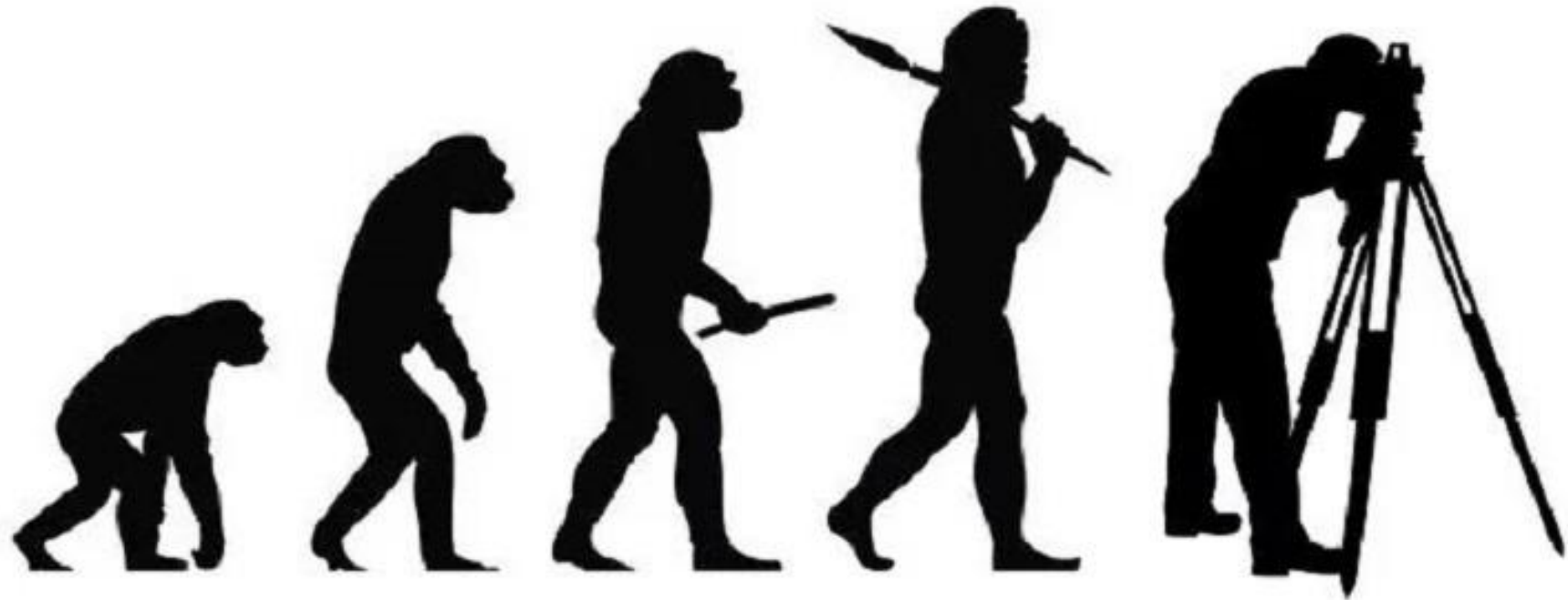


Lecture 6: Digital Surveying



<https://www.satpalda.com/blogs/evolution-in-surveying-techniques>

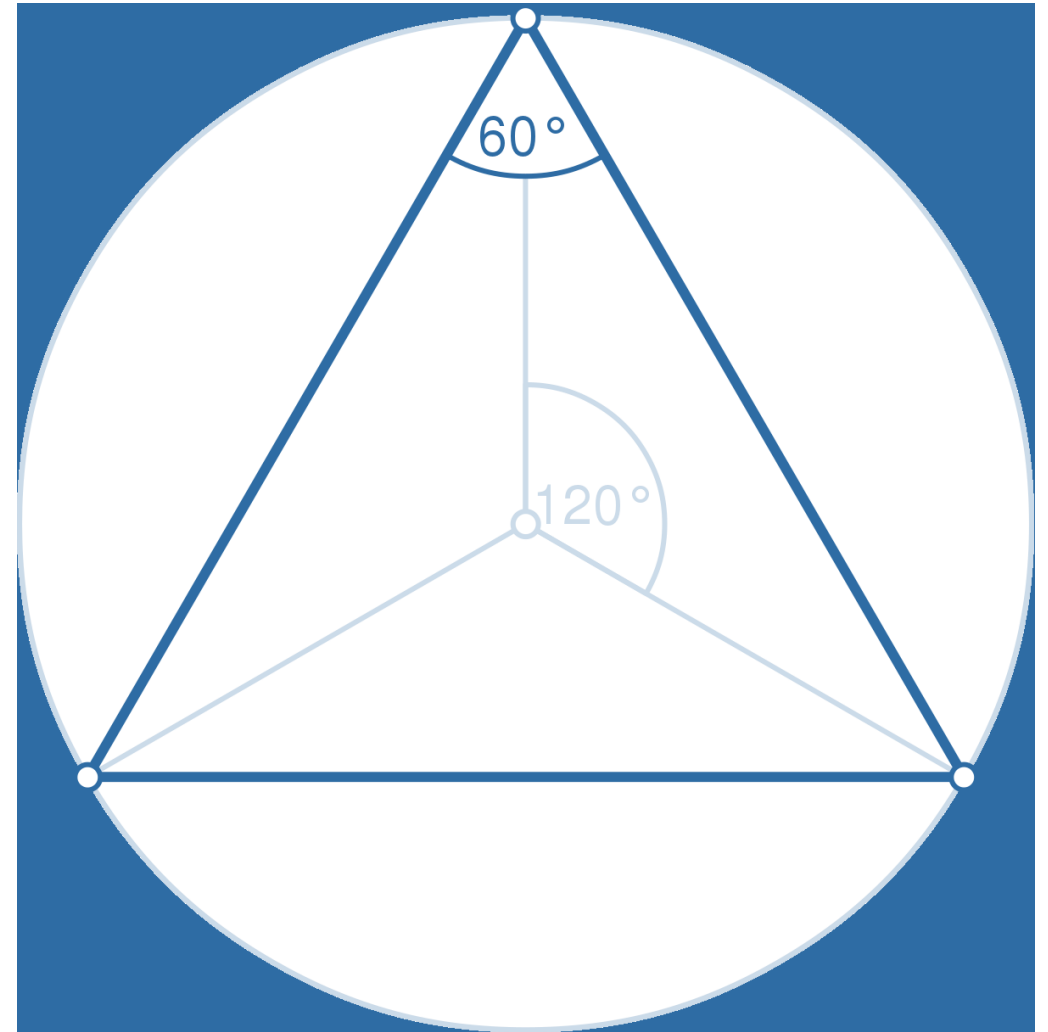
Basic Land Surveying Theory

Trigonometry

Triangulation

Trilateration

Traversing



Basic Land Surveying Tools



Tripod



Electronic Level



Measuring Tape



Umbrella



Field Book



Safety Vest



Hammer



Grade Rod



Marking Paint

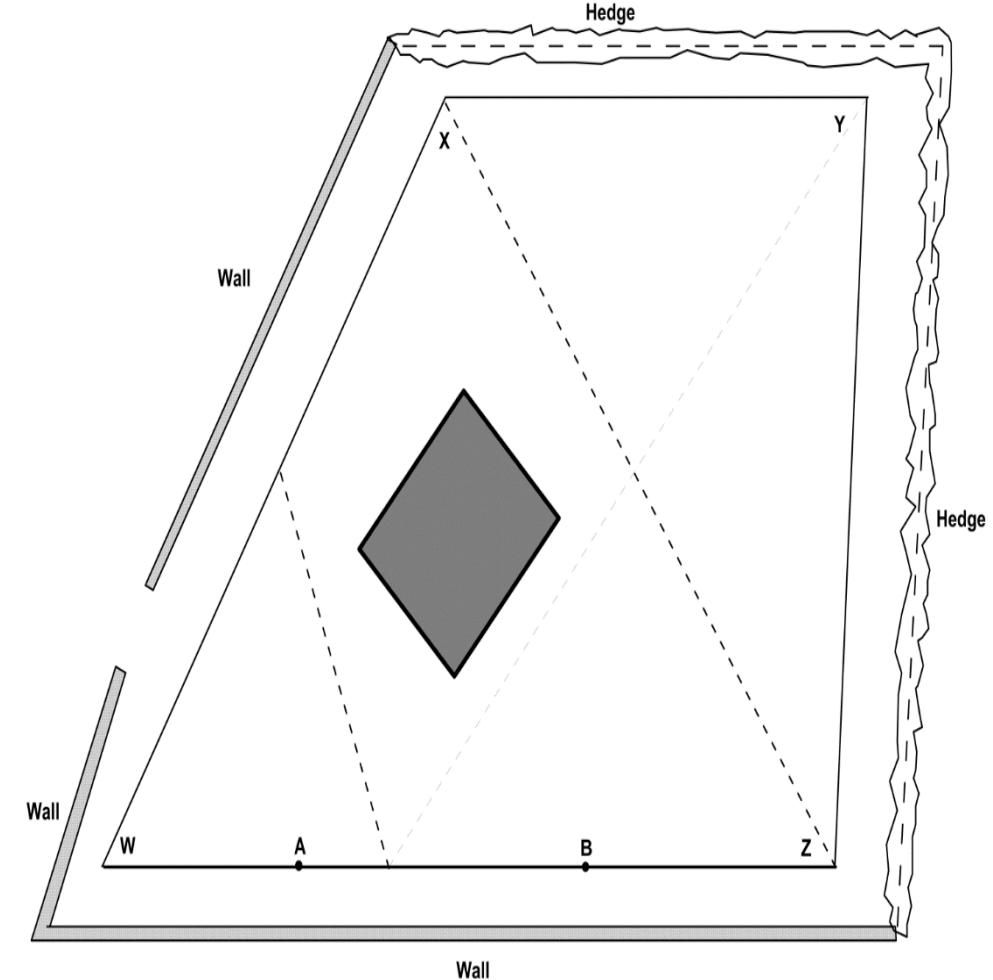


Theodolite

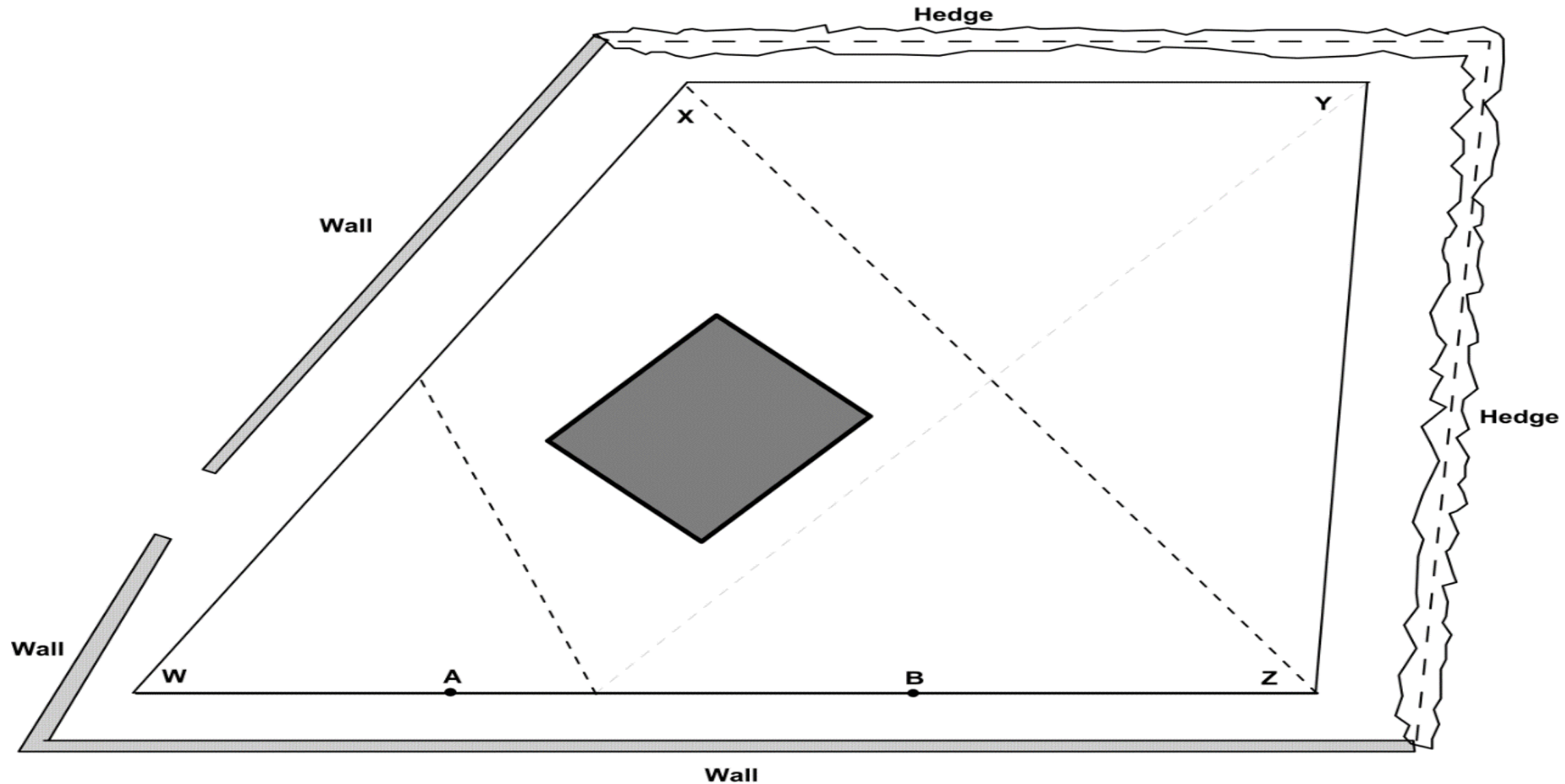
Elementary Land Surveys

Procedure;

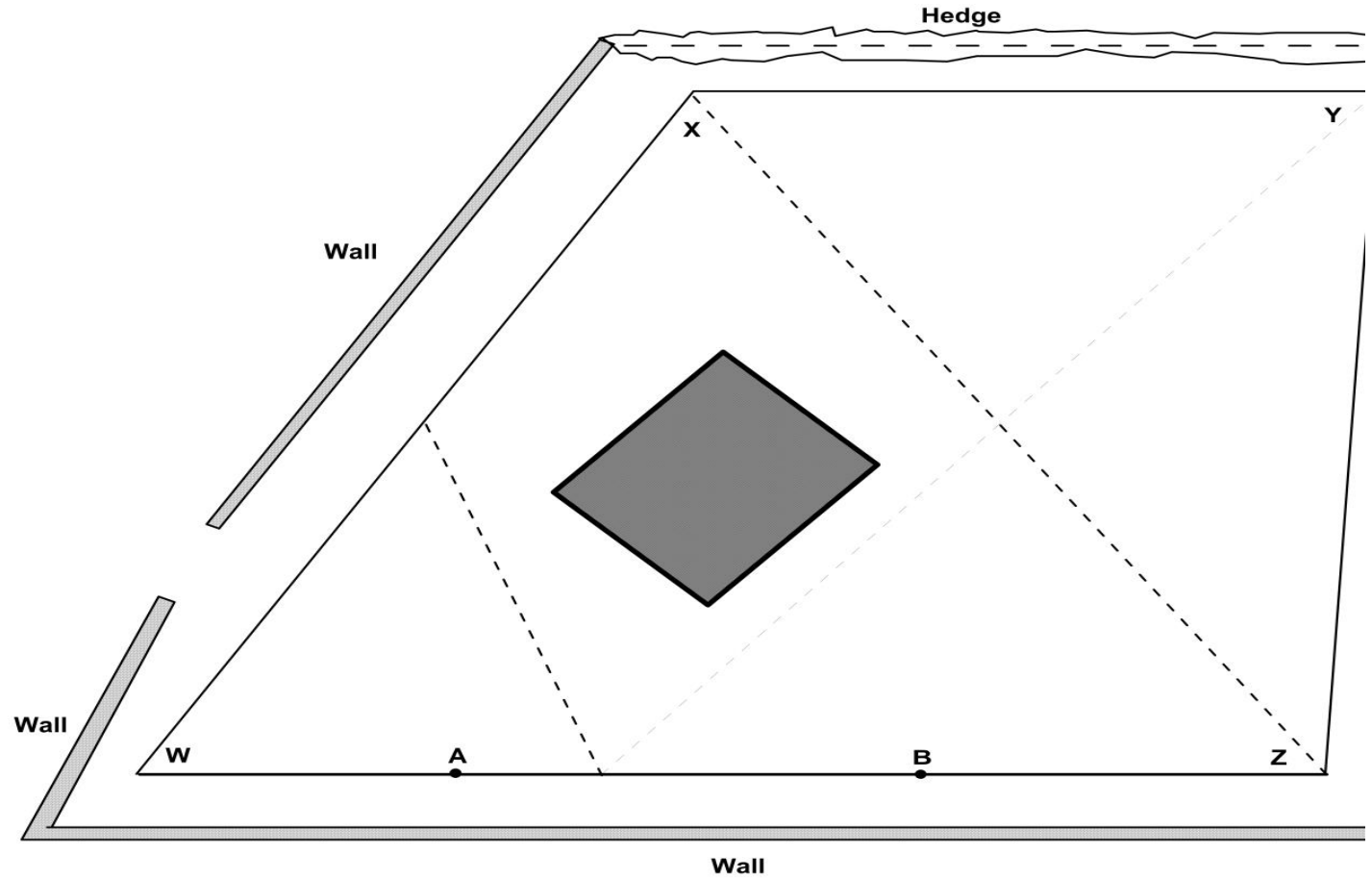
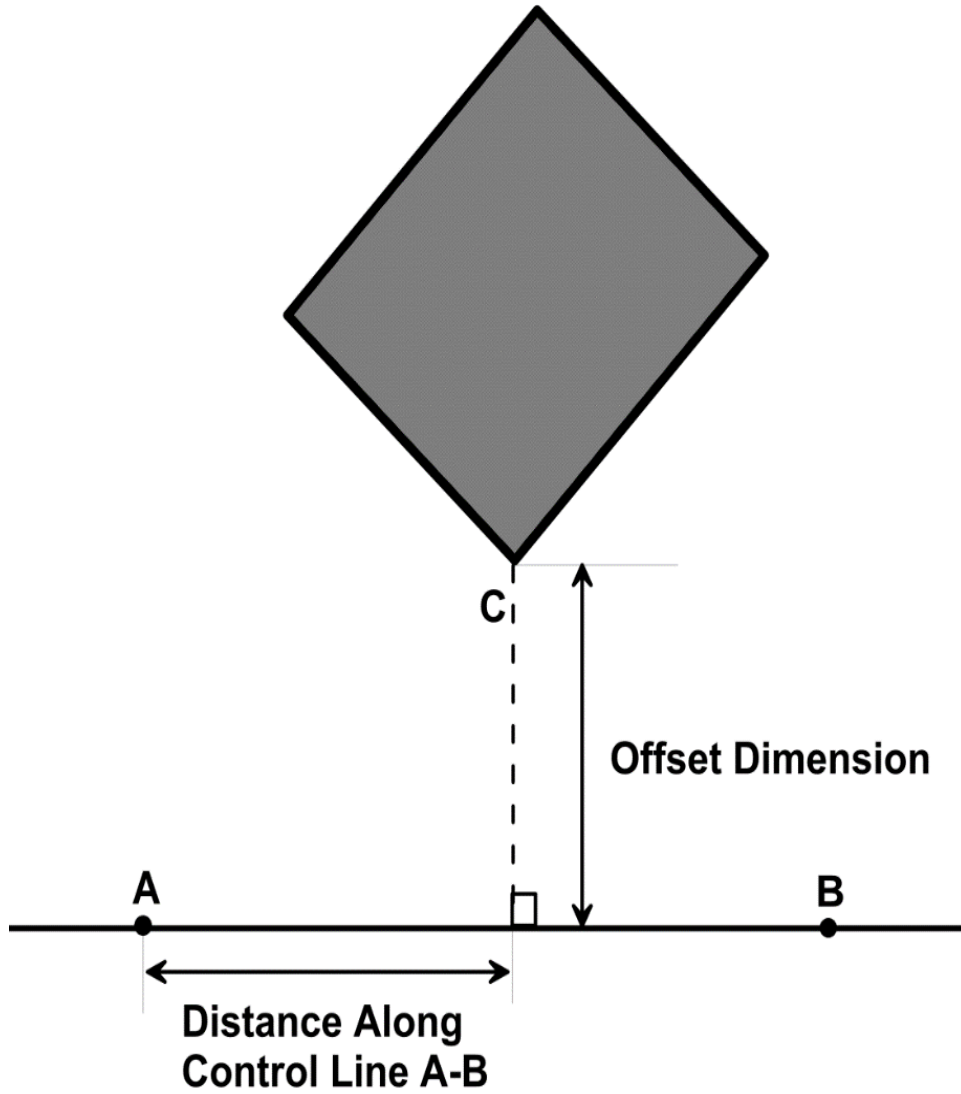
1. Establish a control frames work
2. Record on a rough sketch
3. Reference all control points
4. Record measured length of each control line



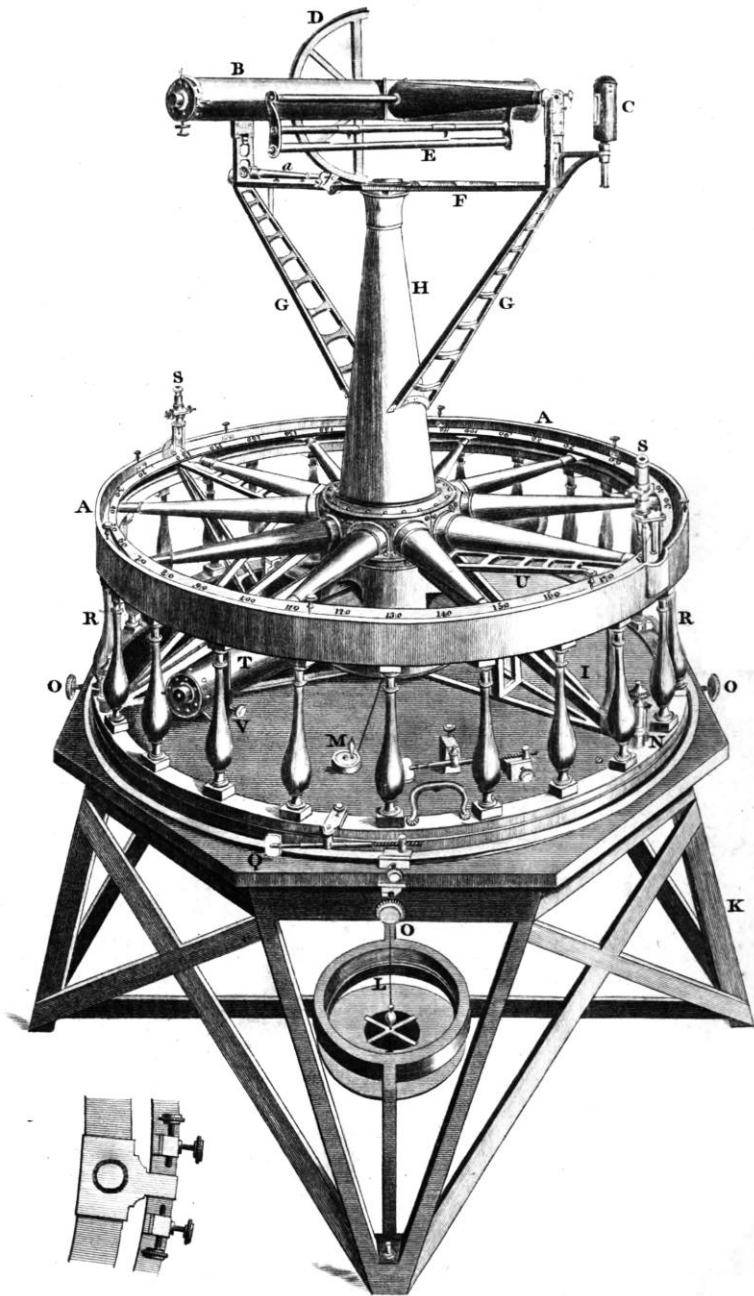
Control Framework



Offsetting



Trigonometry



William Roy's lifelong mission was to build a superior map of Britain, unparalleled in its accuracy. The day the Board of Ordnance set his suggested plan into action, Ordnance Survey was born.

