MODULE-I

INTRODUCTION TO BASIC CONCEPTS.

Surveying:

Surveying is the art of determining the relative positions of points on, above or beneath the surface of the earth by means of direct or indirect measurements of distance, direction and elevation. It also includes the art of establishing points by pre-determined angular and linear measurements. The application of surveying requires skill as well as knowledge of mathematics, physics and to some extent astronomy.

Units of measurements:

Basic units of length:

British units	Metric Units
12" Inches = 1' foot	10 mm = 1 cm
3 feet = 1 yard	10 cm = 1 decimeter
5½ yards = 1 rod, Pole (or) Perch	10 decimeter = 1 m
4 poles = 1 chain (66')	10 m = 1 decameter
10 chains = 1 furlong (or)	10 decameter = 1 hectometer
8 furlongs = 1 mile	10 hectometer = 1 kilometer
100 links = 1 chain = 66'	1852 m = 1 nautical mile (International)
6 feet = 1 fathom	
120 fathoms = 1 cable length	
6080' = 1 nautical mile	

BRITISH UNITS

METRIC UNITS

6080' = 1 nautical mile

1' = 0.3048 m

1" = 2.54 cm

1" = 25.4 mm

1 ton = 1000 kg

1 quinton = 100 kg

11/07/19

Basic units of area:

Metric units

10 sq mm = 1 sq cm

100 sq cm = 1 sq decimeter

100 sq decimetre = 1 sq m

100 sq m = 1 sq decametre / 1 are

~~100 sq decam/ares = 1 sq km~~

100 ares = 1 hectare / 1 sq hectometre.

100 hectares = 1 sq km

British units:

144 sq inches = 1 sq foot

9 sq feet = 1 sq yard

Basic units of volume:

Metric units:

1000 cu.mm = 1 cu cm

1000 cu.cm = 1 cu dm decim

1000 cu.decim = 1 cu.m

British units:

~~1 cu foot~~

1728 cu.inches = ~~1728~~ 1 cu foot

27 cu.feet = 1 cu.yard

1 m = 100 cm = 3.28' feet.

$\frac{100}{30.48}$ = 3.28 feet.

1 Sq m = 3.28' X 3.28' = 10.76 sq ft.

1 Sqm = 10.76 sq ft

Basic units of angular measurements:

In this there are three systems:

1) Sexagesimal system.
2) centesimal system.
3) Hours system.

1) Sexagesimal system:

1 circumference = 360°

$1^\circ = 60'$ min

1 min = 60 sec / $60''$

2) centesimal system:

1 circumference = 400^g. (g-grads)

1 grad = 100 centi grad / 100^c

1 centigrad = 100^{cc} (centi centi grads)

3) Hours system:

1 circumference = 24^h

$1^h = 60$ min / 60^m

1 min = 60^s

Note:

1) 1 cu m = 1000 litres of water

1 gallon = 0.00455 cu m

= 0.00455 × 1000 l

= 4.551

Scanned with CamScanner

Objectives of surveying:

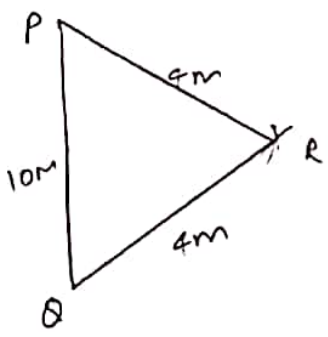
1) To determine dimensions and contours at any part of the earth surface. To prepare a plan or a map.
2) To establish boundaries of the land.
3) To select a suitable site for an engineering project.
4) To measure areas and volumes.

12/7/19.

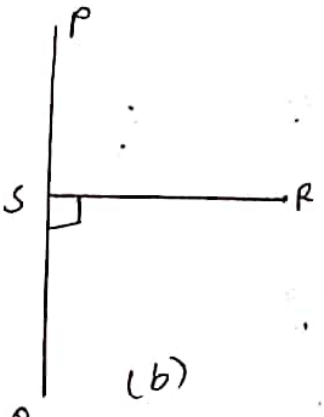
✱ Principles of surveying:

1) Location of a point by measurement from two points of reference.
2) Working from whole to part.

1. Location of a point by measurement from two points of reference.



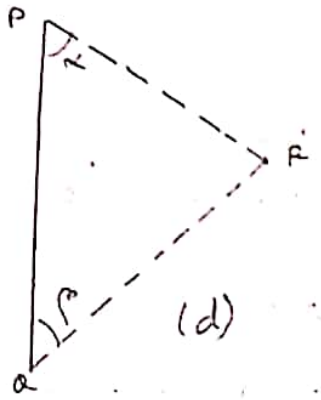
(a) used in chain surveying



(b) used for defining details

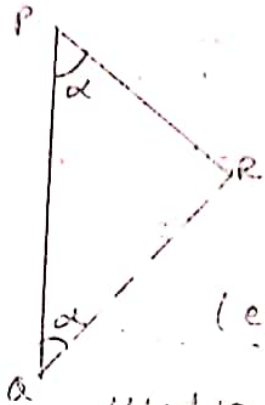
(c) used in traversing

Scanned with CamScanner



(d)

used in Triangulation & used in very extensive work



(e)

used in traversing is of minor utility

2) working from whole to part:

The idea of working in this way i.e from whole to part is to prevent the accumulation of errors and to control and localize minor errors which, otherwise, would expand to greater magnitudes if the ~~rivers crosses i.e~~ reverse process i.e part to whole, thus making the work uncontrollable at the end.

Primary divisions of survey:

1) Plane surveying
2) Geodetic surveying.

1) Plane surveying:

It is the type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected.

Scanned with CamScanner

2) Geodetic Surveying:

In this type of surveying the shape of the earth is taken into account.

All lines lying on the surface are curved lines and triangles are spherical triangles. Therefore, it involves spherical trignometry. All geodetic surveys include work of larger magnitude and high degree of precision.

15/07/19.

Classification of surveying:

1) Surveying can be classified based up on nature of field to be surveyed. In that

i a) Land surveying:

Land surveying is divided as 3-types

a) Topographical survey (Natural - rivers, streams, lakes
Artificial - Roads, Railway tracks etc)

b) Cadastral survey (fixing of boundaries, calculation of land area, transfer of land property from one owner to another etc).

c) city survey. (construction of streets, water supply systems, sewers and other works)

ii) Marine Surveying:

iii) Astronomical surveying.

Marine Surveying: used for navigation, harbour works, determinging mean sea level (MSL), tide's fluctuations, taking soundings to determine the depth of water.

Astronomical Surveying:

observations to heavenly bodies like sun or any fixed star.

Scanned with CamScanner

2) Based on object of surveying:

a) Engineering survey:

To find out quantities - Design of roads, reservoirs, water supply and sewage supply lines.

b) Military Survey:

To determine the points of strategic importance.

c) Mine surveying:

To ~~expro~~ explore mineral wealth.

d) Gelogical surveying:

To determine different strata in earth's crust.

e) Archaeological survey:

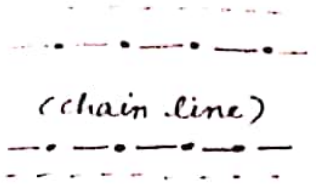
Uncathing relics of antiquity.

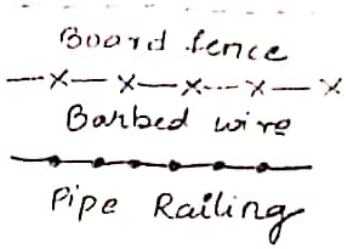
3) Based on instruments used:

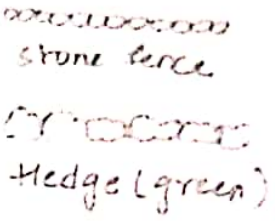
a) Chain surveying
b) Compass surveying
c) plane table surveying
d) Leveling Dumpy level - leveling
e) Theodolite surveying
f) Tacheometric surveying.
g) Traversing surveying
h) Triangulation surveying
i) photogramametric surveying
j) ~~Aer~~ Aerial surveying.

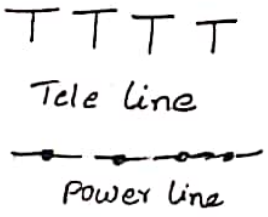
18/7/19

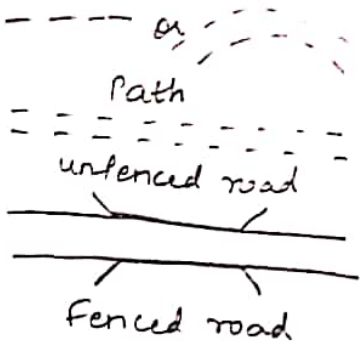
conventional symbols :

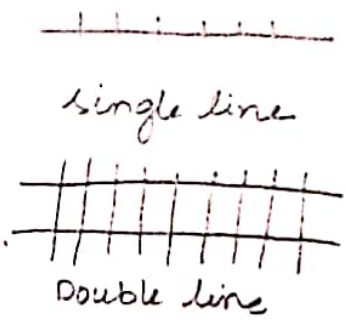


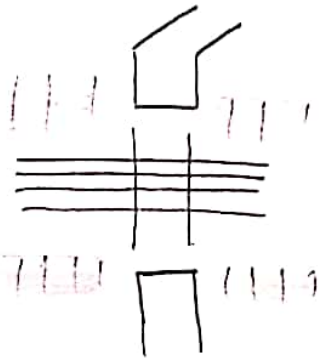


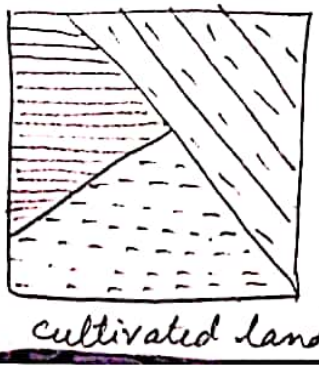


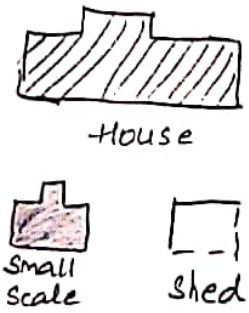


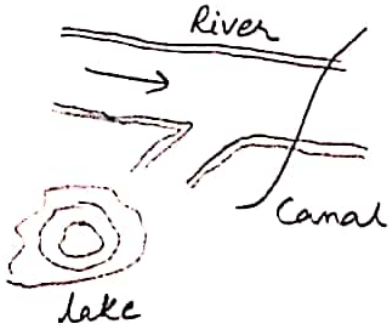






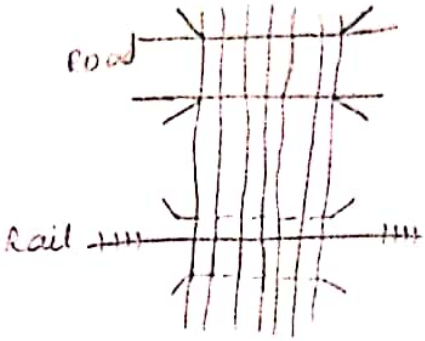






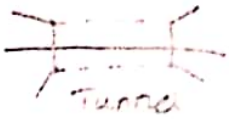
Scanned with CamScanner

Stream line

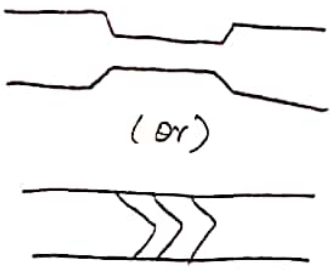


Bridges

Quarry



Tunnel

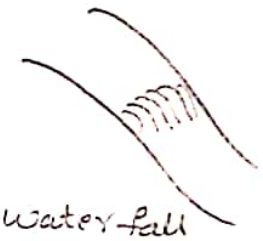


(or)

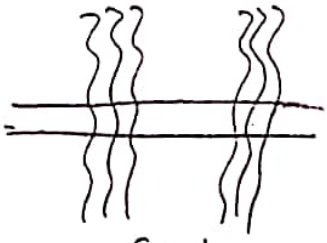
Canal lock.

