Levelling surveying

Leveling: is the operation required in the comparison of heights of points on the surface of the earth. Its purpose to provide spot heights or contour lines on a map, to provide data for making longitudinal and cross-sections.

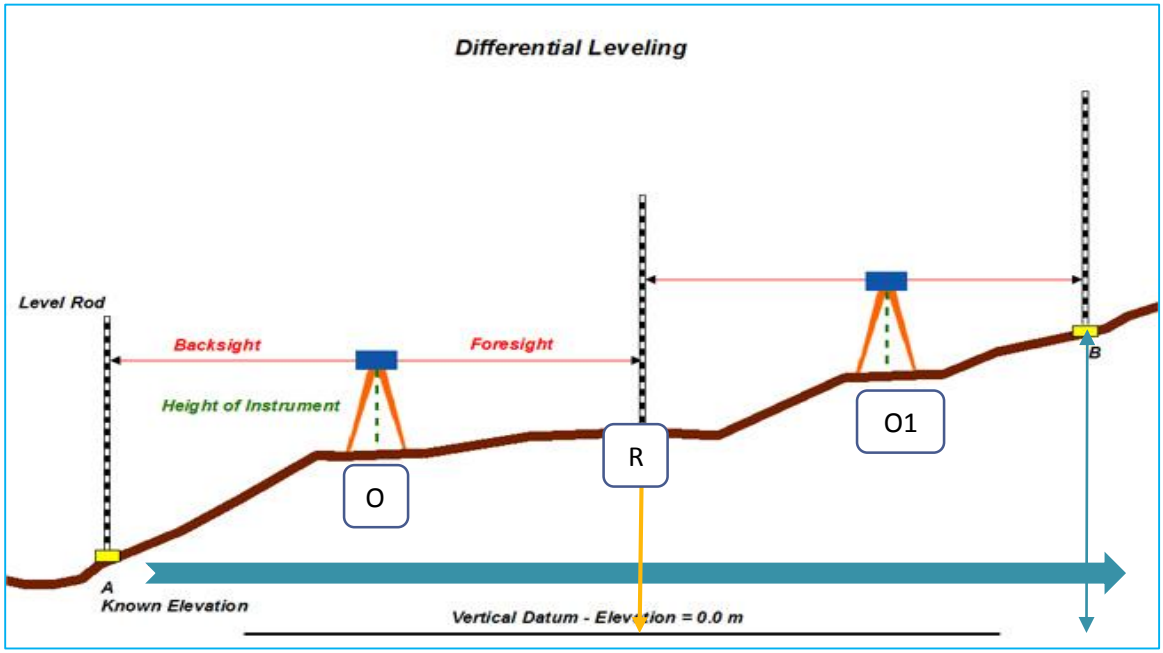
Backsight (BS): This is the first reading taken by the observer at every instrument station after setting up the level.

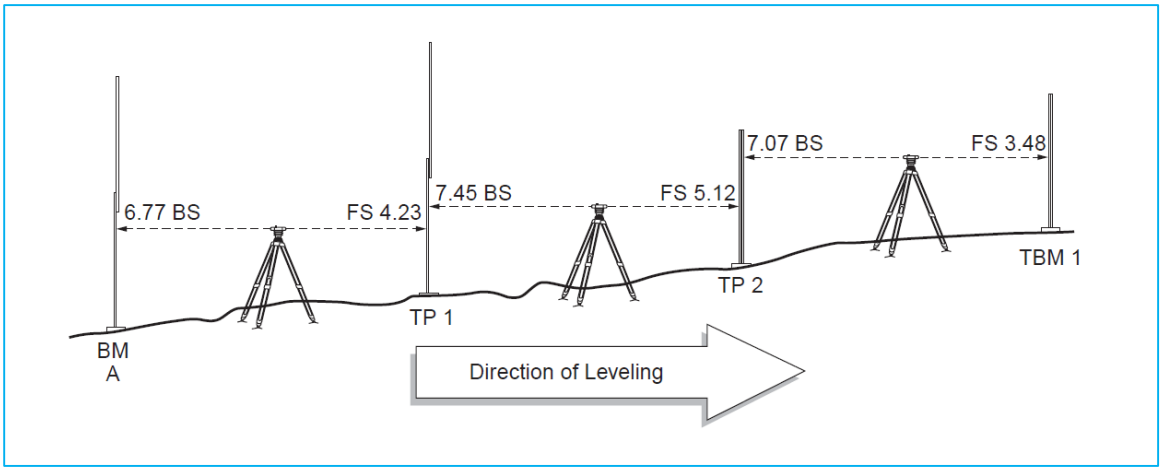
Foresight (FS): This is the last reading taken at every instrument station before moving the level.