In 1784 William Roy, founder of Ordnance Survey, was commissioned by The Royal Society to geodetically connect the Royal Observatories of Greenwich and Paris to resolve a dispute over their relative positions.

Jesse Ramsden, the leading instrument maker of the day took three years in the make the instrument that measured three feet across – The Great Theodolite.

Under the authority of the Master General of the Board of Ordnance, Roy began the London/Paris triangulation in 1785. By using angle measurements and at least a single measured baseline length, a whole country can be measured using the triangulation method. A dense framework of triangles with accurate coordinates at the nodes allows for accurate surveying of map features. Utilising the theodolite and trigonometry, Roy created a network of accurately measured triangles that extended to France and then back to a verification baseline in Kent.

SOH CAH TOA

$$\sin \alpha = \frac{a}{c}$$

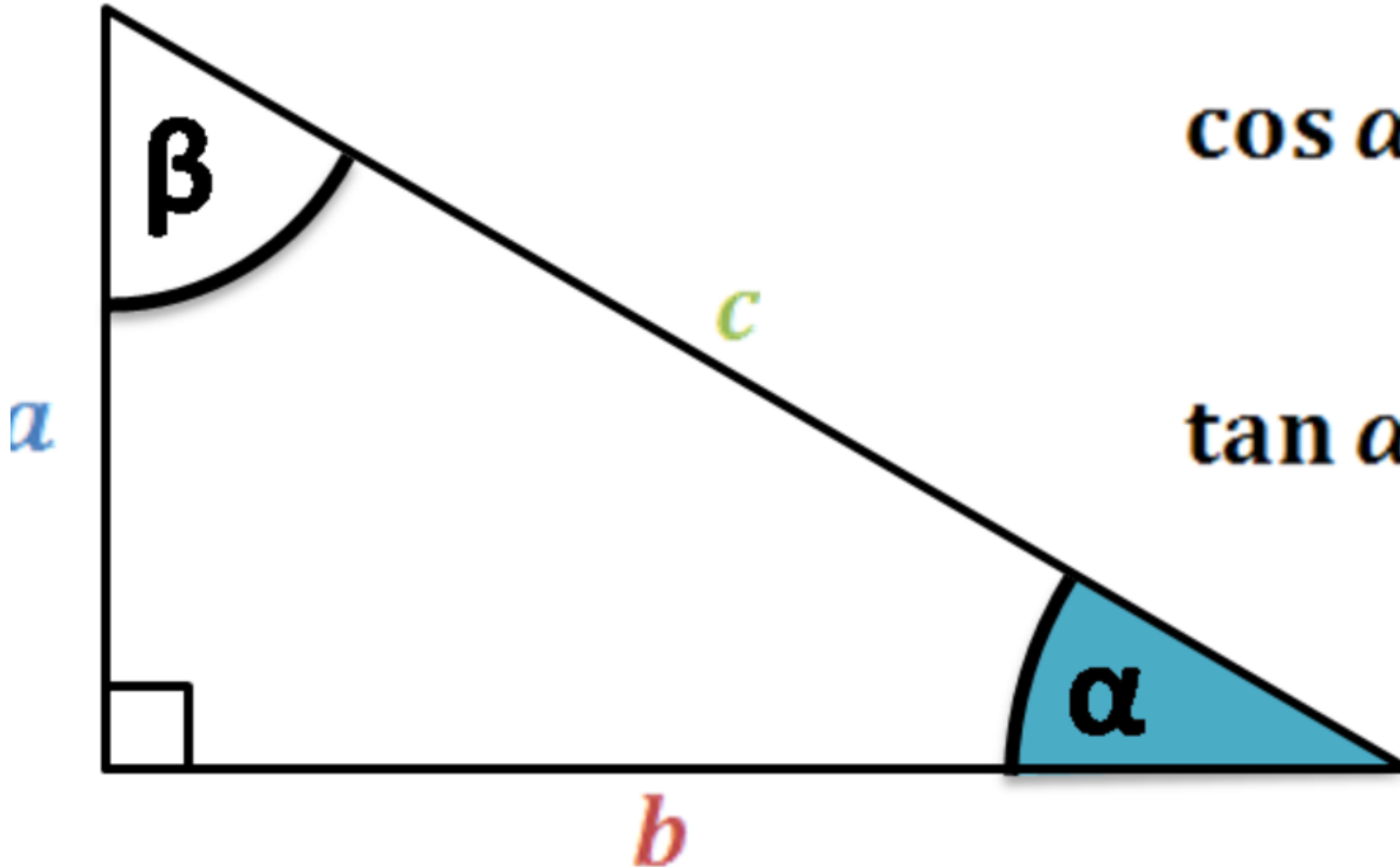
Opposite
Hypotenuse

$$\cos \alpha = \frac{b}{c}$$

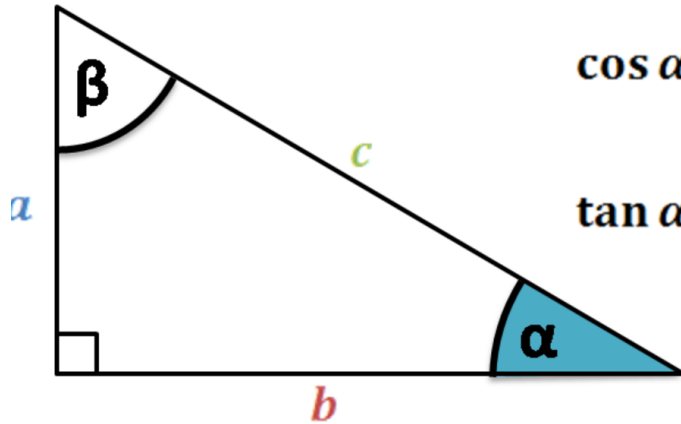
Adjacent
Hypotenuse

$$\tan \alpha = \frac{a}{b}$$

Opposite
Adjacent



Example: $a = 9.5\text{m}$ and $\alpha = 42^\circ$, find the other sides of the triangle.



$$\sin \alpha = \frac{a}{c}$$

$$\cos \alpha = \frac{b}{c}$$

$$\tan \alpha = \frac{a}{b}$$

$$\sin 42 = \frac{9.5}{c}$$

$$c = \frac{9.5}{\sin 42}$$

$$c = 14.2\text{m}$$

$$\cos 42 = \frac{b}{14.2}$$

$$b = 14.2 * \cos 42$$

$$b = 10.6\text{m}$$

$$\tan \beta = \frac{b}{a}$$

$$\tan \beta = \frac{10.6}{9.5}$$

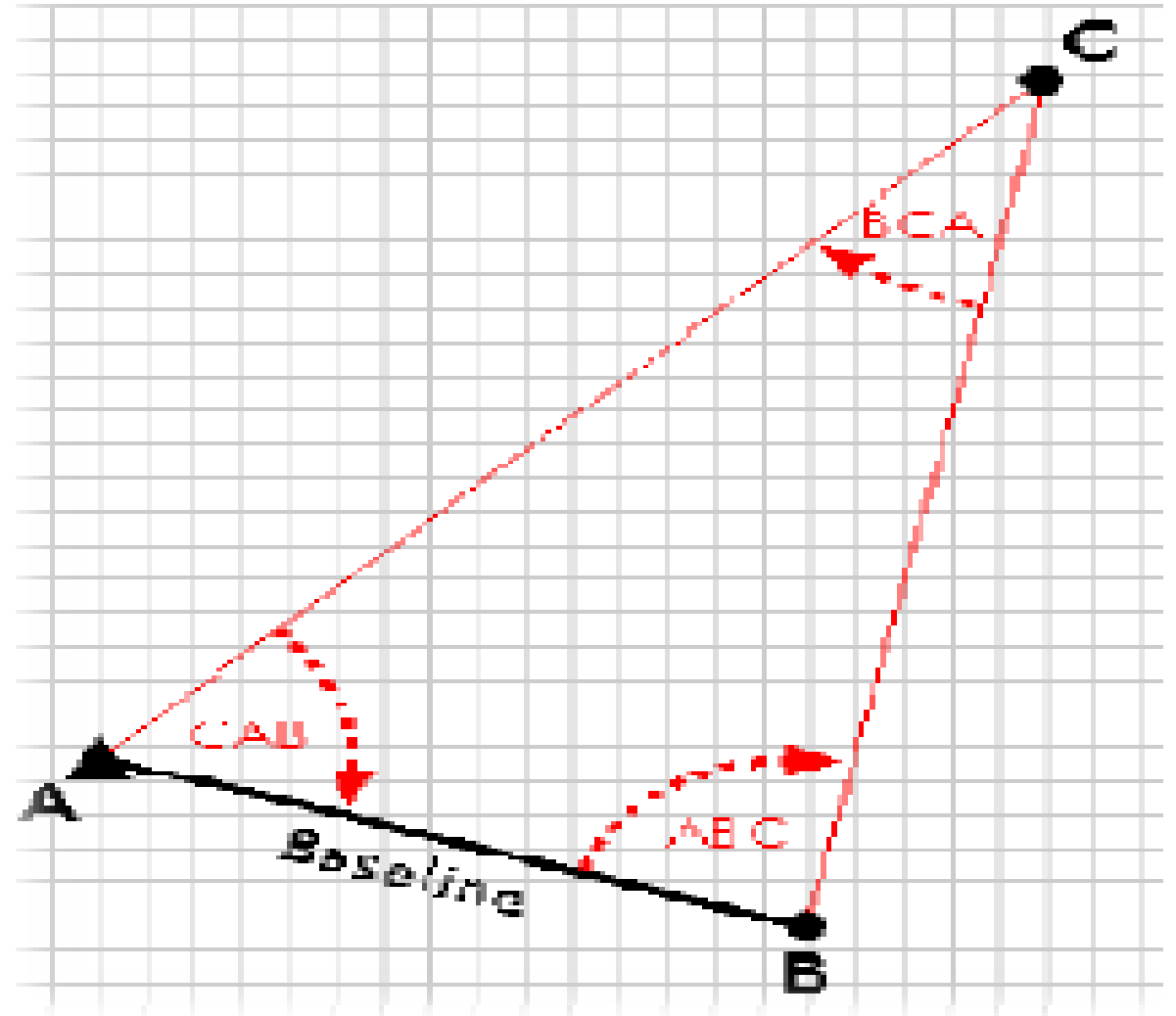
$$\beta = \arctan (1.1106)$$

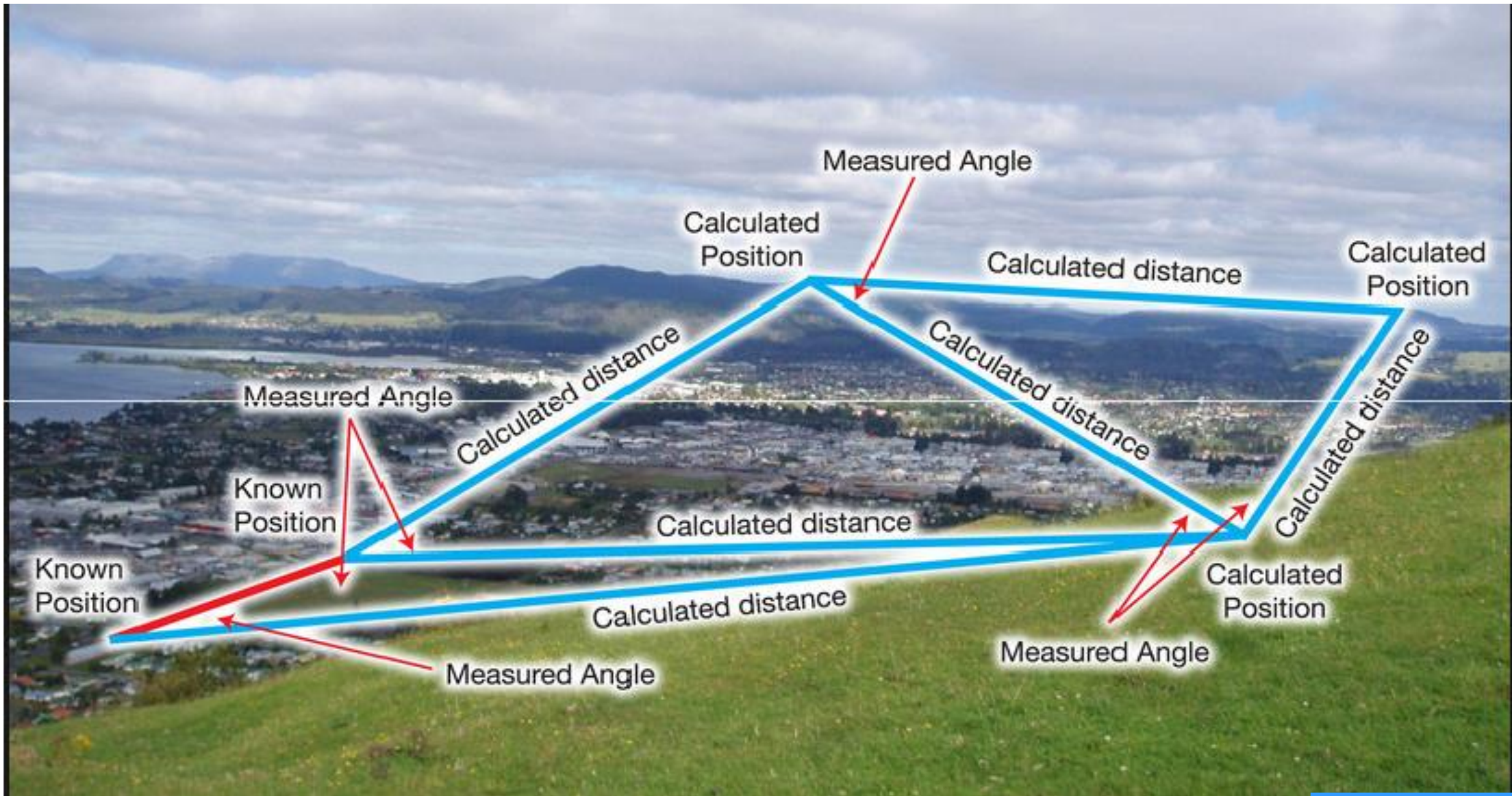
$$\beta = 48^\circ$$

Triangulation

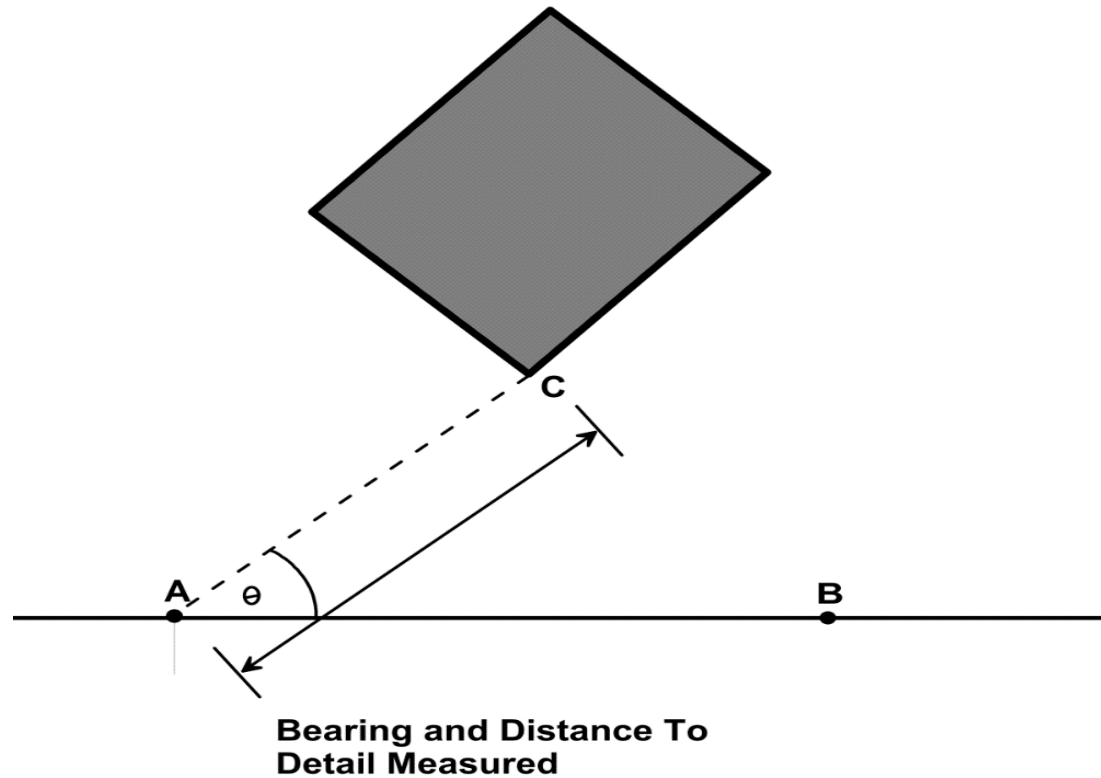
Triangulation and its Principles

- It is the process of measuring the angles of a chain or network of triangles formed by stations marked on the surface of the earth.
- The system consists of a number of interconnected triangles in which the length of only one base line and the angles of the triangles are measured very precisely which are used to calculate the coordinate of vertices.

