Laboratory Exercise #1 - Introduction to Latitude and Longitude

A. Introduction

There are many methods that can be used to locate ones position on the surface of the earth. A common method for location includes use of landmarks and features on the earth's surface, which may not always provide the sufficient detail needed to confidently locate one's position. The method that is universally accepted involves using latitude and longitude, which can provide a highly precise means for locating any place on the planet. Most formalized methods for location, such as latitude and longitude, involve using a grid system that is superimposed on the earth's surface.

B. Overview of Latitude

Latitude defines location on the planet in terms of north or south (Figure 1a). Lines of latitude are also called parallels and define a full circle on the surface of the earth. Zero degrees latitude is defined as the equator, the boundary between the northern and southern hemispheres (Figure 1a). All points north of the equator are within the northern hemisphere and will always have North latitudes. All points south of the equator are within the southern hemisphere and will always have South latitudes.

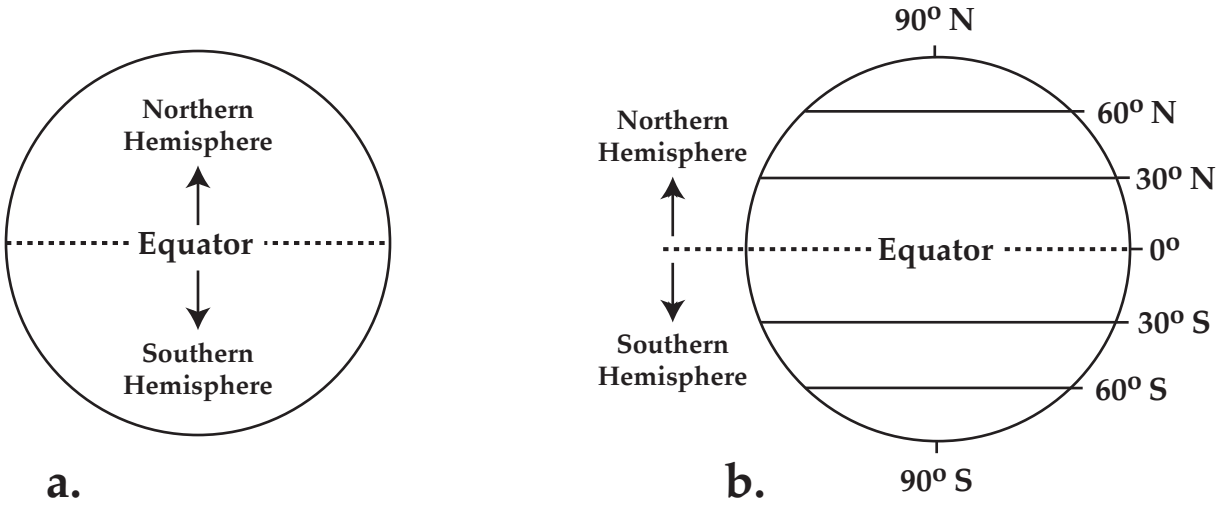


Figure 1. a) Schematic of the earth with the northern and southern hemispheres labeled.
b) The earth with lines of latitude labeled at every 30 degrees.

The maximum number of degrees of latitude that can be present on the earth's surface is 90º. The North Pole has a latitude of 90º N; the South Pole is 90º S. Additionally, parallels of latitude are commonly labeled on world maps or globes normally in 15 or 30º intervals (Figure 1b).

Important terminology that will be used in lecture and later labs: Learn It !

Low Latitudes are defined as:	either N or S	0 to 30°
Middle Latitudes are defined as:	either N or S	30 to 60°
High Latitudes are defined as:	either N or S	60 to 90°

Realize that degrees of latitude actually equates to distance (Figure 2). Traveling one degree of latitude is equivalent to traveling approximately 60 miles.

