Lesson Title: Spot the International Space Station!

Subject	Grade Level	Timeline
Physical Science, Earth & Space Science	4 - 9	30 minutes

Objectives
This lesson investigates the geometry of the orbit of the International Space Station and its motion relative to Earth.

Standards

Next Generation Science Standards
Middle School Physical Sciences Storyline
https://www.nextgenscience.org/sites/default/files/MS%20PS%20DCI%20Combined%206.13.13.pdf

Students who demonstrate understanding can:

MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

Materials
Internet access

Vocabulary

Horizon, angle, orbit

Lesson Plan

Background for teachers: The International Space Station orbits the planet Earth at an altitude of about 250 miles (about 400 km), at a speed of about 17,000 mph (about 28,000 km/h). At that speed, the ISS completes a full orbit around the planet just about once every 90 minutes. But it won't pass over the same spot on each orbit, because the planet rotates about 23° on its axis during that same 90 minutes. So wherever the ISS is right now, it will be 23° west of that spot in 90 minutes.

The ISS's orbital path brings it to pass over 90% of the Earth's population. The only places it does not go are latitudes north of 51.6 degrees in the northern hemisphere, or south of 51.6 degrees in the southern hemisphere, due to the angle at which the ISS orbit is tilted relative to the equator. If you live in an area that far from the equator, you might not be able to see the ISS in its orbit.

Ask: Do you think we can see things that are in space, in orbit around the planet Earth?

Explain: It depends. With the naked eye, we can see some things that orbit Earth, but only when they are in a position to reflect sunlight toward us. Consider that the moon is in orbit around the planet, and sometimes we see it reflecting a lot of light (full moon), while other times it reflects less because of its position relative to us (cresent moon or new moon). And of course, sometimes we cannot see the moon at all, when it is on the other side of the planet. When we do see the moon, we are able to see it because the moon reflects sunlight - it does not make its own light.

Similarly, the ISS does not have exterior lights for us to see, but it does reflect sunlight. At its brightest, ISS is even brighter than Venus - brighter than anything in the sky except the sun and moon. Therefore, we are able to see the ISS (and some other satellites), but not all the time - only when the conditions are right. The ISS cannot be seen during most daylight hours, because the sky is very bright, and the station does not reflect much light at an angle that we could see at that time. The ISS cannot be seen during most night hours, because it is behind the Earth from the perspective of the sun - no sunlight reaches it.

The International Space Station is only able to be seen for a few hours around sunrise and sunset. From one day to the next, the ISS might be passing near you at sunrise or sunset - or it might be in the opposite hemisphere!

How to Spot the Station:

There are times when you can see the station in the sky, but you have to know when and where to look.

NASA has created a website to track the movement of the ISS: spotthestation.nasa.gov**.**

This website lets you know when the ISS is going to pass near your area during a time of day when you could possibly see it. The blue pins on the map are locations for which NASA will calculate sighting opportunities. Use the map to find the pin that is nearest your location, and click on the pin.

The station is able to be seen with the naked eye - it is brighter than a star or planet. It will be moving faster than an airplane, which means it isn't practical to view it with a telescope. The station will not have blinking lights, and it will not leave a trail of any kind - if you see either, you've spotted an aircraft of some kind.

How to use the information on the website:

The following is an example of the information from the spotthestation.nasa.gov website:

Date	Visible	Max Height	Appears	Disappears
Wed Apr 25, 7:45 PM	4 min	66°	10° above WSW	31° above NE

Date: only dates coming up in the next few weeks will appear. The time is given in your local time zone. Remember, the time will always be close to sunrise or sunset.

Visible: the approximate length of time for which the ISS will be visible, starting at the listed time. In this example, the station will be visible for 4 minutes if weather conditions permit.

Max Height: the highest in the sky the ISS will appear from your location.

