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Unit - 2 Surveying

* **Definition :-** Surveying is the art of determining the relative position of various points above, on or below the surface of the earth and with the help of measurement of distance (linear measurement, angular measurement, levelling)
→ The planning & execution of almost every civil engineering project require surveying.

* **Object of the survey -**
(i) finding the horizontal distance between the two points and horizontal angle between to points.
(ii) To find the vertical distance & vertical angle.
(iii) Visualization and topographical view of Houses, building, plots, rivers, cannels, bridges, locate the boundries of countries, states etc. with the help of photogrametic & arial survey.
(iv) To find the execessibility of construct a building on the perticular soil.
(v) To find a perticular meter in mine surveying
(vi) To find water availibility.

- **Classification of survey :-**

(1) Based on the nature -
(i) Astronomical survey
(ii) land survey
(iii) Marine survey

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(2) Based on object of the survey
(i) Topographical survey
(ii) Geographical survey
(iii) Military survey
(iv) Mine survey

(3) Based upon instrument
(i) By Total station
(ii) By Compass
(iii) By theodolite
(iv) By Dumpilevel
(v) By chain

* Type of Surveying -

(A) Geodetic Surveying (B) Plane Surveying

Geodetic Surveying	Plane Surveying
• Radius of curvature of earth is taken into account.	• Radius of curvature of earth is not taken into account.
• For surveying the large area.	• For surveying the small area.
• Degree of accuracy is high.	• Degree of accuracy is comparatively low.
• Using for greater then 250 km^2 area.	• Using for upto or less then 250 km^2 area.

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- **Land survey**

(1) Topographical – Determine natural feature of a country such as hills, valleys, lakes, woods, roads, buildings, canals etc.

(2) Cadastral – Details such boundries of houses, town, fields and other properties

(i) City Survey (ii) Engineering survey.

Site plans:- landscape architectural plan and detailed engg. drawing. It shows a building footprints, roadways, parking, drainage facilities, water lines, lights etc. (2 marks)

Plans and Maps –

Map	Plan
→ Used for large survey.	→ Used for small survey
→ Based on small scale	→ Based on large scale.
→ for country, city, roads or indicates the uneven nature of the ground	→ for surveying ground, plots, buildings, fabrication industries.
→ Scale is taken 1 m = 100 m or more then 100 m.	→ Scale is taken 1 m = 10m (upto or less then)

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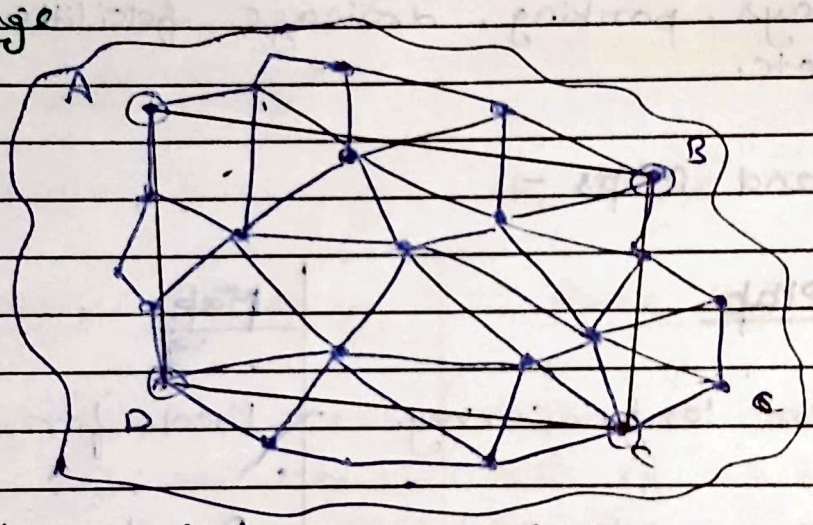
* There are two types of principle of survey-

(1.) Whole the part.
(2.) Location of points with reference at least two points.

(1.) Whole the part :-
A large framework with widely spaced controlled points is established with great accuracy with the large frame work, small frame work is established with less accuracy.

Advantage



-> minimise cost for us.
-> The errors all in the small framework will be localized. means controlled error.

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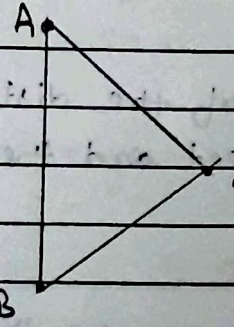
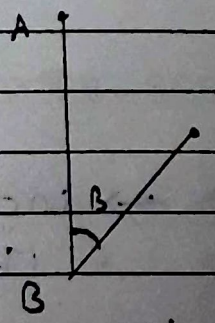
(e.) Location of the point with reference of at least two points

Let A & B are fixed point (reference) on the ground. Point C is to be located.

