Lesson Plan

Satellite Math

Book: *Inventing GPS*
Series: Amazing Inventions
Level: Beacon

Objective

To help students explore how GPS uses the positions of satellites to calculate location.

Supplies

- *Inventing GPS* book
- "How Does GPS Work?" video from the NASA SpacePlace website: https://spaceplace.nasa.gov/gps-pizza/en/
- "Calculating Speed, Distance, and Time" article from BBC Bitesize: https://www.bbc.co.uk/bitesize/topics/z83rkqt/articles/zhbtng8
- Satellite Math Worksheet (attached)
- Whiteboard
- Pencils

Before the Activity

Print a copy of the Satellite Math Worksheet for each student. Read Chapter 3 ("How GPS Works") of the *Inventing GPS* book out loud to students. Then pull up the "How Does GPS Work?" video in your web browser. Skip ahead slightly so you can start playing the video at the timestamp 0:08.

Activity

Play the video for the class, pausing it at the 2:08 timestamp so you don't have to watch the credits. This video gives more details about how a smartphone can use GPS satellites to figure out its location. Ask students the following questions:

- What information does the phone know about each satellite? (Answers: The phone knows where each satellite is, and it knows how long each satellite's signal takes to reach it.)
- What does the phone use that information to calculate? (Answer: The phone can figure out how far away it is from each satellite.)

To explore how the phone does this, read the BBC Bitesize article as a class. This article explains the formula *speed* = *distance* ÷ *time*. It also explains how if you have two of these numbers, you can calculate the third one.

As an example, click through the slides in the "Have a go" section and walk students through solving the equation. On slide 6, make sure to point out how the units (in this case, meters and seconds) are part of the equation, too.

After reading all sections of the BBC Bitesize article, write the three versions of the formula on the whiteboard:

- speed = distance ÷ time
- time = distance ÷ speed
- distance = speed x time

Walk students through what each equation means:

- If you know how far something went and how long it took to get there, you can calculate the object's speed.
- If you know how far something went and how fast it moved, you can calculate how much time the object took to get there.
- If you know how fast something is moving and how long it traveled, you can calculate how far the object went.

GPS units use this third form of the equation to calculate their distance from each satellite. To have students practice using these equations, pass out the Satellite Math Worksheet. Explain that this worksheet has six word problems. For each problem, students will need to use one of the equations from the board. To select the correct equation, students can ask themselves, "Which of the three measurements (speed, time, or distance) am I trying to find?" or, said differently, "Which quantity (speed, time, or distance) is unknown?"

Remind students to include the units in each answer. Review how to calculate the units for each type of equation, demonstrating when and how some units can cancel one another out.

Evaluation

Collect the worksheets at the end of class. Use the attached answer key to give each student up to 18 points total, awarding up to 3 points for each problem:

- 1 point for choosing the correct equation to use
- 1 point for including the correct number in the answer
- 1 point for including the correct unit in the answer

Standards

This lesson may be used to address the Common Core State Standards' reading standards for informational text, grade 3 (RI 3.1), and mathematics standards, grade 3 (CCSS.MATH.CONTENT.3.OA.A.3, CCSS.MATH.CONTENT.3.OA.A.4, CCSS.MATH.CONTENT.3.OA.B.6, CCSS.MATH.CONTENT.3.OA.C.7).

Satellite Math Worksheet

1. How fast is a spaceship traveling if it goes 42 miles in 6 seconds?

2. If a rocket is traveling 5 miles per second, how far will the rocket travel in 6 seconds?

3. How long would it take that same rocket to travel 45 miles?

4. How fast is a spaceship traveling if it goes 100 kilometers in 2 seconds?

5. If a satellite is travelling 8 kilometers per second, how far will the satellite travel in 12 seconds?

6. How long would it take that same satellite to travel 64 kilometers?

Satellite Math Worksheet ANSWER KEY

1. How fast is a spaceship traveling if it goes 42 miles in 6 seconds?
speed = distance ÷ time
speed = 42 miles ÷ 6 seconds
speed = 42 ÷ 6 miles/second
speed = 7 miles/second

2. If a rocket is traveling 5 miles per second, how far will the rocket travel in 6 seconds?
distance = speed x time
distance = 5 miles/second x 6 seconds
distance = 5 x 6 miles (the seconds cancel one another out)
distance = 30 miles

3. How long would it take that same rocket to travel 45 miles?
time = distance ÷ speed
time = 45 miles ÷ 5 miles/second
time = 45 ÷ 5 seconds (the miles cancel one another out)
time = 9 seconds

4. How fast is a spaceship traveling if it goes 100 kilometers in 2 seconds?
speed = distance ÷ time
speed = 100 kilometers ÷ 2 seconds
speed = 100 ÷ 2 kilometers/second
speed = 50 kilometers/second

5. If a satellite is travelling 8 kilometers per second, how far will the satellite travel in 12 seconds?
distance = speed x time
distance = 8 kilometers/second x 12 seconds
distance = 8 x 12 kilometers (the seconds cancel one another out)
distance = 96 kilometers

6. How long would it take that same satellite to travel 64 kilometers?
time = distance ÷ speed
time = 64 kilometers ÷ 8 kilometers/second
time = 64 ÷ 8 seconds (the kilometers cancel one another out)
time = 8 seconds