Surveying-I

Surveying-I

Unit-I

- Definitions, Principle, Various types of surveying-Based on methods and instruments,
- Classifications, uses, necessity and use of various scales and verniers
- Different types of ranging, tapes, chains, linear measurements, approximate, direct, optical and electronic methods, Chain Surveying, Minor Instruments for setting out right angle.

Surveying –I
Lecture 1

Introduction

Course details

First part of a two-semester-course

3 Hours Lecture & 2 hours Practical/week with 4 Course Credits

Communication:

- Activities involve lectures, practicals, tutorials and a field practice
- Lectures - provide the theoretical background of the topics
- Practicals - practical sessions, in which You'll carry out measurements and process them.
- Tutorials - if there's a need for additional guidance in the preparation for assessments. Please note that You have to arrange an appointment in due time.
- Field Practice.

Surveying

- ***"Surveying is the art of and science of determining the relative positions of various points or stations on the surface of the earth by measuring the horizontal and vertical distances, angles, and taking the details of these points and by preparing a map or plan to any suitable scale."***

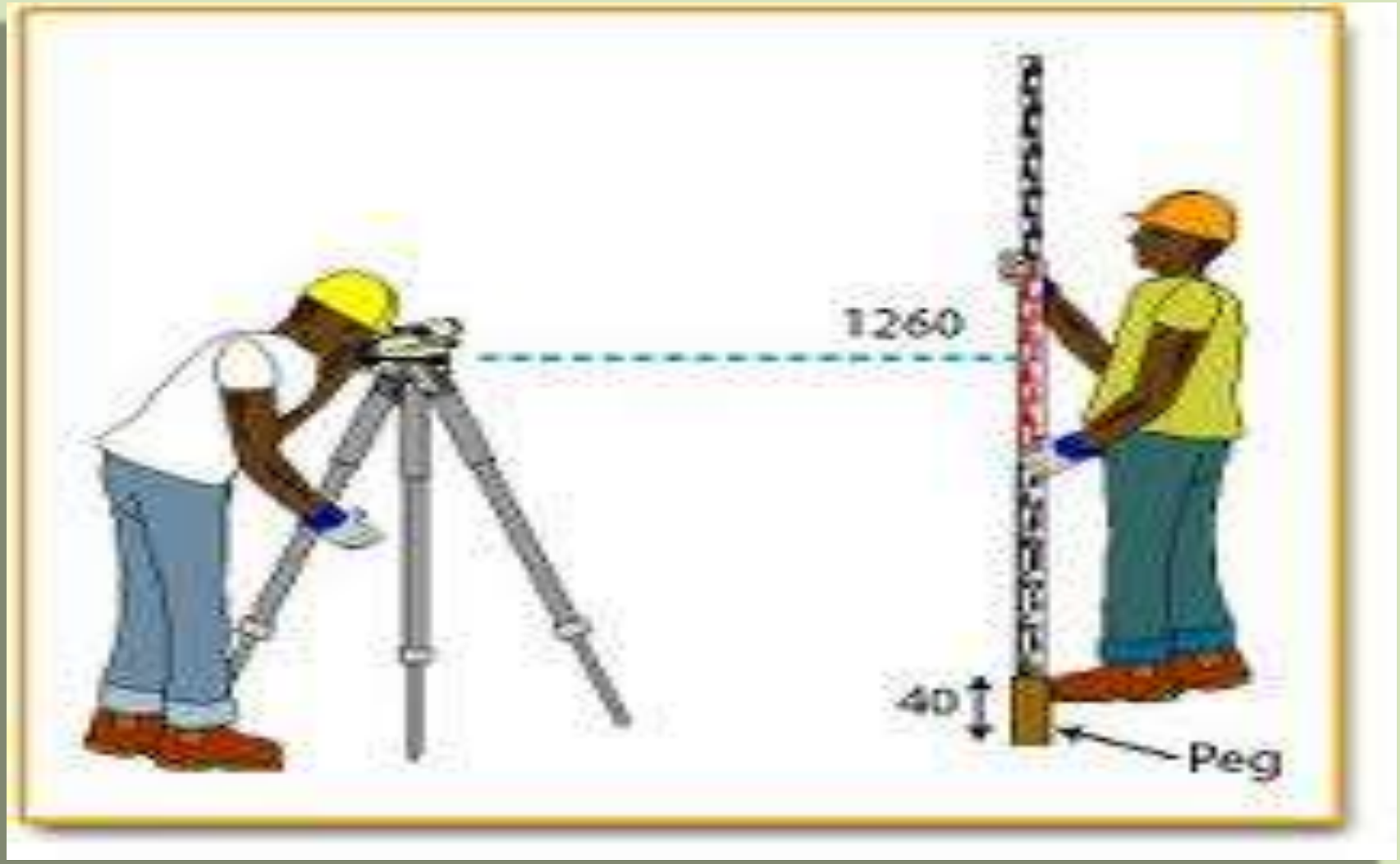
Surveying

Leveling

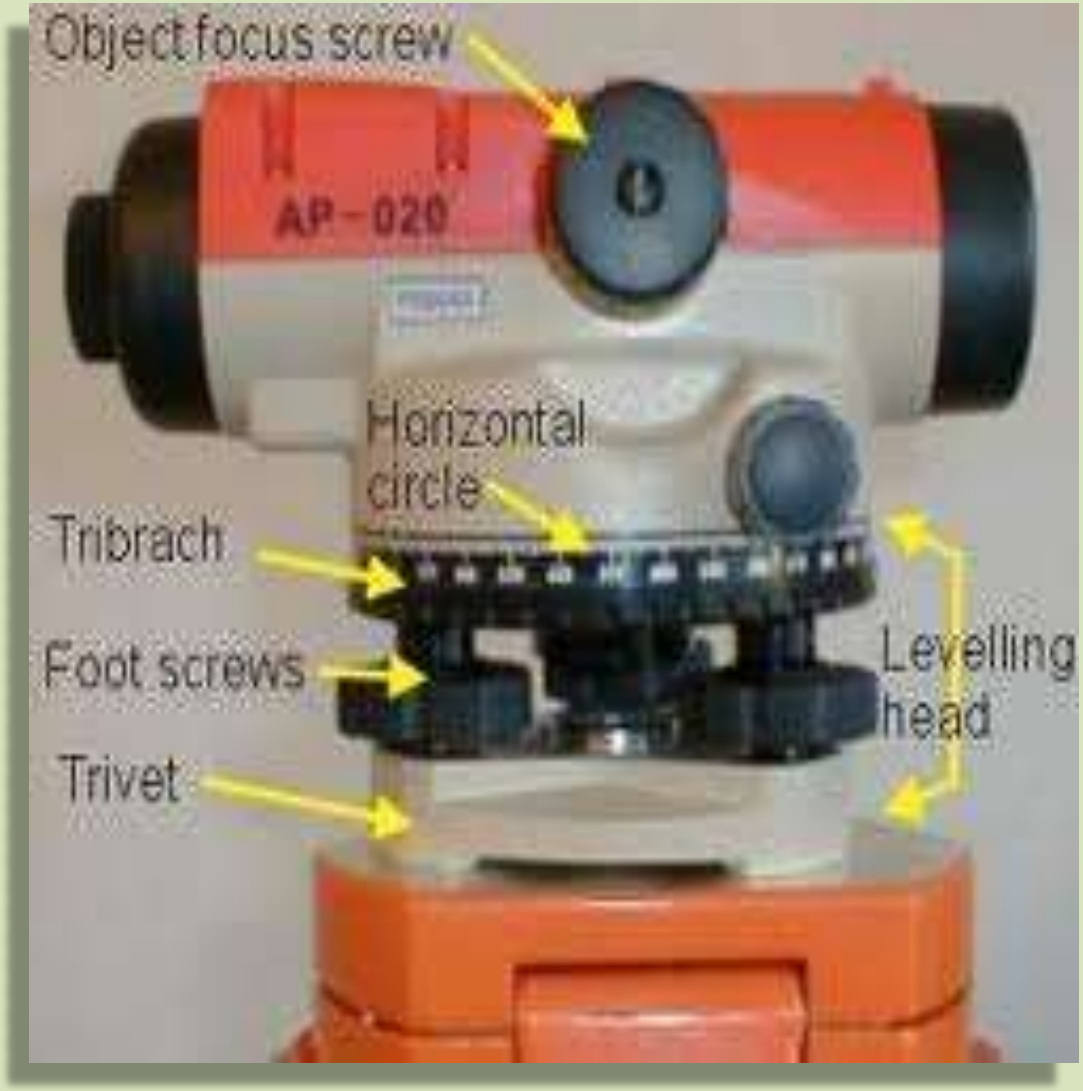
Leveling

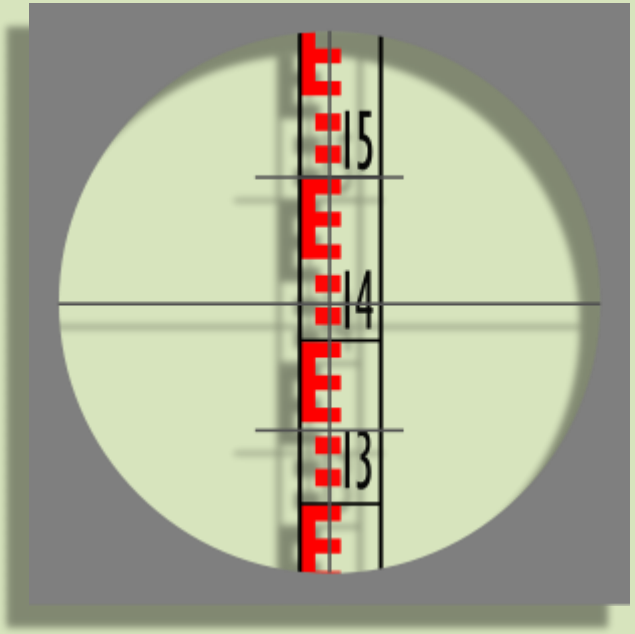
- Leveling is a branch of surveying which deals with the measurement of relative heights of different points on, above or below the surface of the earth. Thus in leveling, the measurements (elevations) are taken in the vertical plane.

Leveling



Leveling


Object focus screw
AP-020
Horizontal circle
Tribrach
Foot screws
Trivet
Levelling head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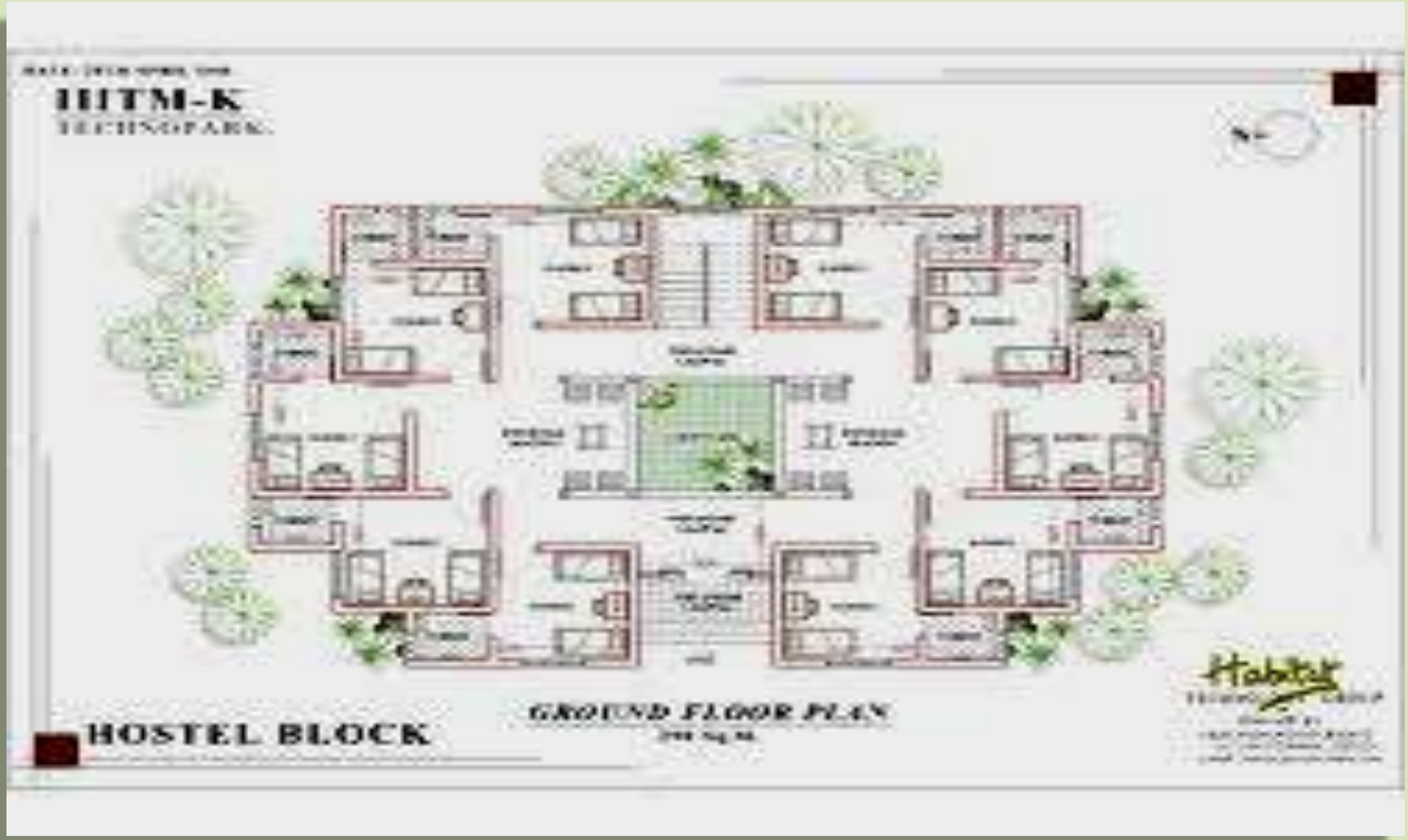
Objective of Surveying

- The object of surveying is to prepare a map or plan to show the relative positions of the objects on the surface of the earth. The map or plan is drawn to some suitable scale. It also shows boundaries of districts, states, and countries too. It also includes details of different engineering features such as buildings, roads, railways, dams, canals etc.

Objective of Surveying



Objective of Surveying

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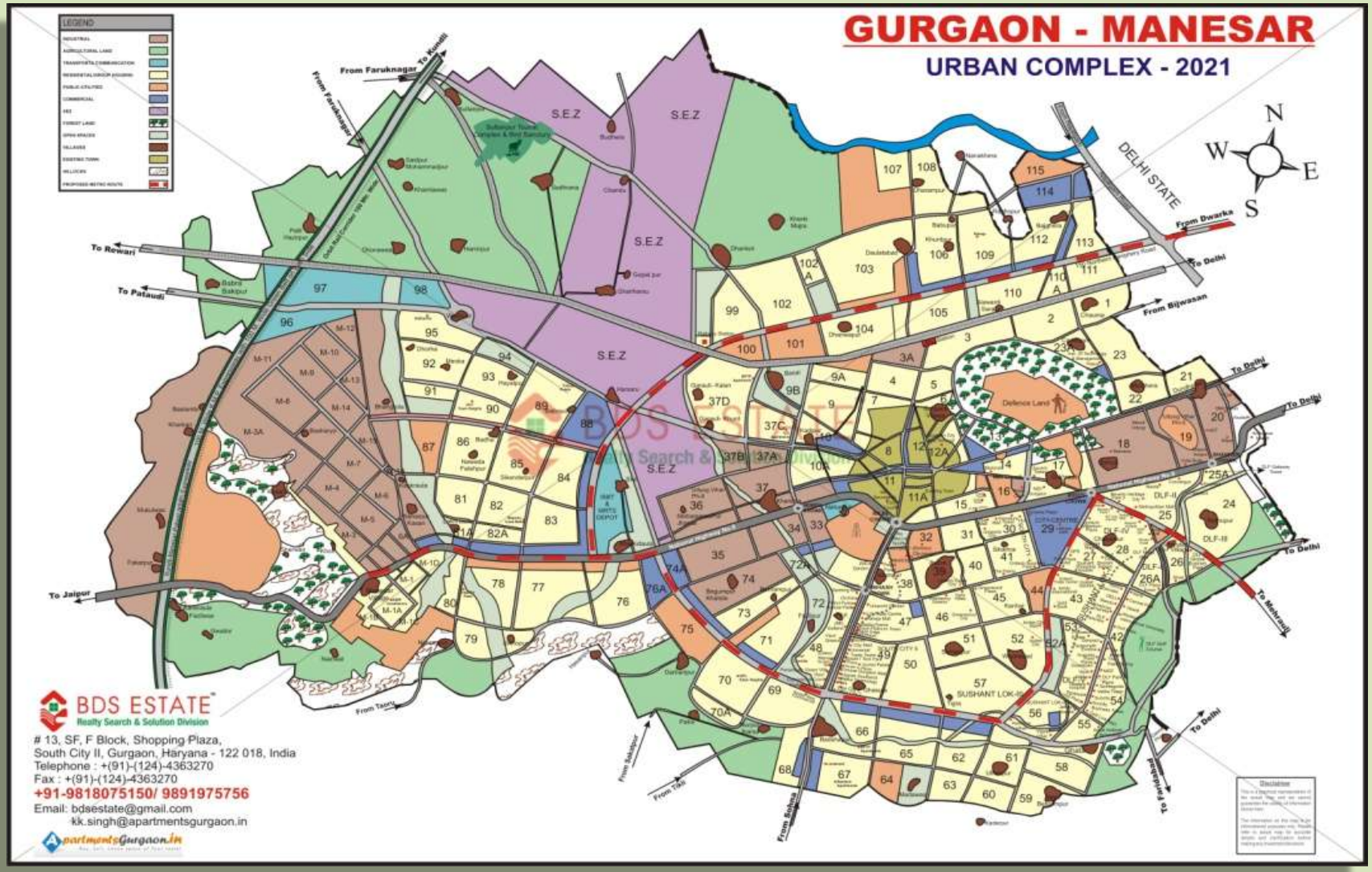
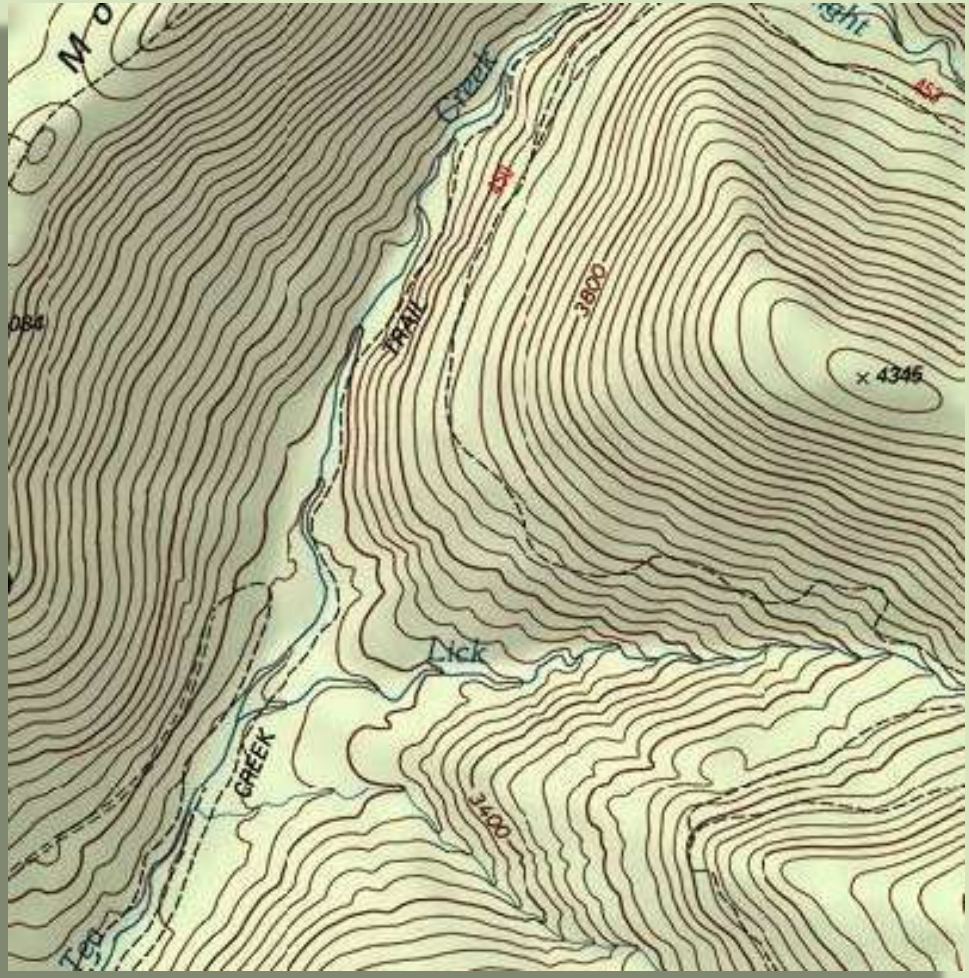


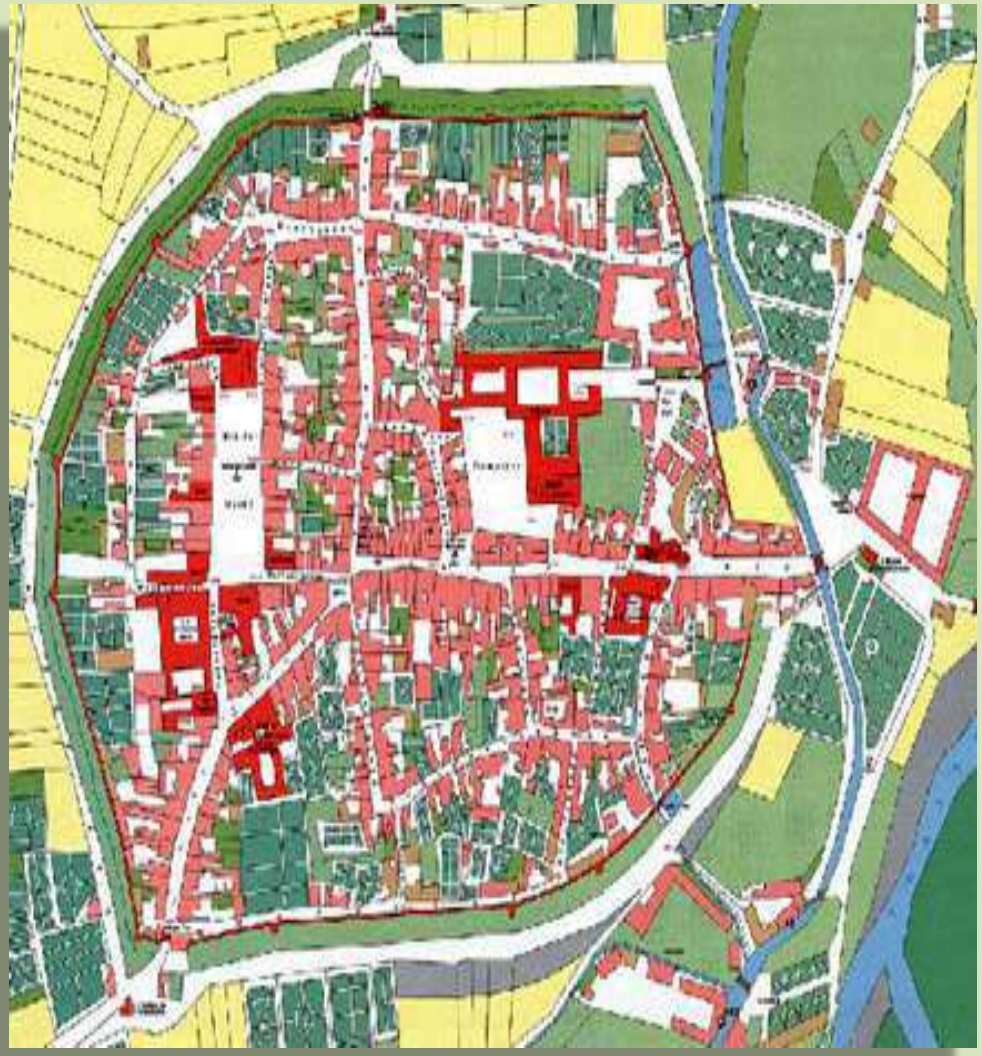
Uses of Surveying

- The surveying may be used for following purposes:
- To prepare a topographical map which shows hills, valleys, rivers, forests, villages, towns etc.
- To prepare a cadastral map which shows the boundaries of fields, plots, houses and other properties..
- To prepare an engineering map which shows the position of engineering works such as buildings, roads, railways, dams, canals.

