LEVELLING

It is a method of surveying to determine the relative elevations of the points on the surface of the earth.

Levelling Instruments :-

① Level ② Levelling staff

① Level :- The instrument which is used for levelling and purpose of which is to provide a horizontal line of sight is called as level. It contains -

ⓐ Telescope ⓑ Level tube or bubble tube

ⓒ Levelling head

Types of Levels :-

(i) Dumpy level (ii) Wye level (iii) Reversible level

(iv) Tilting level

Temporary adjustments of a level :- These are the once those are done at every setting of the instrument, hence these are required when set up is changed.

ⓐ Setting up the level ⓑ Levelling up.

ⓒ Elimination of Parallax

Permanent Adjustment :- These are made only when the fundamental relation between some parts or lines are disturbed.

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Parts of Telescopes :-

(i) objective (ii) Eye piece (iii) Diaphragm

Basic Definitions :-

(1) Level surface
(2) Level line
(3) Datum
(4) Bench Mark (It is the fixed point of known elevation)
(5) Change point or Turning point
(6) Elevation
(7) Altitude
(8) Reduced level
(9) Horizontal plane
(10) Horizontal line
(11) Vertical plane
(12) Mean sea level
*(13) Line of collimation
*(14) Height of Instrument (HI = BM or TBM + BS)
*(15) Back sight / Plus sight
*(16) Fore sight (RL of a point = HI − F.S/IS)
*(17) Intermediate sight
*(18) Turning point or change point

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Methods of Levelling :-

① Direct Levelling
(i) Simple Levelling
(ii) Differential levelling
(iii) Reciprocal levelling
(iv) Profile levelling
(v) cross-sectioning
(vi) Precise levelling.
(vii) check Levieling
(viii) Fly leving

② Indirect Levelling
(i) Barometric levelling
ⓐ Aneroid barometer
ⓑ Mercury material
(ii) Hypsometry
ⓒ Triogonometrical levelling.

Reduction of Levels :-

There are two methods of finding the reduced levels of points from observed staff readings :-

① Collimation or Height of Instrument Method
② Rise and Fall Method

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HI METHOD

Q.1. The following staff readings were observed successively with a level, the instrument is moved after fourth and sixth readings—
2.25, 1.5, 0.95, 2.10, 2.90, 1.54, 0.75, 1.95, 2.10m

Enter the above readings in a page of a level book and calculate the R.L. of points by Height of Instrument Method, if the first reading was taken with a staff held on a B.M. of 500m.

Sol^n:

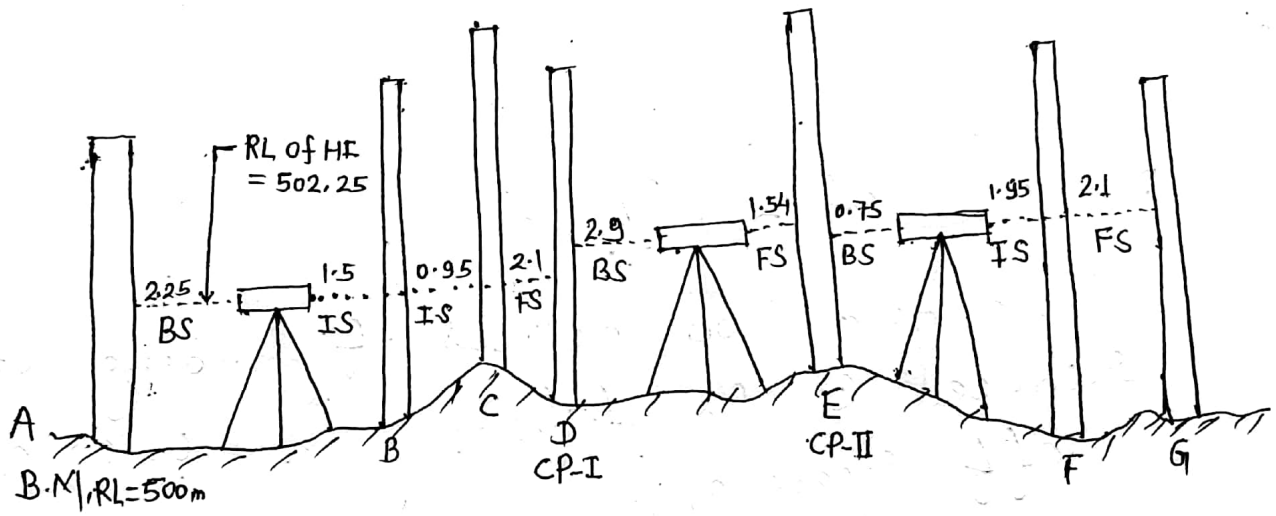

Fig. Height of Instrument Method

H.I. = R.L of B.M. or a point + B.S.

