# Chapter 1

## INTRODUCTION

### MULTIPLE CHOICE QUESTION

1. The survey in which the curvature of earth is not taken into account is called
   (a) geodetic survey (b) hydrographic survey
   (c) plane survey (d) city survey

Ans. (c)

2. Which of the following survey is carried out to fixing of property lines?
   (a) topographical survey (b) cadastral survey
   (c) both (a) and (b) (d) none of these

Ans. (b)

3. The main principle of surveying is to work from
   (a) higher level to the lower level.
   (b) lower level to the higher level.
   (c) part to whole.
   (d) whole to part.

Ans.(d)

4. The primary division of survey is
   (a) Based on instrument used
   (b) Based on nature of field survey
   (c) Plain & Geodetic surveying
   (d) All the above

Ans.(c)

5. Measurement in Geodetic survey is
   (a) Equal to plain survey
   (b) Less than plain survey
   (c) More than plain survey
   (d) Depends upon the situation

Ans.(c)

6. For accurate measurement of distances the instrument used is
   (a) Theodolite (b) Tachometer
   (c) Prismatic Compass (d) Planimeter

Ans.(a)

7. The curvature of the earth is taken into consideration in
   (a) geodetic survey (b) hydrographic survey
   (c) plane survey (d) city survey

Ans.(a)

8. The Scale for a map is given as 1/100000.The scale can be represented as 1cm=?
   (a) 10m (b) 100m
   (c) 1000m (d) 10000m

Ans.(c)

9. The object of surveying is to prepare a
   (a) Drawing (b) Cross section (c) Map

Ans.(c)

10. The curvature of the earth is ignored in
    (a) geodetic survey (b) hydrographic survey
    (c) plane survey (d) city survey

Ans.(c)

### LONG QUESTION ANSWER

**Q1.Define the role or responsibilities of a surveyor in a construction project.State future possible progression and career development provisions on completion of the course.**

**Ans.Responsibilities of a Surveyor:**

(i) **Data Collection:** Gather accurate and detailed information about the physical characteristics of a site.

(ii) **Measurement:** Measure distances, angles, and elevations using advanced tools and techniques.

(iii) **Boundary Determination:** Define property boundaries and resolve disputes.

(iv) **Map Creation:** Create detailed maps, blueprints, and plans for construction or land development projects.

(v) **Compliance and Standards:** Ensure that surveys comply with local, national, and international standards and regulations.

(vi) **Collaborative Work:** Work closely with architects, engineers, and project managers to ensure precise implementation of designs.

(vii) **Risk Assessment:** Identify and mitigate risks associated with terrain, environmental factors, and project requirements.

**Future Progression and Career Development:**

(i) **Career Growth:** Progress to roles such as Senior Surveyor, Project Manager, or Chief Surveyor.

(ii) **Specialization Opportunities:** Specialize in geodetic surveying, hydrographic surveying, cadastral surveying, or GIS (Geographic Information Systems).

(iii) **Certification:** Obtain professional certifications (e.g., RICS, GISP) to enhance credibility and expertise.

(iv) **Advanced Education:** Pursue higher education in Geomatics, GIS, or Remote Sensing.

(v) **Entrepreneurship:** Establish private surveying and consulting firms.

(vi) **Global Opportunities:** Work on international projects in urban planning, infrastructure, and environmental management.

**Q2.Define Surveying? Explain the principles of surveying.** [JUT-2017]

**Ans.** Surveying is the art of determining the relative positions of objects on the earth surface by measuring horizontal distances between them. These distances are then plotted on a suitable scale to prepore a map of the area surveyed.

**Principles of surveying :** The principles of surveying are

(a) To work from whole to the part

(b) To locate a new station by at least two measurements from fixed points of reference.

**Explanation :**

(a) The purpose of this process of working is to prevent accumulation error. During this procedure, if there is any of error in the measurement of any linear distance, then it will not affect the whole work. In the reverse process, minor errors in measurement will magnify and become uncontrollable in the end.

(b) Any new station should be fixed by at least two measurements from fixed reference points by linear or angular or a combination of the two measurements.

**Q3.State the objective of surveying.** [SBTE-2016]

**Ans.** The aim of surveying is to prepare a map to show the relative positions of the objects on the surface of the earth. The map is drawn to some suitable scale. It shows the natural features of a country, such as towns, villages, roads, railways, rivers, etc. Maps may also include details of different engineering works, such as roads, railways, irrigation canals etc.

**Q4.What are the uses of Surveying ?**

**Ans.** Surveying may be used for the following various application.

1. To prepare a topographical map which shows the hills, valleys, rivers, village towns, forests, etc. of a country.
2. To prepare a cadastral map showing the boundaries of fields, houses and other properties.
3. To prepare and engineering map which shows the details of engineering works such as roads, railways, reservirs, irrigation canals, etc.
4. To prepare a military map showing the road and railway communications with different parts of a country. Such a map also shows the different strategic points important for the defence of a country.
5. To prepare a contour map to determine the capacity of a reservoir and to find the best possible routes for roads, railways, etc.
6. To prepare a geological map showing areas including underground resources.
7. To prepare an archaeological map including places where ancient relics exist.

**Q5.What are the types of surveying ?**

OR

**Q5.State the primary divisions of surveying.Describe it in brief.** [JUT-2018]

**Ans.** There are two types of surveying :

(1) **Plane survey :** In plane surveying, the effect of curvature of earth is not considered. The surface of the earth is taken as plane. The lines connecting any two points are considered as straight lines and the angles of polygon are plane angles. plane surveys arre carried out for small areas. The degree of accuracy is comparatively low. It involves plain trigonometry. The extent of surveys up to 260 $km^2$ are considered as plane surveys. Plane survey cab be carried by any agency concerned.

(2) **Geodetic Survey :** In geodetic surveying, the curvature of earth is taken into consideration as the surveys extent for large distances and areas. It is carried out for locating distant control points and for surveying large areas i.e. beyond 260 sq.km. It is generally, performed by Government agencies.In India, it is done by Great Trigonometrical Survey ( G.TS) department. It is carried out with a high degree of precision or accuracy to obtain data concerning the size and shape of earth or to locate the positions of wedely distant points, i.e. control points for further detailed surveys.

**Q6.Classify surveying based upon the nature of the field survey.**

**Ans.Classification based on the Nature of Field:**

(1) **Land surveying:**

(i) **Topographical surveys** are made to determine the natural features of country , such as rivers, lakes, hills etc. and artificial features such as roads, railway, canals, towns and villages.

(ii) **Cadastral surveys** are plotted on larger scale than topographical surveys to determine additional details, such as boundaries of fields, houses and other properties.

(iii) **Engineering surveys** are carried out for the determination of quantities or to collect data for designing of engineering works, such as roads, reservoirs, water - supply and sewage disposal. This can be also called as city surveying.

(2) **Astronomical surveying:** To determine the absolute location of any point or the absolute location and direction of any line on the surface of the earth astronomical survey is used.

(3) **Marine survey:** It deals with bodies of water for purpose of navigation, water supply etc. It is also called as hydrographhic survey.

**Q7.Explain the classification of surveying based on the instruments.** [JUT-2015]

**Ans.Classification based on instruments used :** An alternative classification may be based upon the instruments or methods employed, the chief types being :

(i) Chain survey (ii) Theodolite survey

(iii) Traverse survey (iv) Triangulation survey



(v) Tacheometric survey (vi) Plane table survey

(vii) Photogrammetric survey

(viii) Aerial survey

**Theodolite survey :** The Theodolite is the most precise instrument designed for the measurement of horizontal and vertical angles and has wide applicability in surveying such as laying off horizontal angles, locating points on line, prolonging survey lines, establishing grades, determining difference in elevation, setting out curves etc.

A transit theodolite (or simply 'transit') is one is which the line of sight can be reversed by revolving the telescope through $180^0$ in the vertical plane. The non-transit theodolites are either plain theodolites or Y-theodolites in which the telescope cannot be transited. The trasit is mainly used and non-transit theodolites have now become obsolete.

**Traverse surveying :** Traversing is that type of survey in which a number of connected survey lines form the framework and the directions and lengths of the survey lines are measured with the help of an angle (or direction) measuring instrument and a tape (or chain) respectively. When the lines form a circuit which ends at the starting point, it is known as a closed traverse. If the circuit ends elsewhere, it is said to be an open traverse. The closed traverse is suitabte for locating the boundaries of lakes, woods etc., and for the survey of large areas. The open traverse is suitable for surveying a large narrow strip of land as required for a road or canal or the coast line.

**Plane table surveying :** Plane labling is a graphical method of survey in which the field observations and plotting proceed simultaneously. It is means of making a manustript map in the field while the ground can be seen by the topographer and without intermediate steps of recording and transcribing field notes. It can be used to tie topcgraphy by existing control and to carry its own control systems by triangulation or traverse and by lines of levels.

**Q8.Classify surveying based on the surface and the area of surveyed?** [JUT-2012]

**Ans.** Classication based on the surface and the area surveyed:

(1) **Land survey:** Land surveys are done for objects on the surface of the earth. It can be subdivided into:

(a) **Topographic survey:** This is for depicting the (hills, valleys, mountains, rivers, etc) and manmade features (roads, houses, settlements...) on the surface of the earth.

(b) **Cadastral survey** is used to determining property boundaries including those of elds, houses, plots of land, etc.

(c) **Engineering survey** is used to acquire the required data for the planning, design and Execution of engineering projects like roads, bridges, canals, dams, railways, buildings,etc.

(d) **City surveys:** The surveys involving the construction and development of towns including roads, drainage, water supply, sewage street network, etc, are generally referred to as city survey.

(2) **Marine or Hydrographic Survey:** Those are surveys of large water bodies for navigation, tidal monitoring, the construction of harbours etc.

(3) **Astronomical Survey:** Astronomical survey uses the observations of the heavenly bodies (sun, moon, stars etc) to fix the absolute locations of places on the surface of the earth.

**Q9.Classify surveying based upon the purpose ?**

**Ans.** The classification of surveying based on purpose:

(i) **Engineering survey**

(ii) **Control Survey:** Control survey uses geodetic methods to establish widely spaced vertical and horizontal control points.

