

LAB A8d: HORIZONTAL AND VERTICAL DISTANCE MEASUREMENTS

10/15/03

1) DISTANCES ALONG THE GROUND: PACING

Knowing the length of your stride will allow you to determine distances or aid in determining the vertical height of tall objects. For instance, you can determine the circumference of a large amusement park ride (from which the radius can then be calculated) or the height of such a ride.

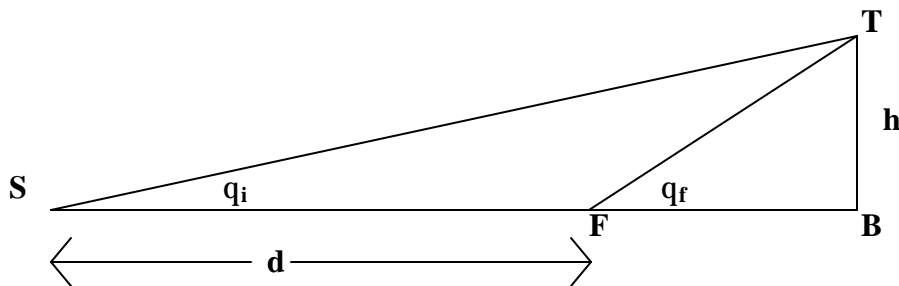
a) Determine the length of your stride: At your normal walking pace, walk ***the entire length*** of the Bryan fourth floor hallway. Count the number of steps required to travel this distance, and then use the known distance (in meters) to determine your average distance covered per step. Show all measurements and calculations.

b) For pre-state-fair practice, determine the distance (in meters) using your stride length from the sidewalk intersection at Club and Broad to closest part of the driveway entrance/exit to Watts lobby. Show work below, with units. Partners should compare answers. The directly measured distance will be given to you later.

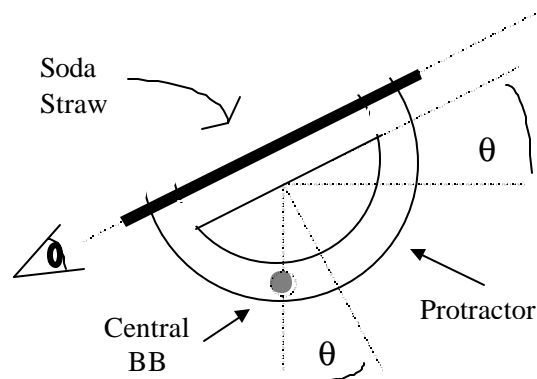
2) VERTICAL DISTANCE: TRIANGULATION

The horizontal accelerometer contains a straw (for sighting) and a protractor (for angle measurement) that can be combined with a known horizontal distance (measured, for example, by pacing) to determine the height of tall objects. This method can be used to determine ride height at the State Fair.

Suppose that the top **T** of a ride is at height **h** above level ground and that you are at point **S** in the diagram shown below.



a) The first task is to measure the angular height, q_i , in degrees, of the top of the ride as seen from point **S**. The picture below shows how an angle q can be determined by the straw-protractor combination. In sighting some mark at an angular height q to the ground, note that the angle q is the difference between the position of the middle BB and the $\theta = 0^\circ$ mark on the protractor.



Sight the top of the ride through the straw and have your partner read the angle of inclination (to the horizontal) of the straw; this is done by noting the angle on the protractor at which the middle BB rests. Call this angle q_i .

b) Now pace off a known distance d directly toward the object whose height is to be determined. You are now at point **F**. (See the diagram on the previous page.) It is important that:

- (1) the ground be relatively level between **S** and **F**
and (2) the distance d be a large fraction of the total distance from the start **S** to the base **B** of the ride.

Again sight the same point on the top of the ride through the straw and have your partner read the straw's new angle of inclination. This angle, q_f , is marked on the diagram on the previous page.

c) The height h can then be calculated from

$$h = \text{observer's height} + d * \sin \theta_i * \sin \theta_f / \sin(\theta_f - \theta_i)$$

d) If you can walk to the base **B** of the height h being measured, $\theta_f = 90^\circ$ and $(\sin \theta_f) = 1$, and the expression above reduces to

$$h = \text{observer's height} + d * \tan \theta_i$$

e) For pre-state-fair practice, determine the height of the easternmost smokestack by walking a level baseline on the soccer field directly to the base of the dorm. Make a large diagram that shows all measurements; show all calculations neatly. Label all numbers with appropriate symbols! How many sets of measurements should you make?