(a) If distance of AC & BC can be measured, then we can locate the position of point C by drawing an arc of length AC from point A & arc of length BC from point B. This principle is used in "chain survey"



(b) If we measure distance BC and angle ∠ABC, the point C can be plotted on sheet. This is used in "Traversing"



(c) If we measure ∠ABC & ∠BAC, then — "Triangulation"

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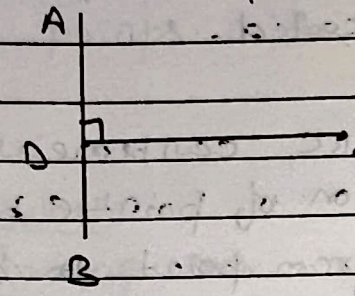
(d) If we drop a perpendicular CD on line AB & measure length CD & AD we can plot point C. This is used in plotting details.



★ **Scale** :- Graphical representation of ground on sheet.

→ It is the ratio of the distance between two points on the sheet and their corresponding distance on ground.

$$\text{R.F.} = \text{Scale} = \frac{\text{distance on the drawing sheet}}{\text{distance on the ground}}$$

→ (Representative factor)

→ Larger the denominator of R.F, the smaller the scale.

Correction in length —

on correct length of scale ⟹ incorrect length
(L_1) (L_2)

$$\text{on 1 unit} = \frac{L_2}{L_1}$$

then

$$\text{in whole chain} = \frac{L_2}{L_1} \times \text{length of whole chain}$$

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Formula

measured correct length = $\frac{(\text{incorrect length})_{tap}}{(\text{correct length})_{tap}}$ × measured length

Q The length of the line is measured with 20m chain was found 250m. Calculate the true length if the chain was 10 cm too long.

Sol:

Correct length = 20 + 0.1 = 20.1 m
incorrect length of tap = 20 m
measured length = 250 m
then
measured correct length = $\frac{20.1}{20} \times 250$

= 251.25 m. Answer

for area

Correct area = $\left[\frac{(\text{Incorrect length})_{tap}}{(\text{Correct length})_{tap}}\right]^2$ × measured Area.

Error due to wrong scale :-

Correct length = $\left(\frac{\text{R.F. of wrong scale}}{\text{R.F. of correct scale}}\right)$ × measured length

for area -

Correct area = $\left(\frac{\text{R.F. of shrunk scale}}{\text{R.F. of correct scale}}\right)^2$ × measured length

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Q. A Surveyer measured the distance between two point. marked on the plan drawn to scale 1cm = 1m & found. It is to be 50m. Later He detacte that wrong scale of 1m = 50cm. Determine correct length.

Sol^n Given that =

R.f. of shrunck scale = $\frac{1}{50}$ cm

R.f of correct scale = $\frac{1}{100}$ cm

measured length = 50m

Then

Correct measured length = $\frac{1/100}{1/50} \times 50$

= 100m Answer

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Unit of measurement :-

(1.) **Linear measurement :-** linear measurement is the measurement of Horizontal distance between two points on the ground.
→ It is done by instruments like chain, tape etc.

Note: 12 inches = 1 foot
3 feet = 1 Yard (गज)
1 mile = 5280 Yard
1 hactare = $100 \times 100\ m^2$
1 inch = 2.54 cm

It is devided into following part based on method-
(i) Direct measurement
(ii) Optical measurement
(iii) Electronical measurement

(A) **Direct measurement :-** (a) Chain
(b) Tape

Chain :- This is used for the measurement of the distance (horizontal) between two points on the ground.
Chain is made up of straight link of galvanized mild steal wires which is bend into rings or small circular rings.
There are four types of chain using in surveying.

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(A) Metric chain (B) Gunters chain
(C) Revenue chain (D) Engineering chain

(A) Metric chain :- In India, metric chains are available in 5m, 10m, 20m, 30m long but the most common in 30m (150 links) to 20 m (100 links) They are made up by galvanised mild steel wire of 4mm.
All links are 0.2 m except the end links.

Advantage of chain :-
→ Suitable for rough use
→ Can be easily repaired on the field.
→ Can be read easily.

* Disadvantages
→ Due to heavy weight, it sags when suspended in Air.
→ It length varies due to shortening/ lengthening of links.

Tolerance :- 5m chain = ± 3mm
10m chain = ± 3mm
20m chain = ± 5mm
30m chain = ± 8mm.

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(2.) Engineer's chain :-
length = 100 feet
number of links = 100
length of each link = 1 feet.

(3) Gunters chain :-
length = 66 feet
number of links = 100
length of each link = 0.66 feet = 7.92 inch.

(4) Revanue chain :-
length = 33 feet
number of links = 16
length of each link = $33/16$ = 2.11 feet.

* Tap correction :-

Correction for the absolute length :-

If the absolute length of the tape is greater then the designed length

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* Tape For high accuracy in linear measurement tapes are generally used in surveying.

(A) Cloth or linen tape made up by synthetic material.

available ⇒ 10m, 20m, 25m, 30m

width = 12-15 mm.

disadvantage -

(i) Affected by moisture

(ii) Its length gets altered by stretching

(B) Metallic Tape The metallic wires are not visible due to linen tape with copper wire.

They are light & flexible.

(C) Steel Tape They are made of steel or stainless steel strips.

→ 6-10 mm width.

→ It is more accurate the metallic tape.

(D) Invar Tape :- Made of an alloy of Ni + steel.

