Introduction:→

Earth:→ Earth is an oblate spheroid.
(Flatted on poles) ③

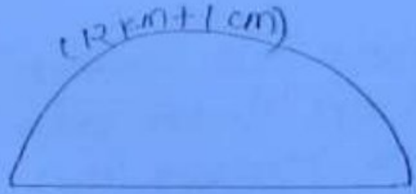
Diameter - polar axis = 12711.80 km.
Equatorial axis = 12756.75 km.
difference = 42.95 km (0.34% less)

Types:→

① plain Surveying:→ at east curvature is not considerd
(Suitable for small area)

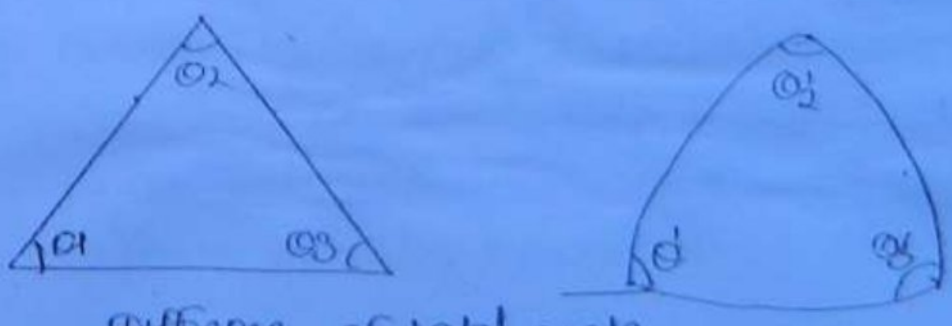
② Geodatic Survey:→ It earth curvature is considerd
(Suitable for large area)

(a)



difference for 12 km length = 1 cm

(b)



Difference of total angle
$(\theta_1' + \theta_2' + \theta_3') - (\theta_1 + \theta_2 + \theta_3) = 1$ second $= 0^\circ 0' 1''$

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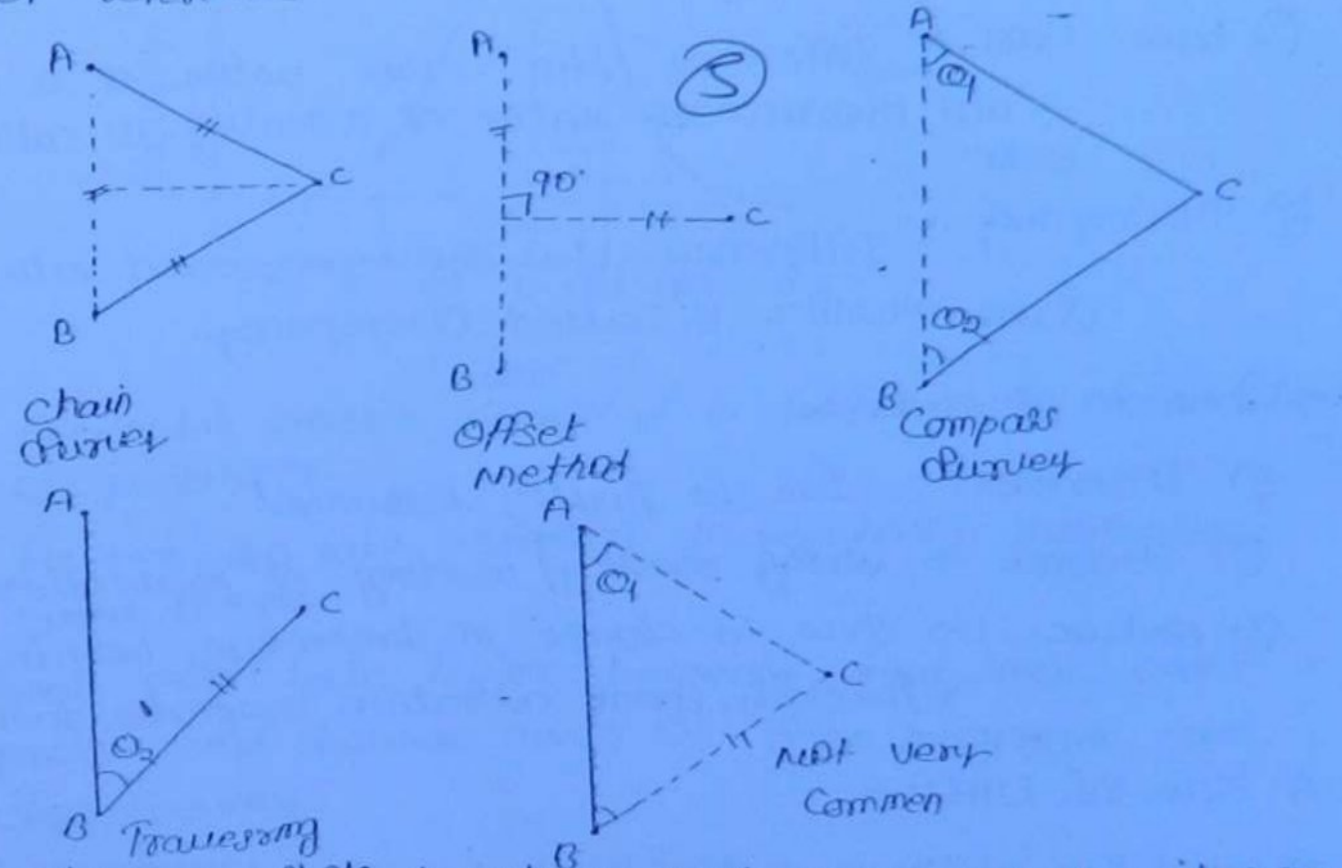
(B) Principal of Surveying:→

