Compute

Σ lat = 2985 {magnitude of mono: algebraic summary}

Error of closure = $\sqrt{\Delta lat^2 + \Delta dep^2} = \sqrt{15^2 + 31^2} = 35.5$ ft.

Total length = 4997.6

Precision $= \frac{35.5}{4997.6} = \frac{1}{142}$

sin 142

δ lat AB $15 \times \frac{500}{4997.6} = 1.5$ (+)

δ lat BC $15 \times \frac{848.6}{4997.6} = 2.6$ (

δ lat CD $15 \times \frac{854.4}{4997.6} = 2.6$

δ lat DE $15 \times \frac{1019.8}{4997.8} = 3.1$

δ lat EF $15 \times \frac{1118}{4997.8} = 3.3$

δ lat FA $15 \times \frac{656.8}{4997.8} = \frac{1.40}{14.6}$ — 3.1.9 — 1.9 [illegible] 6.6 [illegible] 15 [illegible]

$= \frac{}{15}$

|||ly δ dep AB $= 32 \times \frac{500}{4997.8} = 3.2$

δ dep BC $= 32 \times \frac{848.6}{4997.6} = 3.2$

δ dep CD $= 32 \times \frac{854.4}{4997.6} = 5.4$

δ lat DE $= 32 \times \frac{1019.8}{4997.8} = 6.6$

δ lat EF $= 32 \times \frac{1118}{4997.8} = 7.2$

δ lat FA $32 \times \frac{656.8}{4997.8} = 4.2$

correction

Line	lat	dep	N	S	E	W	N	S	E	W
AB	+1.5	+3.2	500	0	0	0	501.5			
BC	+2.6	+5.4	600	0	600	0	601.0			
CD	+2.6	+5.4		300	800	0	[illegible]			
DE	+3.1	+6.6		1000	200	0				
EF	+3.3	+7.2		200		1100				
FA	+1.9	+4.2	335			532				
	+15	+32								

$7 \times 20 \times \sqrt{\frac{2.73 \times 40}{2.5}} + 2\lceil 20 + 20 \rceil$

~~Line~~

	N	S	E	W			N	S	E	W
AB	509		0		+1.5	+3.2	501.5		32	
BC	600		600		+2.56	3.2	602.6		600.56	
CD		309	809		+3.6	5.4		-299	805.4	
DE		1000	209		+3.8	6.2		-996.8	206.2	
EF		200		409	13.3	7.2		-196.8		
FA	325			532	11.4	9.2	336.4			
							1490	1490	1620.66	

Δ Lat = 0 Δ dep = 0

H.W Transit rule.

North + South −

Lat AB = 500

$\delta lat_{AB} = \delta lat \times \frac{Lat\,DB}{\Sigma Lat}$

$= 15 \times \frac{500}{2935} = \frac{7500}{2935} = 2.51$

$\delta lat_{BC} = 15 \times \frac{600}{2935} = \frac{9000}{2935} = 3.02$

$\delta lat_{CD} = 15 \times \frac{200}{2935} = \frac{4300}{2935} = 1.51$

$\delta lat_{DE} = 15 \times \frac{1000}{2935} = 5.03$

$\delta lat_{EF} = 15 \times \frac{200}{2935} = 1.005$

$\delta lat_{FA} = 15 \times 325/2935 = \frac{5800}{2935} = 1.53$

Dep:

$\delta dep_{AB} = 32 \times \frac{0}{3232} = 0$

$\delta dep_{BC} = 32 \times \frac{600}{3232} = \frac{19200}{3232} = 5.94$ 6.13

$\delta dep_{CD} = 32 \times \frac{800}{3232} = \frac{25600}{3232} = 7.93$

$\delta dep_{DE} = 32 \times \frac{200}{3232} = \frac{6400}{3232} = 1.98$

$\delta dep_{EF} = 32 \times \frac{400}{3232} = \frac{12800}{3232} = 3.8$

$\delta dep_{FA} = 32 \times \frac{532}{3232} = \frac{17002}{3232} = 5.25$

	N	S	E	W			N	S	E	W
AB	500		0		2.51	0	502.51			
BC	600		600		3.02	6.43				
CD		300	800		3.01	7.93	603.01			
DE		1000	200		5.03	1.98		299.02		
EF		200		400	1.005	3.8		996.2		
FA	325			532	1.53	5.25				

~~Line~~

	N	S	E	W			N	S	E
AB	500		0		+1.5	+3.2	501.5		3.2
BC	600		600		+2.56	3.2	602.6		605
CD		300	800		+3.6	5.4		-297	805
DE		1000	200		+3.8	6.2		-996.9	206
EF		200		400	+3.3	7.2		-196.7	
FA	385			532	+1.4	9.2	366.4		
						1490	1490		1706

Δ lat = 0 Δ dp = 0

H.W Transit rule.

north + south = -

lat AB = 500

δ lat AB = Δ lat × $\frac{\text{lat AB}}{\Sigma \text{lat}}$

$= 15 \times \frac{500}{2985} = \frac{7500}{2985} = 2.51$

δ lat BC = $15 \times \frac{600}{2985} = \frac{9000}{2985} = 3.02$

δ lat CD = $15 \times \frac{300}{2985} = \frac{4500}{2985} = 1.51$

δ lat DE = $15 \times \frac{1000}{2985} = 5.03$

δ lat EF = $15 \times \frac{200}{2985} = 1.005$

δ lat FA = $15 \times 385/2985 = \frac{5800}{2985} = 1.53$

Dep:

δ dep AB = $32 \times \frac{0}{3232} = 0$

δ dep BC = $32 \times \frac{600}{3232} = \frac{19200}{3232} = \cancel{5.97}\ 6.13$

δ dep CD = $32 \times \frac{800}{3232} = \frac{25600}{3232} = 7.93$

δ dep DE = $32 \times \frac{200}{3232} = \frac{6400}{3232} = 1.98$

δ dep EF = $32 \times \frac{400}{3232} = \frac{12800}{3232} = 3.8$

δ dep FA = $32 \times \frac{532}{3232} = \frac{17000}{3232} = 5.25$

ID	N	S	E	W			N	S	E	W
AB	500		0		2.51	0	~~500~~ 502.51			
BC	600		600		~~3.02~~ 3.01	6.43 ~~7.93~~	603.01			
CD		300	800		~~1.51~~	1.98		~~2980.2~~		
DE		1000	200		5.03	3.8		996.2		
EF		200		400	1.005					
FA	385			532	1.53	5.25				

	N	S	E	W			N	S	E	W
AB	500			0						
BC	600			600						
CD			300	300						
DE			1000	200						
EF			200							
FA	385									

	N	S	E	W			N	S	E	W
AB	500		0		2.51	0	502.9		0	
BC	600		600		3.02	5.13	603.02		[illegible]	
CD		300	300		1.51	7.43		[illegible]	[illegible]	
DE		1000	200		5.03	1.43		[illegible]	[illegible]	
EF		200		1000	1.005	3.3		[illegible]		
FA	385			532	1.33	5.25	398.47			

1490.0 246

Δlat = 0 Δdep = 0

19-6-84

Example ②

The following field notes show the length and bearings of a closed travel ABCDA compute the error of closure and adjust the traverse by transit rule

	Line	Length (ft)	Azimuth →	⊙ B
①	AB	730	0°00'	Due North
②	BC	1414	45°00'	N 45°00' E
③	CD	2000	150°00'	S 30°00' E
④	DA	1996	270°00'	Due West

	Lat		Dep	
	N	S	E	W
①	730	—	0	—
②	1000	—	1000	—
③		1732	1000	
④				1996
	1730	1732	2000	1996

Δlat = −2 Δdep = −4

principle of surveying

refer: ① Surveying by Devis & Foote
② plane and Eevclitic surveying by clark
③ surveying by Remister & Raymind.

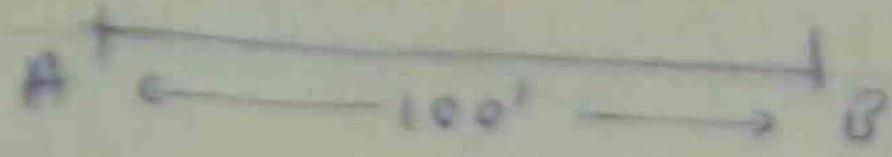
measurement –
① linear measurement – → Horizontal and vertical
② Angular measurement. → f

linear measurement

unit – British system
length – ft (or) foot

① pacing
② chaining
③ Taping
④ Tacheometry
⑤ ~~photog~~ photogrammetry or area survey.

Pacing (Odometer)



(1 operation) no: of paces / 100ft

Range estimation

Time ~~delay~~ error

Chaining

① Engineer chain
100ft with 100 links of 1ft

② Surveyor chain (or) Gunter's chain
66ft, 100 links of 0.66ft.

Figure of chain

Eng chain = 1ft

Surv: chain = 0.66ft

Correction total = linear correction + sag correction + slope correction + temp correction

Correction for a base line line = i e 300.15

$$\therefore 100' = -.1817$$

$$300.15 \longrightarrow ? = -.1817 \times \frac{300.15}{100}$$

$$= -0.5451 \text{ ft}$$

Total length of the base line = 300.15 − 0.5451 ft

= 299.8799

Example ②

For the purpose of establishing measurement in a city. a line long a ~~Pulled~~ Paved street having a glade of 2.5 % is measured on the slope The applied tension in 12 lbs and observation of temp: are made at each application of the tape. The measured length of the slope is 1320.64 fts and the mean of the ~~absol~~ absolute temperature is 87.4° F The 100' steel tape. used for measurement is standarded temp 70° F Supported for all length and is e = .0046 ft per. hori length

$$l = 100'$$

$$\text{slot } \cancel{\text{std}} \text{ slope} = \frac{2.5}{100} = .025 \text{ ft}$$

Pfield = 2 lb Total length = 1320.64

Tfield = 87.4°F α = .0000065 °F

Temp corr:

~~Temp correction = .0000065 x 87.4 ft~~

Temp = (87.4 − 70) x100

Temp corr = 17.4 x .0000065 ft

= .001132 (−)

linear reading = $\frac{2.5}{100}$ = .025'

-length = 1320.64 − (.025 + .001132)

= ft

(E) linear correction = .004 ft (−)

$CSL = \frac{h^2}{2l} = \frac{2.5^2}{200}$ = .03125 ft (−)

Δ Temp = α L Δ T

= -.0000065 x 100 (87.4 − 70)

= -.011310 (+)

Total = −.03124 − .01131 ± .004

= .0243 (±)

Temp > Total Temp > Standard Temp

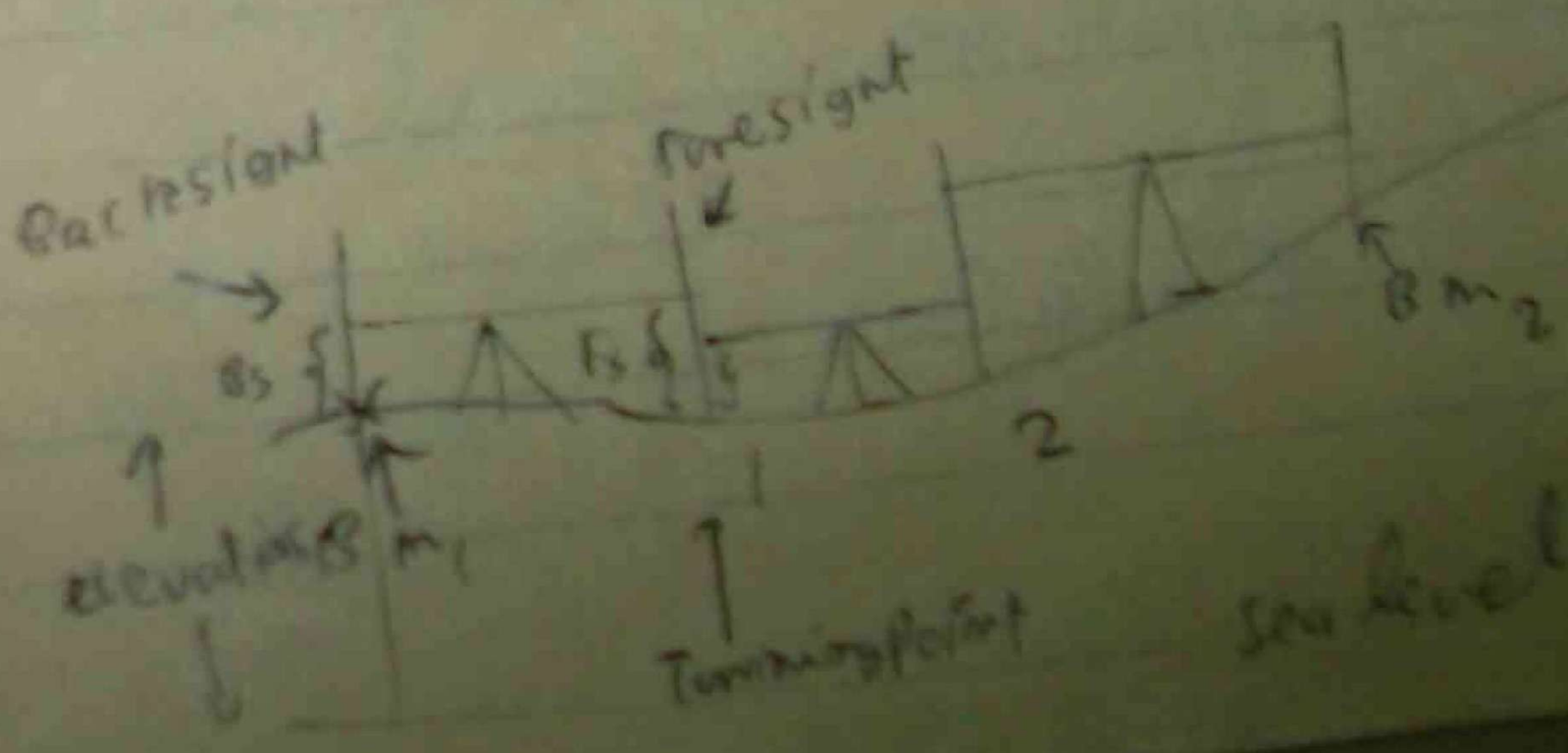
Total ℓ = 1320.64' = -3161 (-)

Length = 1320.64 - -361

= 1320.3239 ft

Definations

A Turning point (T.P) is an intermediate point between 2 BM's upon which point fore sight and back sight staff readings are taken. It may be a pin or plate which is carried forward by staff man after observations have been made, or it may be any stable object such as a street, rail road, or a store. A BM may be used as a turning point.

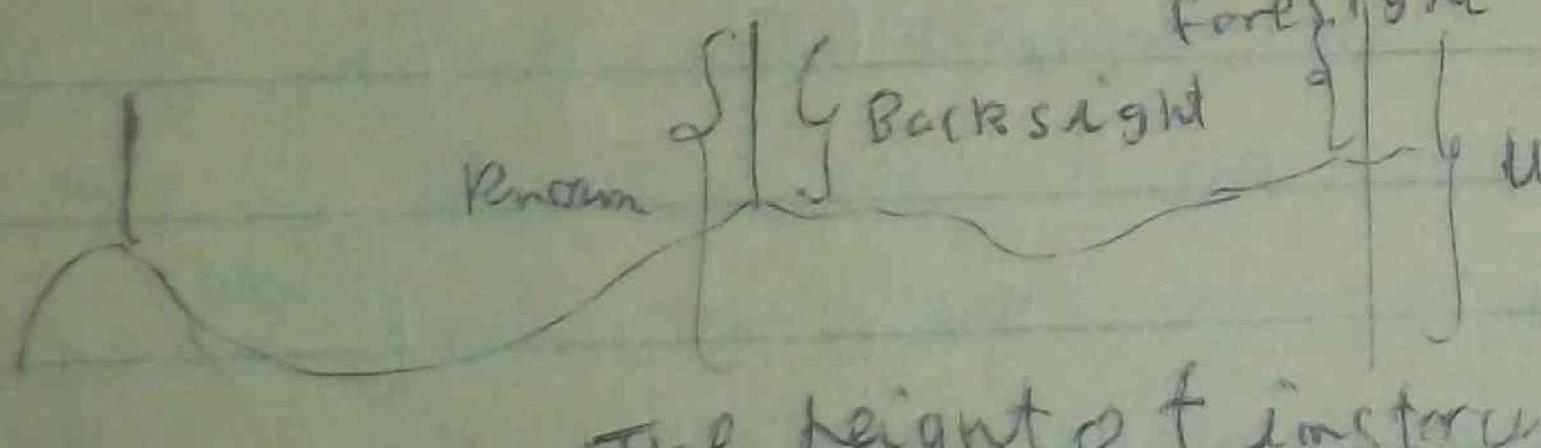


Differential leveling = (Levelling) + Levelling

Provide level = Level + Staff + Change + Staff + ...

