Coach Latitude Longitude
V 11 19 2024

Coach files are a series of short lessons, each for a Road Scholar topic. Most started out as responses to questions from coaches. They are rough notes- maybe refined, maybe not. Questions and answers are from various events. You will be seeing Mapscans (screen grabs) from various USGS maps and AAA Road Maps. It's always better to have the whole map, so I will include the name and date of the USGS Topo map that the Mapscans come from. You can get the maps free online from USGS.gov. (See procedure at end)

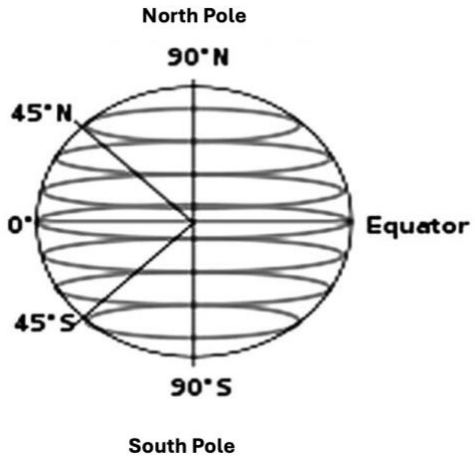
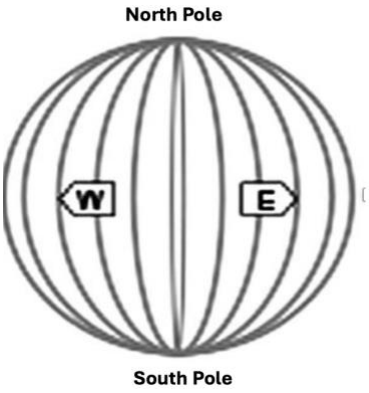
Latitude and Longitude

Worldwide**,** latitude and longitude (lat/long) make up the most common geographic coordinate grid system. Accurate lat/long coordinates allow you to pinpoint your location anyplace on earth to within a few feet. Both are based on imaginary lines that run around the earth. Both are angular measurements drawn from the Earth's center rather than specific distances on the earth's surface.

Latitude measures angles North or South of the Equator. Latitude values vary from 0º to 90º North and 0º to 90º South. Latitude lines run parallel to the equator and are often called parallels.

Longitude measures angles East of West of a specific starting line called the Prime Meridian. The Prime Meridian runs through Greenwich, England. Longitude values range from 0º to 180º East and 0º to 180º West. Time zones are a function of longitude, so the "base" time zone is Greenwich Mean Time (GMT). Lines of longitude (meridians) are spaced far apart at the equator but converge at the North and South pole; they are not parallel to each other.

Quick Comparisons:

Latitude	Longitude
	
Latitude degrees run 0° to 90° N or S	Longitude degrees run 0° to 180° E or W
Latitude lines are parallel all around the Earth	Longitude lines converge at the poles
On globes, latitude is usually marked every 10°	On globes, longitude is marked every 15°. The sun moves at 15° each hour.

Measurement Units:

Both latitude and longitude are expressed in angular units. They do not show a specific distance on the ground! The units are the same as units of time.

A Circle (like the Earth) is divided into 360 degrees. (write as 360°)
A degree is divided into 60 minutes. (write as 60')
A minute is divided into 60 seconds (write as 60")

To write these in reverse:
sixty seconds = one minute (or 60" = 1')
sixty minutes= one degree (or 60' = 1°)
360 degrees = a complete circle (360°) around the earth, such as the equator.

Writing Latitude and Longitude:

A specific location -like where you are standing - always has a specific lat/long. Your phone will display it. The same location can be written a few different ways, but compass directions--N or S, E or W -- must always be included. The equator and prime meridian are exceptions; they are just 0º.

The most common format in Road Scholar is degrees, minutes, and seconds. Using only latitude for the moment: Suppose you and your phone are standing in the middle of Times Square in New York City. Your latitude will be 40º 45' 26" N. Go a block Northwards to Starbuck's, you will be at 45° 45' 29" N. Your original latitude of 40º 45' 26" N can also be written in decimal form as 40.757º N.

Longitude works the same way. In decimal degrees West Longitude can be written as minus (-) and an East Longitude is plus (+). US road maps show longitude as -75 º, -105°. The + is usually assumed but not printed.

Road Scholar Events always have problems in which you must calculate exact lat/long for a specific location on the map. With careful measurements and math, you can get answers within a few seconds. That part gets complicated and is for another "Coach" file.

Math with latitude and longitude

Take a minute to remember how you tell time with hours, minutes, and seconds on a clock.

This clock shows a time of 1 hour, 49 minutes, 59 seconds. You would just read it as 1:50, (leaving out the AM or PM). In 23 minutes, it would be 1:50 plus 23 minutes or 2:13. You are perfectly used to working with 60 seconds per minute, 60 minutes per hour. Degrees, minutes, and seconds of lat/long work the same way.