Triangulation

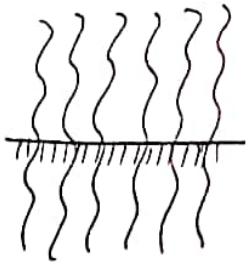
Traverse Stations



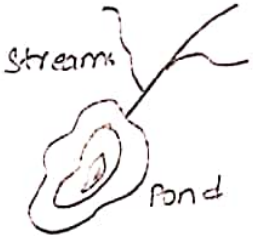
Water fall

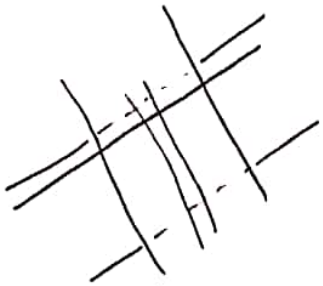


ford

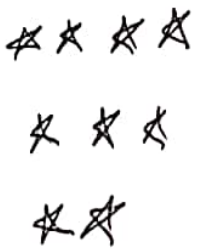


Dam





Level Crossing.

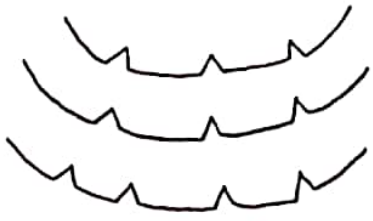


Pine tree

Church

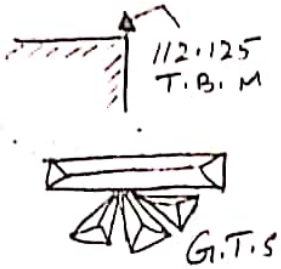
North

Refuse Heap



Rocks.

Sand pit



Bench Marks

Plans and Maps:

Plans and maps are graphical representations.

Plan:

It is a graphical representation to some scale of the features on near or below the surface of the earth as projected or a horizontal plane.

Map:

If the graphical projection on a horizontal plane is small, the plan is called a map.

Map	Plan
1) We can study a part or whole of the earth with the help of a map.	1) Plan is a detailed of drawing of small areas.
2) It contains lot of information.	2) The details are given in the form of symbols.
3) It shows very important features of the area only.	3) Plan shows length and breadth

22/07/19

Scale :

It is the basic requirement for preparation of lands or maps.

→ The proportion or ratio between dimensions adopted for the drawing and corresponding dimensions of object.

→ A scale may be represented numerically by engineer's scale or representative fraction (R.F)

→ Engineer's scale is represented by 1cm = 40cm.

→ For a scale of 1cm = 1km, the R.F is

$$1\,cm = 1\,km$$

$$1\,cm = 1,00,000\,cm$$

$$R.F = \frac{1}{1,00,000} \Rightarrow 1 : 1,00,000$$

→ One should be familiar with the units of measurement in order to calculate R.F.

Units of measurement :

1 cm = 10 mm

1m = 100 cm

1Km = 1000 m

1' = 0.3048m

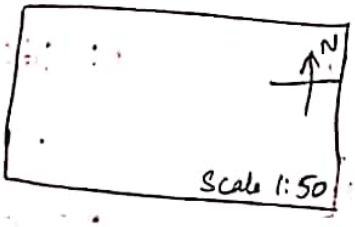
1 hectare = 10000 m^2

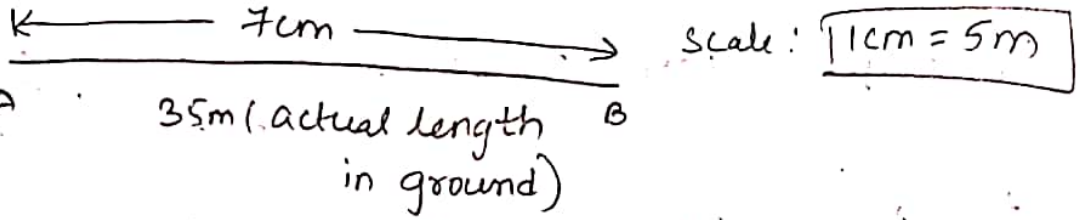
→ The representative fractions and scales recommended for various types of maps are as follows.

Type of map	Scale	R.F
Geographical map	1 cm = 160 km	1 : 1,60,00000
Topographical map	1 cm = 2.5 km	$\frac{1}{2,50,000}$
Location map	1 cm = 5m to 25m	$\frac{1}{500}$ to $\frac{1}{2500}$
Forest map	1 cm = 0.25 km	$\frac{1}{25,000}$
Cadastral map	1 cm = 10m to 50m	$\frac{1}{1000}$ to $\frac{1}{5000}$
Town planning	1 cm = 50 to 100 m	$\frac{1}{5000}$ to $\frac{1}{10000}$
Buildings	1 cm = 10 m	$\frac{1}{1000}$
Mines	1 cm = 10m to 25m	$\frac{1}{1000}$ to $\frac{1}{2500}$
Preliminary survey of ~~plans~~ rails & roads	1 cm = 10 to 60 m	$\frac{1}{1000}$ to $\frac{1}{6000}$

Shrinkage of scale:

We usually represent the scale of a map at the bottom of the drawing sheet as shown below. which is known as graphical scale.





→ when a map shrinks or expands, the scale line also shrinks or expands with it and thus the measurements made from the map are not affected.

Shrinkage ratio (S.R) (or) Shrinkage factor (S.F) :-

The ratio of the shrunk length to the actual length is known as shrinkage ratio or shrinkage factor.

(1) $S.R / S.F = \frac{\text{shrunk length}}{\text{actual length or original length}}$

$= \frac{\text{Shrunk scale}}{\text{original scale}} = \frac{\text{Shrunk RF}}{\text{original RF}}$.

(2) correct distance = $\frac{\text{Measured distance}}{S.F}$

(3) correct area = $\frac{\text{Measured area}}{(SF)^2}$

problem:

The area of the plan of an old survey plotted to a scale of 1cm = 10m which measures now by a planimeter as measured area as 100.20 sq. cm. the plan is found to have shrunk so that a line originally 10cm long now measures 9.7cm only. Find (a) shrunk scale (b) True area of the survey in m^2.

Sol:- original length = 10cm

shrunk length = 9.7cm

$$\text{shrinkage ratio} = \frac{\text{shrunk length}}{\text{original length}}$$

$$S.R = \frac{9.7}{10} = 0.97$$

Shrunk scale = S.R × original scale

$$= 0.97 \times \frac{1}{1000}$$

$$= 0.00097 = \frac{1}{1030.93}$$

Measured area = 100.2 cm^2

$$\text{True area} = \frac{\text{Measured area}}{(SF)^2}$$

$$= \frac{100.20}{(0.97)^2} = 106.49\ cm^2$$

$$= 106.49 \times 10^{-4}\ m^2$$

23/7/19

Wrong scale:

If a wrong measuring scale is used to measure the length of a line already drawn on a plan or a map, the measured length will be erroneous.

$$\text{Correct length} = \frac{\text{RF of wrong scale}}{\text{RF of correct scale}} \times \text{Measured length}$$

In the same way,

$$\text{correct area} = \frac{\text{RF of wrong scale}}{\text{RF of correct scale}} \times \text{Measured area}$$

Problem:

A surveyor measured the distance between 2 points on the plan drawn to a scale of 1 cm = 40m. The result was 468m. Later we discovered that he has used a scale of 1cm = 20m. Find the true distance between the points.

Sol:-

~~R.F original scale~~

Measured length = 468 m.

When 1 cm = 20 m

$$\text{RF of wrong scale} = \frac{1}{20 \times 100} = \frac{1}{2000}$$

$$\text{R.F of correct scale} = \frac{1}{4000}$$

$$\therefore \text{correct length} = \frac{\text{RF of wrong scale}}{\text{RF of correct scale}} \times \text{Measured length}$$

$$= \frac{\frac{1}{2000}}{\frac{1}{24000}} \times 468$$

$$= 2 \times 468$$

$$= 936\ m$$

Q) The plan of an area has shrunk such that a line originally 10cm long now measures 9.5cm. If original scale of the plan was 1cm = 50m. Determine a) Shrinkage factor b) Shrunk scale c) correct distance corresponding to a measured dist of 980m d) correct area corresponding to a measured area of 10,000 m^2.

Sol:- Original length = 10cm,

Shrunk length = 9.5cm

$$\text{Shrunk factor} = \frac{\text{shrunk length}}{\text{original length}}$$

$$S.F = \frac{9.5}{10} = 0.95$$

original scale = 1cm = 50m.

$$\text{original scale RF} = \frac{1}{5000}$$

$$\text{Shrunk scale} = S.F \times \text{original scale}$$

$$= 0.95 \times \frac{1}{5000}$$

$$= 1.9 \times 10^{-4} = 0.00019$$

$$= \frac{1}{5263.15}$$

Measured distance = 980m

correct distance = $\frac{\text{Measured dist}}{SF}$

$= \frac{980}{0.95} = 1031.57\,m$

Measured area = $10000\,m^2$.

correct area = $\frac{\text{Measured area}}{(SF)^2}$

$= \frac{10,000}{(0.95)^2} = 11080.33\,m^2$

Phases of surveying:

The work of a surveyor is divided into 3 parts:

1) Field work.
2) Office work
3) Care & adjustment of instruments.

Field work:

It consists of measurement of angles and distances and keeping a record in the form of field notes.

→ In field notes we have to enter numerical values, sketches and explanatory notes.

Office work:

It consist of a) drafting.
b) Computing
c) Designing.