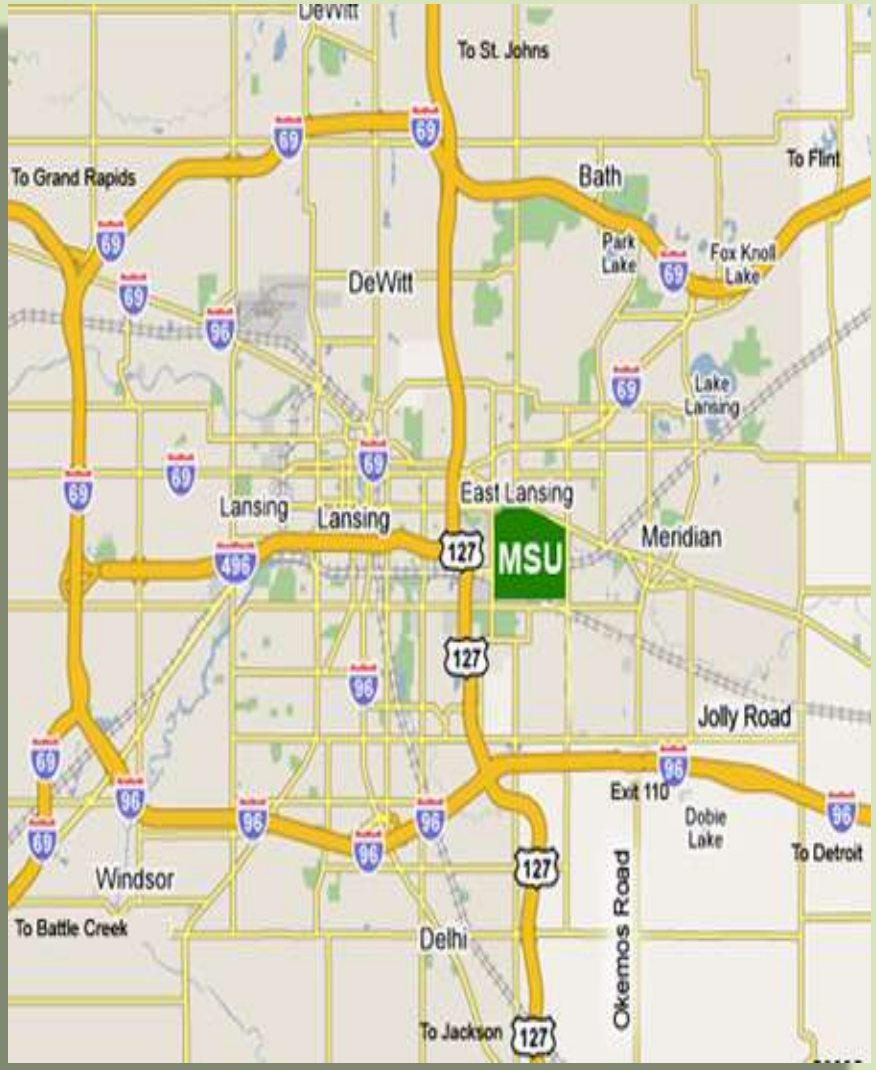
Topographical Maps



Cadastral Map



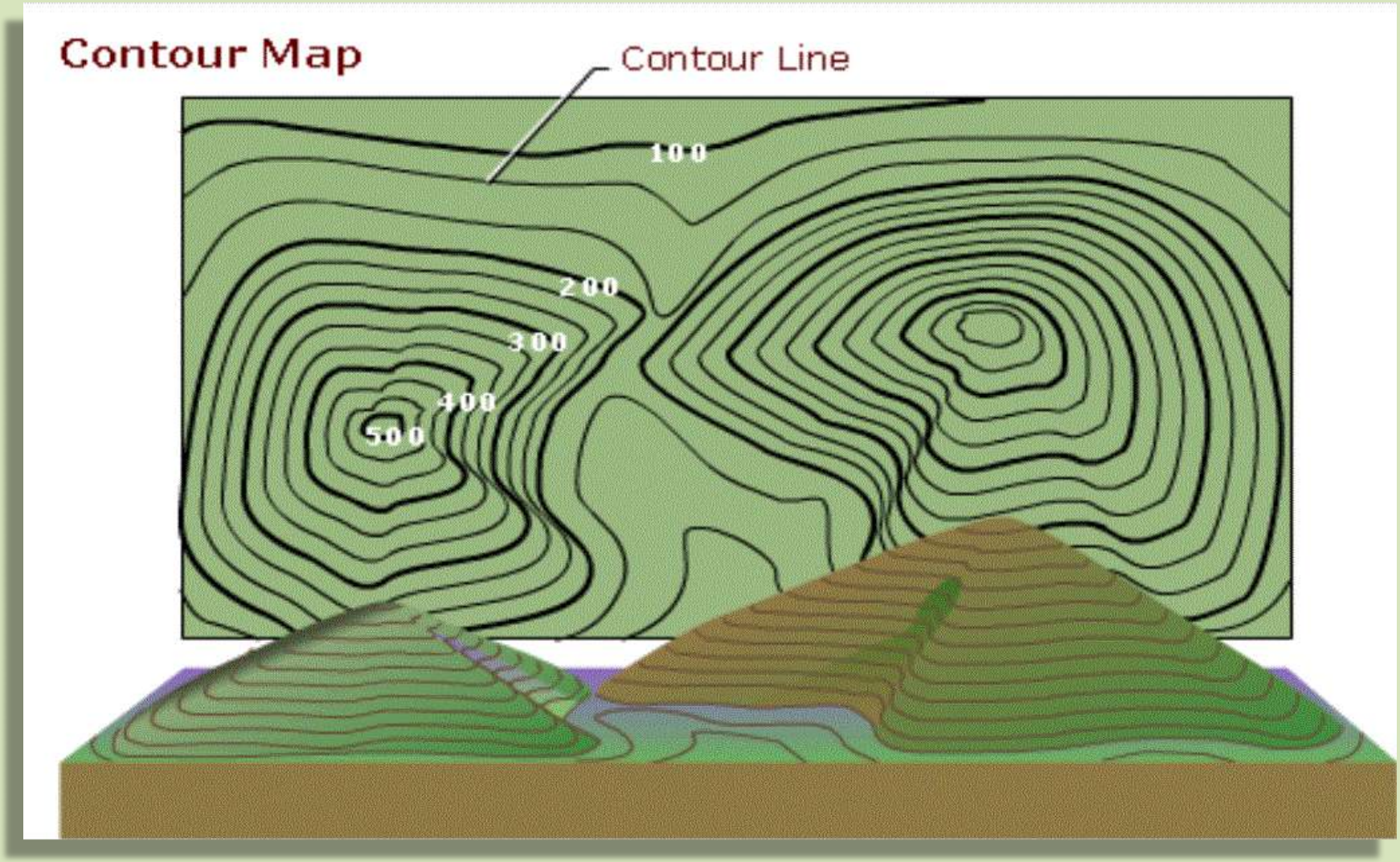
Engineering Map



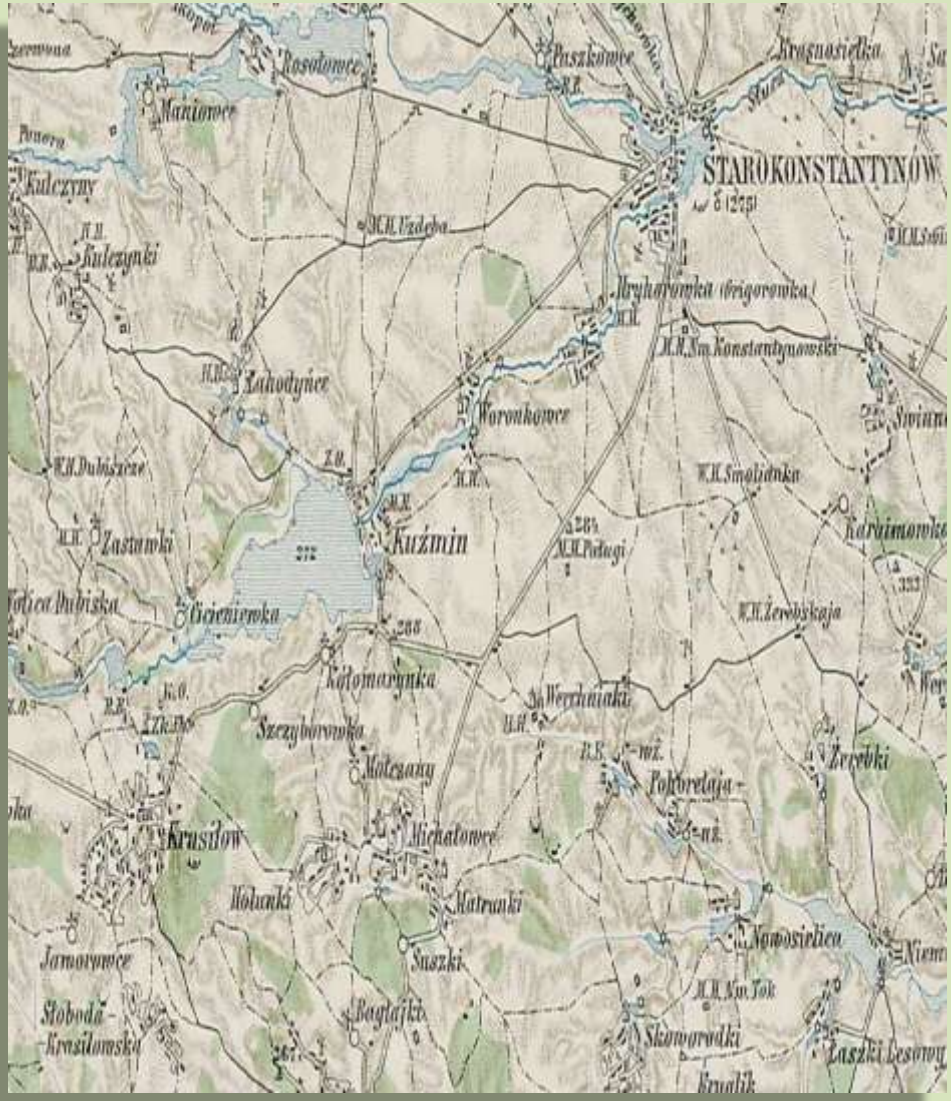
Uses of Surveying

- To prepare a contour map to know the topography of the area to find out the best possible site for roads, railways, bridges, reservoirs, canals, etc.
- Surveying is also used to prepare military map, geological map, archaeological map etc.
- For setting out work and transferring details from the map on the ground.

Contour Map



Military Map



SIZE SYMBOLS

- • Squad
- •• Section
- ••• Platoon
- I Company or Battery
- II Battalion of Squadron
- III Regiment or Air Group
- X Brigade
- XX Division or Wing

UNIT SYMBOLS

- Basic Unit
- ∞ Air
- LVT Amphibian Tractor
- Antiaircraft
- • DB Defense Battalion
- E Engineer
- • Field Artillery
- Infantry
- Para Parachute
- Prcht
- P Pioneer
- Rdr Raider
- Tank

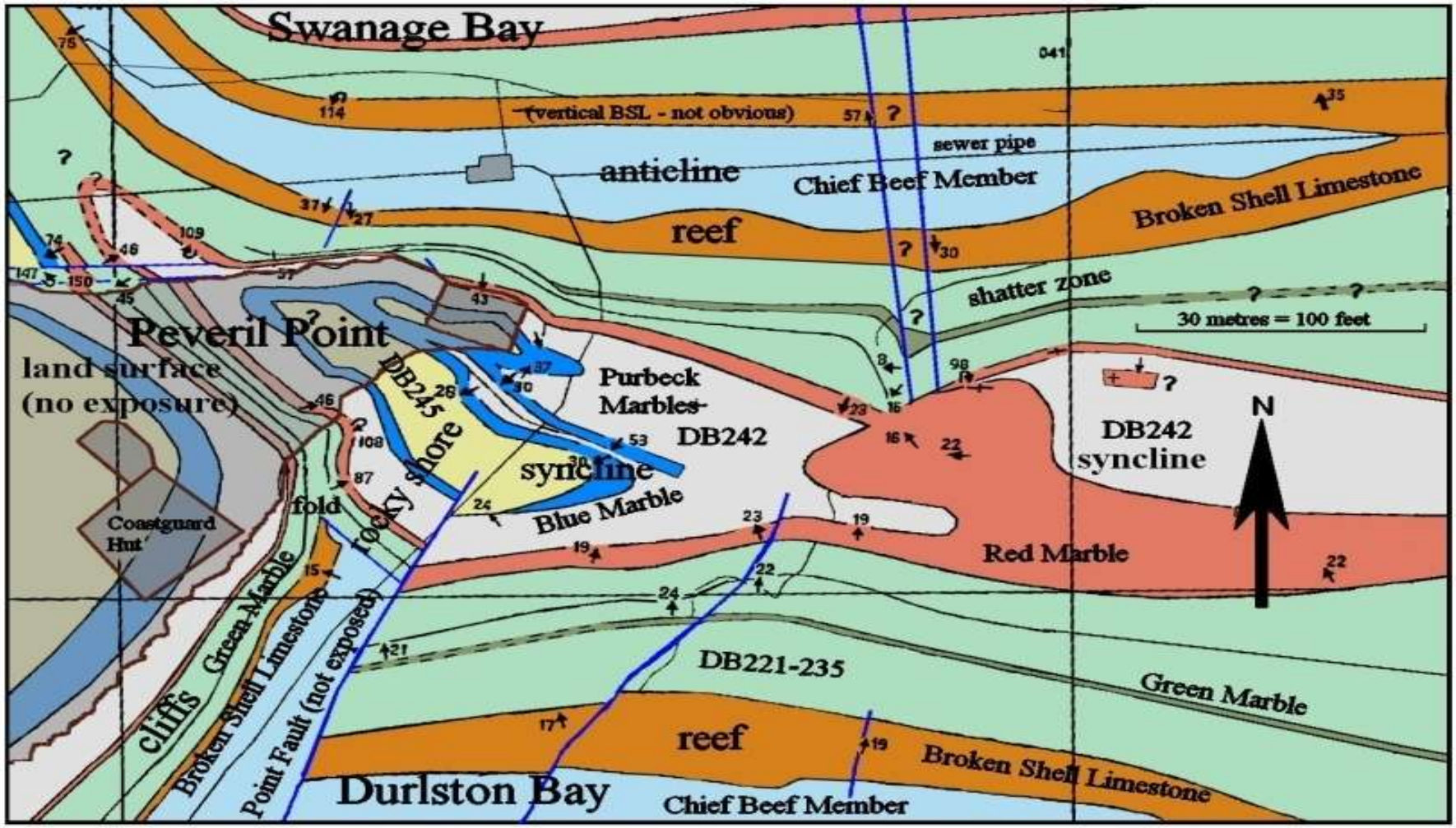
MISC. SYMBOLS

- Command Post
- Observation Post
- Boundary (battalion)
- Aid Station (battalion)

EXAMPLES

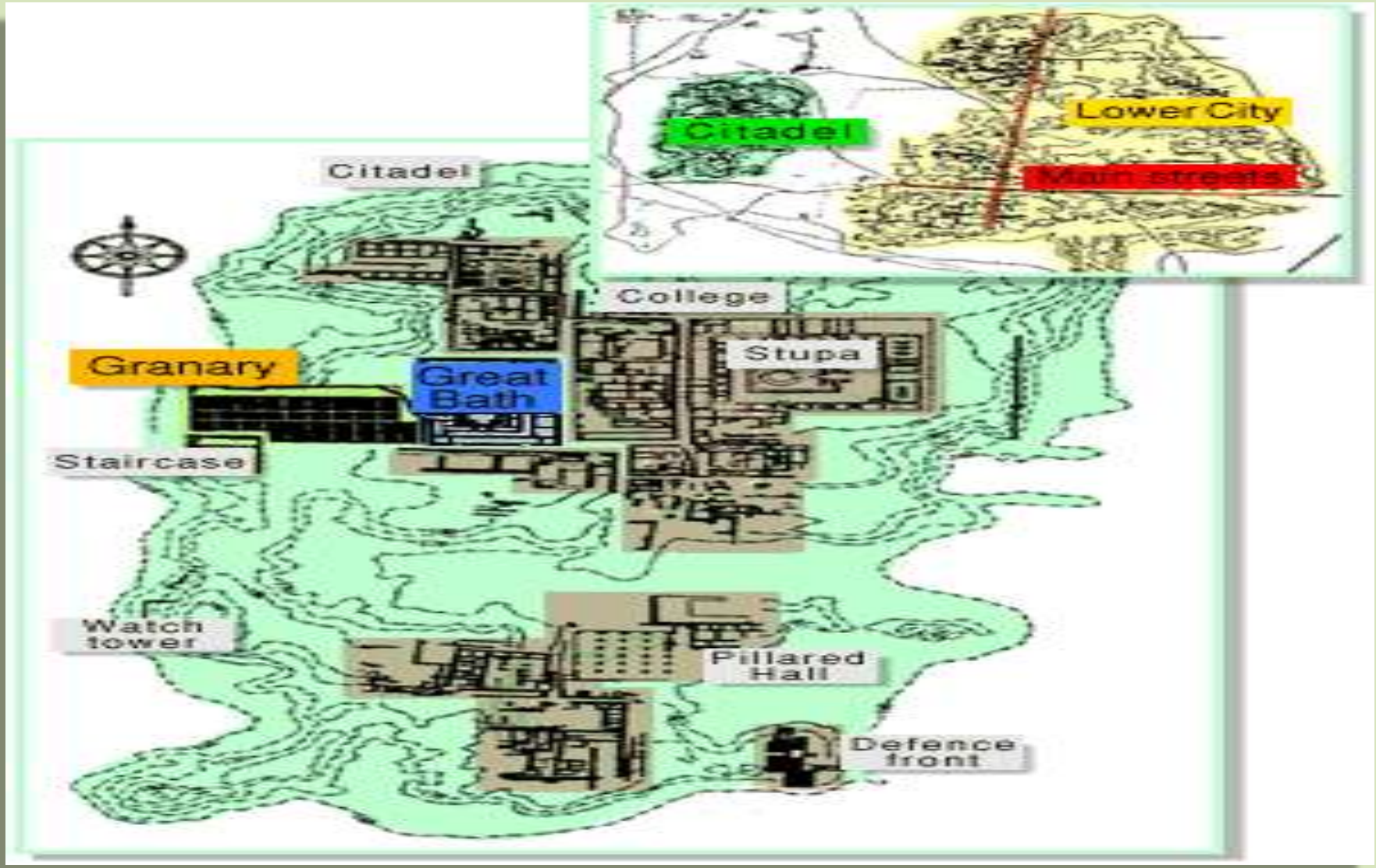
- •• 1L • 1DB — 1st Sec, L Btry, 1st Def Bn
- I B 5 — Co B, 5th Mar Regt
- II 1Rdr — 1st Rdr Bn
- III • 11 — 11th Mar Regt
- II 2 7 — OP, 2d Bn, 7th Mar Regt
- XX 1 — CP, 1st Mar Div

Geological Map

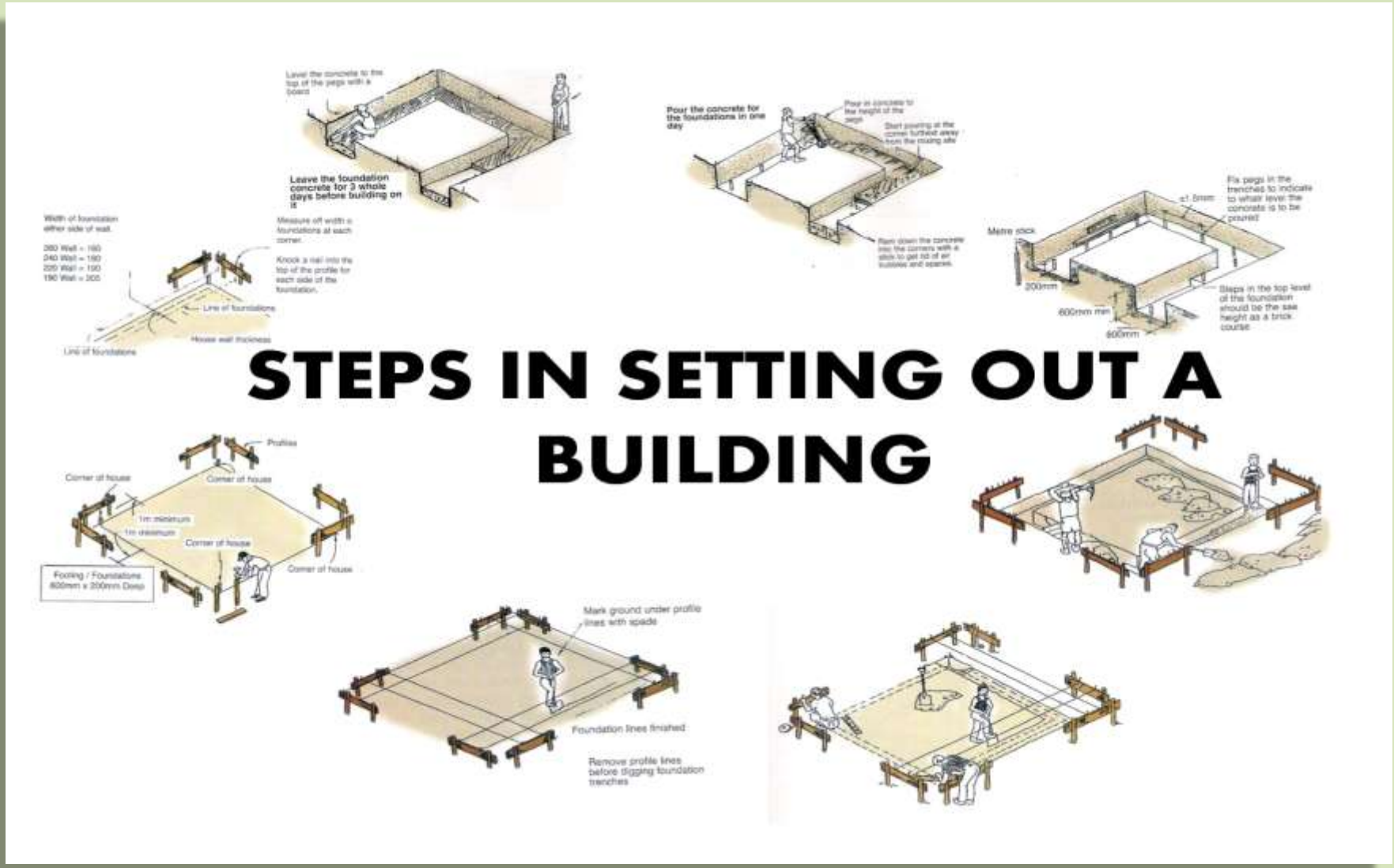


Geological map of Peveril Point, Swanage. Simplified and with some generalisations.
Based mainly on Cosgrove and Hearn (1966) and with some personal observations. Refer to Cosgrove and Hearn for details.

Archaeological Map



Setting Out Work



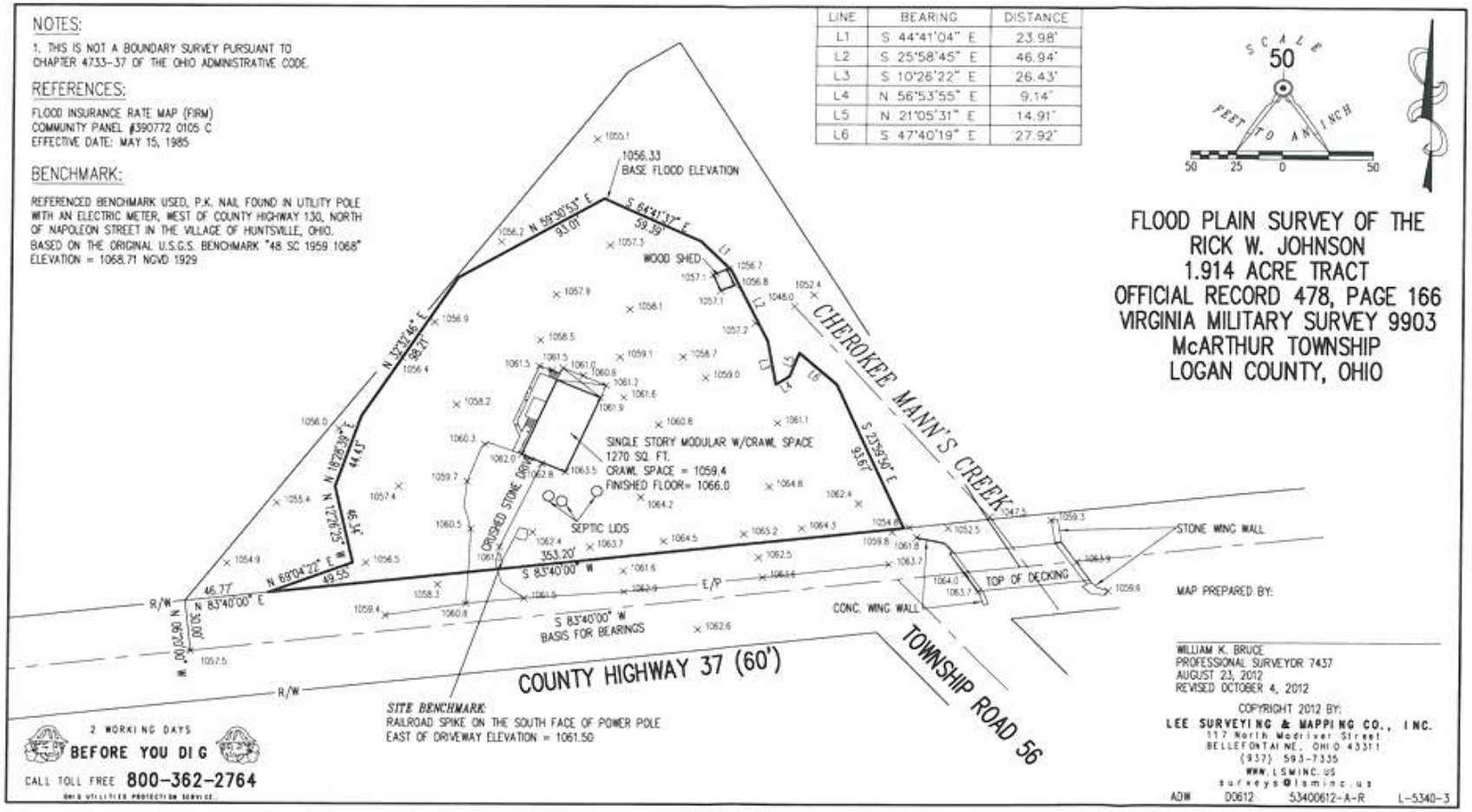
Primary Divisions of Surveying

- We know that the shape of the earth is spheroidal. Thus the surface is obviously curved. Surveying is primarily divided into two types considering the curvature of the earth's surface.
- Plane Surveying
- Geodetic Surveying

Primary Divisions of Surveying

- **Plain Surveying**
- The plain surveying is that type of surveying in which earth surface is considered as a plane and the curvature of the earth is ignored. In such surveying a line joining any two stations is considered to be straight. The triangle formed by any three points is considered as a plane triangle, and the angles of the triangle are considered as plain angles.
- Surveying is carried out for a small area of less than 250 km^2 . It is carried out by local or state agencies like R & B department, Irrigation department, Railway department.

