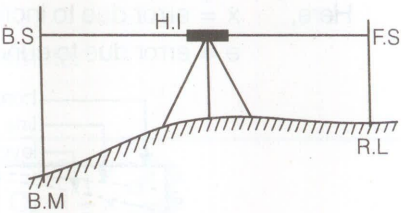
5. LEVELLING

DEFINITIONS

(i) **Reduced level:** The elevation of a point with respect to either Mean Sea Level (MSL) or with respect to a fixed point of known height is called reduced level.

(ii) **Bench mark:** Bench mark is relatively permanent point of reference whose elevation with respect to some assumed datum is known. It is used either as a starting point for levelling or as a point upon which to close as a check.



(iii) **Back sight:** After setting up the instrument Ist reading taken is called back sight. It is also known as plus sight.

(iv) **Fore sight:** Last reading taken from an instrument station is called fore sight. It is also known as minus sight.

(v) **Intermediate sight:** All readings ohter than back sight and fore sight are intermediate sight.

(vi) **Height of instrument:** It is the Reduced Level (RL) of line of sight of the instrument set up at different stations.

$$\boxed{H.I = R.L + B.S}$$

$$\boxed{R.L = H.I - F.S}$$

ARITHMETIC CHECK

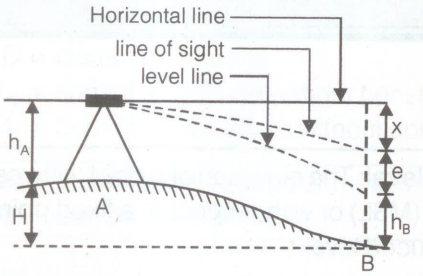
(i) **For rise and fall method**

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

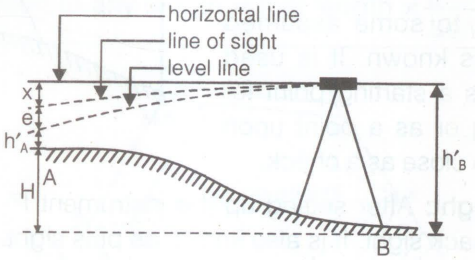
(ii) **Height of instrument method**

$$\boxed{\Sigma B.S - \Sigma F.S = Last\ R.L - First\ R.L}$$

RECIPROCAL LEVELLING



Here, x = error due to inclined line of sight, and
e = error due to curvature and refraction



When instrument is set up at A

Reading on staff at A = h_A

Reading on staff at B = h_B

When instrument is set up at B

Reading on staff at A = h'_A

Reading on staff at B = h'_B

$h_A - h_B = h'_A - h'_B$ If instrument is correct.

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

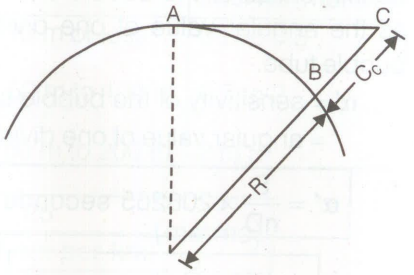
Here 'H' is the true difference of R.L between A and B.

True Readings

Instrument is at	Reading of A	Reading of B
A	h_A	$h_A + H$
B	$h'_B - H$	h'_B

CURVATURE CORRECTION (C_C)

$$C_C = -\frac{d^2}{2R}$$



Here, d = horizontal distance between A and B

R = radius of earth

If R = 6370 km

than $C_C = -0.07849\, d^2$

here 'C_C' is in meter and 'd' is in kilometer

REFRACTION CORRECTION (C_R)

$$C_R = +\frac{1}{7} C_C$$

$$C_R = \frac{1}{7} \times \frac{d^2}{2R}$$

↓ If R is 6370 km

$C_R = 0.01121\, d^2$ meter

Here d is in kilometer.

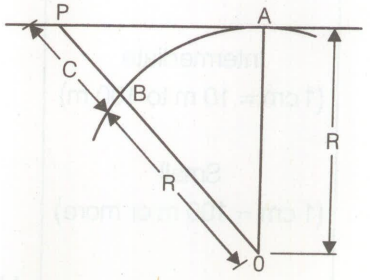
COMBINED CORRECTION DUE TO CURVATURE AND REFRACTION (C)

$$C = -\frac{6}{7} \times \frac{d^2}{2R}$$ If R = 6370 km

$C = -0.06728\, d^2$ meter Here d is in kilometer.

DISTANCE OF VISIBLE HORIZON

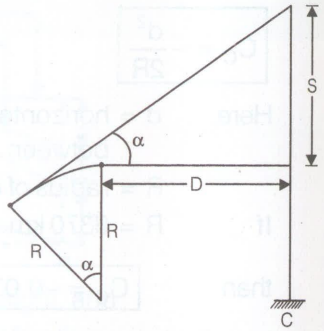
$d = 3.8553\sqrt{c}$ km



Here 'C' being in meters.
(taking both curvature and refraction into accounts)

SENSITIVENESS OF BUBBLE TUBE

Sensitiveness of the bubble tube is defined as the angular value of one division of the bubble tube.



α' = sensitivity of the bubble tube
= angular value of one division

$$\alpha' = \frac{S}{nD} \times 206265 \text{ seconds}$$

or $$\alpha' = \frac{S}{nD \sin 1''} \text{ seconds}$$

Here, S = difference between two staff readings.
n = no. of divisions of bubble

also, $$\alpha' = \frac{l}{R} \text{radian}$$ or $$\alpha' = \frac{l}{R \sin 1''} \text{seconds}$$

where, l = length of one division
R = radius of curvature of bubble tube.

Remember: 1 radian = 206265 seconds = $\frac{1}{\sin 1''}$

CONTOURING

Contours: Contour is an imaginary line joining points of equal elevation on earth surface.

Contour interval: Vertical distance between two contour is called contour internal.

Some suitable value of contour intervals

Scale of map	Type of ground	Contour internal (metres)
Large	Flat	0.2 to 0.5
(1 cm = 10 m or less)	Rolling	0.5 to 1
	Hilly	1, 1.5 or 2
Intermediate	Flat	0.5, 1 or 1.5
(1 cm = 10 m to 100 m)	Rolling	1, 1.5 or 2
	Hilly	2, 2.5 or 3
Small	Flat	1, 2 or 3
(1 cm = 100 m or more)	Rollng	2 to 5
	Hilly	5 to 10
	Mountaineous	10, 25 or 50

Contour internal for various purposes are suggested as:

Purpose of survey	Scale	Interval (metres)
1. Building sites	1 cm = 10 m or less	0.2 to 0.5
2. Town planning schemes, reservoirs etc.	1 cm = 50 m to 100 m	0.5 to 2
3. Location surveys	1 cm = 50 m to 200 m	2 to 3

$$\text{Contour interval} = \frac{25}{\text{No. of cm per km}} \text{(metres)}$$

$$\text{Contour interval} = \frac{50}{\text{No. of inches per mile}} \text{(feet)}$$

■■■