Surveying :→ Surveying is the art of determining the relative positions of points on above or beneath the surface of the earth by means of direct or indirect measurment distance, direction, and elevation.

Principal of Surveying :→

① To work from the whole to the part

② To locate a new stations by at least two measurements (linear or angular) from fixed reference points.

① → According to the first principle.

① the whole area is first enclosed by main stations.

② the area is divided into no. of parts by forming well conditioned triangle.

③ the main survey line and well conditioned triangle are measured.

④. the purpose of this process of working is to prevent accumulation of error.

⑤. if there is any error in the measurment of any side of a triangle, then it will not affect the whole work

if error are present
→ then error can always be detected and eliminated.
→ if the reverse process is followed, then the minor error in measurements will be magnified in the process of expansion and a stage will come when these error will become absolutely uncontrollable.

(2) → According to (1)
→ the new stations should always be fixed by at least two measurments (linear or cirgular) from fixed reference points.
→ Horizontal length measured by - chain, or tape
→ Angular → Surveyor Compass or theodolite or Prismatic Compass.

Classification of Surveying →

A. Primary Classification

1. Plane Surveying :→ is that type of surveying in which the mean surface of the earth is considered as plane and the spheroidal shape is neglected.

on earth surface
1 sec = 195 km^2

Plane surveying is done on an area of less than 250 km^2

2. Geodetic Surveying :→ the curvature of earth is taken into consideration. It is extended over a large area exceeding 250 Km^2.

(2) Secondary Classification :→

(1) Based on Instruments.
- (a) Chain Surveying
- (b) Compass Surveying
- (c) Plane table surveying
- (d) Theodolite "
- (e) Tacheometric "
- (f) Photographic "

(2) Based on methods:
- (a) Triangular Surveying
- (b) Traverse Surveying

(3) Based on Object
- (a) Geological surveying
- (b) Mine "
- (c) Archaeological "
- (d) military "

(4) Based on nature of field.
- (a) Land → topographical (Natural features of Country); Cadastral (Boundry of field, State House); City
- (b) marine
- (c) Astronomical

→ Engg. Surveying.
detail drawing of Roads, Railway etc.

Plans & Maps :→

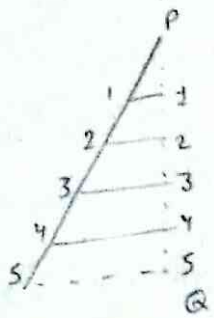
graphical representation to some scale, of the feature on, near or below the surface of the earth or projected on a horizontal plane which is represented by plane of the paper on which plan & maps are drawn

Plans	Maps
1 Cm = 10m	1 Cm = 1 Km
$\frac{1}{10,00}$	$\frac{1}{100000}$
Large Scale	Small Scale.

Scale → Scale is the fixed ratio that every distance on the plan bears with corresponding distance on the ground, Engg Scale = 1cm = 10 m, Representative fraction = $\frac{1}{10,00}$

① Plain Scale → A plain scale is one on which it is possibl to measure two dimension only such as units and larg

② Diagonal Scale → measure such as. 3 dimension. ① unit, ② tenth & hundreds, ③ Yard, feet, etc.



1-1 → represents $\frac{1}{5}$ PQ

2-2 " $\frac{2}{5}$ PQ

③ Vernier Scale →

→ Direct Vernier. $nV = (n-1)S$, Least Count = $\frac{S}{n}$

(nV ↓ Verniers Scale; S ↓ main Scale.)

→ Retrograde Vernier $nV = (n+1)S$.

Units of Measurments :→

12 inche. = 1 foot

3 feet = 1 Yard

1 rod, pole, or perch = $5\frac{1}{2}$ Yard

4 Pole = 1 Chain

10 Chain = 1 furlong

8 furlong = 1 mile

100 link = 1 Chain = 66 feet

6 feet = 1 fathom

6080 feet = 1 nautical mile.

Angular Measurements :→

Angle form

1 Circumference = 360°

1 Degree = 60' minute

1 minute = 60'' Sec

hour form

1 Circumference = 24h

1 hour = 60 min

1 min = 60sec

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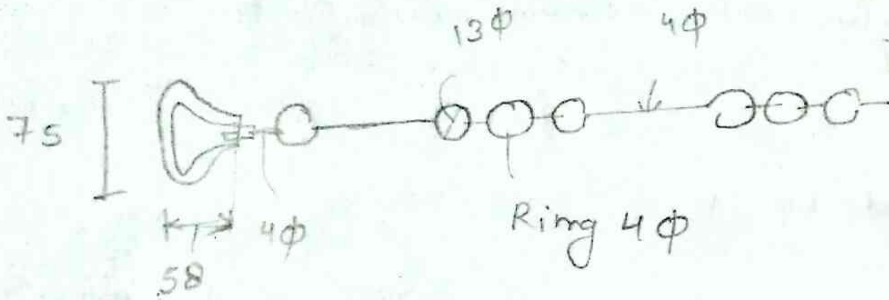
Linear Measurements :→ A chain or tape is invariably used for linear measurements in surveying.
for work of ordinary precision, a chain can be used whereas for higher precision a tape is used.

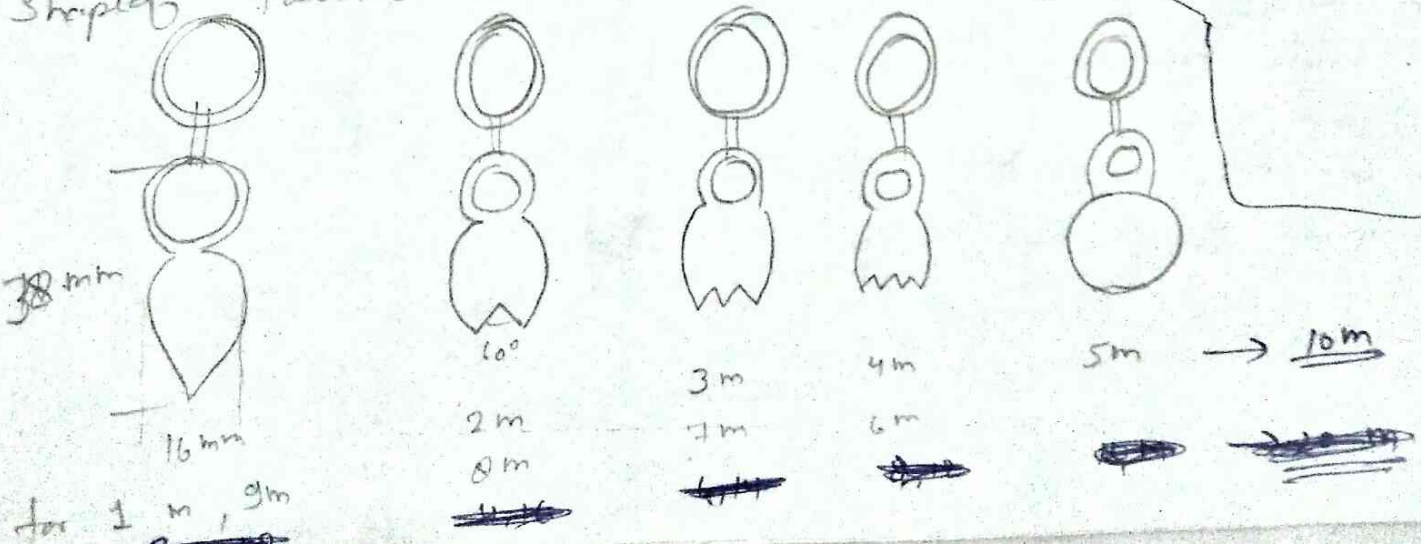
Chain :→



- one link = 0.2 m = 20 cm
- tallies are provided at every meter length for chain of 5m and 10m and every 5m length for the chain of 20m & 30m length.
- In the case of 20m & 30m chain Brass Ring shall be Provided at every meter length.

20m chain	→	100 link	± 5 mm
30m chain	→	150 link	± 8 mm
10m "	→	50 link	± 3 mm
5 m "	→	25 link	± 3 mm

Shaped tallies → for 10 m chain.



diff. type of chain :→

→ Gunter's Chain :→ 66 feet, 100 link, → each link = 0.66ft.