A ~~Block~~ Balk sight (BS) is staff reading taking on a point of known elevation as a B.M or T.P Generally, thought not always, it will be taken with the level sighting back along the line hence the name

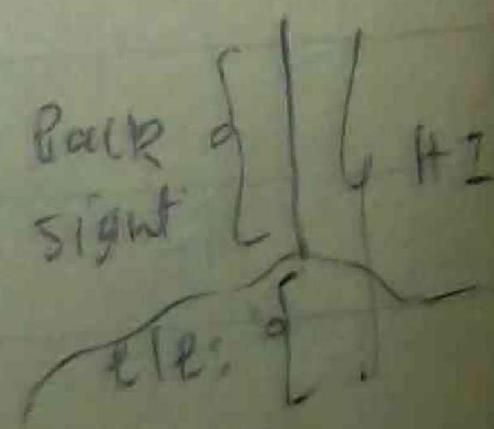
A Foresight (F.S) is a staff reading taken on a point whose elevation is to be determined as on a T.P or a B.M that is to be established



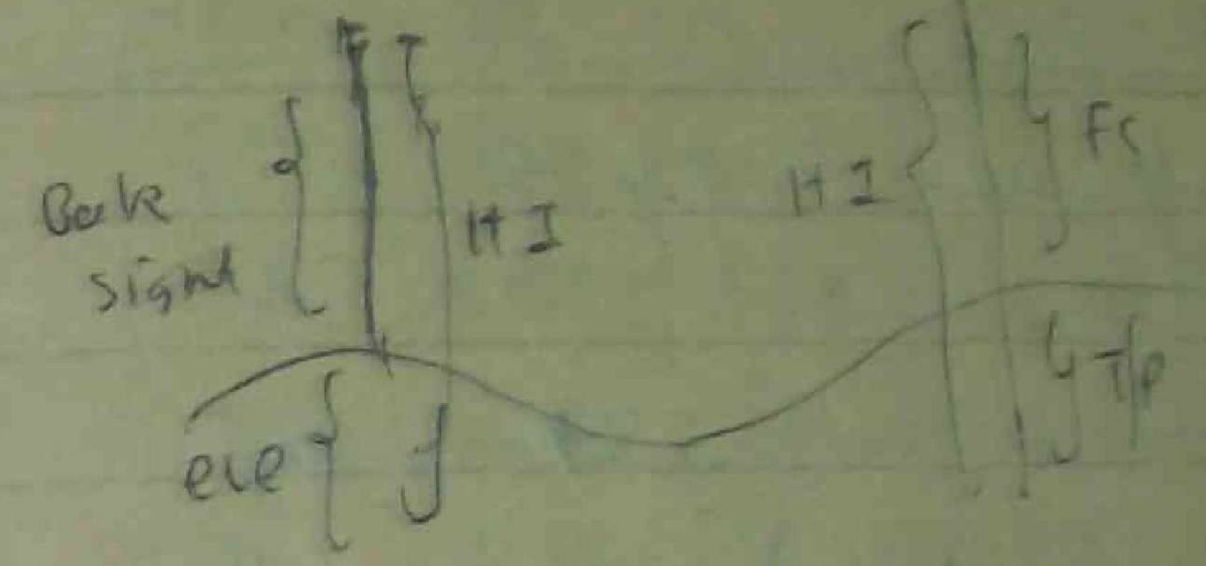
The height of instrument (HI) is the elevation of the line of sight of the telescope when the instrument is levelled.

(Height above the main sea level)

HI = elevation + Balk sight



Elevation point elevation: HI - Fore sight



Back sight = +
Fore sight = (-)

Level Note

21-3-33

Ex (1)

Date = 21-3-33

Place = Along Rangoon Jamalpur Rd:

Instrument man - A

Staff man - B

Recorder (note keep) - C

Station	BS	HI	FS	Elevation	Remarks
Bm 1	7.11	39.74	—	32.634	All readings in
TP1	8.83	47.33	1.24		
TP2	11.72		1.11	46.22	
Bm 2	4.32	57.05	16.24		
TP3	3.06	43.15	9.96	42.89	
TP4	2.74	35.95	8.91		
Bm 3			11.62		

H. Jamethod | HI = elev ① + BS
BS - FS = elev ②

Bm 1

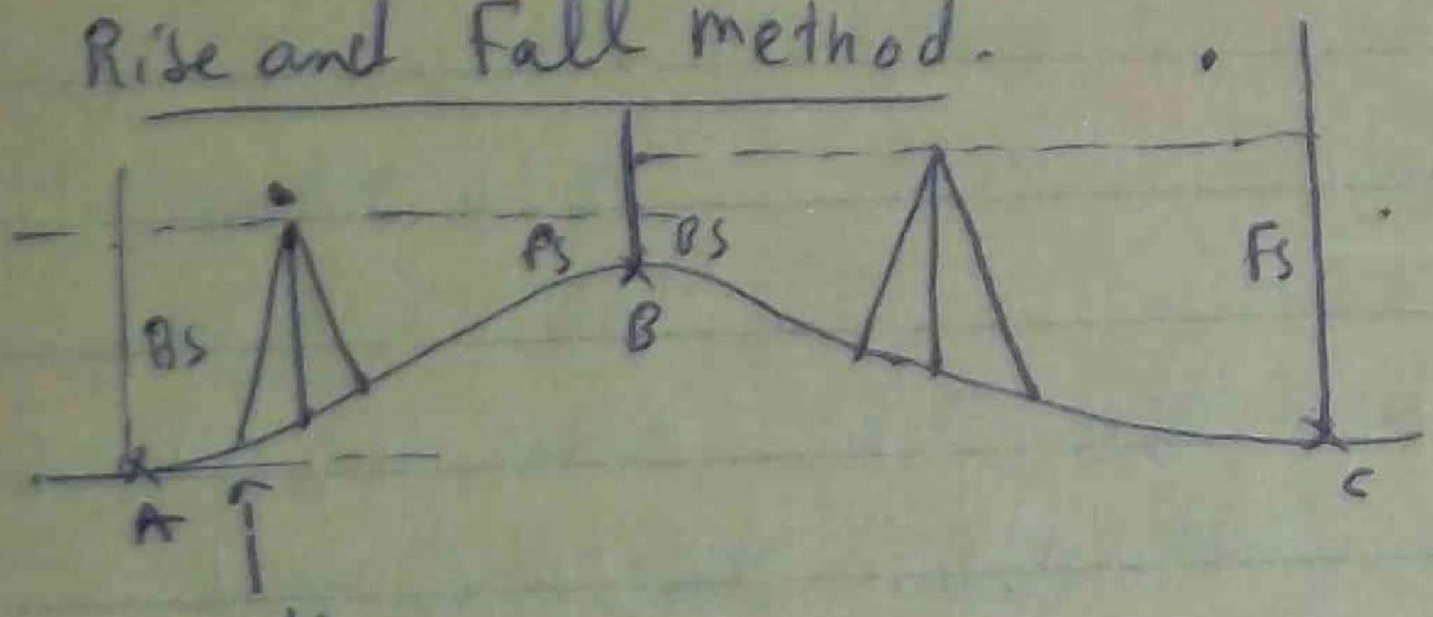
32.63 - 27.8 = 5.27 pillinele:

CHECK = 43.05 - 37.78 = 5.27 ✓

Ex

21-5-84

Rise and Fall method.



elevation of point A: Known

mean sea level.

+BS
-FS
} +

Belevation = +BS - FS
= + (Case B is higher than A)

Rise + elevation of A = elevation of B above sea level.

- FS
+ BS
(Fall)

∴ Fall + elevation of B = elevation of C above sea level.

Example 2

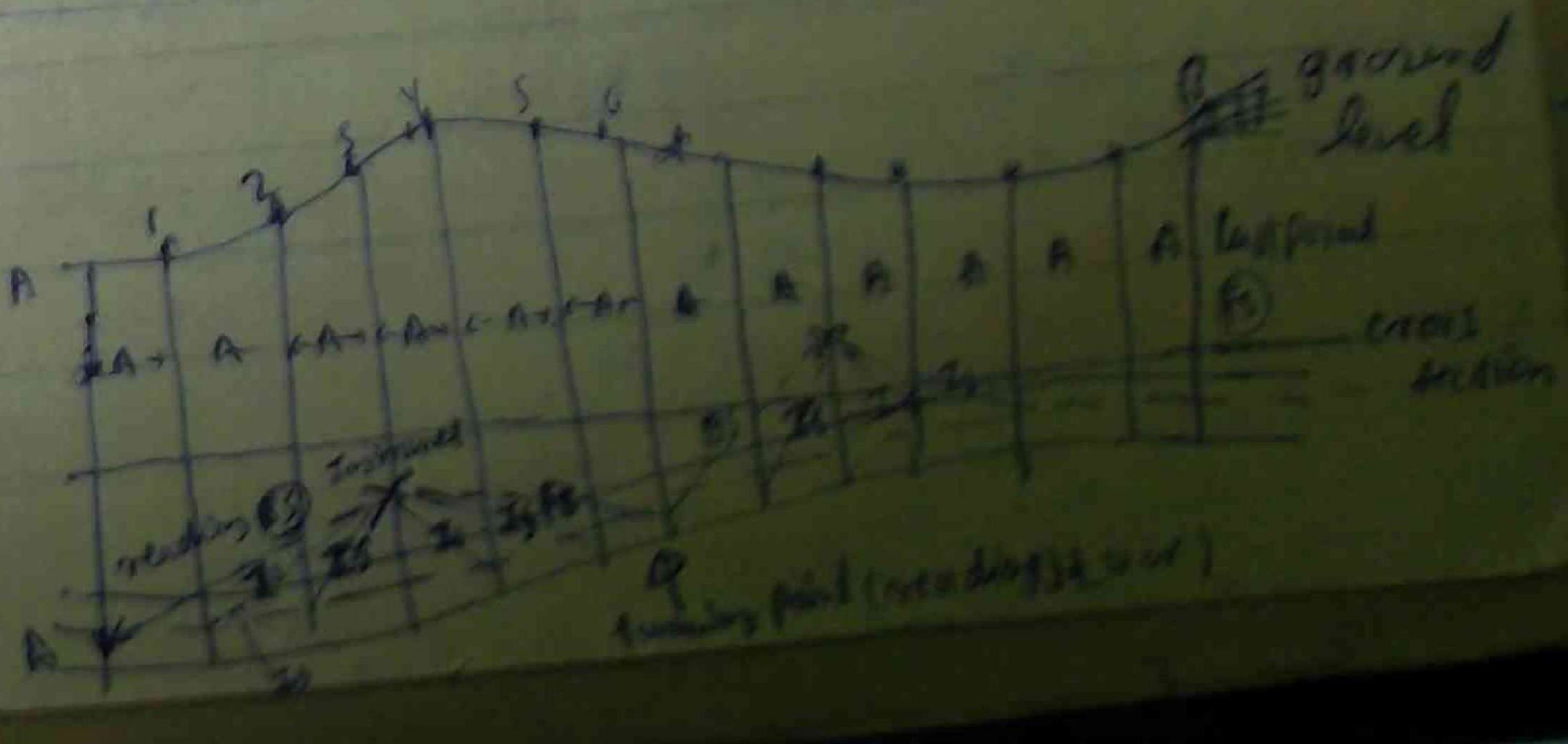
Station	BS	FS	rise	Fall	Elevation	Remark
BM_1	7.11	—			21.05	A Bloading ord in (ft)
TP_1	8.83	1.24	5.87	—	26.92	
TP_2	11.72	1.11	7.72	—	34.64	
BM_2	4.32	10.21	1.51	—	30.45	
TP_3	3.06	9.96	—	5.64	30.51	
TP_4	2.74	8.91	—	5.85	24.66	
TP_5	0.81	11.62	—	8.88	15.78	
BM_3	—	12.42	—	11.61	4.17	
	38.59	55.47				

$55.47 - 38.59 = 16.88$

$21.05 - 4.17 = 16.88$

checking

Profile levelling


A
1
2
3
4
5
6
B
ground level
A
A
A

Is = intermediate sight - {- sight }

Example (3)

The following staff readings in feet were obtained in order with a level the instrument being moved after the 3rd and 7th and the 10th

TP (change point)

BS IS FS / BS IS

The instrument being 4.21, 7.69, 8.72, 2.61, 7.76,

IS FS BS IS FS

6.70, 5.29, 10.01, 5.62, 4.38, 6.55, 2.22, 4.99

Enter the reading in level book from and use the H.I method the reduce ~~ele~~ then. Assume the reduced level or elevation of the 1st point as 100.00 ft.

station	BS	IS (FS)	FS	Elevation	Remarks
	4.21			100.00	all the readings are in feet
		7.69			
			8.72		
	2.61				
		7.76			
		6.78			
			5.29		
	10.01				
		5.62			
			4.38		
	6.55				
		2.22			
			4.99		

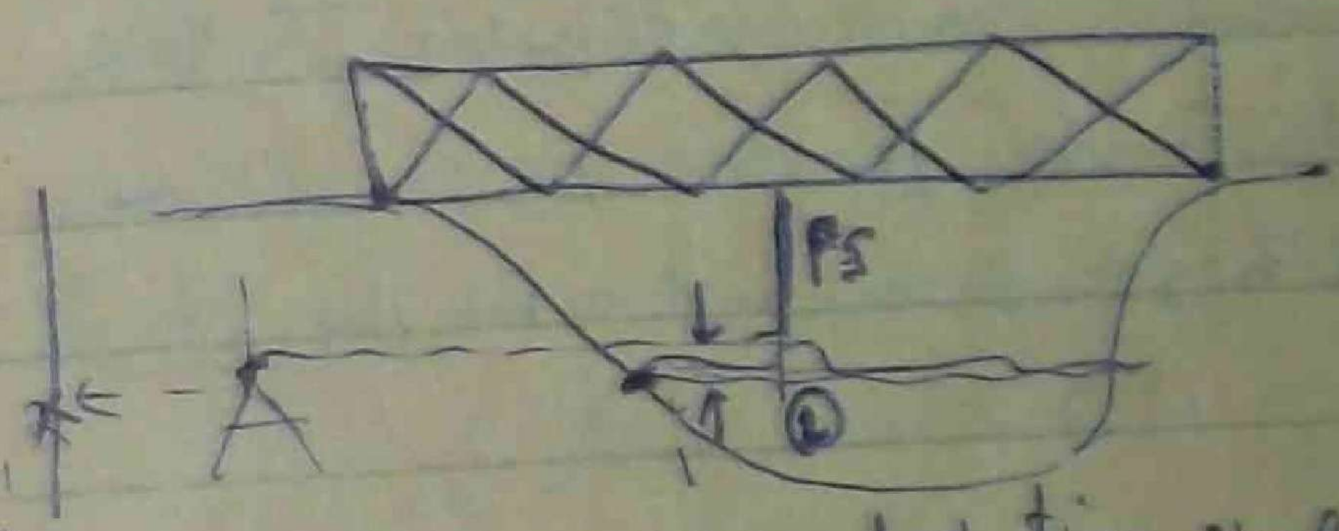
Reduced level ≡ elevation (RL)

HI Elev: + BS - HI

HI - FS = elev.

22-5-24

I onverted staff readings



Staff reading at station are the inverted staff readings.

Inverted staff readings - opposite sense to the normal staff readings. BS (-) sight

F.S (+) sight

Is (+) sight

HI = elev: ⊕ BS

HI ⊖ FS = elev. L

Example (4)

A railway bridge crossa dual carriage way in base span. It is designed to know the minimum clearance between crow level of road and the underside of the bridge grinders the table shown below is an except from the sum seyor's level. Booke showing the staff reading obtained. Reduce the reading and determine the last clearance. The readings in brackets refer to the point on grinder vertically above the pricision points ~~on~~ ~~grinder~~ and the readings are obtained with the staff held inverted.

Station	B.S	H.I	I S	F.S	Elevation	Remark
Bm 1	0.49				859.60	
TP1	0.72			10.34		Crown of road
{ A			10.20			
A1			(2.83)			underside of girder
{ B			9.38			Crown Error
B1			(2.85)			
{ C			9.42			underside of girder Error
C1			(2.63)			"
{ D			10.22			underside Er
D1			(2.61)			

10 link = 10ft = 1 Tallies

10th link

Tallies @ 10' 10'
@ 20' 20'
@ 30' 30'
@ 40' 40'
@ 50' 50'
@ 60' 60'
@ 80' 80'

Taping

(1) Steel tape → Invar tape → Alloy → expension by heat & Cold
(2) Linen tape

Tacheometry

Telescope measured → Theodolite.

Geometry + Trigonometry is known edge

Marking

horizontal

vertical

measure by seeing the distance between two distance, and calculate

Station	BS	HI	IS	FS	ele:
TP2	1.70			-1.57	
BM2				102	

Reduced - elevation

I

But ele: = HI

H2 - Fs reading 2

bracketed ⊕ curve

A~A1, B~B1, C~C1, D~D1 by main: (bearing

opposite

(least clearance 12.05)

Effect of the earth curvature and atmospheric Refraction

FS

BS

A

B

horizontal line

effect of the earth curvature

h = effect of the atmospheric refraction.

h' = combined effect of earth curvature and atmospheric refraction.

