UNIT - I

Surveying :—

Surveying is the science and art of determining the relative positions of various points above, on (or) below the surface of the Earth.

The Relative positions are determined by measuring Horizantal distances, vertical distances (elevations), Horizantal Angles and vertical angles accurately using various surveying Instruments.

Objectives of surveying :—

1. To take measurments to determine the relative positions of the existing features on or near the ground.
2. To layout or to mark the positions of the proposed structure on the ground.
3. To determine areas, volumes and other related quantities.

History of surveying :—

* The Babylonians practised some type of surveying as early as 2500 BC.
* Surveying in some form was used in India & Egypt to divide the land for Taxation purposes even 1400 B.C.
* Surveying methods were used to control points in the Nile valley civilization.

Surveying is thus primarily divided into two types :

1. plane Surveying
2. Geodetic surveying.

Plane Surveying :—

It is the type of surveying in which the curvature of the earth is neglected and it is assumed to be flat surface. All distance and Horizantal Angles are assumed to be projected onto a Horizantal plane.

Plane surveying can safely be used when one is concerned with a small portions of the Earths surface and the areas involved are less than 250 Sq. Km. In plane surveying, the angles of polygons and Triangles are considered as plane angles.

Geodatic surveying :—

In this type of surveying in which the curvature of Earth is taken into consideration. and a very high standard of accuracy is maintained. the main objective of geodatic surveying is to determine the precise location of a system of widely spaced points on the surface of the Earth.

The Geodatic surveying are used to calculate the Spherical Δ^{le} using Spherical Trignometry.

Main differences between plane surveying & Geodatic surveying:

Plane Surveying	Geodatic Surveying
→ It is useful for relatively small areas	→ It is useful for only large areas
→ A curved line on the earth surface is considered as a straight line	→ The surface of the Earth is considered as curved.

Classification of Survey :—

Based on purpose :—

1. Engineering survey
2. Geological survey
3. Defence survey
4. Geographical survey
5. Mine survey
6. Route survey
7. Archeological survey.

Based on Place :—

1. Land survey
2. Topographical survey
3. Cadastral survey
4. City survey
5. Hydrological survey
6. Areal survey.

Engineering survey :—

In this survey, generally we are collecting dimensions, area and is it surface site is suitable for our Engineering work.

Geological survey :—

→ In this survey we determine soil strata and formation of Earth layers i.e Fault zone, Fold zone, unconfirm ties.

→ In this we also determine the Economical minerals & oils

Defence survey :—

It is very important and critical Application. They provide strategic infolmation that conducting in the situation of war and they provide area and Topographical areas of enemy area indicating important routes & also survey provides missile stations & Airport location.

Geographical survey :—

This is conducted to provide a graphical infolmation to prepare maps. The map is may be used to picturise land use efficiency sources and Intensity of Irrigation and surface drianage etc....

Mine survey :—

In this survey both surface and underground investigations are required.

Consists of Topographic survey of mine property and location of particular mine.

Route survey :—

These are undertaken to locate and setout adopted line on ground for a Highway (or) railway to obtain all necessary Features

A sequence of surveys followed

a) Reconnaisance survey
b) Priliminary survey
c) Control survey
d) Locational survey.

Archeological survey :

These are done on earth the relicks of antiquity, civilization kingdoms, towns, villages etc which are collapsed due to earth quakes & other natural calamities.

Land survey :-

In this survey we are identifying old boundary lines of land (or) area (or) city etc..

In this survey we need to determine present Boundary lines & to determine size & shape of land.

Topographical survey :

In this survey we need to determine the earth features like naturally available materials forest areas, river location, coastal region and other required data which is related that survey land

Cadastoal survey :

In this we are generally mark the city and town boundaries and we need to extend the area into villages which are near by town or city.

City survey :-

In this survey generally consists of localitions of various landmarks and clearly marked of road networking system and to establish the relative position to city centres.

Hydrological survey :-

In this survey we determine the water bodies of area which are nothing but surface and subsurface water bodies.

we also determine the depth of water table which also Indicated in map and also determining the location & area of extension also be determined.

Areal survey :-

This is also known as photographical survey

Generally in this survey we are Identifying the location, property and civilization and effective use of land is to be determined.

Plane Surveying	Geodatic Surveying
→ Standard of Accuracy is low as compared to Geodatic	→ Standard of Accuracy is high
→ The directions of plumb lines at various points are assumed to be parallel to one another.	→ The directions of plumb lines at various points are different. Mean sea level is 1er to the direction of gravity.

Classification Based on Instruments Used :—

1. Chain surveying :—

In this surveying the chain is used as a Instrument. Only linear measurments are taken with chain (or) Tape. It is the simplest Way. In this we can't get highly accurate values. Angular measurments are not taken.

2. Compass surveying :—

In compass surveying, the Horizantal Angles are also made in addition to linear measurments with the help of compass. ~~Compass~~ its and measurments with chain (or) Tape. As magnetic compass is not precise angle measuring instrument, this compass survey is not very Accurate. It is better when compared to chain surveying.

3. Levelling :—

Levelling Instrument is used for determination of relative elevations of various points in vertical plane. In this, the vertical line means the direction of gravity Indicated by a plumb bob. The Horizantal direction is direction perpendicular to the gravity.

Levelling is used for finding out the difference in elevations and for finding out the elevations w.r.t some reference plane. It is used for Topographical maps & for the control of elevations during construction.

4. Plane Table Survey :—

In plane table surveys a map is prepared in the field while viewing the terrain after determining the directions of various lines & taking the linear measurments with a chain (or) a Tape.

The accuracy of plane table is low. Its main advantage is that the measurments & plottings are done simultaneously in the field.

5. Theodolite Survey :—

Theodolite is a very precise Instrument for measuring Horizantal & vertical angles. It can be broadly classified into 2 types : (i) Traverse (ii) Triangulation

* In Traverse various stations form a polygon. The Horizantal angles are measured with a theodolite and linear measurments with Tape.

* In Triangulation, line forms a triangles. The base line is measured accurately & all other lines of lengths are from measured angles. It is used for extensive areas.

* theodolite surveys are quite Accurate.

6. Tacheometric Survey :—

Tacheometer is a special type of theodolite which is Fitted with a Stadia diaphragm having two Horizantal cross hairs in addition to central Horizantal Hair.

In this surveying Horizantal angles, Horizantal distances & Elevations are measured with a Tacheometer. It is not very accurate.

7. Photogrammetric Surveying :—

photogrammetry is the science of taking measurments with the help of photographs. Generally used for Topographic mapping of vast areas. These are extremely useful for obtaining topographical details of areas which are difficult to reach. Its taken from Aeroplane and taken from Ground Based Cameras.

8. EDM Surveys :—

Trilateration is a type of Triangulation in which all the three sides of Each triangle are measured accurately with EDM instruments. The angles are computed indirectly from the knowledge of Triangles. EDM instrumnents are modern and they gradually replacing the later for control Surveys.

Principles of surveying :—

Always work from the whole to part :—

The First principle of surveying is to work from the whole to the part. The Surveyor should first establish accurately a large main framework consisting of widely spaced control points. Between the large main Frame work subsidiary small frameworks can be Established by relatively less accurate. The Errors in small Frame works are thus localised and are not magnified and the accumulation of errors is controlled.

Always choose the method of survey that is most suitable for the purpose :—

The cost of surveying increases rapidly if we want highly accurature values because high accuracy requires very costly precise Instruments.

Always choose the method of survey so that the desired accuracy is acheived at a minimum cost.