10 Gunter's chain = 1 furlong.

80 " " = 1 mile.

→ Revenue Chain :→ 33 feet, 16 links. each link = $2\frac{1}{16}$ feet

→ Engginners Chain :→ 100 feet, 100 link, each link = 1 feet

→ Band chain or steel Band :→ steel Band is attached to a blue steel long narrow strip. which has a

uniform width → 12 to 16mm

thickness → 0.3 to 0.6mm thick

available in length = 20m to 30m.

Tape :→ for higher accuracy in linear measurments tapes are invariably used in surveying.

① Linen or cloth tape :→

→ These are closely woven linen or synthetic material and are varnished to resist the moisture.

→ length, → 10 m, 20 m, 25m & 30m, width 12 to 15mm.

→ disadv. → affected by moisture & shrunk

② Metallic tape :→

→ made of varnished strip of water proof linen interwoven with small Brass, Cu, Bronze wire.

→ light & flexible and are not easily broken.

③ steel tape.

→ width 6 to 10mm and is more accurately graduated.

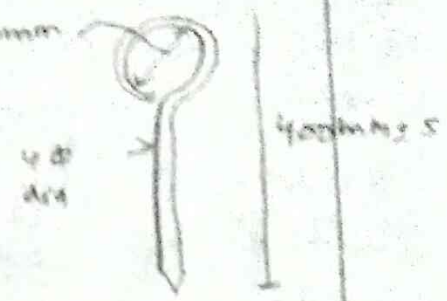
→ the tapes of 10', 20, 30, & 50 m. length are provided with a brass ring at the outer end.

④ Invar tape →

→ use for very high degree of Precision.

→ made of [nickel (36%), steel (64%)]

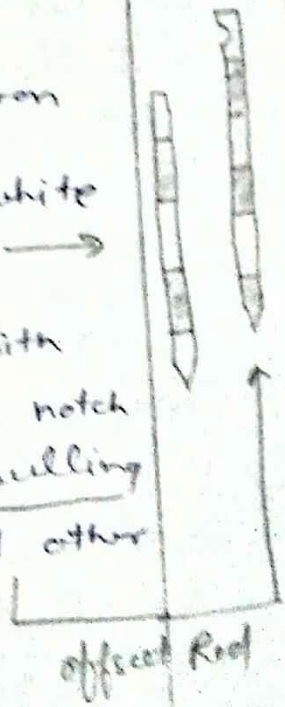
Arrows :→ An arrow is inserted into the ground after every chain length measured on ground. lengths are varry 25 cm to 50 cm.
→ one end of arrow is made sharp and other end is bent into a loop.



Wooden pegs:→
Wooden pegs are used to mark the position of the station or terminal points of a survey line.
→ Size - 2.5 cm or 3 cm sq² & length 15 cm long. & tapered at the end.

Ranging Rods:→
→ length of either 2m or 3m.
→ they are shod at the bottom with a heavy iron Points.
→ Painted in alternative bands of either black & white or Red & white each band 20cm deep.

offset Rod :→ the all other quality are same with Ranging Rod but diff is provided with a notch or a hook at the other. the hook facilitates pulling and pushing the chain through hedges. and other obstruction.



→ **Equipment for measuring Right Angle**
Cross staff, optical Sq, Prism Sq,

Ranging out survey lines :→

While measuring the length of a survey line or chain line the tape must be stretched straight along the line joining its two terminal stations.

→ if the length of line is less than the tape length then there will be no difficulty.

→ if the length of the line exceed the length of the chain some intermediate points will have to be established in line with the two terminal points before chaining is started.

→ the process of fixing or establishing such intermediate points is known as Ranging.

→ Direct Ranging :→ Direct Ranging is done when the two ends of the survey lines are intervisible.

→ Ranging can be done by eye or thorough line ranger or a theodolite.

Method

→ Let A & B be the two points at the ends of a survey line. & fixed the Ranging Rod.

→ the next candidate then goes with another ranging rod and establishes the rod at a point approximately in the line with AB at a distance not greater than one Chain length from A.

→ the surveyor at A then signal the assistant to move transverse to the chain line till he is in line with A and B.

→ Indirect or Reciprocal Ranging :→ when both the ends of the survey line are not intervisible either due to high intervening ground or due to long distance between them.

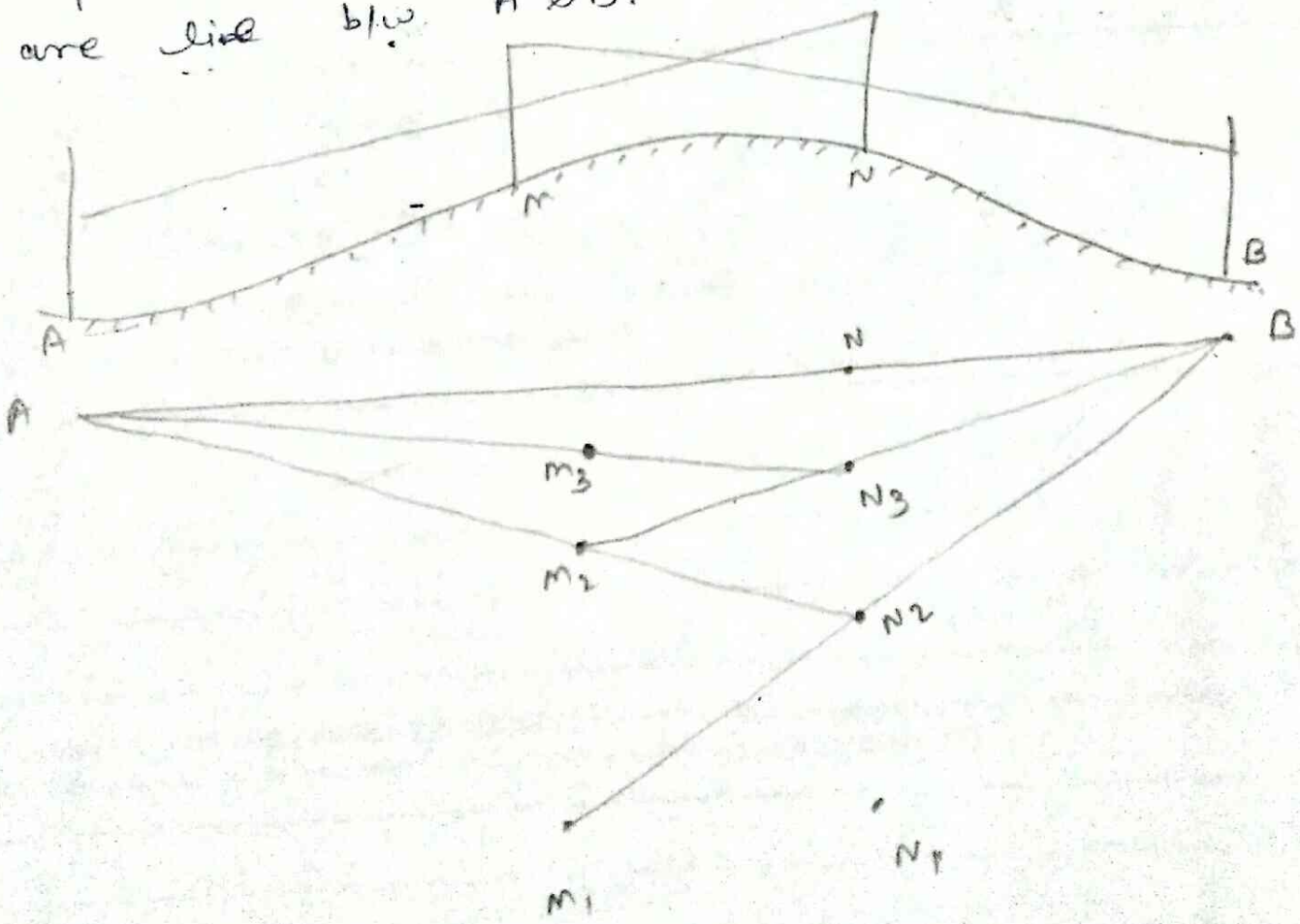
→ In such a case, two Intermediates points m_1 & N_1 selected such that m_1 are visible from N_1 & B & N_1 are visible from m_1 & A.