(iii) **Geological Survey:** Geological survey is used to determine the structure and arrangement of rock strata. Generally, it enables to know the composition of the earth.

(iv) **Military or Defence Survey** is carried out to map places of military and strategic importance.

(iv) **Archeological survey** is carried out to discover and map ancient/relies of antiquity.

**Q10.Differentiate between plain surveying and geodetic surveying.** [JUT-2013]

**Ans.**

| Plane Survey | Geodetic Survey |
|---|---|
| *Curvature effect of earth s surface is not considered.* | *Curvature effect of earth s surface is considered.* |
| *The lines connecting two stations or points are considered as straight line.* | *The lines connecting two stations or points are considered as curved lines parallel to the earth s curved surface.* |
| *Degree of accuracy is comparatively low.* | *Degree of accuracy is very high.* |
| *Extent of survey upto area of 260 sq. km.* | *Extent of survey is beyond 260 sq. km.* |
| *It involves plane trigonometry* | *It involves spherical trigonometry. Hence also called as trigonometrical survey* |
| *It can be carried by any agency concerned.* | *It is to be carried only by specific agency like G.T.S. department in India.* |

**Q11.Define Scale ?What are the different types of scale**

in surveying?

**Ans.Scales:** Scale is the fixed ratio that every distance on the plan bears with corresponding distance on the ground. The different types of scale are as follows:

(a) **Plain scale:** Plain scale is one on which it is possible to measure two dimensions only such as units and lengths and diameters, miles and furlongs etc.

(b) **Diagonal scale:** On a diagonal scale it is possible to measure three dimensions such as meters, decimeters and centimetres, units tenth and hundreds, yards, feet and inches.

(c) **The Vernier:**

(i) **Direct vernier:** It is constructed (n-1) divisions of the main scale is equal to n division of the vernier.In direct vernier, vernier scale moves in same direction of main scale.

$$Least\ count = \frac{s}{n}$$

where, s = value of one smallest division of main scale
n = number of division on the vernier
v = value of one smallest division of vernier
also nv = (n-1) s

(ii) **Retrograde vernier:** It is so constructed that (n + 1) division of main scale is equal to n division of vernier.In retrograde vernier, vernier scale moves in opposite direction of main scale.

(d) **Shrunk scale:** Shrunk scale = original scale x shrinkage factor.

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

**Q12.State the meaning of representative fraction?**

**Ans.** The scale is expressed as a friction whose numerator is always unity. This fraction is known as Representative Fraction. (R.F.)

Representative Fraction

$$= \frac{\text{Plan or map distance}}{\text{Corresponding ground distance}}$$

In R.F., both the numerator and denominator should be in the same units.

i.e. 1 cm = 20 m, R.F. $= \frac{1\text{ cm}}{20\times100\text{ cm}} = \frac{1}{2000}$

Similarly, for 1 cm = 1 kilometre

R.F. $= \frac{1\text{ cm}}{1\times1000\times100\text{ cm}} = \frac{1}{100000}$

Also, from a given R.F. the scale can be found out. Hence RF is the ratio of plan distance to corresponding ground distance which is independent of units.

**Q13.A rectangular plot measure 30 cm 20 cm on the village map drawn to a scale of 1 cm = 80 m.**

**(a) What is the area in hectares ? What is the R.F. of Village map ?**

**(b) What will be its orea on a toposheet drawn to a scale of 1 cm = 0.5 km? What is the R.F. of toposheet ?**

**Ans.(a)** Village map is draw to a scale of 1 cm = 80 m.

$\therefore$ 1 cm² on the map = 80×80 m² = 6400 m² on the ground

The area of plot on map is 30 cm × 20 cm = 600 m²

$\therefore$ The area plot on ground = 600 × 6400 = 3840000 m² ≈ 384 hectares

R.F. of the scale of village,

$$= \frac{1}{80\times100} = \frac{1}{8000} \qquad (1ha = 10^4\ m^2)$$

(b) Toposheet is draw for a scale of 1 cm = 0.5 km.

$\therefore$ 1 cm² on toposheet $= 0.5\times0.5\ km^2$

$= 0.25\ km^2$

$= 0.25\times1000\times1000\ m^2$

i.e. $\frac{3840000}{0.25\times1000\times1000} = 15.36$ cm2

R.F. of the scale of toposheet,

$$= \frac{1}{0.5\times1000\times100} = \frac{1}{50000}$$

**Q14.Scale on map is 1 cm = 0.5 km. What is R.F. ?**

**Ans.** R.F. $= \frac{\text{Distance on map}}{\text{Distance on ground}}$

$= \frac{1\text{cm}}{(0.5\times1000\times100)\text{ cm}}$

$= \frac{1}{50000}$

**Q15.1.5 sq km. area on the ground is represented by 150 sq cm. in the map. What is its R.F. ?**

**Ans.** 150 sq. cm. = 1.5 sq. km

150 sq. cm. = 1.5×1000×1000 sq. m

1 sq. cm. $= \frac{1.5\times1000\times1000}{150}$

1 sq. cm = 10000 sq. m

Hence, 1 cm = $\sqrt{1000}$ m

Scale : 1 cm = 100 m

$\therefore$ R.F. $= \frac{1\text{ cm}}{(100\times100)\text{ cm}}$

R.F. $= \frac{1}{10000}$



# Chapter 2

# Chain Survey

## MULTIPLE CHOICE QUESTION

**1. Gunters chain consist of :**
(a) 33 links (b) 66 links
(c) 100 links (d) 120 links

**Ans.(c)**

**2. A building is an obstacle to :**
(a) Chaining (b) Ranging
(c) Both (a) and (b) (d) None of these

**Ans.(c)**

**3. Correction for slope is always :**
(a) Positive (b) Negative
(c) Both (a) and (b) (d) None of these

**Ans.(b)**

**4. Optical square is used for :**
(a) measuring horizontal angle
(b) Measuring vertical angle
(c) setting out right angle
(d) All of the above

**Ans.(c)**

**5. In metric system of chain 1 link is equal to**
(a) 10 cm (b) 20 cm
(c) 30 cm (d) 10 mm

**Ans.(b)**

**6. The angle between two mirror in optical square is**
(a) 450° (b) 900°
(c) 1350° (d) 300°

**Ans.(a)**

**7. An invar tape is made of an alloy of**
(a) copper and steel (b) brass and steel
(c) brass and nickel (d) nickel and steel

**Ans.(d)**

**8. Ranging is the process of**
(a) fixing ranging rod on the extremities of the area
(b) aligning the chain in a straight line between two extremities
(c) taking offsects from a chain line
(d) chaining over a range of mountain

**Ans.(a)**

**9. For a well-conditional triangle no angle should be**
(a) 20° (b) 30°
(c) 45° (d) 60°

**Ans.(c)**

**10. Compensating errors that occur in chaining is proportional to**
(a) L (b) $\sqrt{L}$ (c) $\frac{1}{L}$ (d) $\frac{1}{\sqrt{L}}$

**Ans.(b)**

**11. An obstacle which obstructs both chaining & ranging is a -**
(a) river (b) lake (c) building (d) hillock

**Ans.(c)**

**12. If the length of chain along a slope 0° is 1, the required slope correction is -**
(a) $1\cos^2\frac{\theta}{2}$ (b) $2l\sin^2\frac{\theta}{2}$
(c) $2l\cos^2\frac{\theta}{2}$ (d) none of the above

**Ans.(d)**

**13. In a metric chain, 2m length is divided into -**
(a) 5 links (b) 10 links (c) 20 links (d) 30 links

**Ans.(b)**

**14. For accurate measurement of distances the instruments used is -**
(a) chain (b) steel tape
(c) metallic tape (d) invar tape

**Ans.(d)**

**15. The distance between two consecutive talies in a metric chain is -**
(a) 1 m (b) 2 m (c) 5 m (d) 10 m

**Ans.(c)**

**16. The sag co-relation of the tape is always -**
(a) positive (b) negative
(c) either positive or negative (d) none of these

**Ans.(b)**

**17. Chain survey is suitable in -**
(a) hilly country (b) flat area
(c) roaded country (d)country with large area & details

**Ans.(b)**

**18. A 20 meter chain is divided into -**
(a) 50 links (b) 100 links
(c) 200 links (d) 150 links

**Ans.(b)**

**19. The sag correction of the tape is -**
(a) always positive (b) always negative
(c) may be positive or negative (d) none of these

**Ans.(b)**

**20. The preliminary inspection of the area to be surveyed is known as -**
(a) primary survey (b) rough survey
(c) location survey (d) reconnaissance survey

**Ans.(d)**

**21. The total number of links in a 30 m chain is -**
(a) 100 (b) 200 (c) 150 (d) 50

**Ans.(c)**

**22. A 20 m chain is divided into -**

(a) 50 links (b) 100 links
(c) 200 links (d) 150 links

Ans.(b)

23. The relative closing error should not exceed be -
(a) 1/450 m (b) 1/350 m (c) 1/600 m (d) 1/550 m

Ans.(c)

24. A ideal conditioned triangle does not have any angle less than -
(a) 20° (b) 30° (c) 45° (d) 60°

Ans.(b)

25. Chain survey is well adopted for -
(a) Small areas in open ground
(b) Small area in crowded ground
(c) large areas with simple details
(d) large areas with difficult details

Ans.(a)

26. The numbers of minimum rod needed for direct ranging -
(a) 1 (b) 2 (c) 3 (d) 4

Ans.(c)

## LONG QUESTION ANSWER

**Q1.State the use of instrument for linear measurement? [JUT-2015]**

Ans.The following types of instrument used for linear measurement:

1. **Chain :** Chain is used for measuring the horizontal distance on the ground. Minimum distance or least count of chain is 20 cm and hence used for large distance measurement with rough calculations.
2. **Tape :** Tapes are used for taking fractional distances which are less than a chain length. They are also used for taking offsets and more accurate distance. Least count of tape varies from 1 mm to 1 cm depending upon the materials of tape used. For e.g. Metallic tape has least count 1 cm while steel tape has least count 1 mm.
3. **Ranging Rod :** These are used to identify the position of object or station from longer distance. These are painted in different colours of 20 cm each to clear the visibility from longer distance. Coloured flags are also provided to named as flag poles for more distances. Ranging rods or flags are also used for ranging survey lines.
4. **Offset Rod :** These are used for pulling or pushing the chain through a hedge or other obstruction for identification of object or station. It is also used for measuring the offsets roughly.
5. **Arrows :** These are also called as making pins and used to mark the end of each chain during chaining.
6. **Pegs :** These are used for marking the positions of stations. Centre or top portion of peg is suppose to be a perfect central position of object or station.
7. **Plumb bob :** It is used
(a) to transfer the points to the ground while chaining on sloping ground.
(b) for accurate centering of instruments used in survey.
8. **Cross-staff :** It is used for marking perpendicular offset.
9. **Optical square :** Used for marking perpendicular offset.
10. **Line Ranger :** It is used for marking the intermediate stations in between two end staions in a one straight line or ranging purpose.