(a) Location of a point by measurement from two point of referance.



(b) Working from whole topart:→ first major control points repre-senting whole are fixed and distance are mesured with higher accuracy then minor details can be taken even with less precision Error involved in ~~can be taken even~~ measurement will not be accumulated.

Accuracy and Errors:→

(I) Definitions

(I) Accuracy:→ Degree of perfection obtained in measurement of a quantity is called accurcy. By using pricise instrument correct meaurment and correct manner of taking measurement.

② Precision :->

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Degree of perfection used in the measurement is called precision.

③ True Error :-> Difference b/w true value of a quantity and measurment value of a quality is called true error.

④ Discrepancy :-> Differency b/w two measured value of same quantity is called Discrepancy.

* Source of Errors :->

① Instrument :- Due to faulty instrument.

② Personal -> Wrong reading / writting of measurment.

③ Nature -> Due to change in temperture, humidity, wind, refraction, local attration megnatic declimanation.

* Kind of Errors :->

① Mistakes :-> Human error's due to less knowledge, carelss confusion in experience.

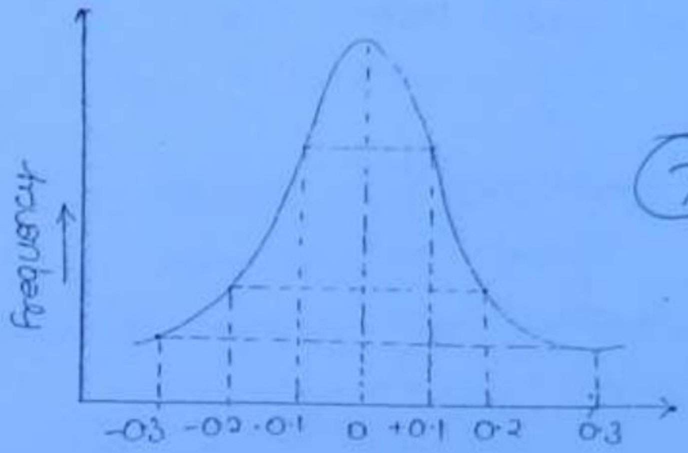
② Systmatic Error :-> (Commulative error)

Always's have same size and directions under same condition of measurment may be either (+)ive or (-)ve

③ Accidental Error's -> (Compensating error) :->

These error's occur's some times in one direction and some times in upposit time and (-)tive error's compersante each others.

Theory of probability :->



(7)

→ Accidental error's Followed a definite rule method law of probability.

As per this law according to possibility distribution curve of error.

(1) Small error have higher frequency than large errors.

(2) positive and negative error's of same magnitude have same frequency.

True value :-> Exact value of a quantity. (Almost impossible to measure)

Most probable value :-> The value of measurement which a chances of being the correct of a quantity than other measurement is called most probable value.

Principal of least square :->

Most probable value of quantity is 1 for which sum of a square of a residual error is min.

Ex:-> when all measurement have equal weight x_1, x_2, x_3 ------ x_n (equal weight = 1.0)

Residual error:→

If most proble value $= x$.

$x = x_1$
$x = x_2$
- - - -
- - - -

(8)

Square $(x-x_1)^2$
$(x-x_2)^2$
- - - - -
- - - - -

As per principal of least square

$$y = (x-x_1)^2 + (x-x_2)^2 + \text{-----} = min^m$$

$$\Rightarrow \frac{dy}{dx} = 2(x-x_1) + 2(x-x_2) + \text{----} = 0$$

$$nx = (x_1 + x_2 + \text{------} x_n) = 0$$

$$n \cdot x = (x_1 + x_2 + \text{-----} x_n) = 0$$

$$x = \left(\frac{x_1 + x_2 + \text{-----} + x_n}{n}\right) = \text{Mean of all}$$

Case (II) Unequal weights

Squares	measurement	weight	M.P.V	Residual error
$(x-x_1)^2 \times w_1$	x_1	w_1	↑	$x-x_1$
$(x-x_2)^2 \times w_2$	x_2	w_2		$x-x_2$
- - - - - -	- - -	- - - -	x	- - -
$(x-x_n)^2 \times w_n$	x_n	w_n	↓	$(x-x_n)$

Sum of square of residual error.

$$y = w_1(x-x_1)^2 + w_2(x-x_2)^2 + \text{---} + \geq min^m$$

$$\frac{dy}{dx} = 2w_1(x-x_1) + 2(w_2)(x-x_2) + \text{-----} = 0$$

$$\text{mpv} \Rightarrow x = \frac{w_1x_1 + w_2x_2 + \text{-----}}{w_1 + w_2 + \text{---}} = \frac{\Sigma wx}{\Sigma w}$$

☆ The probable error of a single observation.

$$E_s = \pm\, 0.6745 \sqrt{\frac{\Sigma V^2}{(n-1)}}$$

V = difference b/w any single observation and mean of the series.