→ Then M_1 & N_1 Person at m_1 directs the person at N_1 to move to a new position N_2 in line with M_1B

→ The person at N_2 then direct the person at m_1 to move to a new position m_2 in line with N_2A

→ Then the two person N_2 & m_2 nearer to chain line

→ The process is repeated till the points m and N are like b/w A & B.



Method of Chaining :→ Two men are reqd for chaining operation The chain man at the forward end → called leader & at the other ~~end~~ man at rear end is called follower.

Duties of leader & follower

Leader → ① To put the chain forward
② To fix arrow at the end of chain
③ To follow the instruction of the follower.

follower ① To direct the leader to the line with the Ranging Rod.
② To carry the rear end of the chain
③. To pickup the arrow inserted by the leader.

Chaining ① The follower holds the zero handle of the chain against the peg & directs the leader to be in line of the ranging rod.
②. The leader usually with to arrows drags the chain along the line.
③. using Code of Signals the follower directs the leader or required to the exactly in the line.
④. The leader then fix the arrows at the end of chain the process is repeated.

Basic Definitions :→

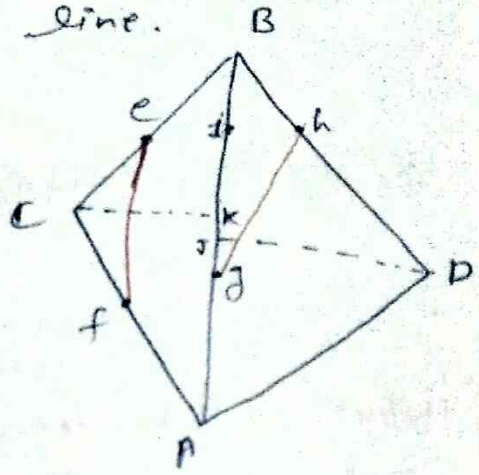
Main Stations :→ main station is a point in the chain survey where the two sides of a triangle meet. These station command the boundary of the survey line.

A, B, C, D are main station.

Tie Station or Subsidiary Station.

Tie station is a stations on a survey line joining two main station.

e, f, g, h, i are the tie station.



main survey line

AD, DB, BC, CA, BA

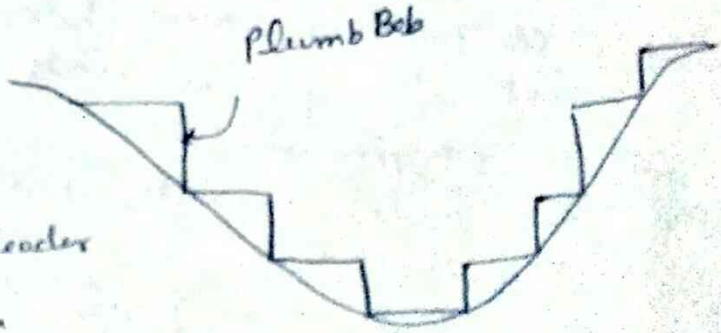
Tie line → A chain line joining two tie station is called tie cline. Tie line are provided to locate the interior detail which are far away from the main survey line.

Base line → It is the longest main survey line, BA.

check line check line or proof line is a line provided to check the accuracy of the field work Ck & Dj are check line.

Measurements on sloping ground: →

1. Stepping : → on ground that is of variable slope this is the best method.
   - → The measurment is done in short length of 5-10 m, the leader holding the length Horizontal.
   - → The point on the ground below the free end of the tape is best located by plumb bob.
   - → It is easier to work down hill while stepping.



② Measuring along the slope :→

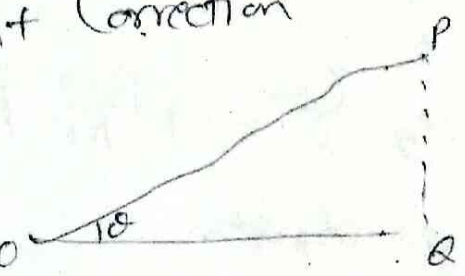
This method is useful where the ground run in long regular slopes.

The slope is measured by.

Abney level or by levelling, a procedure that gives the surface height at points along the slope.

Actual length = measured length + Correction

$$OQ = PO\cos\theta$$



Correction [Correction = T.L - M.L
error = M.L - T.L

1. Correction for Absolute length :→

$$\frac{\text{Corred length } (L)}{\text{Measured length } L'} = \frac{\text{Actual length of tape } (l')}{\text{Nominal length of tape } (l)}$$

$$\frac{CL}{ML} = \frac{AL}{NL}$$

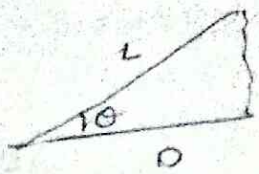
$$\frac{L}{L'} = \frac{l'}{l} \Rightarrow \boxed{L = \frac{L'l'}{l}}$$

Similarly true Area = $\left(\frac{l'}{l}\right)^2 \times$ measured Area

Volume = $\left(\frac{l'}{l}\right)^3 \times$ measured Volume.

2. Correction for Slope (Cg)

(a). When angle of Slope θ is measured

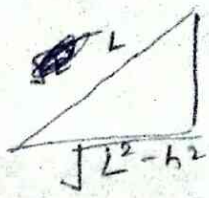


$= D - L$

$= L\cos\theta - L$

$= -L(1 - \cos\theta)$

(b) When difference of elevation (h) measured



$$C_g = \sqrt{L^2 - h^2} - L$$

$$= L\left[\left(1 - \frac{h^2}{L^2}\right)^{\frac{1}{2}} - 1\right]$$

$$= L\left[\left(1 - \frac{1}{2}\frac{h^2}{L^2} - \frac{h^4}{8L^4}\right) - 1\right]$$

$$C_g = -\frac{Lh^2}{2L^2} = -\frac{h^2}{2L}$$

(neglecting Smaller term of higher powers)

3. Correction for pull (Tension) (C_p)

$$C_p = \left(\frac{P - P_s}{AE}\right) L$$

$C_p \rightarrow$ Correction for Pull

$P_s \rightarrow$ Standard Pull

$P \rightarrow$ Pull applied during measurements.

$A \rightarrow$ Area of x section of tape

$E \rightarrow$ MOE of tape.

$= 2.1 \times 10^5$ N/mm^2 of Steel tape

$= 1.54 \times 10^5$ for Invar tape

4. ~~Correction~~ Correction for Standardisation

$$= nL\left(\frac{AL - NL}{NL}\right)$$

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4. Correction for temperature.

The length of tape changes due to changes in the temp.

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

C_t → Correction for temp.

α → Coeff. of thermal expansion of material

= 3.5×10^{-6} /°C for steel tape

= 1.22×10^{-7} /°C for Invar tape.

L = measured length.

T_m → mean temp during measurements.

T_o → temp of Standardisation.

5. Correction for Sag

$$C_s = -\frac{W^2 L}{24 P^2}$$

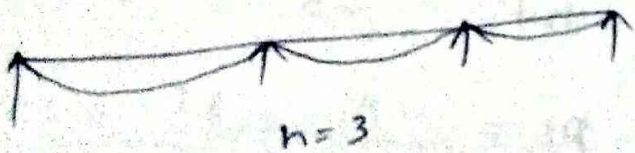
$$C_s = -\frac{W^2 L}{24 n^2 P^2}$$

W → total wt of tape ~~or chain~~

P → applied pull in N.

L → length of tape suspended b/w support

n → no. equal span.



Qus The length of a line measured with a 20m chain was found to be 250m. Cal the true length of the line if the chain was 10cm too long.