**Q2. Define the following terms : [JUT-2017]**
**(i) Survey line (ii) Check line**
**(iii) Tie line (iv) Base line**
**(v) Well conditioned triangle**

Ans. **(i) Survey line:** A Survey line is a line produced on a cast by a surveyor or scribe marking the greatest prominence of contour in relation to the planned path of placement of a restoration.

**(ii) Check line :** It is a line joining the apex of a triangle to some fixed point on the opposite side or a line joining some fixed point on anu two sides of a triangle. The length of check line measured in the field should agree with its length on the plan. Thus, it checks the accuracy of the frame work .

**(iii) Tie line :** It is a line joining some fixed points as tie Stations on the main chain lines. It enables the surveyor to locate the interior details and also to check the accuracy of frame work.

**(iv) Base line :** The base line is generally the longest line umning roughly through the middle of the area. It is laid on a level ground as far as possible. The whole frame work is built upon this line. It fixes up the direction of all the survey lines.This being the most important line, it should be measured very accurately.

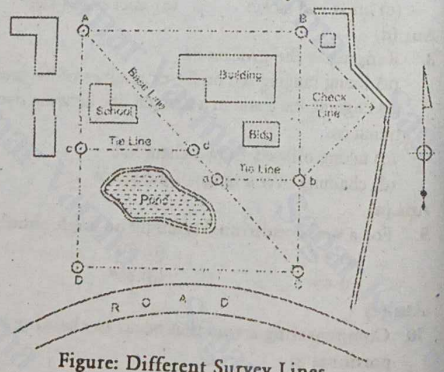



Figure: Different Survey Lines



**(vi) Well conditioned triangle :** A triangle is said to be well - conditioned when no angle in it is less than $30^0$ or greater than $120^0$. An equilateral triangle is considered to be the best - conditioned or ideal triangle.
Well-conditioned triangles are preferred because their apex points are very sharp and can be located by a single 'dot'. In such a case, there is no possibility of relative displacement of the plotted point.

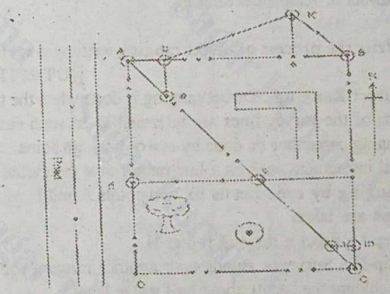
**Q3. State and explain the following terms used in chain surveing : [NN Basak]**
**(i) Main station (ii) Tie Station**
**(iii) Main Survey line (iv) Base line**
**(v) Tie Line (vi) Check line**

Ans.

**(i) Main station :** Main station is a point in chain survey where the two sides of traverse or tringale meet. These stations command the boundaries of the survey and are designated by capital letters such as A, B, etc.

**(ii) Tie or subsidiary station :** Tie station is station on a survey line joining two main stations. These are helpful in locating. the interior details of the area to be surveyed and are designated by small letters such as a, b, c, etc.

**(iii)Main Survey Line :** The chain line joining two main survey stations is called main survey line AB and BC, are the example of main survey lines.



**(iv) Base Line :** It is the longest main survey line on a fairly level ground and passing throughf the center of area. It is the most important line as the direction of all other survery lines are fixed with respect to this line.

**(v) Tie or Subsidiary Line :** A chain line joining two tie stations is called tie line.It is also called auxiliary line. These are provided to location the interior details which are far away from the main lines.

**(vi) Check Line :** Check line or proof line is a line which is provided to check the accuracy of the field work. The measured length of the check line and computed one (on the plan) must be the same.

**Q4. What are the points to be considered while selection the survey stations or survey lines ? [JUT-2014]**

Ans.The following points should be observed while selection survey stations or survey lines.
(1) Main survey stations should be intervisible.
(2) Survey lines if possible should run through a level ground and should be as closed as possible to the boundaries to avoid long offsets.
(3) If possible, a long should run roughly the middle of area to form the backbone of the skeleton.
(4) The survey lines should be as few as possible and should be so arranged as to avoid obstacles in ranging and chaining.
(5) The are should be divided into well conditioned traingles, following the principle of surveying, i.e, working from whole to the part.
(6) The lines should run to locate the details and to avoid long offsets.
(7) Each tringle in the skeleton be provided with at least one check line.

**Q5. What is ment by well-conditioned triangle and ill-conditioned triangle ?**

Ans.During chain survey, area is to be divided into number of triangles. To get better result triangles formed should be nearly equilateral as possible. Such triangles in which no angle is smaller than 30° and greater than 120° are called as well shaped or well-conditioned triangle.
Triangle having angles less than 30° or greater than 120° are know as ill-conditioned triangle.

**Q6. Prepare the list of instruments and items used for chain and cross staff survey and explain use to any two of them. [JUT-2014]**

Ans.Following are the instruments which are used in chain and cross staff survey.
(i) Chain or tape (ii) Pegs
(iii) Arrow (iv) Plumb bob
(v) Cross-staff, etc.

**(i) Chain or tape :** According to the name chain surveying, chain is most essential part of this survey. This survey is based on the linear measurement. A follower and leader play an important role in chain surveying, with the help of chain, we can measure the distance accurately.

**(ii) Cross-staff :** To erect perpendicular line from any other line, cross-staff is used. This is post usuable instrument used in chain survey for erecting the perpendicular lines from main survey line. Cross-staff have also many types:
(a) Open cross staff

(b) French cross staff
(c) Adjustable cross staff

**Q7. Enumerate different types of tapes explain any one.** [JUT-2017]

**Ans. Types of Tapes :**
(a) Cloth or linen tape
(b) Metallic tape,
(c) Steel tape, and
(d) Invar tape

(a) **Cloth or linen tape :** Are closely woven linen and varnished to resist moisture. It is commonly abvailable in lengths of 10m, 20m, 25m and 30m and 12-15mm in width. It is rarely used for making accurate measurements, because of the following reasons :
(i) It is easily affected by moisture and thus gets shrunk.
(ii) Its length gets altered by stretching.
(iii) It is likely to twist and tangle.
(iv) It is not strong as a chain or steel tape.
(v) It is light and flexible and it does not remain straight in strong wind.

**Metallic Tape :** It is made up of linen and reinforced with brass or copper wire to prevent stretching or twisting fibres. It is available upto 30 m length and used for offset and rough measurement.

**Steel Tape :** It is made up of steel or stainless steel strip of 6 mm to 16 mm wide. It is available upto 30 m length. (From 1 m length to 30 m length).

It has a least-count of 5 mm and used for accurate measurement.

**Invar tape :** It is made up of alloy of nickel (36%) & steel (64%). It has a linear thermal coefficient of expansion $0.122\times10^{-6}/C^0$ and used for very accurate measurements as well as for testing the chains.

**Q8.State different types of chain used in surveying?** [JUT-2016]

**Ans.** Depending upon the length of the chain, these are divide into following types,

(a) **Metric chains:** Metric chains are the most commonly used chain in India. These types of chains comes in many lengths such as 5, 10, 20 and 30 meters. Most commonly used is 20m chain. Tallies are provided at every 2m of the chain for quick reading. Every link of this type of chain is 0.2m. The total length of the chain is marked on the brass handle at the ends.

(b) **Steel band or Band chain:** These types of chain consist of a long narrow strip of steel of uniform width of 12 to 16 mm and thickness of 0.3 to 0.6 mm. this chain is divides by brass studs at every 20cm or instead of brass studs, band chain may have graduated engraving as centimeter.

For easy use and workability band chains are wound on steel crosses or metal reels from which they can be easily unrolled. These steel bands are available in 20m and 30m length and the width of about 12-16mm.

(c) **Gunters chain or surveyors chain:** Gunter chain comes in standard 66ft. These chain consists of 100links, each link being 0.66ft or 7.92inches. The length 66ft is selected because it is convenient in land measurements.

(d) **Engineers chain:** This chain comes in 100ft length. Its consist of 100 links each link being 1ft long. At every 10 links a brass ring or tags are provided for indication of 10 links. Readings are taken in feet and decimal.

(e) **Revenue chain:** The standard size of this type of chain is 33ft. The number of links are 16, each link being $2\frac{1}{16}$ ft. This chain is commonly used in cadastral survey.

**Q9.Define Ranging and state its methods of ranging.**

**Ans. Ranging:** The process of establishing intermediate points on a straight line between two end points is known as ranging. Ranging must be done before a survey line is chained. Ranging may be done by the naked eye or by line ranger or by theodolite. Generally, ranging is done by the naked eye with help of three ranging rods.

There are two methods of ranging:
(i) Direct ranging
(ii) Indirect or reciprocal ranging.

**Q10.Write the process of direct ranging with neat sketch.** [JUT-2011]

**Ans. Direct Ranging :** Direct ranging is done when the two ends of the survey lines are intervisible. In such cases, ranging can either be done by eye or through some optical instrument such as a line ranger or a theodolite.

**Ranging by eye :** Let us fix two points A and B which steps are taken.

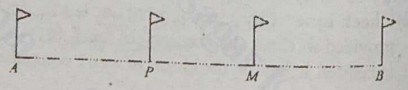
**Step-I :** Erect a ranging rod at B.