Care and adjustment of instruments:

The equipment used in field i.e dumpy level, theoddite, compass etc are very delicate instruments so they must be handled with a great care.

Surveying Accesories:

1) Chain Surveying:

Ranging rods, cross staff, chain, Arrows,

2) Compass Surveying:

prismatic compass, Surveyor's compass, Arrows, Ranging rods, tripod.

3) Theodolite Surveying:

Theodolite, tripod, arrows, Ranging rods etc., plumb bob

4) Traverse Surveying:

Chain
compass
arrows
Ranging rods, plumb bob.

5) Levelling:

Level, & levelling staff, Tripod, Ranging rods, plumb bob

6) Contouring:

Level, leving staff, Tripod, Ranging rods etc.

Scanned with CamScanner

7) plane table surveying:

Plane table, tripod, Drawing sheets, Alidale, U-fork & plumbing folk, Trough compass, Spirit level, stationary items.

Code of Signals for Ranging:

Sl. No	Signal by the surveyor	Action by Assit
1.	Rapid sweep with right hand	Move considerably to right.
2.	Slow sweep with right hand	Move slowly to the right.
3.	Right arm extended	Continue to move to the right.
4.	Right arm up and moved to the right	plumb the rod to the right.
5.	Rapid sweep with left hand	move considerably to left.
6.	Slow sweep with left hand	Move slowly to the left.
7.	Left arm extended	continue to move to the left.
8.	Left arm up and moved to the left.	plumb the rod to the left.
9.	Both hands above head and then brought down	correct
10.	Both arms extended forward horizontally and the hands depressed briskly.	Fix the rod.

Measurement of Distances & Directions.

Linear Distances:

Different methods:

1) Direct measurements
2) Measurement by optical means.
3) Electromagnetic methods.

1) Direct Measurements:

The various methods for direct measurements are as follows.

a) Pacing.
b) Measurement with passometer
c) Measurment with pedometer
d) Measurement with odometer and speedometer.
e) Chaining

a) Pacing: It is a rough one and it can be done as quickly as possible. This method is used to check roughly the distance measured by other methods. The length of pace varies with individual and nature of ground also.

b) Measurement with passometer:

It is like a watch and is carried in Pocket or attatched to one leg. It automatically registers the no. of paces then the no. of paces is to be multiplied by average length of the pace.

c) Measurement with pedometer:

It is smilar to passometer except adjusted to the length of the pace of the person who carring it. It registers the total distance covered by any no of paces.

d) Odometer and Speedometer:

Odometer is an instrument to count the no. of revolutions of a wheel. The well known speedometer works on this principle.

e) Chaining:

It is done with the help of chain or a tape. It is the most accurate method for direct measurement.

25/7/19

CHAINING:

It is the method of measuring the distance with a chain or a tape. Chaining is done for ordinary precision where as steel tape is used for works where great accuracy is required.

Instruments used for chain survey:

Instruments used for measuring distance.

1) Chain
2) Tape

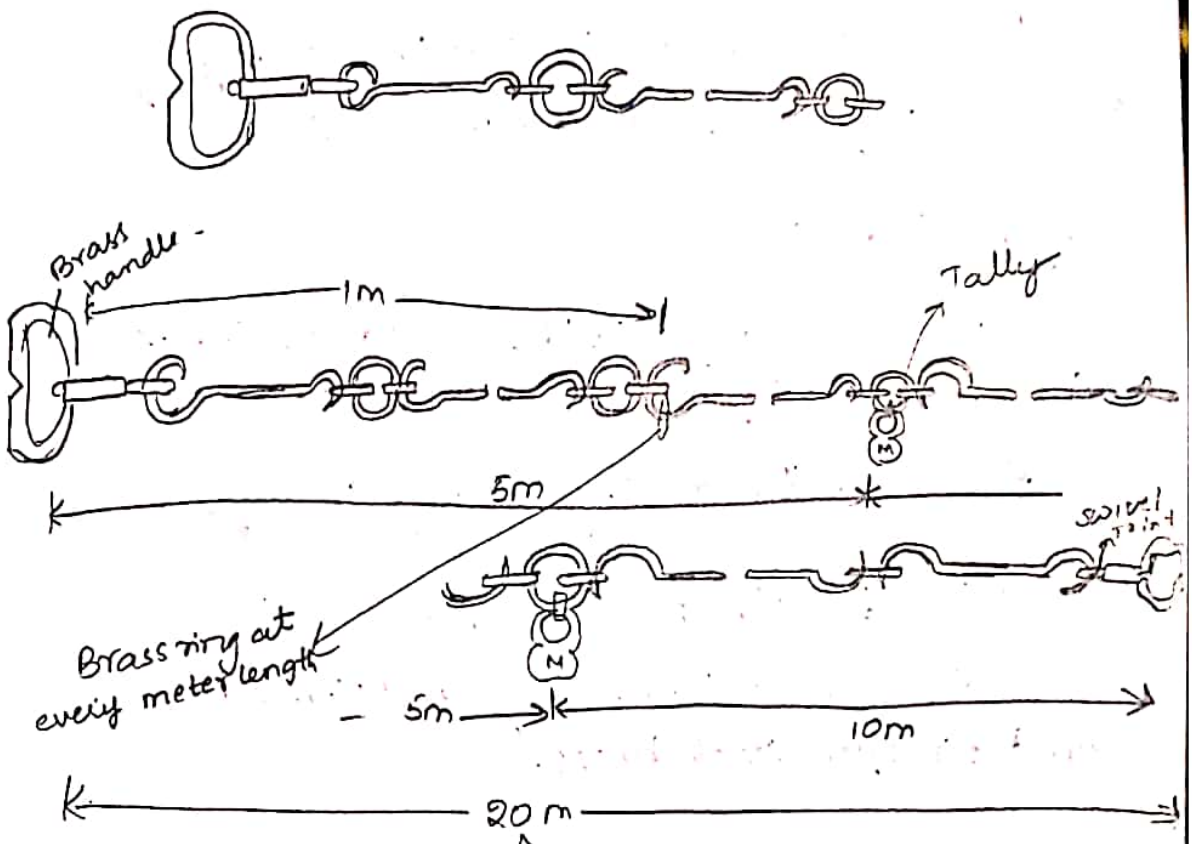
Instrument used for marking survey stations:

1) Ranging rods.
2) Cross-staff → To take offsets, Right angles.
3) Pegs
4) Arrows

Other instruments:

1) Plumb bob

Chain:



each link = 0.20m / 20cm.

It is made up of 4mm dia Galvanized Iron.

Advantages of chain:

1) It is suitable for rough usage in the field.
2) It can be easily readable.

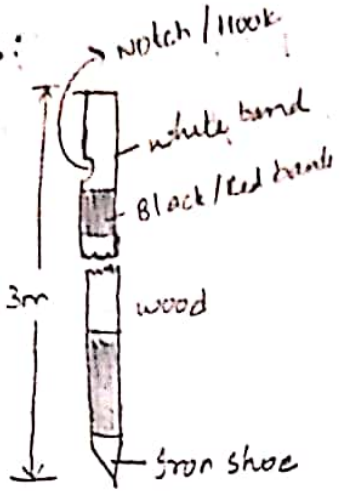
Types of chains:

1) Gunter's chain or Surveyor's chain

66' long
100 links will be there.
each link 0.66'

- It is convinenient to measure the distance in miles and furlongs

Offset rods:



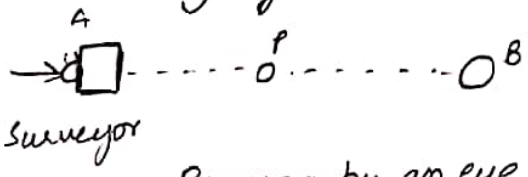
Plumb bob:

~~Plumb bob~~:

Ranging out survey lines:

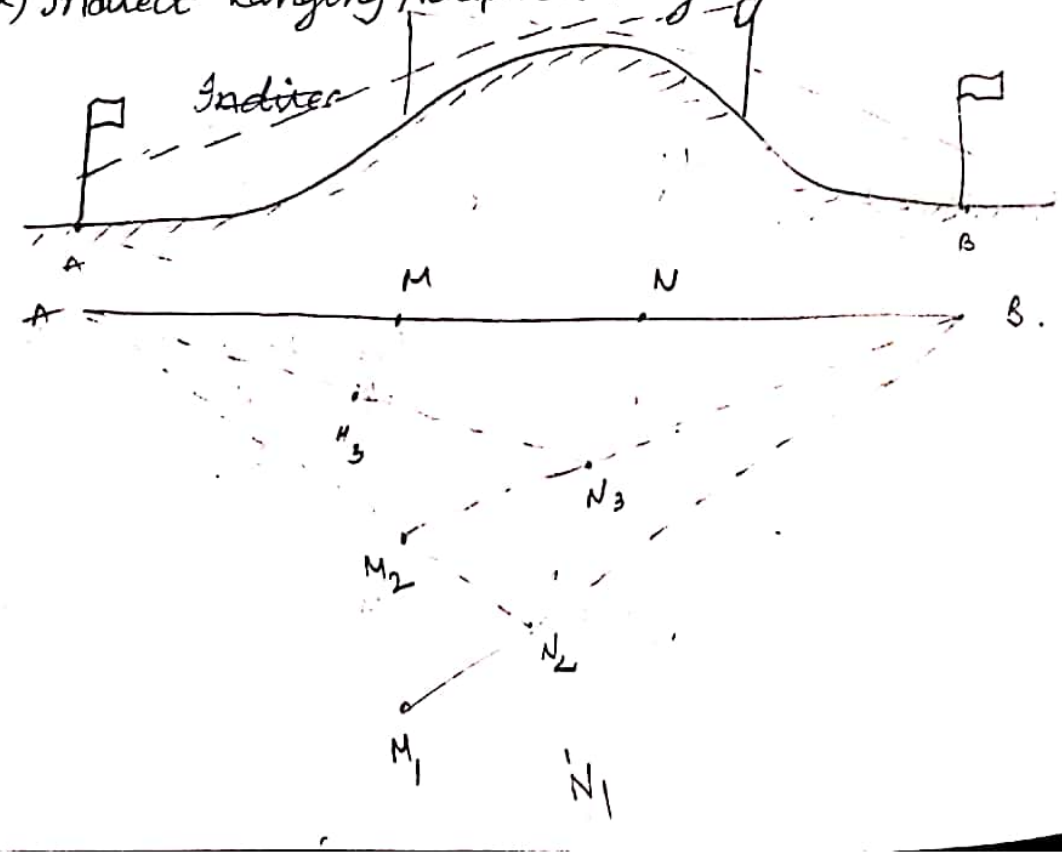
1) Direct Ranging
2) Indirect Ranging

1) Direct Ranging:



Ranging by an eye

2) Indirect Ranging / Reciprocal ranging:



Indirect or reciprocal ranging is used when both the ends of survey line are not intervisible either due to high level of ground or long distance between them in such case ranging is done indirectly by selecting 2 intermediate points M_1, N_1 very near to the chain length, in such a way that from M_1, both N_1 and B are to be visible and from N_1, both M_1, A are to be visible.

