



GPS-UTM Module10: *Old or New?*

Topics Covered: Latitude and longitude, conversion to UTM coordinates, conversion from UTM coordinates

Required Background Material: GPS-UTM Module 1, GPS-UTM Module 5 (or knowledge of the trigonometric functions)

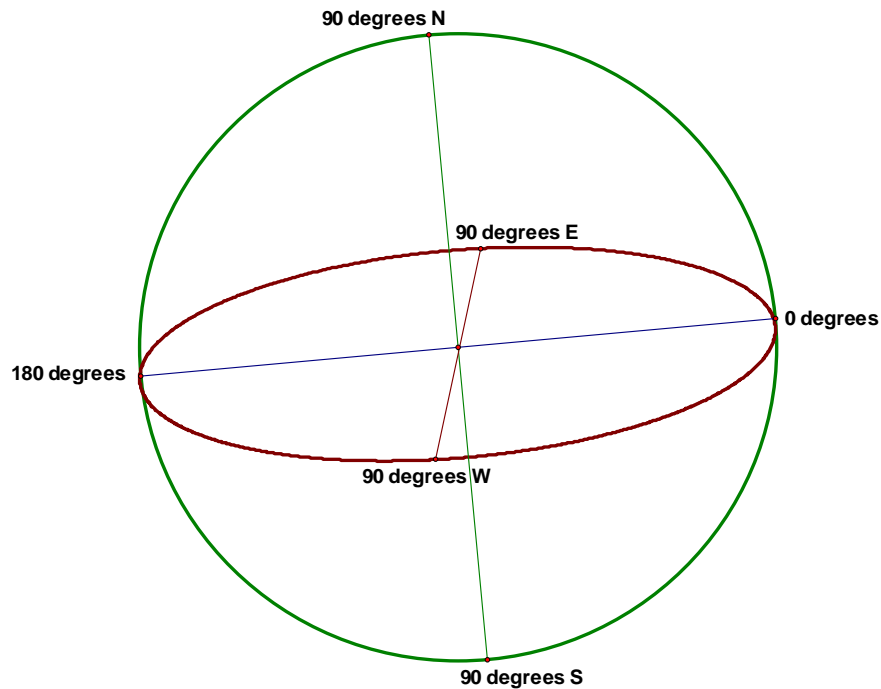
Introduction

The UTM (Universal Transverse Mercator) system of location was introduced in Module 1. We chose to use UTM coordinates in the first nine modules, because they are easier to use, and also because UTM maps resemble the coordinate system used in algebra classes. The Universal Transverse Mercator coordinate system was developed by the United States Army in 1947 in order to simplify the location system used by soldiers in the field. But GPS devices can also use latitude and longitude to describe location. In this module we will discuss the difference between the two location systems, and how to convert coordinates from one system to the other.

Latitude and Longitude (The Old Way)

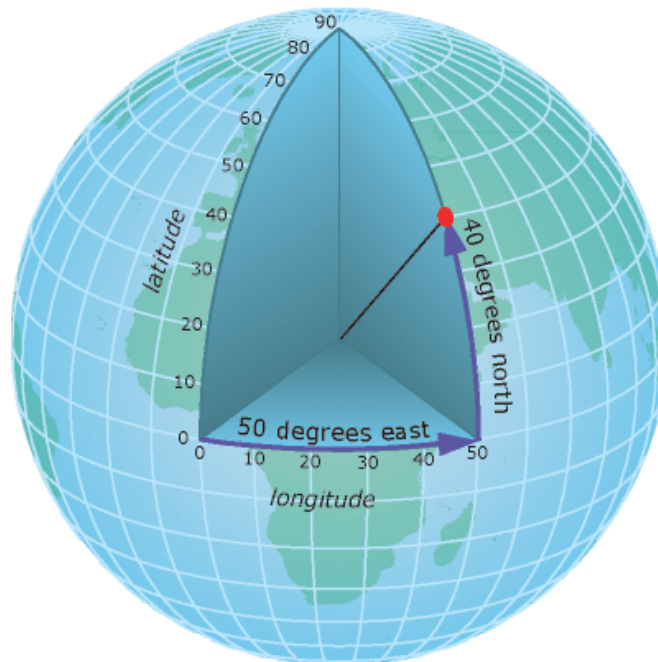
Think of our earth as a huge ball formed by two circles at right angles to each other. One of the circles, the *equatorial circle*, contains the equator. The other circle is a *polar circle*, and it passes through both the North and the South Poles. (See diagram on the next page.) Angles of from 0° to 180° can be marked in two directions on each circle, starting with 0° at a point where the two circles intersect.





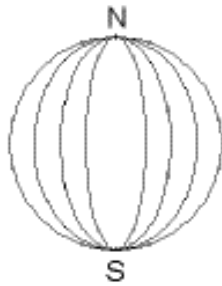
A sphere, as determined by a horizontal circle (brown) and a vertical circle (green), intersecting in a line (blue) through the center.

With this system, any point on the sphere can be uniquely described by the number of degrees east or west (on the brown circle) and the number of degrees north or south (on the green circle). These two measurements are called *longitude* and *latitude*. Notice how this works in the following illustration.