☆ The probable error of the mean:—

$$E_m = \pm\, 0.6745 \sqrt{\frac{\Sigma V^2}{n(n-1)}}$$

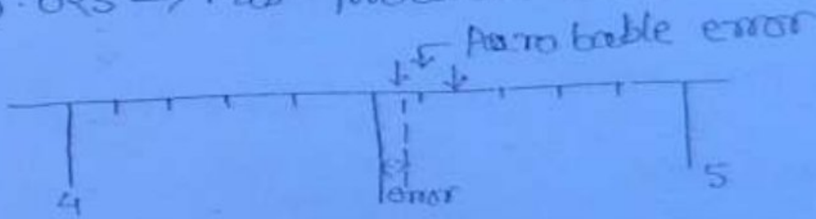
$$E_m = \frac{E_s}{\sqrt{n}}$$

☆ Significant Figures: → / max. error / Most probable error: →

4.6

error 0.05 ← max. error

0.025 → Most probable error



→ No. of significant figures shows the accuracy of measurement

→ If there are n significant figure in a measurement (n-1) figure are called - certain figure

least figure is called - Uncertain figure.

→ There are two types of error

Example	Max. error	probable error
4.6	0.05	0.025
5.86	0.005	0.0025

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Accumulation of error :→

(1) For max. error :→

Total error = Algebric Sum of all errors.

$$e_T = \pm e_1 \pm e_2 \pm e_3$$

(2) For probable error →

Sum = Root mean Square value

$$e_T = \pm \sqrt{e_1^2 + e_2^2 + e_3^2 + \cdots}$$

Error's in Computed Result :→

(1) Addition :→

If x and y are two measured value

$$S = x + y$$

$$\boxed{dS = dx + dy} \quad \text{——— (1)}$$

if max. error's are $= \pm \delta x$ and $\pm \delta y$

max. error

$$S \pm \delta s = (x + \delta x) + (y + \delta y)$$

$$\Rightarrow S \pm \delta s = (x + y) \pm (\delta x + \delta y)$$

$$\delta s = (\delta x + \delta y) \text{ max. error in } S$$

Probable error :-

are e_x and e_y Sum of probable error's

$$e_s = \sqrt{e_x^2 + e_y^2}$$

Range of $S = (S + e_s)$ to $(S - e_s)$

(ii) Sub-Traction :→

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$$S = x - y$$
$$dS = dx - dy$$

Max. error if $\pm \delta x$ and $\pm \delta y$ are max. error

For (S) → $\delta_S = (+\delta x) - (-\delta y)$

$$\delta_S = +(\delta x + \delta y)$$

or

$$= (-\delta x) - (+\delta y)$$
$$= -(\delta x + \delta y)$$

$$\delta_S = \pm (\delta x + \delta y)$$

Range of S

$$S = (S + \delta_S) \text{ to } (S - \delta_S)$$

Probable error

$$e_S = \pm\sqrt{(e_x)^2 + (e_y)^2}$$

Range $= (S + e_S)$ to $(S - e_S)$

(iii) Multiplication :→

$$S = x \cdot y$$
$$dS = x\,dy + y\,dx$$

max. error

Respective error of x and y → δx and

For S in $x \rightarrow y \cdot \delta x$

in $y \rightarrow x \cdot \delta y$

$$\delta = x \cdot \delta y + y \cdot \delta x \quad \text{--- (1)}$$

Range $(S + \delta_S)$ to $(S - \delta_S)$

Probable error :→

Respective error of x and y → e_x and e_y.

for S. error in $x = y\,e_x$

$y = x \cdot e_y$

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Sum $= e_s = \sqrt{(y e_x)^2 + (x e_y)^2}$ (12)

$\Rightarrow \frac{e_s}{s} = \frac{1}{xy} \cdot \sqrt{(y \cdot e_x)^2 + (x \cdot e_y)^2}$

$\Rightarrow \frac{e_s}{s} = \sqrt{\left(\frac{e_x}{x}\right)^2 + \left(\frac{e_y}{y}\right)^2}$

$\Rightarrow e_s = s \times \sqrt{\left(\frac{e_x}{x}\right)^2 + \left(\frac{e_y}{y}\right)^2}$