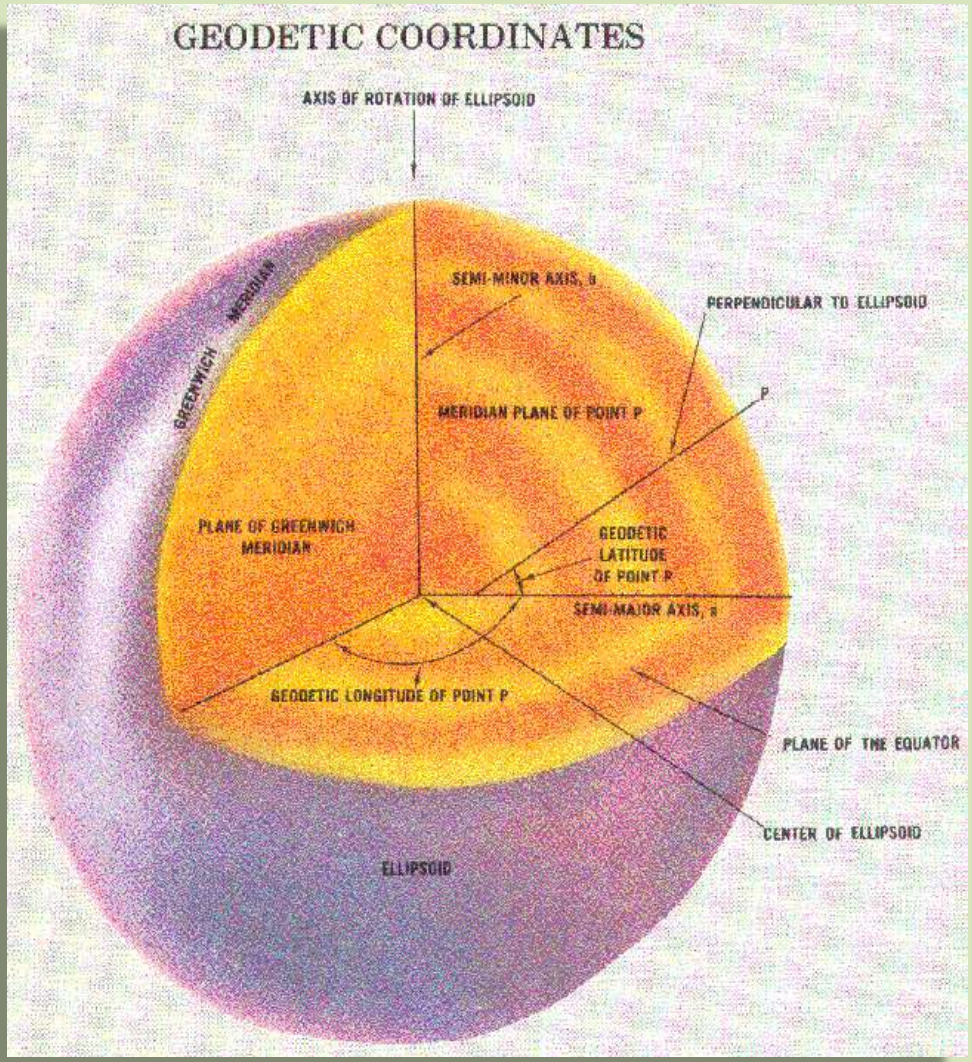
Plain Surveying



Primary Divisions of Surveying

- **Geodetic Surveying**
- The geodetic Surveying is that type of surveying in which the curvature of the earth is taken into account. It is generally extended over larger areas. The line joining any two stations is considered as curved line. The triangle formed by any three points is considered to be spherical and the angles of the triangle are considered to be spherical angles. Geodetic surveying is conducted by the survey of India Department and is carried out for a larger area exceeding 250 km^2

Geodetic Surveying



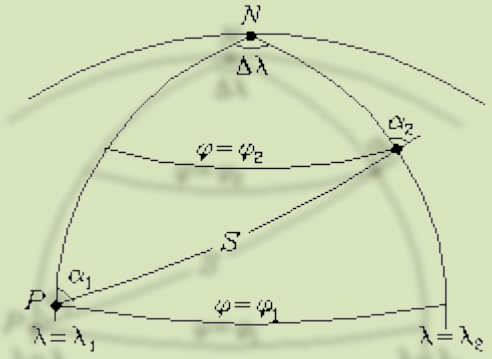
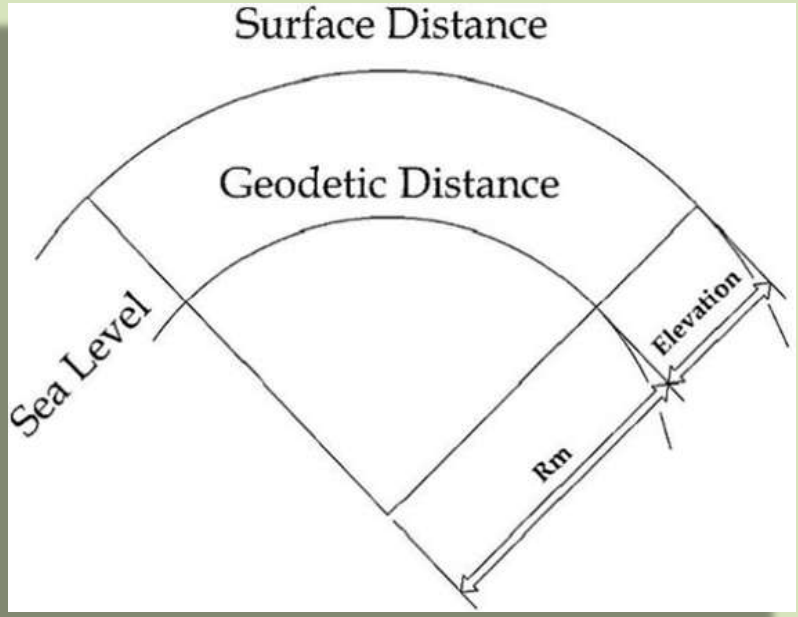
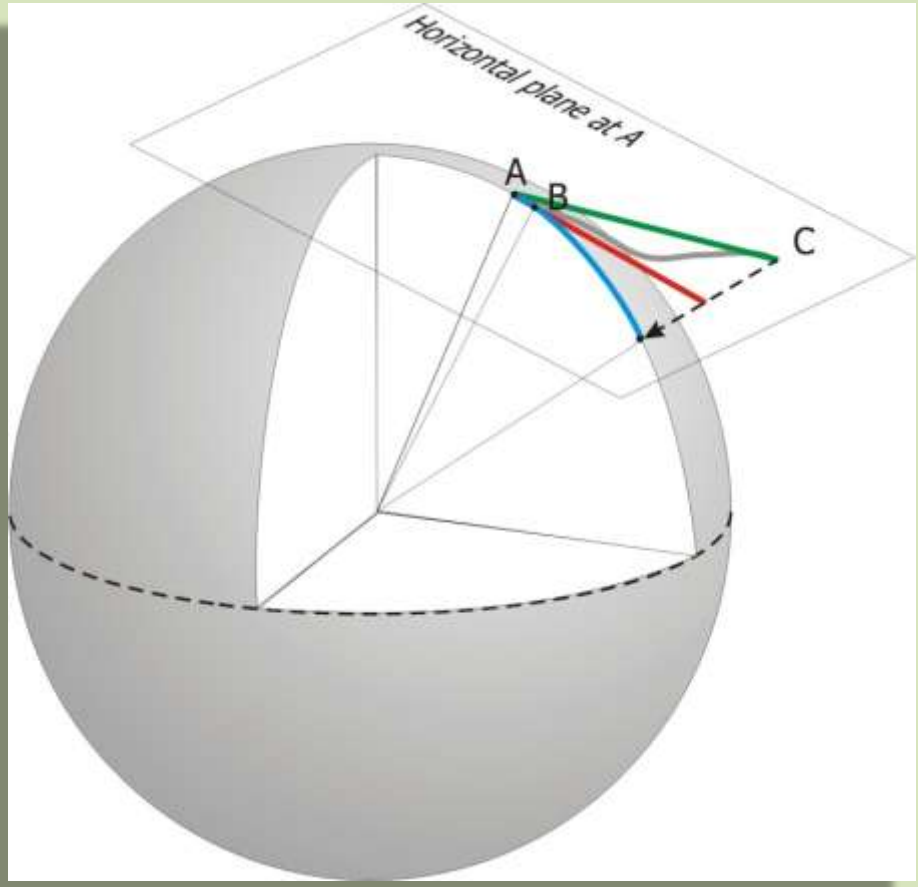
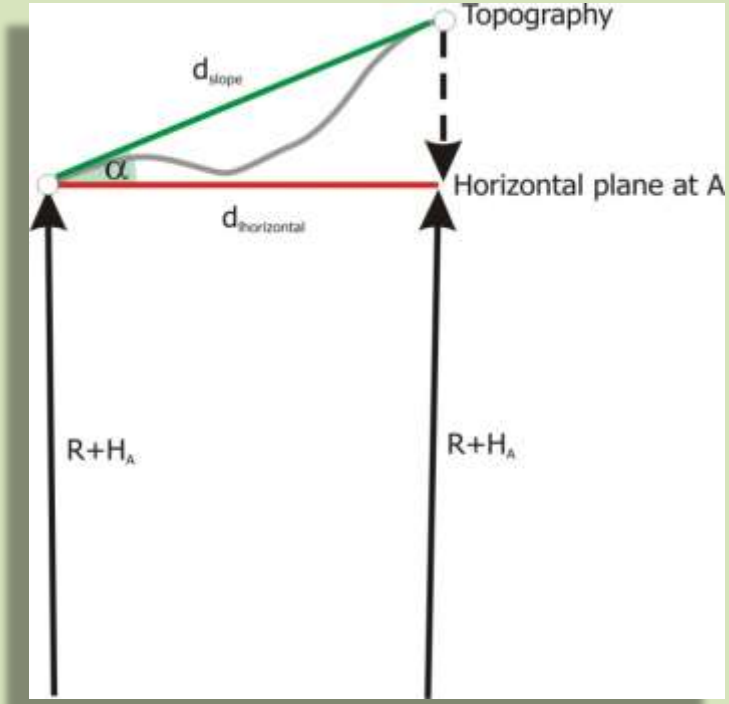


Figure 1. Direct geodetic problem



Geodetic Surveying





Plain Surveying Vs Geodetic Surveying

No.	Plain Surveying	Geodetic Surveying
1	The earth surface is considered as plain Surface.	The earth surface is considered as Curved Surface.
2.	The Curvature of the earth is ignored	The curvature of earth is taken into account.
3	Line joining any two stations is considered to be straight	The line joining any two stations is considered as spherical.
4.	The triangle formed by any three points is considered as plain	The Triangle formed by any three points is considered as spherical.
5.	The angles of triangle are considered as plain angles.	The angles of the triangle are considered as spherical angles.
6.	Carried out for a small area < 250 km^2	Carried out for a small area > 250 km^2

Fundamental Principles of Surveying

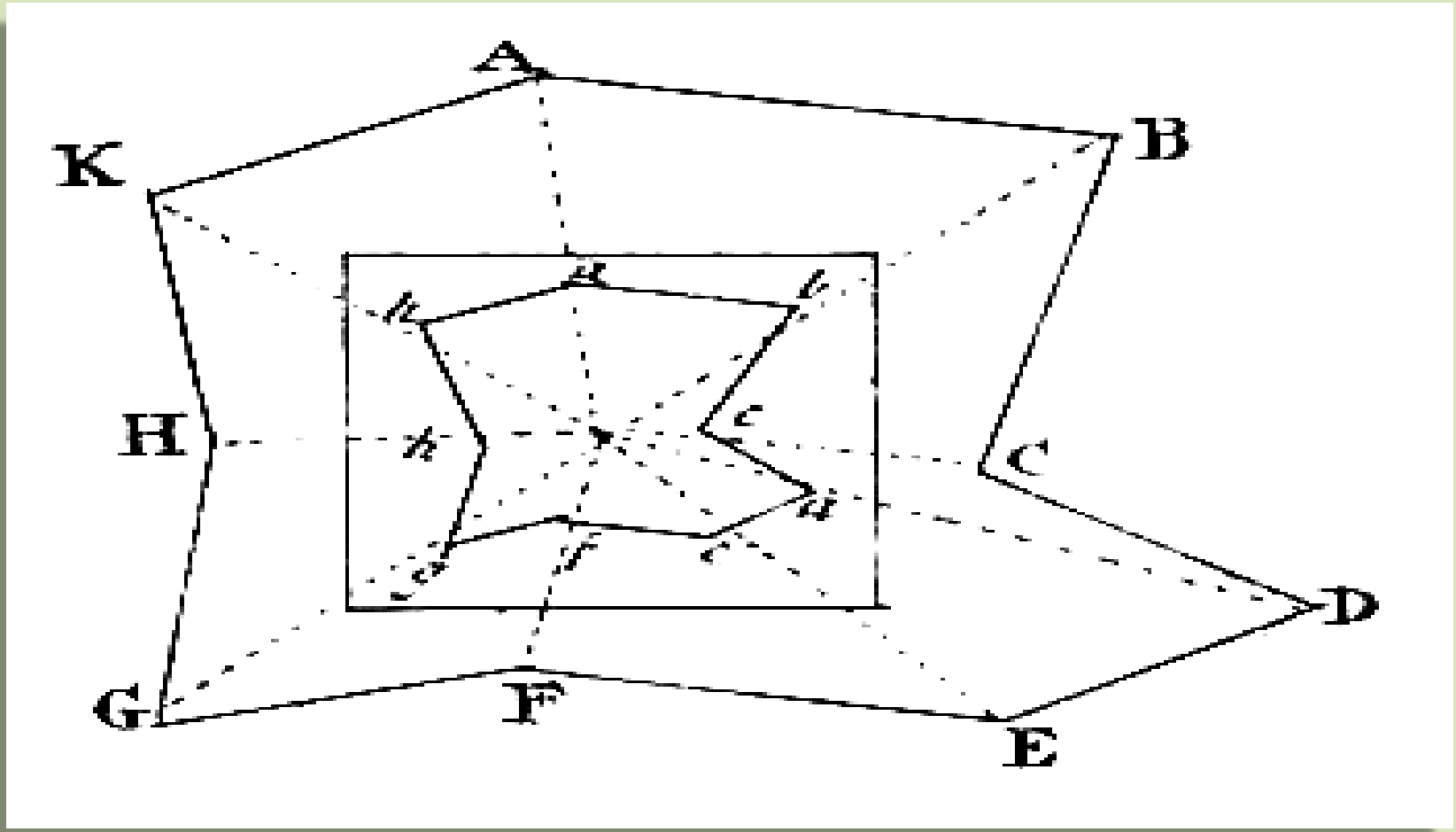
- Two basic principles of surveying are:
- Always work from whole to the part, and
- To locate a new station by at least two measurements (Linear or angular) from fixed reference points.

Fundamental Principles of Surveying

Always work from whole to the part:

- According to the first principle, the whole survey area is first enclosed by main stations (i.e.. Control stations) and main survey lines. The area is then divided into a number of divisions by forming well conditioned triangles.

Work from Whole to the Part



Fundamental Principles of Surveying

- The main survey lines are measured very accurately with precise survey instruments. The remaining sides of the triangle are measured. The purpose of this method of working is to control accumulation of errors. During measurement, if there is any error, then it will not affect the whole work, but if the reverse process is followed then the minor error in measurement will be magnified.

Fundamental Principles of Surveying

- To locate a new station by at least two measurements (Linear or angular) from fixed reference points.
- According to the second principle the points are located by linear or angular measurement or by both in surveying. If two control points are established first, then a new station can be located by linear measurement. Let A & B are control points, a new point C can be established.

Fundamental Principles of Surveying

- Following are the methods of locating point C from such reference points A & B.
- The distance AB can be measured accurately and the relative positions of the point can be then plotted on the sheet to some scale.
- (a) Taking linear measurement from A and B for C.
- (b) Taking linear measurement of perpendicular from D to C.
- (c) Taking one linear measurement from B and one angular measurement as ∠ABC

Fundamental Principles of Surveying

- Taking two angular measurement at A & B as angles / CAB and / ABC.
- Taking one angle at B as / ABC and one linear measurement from A as AC.

Fundamental Principles of Surveying

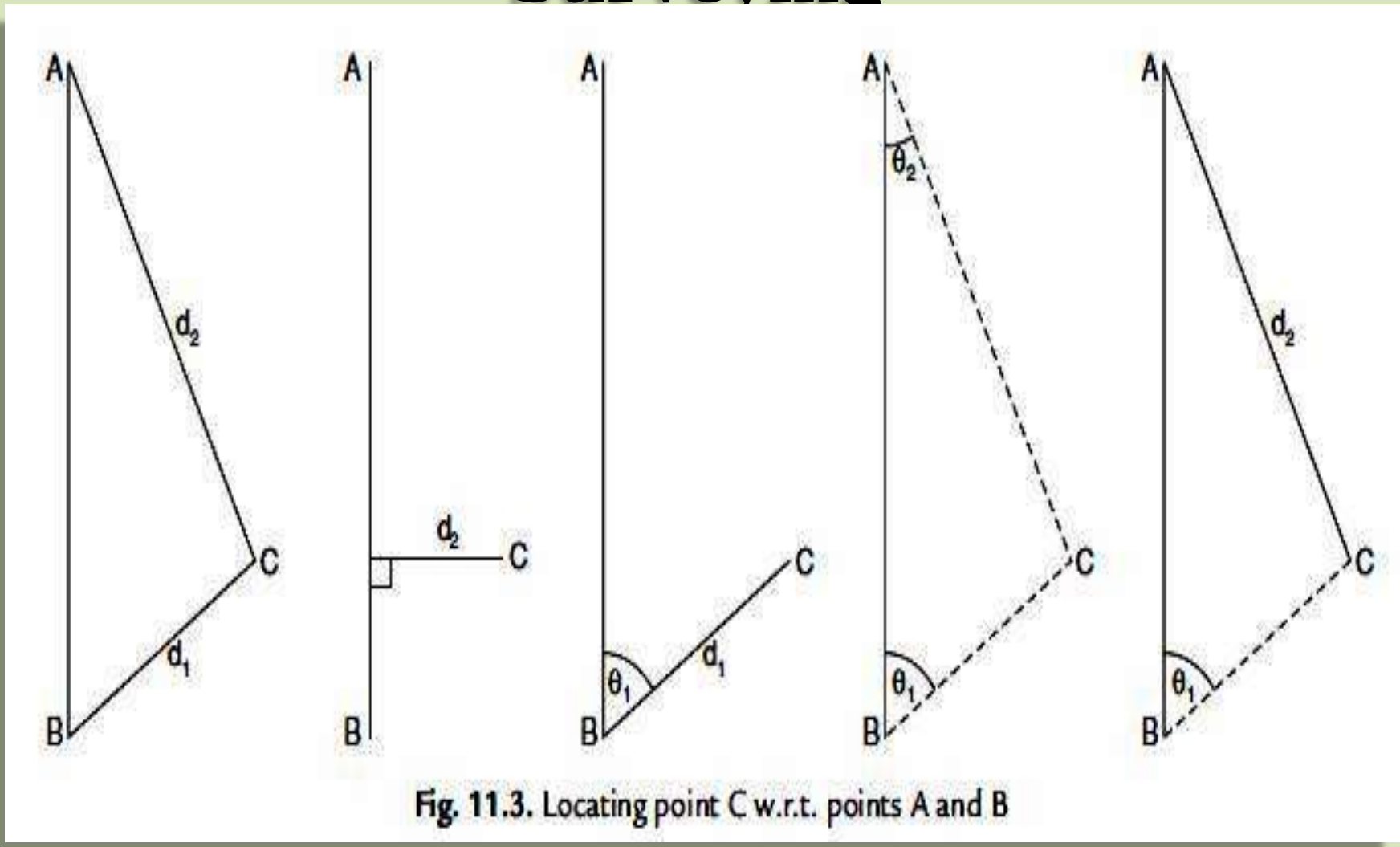
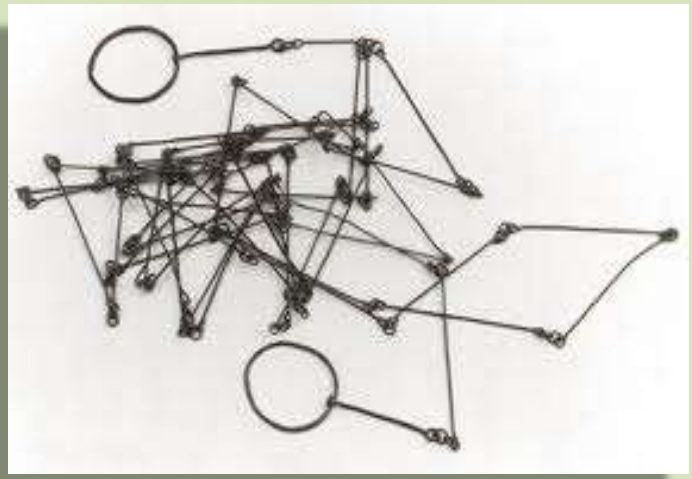


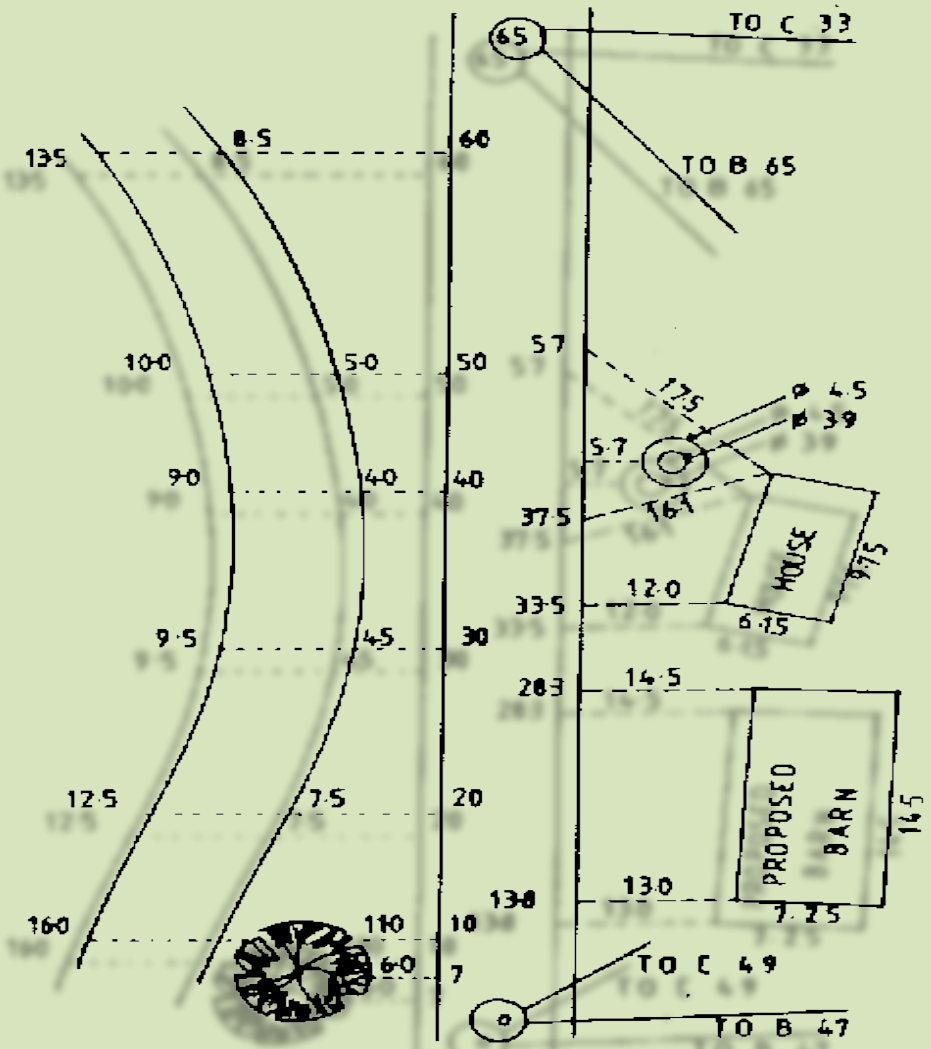
Fig. 11.3. Locating point C w.r.t. points A and B

Classification of Surveying

- Survey can be classified into various categories depending on methods used and nature of the field.
- Classification Based on Instruments.
- **Chain Survey:**
- This is the simplest type of surveying in which only linear measurements are made with a chain or a tape. Angular measurements are not taken.

