Levelling :— ch-5

* The aim of levelling is to determine the relative hights of different object on or below the surface of the earth.

1. Level surface :—

It is a curve surface parallal to the means Spheroidal of a earth.

⇒ the true difference in elevation between two points is the difference in elevation between the level surface through those points.

2. Level line :—

Any line lying on the level surface is called level line.

3. Horizontal surface :—

It is a plane tengential to the level surface at a point.

⇒ A line on the horizontal surface is horizontal line.

D- 06.feb.2020

5. Vertical line :—

the direction indicated by a plumb line is known as the vertical line. this line is perpendicular to the horizontal line.

7. Vertical plane :—

Any plane passing through the vertical line is known as the vertical plane.

8. Datum surface or line :-
this is an imaginary level surface or level line from which the vertical distance of difference point are measured in india the datam adopted for the great trigonometrical survey is the mean sea level at karachi.

9. Reduced level (RL) :-
the vertical distance of a point above or below the datum line is known as the Reduced level of that point. the RL of a point may be posetive or negative according as the point is above or below the datum.

10. Line of collimation :-
It is imaginary line passing through the intersection of the cross-hairs at the diaphragm and optical center of the object glass and its continuation. It is also known as the line of sight.

11. Axis of the telescope :-
this axis is an imaginary line passing through the optical centre of the object glass and the optical centre of the eyepiece.

12. Axis of Bubble tube :-
It is an imaginary line tangential to the longitudinal curve of the bubble tube it's middle point.

13. Bench-marks (BM) :-
these are fixed points or marks of known

⇒ It is done by plane surveying so it less accurate than GTS Bench-marks.

* Arbitary Bench-marks:—

⇒ when the RL of some fixed point are assumed It is called Arbitary Bench-marks.

→ It is done when we have to conduct survey an small areal.

* Temporary Bench-marks:—

when the bench-marks are established temporarily at the end of a day's works their called as temporary Bench work.

eg:- Root of a tree,
parapet of a building etc.

10-07-Feb-2020

Mean sea level (M.S.L):—

⇒ It is the avarage level of sea over a period of 19 years.

⇒ currently the MSL for india is at mombai airport. which as RL value of 0.00m.

Instrument use in leveling:—

(1) Levelling staff
(2) level

1. Levelling staff:—

the leveling staff is a graduated wooden rod for measuring vertical distancence

bet^n the point on the ground and line of collimation.

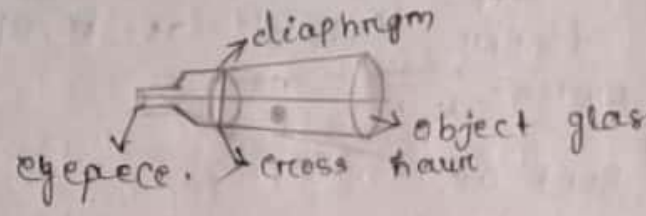
⇒ the foot of the staff represent zero mark.

⇒ the least count of the staff is 5mm

⇒ It can be 4 to 5m of height.

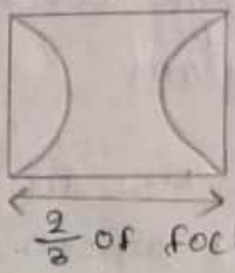
2. level :-

⇒ It is a telescope of internal focussing type known as Keplen's telescop



→ the eyepece used in Ramsden type eyepece.

