

Plane Table Survey



Unit-VI



Syllabus

- **Plane Table Survey:**

Introduction, principle, instruments, setting up the plane table, methods of plane tabling, advantages, sources of Errors.



Plane Table Surveying

- **Plane Table Surveying is a graphical method of survey** in which the field observations and plotting are done simultaneously.
- It is **simple and cheaper than theodolite survey**. It is most suitable for small scale maps.
- The plan is drawn by the surveyor in the field, while the area to be surveyed is before his eyes. Therefore, there is no possibility of omitting the necessary measurements.

Equipments and Accessories for Plane Tabling

The following instruments are used in plane table surveying.

Equipments

- Plane Table
- Tripod
- Alidade



Equipments and Accessories for Plane Tabling

Accessories

- Trough Compass
- Spirit level
- U-Fork with Plumb bob
- Water proof cover
- Drawing paper
- Pins
- Drawing accessories



Equipments

- **Plane Table:** The drawing board for plane tabling is made from well-seasoned wood with its upper surface exactly plane.
- It is normally rectangular in shape **with size 75 cm x 60 cm**
- It is mounted on a tripod and clamps are provided to fix it in any direction. The table can revolved about its vertical axis and can be clamped in any position, when necessary.

Plane Table



Plane Table



Tripod

- The plane table is mounted on a tripod
- The tripod is generally of open frame type, combined rigidity with lightness. The tripod may be made to fold for convenience of transportation.
- Tripod is provided with three foot screws at its top for leveling of the plane table.

Tripod



Alidade

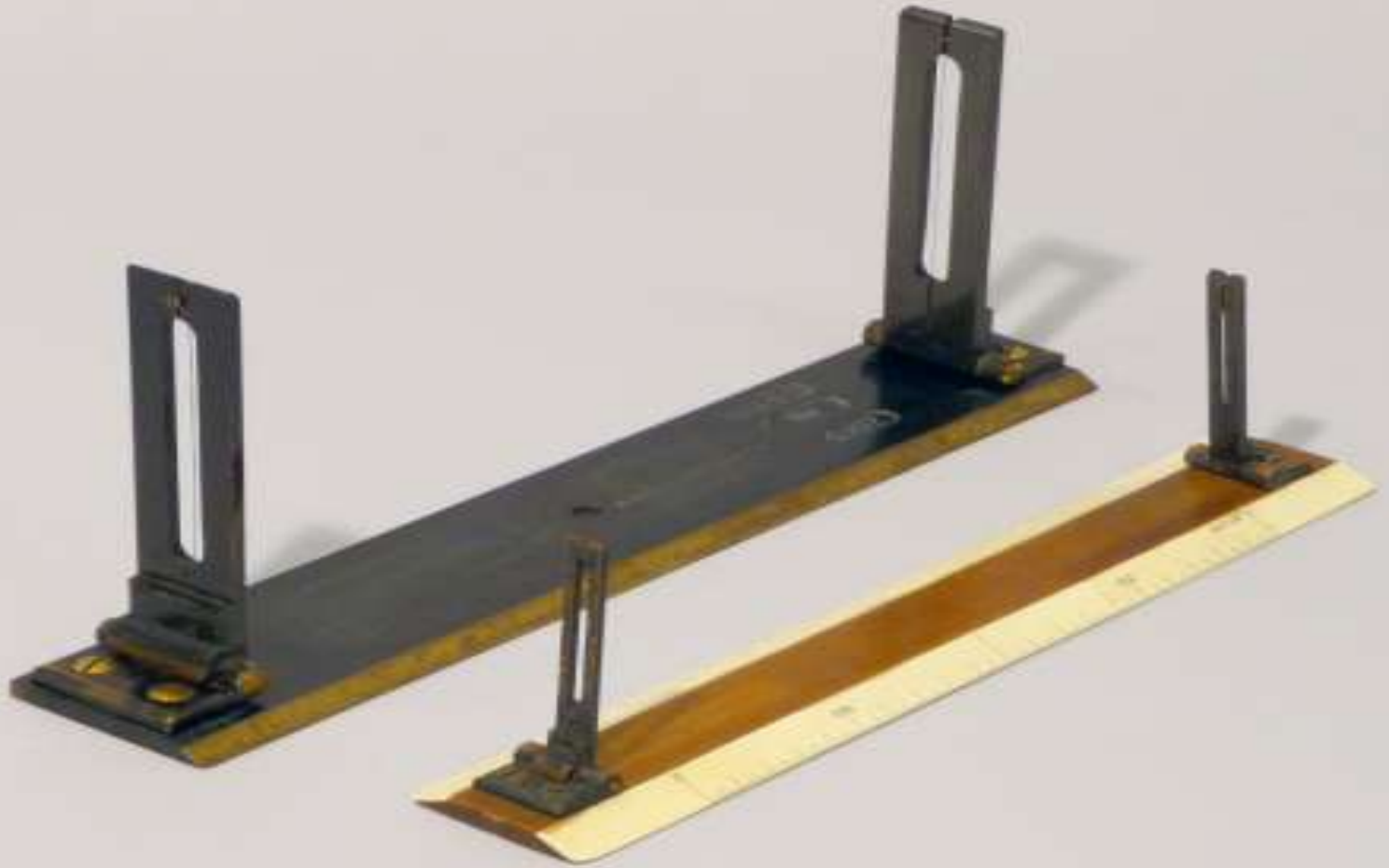
- The alidade is useful for establishing a line of sight.
- Two Types of alidade are used.
- Simple alidade
- Telescopic alidade



Simple Alidade

- It is used for ordinary work
- It is generally consists of a gun metal or wooden rule with two vertical vanes at the ends.
- The eye-vane is provided with a narrow slit while the object vane is open and carries a horse hair. Both the slits, thus provide a definite line of sight which can be made to pass through the object to be sighted

Simple Alidade



Simple Alidade

- To draw the rays, one of the edge of alidade is beveled and this perfectly smooth working edge is known as the **fiducially edge**.
- The **fiducially edge** is graduated to facilitate the plotting of distances to a scale.

Telescopic Alidade

- The **telescopic alidade** is used when it is **required to take inclined sights**.
- It essentially consists of a small telescope with a level tube **and graduated arc mounted on horizontal axis**.
- It gives **higher accuracy and more range of sights**.

Telescopic Alidade



Telescopic Alidade

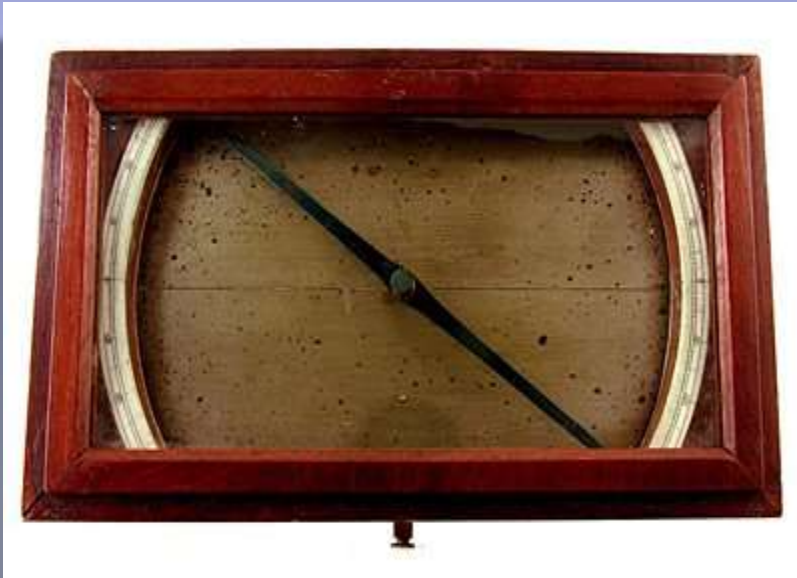


Accessories

Trough Compass

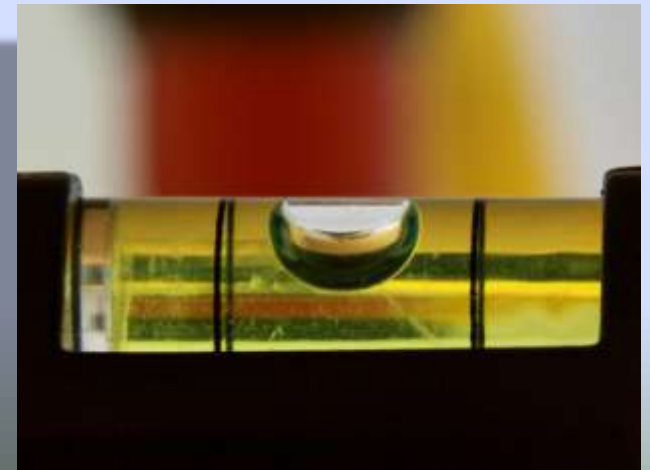
- The **trough compass** is required for drawing the line showing magnetic meridian on the paper. It is used to orient the table to the magnetic meridian.
- When the **freely suspended needle** shows 0^0 at each end, a line is drawn on the drawing paper which represents the **magnetic north**.