Problem 1: Ian walks for 1 min 30 seconds, stops, then walks again for 2 min 45 seconds. How long was he walking? (or 1' 30" + 2' 45") ans: 4 minutes 15 seconds

minutes '	seconds "	
1	30	
2	45	
ans = 3'	75"	75"= 1' 15" add to 3'

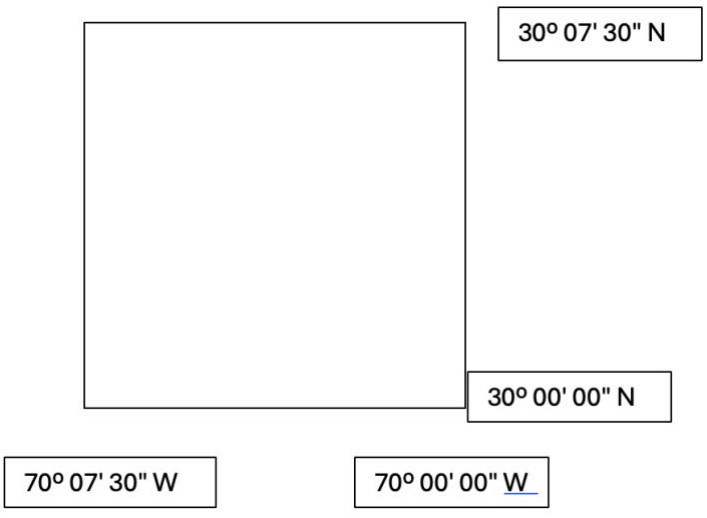
Problem 2: Suppose you are stuck in traffic on Interstate 70 near Topeka, Kansas. Your AAA map shows the longitude as -96. 5º, and your GPs shows 96º 30' 30" W. You drive straight West for 3' 15". What will your new longitude be? Express your answer in degrees, minutes, and seconds.
ans: 96º 30' 30" W + 3' 15" = 96º 33' 45" W

Problem 3: In the question above, suppose you turn around and drive Eastward from your GPs position of 96º 30' 30" W for 3' 15". What will your new longitude be?
longitude will decrease as you move East, so 96º 30' 30" W - 3' 15"= 96º 27' 15" W

Latitude and Longitude on USGS 7.5 Minute Quadrangle Topo Maps:

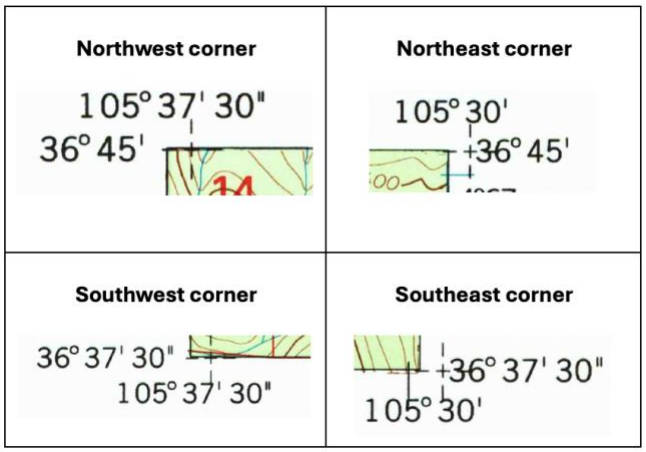
USGS Topo maps are always drawn to show a given number of degrees of lat / long rather than a specific governmental area, such as Pennsylvania. The USGS maps in Road Scholar usually cover 7' 30" of latitude by 7' 30"of longitude. The common term is "seven and a half minute maps".

The drawing below shows an imaginary USGS 7.5 min map with the full latitude marking on the right and longitude marking below. Latitude increases South to North; Longitude East to West. As befits the name, there is a 7' 30' increase in both lat/long on the map area.



Longitude and latitude values are always shown at the four corners of a topo map. However. they show in a shortened form. N, S, E, and W are not listed; you have to figure that out. In the US, all latitudes are North and all longitudes are West. The seconds of lat / long are only shown if they are 30". A 00" value is omitted.

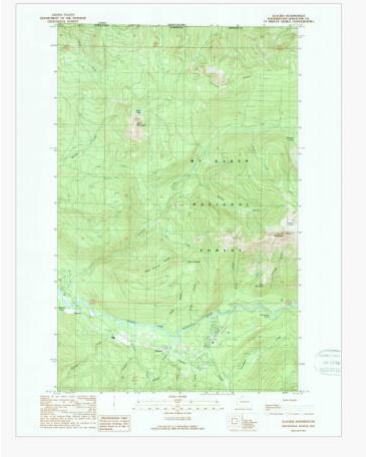
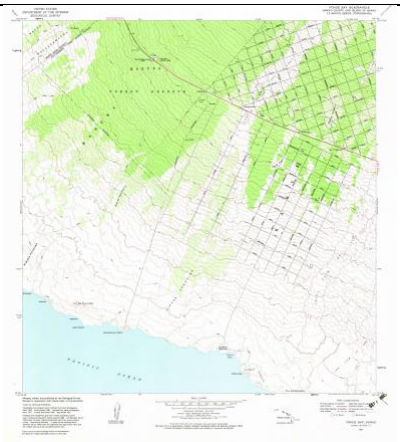
The Mapscan below shows the four corners of a specific USGS map.