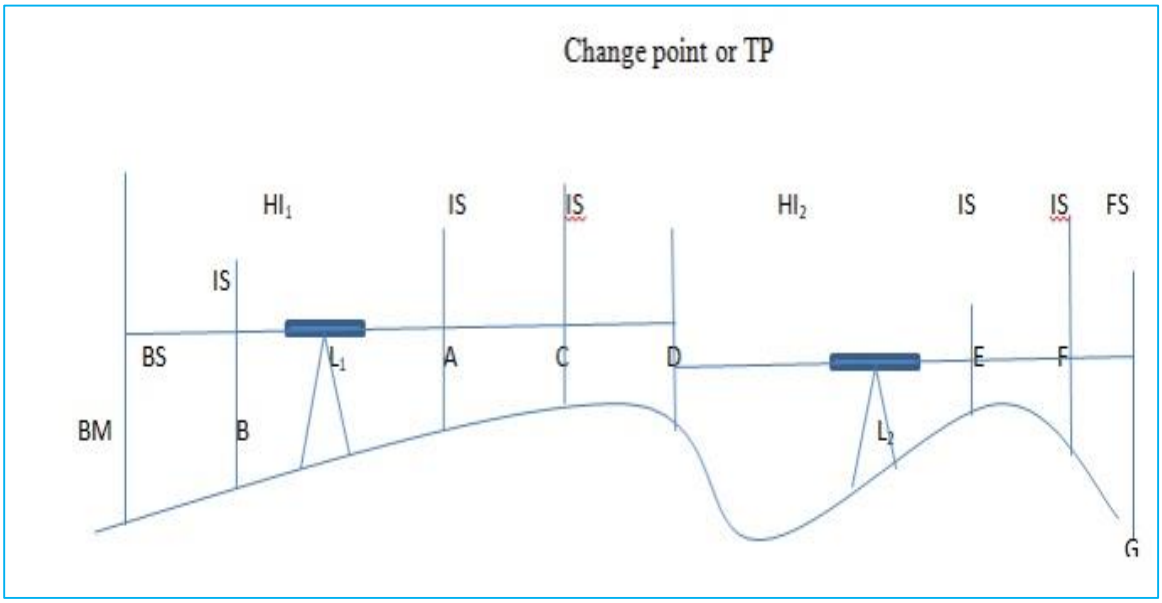
Intermediate Sight (IS): This is any reading taken at an instrument station between the backsight and the foresight.

Turning point (TP): This point at which both a foresight and a back sight are taken before moving the staff.