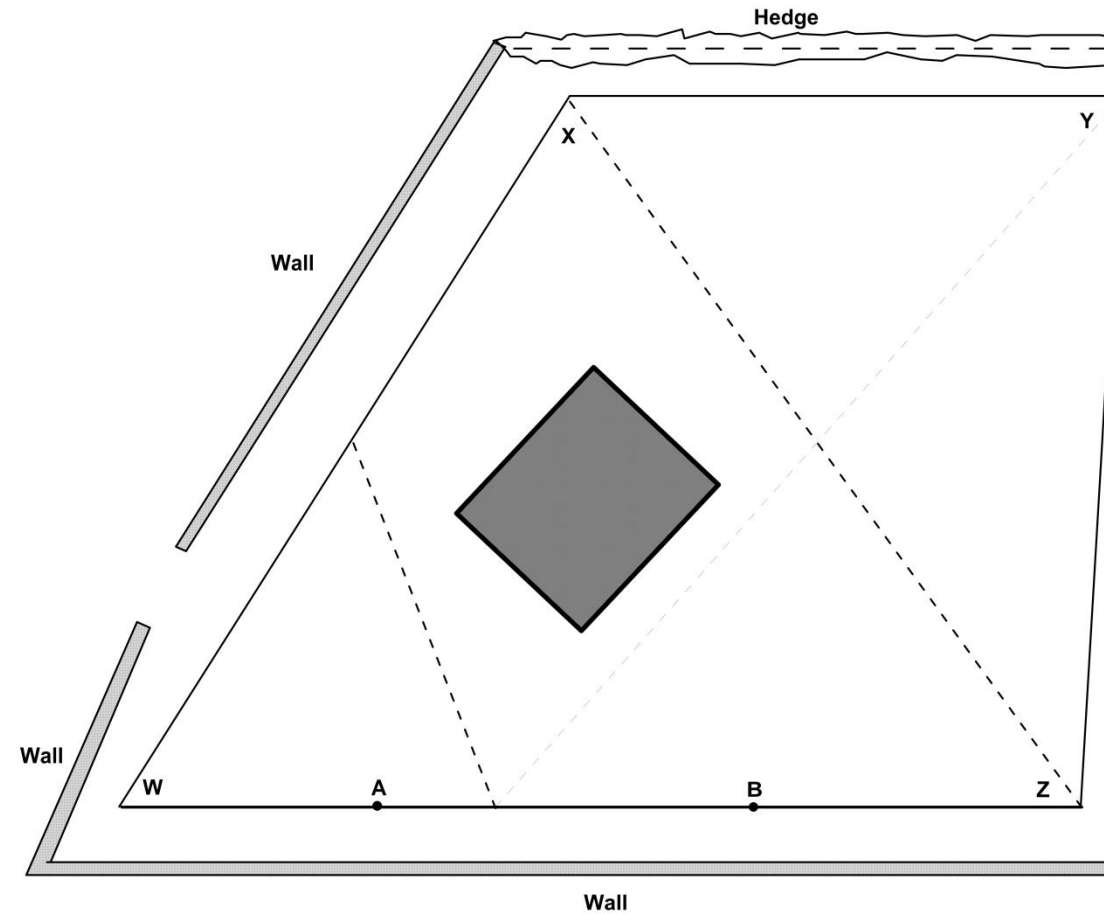




Radiation or Polar Co-ordinates



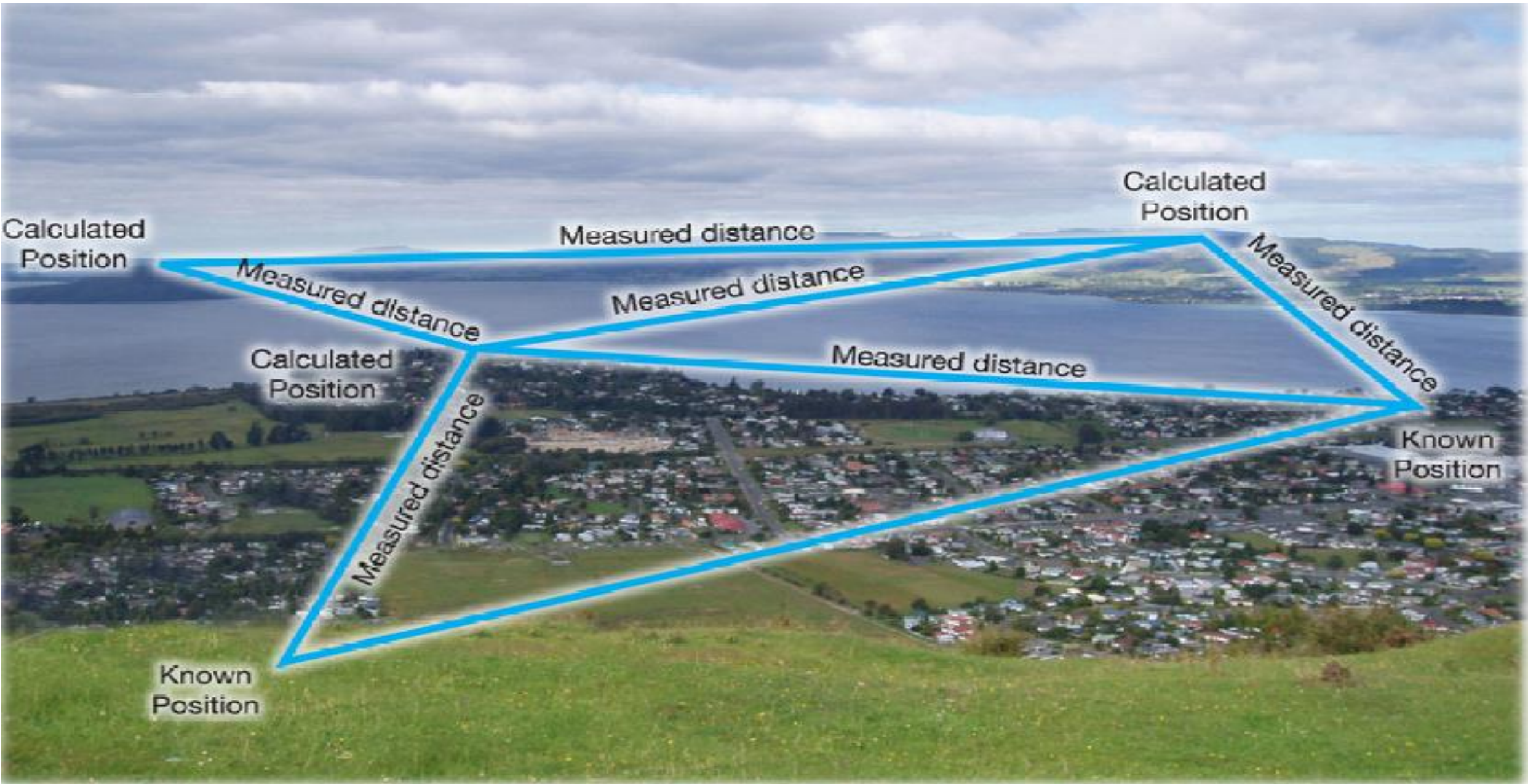
Bearing and distance



Trilateration

Trilateration

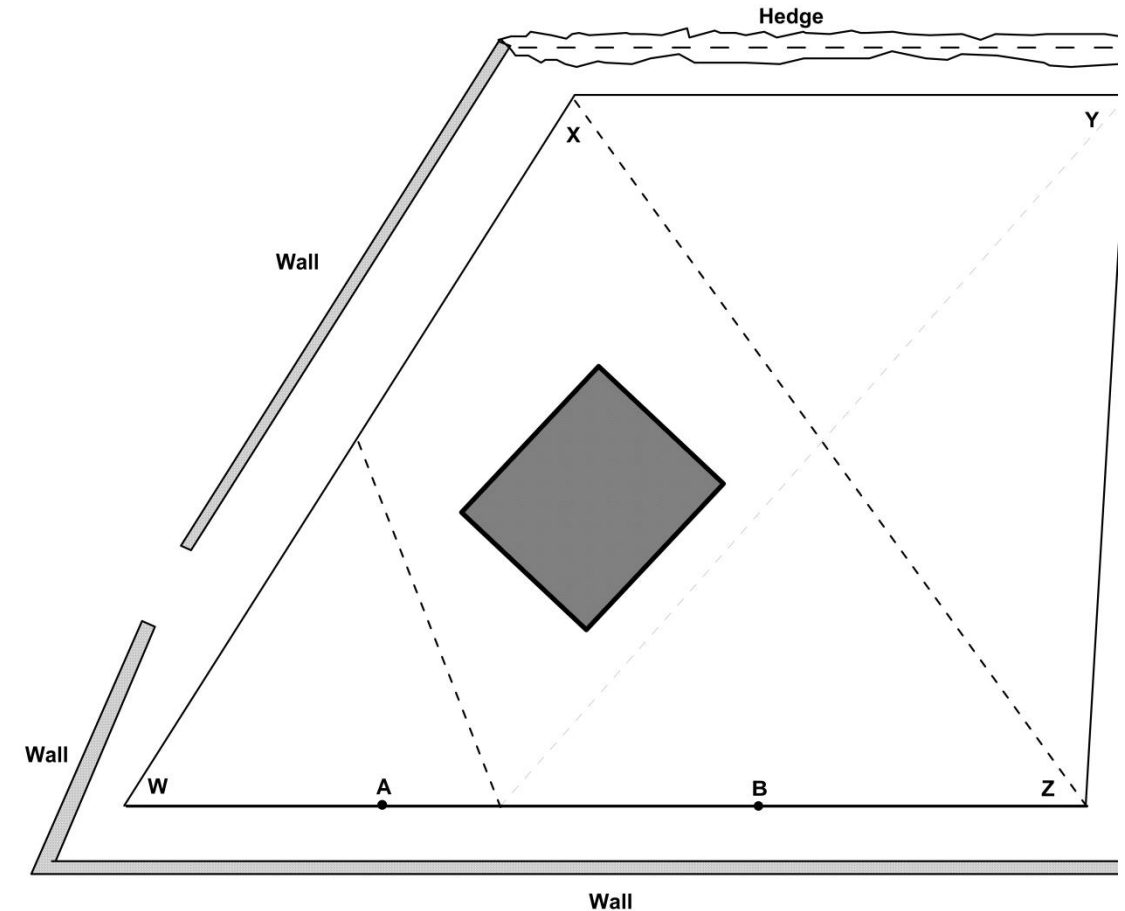
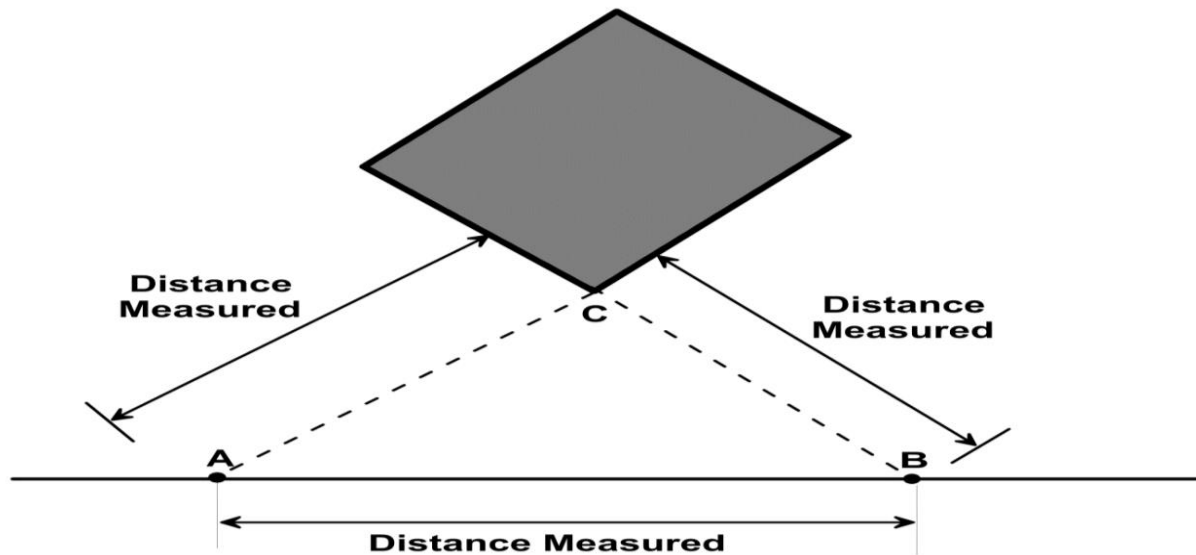
- A surveying method in which the lengths of all sides of a chain of triangles, polygons, or quadrilaterals (or any combination of them) are measured with an electronic instrument or others; the angles then may be computed from these field measurements.
- Uses in the construction of a chain or network of interconnected triangles in a given area and the measurement of all three sides of each triangle.
- Angles of the triangles and the coordinates of their vertices are re-determined by trigonometric computations.
- **In contrast to triangulation, it does not involve the measurement of angles.**
- Trilateration has the same purpose as triangulation.



Trilateration

Using the control line as a base,

Measurements are taken along baseline (A-B) and to C from A- B

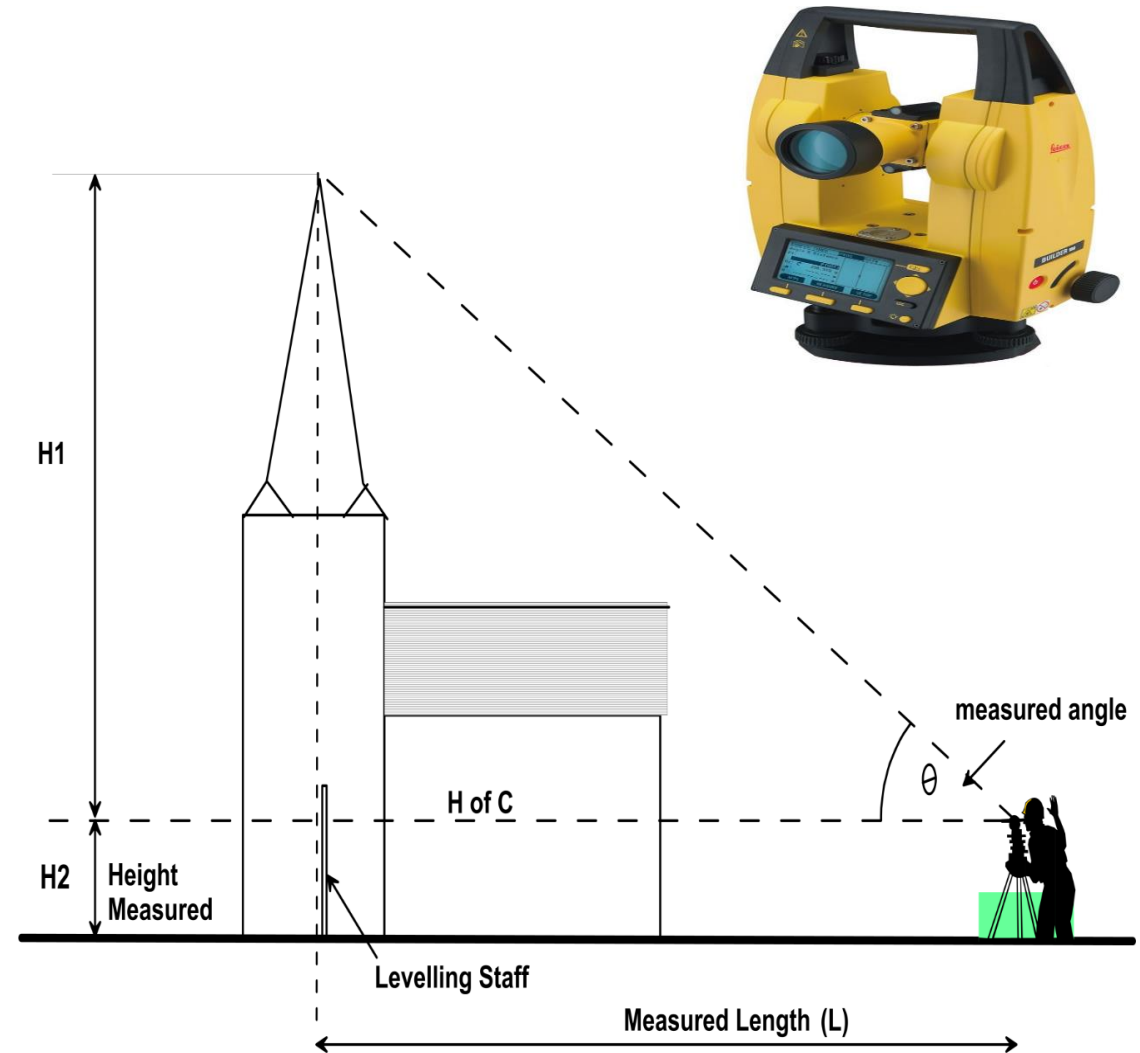


Height Measurement

Trigonometric Heighting using theodolite

Procedure:-

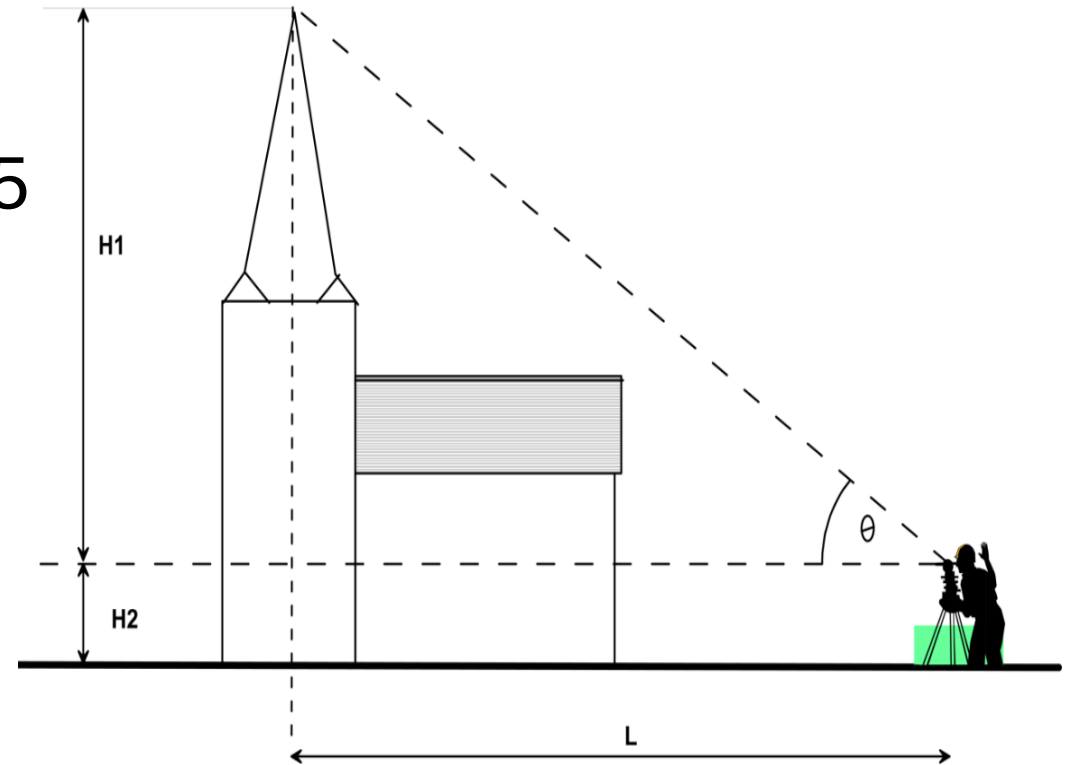
- Set up instrument
- Measure vertical angle between horizontal and object to be measured
- Measure horizontal distance using tape or stadia method
- Measure height between ground level and horizontal plane or datum



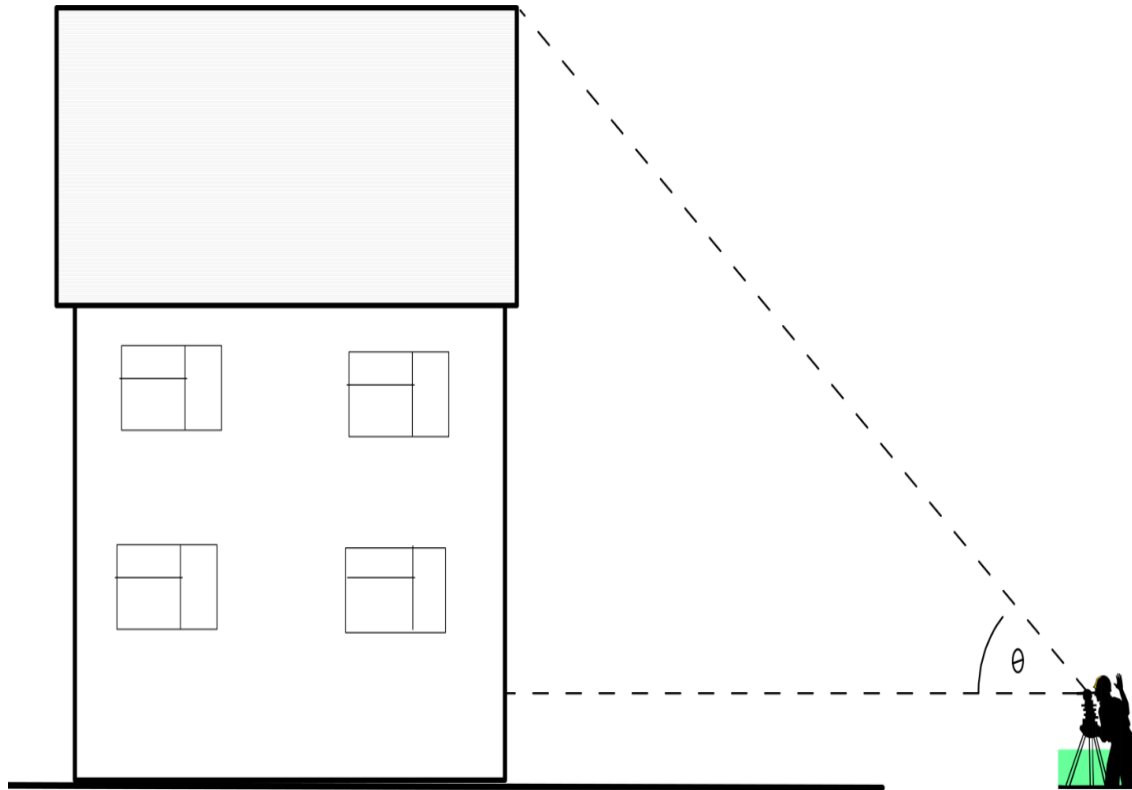
$$\text{Height } (H1 + H2) = (\tan \theta \times L) + H2$$

Example :- given an instrument height of 1.5m, L = 15m and angle of 71.5° calculate the height between the ground and top of the steeple

$$\begin{aligned}\text{Height (H1 + H2)} &= (\tan \theta \times L) + H2 \\ &= (\tan 71.5 \times 15) + 1.5 \\ &= 44.830 + 1.5 \\ &= 46.330 \text{ m}\end{aligned}$$



Example 2 :- given an instrument height of 1.2m, L = 25m and angle of 45° calculate the height between the ground and top of the roof



$$\begin{aligned}\text{Height (H1 + H 2)} &= (\tan \theta \times L) + H2 \\ &= (\tan 45 \times 25) + 1.2 \\ &= 25 + 1.2 \\ &= 26.2 \text{ m}\end{aligned}$$

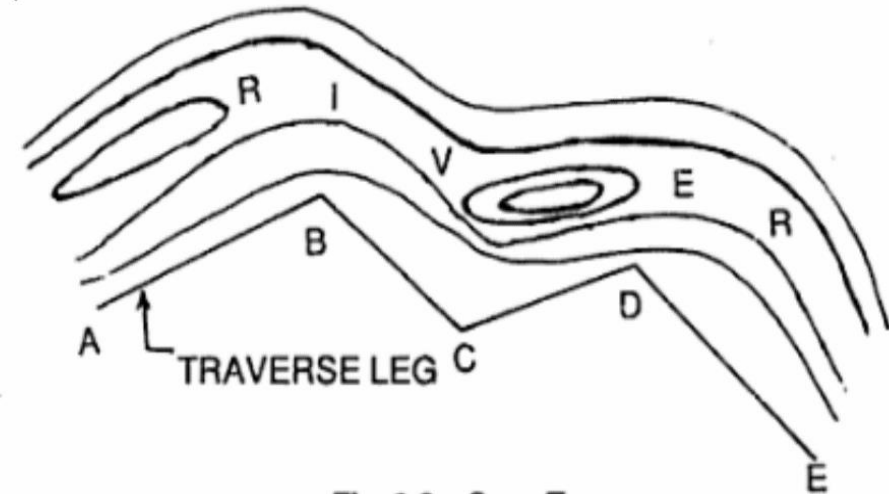
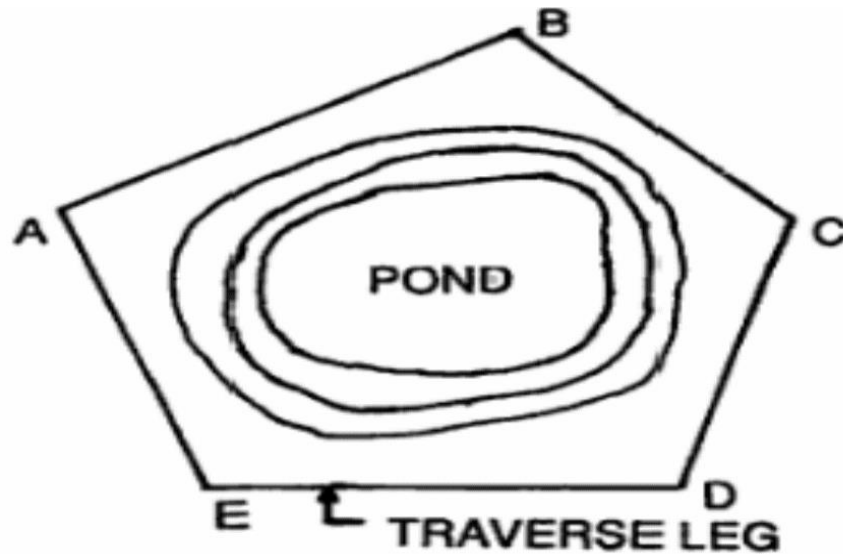
Traversing

What is Traversing ?

