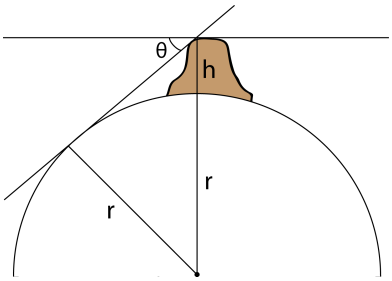
Geophysics 4133
Geodedics
J.R. Leeman

Name: _____

For each of the following problems neatly show all steps of your work (partial credit may be given if your work can be easily followed). Clearly indicate your final answers and answer all parts of the question including the 'describe' and 'why' questions.

1. In about 990 a 17 year old medieval Persian (Abu Rayhan Biruni) computed the radius of the Earth using just an astrolabe and measuring device. Biruni calculated the height of a mountain, then climbed it. He measured the angle from horizontal to a point in the distance. You repeat his experiment at field camp when on Pike's Peak. T dip angle was 2.11°, and the mountain is 4300m tall. *(35 pt.)*

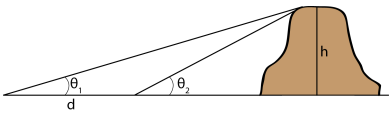
   a) From your observations, what is the radius of the Earth?



   b) We now know the average radius of the Earth is 6356.7 km. What percent was your estimate off?

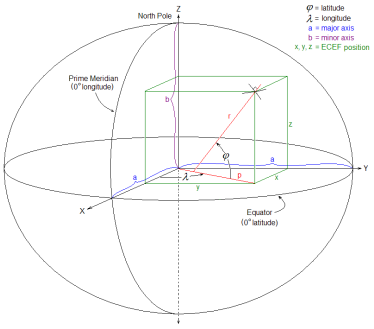
   c) What could have caused the error in your observations?

   d) You are the first person to measure the height of Pike's Peak. You measure the angle to the top of the mountain from a distance D away, then move closer by d and measure the angle again. Derive a formula for the height of the mountain.



2. A magnitude 9 earthquake struck Japan on March 11, 2011. The earthquake epicenter was at 38.322° 142.369° E. *(15 pt.)*

   a) Calculate the position of the epicenter in Earth-Centered-Earth-Fixed (ECEF) coordinates.



   b) Norman, OK is located at 35.25° N 97.47° W. Calculate the position of Norman in the ECEF frame.

   c) Calculate the straight line, through Earth distance between Japan and Norman. Why does the ECEF frame make sense for this problem?

3. GPS satellites orbit around 20,200 km above the Earth's surface. For these problems assume that the radio signal travels at about 98% the speed of light. *(25 pt.)*

   a) To obtain an accuracy of +/-10m in position, how accurate does the GPS clock need to be (ignoring all error sources other than time)? What about 1m?

   b) As the GPS constellation orbits the Earth each satllite passes over the same area once every 12 hours. Calculate the approximate speed each satellite is traveling.

   c) Briefly describe the errors associated with GPS positioning and how differential GPS helps correct them.

4. Describe the difference between topography, the geoid, and the ellipsoid (use drawings if needed). *(10 pt.)*

5. You have been asked to layout a seismic survey line. Using UTM coordinates you pick the start points (x_s, y_s) and end points (x_f, y_f) of the line. Write an equation to find the position of n geophones along the line. *(15 pt.)*