Always make provisions of Adequate checks :—

There is always a possibility of making Errors while taking the measurment, Recording the observations, computing and plotting the results. The survey should be conducted so that the Errors don't pass undetected. There should be a suitable provision of checks. It can be done by suitable Method. checks may be of 2 types. :

1 We must check in field itself

2. We check the data which collected the field from Formulae & Techniques.

Always Record Field data carefully :—

All the measurments taken in a proper field book. The Field book must be in proper way with tables & diagrams. The record must be in standard form & clearly written. Always use 3H (or) 4H pencil so that a permanent impression is left on the paper. The Field record should be accurate, legible, clear, True & properly arranged

Errors in Surveying :—

There are mainly 2 types of Errors due to :

1. Shrinkage of a map
2. Measuring of a Scale

Shrinkage of a map :—

The drawing paper generally shrinks due to variation in the atmospheric temperature, Humidity etc... consequently; all the lines marked on the map shrink to some Extent. Thus the lengths measured from the map after shrinkage of map are not the correct distances.

If the map has shrunk, the actual distance would be more than the corresponding measured distance from the map.

The ratio of the shrunk length to the actual length is known as shrinkage ratio (or) shrinkage Factor.

It is always less than unity

Some Formulae :

$$\text{Shrunk scale} = \text{Original scale} * \text{Shrinkage Factor}$$

$$\text{Shrunk R.F} = \text{Original R.F} * \text{Shrinkage R.F}$$

$$\text{Corrected Distance} = \frac{\text{Measured Distance}}{\text{Shrinkage Factor}}$$

$$\text{Corrected Area} = \frac{\text{Measured Area}}{(\text{Shrinkage Factor})^2}$$

Related Example Problems :—

1. The plan of an Area has shrunk that the line originally 10 cm now measures 9.5 cm. If the original scale of plan was 1cm = 10m. (R.f = 1 : 1000) (i) Shrinkage Factor

(ii) Shrunk scale (iii) Correct distance corresponding to a measured distance of 98 m (iv) correct area corresponding to a measured area of $10,000\ m^2$.

Shrinkage factor $= \frac{9.5}{10} = 0.95$

Shrunk R.F $= \frac{1}{1000} \times 0.95 = \frac{1}{1053}$

Given shrunk scale, 1 cm = 10.53 m

Correct Distance $= \frac{98}{0.95} = 103.16m$

Correct Area $= \frac{10000}{(0.95)^2}$

$= 11080.33\ m^2$

2. A Rectangular plot in plan is 10cm x 30cm, draw to a scale of 1cm = 100m. If the same plot is redrawn on a toposheet to a scale of 1cm = 1Km, what would be its area on the toposheet? Determine also R.F in each case?

R.F. of Original plan $= \frac{1}{10,000} = \frac{1}{10^4}$

Actual Area in the Field $= (10 \times 30)(10^4)^2$

$= 3 \times 10^{10}\ cm^2$

R.F of the Toposheet map $= \frac{1}{100,000} = \frac{1}{10^5}$

Area of the Toposheet map $= \frac{3 \times 10^{10}}{(10^5)^2}$

$= 3\ cm^2$ $\left(\because \text{Area} = \frac{\text{Actual Area}}{(R.F)^2}\right)$

Errors due to Wrong Measuring Scale :—

If a wrong measuring scale is used to measure the length of a line already drawn on the plan, the measured length will not be correct.

$$\text{Corrected length} = \frac{\text{R.F of wrong scale}}{\text{R.F of corrected scale}} \times \text{Measured length}$$

As Area is product of two distances,

$$\text{Corrected Area} = \left[\frac{\text{R.F of wrong scale}}{\text{R.F of correct scale}}\right]^2 \times \text{measured area}$$

1. (a) A Surveyor measured the distance between two points marked on the plan ~~from~~ drawn to a scale of 1 cm = 1 m (R.F = 1:100) and found it to be 50 m. Later he detected that he used a wrong scale of 1cm = 50 cm. (R.F = 1:50) for measurment. Determine correct length.

(b) what would be the correct area if the measured area is 60 m^2

Al

$$\text{Correct length} = \frac{\text{R.F of wrong scale}}{\text{R.F of correct scale}} \times \text{measured length}$$

$$= \frac{\left(\frac{1}{50}\right)}{\left(\frac{1}{100}\right)} \times 50$$

$$= 100 \text{ m}$$

$$\text{Correct Area} = \left[\frac{\text{R.F of wrong scale}}{\text{R.F of correct scale}}\right]^2 \times \text{measured Area}$$

$$= \left[\frac{\frac{1}{50}}{\frac{1}{100}}\right]^2 \times 60$$

$$= 240 \text{ m}^2$$

Errors classified on source :

1. Instrumental Error
2. Personal Error
3. Natural Error

Instrumental Error :—

Generally these Errors are occured due to defect in Instrument which are controlled by clear observations & Necesary checks.

Personal Error :—

Which are done by carelessness of surveyor (or) Improper to take measurments.

Natural Error :—

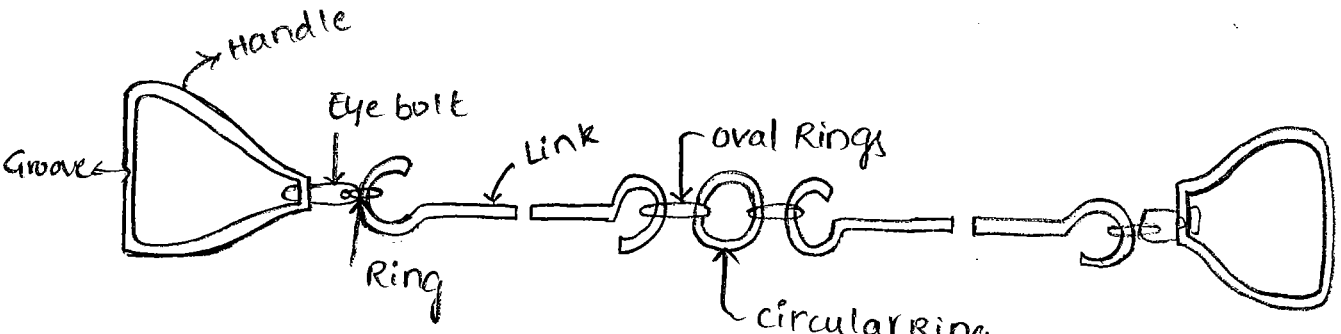
Due to the climatic conditions these Errors are occured.

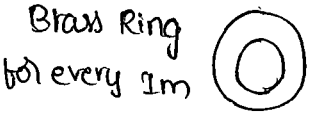
* the terms large scale & small scale are not well defined. The difference between plan & map are rather arbitary.

* When a plan becomes a map the large scale representation of small areas in engineering surveys are called plans Where as small scale represents a large areas are called Map

Overview of chain surveying :—

* Chain surveying is a branch of surveying used to measure the linear distances with a chain (or) Tape.
* This surveying is not very accurate.
* The links in a chain are prepared by Galvanised mild steel wire of 4mm diameter.
* These links consists of three rings there are two oval shape & central ring is circular.





There are 2 types of chains :

1. Metric chain
2. Non Metric chain

Metric chain :—

* Generally metric chain is available in 20 m & 30 m
* 20 m chain has 100 links, Each link having a length of 20 cm
* 30 m chain has 150 links, each link having a length of 20 cm
* Chain provided with Talleys
* In 20 m chain the talley appears at Every 2 m
* In 30 m chain the talley appears at every 5 m
* A Brass ring also provided for every 1 m

Non Metric chain :—

* Generally Gunter chain, Engineers chains, Revenue chains comes under this
* The length measured in this type of chain is in Feets
* Gunters chains having a length of 66 feet and it consists of 100 links, each link having 0.66 Feet length
* Engineers chain consists of 100 links and each link in 1 feet
* Length of Engineers chain is 100 feet* It is also known as Surveyors chain.

Overview of plane Table Surveying :—

Generally, Size of the board is 0.75m x 0.6m

Thickness of the board is 20 mm

~~Depending~~ upon

→ we use this plane table method to determine the area (or) plotting in field itself. & It is the main Feature

Depending upon the methods of Fixing the boards, levelling of table & rotating in Horizantal plane.