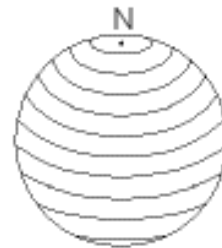


A *great circle* is a circle on a sphere whose radius equals the radius of the sphere. On our earth, each great circle that passes through the North and South poles will contain points on the earth that have a fixed number of degrees east or west. Half of such a circle, from pole to pole, is called a *meridian* or *line of longitude*. Two longitude lines on the same great circle will have longitude degree measurements that are 180° away from each other.

Each set of points, with a fixed number of degrees north or south, also determines a circle. These are called *circles of latitude* and they can be of various sizes.



Longitude Lines



Circles of Latitude

Problem 1

Are any circles of latitude also great circles? If so, which ones?

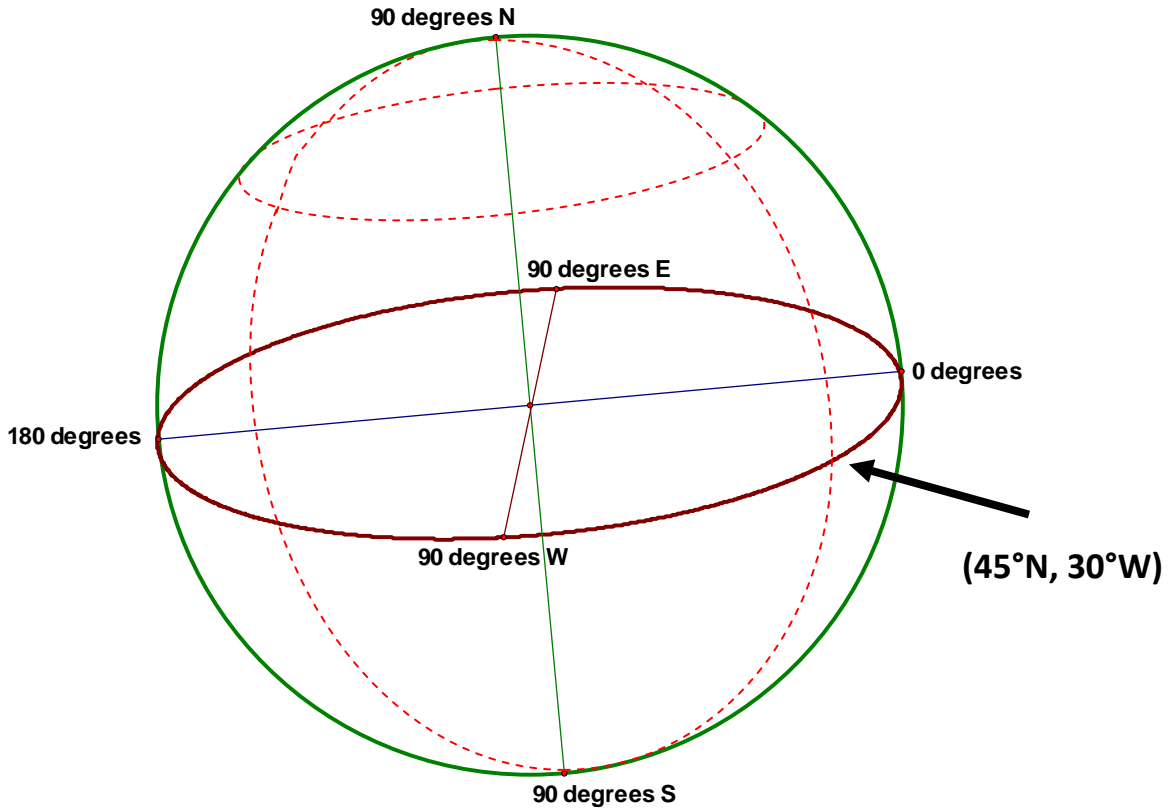
Answer: _____

Given the latitude and longitude of a point on the earth, we can draw the associated latitude line and circle of latitude. The intersection of these two lines will determine the location of the point. For example, suppose we have the following:

Latitude: 45° N

Longitude: 30° W

The diagram on the next page shows how that point can be located.