(iv) Division: $\rightarrow s = x/y$

$ds = \frac{y\,dx - x\,dy}{y^2}$

$ds = \left(\frac{dx}{y}\right)^2 - \left(\frac{x}{y^2}\right) dy$

max error:- Respective error of x and y $\rightarrow$ δx and δy

For s in $x \rightarrow \frac{1}{y}\delta x$

in $y \rightarrow \frac{x}{y^2}\delta y$

$$\boxed{\delta es = \frac{\delta x}{y} + \frac{x}{y^2}\delta y}$$

Range $(s+ds)$ to $(s-ds)$

Probable error:-

Respective error of x and $y \rightarrow e_x$ and e_y

For s error in $x = \frac{1}{y} e_x$

$y = \frac{x}{y^2} e_y$

Sum $e_s = \sqrt{\left(\frac{e_x}{y}\right)^2 + \left(x \cdot \frac{e_y}{y^2}\right)^2}$

$\Rightarrow \frac{e_s}{s} = \frac{y}{x}\sqrt{\left(\frac{e_x}{y}\right)^2 + \left(\frac{x}{y^2} e_y\right)^2}$

$$\Rightarrow \boxed{\frac{e_s}{s} = \sqrt{\left(\frac{e_x}{x}\right)^2 + \left(\frac{e_y}{y}\right)^2}} \quad \text{— B}$$

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Que ① A quantity S is equal to sum of two measured quantities x and y.

(13)

$S = 5.68 + 3.648$

Find out probable error, max. error & most probable limits max. limits of s.

$x = 5.68$ $0.005\ \delta x$ $0.0025\ ex$

$y = 3.698$ $0.0005\ \delta y$ $0.00025\ ey$

max. error   probable error.

Solution: → ① max. error

(for S) $\delta s = \delta x + \delta y$

$\delta s = 0.005 + 0.0005$

$\delta s = 0.0055$

Range max. range $= (S+\delta s)$ to $(S-\delta s)$

$= 9.328 + 0.0055$ to $\begin{array}{r} 9.328 \\ -0.0055 \\ \hline 9.3225 \end{array}$

② most probable error:-

$e_s = \sqrt{e_x^2 + e_y^2}$

$e_s = \sqrt{(0.0025)^2 + (0.00025)^2}$

$e_s = 0.00251$

probable range of s

$= S + e_s$ to $S - e_s$

$= 9.328$ to 9.328

$= 9.33051$ $- 0.00251$

$= 9.3255$ Ans

Que ② Calculated the max. & probable error & range of a computed quantity.

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$$S = \frac{9.58}{4.6}$$

Solution:→

		max^m	probable
x	9.58	$\delta x = 0.005$	$e_x = 0.0025$
y	4.60	$\delta y = 0.05$	$e_y = 0.025$

$$S = 2.0826$$

$$ds = \frac{y\,dx - x\,dy}{y^2}$$

$$ds = \frac{dx}{y} - \frac{x}{y^2}dy$$

max^m error

$$\delta s = \frac{\delta x}{y} + \frac{\delta y}{y^2}x$$

$$\delta s = \frac{0.005}{4.6} + \frac{9.58 \times 0.05}{4.6^2}$$

$$\delta s = 0.0237$$

Range of s

$$\begin{array}{r} 2.0826 \\ +0.0237 \\ \hline 2.1063 \end{array} \quad \text{to} \quad \begin{array}{r} 2.0826 \\ -0.0237 \\ \hline 2.0589 \end{array}$$

Probable error

$$\Rightarrow \frac{e_s}{s} = \sqrt{\left(\frac{e_x}{x}\right)^2 + \left(\frac{e_y}{y}\right)^2}$$

$$\Rightarrow e_s = 2.0826\sqrt{\left(\frac{0.0025}{9.58}\right)^2 + \left(\frac{0.025}{4.6}\right)^2}$$

$$\Rightarrow e_s = +0.0113$$

Range of s

$$\begin{array}{r} 2.0826 \\ +0.0113 \\ \hline 2.0939 \end{array} \qquad \begin{array}{r} 2.0826 \\ -0.0113 \\ \hline 2.0713 \end{array}$$

Ans

(15)

Fundamental definition :→
(Linear measurement)

Scale:→ Scale is ratio of distance plotted on drawing to distance on the ground.

Ex = 1 cm = 1 km

1 cm = 1000 m

1 cm = 1000 x 100 cm

$$R.F = \frac{1}{100000} = \text{Representative fraction}$$

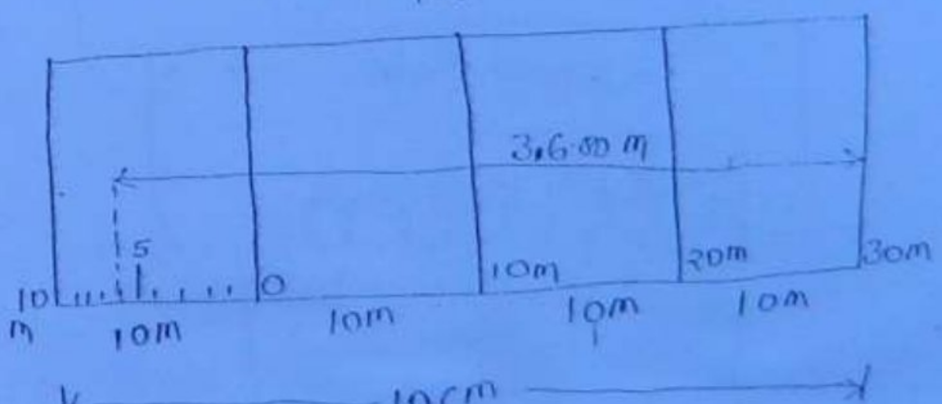
Types:→

1. plane scale.
2. Diagonal Scale.
3. Vernier scale.
4. chord Scale.