CL = ?
ML = 250m
AL of tape = 20.1
N.L of tape = 20

$$\frac{CL}{ML} = \frac{AL}{NL}$$

$$= 250 \times \frac{20.1}{20} = 251.25$$

Qus The length of a survey line was measured with a 20m chain and was found to be equal to 1200m. As a chek the length was again measured with 25m chain and was found to be 1212m. On Comparing the 20 m chain with the test gauge, it was found to be 1 decimeter too long. find the actual length of the 25m chain used.

m, deci cent mm

Sol ① with 20m chain

NL → 20m
ML → 1200m
AL → 20 + 0.10 = 20.1 m

$$\frac{CL}{ML} \rightarrow \frac{AL}{NL} \Rightarrow CL = 1200 \times \frac{20.10}{20} = 1206 m$$

② with 25m Chain

CL → 1206
ML → 1212
AL → ?
NL → 25

$$\frac{1206}{1212} = \frac{AL}{25}$$

$$AL = \frac{1206 \times 25}{1212} = 24.88 m.$$

Qus ~~A20 m~~ A 20 m chain used for a survey was found to be 20.10m at the begining and 20.30m at the end of the work. The area of the plan drawn to a scale of 1 Cm = 8m was measured with the help of a planimeter and was found to be 32.56 Sq Cm. find the true area of the field.

Sol Avg. length of the Chain = $\frac{20.10 + 20.30}{2} = 20.20$ m

Measured Area = 32.56 Cm^2

on plan

Measured area on ground = $32.56 (8)^2 = 2083.84 m^2$

b/c 1 Cm = 8m

$\frac{\text{Correct Area}}{\text{measured Area}} = \left(\frac{AL}{NL}\right)^2$

$= 2083.84 \times \left(\frac{20.20}{20}\right)^2$

$= 2125.73 m^2$

Qus A steel tape of nominal length 30 m was used to measure a line PQ by suspending it between supports if the measured length was 29.861 m when the slope angle was 3°45' and the mean temp and tension applied were respectively 10°C & 100 N, determine the Correct Horizontal length.

The standard length of the tape was 30.004 m at 20°C 44.5 N Tension. The tape weighed 0.16 N/m and had a cross sectional area of 2 mm², $E = 2 \times 10^5$ N/mm² $\alpha = 1.12 \times 10^{-5}$ per °C

Sol ① Slope Correction $= -L(1-\cos\theta)$

$= -29.86(1-\cos 3°45') = -0.064$ m

② Correct length →

$\frac{CL}{ML} = \frac{AL}{NL} \Rightarrow CL = 29.861 \times \frac{30.004}{30}$

$CL = 29.865$

Standardisation Correction $= CL - ML$

$= 29.865 - 29.861$

$= +0.004$

③ Temperature Correction $= \alpha (T - T_0) L$

$= 1.12 \times 10^{-5} (10 - 20) \times 29.861 = -0.003\,m.$

④ Pull Correction $= \dfrac{(P - P_0) L}{AE}$

$= \dfrac{(100 - 44.5)\ 29.861}{2 \times 2 \times 10^5} = 0.004\,m$

⑤ Sag Correction $= \dfrac{W^2 l}{24 P^2} = \dfrac{(w \times l)^2 l}{24 P^2}$

$= -\dfrac{(0.16)^2 \times (29.861)^3}{24 \times 100^2} = -0.003\,m$

⑥. Total Correction

$-0.064 + 0.004 - 0.003 + 0.004 - 0.003 = -0.062$

Correct Horizontal distance

$= 29.861 - 0.062 = 29.799\,m$

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Angular Measurment

Instrument Used.

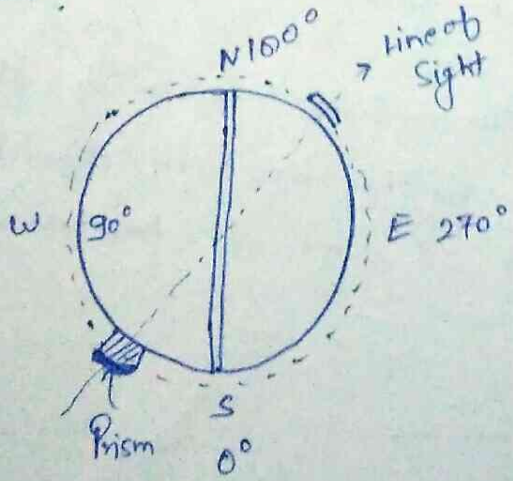
① Prismatic Compass: →

① Magnetic needle → The needle is of broad needle type. The needle does not act as index.

② graduated Card → (i) The graduated card ring is attached with the needle. The ring does not rotate along with the line of sight

(ii) The graduation are in W.C.B system having 0° at South end. 90° at west, 180° N & 270° E

(iii) ~~The graduation are engraved inverted.~~



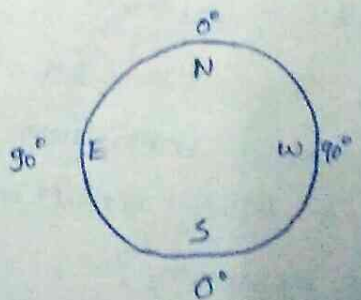
② Surveyor Compass

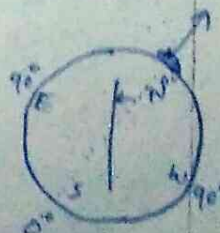
The needle is of edge Bar type. The needle acts as the index also.

(i) The graduated card is attached to the Box and do not to the needle. The card rotate along with the line of sight.

(ii) The graduation are in Q.B System. having 0° at N & S. and 90° at east & west. East & west are interchanged

(iii) ~~The graduation are engraved erect.~~





5. Sighting Vanes :→ (a) The object Vane Consists of metal vane with a vertical hair. (b) The eye Vane Consist of a small metal vane with slit.	(a) The object Vane Consist of a metal vane with a vertical hair. (b) The eye vane Consist of a metal vane with a fine slit
4. Reading : (a) taken with help of a prism.	(b) taken by directly seeing through the top of the glass.
(b) Sighting & Reading taking is done simultaneously from one position of the observer	(a) not Can not be
6. Tripod → Tripod may or may not be provided. we can be used even by holding suitably in hand.	→ the Instrument Can not be used without a tripod.

① Definitions :→

① True Meridian :→ The line or plane passing through the geographical North & south pole and any point on the surface of the earth.

→ The angle B/w True Meridian & line is known as.

True Bearing :

→ It represent the true north-south pole direction at the Pole.

② Magnetic meridian :→ when a magnetic needle is suspended freely and balanced properly, un affected by magnetic substance then its direction show magnetic meridian.

→ Angle B/w line & magnetic meridian is known as

Magnetic Bearing.

③ Arbitrary Meridian :→ if any convenient direction is assumed as meridian, known as the arbitrary Meridian.

& Angle B/w arbitrary meridian & line is known as.

Arbitrary Bearing.

4) Grid Meridian:→ some times for preparing a map some state agencies assumed several line parallel to the true meridian for a particular Zone. These line termed as grid line and the center line the grid meridian. ∅ Bearing w.r.t. grid meridian is known as. grid Bearing.

→ Designation of Magnetic Bearing:→

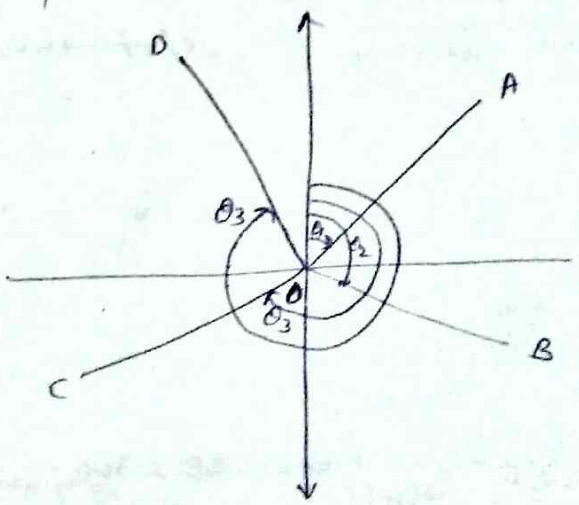
① Whole Circle Bearing (WCB) →

The magnetic Bearing of a line measured clockwise from the North pole towards the line is known as WCB,