Trough Compass



Spirit Level

- A Spirit Level is used for ascertaining If the table is properly level.
- The Table is leveled by placing the level on the board in two positions at right angles and getting the bubble central in both positions.



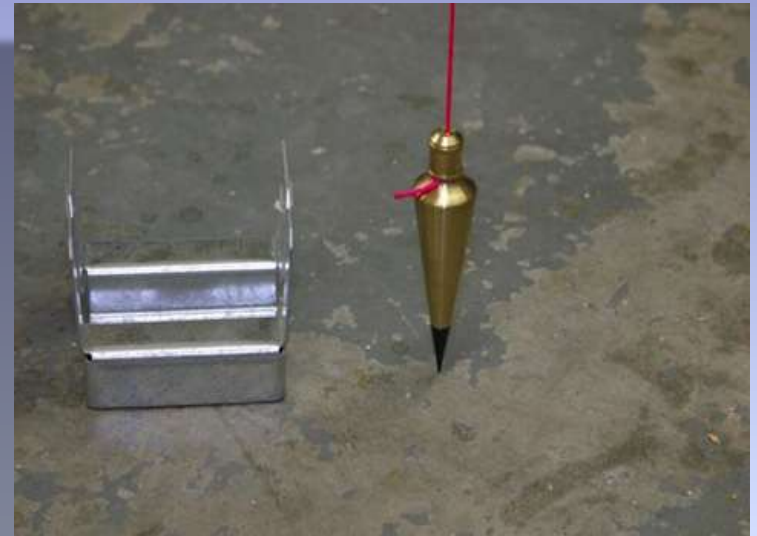
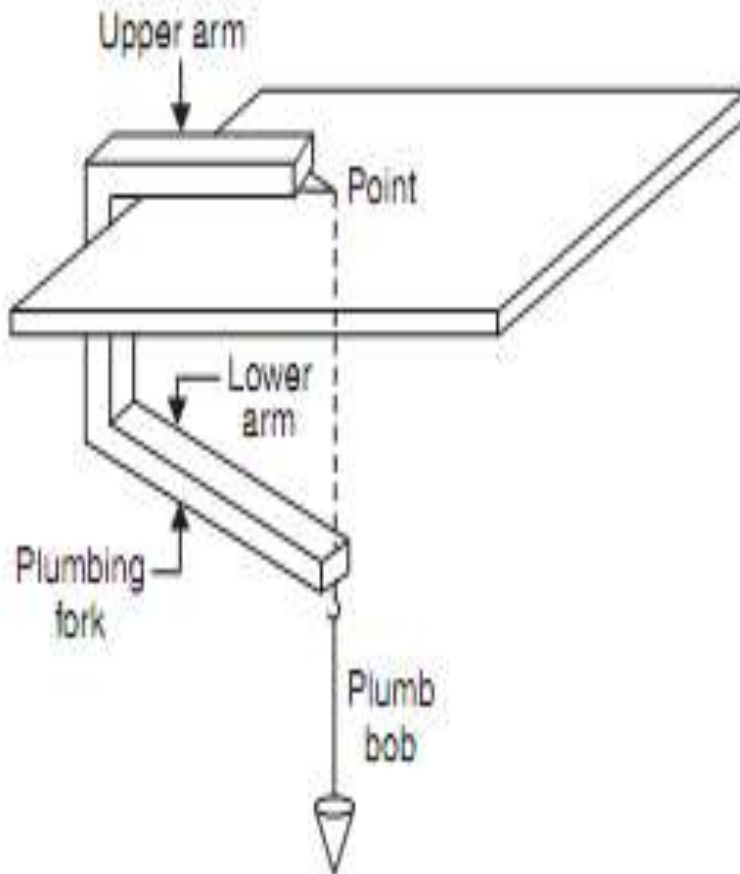
Spirit Level



U-Fork With Plumb bob

- **U-fork with plumb bob is used for centering the table over the point or station occupied by the plane table when the plotted position of that point is already on the sheet.**
- **Also, in the beginning of the work, it is used for transferring the ground point on the sheet.**

U-Fork With Plumb Bob



Water Proof Cover

- An umbrella is used to protect the drawing paper from rain.



Drawing Paper

- Drawing paper is used for plotting the ground details.



Advantages and Disadvantages of Plane Table Surveying

Advantages

- **The plan is drawn by the surveyor himself while the area to be surveyed is before his eyes. Therefore, there is no possibility of omitting the necessary measurements.**
- **The surveyor Can compare the plotted work with the actual features of the area.**

Advantages and Disadvantages of Plane Table Surveying



Advantages

- It is **simple and cheaper** than the theodolite survey.
- It is most **suitable for small scale maps**.
- No **great skill is required** to produce a satisfactory map and work may be entrusted to a subordinate.
- It is **useful in magnetic areas** where compass may not be used.
- The **mistakes in writing field books are eliminated**.

Advantages and Disadvantages of Plane Table Surveying

Disadvantages (Limitations)

- **It is not intended for very accurate work.**
- **It is not suitable in monsoon.**
- **It is essentially a tropical instrument.**
- **Due to heaviness, it is inconvenient to transport.**
- **Since there are so many accessories, there is likelihood of them being lost.**

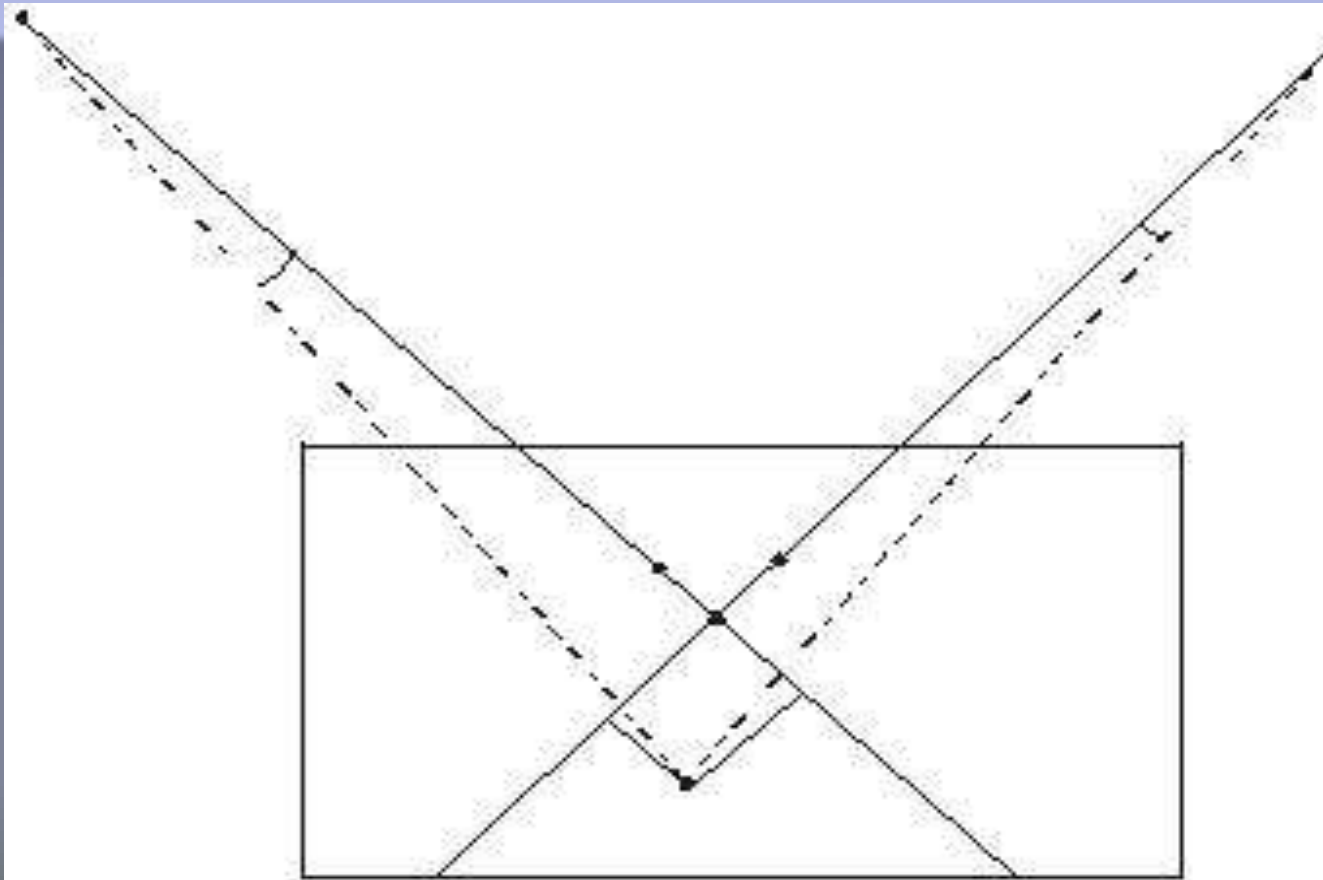
Advantages and Disadvantages of Plane Table Surveying



Principle Of Plane Table Survey

- The principle of plane tabling is parallelism means,
- Principle: “All the rays drawn through various details should pass through the survey station.”
- The Position of plane table at each station must be identical, i.e. at each survey station the table must be oriented in the direction of magnetic north.