**Step-II :** Surveyor stands with another ranging rod at A, holding the rod at about half metre length.

**Step-III :** The assistant goes with another ranging rod and establishes the rod at a point approximately in the line AB (by judgement) at a distance not greater than one chain length from A.

**Step-IV :** The surveyor at A then signals the assistant to move transverse to the chain line, till he is in line with A and B.

**Step-V :** Similarly, other intermediate point can be establish.






**Ranging by Line Ranger :** A line ranger consists of either two placed one above the other. The diagonals of the two prisms are silvered. So a to reflect the incident rays. A handle with a hook is provided at the bottom to hold the instrument in hond to transfer the point on the ground with the help of plumb bob.

To range a point P, two ranging rods are fixed at the ends A and B, and the surveyor at P holds the line ranger very near to the line AB. The lower prism abc receives the rays from A which are reflected by the diagonal ac towards the observer. Similarly, the upper prism abc receives the rays from B which are reflected by the diagonal bd towards the observer. Thus, the observer views the images of ranging rods at A and B, which may not be in the same vertical line. The surveyor then moves the instrument sideways till the two images are in the same vertical line. The point P is then transfered to the ground with the help of plumb bob. Similarly, we can establish an other intermediate points. Only, one person is required in line ranger.

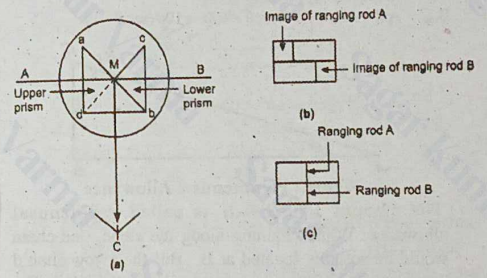



Figure : Line Rangers

**Q11.Explain Indirect or Reciprocal Ranging with neat sketch ?** [NN Basak]

**Ans. Indirect or Reciprocal Ranging :**

When the end stations are not intervisible due to there being high ground between them, intermediate ranging rods are fixed on the line in an indirect way. This method is know, as indirect ranging or reciprocal ranging. The following procedure is adopted for indirect ranging.

Suppose A and B are two end stations which are not intervisible due to high ground existing between them. Suppose it is required to fix intermediate points between A and B. Two chain men take up positions at $R_1$ and $S_1$ with ranging rods in their hands. The chainman at $R_1$ stands with his face toward B so that he can see the ranging rods at $S_1$, and B. Again, the chainman at $S_1$ stands with his face towards A so that he can see the ranging rods at $R_1$ and A. Then the chainmen proceed to range the line by directing each other alternately. The chainman at $R_1$ directs the chainman at $S_1$ to come to the position $S_2$ so that $R_1$, $S_2$ and B are in the same straight line. Again, the chainman at $S_2$ directs the chainman at R1 to move to the position at $R_2$ so that $S_2$, and A are in the same straight line. By directing each other alternately in this manner, they change their positions every time until they finally come to the positions R and W, which are in the straight line time until they finally come to the positions R and S, which are in the straight line AB. This means the points A, R, S and B are in the straight line (Fig. below).

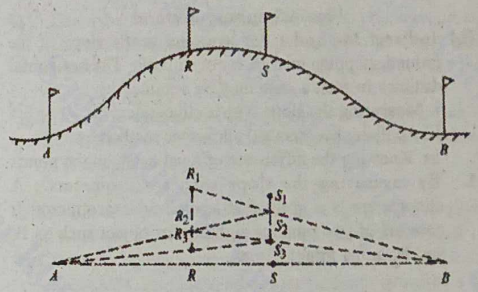



Figure : Reciprocal Ranging.

**Q12.Enumerate different methods of chaining on sloping ground. Explain any one method.** [JUT-2017]

**OR**

**Q12.How will you perform chaining on sloping ground by different method?**

**Ans.** The different methods of chaining on sloping ground are:
a. Direct method or stepping method
b. Indirect method

(a) **Direct method :** For very steep terrain, this method is quite useful. In this method, the sloping ground is divided into a number of horizontal and vertical strips such as steps. The lengths of horizontal portions are added after measurement to get the total horizontal distance between the points.

**Procedure:** Suppose the horizontal distance between points A and B is to be measured. The line AB is first ranged properly. Then the follower holds the zero end of the tape at A. The leader keeping other end of the tape in his hand moves down the slope to $P_2$ and stretches the tape horizontal at arm's height say $P_1P_2$. The exact location of $P_2$ vertically beneath $P_1$ is obtained either by a plumb-bob or simply by dropping a piece of a small stone from $P_1$. The follower then marches to $P_2$ and leader to $P_4$ and so on. The horizontal lengths $P_2P_3$

and $P_4P_5$ are measured. So, the total horizontal length,

$AB = AP_1 + P_2P_3 + P_4P_5$

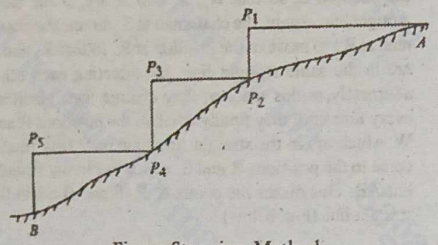



Figure:Stepping Method

(b) **Indirect Method** : For long and gentle slope of the ground, stepping method is not suitable. The horizontal distance in such a case may be obtained by

i. Measuring the slope with a clinometers

ii. Applying hypotenusal allowance method and

iii. Knowing the difference of level between the points

1. **By measuring the slope with a clinometers** : A clinometers is a graduated semicircular protractor. It consists of two pins for sighting the object such as $P_1$ and $P_2$ in the figure below.

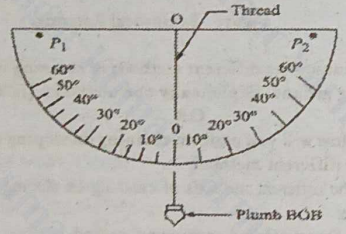



Figure: Clinometer

A plumb-bob is suspended from point O with a thread. When the straight edge is just horizontal, the thread passes through 0°. When the straight edge is tilted, the thread remains vertical but passes through a graduation on the arc which gives the angle of slope.

**Procedure** : Suppose C and D are two points on sloping ground. Two ranging rods are fixed at these points. Then two other points $C_1$ and $D_1$ are marked on the ranging rods so that $CC_1 = DD_1$

The clinometers is placed in such a way that its center just touches me mark $C_1$. The clinometers is tilted gradually now until the points $P_1$, $P_2$ & $D_1$ are in the same straight line.

At this point, the clinometers will show an angle $\mu$ equal to the slope of the ground. Then the sloping distance CD=l is also measured. The required horizontal distance, $CB = l \cos \mu$.

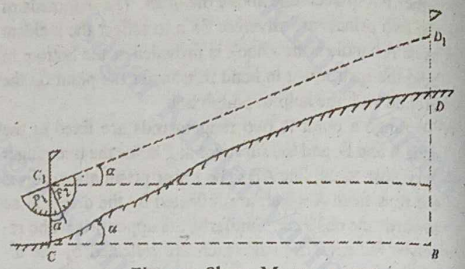



Figure : Slope Measurement

2. **By applying horizontal allowance** : In this method, the slope of the ground is first found by using clinometers. Hypotenusal allowance is then made for each tape length are discussed below:-

Let q = angle of slope found out by clinometers

$AB = AB_1 = 20m = 100links$

$AC = AB \sec q = 100 \sec q$

$\therefore B_1C = AC - AB_1 = 100\sec\theta - 100 = 100(\sec\theta - 1)$

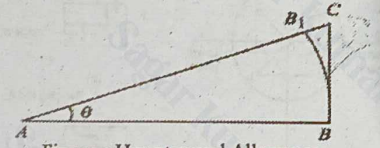



Figure : Hypotenusal Allowance

The amount $100(\sec\theta - 1)$ is called hypotenusal allowance. While chaining along the slope, one chain would be actually located at $B_1$. But the arrow should be placed at C after making hypotenusal allowance. The next chain length will start from C. The same principle is followed until the end of the line is reached.

3. **By knowing the difference of level between the points**:Suppose A, B, C and D are different points on the sloping ground. The difference of level between these points is determined by a levelling instrument.

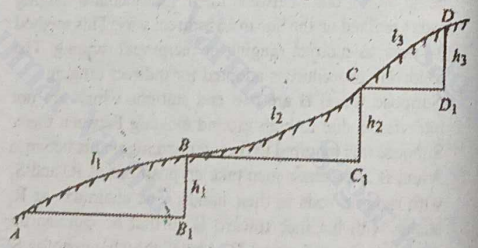



Figure : Difference of level

Let the respective differences be $h_1$, $h_2$, and $h_3$, then the sloping distances be AB, BC, and CD are measured.



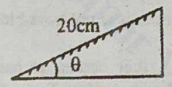
Let these distances be $l_1$, $l_2$ and $l_3$ respectively as shown in the figure. The required horizontal distances are given by

$AB_1 = \sqrt{l_1^2 - h_1^2}$, $BC_1 = \sqrt{l_2^2 - h_2^2}$, $CD_1 = \sqrt{l_3^2 - h_3^2}$

Total horizontal distance = $AB_1 + BC_1 + CD_1$

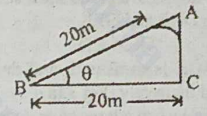
**Q13. While measuring the distance on a sloping ground it was found that the ground rises by 3.5m for each 20 m chain length. Find the angle of slope and the hypotenusal allowance per chain length.** [JUT-2017]

Ans.




$\sin\theta = \frac{3.5}{20} = 0.175 \therefore \theta = \sin^{-1}(0.175) = 10°5'$

*Angle of slope, $\theta = 10°5'$*




*Hypotenusal allowance per chain length,*

*$AA' = BC - BA' = BC\sec\theta - 20$*

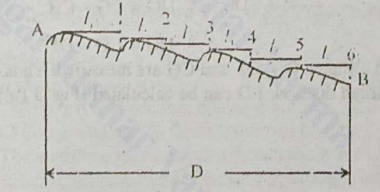
*$= 20\sec\theta - 20 = 20(\sec\theta - 1)$*

*$= 20(\sec 10°5' - 1) = 0.314m$*

**Q14. Explain chaining on sloping ground by the method of stepping.** [JUT-2013]

**Ans.Method of stepping** : Method of stepping is used where the surface is either too sloping or uneven. In method of stepping the following procedures are taken into accounts.