Chain Survey



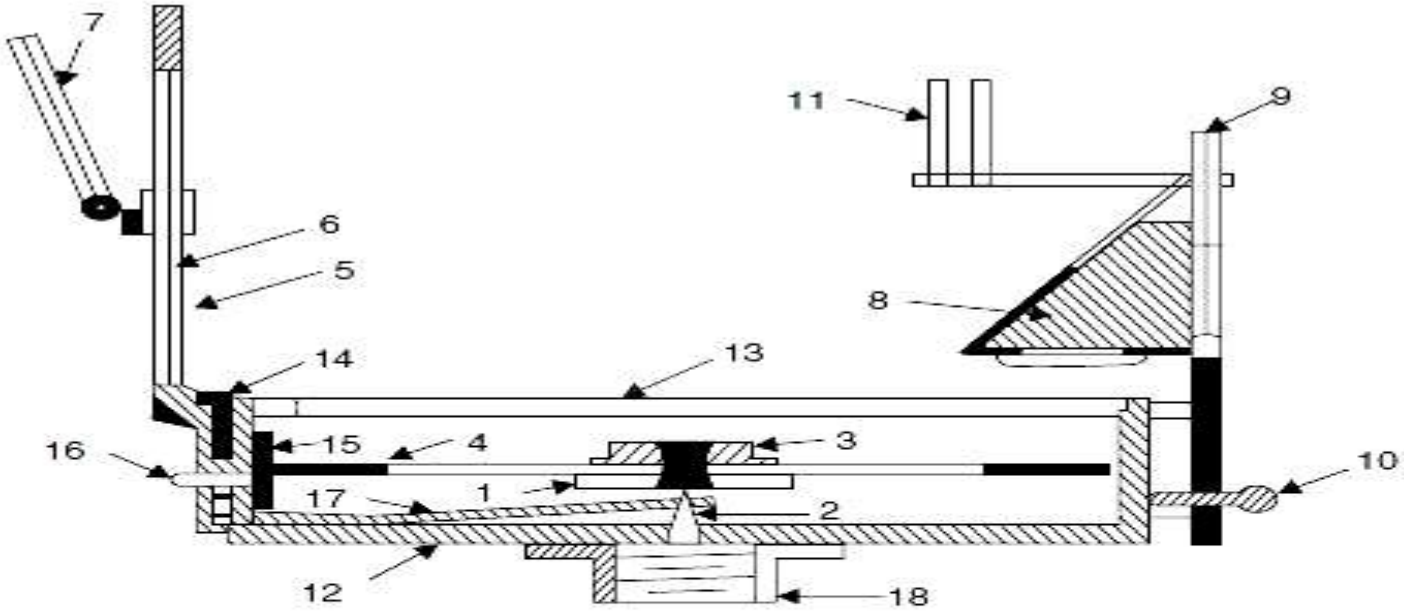


Classification of Surveying

- **Compass Survey:**
- In Compass Survey, the angles are measured with the help of a magnetic compass.
- **Chain and compass survey:**
- In this survey linear measurements are made with a chain or a tape and angular measurements with a compass.

Compass Survey

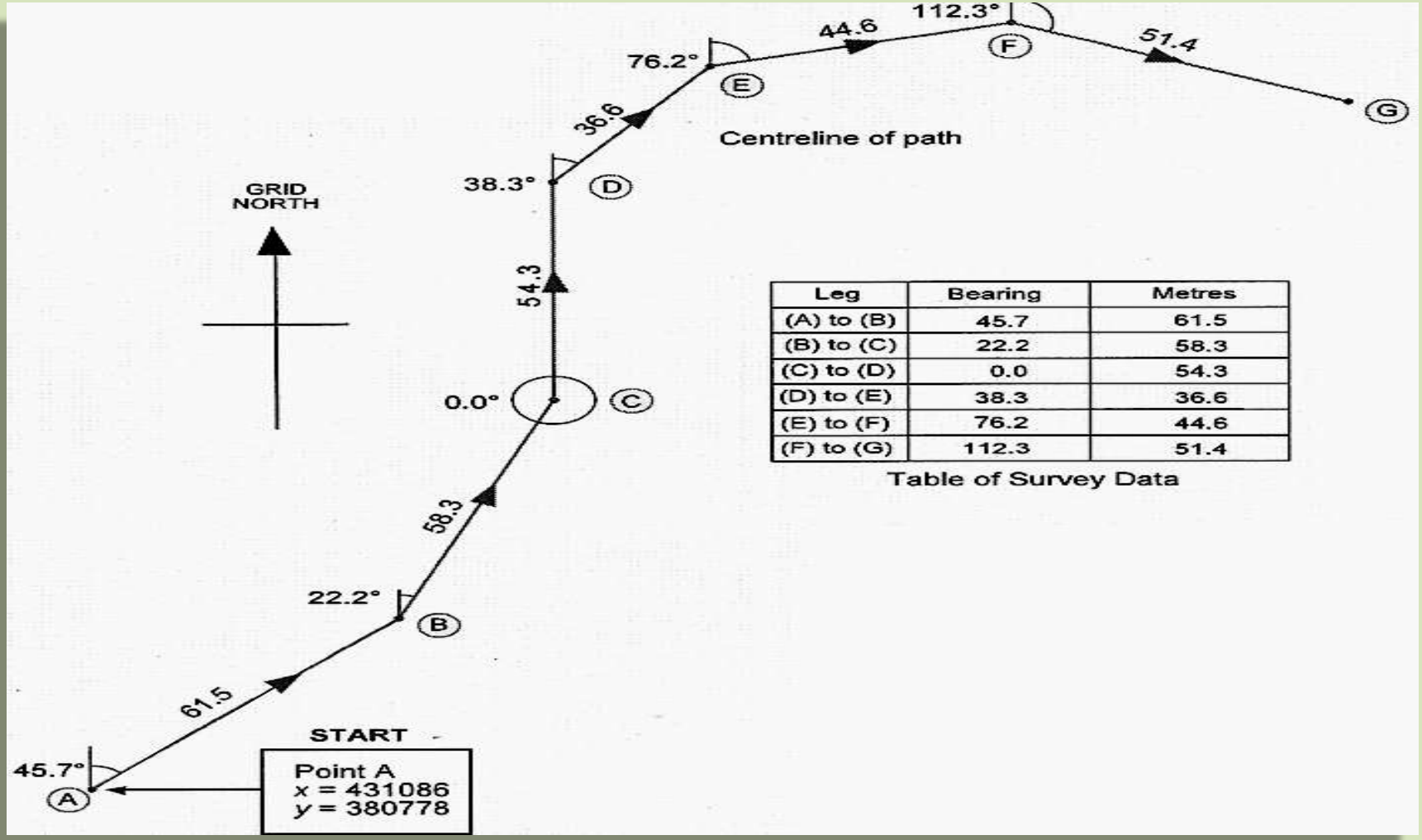
Compass Survey



1. Needle
2. Pivot
3. Agate cap
4. Graduated disc
5. Slit metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye vane
10. Focussing stud
11. Dark sunglasses
12. Box
13. Glass cover
14. Lifting pin
15. Light spring
16. Brake pin or knob
17. Lifting lever
18. Support to fit on tripod

Fig. 13.1. Prismatic compass

Compass Survey



Leg	Bearing	Metres
(A) to (B)	45.7	61.5
(B) to (C)	22.2	58.3
(C) to (D)	0.0	54.3
(D) to (E)	38.3	36.6
(E) to (F)	76.2	44.6
(F) to (G)	112.3	51.4

Table of Survey Data

Classification of Surveying

- **Plane Table Surveying**
- It is a graphical method of surveying in which field works and plotting both are done simultaneously.
- **Theodolite Survey:**
- In theodolite survey the horizontal angles are measured with the theodolite more precisely than compass and the linear measurements are made with a chain or tape.

Plane Table Surveying

Plane Table Surveying

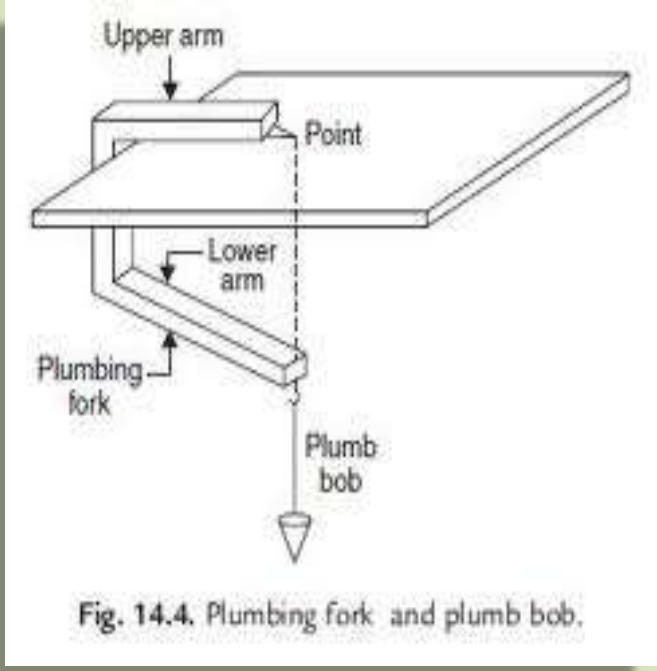


Fig. 14.4. Plumbing fork and plumb bob.

Plane Table Surveying

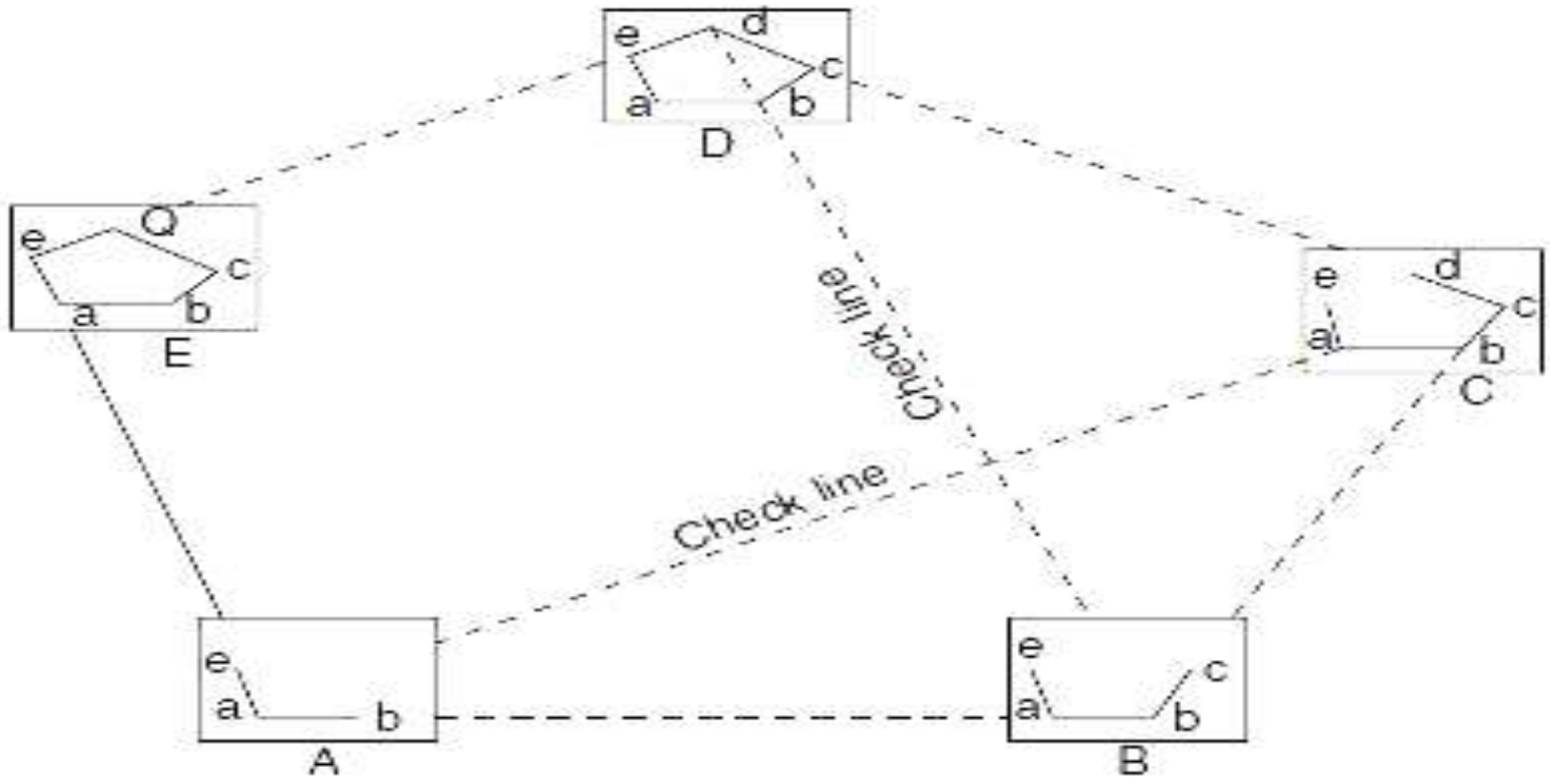
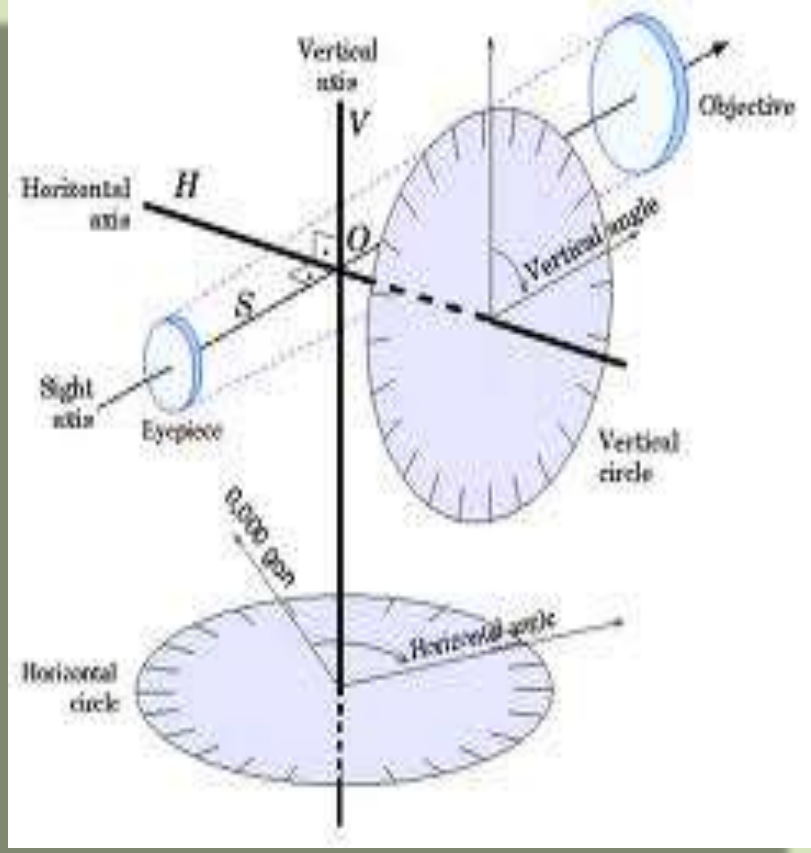
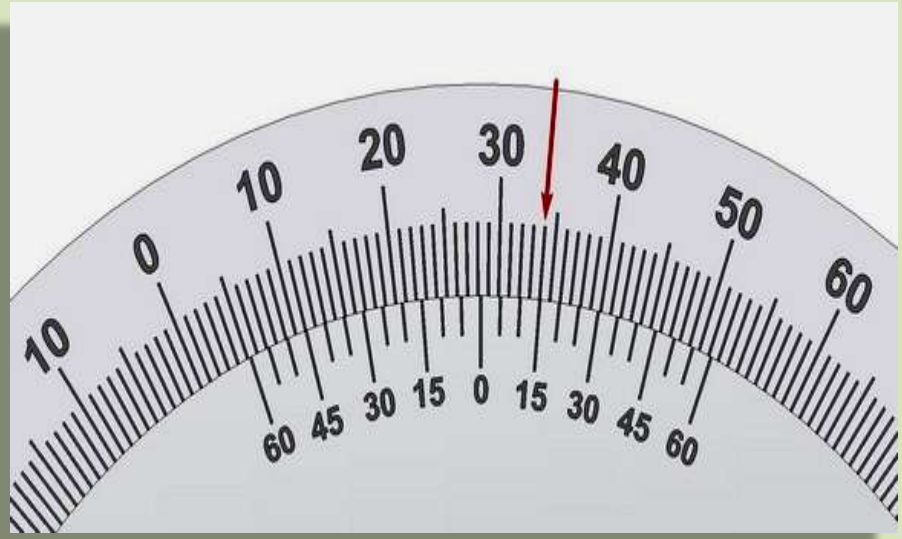


Fig. 14.9. Plane table traversing

Theodolite Survey



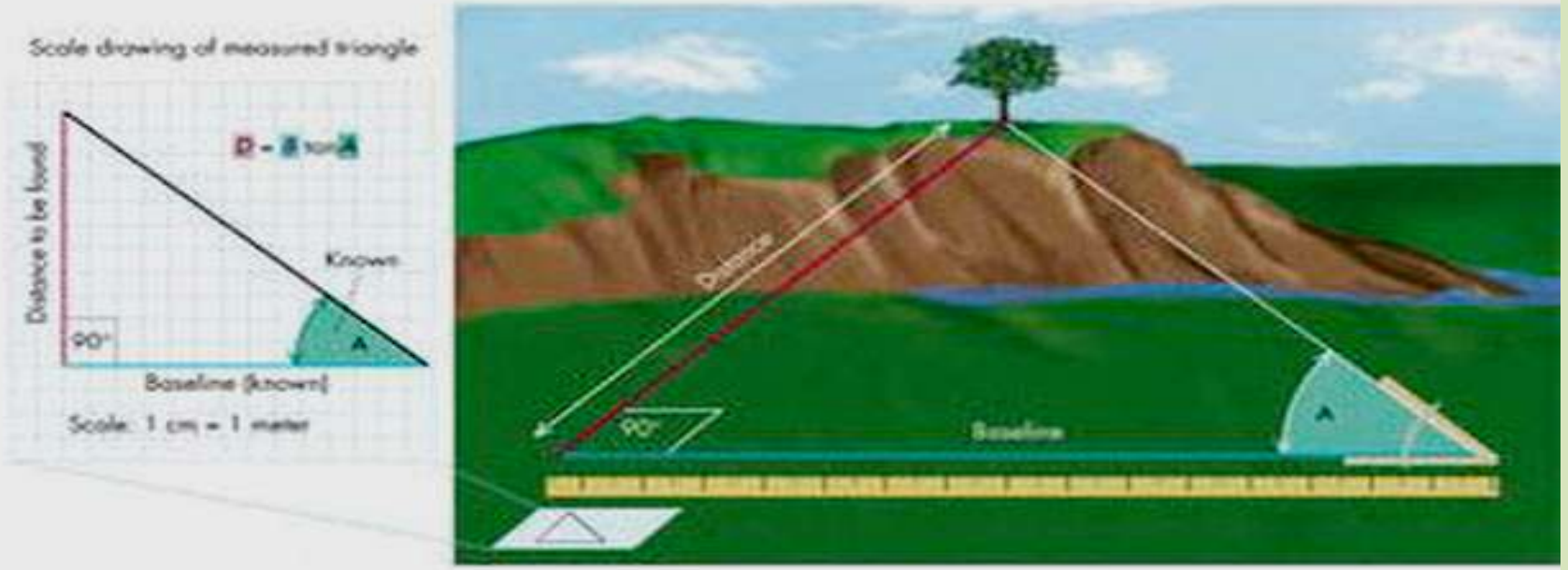
Theodolite Survey



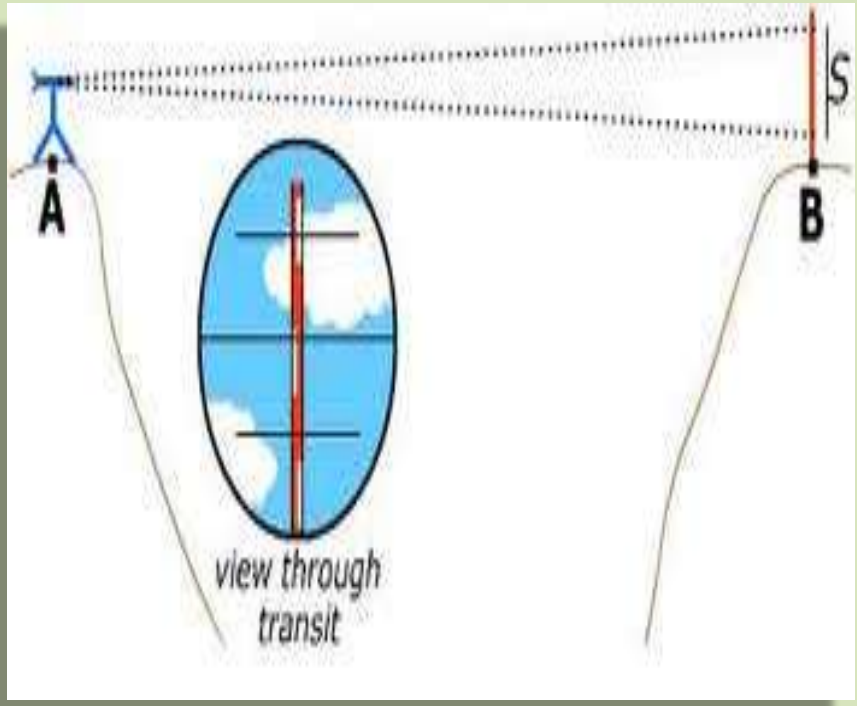
Classification of Surveying

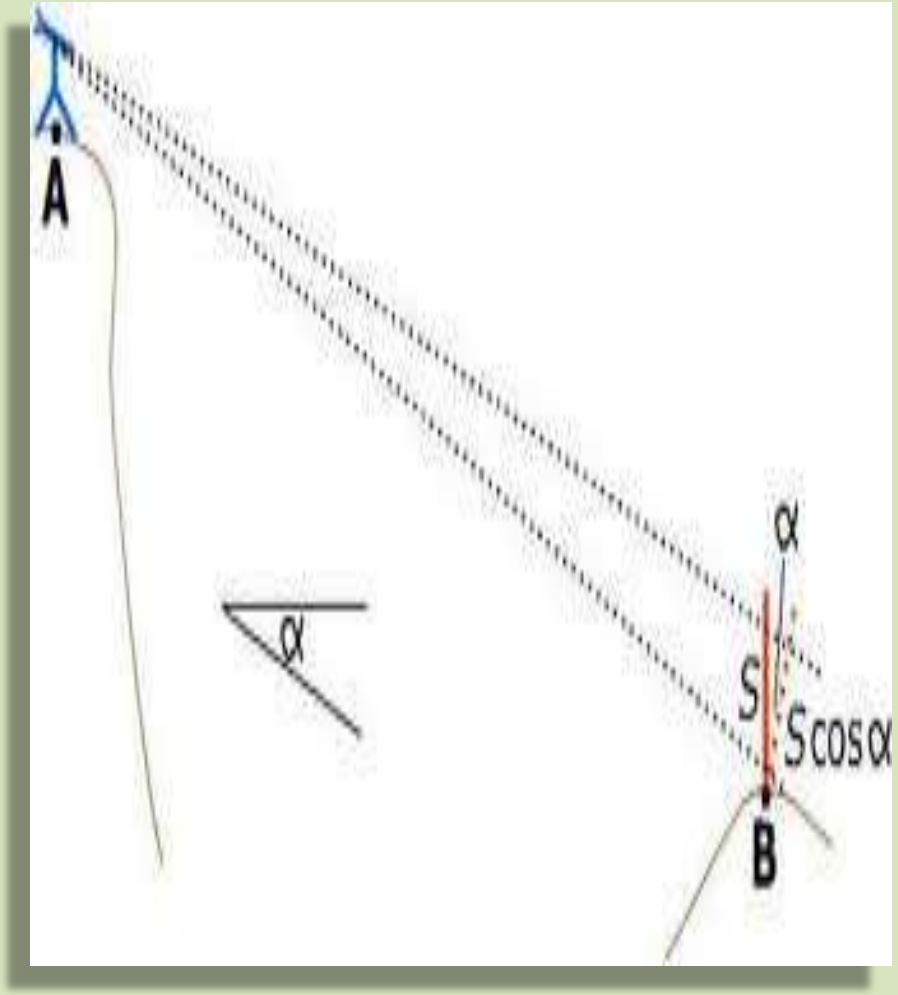
- **Tachometry Survey:**
- A special type of theodolite known as tachometer is used to determine horizontal and vertical distances indirectly.
- **Leveling Survey:**
- This type of survey is used to determine the vertical distances (elevations) and relative heights of points with the help of an instrument known as level.