H.I = 5.00 + 2.25 = 502.25 m

R.L. of a point = H.I. − I.S./F.S.

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The R.Ls of the points may be calculated by H.I. Method as tabulated below –

Station	B.S.	I.S	F.S.	HI = R.L + BS	R.L of Point = HI − IS/FS	Remark
A	2.25	–	–	502.25	500	B.M.
B	–	1.5	–		500.75	
C	–	0.95	–		501.3	
D	2.9	–	2.1	503.05	500.15	C.P.-I
E	0.75	–	1.54	502.26	501.51	C.P.-II
F	–	1.95	–		500.31	
G	–	–	2.1		500.16	
Sum	5.90	4.40	5.74			

Arithmetic Check :-

$\Sigma B.S. - \Sigma F.S. = \text{Last RL} - \text{First RL}$

$5.90 - 5.74 = 500.16 - 500$

$\Rightarrow \boxed{0.16 = 0.16}$

Hence OK

Q.2. Following readings from a dumpy level are recorded along a continuously sloping ground at regular interval of 20m. Book these readings in a page of level book and find slop joining first and last point, the RL of first observation point is 100m., 0.465, 1.230, 2.785, 3.450, 0.850, 1.670, 2.550, 3.670, 0.270, 1.390

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Soln. We observe that, the given readings are gradually increasing initially, but they suddenly decreases after 4th and 8th readings. This indicates that, the instrument was shifted after 4th and 8th readings.

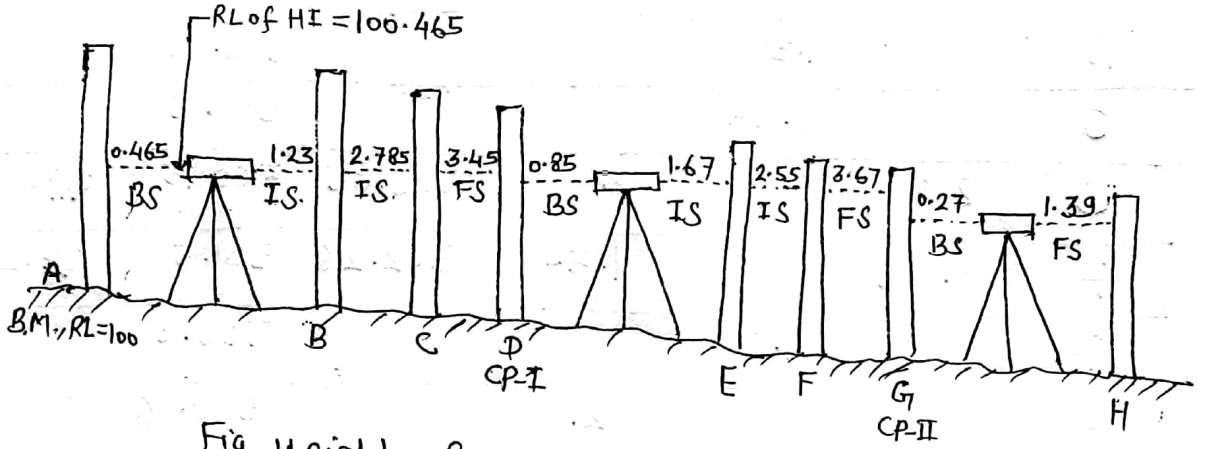

Fig. Height of Instrument Method

Chainage	Station	B.S.	I.S.	F.S.	HI = RL+BS	RL = HI-IS/FS	Remark
0	A	0.465	–	–	100.465	100	B.M.
20	B	–	1.230	–		99.235	
40	C	–	2.785	–		97.680	
60	D	0.850	–	3.450	97.865	97.015	CP-I
80	E	–	1.670	–		96.195	
100	F		2,550			95.315	
120	G	0.270		3.670	94.465	94.195	CP-II
140	H			1.390		93.075	
Sum		1.585		8.510			

