

MAPPING — USE OF COMPASS AND TRANSIT

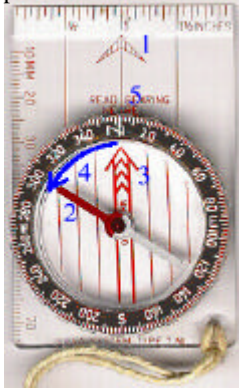
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I. OBJECTIVES:

1. To learn how to use a compass to do mapping.
2. To learn how to use a level-transit and some of its applications.
3. To map some significant landmark here on campus.

II. BACKGROUND:

When discussing features of any ecosystem/community, it is useful to be able to plot them on a map for future reference. Also, factors such as whether an organism is found on the north or south side of a hill are important in discussing some aspects of that organism, because, for example, the north side of a hill stays colder longer in spring. Thus, topological (**topo** = a place) maps can help in understanding various ecological phenomena.



An important measurement when doing mapping is to determine the **azimuth**, (from Arabic **as-samut**, the plural of **as-samt** = the way, direction, path) the distance in angular degrees in a clockwise direction from north. This is done with a compass or transit (note, compass needles point to magnetic north, not "true" north). On the type of compass we have here, the red end of the needle is the north end. To determine an

azimuth, (1) first point the large arrow on the flat bottom of the compass in the direction for which you wish to determine the azimuth. Next, (2) observe where the needle is pointing (north) and turn the black ring (4) (with numbers and directions indicated on it) until the red arrow (3) and other lines on the bottom of the circle are lined up parallel to the needle. The base of the big red arrow (5) will, then, point to the number which is the azimuth reading.

The pocket transit may also be used as a compass--the white tip of the needle points to the azimuth reading.

The level-transit should be mounted on its tripod to use it. You will need to level it using the four screw-feet. Locked into position, it can do level sightings in any horizontal direction to establish the angle between two objects. Released, it can do sightings in any vertical direction. Knowing appropriate angles as measured by the transit and a little trigonometry (**trigono** = a triangle, triangular; **-metry** = measurement), one can calculate the height of objects such as hills and trees. See accompanying illustrations for derivations of formulae to be used. The pocket transit can be used in a similar manner to determine angles between two objects (with the added advantage of using the actual azimuth readings) or to the top of a tree or hill.

III. MATERIALS NEEDED:

magnetic compass	meter stick or some other rigid measuring device
metric measuring tapes	topological map of UC Clermont campus
orange flags	protractor and straightedge
level-transit & tripod	calculator with trig functions or trig tables
pocket transit	

IV. PROCEDURE AND DATA:

The compasses and/or transits will be used, in conjunction with measuring tapes, to map a designated landmark here on the Clermont campus.

1. Insert an orange flag where you will start mapping and if appropriate, establish the location of this point with respect to some previously-mapped item(s).
2. Imagine that the landmark to be mapped is composed of a series of shorter, straight segments. From this first flag, look to where the first straight segment stops and turns a corner, however slight. Place an

orange flag at that location. Measure the distance from one flag to the next.

3. With the compass, sight from each flag to the other and determine the azimuth (In what direction is this segment aligned?). Sight both ways to double check--the readings should be 180° apart.
4. Mark a new position past the second one where the direction changes again. Measure the distance between the flags, and determine the azimuth for that section.
5. Continue in this manner until the whole landmark is measured. If you notice

any other interesting features, make note of them, including distance and azimuth relative to one or two of the orange flags.

6. Make sure all supplies, including all flags, are returned to the lab.

7. Either in lab or on your own, as time permits, use a straightedge and protractor to make a map from your readings:

a. North should probably be toward the top of your notebook page (azimuth = 0°), and you should decide on the scale (1 cm = how many meters?).

b. Using the distance and azimuth readings, plot the map. Also, indicate the width of any features such as stream(s) or trail(s) according to your scale and location(s) of any significant features noted. Place the base of your protractor along the north-south axis of your paper with the center at whatever point you are. Then measure off whatever angle corresponds to the azimuth reading you are mapping (for example, an azimuth reading of 10° or 350° would be plotted as 10° from 0 [= north] to right or left sided as needed).

c. This map can now be used for any

further studies done here on campus. Future "discoveries" can be plotted on the map by measuring distance and azimuth relative to something already plotted. Alternately, by taking two azimuth readings, the location of an object can be plotted by intersecting the lines drawn at the two angle readings (triangulation).