Tachometry Survey

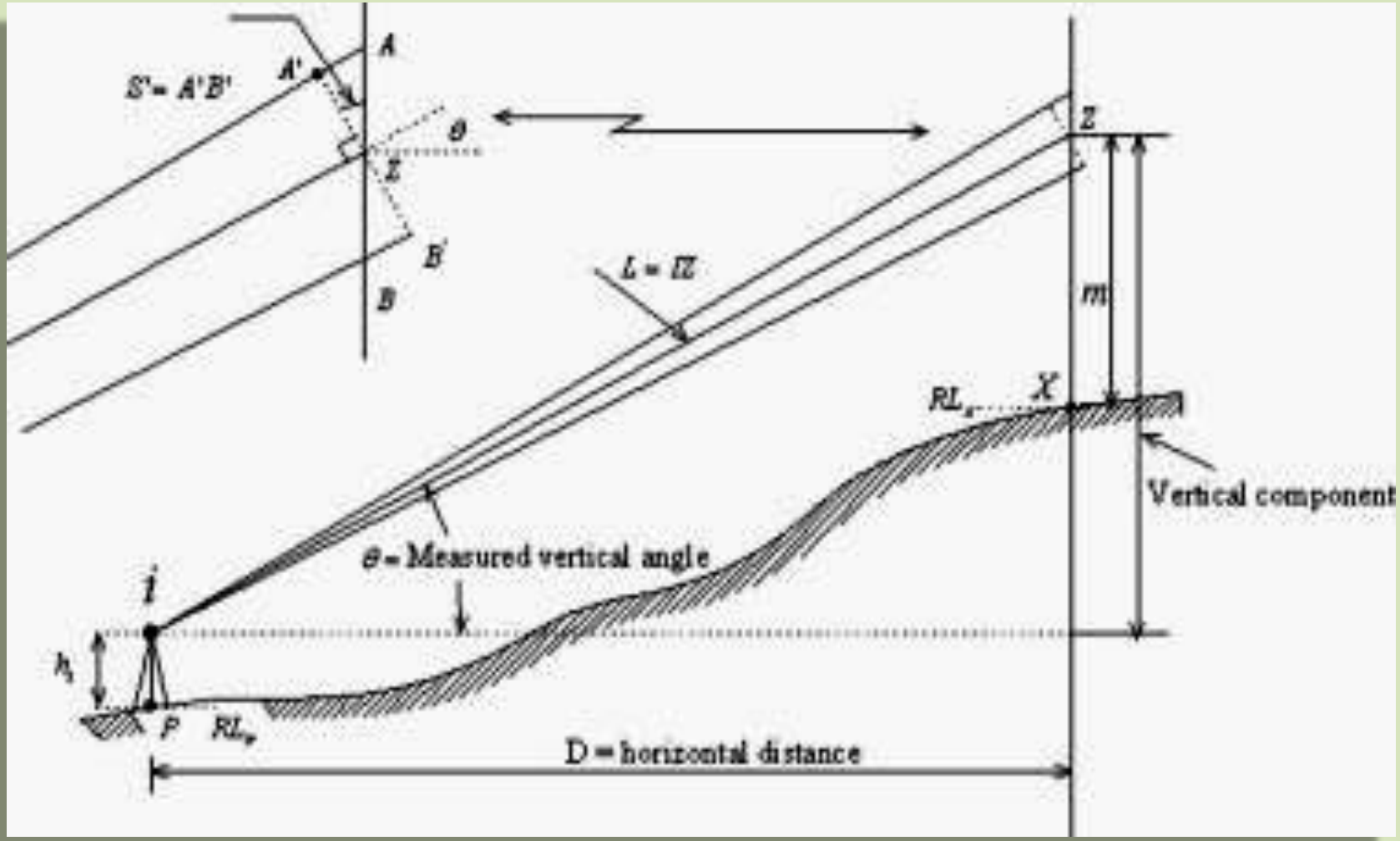


Tachometry Survey

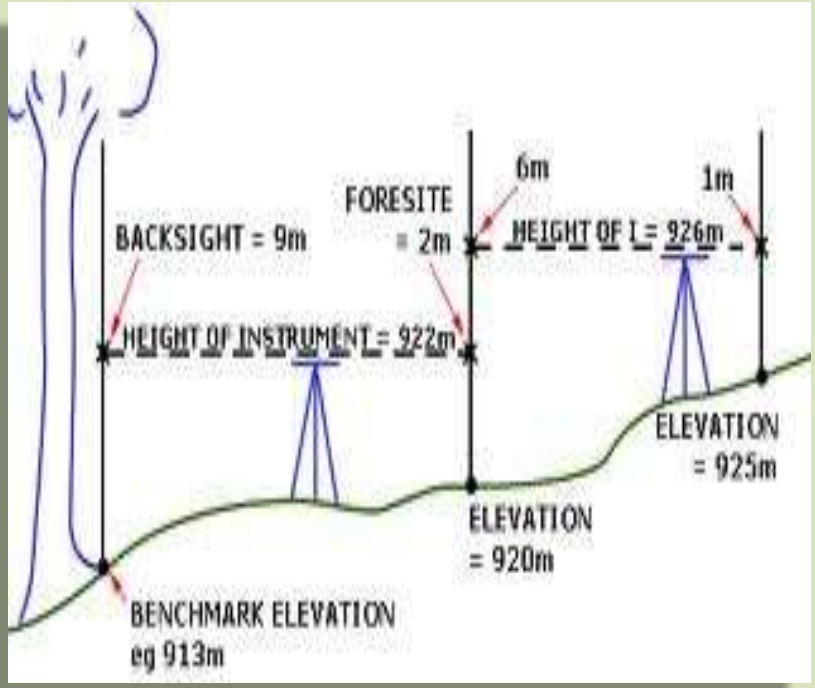




Tachometry Survey

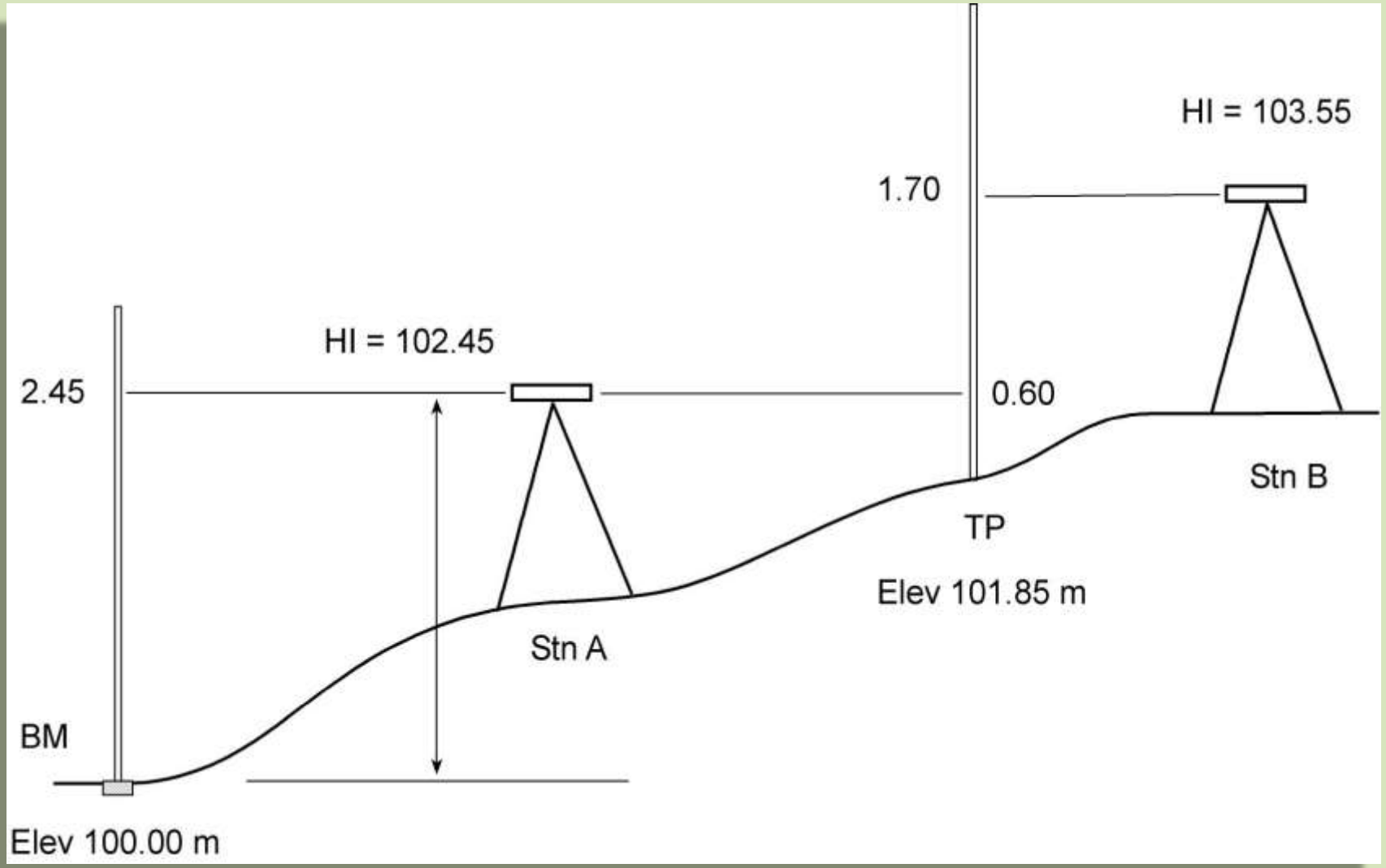


Leveling Survey



Leveling Survey

Leveling Survey

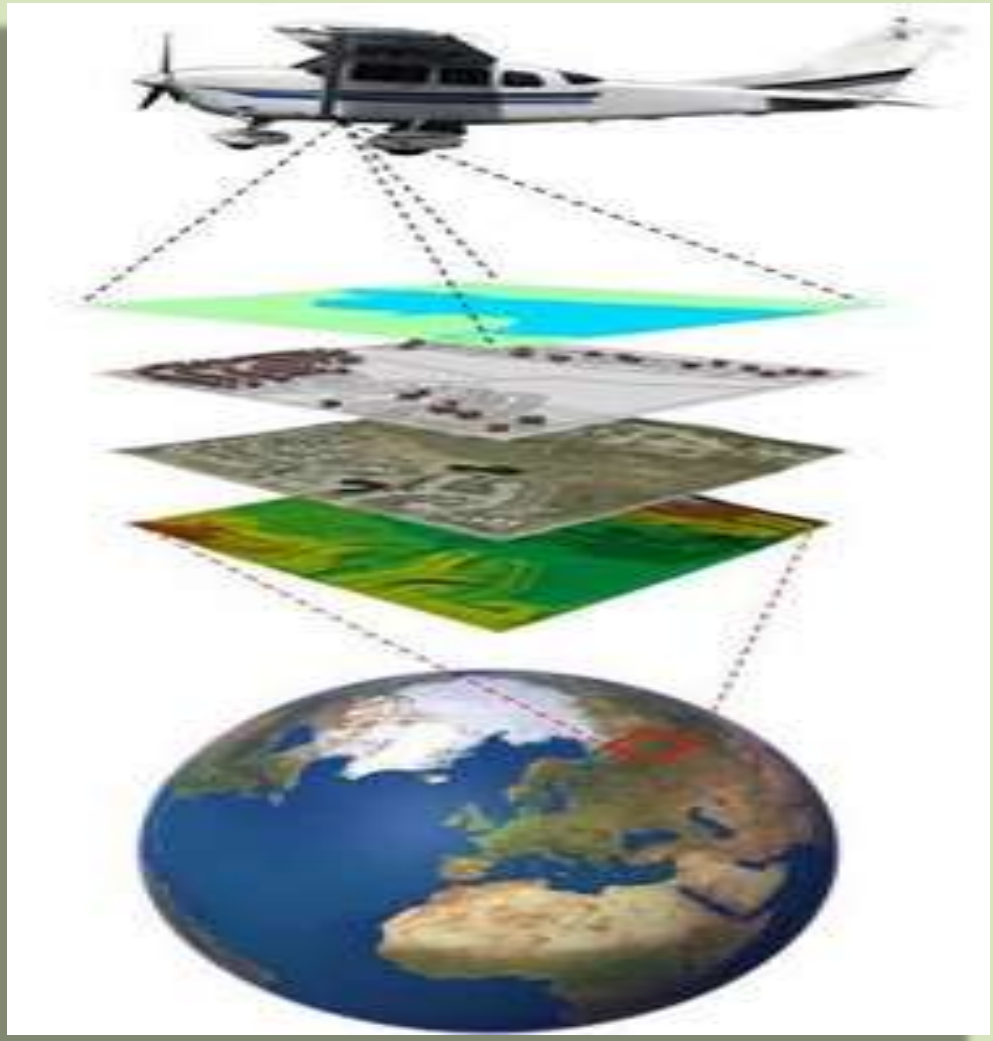


Classification of Surveying

- **Photogrammetric Survey:**
- Photogrammetry is the science of taking measurements with the help of photographs taken by aerial camera from the air craft.
- **EDM Survey:**
- In this type of survey all measurements (length, angles, co-ordinates) are made with the help of EDM instrument (i.e.. Total Station).

Photogrammetric Survey

Photogrammetric Survey



EDM Survey


Targeting Sight
Objective Lens
Horizontal Clamp Knob
Horizontal Tangent Screw
Display Window
Operating Keys
Leveling Screws
Instrument Center Mark
Optical Plummet
Tripod Base Plate

EDM Survey

EDM Survey

Classification of Surveying

- Classification Based on methods.
- **Triangulation:**
- Triangulation is basic method of surveying, when the area to be surveyed is large, triangulation is adopted. The entire area is divided into network of triangles.
- **Traversing:**
- A Traversing is circuit of survey lines. It may be open or closed. When the linear measurements are done with a chain and a tape and the directions or horizontal angles are measured with a compass or a theodolite respectively the survey is called traversing.

Triangulation

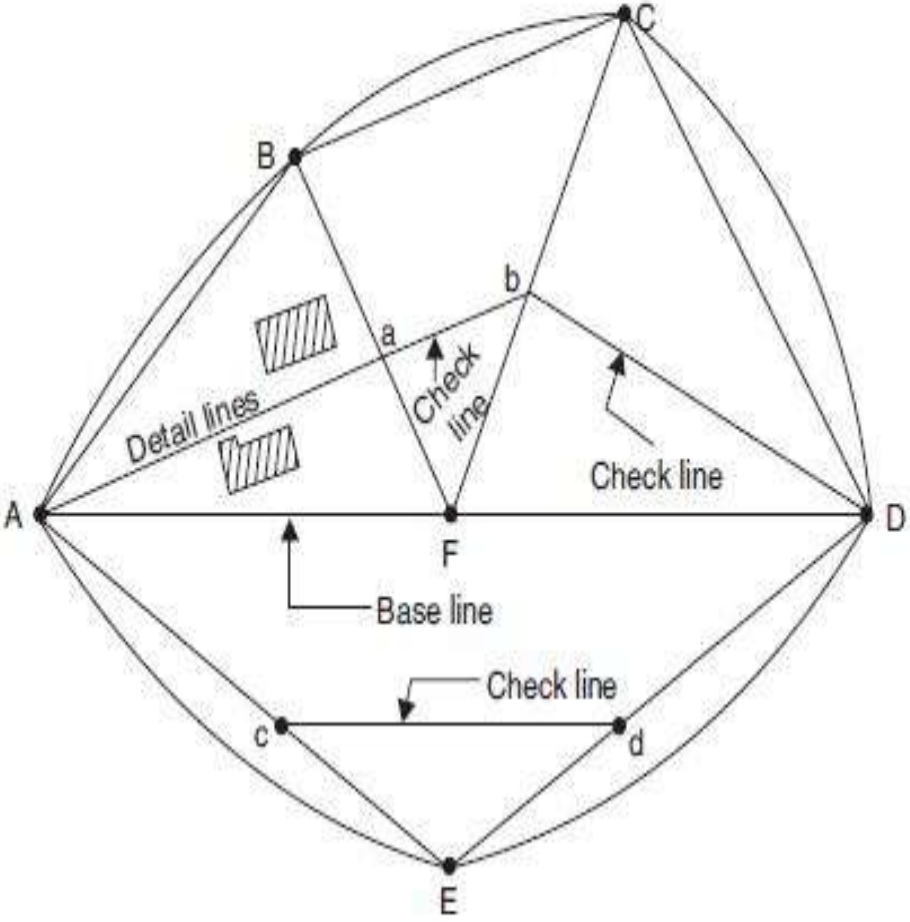
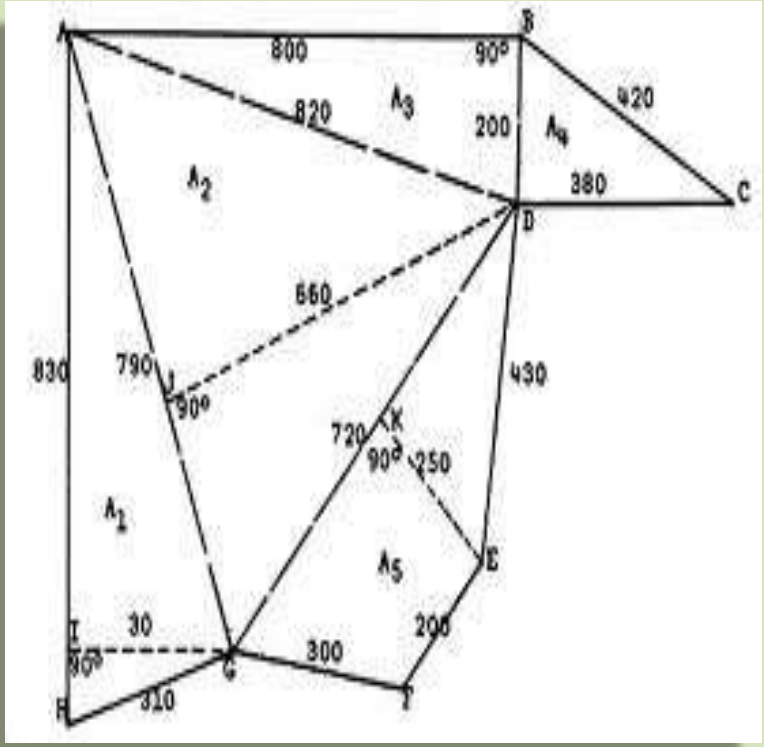
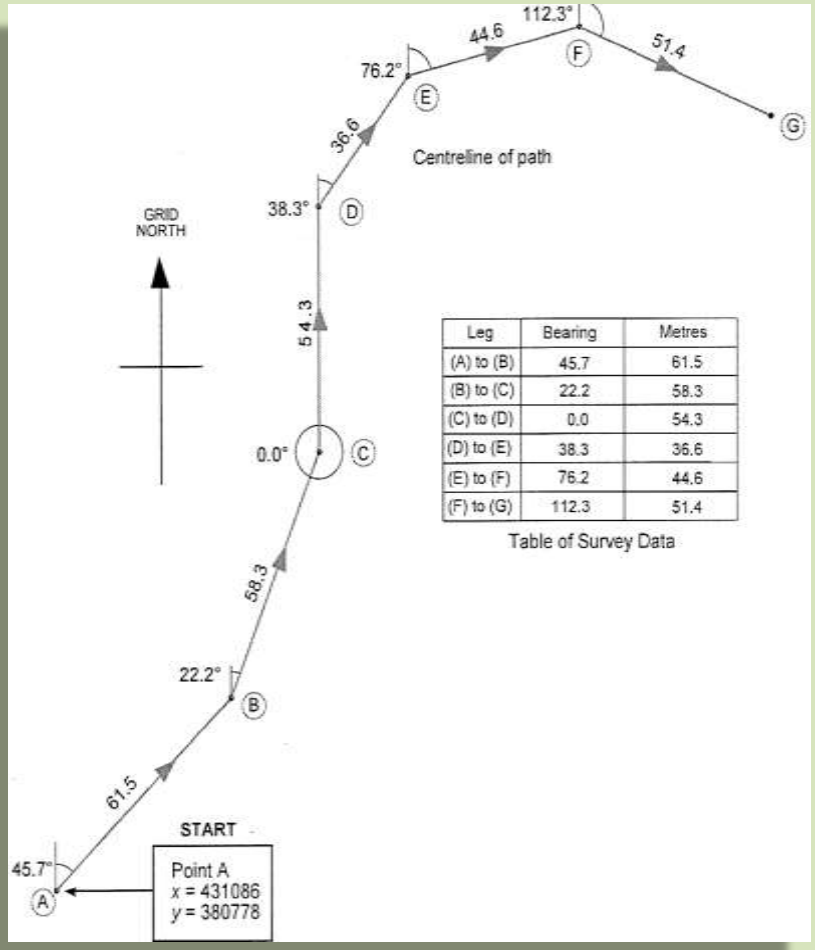


Fig. 12.11. Network of triangles



Traversing



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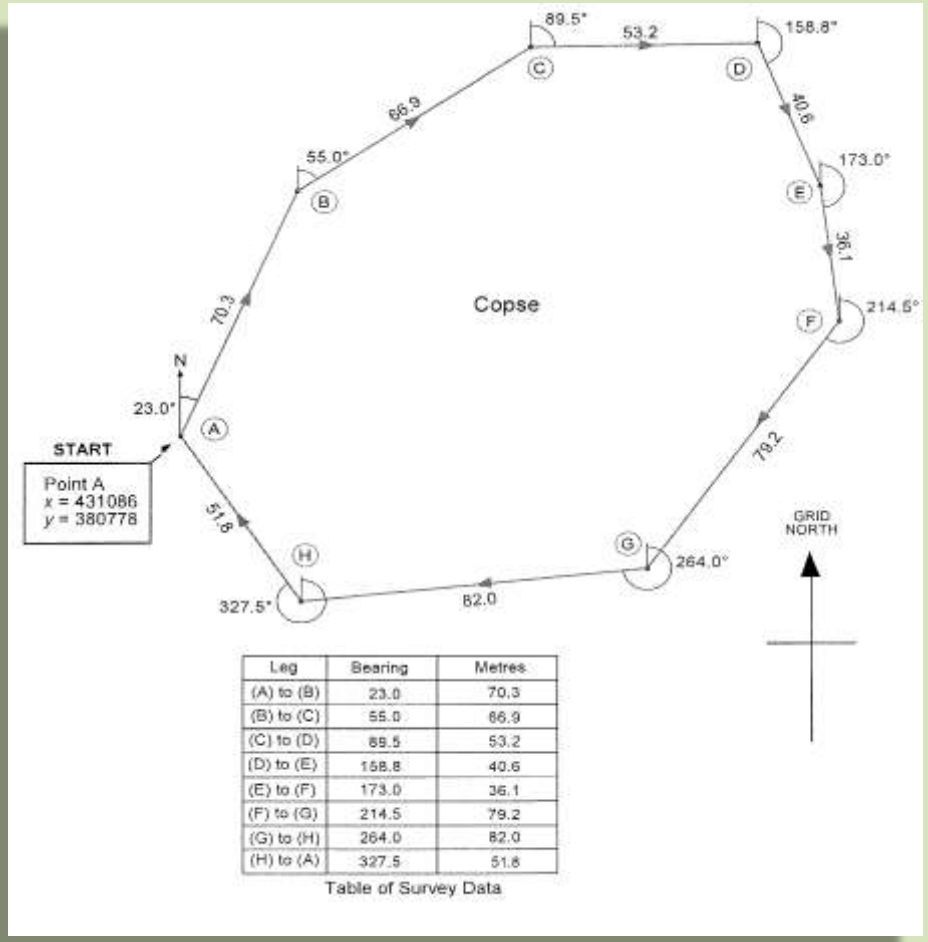
(A) to (B)	45.7	61.5
(B) to (C)	22.2	58.3
(C) to (D)	0.0	54.3
(D) to (E)	38.3	36.6
(E) to (F)	76.2	44.6
(F) to (G)	112.3	51.4

Table of Survey Data



Leg	Bearing	Metres
(A) to (B)	23.0	70.3
(B) to (C)	55.0	66.9
(C) to (D)	89.5	53.2
(D) to (E)	158.8	40.6
(E) to (F)	173.0	36.1
(F) to (G)	214.5	79.2
(G) to (H)	264.0	82.0
(H) to (A)	327.5	51.8

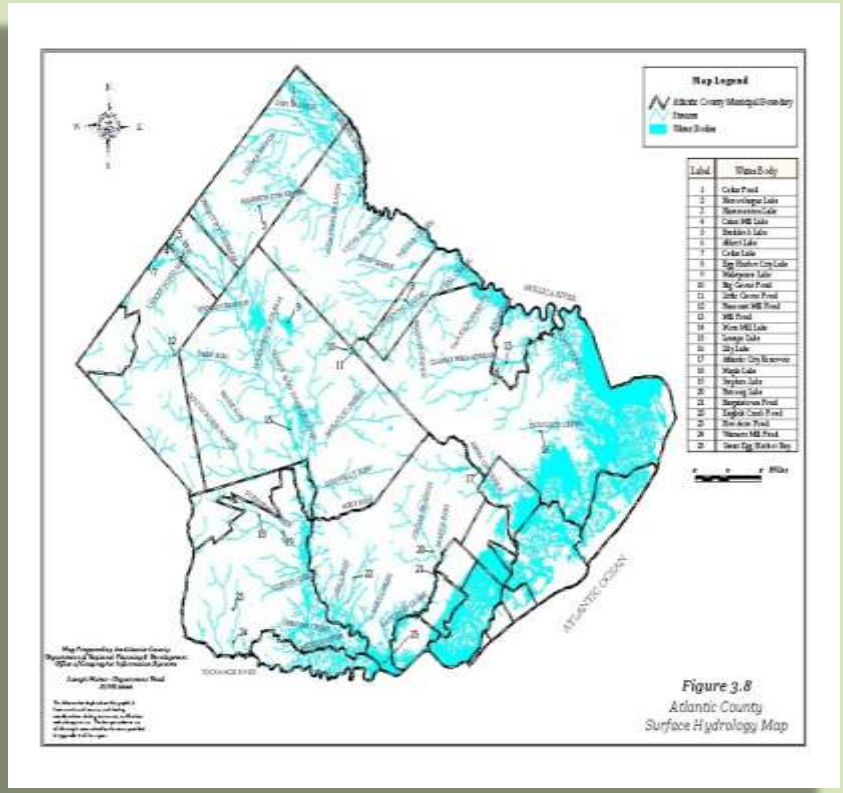
Table of Survey Data

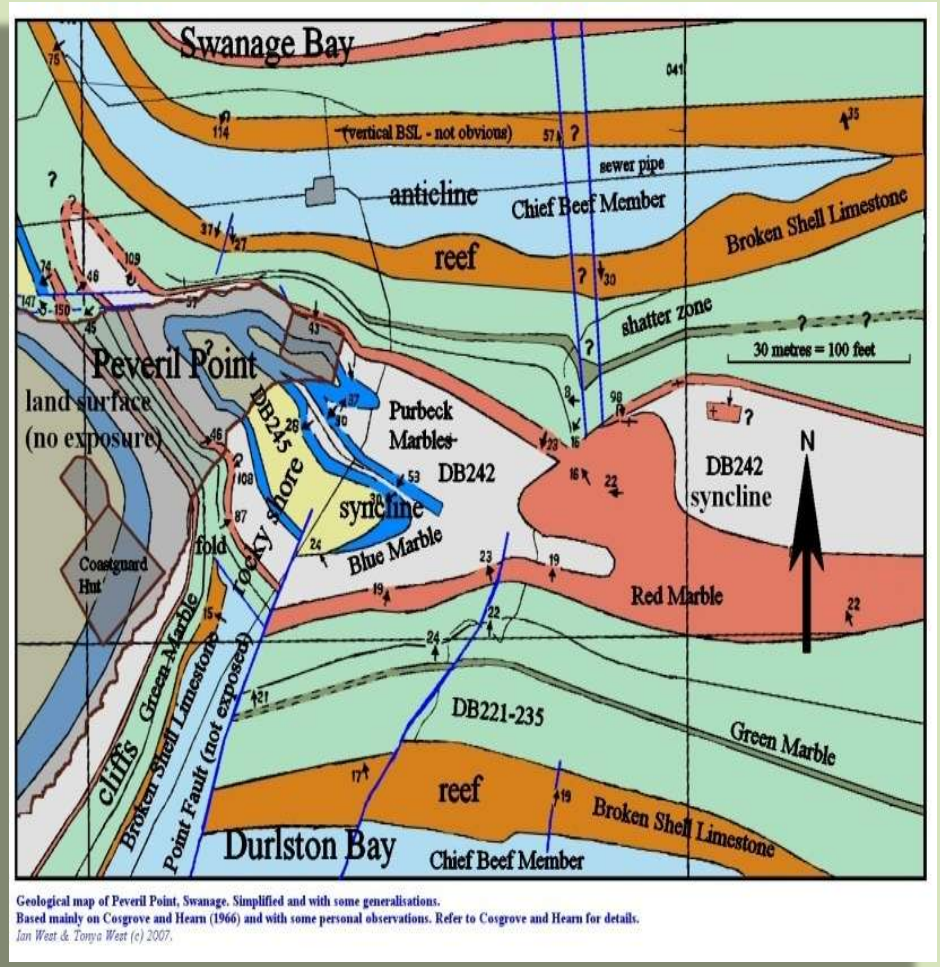
Classification of Surveying

- Classification based on Purpose
- **Geological Survey:**
- In this both surface and subsurface surveying are conducted to locate different minerals and rocks. In addition, geological features of the terrain such as folds and faults are located.