$h' \propto d$ {d-sight distance}

$h' = 0.573 d^2$ 28-5-84

(d = sight distance in mile

(or) $h' = 0.021 m^2$

where m = sight distance in thousands of feet.

when distance = 1000 ft $m = 1$

" 2000 — $m = 2$

" 500 — $m = 0.5$

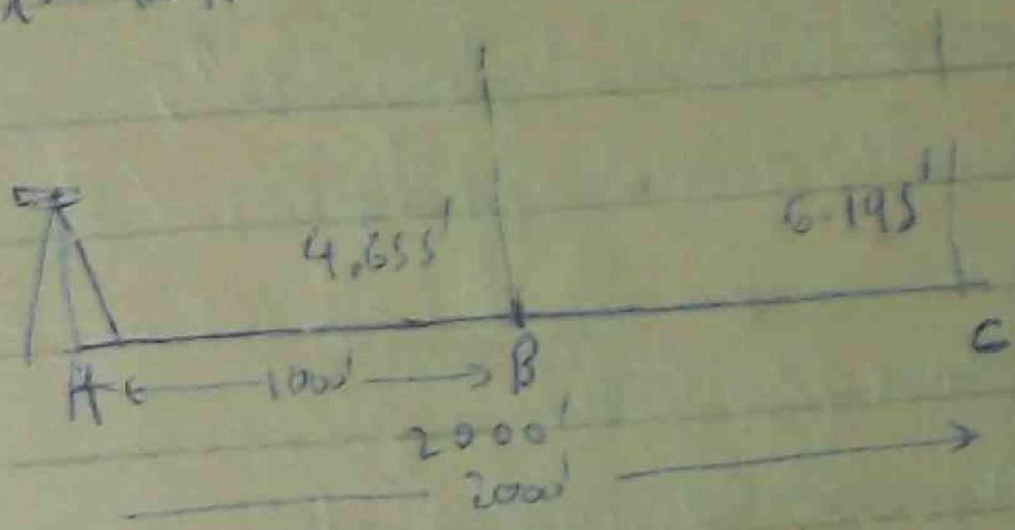
Staff reading $= mq - h'$

Example

A, B and C are three survey stations on a 2000 ft long straight line ABC with Sta: B at the centre. A level instruments was setup at station A and two staff readings were taken at Station B and station C and forwa

To be 4.655 and 6.195 ft respectively.
Find out the difference in elevation between station B and station C.

(a) If in the above problem, the staff readings on station C was taken with the staff held inverted what will be the diff: in elevation Between B and C?



B → h' = 0.021 (1)² = 0.021 ft

C → h' = 0.021 (2)² = 0.084 ft

corrected staff reading (B) = 4.655 - 0.021 = 4.634'

" (C) = 6.195 - 0.084 = 6.111'

Diff: in elevation Bet. B and C = 6.111 - 4.634

= 1.477'

(a) corrected staff reading at B = 4.634

" " C = 6.195 + 0.084 = 6.279'

Diff in elevation Between = 6.279 - 4.634 = 10.913'

=

Angular Measurement

- measurement of the angle.
- To fix the position of the point or a line.
- Protector least count = ½° (30')
- Theodolite — angle } horizontal as well as
  — dist } the vertical angles.
  T_1 T_{15} least count ½ (or) 30"
  T_3 T_2 least count {1"}

- meridian (Reference position)
  ① True meridian ⟶ True north.
  ② magnetic meridian → magnetic north.
  ③ Grid meridian → ####
  ④ Arbitrary meridian

True meridian

True north

S

N pole

S pole

Altitude of the pole.

Altitude of pole = latitude of place of observation.

True North

Daytime = Solar observation.

star Astronomic (Hm SD)

magnetic meridian

magnetic north → magnetic compass.

place of observation in time.

Isogon, Isoyonic Chart.

Relation Between the true north to the magnetic north

magnetic reflection

True north

↑ → magnetic north

d = magnetic reflection.

It can be toward east or toward west.

↖ Two angle between the true north and magnetic north
It can be toward right or left.

Angular Measurement

- Measurement of the angle.
- To fix the position of the point of a line.
- Protector least count = ½° (30')
- Theodolite — Angle } Horizontal as well as
  — Level } the vertical angles.
  (least count ½' (or) 1' (or) ½' (30"))
  T_1 T_{15}
  T_3 T_2 least count {1"}

- Meridian (Reference position)
  1) True meridian ⟶ True north.
  2) magnetic meridian ⟶ magnetic north.
  3) Grid meridian ⟶ ////
  4) Arbitrary meridian ⟶ Reference (RO)

Prismatic Compass

Traverse,

Needle
Pivot
Prism
Glass

Altitude of the pole.

Altitude of pole = latitude of place of observation.

True North

Daytime, Solar observation.

star Nkanomic (Ursa Major)

Magnetic meridian

Magnetic north = Magnetic compass

place of observation or direction.

Isoyer, Isogonic Chart.

Addition / Correction to true meridian

Dry season observation

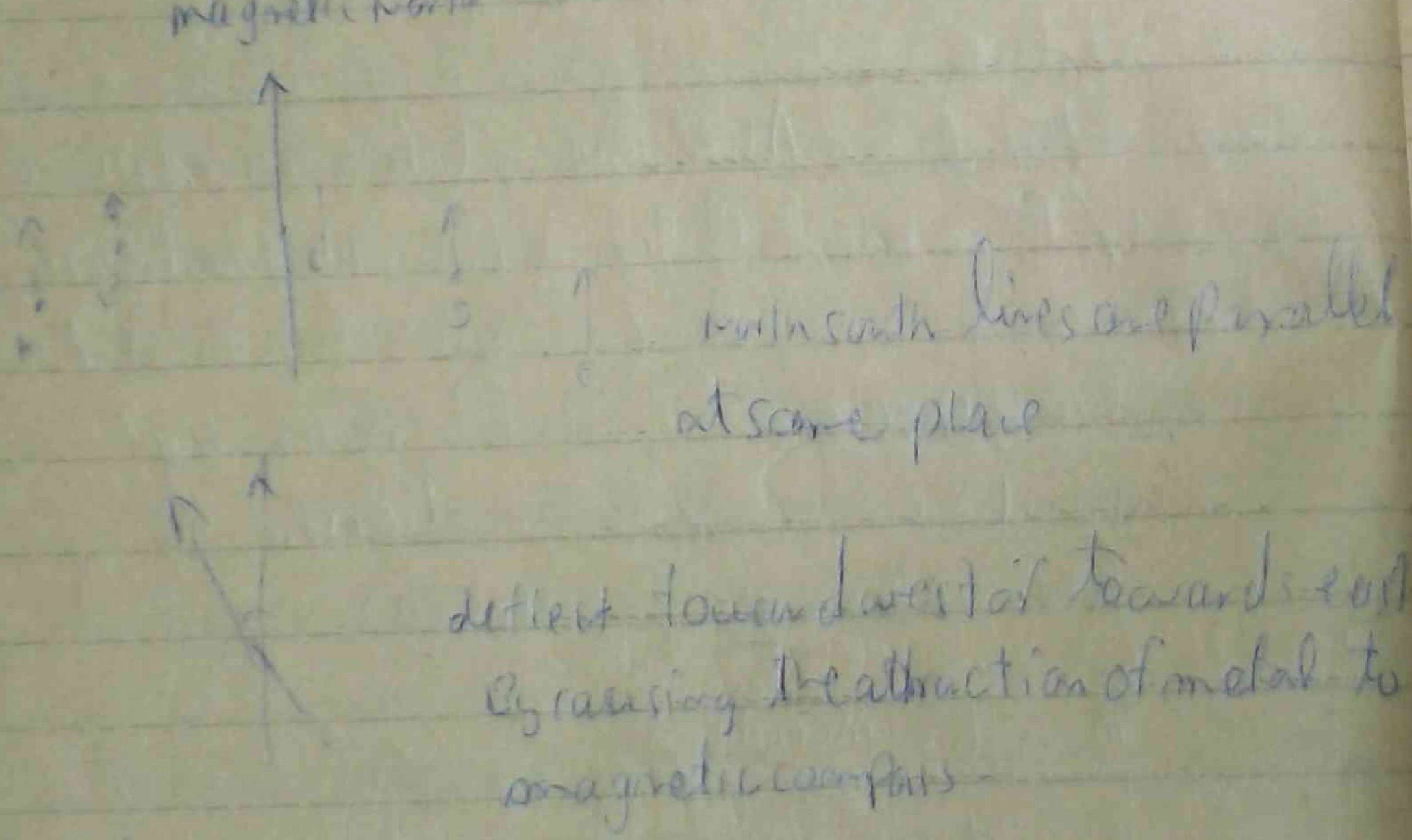
Rainy season observation

Equinox

Summer solstice

Winter solstice

local attraction

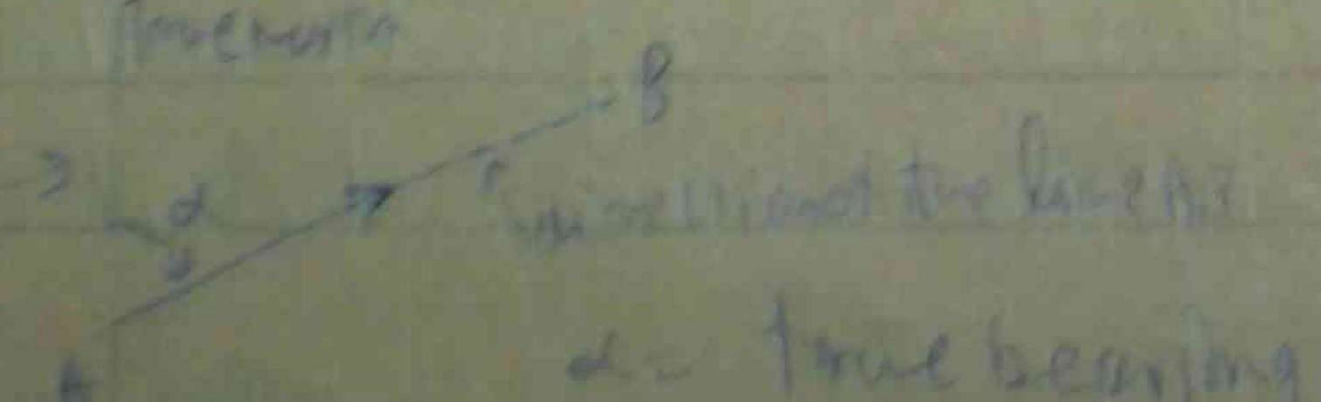


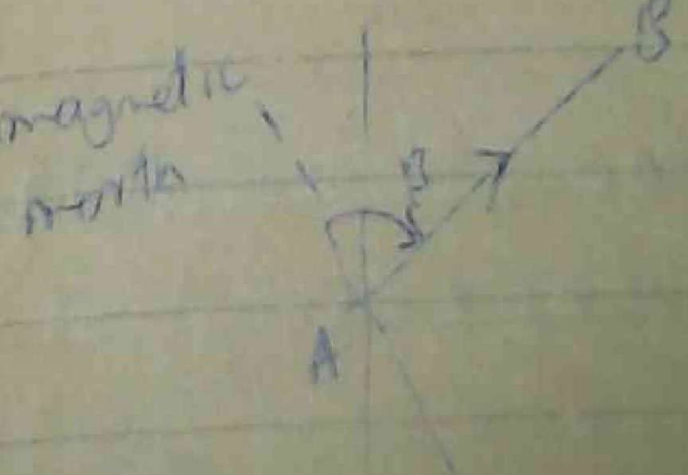
✓ local attraction

The angle between the magnetic north and the magnetic needle. It can be toward east or towards west of the magnetic North.

✓ Direction of the lines

Direction of the line is with reference to the true north or magnetic north (Bearing)





β = magnetic Bearing of the line AB

Bearing system:

① whole circle system (whole circle Bearing) (WCB)

② Quadrantal system (Quadrantal Bearing) ∠B

1 whole circle = 360°

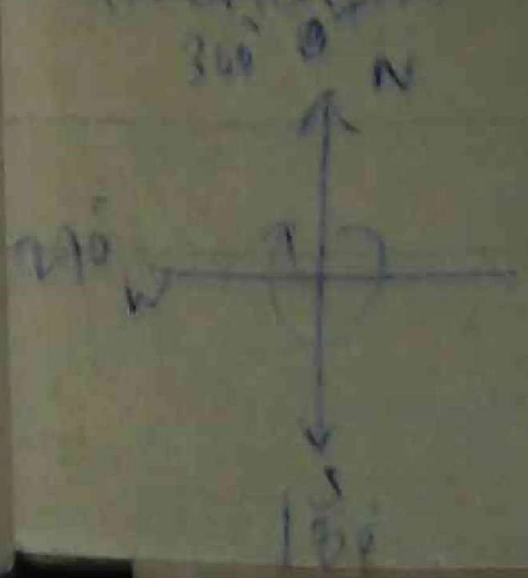
Quadrantal system

1 Quadrantal circle = 90°

True meridian → whole circle

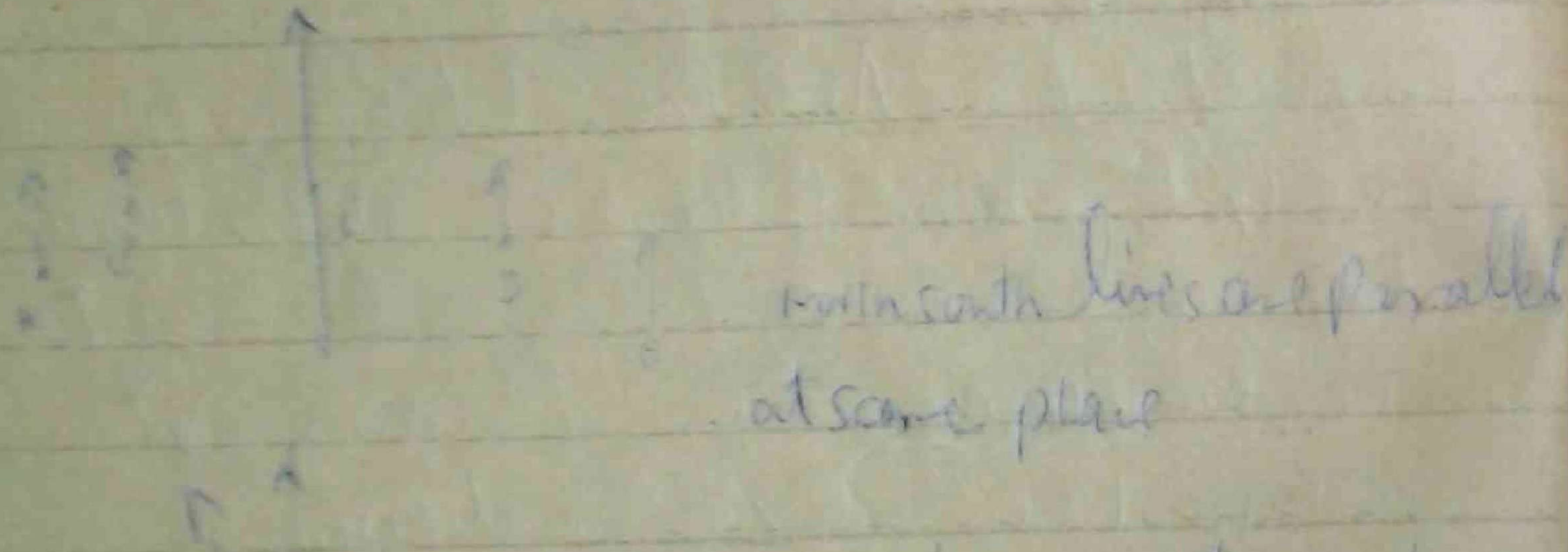
magnetic " → Quadrantal circle

whole circle Bearing is with reference to the true meridian (Azimuth)