① **plane Scale:→** It measures upto two dimension only

A scale 1cm = 4 m to be prepared

$$R.F = \frac{1}{400}$$



→ In this case, 10m and meter are the two dimention that can be measured.

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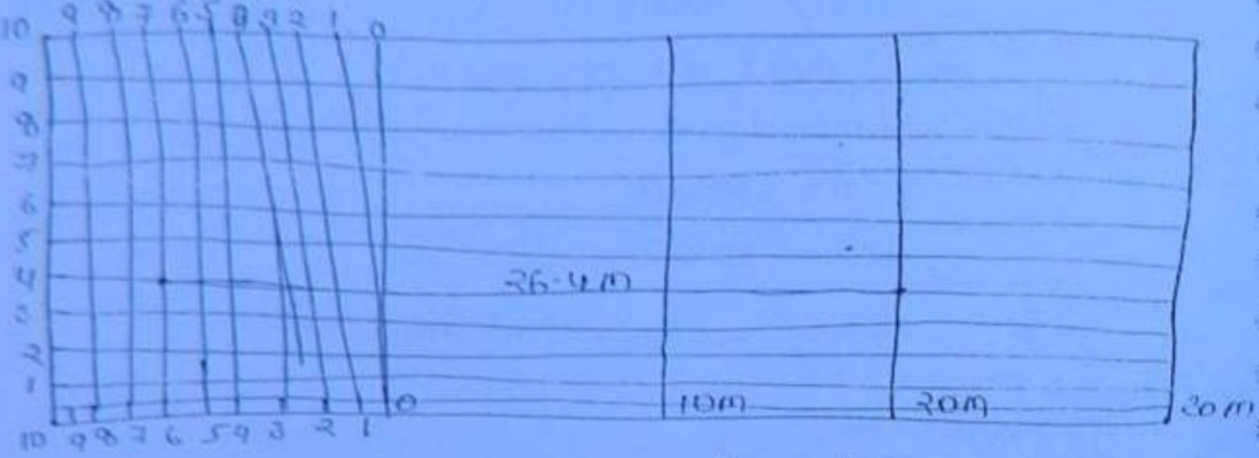
(2) Diagonal Scale :-> It can measured upto 3 dimension. Similar triangle theory is used in diagonal scale.

(16)

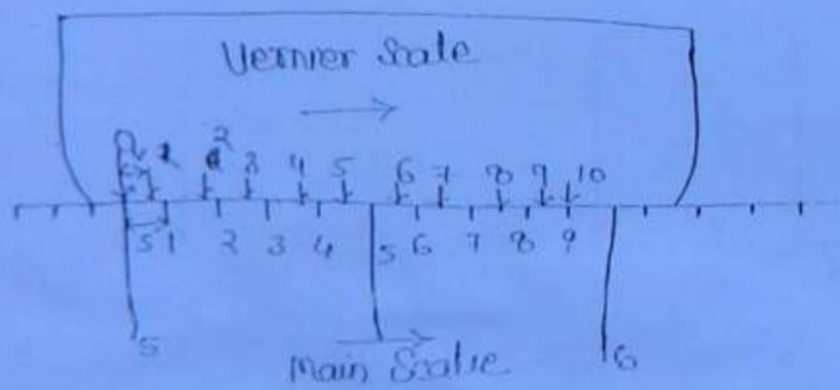


In three diamention in above case

(1) 10m
(2) meter
(3) decimeter

(3) Vernier Scale :->

(a) Direct vernier Scale -> In this case also upto 2 diamention can be read.



In case of direct vernier scale

(1) Vernier scale moves in same direction as of main scale.

(2) (n-1) parts of main scale is equal to n divisions (parts) of vernier scale.

$n \cdot v = (n-1)s$ (17)

s = mean scale

v = vernier scale

$$v = \frac{(n-1)}{n} \cdot s$$

Least count → minimum value that can be used using a scale is called least count.