Geological Survey

Geological Maps





Geological map of Peveril Point, Swanage. Simplified and with some generalisations.
Based mainly on Cosgrove and Hearn (1966) and with some personal observations. Refer to Cosgrove and Hearn for details.
Ian West & Tonya West (c) 2007.

Hydrological Maps

Classification of Surveying

- **Mine Survey**
- Mine Survey includes include both surface and underground surveys. It is conducted for the exploration of mineral deposits and to guide tunneling and other operations associated with mining.

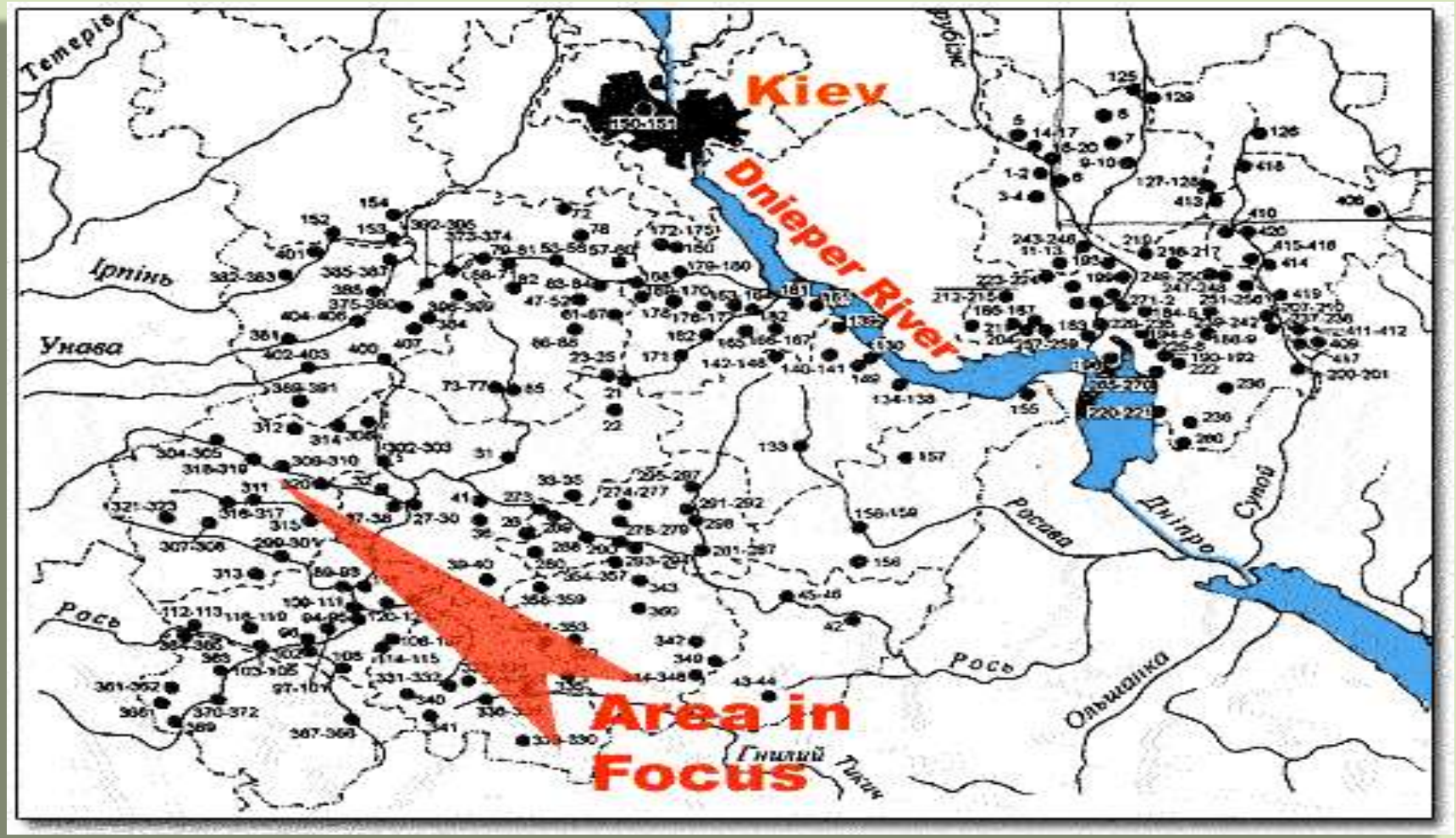
Mine Survey

Classification of Surveying

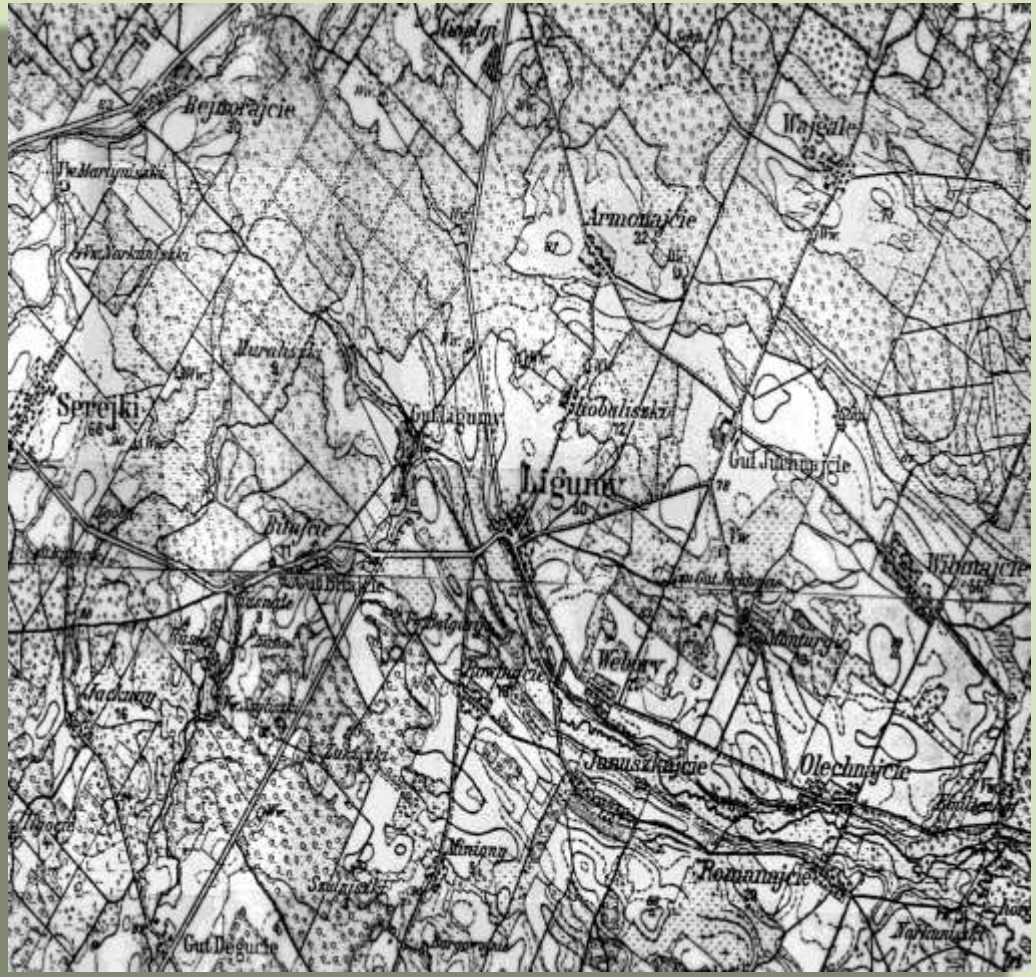
- **Archaeological Survey**
- It is conducted to locate relics of antiquity, civilization, kingdoms, forts, temples, etc.

- **Military Survey**
- It has a very important and critical applications in the military. Aerial surveys are conducted for this purpose. It is conducted to locate strategic positions for the purpose of army operations.

Archaeological Survey



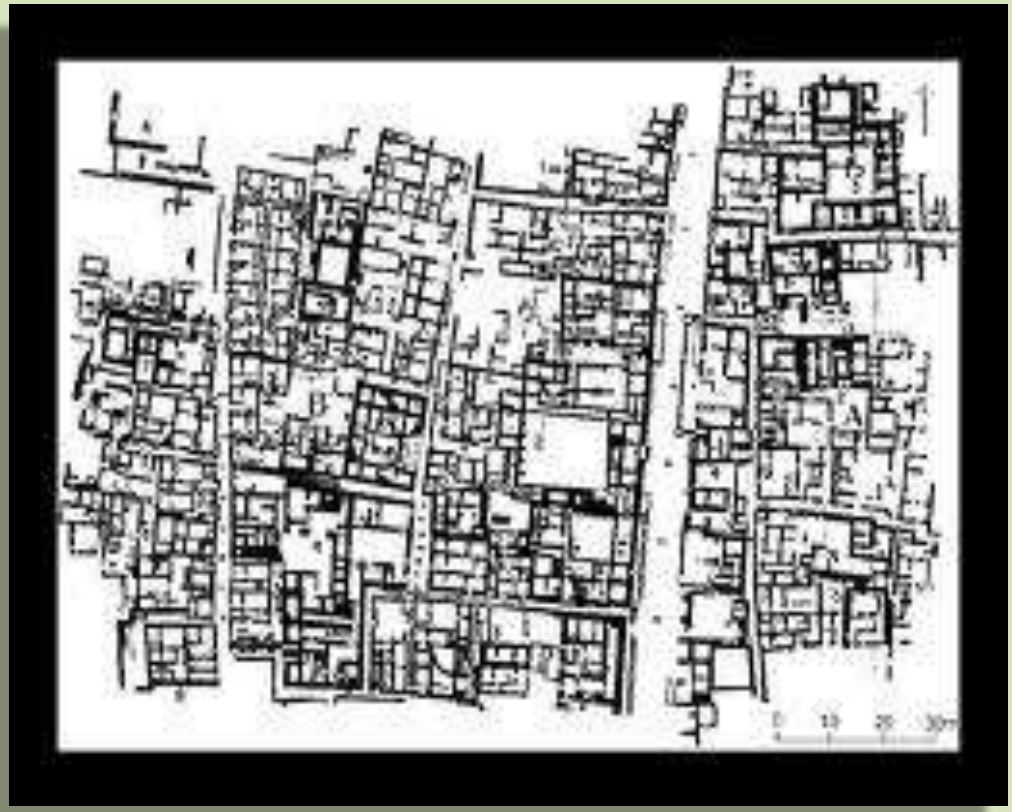
Military Survey



Classification of Surveying

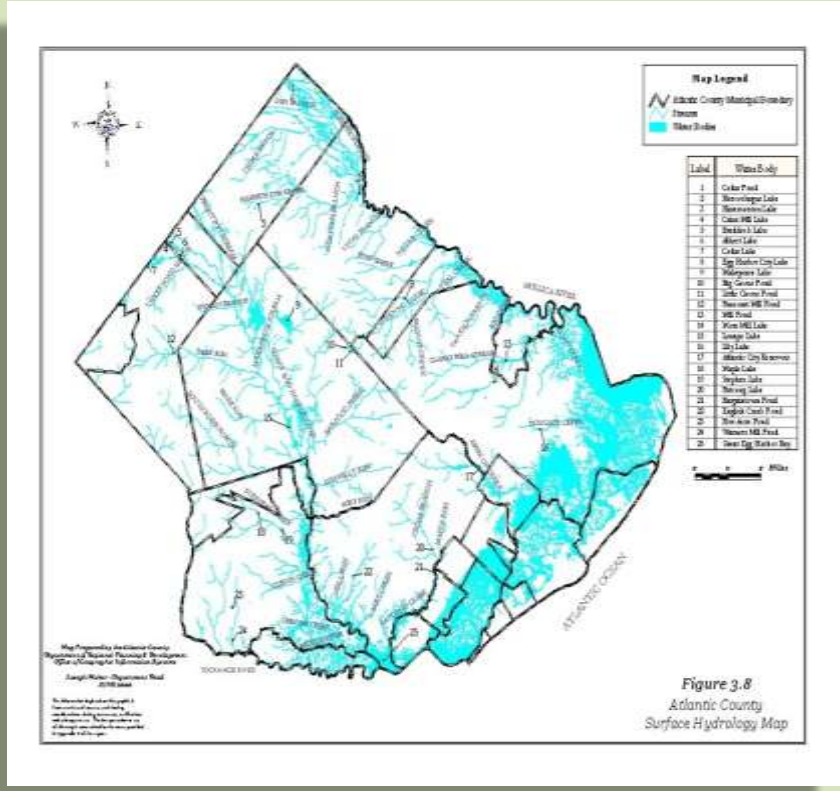
- Classification based on Nature of field
- **Land Survey**
- Land Survey is done on land to prepare plan and maps of a given area. Topographical, city and cadastral surveys are some of the examples of land surveying.
- **Hydrological Surveying**
- This survey is conducted on or near the body of water such as lake, river, coastal area. This Survey consists of locating shore lines of water bodies.

Land Survey



Hydrological Surveying

Hydrological Maps

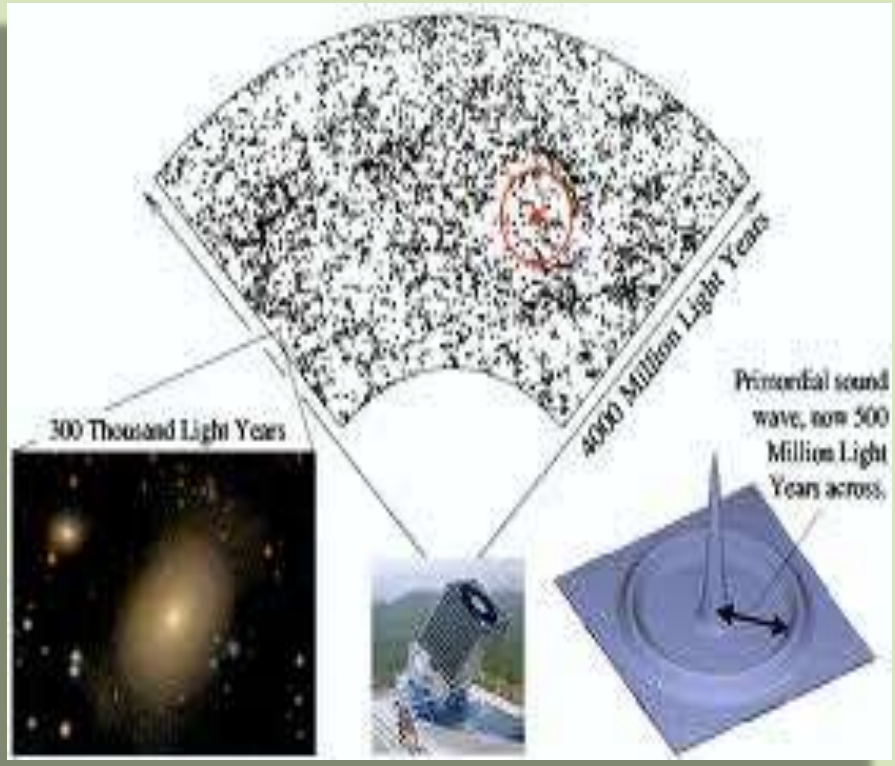


Hydrological Maps

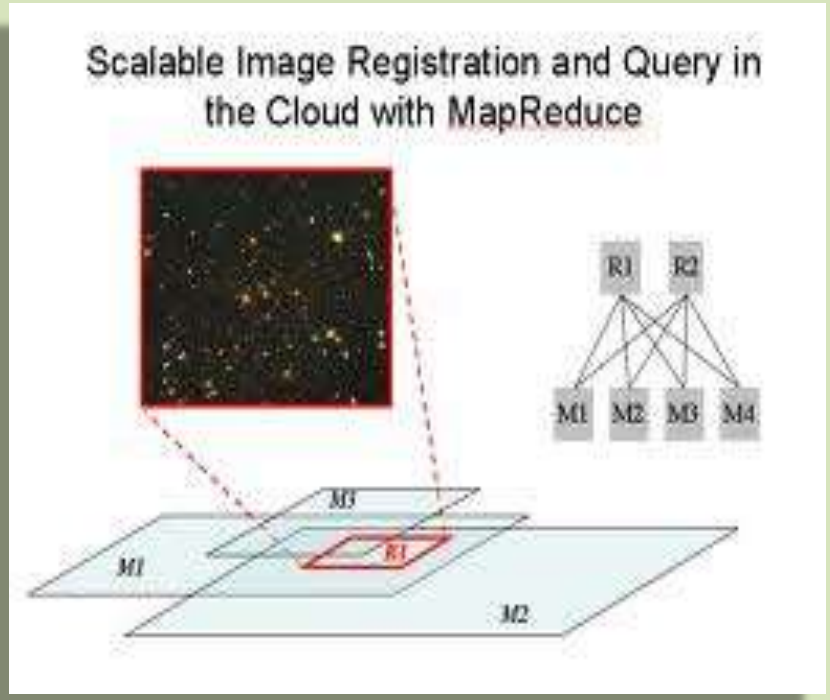
Classification of Surveying

- **Astronomical Survey**
- This survey is conducted for the determining of latitudes, longitudes, azimuths, local time, etc. for various places on earth by observing heavenly bodies (sun or the stars).
- **Aerial Survey**
- An aerial survey is conducted from aircraft. Aerial cameras take photographs of the surface of the earth in overlapping strips of land. This is also known as photographic survey.

Astronomical Survey

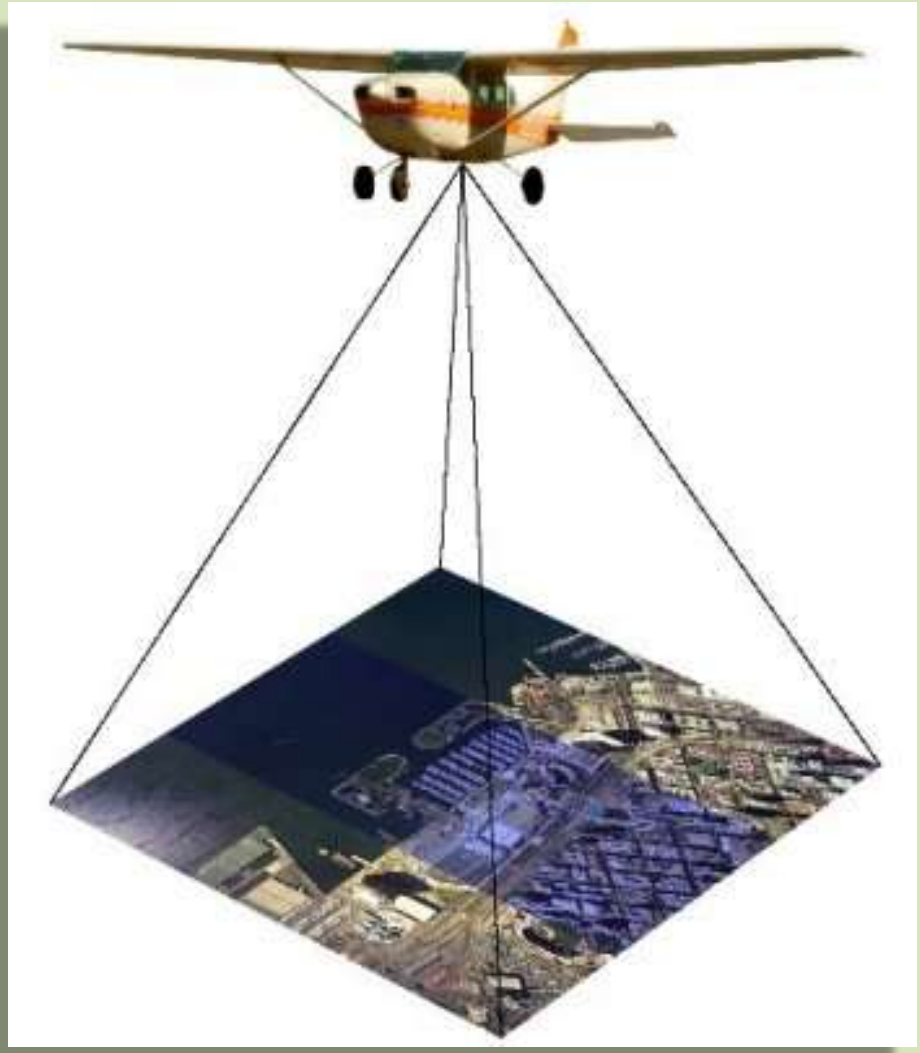


Astronomical Survey



Astronomical Survey

Aerial Survey



Plan and Maps

- One of the basic objective of surveying is to prepare plans and maps.
- **Plan**
- A plan is the graphical representation to some scale, of the features on, near or below the surface of the earth as projected on a horizontal plane. The horizontal plane is represented by plane of drawing sheets on which the plan is drawn to some scale However the surface of the earth is curved it cannot be truly represented on a plane without distortion. In plane surveying the area involved are small, the earth's surface may be considered as plane and hence plan is constructed by orthographic projections. A plan is drawn on a relatively large scale.

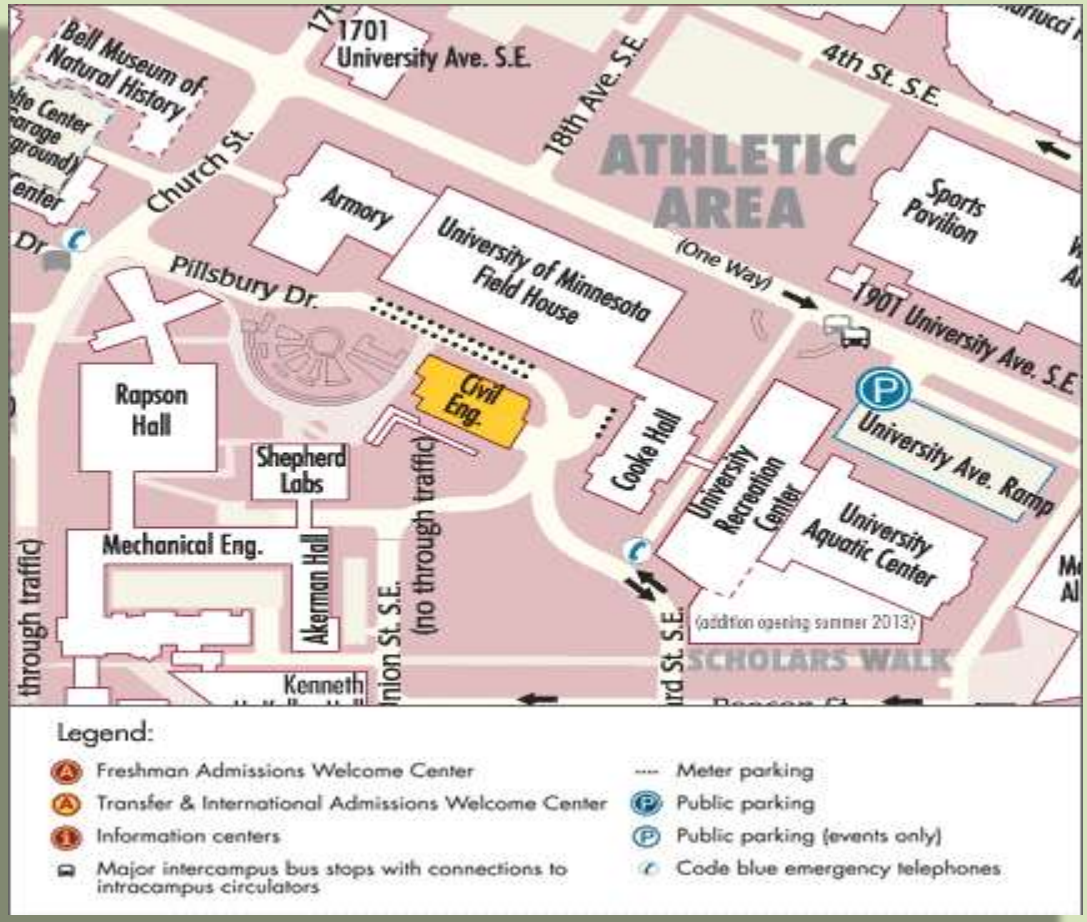
Plan and Maps

- **Map**
- If the scale of the graphical projection on a horizontal plane is small, the plan is called a map. Thus graphical representation is called a plan if the scale is large while it is called a map if the scale is small.
- On plan, generally only horizontal distances and directions or angles are shown. On topographical map, however the vertical distances (elevations) are also represented by contour lines.