Principle Of Plane Table Survey



Method Of Setting Up The Plane Table

- Three processes are involved in setting up the plane table over the station.
- Leveling
- Centering
- Orientation

Leveling



Leveling and Centering

- The Table should be set up at convenient height for working on the board, say about 1 m. The legs of Tripod should be spread well apart and firmly into the ground.

Leveling and Centering

- The table should be so placed over the station on the ground that the point plotted on the sheet corresponding to the station occupied should be exactly over the station on the ground. The operation is known as centering the plane table. **It is done by U-fork and plumb bob.**
- For leveling the table ordinary spirit level may be used. The table is leveled by placing the level on the board in two positions at right angles and getting the bubble central in both directions.

Centering



Orientation

- The **Process by which the positions occupied by the board at various survey stations are kept parallel** is known as the **orientation**. Thus, when a plane table is properly oriented, the lines on the board are parallel to the lines on ground which they represent.
- There are two methods of orientation:
 - By magnetic needle
 - By back sighting

By Magnetic Needle

- In this method, **the magnetic north is drawn on paper at a particular station.** At the next station, the trough compass is placed along the line of magnetic north and the table is turned in such a way that the ends of magnetic needle are opposite to zeros of the scale. The board is then fixed in position by clamps. This method is inaccurate in the since that the results are likely to be affected by the local attraction.

Orientation



By Back Sighting

- A= First survey station
- B= Second survey station
- Suppose a line is drawn from station A on paper as ab, representing line AB on ground
- The table is turned till the line of sight bisects the ranging rod at A. The board is then clamped in this position.
- This method is better than the previous one and it gives perfect orientation.

Orientation



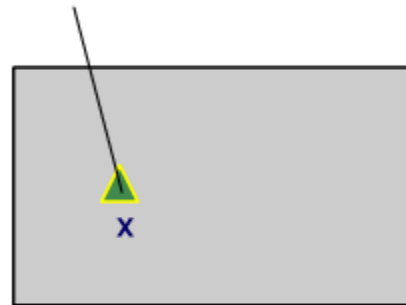
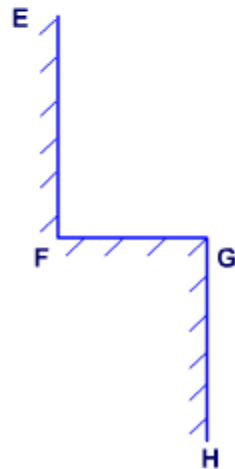
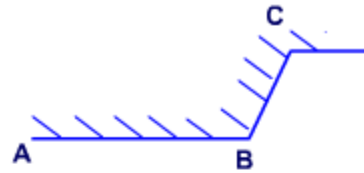
Methods Of Plane Tabling

- There are four distinct methods of plane tabling:
- Method of Radiation
- Method of Intersection
- Method of Traversing
- Method of Resection

Radiation Method

- In the radiation method of plane table surveying, the direction of the objects or points to be located are obtained by drawing radial lines along fiducially edge of alidade after getting the objects or points bisected along the line of sight of the alidade. The horizontal distances are then measured and scaled off on the corresponding radial lines to mark their positions on the drawing.

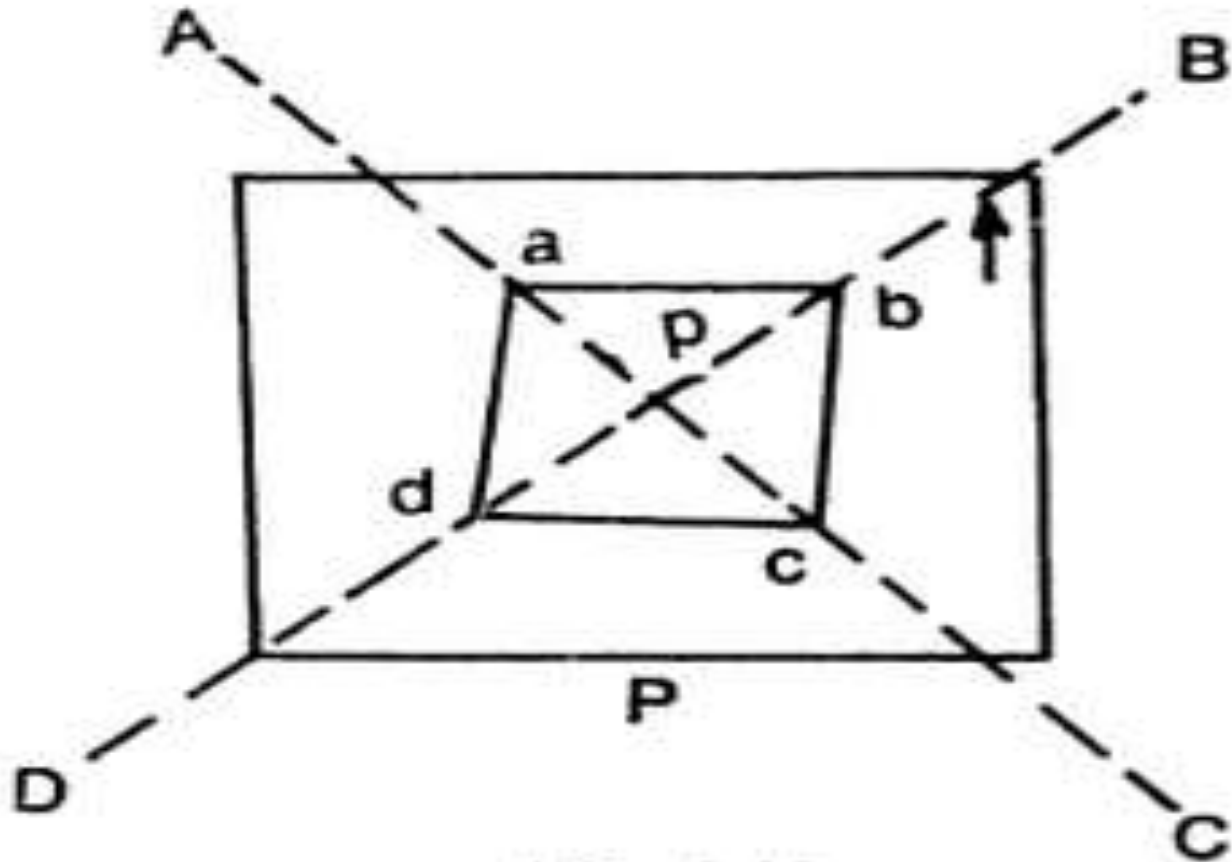
Radiation Method



Radiation Method

- Suppose P is a station on the ground from where the object A, B, C and D are visible.
- The plane table is set up over the station P. A drawing is fixed on the table, which is then leveled and centered. A point p is selected on the sheet to represent the station P.
- The north line is marked on the right-hand top corner of the sheet with trough compass or circular box compass.
- With the alidade touching p, the ranging rod at A,B, C and D are bisected and the rays are drawn.
- The distances PA, PB, PC and PD are measured and plotted to any suitable scale to obtain the points a, b, c and d representing A,B,C,D on paper.