→ 2 surveyors are to be stationed at M_1 and N_1 with ranging rods. The person at M_1 directs N_1 to come in line M_1B to a new position N_2.

→ The person at N_2 directs M_1 to move to a new position M_2 in line with N_2A. Thus the two persons are now at M_2 and N_2. The process is repeated till the points M and N are located in such a way that the person at M, finds the person at N in line with MB. And the person at N finds the person at M in line with NA. After establishing of M and N, other points also can be fixed by direct ranging.

30/7/19

Error due to incorrect chain:

(i) Correction to measured length:

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

where l = actual or true length of the line.

l' = Measured length of the line.

L' = Incorrect (or actual) length of the chain or tape used.

L = actual (true or designated) length of the tape or chain.

(ii) Correction to area :

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

where A = actual (or) true area of the ground.

A' = measured area or computed area of the ground.

L' = Incorrect (or) actual length of chain or tape

L = True or designated length of chain or tape

(iii) Correction to Volume:

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

V = actual or true ~~area~~ volume of the ground

V' = measured ~~area~~ volume or computed volume of

L' & L has the same meaning as above.

Problem :-

1) The length of a line measured with a 20m chain was found to be 250m. Calculate true length of the line if the chain was 10cm too long.

Sol:- True length of chain = 20m = L

l' = measured length = 250m

$$L' = 20\,m + \frac{10}{100}\,m$$

$$= 20.1\,m$$

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

Scanned with CamScanner

$$l = 250\left(\frac{20.1}{20}\right)$$

$$= 251.25\ m$$

2) The length of a survey line was measured with 20m chain and it was found to be equal to 1200m. As a check the length was again measured with 25m chain and found to be 1212 m. On comparing the 20m chain with the test gauge it was found to be 1 decimeter too long then find the actual length of 25m length chain used.

Sol:- Note:- 1 decimeter = 10cm

with 20m chain

$L = 20m$

$l' = 1200m$

$L' = 20 + 0.1 = 20.1\ m$

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

$$l = 1200\left(\frac{20.1}{20}\right)$$

$$l = 1206\ m.$$

with 25m chain,

$l' = 1212\ m.$

$l = 1206\ m$

$L' = 25 + (x).$

$L = 25m$

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

$$L' = \frac{1206 \times 25}{1212} = 24.88$$

Scanned with CamScanner

$$L' = 25 + x$$

$$24.88 = 25 + x$$

$$24.88 - 25 = x$$

$$x = -0.12$$

i.e 0.12m reduced too short.

Thus the 25m chain was 12cm too short.

3) A 20m chain was found to be 10cm too long after chaining a distance of 1500m. It was found to be 18cm too long at the end of day's work, after chaining a total distance of 2900 m. Find the true distance if the chain was correct before the commencement of the work.

Sol:- For 1st 1500 m :-

$$\text{average error } e = \frac{0+10}{2} = 5\text{cm}$$

$$L' = 20 + \frac{5}{100} = 20.05\text{m}$$

$$L = 20\text{m}.$$

$$l' = 1500\text{m}$$

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

$$= 1500\left(\frac{20.05}{20}\right)$$

$$l_1 = 1503.75\text{m}.$$

For next 1400 m :-

$L' = ?$

Avg error $= \frac{10+18}{2} = 14$ cm.

$L' = 20 + 0.14$

$L' = 20.14$ m.

$L = 20$ m

$l_2 = l'\left(\frac{L'}{L}\right)$

$l_2 \Rightarrow 1400\left(\frac{20.14}{20}\right)$

$= 1409.8$ m

$l = l_1 + l_2$

$= 1503.75 + 1409.80$

$= 2913.55$ m.

4) A surveyor measured the distance between 2 points on the plan drawn to a scale of 1 cm = 40 m and the result was 468 m. Later however he discovered that he used a scale of 1 cm = 20 m. Find the true distance between the two points.

Sol:-

Scale: 1 cm = 40 m

1 cm = 4000 cm

Distance between 2 points measured with a scale of 1 cm = 20 m is

9 - 468 m

$\frac{468}{20} = 23.4$ cm

Actual scale of plan is 1 cm = 40 m

Scanned with CamScanner

True dist b/w $\frac{23.4 \times 40}{1}$

$= 936\,m$.

5) A 20m chain used for a survey was found to be 20.1 m at the begining and 20.3 m at the end of the days work. The area of the plan drawn to a scale of 1cm = 8m was measured with the help of Planimeter and was found to be 32.56 sq.cm. Find the true area of the field.

Sol:- $L = 20\,m$

$L' = \frac{20.10 + 20.30}{2} = 20.2\,m$

1cm = 8m

Area of plan $= 32.56\,cm^2$.

Area of the ground $= 32.56 \times 8)^2 = 2083.84\,m^2$.

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

$A = 2083.84\left(\frac{20.2}{20}\right)^2$

$A = 2125.725\,m^2$

) The area of the plan of an old survey plotted to a scale of 1cm = 10m measures now as $100.2\,cm^2$. The plan is found to have shrunk so that a line originally 10cm long now measures 9.7 cm only. There is a note on the plan that the 20m chain used was 8cm too short. Find the true area on the survey.

Scanned with CamScanner

Sol:- present length of 9.7 cm = 10 cm of original length.

∴ present area 'A' of $100.2\ cm^2 = \left(\frac{10}{9.7}\right)^2 \times 100.2$

$= 106.49\ sq.cm$.

= original area of plan.

scale of the plan ⇒ 1cm = 10m

∴ original area of survey $= (106.49)(10)^2$

$= 10649\ sq.m$.

Faulty length of ~~length~~ chain used = 8 cm too long

$20 - 0.08$

⇒ ~~20.08~~ 19.92 m

Correct area $= 10649\left(\frac{19.92}{20}\right)^2$

$= 10563.98\ m^2$

31/7/19.

Chaining on Uneven (or) sloping ground:

1) Direct Method

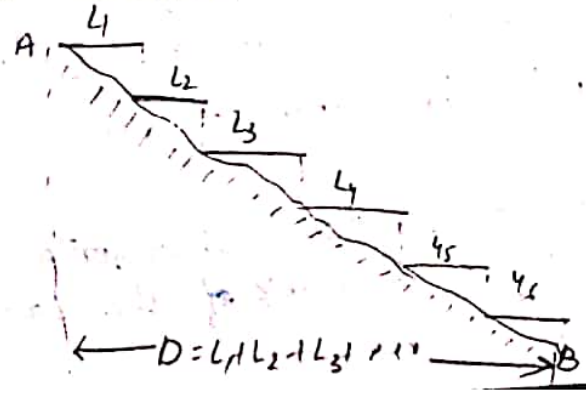
2) Indirect method.

a) Angle measured

b) Difference in level measured.

c) Hypotenusal Allowance.

1) Direct method:



Scanned with CamScanner

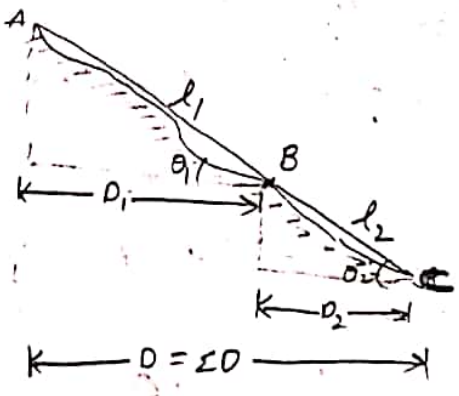
The direct method is also called as method of stepping.

$\therefore D = L_1 + L_2 + L_3 \ldots$

$D = \Sigma L.$

2) Indirect method:

a) Angle measured:

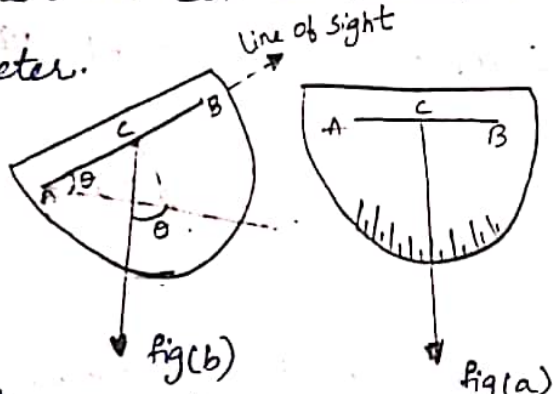


$\cos\theta_1 = \frac{D_1}{l_1}$

$D_1 = l_1 \cos\theta_1$

$D_2 = l_2 \cos\theta_2$

The slopes of the lines can be measured with the help of a clinometer.



A clinometer consists of 1) a line of sight

2) Graduated arc

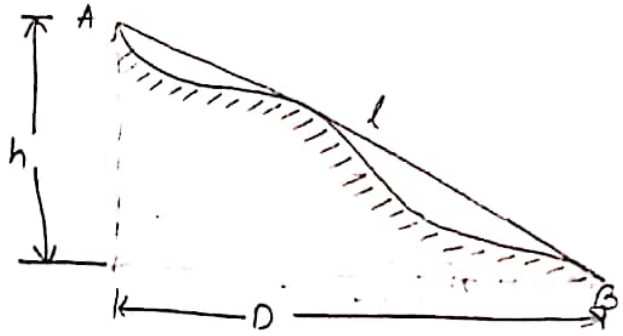
3) A light plumb bob with a long thread suspended at the centre.

→ fig(a) shows a semi-circular graduated arc with 2 pins at A and B forming the line of sight. A plumb bob is suspended from C, the central point.

→ when the clinometer is horizontal, the thread touches the zero mark of the calibrated circle.

→ To sight a point, the clinometer is tilted so that the line of sight AB may pass through the object. Since the thread still remains vertical, the reading against the thread gives the slope of the line of sight.

b) Difference in level measured:



$$l^2 = h^2 + D^2$$

$$l^2 - h^2 = D^2$$

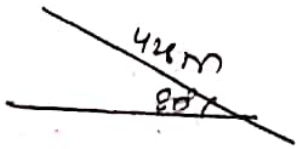
$$D = \sqrt{l^2 - h^2}$$

→ 3,4,5 method is nothing but making right angles using chain and tape using the measurements 3,4&5.

Problem:

The distance between ~~3 4 5 method~~ the points measured along a slope is 428m. Find the horizontal dist b/w them if

a) the angle of slope between the points is 8°



b) The difference in level is 62 m c) The slope is 1 in 4

Sol:- $l = 428\ m$,

a) $\theta = 8°$

$\cos\theta = \frac{D}{l}$ $\quad \cos 8 = \frac{D}{428}$

$D = 428 \cos 8°$

$D = 423.83\ m$

Scanned with CamScanner

b) $h = 62\ m$

$l = 428\ m$.