- A traverse consists of a series of straight lines connecting successive points.
- The points defining the ends of the traverse lines are called traverse stations or traverse points
- Distance along the line between successive traverse points is determined either by direct measurement using a tape or electronic distance measuring (EDM) equipment, or by indirect measurement using tachometric methods.
- At each point where the traverse changes direction, an angular measurement is taken using a theodolite.

Function of Traverse

- Traverses are normally performed around a parcel of land so that features on the surface or the boundary dimensions can be determined.
- A traverse provides a simple network of 'known' points that can be used to derive other information.



Types of Traverse

- There are two types of traverse used in surveying.
- These are **open traverse**, and **closed traverse**.

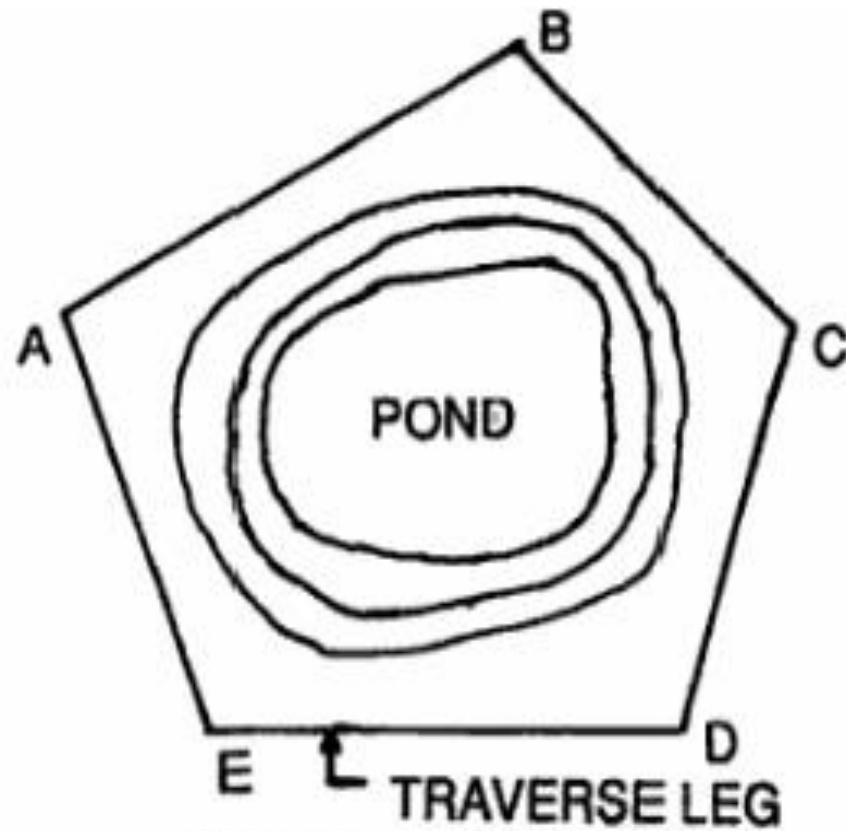
Close Traverse: When a series of connected lines forms a close circuit, it is called a close traverse.

Close traverse is suitable for the survey of boundaries of ponds, forests estates. or starts at a known points and ends at a second known point.

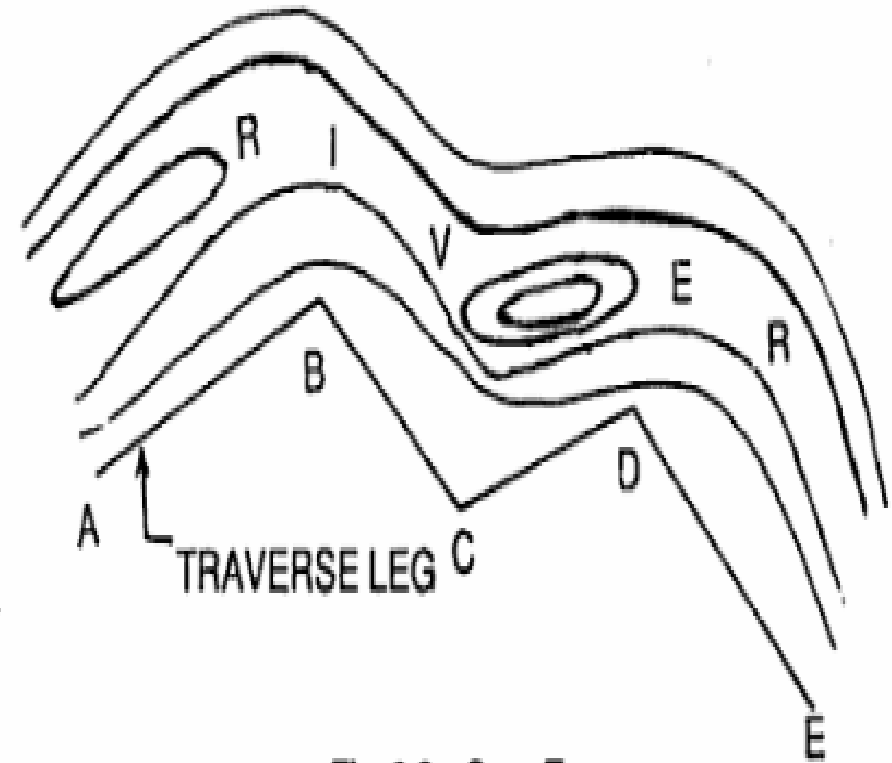
Open Traverse: When a sequence of connected lines extends along a general direction and doesn't return to the starting point, it is known as open traverse or unclosed traverse.

Open traverse is suitable for the survey of roads, rivers and coastlines.

Close and Open Traverse



Close Traverse



Open Traverse

Equipment for Traverse



Theodolite

- Theodolite is a precision instrument for measuring angles in both horizontal and vertical planes.
- It is used to identify the ground level and the ways to construct super structure or sub structure.
- It also able to rotate 360 degree on a tripod stand that's where we get angles from it.
- When the telescope is pointed at a target object, the angle of each axis can be measured with great precision. It is commonly used to measure horizontal and vertical angles, ranging and levelling as well as controlling verticality.



Tripod Stand

- A tripod stand is a three-legged support platform for the level.
- The main function of the tripod stand is to ensure a stable instrument setup for reliable measurements



Optical Plummet

- Optical Plummet is a device that used to centre the instrument over a ground station.
- It is used in place of a plumb bob to centre transits and theodolites over a given point, preferred for its steadiness in strong winds.
- The procedure speeds up the setting up process as well as protect the instrument from accident, because it has a lock below the optical plummet to lock the devices that used in fieldwork.
- Sometimes, the optical plummet can be used to perform angular or distance measurements from the survey point



Plumb Bob

- Plumb bob is used to check if the object are vertical.
- A plumb bob consist of a piece of metal pointing downwards, which is attached to cord.
- It is normally tie on the optical plummet by using the string.
- When the plumb bob is hanging free and not moving, the cord is vertical.
- It is used to mark a point directly under theodolite as well.



Ranging Rod

- Ranging rod is used to mark areas and to set out straight lines on the field.
- It is also used to mark points that must be seen from a distance.
- The length of the ranging rod is either 2m or 3m. It is made up of wood or metal.
- Ranging rod usually painted with alternate red-white or black-white bands.

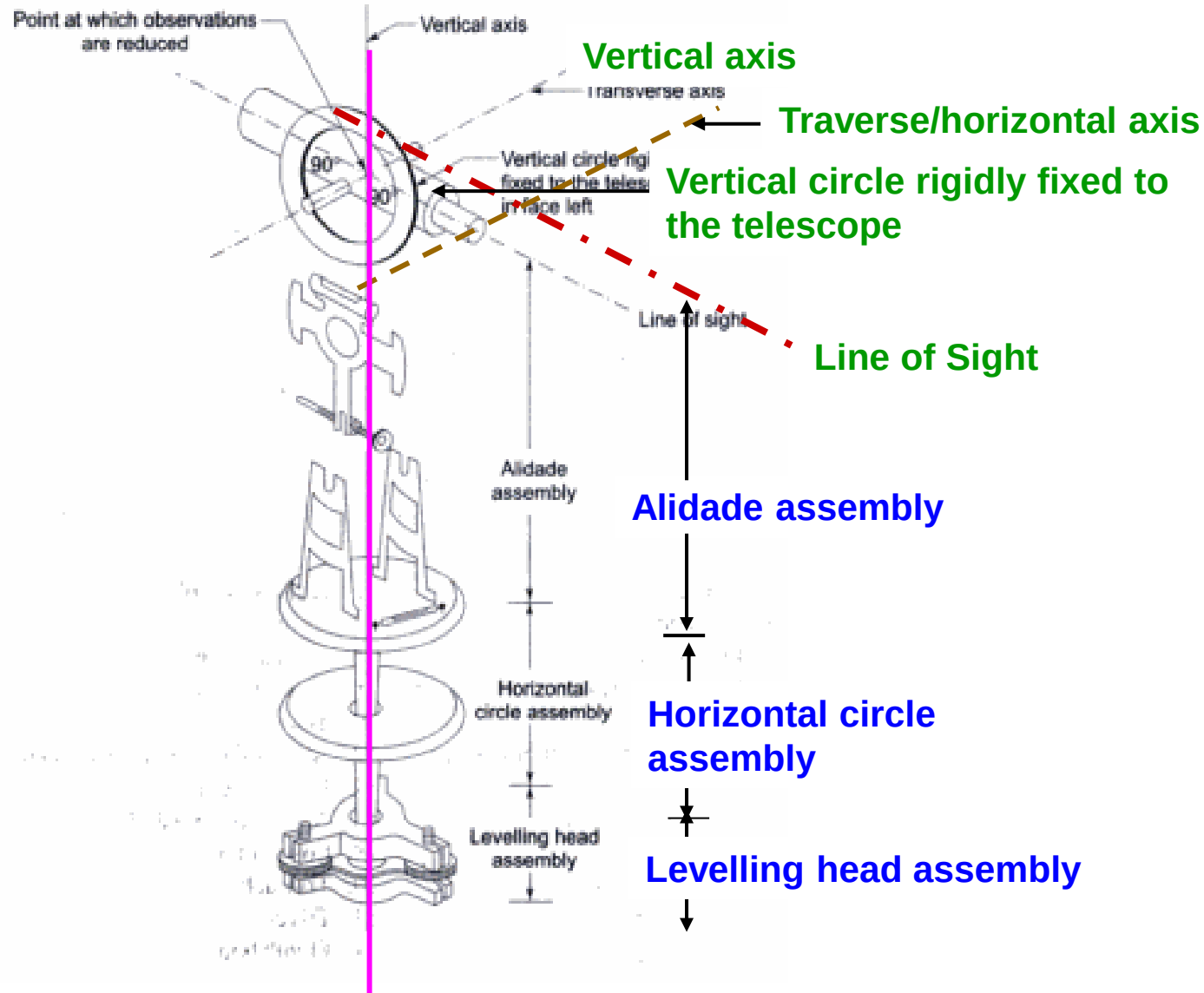


Additional information on Theodolites in Traversing

Theodolite



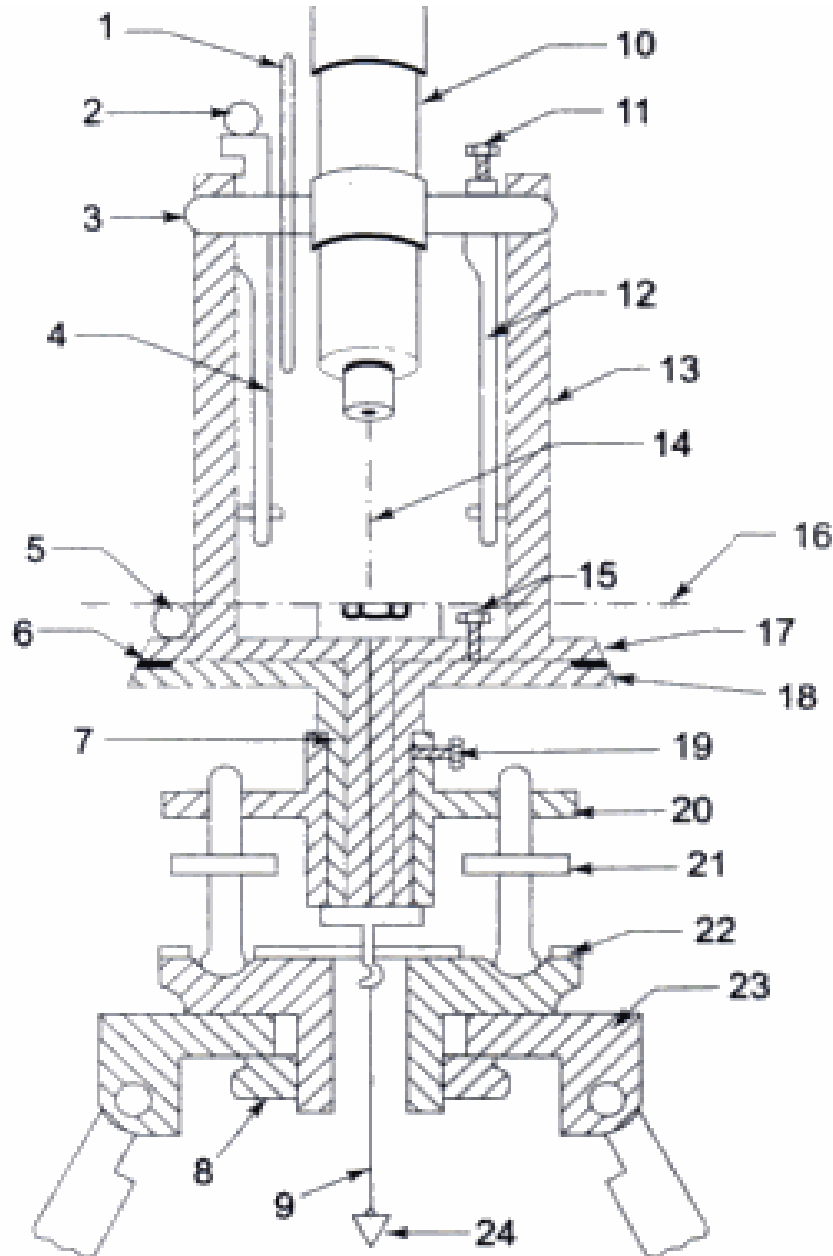
VERNIER THEODOLITE



Three assemblies of Theodolite

- Vernier theodolite is also known as transit.
- A transit theodolite is one in which the telescope can be rotated in a vertical plane.

MAIN PARTS-1



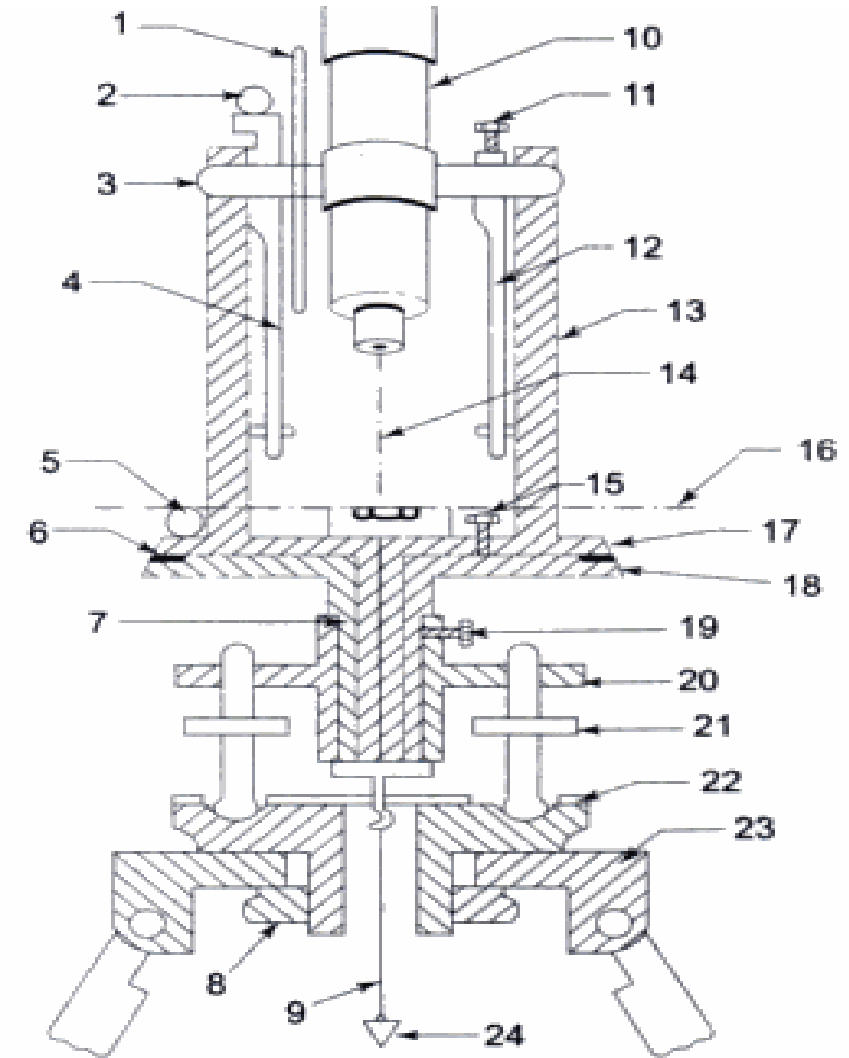
- **Main parts of a theodolite**

- **Levelling head (7):** Levelling head is used to attach the instrument to tripod and attach the plumb bob along the vertical axis of the instrument.

- | | |
|------------------------------------|--------------------------------------|
| 1. Vertical circle | 2. Altitude bubble |
| 3. Horizontal axes | 4. Vernier arm |
| 5. Plate bubble | 6. Graduated arc |
| 7. Levelling head | 8. Clamping nut |
| 9. Vertical axis | 10. Telescope |
| 11. Vertical circle clamping screw | 12. Arm of the vertical circle clamp |
| 13. Standard | 14. Line of sight |
| 15. Upper plate clamping screw | 16. Axis of plate bubble |
| 17. Upper plate | 18. Lower plate |
| 19. Lower plate clamping screw | 20. Tribrach |
| 21. Foot screw | 22. Trivet |
| 23. Tripod top | 24. Plumb bob |

MAIN PARTS-2

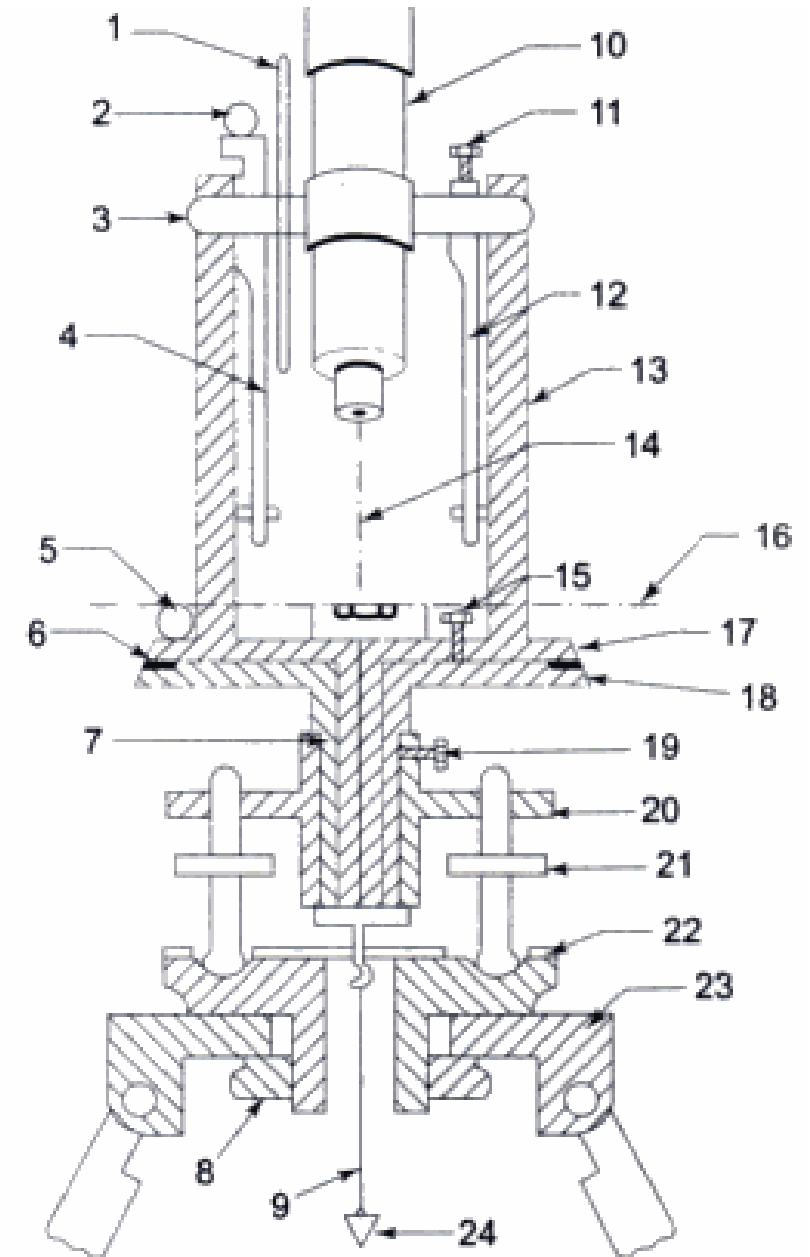
- **Lower plate/circle plate (18):** an annular horizontal plate with the graduations provided all around, from 0 to 360°, in a clockwise direction. The graduations are in degree divided in to 3 parts so that each division equals to 20 min.
- Horizontal angles are measured with this plate.
- The size of the theodolite is defined by the diameter of horizontal circle.
- **Upper plate (17):** Horizontal plate of smaller diameter provided with two verniers. on diametrically opposite parts of its circumference. These verniers are designated as A and B. They are used to read fractions of the horizontal circle plate graduations. The verniers are graduated in 20 min and each minute is divided in 3 to 5 parts making least count 20" or 10".