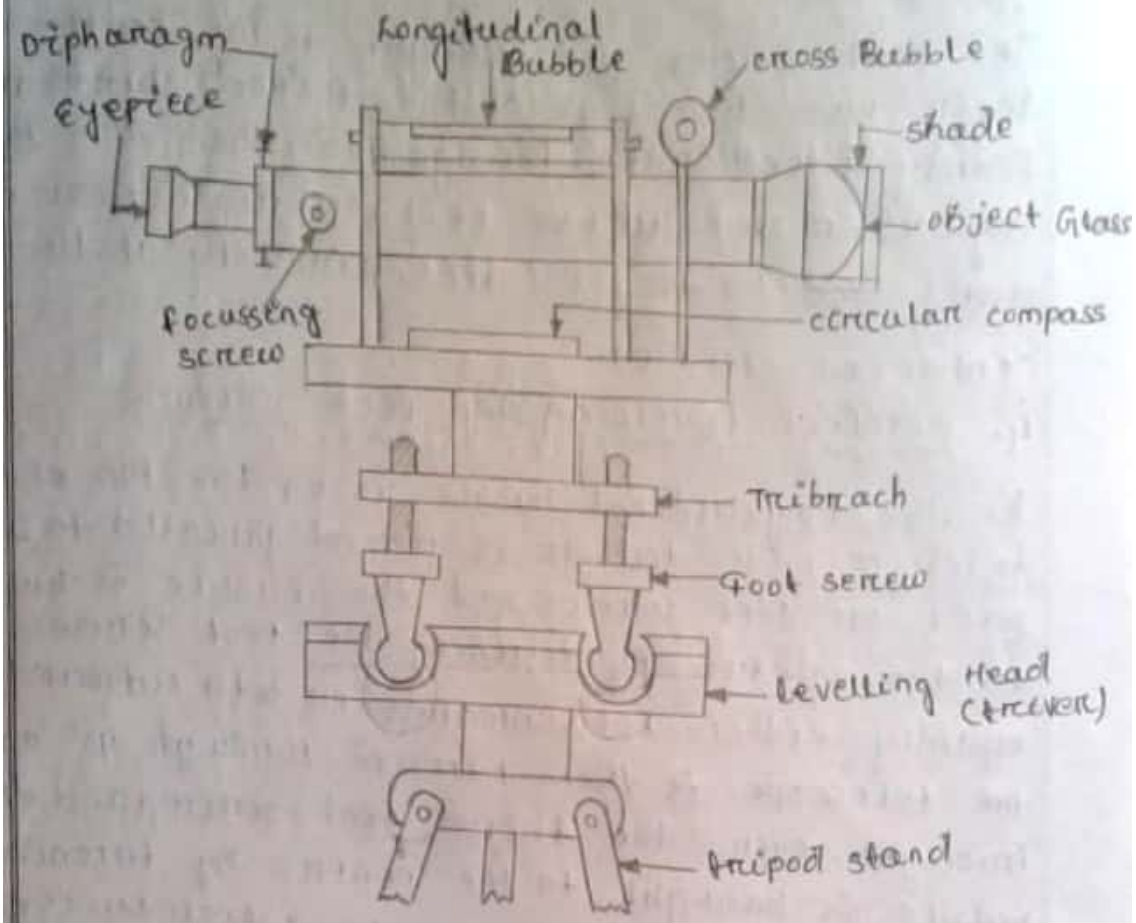
→ It consist of two plano-convex lens.



Object glass :-

⇒ It is an achromatic lens.

⇒ the only design practical for telescope each elemenaction of abberation



:- Dumpy level

1. selection of suitable position :-

A suitable position is selected for setting the level. from this position, it should be possible to take the greatest number of observations without any difficulty. the ground should be fairly level and firm.

2. fixing level with tripod stand :-

the tripod stand is placed at the required position with its legs well apart, and pressed firmly into the ground.

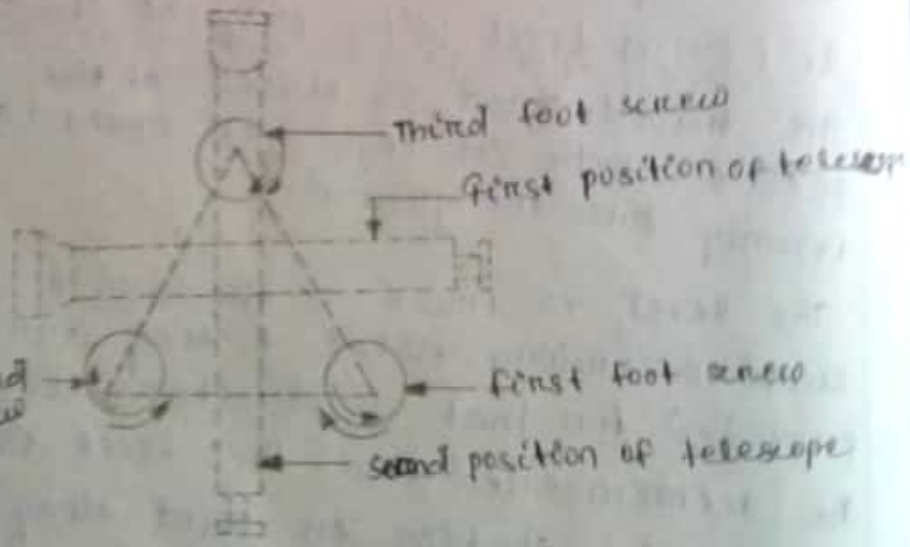
The level is fixed on the top of the tripod stand according to the fixing arrangement provided for that particular level. It should be remembered that the level is not be set up at any station or point along the alignment

3. Approximate levelling by legs of tripod stand :-

The foot screws are brought to the centre of their run. Two legs of the tripod stand are firmly fixed into the ground. Then the third leg is moved to the left or right in or out until the bubble is approximately at the centre of its run.