1. Simple plane Table
2. Johnson plane Table
3. Coast Survey plane Table

* Generally we use simple plane Table

Alidade :—

It is a Straight Edge ruler having some sighting device.

It is of two types :

Plain Alidade → 450 mm long

Telescopic Alidade → 380 mm x 65 mm

Principle of plane Table surveying :—

→ The plane table is levelled and centred over the ground station O.

→ the point 'o' representing the station occupied by the plane is marked on the drawing sheet with the help of plumbing fork.

→ The Alidade is kept on the drawing sheet with zero mark of Fiducial edge set on point 'o'.

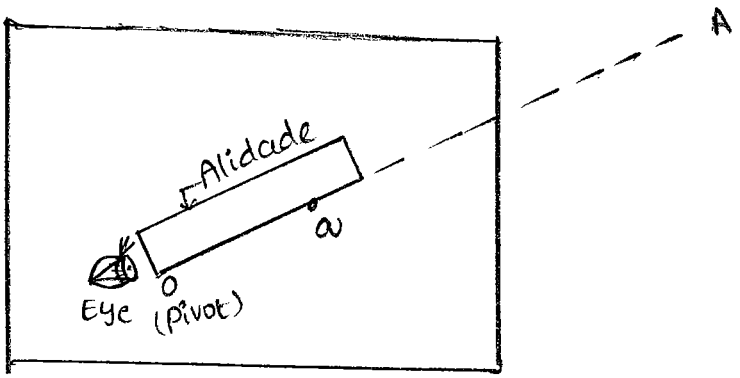
→ The point 'o' is called pivotin of Alidade.

→ With the Alidade pivoted on point 'o'. the Alidade is rotated so that straight line of sight passes through Object 'A'.

→ The line is drawn along on the paper along Fudicial Edge of Alidade.

→ The line represents the direction of station 'o' to 'A'. The distance measured in plane with Tape (or) chain from 'o' to 'A'

→ the measured distance is plotted to scale as 'o' along the line already drawn on the paper



FO Basic Defination → Refer class Notes →

Advantages of plane Table survey :—

* plane table survey is quite suitable fo plotting small scale maps directly in the Field
* Errors in measurments and plotting can be easily detected in the field by taking suitable check lines.
* The plane table can be used even in magnetically disturbed area where the compass survey is not possible.
* It is less costly than most other types
* As instruments are simple, not much skill is required.

Disadvantages of plane Table Survey :—

* It is not possible in wet climates
* It is not accurate
* As no field data are taken it becomes difficult to plot
* The time spent in the field is much more as compared to other types
* It can be used in relatively open country where the stations can be easily sighted

Centring :—

This is the process of setting of the plane table such that plotted point 'o' corresponding to ground station Zero is exactly over the station. The plumbing Fork is used for checking the centring The centring is completed when the pointed of the Fork is at the plotted point 'o' & plumb bob is just above ground station.

Orientation :—

This is the process of aligning the plane table by rotating it in the Horizantal plane such that all plotted lines are parallel to corresponding lines on the ground. This is done by using a compass.

Back sight :—

It is a sight taken from a plane table station to another station whose position has already been plotted on a drawing pad. For taking a back sight to station when the plane table is centred over a station 'A', the alidate is placed along the plotted line $\overline{AB}$. The plane table is rotated until the station is bisecting.

Fore sight :—

It is a sight take from a plane table station to another station whose position hadn't already been plotted on a drawing pad. It is taken to locate the position of Foward station.

Radiation :—

This is a method of locating the point by drawing a Radial line from the plane table station to the point. For locating a point by radiation to plane table is set up & Oriented

then a ray is drawn in the direction of that point using the Alidate as Explain in Theory. A length equal to distance of that point to a suitable scale is correct to locate the point.

Intersection :—

This is a method of locating a point by the intersection of 2 rays drawn from 2 different stations. The method of Intersection is suitable when it is difficult to measure the radial distance of the unknown point due to some obstruction & the radiation method cannot be used.

Resection :—

This is a method of locating the station occupied by the plane table when the position of that station hadn't been previously plotted from other stations.

It is done by sighting to any 2 points whose positions had been previously plotted in a 2 point problem. It is also done by sighting on any 3 points whose positions had been previously plotted in 3 point problem.

"2. Compass Surveying"

* Compass Surveying is a branch of Surveying in which directions of survey lines are determined with a compass and the lengths of the lines are measured with a tape (or) a chain. "In Surveying, a traverse consists of a series of straight lines connected together to form an open or closed polygon". Fig. 8.1 shows a closed loop traverse. The points such as A, B, C, D, E. "Defining the ends of the traverse lines are called traverse station or traverse points."

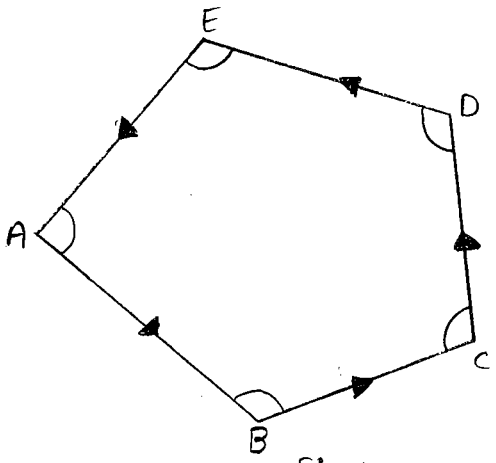


Fig. 1

* Methods of Traversing :-

The methods of traversing can be classified as under:

1. Chain traverse :- In a chain traverse, the directions of the traverse lines are fixed by taking suitable ties near the traverse stations. A chain traverse is not very accurate and is rarely used in practice.

2. Compass Traverse :- In a compass traverse, the directions of the traverse lines are determined with a magnetic compass. The accuracy of a compass traverse is also limited.

3. plane Table Traverse :- A plane table can be used for plotting a traverse directly in the field. The plane table traverse is also not accurate.

4. Stadia Traverse:- In a Stadia traverse, the length of the traverse lines, the angle between the traverse lines and the elevation of traverse stations are measured with a tacheometer. The method is used where elevations are also to be determined in addition to the horizontal control.

5. Theodolite Traverse :- In a theodolite traverse, the angles are measured with a theodolite. This is the most accurated method of traversing, and is generally used for providing a horizontal control.

* Difference between traverse Surveying and chain Surveying.

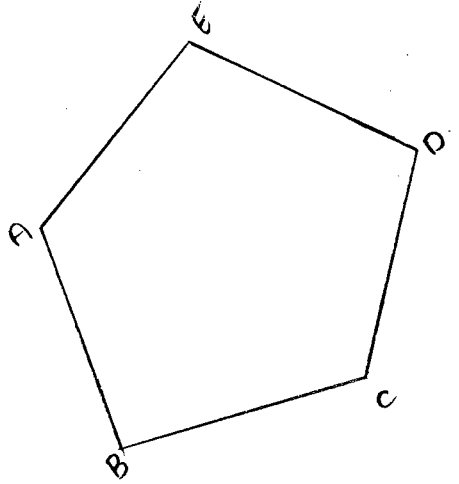
	Traverse Surveying	Chain Surveying.
1.	The framework consists of a series of connected lines forming an opening or closed polygon.	The framework consists of a system of triangles.
2.	In traverse Surveying, the directions of the lines are measured.	Chain Surveying requires only linear measurements.
3.	The traverse Surveying is generally done by trained personnels.	Relatively easier and can be done by less qualified persons.
4.	Check lines are generally not taken in traverse surveying.	check lines are required in chain Surveying.

