

# SURVEYING MERIT BADGE

## Help page

### *Basics for plane surveying:*

#### **Leveling Example**

Levels are used to transfer elevations from a known point to other points. Levels are used where it is important to know the relative elevation between objects. This is very important in construction sites and areas of flooding.

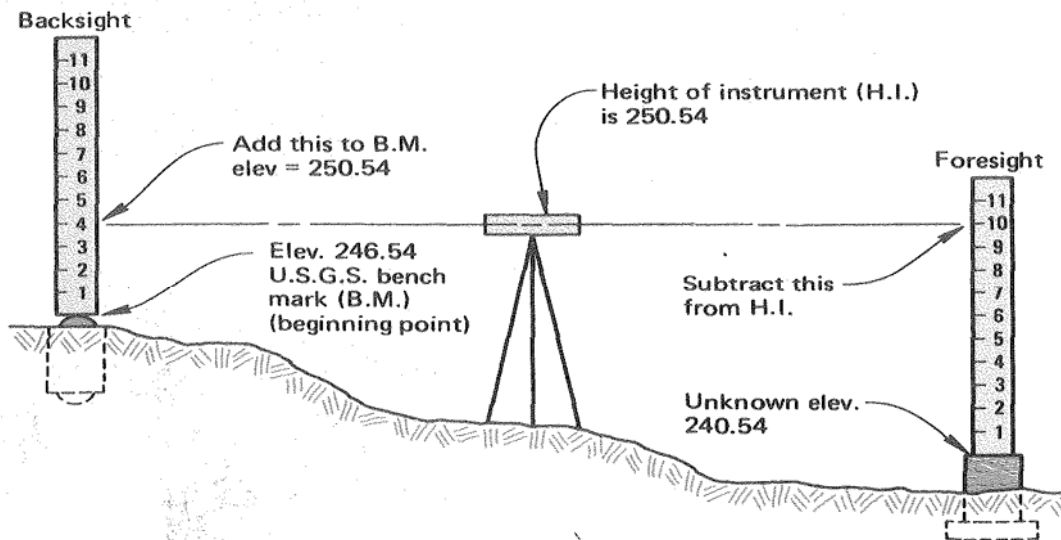


Figure 1

Point	B.S. (+)	H.I.	F.S. (-)	Elevation
Backsight	4.00			246.54
		250.54		
Foresight			10.00	240.54

Table 1

## Traverse - Equations for Horizontal plane surveying

A Traverse is a series of continuous lines connecting points called traverse stations. The angles between the stations are measured as well as the lengths between the stations. In this exercise we will be performing a closed traverse because we will create a close polygon, such as the one shown in figure 2.

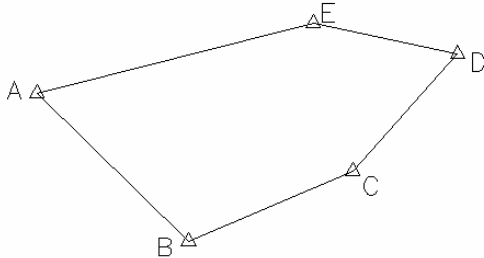


Figure 2

Using the following formulas to reduce the traverse laid out by your instructor; which you have completed on the ground by measuring angle and horizontal distances. If the distances that you measured were slope distances they will need to be reduced to the horizontal before you begin this section.

The example below shows the formulas to reduce a traverse to departures (X) and latitudes (Y), which are similar to X and Y coordinates. Surveyors use coordinate geometry to measure distances between objects on the ground where direct measurements were not made between the objects.

The first step in determining if the traverse makes a closed polygon is to add up the angles to make sure that they equal the correct sum of the polygon. This is done by using the formula for interior angles =  $(n-2)180$ , where  $n$ =the number of sides of the polygon. In our case the formula would work out as follows:

$$\text{InteriorAngles} = (n - 2)180$$

$$\text{InteriorAngles} = (5 - 2)180$$

$$540 = (5 - 2)180$$

The final answer of 540 is given in degrees. This means that on our five sided traverse the interior angles should add up to 540 degrees. The angles and distances of the figure 2 are as shown in the table below.