MAIN PARTS-3

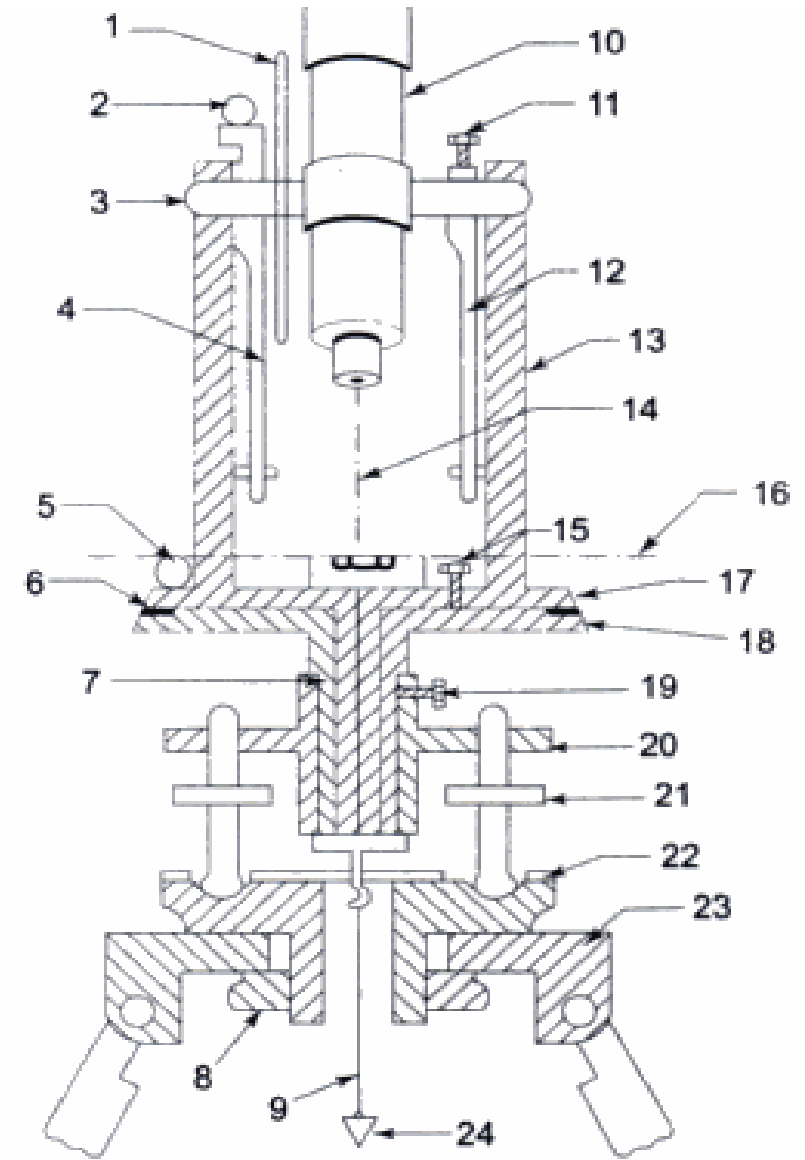
- **Clamps and tangent screws (15, 19):**

- There are two clamps and associated tangent screws with the plate. These screws facilitate the motion of the instruments in horizontal plane.
- Lower clamp screw locks or releases the lower plate. When this screw is unlocked both upper and lower plates move together. The associated lower tangent screw allows small motion of the plate in locked position.
- The upper clamp screw locks or releases the upper vernier plate. When this clamp is released, the lower plate does not move but the upper vernier plate moves with the instrument. This causes the change in the reading. The upper tangent screw allows the fine adjustment.



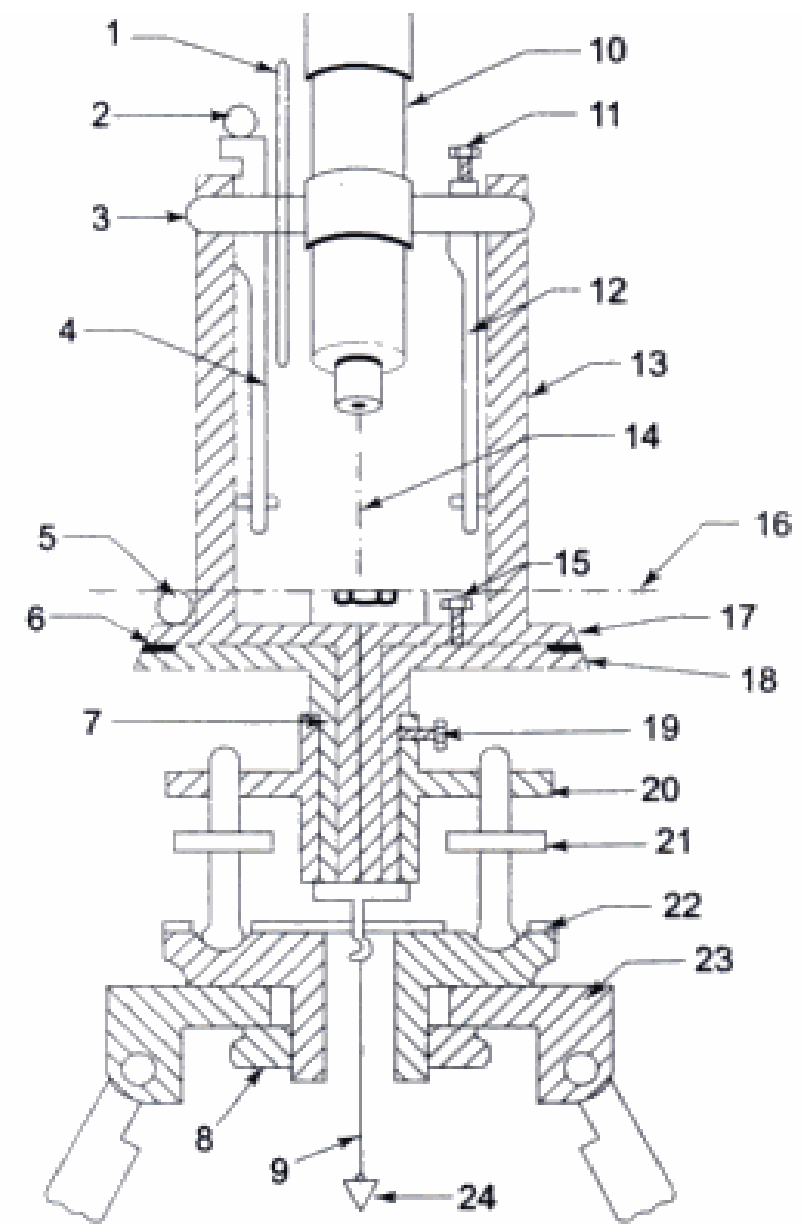
MAIN PARTS-4

- **Plate level (5):**
 - Spirit level with the bubble and graduation on glass cover.
 - A single level or two levels fixed in perpendicular direction may be provided.
 - The spirit level can be adjusted with the foot screw (21) of the levelling head (7).
- **Telescope (10):** The essential parts of the telescopes are eye-piece, diaphragm with cross hairs, object lens and arrangements to focus the telescope.



MAIN PARTS-5

- **Vertical circle (1):** circular plate supported on horizontal axis of the instrument between the A-frames. Vertical circle has graduation 0-90 in four quadrants. Vertical circle moves with the telescope when it is rotated in the vertical plane.
- **Vertical circle clamp and tangent screw (11):** Clamping the vertical circle restrict the movement of telescope in vertical plane.
- **Altitude level (2):** A highly sensitive bubble is used for levelling particularly when taking the vertical angle observations.



Important Definition

Face Right When the vertical circle of a theodolite is on the right of the observer, the position is called *face right* and the observation made is called face right observation.

Face Left When the vertical circle of a theodolite is on the left of the observer, the position is called *face left* and the observation made is called face left observation.

By taking the mean of both face readings, the collimation error is eliminated.

Telescope Normal The telescope is said to be *normal* or *direct* when its vertical circle is to the left of the observer and the bubble is up.

Telescope Inverted The telescope is said to be *inverted* when its vertical circle is to the right of the observer and the bubble is down.

Changing face

- Revolving the telescope by 180° in vertical plane about horizontal axis
- Again revolving the telescope in horizontal plane about vertical axis.



- **Temporary Adjustment**

1. The levelling screws are at the centre of their run.
2. The shifting head of the theodolite is at its centre so that equal movement is possible in all the directions.
3. The wing nuts on the tripod legs are tight enough so that when raised, the tripod legs do not fall under their own weight.

- **Setting up the theodolite**

Centring This involves setting the theodolite exactly over the station mark or on the station peg. It is done by the following steps:

1. The plumb bob is suspended from a small hook attached to the vertical axis of the theodolite.
2. The instrument is placed over the station mark with the telescope at a convenient height and with the tripod legs set well apart.
3. Two legs of the tripod are set firmly into the ground and the third leg is moved radially to bring the plumb bob exactly over the station mark. Then the third leg is also pushed into the ground.
4. If the instrument has a shifting head, the instrument is roughly centred over the station mark and then by means of the shifting head, the plumb bob is brought exactly over the station mark.

Approximate levelling This implies levelling the instrument with the legs of the tripod, i.e. by bringing the small circular bubble provided on the tribrach in the centre. To achieve this, two of the tripod legs are pushed firmly into the ground and the third leg of the tripod is moved to the right or to the left, i.e. in the circumferential direction until the bubble is centred. This leg is then pushed into the ground.



4.9.2 Levelling up

This means making the vertical axis truly vertical. This is done with the help of the foot screws. The procedure is as follows:

1. The longer plate level is brought parallel to any two foot screws.

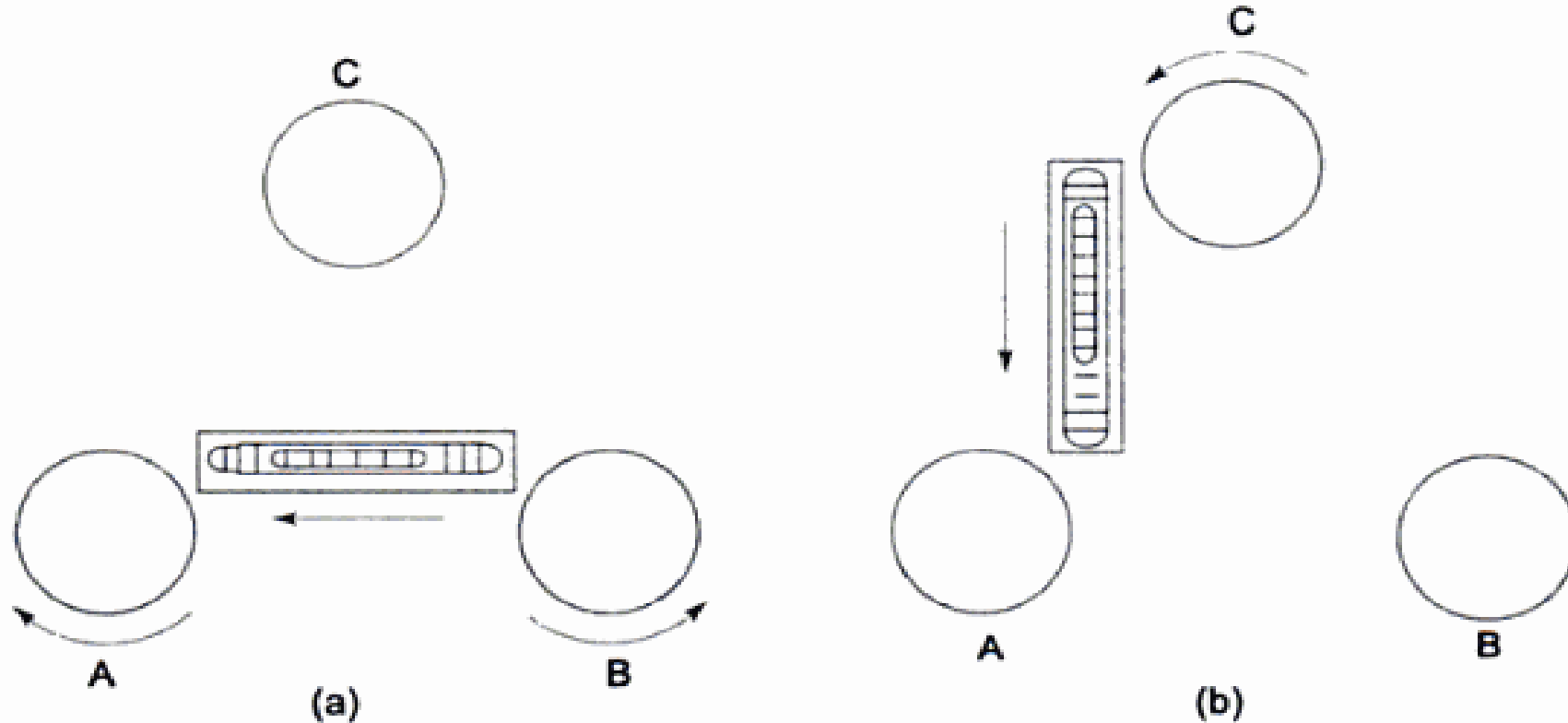


Fig. 4.4 Levelling with three foot screws

In the case of a three screw levelling head, the other plate level will then be parallel to the line joining the third foot screw and the mid-point of the line joining the first two foot screws, as shown in Fig. 4.4.

2. Bring the bubble of the longer plate level to the centre of its run by moving the two foot screws, say A and B, uniformly either inwards or outwards (Fig. 4.4(a)). It may be noted that the bubble always moves in the direction of the left thumb as the surveyor turns the screw.
3. Move the third foot screw C so that the bubble in the other plate level is centred (Fig. 4.4(b)).

4.9.3 Focussing

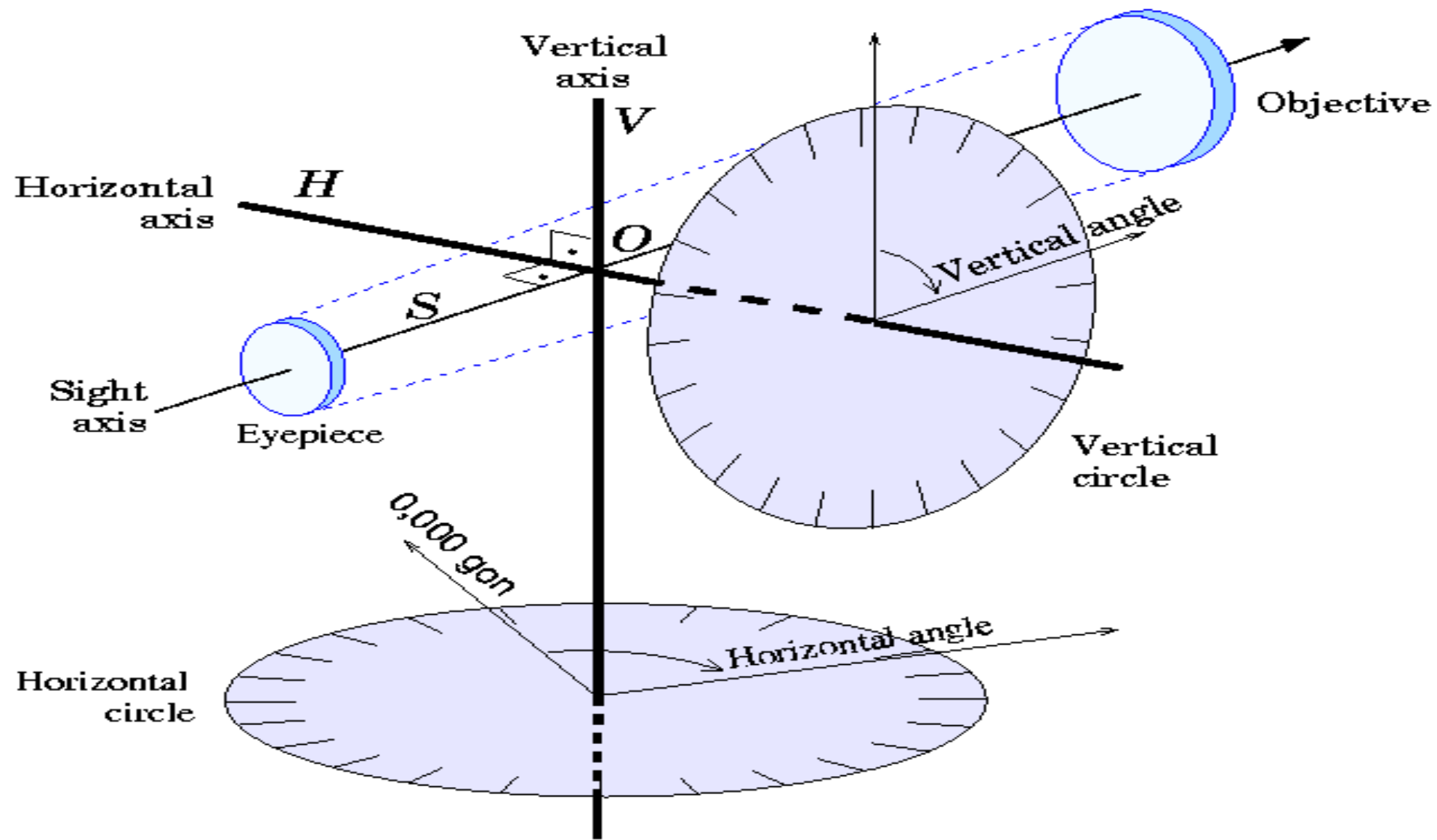
It consists of focussing the eyepiece and the objective.

Focussing the eyepiece This operation is done to make the cross-hairs appear clearly visible. The following steps are involved:

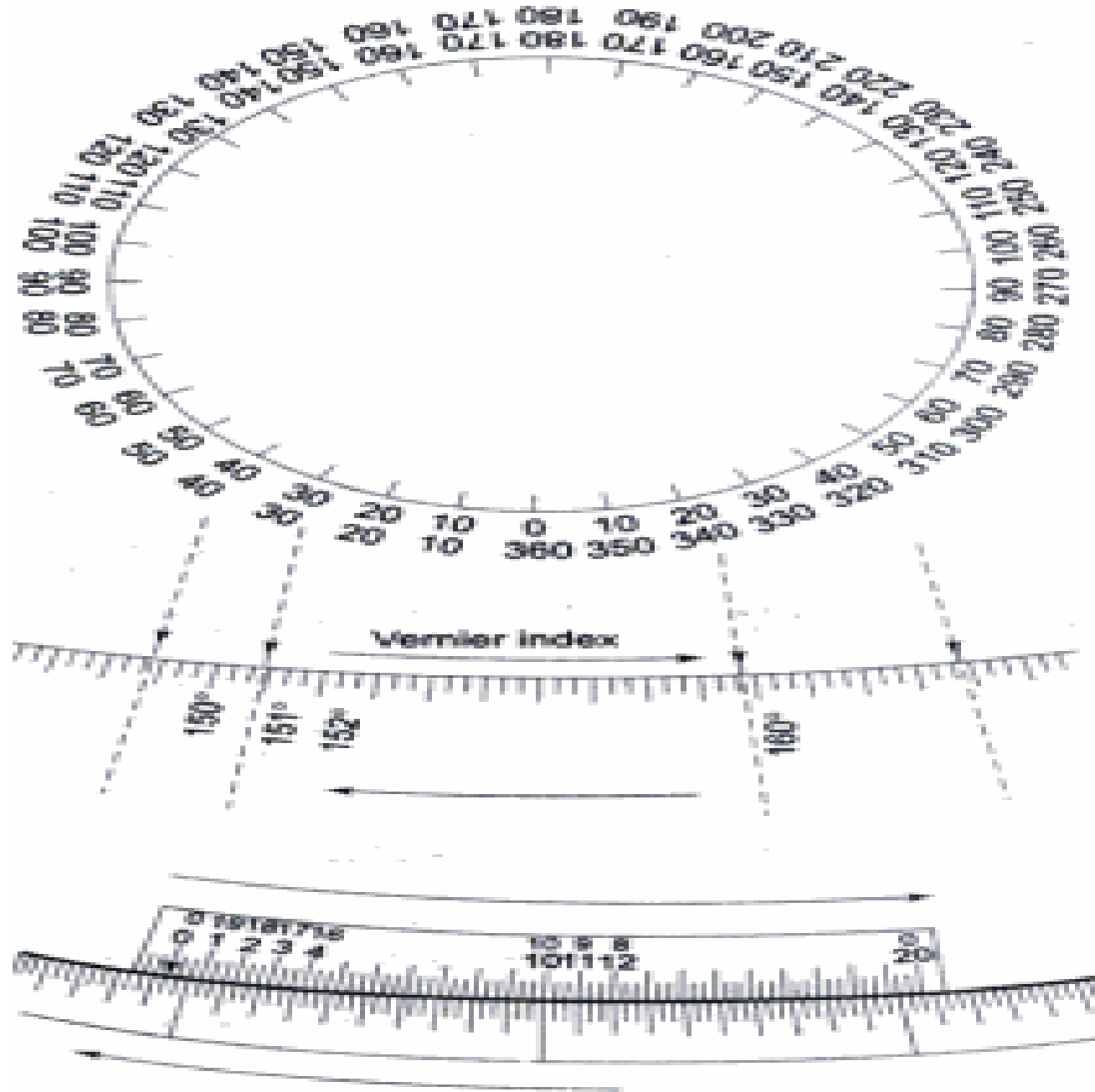
1. The telescope is directed towards the sky or a sheet of white paper held in front of the objective.
2. The eyepiece is moved in or out until the cross-hairs appear clear and distinct.

Focussing the objective This operation is done to bring the image of the object in the plane of the cross-hairs. The following steps are involved:

1. The telescope is directed towards the object.
2. The focussing screw is turned until the image appears clear and sharp.