→ Prismatic Compass is used ~~for~~ in WCB

→ Bearing may have any value b/w 0° to 360°

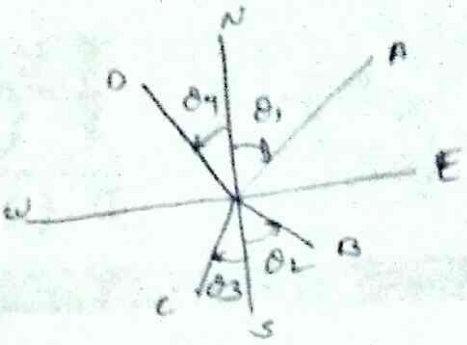
WCB of OA = θ_1
" OB = θ_2
" OC = θ_3
" OD = θ_4



(2) Quadrantal Bearing :- WB of line measured clockwise or Anti clockwise from the North or South pole (whichever is nearer the line)

→ Surveyor Compass used in QB

→ angle B/w 0° to 90°



QB of OA = N θ1 E
OB = S θ2 E
OC = S θ3 W
OD = N θ4 W

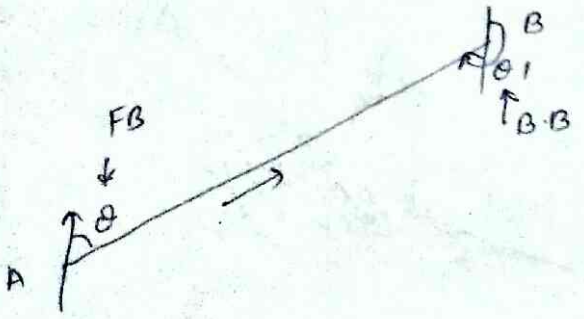
(3) Reduced Bearing → When WCB Converted into QB.

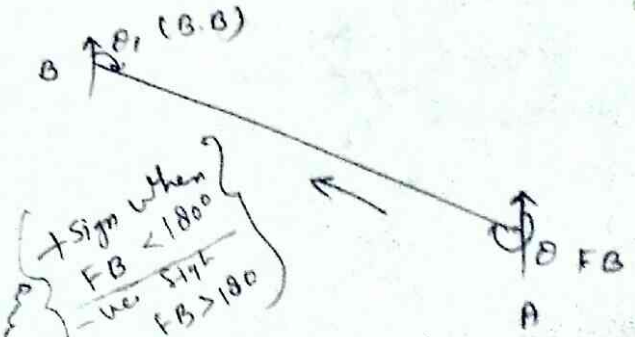
WCB between	RB	Quadrant
0° to 90°	RB = WCB	NE
90° to 180°	RB = 180° - WCB	SE
180° to 270°	RB = WCB - 180°	SW
270° to 360°	RB = 360° - WCB	NW

(4) Fore & Back Bearing →

→ The bearing of a line measured in the direction of the Progress of survey is called the fore bearing of the line

→ The bearing of a line measured in the direction opposite to the survey is called the Back bearing.





In WCB System ~~FB = BB ± 180°~~ → FB & BB Numerically equal

In QB System but the Quadrent are just opposite.

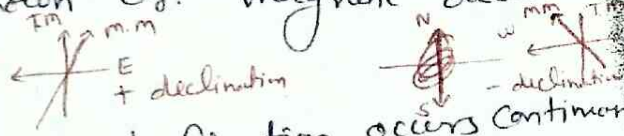
N 30° E ⇄ S 30° W

N 30° W ⇄ S 30° E

Name of Faculty: ..... Name of Subject: ..... Code: .....

Magnetic declination :→ The horizontal angle b/w magnetic meridian & true meridian is known as magnetic declination.

Variation of magnetic declination



① Secular Variation → Secular Variation of declination occurs continuously over a long period (> 100 Yrs).
→ It swing from one direction to opposite direction

② Annual Variation →
→ It is the change in the declination at a place over a Period of 1 Year.

③ Diurnal Variation
→ It is the change in the declination at a place in 24 hr. b/c rotation of earth its own axis.
→ amount of variation in diff. position of time.
(i) Geographical position of the pole (lesser at equator & more at pole)
(ii) Time of day (more in day)
(iii) Season of the year (more in summers)

④ → Irregular Variation → Magnetic declination is found to vary suddenly due to some natural causes., such as earthquakes, Volcanic erruptions and so on.

Local attraction :- Local magnetic attraction is the attraction of the magnetic needle to a local magnetic field other than earth's field.
Eg Iron pipes, iron fnes., steal Bars etc.

Qus① Convert WCB to QB

① $22°3'$ → $N\ 22°30'\ E$
② $170°12'$ → $180° - WCB = S\ 9°48'\ E$
③ $211°54'$ → $WCB - 180° = S\ 31°54'\ W$
④ $327°24'$ → $360° - WCB = N\ 32°36'\ W$

② Convert QB to WCB

① $N\ 12°24'\ E = R.B = 12°24'$
② $S\ 31°36'\ E = 180° - RB = 148°24'$
③ $S\ 68°6'\ W = 180 + RB = 248°6'$
④ $N\ 5°42'\ W = 360° - RB = 354°18'$

Qus. The following are observed fore Bearing of the line. & find their back bearing.

Line	Bearing	Back Bearing.
AB	$12°24'$	$180° + 12°24' = 192°24'$
BC	$119°48'$	$119°48' + 180° = 299°48'$
CD	$266°30'$	$266°30' - 180° = 86°30'$
DE	$354°18'$	$354°18' - 180° = 174°18'$
PQ	$N\ 18°0'\ E$	$S\ 18°0'\ W$
QR	$S\ 12°24'\ E$	$N\ 12°24'\ W$
RS	$S\ 59°18'\ W$	$N\ 59°18'\ E$
ST	$N\ 86°12'\ W$	$S\ 86°12'\ E$

Interior

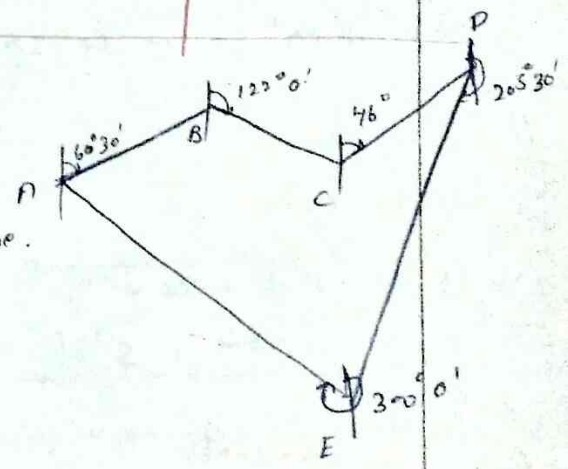
PAGE NO. .....

~~Include~~ Angle → = F.B of Previous line - F.B of next line.

Que The following bearing were observed with a compass. Cal. the interior angle.

Line	Fore Bearing.	B.B
AB	60°30'	
BC	122° 0'	
CD	46° 0'	
DE	205° 30'	
EA	300° 0'	

Sol



Include angle

= Bearing of previous line - Bearing of next line.

$\angle A$ = Bearing of AE - Bearing of AB

= (300° - 180°) - 60°30' = 59°30'

$\angle B$ = Bearing of BA - Bearing of BC

= (60°30' + 180°) - 122° = 118°30'

$\angle C$ = Bearing of CB - Bearing of CD

= (122° + 180°) - 46° = 256°

$\angle D$ = Bearing of DC - Bearing of DE

= (46° + 180°) - 205°30' = 20°30'

$\angle E$ = Bearing of ED - Bearing of EA

= (205°30' - 180°) - 300° + 360° = 85°30'

Sum = 540°00'

Check = (2n-4) 90°

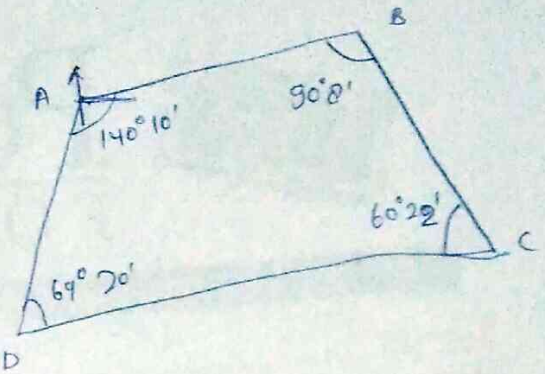
= (2×5-4) × 90°

= 540°

Qus Cal. the Bearing of line if.