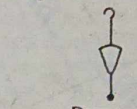
Lets us consider that we have to measure the horizontal distance between A to B.




Step-I : The follower holds the tape or chain at zero end at A while leader select any suitable length $l_1$ of the chain and moves forward.

Step-II : The leader pulls the tape or chain tightly and make it horizontal and the point 1 is transfered to the ground by a plumb bob or by a drop arrow.

Step-III : Again we starts from point 1 and the process as we have already done before have to repeat again we will get point 2. Similarly the process will be repeat since we get required distance.




And finally the horizontal distance.

$\phi = l_1 + l_2 + l_3 + l_4 + .....$

**Q15.Describe with a neat sketch how will you overcome an obstacle when both chaining and vision are obstructed?** [JUT-2018, 2019]

**OR**

**Q15.Describe with a neat sketch how will you overcome an obstacle when chaining is obstructed but vision is free and viceversa ?**

**OR**

**Q15.What are the obstacles in chaining? Describe with a neat sketch how will you overcome an obstacle .**

**Ans.**During chaining operations various obstacles such as rivers, hills, buildings, woods etc. are met with.But it is essential that chaining should be continued in a straight line.

Various obstacles to chaining may be grouped into:

(i) Obstacles to ranging (chaining free-vision obstructed)

(ii) Obstacles to chaining (chaining obstructed-vision free)

(iii) Obstacles to both ranging and chaining.

1. **Chaining free but Vision Obstructed:**Such a problem arises when a rising ground or a jungle area interrupts the chain line. Here, the end stations are not intervisible. There may be two cases.

**Case I** : The end stations my be visible form some intermediate points on the rising ground. In this case, reciprocal ranging is resorted to, and the chaining is done by the stepping method.

**Case II** : The end stations are not visible from intermediate points when a jungle area comes across the chain line. In this case the obstacle may be crossed over using a random line as explained below :

Let AB be the actual chain lin which connot be ranged and extended because of interruption by a jungle. Let the chain line be extended up to R.A point P is selected on the chain line and a random line PT is taken in a suitable direction. Points C, D and E are selected on the random line, and perpendiculars are projected from them. The perpendicular at C meets the chain line at $C_1$.

Theoretically, the perpendiculars at D and E will meet the chain line at D1 and $E_1$. Now, the distances PC,

PD, PE and $CC_1$ are measured (Fig. 1.).

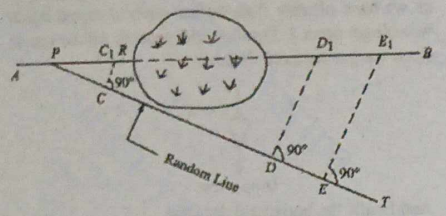



**Figure 1 : Chaining Free but Vision Obstruction**

From triangles $PDD_1$ and $PCC_1$,

$$\frac{DD_1}{PD} = \frac{CC_1}{PC}$$

$$DD_1 = \frac{CC_1}{PC} \times PD \qquad \text{(i)}$$

Again, from triangles $PEE_1$ and $PCC_1$,

$$\frac{EE_1}{PE} = \frac{CC_1}{PC}$$

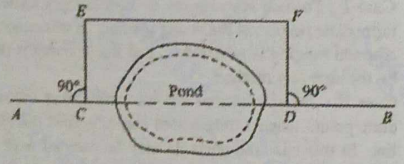
$$EE_1 = \frac{CC_1}{PC} \times PE \qquad \text{(ii)}$$

From equations (i) and (ii), the lengths $DD_1$ and $EE_1$ are calculated. These calculated distance are measured along the perpendiculars at D and E. points $D_1$ and $E_1$ should lie in the chain line AB, Which can be extended accordingly.

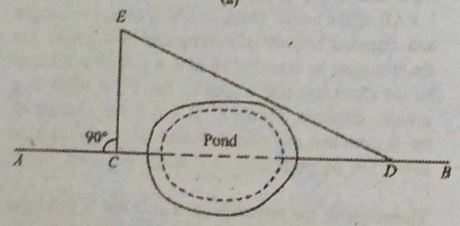
Distance $PE_1 = \sqrt{PE_2 + EE_1^2}$

2. **Chaining Obstructed but Vision Free:** Such a problem arises when a pond or a river comes across the chain line. The situations may be tackled in the following ways.

**Case I :** When a pond interrupts the chain line, it is possible to go around the obstruction.




(a)




(b)

Suppos AB is the chain line. Two points C and D are selected on it opposite banks of the pond. Equal perpendiculars CE and DF are erected at C and D. The distance EF is meaured.

Here, CD = EF [Fig. 2. (a)]

The pond may also be crossed by forming a tringle as shown in Fig. 2. (b). A point C is selected on the chain line. The perpendicular CE is set out at C, and a line ED is suitable taken. The distance CE and ED are measured.

So $CD = \sqrt{ED^2 - CE^2}$

**Case II :** Sometimes it is not possible to go around the obstruction.

(a) Imagine a small river comes across the chain line. Suppose AB is the chain line. Two points C and D are selected on this line on opposite banks of the river. At C, a perpendicular CE is erected and bisected at F. A perpendicular is set out at E and a point G is so selected on it that D, F and G are in the same straight line.

From triangles DCF and GEF,

GE = CD

This distance GE is measured, and thus the distance CD is obtained indirectly.[Fig 3.(a)]

(b) Consider the case when a large river interrupts the chain line.

Let AB be the chain line. Points C, D and E are selected on this line such that D and E are on opposite of the river, The perpendiculars DF and CG are erected on the chain line in such a way that E, F and G are on the same straight line. The line FH is taken parallel to CD. Now, from triangles DEF and HFG,

$$\frac{ED}{DF} = \frac{FH}{HG} \qquad \text{Where, } FH = CD$$

$$ED = \frac{FH}{HG} \times DF \qquad CH = DF$$

$$= \frac{CD}{CG - DF} \times DF \qquad HG = CG - CH$$

$$\therefore HG = CG - DF$$

The distance CD, DF and CG are measured. Thus, the required distance ED can be calculated [Fig. 3 (b)].



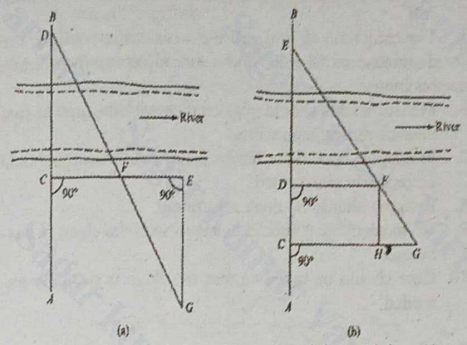



**Figure 3 : Chaining Obstructed but Vision Free River.**

3. **Chaining and Vision both Obstructed:**

**Ans.** Such a problem arises when a building comes across the chain line. It is solved in the following manner.

Suppose AB is the chain line. Two points C and D are selected on it at one side of the building. Equal perpendiculars $CC_1$ and $DD_1$ are erected. The line $C_1D_1$ is extended until the building is crossed. On the extended line, two points $E_1$ and $F_1$ are selected. Then perpendiculars $E_1E$ and $F_1F$ are so erected that. Thus the points C, D, E and F will lie on the same straight line AB.

Here, $DE = D_1E_1$

The distance $D_1E_1$ is measured and is equal to the required distance DE (Fig. 4).

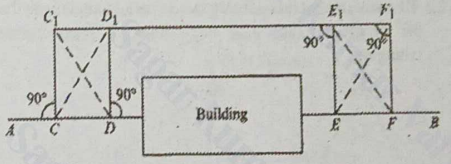



**Figure 4 : Chaining and Vision both Obstructed.**

**Q16. State the types of errors in measuring the length in chain surveying.** [NN Basak]

**Ans.** The errors that occur in chaining are classified as

(i) Compensating, (ii) Cumulative (iii) Mistakes.

These errors may be due to natural causes such as say variation in temperature, defects in construction and adjustment of the instrument, personal defects in vision etc.

**Compensating Errors:** The compensating errors are those which are liable to occur in either direction and hence tend to compensate i.e. they are not likely to make the apparent result too large or too small.

In chaining, these may be caused by the following:

(a) Incorrect holding of the chain: The follower may not bring his handle of the chain to the arrow, but may hold it to one or other side of the arrow.

(b) Fractional parts of the chain or tape may not be correct if the total length of the chain is adjusted by insertion or removal of a few connection rings from one portion of the chain, or tape is not calibrated uniformly throughout its length.

(c) During stepping operation crude method of plumbing (such as dropping of stone from the end of chain) is adopted.

(d) When chain angles are set out with a chain which is not uniformly adjusted or with a combination of chain and tape.

**Cumulative Errors:** The cumulative errors are those which occur in the same direction and tend to add up or accumulate i.e. either to make the apparent measurement always too long or too short.

**Positive errors:** (making the measured lengths more than the actual) are caused by the following:-

(a) The length of the chain or tape is shorter than the standard, because of bending of links, removal of too many links in adjusting the length, 'knots' in the connecting links, cloggings of rings with clay, temperature lower than that at which the tape was calibrated, shrinkage of tape when becoming wet.

(b) The slope correction is not applied to the length measured along the sloping ground.

(c) The sag correction is not applied when the tape or the chain is suspended in the air.

(d) Measurements are made along the incorrectly aligned line.

(e) The tape bellys out during offsetting when working in the windy weather.

**Negative errors:** (making the measured lengths less than the actual) may be caused because the length of the tape or chain may be greater than the standard because of the wear or flattening of the connecting rings, opening of ring joints, temperature higher than the one at which it was calibrated.