Reading a Theodolite

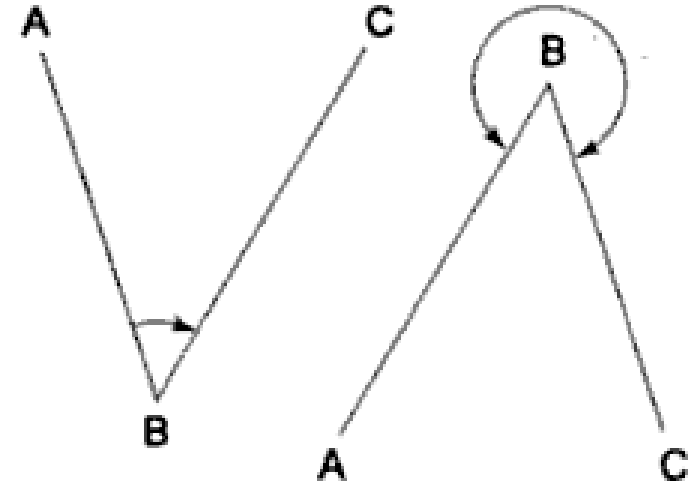


Vernier scale graduation

Horizontal Angle Measurement

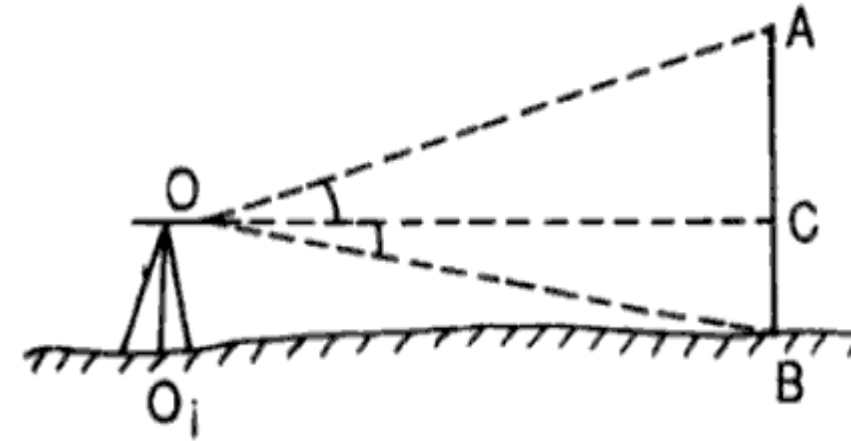
- **Measurement of Angle ABC**

- The instrument is set over B.
- The lower clamp is kept fixed and upper clamp is loosened.
- Turn the telescope clockwise set vernier A to 0° and vernier B to approximately 180° .
- Upper clamp is tightened and using the upper tangent screw the vernier A and B are exactly set to 0° and 180° .
- Upper clamp is tightly fixed, lower one is loosened and telescope is directed towards A and bisect the ranging rod at A.
- Tightened the lower clamp and turn the lower tangent screw to perfectly bisect ranging rod at A.
- Loose the upper clamp and turn the telescope clockwise to bisect the ranging rod at C tightened the upper clamp and do the fine adjustment with upper tangent screw.
- The reading on vernier A and B are noted. Vernier A gives the angle directly and vernier B gives the reading by subtracting the initial reading (180°) from final reading



Vertical Angle Measurement

1. The theodolite is set up at O. It is centred and levelled properly. The zeros of the verniers (generally C and D) are set at the $0^{\circ}-0^{\circ}$ mark of the vertical circle (which is fixed to the telescope). The telescope is then clamped.
2. The plate bubble is brought to the centre with the help of foot screws (in the usual manner). Then the altitude bubble is brought to the centre by means of a clip screw. At this position the line of collimation is exactly horizontal.
3. To measure the angle of elevation, the telescope is raised slowly to bisect the point A accurately. The readings on both the verniers are noted, and the angle of elevation recorded.
4. The face of the instrument is changed and the point A is again bisected. The readings on the verniers are noted. The mean of the angles of the observed is assumed to be the correct angle of elevation.
5. To measure the angle of depression, the telescope is lowered slowly and the point B is bisected. The readings on the verniers are noted for the two observations (face left and face right). The mean angle of the observation is taken to be the correct angle of depression. The result is tabulated as shown in Table 9.4.



Sources of Errors in Theodolite

- **Instrumental errors**

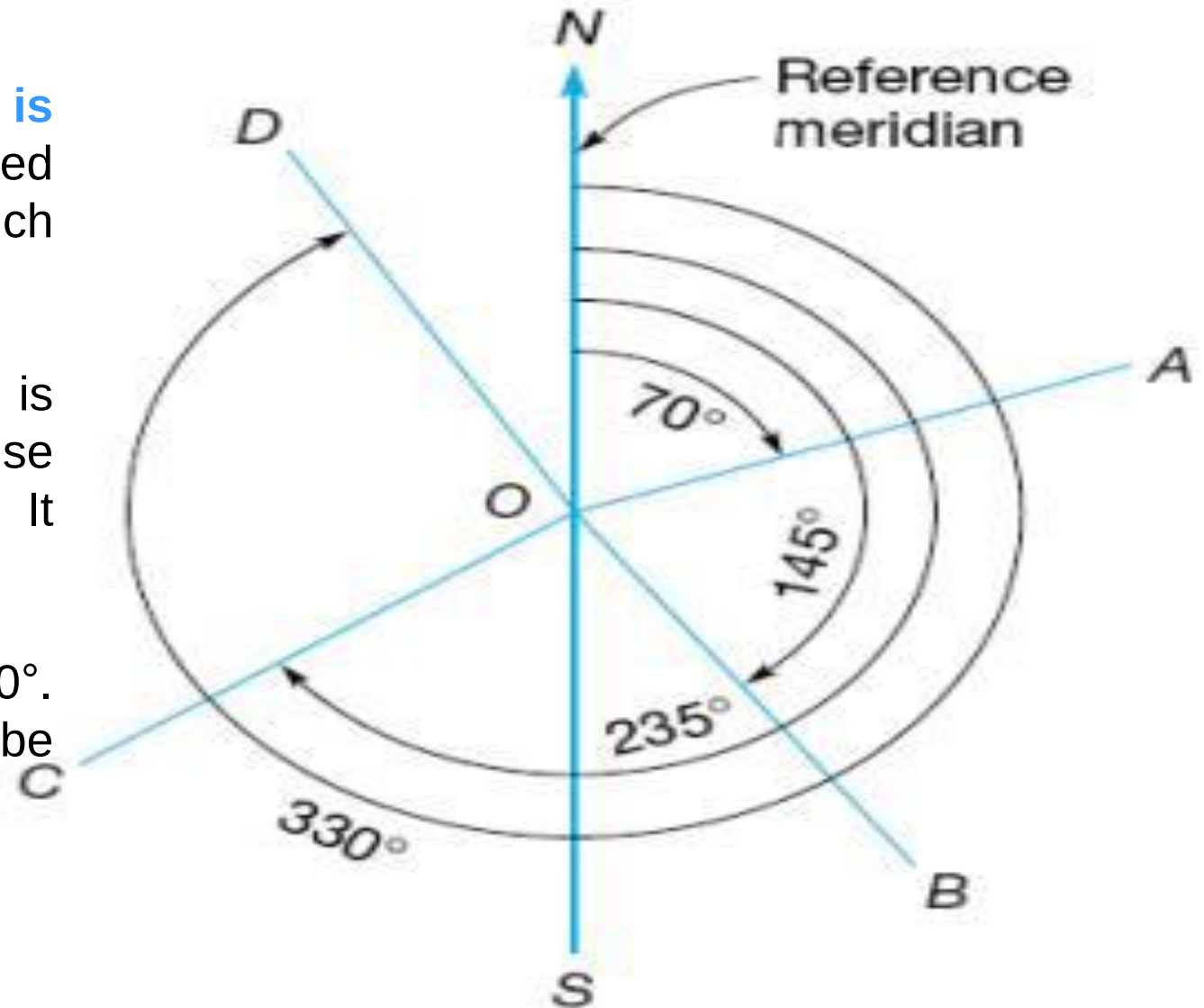
- Non adjustment of plate bubble
- Line of collimation not being perpendicular to horizontal axis
- Horizontal axis not being perpendicular to vertical axis
- Line of collimation not being parallel to axis of telescope
- Eccentricity of inner and outer axes
- Graduation not being uniform
- Verniers being eccentric

Traversing Survey

- A traverse consists of a series of straight lines connecting successive points.
- The points defining the ends of the traverse lines are called traverse stations or traverse points
- Distance along the line between successive traverse points is determined either by direct measurement using a tape or electronic distance measuring (EDM) equipment, or by indirect measurement using tachometric methods.
- At each point where the traverse changes direction, an angular measurement is taken using a theodolite.

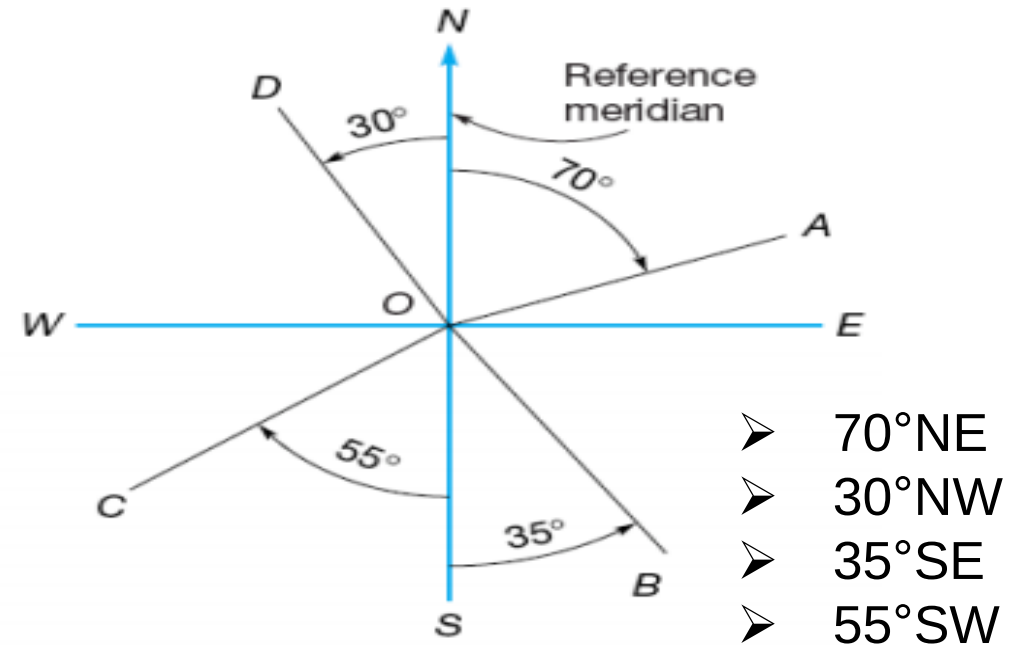
Terms in Traversing

- **Whole Circle Bearing or Azimuth** is defined as horizontal angle turned clockwise from the reference line. Which is between the ranges from 0° to 360° .
- Whole circle bearing (W.C.B) of a line is the horizontal angle measured clockwise from the North limb of the meridian. It varies from 0° to 360°
- For example: 70° , 145° and 330° . Generally, the angles should be measured only from the north.



Bearing

- Bearings is defined as an acute angle which is less than 90° . It is a horizontal angles measured from the meridian either east or west.
- Usually required two letter with an acute angle which is North (N), South (S), East (E) & West (W).
- The different between azimuths and bearing is bearing can be measured both either clockwise or counter clockwise. It can be measured from North or South axis of the meridian.



Angular Measurement

Angles in traversing are measured in degrees, minutes, seconds

How to convert degrees, minutes, seconds to decimal degrees

One degree is equal to 60 minutes and equal to 3600 seconds:

$$1^{\circ} = 60' = 3600''$$

One minute is equal to 1/60 degrees:

$$1' = (1/60)^{\circ} = 0.01666667^{\circ}$$

One second is equal to 1/3600 degrees:

- $1'' = (1/3600)^{\circ} = 2.77778e-4^{\circ} = 0.000277778^{\circ}$

- One minute is equal to 1/60 degrees:

$$1' = (1/60)^{\circ} = 0.01666667^{\circ}$$

- One second is equal to 1/3600 degrees:

$$1'' = (1/3600)^{\circ} = 2.77778e-4^{\circ} = 0.000277778^{\circ}$$

- For angle with d integer degrees m minutes and s seconds:

- $d^{\circ} m' s''$

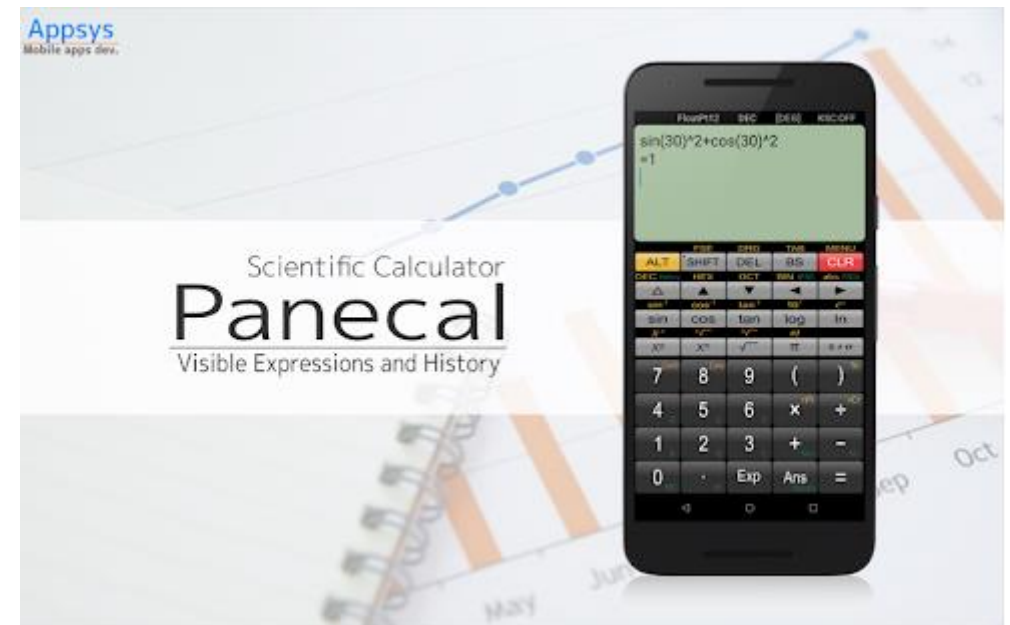
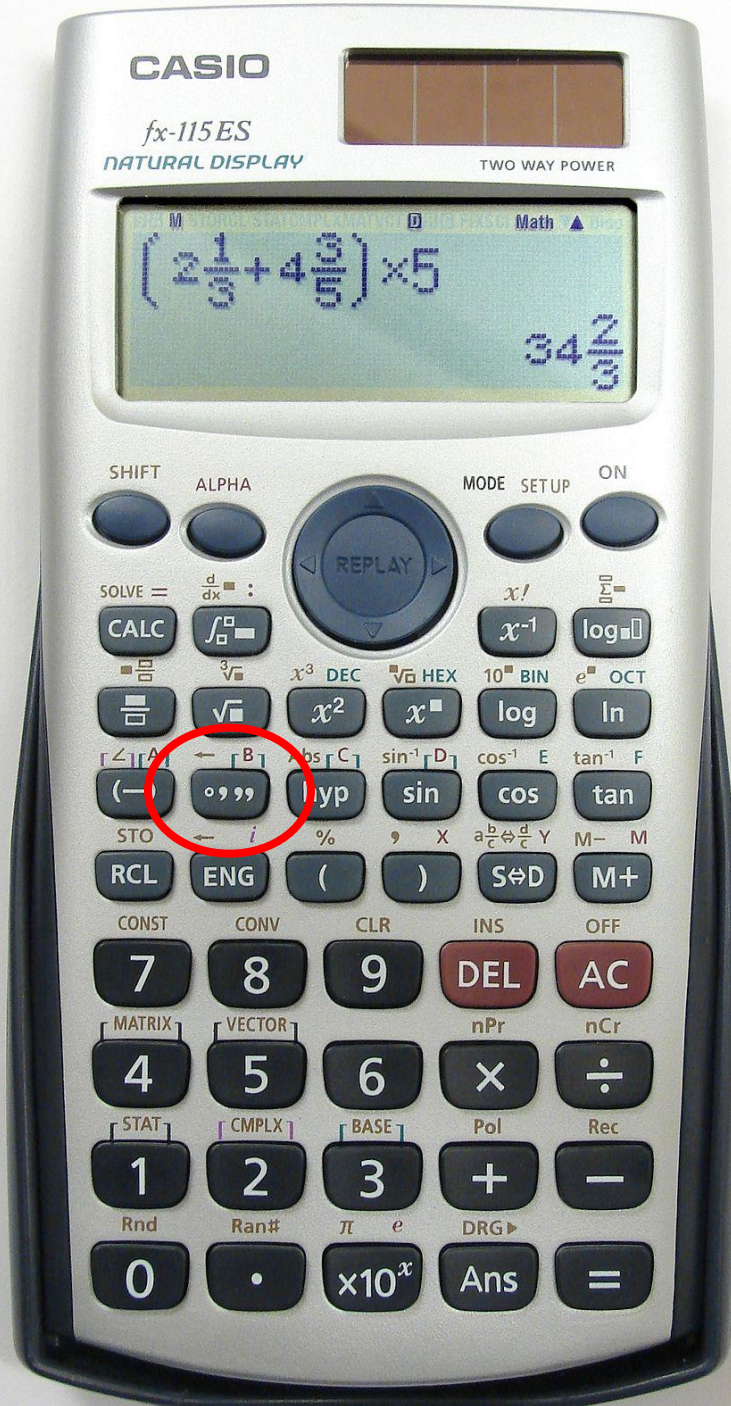
Example

Convert 30 degrees 15 minutes and 50 seconds angle to decimal degrees:

$$30^{\circ} 15' 50''$$

The decimal degrees dd is equal to:

$$\text{dd} = d + m/60 + s/3600 = 30^{\circ} + 15'/60 + 50''/3600 = 30.263888889^{\circ}$$



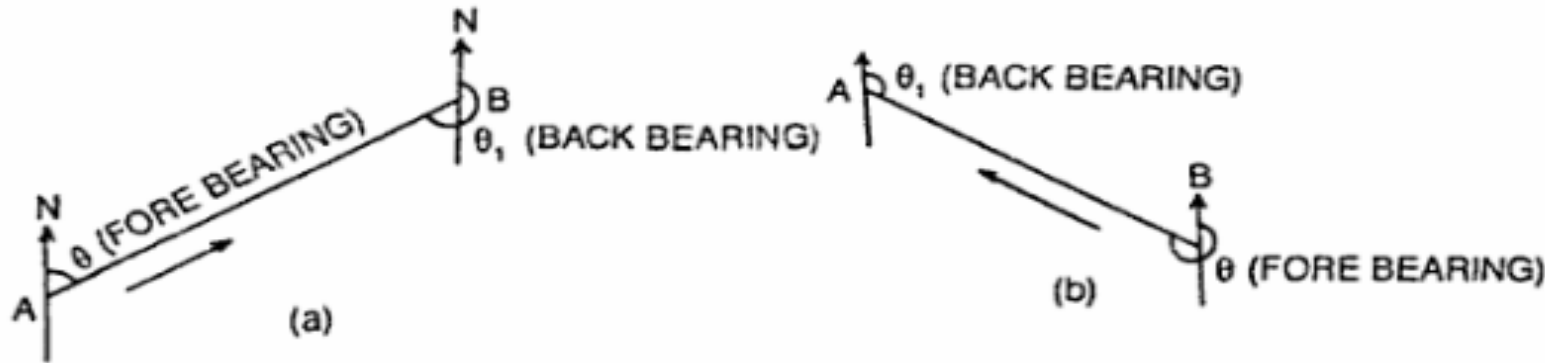
Fore Bearing and Back Bearing

➤ Fore bearing or Forward Bearing:
The bearing of a line measured in the forward direction (i.e., along the progress of survey) is known as fore bearing.

➤ Fore bearing = Back bearing $\pm 180^\circ$

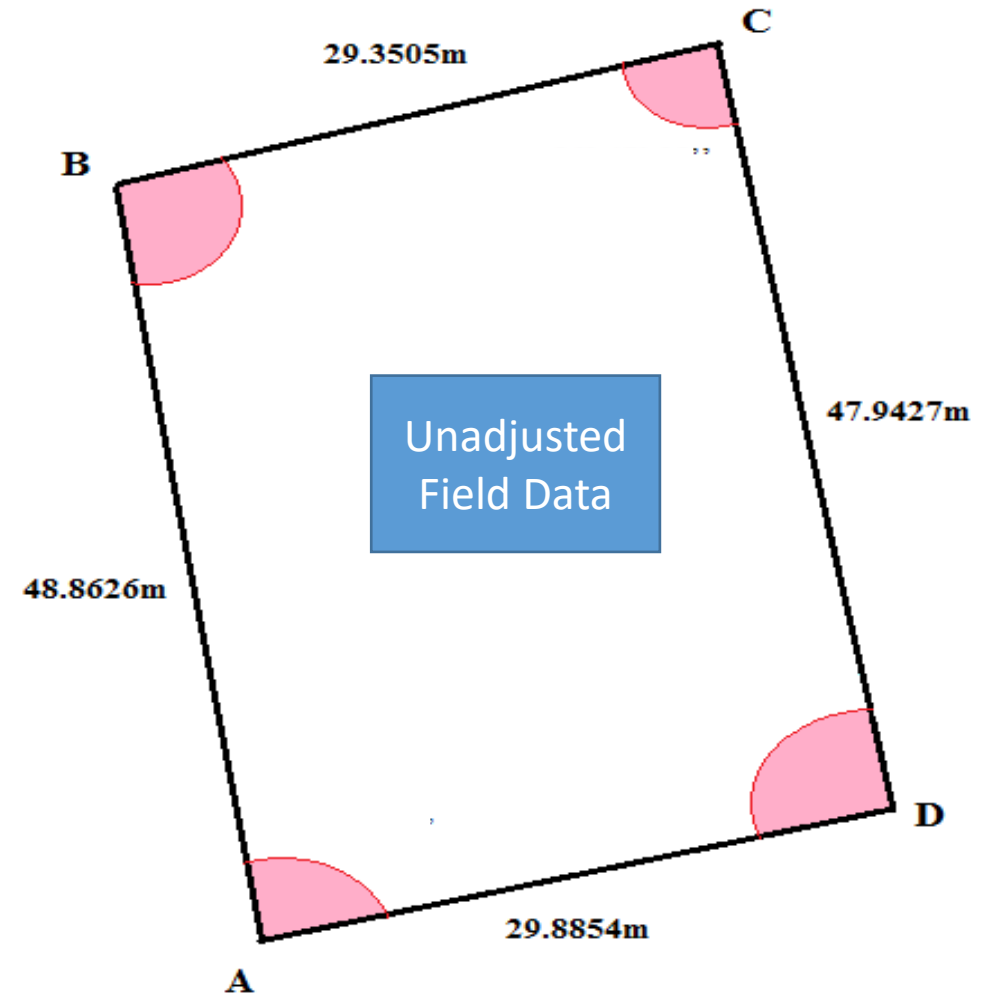
➤ Back Bearing: The bearing of a line measured in the backward direction (i.e., opposite to the direction of progress of survey) is known as back bearing.