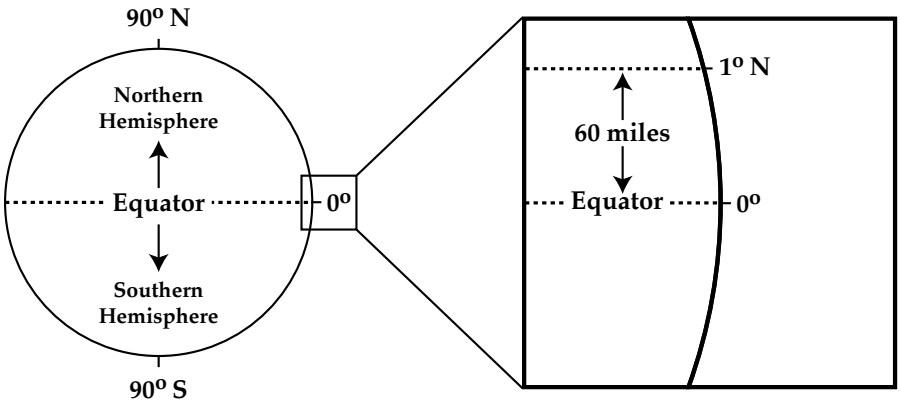


Figure 2. Diagram showing the relationship between degrees of latitude and ground distance.

For example, suppose you are located at a latitude of 30° N. Note that many places on the planet are also located at approximately 30° N such as Austin, TX, northern Florida, or northern Africa (Figure 3).

Figure 3. World map showing different geographic places along the same parallel.

Questions:

1. What is the minimum number of degrees of latitude that can exist on the earth ?

   _____ °

2. Give the latitude of the features on the earth that are the furthest away from the equator.

   _____ and _____

3. What is your favorite town and what is its approximate latitude? Note: that latitude is always written in the following format:
   ##° N if you are in the northern hemisphere or
   ##° S if you are in the southern hemisphere.

   _____, _____ ° ____

4. Is your favorite town located at a low, middle, or high latitude? Explain.

5. How many miles is your favorite town located away from the equator?

6. In which hemisphere (north or south) is:

   North America _____ ?
   Australia _____ ?

7. Can you locate yourself by just using latitude? Explain in detail. (Hint: read page 2 very carefully)

C. Overview of Longitude

Longitude, the second part of this locating system, defines a position on the planet in terms of east or west. Unlike parallels of latitude, which are defined by full circles, lines of longitude (or meridians, as they are also called) form half circles which go from the north to the south pole and do not encircle the whole planet (Figure 4).

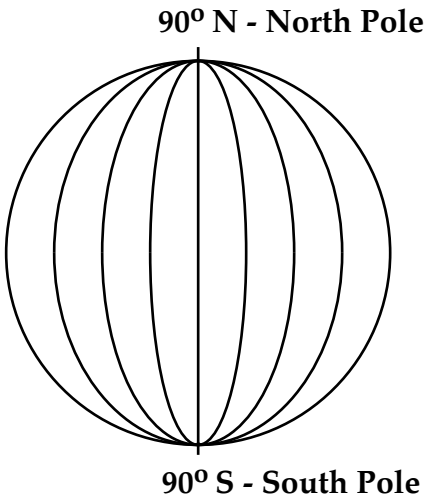


Figure 4. Globe showing meridians going from the north to the south pole.

Unlike the equator, which is defined as a circle exactly halfway between the north and south pole, the zero degree meridian of longitude (the **prime meridian**) was arbitrarily defined. The prime meridian is a line draw from the north to the south pole and is drawn through the city of Greenwich, England; because the British were the first to formalize longitude as a measure of east-west position (Figure 5).