$\angle A = 140°10'$, $\angle B = 99°8'$, $\angle C = 60°22'$ $\angle D = 69°30'$

& FB of line AB = 60°0'



~~Bearing of AD = FB of~~

∠- BB of Pre. line - FB of Next line.

$\angle A$ = AD − 60°0' (AB)

Bearing of.

AD = $\angle A$ + 60°0'

= 140°10' + 60°0' = 200°10'

$\angle B$ = BA − BC

BC = BA − $\angle B$

= 240° − 90°8' = 149°52'

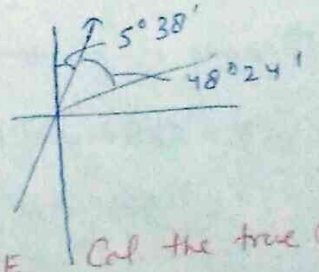
$\angle C$ = CB − CD

$\angle C$ = 329°52' − CD

CD = 329°52' − 60°22' = 269°30'

AB	60°0'	BA	240°00'
BC	149°52'	CB	329°52'
CD	269°30'	DC	89°30'
DA	20°10'	AD	200°10'

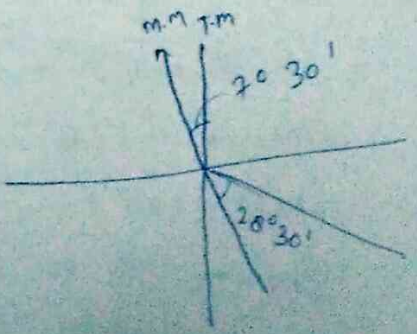
Qus The M.B of line → 48°24'. Cal. T.B of line if magnetic declination is 5°38' East.



T.B = M.B + declination

= 48°24' + 5°38' = 54°02'

Qus The magnetic B. of line AB is S28°30'E. Cal the true Bearing if the 7°30' west



True Bearing = S28°30'E + 7°30'

= S 36°00' E

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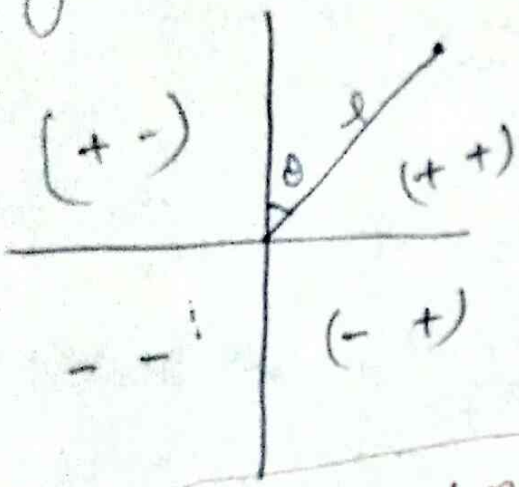
Latitude & Departure

Latitude → latitude of a survey line may be defined as co-ordinate length measured ⊥ to an assumed meridian direction.

Departure :→ Departure of a survey line may be defined as its co-ordinate length measured at right angles to the meridian direction.



$L = +L\cos\theta$

$D = +L\sin\theta$.

Ex-

Line	Length (m)	W.C.B	R.B.	Latitude	Departure
AB	232	32° 12'	N 32°12'E	+ 196.32	+ 123.63
BC	140	138°36'	S41°24'E	- 111.02	+ 97.88
CD	417	202°24'	S 22°24'W	- 385.54	- 158.90
DE	372	292° 0'	N68° 0'W	+ 139.36	- 329.39

Introduction of total Station :→

→ total Station is Combination of an electronic theodolite ⊗ electronic distance measuring (EDM) device ⊗ a micro processor with memory unit.

→ This Combination make possible to determine the co-ordinates of a reflector aligning the instrument cross hair on the reflector ⊗ simultaneously measuring the verticle ⊗ horizontal angle ⊗ slope distance.

→ A micro processor in the instrument takes care of recording reading and the necessary computation.

Advantage

→ Quick Setting of the Instrument on the tripod using laser plummet.

→ On Broad area computation programme to compute the area of the field.

→ Greater accuracy in area computation

→ Full GIS Creation (using mapinfo Software)

→ gis reduce the time ⊗ also its measure upto 3 to 5 km distance.

Dis advantage

→ The instrument is costly ⊗ Conducting survey using total Station skilled person are required.

→ for an over all check of the survey, it will be nessary to return to the office and prepare the drowing using appropriate software.

~~Precaution~~ :→ Precaution

→ Setup the tripod as stable as possible

→ Do not move or carry a tripod with the total Station fixed on it. except for centering.

→ Store the battery pack with the battery discharged.

→ Do not over tighten any of the clamp screw

→ take max care when the tribach is removed from the total Station.

Levelling

Object → The aim of levelling is to determine the relative height of different objects on or below the surface of the earth and to determine the undulation of the ground surface.

Instrument used in levelling :→

① → dumpy level → The telescope of the dumpy level is rigidly fixed to its supports. It cannot be removed from its supports nor can it be rotated about its longitudinal axis. The instrument is stable and retains its permanent adjustment for a long time.

② → WYE (Y-level) → The telescope is held in two Y supports. The Y support consist of two curved clips which may be raised. Thus the telescope can be rotated about its longitudinal axis.

③ → Cooke's reversible level → This is the combination of the dumpy level and the Y-level. It is supported by two rigid socket. The telescope can be rotated about its longitudinal axis.

④ Cushing level → The telescope cannot be removed from the socket and rotated about its longitudinal axis. The eye piece & object glass are removable and can be interchanged from one end of telescope to the other end.

⑤. Modern tilting level :→ the telescope can be tilted slightly about its horizontal axis with the help of of tilting screw. In this instrument the line of Collimation is made horizontal for each observation by means of the tilting screw.

⑥ Automatic level :→ This is also known as the self aligning level. This instrument is levelled automatically within a certain tilt range by means of a compensating device

Definitions :→

1. Levelling :→ The art of determining the relative height of diff. Points on or below the surface of the earth is known as levelling.

2. Level Surface :→ Any surface ∥ to the mean spheroidal surface of the earth. is said to be a level surface.

3. level line → Any line lying on a level surface is called a level line. This line is normal to the plumb line at all points.

4. Horizontal Plane → Any plane tangential to the level surface at any point is known as the horizontal plane.

5. Horizontal line → Any line lying on the horizontal plane is said to be a horizontal line. It is a straight line tangential to the level line.

6. Datum surface or line → This is an imaginary level surface or level line from which the vertical distance of diff. points are measured.

→ In India datum adopted for the great Trigonometrical Survey (GTS) is the mean sea level (MSL) at Karachi.

7. Reduced level (RL) → The vertical distance of a point above or below the datum line is known as the R.L

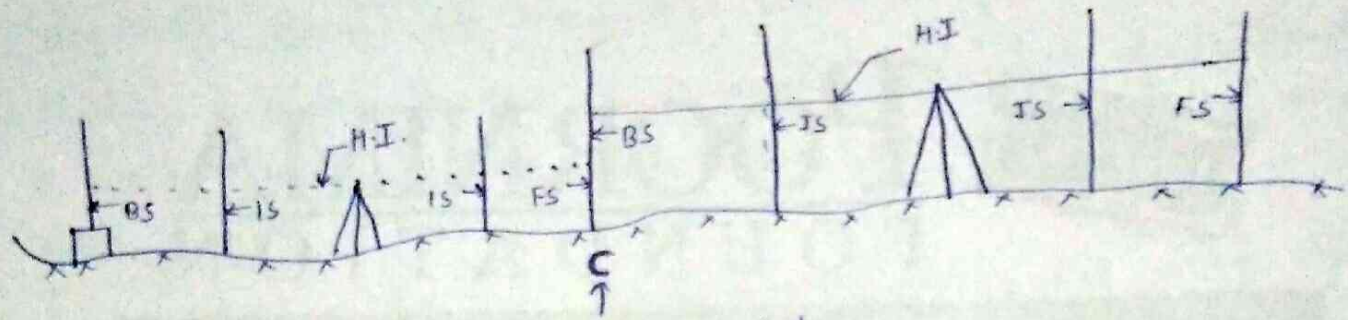
8. Line of Collimation → It is an imaginary line passing through the intersection of the cross hairs of the diaphragm and the optical centre of the object glass & its continuation. It is also known as line of sight.