How Big Is a Degree on the Earth's surface?

Because degrees are angles rather than specific distances, it depends on where you are. The earth has a circumference of about 24,000 miles at the equator. Assuming the Earth is a perfect sphere, then at the equator (Oº latitude) there are 360º of longitude. One degree of longitude = 24,000/360 or about 67 miles East-West. However, since longitude lines converge as you move toward the poles, a degree of longitude contains many fewer miles as you move North or South from the equator.

Both maps below are USGS 7.5 minutes. Because of the northward convergence of longitude meridians, the map area of a map further North is narrower than that of a map further South.

USGS Clacier, WA	***USGS Pohue Bay, Hawaii***
 **At Canadian border, Lat 49° N**	 **Southern tip of Hawaii, 19° N**

Sample Problems: (These are only to show how a question may be asked. You do not have enough information to do calculations and answer them)

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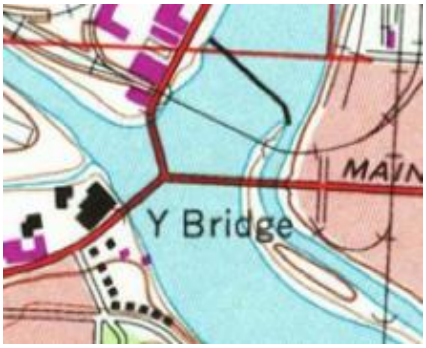
USGS Zanesville, OH 1961 (revised 1985)

Three Science Olympiad teams want meet at the Y Bridge intersection for a pizza party. How will you tell the Doordash driver where to deliver the pies?



Problem: What is the latitude at the Y Bridge intersection? Express your answer in degrees, minutes, and seconds. Don't forget North or South!

Problem: What is the longitude at the Y Bridge intersection? Express your answer in degrees, minutes, and seconds. Don't forget East or West!

Background- Historical Development of Latitude and Longitude:

The latitude/longitude system was developed over many centuries. When people traveled on land, they could find their way based on various landmarks- rivers, mountains, etc. Sailors close to land could do the same thing. However, sailors traveling out of sight of land had no landmarks! To tell where they were and where they had to go, they relied on positions of the sun and stars. Compasses, when developed, were a big help for direction. But to express the position accurately, they developed the numerical grid of latitude, and then much later longitude. Latitude is easy to measure at sea based on the North Star or sun; on a sunny day, you can even measure you own latitude on land with a stick and protractor. Accurate measurement of longitude at sea requires a very accurate clock, but clocks that could work accurately on a moving ship at sea took many years to develop.

For lots of details on longitude, see the Greenwich Observatory at:
https://www.rmg.co.uk/stories/topics/what-prime-meridian-why-it-greenwich

Next steps:

See Coach Map Sectors. latitude, longitude for details on how to calculate lat/long

Questions?

Contact writer Brendan Herlihy at *ctsciencedirector@gmail.com*

To get USGS topo maps online:

www.usgs.gov Is the website for The United States Geologic Survey. USGS no longer makes routine paper prints of topo maps. You can order custom printed maps, but you can download most USGS topo maps for free. If you have a large monitor you can display downloaded maps actual size on your screen. This allows you to make measurements and calculations. You can thus do practice events without the hard topo map. How cool is that?

The USGS site changes constantly but this worked as of October 2024:
Example using Questa, NM 1:24000 map dated 1995 needed for *Zombie Bedtime Rhymes* (a Road Scholar resource event on soinc.org)

Steps: usgs.gov → products → topographic maps → get topo maps → historical topo map collection → (see menu) search by map name → Enter "Questa" in search box → click "24K" below search box → Slide date bar to about 1980 → Results should show: Questa, NM 1995" → pick "↓GEOPDF 17 MB" from menu. Download may take a while.

On your own computer: by adjusting "view" to 100% you will have the same map used in competitions. Save any maps as, for example. "USGS Questa NM 1995" and all your downloaded maps will be together. You can make measurements right on your screen but note that "actual size" on your screen is probably different than the same setting on another screen. Try adjusting your screen so that the black UTM grid measures as 42mm squares. You cannot print a whole map on a standard printer, but you can screen grab one map sector at a time and print it actual size on an 8.5 x 11" sheet of paper.