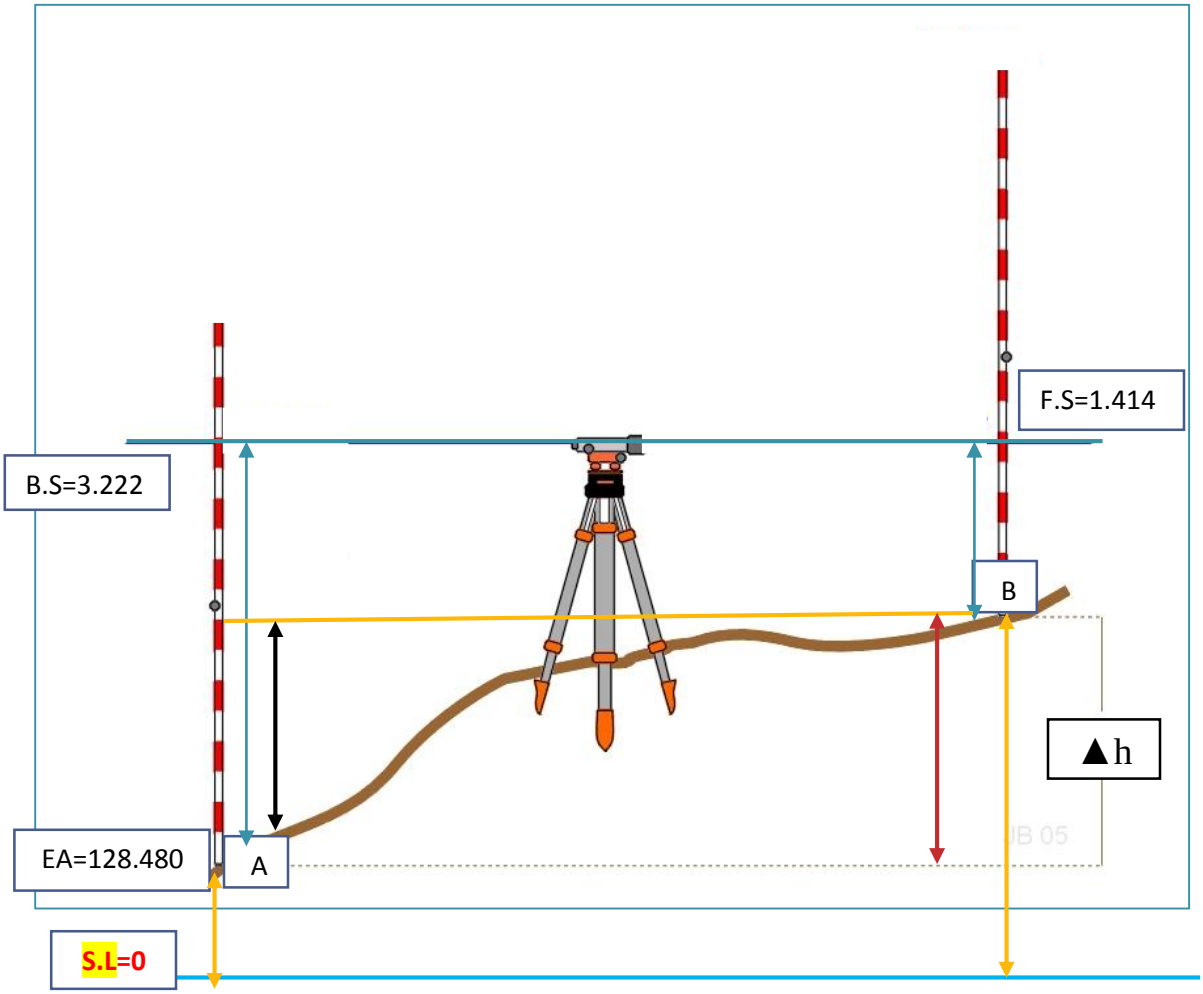
Type of Leveling




6.77 BS
FS 4.23
7.45 BS
FS 5.12
7.07 BS
FS 3.48
BM
A
TP 1
TP 2
TBM 1
Direction of Leveling


Change point or TP
HI1
IS
IS
HI2
IS
IS
FS
IS
BS
L1
A
C
D
E
F
BM
B
L2
G

1. Rise and Fall



▲h= B.S or I.S-F.S or I.S

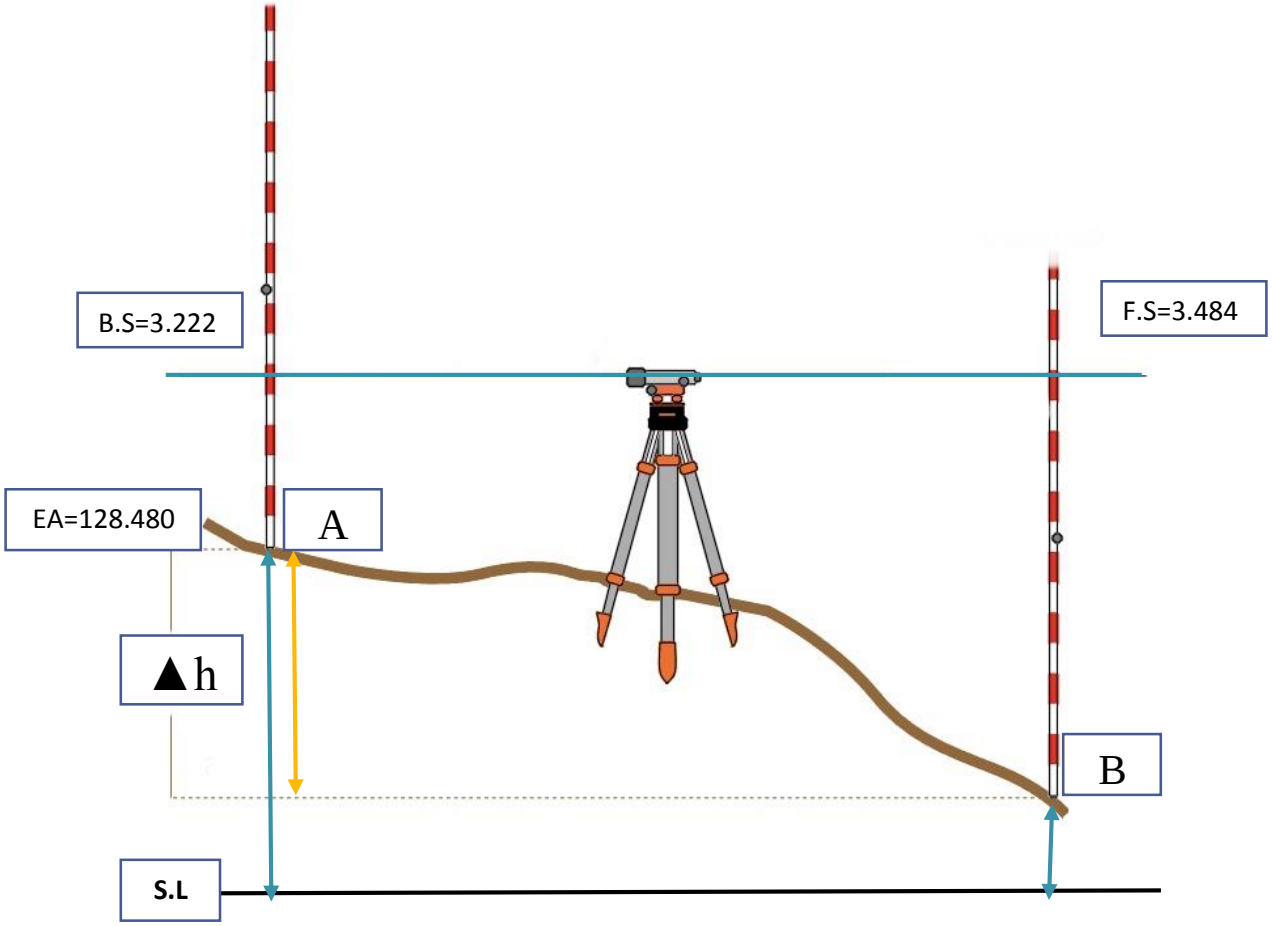
▲h=3.222-1.414

▲h=1.808m, Rise

EB=EA+▲h

EB = 128.480+1.808=130.288m

Station	B.S	I.S	F.S	Rise (+)	Fall (-)	Elevation	Remarks
A	3.222					128.480	B.M
B		-	1.414	1.808	+	130.288	



