

LEVELLING

$$\boxed{x_1 = 204.6 \text{ m}}$$

$$200 \sin \theta = x - 4.93$$

$$\sin \theta = \frac{199.67}{200}$$

$$\sin \theta = 0.9986$$

$$\cos \theta = 0.0578$$

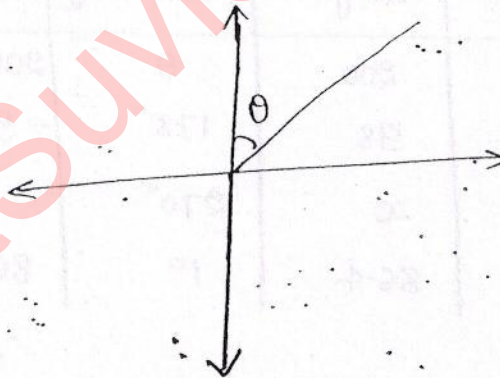
$$\tan \theta = \frac{0.9986}{0.0578} = 17.274$$

$$\theta = 86.68^\circ$$

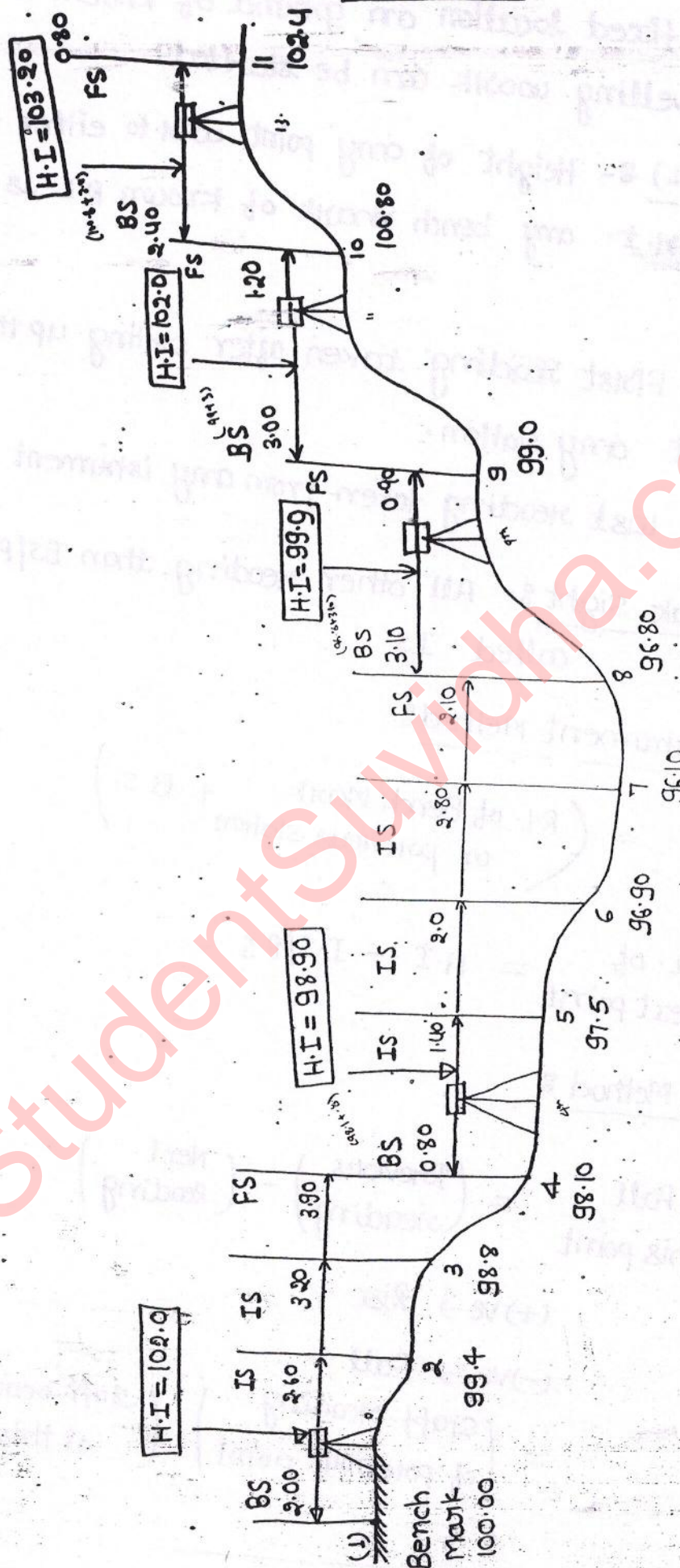
$$\boxed{\theta = 86^\circ 41' 13''}$$

both angle (+ve)

$$\begin{aligned} \text{Bearing} &= \theta \\ &= 86^\circ 41' 13'' \end{aligned}$$