Radiation Method



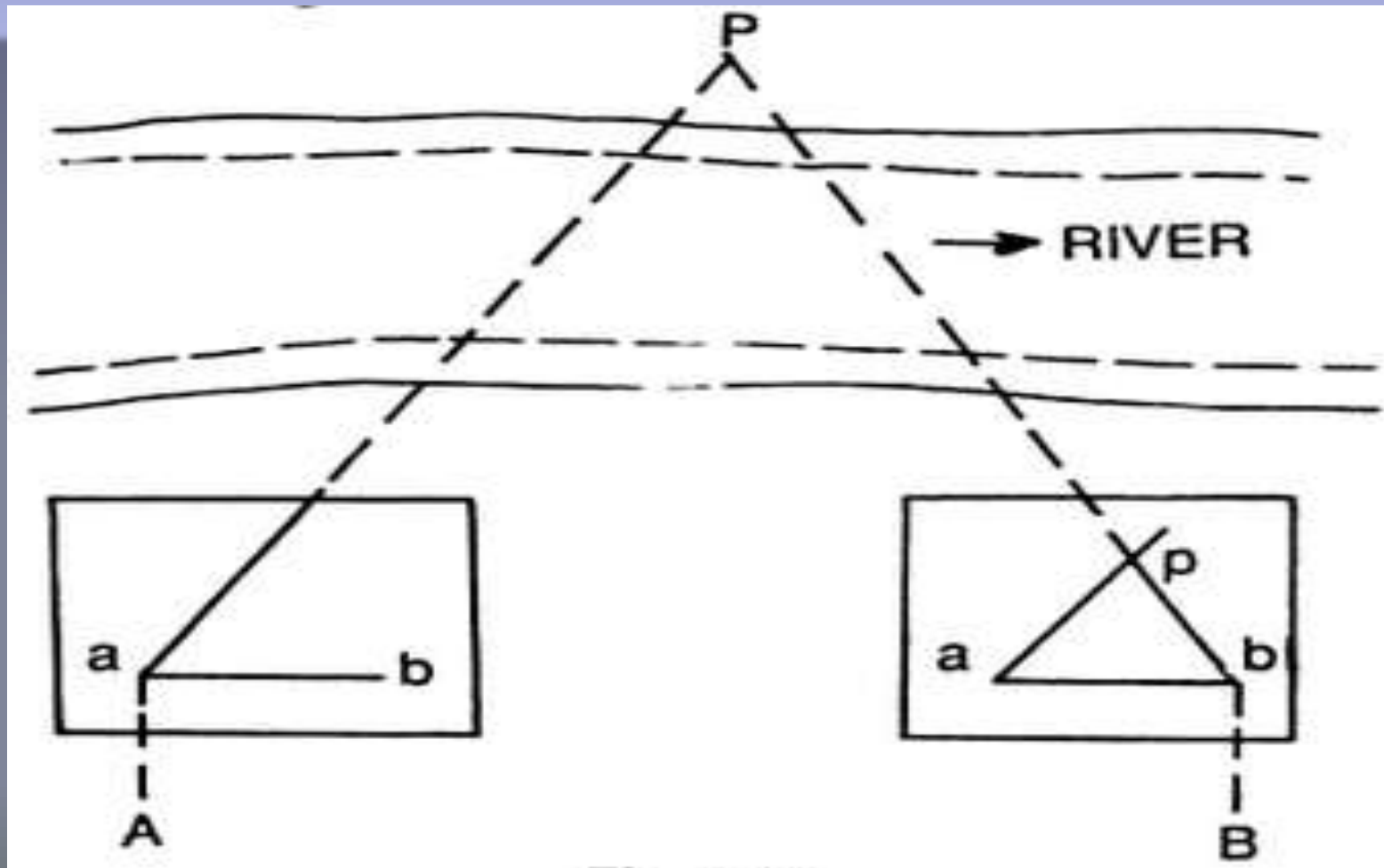
Method Of Intersection

- In intersection method of plane table surveying, the objects or points to be located are obtained at the point of intersection of radial lines drawn from two different stations.
- In this method, the plotting of plane table stations are to be carried out accurately. Checking is important and thus done by taking third sight from another station.
- The intersection method is suitable when distances of objects are large or cannot be measured properly. Thus, this method is preferred in small scale survey and for mountainous regions.

Method Of Intersection

- Suppose A and B are two station and P is the object on the far bank of a river. Now it is required to fix the position of P on the sheet by the intersection of rays, drawn from A and B.
- The table is set up at A. It is leveled and centered so that a point a on the sheet is just over the station A. The north line is marked on the right-hand top corner, the Table is then clamped.
- With the alidade touching a, the object P and the ranging rod at B are bisected, and rays are drawn through the fiducial edge on alidade,

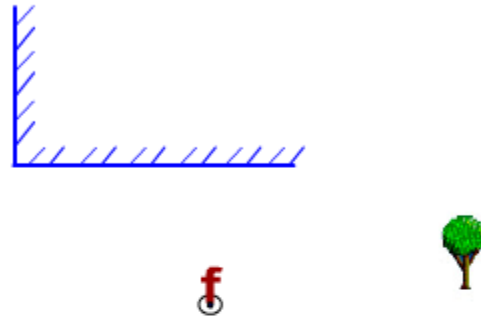
Method Of Intersection



Method Of Intersection

- The distance AB is measured and plotted to any suitable scale to obtain point b.
- The table is shifted and centered over B and leveled properly. Now the alidade is placed along the line ba and orientation is done by back sighting
- With the alidade touching b, the object P is bisected and a ray is drawn, suppose this ray intersects the previous rays at point p. the point p is the required plotted position of P

Method Of Intersection



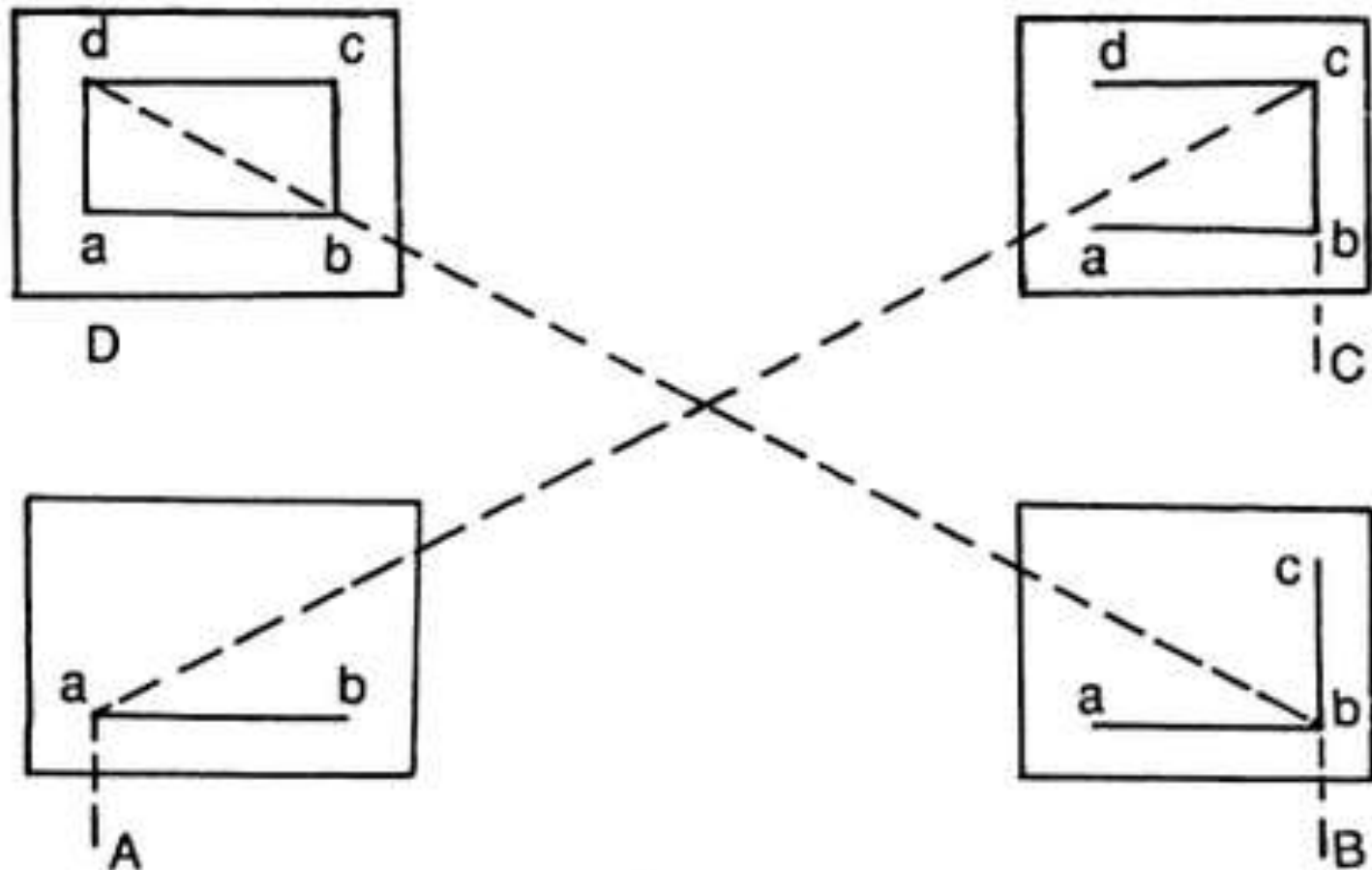
Method Of Traversing

- This method of plane table surveying is used to plot a traverse in cases stations have not been previously plotted by some other methods. In this method, traverse stations are first selected. The stations are plotted by method of radiation by taking back sight on the preceding station and a fore sight to the following station. Here distances are generally measured by tachometric method and surveying work has to be performed with great care.

Method Of Traversing

- Suppose A,B,C,D are the traverse stations,
- The table is set up at the station A, a suitable point a is selected on the sheet in such a way that the whole area may be plotted in the sheet. The table is centered, leveled and clamped. The north line is marked on the right-hand top corner of the sheet.
- With the alidade touching point a the ranging rod at B is bisected and a ray is drawn. The distance AB is measured and plotted to any suitable scale.

Method Of Traversing



Method Of Traversing

- The table is shifted touching point a the ranging rod at B is bisected and a ray is drawn. The distance is measured and plotted to any suitable scale.
- The table is shifted and centered over B. It is then leveled, oriented by back sighting and clamped.
- With the alidade touching point b, the ranging rod at C is bisected and ray is drawn. The distance BC is measured and plotted to the same scale.
- The table is shifted and set up at C and the same procedure is repeated.
- In this manner, all stations of the traverse are connected.

