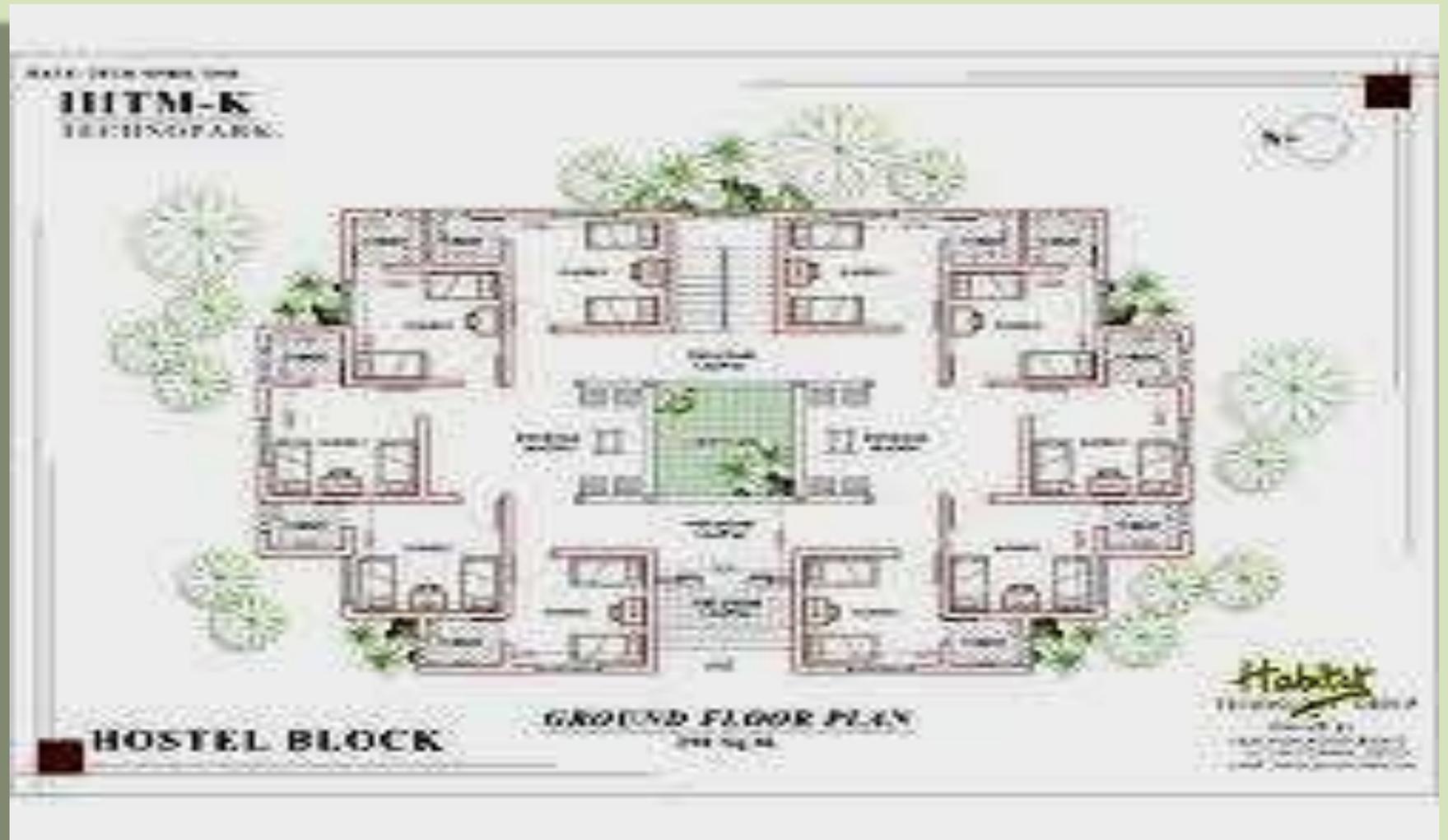


Objective of Surveying

- 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



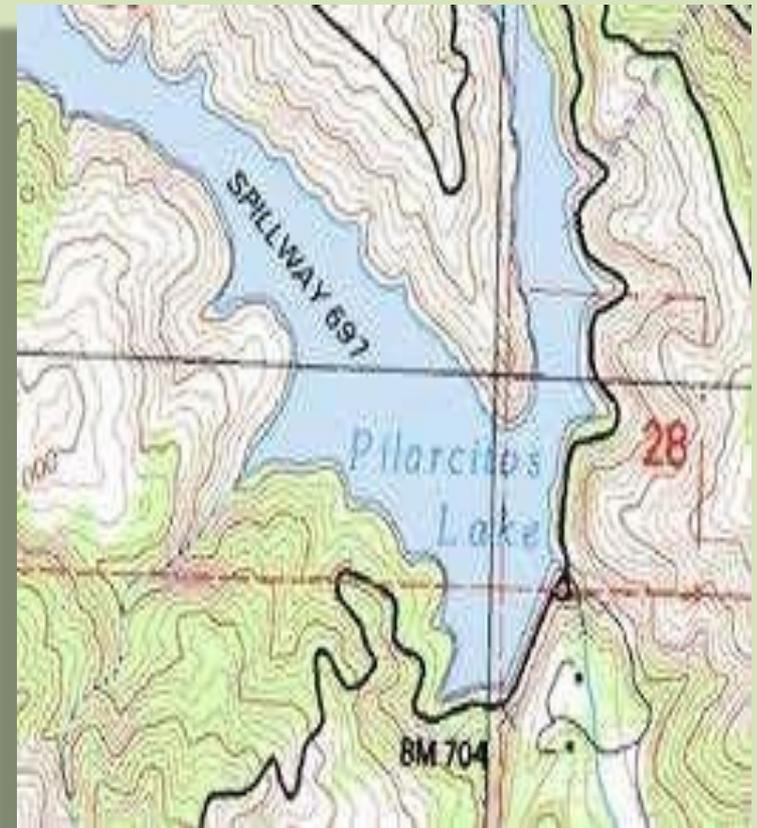
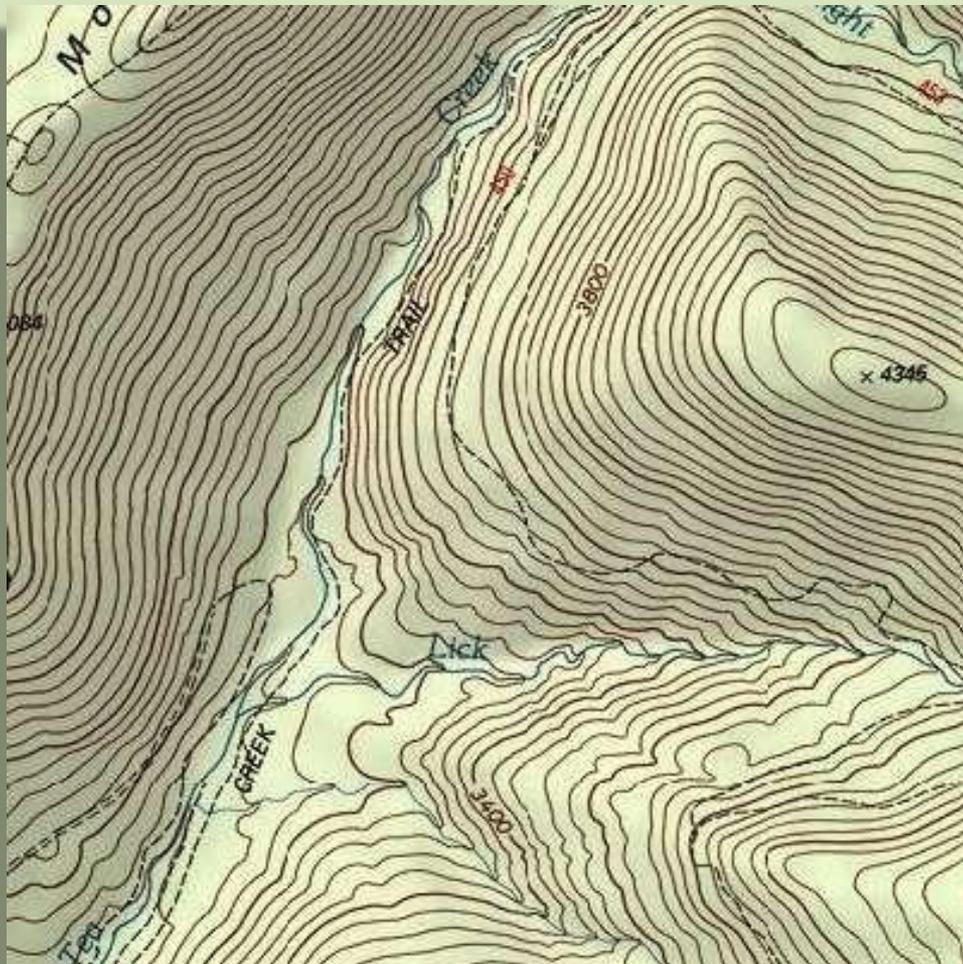
Objective of Surveying



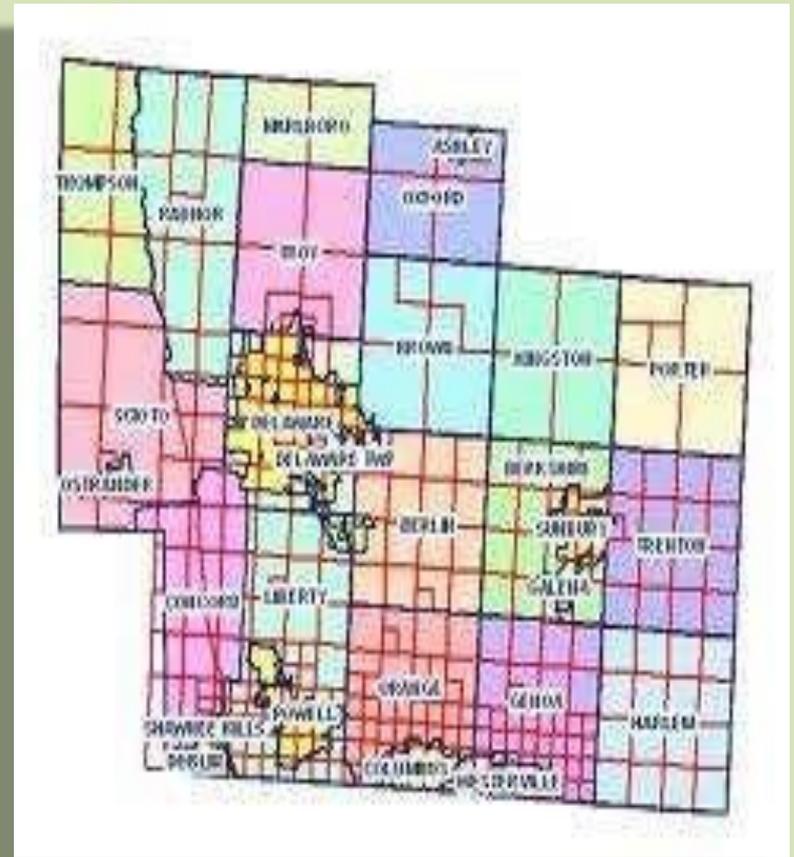
Uses of Surveying

- 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



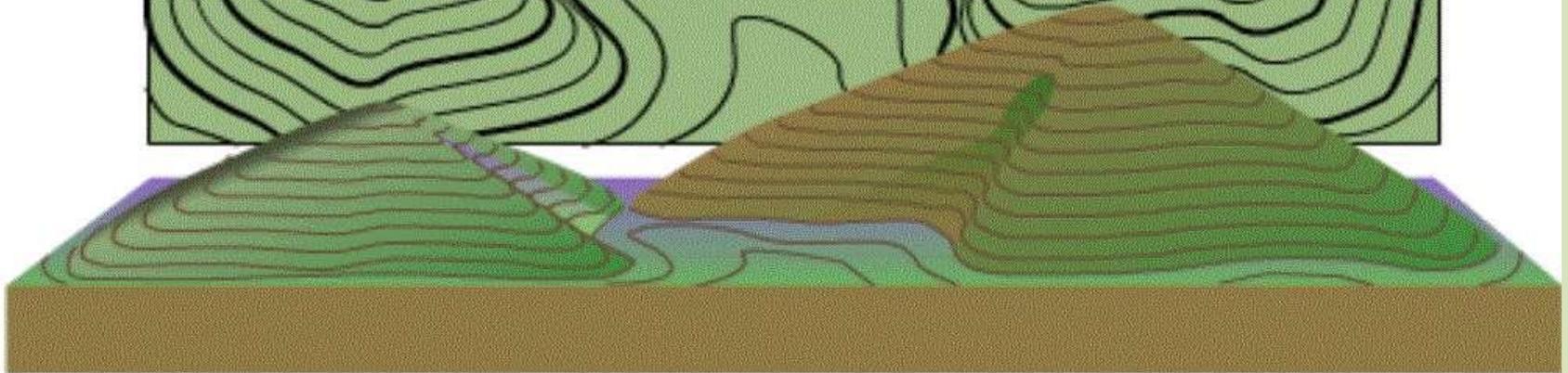
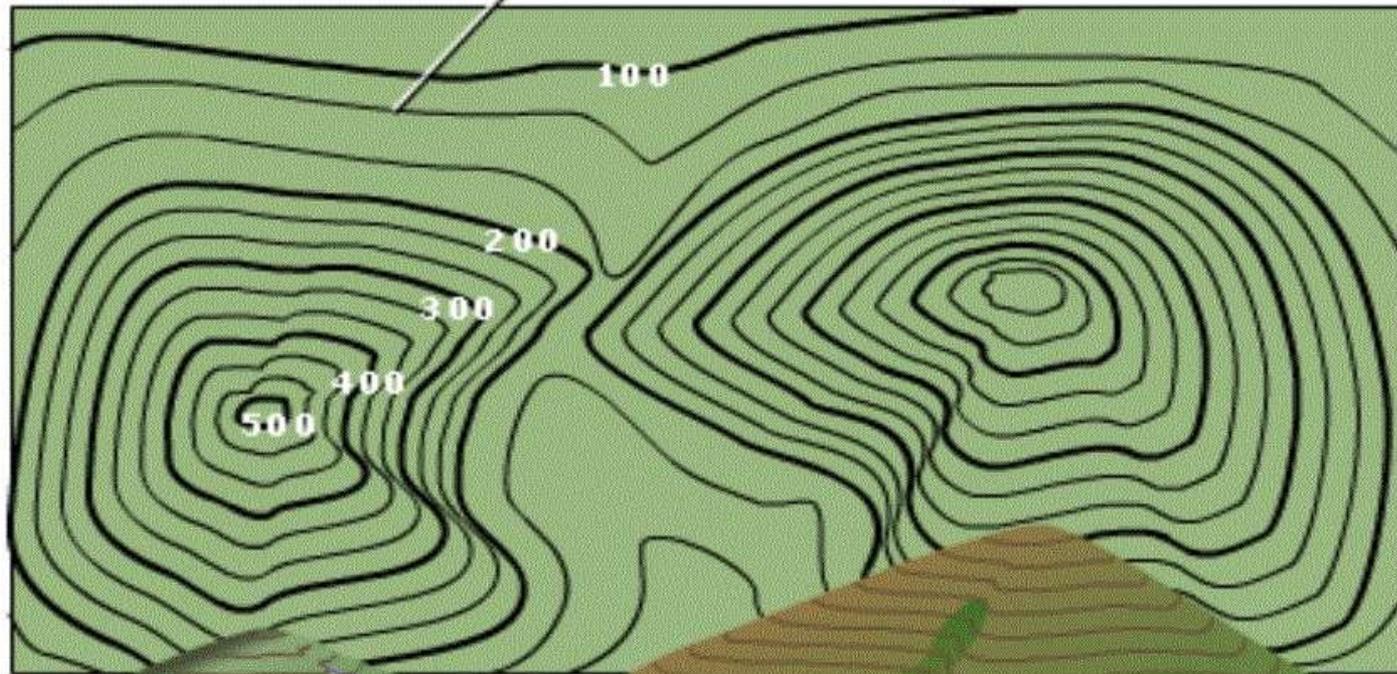
Uses of Surveying

- 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

Contour Map

Contour Line



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
- Amphibian Tractor
- Antiaircraft
- Defense Battalion
- Engineer
- Field Artillery
- Infantry
- Parachute
- Parachute
- Pioneer
- Raider
- Tank