▲h= B.S-F.S

▲h=3.222-3.484

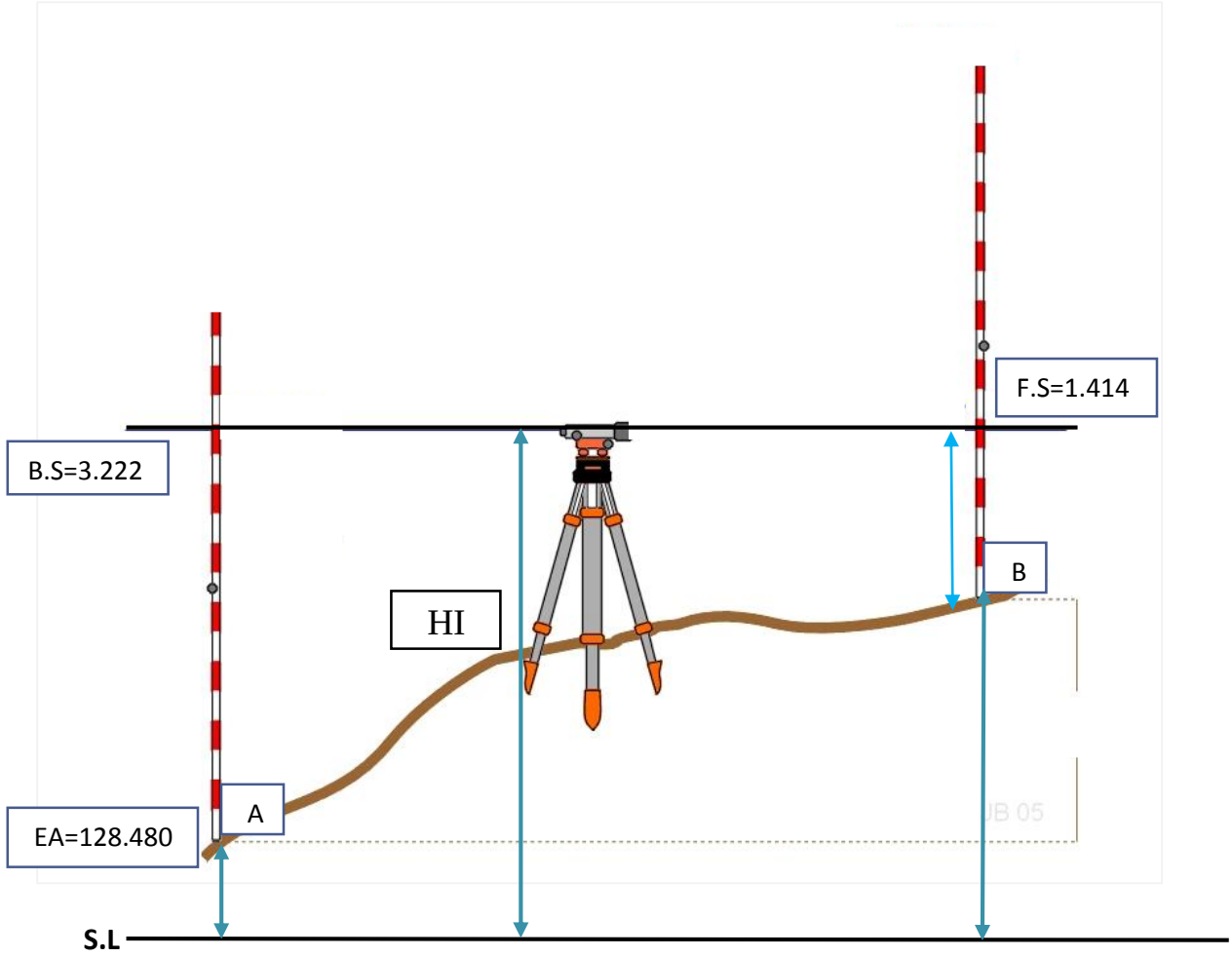
▲h=-0.262m. Fall

EB=EA-▲h

EB = 128.480-0.262m =128.218m

Station	B.S	I.S	F.S	Rise (+)	Fall (-)	Elevation	Remarks
A	3.222					128.480	
		-			-		
B			3.484		0.262	128.218m	