Method Of Traversing

- **Check lines.** To check the accuracy of the plane table traverse, a few check lines are taken by sighting back to some preceding station.
- **Error of closure .** If the traverse to be plotted is a closed traverse, the foresight from the terminating station should pass through the first station. Otherwise the amount by which plotted position of the first station on the foresight fails to close is designated as the error of closure. It is adjusted graphically, if the error is within permissible limits, before any further plotting works are done.

Method Of Traversing

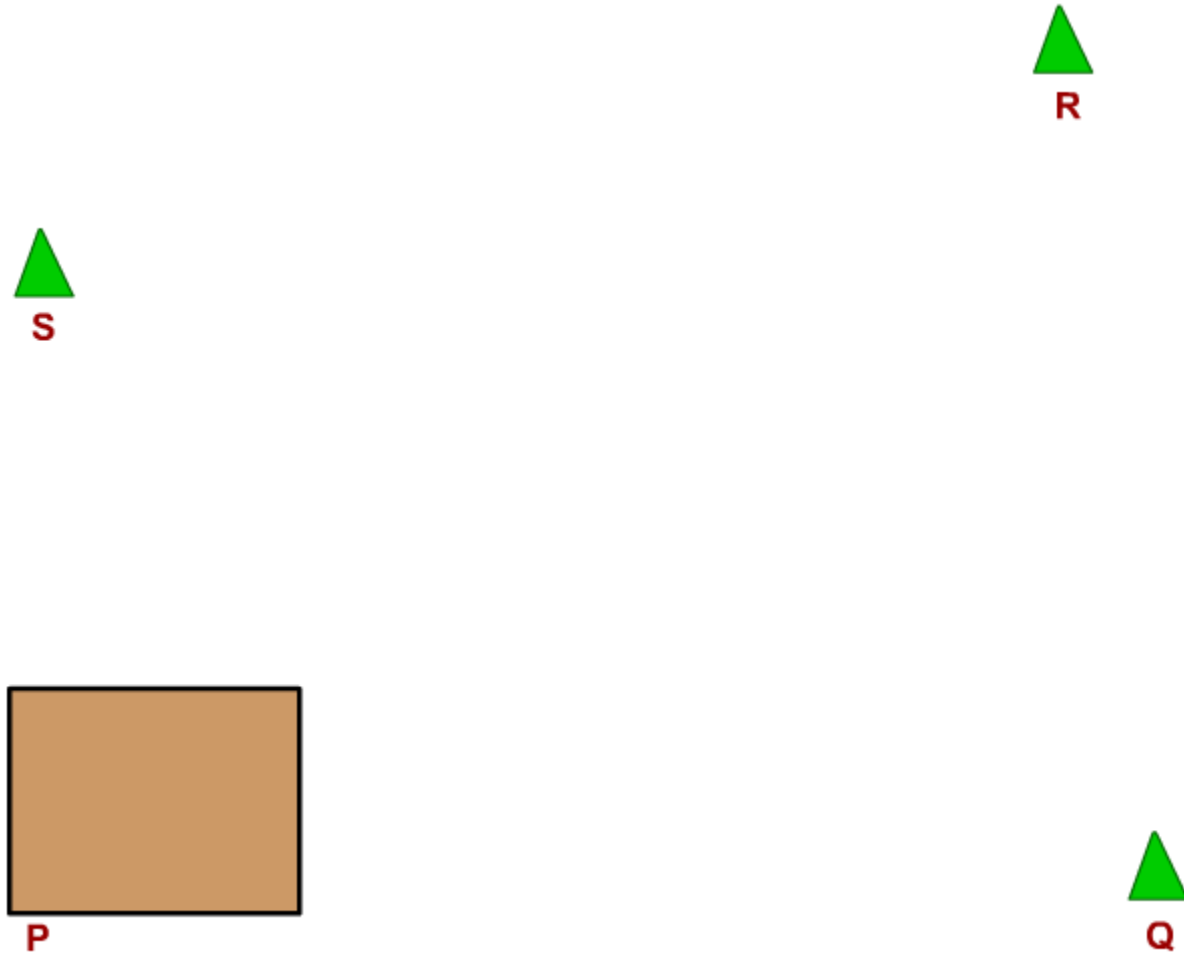


Figure 34.3 Traversing method

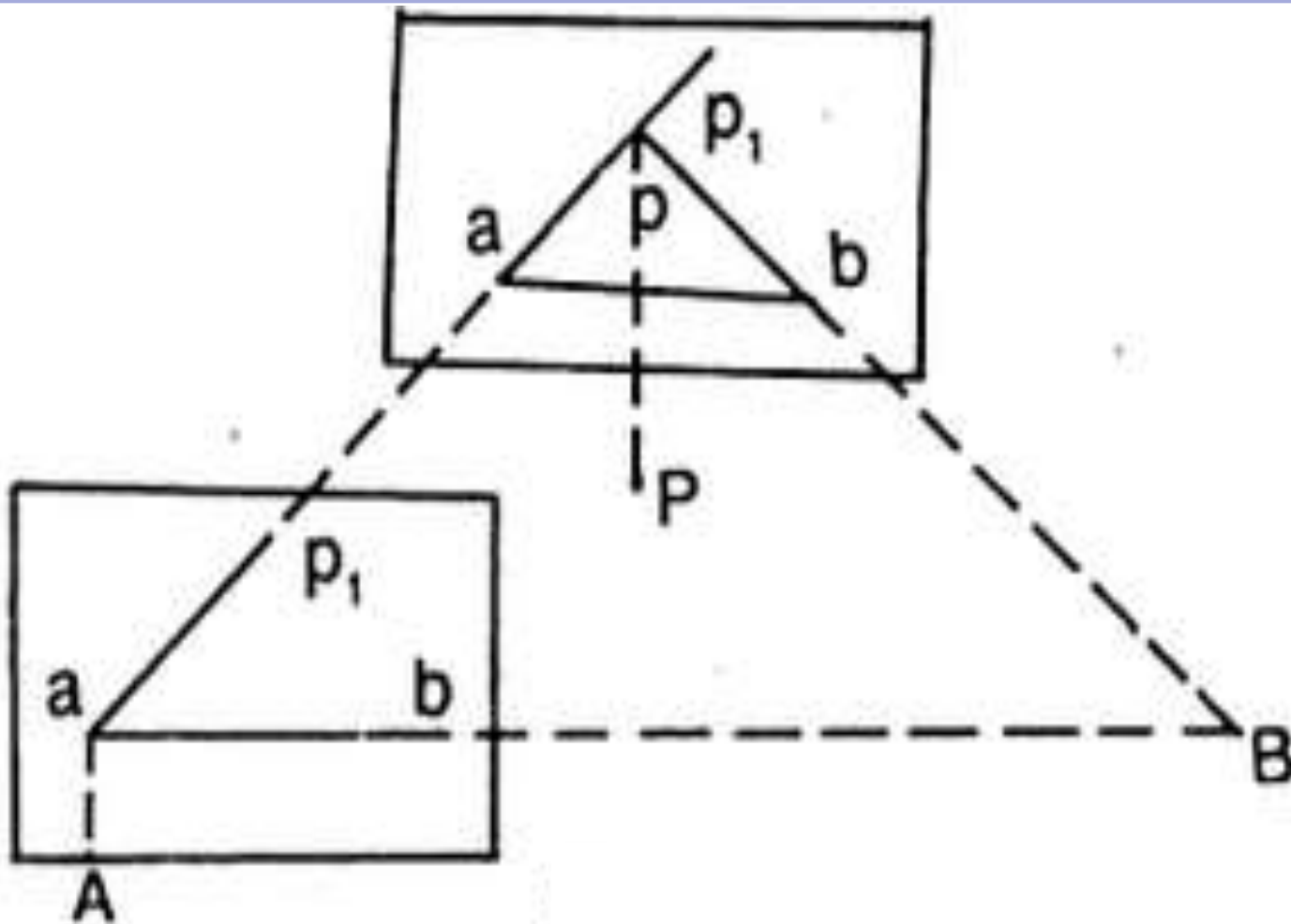
Method of Resection

- Resection is the process of determining the plotted position of the station occupied by the plane table, by means of sights taken towards known points, locations of which have been plotted.
- There are four methods of resection.
- By Compass
- By back sighting
- By two point problem
- By three point problem

Method of Resection

- Suppose It is required to establish a station at position P. Let us select two points A and B on the ground. The distance AB is measured and plotted to any suitable scale. The line AB is known as the “base line”
- The table is set up at A. It is leveled, centered and oriented by bisecting the ranging rod at B. The table is then clamped.
- With the alidade touching point a, the ranging rod at P is bisected and a ray is drawn. Then a point P_1 is marked on this way by estimating with the eye.

