i>Before the Lesson</i> section, which contains important information about the reception. In addition, please realize that satellites only travel over your location at set times. Therefore, no satellite may be traveling above you during your class time. If this is true for you, attempt to scan for satellites outside of class time. Then, record the signal from the satellite with a screen recording program.</p>

Suppose you don't have a screen recording program installed on your computer. In that case, many versions are available for free download from the internet.

If you were able to get a signal from a satellite, have the students look it up and provide the following information:

- a. Owner
- b. Purpose

2. (Alternative) Investigate local satellites

Suppose you couldn't get a signal from a satellite. In that case, the students should learn about the satellites that travel over your location.

Project a list of the web pages 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 it will be found in the sky.

3. Satellite activities

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

a. Satellite size activity

1. 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

2. Next, students are going to read about satellite orbits. Again, 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, with 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.

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?

This information will be combined to create a class data set. You will then compare your findings with those of the webpage. This will allow you to talk about sampling and sampling error.

1. 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.

Then students will investigate three of those satellites and collect some data. It would be best if you had a way of ensuring students are exploring different satellites. For example, students could write their satellite names on the board before collecting the information. A better solution would be to have students record their satellite names on a Google doc. This would allow them to check if another student had already investigated that satellite quickly.

You also need a place where students can add their data to the class set. For example, 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.

Table headings:

Satellite name	Purpose	Country	Orbital parameters
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After collecting the data, 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.

End this activity by discussing sampling procedures and how that affects the results of a scientific investigation.

Satellite interference Research and Discussion

Students should be placed in a group of three. First, each student should select one of the following three topics: satellite interference with radio astronomy, satellite interference with weather forecasting, or satellite interference with stargazing. Only one student in the group should be investigating a topic. Then, each student should find and read one article on their topic. After reading, the students will write a brief 5-7 sentence summary paragraph.

Small group discussion: Give the students approximately 15 minutes to discuss their articles as a small group.

Large group discussion: Bring the class together and discuss the articles as a large group. Go through the topics one at a time allowing students to share what they found with the class. In the end, have a discussion consisting of some of the following questions:

How can the needs of the satellite companies be balanced with the requirements of radio astronomers and 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 to have the newest technologies?

Culturally Inclusive/Responsive Components

Suppose your area has reliable access to the internet. In that case, it is beneficial to make students aware that it is not a universal service. Tell them that the internet is not available everywhere in the US, not to mention the world. Discuss how life would be different if students could not use the internet. Challenge students to figure out how to accomplish things without the internet. Ask students how they would feel if your area did not have the internet, but the rest of the world did have reliable access. What would they do in that situation?

Then discuss the satellite companies, such as Star link, that are trying to provide the internet to those areas. Finally, ask students if this information changes their views on the number of satellites in orbit.

Satellite scientists

- Thomas Choi
- Valerie Thomas
- Scarlin Hernandez
- Noura Saud Altuwaim
- Gladys B. West
- James A. Van Allen
- John R. Pierce

- Takuro Muratani
- Noah A. Samara
- Ellen Hoff

Accommodations

During the *Jigsaw Reading Activity*, ensure 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. For example, 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 if 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)