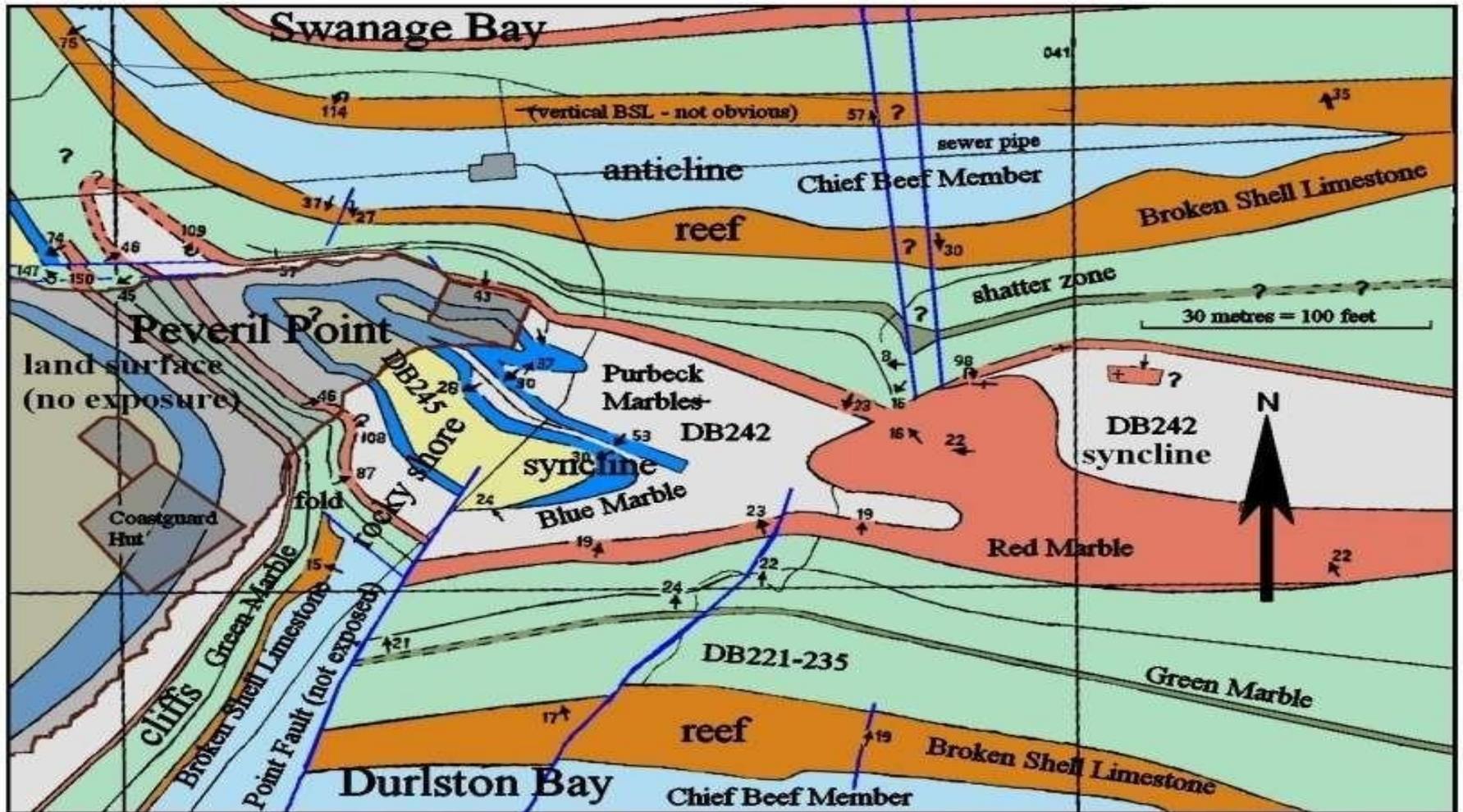
MISC. SYMBOLS

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

EXAMPLES

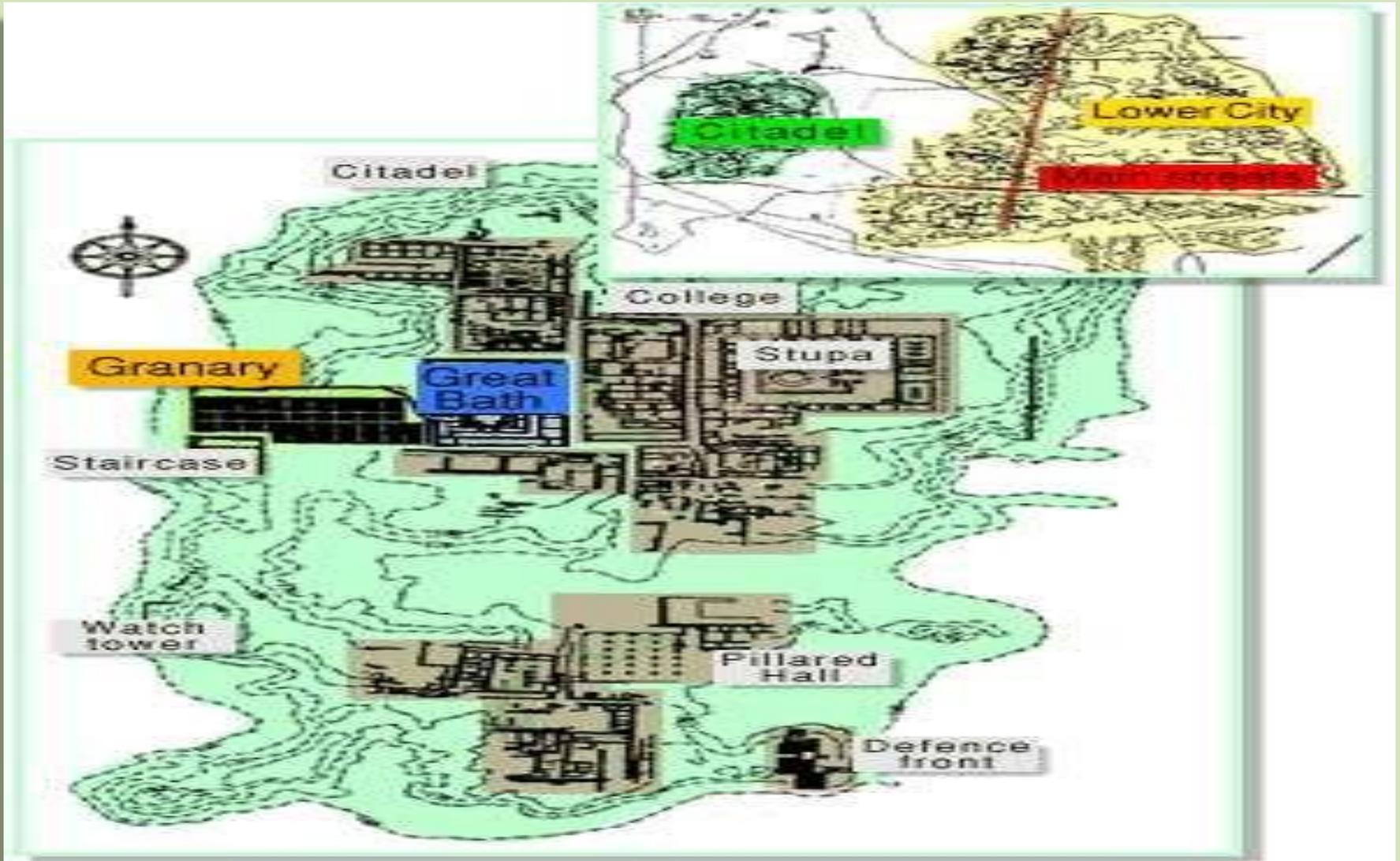
- 1L 1DB 1st Sec, L Btry, 1st Def Bn
- B 5 Co B, 5th Mar Regt
- 1Rdr 1st Rdr Bn
- 11 11th Mar Regt
- 2 7 OP, 2d Bn, 7th Mar Regt
- 1 CP, 1st Mar Div

Geological Map

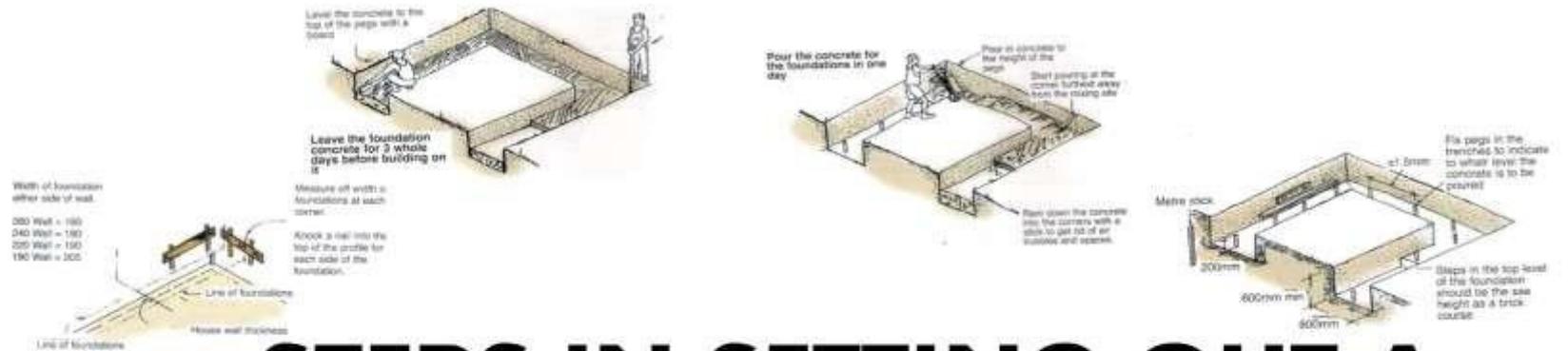


Geological map of Peveril Point, Swanage. Simplified and with some generalisations. Based mainly on Cosgrove and Hearn (1966) and with some personal observations. Refer to Cosgrove and Hearn for details. Ian West & Tonya West (c) 2007.

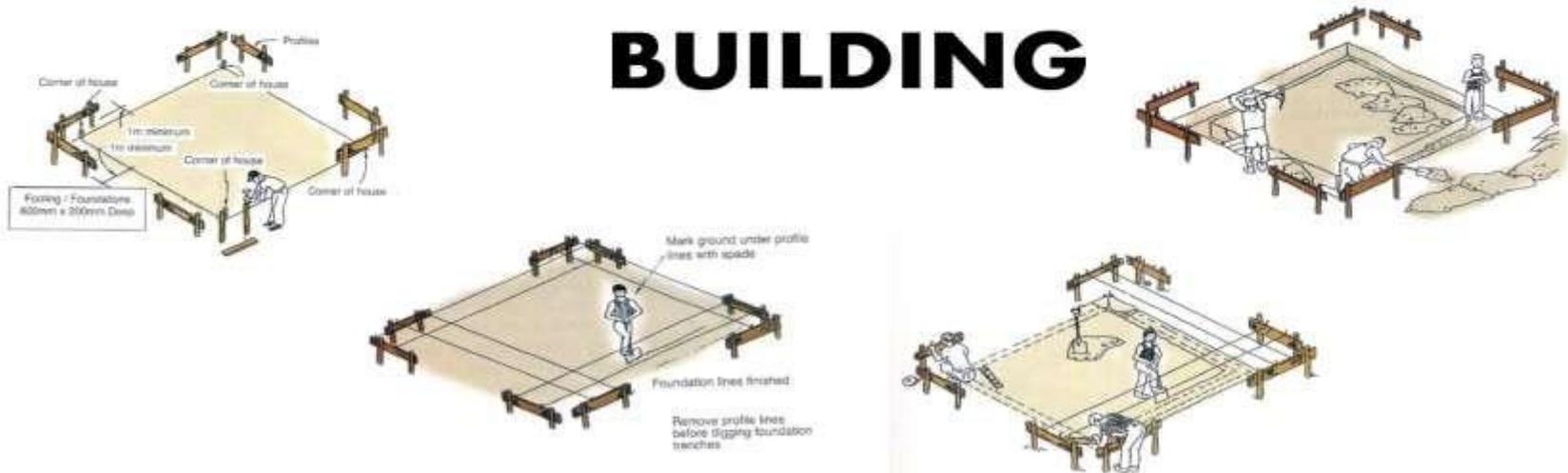
Archaeological Map



Setting Out Work



STEPS IN SETTING OUT A BUILDING



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

NOTES:

1. THIS IS NOT A BOUNDARY SURVEY PURSUANT TO CHAPTER 4733-37 OF THE OHIO ADMINISTRATIVE CODE.

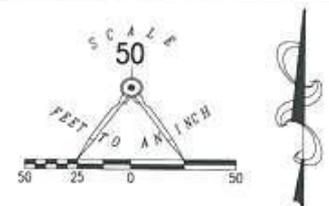
REFERENCES:

FLOOD INSURANCE RATE MAP (FIRM)
COMMUNITY PANEL #390772 0105 C
EFFECTIVE DATE: MAY 15, 1985

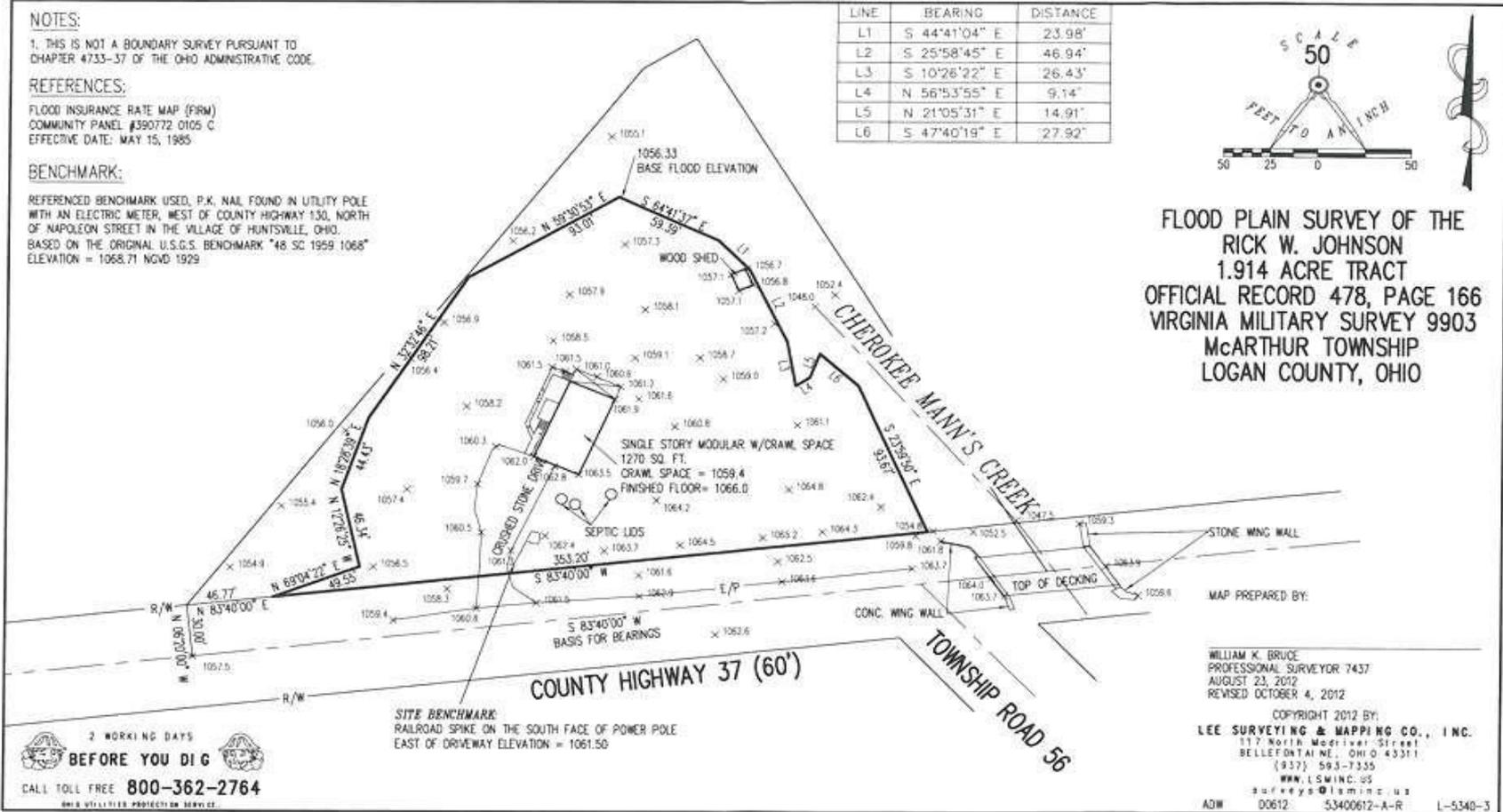
BENCHMARK:

REFERENCED BENCHMARK USED, P.K. NAIL FOUND IN UTILITY POLE WITH AN ELECTRIC METER, WEST OF COUNTY HIGHWAY 130, NORTH OF NAPOLEON STREET IN THE VILLAGE OF HUNTSVILLE, OHIO. BASED ON THE ORIGINAL U.S.G.S. BENCHMARK "48 SC 1959 1068" ELEVATION = 1068.71 NGVD 1929

| LINE | BEARING | DISTANCE |
|------|---------------|----------|
| L1 | S 44°41'04" E | 23.98' |
| L2 | S 25°58'45" E | 46.94' |
| L3 | S 10°26'22" E | 26.43' |
| L4 | N 56°53'55" E | 9.14' |
| L5 | N 21°05'31" E | 14.91' |
| L6 | S 47°40'19" E | 27.92' |



FLOOD PLAIN SURVEY OF THE
RICK W. JOHNSON
1.914 ACRE TRACT
OFFICIAL RECORD 478, PAGE 166
VIRGINIA MILITARY SURVEY 9903
McARTHUR TOWNSHIP
LOGAN COUNTY, OHIO



MAP PREPARED BY:

WILLIAM K. BRUCE
PROFESSIONAL SURVEYOR 7437
AUGUST 23, 2012
REVISED OCTOBER 4, 2012

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OHIO STATE DEPARTMENT OF TRANSPORTATION

