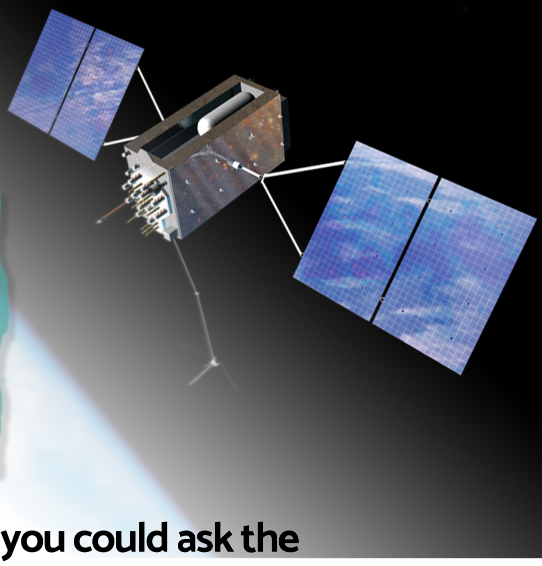
SEE HOW

GPS Satellites Can Find Your Location

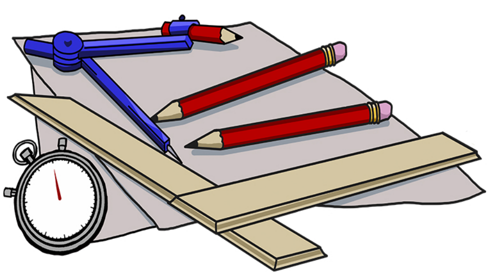


If you want to know where on Earth you are right now, you could ask the dozens of satellites in orbit 20,000 kilometres over your head.
Together they form Global Navigation Satellite Systems (GNSS), an example of which is the United States-based Global Positioning System (GPS).

These constellations of receivers and transmitters use trilateration to give you a pinpoint measurement of your position anywhere on the planet.

WHAT YOU'LL DISCOVER

By measuring the precise distance from three GNSS satellites, it's possible to narrow down your position using distances on a map of overlapping shapes. This is referred to as trilateration.



What you need

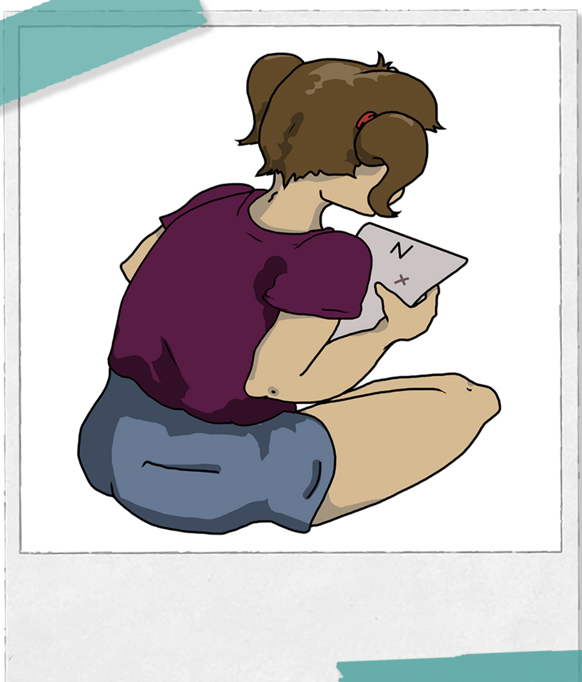
- 2 x A4 sheets of paper
- 2 x pens or pencils
- 2 x 30 centimetre rulers
- A drawing compass
- A clock or stopwatch
- A cooperative friend

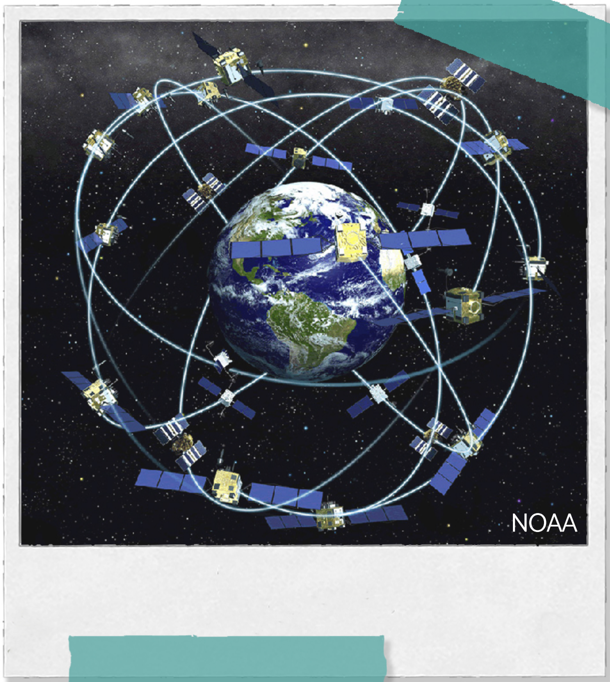
How to build

1. Label each side of the far edges of both sheets of paper with N for north (top), S for south (bottom), E for east (right), and W for west (left). (Want to get creative? Design a whole map and then photocopy it for both sheets.)
2. Determine between you and your partner who will be 'lost' and who will be the GPS.
3. The lost partner will have a ruler and a stopwatch. The GPS partner will have a ruler and a compass.
4. Sit either back-to-back with your partner, or find a space where you can each look at your own paper without seeing your partner's sheet.