Method of Resection



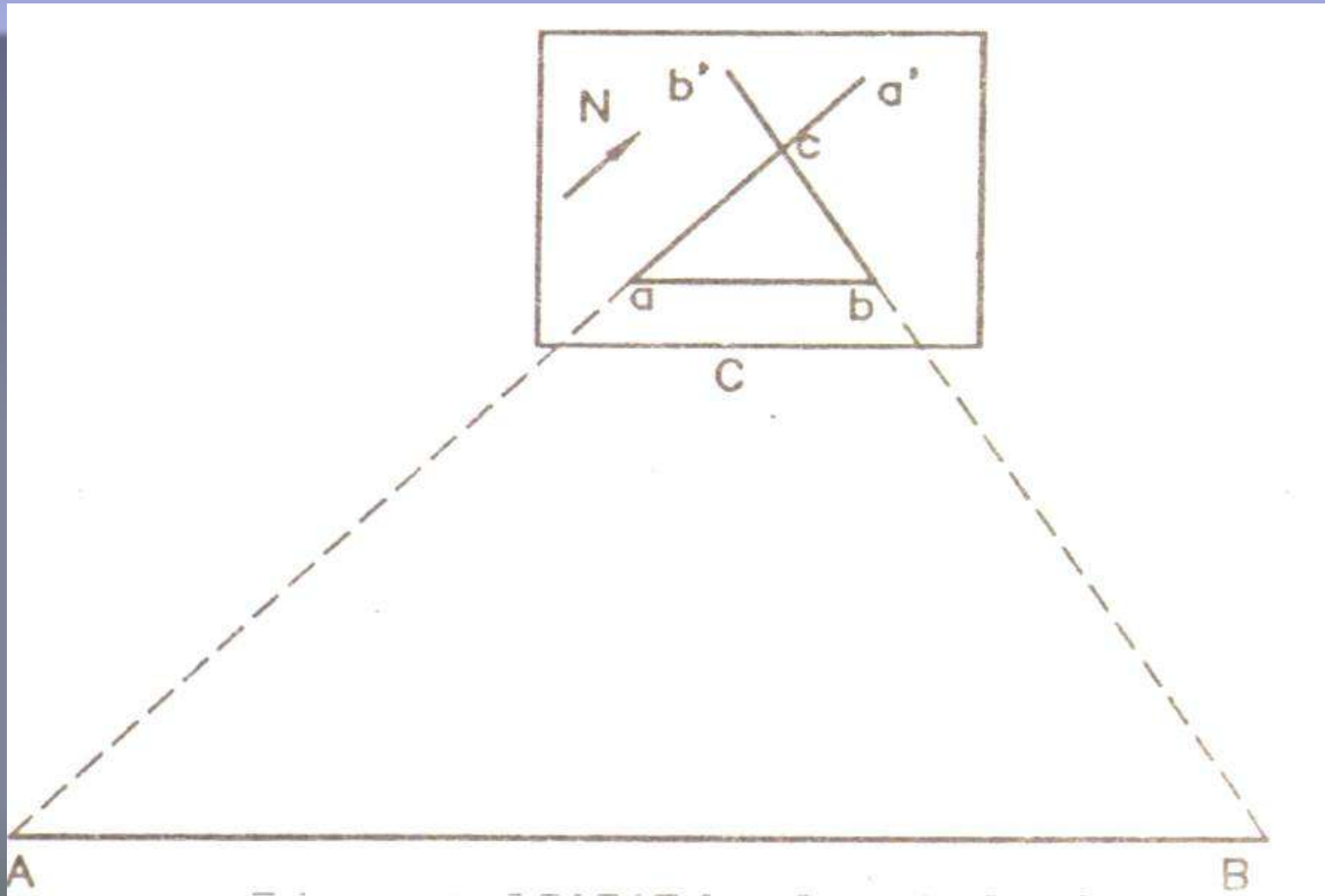
Method of Resection

- The table is shifted and centered in such a way that P_1 is just over P. It is then oriented by back-sighting the ranging rod at A.
- With the alidade touching point b, the ranging rod at B is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point P. This point represents the position of the station P on the sheet. Then the actual position of the station is marked on the ground by U-fork and plumb-bob

By Compass

- This method is used only for small scale or rough mapping.
- Let A and B be two visible stations which have been plotted on the sheet as a and b. Let C be the instrument station to be located on the plan.
- Set the table at C and orient it with compass. Clamp the table.
- Pivoting the alidade about a, draw a ray towards A, as Similarly, pivoting the alidade about b, draw a ray towards B, as bb', The intersection of aa' and bb' will give point c on the paper.

By Compass



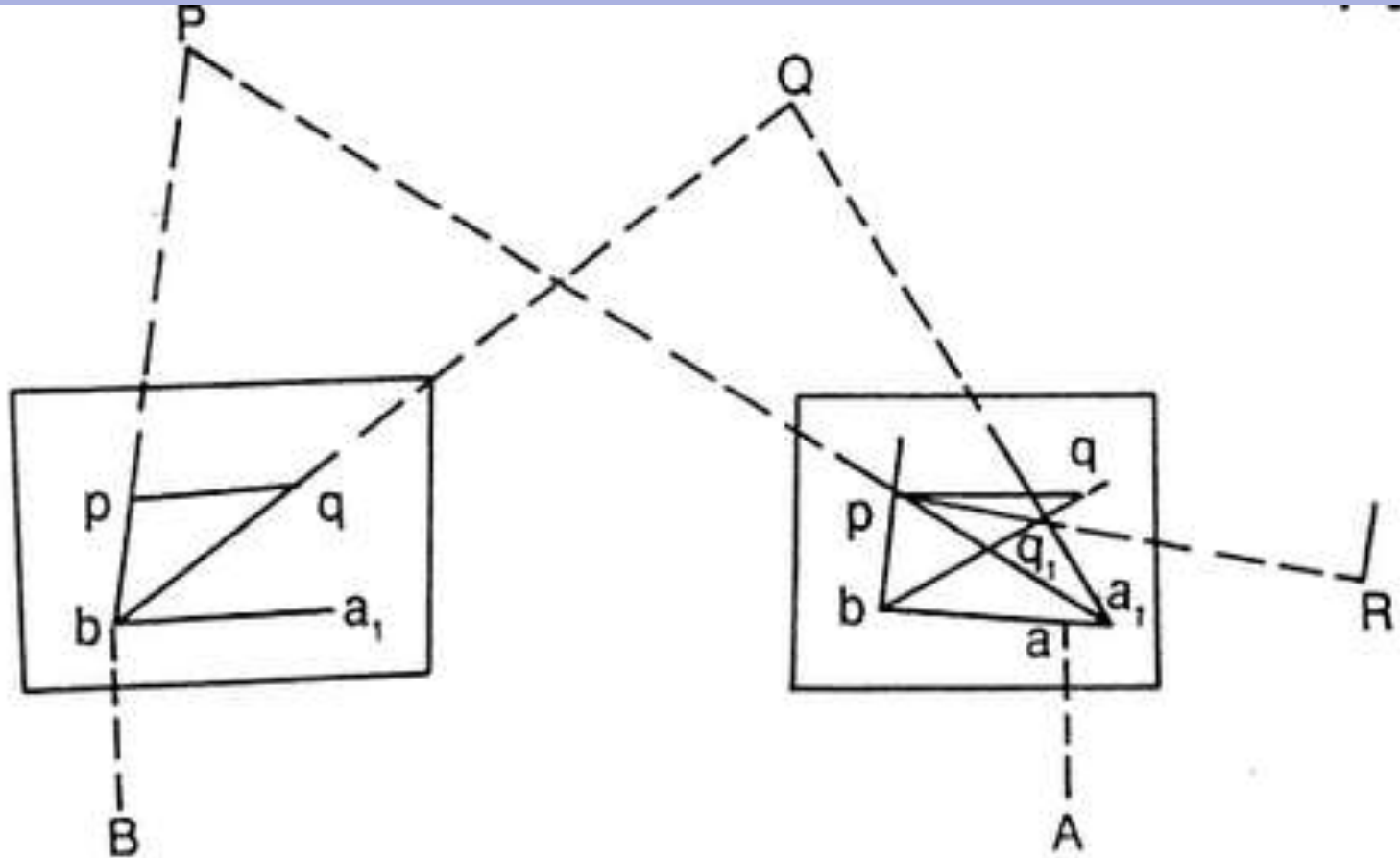
The Two Point Problem

- In this problem, two well-defined points whose positions have already been plotted on the plan are selected. Then, by perfectly bisecting these points, a new station is established at the required position.

The Two Point Problem

- Suppose P and Q are two well-defined points whose positions are plotted on map as p and q. It is required to locate a new station at A by perfectly bisecting P and Q
- An auxiliary station B is selected at a suitable position. The table is set up at B, and leveled and oriented by eye estimation. It is then clamped.
- With the alidade touching p and q, the points P and Q are bisected and rays are drawn. Suppose these rays intersect at b

The Two Point Problem



The Two Point Problem

- With the alidade centre on b , the ranging rod at A is bisected and rays is drawn. Then, by eye estimation, a point a_1 is marked on this ray.
- The table is shifted and centre on A with a_1 just over A . It is leveled and oriented by back sighting. With the alidade touching p , the point P is bisected and a ray is drawn. Suppose this ray intersects the line ba_1 at point a_1 , as was assumed.

