**ACTIVITY: Spotting satellites**

**Activity idea**

In this activity, students use web-based resources to help them spot and learn more about artificial satellites as they move across the sky.

By the end of this activity, students should be able to:

* use selected internet resources to further their knowledge about satellites and their orbits
* use some of the terminology associated with satellite spotting
* discuss why we can see some satellites more easily than others.

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**Introduction/background**

Believe it or not, there are nearly 20 000 artificial objects orbiting the Earth. Some of these are active satellites – 2,218 as of October 2019. Others are space junk – retired satellites, rocket bodies left over from launches and other debris. Some of these satellites, like the International Space Station (ISS), Iridium flares and SpaceX’s Starlink satellites, are easily visible with the naked eye. We can see satellites about 45 minutes before sunrise (before the sky becomes too light) and 45 minutes after sunset (before the satellite moves into the Earth’s shadow).

As with all stargazing, conditions are best with clear, relatively dark skies away from as much light pollution as possible.

The purpose of this activity is to introduce students to selected internet resources that predict satellite passes, show their orbits and location in space and provide additional data about the satellites.

**What you need**

* Access to the internet
* Access to a satellite-spotting app (optional)
* Access to [Google Earth](http://www.google.com/earth/index.html)
* Copies of the article [Artificial satellites](https://www.sciencelearn.org.nz/resources/269-artificial-satellites)
* Copies of the student handout [Spotting satellites](#handout)

**What to do**

1. Before working with students, read through the student handout and become familiar with the websites mentioned. The handout is in Word so you can edit the document to remove excess content or to add your own websites.

***Satellite spotting***

1. Choose and download the appropriate satellite-spotting app(s).
2. Provide students with copies of the student handout [Spotting satellites](#handout).
3. Discuss the useful terms.
4. Direct students to the [Heavens Above](http://www.heavens-above.com/) website. Ask them to gather information on the visible passes of the ISS, Starlink or for visible Iridium flares.
5. Choose a date and time to spot a satellite. Take the students outside and let them practise locating the azimuth and altitude for that particular satellite pass.
6. While outside, use a satellite-spotting app to locate any satellites that might be overhead.
7. Views of the ISS will most likely occur outside of school hours. Encourage students to note the satellite-spotting details in their phones or diaries so they remember to do it!

***Viewing satellites on the internet***

1. For online satellite viewing, introduce your students to the [Google Earth](http://www.google.com/earth/index.html) and [NASA Eyes on the Earth](http://eyes.nasa.gov/earth/) websites. Take them on a tour of the sites via an IWB or data projector.
2. Give students the opportunity to use the sites on their own or give them some search tasks. For example:

Using [Google Earth](http://www.google.com/earth/index.html) and the [Heavens Above](http://www.heavens-above.com) sites, find:

* a satellite with a perigee within 500 km of the Earth
* a satellite with an apogee of more than 30 000 km above the Earth
* a satellite whose perigee and apogee differ by more than 2000 km – what is the shape of its orbit? (Hint: search for Japan’s Akebono satellite.)
* a satellite whose perigee and apogee are similar – what is the shape of its orbit? (Hint: search for Australia’s Optus D1.)
* a satellite owned by a particular country
* a satellite whose mission is navigation
* a satellite whose mission is communication
* a satellite whose mission is unknown – make a guess as to why!
* a satellite with a period under 100 minutes
* a satellite with a period of over 1000 minutes
* a satellite you are likely to spot within the next week due to its magnitude.

Using [Eyes on the Earth](http://eyes.nasa.gov/earth/) site, choose a mission such as AQUA or OSTM and find:

* the satellite’s mission
* the satellite’s size in relation to a human being or a school bus
* the types of datasets the satellite collects and are displayed on the site.

**Student handout:** **Spotting satellites**

Believe it or not, there are about 20 000 artificial objects orbiting the Earth. Some of these are active satellites. Others are space junk – retired satellites, rocket bodies left over from launches and other debris. Some of these objects can be seen with the naked eye. We can see satellites about 45 minutes before sunrise (before the sky becomes too light) and 45 minutes after sunset (before the satellite moves into the Earth’s shadow). As with all stargazing, conditions are best with clear, relatively dark skies away from as much light pollution as possible.