$$L.C. = s - v$$

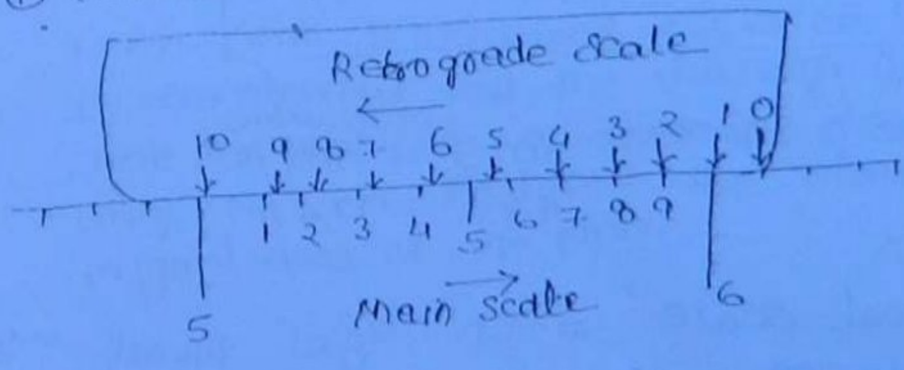
$$L.C. = s - \frac{n-1}{n} \cdot s$$

$$L.C. = \frac{ns - ns + s}{n}$$

$$\boxed{L.C. = \frac{s}{n}}$$ — least count of this vernier scale.

(b) Retrograde Scale :→ In case of Retrograde scale

(1) Vernier scale moves in opposite direction as the main scale.



(2) $(n+1)$ parts of main scale is equal n division (parts) of vernier scale.

$$n \cdot v = (n+1)s$$

$$v = \frac{(n+1)}{n} \cdot s$$

Least count → minimum value that can be read using a scale is called least count

$$L.C. = V - S$$

$$L.C. = \frac{(n+1)}{n} \times S - S$$

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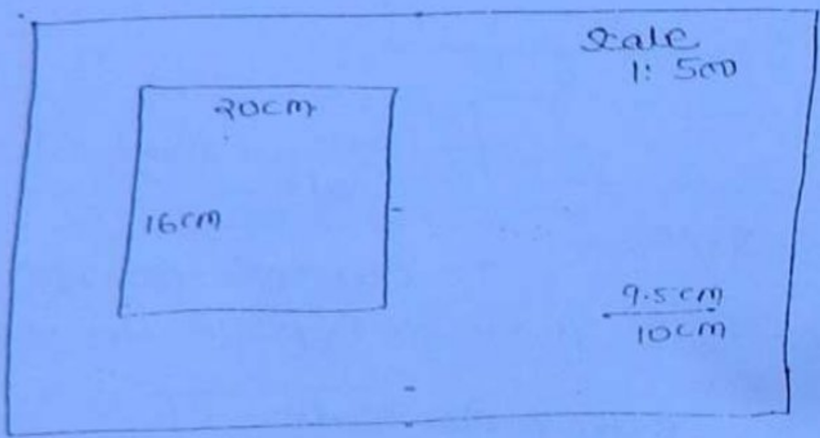
$$L.C. = \frac{nS + S - nS}{n}$$

$$\boxed{L.C. = \frac{S}{n}}$$

★ Shrink Scale :→
(and Shrinkage factor)



1: 500
1cm = 500 cm
1cm = 5m

This line is represent $20 \times \overset{\text{scale value}}{5} = 100$ m
$16 \times 5 = 80$ m

original scale
1 : 500
10cm = 5000 cm

Now
present Scale
9.5 cm = 5000 cm

$1 \text{ cm} = \frac{5000}{9.5}$ cm

1 cm = 526.316 cm $\boxed{1 : 526.316}$

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→ Shrinkage factor :- It is the ratio of shrunk length to orignal length of the [illegible]

(19)

$$SF = \frac{\text{Shrunk length}}{\text{orignal length}}$$

→ Shrunk Scale = Shrinkage factor x orignal scale.

Ex. For given example.

$$SF = \frac{9.5}{10}$$

$$SF = 0.95$$

Shrunk scale = Shrinkage factor x orignal scale

$$= 0.95 \times \frac{1}{500}$$

$$= \frac{1}{526.316}$$

problem:→ Area of a plan in a drawing plotted to a scale 1 cm = 50 m is measured 250 sq. cm by planimeter. It was observed that the drawing has shrunk and line originally 10 cm drawn on drawing measured only 9.20 cm. Find out the shrunk scale and original area of the plan.

Solution:→ Shrunk length = 9.2 cm

orignal length = 10 cm

$$\text{Shrinkage factor} = \frac{\text{Shrunk length}}{\text{orignal length}}$$

$$= 9.2/10$$

$$= 0.92$$

orignal scale = 1 cm = 50 m

1 cm = 5000 cm

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$= 1/5000$

Shrunk scale $= S.F. \times 0.5$

$= 0.92 \times \frac{1}{5000}$

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$= \frac{1}{5434.78}$

Scale $1 cm = 54.35 m$

Original area $= 250 cm^2 \times (54.35)^2$

$= 738490.6 \; m^2$

Ans :-

☆ Error due to wrong length of chain / Tape :→

l = length (Designated) length of Tape/chain

l' = wrong length of Tape/chain [actual length]

L' = wrong Measured (written) length of a line

L = True of line measured

$$\boxed{\begin{aligned} \text{True} \times \text{True} &= \text{wrong} \times \text{wrong} \\ L \times l &= l' \times L' \end{aligned}}$$

True length of line $L = \left(\frac{l'}{l}\right) \times L'$

Ex:→ If a 30 m chain is actually 30.20 m long. what will be the actual length of a line which is measured 3052 m using above tape.