➤ Back Bearing = Fore Bearing $\pm 180^\circ$



Example of Field Data

Station	Field Angles
A	$86^{\circ} 44' 20''$
B	$92^{\circ} 39' 40''$
C	$86^{\circ} 46' 20''$
D	$93^{\circ} 46' 40''$
Total	$357^{\circ} 175' 120''$



Computation of Angular Error and Adjustments of Angles

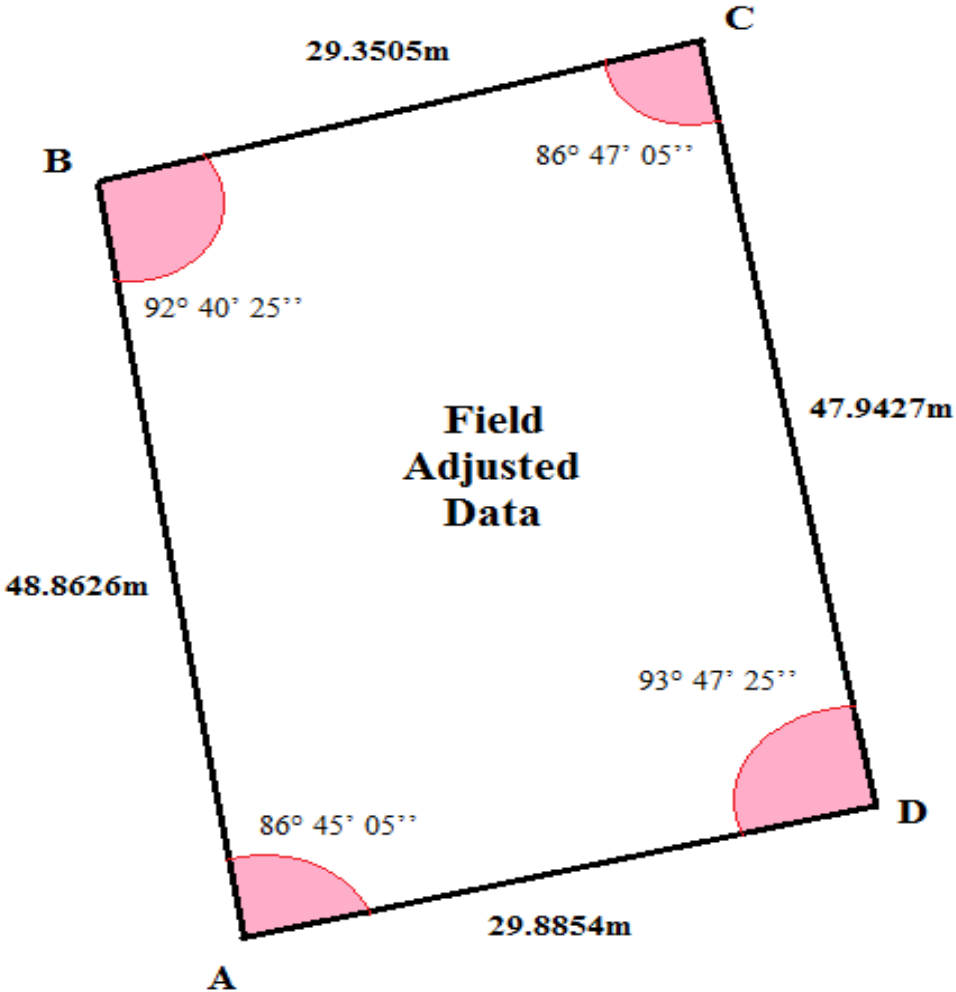
The sum of the interior angles in any loop traverse must equal to 360° .

$$\begin{aligned}\text{Total angular error} &= 360^\circ - 359^\circ 57' 00'' \\ &= 00^\circ 03' 00''\end{aligned}$$

$$\text{Error per angle} = 00^\circ 03' 00'' / 4$$

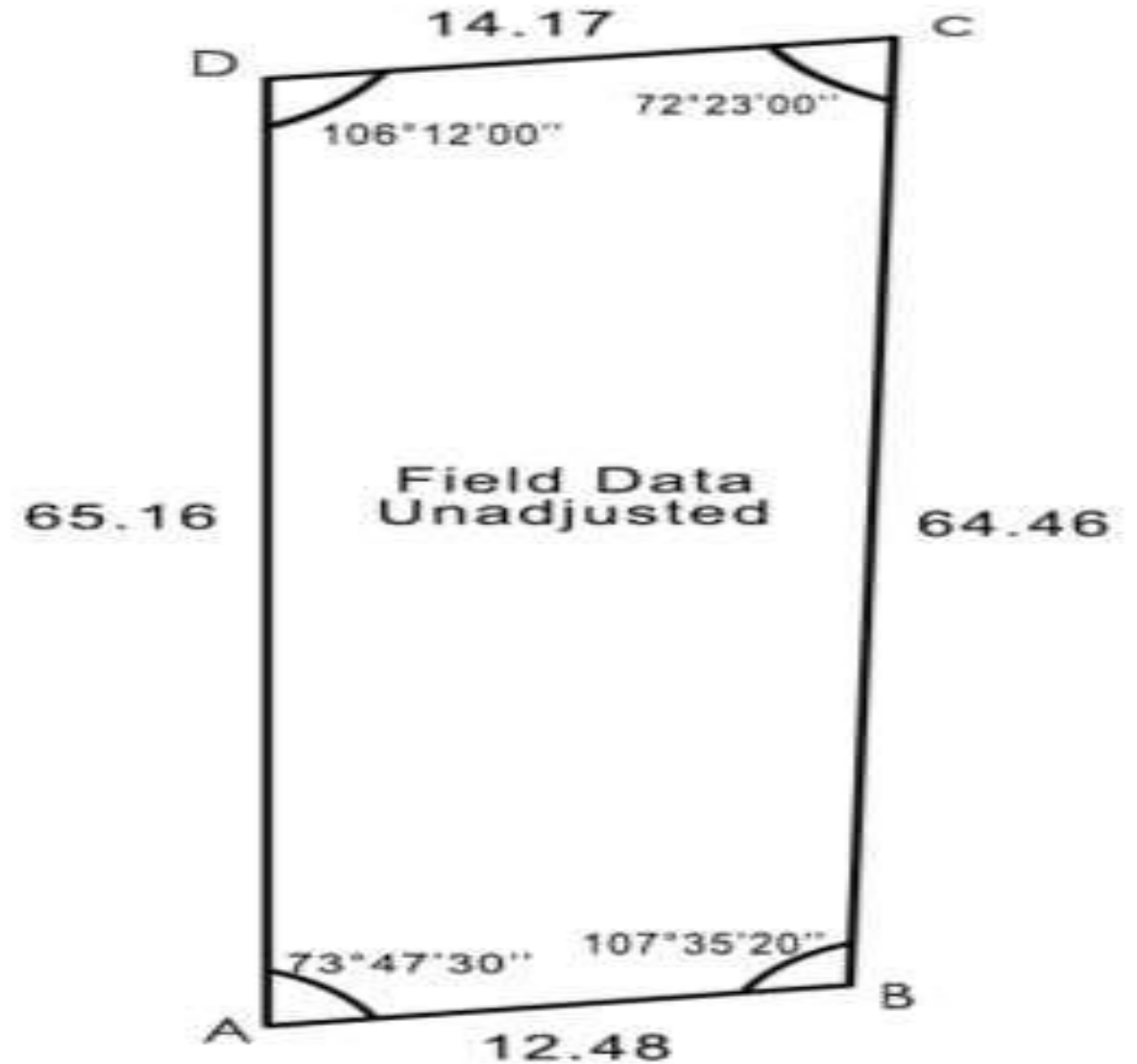
$$= 00^\circ 00' 45'' / 45'' \text{ per angle}$$

Station	Field Angle	Correction	Adjusted Angles
A	86° 44' 20"	+ 00° 00' 45"	86° 45' 05"
B	92° 39' 40"	+ 00° 00' 45"	92° 40' 25"
C	86° 46' 20"	+ 00° 00' 45"	86° 47' 05"
D	93° 46' 40"	+ 00° 00' 45"	93° 47' 25"
Total	359° 57' 00"		360° 00' 00"

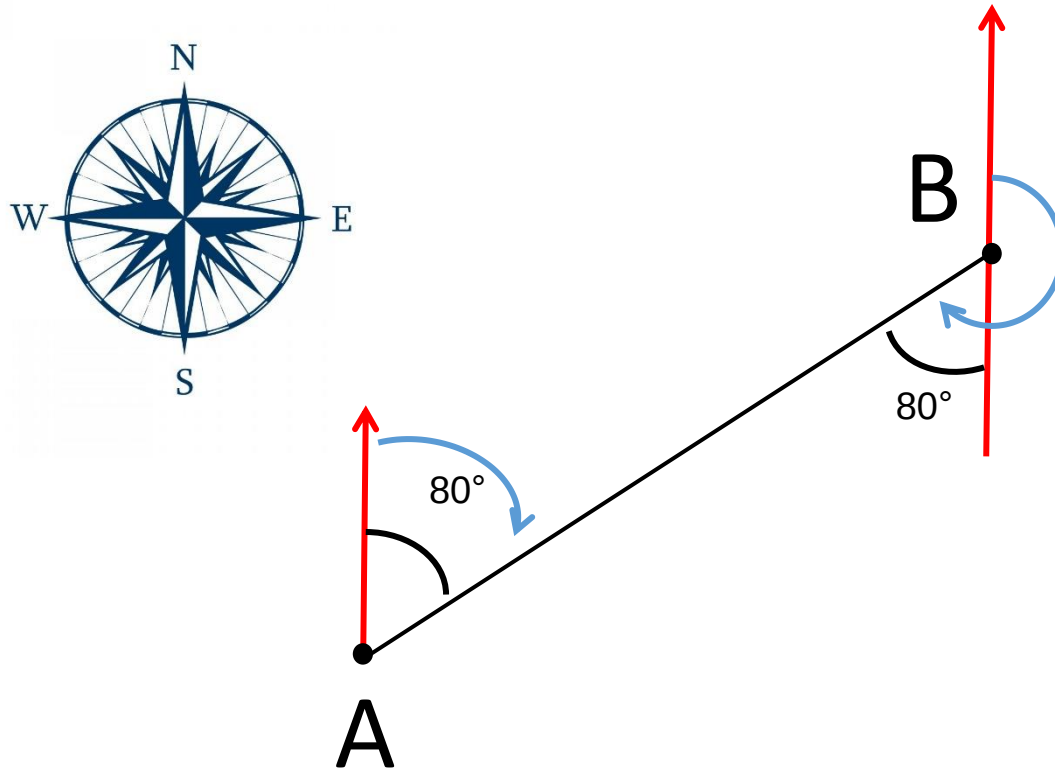


Class Exercise

Checks for errors and
adjust the field angles
for the field data on the
diagram



Calculating Bearings and Whole Circle Bearings



- Bearing from A – B is $N80^\circ E$
- WCB A - B is 80°
- The Bearing from B – A is $S80^\circ W$
- WCB B-A is $260^\circ (80 + 180)$

Closed Traverse

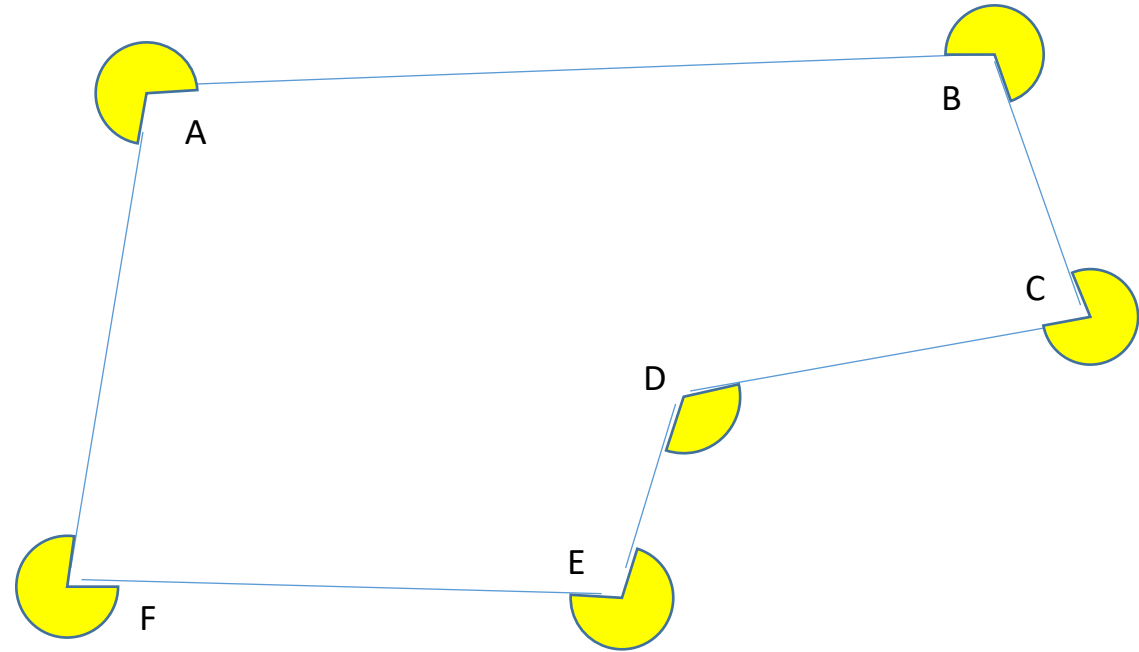
In a closed traverse the lines form a closed polygon.

Exterior angles are measured in a clockwise direction. (Interior angles in an anticlockwise direction can also be measured instead).

To check the accuracy of the measured exterior angles this small formula is used:-

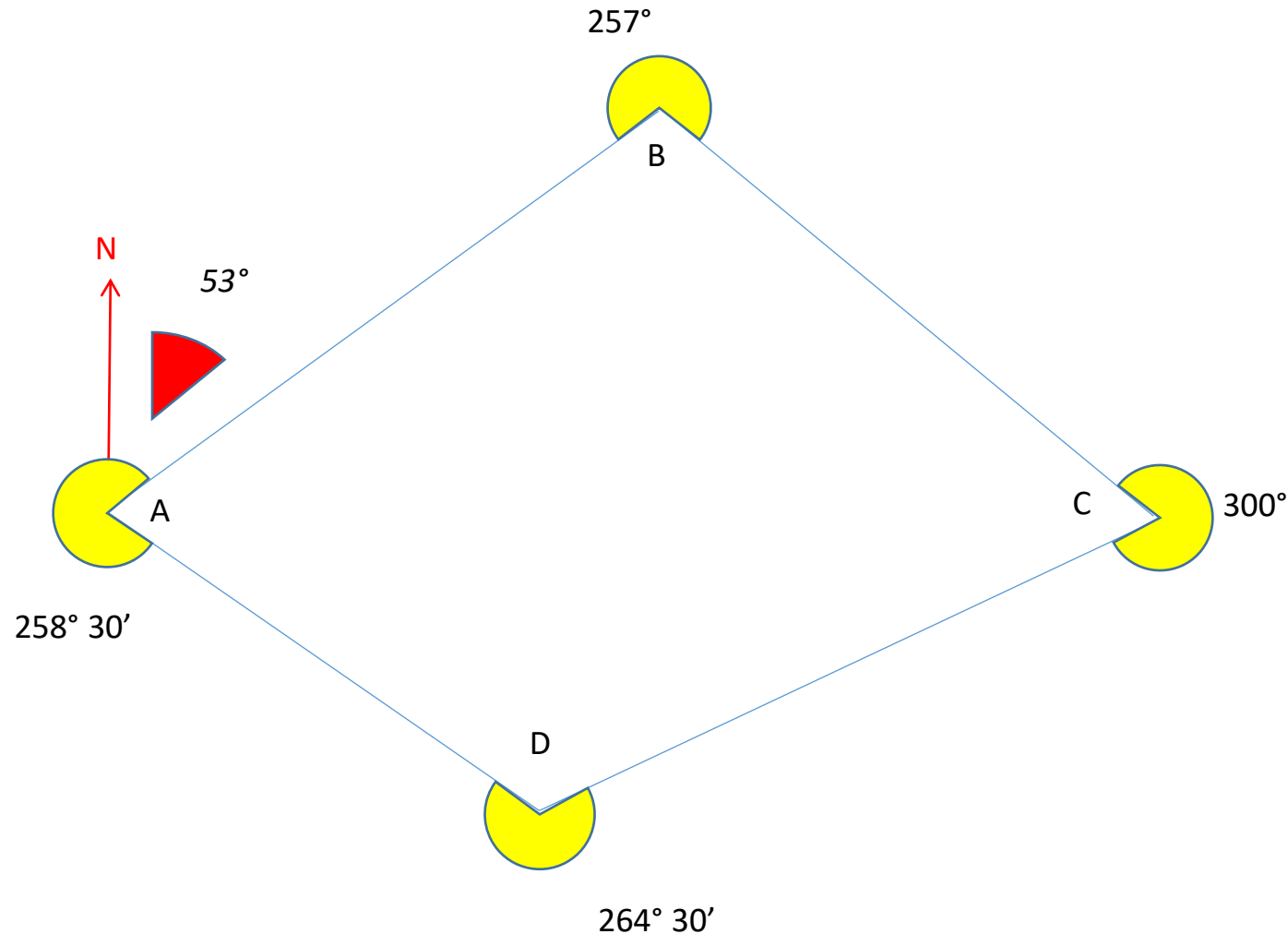
$(2n+4)90$ where 'n' is the sum of the number of sides.

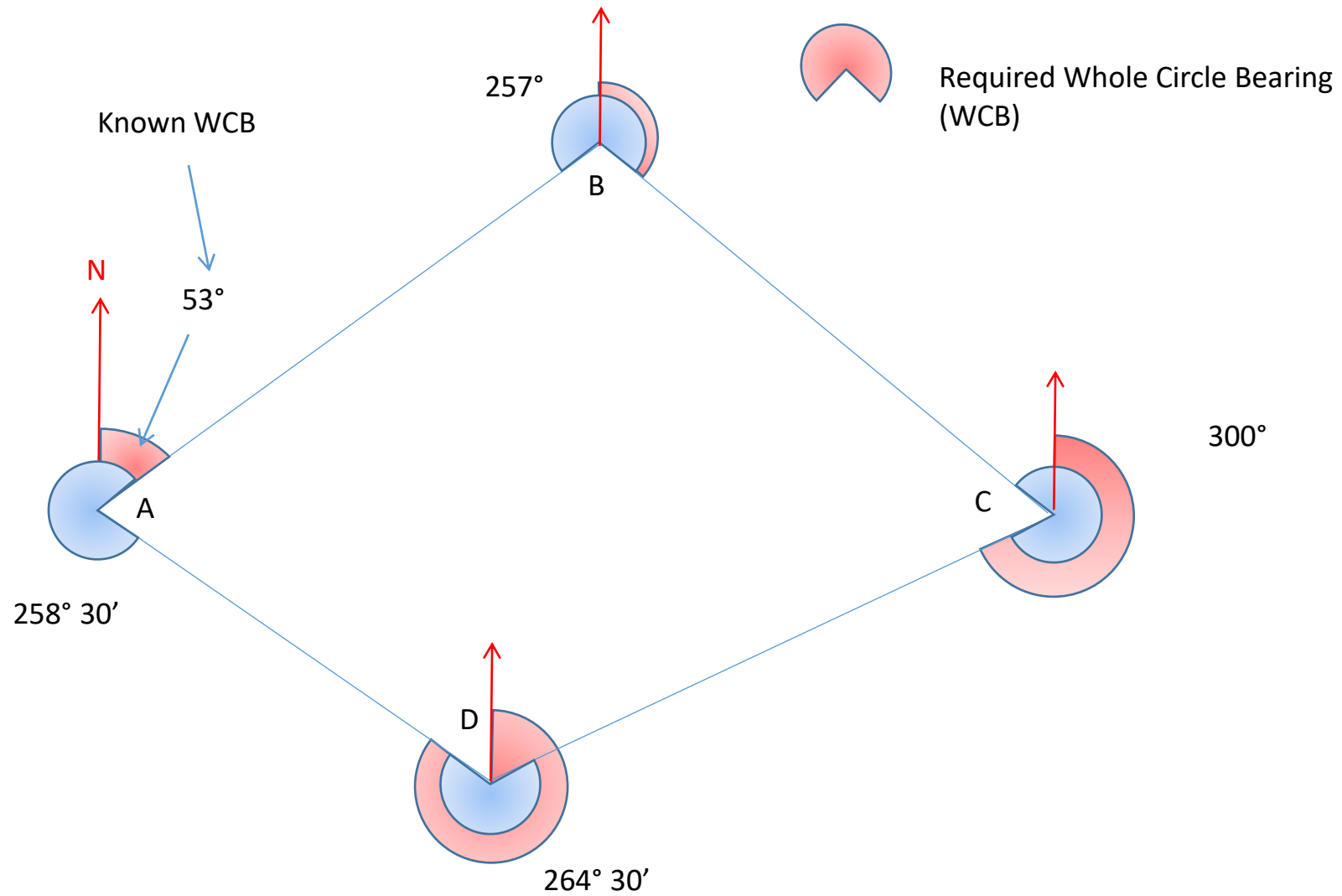
$$((2 \times 6) + 4) \times 90 = 1440$$



Measured Angles to Bearings in a Closed Traverse

ABCD is a closed traverse in which the external angles have been measured.