4. Perfect levelling by foot screws :-

If the longitudinal bubble is on the top of the telescope, the latter is placed parallel to any pair of foot screws and the bubble is brought to the centre by turning the foot screws equally either both inwards or both outwards. The telescope is then turned through 90° and brought over the third foot screw, and the bubble is brought to the centre by turning this foot screw clockwise or anticlockwise. The telescope is again brought to its original position and the bubble is brought to the centre. The process is repeated several times until the bubble remains in the central position in the first as well as the second position. Then the telescope is turned through.



: LEVELLING OF FOOT SCREWS

180° If the bubble still remains in the central position, the temporary adjustment is perfect and so is the permanent adjustment. But if the bubble is deflected from its central position, the permanent adjustment is not perfect and needs to be modified.

5. Focussing the Eyepiece :—

A piece of white paper is held in front of the object glass and the eyepiece is moved in or out by turning it clockwise or anticlockwise until the cross-hairs can be seen clearly.

6. Focussing the object glass :—

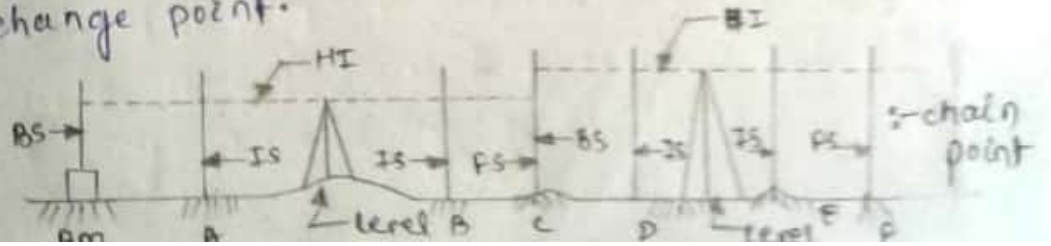
The telescope is directed towards the levelling staff. Looking through the eyepiece, the focussing screw is turned clockwise or anticlockwise until the graduation of the staff is distinctly visible and the parallax is eliminated. To eliminate the parallax, the eye is moved up and down to verify whether the graduation of the staff remains fixed relative to the cross-hairs.

7. taking the staff Readings :—

Finally, the levelling of the instrument is verified by turning the telescope in any direction - when the bubbles remain in the central position for any direction of the telescope, the staff readings are taken.

* Backsight Reading :— (BS)

This is the first staff reading taken in any set-up of the instrument after the levelling has been perfectly done. This reading is always taken on a point of known RL on a bench-mark or change point.



(*) Foresight Reading :— (FS)

It is the last staff reading in any set-up of the instrument ~~after the Levelling is perfectly done. this reading is always taken on a point of which~~ and indicates the shifting of the latter.

(16) Intermediate sight Reading (IS) :—

It is any other staff reading between the BS and FS in the same set-up of the instrument.

(17) change point (CP) :—

this point indicates the shifting of the instrument. At this point, an FS is taken from one setting and a BC from the next setting.

(18) Height of Instrument (HI) :—

when the levelling instrument is properly levelled, the RL of the line of collimation is known as the height of the instrument this is obtained by adding the BC reading to the RL of the BM or CP on which the staff reading was taken.

10.02.2020

The following consecutive readings where taken with the help of a level.

1.905, 2.652, 3.245, 4.195, 1.154, 1.750, 7.550, 1.350, 1.815, 2.850, 3.145 and 1.725.

The instrument was taken on staff held on bench mark (BM) having RL of 100m. Cultural the RL of other point.

Ans:-

station	B.S	I.S	F.S	Rise	fall	R.L	Remark
1	1.905	—	—	—	—	100	B.M
2	—	2.652			0.747	99.253	
3	—	3.245			0.593	98.66	
4	1.854		4.195		0.880	97.78	C.P
5		1.750		0.104		97.884	
6	1.550		1.550	0.2		98.084	
7					0.465	97.619	C.P
8		1.815			0.235	97.384	
9		2.050			1.095	96.289	
10		3.145	1.725	1.42		97.709	
	5.109		7.4				

★ $\Sigma B.S - \Sigma F.S = \Sigma Rise - \Sigma fall$
$= last\ R.L - 1st\ R.L$

The following consective readings where taken with a levelling instrument at interval of 40m.