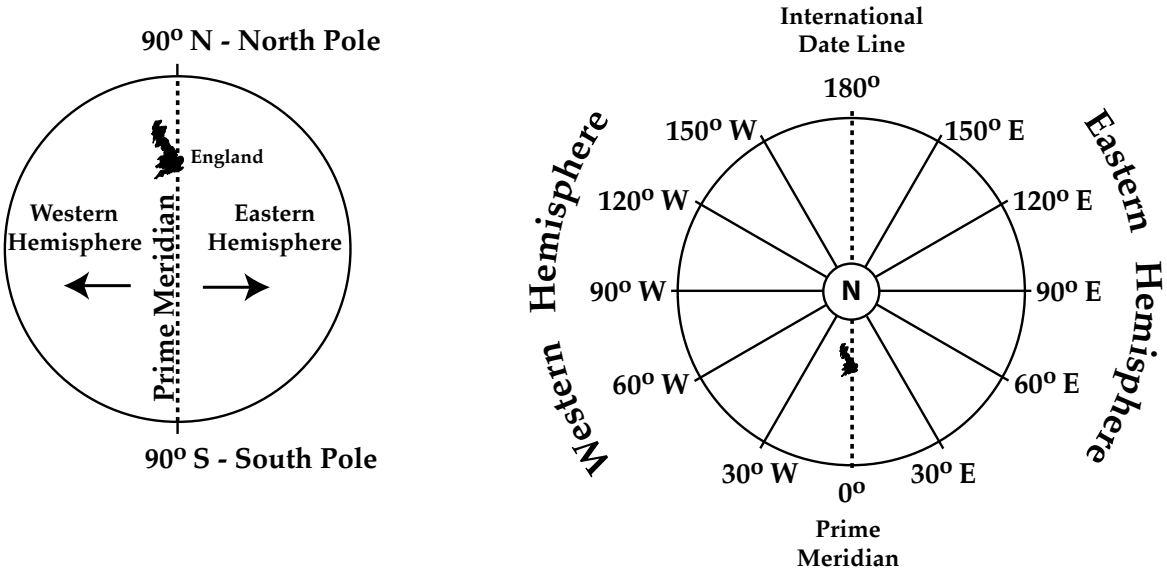


Figure 5. Globes with the prime meridian, western and eastern hemispheres labeled.

Question: Are lines of longitude parallel to each other? Answer: NO.

Therefore, lines of longitude are called meridians, which literally mean pie-shaped wedges (Figure 6).

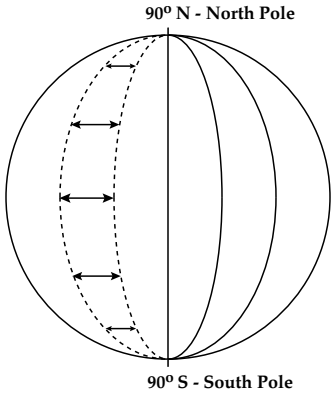


Figure 6. Diagram showing the pie-shaped nature of meridians (lines of longitude).

Because meridians are not parallel to each other, the distance between adjacent meridians is different at the equator versus at the poles. For example:

Meridians are located furthest away from each other at the equator.
Meridians intersect with each other precisely at the poles.
The distances between meridians becomes less with higher latitudes.

Questions:

8. What is the maximum number of degrees of longitude that are possible?

_____ º

9. What is your favorite town and what is its approximate longitude? Note: that longitude is always written in the following format:

###º W if you are in the western hemisphere or
###º E if you are in the eastern hemisphere.

_____, _____ º ____

10. In which hemisphere (west or east) is:

North America _____ ?
Australia _____ ?

D. Using Latitude and Longitude

From the preceding discussion you should realize at this point that in the continental United States latitudes are always north and longitudes are always west (Figure 7). These facts result from the fact that the United States is north of the equator (in the northern hemisphere) and west of the prime meridian (in the western hemisphere).

Figure 7. Map showing the continental United States in terms of latitude and longitude.
Next, you should learn how to write the coordinates of latitude and longitude of a location on the earth in the correct format. Note that failure to correctly write latitude and longitude in the right format will result in a loss of points on your laboratory assignment. Latitude is always written first and longitude second as indicated below:

##^{o} N, ###^{o} W

You not only need to write latitude and longitude correctly but also need to be able to determine the latitude and longitude of a point on a map. Refer to the map on Figure 8.