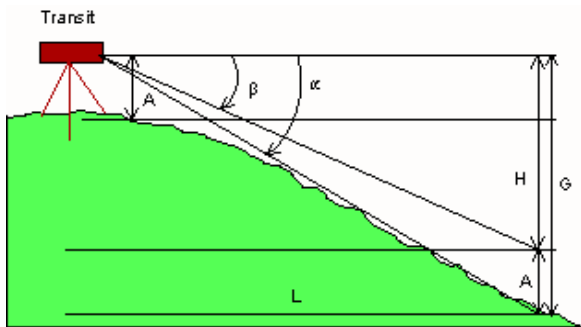
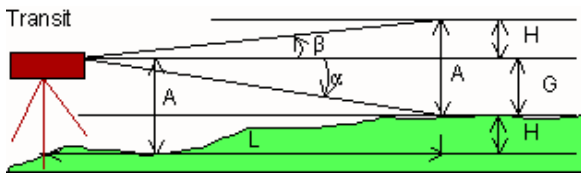
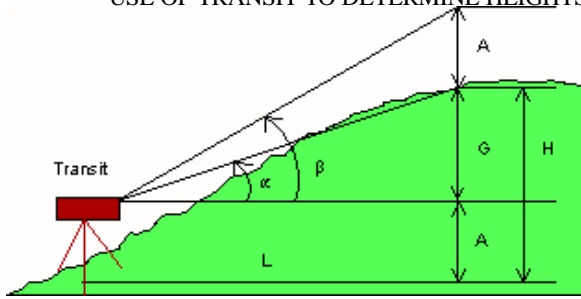
The transit(s) can also be used to determine elevations of objects such as the height of a hill or a tree.

1. Choose an object such as a hill or tree whose height you wish to determine. Refer to the accompanying illustrations to decide which is applicable in your situation.

2. Based on the instructions accompanying that illustration, take the necessary measurements to determine the height of the object.

3. Do the necessary calculations to determine the height of the object. Use a calculator or computer with trig functions (or a trig table) to determine the tangents needed for the calculations.

USE OF TRANSIT TO DETERMINE HEIGHTS OF LAND FEATURES



Measure A (height of transit), α (angle to top edge of hill), β (angle to height of transit above hill)

then, $H = A + G$,
 but $\tan \alpha = \frac{G}{L}$, so $G = L(\tan \alpha)$
 and $\tan \beta = \frac{H}{L} = \frac{(A + G)}{L}$