The final error in a linear measurement is composed of two portions:

(i) cumulative errors which are proportional to L and

(ii) compensating errors which are proportional to $\sqrt{L}$, where L is the length of the line.

3. **Mistakes:** Errors occuring due to the carelessness of the chainman are called mistakes.

The following are a few common mistakes.

(a) Displacement of arrows : Once an arrow is withdrawn from the ground during chaining, it may not be replaced

in proper position, if required due to some reason.

(b) A full chain length may be omitted or added. This happens when arrows are lost or wrongly counted.

(c) A reading may be taken from the wrong end of the chain. This happens when the tooth of the tally is noted without observing the central tally (i.e. when the tooth is noted from the wrong end).

(d) The numbers may be read from the wrong direction; for instance, a '6' may be read as a '9'.

(e) Some numbers may be called wrongly. For example, 50.2 may be called "fifty-two" without the decimal point being mentioned.

(f) While making entries in the field book, the figures may be interchanged due to carelessness : for instance, 244 may be entered instead of 254.

**Q17.How the correction is applied to an incorrect chain length? Explain.** [JUT-2012]

**Ans.** If the length of the chain used in measuring length of the line is not equal to the true length or the designated length, the measured length of the line will not be correct and suitable correction will have to be applied. If the chain is too long, the measured distance will be less. The error will, therefore, be negative and the correction is positive.

Similarly, if the chain is too short, the measured distance arill be more, the error will positive and the correction will be negative.

Let L = True or designated length of the chain

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

(i) Correction to measured length :

let $l'$ = measured length of the line

$l$ = actual or true length of the line

Then, true length of line = measure length of line $\times \frac{L'}{L}$

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

**Q18.What precautions would you take to guard against these types of error?** [JUT-2013]

**Ans.** The following precautions should be taken to guard against errors :

1. The point where the arrow is fixed on the ground should be marked with a cross (×).
2. The zero end of the chain or tape should be properly held.
3. During chaining, the number of arrows carried by the follower and leader should always tally with the total numbers of arrows taken.
4. While noting the measurement from the chain, the teeth of the tally should be verified with respect to the correct end.
5. The chainman should call the measurement loudly and distinctly and the surveyor should repeat them while booking.
6. Measurements should not be taken with the tape in suspension during high winds.
7. In stepping operations, horizontality and verticality should be properly maintained.
8. Ranging should be done accurately.
9. No measurement should be taken with the chain in suspension.
10. Care should be taken so that the chain is properly extended.

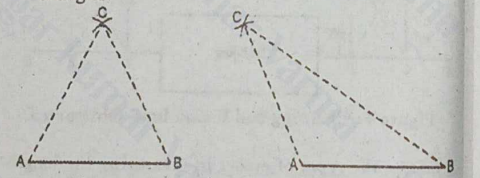
**Q19.State the principle of chain surveying?** [JUT-2014]

**Ans.** The principle of chain surveying is triangulation. Triangulation consists of frame work of triangles. The whole area is divided into network of triangles. A triangle is the only simple plane figure which can be plotted by measuring its sides alone in the field. The frame work of triangles, to be adopted depend upon the shape and configuration of the ground and the natural obstacles.

To obtain good results, the frame work should consist of triangles which are nearly equilateral as possible. Such triangles are known as well shaped or well conditioned triangles.

(1) **In well-conditioned triangle :** A triangle in which no angle is smaller than $30^0$ and no angle is greater than $120^0$ is known as well condition triangle.

(2) **Ill condition triangle:** A triangle having angle less than $30^0$ or greater than $120^0$ are known as ill-conditioned triangles.




**(a) Well-conditioned triangle** **(b) Ill-conditioned triangle**

Well-conditioned triangles can be plotted more accurately than the Ill-conditioned triangles.

Ill-conditioned triangles should always be avoided. If they are unavaoidable great care should be taken in chaining and plotting.

**Q20.Define offset ?State the types of offsets.**

**Ans.** The lateral measurement taken from an object to the chain line is known as 'offset'. Offset are taken to locate objects with reference to the chain line .There are two types of offsets.



(i) Perpendicular offset.

(ii) Oblique offset.

**(i) Perpendicular offset :** When the lateral measurements are taken perpendicular to the chain line, they are known as perpendicular offsets (Fig. 1).

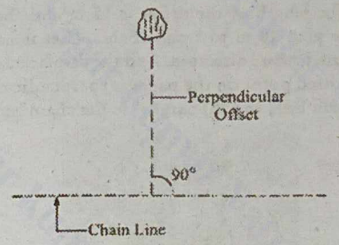



**Figure 1 :Perpendicular Offset**

Perpendicular offsets may be taken in the following ways:

(a) By setting a perpendicular by swinging a tape from the object to the chain line. The point of minimum reading on the tape will be the base of the perpendicular (Fig. 2).

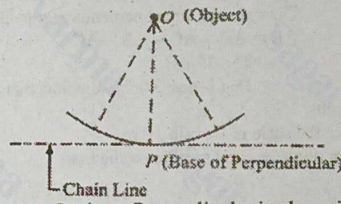



**Figure 2 :Setting a Perpendicular in the ratio 3:4:5**

(b) By setting a right angle in the ratio 3 : 4 : 5 (Fig. 3).

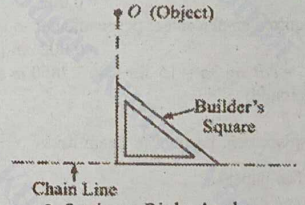



**Figure 3 :Setting a Right Angle**

(c) By setting a right angle with the help of builder's square or tri-square (Fig. 4).

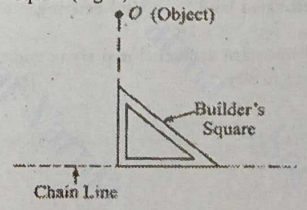



**Figure 4 : Setting a Right Angle by a Builders Square**

(d) By setting a right angle by cross-staff or optical square.

**(ii) Oblique offsets :** Any offset not perpendicular to the chain line is said to be oblique. Oblique offsets are taken when the objects are at a long distance from the chain line or when it is not possible to set up a right angle due to some difficulties. Such offsets are taken in the following manner.

Suppose AB is a chain line and P is the corner of a building. Two points a and b are taken on the chain line. The chainages ap and bp are measured and noted in the field book. Then ap and bp are the oblique offsets (Fig. 5). When the triangle abp is plotted, the apex point p will represent the position of the comer of the building.

Perpendicular offsets are preferred for the following reasons:

(a) They can be taken very quickly.

(b) The progress of survey is not hampered.

(c) The entry in the field book becomes easy.

(d) The plotting of the offsets also becomes easy.

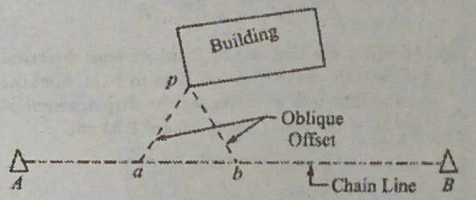



**Figure 5 : Oblique Offset**

**Q21. What is ment by degree of offset?**

**Ans.** The degree of offset means degree of accuracy in taking offset.

It depends upon-

i. Scale of plotting

ii. Length of offset and

iii. Importance of object of which the offsets arew taken.

**Q22.What is the limiting length of an offset? How the error is calculated ?** [JUT-2011]

**Ans. Limiting length of offset :** The maximum length of the offset should not be more than the length of the tape used in the survey. Generally, the maximum length of offset is limited to 15m. However, this length also depends upon the followring factors.

(i) The desired accuracy of the map.

(ii) The scale of the map.

(iii) The nature of the ground.

(iv) The maximum allowable deflection of the offset from its true direction.

Calculate the error :

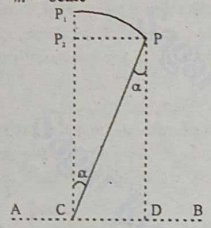
Let the offset CP be laid out from a point C on the chain line to the object P, and let the angle BCP be $(90^0 - \alpha)$ where $\alpha$ is the error in laying the perpendicular. Let the length CP be l. While plotting, the point P will be plotted at $P_1$, $CP_1$, being perpendicular to AB and of length l.

Thus, the displacement of the point P along the chain line is given by

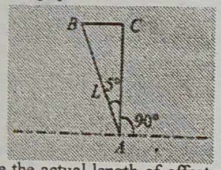
$$PP_2 = \frac{l \sin \alpha}{S} cm$$

where; $l$ = length of offset in m

$m$ = scale




**Q23.An offset was laid out 5° from its true direction and the scale of the map was 20 m to 1 cm. Find the maximum length of offset for the displacement of a point on the paper not to exceed 0.03 cm.**




**Ans.** Let AB be the actual length of offset which was laid out 5° from its true direction. So, BC is the displacement of the point.

Let the maximum length of offset, AB = Lm

From tringle ABC, $\frac{BC}{AB} = \sin 5°$

or BC = AB sin 5° = L sin 5° m

(displacement of the ground)

Since the scale is 1 cm to 20 m, 20 m on the ground represents 1 cm on the paper.

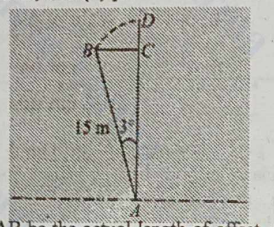
Therefore, L sin 5° on the ground represents $\frac{L \sin 5°}{20}$ cm on the paper.

According to the given condition, $\frac{L \sin 5°}{20} = 0.03$

$$L = \frac{0.03 \times 20}{\sin 5°} = 6.884 \text{ m}$$

Therefore, the maximum length of offset should be 6.88 m.