The locations of points 1 to 4 on Figure 8 are as follows:

Point 1 occurs on both a parallel and meridian and its location can be directly determined by examining the map.
15^o N, 30^o W

Point 2 occurs on the equator and a meridian. The latitude on the map (equator) is defined as 0^o and the longitude can be determined from the meridian on the map.
0^o, 90^o E

Point 3 occurs on a parallel and the prime meridian. The latitude can be determined from the parallel on the map and the longitude is defined as 0^o.
75^o N, 0^o

Point 4 does not occur on either a parallel or meridian and must be determined by interpolating the latitude and longitude between the parallels or meridians. Note that on a global scale the error associated with interpolating latitude and longitude can be as great as a few degrees
5^o S, 102^o W

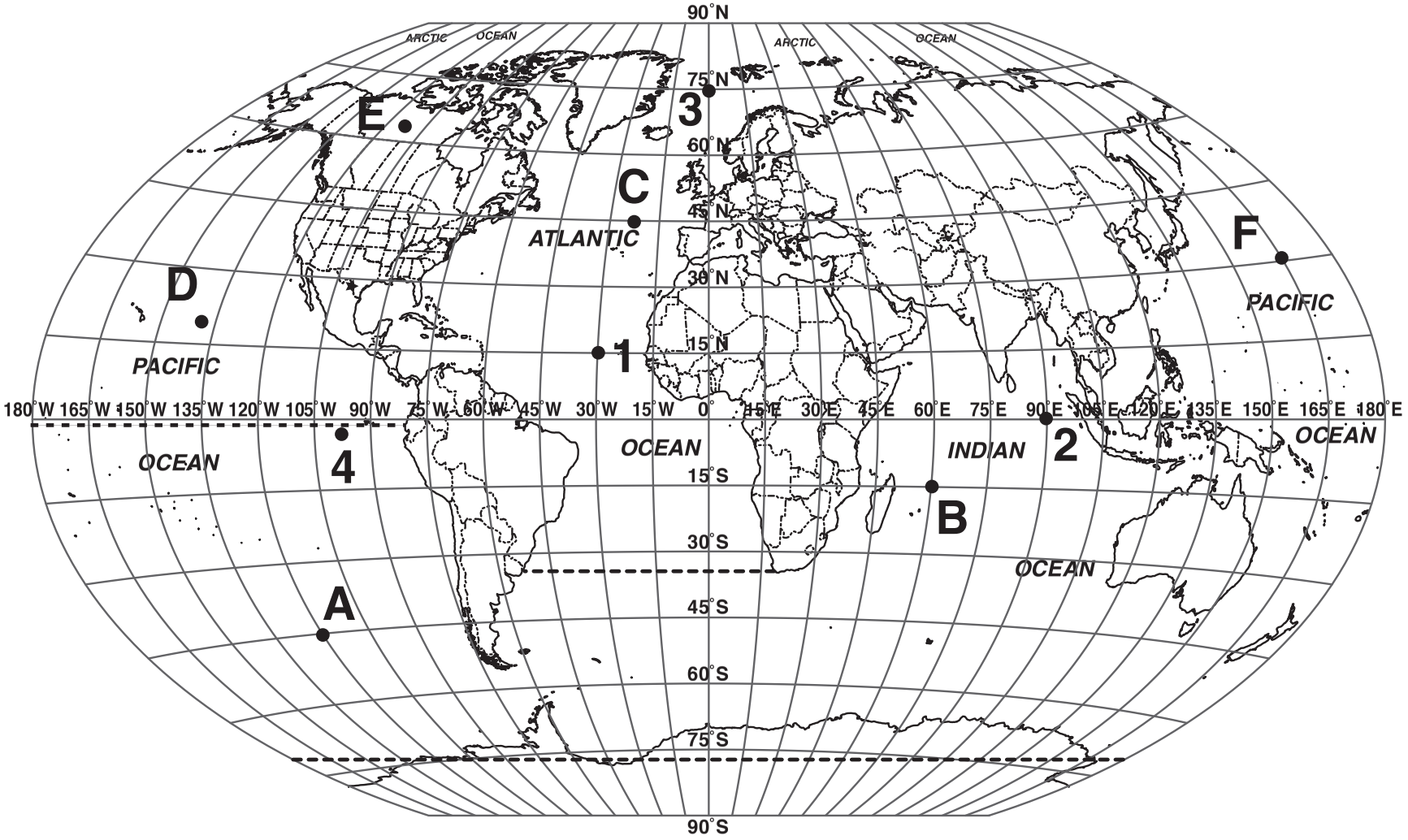

90°N
ARCTIC OCEAN
ARCTIC OCEAN
75°N
60°N
45°N
30°N
15°N
15°S
30°S
45°S
60°S
75°S
90°S
180°W 165°W 150°W 135°W 120°W 105°W 90°W 75°W 60°W 45°W 30°W 15°W 0° 15°E 30°E 45°E 60°E 75°E 90°E 105°E 120°E 135°E 150°E 165°E 180°E
A
B
C
D
E
F
1
2
3
4
ATLANTIC
PACIFIC
PACIFIC
INDIAN
OCEAN
OCEAN
OCEAN
OCEAN
OCEAN

Figure 8. World map with points labeled for homework questions.
Questions:

Answer the following questions by looking at the world map (Figure 8).

11. Find points A to F on Map #1. Determine the correct latitude (N or S) and longitude (E or W) of these points in degrees.

A. _____ D. _____

B. _____ E. _____

C. _____ F. _____

12. Place a dot and the letter (I to L) on the world map (Figure 8) based on the coordinates listed below (please make the dots and letters are large enough to read).

I. 0^o, 100^o E K. 45^o S, 130^o W

J. 35^o N, 110^o E L. 30^o N, 70^o W

E. Making a Three-Dimensional Globe a Two-Dimensional Map
Most maps are two-dimensional representations of our three-dimensional planet. To produce a map requires us to conceptually peel the planet and flatten the world out to get a paper map. The classic example of this process involves a three-dimensional orange peel that is flattened out into a two-dimensional object. The process of the dimensional transformation involved in making a map is called a map projection (Figure 9). There are many different ways to project a map with each projection having various advantages and disadvantages. However, all map projections have some distortion (error) associated with them.

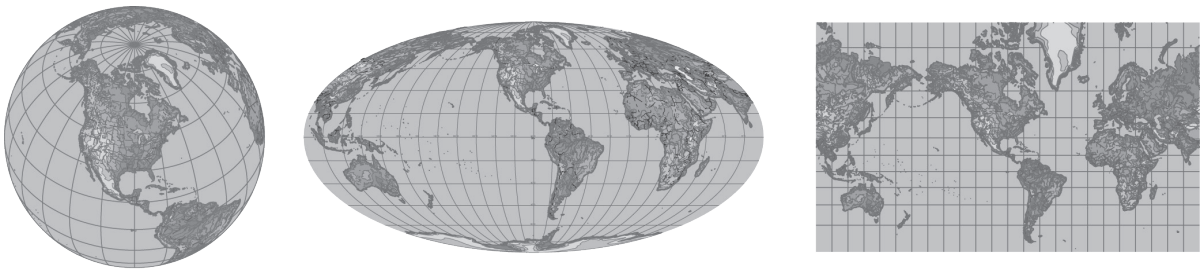


Figure 9. Map projections; three diagrams showing how a globe is transformed into a flat map.