9. Axis of telescope → This axis is an imaginary line passing through the optical centre of the object glass and the optical centre of the eye piece.

10. Axis of bubble tube → It is an imaginary line tangential to the longitudinal curve of the bubble tube at its middle point.

11. Bench Marks (BM) → These are fixed points or marks of known R.L determined with reference to the datum line.

12. Backsight Reading :→ This is the first staff reading taken in any setup of the instrument after the levelling has been perfectly done. This reading is always taken on a point of known R.L. i.e on a bench mark or change point



13 Foresight Reading (FS) → It is the last reading in any setup of the instrument and indicate the shifting of the latter.

14 Intermediate Sight Reading (IS) → It is any other staff Reading between the BS and FS in the same set up of the instrument.

15 Change point (CP) This point indicates the shifting of the Instrument. At this point, an FS is taken from one setting and a BS from the next setting.

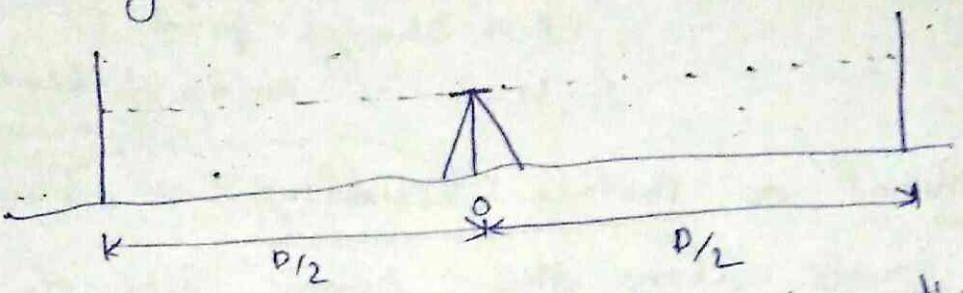
16 Height of Instrument (HI) →

HI = R.L of BM + BS

17 Parallax → The apparent movement of the image relative to the cross hair is known as. Parallax.

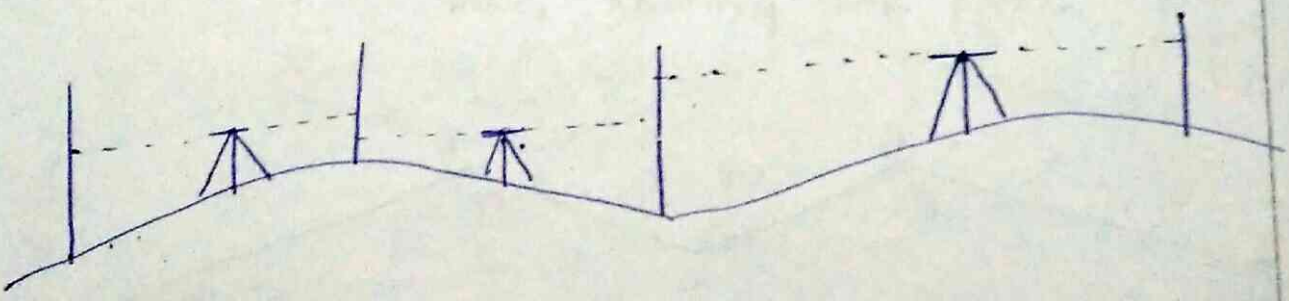
Type of levelling :→

1. Simple levelling :→ When the diff of level b/w two points is determined by setting the levelling instrument midway between the points, the process is called simple levelling.



In this case diff. of these reading give the diff of level b/w A & B.

2. Differential levelling :→ adopted when.
(i) the points are a great distance apart,
(ii) the diff of elevation b/w the points is large
(iii) there are abstacles b/w the points.

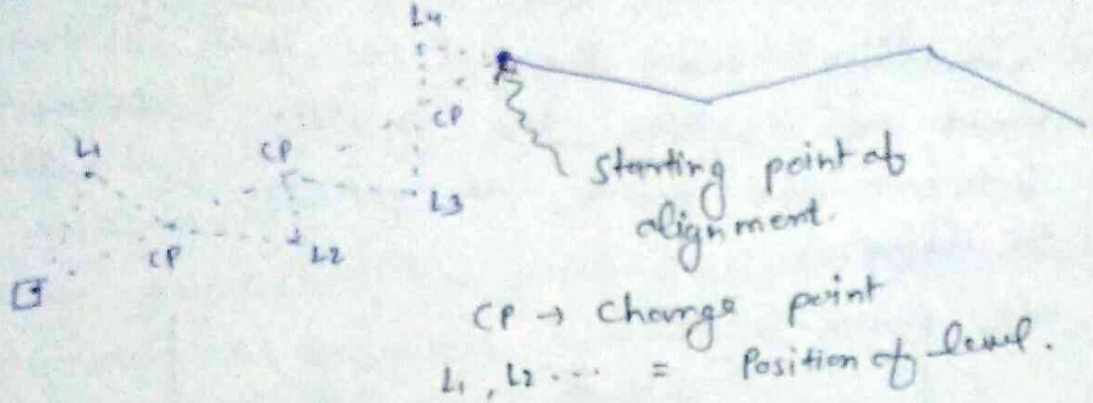


3. Fly levelling → When differential levelling is done in order to connect a benchmark to the starting part of the alignment of any project, it is called fly levelling

→ In such case only BS & FS reading are taken at

→ every setup & no distance are measured along the direction of levelling.

→ The level should be set up just midway between the BS & the FS



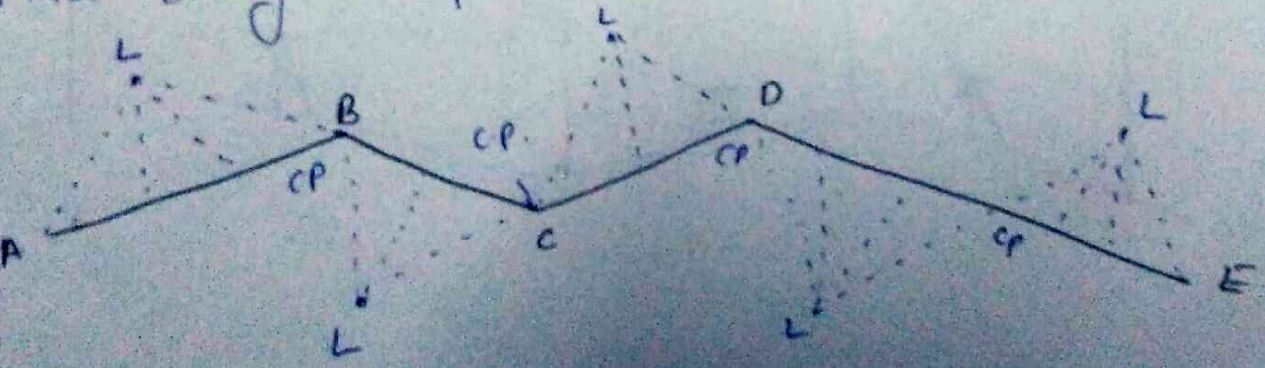
CP → change point

$L_1, L_2 \cdots$ = Position of level.

4. Longituclinal or Profile levelling :→ The operation of taking levels along the centre line of any alignment (road, Railway, etc.) at regular interval is known as Profile levelling.

→ In this operation, BS, FS & IS are taken at regular interval.