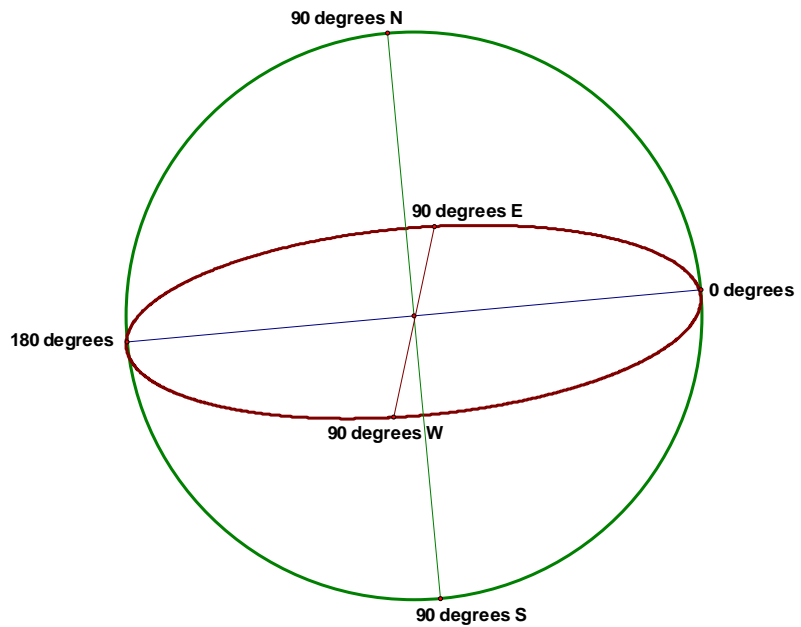


Longitude and Latitude Circles Used to Find the Location of a Point

Problem 2

Sketch longitude and latitude circles on the diagram below, in order to locate a point with the following coordinates:

Latitude: 30° S
 Longitude: 135° W



Problem 3

To divide up our world, the UTM system takes 60 evenly spaced vertical zones from the North Pole to the South Pole. These zones are separated by longitude lines.



How many longitude degrees does each zone span from east to west?

Answer: _____

Problem 4

How wide is each zone, in meters, at the equator? [Hint: You may need to look up some information.]

Answer: _____

How wide is each zone, in miles, at the equator?

Answer: _____

How wide is each zone, in meters, at the North Pole?

Answer: _____

Problem 5

Each vertical zone is cut into 20 evenly spaced latitude zones (designators), between the North Pole and the South Pole. How far is it, in degrees, from the southern to the northern edge of each designator?

Answer: _____

How far is it in meters?

Answer: _____

Compare the last answer to the southern and northern latitude distances for Zone 17 Designator S, where West Virginia is located. (This information is given in Module 1.)

Problem 6

The earth is not perfectly round. The distance from pole to pole is actually a little less than the diameter at the equator. But, assuming that it is perfectly round, how far would you need to travel in meters if you moved one degree in any direction around the world?

Answer:



Problem 7

Now do Problem 6 backwards. Put your answer to Problem 6 in the appropriate place in the following chart, and then calculate the number of degrees in one meter.

Distance in Degrees	Distance in Meters
1°	
	1 meter
	1000 meters
	10,000 meters

Problem 8

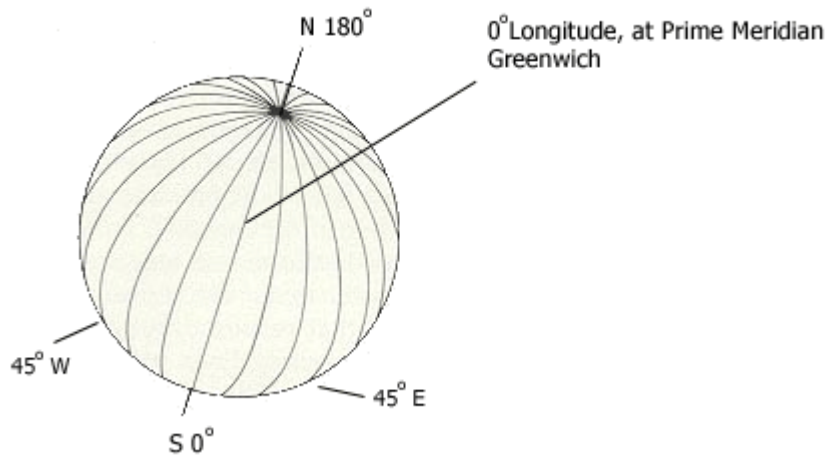
Copy your answers to Module 1, Problem 4, into the following chart. (Or take new readings of your current location.)

	ZONE	DESIGNATOR	NORTHING	EASTING
Example	13	R	3391520	704250
Your Data				

What is your latitude?

Answer: _____

It is easy to see where the circle of latitude for 0° is. It's on the equator! The location of longitude 0° is not so clear, but in 1884 the location of the 0° longitude line was arbitrarily defined as the east west location for the town of Greenwich, England, the home of world time. This longitude line is called the *prime meridian*. (See below.)



Problem 9

In UTM coordinates, Greenwich is in Zone 31 with an Easting Number of 186,073.72. Since West Virginia is in Zone 17, we are $31 - 17 = 14$ zones away from Greenwich in a westerly direction. What is the longitude of a point in Zone 17 that has an Easting Number of 186,073.72? [See Problem 3, if you need a hint.]

Answer: _____

Problem 10

What is the latitude and longitude of your current position, as given in Problem 8?

Answer: _____

Problem 11

Set your GPS device in latitude/longitude mode and check the coordinates of the location you used for Problem 8. What reading do you get?

Answer: _____

How do your answers to Problems 10 and 11 compare?

Problem 12 (Opt.)

Now try this in the other direction; change latitude and longitude to UTM coordinates. Using the world map in Module 1, find the correct zone and designator for the points given below. Then find the UTM coordinates.

Latitude: 30° S
Longitude: 135° W

Answer: _____