Plan


Master Plan
RESIDENTIAL ENTRY & EXIT
OFFICE ENTRY & EXIT
OFFICE BUILDING
RESIDENTIAL BUILDING
DROP OFF
18.2M WIDE ROAD
PARK & OPEN SPACE
1
2
3
4
5
6
7
8

Map

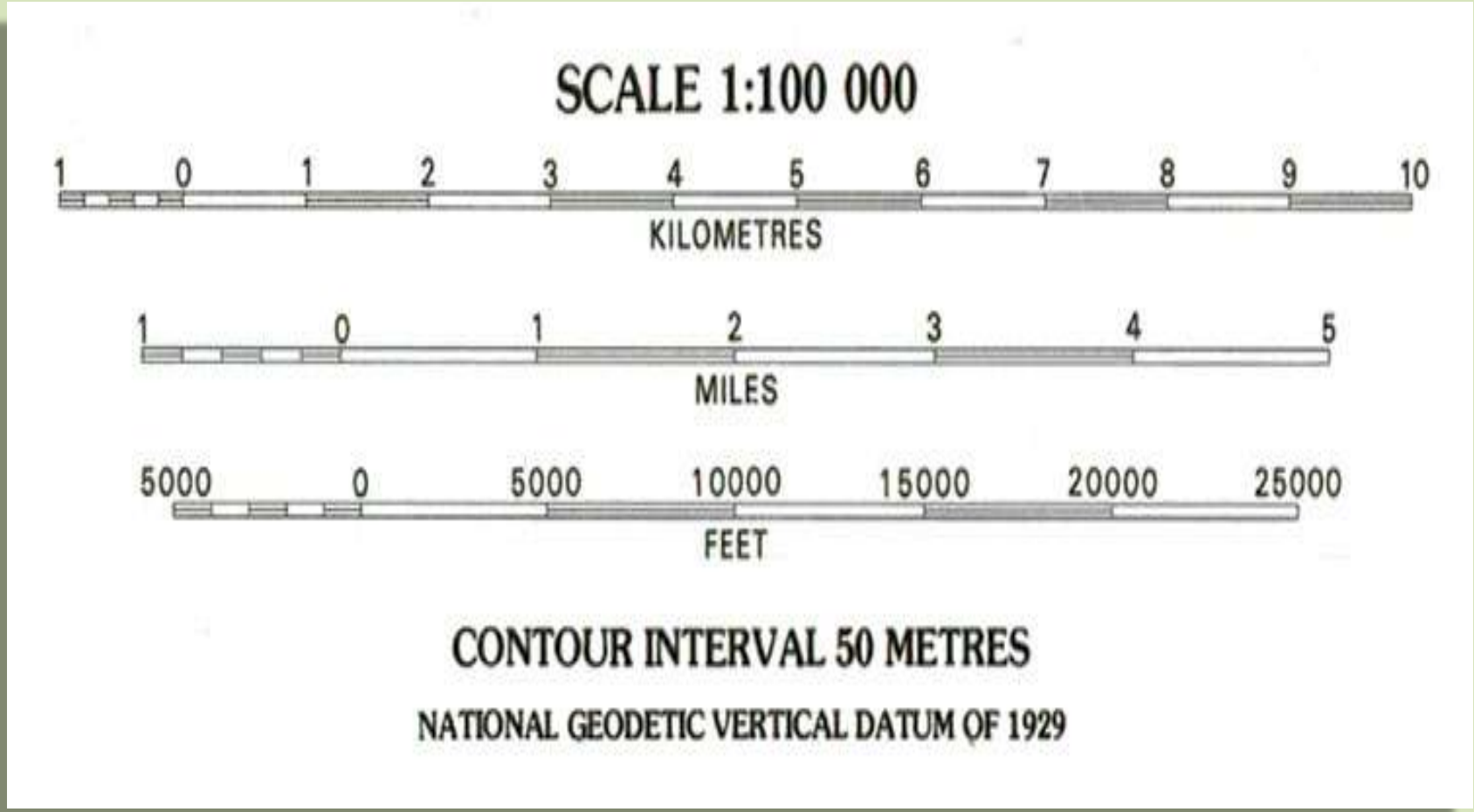

Bell Museum of Natural History
1701 University Ave. S.E.
18th Ave. S.E.
4th St. S.E.
Church St.
ATHLETIC AREA
Armory
University of Minnesota Field House
Sports Pavilion
(One Way)
1901 University Ave. S.E.
Pillsbury Dr.
Rapson Hall
Civil Eng.
Shepherd Labs
Cooke Hall
University Recreation Center
University Ave. Ramp
University Aquatic Center
Mechanical Eng.
Akerman Hall
(addition opening summer 2013)
SCHOLARS WALK
Kenneth
(no through traffic)
Legend:
Freshman Admissions Welcome Center
Transfer & International Admissions Welcome Center
Information centers
Major intercampus bus stops with connections to intracampus circulators
Meter parking
Public parking
Public parking (events only)
Code blue emergency telephones


SPILLWAY 697
Pilarcitos Lake
28
BM 704

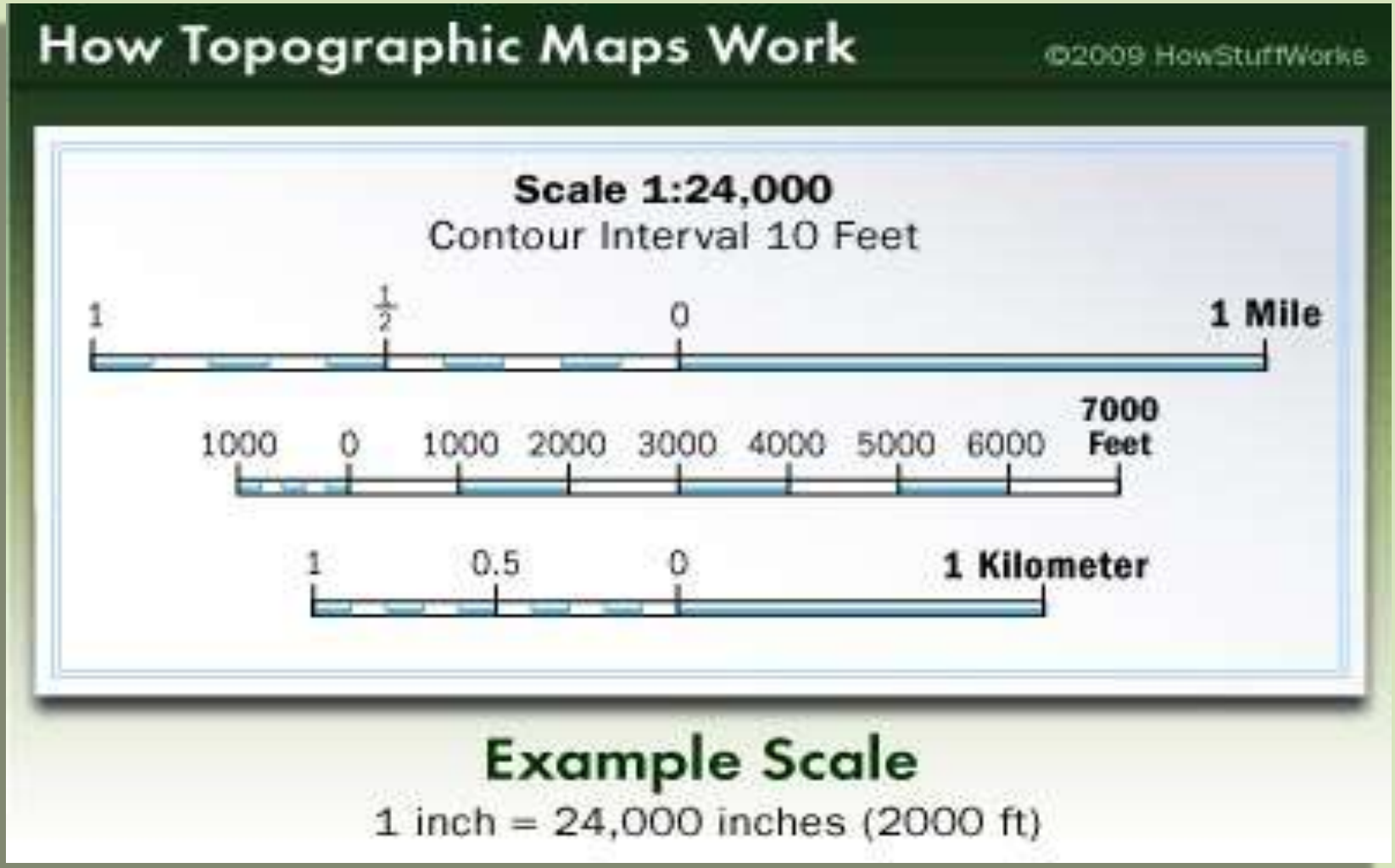
Plan and Maps

- **Scale**
- It is basic requirement for the preparation of plan or map Scale is used to represent large distances on paper. The ratio by which the actual length of the object is reduced or increased in the drawing is known as the ‘Scale’ for example., if 1 cm on a map represents a distance of 10 metres on the ground, the scale of the map is said to be 1 cm = 10 m.

Scale


SCALE 1:100 000
1 0 1 2 3 4 5 6 7 8 9 10
KILOMETRES
1 0 1 2 3 4 5
MILES
5000 0 5000 10000 15000 20000 25000
FEET
CONTOUR INTERVAL 50 METRES
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Scale


How Topographic Maps Work
©2009 HowStuffWorks
Scale 1:24,000
Contour Interval 10 Feet
1
1/2
0
1 Mile
1000
0
1000
2000
3000
4000
5000
6000
7000 Feet
1
0.5
0
1 Kilometer
Example Scale
1 inch = 24,000 inches (2000 ft)

Representative Fraction

- The ratio of the distance on the drawing to the corresponding actual length of the object on the ground is known as the representative fractions. i.e..
- **R.F= Distance of the Object on Drawing**

  Corresponding Actual distance of object on Ground

Both the distances are in same unit.

Representative Fraction

- For example,
- If a scale is
- 1 cm = 10 m
- R.F. = $\frac{1}{10 \times 100} = \frac{1}{1000}$ or 1: 1000

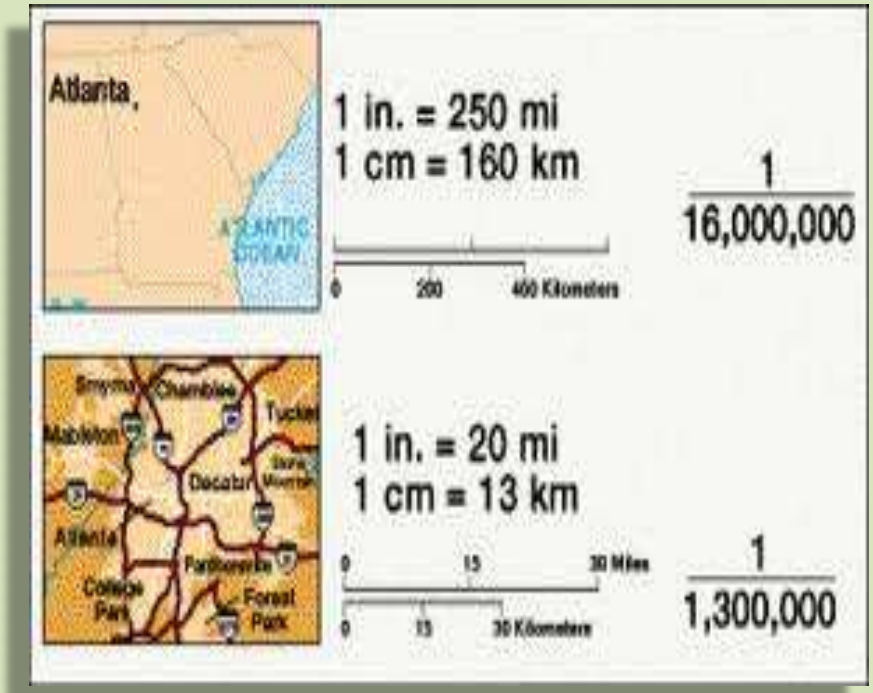
Representative Fraction

- For example,
- If a scale is
- 1 cm = 100 m
- R.F. = $\frac{1}{100 \times 100} = \frac{1}{10000}$ or 1: 10000

Representative Fraction

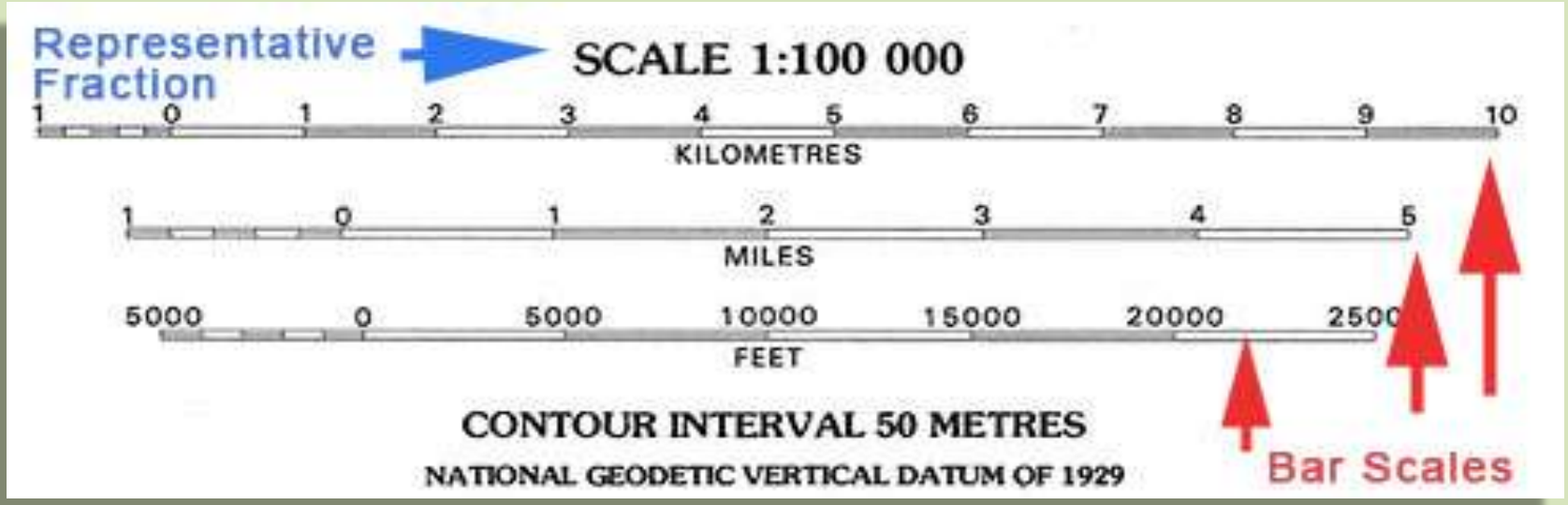
- For example,
- If a scale is
- 1 cm = 1000 m or 1 km
- R.F. = $\frac{1}{100000} = \frac{1}{1 \times 1000 \times 100} = \frac{1}{100000}$ or 1:

Representative Fraction



Graphical Representation of Scale

- Graphical representation of scale on maps has the advantage that if the paper shrinks, the scale will also shrink accordingly and the distance representation will not be disturbed.

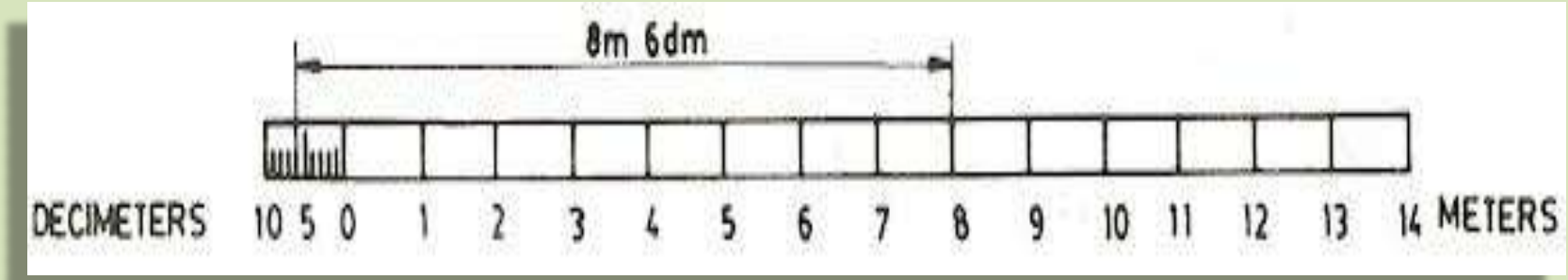


Types of Scales

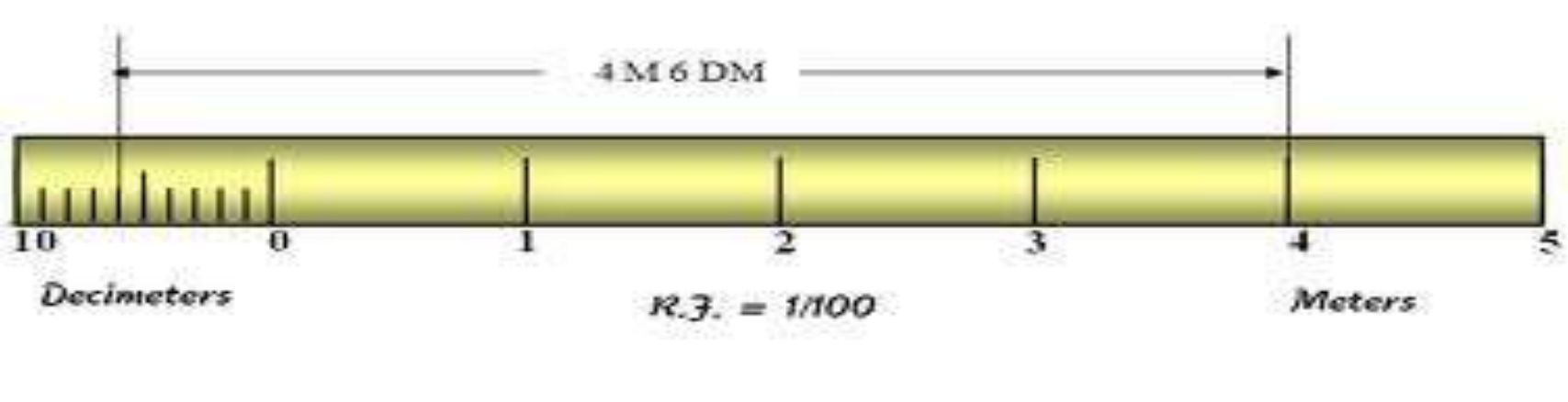
- (a) Plain Scale
- (b) Diagonal Scale
- (c) Chord Scale
- (d) Vernier Scale

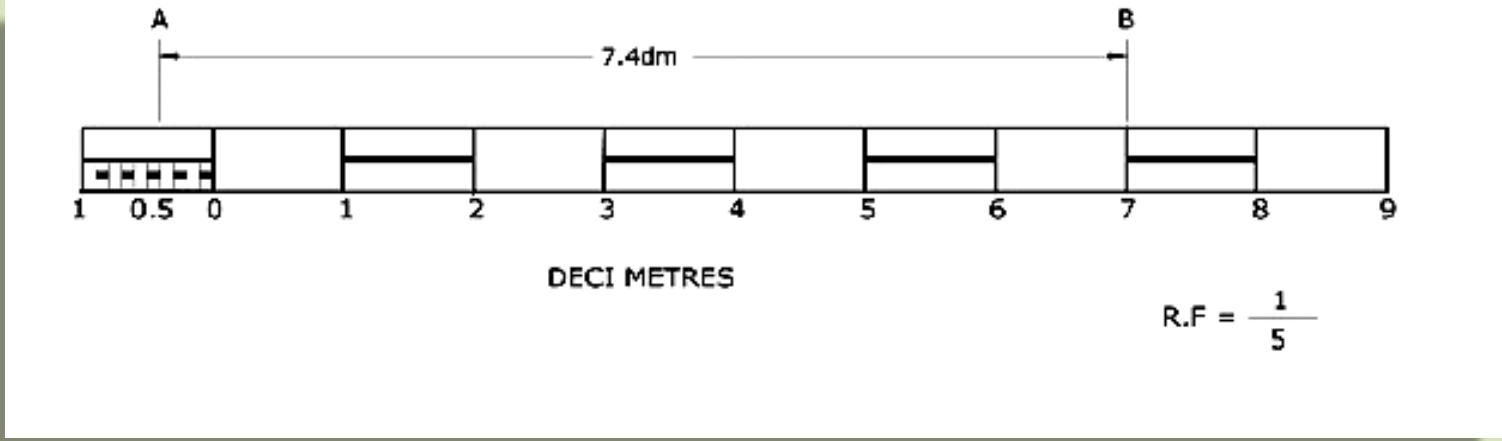
Types of Scales

- **Plain Scale**
- The plain Scale is the most commonly used in maps, this scale is used to represent two successive units, such as tenths, metres, decimetres, etc.