Relation

local attraction

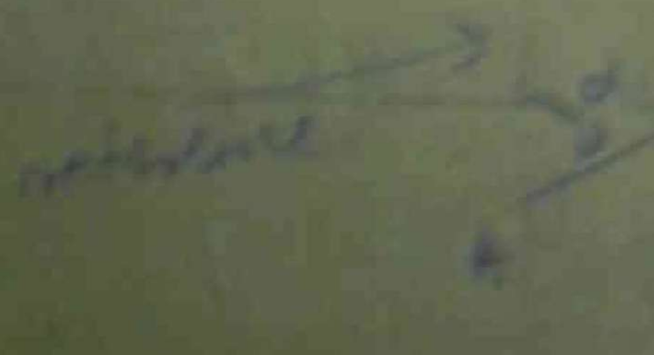


✓ Local alteration

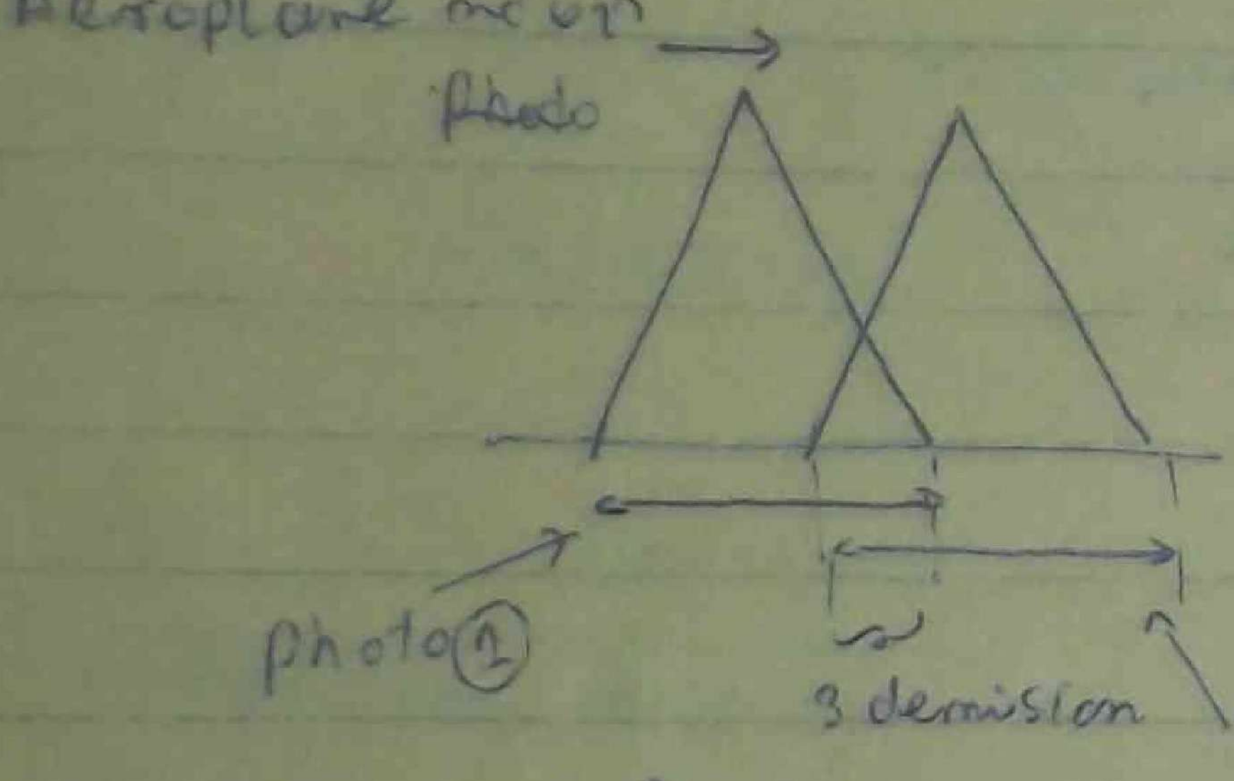
The angle between the magnetic north and the magnetic needle. It can be toward east or towards west of the magnetic north.

✓ Direction of the lines

Direction of the line is with reference to the true north or magnetic north (bearing)



Aerial survey



Aerial survey ⟶ Route survey

↓

20 m ~ 8 : 1 ~ 8 : 60 m ~ 25

Baseline measurement and tape connection

(1) straight

(2) Convert to horizontal

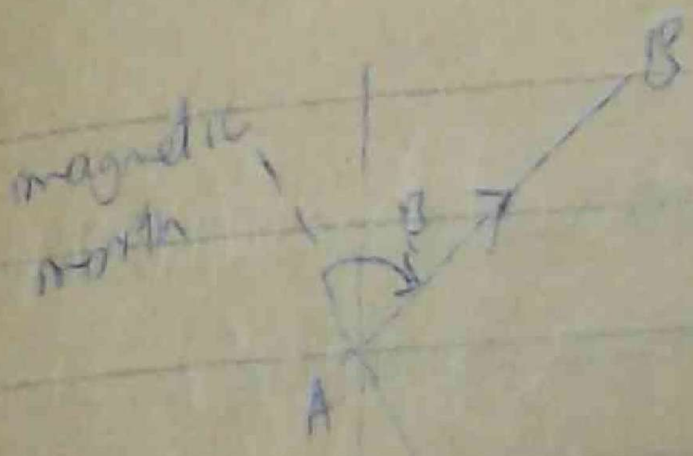
(3) redue error.

It needs to know mistake and errors

(1) Standardifaction

(cstd)

It need standard tape.



β = magnetic Bearing of the line AB

Bearing system:

① whole circle system (whole circle Bearing) (WCB)

② Quadrantal system (Quadrantal Bearing) ∠B

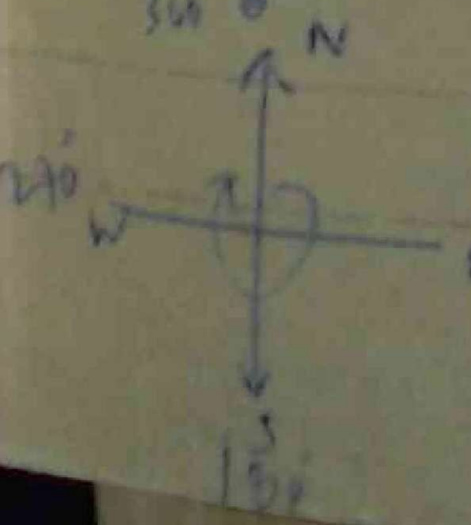
Quadrantal system

1 Quadrantal circle = 90°

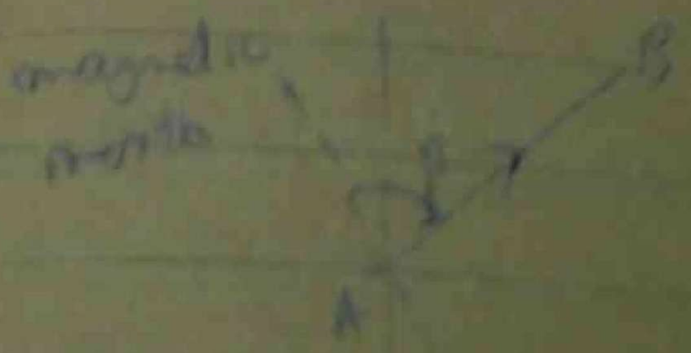
True meridian → whole circle Quadrantal circle.

magnetic N

whole circle Bearing is with reference to the true meridian. (Azimuth)



Relation



B = magnetic Bearing of the line AB

Bearing System:

① whole circle system (whole circle Bearing) (WCB)

② Quadrantal System (Quadrantal Bearing) QB

1 whole circle = 360°

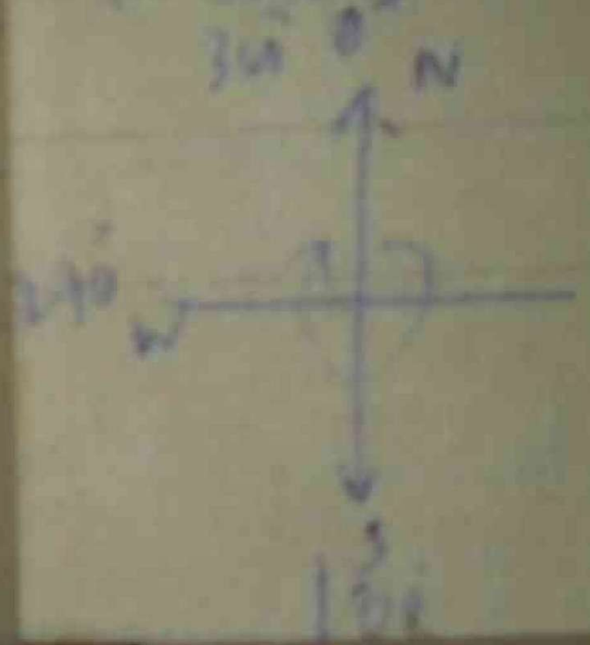
N

Quadrantal system

1 Quadrantal circle = 90°

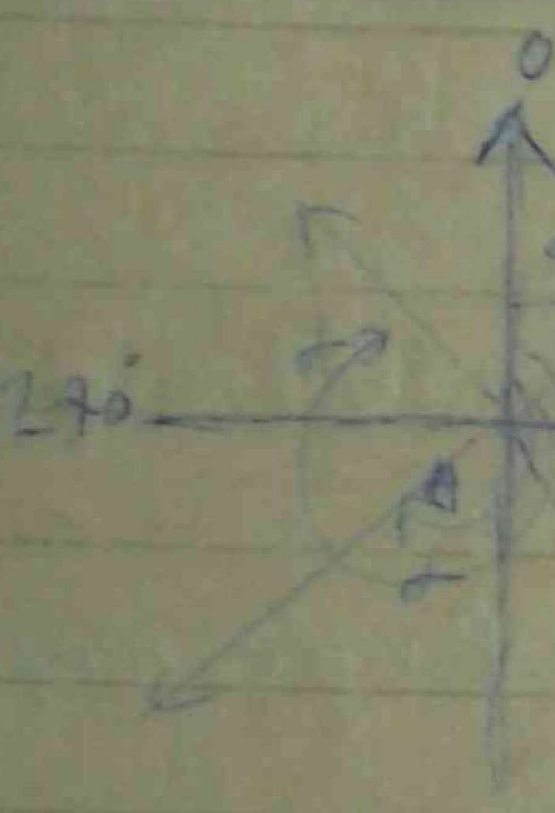
True north / direction → whole circle Quadrantal circle.

whole circle Bearing is with reference to the true direction. (Azimuth.)



Reduction

Relation Between Two WCB in the Quadrantal Bearing



I when $0 < \alpha < 90°$ → WCB = α

II $\alpha = 90°$ → WCB = α

III $90 < \alpha < 180°$ → WCB = α

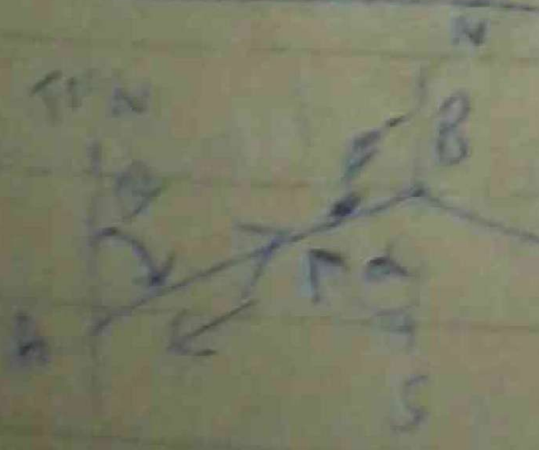
IV $180 < \alpha < 270°$ → WCB = α

V $270 < \alpha < 360°$ → WCB = α

0° = Due north. 180° = due South

90° = Due East 270° = due west.

Forward and Backward Bearings



(Quadrantal Bearings)

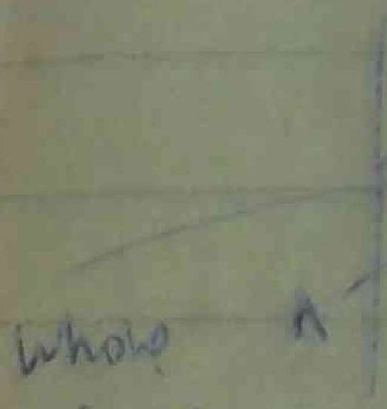
Forward Bearing of AB = N 0° E

The Bearing of the line CA = Backward Bearing

d) If there is no local attraction check the bearing at A & B.

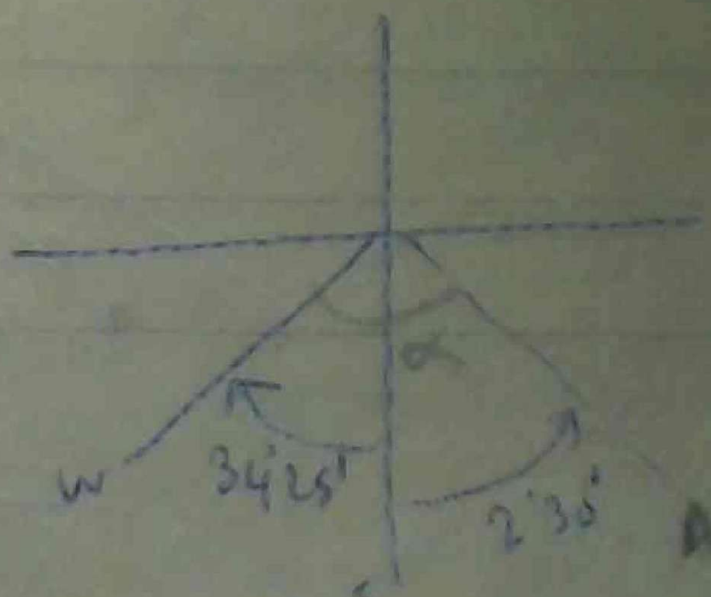
Back bearing → opposite direction of the forward bearing.

Same magnitude with opposite direction.



Ex① The bearing of line AB measured with a magnetic compass and found to be S 34°25' W if the magnetic declination of the place is 3°W and the local attraction there is found to be 5°30' E what is the true bearing of the line.

local attraction = 6°30' East
magnetic declination = 3° West
2°30' East



∴ Adjust.

True bearing =

=

$Sw_2 > Sw_1$

S-W_1 + East → S-W_2

S-E_1 + West → S-E_2

SE - SE → W

$Sw_2 < Sw_1$

~~Sw~~ Sw_1 - West = Sw_2

SE_1 - East = SE_2

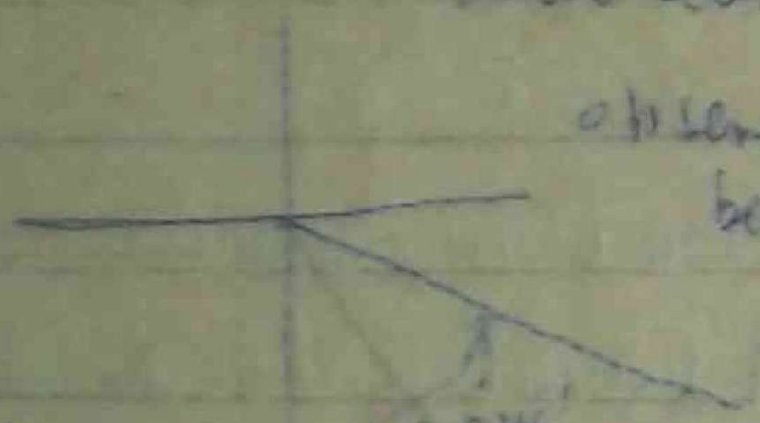
E + ②

The true bearing of a line ~~of~~ S 43° 49' E and the observed compass bearing of that line (1) found to be S 24 30 E. If the magnetic declination at that point is 9° W. what is the error caused by the local attraction.

True bearing = S 43° 49' E

observed bearing = S 24 30' E

1919 west



~~local~~ attraction?