SITE BENCHMARK:
RAILROAD SPIKE ON THE SOUTH FACE OF POWER POLE
EAST OF DRIVEWAY ELEVATION = 1061.50

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

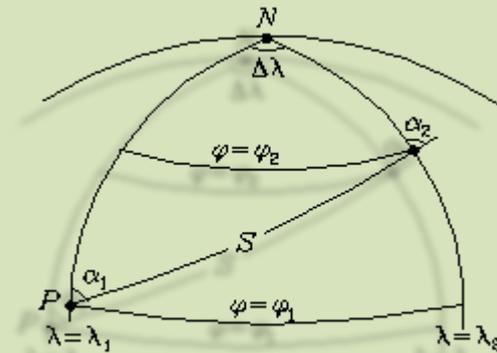
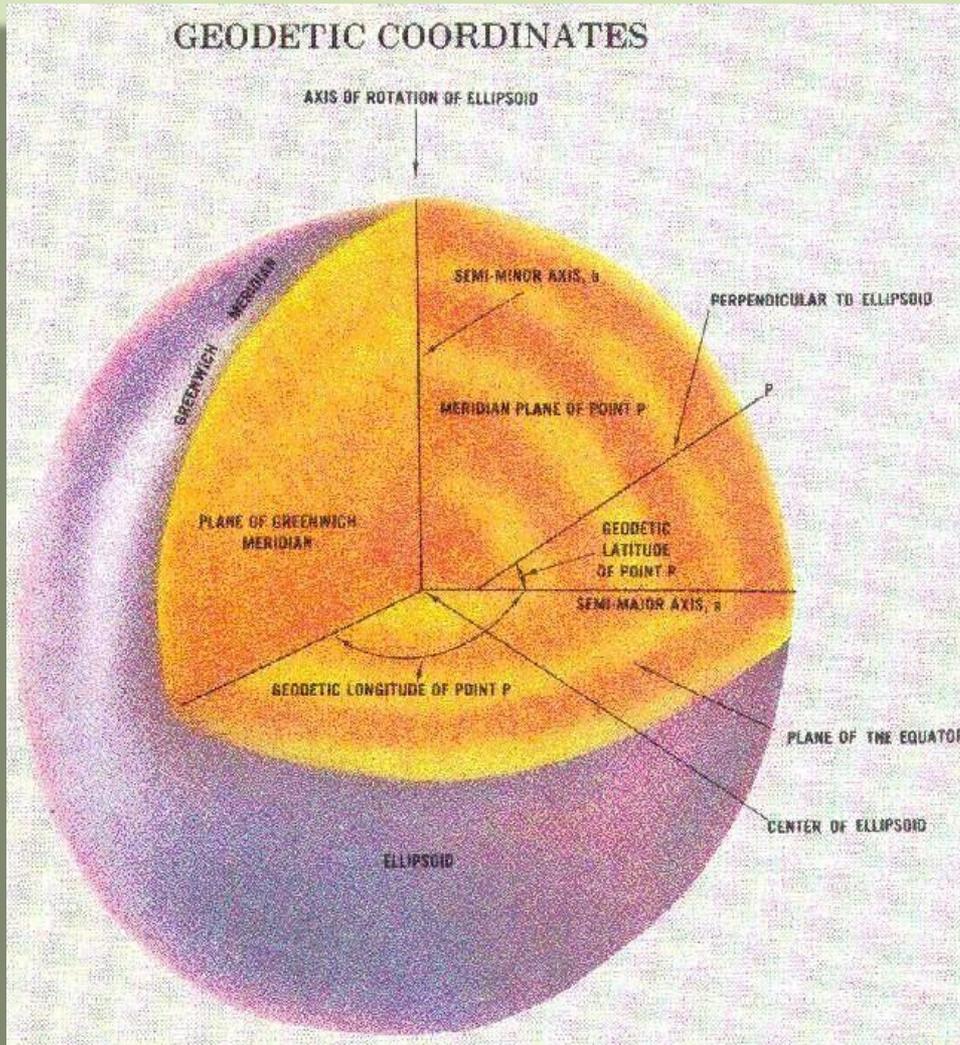
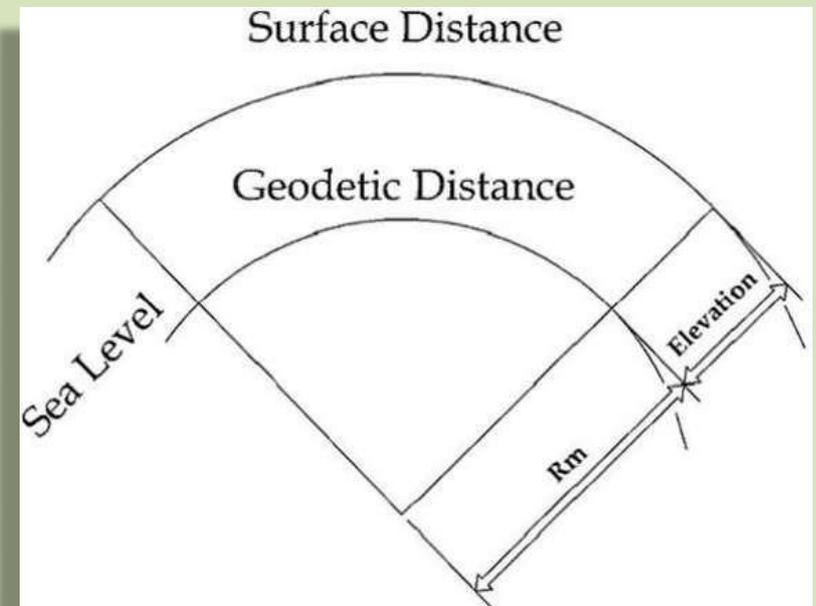
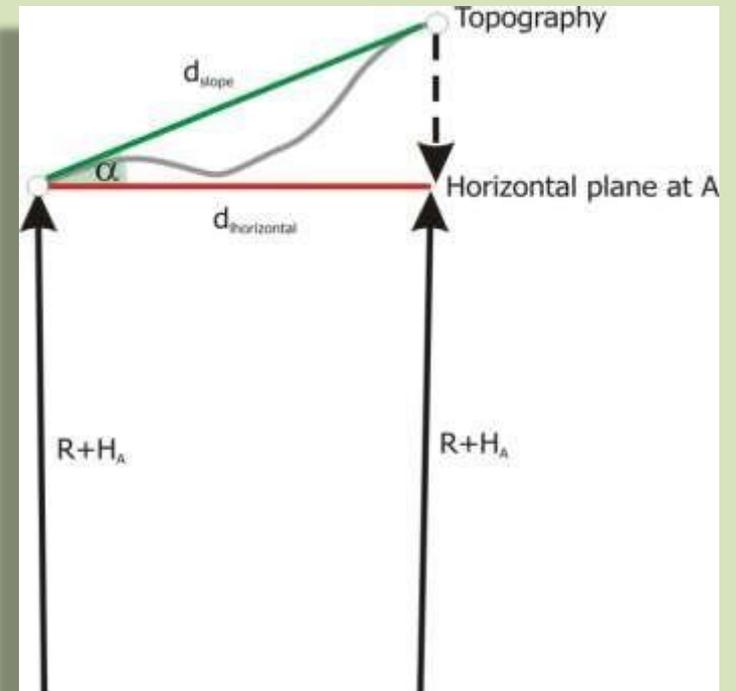
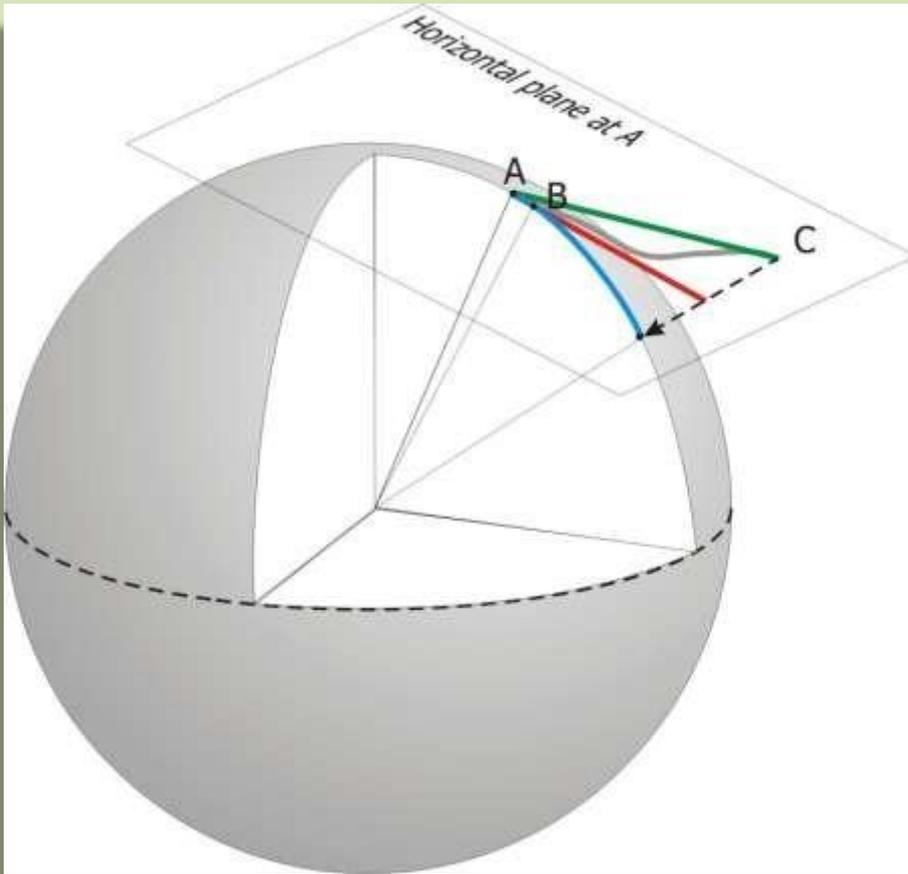


Figure 1. Direct geodetic problem



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 $< 250 \text{ km}^2$ | Carried out for a small area $> 250 \text{ km}^2$ |

Fundamental Principles of Surveying

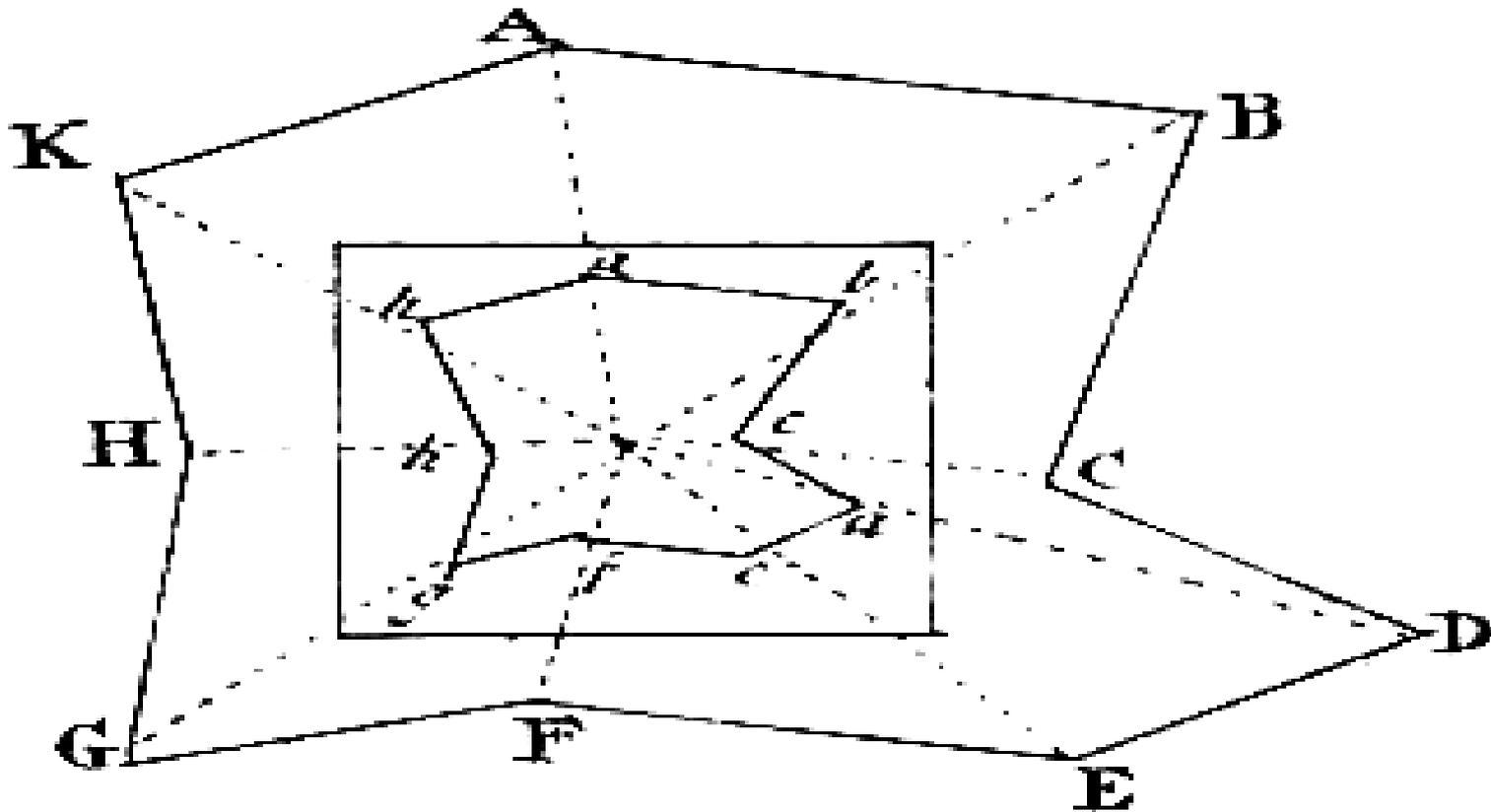
- Two basic principles of surveying are:
- Always work from whole to the part, and
- To locate a new station by at least two measurements (Linear or angular) from fixed reference points.

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 $\angle ABC$

Fundamental Principles of Surveying

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

Fundamental Principles of Surveying

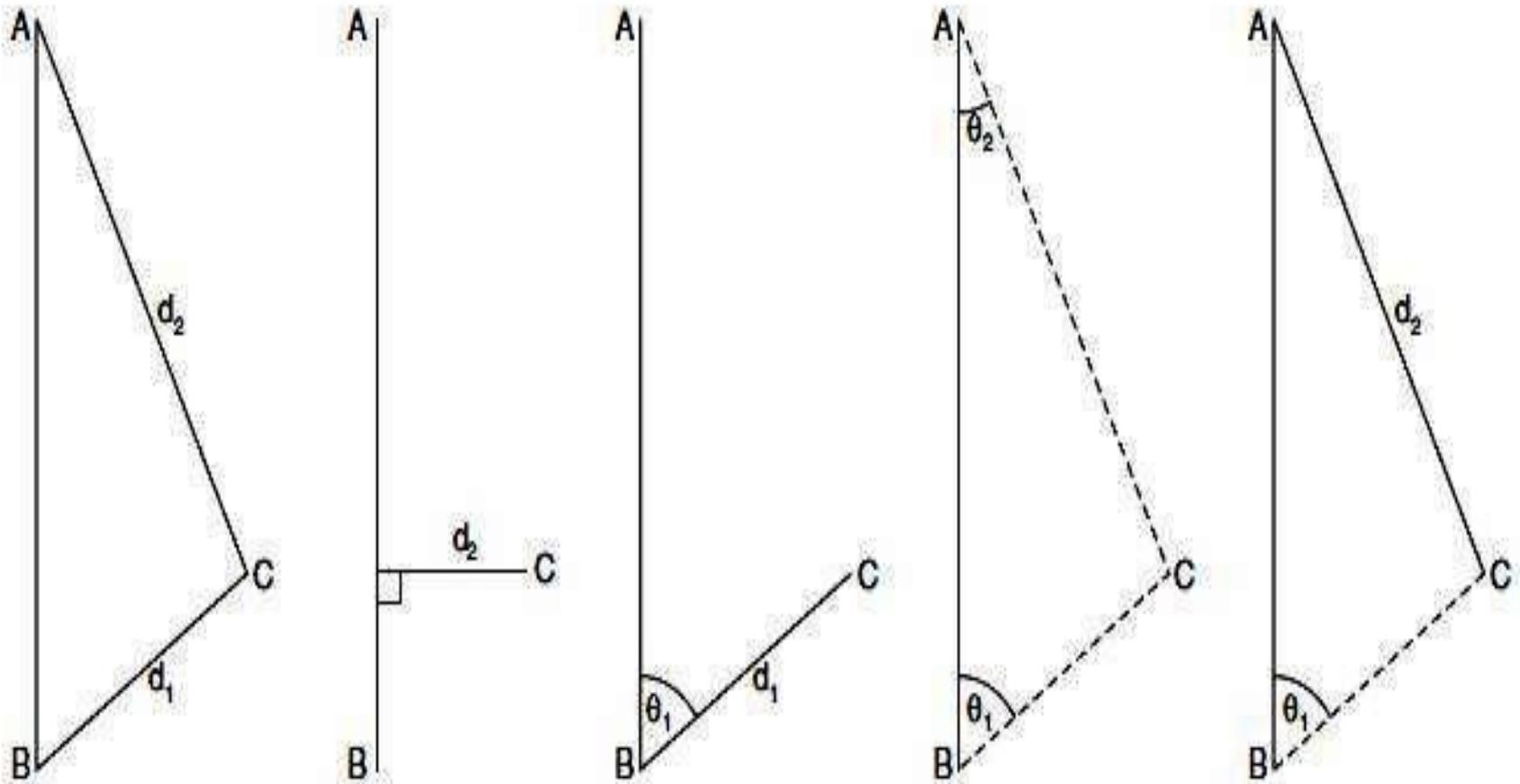
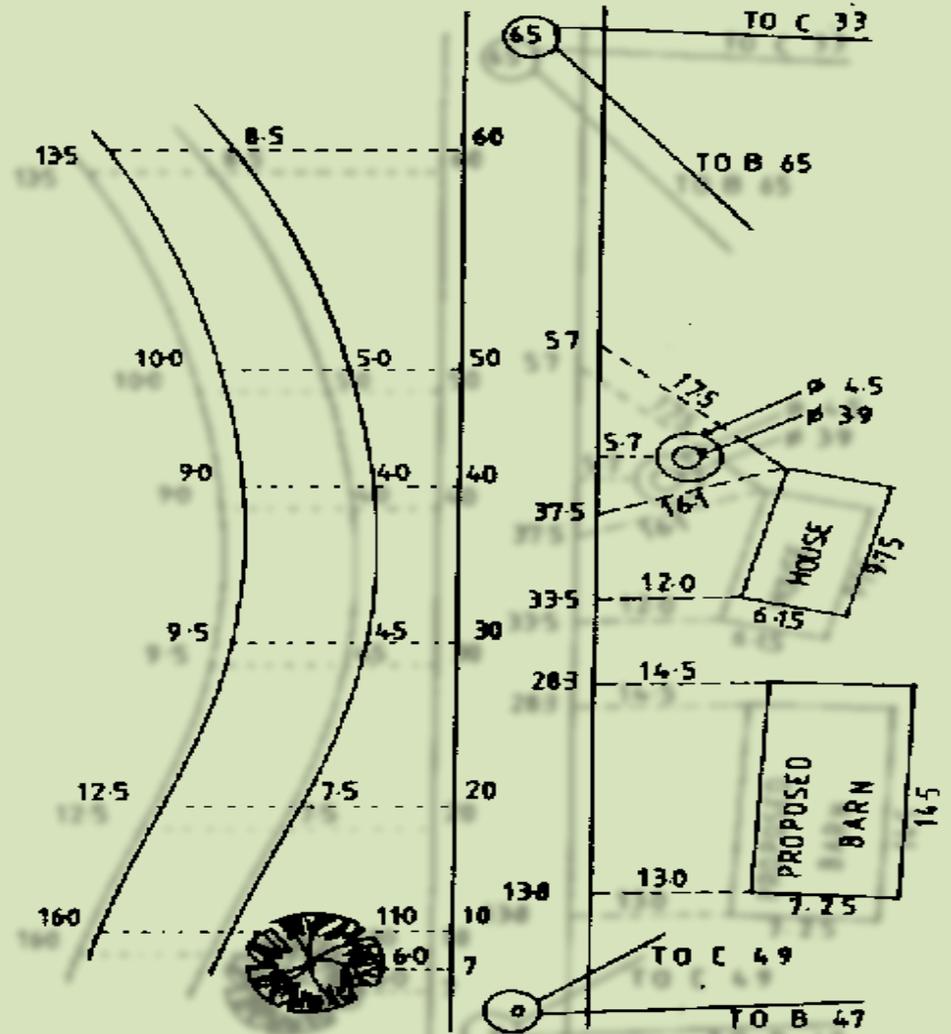
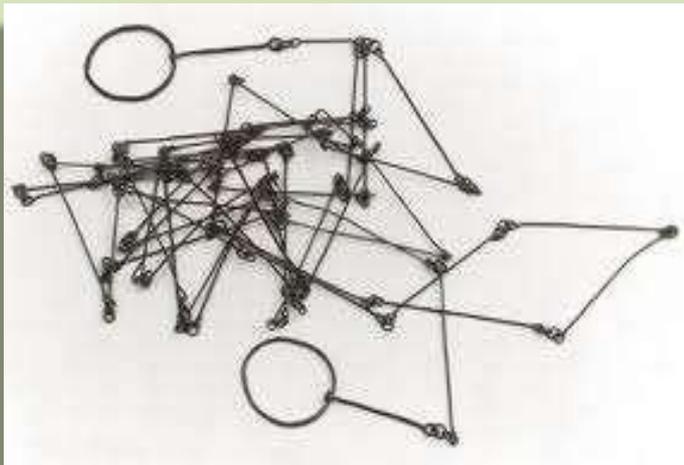