α (thermal expension) = 0.122×10^{-6} /°C (Very low)

width = 6 mm

Advantage (i) High precision

(ii) It is less affected by temp.

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Disadvantage :- i) It is soft & deform easily.
ii) It requires much attention.

Tape correction :-

For absolute length

If the absolute length of the Tape is greater then the designed length, the measurement distance will be too short. And correction will be additive.
visa - vercea -

$$C_a = \frac{L \cdot C}{l}$$

C_a = Correction for absolute
L = measured length
l = designed length
C = Correction for per tape length.

For Temperature

If the temperature during the measurement is more than the temperature at standardized of the tape then the ~~measurement~~ measured distance becomes less & correction will be positive.
visa - vercea

$$C_t = \alpha (T_m - T_o) L$$

here C_t = Correct for L = measured length.
α = ~~temp~~ Coeffi Thermal coefficient
T_m = T_o =

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* Impact of Infrastructual Developement :-

→ Infrastructural development will make import or export daily.
→ Increasing or irrigation facilities will lead to good production.
→ Providing of bettes education and medical infrastructural will provides the healthy & skilled workforce.
→ Boost in infrastructure will create the job opportunity and hence antisocial activities will reduce.
→ Quality of life will reduce.
→ Enhancement defence infrastructure will have been in existing peace in the country.
→ In case of natural clarities loses will be reduce results in.
→ Developement in the infrastructure the respectative status in the world.

* Role of Civil Engineers :- Following are the roles of civil engineers -
→ Measure the earth surface to prepare plan or map.
→ To provide transportation system.
→ To build various types of building.
→ To build bridges.
→ To provide irregation facilities.

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→ Provision of given lines : treatment plant.
→ Construction of Canal ; dams etc.

$= \alpha (T_m - T_o) \times L$

α = Coefficient of the thermal expention.
T_m = Temp. of the field during measurement
T_o = Temp. of which tape standardization.

Temp	Length of Tape	Distance measure	Correction
$T_m > T_o$	Increase	Less	Additive (+)
$T_o > T_m$	Decrease	More	Substractive (-)

Correction for the pull :-

$$C_p = \frac{P_m - P_o}{AE} \times L$$

here

P_m = Standard pull : (~~Press~~ Force) N
P_o = Pull applied during measurement
A = Cross section Area
E = Young modulas of elasticity N/mm²
L = Measured length on the ground.

Pull	length of tape	measured distance	Correction
$P_m > P_o$	Increase	less	Additive
$P_o > P_m$	Decrease	More	Substractive

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Correction for the Sag :- When the tape is stretched on the support between the points. it takes the horizontal distance which will be less then the along the curve.

→ The difference between horizontal distance & measured length along the curve is called the sag correction.

Correction of the slope :- The distance measured along the slope is always greater then the horizontal distance hence correction is always substructive

$$C_s = \frac{h^2}{2L}$$

this formula is used for gental correction slope.

→ For stip slope (20° to 30°) correction will be

$$C_s = \frac{h^4}{8L^3}$$

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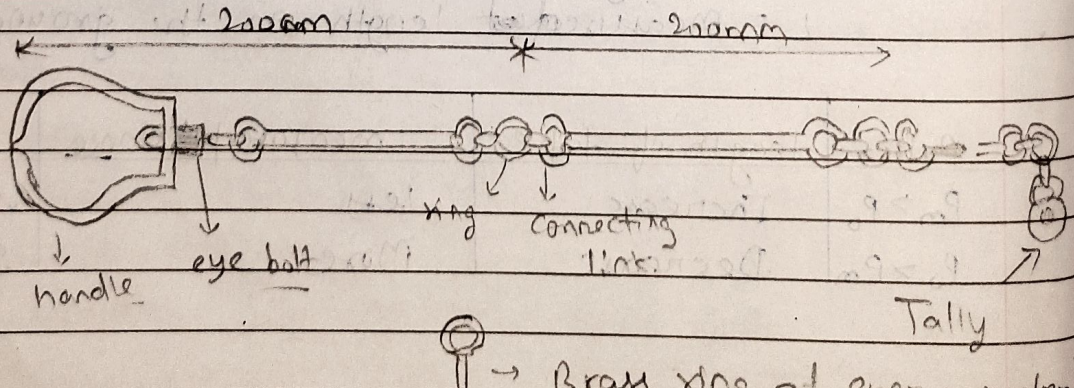
Chain



→ Brass ring at every meter length.

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Correction in Length:-

$$L = l_m \pm C_t$$

C_t = temp. correction

&

$$L = l \pm C_p$$

C_p = pull correction

* Ranging of surveying length:-

In a linear measurement for measurement of horizontal distance between two points, needed chain & Tap.

If the length of chain or tap is less then distance between the two points, Intermidiate point is established between both the points. To draw the straight line & measure the distance between both the points.

Straight line between the two points, is known as "survey line" (Chain line).

End points which are going to be measured horizontal distance between that points, known as "survey station."

→ To draw straight line or ranging out the survey line, there are two method are used in surveying.

(i) Direct ranging (ii) Indirect ranging.