How to play

1. When both partners are ready, set the timer and let it run.
2. **Lost partner:** Mark a 'location' on your page with an X. It can be random or deliberate. You must keep this secret.
3. **GPS partner:** Mark the first of your three satellite positions on your map. This can also be random or deliberate.
4. **GPS partner:** Measure the distance from the two closest edges to your first satellite. Communicate these two numbers to your partner. For example, it might be 15.5 centimetres from the north side, and 7.2 centimetres from the east side.
5. **Lost partner:** Measure and mark the first satellite's position on your map. Measure the distance between X and this satellite. For example, it might be 10.4 centimetres away.





6. **Lost partner:** Count this number in seconds, using the stopwatch as a guide. When you get to the last number, add any decimals. For example, count one to 10.

   When you get to 10, say 10 point 4.
7. **GPS partner:** Use the compass to draw a circle with the first satellite at the centre, and with a radius the length of the distance provided by your partner. Their position will be somewhere on this circle's circumference.
8. **GPS partner:** Mark the position of a second satellite, like you did in step 3.
9. Repeat steps 4 to 7 for this second satellite.
10. Repeat steps 4 to 7 for a third and final satellite.

NOTE: See the following page for an example of what your results could look like.

11. Check the point where the circumferences of the three satellites touch. If this is within one centimetre of X, consider yourself 'found'.

12. Check the time on the timer. Try again, and see if you can do it even faster.

HOW IT WORKS

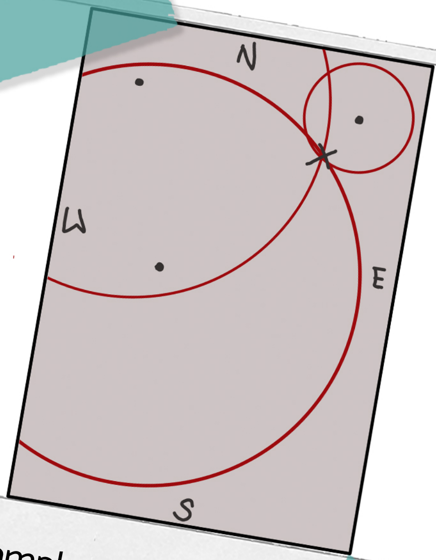
Global Navigation Satellite Systems such as GPS (USA), GLONASS (Russia), and BeiDou (China) are made up of three parts: dozens of satellites that loop the planet roughly twice every day, a ground control network, and the receiver we use to connect ourselves to the system.

To calculate our position, a receiver picks up signals from at least four different satellites. Each signal contains a code and the time it left the satellite. This time is provided by a special atomic clock, making it super precise.

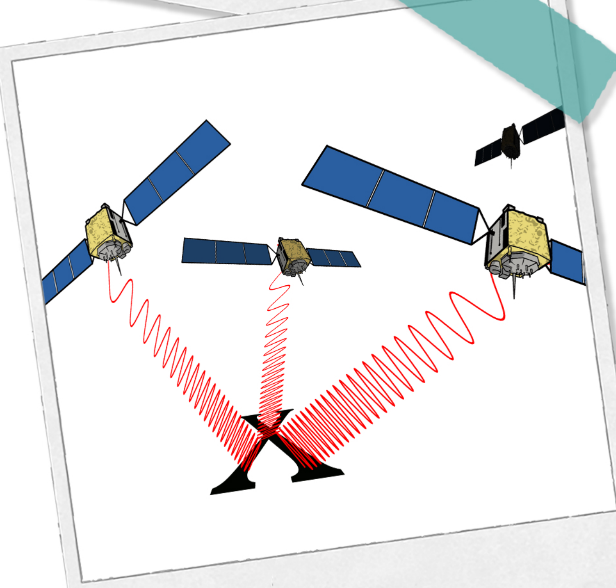
Since the speed of the signal is always exactly the same, the system can calculate the time it took to travel. This is used to provide an accurate distance between the receiver and each satellite.

Having one distance, as you found, isn't enough. Three are required. A fourth satellite is needed for mathematics used to calculate the timing properly.

In reality, these overlapping circles are actually spheres, providing a position in 3D, in what is known as trilateration.



Example game sheet




GPS III SLR (NASA)