2.375, 1.730, 0.615, 3.450, 2.835, 2.070, 1.835, 0.985, 0.435, 1.630, 2.55, 3.630.

The instrument shifted at the 4th and 8th reding. If the RL of 1st point is 0.2620 find the R.L of all other points.

Ans:-

Station	B.S	I.S	F.S	Rise	Fall	R.L	Remarks
1	2.375					113.400	
2		1.730		0.645		113.345	
3		0.615		1.115		114.38	
4	2.835		3.450		2.835	111.545	
5		2.070		0.765		112.31	
6		1.835		0.235		112.545	
7	0.435		0.985			111.395	
8		1.630			1.195	112.2	
9		2.955			0.625	111.515	
10			3.630		1.375	110.2	
	5.645		8.065	3.61	6.03	-2.40	

Q. T

∴ Error = $A a_1 - Aa = a a_1 = D \tan \alpha$

So, True reading $Aa - aa_1 = Aa_1 - D \tan \alpha$

Similarly Bb = true reading

∴ Error $= Bb_1 - Bb = bb_1 = D \tan \alpha$

So, True reading $Bb = Bb_1 - bb_1 = Bb_1 - D \tan \alpha$

from (5.1) & (5.2)

True difference of level between A and B

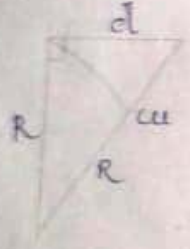
$= Aa - Bb$ (Fall from B to A)

$= Aa_1 - D \tan \alpha - Bb_1 + D \tan \alpha$

$= Aa_1 - Bb_1$

Thus it is seen that the error due to inclination of the collimation line is completely eliminated and the apparent difference is equal to the true difference.

Corrections:—



$R^2 + d^2 = (R + \text{curvature})^2$

$R^2 + d^2 = R^2 + cur^2 + 2R\,cur$

$km \leftarrow \frac{d^2}{2R \rightarrow 6370} = cur$

$0.785 d^2 = \text{curvature}$

↓

km

R = Radius of earth and

$R = 637$ km.

d = distance bet^n instrument and staff.

⇒ due to curvature of earth the staff reading and will increased, the of earth

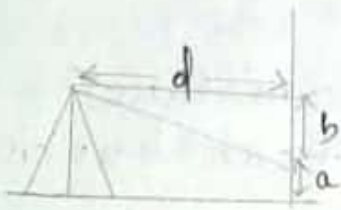
Staff reading are always with respect to level lines.

→ due to curveture the point on earth will appear lowear than it actually each.

correction of Refraction:—

→ Refraction is atmospheric fenomena due to refraction the light lines will bend from dencer miblimum to ranker midimum.

It is observed that due refraction the line of sight will bend towards the earth surface. that is the staff reading reduces it makes point appear higher than the actual.



- true reading = ab

observed reading = 0.9

· ab + error = true

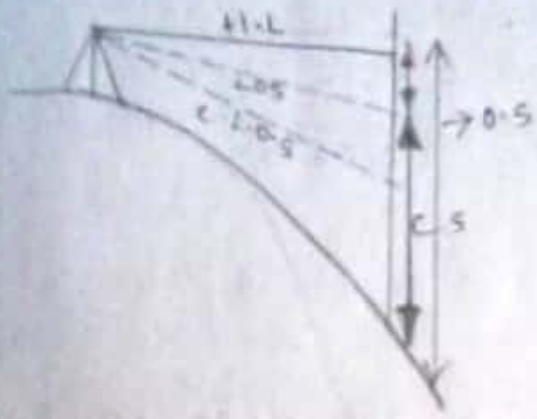
$+\frac{1}{7} \times \frac{d^2}{R}$ = crep (correction of refraction)

$= 1.121 \times 10^{-5} d^2$ km = crep

$= +0.01121\ d^2$ m = crep

Combined correction:—

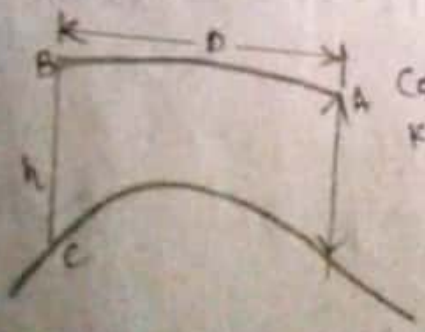
It is the combination of correction for curvature (-ve) and correction for refraction (+ve)



$$C_{comb} = C_{curr} + C_{ref}$$
$$= -0.785d^2 + 0.0112d^2$$
$$= 0.0675d^2 \rightarrow km$$

Distance to visible Horizon: — (1)

Horizon is the point of intersection of sky and earth surface as observed from a distance.