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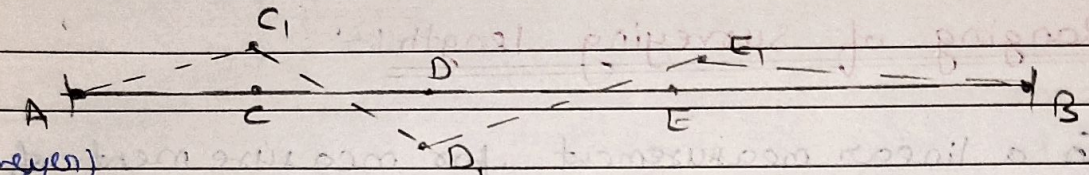
(End stations)

* Direct ranging :- When the two points are intervisible to each other, then the ranging is used, is known as Direct ranging.

(A) Eye Judgement (B) Line Ranger.

(A) Eye Judgement :-



(Surveyer)

→ Less accuracy.

→ It needs two surveyer

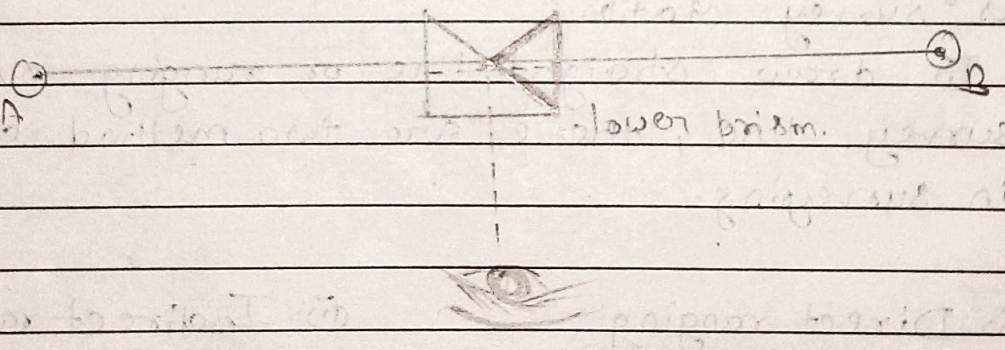
→ minimum three ranging rods are required.

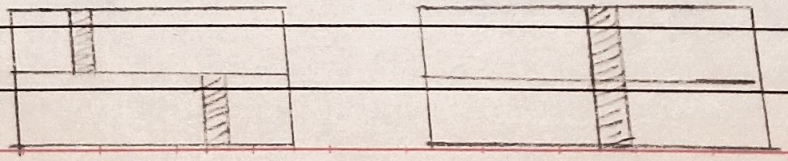
Process Ranging Rods erected at A & B

→ at intermidiate point C third rod erect & by eye judgement it should be in straight line with A & B. (Should be less then length of one Chain)

Again this process will be repeated & Distance is measured.

(B) Line Ranger It is used to establish intermidi point between two station.





Incorrect Correct

→ It needs only one surveyor.
→ fix two rods on A & B, And surveyor at point C in line of AB.
→ He would check by line ranger to see upper point A by upper prism & point B by lower prism.
→ If point B is not in line with A & B, then two image viewed may be separated.

* Indirect ranging :- When two end stations are not inter-visible to each other then Indirect ranging is used.

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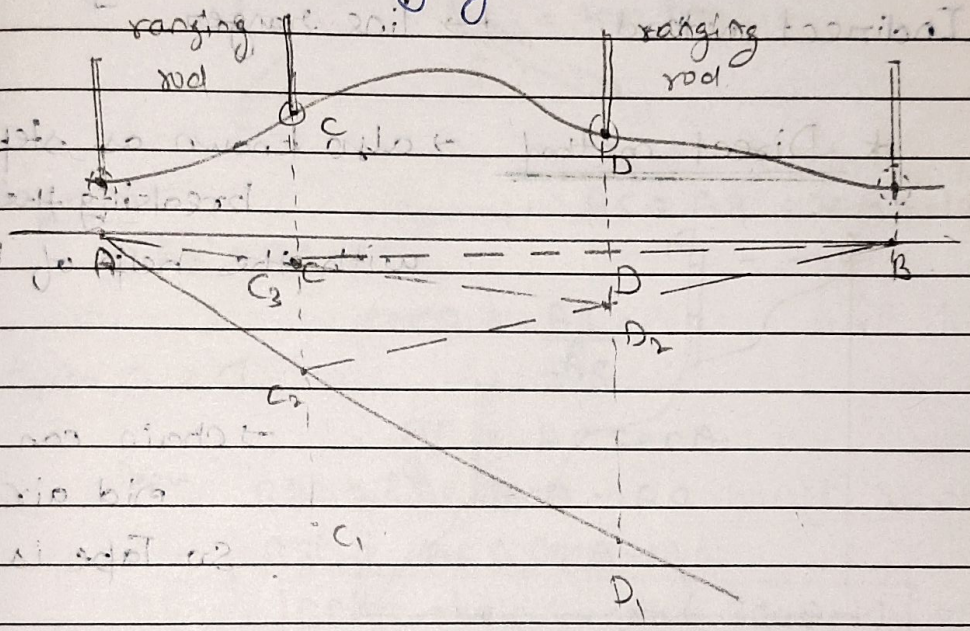


→ minimum 4 ranging rods are required.