* Types of Traverse :-

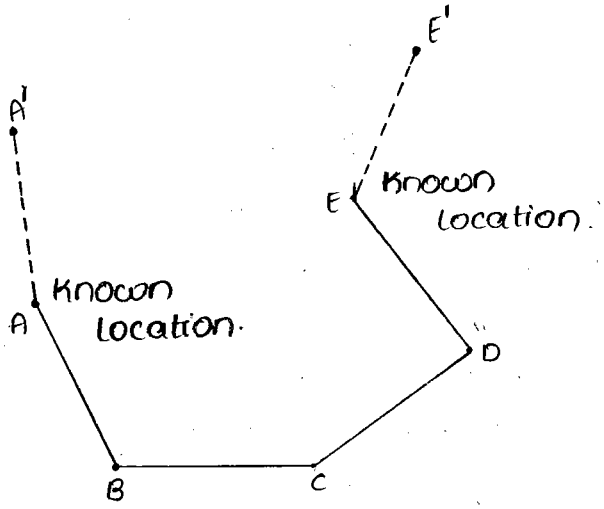
The traverse may be classified into two types.

1. Closed traverse.
2. Open traverse.

* Closed traverse:- A closed traverse starts from one traverse station and closed either on the same station (or) another traverse station whose location is already known. Fig(2)(a), the traverse starts from the station A and closes on the same station. It forms a closed polygon. This types of closed traverse is known as a loop traverse. In fig(b), the traverse starts from the station A whose location is already known (or) established, and closed at the station E whose location is also known (or) established. This type of closed traverse is called a link traverse or connecting traverse. The location of the end point A and E are already established with respect to reference point A' & E', respectively, shown in Fig (b).



(a) loop traverse.



(b) Link traverse.

* Open traverse:- An open traverse starts from one station and close at another station whose location is neither known nor established. It consist of a series of connected lines. fig(a) An open traverse is generally run for surveying of a long strip of the area for a road, railway line, canal etc.... A Open traverse cannot be properly checked and adjusted.

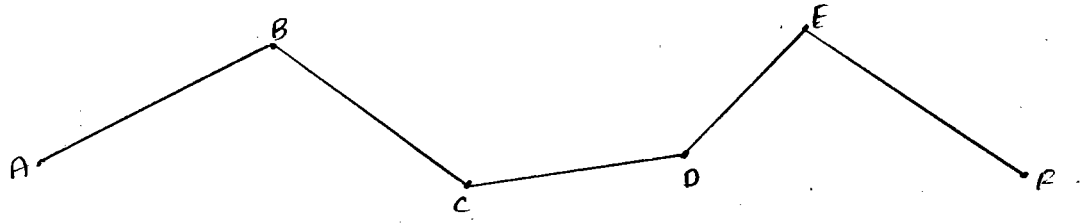
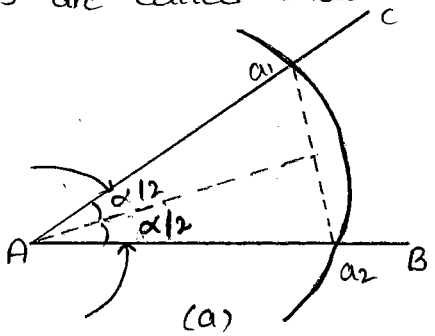


Fig: a.

* Chain angles :- In chain traversing, the angles can be computed from the linear measurements. The angles computed from the linear measurements are called chain angles.



(a)

* Types of Meridians :—

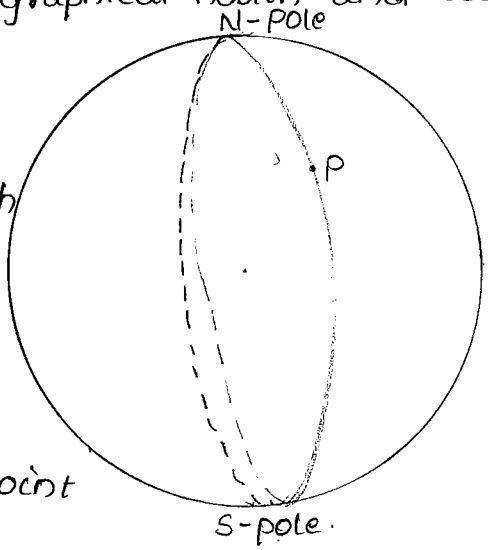
The direction of a line is defined by the horizontal angle which the line makes with a reference line. Thus the direction is the angular relationship of one line to another line. Generally, directions are measured clockwise from the reference line. The fixed line of reference is called a "meridian."

There are 4 types of meridians used in Surveying.

1. True meridian
2. Magnetic meridian.
3. Grid meridian.
4. Arbitrary meridian.

* True meridian :—

→ True meridian at a point 'p' is the great circle passing through the point 'p' and the graphical north and South poles of the earth.



→ True meridian may also be considered a plane passing through the point p on the Surface of the earth and containing the earth's axis of rotation.

→ The geographical poles are the point of intersection of the earth's axis and the Surface of the earth.

→ The geographical poles are known as true pole.

→ These are generally assumed to be parallel to one another.

* Magnetic Meridian:-

→ Magnetic meridian at a point is the direction indicated by a freely suspended, balanced magnetic needle at that point.

→ The magnetic needle should not be affected by magnetic forces other than that of the earth for obtaining the correct direction of the magnetic meridian.

→ The magnetic poles are not fixed in position on the earth.

* Grid meridian :-

→ For Survey of a state, the true meridian of a central place is Sometimes taken as a reference meridian for that whole state. Such a reference meridian is called the Grid meridian.

→ The meridians of all other places in that state are assumed to the parallel to the grid meridian.

* Arbitrary meridian :-

→ Arbitrary meridian is the meridian which is taken in any convenient, arbitrary direction. Any reference line may be taken as arbitrary meridian.

→ The arbitrary meridian is used to determine the relative directions of various lines in a Small traverse.

* Types of Bearings:-

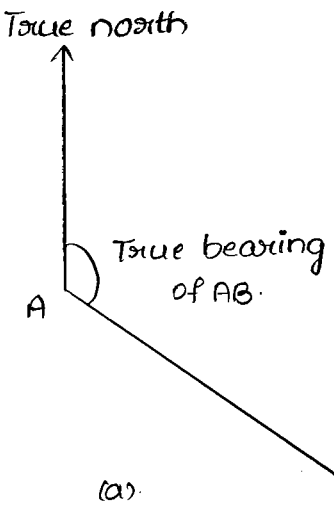
The bearing of a line is the horizontal angle which it makes with a reference line (meridian).

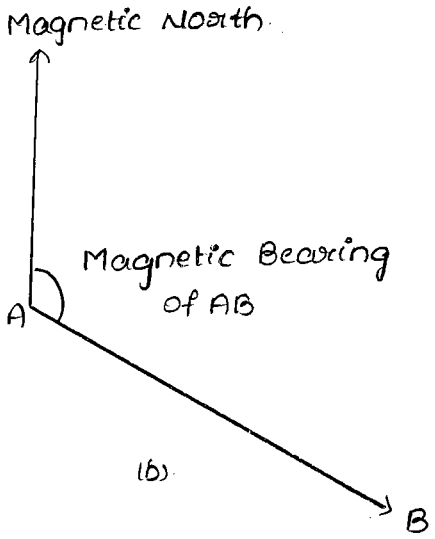
Depending upon the meridian, There are four types of bearings,

1. True Bearing:- The true bearing of a line is the horizontal angle between the true meridian and the line.

→ "The true bearing of a line is also known as the "Azimuth."

→ The true bearing of a line can be determined by astronomical Observations.





2. Magnetic Bearing:- The magnetic bearing of a line is the horizontal angle which the line makes with the magnetic north.

→ The magnetic bearings are used for small, unimportant Surveys.

→ The magnetic bearings are determined with a prismatic compass as the whole circle bearing and with a surveyor's compass as the quadrantal bearing.