A major error associated with map projections involves distortions in the distance represented by the map. Map scale provides an indication of how map distance can be related to real world distances. A graphic map scale is the device by which map distance is translated into real world distances. Figure 10 shows the three map scales associated with the world map (Figure 8). Note that these graphic scales are latitude sensitive and therefore we include three graphic scale bars with the world map:

A. Equator Graphic Scale
B. 30° Latitude Graphic Scale
C. 60° Latitude Graphic Scale

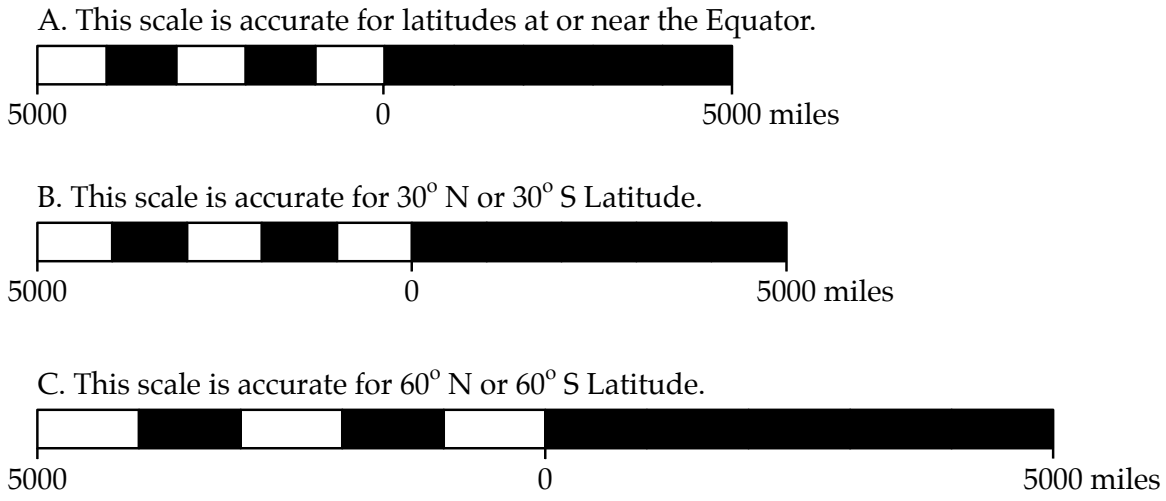


Figure 10. Graphic scales that correspond with the world map in Figure 8.

Procedure for using the graphic scale:

i. Select the correct graphic scale based on the latitude of the points whose distance you will be measuring.

ii. Lay a blank piece of paper between two points and mark the position of the points on the piece of paper.

iii. Take these points to the appropriate graphic scale to determine real ground distances.

Questions:

13. Determine the distance in miles that separates South America from the 180 degree west longitude along 0 degrees latitude (along the equator, dashed line on map).

Which scale: _____ What distance: _____

14. Determine the distance in miles that separates South America from Africa along the 35 degrees South latitude parallel.

Which scale: _____ What distance: _____

15. Determine the total distance (from edge to edge) along the 60 degree South parallel.

Which scale: _____ What distance: _____

16. Is the length of the map scale always the same with increasing latitude? Explain in detail. (Hint: examine page 10 carefully).

F. Maps Depicting Small-Scale Features

Observe the map of Texas (Figure 11). Note that there are large visible distances between individual parallels and meridians of latitude and longitude.

Q: Can you accurately locate geographic features using degrees of latitude and longitude alone?
A: No

Degrees can be further subdivided into smaller units called minutes.

1^{o} = 60 minutes (‘)

Q: If 1^{o} of latitude is approximately 60 miles then what is the distance for 1 minute?
A: Approximately 1 mile.