Process

→ set C & D which are visible to each other.
→ Now draw point C, D, B in straight line.
Let D in straight with A & B one by one.
→ Two assistant are on C1 & D1 such as C1 can see D1 & A // D1 can see C1 & B
→ D1 directs C1 to move to C2 such as A, C2 & D1 in straight line.

→ Then C_2 directs the D_1 to move D_2 such as D_2, C_1 & B are on straight line
→ Then C & D are directed to the straight line.
By this C & D are the required intermediate points between A & B are found.

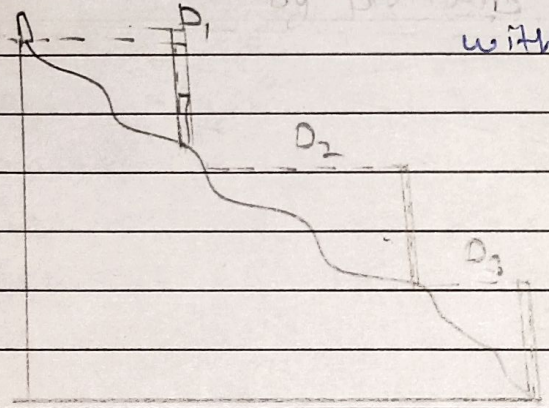
* Measurement of Sloping ground :-

for more the 3°

(i) Direct method → Eye judgement
(ii) Indirect method → line ranger

$L = L_1 + L_2 + L_3$

* Direct method → also known as stepping or breaking the chain meth
with the help of plumb bob

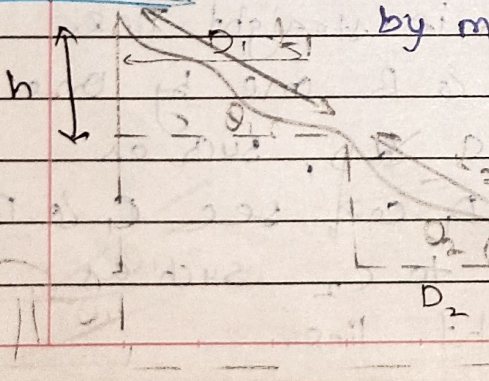


$D = D_1 + D_2 + D_3 + D_4$

→ chain can sag in mid air
So Tape is suggested

* Indirect Method

1. Method → with the help of clinometer or sextent by measuring horizontal angle.



$\frac{h}{D} = \tan\theta$

$h = D \tan\theta$

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or, $D_1 = L_1 \cos\theta_1$ θ = horizontal angle

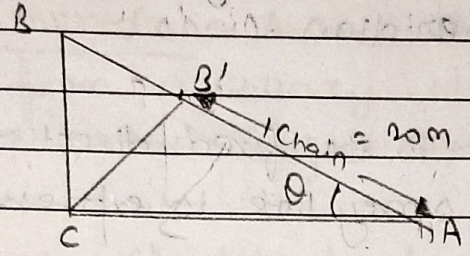
$D_2 = L_2 \cos\theta_2$

like wise

$D = D_1 + D_2 + D_3 + \ldots$

$$D = L_1\cos\theta_1 + L_2\cos\theta_2 + L_3\cos\theta_3 \ldots$$

Method 2 (hypotensual method)



by diagram $AC = AB' = 20m = 100$ links

$BB' = AB - AB'$

$\sec\theta = \frac{AB}{AC}$

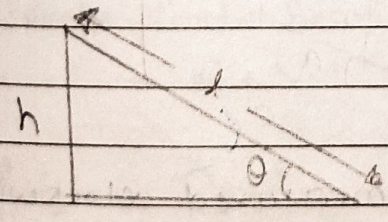
$AB = AC\sec\theta$

Now $BB' = AC\sec\theta - AC$

$BB' = AC(\sec\theta - 1)$

$$BB' = \text{chain length}(\sec\theta - 1)$$

Method 3 (Pythagoras theorem)



$h = D\tan\theta$

$$D = \sqrt{l^2 - h^2}$$

(less effective)

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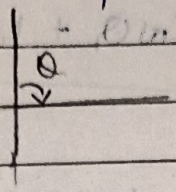
* **Compass Surveying :-** Compass is used to measure the horizontal angle with the stop. This survey is more accurate & done quickly as compared to chain survey.



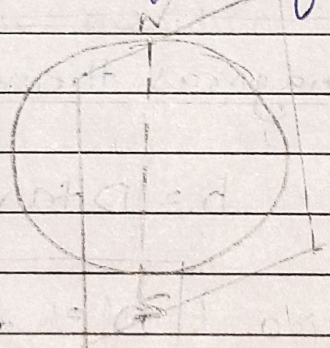
* **Bearing :-** It is an angle which measured from meridian.

Meridian :- It is the fixed direction in which the bearing of survey line is expressed.

Types of Meridian :-

(i) True meridian (ii) Magnatic Meridian
(iii) Arbitrary meridian.

True Meridian :- Direction line which passes through north & south poles & intersects the surface of earth.