Fig. 11.3. Locating point C w.r.t. points A and B

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



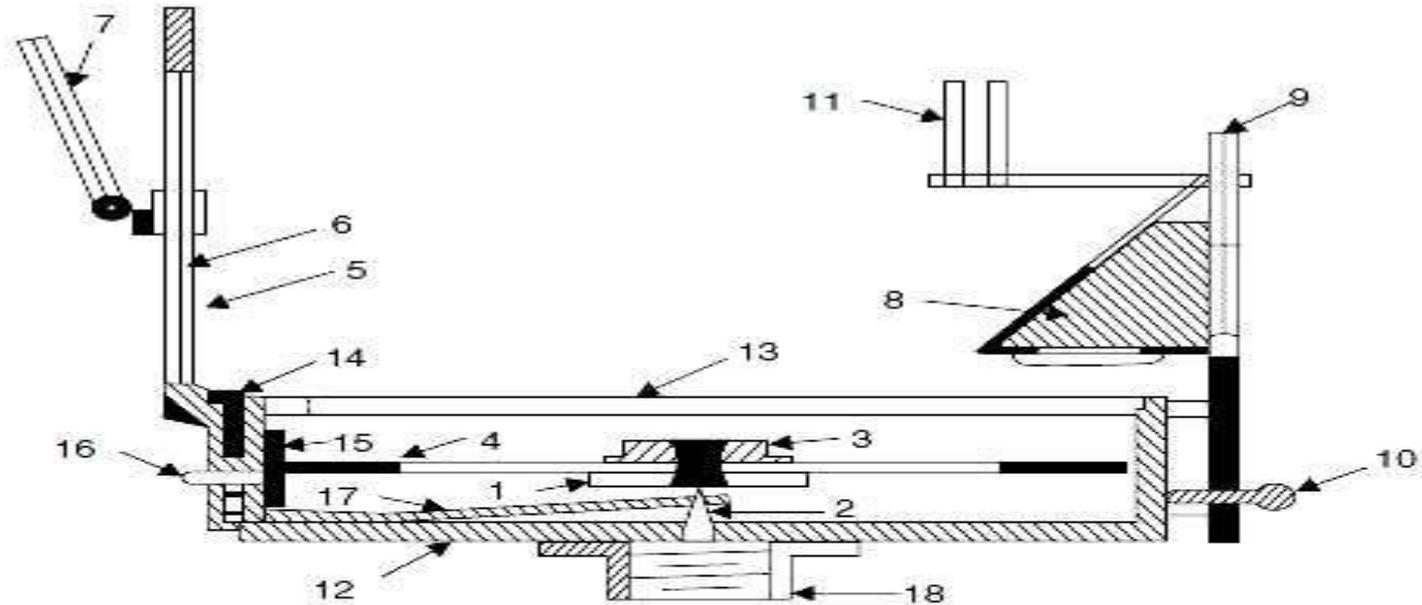
Classification of Surveying

- **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

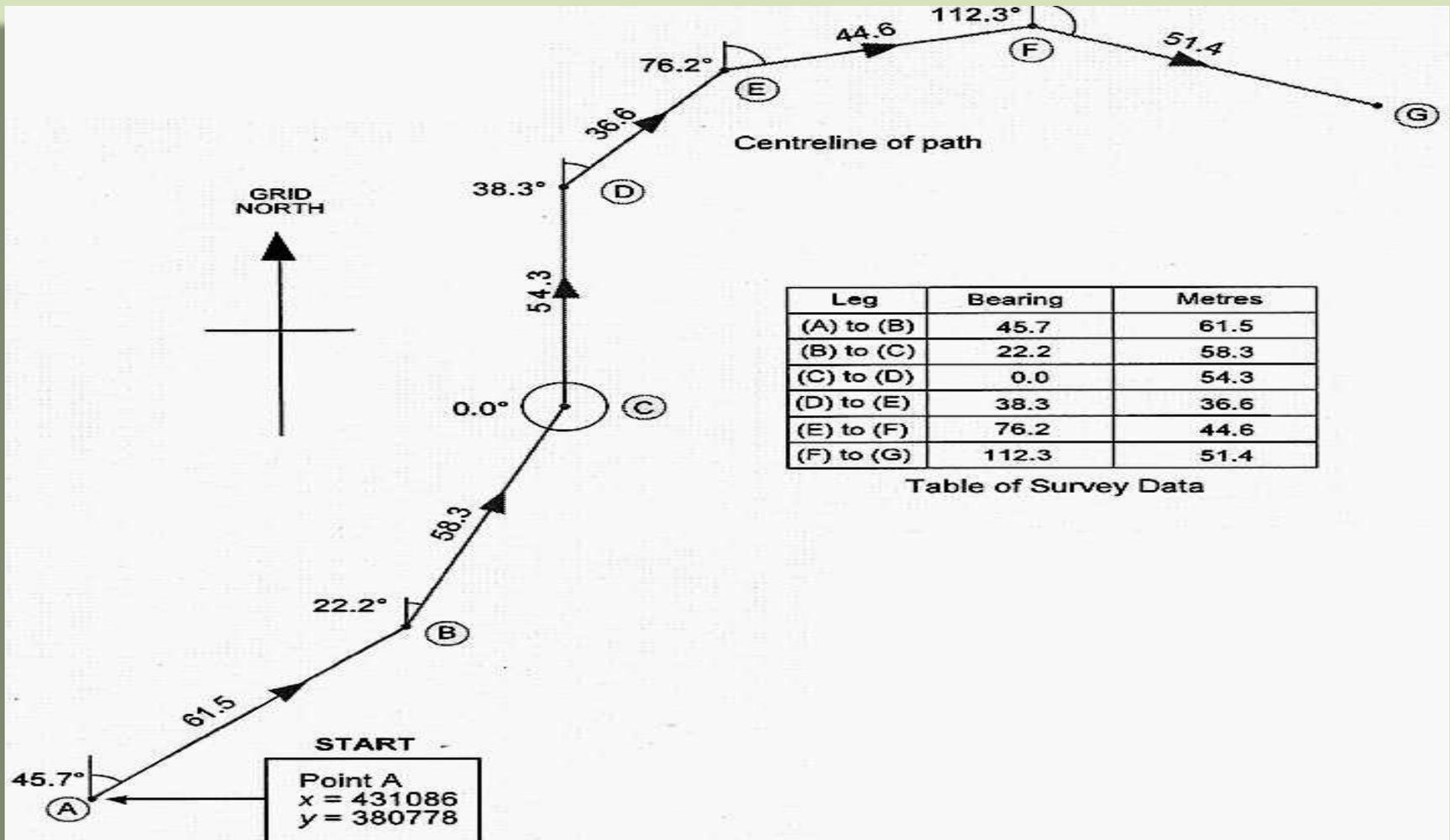


1. Needle
2. Pivot
3. Agate cap
4. Graduated disc
5. Slit metal frame
6. Horse hair
7. Mirror
8. Reflecting prism with cap
9. Eye vane

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



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

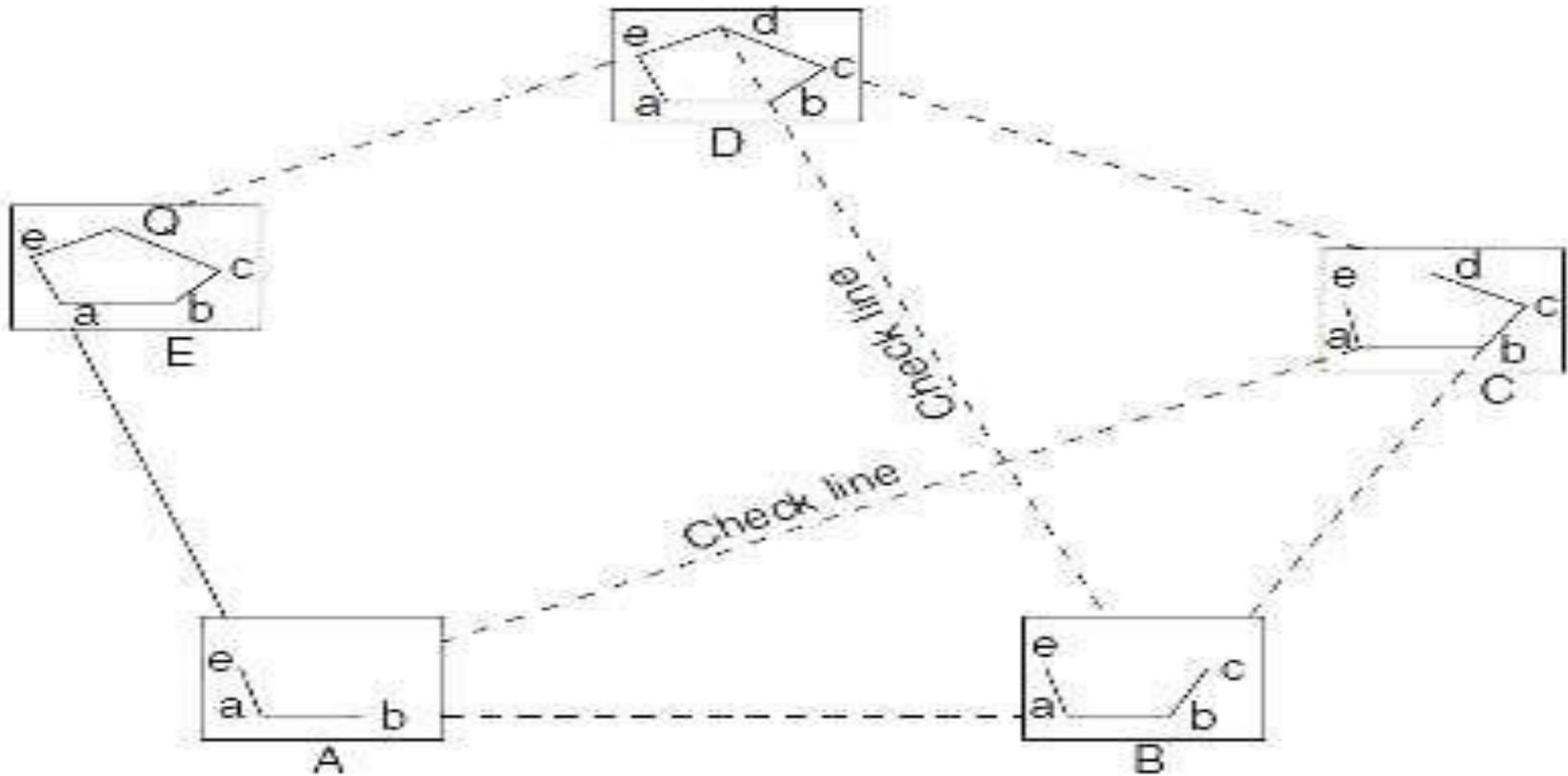
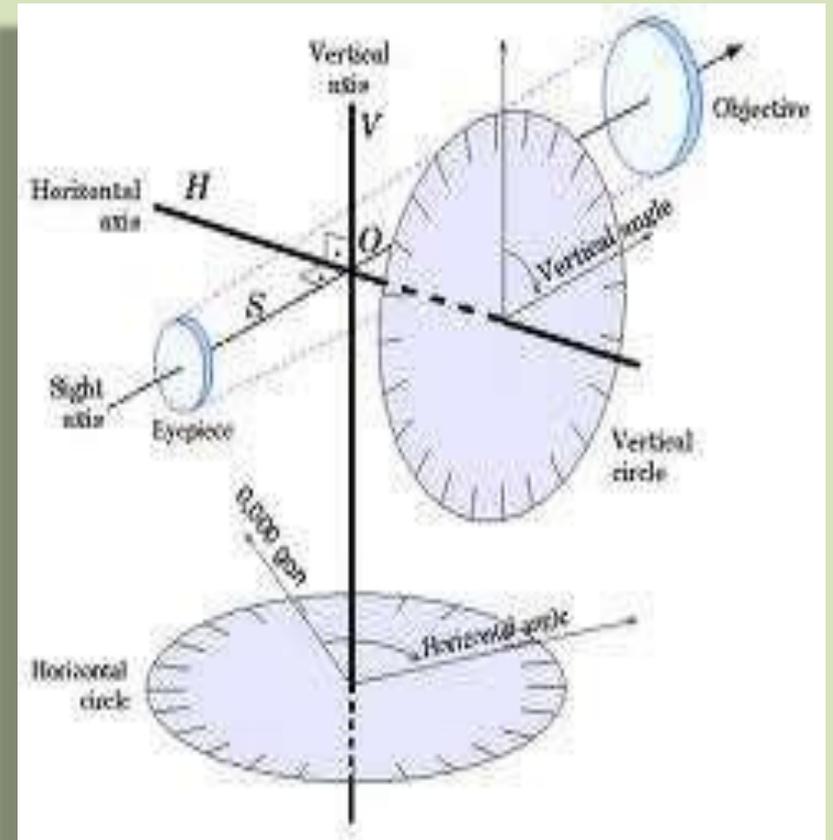
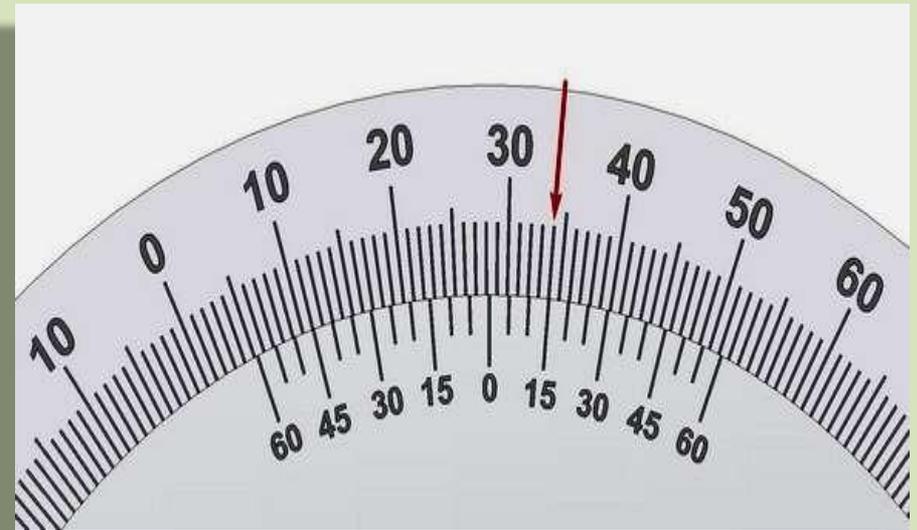


Fig. 14.9. Plane table traversing

Theodolite Survey



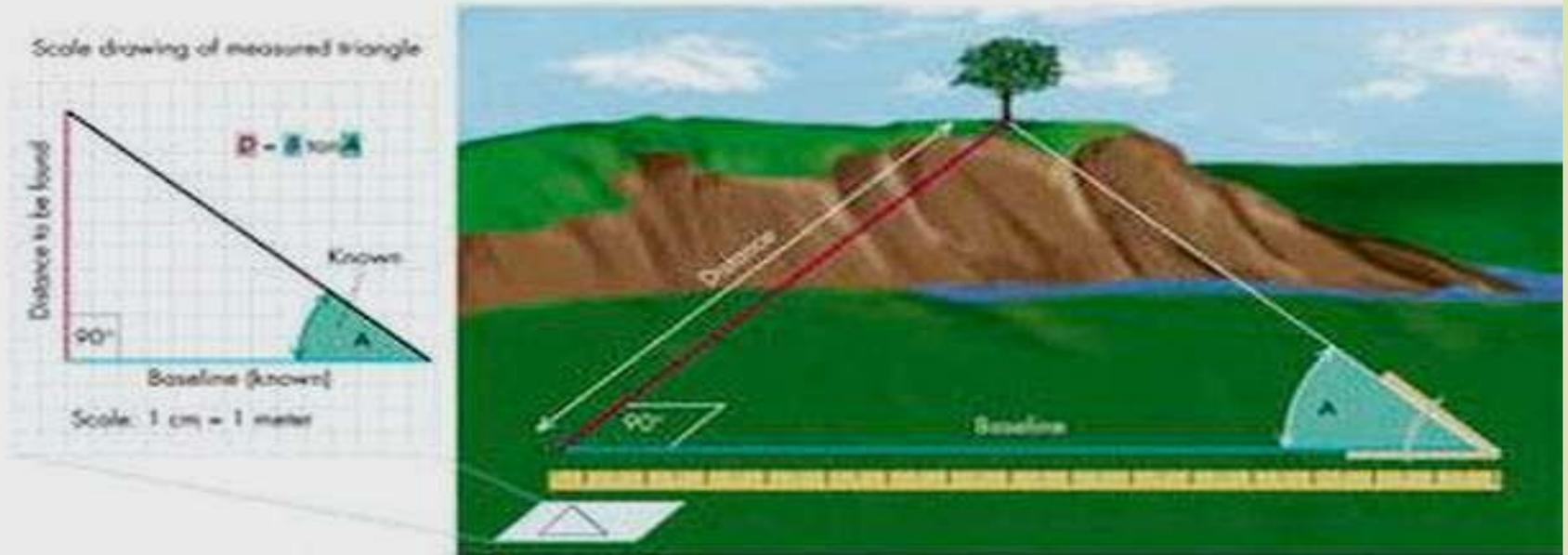
Theodolite Survey



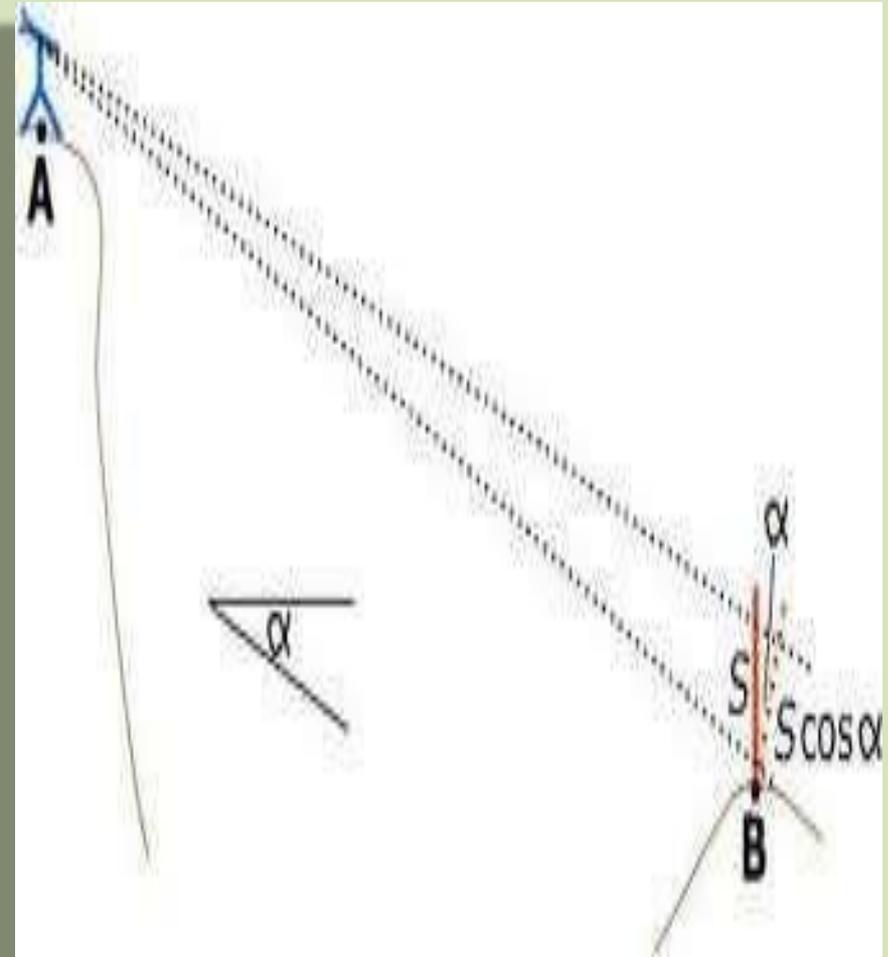
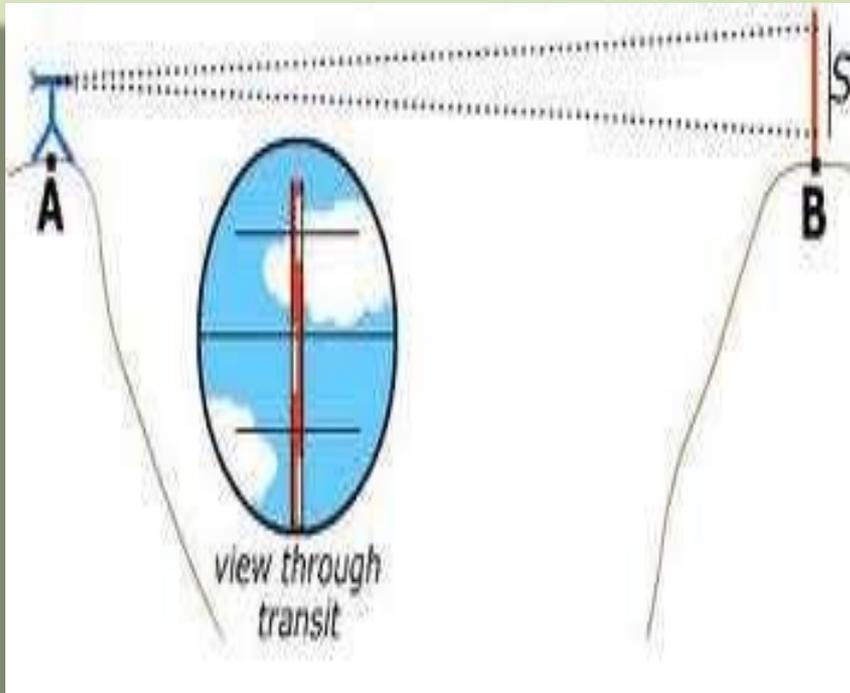
Classification of Surveying

- **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.