2. Height of Instrument



HI= EA+B.S

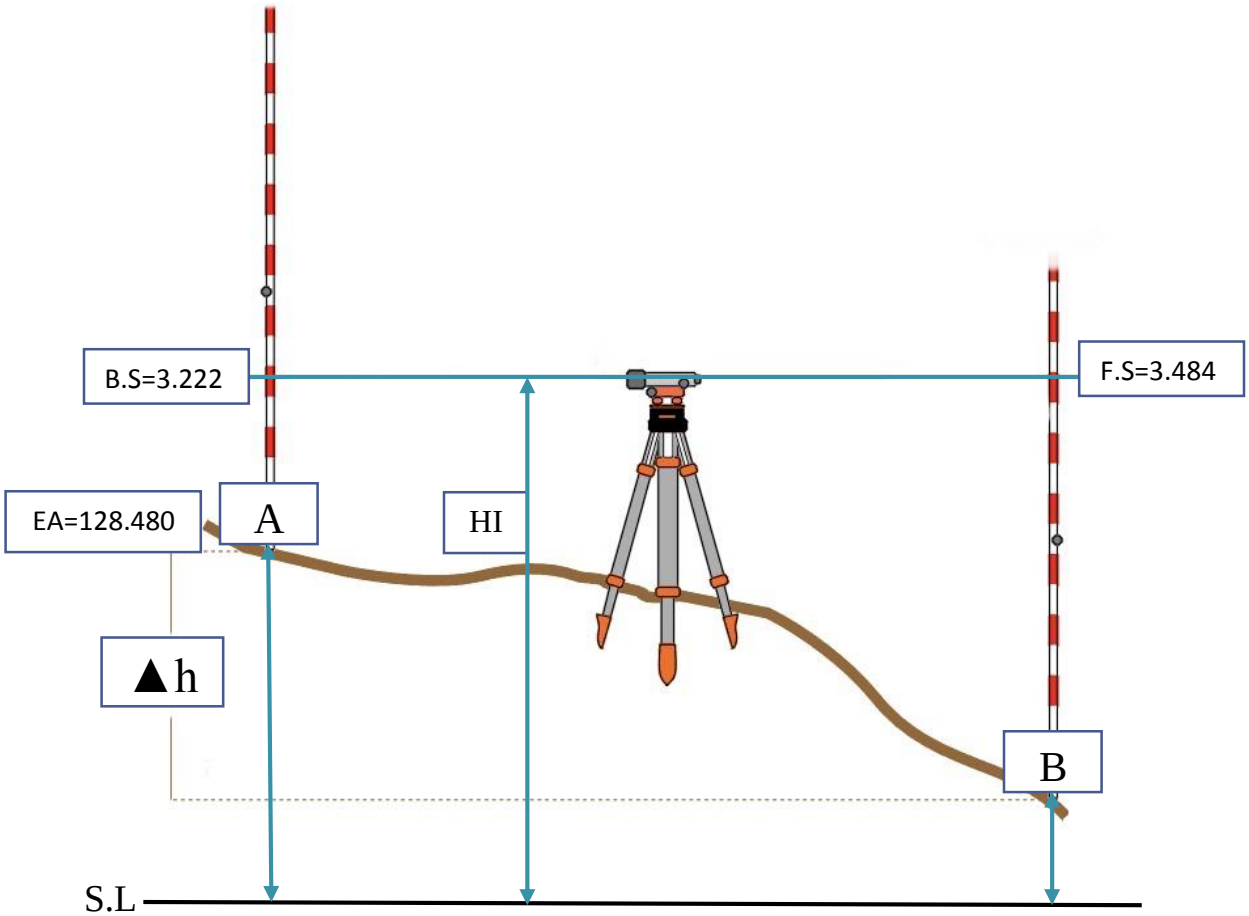
HI=128.480+3.222

HI=131.702m

EB=HI-F.S or I.S

EB = 131.702-1.414=130.288m

Station	B.S	I.S	F.S	HI	Elevation	Remarks
A	3.222		+	131.702	128.480	
B			1.414	-	130.288	



HI= EA+B.S

HI=128.480+3.222

HI=131.702m

EB=HI-F.S or I.S

EB = 131.702-3.484=128.218m

Station	B.S	I.S	F.S	HI	Elevation	Remarks
A	3.222			131.702	128.480	
B			3.484		130.288	

+

-

1. Rise and Fall

Station	B.S	I.S	F.S	Rise (+)	Fall (-)	Elevation or RL	Remarks
A	0.628					100	C.M
B		1.564			0.936	99.064	
C		1.000		0.564		99.628	
D	2.259		1.210		0.210	99.418	TR
E			0.991	1.268		100.686	
SUM	2.887		2.201	1.832	1.146		

Sum (B.S)-Sum (F.S)=Sum (Rise)-Sum (fall) = Last RL-First RL

2.887-2.201=1.832-1.146=100.686-100

0.686=0.686=0.686

▲h= B.S or I.S - F.S or I.S

EB=EA+▲h RISE

EB=EA-▲h FALL

2. Height of Instrument

Station	B.S	I.S	F.S	HI	Elevation	Remarks
A	0.628			100.628	100	B.M
B		1.564			99.064	
C		1.000			99.628	
D	2.259		1.210	101.677	99.418	C.P or T.P
E			0.991		100.686	
SUM	2.887		2.201			