Arithmetic Check; $\Sigma B.S. - \Sigma F.S. = \text{Last RL} - \text{First RL}$

$1.585 - 8.510 = 93.075 - 100$

$\Rightarrow (-)6.925 = (-)6.925$ Hence ok

Falling Gradient of Line $= \frac{\text{Difference in Level}}{\text{Horizontal Distance}} = \frac{6.925}{140} = \frac{1}{20.2}$ i.e 1 in 20.2

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Q.3. The following readings were taken by a 4m staff - 0.875, 1.225, 1.285, 1.425, 1.165, 0.785, 0.925, 1.225, 2.825, 0.895, 1.255, 1.685, 0.915 The instrument was shifted after 5th & 9th reading. Enter the data in level book and calculate R.L. of all the points if first reading was taken on B.M. 100.

Q.4. The following consecutive readings were taken with a level and a 4m levelling staff on a continuously sloping ground - 0.755, 1.545, 2.335, 3.545, 3.655, 0525, 1.275, 2.650, 2.895, 3.565, 0.345, 1.525, 1.850, 2.675 and 3.775. The first reading was taken on a benchmark whose R.L. is 200m. Calculate R.Ls of the stations by the line of collimation method and apply normal arithmetical checks.

Q.5. The following staff readings were taken with a level - 0.675, 1.565, 2.780, 2.985, 0.575, 0.610, 0.885, 0.225, 1.250, 0.850, 2.235 The instrument was shifted after 4th and 8th readings. The first reading was taken on a benchmark of R.L. 300m. Rule out a page of a level field book and enter the above readings. Calculate the reduced level of all the stations. Apply checks.

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RISE and FALL METHOD

Q.1. The following consecutive readings were taken with a dumpy level along a chain line at a common interval of 15m. The R.L. of B.M. is 150m. The instrument was shifted after 4th and 9th readings.

3.450, 2.54, 1.25, 0.75, 3.25, 2.50, 1.85, 1.45, 1.95, 1.50, 2.50 and 3.05 m.

Find the R.L. of all the points by Rise and Fall method.

Soln.

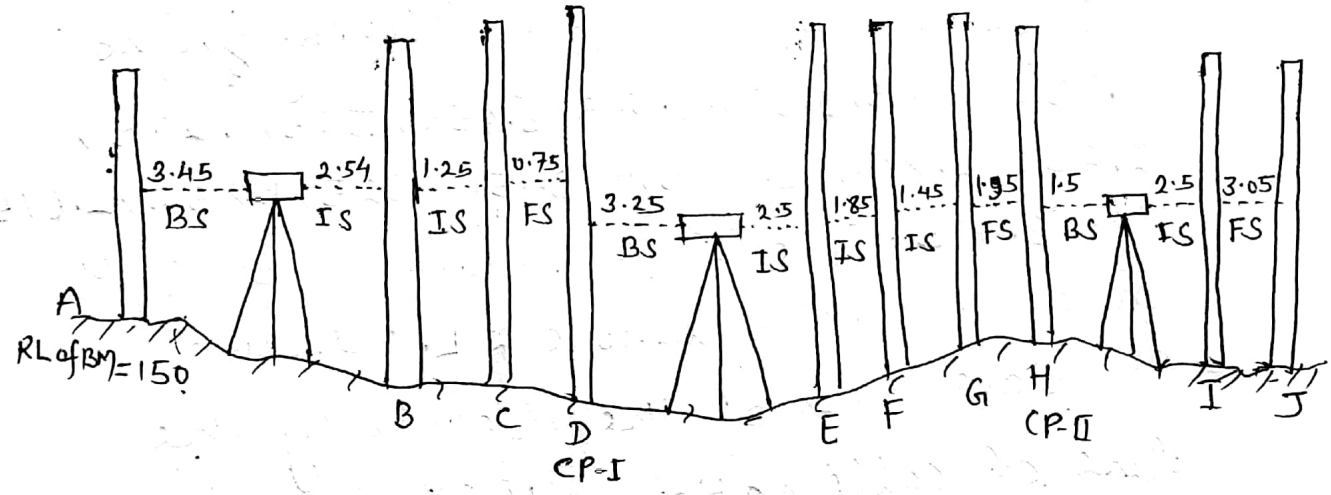

Fig. Rise and Fall Method

Rise or Fall = B.S. - I.S / F.S.