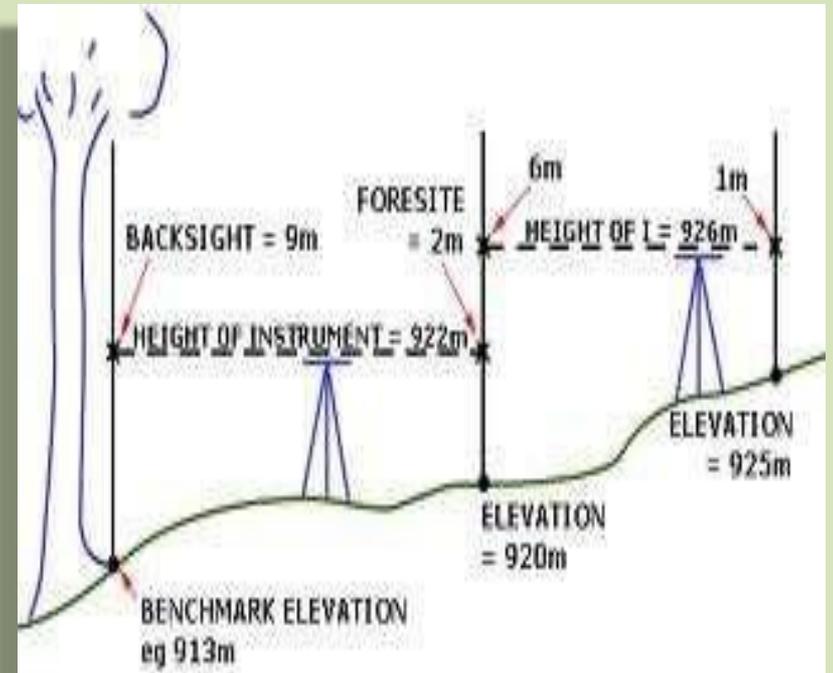
Tachometry Survey



Tachometry Survey



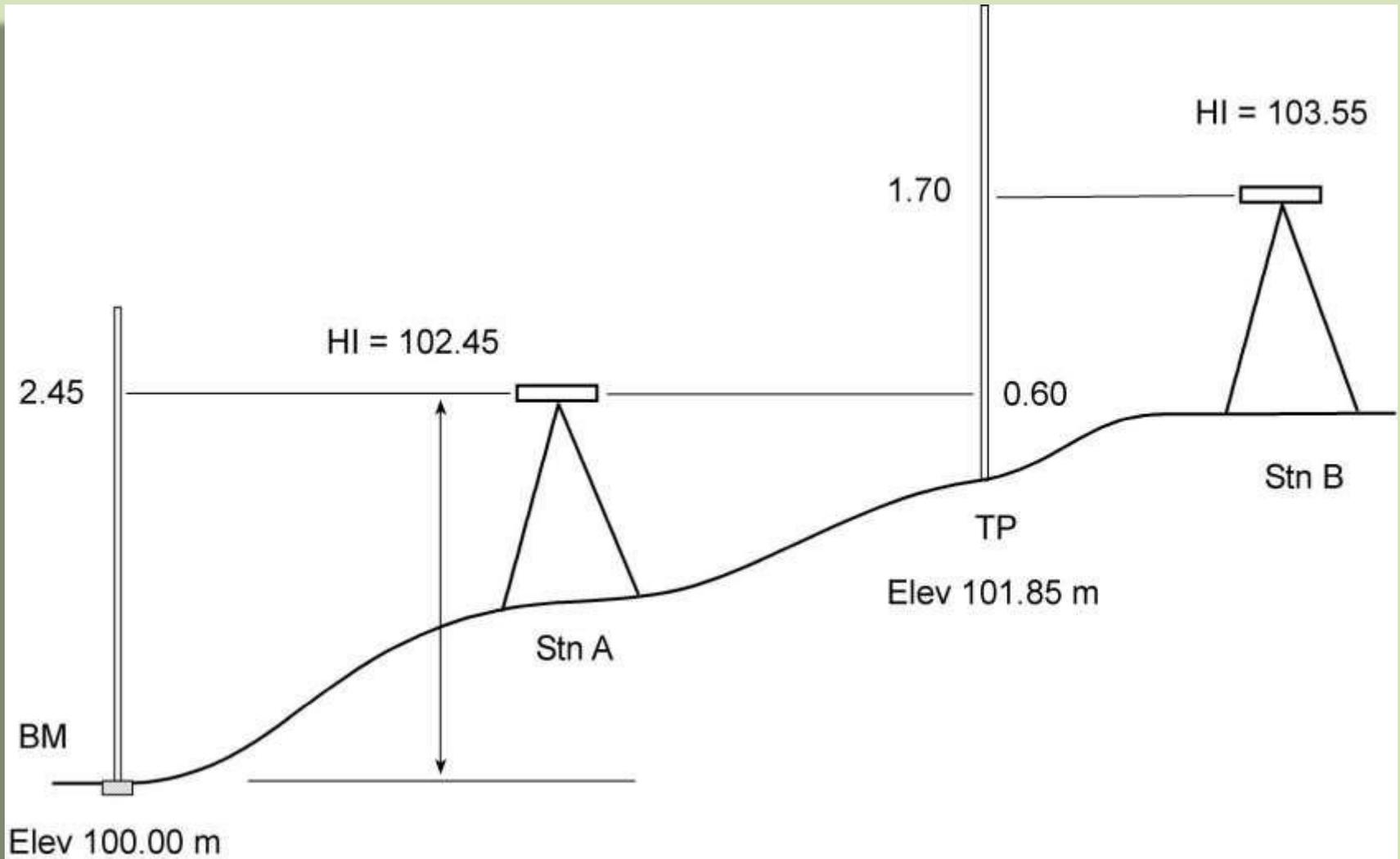
Leveling Survey



Leveling Survey



Leveling Survey



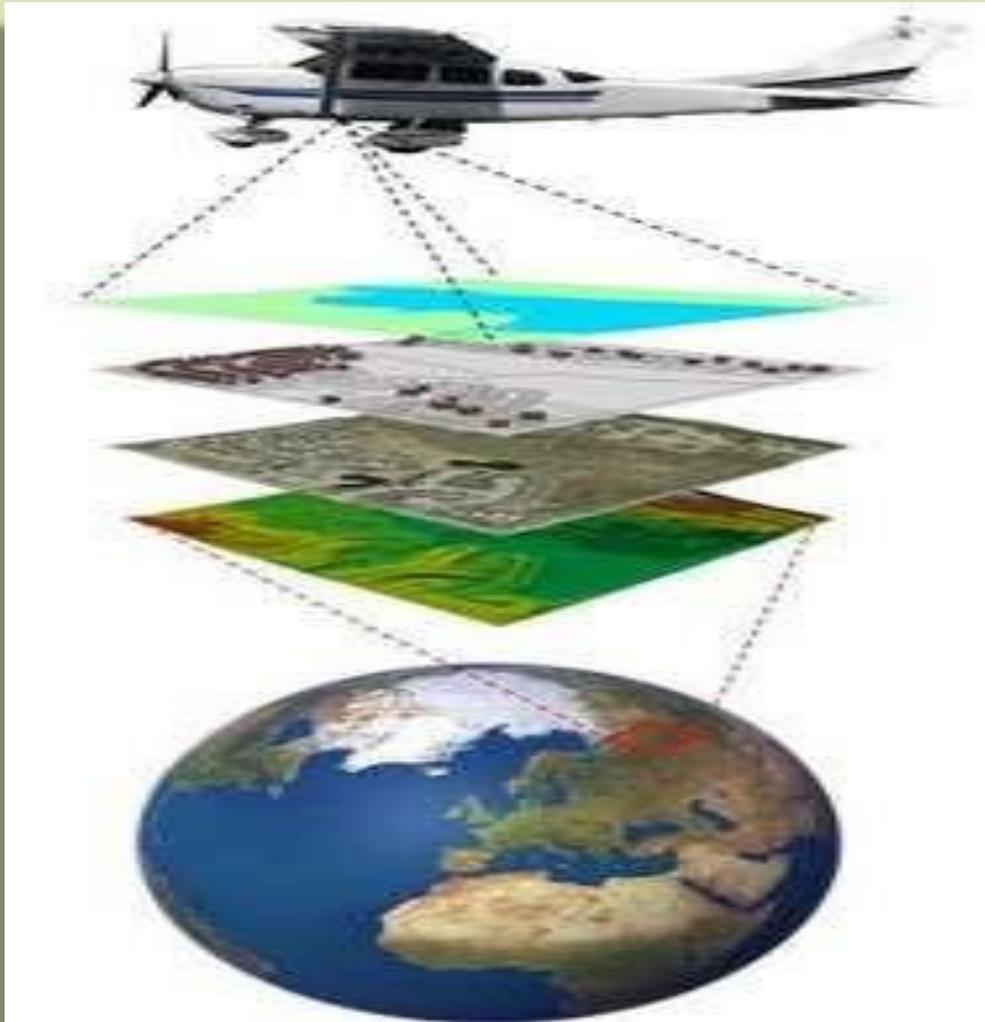
Classification of Surveying

- **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).
Station).

Photogrammetric Survey



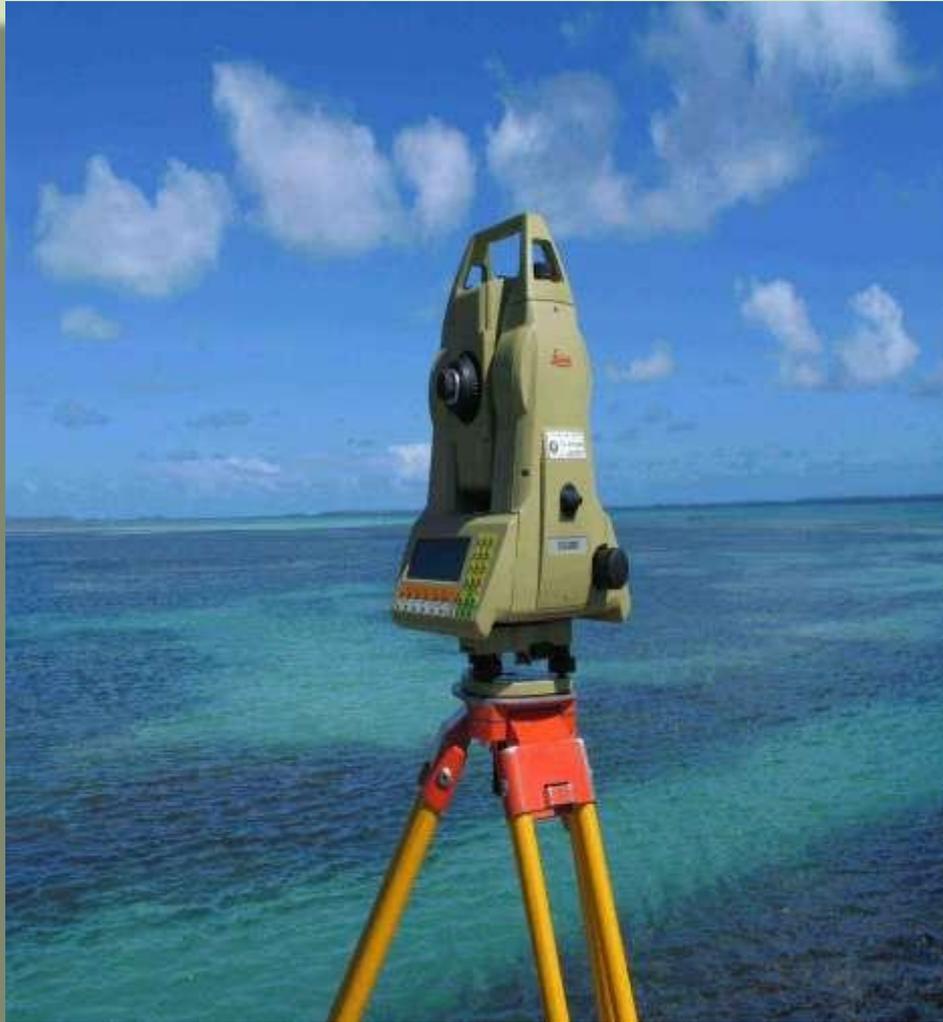
Photogrammetric Survey



EDM Survey



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

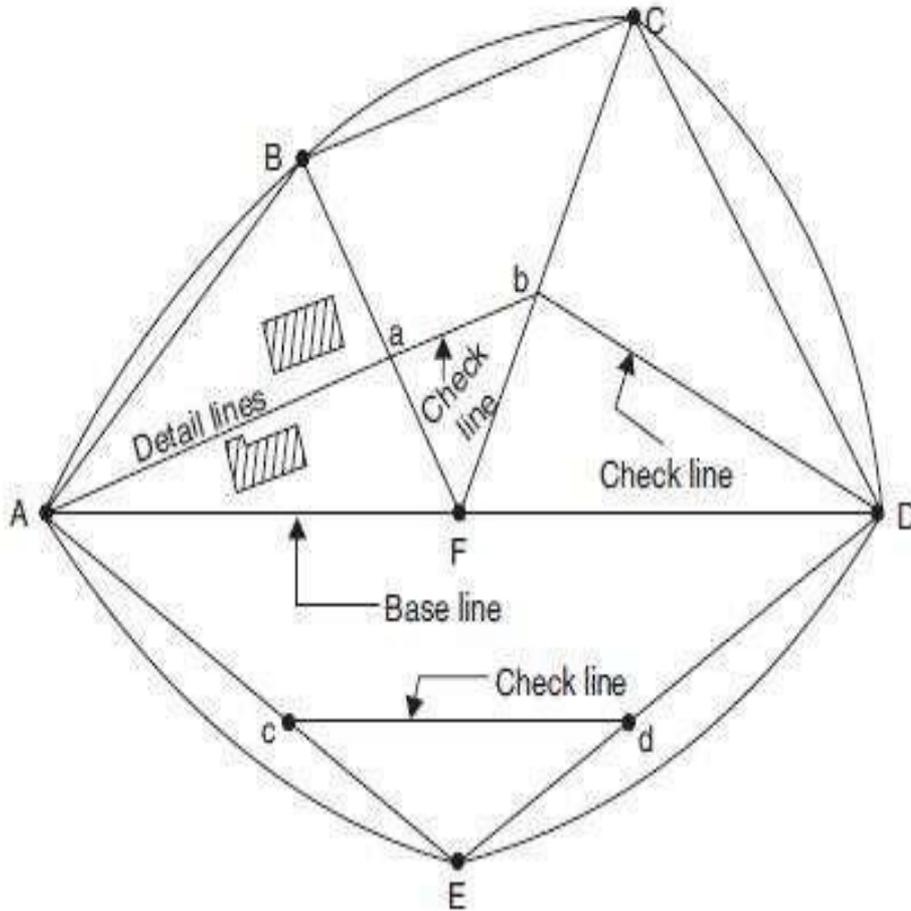
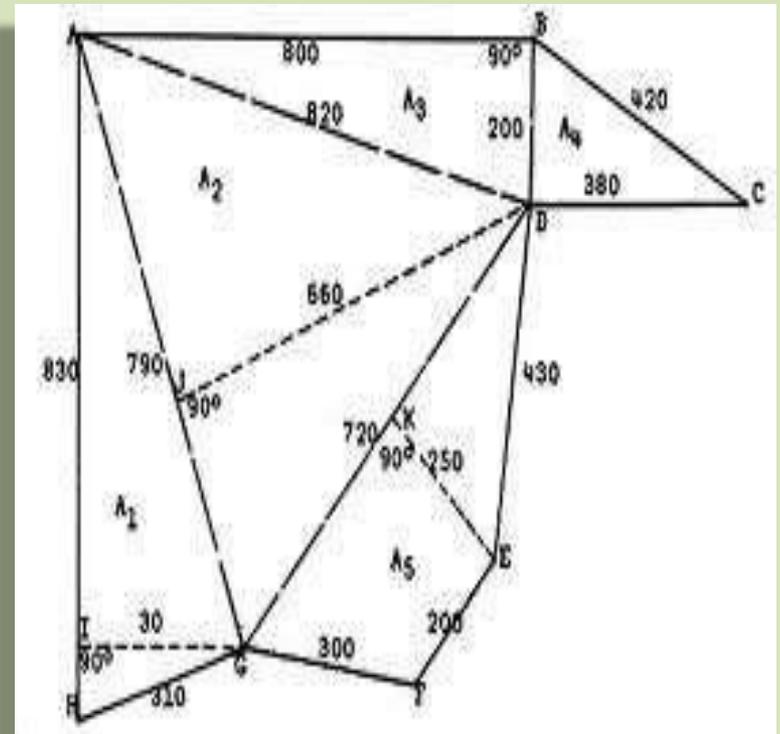
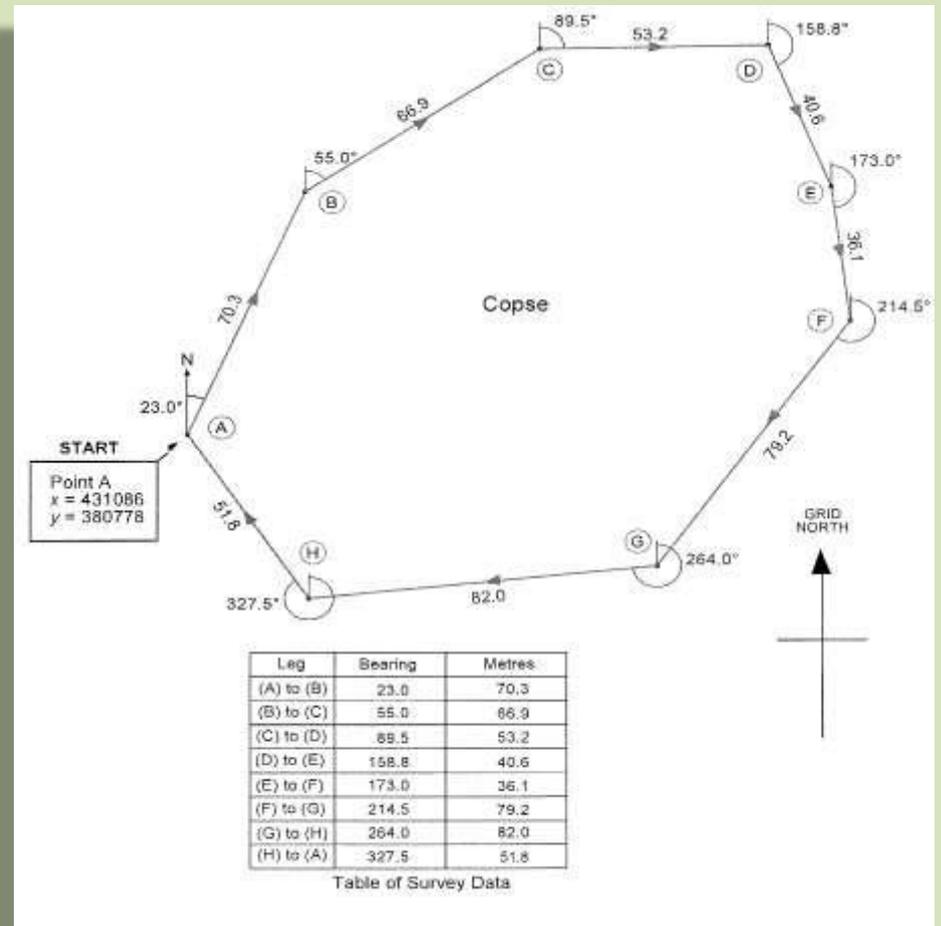
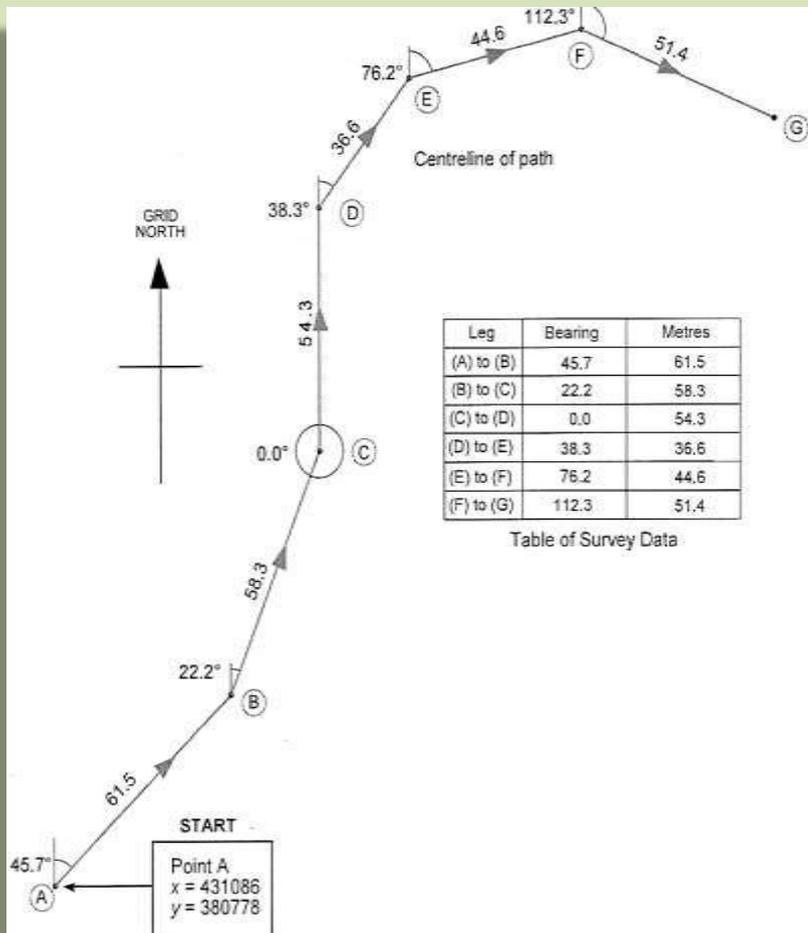


Fig. 12.11. Network of triangles



Traversing



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.