C_{curv} km $\quad h = 0.0673 D^2 \rightarrow d$

$D = \sqrt{\frac{h}{0.0673}} \rightarrow mtr$

D = visible horizon distance in kilometers

h = height of the point above mean sea level, in meters.

Q1/ What is the distance to the visible horizon for an observer standing on the deck of ship having his line of sight 12m above sea level.

Ans:- los = 12m = h

D = ?

$$D = \sqrt{\frac{h}{0.0673}} = \sqrt{\frac{12}{0.0673}}$$

↓ km

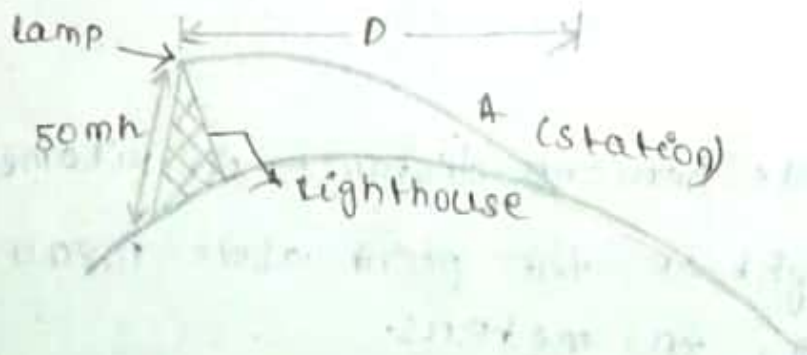
$$= 13.35 \text{ km}$$

Q2/ A man standing on the deck of ship observes a luminous object which is 50m above sea level if the man's eye level is 10m above sea level find the distance between him and the object.

Ans:- $D_1 = \sqrt{\frac{50}{0.0673}} = 27.25 \text{ km}$

$$D_2 = \sqrt{\frac{10}{0.0673}} = 12.18 \text{ km}$$

$$D_1 + D_2 = 27.25 + 12.18 = 39.93 \text{ km}$$



D - 13.02.2020

Reciprocal Levelling :-

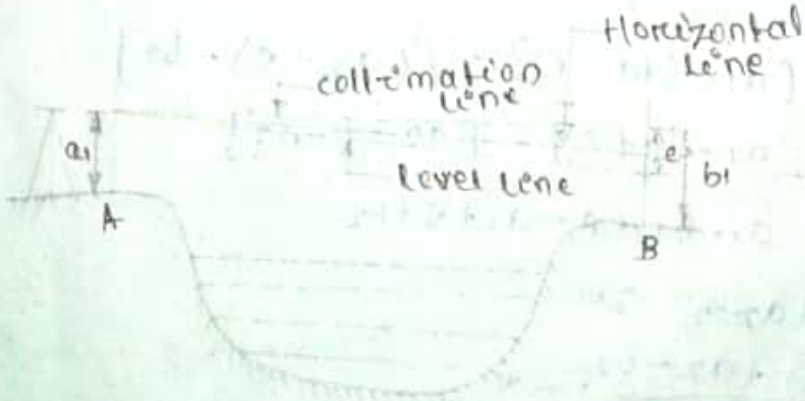
→ when ever it is not possible to balance the side due to field condition we adopt reseprocal levelling by doing reseiprocal levelling the following errors are eliminated

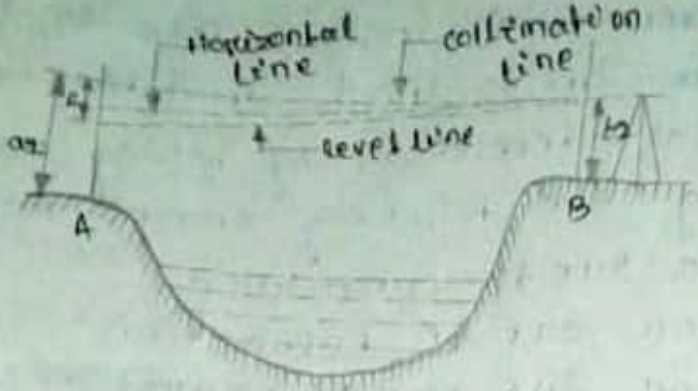
(i) error due to curvature
(ii) error due to refraction
(iii) error due to polimanation

procedure :—

1. suppose A and B are two points on the opposite banks of a river. the level is set up very near A and after proper temporary adjustment, staff readings are taken A & B. suppose the readings are a1 and b1.

