1. Show that you know about the Global Positioning System (GPS) by explaining: how it works, ownership and control of the system, its benefits to society, what factors affect its accuracy.

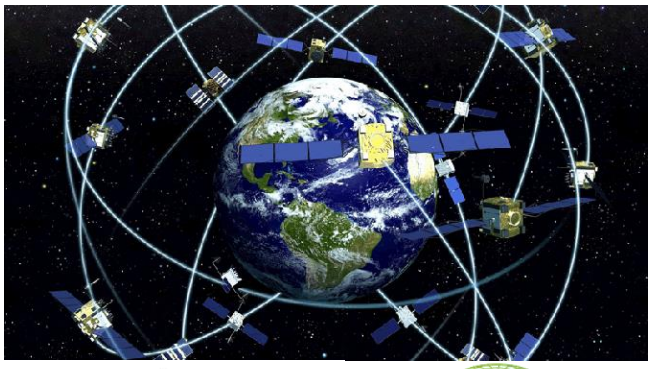
3. Show that you know the difference between Ordnance Survey, and latitude and longitude coordinates.

Understanding GPS – Global Positioning System

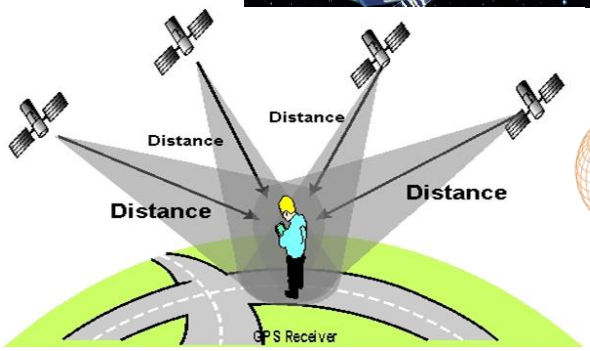
"Where am I ???"

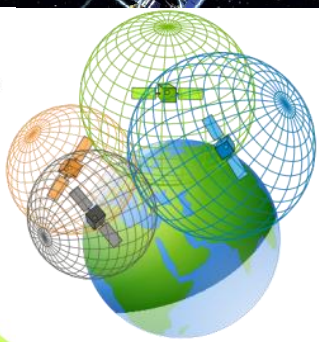
If you have GPS technology in your phone or device, it can tell you exactly where you are, often to within a meter. Imagine if you're on a hike and wondering if you've missed the turning and you could look on a map to see if you have. You've probably used GPS many times, it's what Sat-Navs use to know where you are and how far to your next turning.

"How can it do that?"



Up high above you are satellites, just to work out where you are. At any time, at least 4 satellites above you will be able to transmit a radio signal to you. There are more than that because some will be on the other side of the earth. Have you done trigonometry in maths yet? Well let's not make this a maths lesson but if 4 satellites each transmit to your GPS receiver simultaneously, saying where they are and when they sent the info, the clever maths in your GPS receiver can then work out where you are. Its all about the angles and the distance, the distance is measured by working out how long the signal took to get to you.





"But where's here?"

Clever maths is no good if it says you're at some complicated number. We think about places using maps, so our GPS receiver gives the complicated number to a map piece of software which can show you where you are or show you the longitude/latitude. If the complicated number is clever, the maps need to be too, or what you're shown won't be accurate. Old maps were never accurate enough for this sort of task, partly as the technology wasn't invented yet to make them accurate and partly because it wasn't needed. It needed the ability to do digital mapping which took images from satellites to make accurate maps.

“Is it always accurate?”

No! The main reason is if your GPS receiver can’t see 4 satellites. Under trees makes it tricky, down a cave makes it impossible, between high buildings makes it hit and miss, can you think of other things that would make it tricky? Clouds or rain isn’t one of them. Most GPS receivers will tell you their accuracy. Moving a few meters can often really help.

Yes! Actually, it’s usually the map which isn’t right, not the GPS accuracy. Who hasn’t heard of sat-nav stories where someone was directed into a river or the wrong way down a street. So if you’re using it on a hike, don’t forget all your other skills so that you don’t walk into a bog or a field with a bull in it!

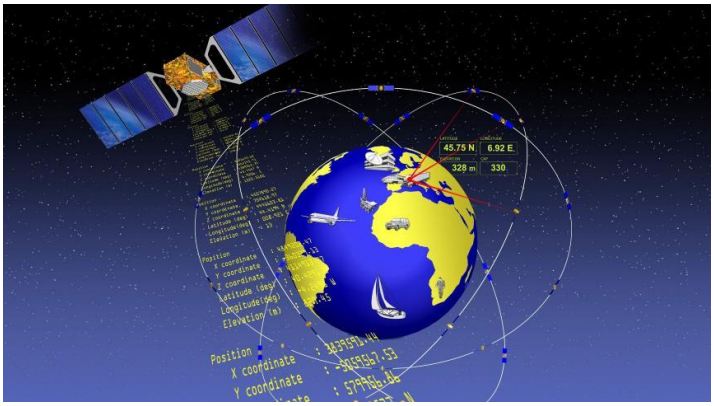
“Is it always available?”