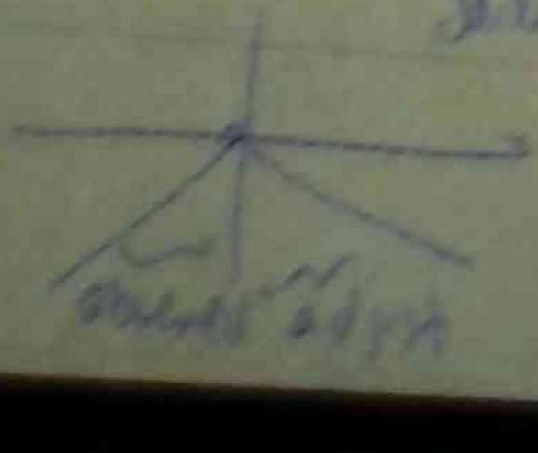
magnetic declination = 9 W

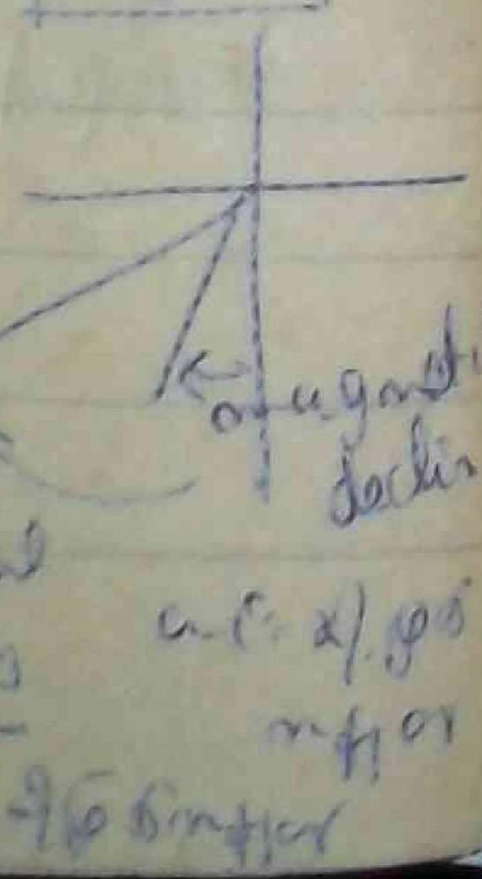
local attraction = 19 19' - 9 W

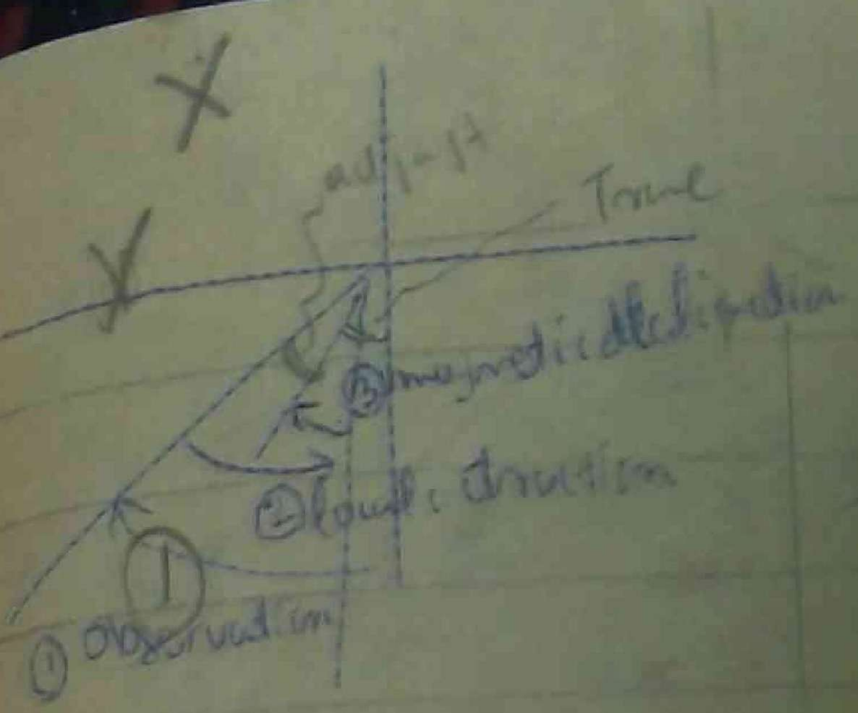
= 10° 19' west

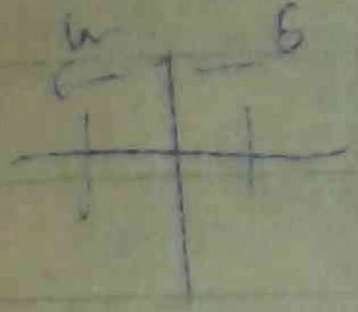
local attraction ± magnetic declination = adjust

adjust ± observed = true bearing







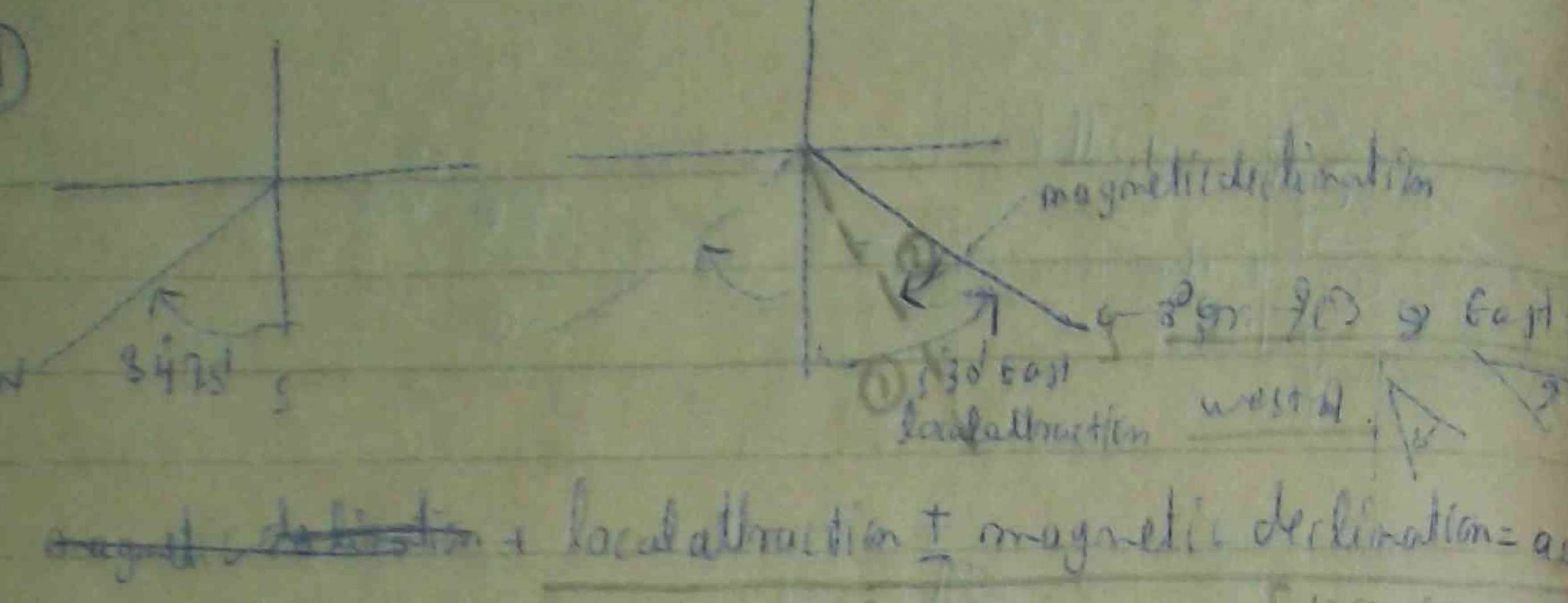


$$\text{Tmue} = 3430\,3425' - [5'30']$$

$$\text{Tmue} = 3425' + [5'30' - 3']$$

$$= 3565$$

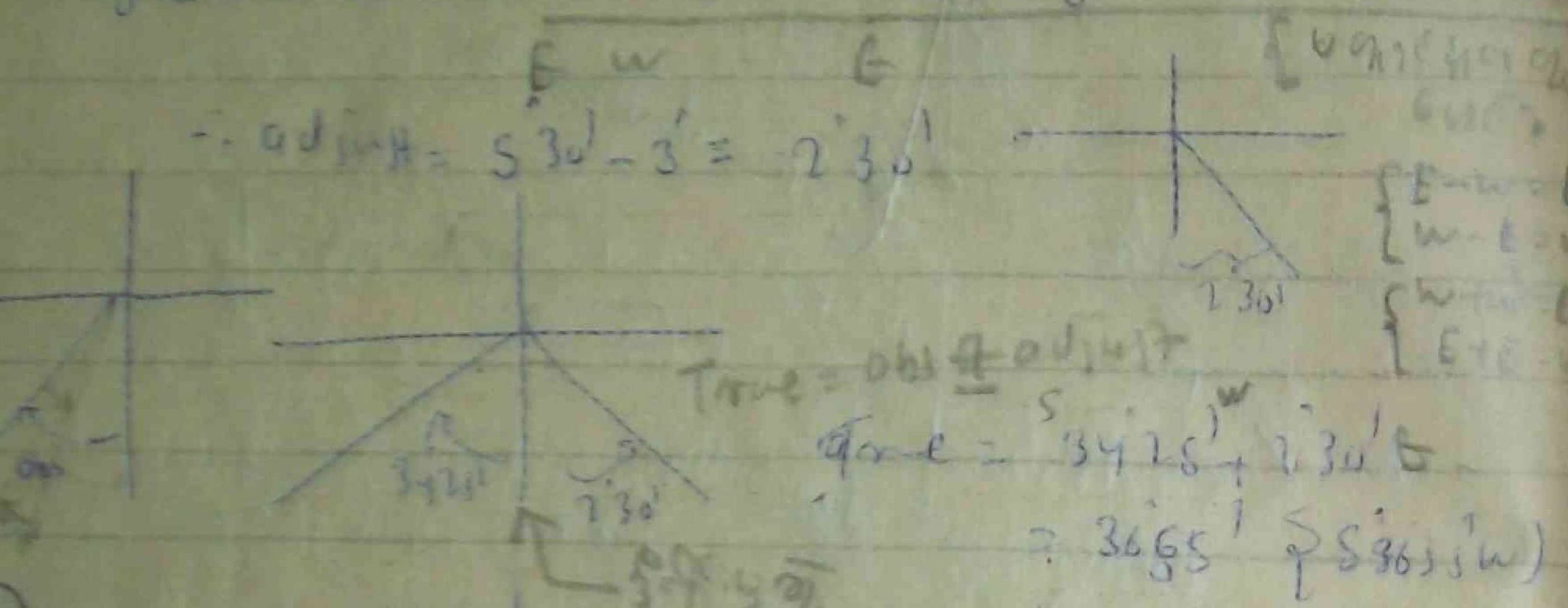
$$= 10^{\circ}19'\,W$$



~~magnetic declination~~ + local attraction ± magnetic declination = a

E W E

∴ adjust = 5°30' − 3° = 2°30'



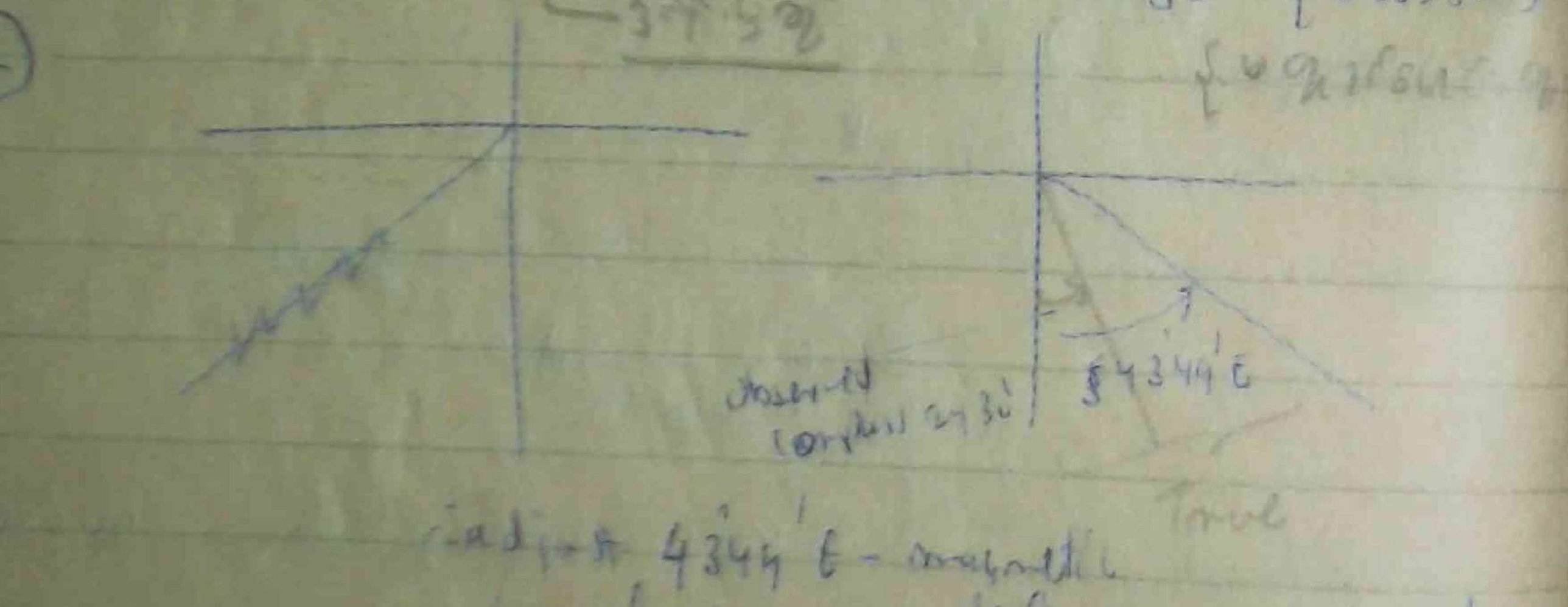
True = obs ± adjust

S W

Var = 3°45' W + 2°30' E

= 3°15' W

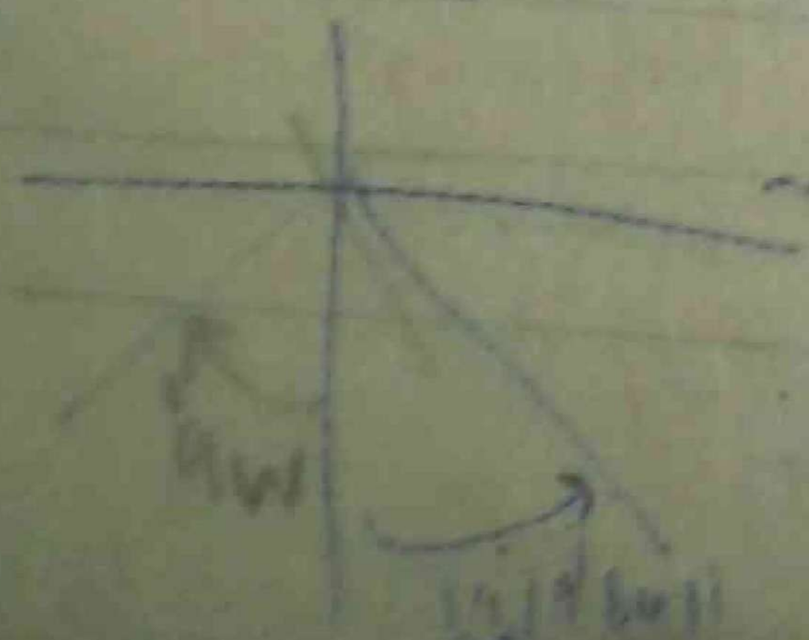
Dev = 3°15' W



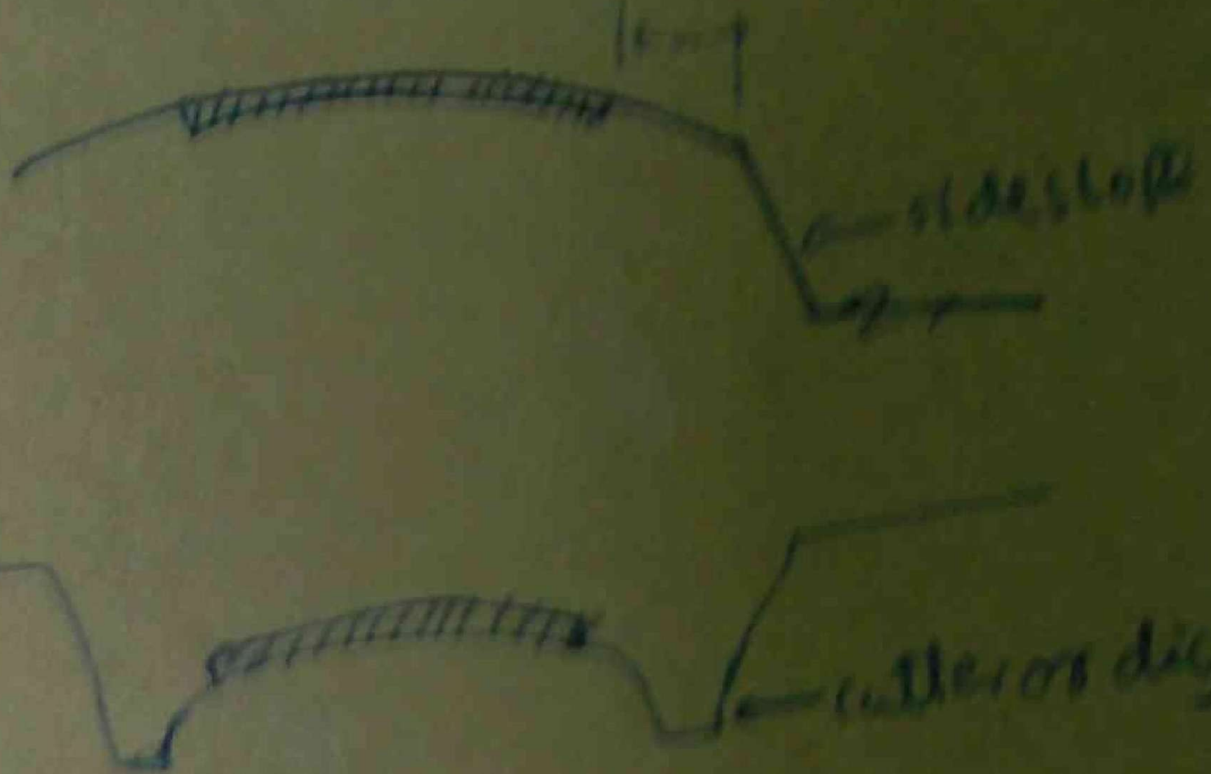
adjust = 4°45' E - compass

Load = 73°15' E - 52°30' E

deflection = 19°15' East



Shoulders page 14



outer edge of ~~drain~~ pavement; inner edge of ditch/gutter/curb.