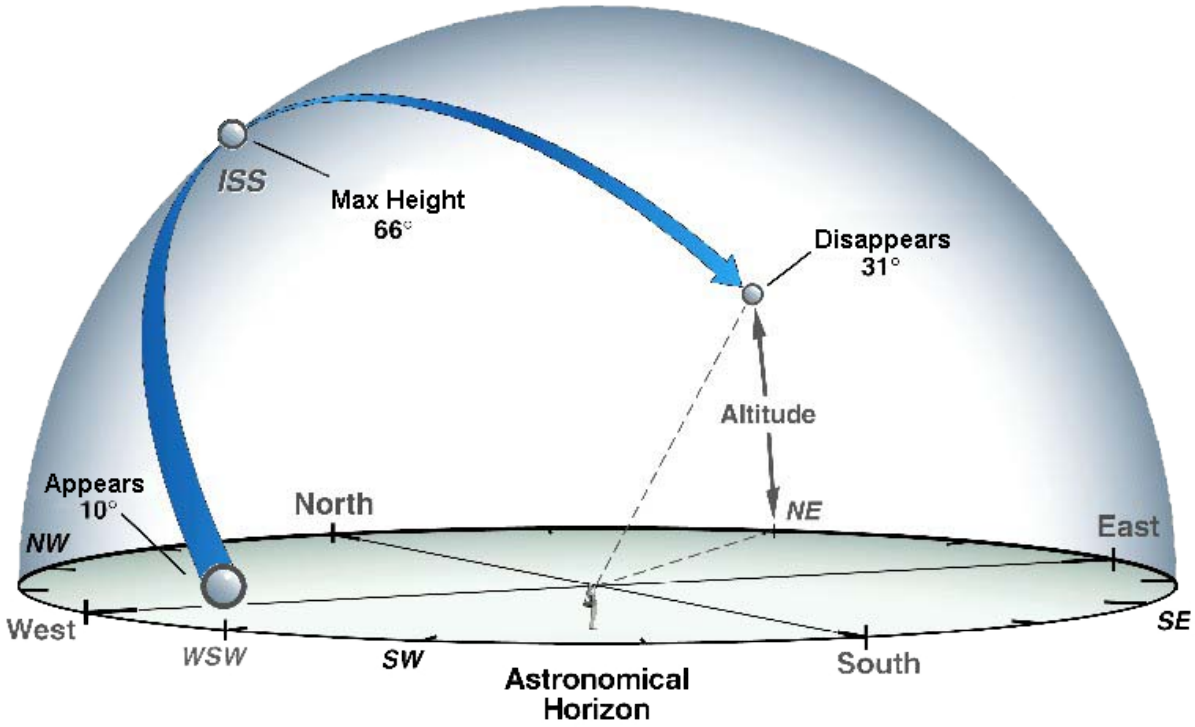
Appears: information to tell you approximately where in the sky the station will first appear. The angle is measured from the horizon, and the compass direction is also given.

Disappears: information to tell you where in the sky the station will be when the viewing period ends for your location. Again, the angle is measured from the horizon, and the compass direction is given.

To use the given angle to figure out how high up in the sky to look, use the following rules:

- Angles are measured in degrees up from the horizon.
- An angle of 90° would mean to look straight up.
- Use your fist to estimate angle measurements. If you make a closed fist and hold it at arm's length with the back of your hand toward your face, that takes up approximately 10° in the sky. This can help novice station-watchers to figure out how high above the horizon to look.

The image here corresponds to the location information given in the example on the previous page. Be aware that trees, buildings, and mountains can block your view of the station.



[source: https://spotthestation.nasa.gov/message_example.cfm]

Have students practice finding compass directions.

- Students should be able to determine which direction to look in the sky based on compass directions they are given. They could use an actual compass, or a compass app, or the observed locations of sunrise and sunset. They might also use a map and known landmarks.
- Have students practice finding North, South, East, and West.
- Have students practice finding NE (northeast), SE (southeast), SW (southwest), and NW (northwest).
- Have students practice finding some of the “16-point” directions, like NNE (north-northeast, which is between north and northeast), or WSW (west-southwest, which is between west and southwest).

Extensions

Spot the Station! Ask students to note the time and date of an upcoming sighting in your area and try to spot the station as it orbits at more than 17,000 mph at an altitude of about 250 miles! Can they find it?

Resources

Spotthestation.nasa.gov - Information on where and when you can spot the International Space Station in your area. You can get free email alerts and text alerts of upcoming dates and times when the ISS will be visible in your area.

http://iss.astroviewer.net - See the current position of ISS and a map of what the astronauts would see if they were looking down at Earth right now. Note that this is not real-time video from the ISS, but the position is real-time.

https://twitter.com/ISS_Research