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

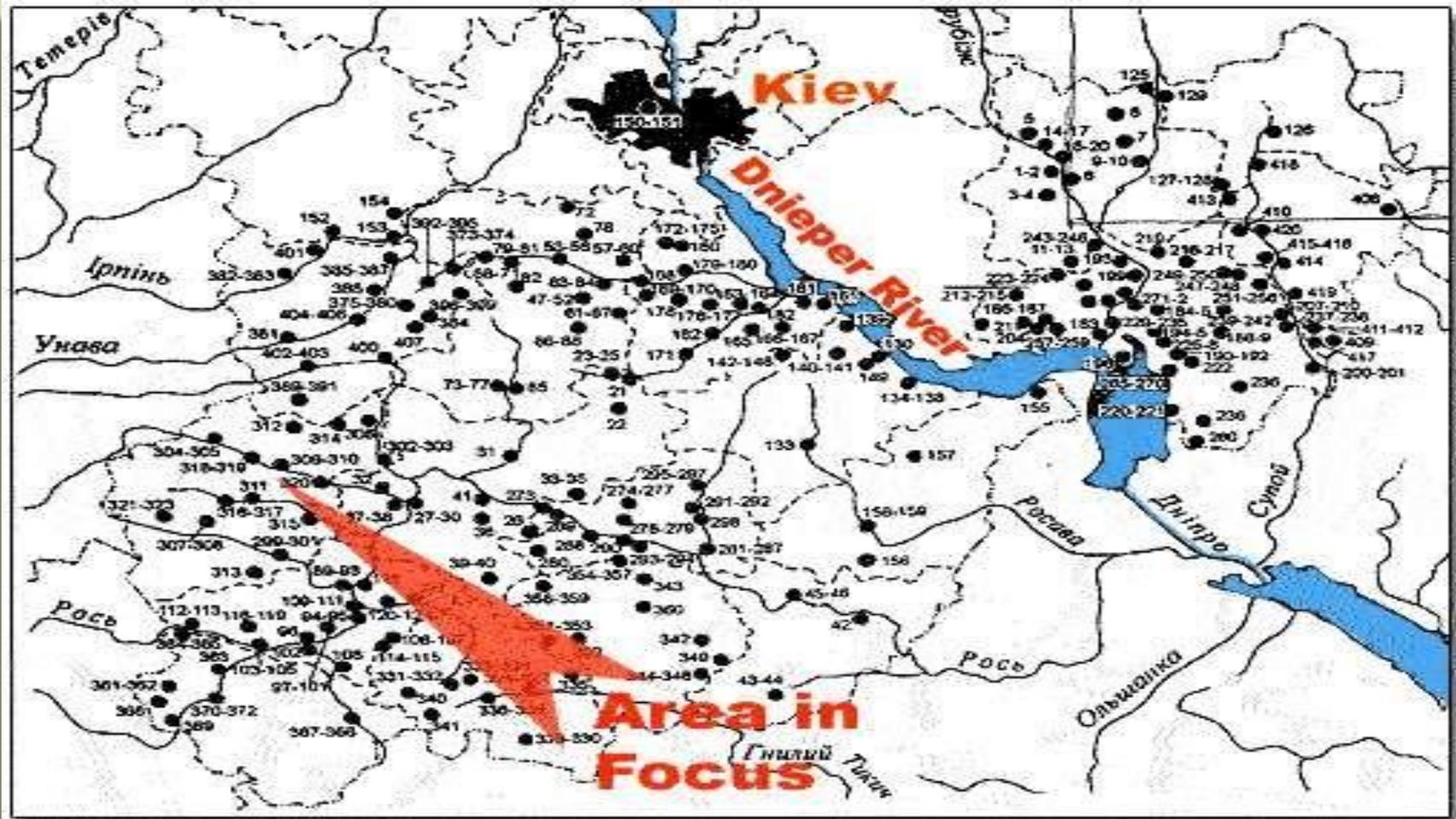


Classification of Surveying

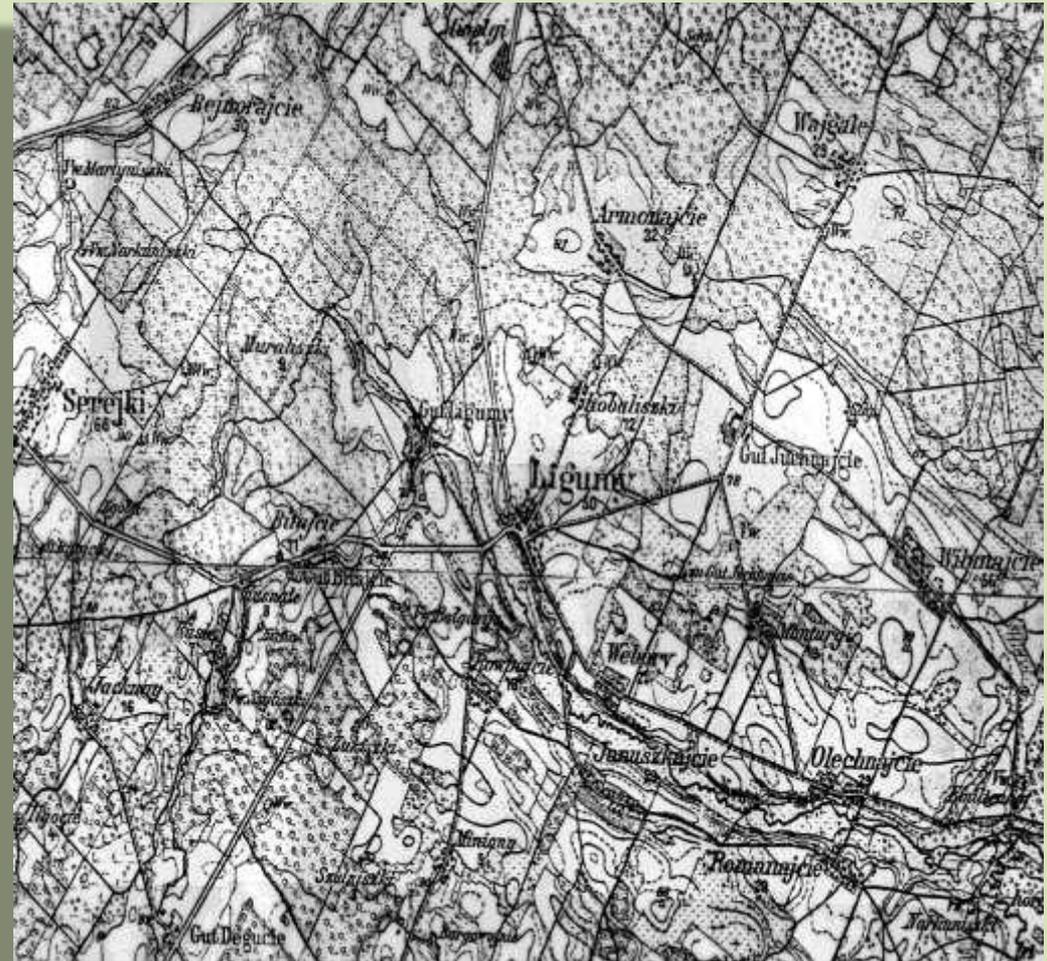
- **Archaeological Survey**
- It is conducted to locate relics of antiquity, civilization, kingdoms, forts, temples, etc.

- **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



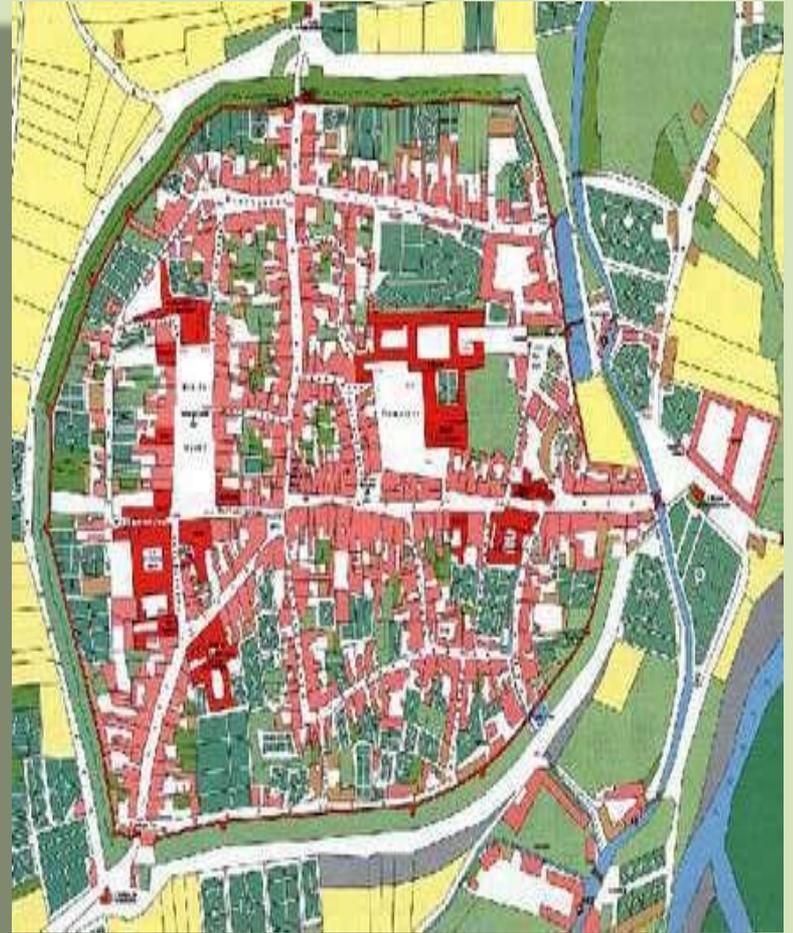
Military Survey



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.

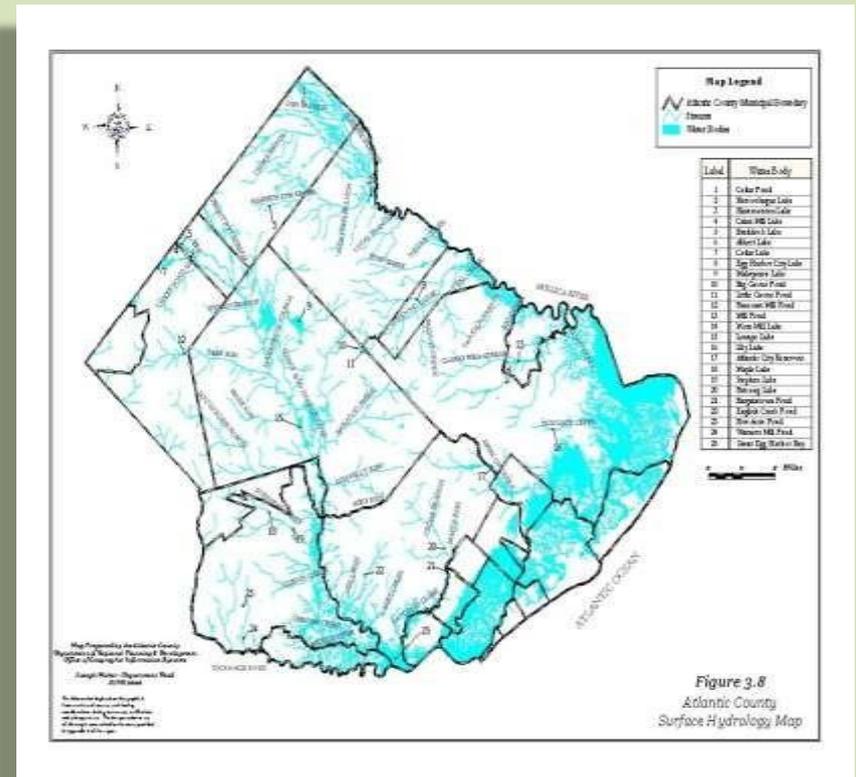
Land Survey



Hydrological Surveying



Hydrological Maps

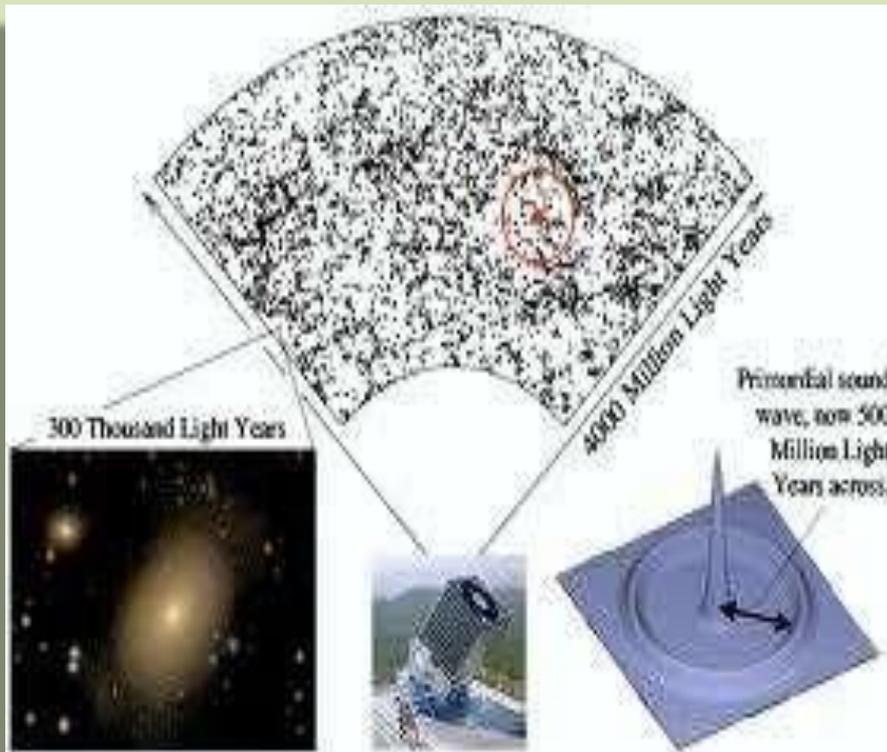


Hydrological Maps

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



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.

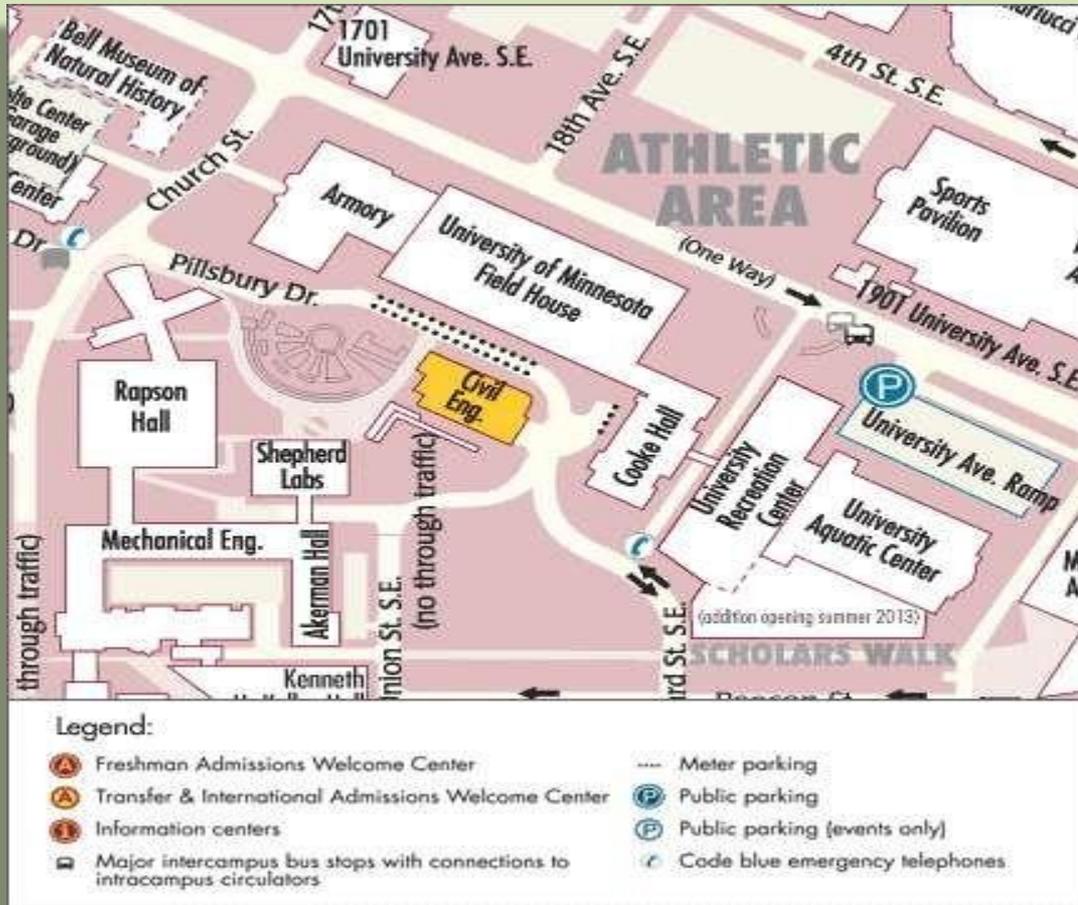
Plan



Master Plan



Map



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



CONTOUR INTERVAL 50 METRES

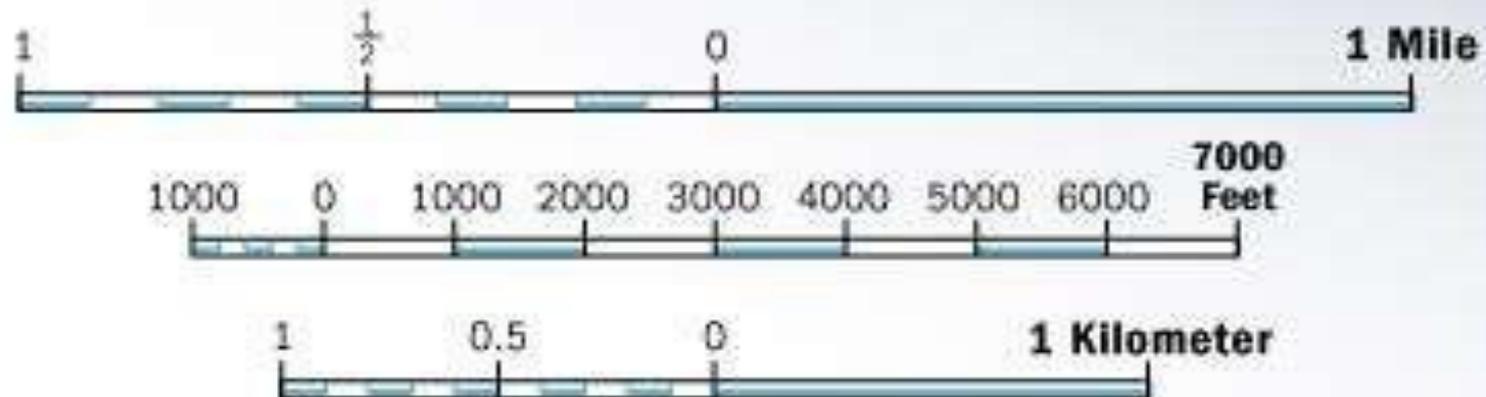
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Scale

