Latitude and Longitude – Tutorial Script

Imagine we're doing field work in the middle of the oceans or deep in a mountain range? How can we describe our location in such a way that there is no confusion? How can we uniquely locate ourselves on Earth's surface?

We use a spherical coordinate system known as latitude and longitude. Just like a planar graphing coordinate system, we need an origin or zero reference and we measure away from that origin in two directions. This simple graph should look familiar – with the x-axis lying horizontally and the y-axis lying perpendicularly or vertically, and both passing through the zero of the other. Any location on the flat page or screen can be uniquely located by how far to the left or right it is of the y-axis and how far above or below it is of the x-axis. The sample point has a unique set of coordinates of minus 3 and positive 5. To locate ourselves on the surface of the planet, we need a similar method of coordinates, but the challenge is that Earth's surface isn't flat. It's basically a sphere, though not even that is perfect, as it's a bit egg-like as well, with a fatter middle and thinner edges. But for our purposes, we'll work with the perfect sphere idea. How do we develop an x- and y-axis on a sphere? The axes won't be lines, but circles that wrap completely around Earth and intersect each other in two spots, as this image shows. The horizontal circle that cuts across Earth's center is called the **Equator**. The vertical circle is called the **Prime Meridian** on the half that runs through Greenwich, England, and the **International Date Line** on the other half that runs through the center of the Pacific Ocean.

Let's pick a spot that lies between these two axes. How can we locate this spot uniquely, when the surface is curved? First we designate the Prime Meridian as our facing or front vertical axis of the coordinate system. The equator is our horizontal axis. Now we need to indicate how far the point is north or south of the equator and east or west of the prime meridian. To do so on a sphere, we need to use angles. Instead of distances measured, we project an arc or angle that we would travel along a ring's edge.

We break the planet up into equal length lines of **longitude** that run from north pole to south pole at intervals east and west of the prime meridian. Anywhere along a longitude line, a point is an equal angle of a circle away from the prime meridian. Since a complete circle is 360 degrees, half of one is 180 degrees, and one quarter is 90 degrees. If we travel ¼ of the way around the planet west of the prime meridian, we have travelled 90 degrees west longitude. If we travel ¾ of the way, it's the same as travelling 90 degrees east. If we travel all the way to the opposite side, we're at 180 degrees east or west. So even though 90 degrees of western arc travel is much smaller near the poles than it is at the equator, we can still accurately locate our east-west position by an angle measurement of longitude. Are longitude lines parallel? Do they run from pole to pole? Are they roughly the same circumference, all of them? Would a circle cut along a longitude line cut through the center of the Earth?

Pause now.

Now let's add in the other coordinate – the position north or south of the equator. To help us with this coordinate, we can generate equal-interval circles that ARE parallel to each other and north and south of it. We call these **latitude**, because they run east-west or side to side – laterally. However, we use them to determine the angle along a circle that we travel north or south of the equator. For example, if we travel to the north pole, we have travelled ¼ of a circle away from the equator, or 90 degrees north latitude. The south pole is at 90 degrees south latitude. ½ way in between the equator and the poles, we travel 45 degrees north or south. Are latitude lines parallel? If we cut them, will they intersect the center of the Earth? Are they equal circumferences?

Pause now.

Let's use this coordinate system to determine the location of Upheaval Dome in Utah. To help us, we'll cut a section of the earth away and show angles. The prime meridian lies along the eastern side of our cut, the equator, the southern side. Starting at the prime meridian, we have to travel more than ¼ of a circle west to get to Utah. In fact, we travel exactly 109 degrees west. And from the equator, we travel not quite 45 degrees north, but 38 degrees north. If we do both those things, we end up at Upheaval Dome and nowhere else. Thus, Upheaval Dome is located at 38 degrees North of the equator and 109 degrees West of the Prime Meridian.

Now pause the video and test your understanding by accurately locating points A and B as shown in this image.

Pause now.

Now try to accurately locate or place a dot on the spot that is located 45 degrees South of the Equator and 45 degrees West of the Prime Meridian.

Pause now.

As one last note, in the oceans, we have typically, in the US and in Great Britain, used **a nautical mile** as a measurement of distance. Each degree of longitude and latitude can be broken up into 60 equal intervals called minutes. 1 minute of longitude, as measured along the equator, is equal to 1 nautical mile. Why the equator? That's the maximum distance that 1 minute or 1 degree of any interval will have. As we travel away from the equator north or south, that distance shrinks. Land or statute miles, which are what we usually refer to when we use the unit mile, are smaller than nautical miles by about 20%. 1 nautical mile = 1.16 land or statute miles. Why does this matter? Marine navigation often uses nautical miles as the standard distance unit. If you've ever heard of **knots**, that's a unit used to measure speed of ships and is equal to nautical miles divided by hours. 1 knot = 1 nautical mile per hour. While the SI system of units with kilometers have largely replaced miles in most parts of the world, here in the U.S., we continue to use land and nautical miles as well as knots in most instances.

Pause now.

[end credits]