Classroom Procedure:

1. Begin by telling students they have been invited to a party and given an address. Ask students how they would figure out how to get to that address. Some students will say to use the mapping app on the phone. Probe students about how the phone knows where to go. Ask students to think of their answers with a partner and then share as a whole group.
2. While reading the *GPS Satellites STEM* Content pages, reinforce vocabulary, and give students additional examples of global positioning satellites to help them see how it is used in almost every profession. Use the Additional Resources to enhance understanding.
3. Introduce notes on Global Positioning Satellites.
4. Follow the Activity page with students. Have students work in small groups of 2-3 on the activity. Turn on all GPS receivers. Assign a number to each GPS receiver and the same number to a specific container. Tell students the boundaries of the space they can use for hiding the containers and designate a home base where the teacher will be located. Once all the groups have hidden their treasure, mix up the papers, hand out a different one to each group, and a matching receiver. Tell each group they must find the container with their receiver number on it. Help any struggling teams.
5. Distribute the Practice page. Use the GPS receiver to help students draw their initials or images. Then use a software program to download the data into the mapping software to check their accuracy.
6. Distribute the Homework page. Have students share their findings at the beginning of the next class to reinforce their understanding.
7. In closing, ask students how GPS can help people in emergencies. Allow for responses and discussion.

SSPEH

Objectives: Students will understand the history and use of global positioning systems (GPS) and understand how GPS works. Students will relate the use of GPS in their daily experiences.

State Educational Objectives: NGSS.HS-ESS1-4, NGSS.MS-ESS3, & NGSS.MS-ESS2

Class Sessions (45 minutes): 2 – 3

Teaching Materials/Worksheets: *Global Positioning Satellites* Content Pages (2), Activity Page (1), Practice Pages (2), Homework Pages (2)

Student Supplies: Pen or pencil

Prepare Ahead of Time: Activity: Small containers filled with a prize for each student, GPS receivers, extra paper, pens or pencils, a large outdoor area Practice: GPS receivers, mapping software for GPS receiver
Copies of worksheets