$D = \sqrt{l^2 - h^2}$

$D = \sqrt{(428)^2 - (62)^2}$

$D = 423.48\ m$

c) Slope is 1 in 4

$\tan\theta = 1/4$

$\theta = \tan^{-1}(1/4) = 14.03^\circ$

$\cos\theta = \frac{D}{l}$

$\cos(14.03) = \frac{D}{428}$

$D = 428 \cos(14.03)$

$D = 415.23\ m$.

Errors in chaining:

Errors and mistakes are classified into 2 types. Cumulative error, compensating error.

1) Cumulative error:

which occurs in the same direction and tends to accumulate.

2) Compensating error:

It may occur in either direction and hence tends to compensate. Errors are regarded as +ve or -ve according to they make the result too great or too small.

→ Errors and mistakes arises from

1) Erroneous length of chain or tape.
2) Bad ranging.
3) Careless holding and marking.
4) Bad straightening
5) Non-horizontality.
6) Sag in chain.
7) Variation in temperature.
8) Variation in pull.
9) personal mistakes.

1) Erroneous length of chain or tape: (cumulative +or -)

If the length of chain is more, the measured distance will be less and hence error will be -ve. Similarly if chain is too short, measured distance will be more and error will be +ve. Proper correction has to be applied.

2) Bad Ranging: (cumulative, +)

For each and every stretch of the chain, the error due to bad ranging will be cumulative and the effect will be too great.

3) Careless handling & Marking (compensating, + or -).

This causes a variable systematic error.

4) Bad Straightening: (Cumulative, +)

If the chain is not straight but is lying in an irregular horizontal curve, the measured distance will always be too great.

Scanned with CamScanner

5) Non - horizontality (cumulative, +)

If the chain is not horizontal especially in the case of sloping or irregular ground, the measured distance will always be more.

6) Sag in chain (cumulative, +)

When the distance is measured by stepping or when the chain is stretched above the ground due to undulations, the chain gets sags.

7) Variation in temperature: (cumulative, +)

When a chain or a tape used at temperature different from that at which it was calibrated, its length changes. Due to raise in temperature, the length of chain increases then the measured distance will be less and the error becomes -ve.

Due to fall in temp, the length of chain decreases, the measured dist will be more and error becomes -ve. In either cases the error is cumulative.

8) Variation in pull (compensating ±, cumulative ±):

If the pull applied in straightening the ~~to~~ chain or tape is not equal to that of standard pull at which it was calibrated. Therefore its length changes.

9) personal mistakes:

1) Displacement of arrows:
2) Miscounting the chain line.
3) Misreading
4) Erroneous booking

1/8/19.

Optical Methods:

In optical methods observations are taken through telescope and calculations are done for the distances such as in tacheometry or triangulation

EDM Methods: (Electro Magnetic Distance Measurements)

In this method, distances are measured with instruments that rely on propagation reflection and subsequent reception of either radiowaves, light waves or Infrared waves.

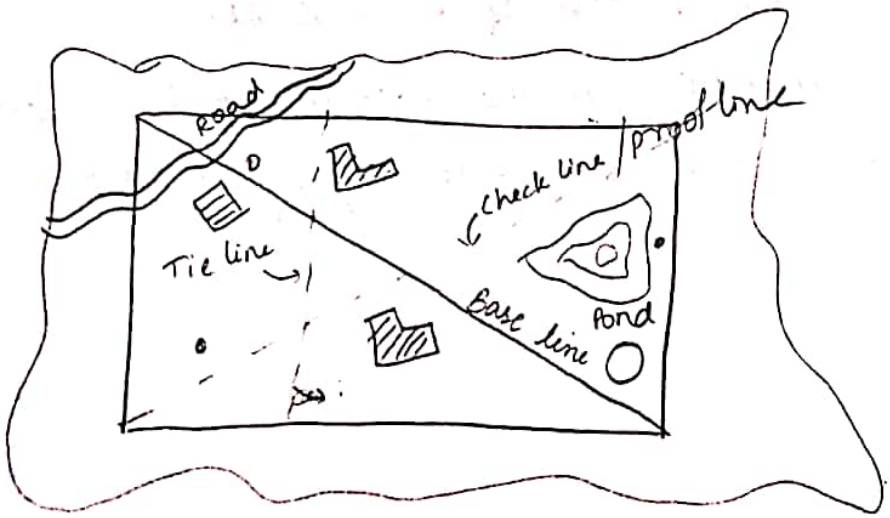
Well Conditioned Triangle:

A well conditioned Δle is a triangle in which no angle is less than 30° or greater than 120°. An equilateral Δle is the best condition or ideal Δle.

Ill conditioned triangle:

Ill conditioned Δles are those Δles in which atleast one angle is less than 30° or greater than 120°.

Base line, check line and Tie line:



Scanned with CamScanner

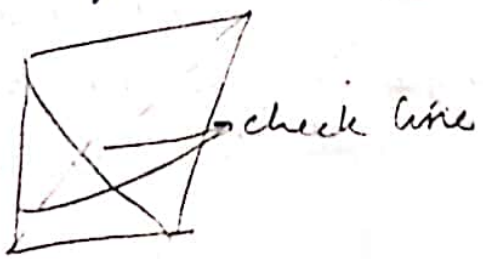
Base line:

The lines joining main survey stations are called main survey lines. The biggest of the main survey lines is called base line and various survey stations are plotted with reference to base line.

Check line:

These are proof lines, are the lines which are run in the field to check accuracy of the work.

A check line may be laid by joining apex of the ole to any point on the opposite side or by joining 2 points on any 2 sides of a ole.



Tie line:

It is a line which joins subsidiary stations or tie stations on the main line. The object of tie line is to take the details of near by objects but it also serves a purpose of a check line.

The accuracy in the location of the objects depend upon the accuracy in laying the tie line.

Scanned with CamScanner

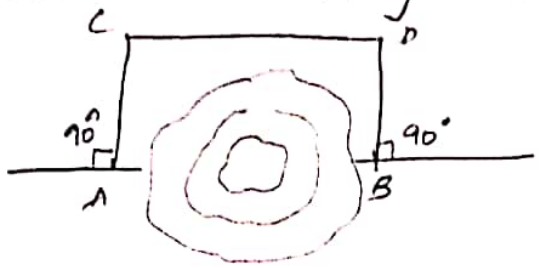
Obstacle in chaining :-

a) obstacle to ranging but not chaining

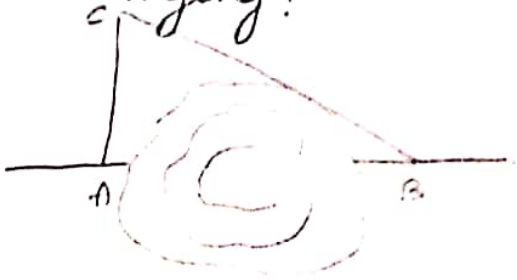
*b) obstacle to chaining but not ranging

c) obstacle to both chaining & ranging.

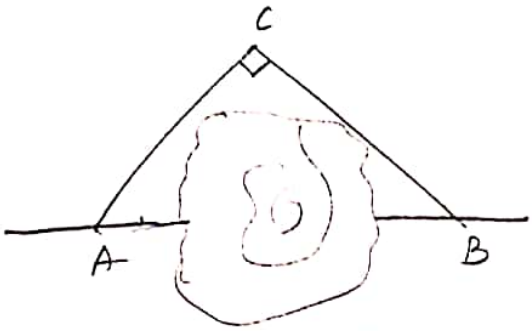
obstacle to chaining but not ranging:



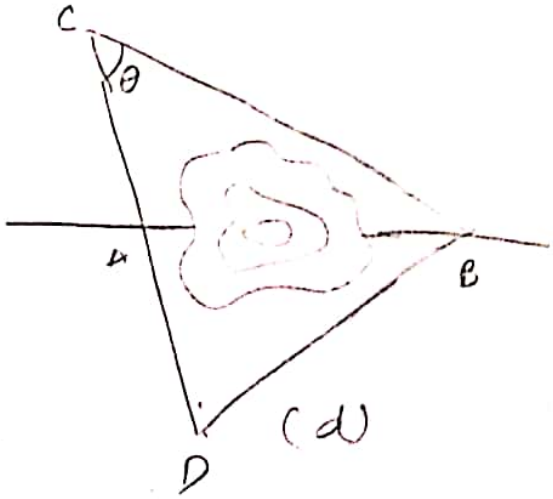
(a) CD = AB



(b) $AB = \sqrt{BC^2 - AC^2}$



(c) $AB = \sqrt{AC^2 + BC^2}$



(d)

For method (d)

Select 2 points C and D on both sides to A and these points should be in the same line. Measure AC ~~and~~, BD, BC also AD let ∠BCD = θ

From ΔBCD,

$$BD^2 = BC^2 + CD^2 - 2BC\,CD\cos\theta$$

$$\cos\theta = \frac{BD^2 - BC^2 - CD^2}{2BC \cdot CD}$$

$$\cos\theta = \frac{BC^2 + CD^2 - BD^2}{2BC \cdot CD}$$

Scanned with CamScanner

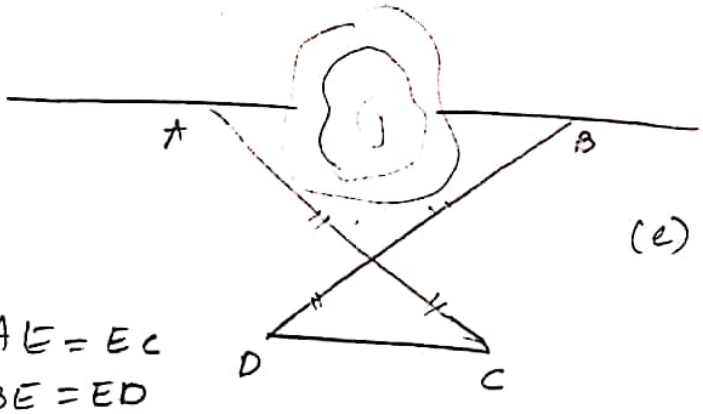
Similarly, ΔBCA, $AB^2 = BC^2 + AC^2 - 2BC\,AC\cos\theta$.

$$\cos\theta = \frac{BC^2 + AC^2 - AB^2}{2BC \cdot AC}$$ (acc to cosine rule)

~~$BC^2 + CD^2 - BD^2 = \cos\theta = BC^2$~~

~~$2BC\,CD$~~

$$AB = \sqrt{BC^2 + AC^2 - 2BC\,AC\cos\theta}.$$

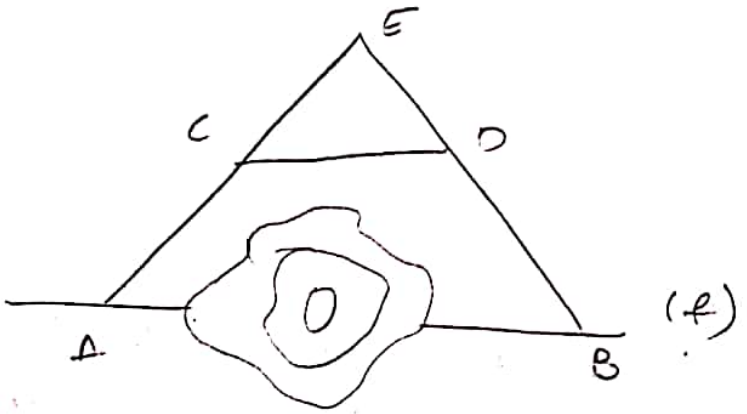


(c)

$AE = EC$

$BE = ED$

$AB = CD$.