LEVELLING



Important definition :-

- 1) Bench Mark :- A fixed location on ground of known R.L., from where levelling work can be started.
- 2) Reduced Level (R.L) :- Height of any point w.r.t. to either mean sea level or w.r.t. any bench mark of known R.L. is called Reduced level.
- 3) Back Sight :- First reading taken after setting up the instrument at any station.
- 4) Fore Sight :- Last reading taken from any instrument location.
- 5) Intermediate Sight :- All other reading than BS/FS are called IS.
- 6) Height of Instrument Method :-

$$H.I. = \left(\begin{array}{l} \text{R.L. of Bench Mark} \\ \text{or previous station} \end{array} + B.S. \right)$$

$$\text{R.L. of Next point} = H.I. - I.S./F.S.$$

- 7) Rise & Fall Method :-

$$\text{Rise / Fall of this point} = \left(\begin{array}{l} \text{Previous} \\ \text{reading} \end{array} \right) - \left(\begin{array}{l} \text{Next} \\ \text{reading} \end{array} \right)$$

(+)ve \rightarrow Rise

(-)ve \rightarrow Fall

$$= \left(\begin{array}{l} \text{staff reading} \\ \text{of previous point} \end{array} \right) - \left(\begin{array}{l} \text{staff reading} \\ \text{at this point} \end{array} \right)$$

R.L. of this point = R.L. of previous point + Rise (or) - Fall.

Ques 8 (1) Following readings were taken in a fly levelling using a staff of 4.0m length.

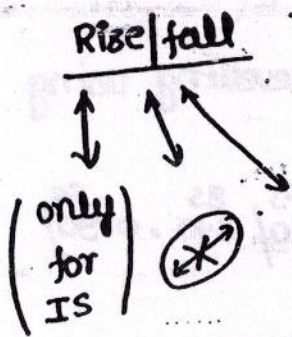
BS 2.00, IS 2.60, IS 3.20, FS 3.90 / BS 0.80, IS 1.40, IS 2.0, IS 2.80, FS 2.10 / BS 3.10, FS 0.90 / BS 3.00, FS 1.20 / BS 2.40, FS 0.80

Instrument was shifted after 4th, 9th, 11th & 13th reading.

1st reading was taken on a B.M. of R.L - 100.00m. Fill the level book and calculate R.L of different points.

Point	BS	IS	FS	H.I	R.L	Rise	Fall	R.L
1	2.00	2.60		102.00 ← 100.00		X	X	100.00
2		2.60			99.4		0.6	99.4
3		3.20	3.90		98.8		0.6	98.8
4	0.80		3.90	98.9 ← 98.1			0.70	98.1
5		1.40			97.5		0.60	97.5
6		2.0			96.9		0.6	96.9
7		2.80			96.1		0.8	96.1
8	3.10		2.10	99.9 ← 96.80		0.7		96.8
9	3.10		0.90	102.0 ← 99.0		2.20		99.0
10	2.40		1.20	103.2 ← 100.8		1.80		100.8
11			0.80		102.40	1.60		102.40
12	11.3		8.9		102.40			102.40