(O) ROW: Curb & gutter plus extra width for curb & gutter maintenance/repair if any

(W) Shoulder width from edge of pavement to edge of ROW

(P) ~~Over~~ Top of curb from edge of pavement

(S) Width of roadway with widest part of ROW

(T) Pavement ~~type~~: width of roadway with signs if any

(B) Shoulder width and width of curb & gutter type: concrete, asphalt

(G) Shoulder type: concrete, asphalt, gravel, dirt

(Z) Other features: ditch, curb, gutter, etc.

(contd)

Elat: 2985 { magnitudes of misc: algebraic sum wise by

Error of closure = $\sqrt{\Delta lat^2 + Dep^2} = \sqrt{15^2 + 31^2} = 35.5$ ft.

Total length = 4997.6

Precision = $\frac{35.5}{4997.6} = \frac{1}{142}$

Since 142

Slat AB is $\frac{500}{4997.6} = 1.5$ (+)

Slat BC is $\frac{878.6}{4997.6} = 2.6$ (

Slat CD is $\frac{2574}{4997.6} = 2.6$

Slat DE is $\frac{1019.6}{4997.3} = 3.1$

Slat EF is $\frac{1113}{4997.6} = 3.3$

Slat FA is $\frac{6386}{4997.3} = \frac{1.40}{14.6}$ — 1 part of 60

$= \frac{}{15}$

III ly $\delta dep\ AB = 32 \times \frac{50.2}{4991.1} = 3.2$

$\delta dep\ BC = 31 \times \frac{2 \times 3.6}{4991.6} = 3.2$

$\delta dep\ CD = 32 \times \frac{254.4}{4991.6} = 1.6$

$\delta lat\ DE = 32 \times \frac{1019.2}{4991.8} = 6.6$

$\delta lat\ EF = 32 \times \frac{111.2}{4991.8} = 7.2$

$\delta lat\ FA \quad 32 \times \frac{456.8}{4991.7} = 4.2$

correction

	line	lat	dep	N	S	E	W	N	S	E	W
	AB	+1.5	+3.2	500	0	0	0	501.5			
	BC	+2.6	+5.4	600	0	600	0	601.6			
	CD	+2.6	15.4		300	800	0	-298.4			
	DE	+3.1	+6.6		1000	200	0				
	EF	+3.3	+7.2		200		1100				
	FA	+1.9	+4.2	315			532				
		+15	+32								

standard — ex: 20c, 20 lb tensile strength, — rated length.

It needs to check with standard

~~may~~ Tape too long → + correction

Tape too short → — correction

cstd = true length — nor nominal length
(standard length)

Example

nor nominal length = 100'

true length = 100.5'

Cstd = 100.5 — 100 = +.5' (+ correction)

Example

true length = 99.9'

Cstd = 99.9 — 100 = —.1' (— correction)

So correction → { + / — }

~~bfcd~~

	N	S	E	W			N	S	E	W
AB	509		0		+1.5	+3.2	509		3.2	
BC	600		600		+2.36	3.2	602.6		600	
CD		309	800		+3.4	5.4		-241	801	
DE		1000	207		+3.8	8.2		-969	206	
EF		200		409	T3.3	7.2		-196		
FA	325			532	T1.4	9.2	366.4			
							1490	1490	1206	

Δ Lat = 0 Δ dep = 0

H.W Transit rule.

North + South -

Lat AB = 500

$\delta lat_{AB} = \Delta Lat \times \frac{Lat\ AB}{\Sigma Lat}$

$= 15 \times \frac{500}{2935} = \frac{7500}{2935} = 2.51$

$\delta lat_{BC} = 15 \times \frac{600}{2935} = \frac{9000}{2935} = 3.02$

$\delta lat_{CD} = 15 \times \frac{200}{2935} = \frac{4300}{2935} = 1.51$

$\delta lat_{DE} = 15 \times \frac{1000}{2935} = 5.03$

$\delta lat_{EF} = 15 \times \frac{200}{2935} = 1.005$

$\delta lat_{FA} = 15 \times 325/2935 = \frac{5300}{1935} = 1.53$

Dep:

$\delta dep AB = 32 \times \frac{0}{3232} = 0$

$\delta dep BC = 32 \times \frac{600}{3232} = \frac{19200}{3232} = 5.94$ ~~5.97~~ 6.13

$\delta dep CD = 32 \times \frac{800}{3232} = \frac{21600}{3232} = 7.93$

$\delta dep DE = 32 \times \frac{200}{3232} = \frac{6400}{3232} = 1.98$

$\delta dep EF = 32 \times \frac{400}{3232} = \frac{12800}{3232} = 3.8$

$\delta dep FA = 32 \times \frac{532}{3232} = \frac{17022}{3232} = 5.25$

	N	S	E	W			N	S	E
AB	509		0		2.51	0	502.9		0
BC	600		600		3.02	5.13	603.02		606.[illegible]
CD		300	300		1.51	7.43		[illegible]	307.[illegible]
DE		1000	200		5.03	1.93		994.07	201.[illegible]
EF		200		1100	1.00	3.3		199.[illegible]	
FA	333			532	1.33	5.25	298.47		

1489.00 246

532

14-6-84

Example (2)

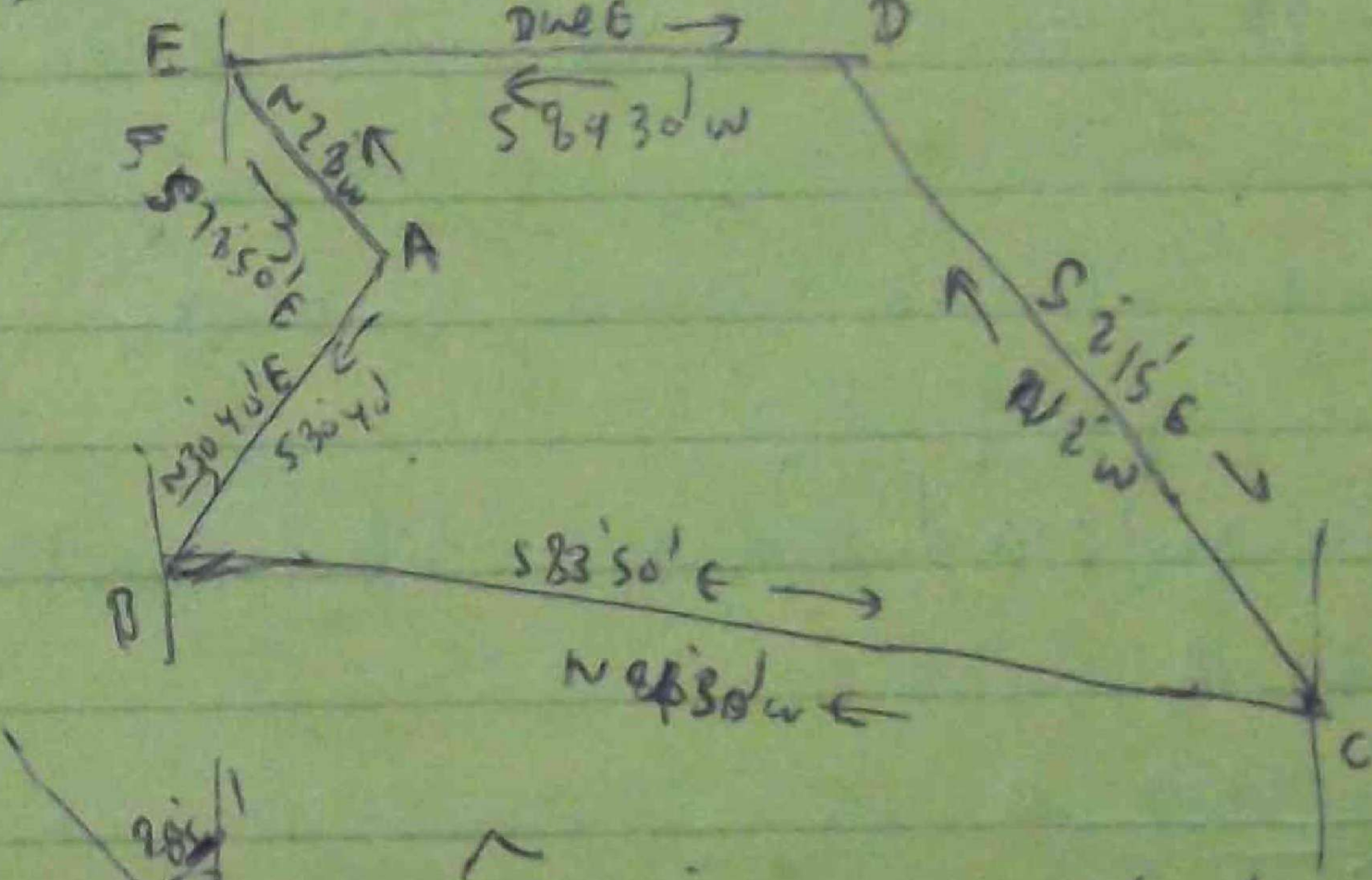
The following field notes from the length and bearings of a closed traverse ABCDA compute the error of closure and adjust the traverse by transit rule

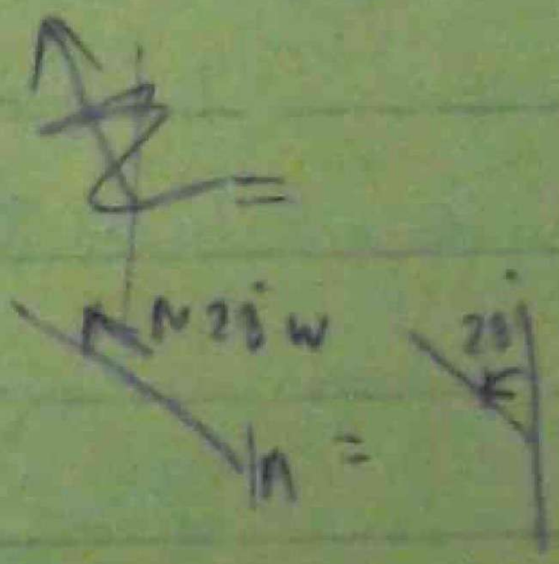
Line	Length (ft)	Azimuth → QB
① AB	730	0°00' Due North
② BC	1414	45°00' N 45°00' E
③ CD	2000	150°00' S 30°00' E
④ DA	1996	270°00' Due West

	Lat		Dep	
	N	S	E	W
①	730	—	0	—
②	1000	—	1000	—
③	—	1732	1000	—
④	—	—	—	1996
	1730	1732	2000	1996

$\Delta Lat = -2$ $\Delta dep = -4$

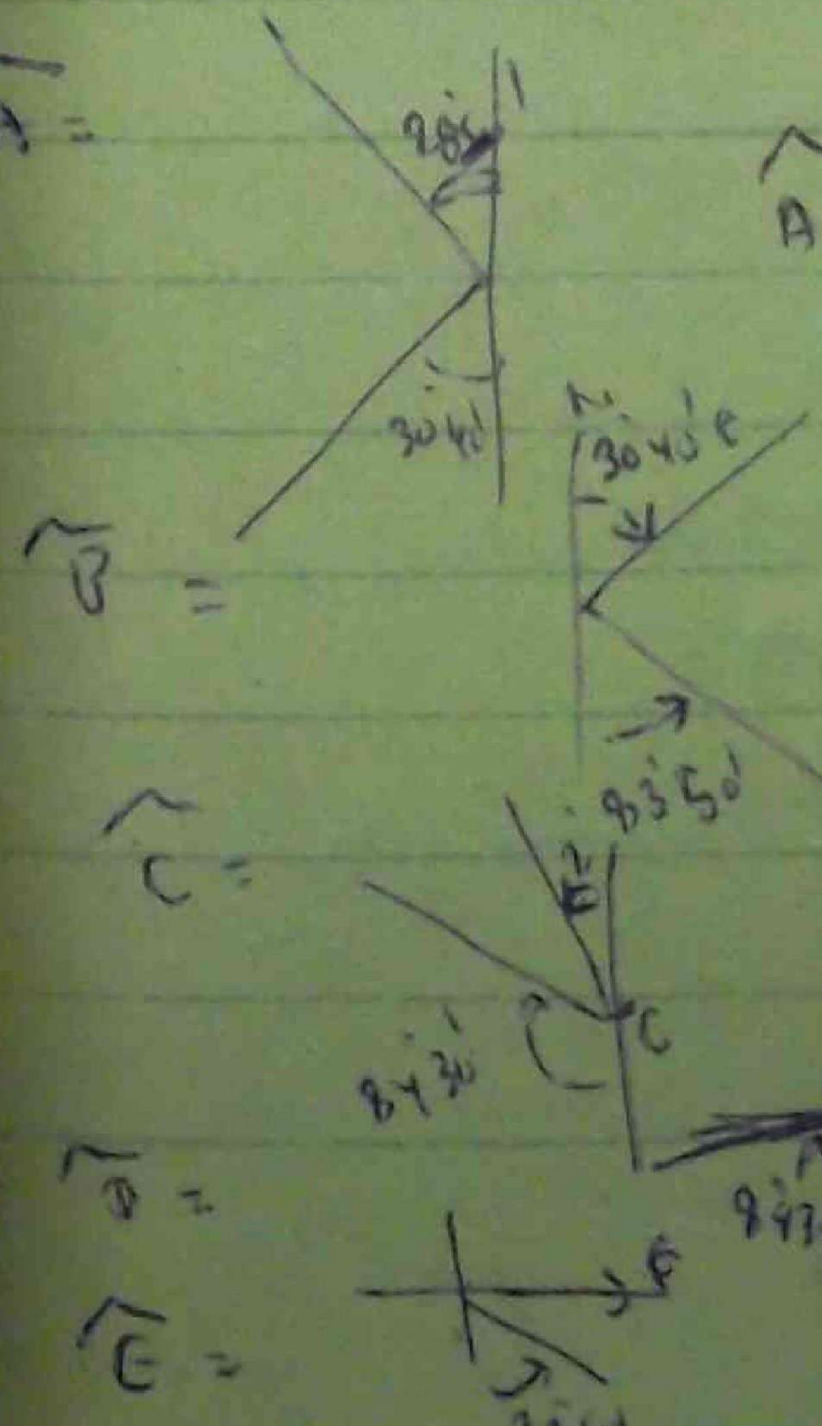
Transverse





$\hat{A} = 120^\circ + 30^\circ 40' + 28^\circ 50'$

$= 23^\circ 40'$



$\hat{B} = 120 - [83^\circ 50' + 30^\circ 40']$ $= 65^\circ 30'$

$\hat{C} = 180 - [84^\circ 30' + 2^\circ]$

$= 82^\circ 30'$

$D = 84^\circ 30' + 2^\circ 15' = 91^\circ 45'$

$\hat{E} = 90 - 71^\circ 50' = 61^\circ 10'$

$\hat{E} + \hat{A} + \hat{B} + \hat{C} + \hat{D} + \hat{E} = 5 \times 180°$

$(2n-4) \times 90° = (2 \times 5 - 4) 90° = 5 \times 90°$

- diff $5.40° - 3° = 2°$ diff $/ = -5'$
  $5°43'$ / drive

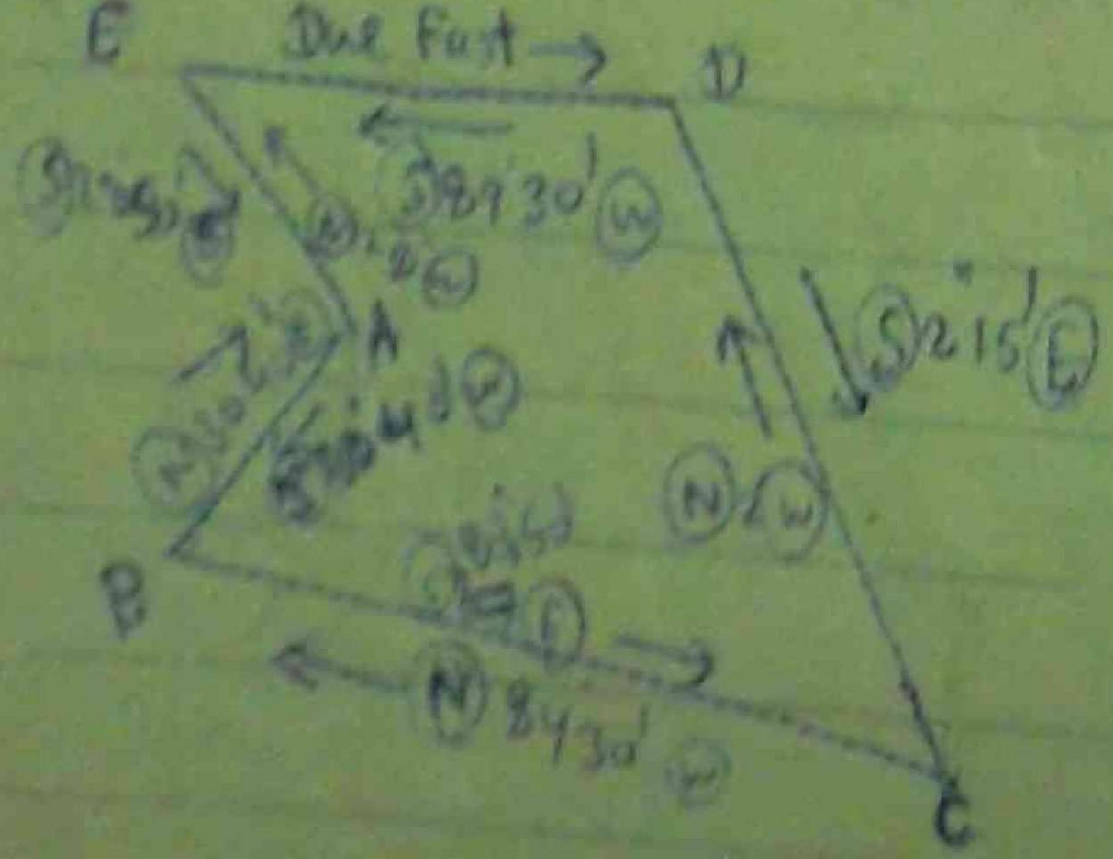
$\therefore$ adjusted $= 238°40' + 5' = 238°45'$