True bearing :- The angle measured clockwise between the true meridian & the line is called true bearing.

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Megnatic Meridian :- It is the direction shown by a freely suspended / floating & balanced megnatic needle, unaffected by local attractive forces.

Megnatic bearing :- Angle measured from the megnatic meridian. It is known as Megnatic bearing :-

Arbitrary meridian :- A convenient direction, usually from a survey station to some well defined permanent object like the top of pier.

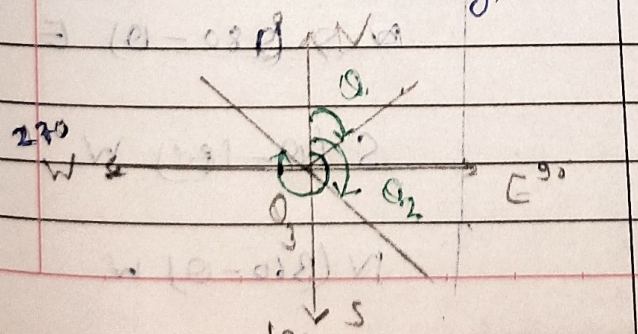
Usually some well defined objects like spire, chimney, top pear, etc.

Arbitrary meridian :- Angle measured from the arbitrary meridian. It is known as arbitrary meridian.

There are two method we use to measured bearing :-

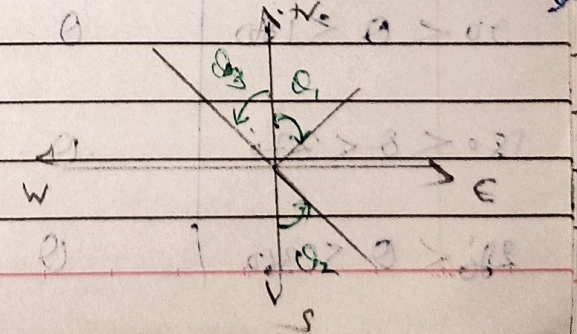
WCB

(Whole circle bearing)



QB / RB

(Quadrantal or Reduced bearing)



WCB	QB / RB
→ It is measured from north to south only.	→ It can be measured from north to south or south to north both.
→ Only in clock wise	→ anticlock wise or clockwise both direction. (as per suitability.)
→ In this method, angle is return as θ_1, θ_2, θ_3 & θ_4 (normal terms)	→ In this method, angle is return as N θ E, S θ E, S θ W, N θ W (with information of direction & compass)
→ Where θ is in 0 to 360°	→ where θ is in 0° to 90°
→ In this method; prismatic compass	→ In this method; surveying compass.

Conversion of Bearing WCB to QB :-

θ	WCB	QB
$0° \leq \theta \leq 90°$	θ	N θ E
$90 < \theta < 180$	θ	S (180 − θ) E
$180 < \theta < 270$	θ	S (θ − 180) W
$270 < \theta < 360$	θ	N (360 − θ) W

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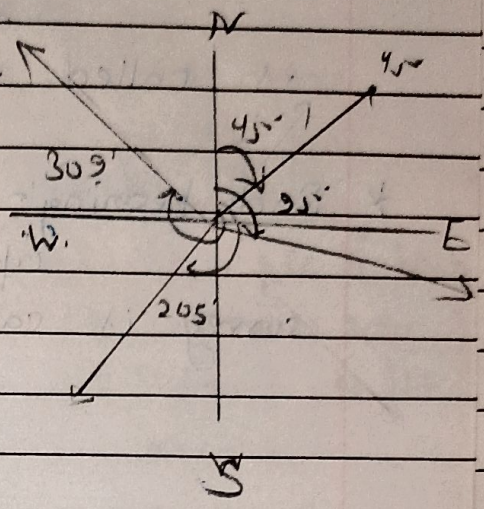
Q WCB ⇒ 45°, 95°, 205°, 309°

Soln ① QB ⇒ 45° ⇒ N 45° E

② 5° ⇒ S 5° E

③ 205° ⇒ S 25° W

④ 309° ⇒ N 51° W



Q

WCB	QB
45°15'	
95°25'	
205°45'	
309°35'	