2. the level is shifted set up very near B and after proper adjustment staff readings are taken at A and B. suppose the readings are a2 & b2.





:- Reciprocal levelling

Note

we assume point A is at layer elevation than point B.

$h = a_1 - (b_1 - e)$ —(i)

$h = (a_2 - e) - b_2$ —(ii)

adding eqn (i) and (ii)

$h + h = [a_1 - b_1 + e] + [a_2 - e - b_2]$

$2h = (a_1 - b_1) + (a_2 - b_2)$

$$\boxed{h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}}$$

Two difference of level between A and B

substanting eqn (1) and (2)

$h - h = [a_1 - (b_1 - e)] - [(a_2 - e) - b_2]$

$0 = [a_1 - b_1 + e] - [a_2 - e - b_2]$

$0 = a_1 - b_1 + e - a_2 + e + b_2$

$-a_1 + b_1 + a_2 - b_2 = 2e$

$$\frac{-a_1 + b_1 + a_2 - b_2}{2} = e$$

$$e = \frac{(a_2 - b_2) - (a_1 - b_1)}{2}$$

$$e = \left[-\frac{(a_2 - b_2) + (a_1 - b_1)}{2} \right]$$

$$\boxed{e = -\left[\frac{(a_4 - b_4) - (a_2 - b_2)}{2} \right]}$$

→ combine error due to curveture, refraction collimation.

Q. the following observation were taken while conducting reciprocal levelling.

Instrument at	Staff reading on A	Staff reading on B	Remarks
A	1.155	2.595	dist AB = 500 m
B	0.985	2.415	R.L of A = 525.5m

(i) find the R.L of B

(ii) combined correction for curveture and refraction.

(iii) collimation error.

Ans:- $h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$

$= \frac{(1.155 - 2.595) + (0.985 - 2.415)}{2}$

$= 1.485$

$= 525.5 - 1.485$

R.L of B = 524.065 m

$C_{comb} = 0.0675 d^2$

$= 0.0675 (0.5)^2$

$= 0.0168$ m

dist AB = 500m

R.L of A = 525.5m

$e = e_{can} + e_{col} + e_{ref}$

$e = e_{com} + e_{col}$

$e = -\left[\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right]$

$= \left[\frac{(1.155 - 2.595) - (0.985 - 2.45)}{2}\right]$

$= 5 \times 10^{-3}$

$e = e_{com} + e_{col}$

$5 \times 10^{-3} = (+0.0168)\,\phi - e_{ref}$

$= 5 \times 10^{-3} - 0.0168 = +C_{REF}$

$= 0.0118$.

Instrument at	staff reading A	staff reading B	Remarks
A	1.725	2.245	RL of A = 450m
B	2.145	3.045	RL of B = ?

find the RL of B

Ans:- $h = \left[\frac{(a_1 - b_1) - (a_2 - b_2)}{2}\right] = -0.71$

= R.L of A = 450 + (-0.7) = 449.29

D - 14.02.2020

Instrument at	staff reading A	staff reading B	Remarks.
A	1.725	1.370	R.L of A = 120.3
B	1.560	1.235	dist AB = 600m

→ find R.L of B.

→ combind correction for refraction and curvature.

Ans:- $h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$

$= \frac{(1.725 - 1.370) + (1.560 - 1.235)}{2}$

$= 0.34$

R.L of B = 120.3 + 0.34

= 120.64

(ii) $C_{com} = -0.0675 \times d^2$

$= -0.0675 \times (0.6)^2$

$= -0.0243$

Sensitivity of (bubble tube) Air spirit level :—

→ sensitevity of bubble tube means the effect cosed by the deviation of bubble per division of gradiation of bubble tube.

→ sensitiveness is expressed in terms of radeous of curveture of upper surface of the tube or by angle through each axis is tilted for the diflection of one division.