**Q24.The length of the offset is 15 m and the scale of the plan 10 m to 1 cm. If the offset is laid out 3° from its true direction, find the displacement of the plotted point on the paper (a) perpendicular to the chain line, and (b) parallel to the chain line.**




**Ans.** Let AB be the actual length of offset, which is 15 m long and deflected by 3° from its direction.

Here. BC = displacement parallel to chain line

CD = displacement perpendicular to chain line

(a) CD = AD – AC = AB – AC

= 15 –15 cos 3°

= 15 (1–cos 3°) m (displacement to the ground)

Since the scale is 1 cm to 10 m,

10 m on the ground = 1 cm on the map

15 (1–cos 3°) on the ground $= \frac{15(1-\cos 3°)}{10}$

= 0.002 cm on the map

Required displacement perpendicular to chain line = 0.002 cm (on paper)

(b) BC = AB sin 3o = 15 sin 3° = 0.7850 m (displacement on ground)

Displacement parallel to chain line = $\frac{0.7850}{10}$ =0.0785 cm (on paper)

**Q25.Draw a conventional symbols for**

**(i) Embankment (ii) Orchard**

**(iii) Cultivated land (iv) Fencing**

**OR**

**Q25.State important conventional signs and symbols related to survey.** [NN Basak]

**Ans.**



| Object | Symbol | Colour |
|---|---|---|
| North line | | Black |
| Main stations or triangulation stations | | Red or crimson lake |
| Traverse stations or substations | | Red or crimson lake |
| Chain line | | Red or crimson lake |
| River | | Prussian blue |
| Canal | | Prussian blue |
| Lake or pond | | Prussian blue |
| Open well | | Prussian blue |
| Tube well | | Black |
| Footpath | | Black |
| Metalled road | | Burnt sienna |
| Unmetalled road | | Burnt sienna |
| Railway line (single) | | Black |
| Railway line (double) | | Black |
| Road bridge or culvert | | Black |
| Railway bridge or culvert | | Black |
| Level crossing | | Black and burnt sienna |
| Wall with gate | | Black |
| Boundary line | | Black |
| Hedge | | Green |

| Object | Symbol | Colour |
|---|---|---|
| Tree | | Green |
| Jungle | | Green |
| Orchard | | Green |
| Cultivated land | | Black and green |
| Barren land | | Black |
| Rough pasture | | Black |
| Marsh or swamp | | Black |
| Embankment | | Black |
| Cutting | | Black |
| (a) Telegraph line | | Black |
| (b) Telegraph post | | Black |
| (a) Electric line | | Black |
| (b) Electric post | | Black |
| Burial ground or cemetery | OR | Crimson lake |

**Q26.Define field book?What detailed instruction should be given to a fresh trainee surveyor regarding the care and use of his field book for recording survey measurements?**

**Ans.Field book:**The notebook in which field's measurement are noted is known as "Field book".The size of field book is 20 cm x 12 cm and it opens lengthwise.It is of two types

(i) **Single line field book**

(ii) **Double line field book**

Intructions given to fresh trainee surveyor regarding the care and use of his field book are as follows :-

(1) All measurements should be noted as soon as they are taken.

(2) Each chain line should be recorded on a separate page. Normally it should start from the bottom of one page and end on the top of same. No line should be started from any intermediate position.

(3) Over-writing should be avoided.

(4) Figures and hand-writing should be neat and legible.

(5) Index-sketch, object sketch and notes should be clear.

(6) The field book should be entered in pencil and not in ink.

(7) Erasing a sketch, measurement or note should be avoided.

(8) The field book should be carefully preserved.

**Q27.Discuss the working principle and construction of optical square. How will you use it in the field?** [SBTE-2013]

**Ans.**Optical square is also used for setting out right angles. It consists if a small circular metal box of diameter 5cm and depth 1.25cm. It has a metal cover which slides round the box to cover the slits. The followings are the internal arrangements of the optical square.

(i) A horizon glass it is fixed at the bottom of the metal box. The lower half of the glass is un-silvered and the upper half is silvered.

(ii) An index glass I is also fixed at the bottom of the box which is completely silvered.

(iii) The angle between the index glass and horizon glass is maintained at $45^0$.

(iv) The opening 'e' is a pinhole for eye E, 'b' is a small rectangular hole for ranging rod B. 'P' is a large rectangular hole for object P.

(v) The line EB is known as horizon sight and IP as index sight.

(vi) The horizon glass is placed at an angle of $120^0$ with the horizon sight. The index glass is placed at an angle of $105^0$ with the index sight.

(vii) The ray of light from P is first reflected from I, then it is further reflected from H, after which it ultimately reaches the eye E.

**Principle :**According to the principle of reflecting surfaces, the angle between the first incident ray and the last reflected ray is twice the angle between the mirrors is fixed at $45^0$, So, the angle between the horizon sight and index sight will be $90^0$.

**Setting up the optical square :**

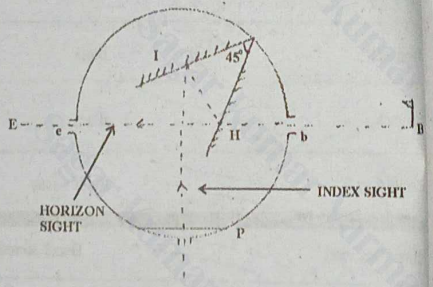
(i) The observer should stand on the chain line and approximately at the position where the perpendicular is to be set up.

(ii) The optical square is held by the arm at the eye level. The ranging rod at the forward station B is observed through the unsilvered portion on the lower part of the horizon glass.

(iii) Then the observer looks through the upper silvered portion of the horizon glass to see the image of the object P.

(iv) Suppose the observer finds that the ranging rod B and the image of object P do not coincide. Then he should move forward or backward along the chain line until the ranging rod B and the image of P exactly coincide.

(v) At the position the observer marks a point on the ground to locate the foot of the perpendicular.




**Q28.Describe the following along with sketch :**
**(a) Open cross -staff** **(b) Arrows**

**Ans.(a)Open cross -staff :**The simplest form of open cross-staff is shown in figure below.

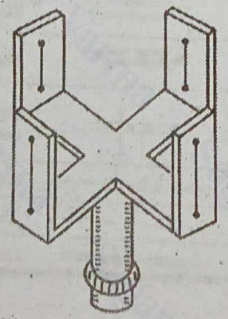


Figure : Open cross-staff



It is made of round or square piece of wood about 4 to 5 cm thick and 20 to 30 cm in diameter or side, mounted on a wooden staff 2.5 to 3 cm in diameter 1.5 m long and fitted with a iron shoe to make it easier to be driven into the ground. The wooden block is provided with two saw cuts 1 cm deep at right angles to each other. Thus it gives two lines of sights.

**Ans.(b) Arrows :**The marking pins which are made of stout steel wire 4 mm (or 8 SWG) in diameter and having length equal to 40 cm in all are called arrows. One end of the arrow is made sharp and other end is bent into a circular ring for making it easier to carry (see fig. below) Usually ten arrows are supplied with a chain. Arrows are used to mark the end of a chain during the process of chaining. Sometimes a piece of red cloth is tied to the ring of the arrows for easy visibility. Specially when used in a grassy plot.

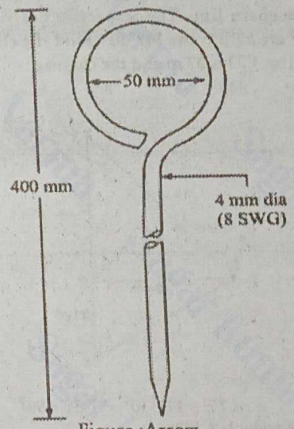
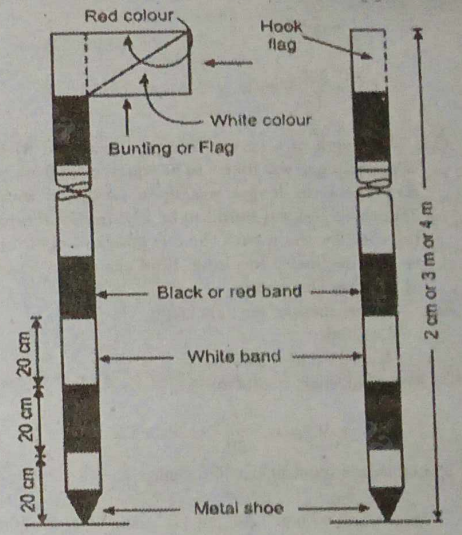



Figure :Arrow

**Q29.Differentiate between offset rod and ranging rod.** [JUT-2017]

**Ans.Offset rods :** It is similar to a ranging rod and has a length of 3m. They are round wooden rods, shod with pointed iron shoe at one end, and provided with a notch or a hook at the other. The hook facilitates pulling and pushing the chain (bushes) through hedges and other obstructions. The rod is mainly used for measuring rough offsets nearby.

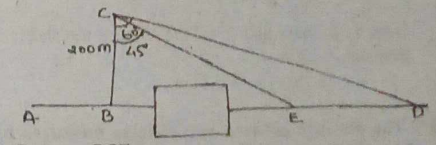
**Ranging rods :** Have a length of either 2m or 3m. they are painted in alternative bands of either black and white or red and white, each band being 20cm deep so that it can be used for rough measurement of short lengths. Its lower end is provided with a cross shoe of 15cm length Ranging rods are used to some intermediate points in the survey line. They are circular or octagonal in c/s nomical diameter, made of well-seasoned, straight grained timber.




Figure

**Q30.To continue a survey line AB part an obstacle a line BC 200 metres long was set out perpendicular to AB and from C angles BCD and BCE were set out at $60^0$ and $45^0$ respectively. Determine the length which must be chained off along CD. Determine the obstructed length BC.**

**Ans.**




*From* $\Delta BCE$

$$\frac{BC}{CE} = \cos 45^0$$

$$CE = \frac{BC}{\cos 45^0} = 200 \times \sqrt{2} = 282.8\text{m}$$

*and* $$\frac{BE}{BC} = \tan 45^0$$

$BE = BC \times \tan 45^0$
$= 200 \times 1 = 200\,m$

*From* $\Delta$ *BCD*

$$\frac{BC}{CD} = \cos 60^0$$

$$CD = \frac{200}{1/2} = 400\,m$$

**Q31.The length of a survey line was measured with a 20m chain and was found to be equal to 1200 metres. As a check the length was again measured with a 25m chain and was found to be 1212m. On comparing the 20m chain with the teet guage it was found to be 1 decimetre too long. Find the actual length of the 25m chain used.**

**Ans.** Let us consider the 20m chain

$L = 20m$

$L' = 20 + 0.01 = 20.01m$

Measured length = 1200m

$$\text{True length of line} = \frac{20.01}{20} \times 1200 = 1200.6m$$

Let us now consider the 30m chain

$L = 25m$ $L' = ?$

True length of line 1200.6m (as obtained from 20m chain)

Measured length = 1212m

From the relation,

$$TL = \frac{L'}{L} \times ML$$

$$1200.6 = \frac{L'}{25} \times 1212$$

$$L' = \frac{1200.6 \times 25}{1212} = 24.76m$$

Now, L' is lesser than L so, the chain is too short.