3. Grid Bearing:- The grid bearing of a line is the horizontal angle which the line makes with the grid meridian.

4. Arbitrary Bearing:- The arbitrary bearing of a line is the horizontal angle which the line makes with the arbitrary meridian.

* Designation of Bearings:-

The bearings of a line can be designated in the following systems.

1. Whole circle Bearing System.
2. Quadrantal Bearing System.

* Whole circle Bearing (W.C.B) System :- In this system, the bearing of a line is measured clockwise from the north end of the reference meridian. Thus the whole circle bearing (W.C.B) of a line is the horizontal angle which the line makes with the north end of the reference meridian. The direction of the line is indicated by an arrow.

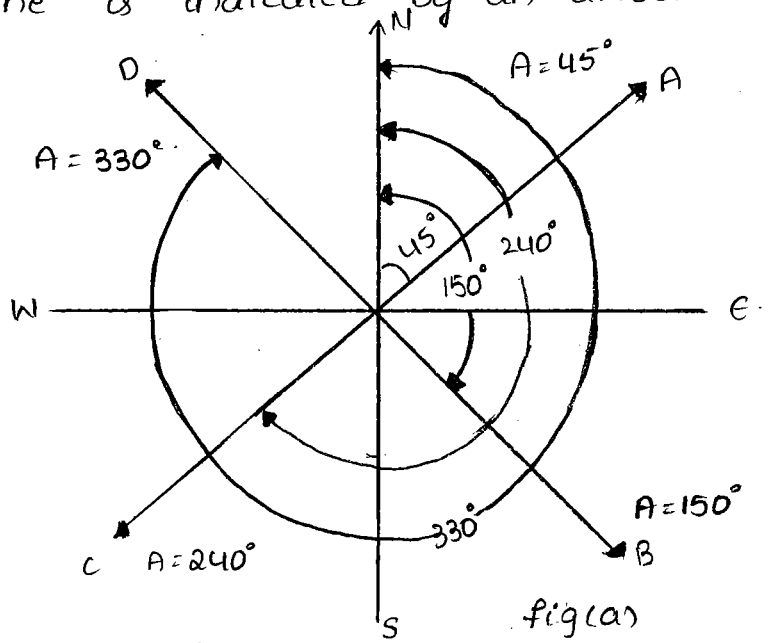
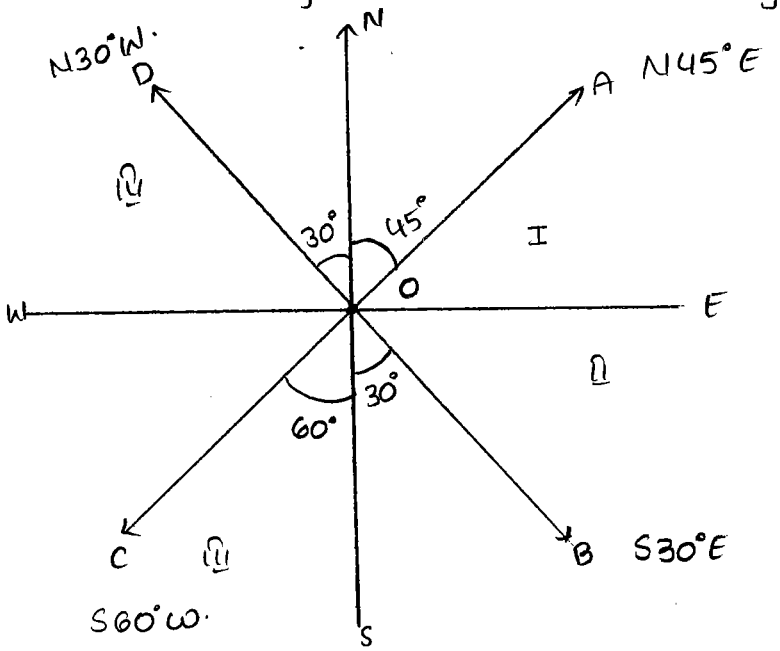


fig (a)

* Quadrantal Bearing (Q.B) System :-

→ The quadrantal bearing (Q.B) of a line is the acute angle which the line makes with the meridian.

→ The quadrantal bearing of a line cannot be greater than 90°.



Quadrantal Bearing

fig (a).

For example, in fig (a), The quadrantal bearings of the lines OA, OB, OC and OD are as under.

line OA, N 45° E

line OB, S 30° E

line OC, S 60° W

line OD, N 30° W.

The quadrantal bearing of a line is measured with a Surveyor's compass.

* Conversion of Q.B to W.C.B.

Line	Quadrant	Quadrantal Bearing	Whole circle Bearing (W.C.B)
OA	I	$N\theta_1 E$	θ_1
OB.	II	$S\theta_2 E$	$180 - \theta_2$
OC	III	$S\theta_3 W$	$180 + \theta_3$
OD	IV	$N\theta_4 W$.	$360 - \theta_4$.

* Conversion of W.C.B to Q.B :-

Line	Quadrant	Quadrantal Bearing	Whole circle Bearing (W.C.B)
OA	I	$\theta = 0°$ to $90°$	$N\theta E$
OB	II	$\theta = 90°$ to $180°$	$S(180° - \theta)E$
OC	III	$\theta = 180°$ to $270°$	$S(\theta - 180°)W$
OD	IV	$\theta = 270°$ to $360°$.	$N(360° - \theta)W$.

→ N0° = Due north

→ N90°E = S90°E = Due East.

→ N90°W = S90°W = Due West.

→ S0° = Due South.

Reduced Bearing (R.B):- The reduced bearing of a line is the angle less than 90° which has the same numerically value of sine as that of the whole circle bearing ~~of a line~~ is 150°,

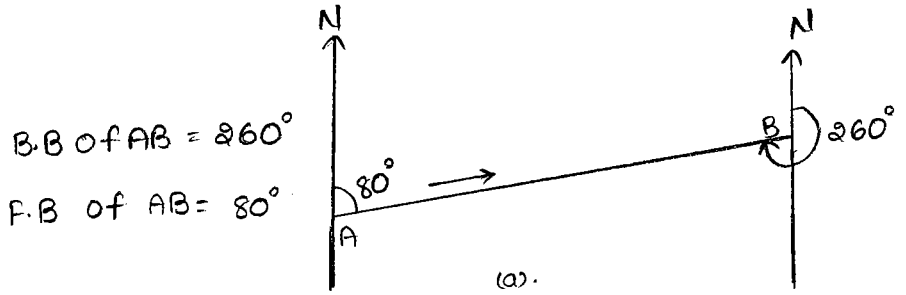
For example, If the whole circle bearing of the line is 150°, Its reduced bearing is 30°,

In the above example, the quadrantal bearing of the line is S 30° E. Sometimes, the quadrantal bearing is also called the reduced bearing.

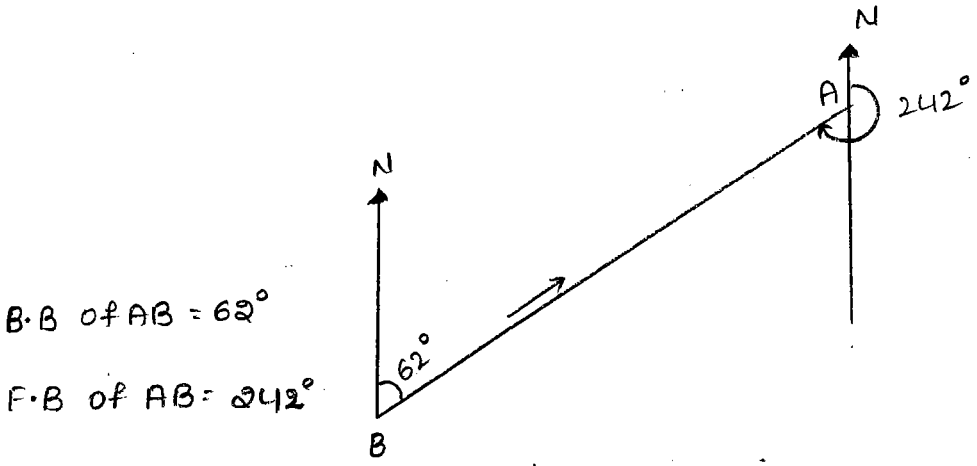
* **Fore bearing and Back bearing :-**

→ "The bearing of a line in the direction of the progress of survey is called the fore bearing. (F.B)".