diff = 2.4
2.4m
2.4m
2.4m



⊕ Arithmetic check

$$= \Sigma BS - \Sigma FS = 11.30 - 8.90 = 2.40$$

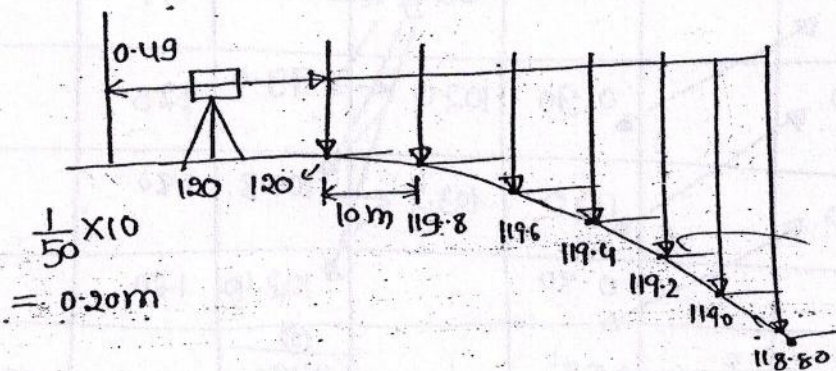
$$= \left(\begin{matrix} \text{last} \\ \text{R.L} \end{matrix} \right) - \left(\begin{matrix} \text{1st} \\ \text{R.L} \end{matrix} \right) = 102.4 - 100.00 = 2.4 \quad \underline{\underline{2.4}}$$

$$= \Sigma \text{Rise} - \Sigma \text{fall} = 6.3 - 3.9 = 2.4$$

Ques: 7(b) In running fly level from a bench mark, of R.L 120.75 m. Following readings were taken —

B.S	0.85	1.285	1.182	0.965	0.49
F.S	0.555	1.150	1.945	1.755	—

From the last position of instrument seven pegs at 10m interval are to be set out on a uniform falling gradient of 1 in 50. R.L of 1st peg is 120.0 m. work out the staff reading for top of the pegs. fill level book and apply arithmetic check.



Point	BS	I.S	F.S	H.I	R.L	Rise	Fall	R.L
1	0.85				120.75	x	x	
2	1.285		0.555		121.045	0.295		
3	1.185		1.150		121.180	0.135		
4	0.965		1.945		120.417		0.763	
5	0.49		1.755		119.627		0.790	
6		0.117			120.00	0.373		
7		0.317			119.8		0.20	
8		0.517			119.6		0.20	
9		0.717			119.4		0.20	
10		0.917			119.2		0.20	
11		1.117			119.0		0.20	
12			1.317		118.8		0.20	

$$\Sigma BS = 4.772$$

$$\Sigma FS = 6.722$$

$$0.803 \quad 2.753$$

Rise / fall for point No-6

$$= 120.00 - 119.627$$

$$= 0.373$$

$$0.49 - x = 0.373$$

$$x = 0.49 - 0.373$$

$$x = 0.117$$

check -

$$\Sigma BS - \Sigma FS$$

$$= 4.772 - 6.722$$

$$= (-) 1.95$$

$$\text{last RL} - \text{1st RL}$$

$$= 118.8 - 120.75$$

$$= (-) 1.95$$

$$\Sigma \text{Rise} - \Sigma \text{fall} = 0.803 - 2.753$$

$$= (-) 1.95$$

(0.1)

Ques: (2) Find out missing values in a level book as shown below:-

Points	BS	IS	FS	R.L	Rise	Fall
1) B.M	240.0			120.00		
2)	5.75		121.2	121.2	1.20	
3)		2.85		124.00	2.80	
4)		1.65		125.00	3.00 1.2	
5)	3.55		11.80	125.05		0.15
6)			126.00	126.00	0.95	

Missing Value -

(5) $240 - 1.20 = 1.20$ (Rise)

(6) $124 - 121.2 = 2.80$ (Rise)

(7) $127 - 124 = 3$ (Rise)

(8) $126.8 - 1270 = -0.2$ (fall)

(9) $125.0 - 126.8 = -1.8$ (fall)

(1) $= 2.80 + 2.85 = 5.65$ ✓

(2) $120.0 + 1.20 = 121.20$ m ✓

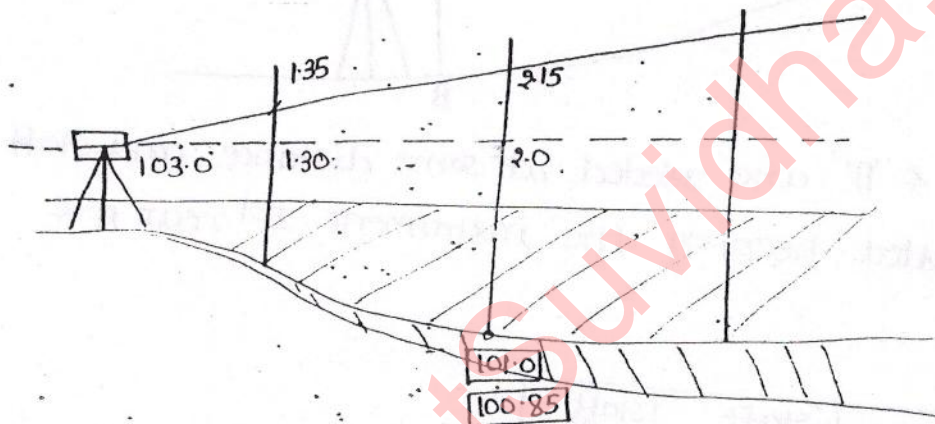
(3) $1.80 = -0.20$ (3) $1.80 - 0.20 = 1.6$