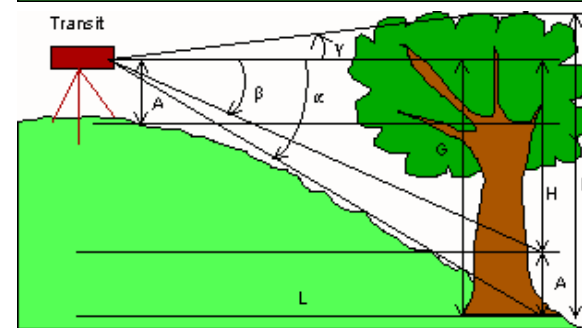
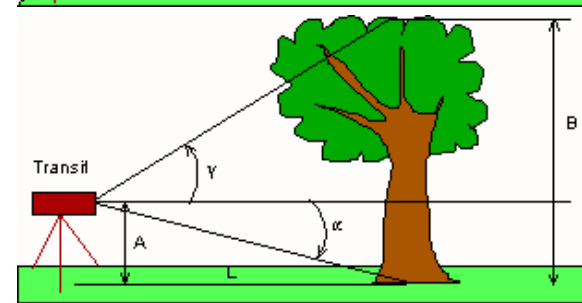
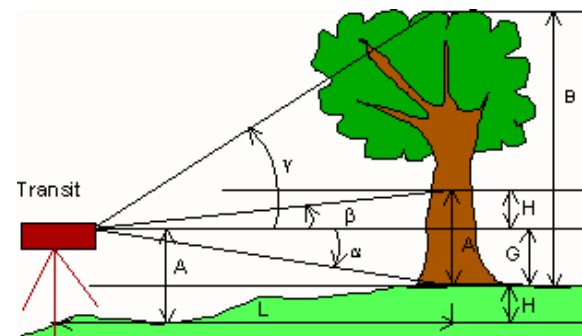
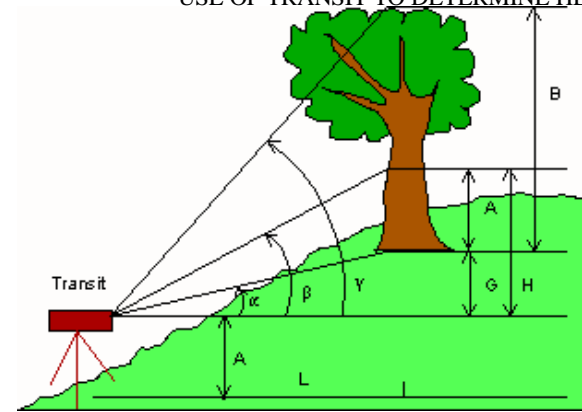
$A + G = L(\tan \beta)$
 $A = L(\tan \beta) - G$
 $A = L(\tan \beta) - L(\tan \alpha)$
 $A = L(\tan \beta - \tan \alpha)$
 $L = \frac{A}{(\tan \beta - \tan \alpha)}$

Since $G = L(\tan \alpha)$,
 then $G = \frac{A(\tan \alpha)}{(\tan \beta - \tan \alpha)}$
 and since $H = A + G$,
 $H = A + \frac{A(\tan \alpha)}{(\tan \beta - \tan \alpha)}$

$H = A \left[\frac{1 + (\tan \alpha)}{(\tan \beta - \tan \alpha)} \right]$
 $H = A \left[\frac{(\tan \beta - \tan \alpha) + (\tan \alpha)}{(\tan \beta - \tan \alpha)} \right]$
 $H = A \left[\frac{(\tan \beta)}{(\tan \beta - \tan \alpha)} \right]$

Note that upward angles (and their tangents) are considered positive, while downward angles (and their tangents) are negative. "A" is the height of the transit and "H" represents the change in height of the ground. A hill would be a positive change in ground height, while a valley would be a negative change in ground height.

USE OF TRANSIT TO DETERMINE HEIGHTS OF TREES



Measure A (height of transit), α (angle to base of tree), β (angle to height of transit above base of tree), γ (angle to top of tree).

$\tan \alpha = \frac{G}{L}$
 $G = L(\tan \alpha)$
 $\tan \beta = \frac{H}{L} = \frac{(A + G)}{L}$

$A + G = L(\tan \beta)$
 $A + L(\tan \alpha) = L(\tan \beta)$
 $A = L(\tan \beta - \tan \alpha)$
 $L = \frac{A}{(\tan \beta - \tan \alpha)}$
 $\tan \gamma = \frac{(G + B)}{L}$

$G + B = L(\tan \gamma)$
 $B = L(\tan \gamma) - G$
 $B = L(\tan \gamma - \tan \alpha)$
 $B = A \left[\frac{(\tan \gamma - \tan \alpha)}{(\tan \beta - \tan \alpha)} \right]$

In addition to the above notes, "B" is the height of the tree. On level ground, the equation is simplified because angle β , its tangent, and H (the change in ground height) all are 0, thus $G = -A$.