



Introduction to Satellites: 6-8 Script

Objective

By the end of the lesson students will be able to: (1) define and understand the types of satellites; (2) understand the parts of satellites; (3) define and understand the uses of satellite imagery; (3) define and discuss the history of aerial mapping; (4) understand what GPS is.

Prepare for Lift Off!

Welcome to the crew of the USGIF Explorer! We're on a mission to fly to space and learn all about satellites. Before we lift off, you need to learn some basics and prove you've earned your spot aboard our ship.

USGIF

The United States Geospatial Intelligence Foundation, also known as the USGIF, is an educational nonprofit dedicated to promoting geospatial intelligence (GEOINT).

GEOINT

GEOINT, short for Geospatial Intelligence, is using maps, satellites, drones, and sensors to gather and visualize data in order to make a decision. GEOINT can be applied to most career fields.

1, 2, 3... Lift Off!

Spectacular! Because you learned your basics, we can now blast off into space.

Satellite Basics

Our mission is to gather as much intelligence on satellites as we can while we are in space. Wait... we probably should have checked to see if you knew anything about satellites before we brought you aboard. Oh well, it's too late now. Let's get you up to speed!

What is a Satellite?

What is a satellite? A satellite is something that orbits, or travels around, a planet or other object.

Natural Satellites

The Earth is considered a satellite, because it orbits the sun. The moon orbits the Earth, making it a satellite as well. These are examples of natural satellites. You are probably more familiar with artificial, or man-made, satellites, and they are what we will focus on here.

Artificial Satellites

Artificial satellites are launched into space aboard a rocket. They are then placed into orbit around a planet in order to collect information or for communication.

Artificial Satellites

Some of these satellites have big, high-resolution cameras in them to take pictures of the Earth. Satellites provide us with a birds-eye view so we can learn new information we cannot see from the ground with our eyes.

Artificial Satellites

Because satellites orbit above clouds and other atmospheric particles, they show us space more clearly than telescopes on Earth can.

Satellite Launch

Let's watch a video of a satellite being launched into orbit

Sputnik 1

In 1957, Russia launched Sputnik 1, the first satellite sent into space. The whole world was shocked, and to stop from falling behind, the United States started to spend a lot of money on space exploration.

Sputnik 2

Russia then launched Sputnik 2, a satellite carrying Laika the dog, into space. Laika was the first living thing to orbit the Earth.

Explorer 1

The United States launched their first satellite, Explorer 1, in 1958.

Parts of a Satellite

Sputnik was a very simple satellite. It was about the size of a beach ball, made of aluminum, battery powered, and just had a few antennae and radio transmitters. Today, satellites look very different. The goal when building a modern satellite is to make it as strong and light as possible. It needs to be able to withstand space travel, but still be lightweight and aerodynamic. Let's spend some time discussing the different parts of satellite. The parts of a satellite include the satellite body, antennae, special equipment, solar arrays, and protective shielding.

Satellite Body

The body of a satellite houses all of the computer parts that make the satellite function.

Antennae

Attached to the satellite body are antennae, which allow for communication to and from Earth.

Special Equipment

Also attached to the satellite body are whatever special equipment the designer has included, like cameras or telescopes.

Solar Arrays

As we said earlier, Sputnik was battery powered. Today, satellites rely on solar power. The solar panels attached to the satellite are called arrays and resemble wings.

Protective Shielding

Satellites also have some sort of protective shielding to protect them from their harsh space environment.

How Big Are Satellites?

Satellites vary in size. The biggest satellites are as big as a small school bus. As technology advances, satellites can be made faster, cheaper, and smaller.

Small Sats

Today, we have more and more small satellites or “small sats” being launched into space. These satellites are similar to the size of a shoebox. While the picture quality is not as good as the larger satellites, more information can be relayed faster.

Cube Sats

Cube satellites or “cube sats” are even smaller than small sats. These are about the size of a tissue box and can be held in one hand.

Doves Launch

Let’s watch a video of Planet’s CubeSats “Doves” being launched from the International Space Station.

How Many Satellites are There?

There are thousands of satellites orbiting in space. There isn’t an exact number because satellites are always being launched in space and others are being decommissioned, or turned off. As of now, there are almost 3,000 satellites in orbit.

Let’s Get Orbital

Now that you are a satellite expert, we need your help! In order for us to get our rocket into orbit, we need to be going much faster. You’ve been challenged to a pop quiz, and every correct answer will give us a speed boost until we are safely in orbit.

Question #1

Is the moon a natural or artificial satellite?

Answer

The answer is natural satellite! The moon is a natural satellite because it orbits the Earth but is not manmade.

Question #2

Which country was the first to launch a satellite into space:

- A. United Kingdom
- B. Russia
- C. Japan
- D. United States

Answer

The answer is B. Russia. Russia (then the Soviet Union), launched Sputnik 1 in 1957, starting the Space Race.