How Topographic Maps Work

©2009 HowStuffWorks

Scale 1:24,000
Contour Interval 10 Feet



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
-

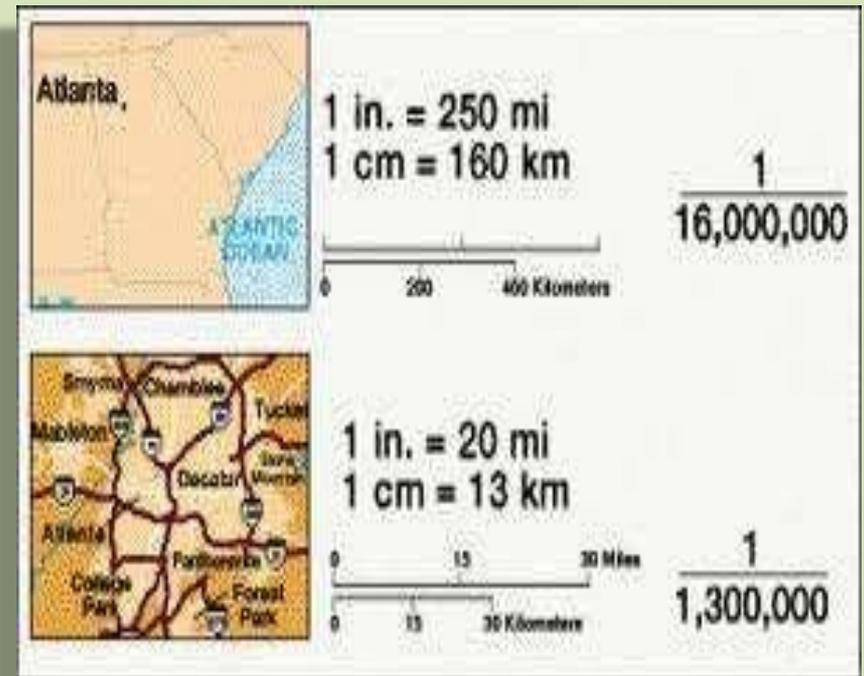
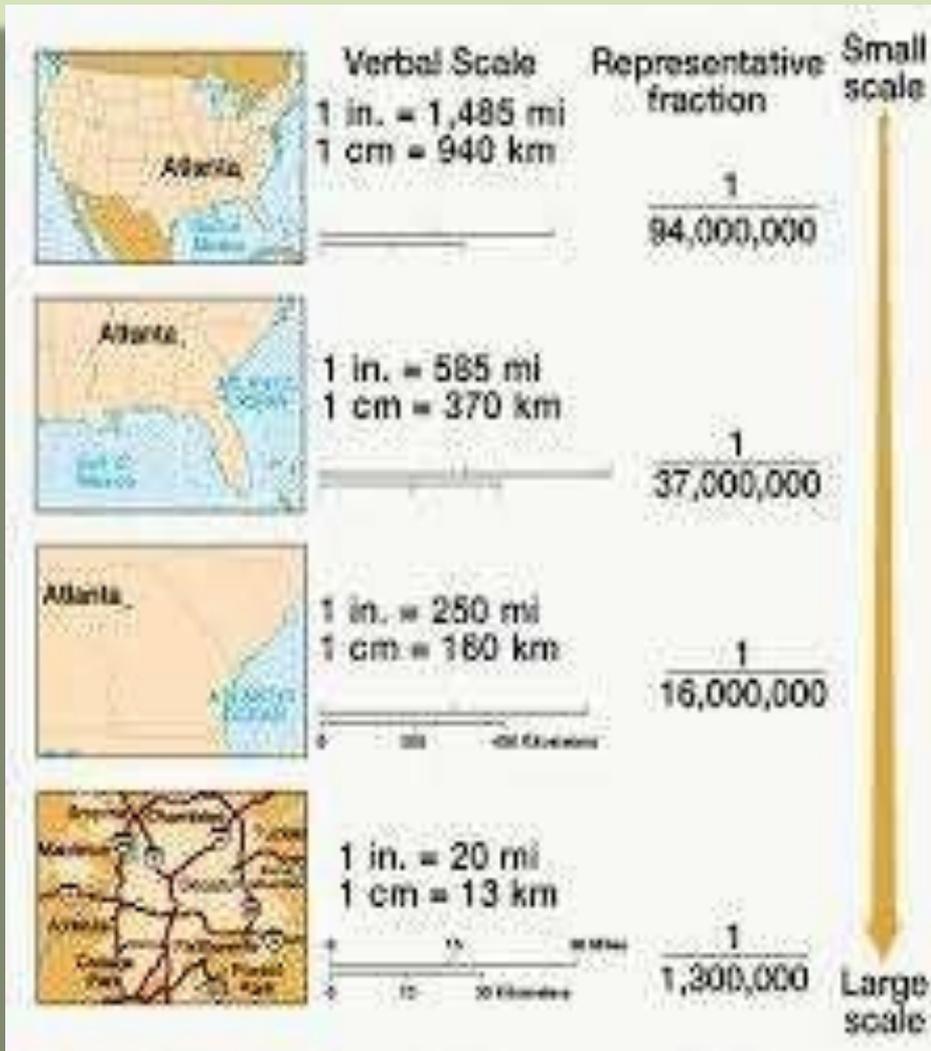
Representative Fraction

- 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

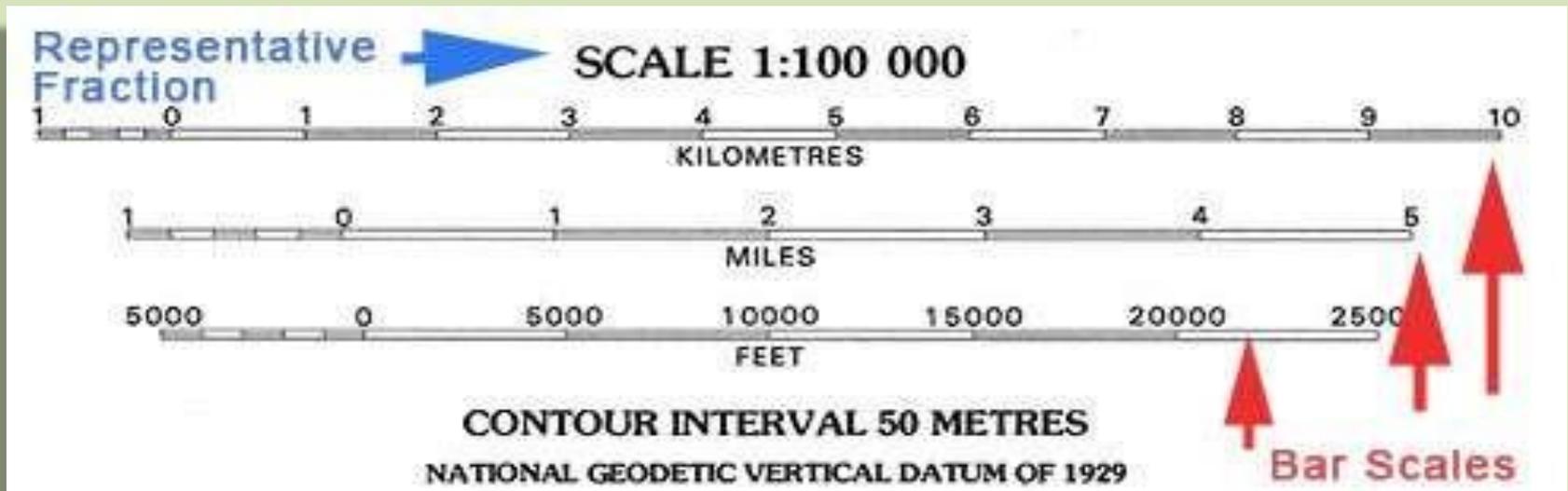
- For example,
- If a scale is
- 1 cm = 1000 m or 1 km
- R.F. = $\frac{1}{100000}$ = $\frac{1}{1000 \times 100}$ or 1:

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.

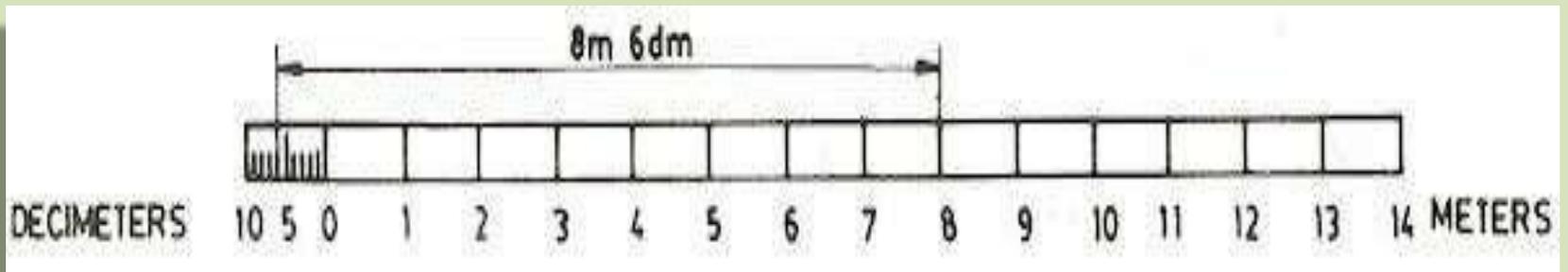


Types of Scales

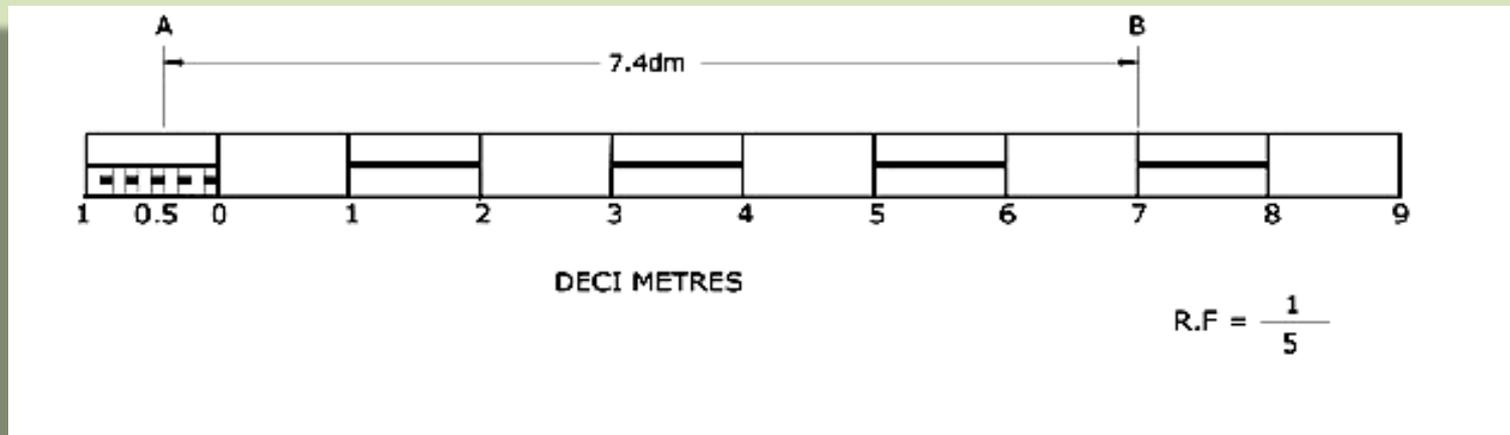
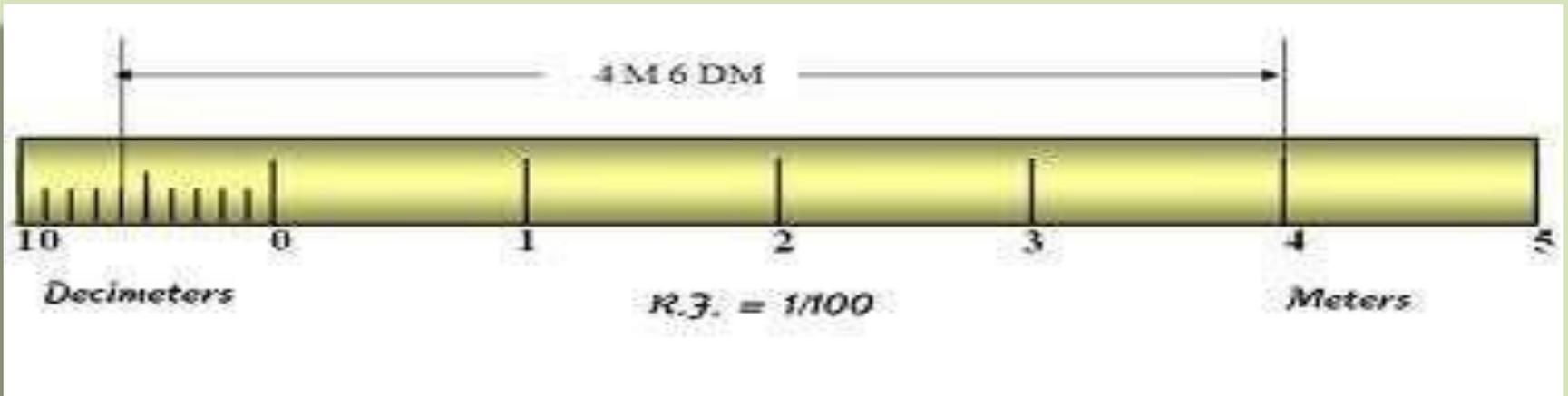
- (a) Plain Scale
- (b) Diagonal Scale
- (c) Chord Scale
- (d) Vernier Scale

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.

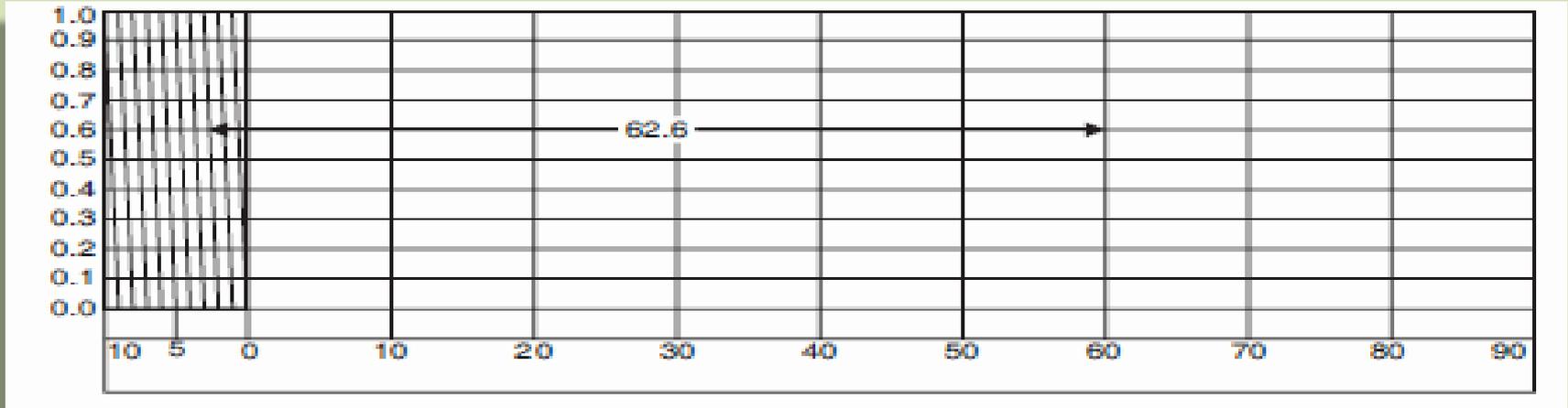


Plain Scale

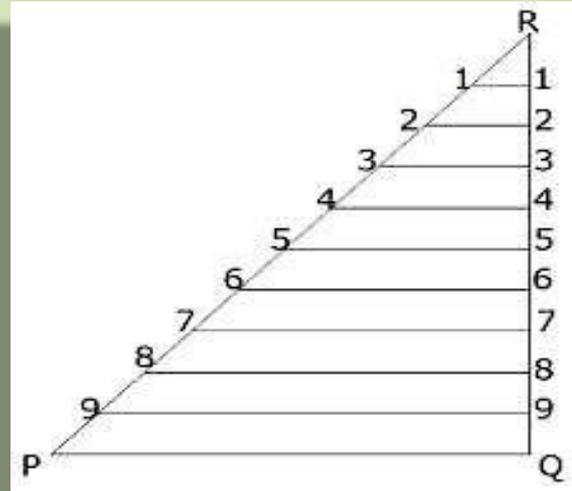
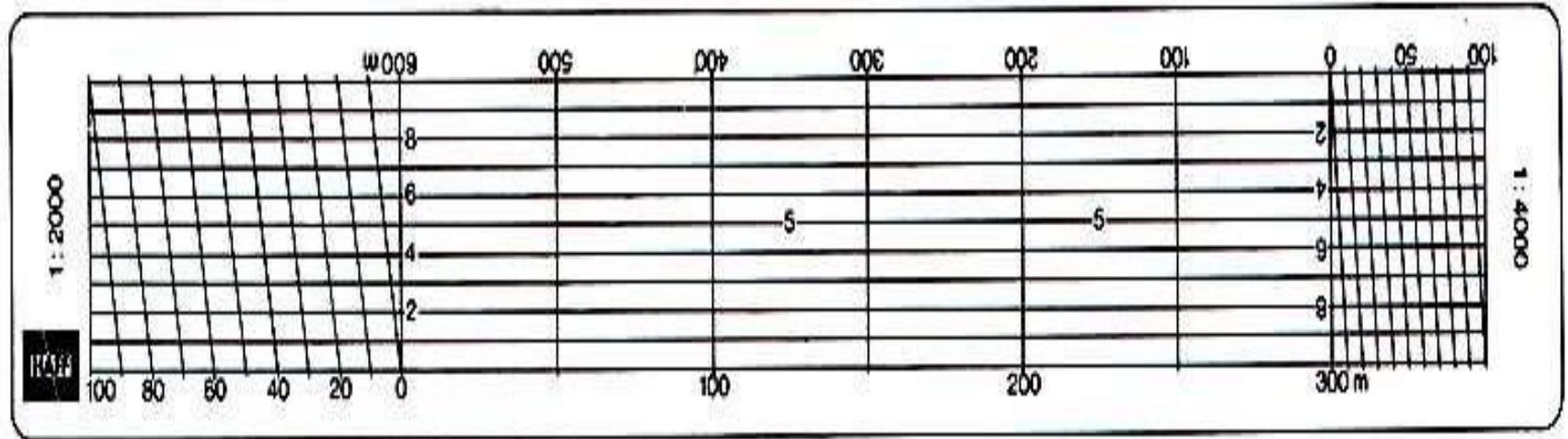