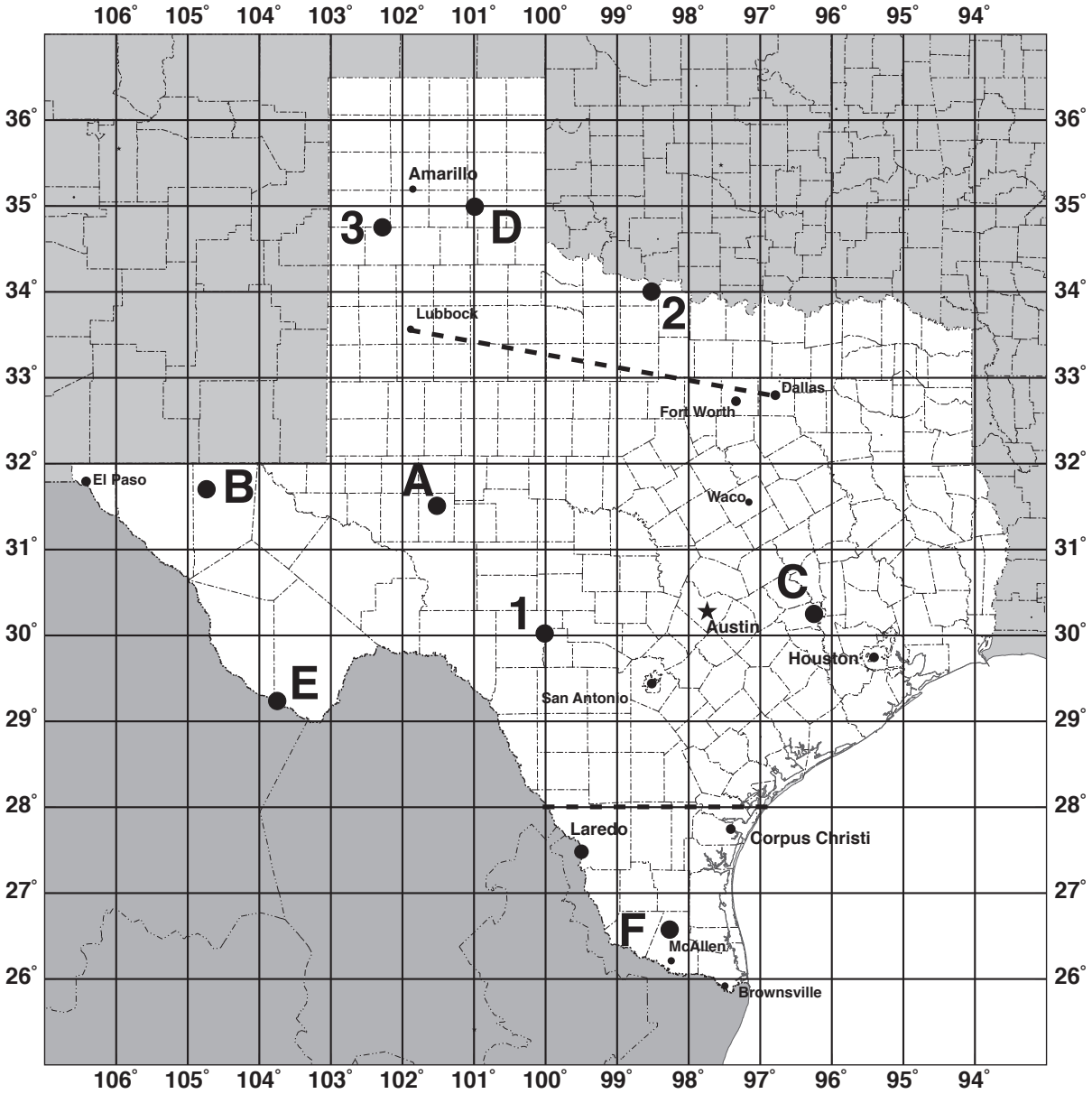


Figure 11. Texas map used for homework questions.

Now you should realize that most maps that cover areas smaller than the whole world use both degrees and minutes. Again latitude is always written first and longitude written second as with degrees first and then minutes (') as indicated below:

##° ##' N, ###° ##' W

Again you not only need to write latitude and longitude correctly but also need to be able to determine the latitude and longitude of a point on a map. Refer to map on Figure 11.