$\therefore$ Required adjusted bearing

5-6-84

Example

Adjust the unbalanced bearings of the following closed traverse ABCDEA

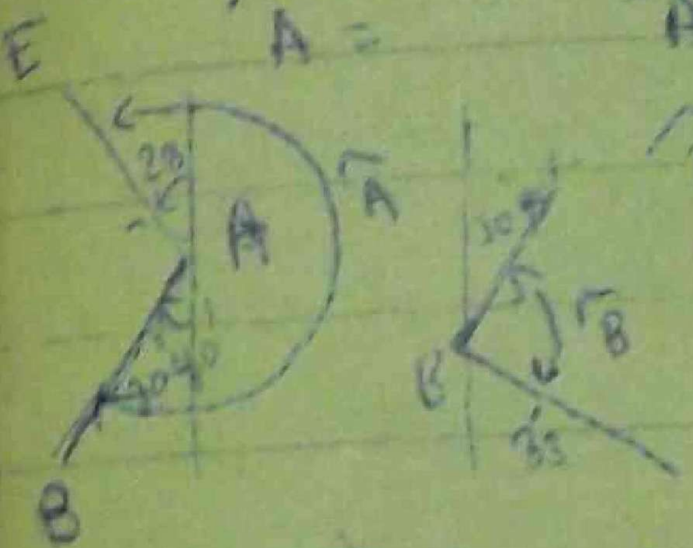


{ Corrected Ref. Lg of one of the adj. sides

{ bearing of next adj. side corrected by Lg. of 1st

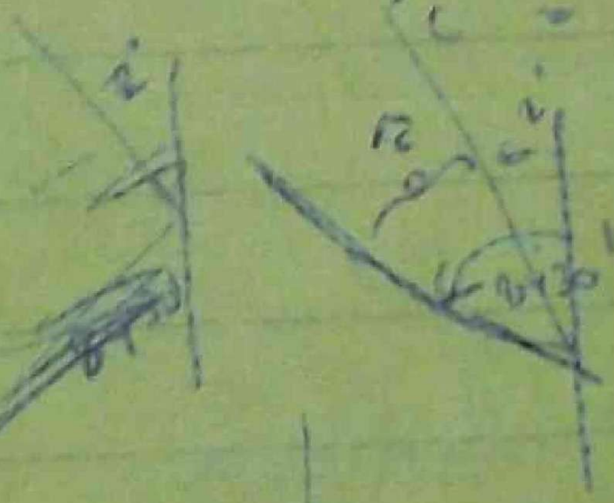
Forward and Backward bearing:-

$\widehat{A}$ = $\widehat{A} = 28°00' + 180°60' + 30°40' = 233°40'$



$\widehat{B}$ = $\widehat{B} = 180° - (30°40' + 83°50') = 65°30'$

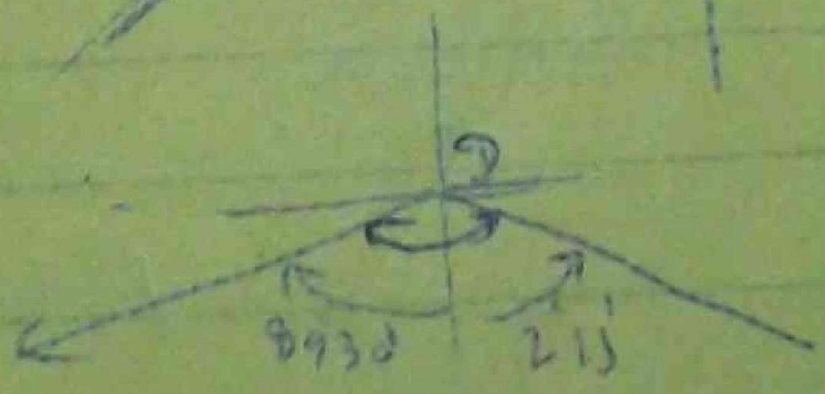
$\widehat{C} = 84°30' - 2° = 82°30'$



$\widehat{D}$ = ?

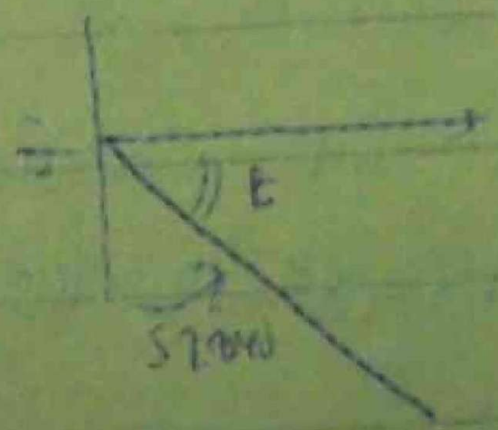
$\widehat{D} = 2°15' + 84°30'$

$= 91°45'$



$E = 90 - 22°45'$

$= 67°30'$



The sum of the E angle = $23°45' + 65°30' + 91°45' + 67°30' + 90° = 539°30'$

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

Error $540° - 539°30' = 30'$

Distribute 30' among the interior angles equally

3-

Correction

$\widehat{A}$: 232°40' + 5' = 238°45'

$\widehat{B}$: 65°30' + 5' = 65°35'

$\widehat{C}$: 82°30' + 5' = 82°35'

$\widehat{D}$: 91°45' + 5' = 91°50'

$\widehat{E}$: 61°20' + 5' = 61°25'

540°00'

Adjustment Bearing

Bearing of line AB = S 30°40' W

" BA N 30°40' W

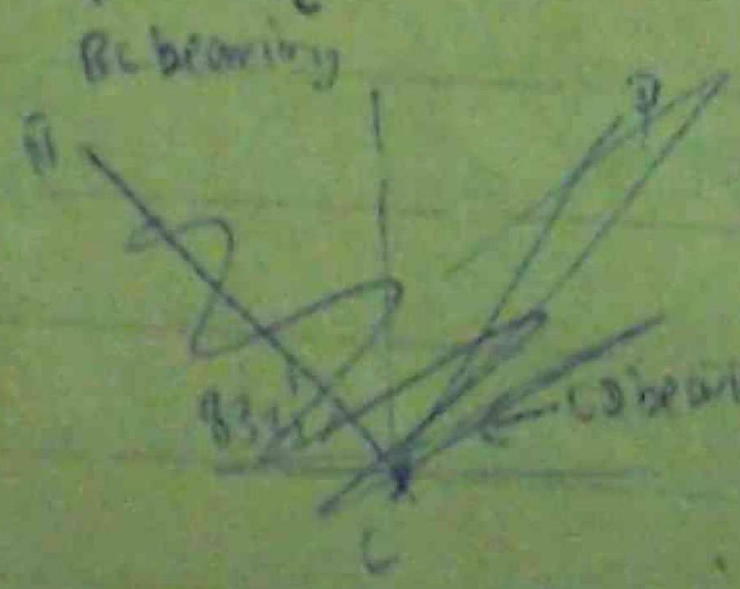
{ formula & Back bearing magnitude of both }

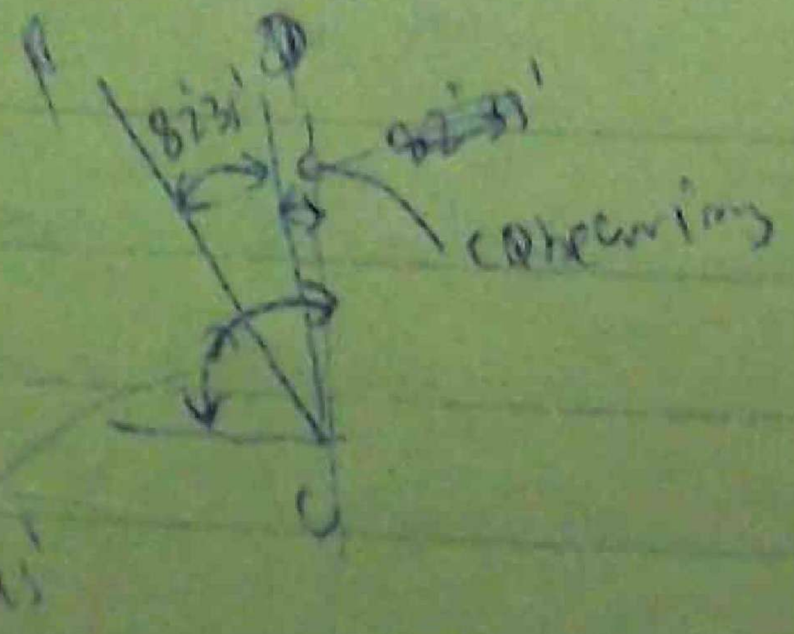
30°40' + " BC = 180° − {30°40' + 61°31'}

= S 83°45' E

CB = N 83°45' W

Bearing CD = 273°45' − 82°35' N 1°10' W



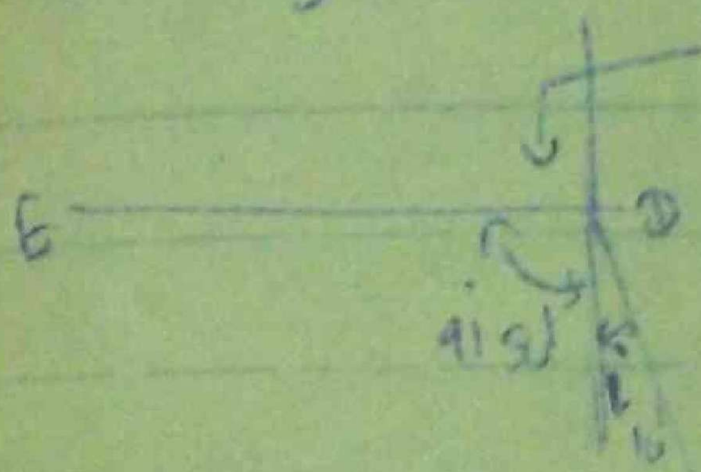


Bearing DE = 180 + 1°10' − 91°5d

= 181°10' − 91°5d

= 89°20' W

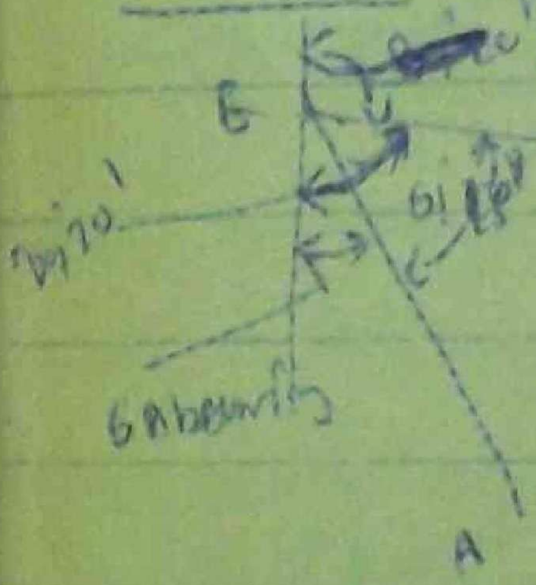
Bearing DE



∴ EA bearing = 360 − 91°5d − 89°20'

= 270° 03' E

Bearing EA

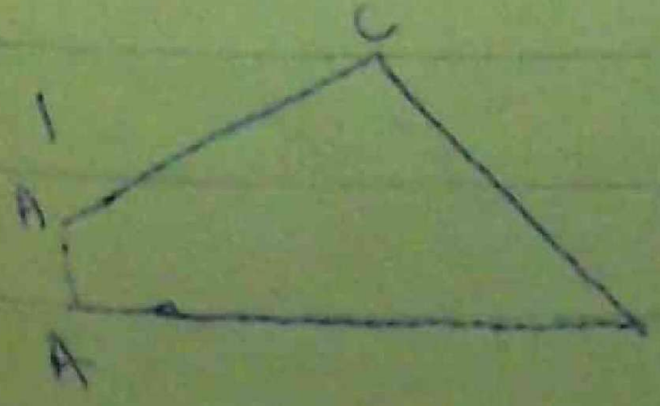


AD = 238°45' − 180 − 28°5' = 5°30'40" W

Adjustment of the figure

Closed traverse — lengths — Lengths adjustment

— angles (bearing) → angle adjustment



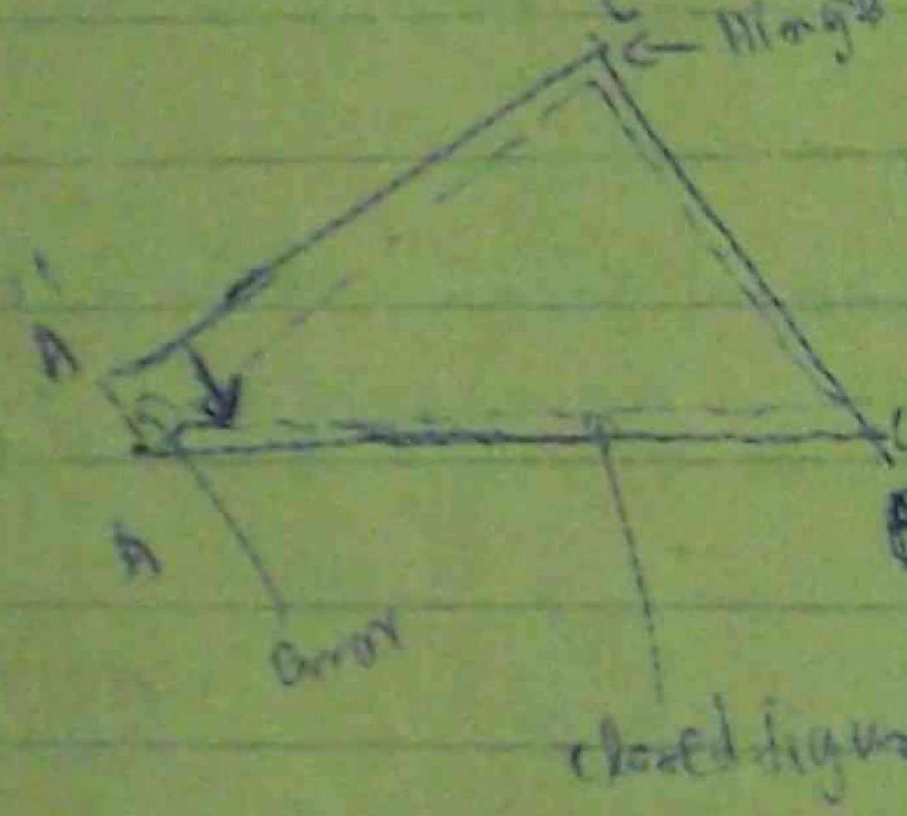
AA' = Error of closure

AA' → a geometric figure → closed traverse.

∴ AA

① graphically adjustment
② Adjustment by calculation.