Sum (B.S)-Sum (F.S) = Last RL-First RL

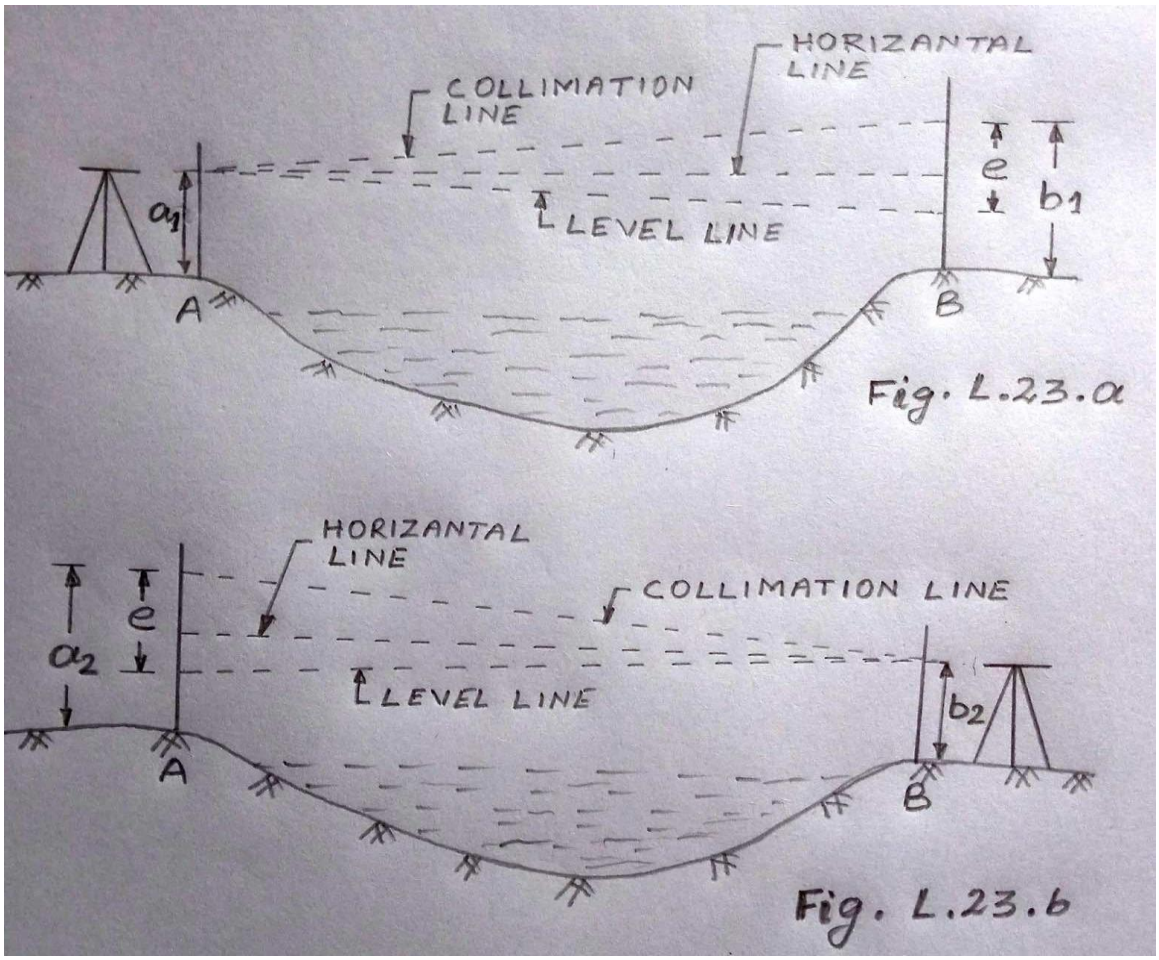
2.887-2.201=100.686-100

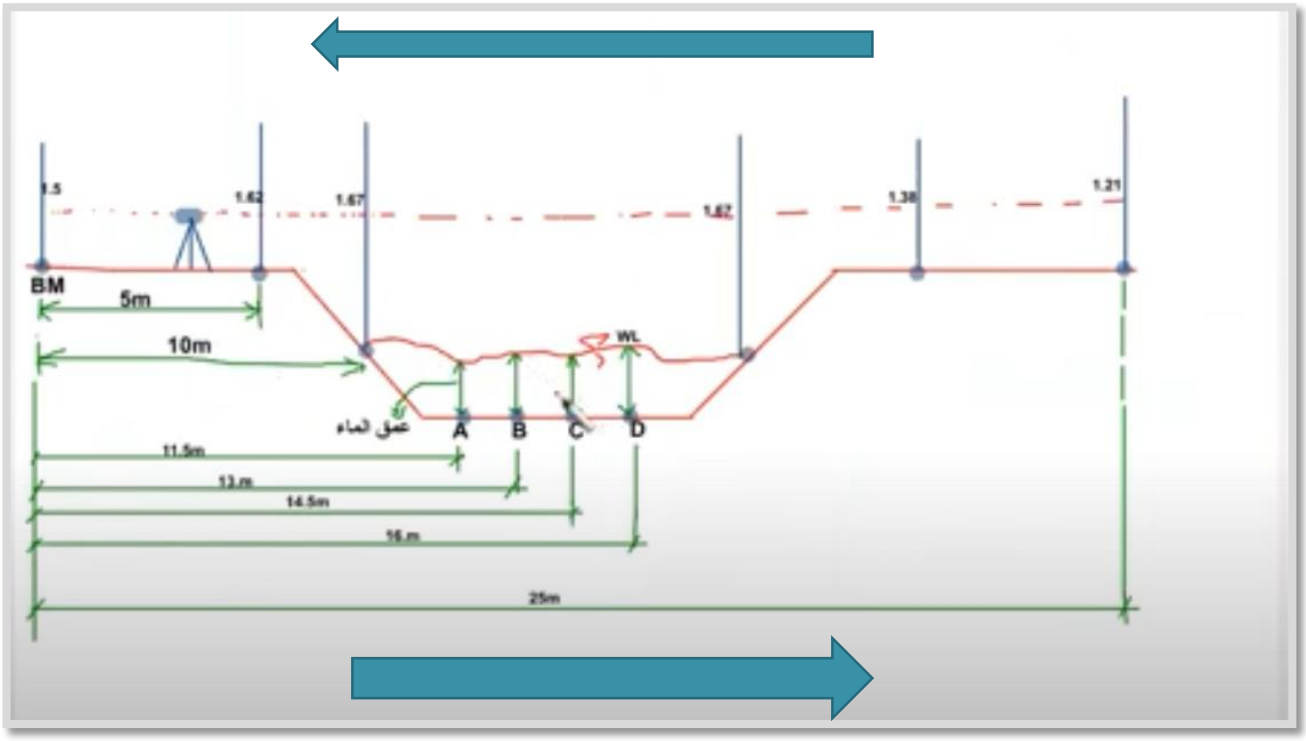
0.686=0.686

HI= EA+B.S

EB=HI-F.S or I.S

Reciprocal Levelling





RISE AND FALL

Station	B.S	I.S	F.S	HI	Elevation	Remarks
1	1.50			23.65	22.15	
2		1.62			22.03	
3		1.67			21.98	
A		0.75			21.23	
B		0.85			21.13	
C		0.65			21.33	
D		0.85			21.13	
4		1.67			21.98	
5		1.38			22.27	
6			1.21		22.44	
SUM						

▲h1=B.S or I.S – I.S or F.S (a1-b1)

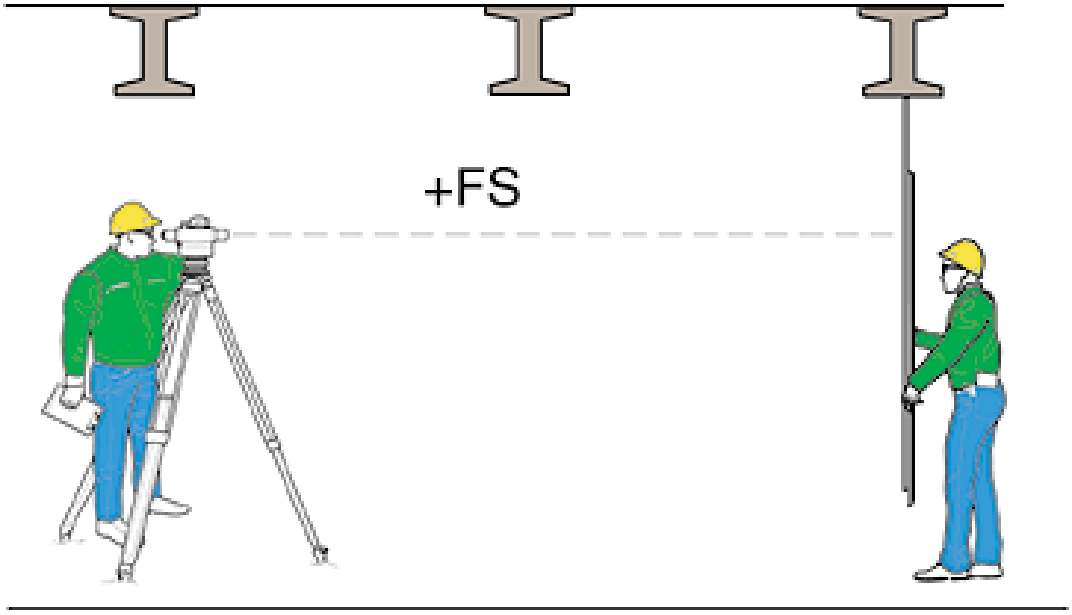
▲h2= B.S or I.S – I.S or F.S (a2-b2)

(▲h1+▲h2)/2

▲h= B.S-F.S

EB=EA (- o r +) ▲h

Inverted Rod Levelling



Station	B.S	I.S	F.S	HI	Elevation	Remarks
1	2.155			26.397	24.242	B.M
2		-3.44			29.839	
3	-1.315		-0.575	25.657	26.972	T.P
4			1.757		23.90	
SUM						

▲h=2.155-(-3.44) = 5.595m

E2= 24.244+5.595