Question #3

The solar arrays provide the satellite with:

- A. Protection
- B. Speed
- C. Communication with Earth
- D. Power

Answer

The answer is D. Power. The solar arrays are solar panels that power the satellite.

Question #4

What do we call a satellite the size of a tissue box?

- A. Sneeze Sat
- B. Tissue Sat
- C. Cube Sat
- D. Rubik's Sat

Answer

The answer is C. Cube Sat. Cube sats are even smaller than small sats and typically can be held in one hand.

Mission Success

Stellar job. Thanks to you, we gained enough speed to get into orbit. Now that we are here, let's learn about the different types of satellites we will see while we are up here!

Types of Satellites

There are many different types of satellites that are used for a specific purpose, including weather, navigation, communications, earth observation, astronomical, manned space stations, and spy satellites.

Weather Satellites

Weather satellites track weather patterns and measure things like cloud cover, temperature, and rainfall.

Weather Satellites

We can track hurricanes using satellites to see where a hurricane will make landfall to help people prepare. The National Oceanic and Atmospheric Administration (NOAA) has a group of satellites that track severe weather events like snowstorms and tropical storms.

Navigation Satellites

Navigation satellites are used to find the exact location of a GPS receiver like your phone on the Earth's surface.

Navigation Satellites

There are up to 32 satellites in the United States Global Positioning System (GPS) that make up the most frequently used navigational satellite system in the world.

What is GPS?

What is GPS? GPS is a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world

How GPS Works

Let's watch this video to learn more about how GPS works.

Flash Quiz

Can you think of some of your favorite apps that use GPS to work?

GPS Apps

So many of the apps we rely on and love require GPS. Social media platforms like Instagram and Snapchat, navigation apps like Google Maps and Waze, food delivery services like DoorDash, and games like Pokémon Go all rely on GPS to get the job done.

Communications Satellites

Communication satellites work so that we can get internet, telephone, radio, and television access

Communications Satellites

Sputnik 1 was a communications satellite because it carried a radio transmitter into space.

Earth Observation Satellites

Earth Observation Satellites are used to photograph and study the Earth. Earth observation satellites monitor the environment, our natural resources, and are used for humanitarian purposes.

Earth Observation Satellites

NASA's Earth Observing System (EOS) is a cluster of low orbiting satellites that monitor the Earth's oceans, land cover, and atmosphere.

Astronomical Satellites

Astronomical satellites monitor space. The Hubble Space Telescope is an astronomical satellite that has taught us a lot about stars and galaxies through its photos.

Manned Space stations

Manned Space Stations are a type of satellite that people can live on. The International Space Station is a space lab where scientists can perform experiments to better understand space.

Spy Satellites

Spy satellites are used to monitor things happening on the ground. Satellite images are used to see information that is usually invisible, like the growth levels of a country's crops or the heat given off by certain buildings.

Houston, We Have a Problem

Oh no, we have an emergency! There is an asteroid barreling toward our ship. You need to answer these questions to change our orbit path and guide us to safety.

Question #1

What type of satellite would you use to monitor deforestation in the Amazon?

- A. Spy satellite
- B. Communications satellite
- C. Earth Observation satellite
- D. Astronomical satellite

Answer

The answer is C, an Earth Observation satellite. Earth Observation satellites are used to monitor the environment and natural resources. This satellite image shows deforestation in the Amazon.

Question #2

What kind of satellite is the Hubble Space Telescope?

- A. Astronomical satellite
- B. Weather satellite
- C. Spy satellite
- D. Communications satellite

Answer

The answer is A, astronomical satellite. The Hubble Space Telescope is an astronomical satellite that monitors space. This is a photo that the Hubble Space Telescope took of almost 1,000 galaxies that had never been seen before.

Questions #3

What type of satellites does GPS use?

- A. Manned space stations
- B. Communications satellites
- C. Earth Observation satellites

D. Navigation satellites

Answer

The correct answer is D, navigation satellites. There are up to 32 navigation satellites that make up the Global Positioning System (GPS).

Thank Our Lucky Stars

Awesome work! Because of your quick thinking, we were able to adjust our path and avoid collision. Now let's turn our attention to the flight paths of satellites.

How high do satellites orbit?

The altitude, or height, of a satellite's orbit varies. The three most common orbits are Low Earth orbit, Medium Earth orbit, and Geostationary orbit.

Low Earth Orbit

Satellites in Low Earth orbit typically have an altitude of 120 to 1,200 miles, and one orbit takes about 90 minutes. The International Space Station is an example of a Low Earth orbit satellite.

Medium Earth Orbit

Medium Earth orbit satellites have an altitude of around 12,000 miles and one orbit lasts 12 hours. The GPS satellite system are Medium Earth orbit satellites.

Geostationary Orbit

Geostationary orbit satellites have an altitude of around 20,000 miles and take 24 hours to orbit the Earth. Satellites used for communications and weather tracking are often Geostationary orbit satellites.