→ "The bearing of the line in the direction opposite to the direction of the progress of survey is called the Back bearing (B.B)."



(a).



(b).

* Figure (1) (a) Shows a traverse ABCDE. As the direction of the progress of Survey is from A to B, the fore bearing of the line AB is 148°. Fig 1(b) Shows a traverse AEDCB. As the direction of the progress of survey is from B to A, the back bearing of the line BA is 148°. The reader should note the order in which the alphabets A and B appear. As is evident from Fig. 1 (a) and Fig. 1 (b), the back bearing of BA is equal to the fore bearing of AB. Likewise, it can be shown that the fore bearing of BA is equal to the back bearing of AB.

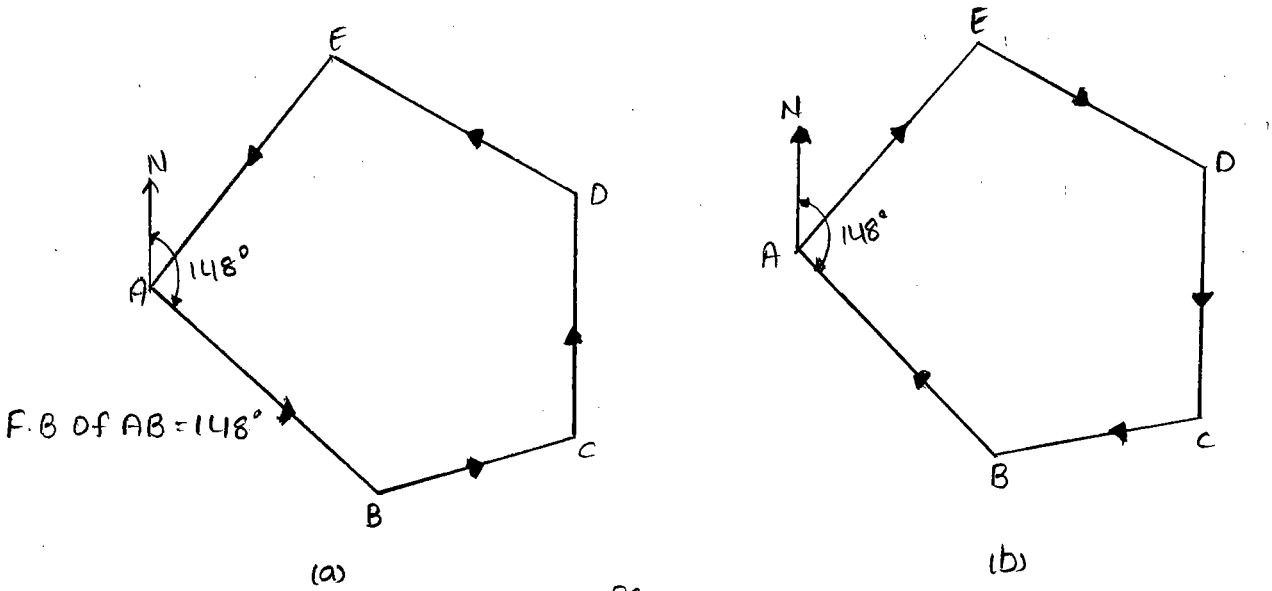


Fig. 1

* Determination of Back Bearing from Fore Bearing :-

*The back bearing of a line may be determined if its fore bearing is given and vice versa.

* If the fore bearing of a line is given as the whole circle bearing,

Back bearing = Fore bearing + 180°, if F.B < 180° and

Back bearing = Fore bearing - 180°, if F.B > 180°.

* If the fore bearing of a line is given as the quadrantal bearing,

Back bearing = numerically equal to Fore bearing. and change N for S, and vice-Versa and E for W, and vice-Versa.

* Calculations of included angles from bearings:-

* Whole circle bearings :-

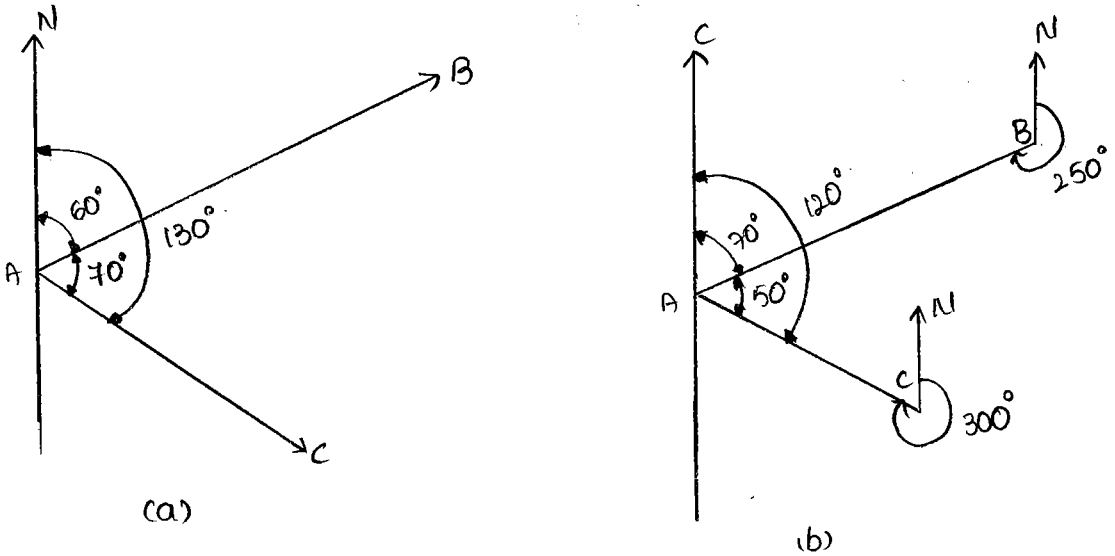
a) If the whole circle bearings of the two lines are measured from a common point, the included angle between the lines is equal to the difference in the two bearings,

Thus

Included angle, $\alpha = \theta_2 - \theta_1$.

where θ_1 and θ_2 are the two bearings.

Fig 2.(a) The included angle CAB between the lines AC and AB is $130^\circ - 60^\circ = 70^\circ$.



For example, in Fig. 2(b), If the bearing of the line BA is given as 250° and the bearing of the line CA is given as 300°,

Bearing of the line AB = 250° − 180° = 70°

Bearing of the line AC = 300° − 180° = 120°

Included angle BAC = 120° − 70° = 50°.

* Quadrantal bearings:—

If the quadrantal bearings of the two lines are measured from their common point, the following rules are applied for the determination of the included angle.

For example, in fig 3.(a), angle CAB = 80° − 50° = 30°.