Types of Scales

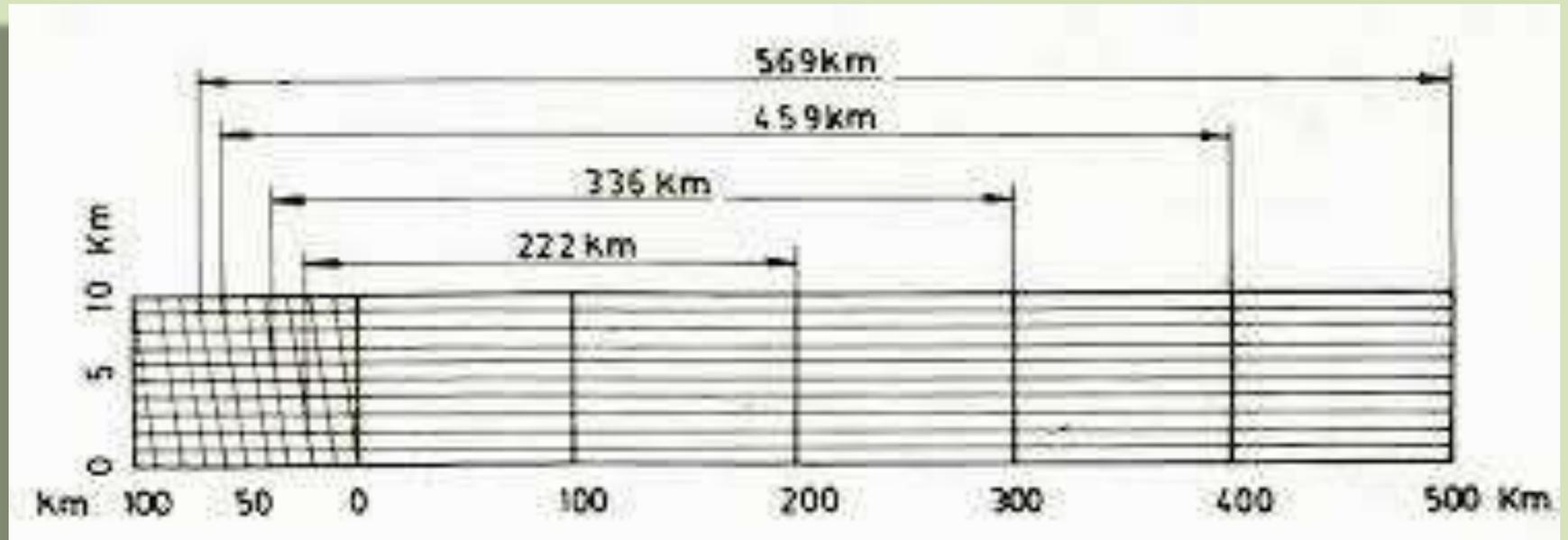
- **Diagonal Scale**
- Using a diagonal scale, one can measure three dimensions such as “ Units, tenths and hundredths”, i.e. metre, decimeter, and centimetres, and so on.



Diagonal Scale



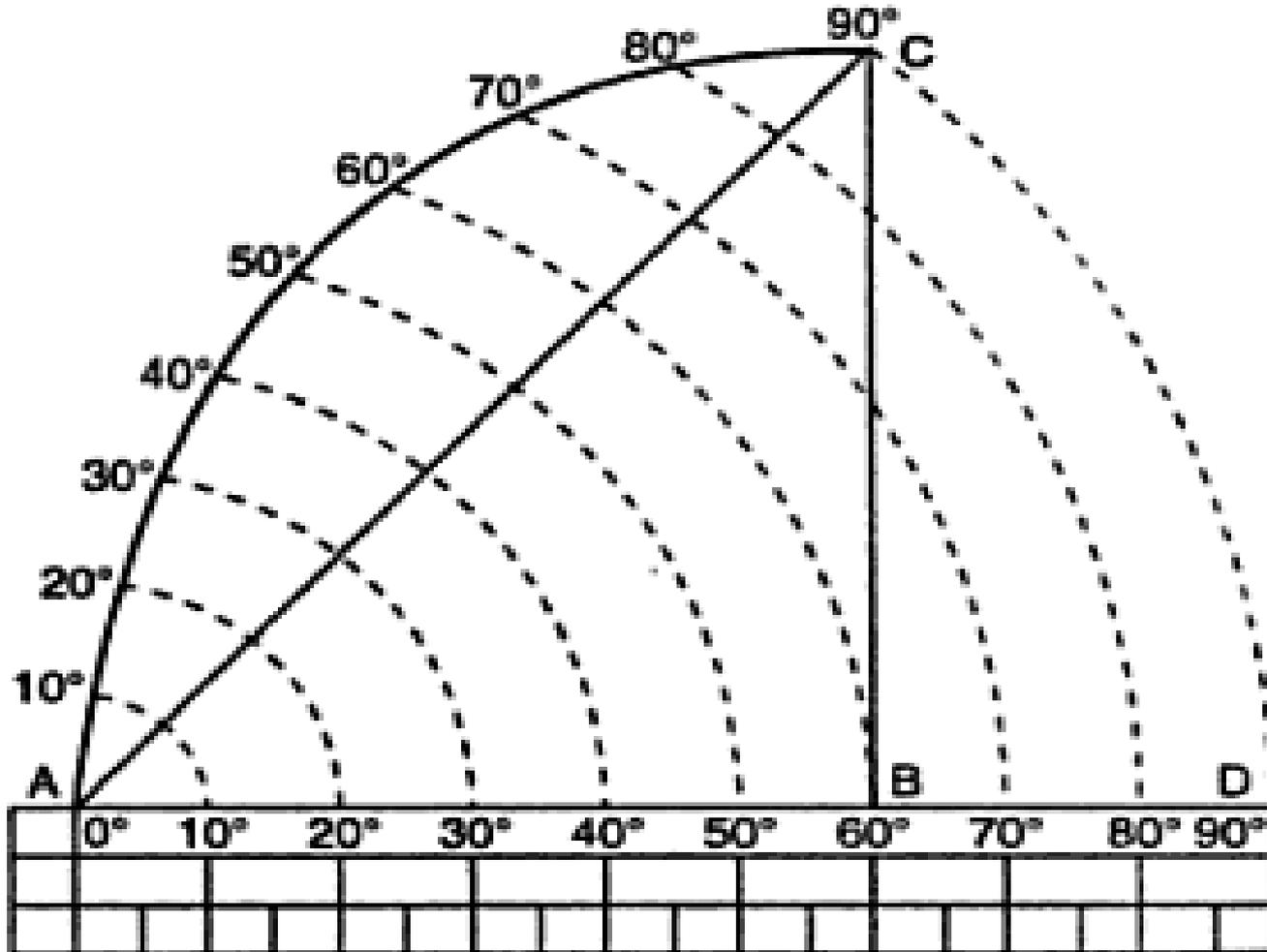
Diagonal Scale



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.

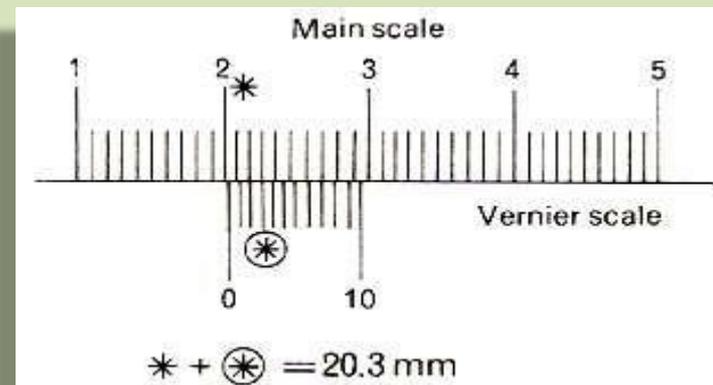
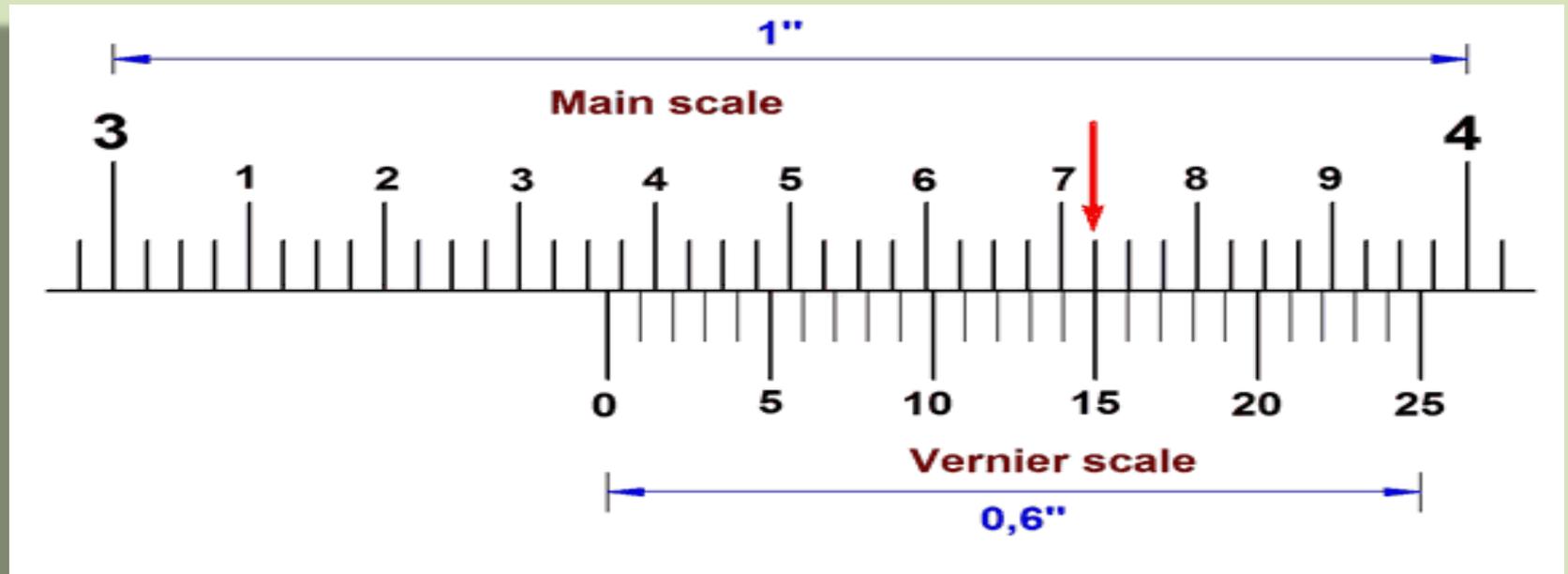
Chord Scale



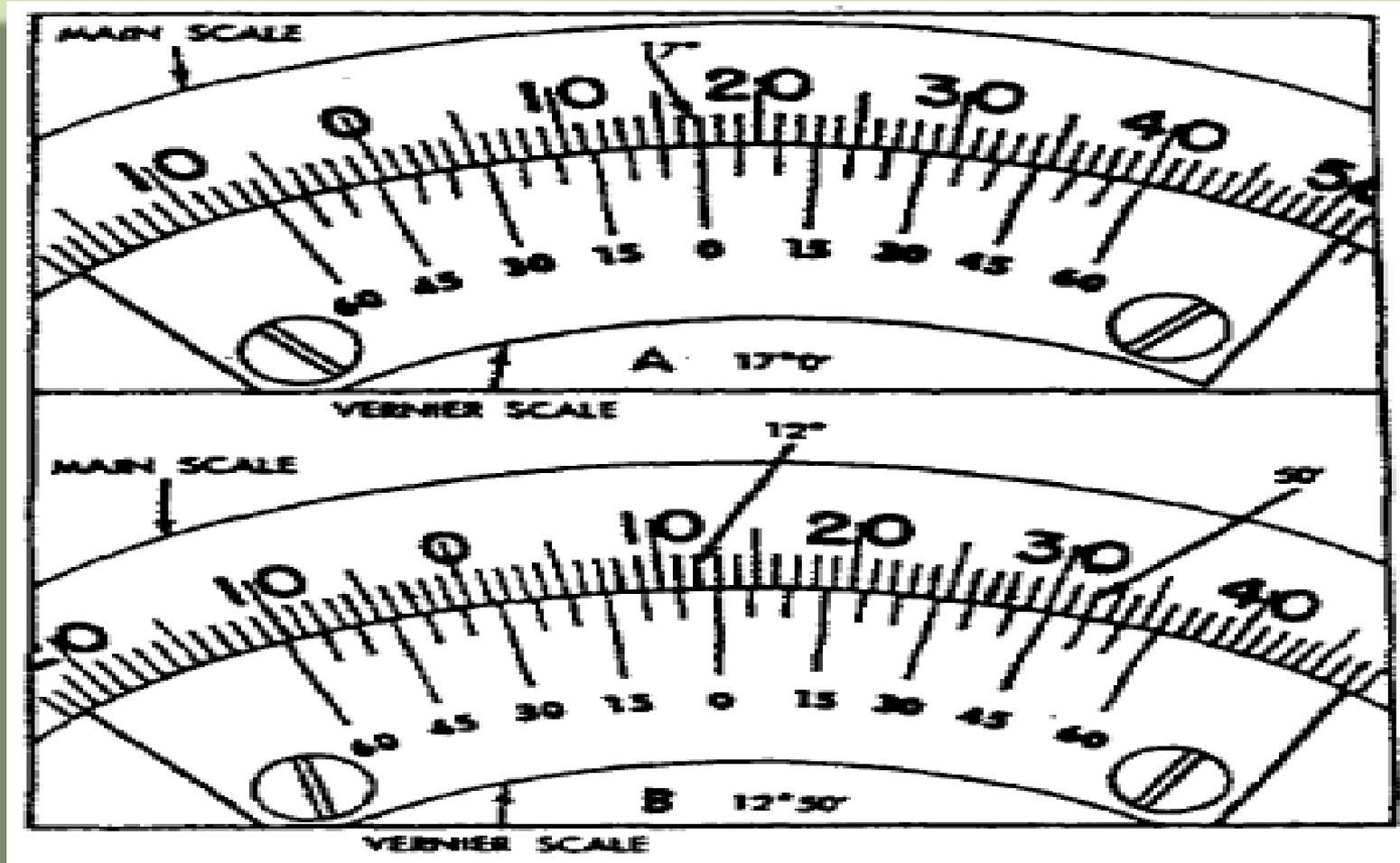
Types of Scales

- **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 $1 \text{ cm} = 2.5 \text{ m}$ to 100 m . Small scale topographical maps are usually drawn to scale $1 \text{ cm} = 1 \text{ km}$, a scale of $1 \text{ cm} = 5 \text{ m}$ to 50 m is generally used for plans prepared for subdivisions of land.

Choice of Scale of a Map

| <i>Type of Survey</i> | <i>Scale</i> | <i>RF</i> |
|---|---|--|
| 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 |
| 1 nautical mile = 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

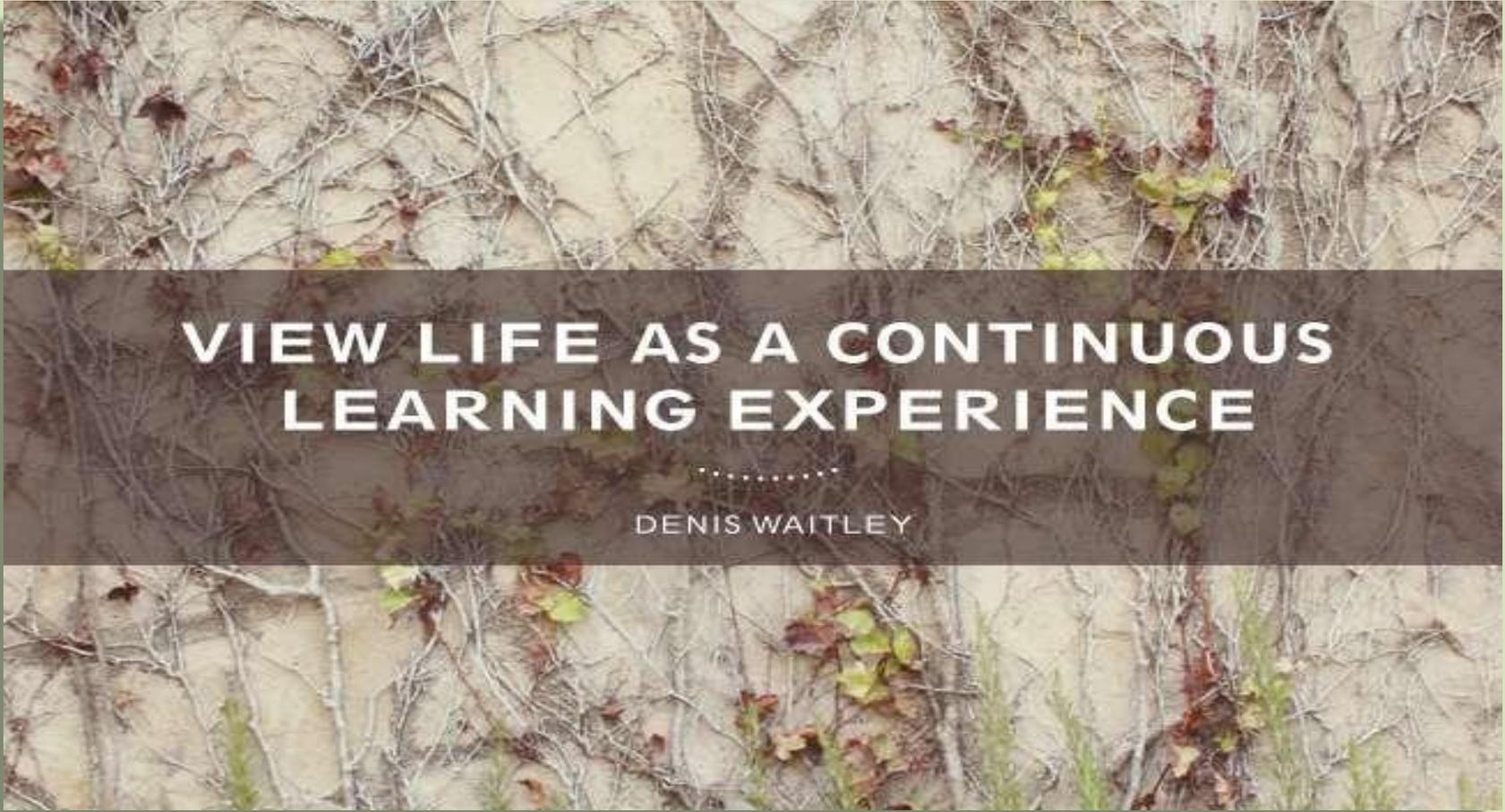
- <http://www.surveyofindia.gov.in/>
- <http://www.portal.gsi.gov.in/>
- <http://www.usgs.gov/>
- <http://asi.nic.in/>
- <http://www.imd.gov.in/>



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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....



**VIEW LIFE AS A CONTINUOUS
LEARNING EXPERIENCE**

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DENIS WAITLEY

