Latitude and Longitude History

Author : *Dr. Davis P. Stern*

Latitude and Longitude

Any location on Earth is described by two numbers--its **latitude** and its **longitude**. If a pilot or a ship's captain wants to specify position on a map, these are the "coordinates" they would use.

Actually, these are two **angles**, measured in degrees, "minutes of arc" and "seconds of arc." These are denoted by the symbols (°,',") e.g. 35° 43' 9" means an angle of 35 degrees, 43 minutes and 9 seconds. A degree contains 60 minutes of arc and a minute contains 60 seconds of arc--and you may omit the words "of arc" where the context makes it absolutely clear that these are **not** units of time.

Calculations often represent angles by small letters of the Greek alphabet, and that way latitude will be represented by λ (lambda, Greek L), and longitude by ϕ (phi, Greek F). Here is how they are defined.
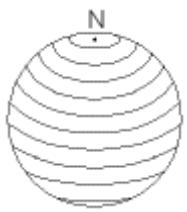
Latitude
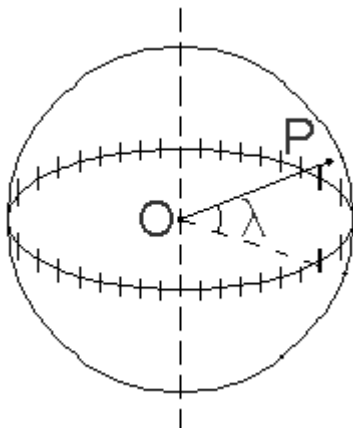
The latitude angle λ

Imagine the Earth was a **transparent sphere** (actually the shape is slightly oval; because of the Earth's rotation, its equator bulges out a little). Through the transparent Earth (drawing) we can see its equatorial plane, and its middle the point is O, the center of the Earth.

To specify the latitude of some point P on the surface, draw the radius OP to that point. Then the **elevation angle** of that point **above the equator** is its latitude λ--northern latitude if north of the equator, southern (or negative) latitude if south of it.
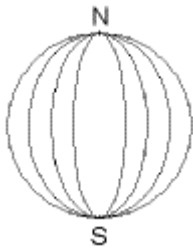

Lines of latitude

On a globe of the Earth, lines of latitude are circles of different size. The longest is the **equator**, whose latitude is zero, while at the poles--at latitudes 90° north and 90° south (or -90°) the circles shrink to a point.

Longitude

On the globe, lines of constant longitude ("meridians") extend **from pole to pole**, like the segment boundaries on a peeled orange.

Longitude lines or "meridians"

Every meridian must cross the equator. Since the equator is a circle, we can divide it--like any circle--into 360 degrees, and the **longitude ϕ of a point** is then the marked value of that division where its meridian meets the equator.

What that value is depends of course on where we begin to count--on where **zero longitude** is. For historical reasons, the meridian passing the old Royal Astronomical Observatory in Greenwich, England, is the one chosen as zero longitude. Located at the eastern edge of London, the British capital, the observatory is now a public museum and a brass band stretching across its yard marks the "prime meridian." Tourists often get photographed as they straddle it--one foot in the eastern hemisphere of the Earth, the other in the western hemisphere.

A lines of longitude is also called a **meridian**, derived from the Latin, from **meri**, a variation of "medius" which denotes "middle", and **diem**, meaning "day." The word once meant "noon", and times of the day before noon were known as "ante meridian", while times after it were "post meridian." Today's abbreviations **a.m.** and **p.m.** come from these terms, and the Sun at noon was said to be "passing meridian". All points on the same line of longitude experienced noon (and any other hour) at the same time and were therefore said to be on the same "meridian line", which became "meridian" for short.

Local Time (LT) and Time Zones

Longitudes are measured from zero to 180° east and 180° west (or -180°), and both 180-degree longitudes share the same line, in the middle of the Pacific Ocean.

As the Earth rotates around its axis, at any moment one line of longitude--"**the noon meridian**"--faces the Sun, and at that moment, it will be **noon** everywhere on it. After 24 hours the Earth has undergone a full rotation with respect to the Sun, and the same meridian again faces noon. Thus each hour the Earth rotates by 360/24 = 15 degrees.

When at your location the time is 12 noon, 15° to the **east** the time is 1 p.m., for that is the meridian which faced the Sun an hour ago. On the other hand, 15° to the **west** the time is 11 a.m., for in an hour's time, **that** meridian will face the Sun and experience noon.

Glossary

Equator—The line which encircles the Earth at an equal distance from the North and South Poles.

Geographic coordinates—Coordinate values given as latitude and longitude.

Great circle—A circle formed on the surface of a sphere by a plane that passes through the center of the sphere. The Equator, each meridian, and each other full circumference of the Earth forms a great circle. The arc of a great circle shows the shortest distance between points on the surface of the Earth.

Meridian—A great circle on the surface of the Earth, passing through the geographical poles and some third point on the Earth's surface. All points on a given meridian have the same longitude.

Parallel—A circle or approximation of a circle on the surface of the Earth, parallel to the Equator and connecting points of equal latitude.

Prime Meridian—The meridian of longitude 0 degrees, used as the origin for the measurement of longitude. The meridian of Greenwich, England, is the internationally accepted prime meridian in most cases.

Conversion between geographic coordinates and cartesian coordinates

Assume that the geographic coordinates of a point M are λ and ϕ ; assume that the radius of the Earth is R. The problem is the determination of the cartesian coordinates of M in a coordinate system of origin the center of the Earth, with the horizontal plane xoy the plane of the equator, with the x-axis going through the Greenwich meridian, the y-axis directly perpendicular to the x-axis, and, finally the z-axis going through the poles.
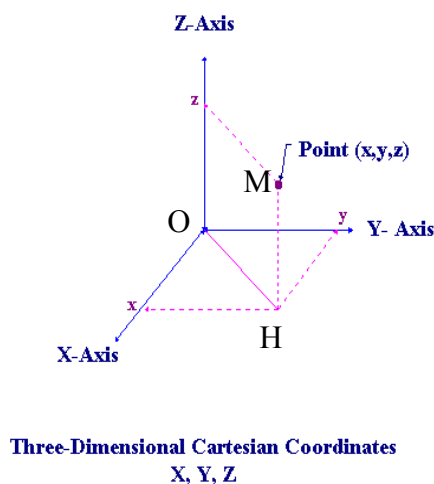
The goal is to find x, y and z .

Show on the drawing the angles λ and ϕ ;

What is the distance OM ?

Calculate the distance OH according to λ .

What is the value of x and y according to λ and ϕ ;

What is the value of z?

Assume that the geographic coordinates of a point V are:

latitude : 45°41'47.59" N
longitude : 4°52'+49.98" E

What are the cartesian coordinates of V (with R = 1) Actually, this point is exactly our school!

Z-Axis

z

Point (x,y,z)

M

O   y   Y- Axis

x

H

X-Axis

Three-Dimensional Cartesian Coordinates
X, Y, Z