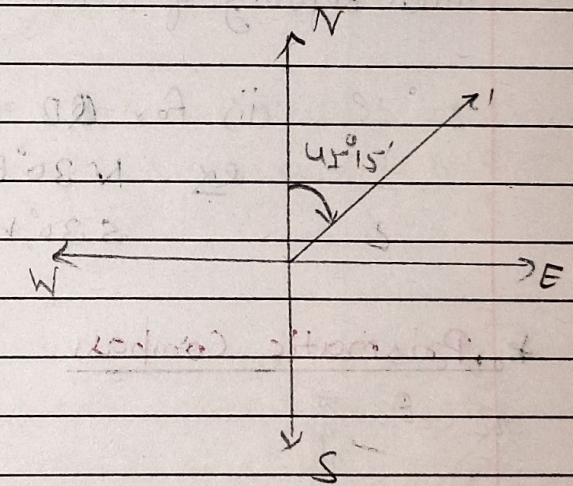
Soln

QB₁ = N 45° 15' E

QB₂ = S 84° 35' E

QB₃ = S 25° 45' W

QB₄ = N 51° 25' W



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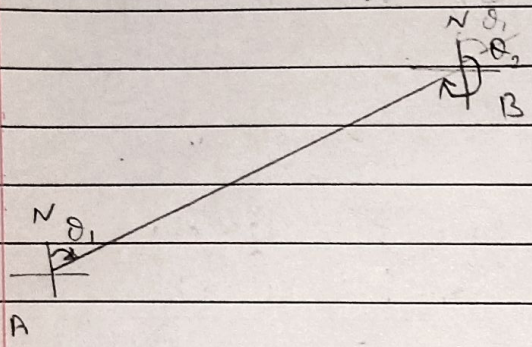
* **Fore bearing :-** The bearing of a line, in the direction of progress of the survey is called the fore bearing.

* **Back bearing :-** The bearing of a line in the opposite direction of progress of the survey is called the back bearing. (Reverse bearing)



Relation between FB & BB

(i) WCB System :-

$$BB = FB \pm 180$$

if bearing A to B = Fore bearing
then bearing of B to A = back bearing

(+ ⇒ FB < 180
− ⇒ FB > 180)

(ii) for QB ⇒ only directions are opposite

eg N 30° E = FB

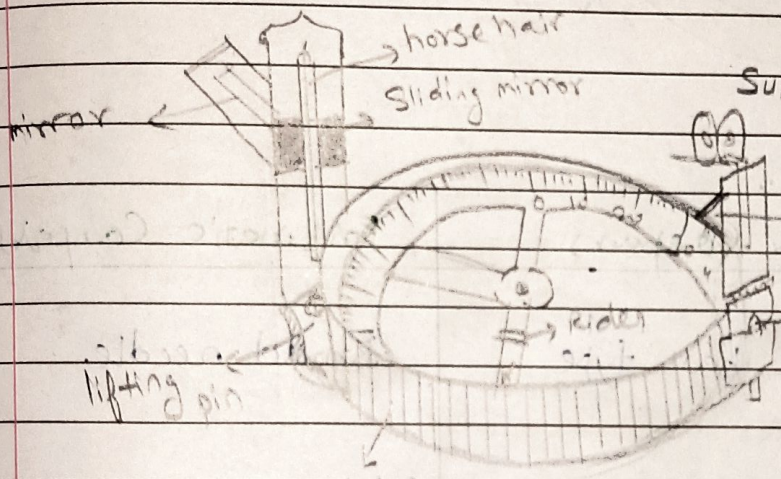
S 30° W = BB

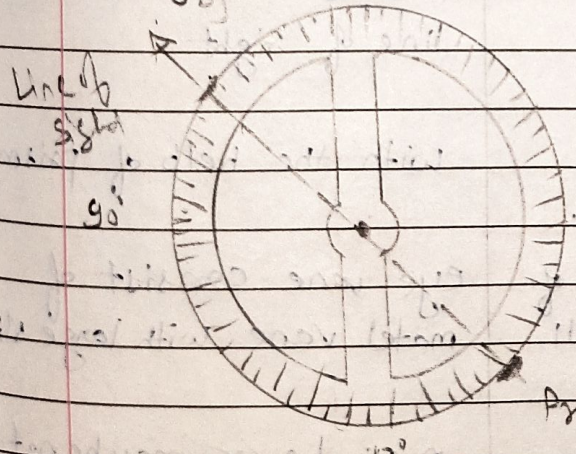
* **Prismatic Compass**

Date : __/__/____

Name

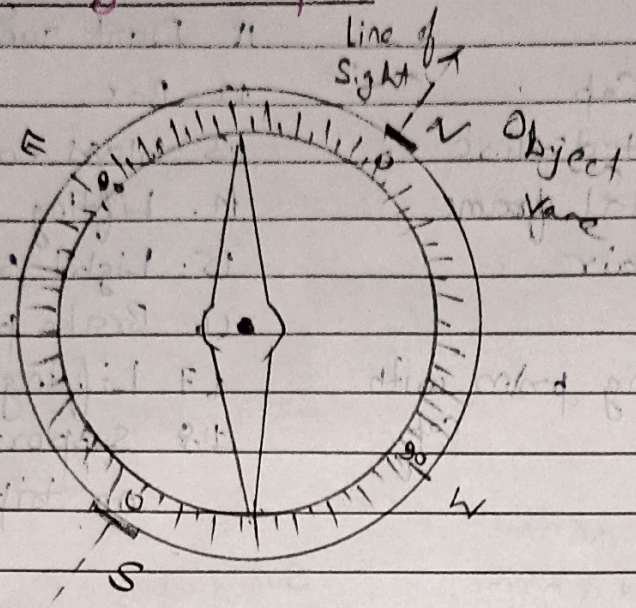
1. Needle
2. Pivot
3. Agate Cap
4. Graduated disc
5. Slit metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye Vane
10. Focusing stud
11. Dark sunglasses
12. Box
13. Glass cover
14. Lifting pin
15. Light spring.
16. Brake pin or knob
17. Lifting Lever
18. Support to fit on tripod.