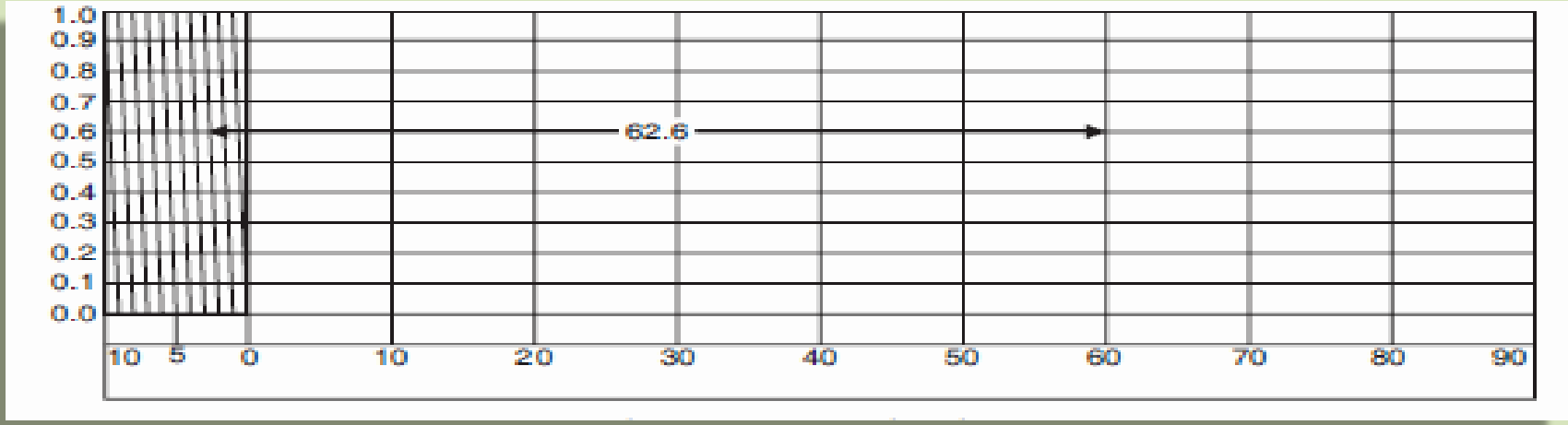
Plain Scale


4 M 6 DM
10
0
1
2
3
4
5
Decimeters
R.F. = 1/100
Meters

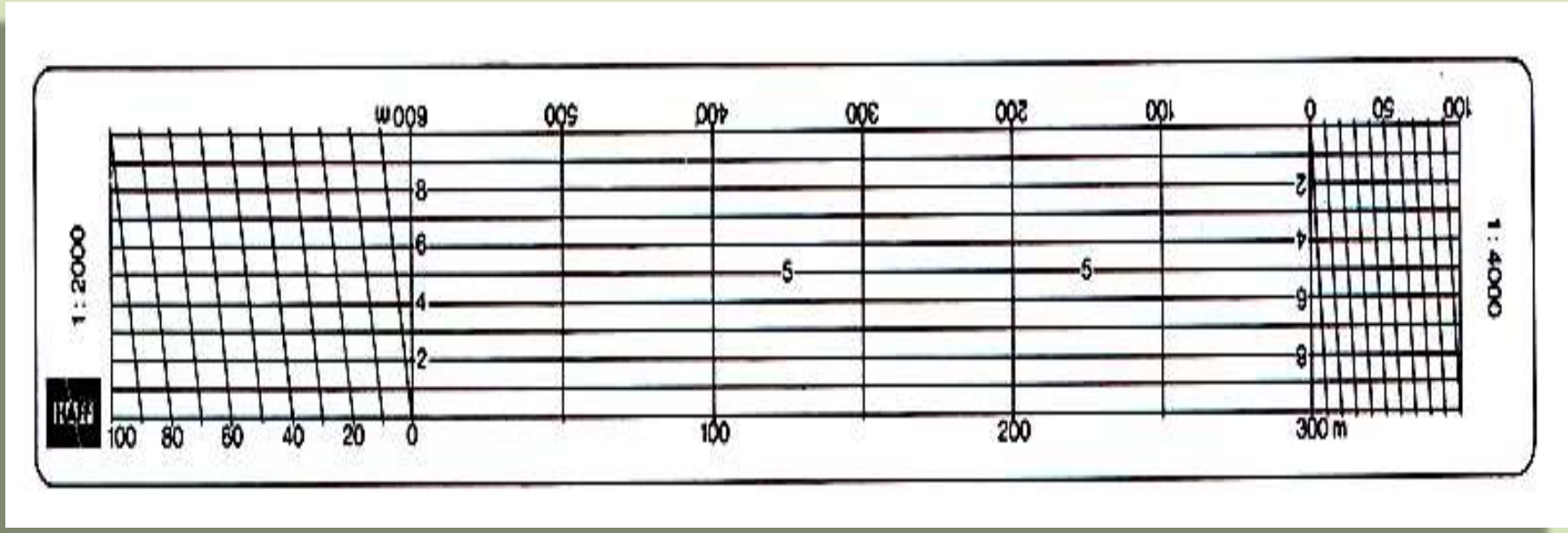

A
B
7.4dm
1
0.5
0
1
2
3
4
5
6
7
8
9
DECI METRES
R.F = 1/5

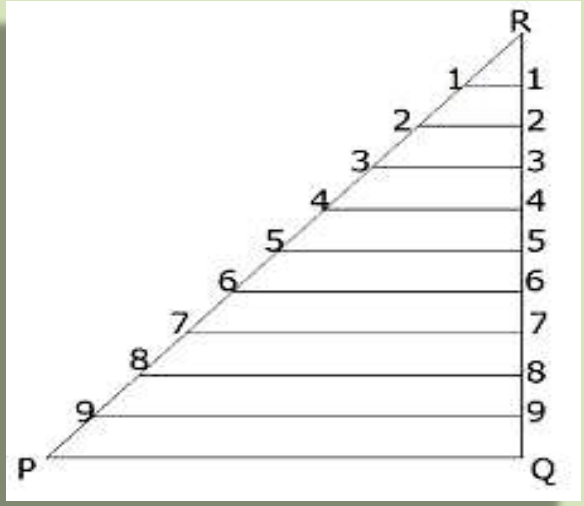
Types of Scales

- **Diagonal Scale**
- Using a diagonal scale, one can measure three dimensions such as “ Units, tenths and hundredths”, i.e. metre, decimeter, and centimetres, and so on.

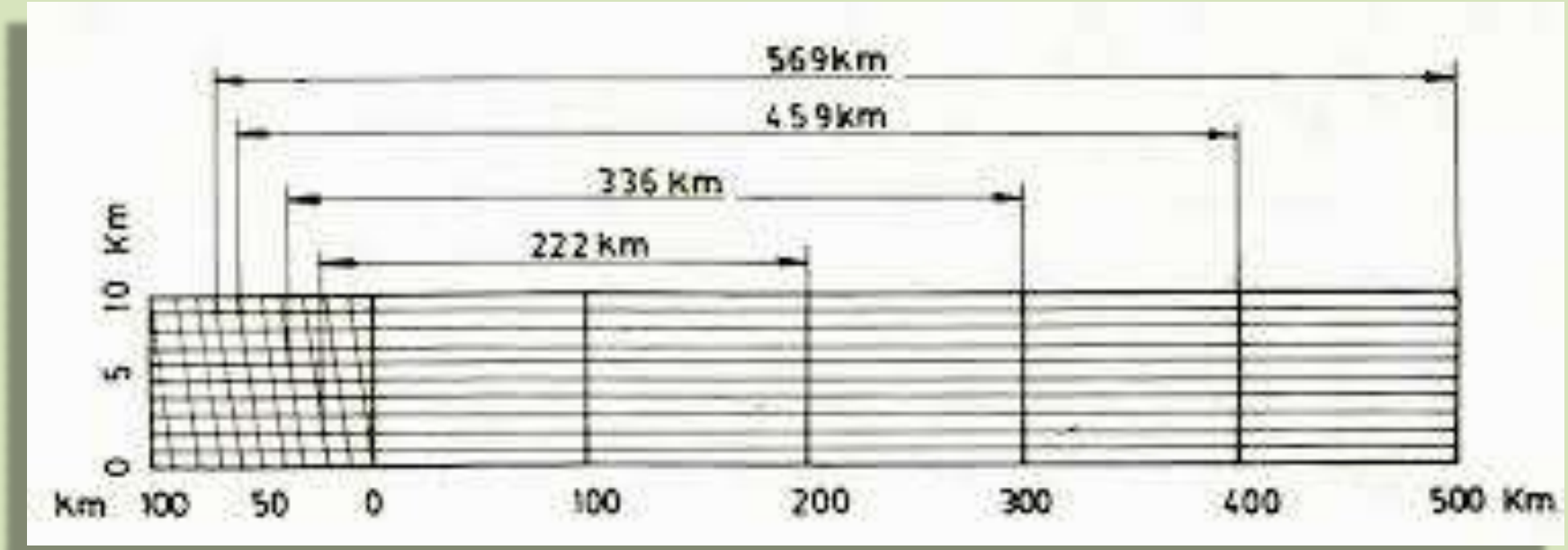


Diagonal Scale





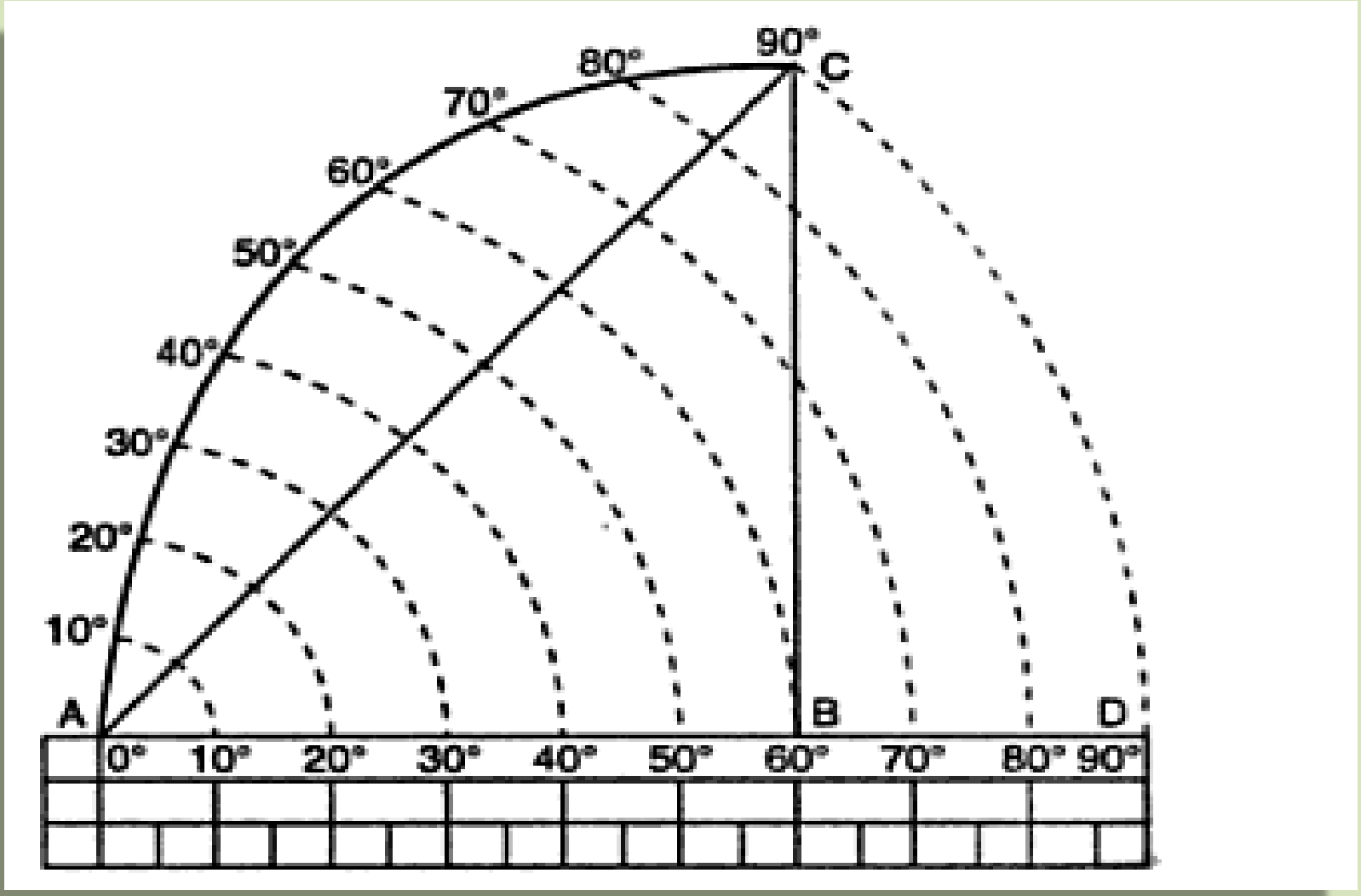
Diagonal Scale



Types of Scales

- **Chord Scale**
- A scale of chord is used to measure or to set off angles. It is marked either on rectangular or on an ordinary wooden scale.

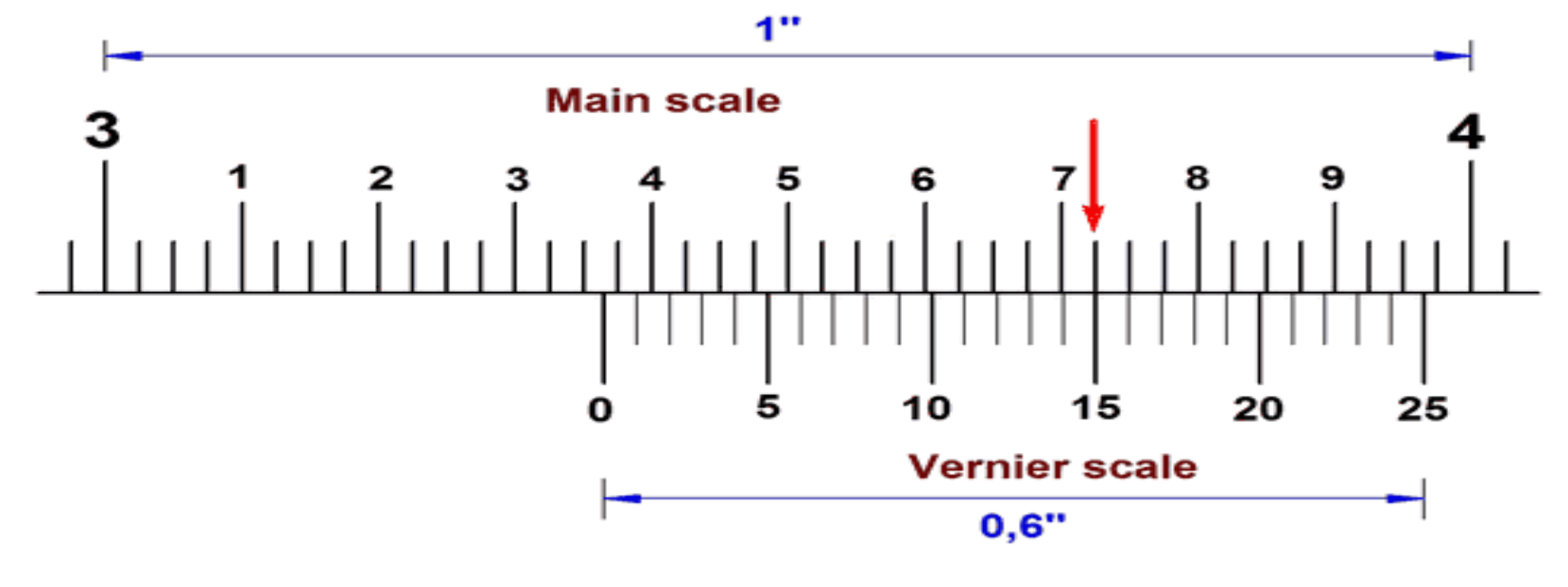
Chord Scale

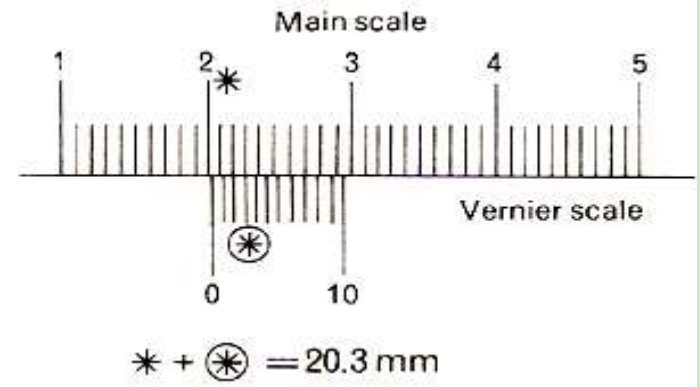


Types of Scales

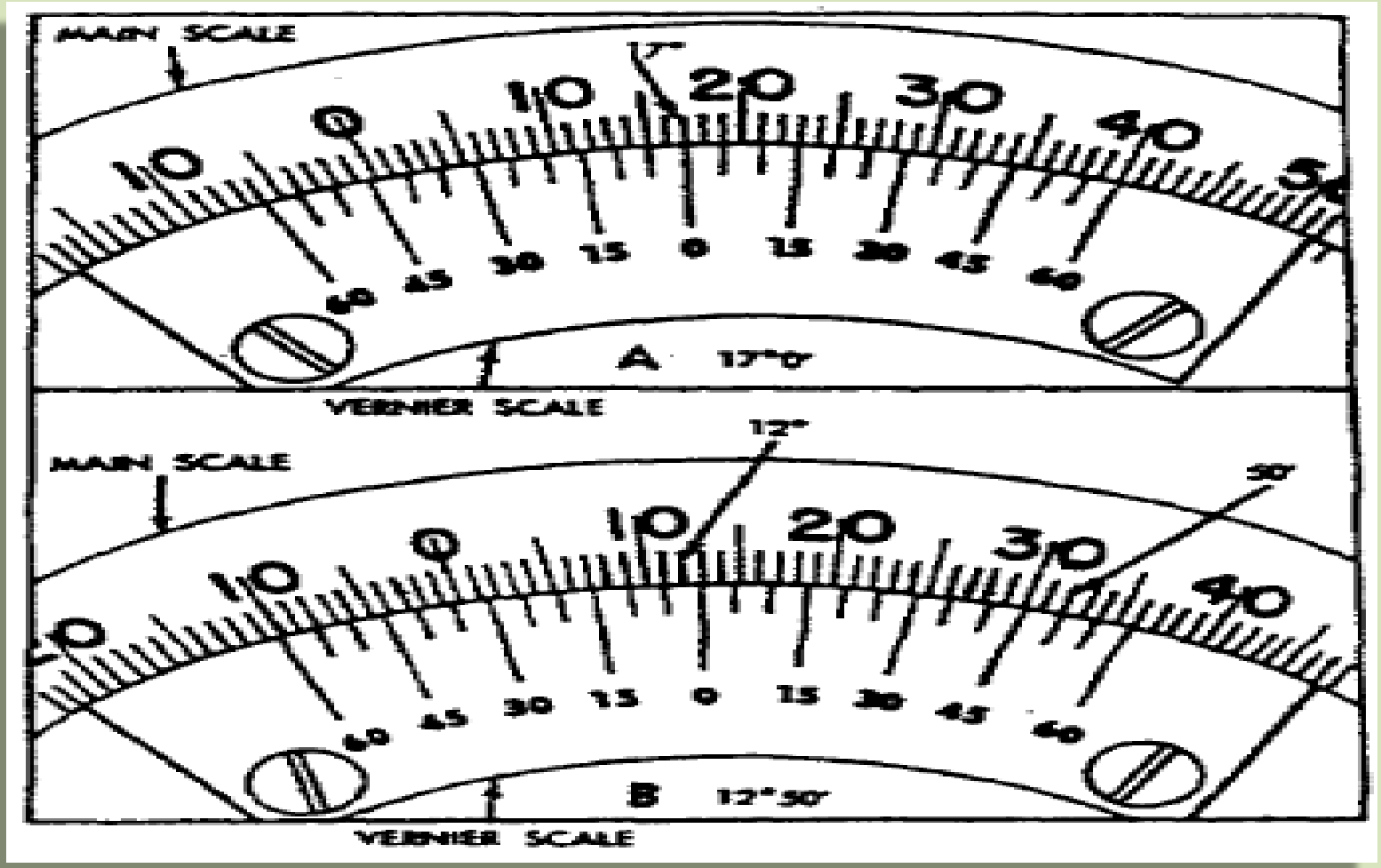
- **Vernier Scale**
- In 1631, Pierre Vernier invented a device for the purpose of measuring a fractional part of a graduated scale. It consists of two approximating scales, one of them is fixed and is called the primary scale. The other movable and is called the vernier.

Vernier Scale





Vernier Scale



Choice of Scale of a Map

- Scale of a map is the ratio of the distance drawn on the map to the corresponding distance on the ground. As the area involved are rather large, it is essential to select a suitable scale for representing the area on a map. Selection of the scale depends upon the purpose, size and the required precision of plotting.

Choice of Scale of a Map

- Scales are generally classified as large, medium and small as under.
- **Large Scale:** 1 cm= 10 m or less than 10 m
- **Medium Scale:** 1 cm = 10 m to 100 m
- **Small Scale:** 1 cm= 100 or more than 100 m

Choice of Scale of a Map

- For most of engineering projects, the scale varies from 1 cm = 2.5 m to 100 m Small scale topographical maps are usually drawn to scale 1 cm = 1 km, a scale of 1 cm= 5 m to 50 m is generally used for plans prepared for subdivisions of land.

Choice of Scale of a Map

Type of Survey	*Scale*	*RF*
1. Building sites	1 cm = 10 m or less (1 : 1000 or less)	$\frac{1}{1000}$ or less
2. Town planning schemes and reservoirs	1 cm = 50 m to 100 m (1 : 5000 to 1 : 10000)	$\frac{1}{5000}$ to $\frac{1}{10000}$
3. Cadastral maps	1 cm = 5 m to 500 m (1 : 5000 to 1 : 50000)	$\frac{1}{500}$ to $\frac{1}{50000}$
4. Location surveys	1 cm = 50 m to 200 m (1 : 5000 to 1 : 20000)	$\frac{1}{5000}$ to $\frac{1}{20000}$
5. Topographic surveys	1 cm = 250 m to 2500 m (1 : 25000 to 1 : 250000)	$\frac{1}{25000}$ to $\frac{1}{250000}$
6. Geographic maps	1 cm = 5000 m to 160000 m (1 : 500000 to 1 : 16000000)	$\frac{1}{500000}$ to $\frac{1}{16000000}$
7. Route surveys	1 cm = 100 m (1 : 10000)	$\frac{1}{10000}$
8. Longitudinal sections		
(*i*) Horizontal scale	1 cm = 10 m to 200 m (1 : 1000 to 1 : 20000)	$\frac{1}{1000}$ to $\frac{1}{20000}$
(*ii*) Vertical scale	1 cm = 1 m to 2 m (1 : 100 to 1 : 200)	$\frac{1}{100}$ to $\frac{1}{200}$
9. Cross-sections (Both horizontal and vertical scales same)	1 cm = 1 m to 2 m (1 : 100 to 1 : 200)	$\frac{1}{100}$ to $\frac{1}{200}$

Units of Measure

- The system of units in India in the recent years in M.K.S. and S.I. but all the records available in surveying done in the past are in F.P.S. units therefore, for an engineer it becomes necessary to know the conversion of units from one system to another, a few are listed below.

Length	Area
1 inch = 2.54 cm	1 are = 100 ^{2}
1 foot = 0.3048 m	100 are= 1 hectare
1 yard = 3 feet	1 hectare = 10,000 m ^{2}
1 mile = 1.609 km	1 hectare = 2.471 acres
1nauticalmile = 1.852 km	100 hectares= 1 km^2

Important Questions

- What is surveying? State its objects and uses.
- Distinguish between geodetic surveying and plain surveying.
- Explain the terms topographical surveying and cadastral surveying.
- What are the fundamental principles of surveying? Explain briefly.
- Discuss the classifications of surveying based on
  - (i) instruments used
  - (ii) objective of survey and
  - (iii) methods employed.
- Distinguish between plans and maps.
- Explain on Scales

Important Web-links

- http://www.surveyofindia.gov.in/
- http://www.portal.gsi.gov.in/
- http://www.usgs.gov/
- http://asi.nic.in/
- http://www.imd.gov.in/

References

- "Surveying and Levelling" Vol I

  Kanetkar and kulkarni (2011) Pune Vidhyarthi Griha, Pune

- " Surveying and Levelling"

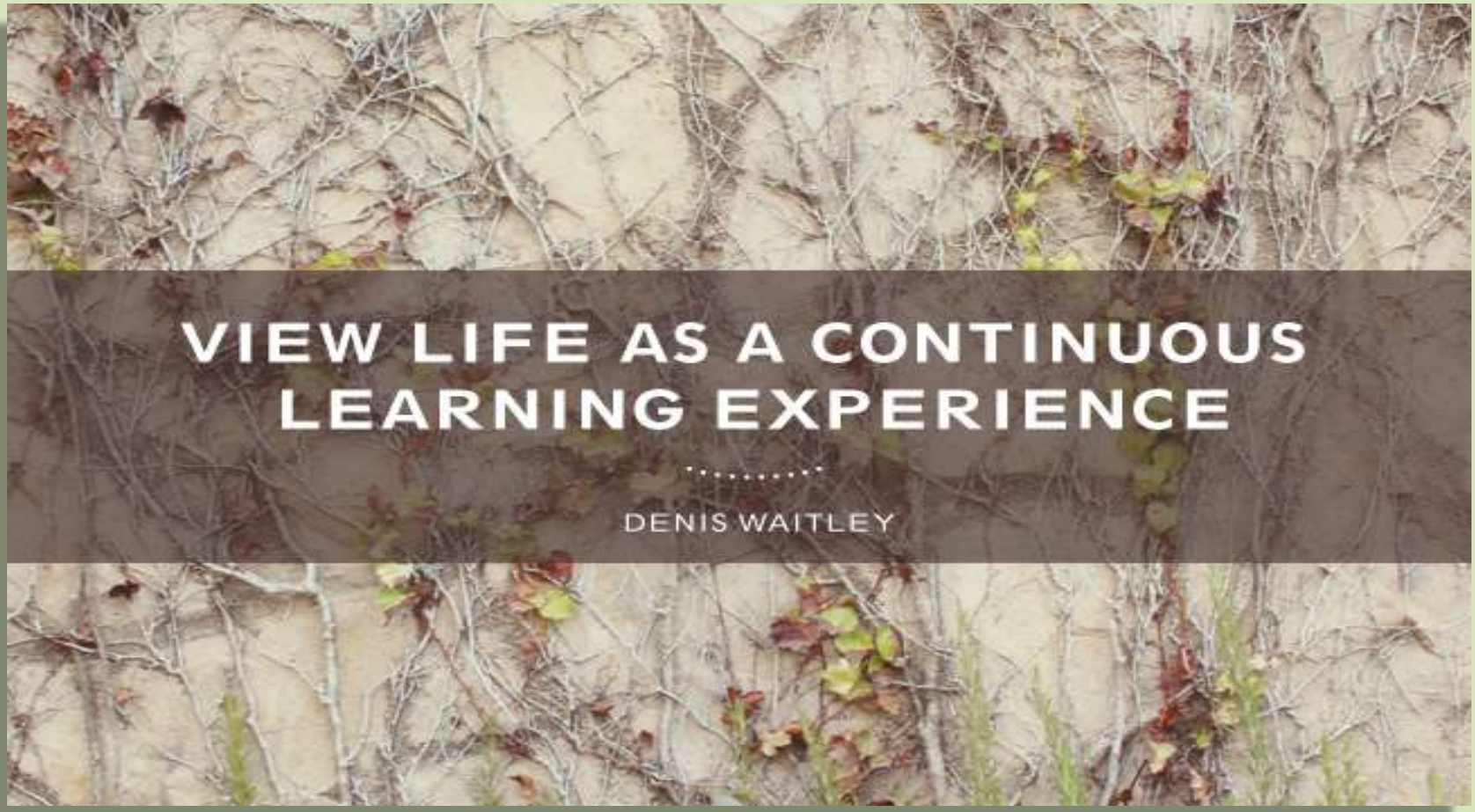
  N.N.Basak (2010) Tata Mcgraw Hill

- " Surveying Vol- I II & III'

  Dr. B.C. Punamia Laxmi Publication

- Internet Websites

Thanks….



GHT