Example: The following staff readings were taken with a level. The instrument was moved after fifth and last readings. 0.663 (First reading on BM 98.760 m), 1.946, 1.008, 1.153, 1,585, 2.787, 2.270, 1.218, 0.646. Enter the above readings in a level table and calculate the elevations of all points.

عدد النقاط = عدد القراءات – عدد نقاط التحويل

8=1-9

Sol:

Station	B.S	I.S	F.S	Rise (+)	Fall (-)	Elevation or RL	Remarks
1	0.663					98.760	B.M
2		1.946			1.283	97.447	
3		1.008		0.938		98.415	
4		1.153			0.145	98.270	
5	2.787		1.585		0.432	97.838	TP
6		2.270		0.517		98.355	
7		1.218		1.052		99.407	
8			0.646	0.572		99.979	Last Read
SUM	3.450		2.31	3.079	1.860		

Sum (B.S)-Sum (F.S)=Sum (Rise)-Sum (fall) = Last RL-First RL

3.450-2.31=3.079-1.860=99.979-98.670=1.219

واجب حل بطريقة الاخرى

Example: The following staff readings were taken with a level. The instrument was moved after second, third and fourth point. The elevation of First reading on BM is (653.25 m), 2.20, 2.52, 2.70, 2.30, 2.15, 1.95, 2.04, 2.26. Enter the above readings in a level table and calculate the elevations of all points.