→ The included angle is equal to 180° minus the sum of the two bearings

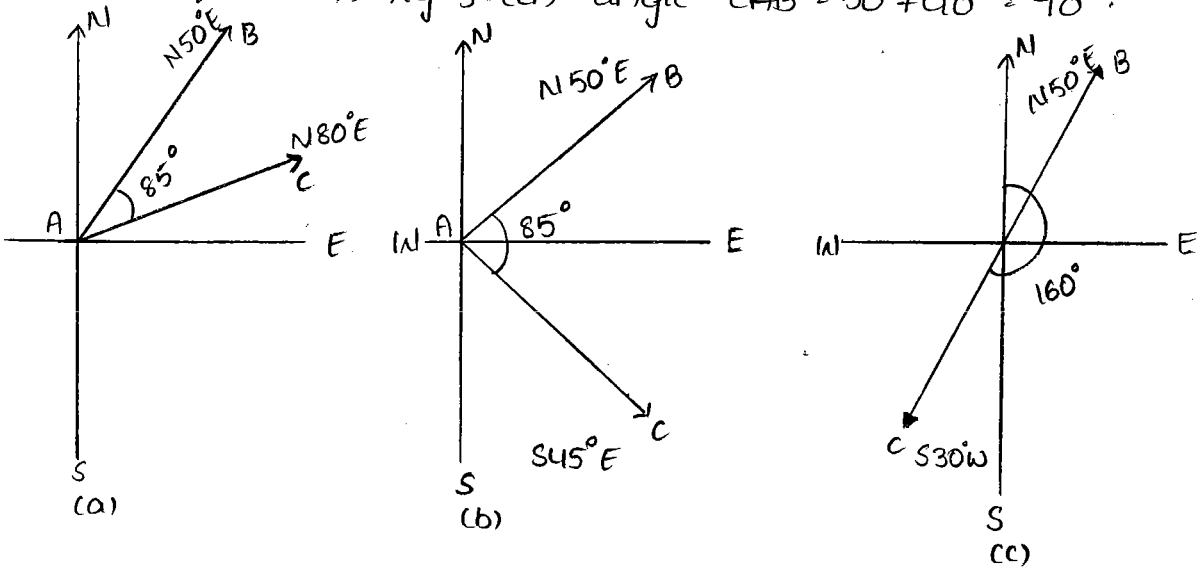
For example, in fig 3.(b), angle CAB = 180° − (50° + 45°) = 85°.

→ The included angle is equal to 180° minus the difference of the two bearings.

For example, in fig 3.(c) angle CAB = 180° − (50° − 30°) = 160°.

→ The included angle is equal to the sum of the two bearings.

For example, in fig 3.(d) angle CAB = 50° + 40° = 90°.



* prismatic compass :-

→ The prismatic compass is a magnetic compass in which there is a prism for taking observations

→ The prismatic compass is generally smaller in size than a Surveyor's compass.

→ The prismatic compass is used for the determination of the whole circle bearings (W.C.B) of the lines.

→ The box is made of brass or a non-metallic material.

* Temporary Adjustments of a prismatic compass :-

* The temporary adjustments of a prismatic compass are similar to those of a surveyor's compass. As already mentioned, the temporary adjustments are done at each station where the compass is set-up.

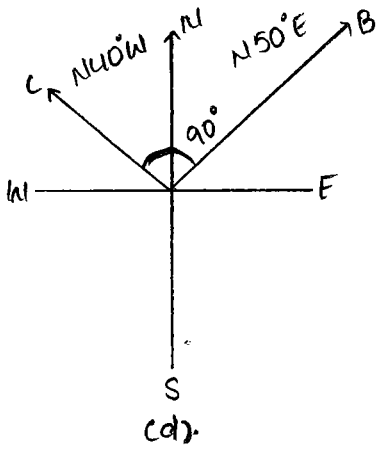
1. Centring :- The centring of the compass is done so that its centre lies exactly over the station peg. The centring of the prismatic compass is generally done by moving the legs of the tripod so that the plumb bob is exactly over the station peg.

2. Levelling :- Levelling is done to make the compass exactly horizontal.

→ The prismatic compass is usually levelled by means of the ball-and socket arrangement provided on the tripod.

→ The aluminium ring swing freely, when the compass is levelled.

3. Focussing :- The prism is moved up or down in its slide till the graduations on the aluminium ring are seen to be clear, sharp and in perfect focus. The position of the prism will depend upon the vision of the observer.



(d).

* Temporary Adjustments of a Surveyor's Compass:-

There are two types of adjustments.

1. Temporary adjustments:- Temporary adjustments are also called Station adjustments. These adjustments are made at every set-up of the instruments.

2. permanent adjustments:- permanent adjustments once made generally last for a long time, and these need not be repeated for a considerable time. The permanent adjustments are required to ensures that the various components of the instrument are in the proper generally done in a laboratory or a workshop by skilled persons.

"Temporary Adjustments of a Surveyor's Compass:-"

The following temporary adjustments are done after fixing the Surveyor's compass to the tripod.

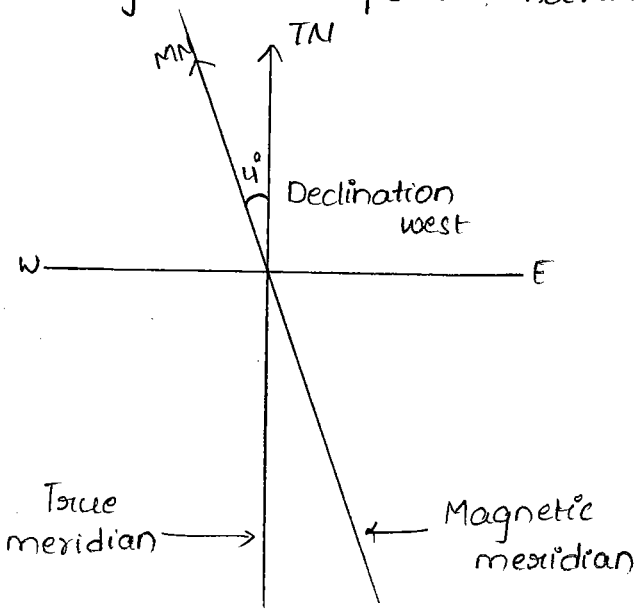
* Centring:- Centring is the process of setting up the instrument exactly over the station peg. The centering is done by moving the legs of the tripod.

* Levelling:- Levelling is required so that the graduated ring is horizontal and it swings freely on the pivot. Both the ends of the needle should be in level with the graduated ring.

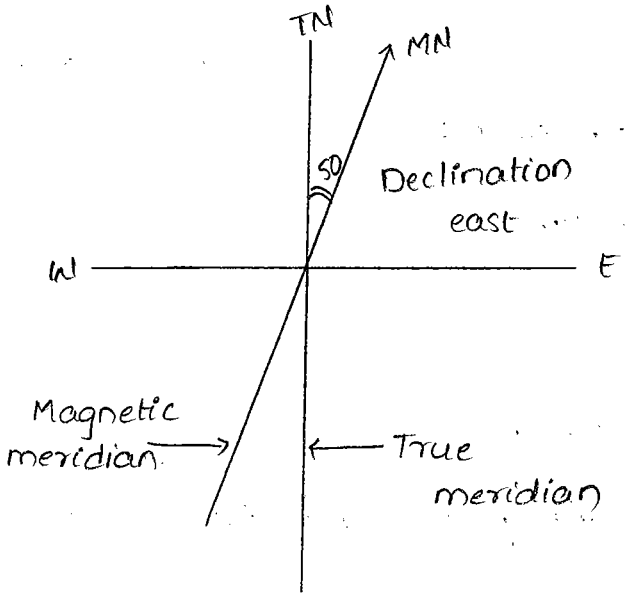
* Magnetic Declination :-

The magnetic meridian and the true meridian at a place generally do not coincide. The horizontal angle which the magnetic meridian makes with the true meridians is called the magnetic declination (or) simply declination.

* The declination varies from one place to the other.
* It also varies at the same place from time to time.
* The variation of declination at various place is shown by Isogonic lines.
* The Isogonic lines do not form complete great circles.
* Isogonic charts are maps showing the isogonic lines of the region.
* Agonic lines are special isogonic lines which pass through the point having declination.



(a)



(b)

Variation of Magnetic Declination :-

* Secular Variation.
* Annual Variation.
* Diurnal Variation.
* Irregular Variation.

* Secular Variation:- Secular Variation of declination occurs continuously over a long period of time.

Ex:- In London the declination was 11°E in 1580 and 24° W in 1820.