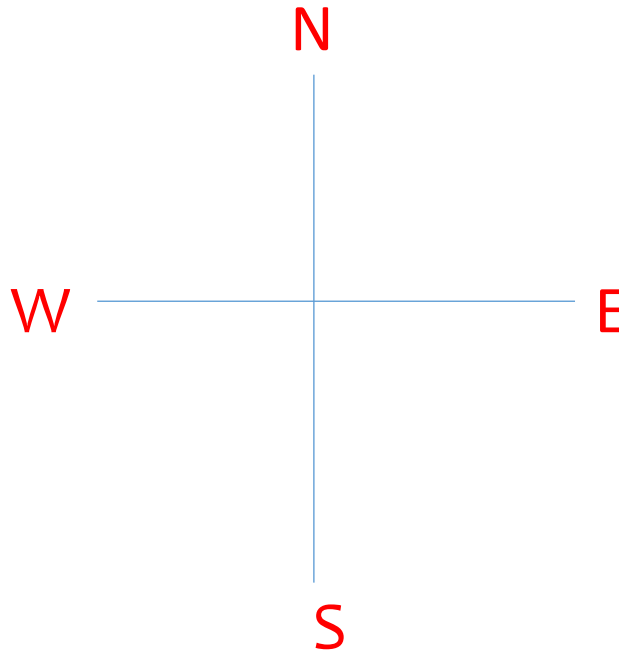


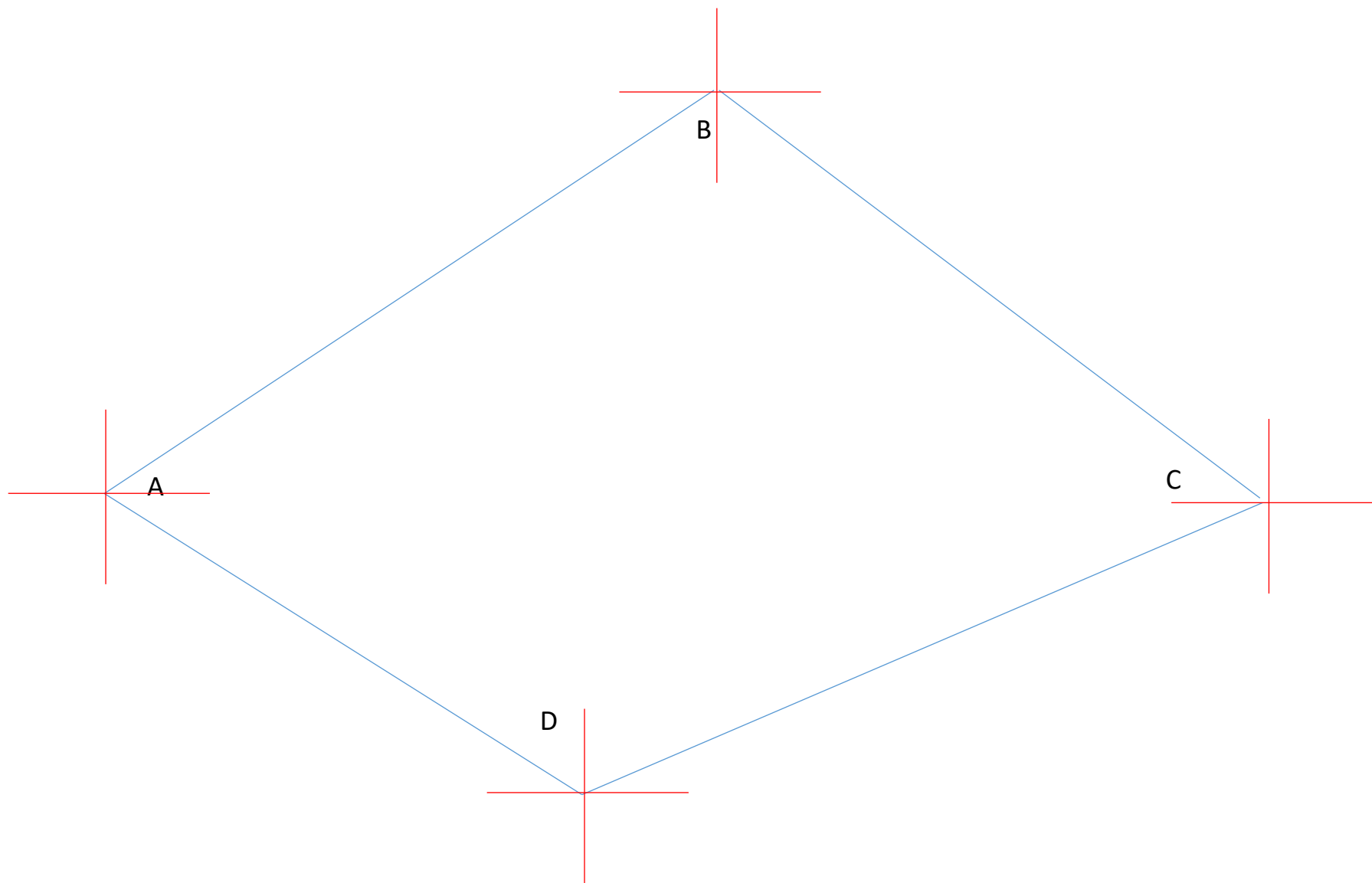


Since this is a closed traverse the accuracy of the traverse can be checked using the formula $(2n+4)90$ where 'n' is the number of sides of the traverse:-

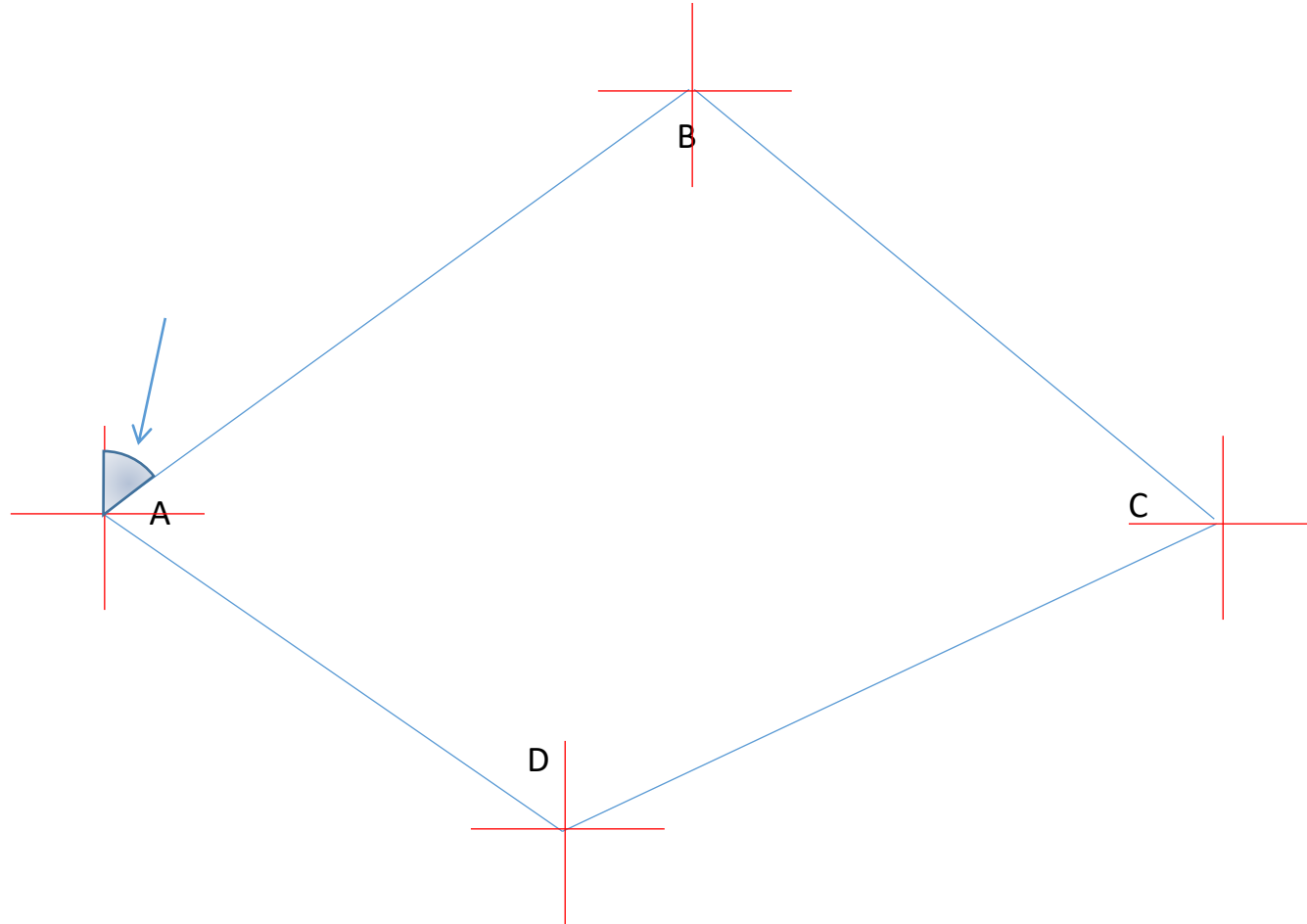
$$(8+4)90 = 1080^{\circ}$$

The line A-N (North) is known as the North Meridian and the WCB is the angle between the North Meridian and the survey line.



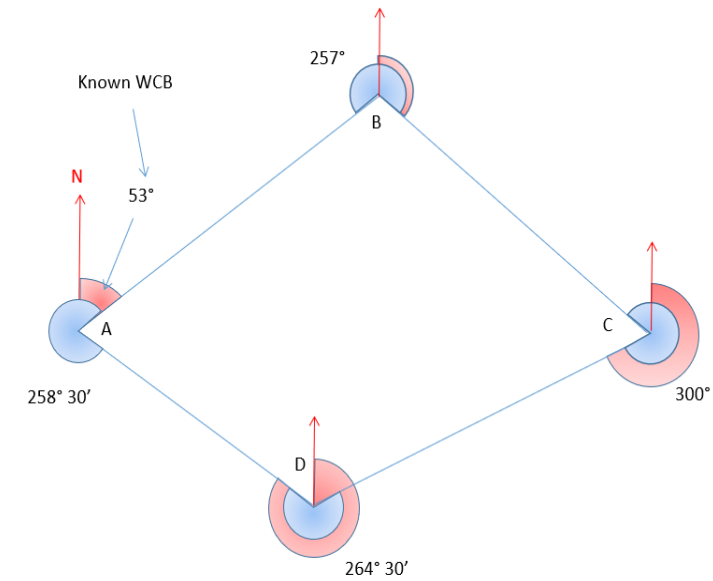
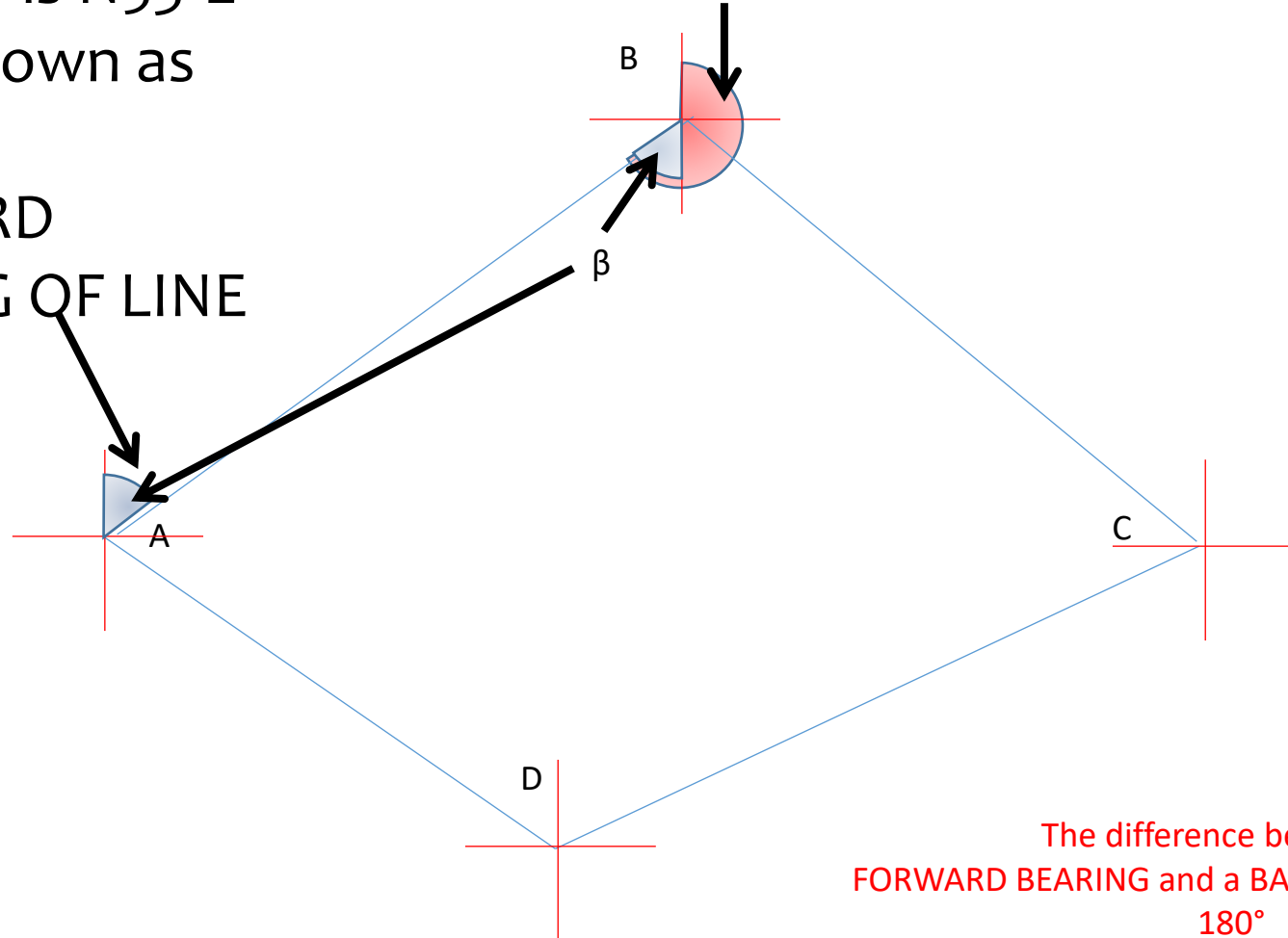


The WCB is 53°
The Reduced or Quadrant
Bearing is
 $N53^\circ E$



The WCB is $N53^{\circ}E$
and is known as
the
FORWARD
BEARING OF LINE
A-B

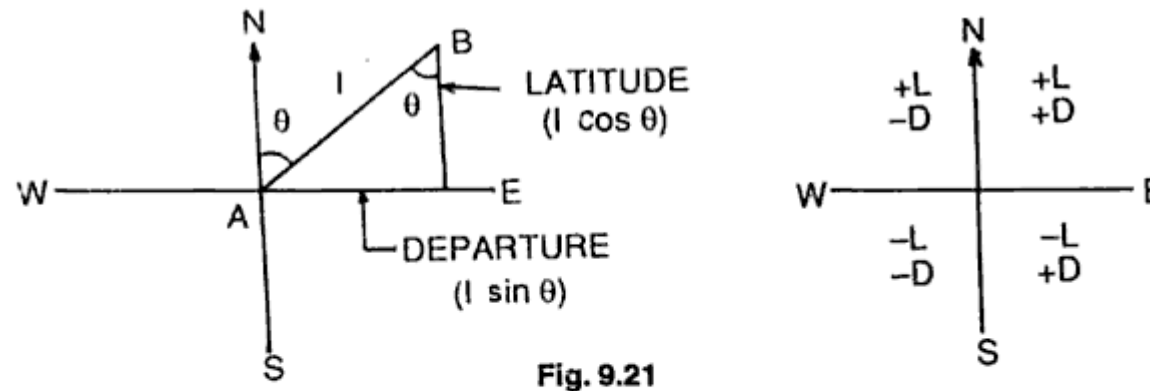
Back Bearing of Line B-A
 $180^{\circ} + \beta = ?$



The difference between a
FORWARD BEARING and a BACK BEARING is always
 180°

Computation of Latitude and Departure (Northings and Eastings)

- Latitude (Northing) of a line is the distances measured parallel to the north south of the North-South direction
- Departure (Easting) of the line is the distance measured parallel to the east-west direction



The latitude and departure of lines are also expressed in the following ways:

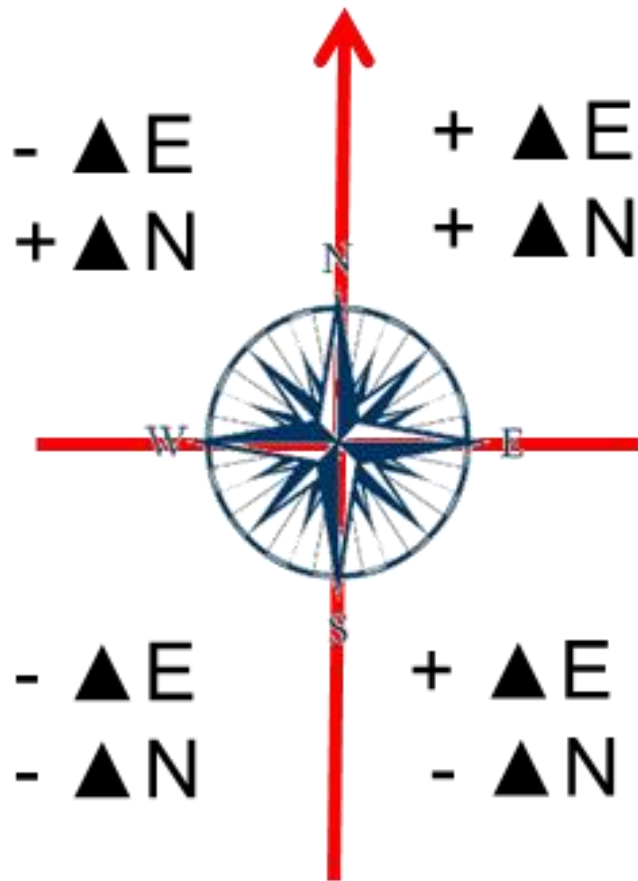
Northing = latitude towards north = $+L$

Southing = latitude towards south = $-L$

Easting = departure towards east = $+D$

Westing = departure towards west = $-D$

Computation of Latitude and Departure (Northings and Eastings)



Latitudes and Departures are now considered positive and negative Northings and Eastings

Class Exercise 1

A contractor requires new fencing to the one edge of a site boundary.

The two end points of the boundary 'A and B' have given Northing and Eastings positions.

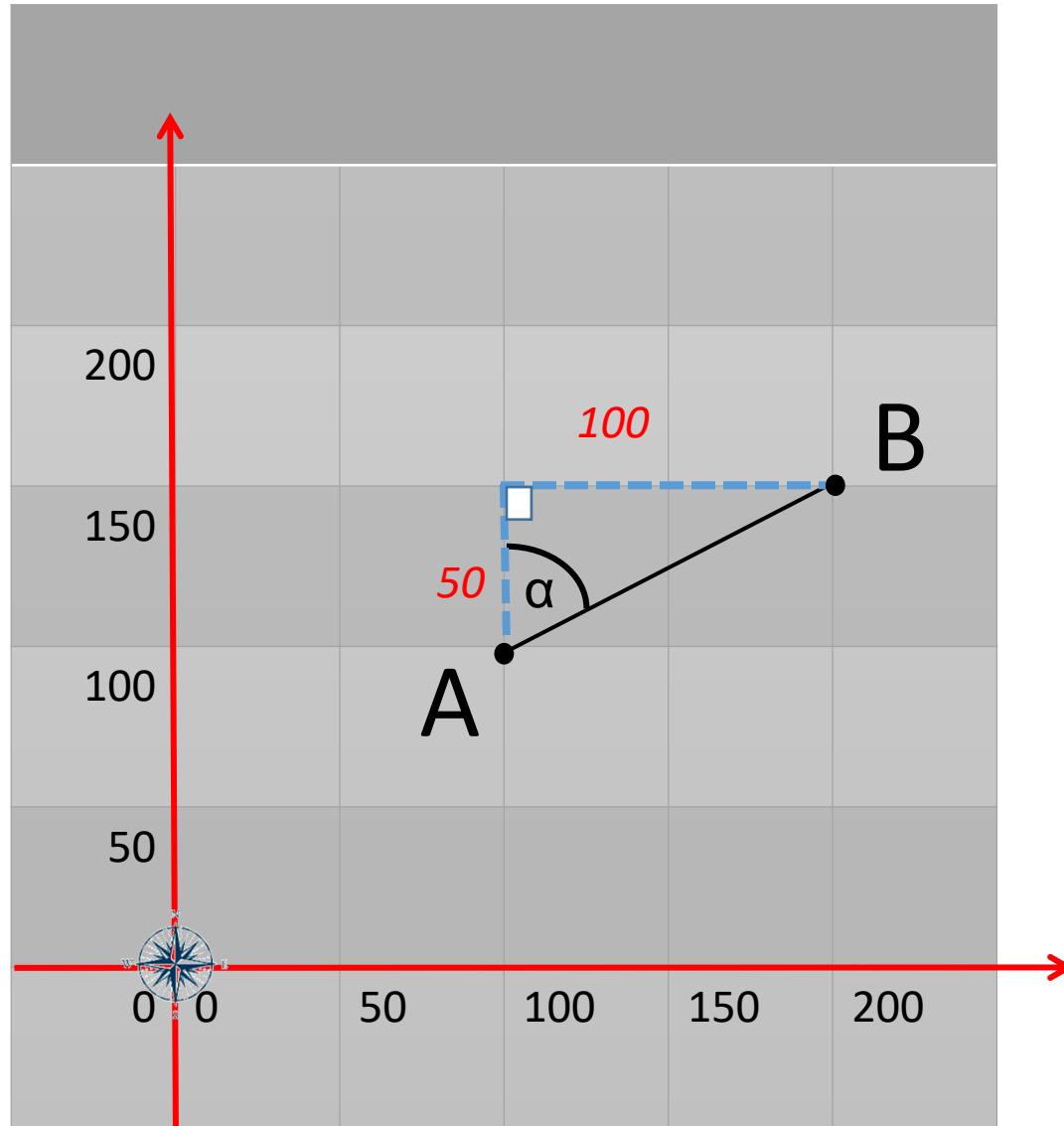
Calculate the distance between the two points to determine the length of fencing required, and calculate the Whole Circle Bearing from A – B to allow setting out of the fencing along the angle.

WCB must be expressed in Degrees, Minutes and Seconds.

Point A 100N 100E

Point B 150N 200E

Class Exercise 1



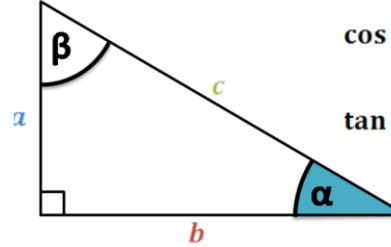
Trigonometry

SOH CAH TOA

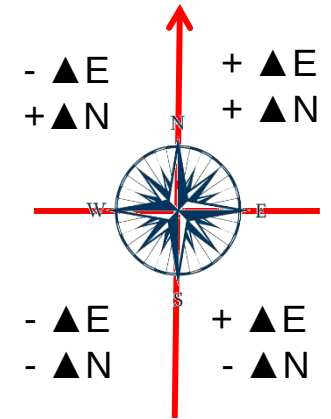
$$\sin \alpha = \frac{a}{c} \quad \begin{array}{l} \text{Opposite} \\ \text{Hypotenuse} \end{array}$$

$$\cos \alpha = \frac{b}{c} \quad \begin{array}{l} \text{Adjacent} \\ \text{Hypotenuse} \end{array}$$

$$\tan \alpha = \frac{a}{b} \quad \begin{array}{l} \text{Opposite} \\ \text{Adjacent} \end{array}$$



Pythagorean Theorem $a^2 + b^2 = c^2$



Distance AB

$$50^2 + 100^2 = AB^2$$

$$\sqrt{(50^2 + 100^2)} = AB$$

$$AB = 111.803\text{m}$$

Whole Circle Bearing α

$$\tan \alpha = \text{Opp/Adj}$$

$$\tan \alpha = 100/50$$

$$\alpha = (100/50)\tan^{-1}$$

$$\alpha = 63.43494882^\circ$$

$$\alpha = 63^\circ 26' 06''$$

Class Exercise 2

A new swale is required to cross a proposed wetland site. You have been asked to mark out the position of the swale from limited field data.

Point A 100E 100N

Point B 50E 75N

Point C is 75m away from Point A and an exterior angle BAC of 170deg was measured.

Calculate:

The distance between B and A

The Whole Circle Bearing from B – A

WCB from A – C

The Northings and Eastings of point C

WCB must be expressed in Degrees, Minutes and Seconds.

Next Week!!!

Levelling