عدد النقاط= عدد القراءات – عدد نقاط التحول

8-3=5

Sol:

Station	B.S	I.S	F.S	Rise (+)	Fall (-)	Elevation or RL	Remarks
1	2.20					653.25	B.M
2	2.70		2.52		0.32	652.93	T.P
3	2.15		2.30	0.4		653.33	T.P
4	2.04		1.95	0.2		653.53	T.P
5			2.26		0.22	653.31	Last Reading
SUM	9.09		9.03	0.6	0.54	0.06	

Sum B.S. =Sum F.S

Sum (B.S)-Sum (F.S) =Sum (Rise)-Sum (fall) = Last RL-First RL

9.09-9.03=0.6-0.54=653.31- 653.25

واجب حل بطريقة الاخرى

Example: The following staff readings were taken with a level between kilometers 14.00 km and 14.50 km and the horizontal distances between the points were equal. The instrument was moved after third, sixth, ninth twelfth and last reading and the height readings were as follows: The elevation of First reading on BM is (18.40 m), 1.52, 1.91, 2.41, 2.59, 1.92, 1.48, 1.12, 0.44, 1.50, 1.16, 1.82, 1.91, 1.22, 2.30, and 3.85. Draw the longitudinal section between kilo meter14.00 and kilo mter14.50, if the slope is 0.4% in down and elevation of first point is the same elevation of B.M. Calculation height of cut and fill?

عدد النقاط= عدد القراءات – عدد نقاط التحول

15-4=11

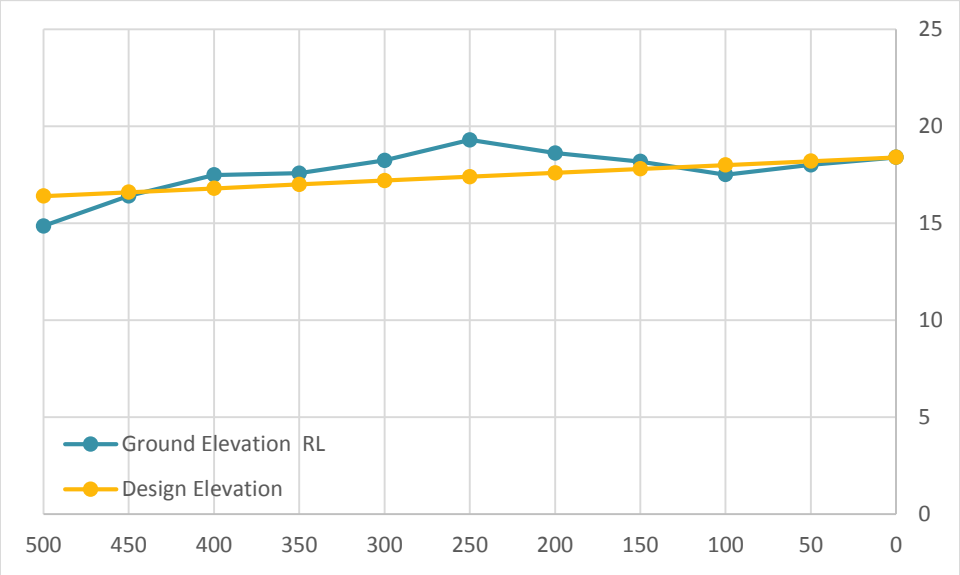
Distance between station =Total Distance (m)/ No.of point-1 = 500/10 =50m

Point	St.	B.S	I.S	F.S	HI	Elevation or RL	Design Elevation	Cut +	Fill -	Remarks
1	**0**	1.52			19.92	18.40	18.40	0	0	B.M
2	**50**		1.91			18.01	18.20		0.19	
3	**100**	2.59		2.41	20.1	17.51	18.00		0.49	TP
4	**150**		1.92			18.18	17.80	0.38		
5	**200**	1.12		1.48	19.74	18.62	17.60	1.02		TP
6	**250**		0.44			19.30	17.40	1.90		
7	**300**	1.16		1.50	19.40	18.24	17.20	1.04		TP
8	**350**		1.82			17.58	17.00	0.58		
9	**400**	1.22		1.91	18.71	17.49	16.80	0.69		TP
10	**450**		2.30			16.41	16.60		0.19	
11	**500**			3.85		14.86	16.40		1.54	Last Reading
SUM		7.61		11.15						

1. No. of B.S= No. of F.S=5=5√
2. SUM B.S-SUM F.S= Rl. of last reading – Rl. of first Reading
   7.61-11.15= 14.86-18.40 ⇒ -3.54=-3.54 √

Slop = $\frac{elevation\ last - elevation\ first}{distance}$ * **100 = - 0.4%**

Elevation unknown= elevation known ± $\frac{slop}{100}$ * distance between point



St.	B.S	I.S	F.S	HI	RL	L	C	R	DL	Cut +	Fill -
B.M	1.4			17.6	16.2						
	1.42				16.18			6	16.20		0.02
		1.5						3			
0		1.45				3	0				
		1.35				6					
			1.37								
	1.46				16.18						
		1.4									
		1.42									
50		1.45									
			1.4								

Slop = $\frac{elevation\ last - elevation\ first}{distance}$ * 100 = - 0.4%

Elevation unknown= elevation known ± $\frac{slop}{100}$ * distance between point