Geostationary Orbit

A Geostationary satellite gets its name because it moves in the same direction and at the same speed as the Earth rotates. Because of this, these satellites look like they are staying still, or stationary, because they are always at the same spot above Earth.

How fast does a satellite travel?

How fast does a satellite travel? There is no exact number, but the best estimate is about 17,000 miles per hour. Satellites in lower orbit are going faster than 17,000 and satellites in higher orbit are going less than 17,000. For some perspective, a cheetah can run up to 58 miles per hour, some cars can go up to 250 miles per hour, a plane can go up to 575 miles per hour. Satellites are moving really fast!

What is satellite imagery?

What is satellite imagery? Satellite imagery refers to images of the Earth and other planets collected by satellites equipped with cameras. These satellites are operated by governments and businesses around the world. Let's take a look back at the history of aerial mapping and imaging.

Aerial Mapping

Aerial mapping allows us to get a better and more accurate view of the land, or a “birds eye view”.

History of Aerial Mapping

During the Civil War, armies used hot air balloons to gather intelligence on the enemy. Can you think of some advantages and disadvantages of using a hot air balloon to take aerial images?

Advantages:

- It provides a better view than eyes on the ground and allows us to see farther in the distance
- Able to gain a tactical advantage in the war with your new knowledge

Can you all think of some disadvantages of using a hot air balloon to gather intelligence?

Disadvantages:

- The time it takes to assemble and disassemble the balloon which could become costly.
- The balloon is not stealthy. Being so big, the balloon is visible and becomes a target

Pigeon Photography - WWI

During WWI, the balloon was upgraded to carrier pigeons. These birds were fitted with cameras and used to fly over enemy areas, giving detailed photographs from a lower height. What are some advantages to using carrier pigeons to collect images?

Advantages:

- Pigeons are more stealthy than hot air balloons
- Pigeons can fly further and higher than a balloon
- Better technology with cameras and film during WWI made better photos

What are some disadvantages?

Disadvantages:

- Pigeons are animals with minds of their own. They may not fly back!
- If the camera breaks, there is no human flying the pigeon to fix it

U-2 Spy Planes - WWII

In WWII pigeons were upgraded to spy planes. Cameras were attached to the planes and

would fly over areas of interest. Analysts would then look over the images. What are some advantages of spy planes?

Advantages

- Much stealthier than a balloon or bird.
- There are human pilots on the plane, allowing for the best decision making.
- Better technology allows for better photos

Can you think of any disadvantages?

- It costs a lot more money to fly a plane than it does to fly a pigeon.

Satellite Imagery

Like we discussed earlier, we now rely on satellites to take images of the Earth from space.

Uses of Satellite Imagery

What are some uses of satellite imagery, and how does it relate to geospatial intelligence? Satellite images are crucial to solving real world problems as they collect information about a specific location on the Earth.

- **Natural Disasters:** Satellite imagery is very useful during natural disasters. For example, we can look at satellite images before and after Hurricane Harvey in Houston to see how the city changed after hurricane. The imagery is given to first responders to identify where people were trapped, where roads were inaccessible, and other ways to help save lives.
- **Climate Change:** Scientists look at satellite imagery of locations around the world over time in order to determine things like water levels rising or ice caps melting.
- **Archaeology:** Archaeologists use satellite imagery to look for and analyze historic sites and ruins.
- **Natural Resources:** The forestry, mineral, and oil industries use satellite imagery to monitor and mine these resources.

Journey Home

Our time in space is coming to a close. To bring us back down to Earth, you'll need to answer these questions.

Question #1

The speed of a satellite depends on what?

- A. The orbit the satellite is in
- B. Weather in space
- C. The material the satellite is made of
- D. All satellites move at the same speed

Answer

The answer is A, the orbit the satellite is in. Satellites in lower orbit are going faster than 17,000 mph and satellites in higher orbit are going less than 17,000 mph.

Question #2

Why did the United States begin using pigeons instead of hot air balloons during World War I to take aerial images?

- A. Pigeons are easier to control
- B. Pigeons are cuter than hot air balloons
- C. Pigeons are stealthier than hot air balloons
- D. Pigeons have a human pilot

Answer

The Answer is C, pigeons are stealthier than hot air balloons. They are much smaller and more difficult to spot.

Question #3

Can you name an example of a use for satellite imagery?

Answer

Studying climate change, managing natural resources, recovering from a natural disaster, and many other examples!

Intergalactic!

Fantastic job. Space has been fun, but I'm starting to miss gravity. It's time to begin our descent back to Earth.

The Eagle has Landed

Mission accomplished! Thank you for joining us on this intelligence gathering mission. You helped us narrowly avoid disaster multiple times, and hopefully learned a thing or two about satellites. Now it is time to use what we taught you and tackle some activities.