* For small angle of α

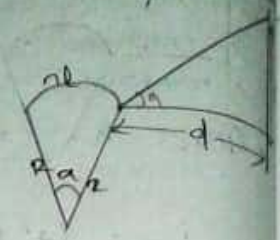
$\tan\alpha \simeq \sin\alpha \simeq \alpha$

$\tan 5' = \sin 5' = 5' = \frac{\pi}{180} \times 5$

$\alpha = \frac{nl}{R}$, $\alpha = \frac{s}{d}$

$\frac{nl}{R} = \frac{s}{d}$

$$R = \frac{nlD}{s}$$



R = radious of curvature
n = no of division shifted by bubble
l = length bet^n two consecutive divisi
D = difference bet^n los when l.o.s is horizontal and inclined.

$$\alpha = \frac{nl}{R} = \frac{s}{D}$$

$$\alpha' = \frac{\alpha}{n} = \frac{nl}{nR} = \frac{s}{nD}$$

Collimation system	Rise-and-fall system
1. It is rapid it involves few calculations.	It is laborious, involving several calculations.
2. there is no check on the RL of intermediate points.	there is a check on the RL of intermediate.
3. Errors in intermediate RLs can't be detected.	Errors in intermediates RLs can be detected as all the points are correlated.
4. there are two checks on the accuracy of RL calculation,	there are three checks on the accuracy of RL calculation.
5. this system is suitable for longitudinal leveling where there are a number of intermediate sights.	this system is suitable for dry levelling where there are no intermediate sights.

Contouring :— D-15.Feb.2020

→ What is contouring?

Ans:- Contouring line are imaginary line joining points to equal elevation (R.L)

→ the elevation of contour lines are expressed with respect to means sea level (m.s.l)

→ A zero meter contour line represent coastal line of a country.

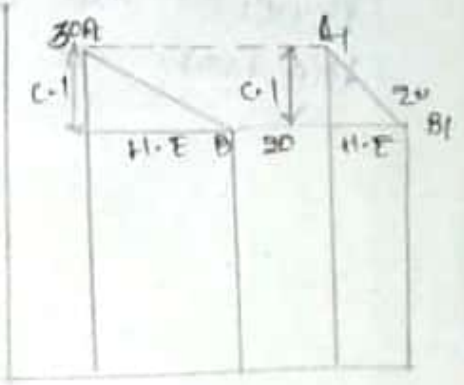
→ contour line gives the topographical feature of a ground

Contour Internal (C.I):—

→ It is the difference in elevation of two consicutive controls lines.

→ It is measure in vertical plane only.

→ It is always constant for a map.



Horizontal equivalent :- (H.E).

→ It is the horizontal distance between two consicutive controls lines. It is measurable horizontal plane.

→ It is not constant it may vary.

Control gradient:- (C.G)

It is a line on the ground making constant inclination with the horizon

→ roads are build with constant contr gradient.

$$C.G = \frac{CI}{H.E}$$

USES OF CONTOUR MAP:-

~~The nature of the ground surface of country can be understood by studying~~

ID-17-02-20207

CHARACTERISTICS OF CONTOURS:-

1. the contour lines are closer near the to of a hill or high ground and wide apart the foot. this indicates a very steep slope towards the peak and a flatter slope ~~towards the peak and a~~ toward the foot.

Fig:- Hill

2. the contour lines are closer near the bank of a pond, or depression and wide apart towards the centre. this indicates a steep slope near the bank and flatter

slope at the centre.

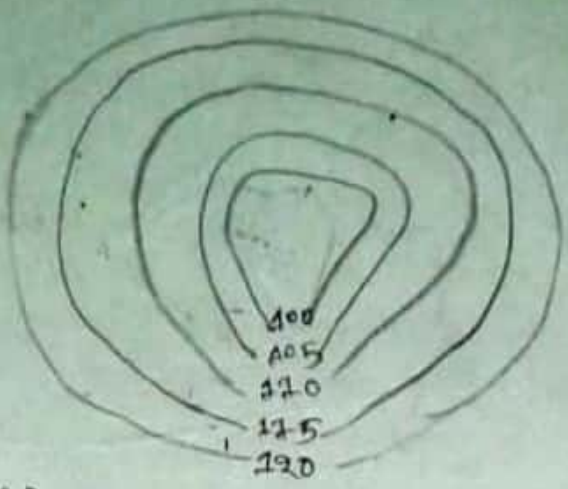


fig :- Depression

3. uniformly spaced lines indicate a uniform slope.