= I.S - F.S

The R.Ls of the points may be calculated by Rise and Fall method as tabulated below -

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Stations	B.S.	I.S.	F.S.	Rise (+)	Fall (−)	R.L	Remark
A	3.45	-	-	-	-	150	B.M.
B	-	2.54	-	0.91	-	150.91	
C		1.25		1.29		152.20	
D	3.25		0.75	0.50		152.70	CP-I
E		2.50		0.75		153.45	
F		1.85		0.65		154.10	
G		1.45		0.40		154.50	
H	1.50		1.95		0.50	154.00	CP-II
I		2.50			1.00	153.00	
J			3.05		0.55	152.45	
Sum	8.20		5.75	4.50	2.05		

Arithmetic check:-

$\Sigma B.S. - \Sigma F.S. = \Sigma Rise - \Sigma Fall = Last\ R.L. - First\ R.L.$

$8.2 - 5.75 = 4.50 - 2.05 = 152.45 - 150$

$2.45 = 2.45 = 2.45$

Hence OK

Q.2. The following readings were observed with a dumpy level – 0.795, 1.535, 2.855, 3.125, 0.945, 0.635, 0.555, 0.230, 1.550, 0.995, 2.015 The instrument was shifted after 4th and 8th readings. The first reading was taken on a B.M. of R.L. 608.400. Write entries in the page of a level field book. Calculate R.Ls of the points.

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Sol^{n}

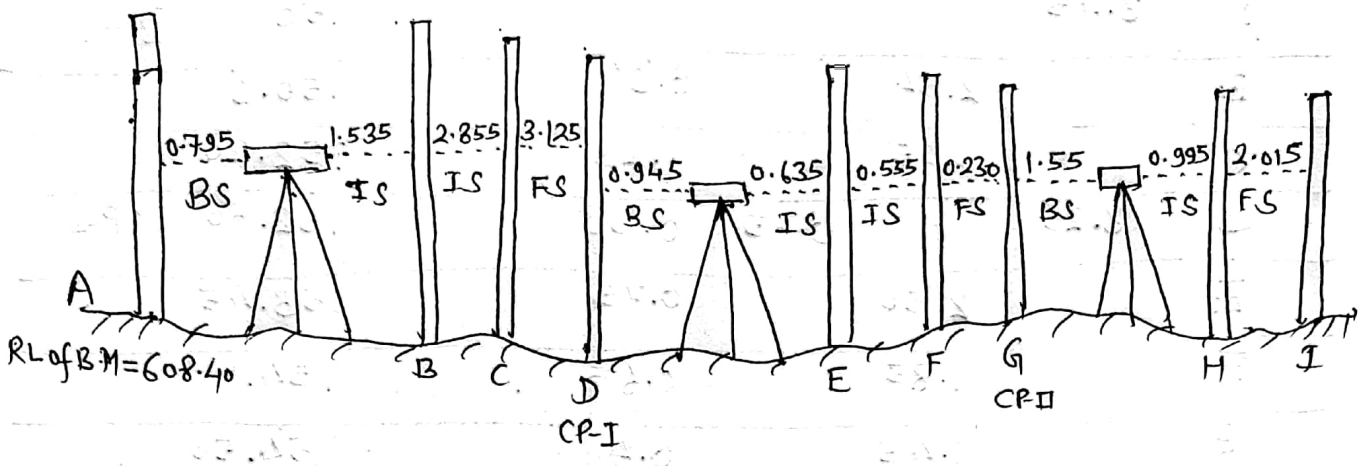

Fig Rise and Fall Method

Station	B.S.	I.S.	F.S.	Rise (+)	Fall (−)	R.L.	Remark
A	0.795	-	-	-	-	608.40	B.M.
B		1.535		-	0.74	607.66	
C		2.855		-	1.32	606.34	
D	0.945		3.125	-	0.27	606.07	CP-I
E		0.635		0.31	-	606.38	
F		0.555		0.08	-	606.46	
G	1.55		0.230	0.325	-	606.785	CP-II
H		0.995		0.555	-	607.34	
I			2.015	-	1.02	606.32	-
Sum	3.29		5.37	1.27	3.35		

Arithmetic Check:-

$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall = Last\ RL - First\ RL$

$3.29 - 5.37 = 1.27 - 3.35 = 606.32 - 608.40$

$-2.08 = -2.08 = -2.08$ Hence OK

Difference in levels between the first and last point is $606.32 - 608.40 = 2.08$ m Ans.

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