This handout helps you locate and view a few of the low Earth orbit satellites (such as the International Space Station, Iridium communication satellites and Starlink satellites) as they pass overhead.

Additional references provide information about the orbits, owners and functions of some of the thousands of satellites that orbit our planet.

***Useful terms***

Here are some terms and definitions that you will find useful when using satellite-spotting websites:

* Apogee – the point in a satellite’s orbit at which it is farthest from the Earth.
* Azimuth – corresponds to compass headings on the viewer’s horizon. 0° corresponds to true north, 90° to east, 180° to south and 270° to west. The azimuth changes as the satellite makes its pass.
* Altitude – (also known as elevation) the angle of the satellite, above the local horizon, at the start of its pass. A satellite with an altitude of 0° is on the viewer’s horizon. A satellite with an altitude of 90° is directly over the viewer’s head. A simple method to determine altitude is to hold your fist out at arm’s length. The width of the fist is approximately 10°. The altitude changes as the satellite makes its pass.
* Magnitude – for satellite spotting, magnitude indicates the brightness of the object. A lower value corresponds to a brighter pass. For example, the Sun is magnitude (mag.) -27, the full Moon is mag. -12.5 and faint stars visible to the naked eye under good viewing conditions are mag. +6.
* Perigee – the point in a satellite’s orbit at which it is nearest to the Earth.
* Period – the time it takes a satellite to make a full orbit of the Earth. Satellites close to the Earth (at an altitude of 100 km) need to move at 28 000 km/hr to stay in orbit. At an altitude of 36 000, a satellite needs to travel at 11 000 km/hr. A satellite with a low Earth orbit has a much shorter period than those further away.

***Heavens Above***

The website [www.heavens-above.com](http://www.heavens-above.com) provides prediction services for bright satellites. Here are a few notes to help you navigate the site.

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| --- | --- |
| *Configuration* Either Login or select Change your observing location. Use the search to find and update your location. |  |
| *Satellites* This section provides information on a number of satellite passes.  |  |

A good place to begin is ISS (International Space Station). This is a low Earth orbit satellite. Click on ISS to get start times and dates for all of the ISS passes. Alternatively, narrow your search and select for ‘visible only’ passes.

An information table is generated that lists brightness (magnitude), start (time, altitude and azimuth), highest point (time, altitude and azimuth) and end (time, altitude and azimuth) to guide your spotting.

Use the navigation tabs in the upper right-hand corner to find out more about the ISS. The Info tab gives additional details and a photo of the ISS. The Orbit tab provides multiple views of the satellite’s orbit as well as data on perigee and apogee height, revolutions per day and much more. (Similar information is given for most of the satellites featured in this site.)

Iridium flares (listed under the ‘Satellites’ heading) are another way to observe satellites. The Iridium satellite constellation consists of 66 active satellites in low Earth orbit. They are relatively small and difficult to see on their own, but their antennae are made of highly reflective aluminium plates. The antennae act like mirrors and reflect sunlight back to the Earth. These flashes of light (flares) last from 5 to 20 seconds. Some of flares are visible during the daytime.

***Apps for spotting satellites***

There are various apps available to spot satellites as they move over your location. For example, [ISS Detector](https://www.issdetector.com/) for Android and iOS has a free version that tracks the ISS and Iridium flares.

***Viewing satellites on the internet***

If you want to spot satellites without having to go outside, there are many websites with satellite orbits and other data. Here is one to help you get started.

*NASA*

NASA’s Eyes on the Earth (<https://eyes.jpl.nasa.gov/eyes-on-the-earth.html>) site features 16 NASA satellites that monitor the Earth from space. These satellites collect data about Earth’s atmosphere, land and oceans. Chose a satellite by clicking on the ‘Missions’ icon on the top navigation bar. Use the right-hand navigation panel to access information about the satellite’s mission and the datasets it collects. The data is in graphic or pictorial form so there are no difficult statistical tables to work through! You can also see the orbit of your chosen satellite. Clicking on the orbiting satellite not only allows you to see the satellite’s configuration but it also provides a bird’s eye flyover of the Earth.

To search for an individual spacecraft name, for example Optus D1, use NASA’s National Space Science Data Center Master Catalog Search <http://nssdc.gsfc.nasa.gov/nmc/SpacecraftQuery.jsp>. The site provides a description of the satellite along with its orbit, purpose and facts about its launch.