(3) $2.85 - 1.2 = 1.65$

Reciprocal Levelling :-

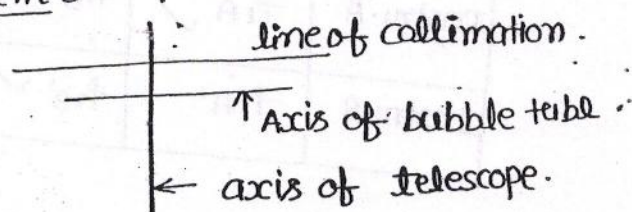
→ Reciprocal levelling is used to find out any error in the levelling instrument and to eliminate the effect of such error and other error like due to earth curvature & refraction.

→ If line of sight is not horizontal when bubble is showing in centre. The instrument is faulty. In this case all the readings taken will be wrong.



Adjustments

→ (1) Permanent Adjustment :-

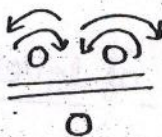


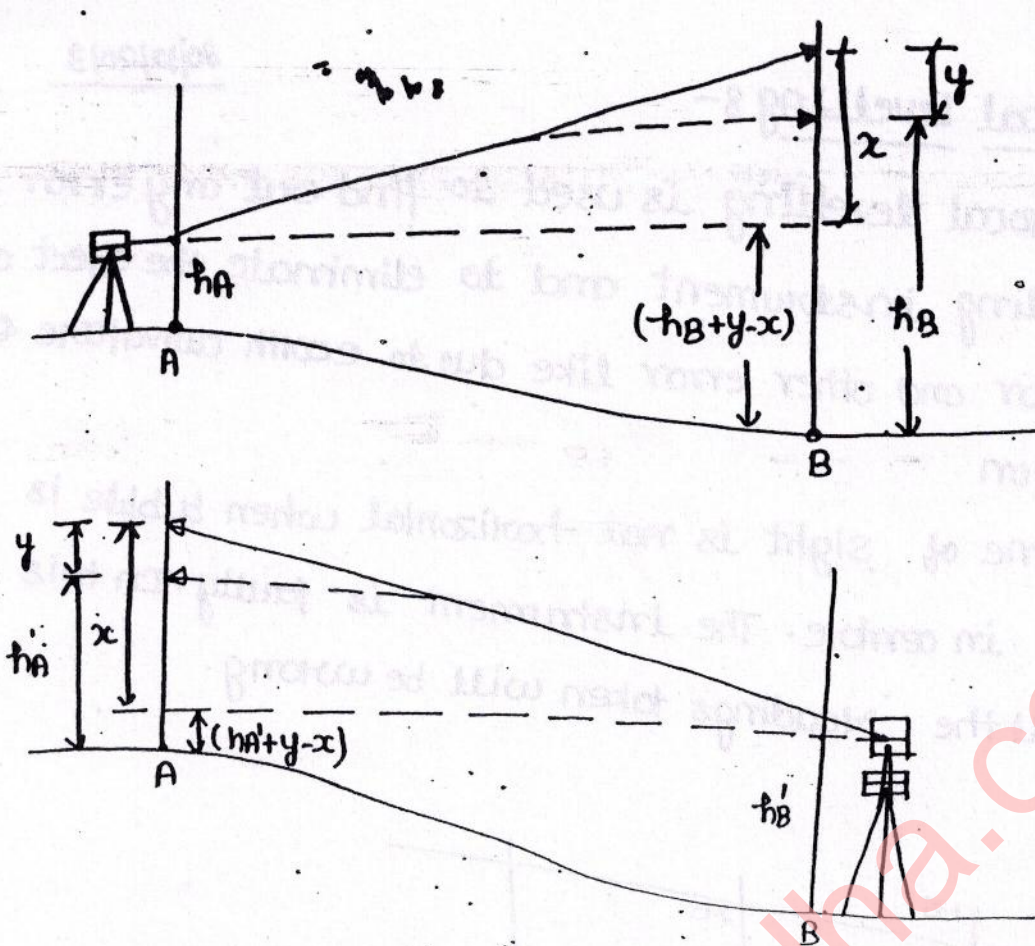
→ (2) Temporary Adjustment :-

(i) centring

(ii) Levelling

(iii) Removal of parallax - crosshair (disturbance)
(focusing of crosshair.)





Two point 'A' & 'B' are selected at some distance; and staff readings are noted keeping the instrument 1st near A & then near B.

	Staff reading at 'A'	Staff reading at B.
Instru. A	h_A ✓	h_B
Instru. B	h_A'	h_B' ✓

⊕ When the Instrument is at A

correct reading at A = h_A

" " " B should be = $(h_B + y - x)$

exact difference of level b/w A & B

$$H = (h_B + y - x) - h_A \quad \text{--- ①}$$

⊕ When instrument is at B -

Correct reading at A should be $= (h_A' + y - x)$

" " " " $B = h_B'$ " =

exact difference of level

$$H = h_B' - (h_A' + y - x)$$

$$H = (h_B' - h_A' - y + x) \quad \text{--- (2)}$$

Add (1) & (2)

$$2H = h_B + y - x - h_A + h_B' - h_A' - y + x$$

$$H = \frac{(h_B - h_A) + (h_B' - h_A')}{2}$$