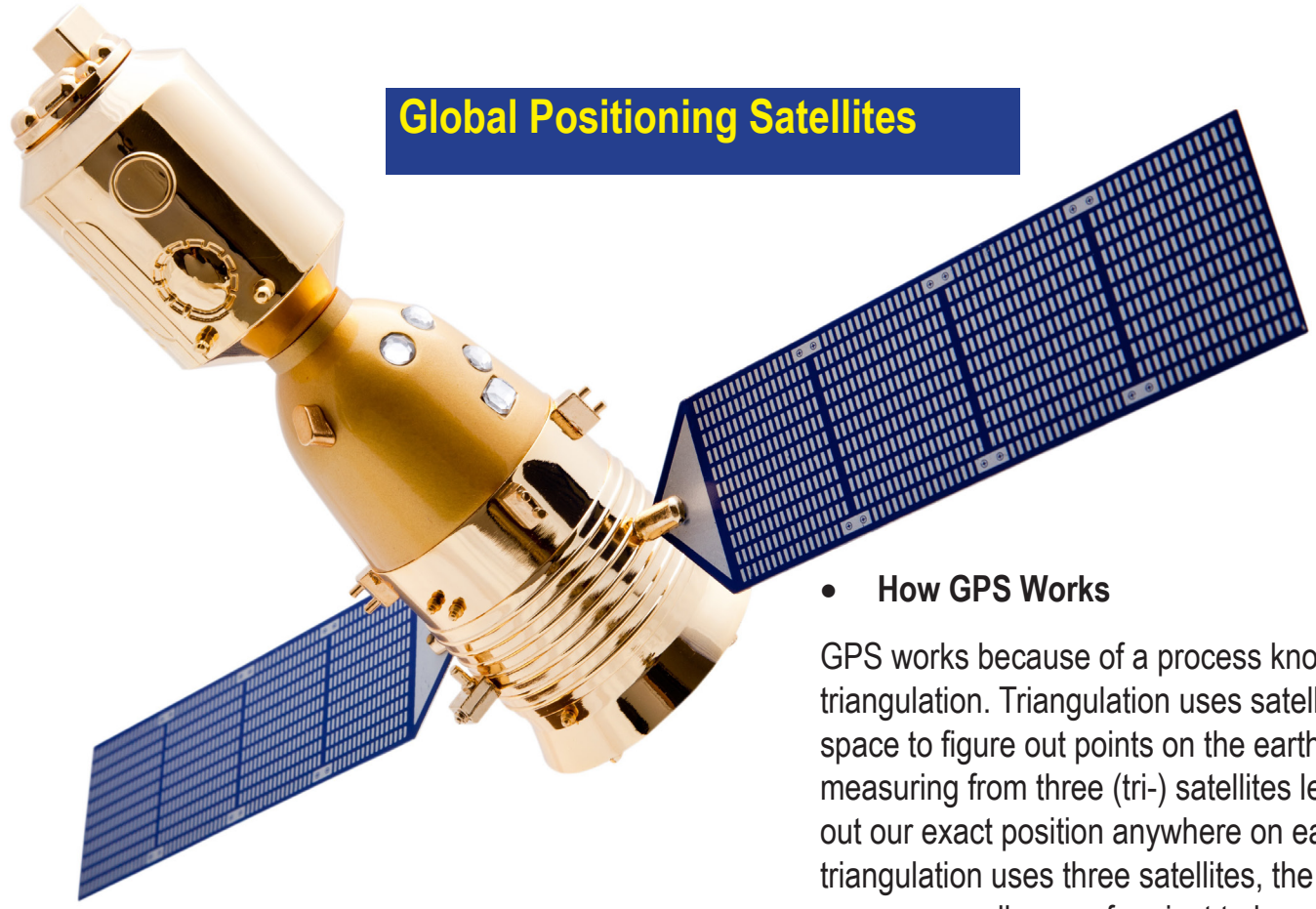
Options for Lesson: Show students examples of artists that use GPS to create their own masterpieces! Have students create their own art using GPS receivers and coordinates. Have students design a scavenger hunt for other classmates to solve. If students are advanced in math, show them how to use the math formula for solving triangulation problems. Practice geocaching as a class instead of doing the art project and then have students find one on their own for homework.

*Lessons are aligned to meet the education objectives and goals of most states. For more information on your state objectives, contact your local Board of Education or Department of Education in your state.

Teacher Notes

In this lesson, students will learn about global positioning systems. They will explore the history, learning about how GPS works, and look at different people who use GPS every day. Students will become treasure hunters as they hide and find treasure containers using GPS receivers. Students also participate in geocaching, getting them outside, and with their friends or family. The world will come alive in this kinesthetic lesson that will be helpful for years to come!

GPS Satellites STEM



Global Positioning Satellites

- **History**

In the middle of the 20th century, people started putting radio transmitters into satellites. The government created a Navistar system in 1970, which later became known as GPS (global positioning system). At first, only the military was allowed to use this new system. But then-President Ronald Reagan made an order that allowed anyone to use the navigation system.

At first, GPS receivers could only give another receiver the position. In modern times, GPS is part of almost every cell phone and wristwatch. GPS (global positioning system) is the system or technology that is used by a person. GPI (global positioning instrument) is the physical device used by a phone, car, or watch.

- **How GPS Works**

GPS works because of a process known as triangulation. Triangulation uses satellites out in space to figure out points on the earth. Accurately measuring from three (tri-) satellites lets us figure out our exact position anywhere on earth. While triangulation uses three satellites, the actual process usually uses four just to be more precise.

Here is how GPS works:

1. A GPS receiver measures the distance between itself and each of the three (or four) satellites. It figures this out by using the equation: distance = time of arrival times the speed of light.
2. It uses atomic clocks on the satellite to be super exact with the timing.
3. The GPS receiver keeps the exact place in space where the satellites are located.
4. Using some advanced mathematics, the receiver then calculates precisely where you are located on the earth.