* Annual Variation:- The Variation of declination in a year from the mean position of the year is called the annual Variation.

* Diurnal Variation:- The Variation of the declination in one day from the mean position is called diurnal Variation. The diurnal Variation mainly depends upon the following factors:

(i). Locality:- It is greater at places near the poles than those near the equator. In generally, as the latitude of the place increases, the diurnal variation also increases.

(ii). Season:- It is greater in Summer than in winter.

(iii). Time:- It is greater in day time and smaller during night hours. However, the rate of variation in 24 hrs of the day is quite irregular.

(iv) Year:- The diurnal Variation also changes from year to year.

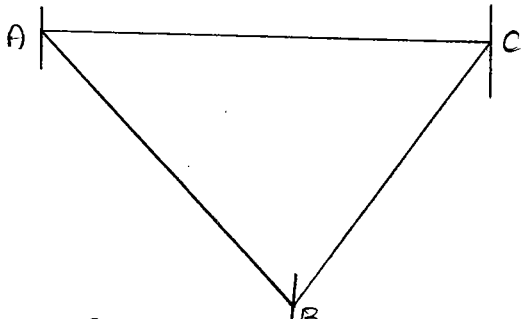
* Irregular Variation:- Magnetic disturbances or magnetic storms in the earth's magnetic field cause irregular Variation of the declination at a place.

Natural phenomena, such as Aurora Borealis, earth quakes, Volcanic eruptions, also cause irregular Variation of declination.

* Local Attraction:-

Local Attraction is the attraction of the magnetic needle toa local magnetic field other than earth's magnetic field.

The local magnetic field is caused by iron fences, iron pipes, steel bars, vehicles, steel doors and windows, iron deposits, etc... taping arrows and steel tapes cause local attraction. D.C. power lines also develop a local magnetic field.



* Example:-1.

A compass traverse ABCDEA was run anticlockwise and the following bearings were taken where local attraction was suspected.

Line	FB	BB.
AB	150°0°	329°45'
BC	77°30'	256°0'
CD	41°30'	222°45'
DE	314°15'	134°45'
EA	220°15'	40°15'

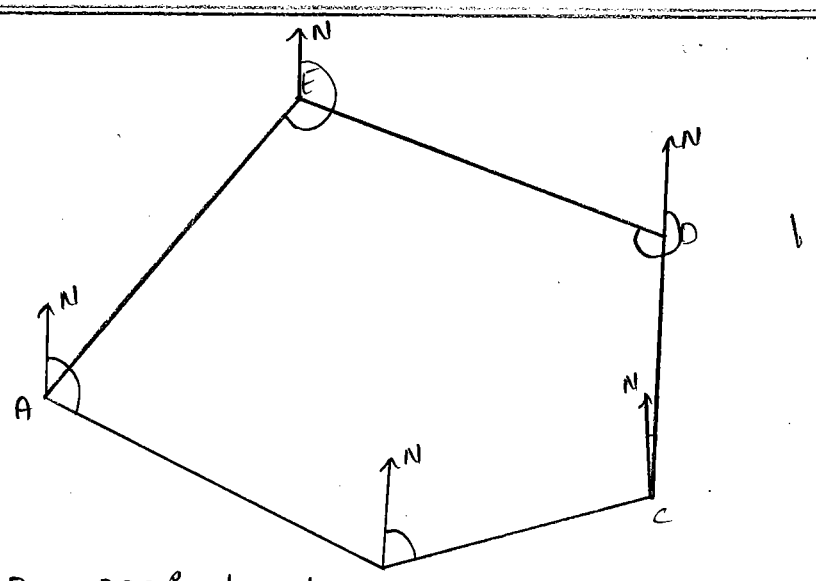
Determine the local attraction and the correct bearings by both the both the methods?

Sol:- As the FB and BB of line EA differ exactly by 180°, Station E and A are free from local attraction. ∴ the FB of AB and BB of DE are also free from local attraction.

Correct FB of DE = 134°45' + 180° = 314°45'.

Error at D = 314°15' − 314°45' = −30'.

correction at D = +30'.



correct BB of CD = 222°45' + 30'

= 223°15'

correct FB of CD = 223°15' − 180° = 43°15'

Error at C = 41°30' − 43°15' = −1°45'

correct BB of BC = 256°0' + 1°45' = 257°45'

correct FB of BC = 257°45' − 180° = 77°45'.

Error at B = 77°30' − 77°45' = −15'.

correct BB of AB = 329°45' + 15' = 330°0'

correct FB of AB = 330°0' − 180° = 150°0'

Error at A = 150°0' − 150°0' = 0'0".

Already mentioned, there is no local attraction at A.

Second method:-

$\angle A = 150°0' - 40°15' = 109°45'$

$\angle B = 329°45' - 77°30' = 252°15'$ (exterior) $= 107°45'$

$\angle C = 256°0' - 41°30' = 214°30'$ (exterior) $= 145°30'$

$\angle D = 314°15' - 222°45' = 91°30'$.

$\angle E = 220°15' - 134°45' = 85°30'$.

Sum of included angles = 109°45' + 107°45' + 145°30' + 91°30' + 85°30' = 540'

$(2N-4) \times 90° = (2 \times 5 - 4) \times 90 = 540°$.

There is no error in the sum of the included angles.

As there is no local attraction at A, the F.B of AB is correct

correct B.B of AB = $150^\circ + 180^\circ = 330^\circ$

correct B.B of BC = $330' + LB + 107^\circ 45 = 437^\circ 45' - 360^\circ$

$= 77^\circ 45'$

Note:- [When ever the bearing is greater than 360°, Subtract 360°.].

correct B.B. of BC = $77^\circ 45' + 180^\circ$.

$= 257^\circ 45'$

correct F.B of CD = $257^\circ 45' + 145^\circ 30' = 403^\circ 15' = 43^\circ 15'$.

correct B.B of CD = $43^\circ 15' + 180^\circ = 223^\circ 15'$

correct F.B of DE = $223^\circ 15' + 91^\circ 30' = 314^\circ 45'$.

correct B.B of DE = $314^\circ 45' - 180^\circ = 134^\circ 45'$.

As there is no local attraction at E, the computed B.B of DE is equal to the Observed bearing.

Ex:-2 In the Illustrative example 1, If the observed bearings are as under, determine the correct included angles.

Line	FB	BB.
AB	$150^\circ 30'$	$329^\circ 45'$
BC	$78^\circ 0'$	$256^\circ 30'$
CD	$42^\circ 30'$	$223^\circ 45'$
DE	$315^\circ 45'$	$134^\circ 15'$
EA	$220^\circ 15'$	$40^\circ 15'$.

Sol:-

$LA = 150^\circ 30' - 40^\circ 15' = 110^\circ 15'$

$LB = 329^\circ 45' - 78^\circ 0' = 251^\circ 45'$ (exterior)

$= 108^\circ 15'$ (interior)

$LC = 256^\circ 30' - 42^\circ 30' = 214^\circ 0'$ (exterior).

$= 146^\circ 0'$ (interior).

$\angle D = 315^\circ 45' - 223^\circ 45' = 92^\circ 0'$.

$\angle E = 220^\circ 15' - 134^\circ 15' = 86^\circ 0'$.

Sum: $110^\circ 15' + 108^\circ 15' + 146^\circ 0' + 92^\circ + 86^\circ 0' = 542^\circ 30'$

Theoritical Sum $= (2 \times 5 - 4) \times 90 = 540^\circ$.

Error $: 542^\circ 30' - 540^\circ = +2^\circ 30'$.

Error per angle $= \frac{2^\circ 30'}{5} = +30'$

correction per angle $= -30'$.

corrected angles $\angle A = 109^\circ 45'$.

$\angle B = 107^\circ 45'$

$\angle C = 145^\circ 30'$.

$\angle D = 91^\circ 30'$

$\angle E = 85^\circ 30'$.