The Two Point Problem

- With the alidade centered on a_1 the point Q is bisected and a ray is drawn. Suppose this ray intersects the ray bq at a point q_1 . The triangle pqq_1 is known as the triangle of error, and is to be eliminated.
- The alidade is placed along the line pq_1 and a ranging rod R is fixed at some distance from the table. Then, the alidade is placed along the line pq and the table is turned to bisect R. At this position the table is said to be perfectly oriented.
- Finally, with the alidade centered on p and q, the points P and Q are bisected and rays are drawn. Suppose these rays intersect at a point a. This would represent the exact position of the required station A. Then the station A is marked on the ground.

The Three Point Problem

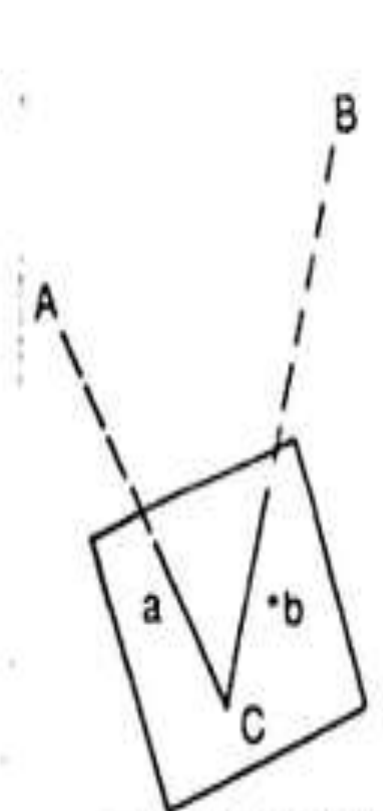
- In this problem, three well defined points are selected, whose position have already been plotted on the map. Then, by perfectly bisecting these three well-defined points. A new station is established at the required position.
- No auxiliary station is required in order to solve this problem. This table is directly placed at the required position. The problem may be solved by following methods
 - (a) Bessel's method
 - (b) Mechanical Method
 - (c) The trial and error method

The Three Point Problem

The graphical method or Bessel's method

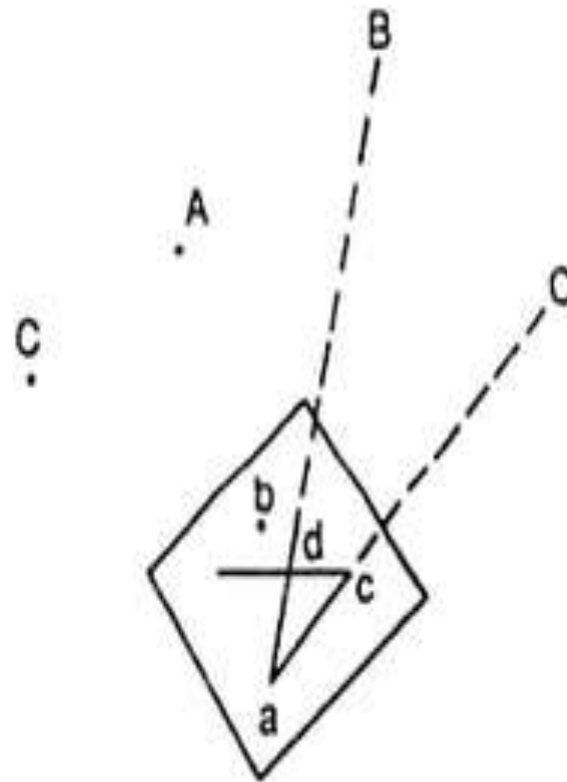
- (i) suppose A,B, and C are three well-defined points which have been plotted as a, b and c. Now it is required to locate a station at P.
- (ii) The table is placed at the required station P and leveled. The alidade is placed along the line ca and the point A is bisected. The table is clamped. With the alidade in centre on C, the point B is bisected and rays is drawn

Bessel's Method



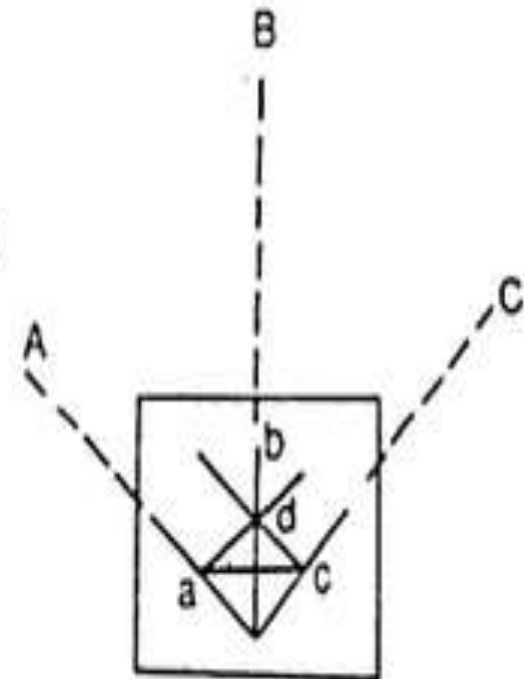
1ST OPERATION

(a)



2ND OPERATION

(b)



3rd OPERATION

(c)

The Three Point Problem

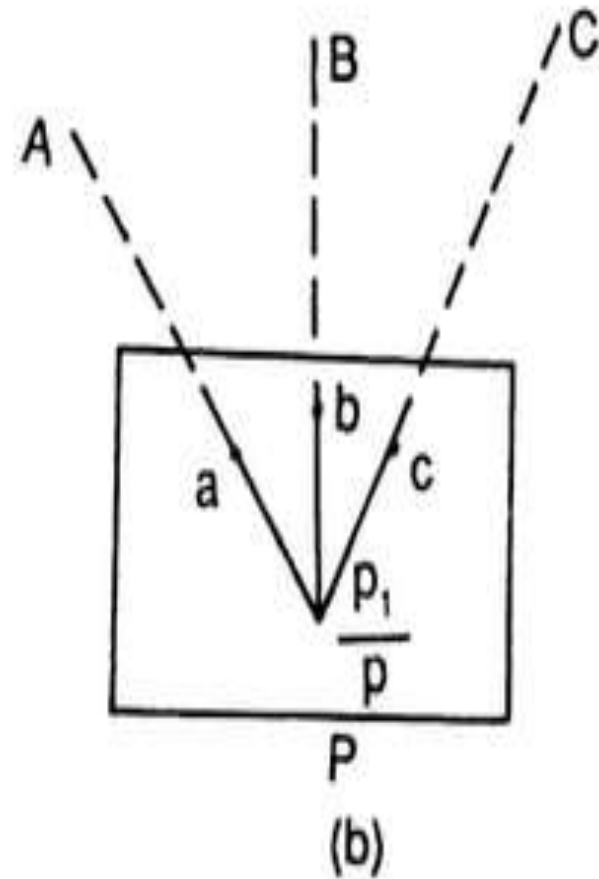
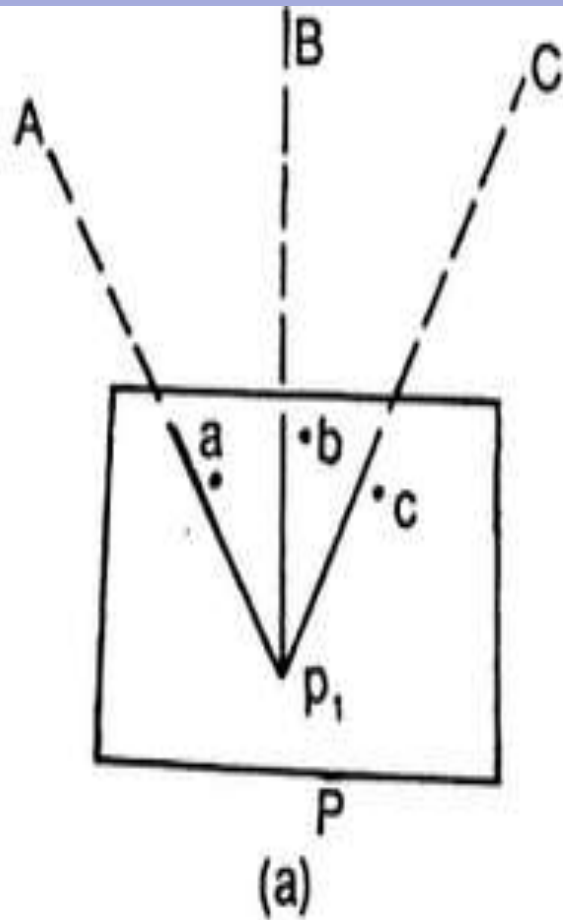
- Again the alidade is placed along the line ac and the point C is bisected and the table is clamped. With the alidade touching a , the point B is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point d
- The alidade is placed along db and the point B is bisected. At this position the table is said to be perfectly oriented. Now the rays Aa , Bb and Cc are drawn. These three rays must meet at a point p which is the required point on the map. This point is transferred to the ground by U-fork and plumb bob.