Ques: (1) For a reciprocal levelling, following readings were taken: -

	Staff reading at (A)	Staff reading at (B)	difference
Instrument (A)	1.82 h_A	2.72 (2.785) $(\downarrow) h_B = 0.065$	0.90
Instrument (B)	0.92 h_A' 0.985 $error = 0.065 (\downarrow)$	1.95 h_B'	1.03

0.965 (Avg)
exact difference

R.L B - 199.035

If R.L of point A is 200.00m and distance b/w (A) & (B) is 260m. Calculate the exact R.L of point B & angular error

Solⁿ in the instrument. Neglect the effect of curvature and refraction.

Solⁿ Exact difference of level b/w A & B.

$$H = \frac{(h_B - h_A) + (h_B' - h_A')}{2} = \frac{(2.72 - 1.82) + (1.95 - 0.92)}{2}$$

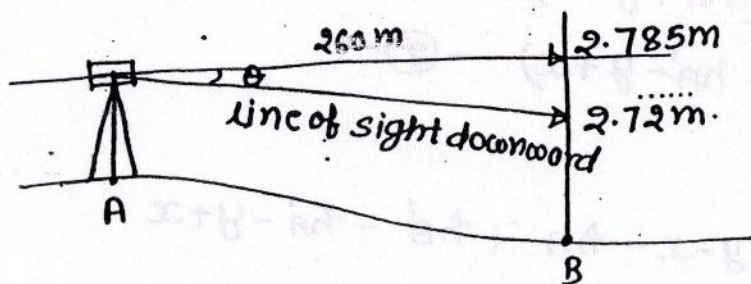
$$H = 0.965$$

R.L. of A = 200.00 m.

\therefore R.L. of B = 200.00 (R.L. of A) - difference of level

$$\begin{aligned} \text{(B is below A)} &= 200.00 - 0.965 \\ &= 199.035 \text{ m.} \end{aligned}$$

Error in Instrument :-



when instrument is at A -

Correct Reading at A = 1.82

exact Reading diff of level = 0.965

$$\begin{aligned} \text{exact Reading at B should be} &= 1.82 + 0.965 \\ &= \underline{2.785 \text{ m}} \end{aligned}$$

$$\begin{aligned} \text{Reading taken at B} &= 2.72 < 2.785 \text{ m.} \\ &\text{line of sight} \end{aligned}$$

error in inclination :-

$$\begin{aligned} &= \frac{\text{difference of Reading}}{\text{distance}} = \frac{2.785 - 2.72}{260} \\ &= \frac{1}{4000} \text{ Ans} \end{aligned}$$