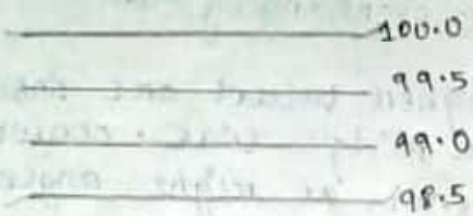


fig :- uniform slope

4. contour lines always form a closed circuit. But these may be within or outside the limits of the map.

fig :- contour closed within map

5. contour lines cannot cross any another, except in the case of an overhanging cliff. But the overlapping portion must be shown by a dotted line.

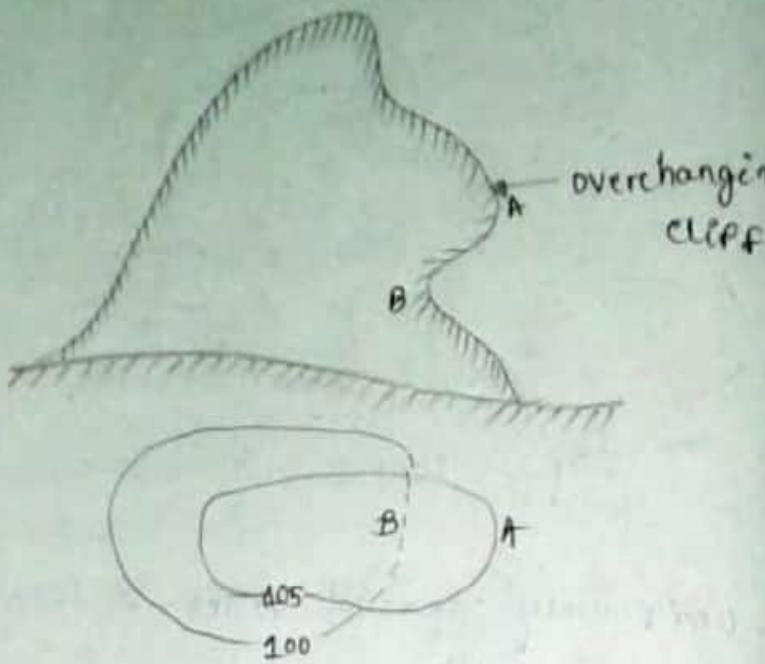


fig:— overhanging cliff

6. when the higher values are enscole the loop, it indicates a ridge line. contour lines cross ridge lines at right angles.

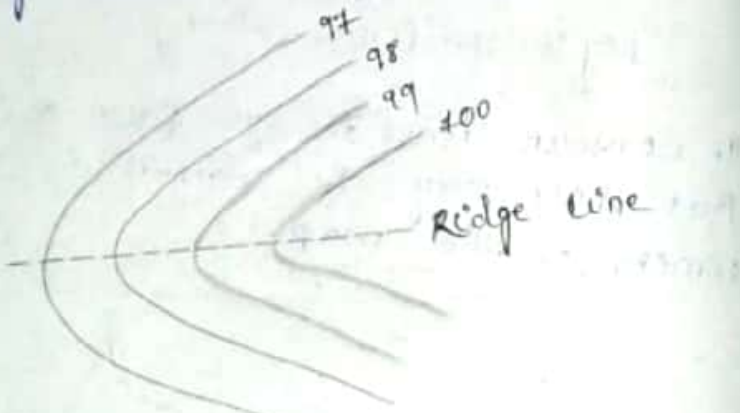


fig:— ridge line.

7. when the lower values are enscole the loop. it indicates a valley line. contour lines cross the valley line at right angles.

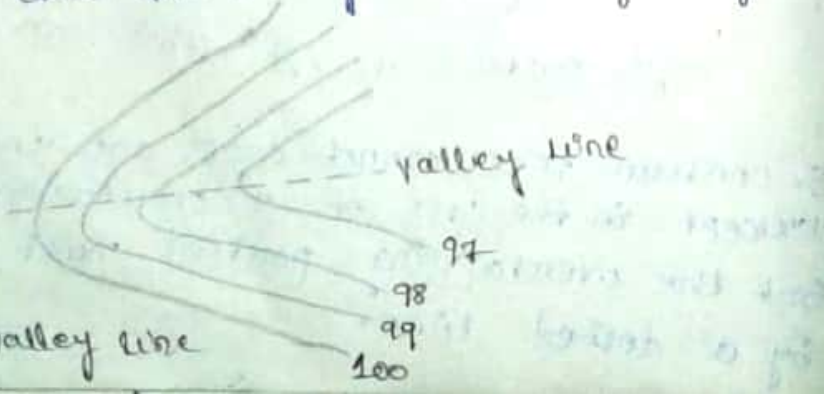


fig:— valley line