I. Objectives:

1. Demonstrate an understanding of basic geometric and trigonometric expressions relating to latitude and longitude angular measures.
2. Demonstrate how latitude and longitude angular measures have a relationship with arc length on the surface of earth.

II. Introduction

Recall that a circle has $360°$ and the circumference of a circle is $C = 2\pi r$, where $\pi = 3.14$ and r = the radius of the circle.

The circumference of the Earth at the equator is $2\pi R_E$, where the radius of Earth is symbolized by R_E.

Note that 1° of latitude corresponds to about 111 km distance measured along the surface of earth at any latitude. At the equator, 1° of longitude *also* corresponds to an arc length of about 111 km [111.32 km, actually]. But, at any other latitude, 1° of longitude will correspond to a shorter length given by:

arc length $L = 111.32\cos\Phi$, where Φ is the latitude of the observer's location.

III. Prelab Definitions

1. latitude

2. longitude

3. parallel

4. latitudinal geographic zones

5. meridian

6. prime meridian

7. cartography

8. maps

9. map scales

10. map projections

IV. Lab Procedure

Based on the table below, calculate the longitudinal arc lengths (in km) corresponding to a span of 30° in longitude at the following 2 latitudes: Write your answers in column D of the table.

Problem #1: at the equator **(show your computation here)**

Problem #2: at latitude 60° **(show your computation here)**

TABLE: LATITUDINAL AND LONGITUDINAL ARC LENGTHS (km)

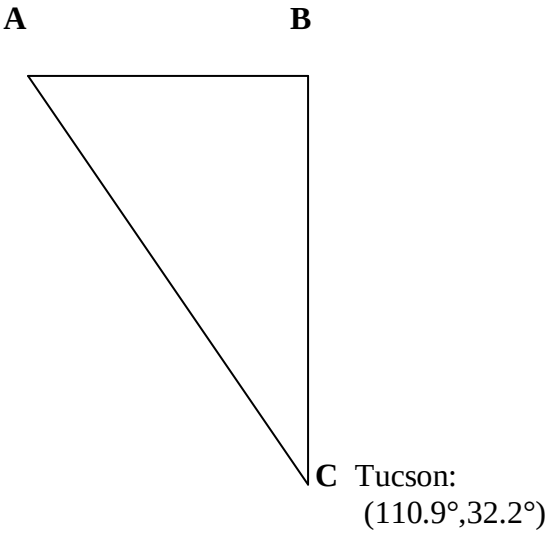
A	B	C	D
Lat.	Latitudinal arc length per 1 km	Longitudinal arc length per 1 km	Longitudinal arc length for 30° longitude span
90°	111.70	0.00	
60°	111.42	55.80	
30°	110.86	96.49	
0°	110.58	111.32	

Problem #3: Geographic coordinates can be listed as: (X,Y) , where X ≡ longitude value, and Y ≡ latitude value. Shown below are the approximate locations of Downtown Phoenix and Downtown Tucson, with each city's longitude and latitude values given.

Again, using the relationships for latitude and longitude arc lengths which you used in problems 1 and 2 above, find the approximate separation distance (i.e, length **AC**) between Phoenix and Tucson. **Hint: make use of the right triangle ABC drawn below.** Remember that by the Pythagorean Theorem, the hypotenuse of the right triangle is related to the other 2 sides as:

$$(AC)^2 = (AB)^2 + (BC)^2$$

Phoenix:
(112.0°, 33.4°)



Tucson:
(110.9°,32.2°)

Note: In actuality the length **AC** you have found would be slightly different from the true curved path drawn on the earth's surface which separates the 2 cities. However, the error we have introduced in our planar right triangle approximation is very small.

V. Lab Discussion

1. Why is it important to have an understanding of latitude and longitude?

2. Where is the Prime Meridian located? What is its longitude in degrees?

3. Why is the Prime Meridian important in the measurement of astronomical and civil time?

4. What is the Tropic of Cancer? At what latitude is it located?

5. What is the Tropic of Capricorn? At what latitude is it located?

Lab courtesy of Dr. Dana Kerola