(f)

Select any point E and measure AE and BE

Mark 'C' and 'D' on AE and BE such that $CE = \frac{AE}{n}$

$$DE = \frac{BE}{n},$$

Measure CD. Then $\boxed{AB = n \cdot CD}$

Scanned with CamScanner

Tape corrections:

1) corrections for Absolute length

$$C_a = \frac{L \cdot C}{l}$$

2) corrections for Temperature

$$C_t = \alpha (T_m - T_0) L$$

3) correction for pull (or) tension

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

4) correction for shape (or) Vertical alignment

$$C = \frac{h^2}{2L} \quad \text{(subtractive)}$$

5) Correction for horizontal alignment

(i) Bad ranging / Mis alignment

$$C_h = \frac{d^2}{2L}$$

6) Reduction to MSL

$$\text{correction } (C_{msL}) = L - D = \frac{Lh}{R} \text{ (subtractive)}$$

7) correction to measurement in vertical plane

when $M = 0$

$$S = \frac{mgl^2}{2AE}$$

Scanned with CamScanner

2/8/19

Compass Surveying:

Prismatic compass:

In some cases it becomes essential to use some type of instruments which gives angles & directions of the survey lines to be observed.

In engineering practice

a) surveyor's compass
b) prismatic compass

are used for direct measurement of directions.

Traversing:

It is the type of survey in which the no. of connected survey lines form the frame work and directions and lengths of survey line are measured with an angle measuring instrument and a tape or chain respt.

Closed traverse:

When the lines a circuit which ends at the starting point, it is called as closed traverse.

Open traverse:

If the circuit ends elsewhere it is called as open traverse.

Bearing:

Bearing of a line is its direction relative to a given meridian.

→ A meridian is any direction such as true meridian, magnetic meridian, Arbitrary meridian.

Scanned with CamScanner

True Meridian :

True meridian through a point is the line in which a plane passing that point and north-south poles, intersects with the surface of the earth. Thus it passes through true north and true south.

True Bearing :

The bearing of a line is the horizontal angle which it makes with true meridian.

Magnetic Meridian:

Magnetic meridian through a point is the direction shown by a freely floating and balanced magnetic needle free from all other attractive forces. The direction of magnetic meridian can be established with the help of magnetic compass.

Magnetic bearing :

It is the horizontal angle which it makes off the line with magnetic meridian.

Arbitrary Meridian:

It is any convinient direction towards as Permanent and prominent mark or signal such as a church spire or top of a chimney. Such meridians are used to determine the relative positions of lines in a small area.

Arbitrary bearing :

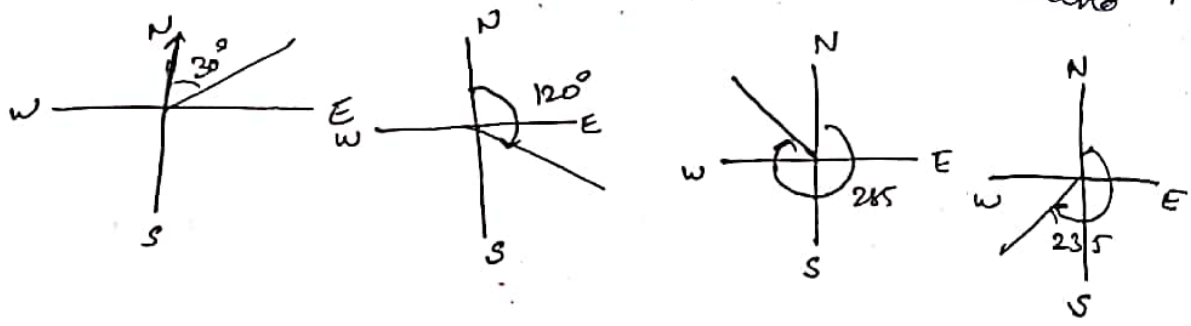
It is the horizontal angle of line which it makes with any arbitrary meridian passing through one of the extremities. A theodolite or sextant used to measure the horizontal angle.

Scanned with CamScanner

Designation of bearing:

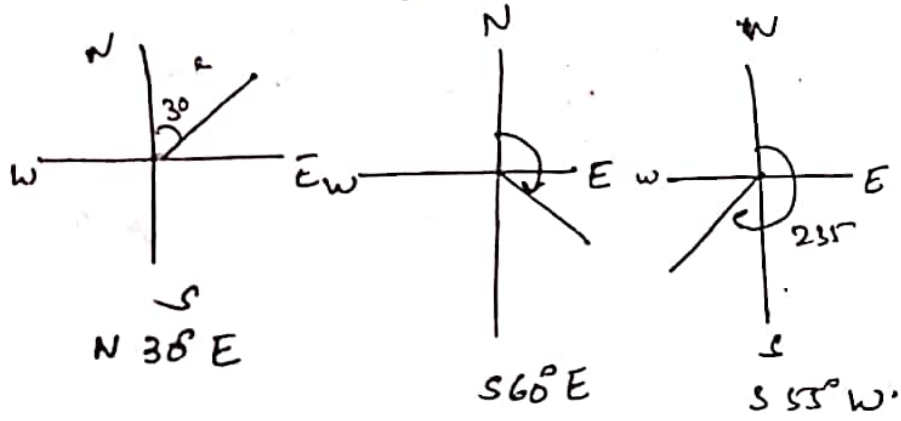
There are two types:

1) W.C.B → whole circle Bearings / Azimuth System.



2) R.B/Q.B

Reduced Bearing & Quadrantal Bearing.



1Q) Convert the following W.C.B to Q.B.

a) 82° 30' b) 170° 12' c) 211° 54' d) 327° 24'

1Q) convert following Q.B to WBC.

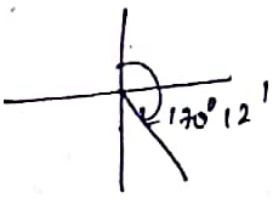
a) N 12° 24' E b) S 31° 36' E c) S 68° 6' W d) N 5° 42' W

1 Ans) a) WCB to QB

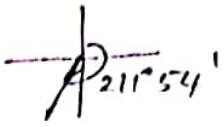
22° 30' — N 22° 30' E

b) 170° 12' = QB = 180 − WCB

= 89° 48' E



b c) $211^\circ 54'$



~~QB =~~ $211^\circ 54'$

$180^\circ + \alpha = 211^\circ 54'$

$QB = 211^\circ 54' - 180^\circ$

$QB = S\ 31^\circ 54' W$

d) $327^\circ 24'$

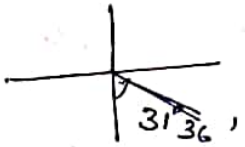
$QB = 360^\circ - 327^\circ 24'$

$QB = N\ 32^\circ 36' W$

2 Ans:- a) $N\ 12^\circ 24' E$

$\Rightarrow$ ~~12°~~ $WCB = 12^\circ 24'$

b) $S\ 31^\circ 36' E$



$WCB = 180^\circ - QB$

$= 180^\circ - 31^\circ 36'$

$WCB = 148^\circ 24'$

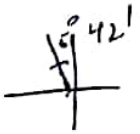
c) $S\ 68^\circ 6' W$

$WCB = 180 + QB$

$= 180^\circ + 68^\circ 6'$

$WCB = 248^\circ 6'$

d) $N\ 5^\circ 42' W$



$W.C.B = 360 - QB$

$= 360^\circ - 5^\circ 42'$

WCB ~~QB~~ $= 354^\circ 18'$

Scanned with CamScanner

5/7/19

1) WCB / Azimuthal system:

In this system the bearing of a line is measured with magnetic north or (with south) in clock wise direction.

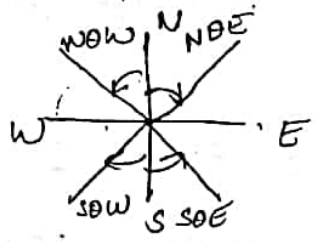
→ The value of the bearing varies from 0 to 360°.

→ Prismatic compass is graduated with this system.

→ ~~In~~ In India & UK, WCB is measured clockwise with magnetic north.

2) QB Quadrantal bearing system (Reduced Bearing):

In this system bearing of a line is measured east ward or west ward from north or south which ever is nearer.



Thus both north and south are used as reference meridians and directions can be either clockwise or anti-clockwise depending upon the position of the line.

→ These bearings are observed by surveyor's compass. In this system, therefore the quadrant in which the line lies, has to be mentioned.

→ The QB of a line varies from 0 to 90°

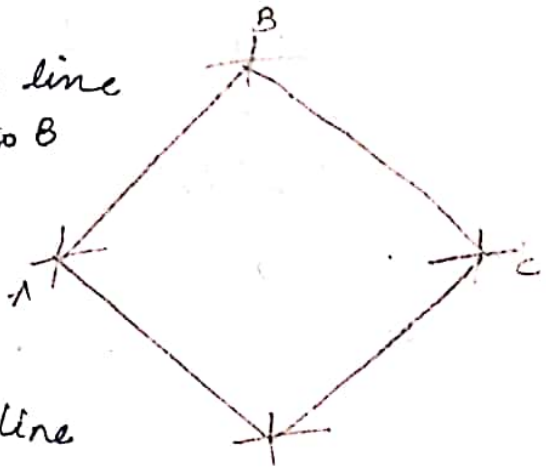
→ The bearings of this system are known as reduced bearings (RB).

Scanned with CamScanner

Fore/ bearing and Back bearing :
Forward (FB) (BB)

~~Fore/ Forward bearing :-~~

If the bearing of a line AB is measured from A to B it is known as forward bearing or fore bearing (FB).



If the bearing of the line AB is measured from B towards A, it is known as backward bearing (or) back bearing (BB), because it is measured in backward direction.

$$BB = FB \pm 180^\circ$$

→ use '+' sign, $BB = FB + 180^\circ$ when FB is less than 180°.