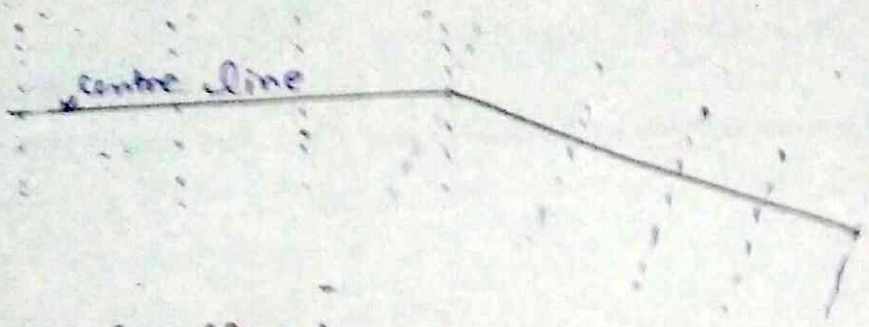
→ This method determine the undulation of the ground surface along the profile line.



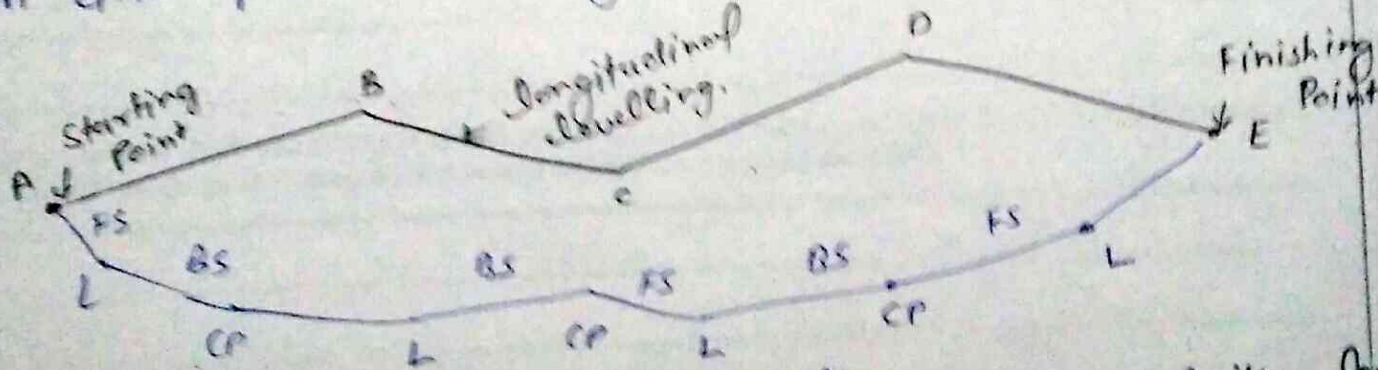
L → Position of level

CP → Change point

5. Cross Sectional Levelling :- The operation of taking levels transverse to the direction of longitudinal levelling is known as Cross sectional levelling.
→ Define the nature of ground across the centre line of any alignment.



6. Check levelling :-
The fly levelling done at the end of day's work to connect the finishing points with the starting point on that particular day is known as check levelling.



Check levelling.

L → Position level
CP → Change point
BS → Back Sight
FS → fore Sight

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Name of Faculty: ..... Name of Subject: ..... Code: .....

~~H~~ I: Height of Instrument Method → / Callimation method.

Station	BS	I.S	F.S	H.I	R.L	Remark
A	0.865			561.365 (A)	560.500	B.Mon gate
B	1.025		2.105	560.285	559.260 (B)	
C		1.500			558.795	Plat form
B	2.230		1.865	560.65	558.42	
E	2.355		2.835	560.17	557.815	
			1.760		558.410	
Check	ΣBS = 6.475		~~ΣF~~ 8.565			

① $H.I_A = R.L_A + BS_A$

② $H.I_A - FS_{at\ B} = R.L_B$

③ $H.I_B = RL_B + BS_A$

④ $RL_C = HI_B - IS_C$

⑤ $RL_D = HI_B - FS_D$

⑥ $HI_D = RL_D + BS_D$

⑦ $RLE = HI_D - FS_E$

Check

$$\Sigma BS - \Sigma FS = \text{Last R.L} - \text{First R.L}$$

$6.475 - 8.565 = 558.410 - 560.500$

$2.090 = 2.090$

RISE & fall method

Stn	BS	IS	FS	Rise	fall	R.L	Remarks
A	0.865					560.500	
B	1.025		2.105		1.240	559.260	
C		1.58			0.555	558.705	Plat form
D	2.230		1.865		0.285	558.42	
E	2.355		2.835		0.605	557.815	
F			1.760	0.595		558.41	
Σ =	6.475		8.565	Σ 0.595	Σ = 2.685		

Check ⇒ $\Sigma BF - \Sigma FS = \Sigma Rise - \Sigma Fall$ = Last R.L − First R.L.

$= 6.475 - 8.565 = 0.595 - 2.685 = 558.41 - 560.500$

$= -2.090$

Contour :→ A contour is an imaginary line on the ground joining the points of equal elevation.

It is a line in which the surface of ground is intersected by a level surface.

Contour Interval :→ The vertical distance b/w any two consecutive Contour is called Contour interval

$$\text{Contour interval} = \frac{25}{\text{No. of Cm per Km}} \quad \text{(meters)}$$

$$= \frac{50}{\text{No. of inches per mile}} \quad \text{(feet)}$$

Use of Contour Map :→

→ The nature of the ground surface of a country can be understood by studying a Contour map.

→ A suitable sight site or an economical alignment can be selected for any engg. project.

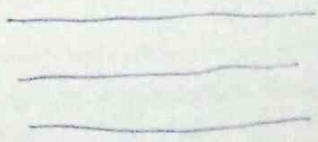
→ A suitable route for a given gradient can be marked on the map.

→ Quantities of earth work can be approximately computed.

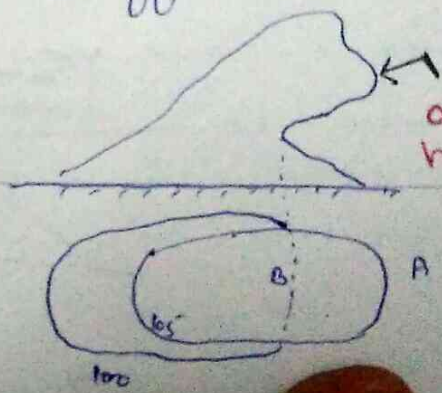
→ A section of the ground ~~map~~ surface can be drawn in any direction from the contour map.

Characteristics of Contour :→

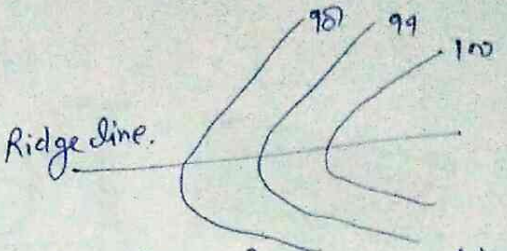
→ Uniformly spaced, Contour lines indicates a uniform slope



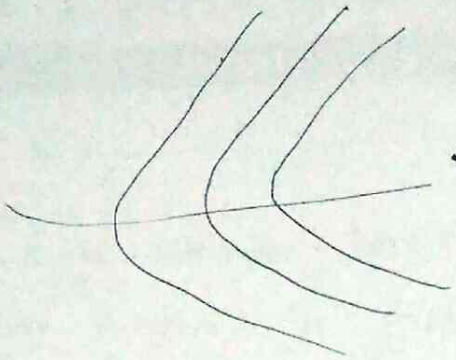
→ Contour line can not cross one another, except in the case of over hanging cliff.



→ When the higher value are inside the loop, indicates a ridge line.

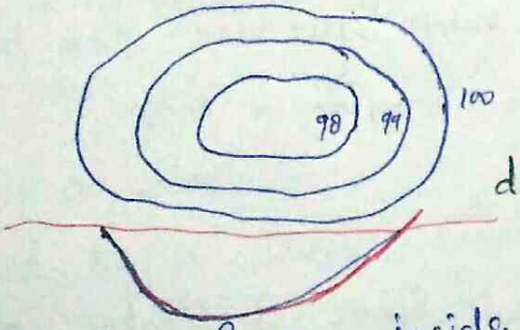


→ When the lower value are inside the loop, indicates a valley line.



→ A series of closed contour always indicates a depression or summit

↳ lower value being inside the loop indicates a depression



↳ higher value inside the loop indicate a summit