Solution :→

$l = 30 m$

$l' = 30.20 m$

$L' = 3052 m$

$L = ?$

$l \times L = l' \times L'$

$L = \left(\frac{l'}{l}\right) \times L'$

$L = \frac{30.20}{30} \times 3052 = \boxed{3072.35 m}$

Formula

① $l = \left(\frac{L'}{L}\right) \times l'$ for length

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② For Area

$$A = \left(\frac{L'}{L}\right)^2 \times A'$$

③ For volume

$$V = \left(\frac{L'}{L}\right)^3 \times V'$$

★ Tape Correction :→

ⓐ Correction due to standardization. [Due to wrong length of chain / Tape].

Total Correction required

$$C_a = \frac{\text{Total length of line } (l')}{L} \times C$$

$$C_a = \frac{l'}{L} \times C$$

★ C_a = Total Correction

C = Correction required per chain length

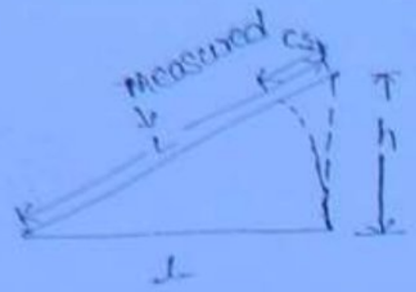
L = Designated length of tape / chain

this Correction may be (+) or (−)

② Measured length	③ written noted length	④ Error	⑤ Correction	① Case
More 30.50	less 30.0	(−)ve −0.50m	(+)ve +0.50m	Tape is long
less 29.5m	More 30.0m	(+)ve +0.50m	(−)ve −0.50m	Tape is short

(b) Correction due to slope (C_s)

(22)



In case of chaining along a sloping area we need to measured the horizontal distance

Slope correction (C_s) $= l - L$

$$C_s = l - \left(\sqrt{l^2 - h^2}\right)$$

$$C_s = l - l\left[1 - h^2/l^2\right]^{1/2}$$

$$C_s = \cancel{l} - \cancel{l} + \frac{h^2}{2l} + ---$$

$$\boxed{C_s = \frac{h^2}{2L}}$$

Errors always positive (+)ve correction is always (−) ve.

(c) Correction due to alignment :→ (C_{al}) :→

If h is error in alignment
l = length of line measured

Correction due to alignment

$$C_{al} = \frac{h^2}{2L}$$ ← Same as slope correction

[Error always (+) ve] [correction always (−) ve]

(d) Correction due to Temperature:→ The correction requred C_T

(23)

$$C_T = L(T_m - T_0) \times \alpha$$

here L = length of line measured
T_m = Temperature at the time of measure
T_0 = Temperature at the time of Standrzation.

Case(1) – If T_m is more than T_0
$(T_m > T_0)$
Tape length is increase.
error = (–)ve
Correction = (+)ve

Case(2) = If $(T_m < T_0)$
Tape length is dicrease
error = (+)ve
correction = (–)ve

(e) Pull Correction:→
If L = length of line measured.
P_m = Pull applied at the time of measurment.
P_0 = Pull applied at the time of Standardization

Pull Correction

$$C_p = \frac{(P_m - P_0) \cdot L}{AE}$$

A = c/s area of Tape/chain
E = young's modulus of elasticity of Tape/cha

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Case(1) $P_m > P_0$ length increases

Error = (-)ve

Correction = (+) ve

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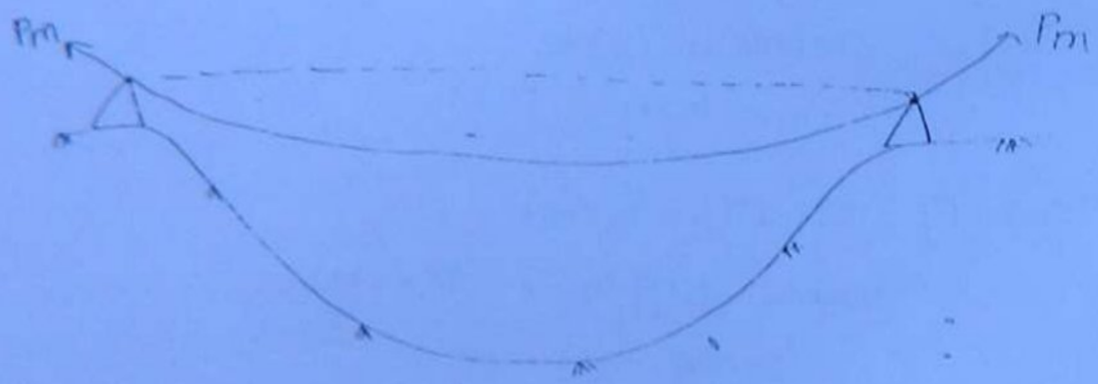
case (2) $P_m < P_0$

length is less

Error = (+) ve

correction = (-) ve

(F) Sag correction :->



Sag correction $C_{sag} = \frac{W^2 l}{24 P_m^2} = \frac{(w l_1)^2 l}{24 P_m^2}$

W = Total weight of chain

$= w l_1$

w = weight per meter

l_1 = length of chain/Taper

P_m = Pull applied at the time of measured.