→ use '−' sign when $BB = FB - 180^\circ$ when FB is more than 180°.

Problem :

The following are fore bearings of lines. Find out their back bearings.

(i) AB $12^\circ 24'$

$BB = FB + 180^\circ$

$= 192^\circ 24'$

(ii) BC $119^\circ 48'$

$BB = FB + 180^\circ$

$= 119^\circ 48' + 180^\circ$

$= 299^\circ 48'$

(iii) CD $266^\circ 30'$

$BB = FB - 180^\circ$

$= 266^\circ 30' - 180^\circ$

$= 86^\circ 30'$

(iv) DE $354^\circ 18'$

$BB = FB - 180^\circ$

$= 354^\circ 18' - 180^\circ$

$= 174^\circ 18'$

(iv) PQ N 18°0'E

WCB = 18°

BB = 180 + FB

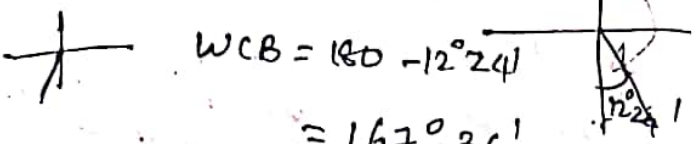
= 180 + 18°

= 198°

RB = 198 − 180

= S 18° W.

vi) QR S 12°24' E



WCB = 180 − 12°24'

= 167°36'

BB = 180 + 167°36'

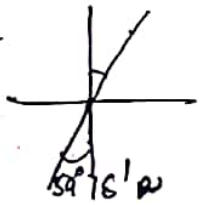
= 347°36'

QB = 12°24'

= N 12°24' W.

vii) RS S 59°18' W

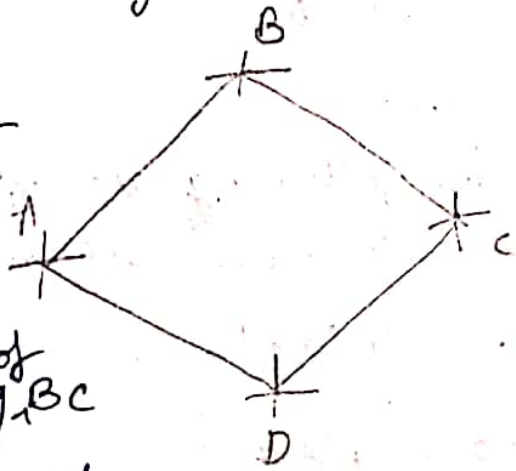
= N 59°18' E



(viii) ST N 86°12' W

S 86°12' E

Calculation of Angles from Bearings:



∠A = Bearing of previous line − Bearing of next line

= Bearing of (AD − AB.)

∠B = Bearing of BA − Bearing of BC

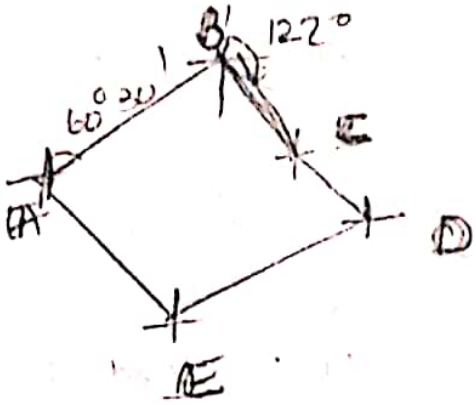
∠C = Bearing of CB − Bearing of CD

∠D = Bearing of DC − Bearing of DA

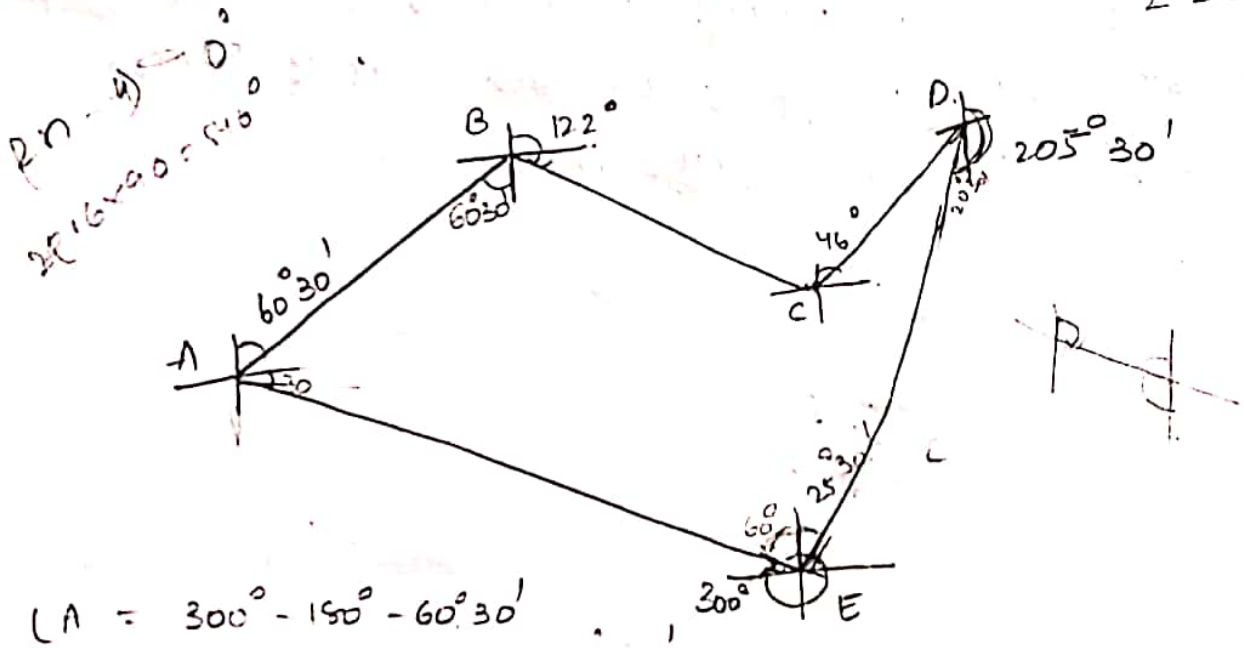
= 360° − (−Bearing of DC + Bearing of DA)

1) The following bearings were observed with a compass. Calculate interior angles.

Line	FB
AB	60° 30'
BC	122°
CD	46°
DE	205° 30'
EA	300°



BB = 180-1
2 2 6



$\angle A = 300° - 180° - 60°30'$

$= 59°30'$

$\angle B = 60°30' + 180° - 122° = 118°30'$

$\angle C = 122° + 180° - 46° = 256°$

$\angle D = 46° + 180° - 205°30' = 20°30'$

$\angle E = 60° + 25°30' = 85°30'$

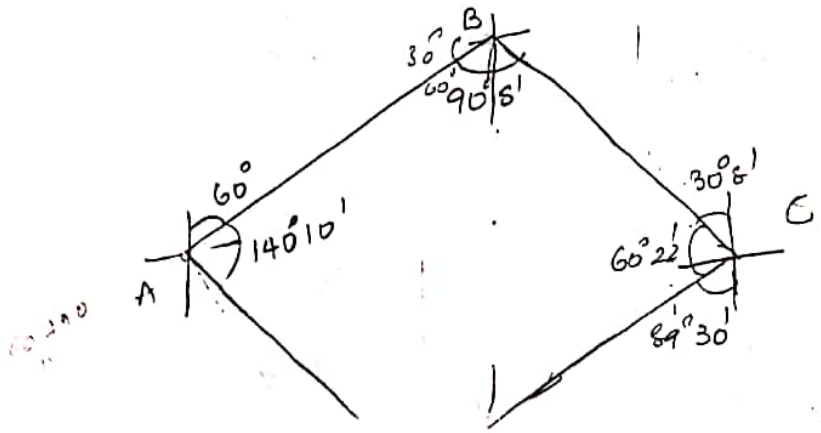
6/8/19.

Calculation of Bearings from Angles:

Add the measured clockwise angles to the bearing of previous line if sum is more than 180° deduct 180°, if sum is less than 180° add 180°.

problem:

The following interior angles were measured with a sextant. in a closed traverse. The bearing of line AB was measured as 60° with prismatic compass. Calculate the bearings of all other lines if ∠A = 140°10', ∠B = 90°8', ∠C = 60°22' ∠D = 69°20'.



Bearing of AB = 60° + 180° = 200°10'

Bearing of AD = (180° + 60°) + 140°10' = ~~200°10' − 180° = 20°10'~~

Bearing of BA = 180° + 60° = 240°

Bearing of BC = ~~90° +~~ (180° − 90°8' = 89°52' − 30° = 59°52')

⇒ 90° + 59°52' = 149°52'

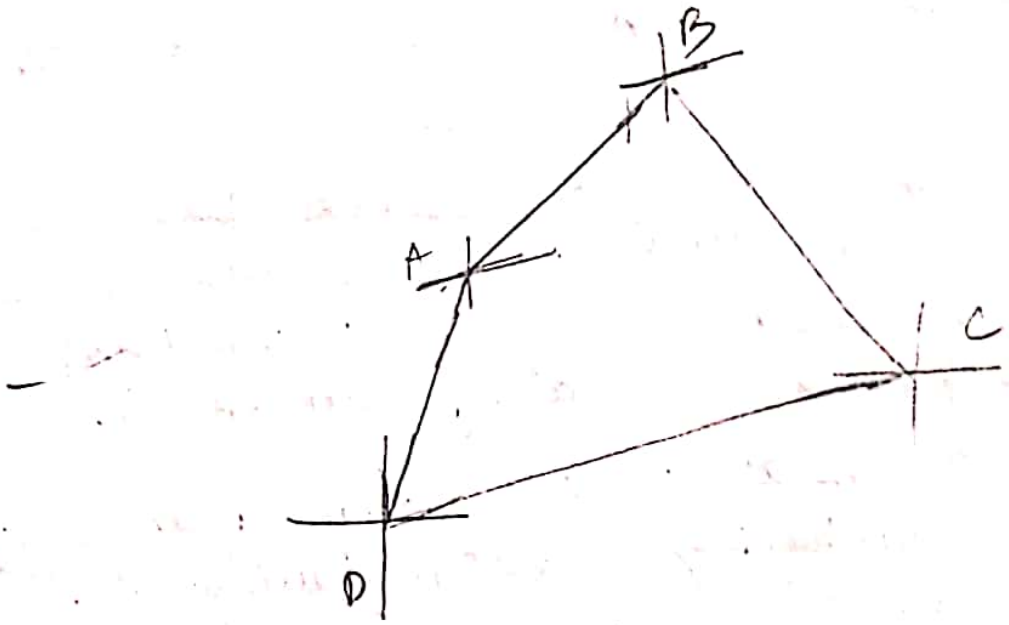
Bearing of CB = (~~90~~. 360° − 30°8' = 329° 52'

Bearing of CD = ~~180~~ 360° − (60°20' + 30°8')

= 269°30'

Bearing of DC = 89°30'

Bearing of DA = 360° − 69°20' = 290°40'



8/8/19

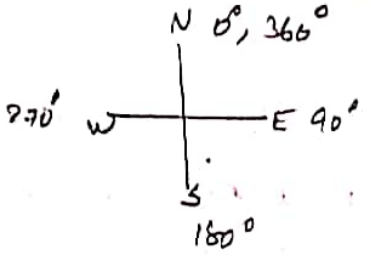
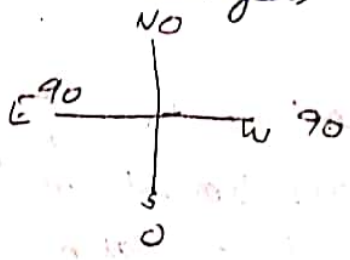
Dip:

The ~~horizont~~ lines of faces of earth magnetic field runs from south to north, near equator they are parallel to earth surface. the horizontal projections of the lines of faces define the magnetic meridian, the angle which these lines of face, makes with the surface of the earth is called angle of dip (δ) dip of the needles.