The Three Point Problem

The Mechanical Method

- Suppose A, B and C are the three well-defined points which have been plotted on the map as a, b and c. It is required to locate a station at P.
- The table is placed at P and leveled. A tracing paper is fixed on the map and a point p is marked on it.
- With the alidade centered on P the points A, B and C are bisected and rays are drawn. These rays may not pass through the points a, b and c as the orientation is done approximately

The Mechanical Method



The Three Point Problem

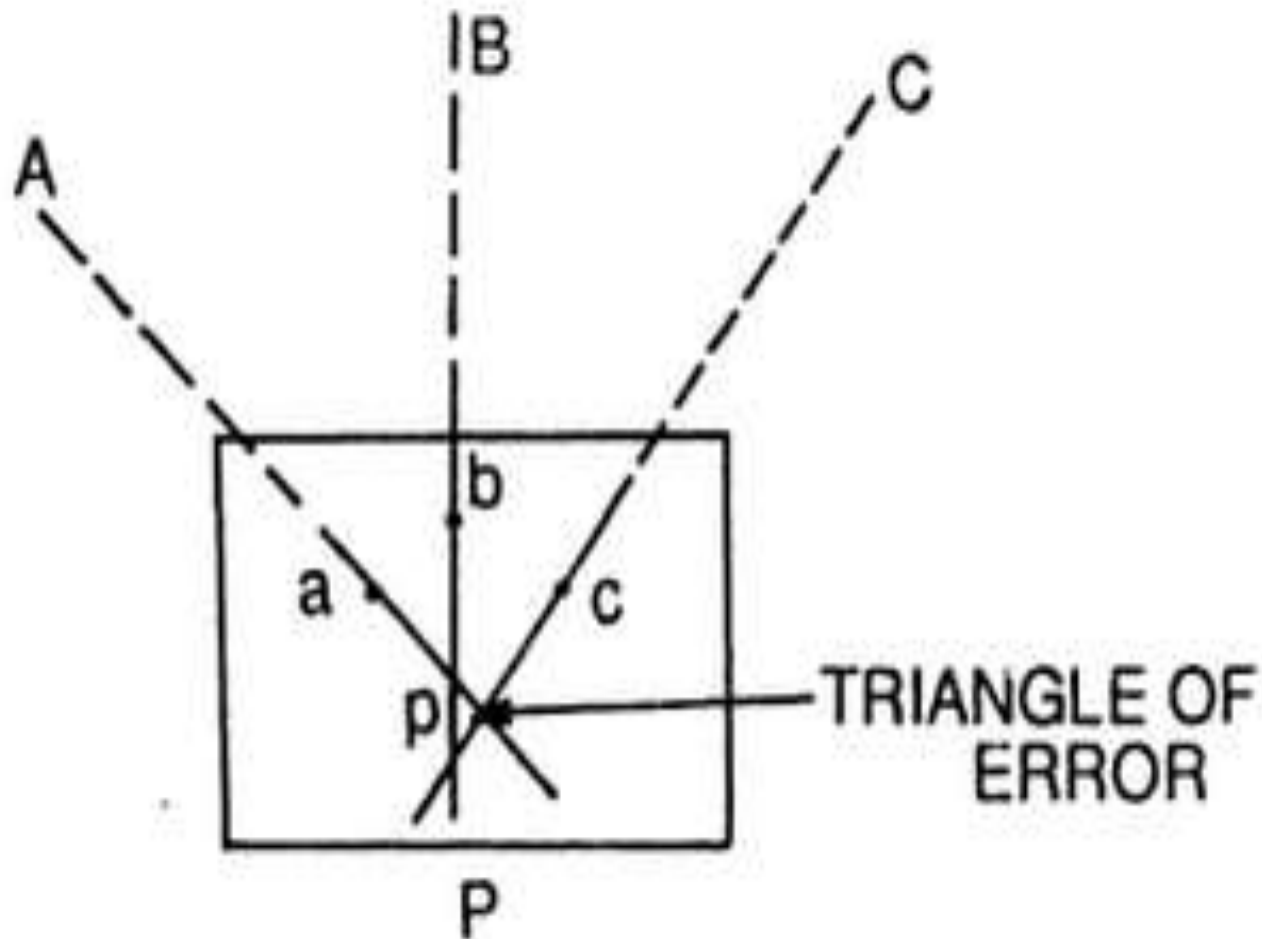
- Now a tracing paper is unfastened and moved over the map in such a way that the three rays simultaneously pass through the plotted positions a, b and c. Then the point p is pricked with a pin to give an impression p on the map. P is the required point on the map. The tracing paper is then removed.
- Then the alidade is centered on p and the rays are drawn towards A, B and C. These rays must pass through the points a, b and c

The Three Point Problem

The method of Trial and error

- Suppose a, B and C are the three well-defined points which have been plotted as a, b and c on the map. Now it is required to establish a station at P.
- The table is set up at P and leveled. Orientation is done by eye estimation
- With the alidade, rays Aa, Bb and Cc are drawn. As the orientation is approximately, the rays may not intersect at a point, but may form a small triangle the triangle of error.
- To get the actual point, this triangle of error is to be eliminated. By repeatedly turning the table clockwise or anticlockwise. The triangle is eliminated in such a way that the rays Aa, Bb and Cc finally meet at a point p. This is the required point on the map. This point is transferred to the ground by U-fork and plumb bob.

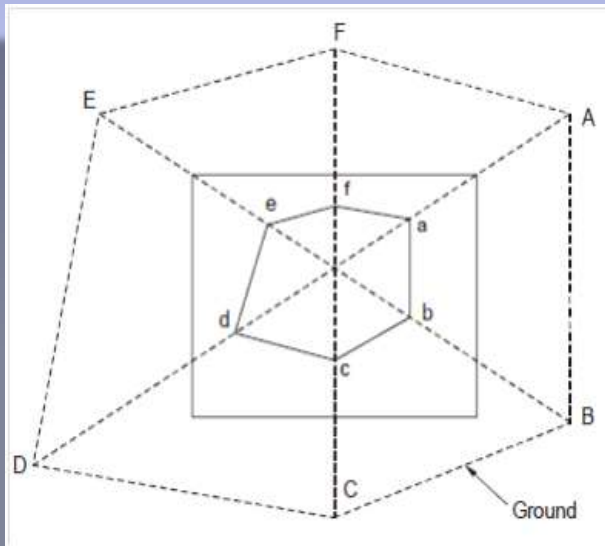
The method of Trial and Error



Points to be kept in mind in plane tabling

- The following points should be kept in mind while doing plane table survey.
- 1. Ground points shall be marked as A, B, C... etc. and plan. Points (on Paper) shall be marked as a, b, c etc.
- 2. The rays from survey stations to the objects shall be drawn by dashed line.
- 3. The alidade should be properly pivoted while sighting the objects

Points to be kept in mind in plane tabling



Points to be kept in mind in plane tabling

- 4. The first survey station and the scale of the map shall be so chosen that the entire area can be plotted on the paper.
- 5. While establishing magnetic north on the paper using trough compass, things causing local attraction shall be kept away of the table.
- 6. The Plane table should be clamped after centering and leveling. The table should be rotated at the time of orientation.

Error In Plane Tabling

- The various sources of error may be classified as :
- Instrumental errors
- Errors in manipulation and sighting
- Errors in plotting

Instrumental Errors

- The surface of drawing board is not plane
- The edge of alidade is not straight.
- The object vane and sight vane are not perpendicular to the alidade.
- The edge of alidade is not is not parallel to the line of sight.
- The fixing clamp is not proper.

Errors In Manipulation And Sighting

- Defective Leveling
- Defective Sighting
- Defective Orientation
- Defective Centering
- Movement of Board between sights

Errors in Plotting

- Defective scale of map
- Wrongly intersecting the rays drawn from two different stations.



Important Questions

- *List Of Instruments used in plane tabling and give their uses.*
- *Give advantages and disadvantages of plane table survey.*
- *List of methods of plane table survey and explain any one.*
- *Explain the following methods of plane tabling.*
 - *Method of intersection*
 - *Method of traversing*
- *Explain the method of intersection for plane table survey.*
- *Explain the principle of plane table survey.*
- *Give limitations of plane table survey.*
- *What is orientation? Explain orientation by back sighting.*
- *Explain the procedure of plain table survey.*
- *Explain errors in plane table survey.*



References

- **“Surveying and Levelling” Vol- I**
Kanetkar and Kulkarni (2011)
- **“Surveying” Vol- I**
Dr. B.C. Punamia
- **“Surveying and Leveling”**
N.N. Basak

Thanks !