Date : / /

Ans : Surveyor Compass



Difference

	Surveyor Compass	Prismatic Compass
Magnetic needle	Edge bar type	Broad needle.
Graduated ring	Attached to the box & rotates along with line of sight	Attached to the needle & does not rotate with line of sight
Reading System	by seeing directly through the glass.	with the help of prism.
Vanes	Eye vane consists of small vane with small slit	Eye vane consist of metal vane with large slit
Tripod	Essential.	may be or may be not.
Bearing system	QB System	WCB System

Date : __/__/____

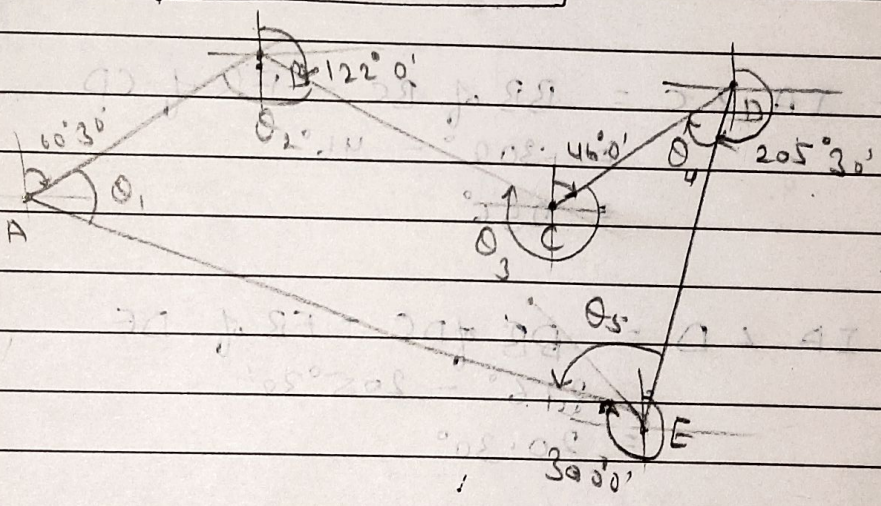
Interior Angle :- The Angle formed within a closed traverse is known as Interior Angle.

Q.

line	Fore bearing
AB	60°30'
BC	122° 0'
CD	46° 0'
DE	205°30'
EA	300° 0'

(1) Find the interior angle of the following forbearing

Soln



Back bearing of

AB = 60°30' + 180 = 240°30'

BC = 122°0' + 180 = 302°0'

CD = 46°0' + 180 = 126°0'

DE = 205°30' - 180 = 25°30'

EA = 300°0° - 180 = 120

Date : / /

Interior

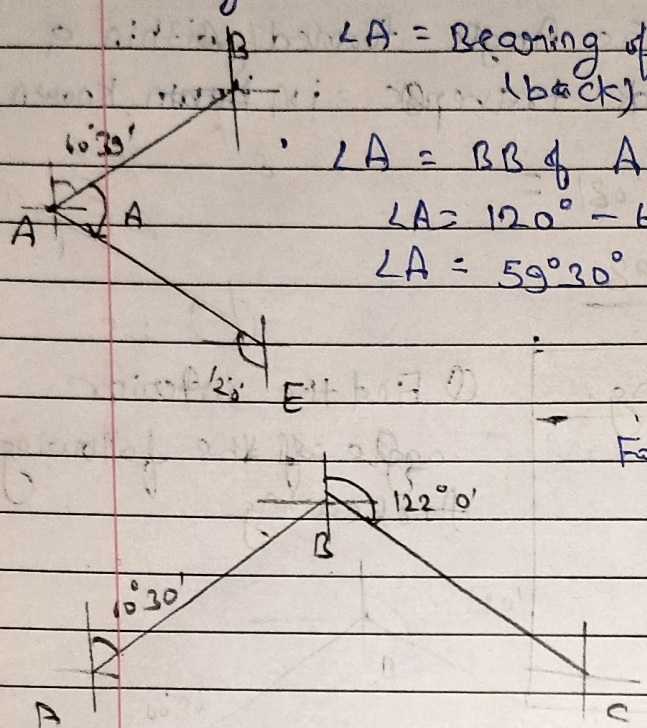
Angle A

$\angle A$ = Bearing of Previous line − Fore bearing of next line (back)

$\angle A$ = BB of AE − FB of AB

$\angle A = 120° - 66°39'$

$\angle A = 59°30'$



For IA

$\angle B$ = BB of AB − FB of BC

$\angle B = 302°30' - 120°$

$\angle B = 118°30'$

For IA $\angle C$ = BB of BC − FB of CD

$= 302° - 46°$

$= 256°$

For IA $\angle D$ = BB of DC − FB of DE

$= 226° - 205°30'$

$= 20.30°$

For IA $\angle E$ = BB of DE − FB of EA

$= 25°30' - 300° + 360°$ ↳ (for Anticlock wise)

$\angle E = 85°30'$

Note

[for cross check

Sum of $A+B+C+D+E = (2n-4)\,90°$

n = number of side]

$A+B+C+D+E = 540°$ Ans