Scanned with CamScanner

Adjustments of prismatic compass:

1. Centering
2. Levelling
3) Focussing the prism.

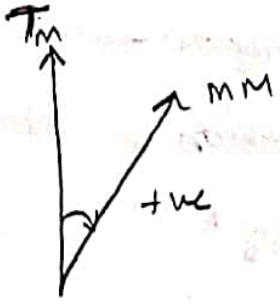
Prismatic compass	Surveyor's compass
1. The needle is broad needle type. It does not act as index.	1. The needle is edge bar type. Needle acts as index.
2. The graduated card ring attatched with needle. Ring does not rotate along with line of sight.	2. Graduated card is attatched to the box and not to the needle. The card rotates along with the line of sight.
3. The graduations are in WCB system. having 0° at south, 90° at west, 180° at north, 270° at east. 	3. Graduations are in QB system having 0° at N&S. and 90° at W&E (E&W are interchanged) 
4. The graduations are engraved inverted	4. The graduations are engraved erect.
5. Object vane consists of metal vane with a vertical head. Eye vane consists of small metal vane with slit.	5. Object vane consists of metal vane with vertical head. Eye vane consists of metal vane with a fine slit.
6. Reading is taken with the help of prism provided at eye slit.	6. Reading is taken by directly seeing through top of the box glass

7. Sighting and reading can be done simultaneously from one position of the observer.	7. Sighting and reading cannot be done simultaneously from one position of the observer.
8. Tripod may or may not be provided. Instrument can be used even by holding suitably in hand.	8. Instrument cannot be used without a tripod.

Magnetic declination:

Magnetic declanation at a place is the horizontal angle between true meridian and magnetic meridian shown by the needle at the time of observation. If the magnetic meridian is to the right side or to the eastern side of true meridian, the declination is said to be eastern or positive.

If it is to the left side or western side of true meridian the declination is said to be western.



* Mariners called declination by the name "Variation"

Determination of True Bearing:

All imp surveys are plotted with reference to the true meridian, since the direction of magnetic meridian at a place changes with the time. Therefore true bearing = Magnetic bearing ± Declination.

Use + sign when declination is towards east and use − sign when declination is towards west.

The above rule is valid for WCB bearings only.

→ If a reduced bearing has been observed it is advisable to draw the diagram and calculate bearing.

Problem:

The magnetic bearing of a line is 48° 24'. Calculate true bearing if magnetic declination is 5° 38' east.

Sol:- Declination. 5° 38' E

Mag bearing 48° 24'.

TB = Mg B + Delandion

TB = 48° 24' + 5° 38'

= & 54° 2'

Local Attraction:

It is a term used to denote any influence ~~such as~~ which prevents the needle from pointing to the magnetic north in a given locality.

Some of the sources of local attraction are.

Magnetite in the ground, wires carrying electric current, steel structures, rails, under-ground level pipes, keys, steel bowed spectacles, metal buttons, axes, chains, steel tapes etc. which may be lying on the ground nearby.

9/8/19

Elimination of local attraction:

There are 2 methods to eliminate local attraction.

Method 1:

In this method, the bearings of the lines are calculated on the basis of bearing of that line which has a difference of 180° in its fore and back bearings.

Method - II

This is a more general method and it is based on the fact that though the bearings measured at a station may be incorrect due to local attraction, the included angle calculated from bearings will be correct since the amount of error is same for all bearings measured at the station.

The included angle between the lines are calculated at all the stations. If the traverse is closed traverse the sum of interior or internal included angles must be equal to $(2n-4)90°$

Problem:-

1) The following bearings were observed while traversing with a compass.

Line	FB	BB	
AB	45°45'	226°10'	BA
BC	96°55'	277°05'	CB
CD	29°45'	209°10'	DC
DE	324°48'	144°48'	ED

Soln

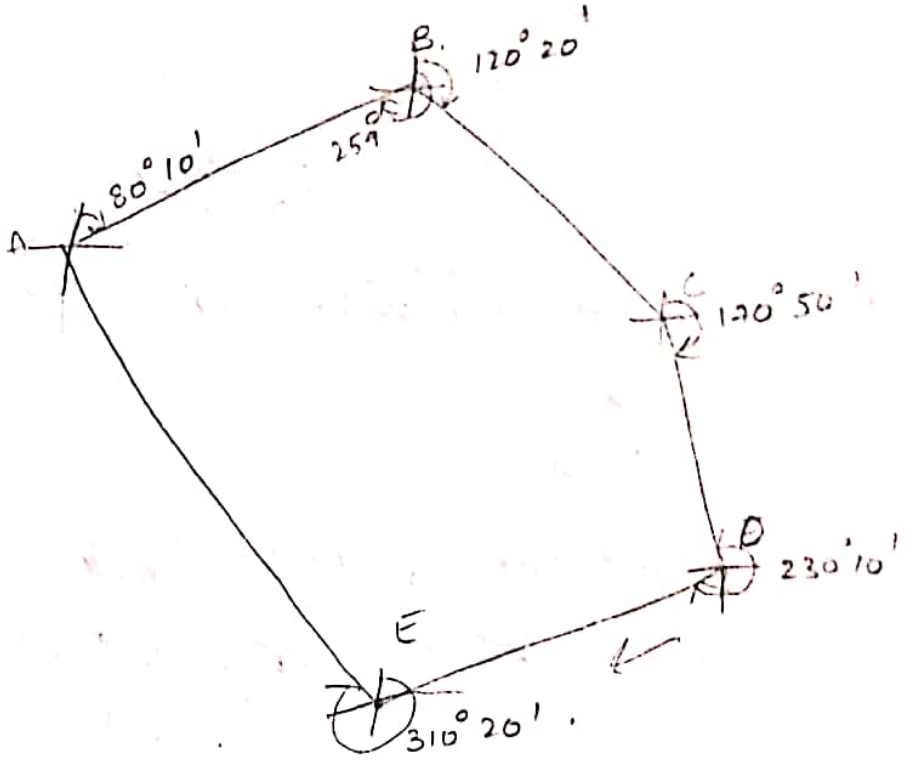
Line	observed Bearing	correction	Corrected Bearing	Remarks
AB	45°45'	0° at A	45°45'	
BA	226°10'	−25' at B	225°45'	B & C Stations are affected by L.A. A, D & E are free from local attract
Bc	96°55'	−25' at B	96°30'	
CB	277°05'	−35' at c	276°30'	
CD	29°45'	−35' at c	29°10'	
DC	209°10'	0° at D	209°10'	
DE	324°48'	0° at D	324°48'	
ED	144°48'	0° at E	144°48'	

Method:

2) The following are bearings taken by on a closed compass traverse

Line	FB	BB	
AB	80°10'	259°	BA
BC	120°20'	301°50'	CB
CD	170°50'	350°50'	DC ✓
DE	230°10'	49°30'	ED
EA	310°20'	130°15'	AE

Compute the interior angles and correct them for observational errors assuming the observed bearing of the line CD to be correct, and adjust the bearings of remaining sides.



$\angle A$ = Bearing of prev line − Bearing of next line.

$= 310°20' - 180°10' =$

$= 130°15' - 80°10' = 50°5'$

$\angle B = 259° - 120°20' = 138°40'$

$\angle C = 301°50' - 170°50' = 131°$

$\angle D = 350°50' - 230°10' = 120°40'$

$\angle E = 49°30' - 310°20' + 360° = 99°10'$

error $= -25'$ correction $= +\frac{25'}{5} = 5'$

Corrected included angles $= \angle A = 50°10'$, $\angle B = 138°45'$

$\angle C = 131°5'$, $\angle D = 120°45'$; $\angle E = 99°15'$

Bearing of DE

LD = Bearing of DC − Bearing of DE

108°45′ = 350°50′ − Bearing of DE

Bearing of DE = 350°50′ − 120°45′

= 230°5′

Bearing of ED = 230°05′ − 180° = 50°05′

LE = Bearing of ED ∴

Bearing of EA :

LE = Bearing of ED − Bearing of EA .

EA = 50°05′ → 99°15′ − 50°05′ + 360°

EA = 49°10′ 310°50′

Bearing of AE = 180° + 49°10′ = 229°10′

310°50′ − 180° = 130°50′

Bearing of AB :

∵ Bearing of AB = Bearing of AE − LA

= 130°50′ − 50°10′

= 80°40′

Bearing of BA = 80°40′ + 180° = 260°40′

Bearing of BC = Bearing of BA − LB

= 260°40' − 138°45'

= 121°55'

Bearing of CB = 121°55' + 180° = 301°55'

Bearing of CD = Bearing of ~~BC~~ CB − LC

= ~~350°50~~ 301°55' − 131°05'

= ~~219°45~~ 170°50'

Bearing of DC = 170°50' + 180° = 350°50'

Errors in compass survey:

The errors classified as

a) Instrumental errors

b) personal errors

c) Errors due to natural causes.

a) Instrumental errors:

1) If Needle is not perfectly straight

2) pivot being bent

3) sluggish needle.

4) Blunt pivot point.

5) Improper balancing weight

6) plane of sight not being veitical.

7) Line of sight not passing through the centres.

Scanned with CamScanner

b) personal error :

1) Inaccurate leveling of the compass box.
2) Inaccurate centering.
3) Inaccurate bisection of objects.
4) Carelessness in reading and recording.

c) Errors due to natural causes :

1) Variation in declination
2) Local attraction due to proximity of local attraction forces.
3) Magnetic changes in the atmosphere due to clouds and storms.
4) Irregular variations due to magnetic storms etc.