That depends on a number of things. If you’re thinking of leaving your map and compass behind on a hike, that might not be a good idea. The main thing that gives a problem is your GPS device/receiver, usually because it runs out of power. The system itself is almost completely reliable.

Why? Because the only system in use for years was set up by the US military and they want it working! GPS started in 1994 with 24 satellites and now has 30 to make it even better. Initially it was a prototype and only for military use but in 1983, 269 people were killed when their plane was shot down as it had gone into airspace they weren’t welcome in. The US government realised GPS could be useful for everyone and decided to make it available to everyone as soon as it was complete.

Since then many countries have realised that GPS is so useful that if the US chose to stop people using theirs, this could be a problem! There are now other systems available and others in construction. For the UK, the main one is Galileo, developed by the EU and partner countries, switched on in 2016 and gradually coming into full use in 2020. Some of your phones may have already used it.

GPS, Galileo, GNSS…. GPS is the US’s system but as it was the only one for years, we will probably continue to call all satellite-based radio navigation systems, GPS. Just like we mostly call sticky tape, Selotape, even when it isn’t.



GPS and mapping

Navigating by sight

Centuries ago, people would have navigated with instructions such as turn right just before the forest, turn left at the castle or follow the ridge. They were using physical objects they could see. Another one they used would have been ancient burial mounds as they were often on high places making them more visible. When people laid claim to land they would often mark the edges, for example, the New Forest was marked with boundary stones, many of which still exist. These would be another navigation tool. We still navigate by sight daily. Think about your route to your classroom, I bet you don't use a map or GPS for that!

Old, really old, maps

These would have been more like pictures. This one is of Great Britain from about 1800 years ago. It was the sort of thing the Romans had when they invaded England. Quite surprising they found us!!

Here's another famous map of Great Britain, the Gough map (below) which is 700 years old. They've shown North to the left, they must have often got lost!

Longitude and Latitude

Knowing where we are on Earth needed a system other than "over here!" or a picture map. 2200 years ago, a Greek dude called Eratosthenes came up with longitude and latitude as a way to state where you are in the world so they could create good maps.

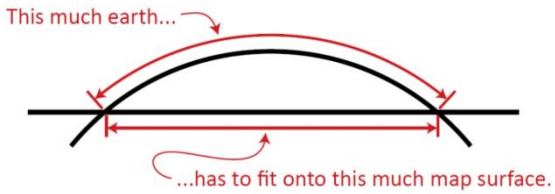
Latitude is how far up or down the world you are and Longitude is how far round the world you are.

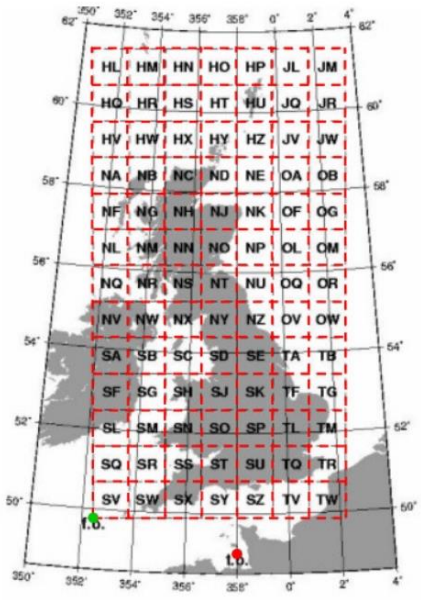
When we write it is looks like this; N50°47'45.8" W001°44'19.6". This is the location of Braggers Wood campsite which is just over 50° north of the equator and just over 1° degree west of the Greenwich meridian (in London).

OS Map co-ordinates

But are you thinking that doesn't look like the map references my leader has been showing me! Well they're not. In England, the Ordnance Survey came up with their own system when they were mapping England. Braggers Wood campsite is at SZ184996, quite different to N50°47'45.8" W0011°44'19.6".

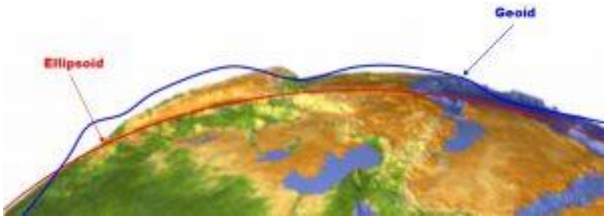
Ok, deep breath, here's the problem with mapping – the earth is round! Well, technically it's ellipsoid but let's keep this simple. How do you draw something that's on a sphere onto a flat bit of paper? Have you ever looked at the bits from a burst balloon, could you imagine ever getting it flat? Map makers have to decide how they're going to draw it so that you end up with something useful. Working things out usually uses maths so map-makers liked using maths ideas like squares and graphs. The problem with longitude and latitude is that it makes funny, not-quite rectangle shapes. When they decided to map Great Britain accurately from 1936-1962, they did it with triangulation. You may not know what that is but I expect you've seen triangulation stations, which used trigonometry which works best with squares. Ordnance Survey came up with the National Grid system. Rectangles work fine locally with something the size of a small country but globally latitude and longitude works best. Yep, that's why GPS uses them, the clues in the name, G is for Global.