**Angles and Distances of Traverse**

Course	Distance	Angle
E-A-B	19.15 ft	58°
A-B-C	16.15 ft	113°
B-C-D	14.21 ft	60°
C-D-E	13.35 ft	154°
D-E-A	25.76 ft	155°

Table 2

Azimuths are calculated from the angles, assume that the azimuth of course A-B is 134°, then to get the azimuth of the next course we use the following formula:

$$\text{Azimuth of the previous course} + 180^\circ + \text{Angle} = \text{Azimuth of the next course}$$

If the resulting answer is greater than 360°, then we subtract 360 from the answer until we get a result that is between 0 and 360, this is the azimuth of the next course. We continue using this formula until we get back to the beginning where we started our traverse.

Once you have the azimuths of our traverse you can use a table similar to the one below to calculate the latitude and departure for each course. Below is an example of latitude (Y) and departure (X). a sample table is included in your workbook for you to use in completing these exercises.

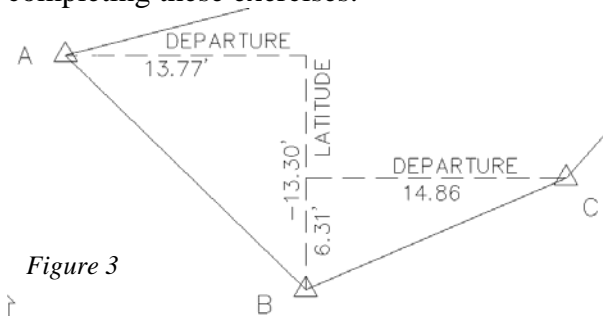


Figure 3

Traverse Reduction

Course	Distance	Azimuth	Cosine	Sine	Latitude	Departure
A-B	19.15	134	-0.69466	0.71934	-13.30	13.78
B-C	16.15	67	0.390731	0.920505	6.31	14.87
C-D	14.21	42	0.743145	0.669131	10.56	9.51
D-E	13.35	282	0.207912	-0.97815	2.78	-13.06
E-A	25.76	256	-0.24192	-0.9703	-6.23	-24.99
Totals					0.11	0.10

Table 3

The totals at the bottom of the traverse reduction indicate the closure of the traverse. We need to make sure that this traverse closes within 5 feet. The units of the latitude and departure are indicated in feet and decimals; inches are not used. Use the Pythagorean theorem to determine if the closure is acceptable.

$$Closure = \sqrt{X^2 + Y^2}$$

### Scale interpretation:

We will be using a scale of 1"=10' for the preparation of our map, this means that 1" on your paper is equal to 10' on the ground. Use the scale provided to help with the layout of your map. As you can see in the attached figure, in engineering and surveying an inch is broken in to 10 parts, or tenths, at a scale of 1"=10'; Each line on the scale is equal to 1 foot on the ground.

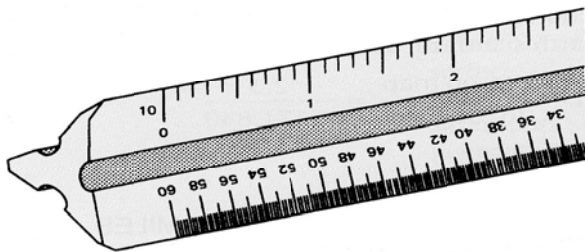


Figure 4

To plot your traverse, pick a starting point on the graph paper and scale the latitude and departures listed above to plot your traverse.

**Sample Legal Description Phrases:**

*Preamble*

Lying within the State of California, County of Sonoma, City of Sebastopol, being a portion of the lands of John A. Doe, as described by deed recorded under Document Number 2007-XXXXXX Official Records of Sonoma County, said portion is more particularly described as follows:

*Point of Beginning:*

BEGINNING at the southwest corner of said lands of Doe marked by a ½” iron pipe tagged LS 9001;

*Phrases used to described lines and curves*

*To define a line:*

Thence North 15°15’45” East 150.00 feet;

*To define a line with calls:*

Thence along the west line of said lands of Doe, North 15°15’45” East 150.00 feet to the northeast corner of said lands