Graphical Adjustment



ABCD: ची आकृती

A' ची स्थिती योग्य (?) ही दुरुस्ती केली

11-6-84

Δlat: Σ of lat (South) ~ Σ of lat (North)

Δ departure: Σ dep: west ~ Σ dep: east

Closure = $\sqrt{\Delta lat^2 + \Delta dep^2}$

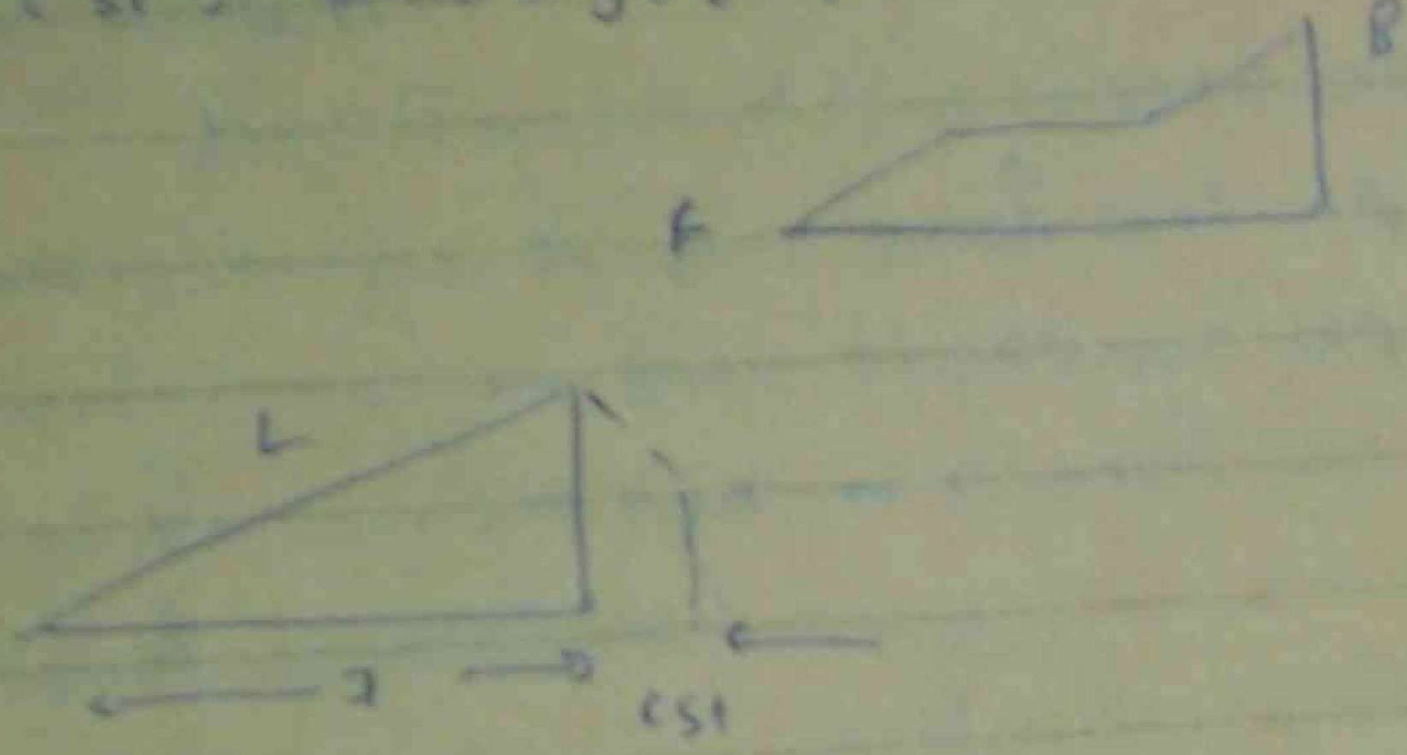
Precision: $\frac{\text{closure}}{\Sigma \text{length}}$.

lat ~~correct~~ of AB ~~Δ lat × dep~~ Δ lat

lat correct AB = Δ lat × $\frac{AB \text{ length}}{\Sigma \text{length}}$.

(2) Slope correction

(cst) always (-)



* Angle of inclination } slope angle θ
* angle of declination }

If the slope angle θ is known

$cst = L - D$

$= L - L\cos\theta$

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

If the different in height for elevation 'h' is known

$h^2 = L^2 - D^2$

$= (L - D)(L + D)$

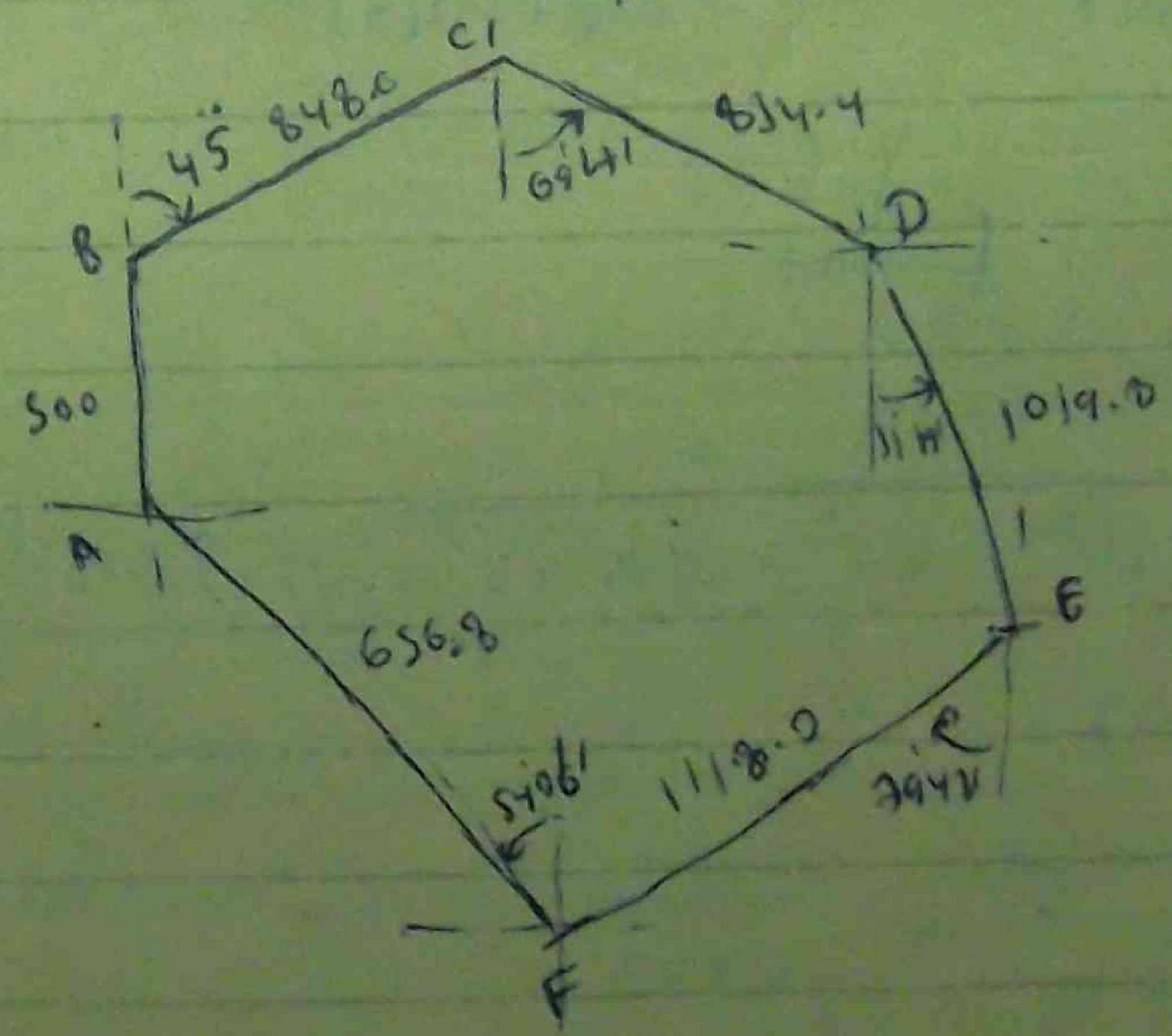
$cst = L - D = \frac{h^2}{L + D}$

If the angle θ is small

Example ①

Following are tabulated the bearings and length for a closed traverse of six sides the traverse is to be balanced by both the compass rule.

Line	Bearing	Length (ft)
AB	Due North	500.0
BC	N 45°00' E	848.6
CD	S 69°27' E	854.4
DE	S 11°19' E	1019.8
EF	S 79°42' W	1113.0
FA	N 54°06' W	656.8
		1997.6



Line	Latitudes North	Latitudes South	departure East	departure West
AB	500	0	0	0
BC	600	0	600	0
CD		800	800	
DE		1000	200	
FF		~~1000~~ 200		1100
FA	385			532

$\Sigma lat_{(N)}$ 1485 $\Sigma lat_{(S)}$ 1500 Σdep_E = 1600 Σdep_W 1632

δlat: 1500 − 1485 = 15 [S] North(+)

δdep: 1632 − 1600 = 32 (W) dep East(+)

δlat: 15 (south)

δdep: 32 (west)

Clearance = $\sqrt{\delta lat^2 + \delta dep^2} = \sqrt{15^2 + 32^2} = 35.5$ ft.

Σ length = 4997.0

precision = $\frac{\text{clearance}}{\Sigma \text{length}} = \frac{35.5}{4997} = \frac{1}{140}$ 1 in 140

latitude correction

AB latitude correction: $\frac{AB\ length}{\Sigma length} \times \delta lat = \frac{500}{4997} \times 15 = 1.5$ lat

Bearings { AB lat (N) + dep (E) / AB lat (S) − dep (Sout) } corrected

B ~~correction~~ AB lat corrected = 500 + 1.5 = 501.5 North

BC lat correction = $\frac{3486}{4997} \times 15 = 2.6$ (S)

BC corrected = 600 + 2.6 = 602.6 S

CD lat correction = $\frac{3594}{4997} \times 15 = 2.6$ ~~South~~ North

C D lat corrected = 300 (S) − 2.6 (N) = 297.4 (S)

DE Lat correction = $\frac{1593}{4997} \times 15 = 3.1$ (S)

DE corrected lat = 1000 (S) − 3.1 (N) = 996.97 (S)

EF lat correction = ~~15 ×~~ $\frac{1719}{4997} \times 15 = 1.4$ 3.3 (S)

corrected EF lat = 200 (S) − 3.3 (S) = 196.75 (S)

FA lat correction = $\frac{693}{4997} \times 15 = 1.4$ (S)

fA lat corrected = 385 (N) + 1.4 (S) = 386.4 (N)

Departure correction

AB departure = $\frac{500}{4997} + 32 = 32$ (W)

AB departure = 0 + 32 = 32 (~~West~~) (E)

BC dep correction = $\frac{6486}{4997} \times 32 = 5.4$ (W)

∴ B C dep: corrected = 600 (East) + 5.4 (West) = 605.4 (East)

CD dep: correction = $\frac{854.4}{4997} \times 32 = 5.4$ (west)

$\therefore$ CD depcorrected: 800 east + 5.4 west

= 805.4 east

DE dep: correction = $\frac{1014.9}{4997} \times 32 = 6.6$ (west)

DE dep: corrected = 200 (east) + 6.6 (west)

= 206.6 East

EF dep correction = $\frac{1113.9}{4997} \times 32 = 7.2$ (west)

EF dep: corrected = 1100 (west) - 7.2 west

= 1092.8 (west)

FA dep correction = $\frac{656.6}{4997} \times 32 = 4.2$ (west)

FA dep corrected = 532 (west) - 4.2 (west)

= 527.8 (west)

Completed

	Latitude		departure	
	N	S	E	W
AB	501.5		3.2	
BC	602.6		605.4	
CD		297.4	805.4	
DE		996.9	206.6	
EF		146.35		1092.2
FA	386.9		527.2	
	1491.0	1491.0	1620.6	1620.6
	Δlat = 0		Δdep = 0	

Transit Rule

12-6-84

Transit adjustment

Assumption – ① All the errors are accidental
② angles are measured more precisely.

Adjustment

Distribute Δlat among the latitude in the ratio of latitude.

(2) Distribute Δ departure among the departure in the ratios of departure.

$$\delta Lat_{AB} = \Delta Lat \times \frac{Lat_{AB}}{\Sigma Lat}$$

$$\delta Lat_{BC} = \Delta lat \times \frac{lat_{BC}}{\Sigma Lat}$$

$$\delta Lat_{CA} = \Delta Lat \times \frac{Lat_{CA}}{\Sigma Lat} =$$

$$\delta dep_{AB} = \Delta dep \times \frac{dep_{AB}}{\Sigma dep}$$

$$\delta dep_{BC} = \Delta dep \times \frac{dep_{BC}}{\Sigma dep}$$

$$\delta dep_{CA} = \Delta dep \times \frac{dep_{CA}}{\Sigma dep}$$

$\delta Lat_{AB} + \delta dep\ lat_{BC} + \delta dat_{CA} = \Delta Lat$.

$\delta dep_{AB} + \delta dep_{BC} + \delta dep_{CA} = \Delta dep$.

bearing - angle
Range - transit

length of arc
equally precised

Example ②

Following are tabulated the bearing and lengths for a closed traverse of six sides. The traverse is to be balanced by both the transit rule and compass

Line	Bearing	Length
AB	Due North	500.00
BC	N 45° 00' E	348.6
CD	S 69° 27' E	854.4
DE	S 11° 18' E	1019.8
EF	S 79° 42' W	1118.0
FA	N 54° 06' W	656.2

	Latitudes		Departure	
Line	North	South	East	West
AD	509			
BC	600		609	
CD		310	300	
DE			200	
EF		200		1100
FA	385			532
	1494	1509	1609	1632

δ Lat. -15 δ dep -23

Example ②

Following are tabulated the bearing and lengths of a closed traverse of six sides. The traverse is to be balanced by both the transit rule and compass

Line	Bearing	Length
AB	Due North	500.00
BC	N 45° 00' E	848.6
CD	S 69° 27' E	854.4
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EF	S 79° 42' W	1118.0
FA	N 54° 06' W	656.8

	Latitudes		Departure	
Line	North	South	East	West
AD	509			
BC	600		600	
CD		300	300	
DE		200		
EF		200		1100
FA	385			532
	1494	1500	1600	1632

δ Lat: −15 δ dep −32

$$D \approx L$$

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

(3) Temperature correction

~~Ccs~~ Ctemp (±)

$$Ctemp = \alpha \, l \, \Delta T$$

where α = coefficient of thermal expention of the tape/F

Normally 0.000 0065 For average steel tape

L = Norminal length (ft)

ΔT = change in temperature (°F)

$\Delta T = T_{field} - T_{std}$

$T_{emp} Temp: \alpha \, l \, (T_{field} - T_{std})$

(4) Full correction or tension correction (Cpull) (±)

plastic limit
elastic limit

$$Cpull = \frac{OPL}{AE}$$

where OP = change in pull (Tension)

= Pfield - Pstd

l = nominal length (ft)

A = cross-sectional area of the tape (in^2)

E = modulus of elasticity (or) Young's modulus (lb/in^2)

$$C_{pull} = \frac{(P_{field} - P_{stad})L}{AE} \quad ft$$

Sage correction

(Sag)

simple parabolic curve

$$C_{sag} = \frac{w^2 l^3}{24P^2} = \frac{w^2 l}{24P^2}$$

where w = Unit weight of the tape (lb/ft)

~~w = L'~~ $w = L'$ Total weight of the tape (lb) wt

p = tension applied (lbs)

Example ①

A steel tape 100 ft nominal length Standardized on the flat and its length under a pull of 20 lb was found to be baseline. along a slope of 1 in 20 the tops was used with the ends ~~supplied~~ supported and subjected to the same pull the baseline was found to be 300.4 ft what was the length of the baseline of the unit wt of steel tape = .32 ~~lb~~ oz/ft

(Nor = 100, true = 99.985) (-)

linear correction

L = 100 ft p_{std} = 20 lb

C_{std} = true length − nominal length

= 99.985 − 100

= −.015 in

slope correction

$$\frac{1}{\sqrt{20^2 + 20}}$$

length 120 ft → edge − 1

100 $\frac{100}{20} = 5'$ (h)

$$C_{std} = \frac{h^2}{2l} = -\frac{25}{2 \times 100} \quad (-)$$

= .125 ft (−)

Sag correction

$$C_{Sag} = \frac{w^2 l^3}{24 p^2} = \frac{w^2 l}{24 p^2}$$

$l = 100$ ft $w = ?$

$$w = \frac{0.32 x}{16} = 0.02$$

$$w = 0.02 \text{ lb/ft} \times 100 = 2 \text{ lb}$$

$P = 20$ lb

$$C_{Sag} = \frac{w^2 l^3}{24 p^2} = \frac{w^2 l}{24 p^2}$$

$$= \frac{2^2 \times (100)^2}{24 \times (20)^2} \quad (-)$$

$$C_{sag} = \frac{1}{24} \quad (-)$$

$$C_{sag} = 0.0417 \text{ ft} \quad (-)$$

C_{total} = Total correction for a tape length i, e 100 ft

$$C_{total} = C_{std} + C_{Sag} + C_{SL}$$

$$= -0.015 + .125 - 0.0417$$

$$= -.1817$$