- **Uses of GPS**

There are five main uses of GPS:

1. Location
This helps people determine their position on Earth.

2. Navigation
This helps people get from one location to another.

3. Tracking
This allows people to see where other people or objects are moving.

4. Mapping
This helps people create an accurate map of the world.

5. Timing
This helps people take very precise time measurements.

GPS can be used for so many things!

People who use GPS every day are:

Surveyors
Boat captains
Pilots
Miners
Construction
Trucking Companies
Security guards

First responders

When a natural disaster hits, first responders use GPS to track the weather, map the area, and figure out where people are located.

Parents and Kids

Parents use GPS in their car to find their way to new addresses, and kids use GPS when they play games like Pokémon Go or geocaching. Lots of game and activity apps on your phone use GPS.

Activity **Name** _____ **Date** _____

Instructions: Come up with a team name. Find a "hiding spot" for your container within the area where it could be seen by another group.

1. Mark the waypoint (remember this means location!) using the GPS receiver.
2. Record the number of the waypoint.
3. Record the latitude and longitude in the box.

Write your team name and information from 1 – 3 on a slip of paper and give it to your teacher.

Get another group's paper from your teacher and work with your group to find the hidden container!

How did you work together as a team?

_____

_____

Did you find the container?

_____

Where was it hidden?

_____

What was in the container?

_____

What steps did you take to find the container?

_____

_____

_____

_____

Practice

Name _____ Date _____

Instructions: In the box below, sketch your initials or a short word. Write out directions you will need to follow as well.

1. **Create your art using your GPS unit.**

2. **Once you have been able to view your art, answer the following questions:**

On a scale of 1 (totally off) to 10 (perfect) how much does your drawing look like your sketch?

_____

Could someone else read what you wrote? _____

What would you do differently next time?_____

_____

_____

What is something you would like to draw with GPS other than a word? _____

_____

_____

Practice Name Answer Key Date _____

Instructions Instructions: In the box below, sketch your initials or a short word. Write out directions you will need to follow as well.

1. **Create your art using your GPS unit**.

Answers will vary depending upon student project and experience.

2. **Once you have been able to view your art, answer the following questions:**

On a scale of 1 (totally off) to 10 (perfect) how much does your drawing look like your sketch?

_____

Could someone else read what you wrote? _____

What would you do differently next time?_____

_____

_____

What is something you would like to draw with GPS other than a word? _____

_____

_____

Homework

Name _____ **Date** _____

Instructions: Did you know there are treasures you can find all over the world? There is probably one near you right now! Geocaching is real life, outdoor treasure hunting game. It uses GPS-enabled devices that navigate you to a specific set of coordinates. Once at the location, you have to search for the hidden treasure! The treasure containers can be magnetized to a pole, hidden in a tree branch, or slyly placed under an object. Once you have found the treasure, write your name on the paper, take (or leave) a treasure, and return it to its original location so that someone else can find it.

Download a geocaching app on your phone or your parent's phone (there are lots of free geocaching apps) and find a hidden treasure near you.

What is one thing that happened while trying to find the treasure?

_____

_____

How did you know when you were close to the treasure?

_____

_____

Did you find the treasure? _____

What was inside? _____

About how many people had found the treasure before you?

_____

Did you leave a gift inside?

_____

Did you enjoy geocaching? Why or why not?

_____

_____

_____

Homework

Name Answer Key Date _____

Instructions: Did you know there are treasures you can find all over the world? There is probably one near you right now! Geocaching is real life, outdoor treasure hunting game. It uses GPS-enabled devices that navigate you to a specific set of coordinates. Once at the location, you have to search for the hidden treasure! The treasure containers can be magnetized to a pole, hidden in a tree branch, or slyly placed under an object. Once you have found the treasure, write your name on the paper, take (or leave) a treasure, and return it to its original location so that someone else can find it.

Answers will vary depending upon the student experience

Download a geocaching app on your phone or your parent's phone (there are lots of free geocaching apps) and find a hidden treasure near you.

What is one thing that happened while trying to find the treasure?

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How did you know when you were close to the treasure?

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What was inside? _____

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Did you enjoy geocaching? Why or why not?

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_____