One more deep breath, here's another problem (there are loads, it's really tricky) – the earth isn't flat. I don't mean it's not flat because its round, I mean it's not level on the outside. Lots of hills and mountains makes it hard to decide where the line of the outside of earth is. Even if we used the sea, after all, water is level right, the tides cause a problem and make that go up and down. You need to know where the outside line is as it decides how big the world is. Imagine getting a bit of string out to measure that!.

Map makers have to decide on an outside line which they will use with their coordinate system and they call this a datum. And there's different ones used around the world and over the history of map making. There isn't one best one and there can be up to 200m difference in maps using different datums. No wonder the maths in GPS receivers is complicated. OS maps use OSGB36 which best fits UK's shape at its point on the earth. GPS uses GRS80. Google maps use WSG84.



Latitude/longitude units and formats

Everything in mapping seems to have lots of ways to write something. Latitude and longitude can use one of 4 formats;

- degrees and decimal minutes (DDM): N50° 47.763' W001° 44.327'
- decimal degrees (DD): 50.796061, -1.738773
- hemisphere decimal degrees (HDD): N50.79606° W001.73878°
- sexagesimal degree: degrees, minutes, and seconds (DMS): N50° 47' 45.800" W001° 44' 19.600"

Google maps, like most web mapping software, uses DD and Geocaching uses DDM. DMS is used in nautical navigation and isn't very accurate, certainly not accurate enough to locate a geocache. Some apps such as iPhone compass use DMS so be careful as you would need to hunt a 100 square meters area!

GPS and radio signals

To make a cake you need eggs, butter, flour.... To make a GPS system you need satellites, clocks and radio signals. And some amazing computer programmes. The development of radio signals has a link with Baden-Powell. First, we need to go back to 1887 when Heinrich Hertz creates electromagnetic waves. This is mahoosive, he proved that electricity, magnetism and light are related. It inspired other scientists to experiment with radio waves. The scientist who made the breakthrough in sending radio messages over long distances was Marconi and he did this in 1895. Later he sent messages across the Atlantic, 3500 miles, now they can send them over 12000 miles from satellites to earth.

Marconi did most of his research on the Isle of Wight, at Bournemouth, Sandbanks and at Swanage. He was friends with Mr and Mrs van Raalte who owned Brownsea Island who in turn were friends with Baden-Powell. One of Baden-Powell's brothers was an artist and he drew a silhouette of Marconi. You can imagine the conversation between Baden-Powell who knew maps, tracking and signalling, and Marconi who was developing radio messages. Did they ever imagine scouts doing geocaching using satellites!!

6. Show that you understand the safety and environmental aspects of geocaching, such as the Highway Code, Countryside Code and the Geocaching Association of Great Britain guidelines.

Geocaching Association of Great Britain (GAGB) guidelines

GAGB Geocache Hiding Guidelines

To check a location a good resource is **MAGIC** and a very useful link called MagicMaplt! where you can enter any coordinates to check a location.

What Makes a Good Geocache Hide?

1. **Permission:** When placing a geocache, you must seek the permission of the landowner
2. **Labelled:** Ensure the geocache container is clearly marked, stating that the content is harmless and giving the placer's e-mail address or other contact method (eg GAGB contact phone number).
3. **Family safe:** Only items that would be deemed safe and acceptable for an unaccompanied child to find should be placed in a geocaches
4. **No perishables:** No items of food or drink of any kind should be placed in the geocache
5. **Hidden:** Geocaches should be placed in a way that they will not be accidentally found by non-geocachers and there should be no visual sign of disturbance.
6. **Respect the land:** Geocaches should not be buried. Holes should not be dug to place a geocache. Also, geocaches should not be hidden in animal holes or runs, and fences should never need to be climbed to access the site (other than through a gate or by a stile)
7. **Parking:** If parking is not obvious, consider adding a waypoint to indicate a good parking location, to minimise the chance of seekers attempting to drive in unsuitable locations
8. **Maintenance:** Maintenance of the geocache is the responsibility of the placer (cache owner)

You MUST NOT hide:

- On or adjacent to **Airports & Military Bases**
- On or adjacent to **Ministry of Defence Land**
- In or adjacent to **Railway Stations**
- In or on a **BT phone-box**
- Adjacent to **Schools and Playgrounds**
- In or on a **Dry Stone Walls**

Do not impede **Emergency Services**

Do not create suspicion in **urban areas**

Do not harm the **environment**

Stay safe around **water**

You can only hide IF YOU HAVE specific permission:

- In or adjacent to **Religious Grounds and Cemeteries**
- On or adjacent to **War Memorials**
- On **SSSI or SAM** land