Error-always = (+) ve

Correction-always = (-) ve

(ii) Normal Tension:→

If ($P_m > P_0$) Pull correction is (+)ve
Sag correction is (−)ve

Pull correction and Sag correction neutralize each other

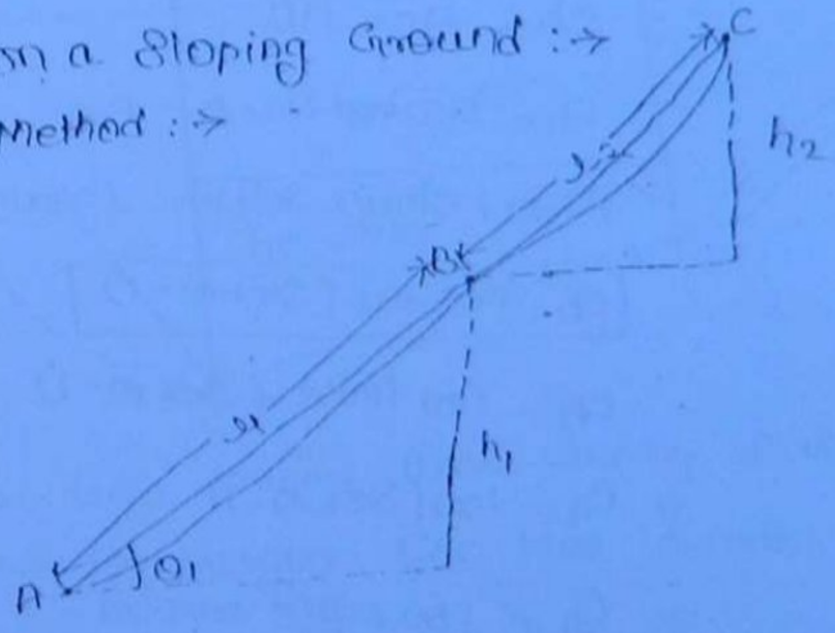
→ the value of pull (P_m) for which pull correction is equal to Sag correction is called Normal tension

$$\boxed{\frac{(P_m - P_0)L}{A \cdot E} = \frac{W^2 L}{24 P_m^2}}$$

This eq. can be solved by trial and error for (P_m)

(ii) Chaining on a Sloping Ground:→

(1) Indirect Method:→



Horizontal distance A to C

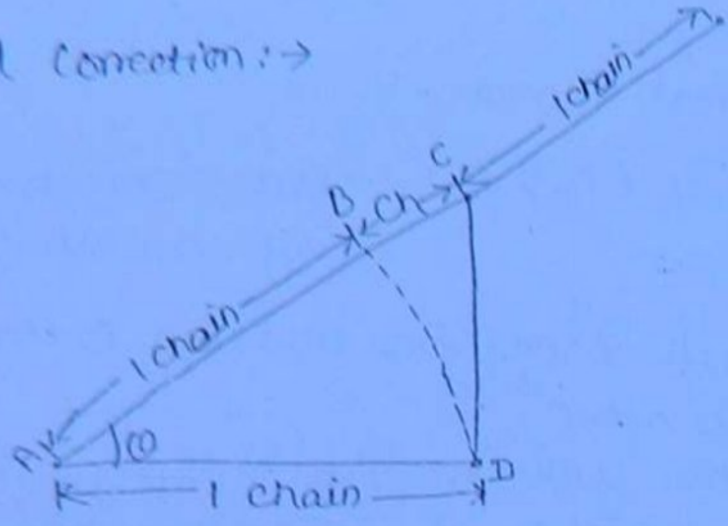
$$= l_1 \cos\theta_1 + l_2 \cos\theta_2 + \cdots$$

(2) Measuring difference of level:→

$$\text{Horizontal distance} = \sqrt{l_1^2 - h_1^2} + \sqrt{l_2^2 - h_2^2} + \cdots$$

(3) Hypotenusal correction :→

(26)



Hypotenusal correction $Ch = BC$

$$\frac{AD}{AC} = \cos\theta$$

$$Ch = AC - AB$$

$$Ch = AD \sec\theta - AB$$

$$Ch = 1 \text{ chain} \sec\theta - 1 \text{ chain}$$

$$\boxed{Ch = 1 \text{ chain} (\sec\theta - 1)}$$

$$Ch = 100 \text{ links} (\sec\theta - 1)$$

$$\Rightarrow Ch = 100(\sec\theta - 1)$$

$$\Rightarrow Ch = 100 \times \frac{\theta^2}{2}$$

$$\Rightarrow \boxed{Ch = 50\theta^2} \text{ links}$$

This correction is applied after each chain, and next chaining is started after correction.