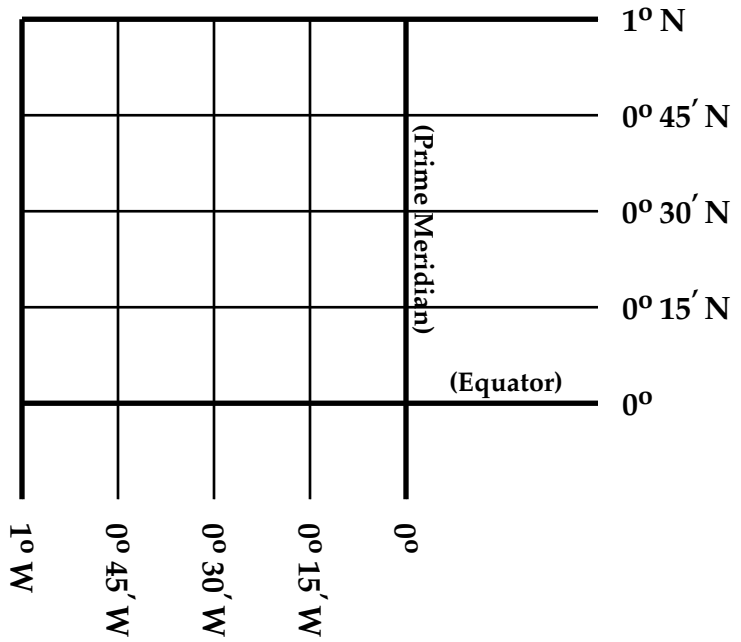


Figure 12. Map that shows how degrees are subdivided into minutes.

The locations of points 1 to 3 on Figure 11 is as follows:

Point 1 occurs on both a parallel and meridian and its location can be directly determined by examining the map.

30° N, 100° W

Point 2 occurs on a parallel but not a meridian. The latitude can be directly determined by examining the map and the longitude must be determined by interpolating between meridians.

34° N, 98° 30' W

Point 3 does not occur on a parallel and does occur on a meridian. The latitude must be determined by interpolating between parallels and the longitude can be directly determined by examining the map.

34° 45' N, 102° 20' W

Questions:

17. Find points A to F on Figure 11. Determine the correct latitude (N or S) and longitude (E or W) of these points in degrees and minutes. Note that there are 60 minutes in a degree. (Hint: what hemispheres does Texas reside within (northern or southern?; eastern or western?). These answers will help you to determine whether latitude is N or S and longitude is E or W in Texas.

A. _____ D. _____

B. _____ E. _____

C. _____ F. _____

18. Place a dot and the appropriate letter on the Texas map (Figure 11) based on the coordinates listed below.

I. 33^{o} 30' N, 99^{o} 50' W K. 31^{o} 20' N, 98^{o} 30' W

J. 28^{o} 45' N, 102^{o} 40' W L. 35^{o} 30' N, 100^{o} 15' W

19. Find Laredo, TX on the Texas map and indicate its correct latitude and longitude using both degrees and minutes.

20. Determine the location (using degrees and minutes) of the following Texas cities.

City	**Location**
Austin	_____
Dallas	_____
Brownsville	_____
Amarillo	_____

21. Of the cities listed above in question 20, indicate the city that is located the most north, the city that is located the most south, the city that is located the most east, and the city that is located the most west ?

	City
North	_____
West	_____
South	_____
East	_____

G. Map Scale - Again

Remember that scale varies with latitude so there are different scales to reflect the different latitudes of Texas. Use the graphic scale bars on Figure 13 to determine some distances in Texas.

22. Determine the distance (in miles) along the 28th parallel from the Texas coast to the Mexican border on your map using the correct scale (dashed line on map).

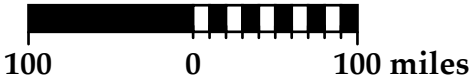
Which scale: _____ What distance: _____

23. Determine the distance (in miles) from the Lubbock to Dallas on your map using the correct scale (dashed line on map).

Which scale: _____ What distance: _____

24. Is the distance determined in question 23 truly accurate or just an approximation? Explain!

A. Parallel scale at 33° N Latitude



B. Parallel scale at 29° N Latitude

Figure 13. Graphic scale bars that correspond to the Texas map in Figure 11.