Amount of error

$e = 24.76 - 25 = -0.24m$

**Q32.The distance between two villages measured by a 20m chain was 1700 m and when measured by 30m chain it was 1710m .The test shows that both chains were incorrect .What correction is required in 20m chain if the 30m chain is 0.4 link too long.[JUT-2014]**

**Ans.** Let us consider the 30m chain

$L = 30\,m$

$L' = 30 + (0.4 \times 0.2) = 30.08\,m$

Measured length = 1710 m

True length of line

Let us now consider the 20m chain

$L = 20$ ; $L' = ?$

True length of line 1714.56 m (as obtained from 3 m chain)

Measured length = 1700 m

From the relation

$$TL = \frac{L'}{L} \times ML$$

$$\Rightarrow \quad 1714.56 = \frac{L'}{20} \times 1700$$

$$\Rightarrow \quad L' = \frac{1714.56 \times 20}{1700}$$

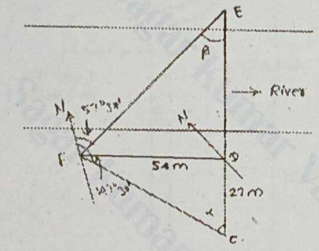
$$\Rightarrow \quad L' = 20.171M$$

Now $L'$ is greater than L. So the chain is too long.

Amount of error (e) = 20.171 – 20 = + 0.171 M

**Q33.A chain line CDE crosses a river ,D and E being on the near and distant banks respectively .A perpendicular DF ,54 m long is set out at D on the line on the chain line .The respective bearing of E and C at F are 57°30' ans 147°30' .Find the chainage of E given that CD is 27 m and the chainage of D is 356.5m**

**Ans.** Here DF = 54 and CD = 27 m




$\angle CFE = 147^0 30' - 57^0 30' = 90^0$

from triangle CFD

$$\tan\alpha = \frac{DF}{CD} = \frac{54}{27} = 2$$

$$\therefore \alpha = \tan^{-1}(2) = 63^0 26^1$$

and $\beta = 90^0 0^1 - 63^0 26^1 = 26^0 34^1$

From triangle DFE $= \frac{DF}{DE} = \tan\beta$

$$\Rightarrow \quad DE = \frac{DF}{\tan\beta}$$

$$\Rightarrow \quad DE = \frac{54}{\tan 26^0 34^1}$$

$$\Rightarrow \quad DE = 108m$$

So, chainage of E = 108 + 356.5 = 464.5 m.

**Q34.The length of line measured with a 30 metre chain**



**was found to be 1428 m. Find true length of the line if chain used was found to be 0.05m short. [SBTE-2012]**

**Ans.** Here, let

L = Actual length of chain

$L'$ = Incorrect length of chain

l = Actual length of the line

$l'$ = Incorrect length of the line

L = 30m

$l' = 1428$ m

$L' = 29.95$ m

$l = ?$

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

$$\Rightarrow l = 1428 \times \frac{19.95}{30} = 1425.62m$$

**Q35.A steel tape is exactly 30m long at 20° C under a standard pull of 15kg. A line was measured with a pull of 10kg at a mean temparature of 13° C and found to be 810m for steel $= 11 \times 10^{-6}/^0C$, E for steel $= 2.1 \times 10^6 kg/cm^2$. Compute the true length of line if the tape was supported during measurement (i) at every 30 m (ii) every 15m. [JUT-2010]**

**Ans.**(i) at every 30m

Correction for temp. $= t \propto (\Delta T)$

$= 30 \times 11 \times 10^{-6} \times (13 - 20)$

$= 30 \times 11 \times 10^{-6} \times -7$

$= 0.00231\,m$ (sub)

$$\text{Correction for pull} = \frac{(P_s - P_0)L}{AE}$$

$$= \frac{(10-15) \times 30}{0.03 \times 2.1 \times 10^6} = \frac{150}{3 \times 21 \times 10^3}$$

$$= -\frac{1}{21 \times 20} = 0.00238\,m\,(sub)$$

$$\text{Correction for sag} = \frac{l \times w^2}{24n^2(P)^2} - \frac{l \times w^2}{24 \times n^2 \times P_2^2}$$

$$= \frac{30 \times 0.65^2}{24 \times 1}\left\{\frac{1}{10^2} - \frac{1}{15^2}\right\}$$

$$= 0.528\left\{\frac{1}{100} - \frac{1}{225}\right\} = 0.003\,Addi$$

Total Correction $= 0.003 - 0.00238 - 0.00231$

$= 0.00176$ m (substractive)

$\therefore$ Corrected length $= 810 - 0.00176 = 809.998m.$

(ii) At every 15m -

Correction for

Temp = 0.00231 m (Subtractive)

Pull = 0.00238 m (Subtractive)

for sag $= \frac{30 \times 0.65^2}{24 \times 2^2}\left\{\frac{1}{100} - \frac{1}{225}\right\}$

$= 0.132\{0.01 - 0.0044\}$

$= 0.00073$ (Additive)

Total Correction $= -0.00231 - 0.00238 + 0.00073$

$= -0.00396$ (Sub)

$\therefore$ Corrected length $= 810 - 0.00396$

$= 899.996m.$

**Q36.A 20m steel tape was standardised on flat ground, at a temperature of 20°C and under a pull of 15kg.The tape was used in catenary at a temperature of 30°C and under a pull of P kg.The crosssectional area of the tape is 0.22 $cm^2$, and its total weight is 400g.The Youngs modulus and coefficient of linear expansion of steel are 2.1 x $10^6$ $kg/cm^2$ and 11 x $10^{-6}$ per °C respectively.Find the correct horizontal distance if P is equal to 10kg.**

**Ans.** Given data :

| | |
|---|---|
| L = 20 m | A = 0.02 $cm^2$ |
| $T_o$ = 20°C | $\alpha$ = 11×$10^{-6}$ per °C |
| $P_o$ = 15 kg | E = 2.1×$10^6$ $kg/cm^2$ |
| $T_m$ = 30°C | W = 400 g = 0.4 kg |
| P = 10 kg | n = 1 |

Here, applied pull P = 10 kg.

(a) Temperature correction, C1 $= \alpha(T_m - T_o)L$

$= 11 \times 10^{-6}(30 - 20)20$

$= 11 \times 10^{-6} \times 10 \times 20$

$= 0.00220$ m (+ ve)

(b) Pull correction $C_p = \frac{(P - P_0)L}{A \times E}$

$$= \frac{(10-15)20}{0.02 \times 2.1 \times 10^6}$$

$$= \frac{5 \times 20}{0.02 \times 2.1 \times 10^6}$$

$= -0.00238$ m (–ve)

(c) Sag correction, $C_s = \frac{LW^2}{24n_2P_2}$ (n = 1)

$$= \frac{20 \times (0.4)^2}{24 \times (10)^2} = 0.00133\,m\,(-ve)$$

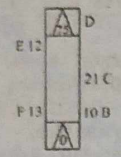
Total correction $= +0.00220 - 0.00238 - 0.00133$

$= 0.00151$ m

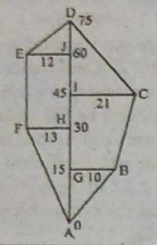
Correct horizontal distance = 20 – 0.00151 = 19.99849 m.

**Q37. Plot the following cross staff survey of a field**

and calculate its area. [JUT-2017]



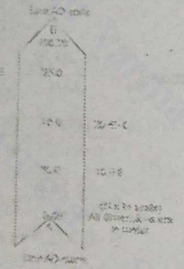

Ans.



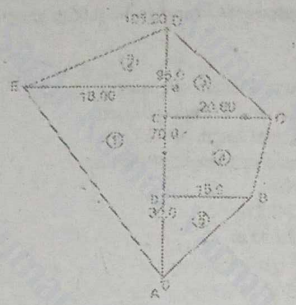

| Sl. No. | Figure | Chainage (m) | Base (m) | Offsets (m) | Mean (m) | Area ($m^2$) |
|---|---|---|---|---|---|---|
| 1 | ABG | 0 & 15 | 15 | 0 & 10 | 5 | 75 |
| 2 | GBCI | 15 & 45 | 30 | 10 & 21 | 15.5 | 465 |
| 3 | ICD | 45 & 75 | 30 | 21 & 0 | 10.5 | 315 |
| 4 | AFH | 0 & 30 | 30 | 0 & 13 | 6.5 | 195 |
| 5 | FHJE | 30 & 60 | 30 | 13 & 12 | 12.5 | 375 |
| 6 | JDE | 60 & 75 | 15 | 12 & 0 | 6 | 90 |
| | | | | | Total = | 1515 |

∴ *Area of field = 1515 m²*

**Q38. Calculate the area of a field from the chain and croos-staff survey.**



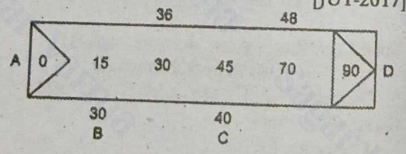
Ans. From above data ABCDEA is a plot measured using cross-staff survey.




To find area of closed figure ABCDEA, following tabular form of calculations are used.

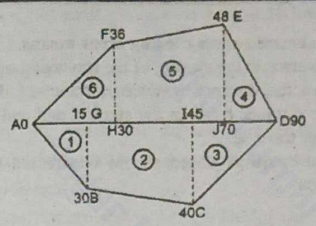
| S. No. | Figure | Chainage (m) | Base (m) | Offsets (m) | Mean offset (m) | Area ($m^2$) +ve | Area ($m^2$) -ve | Remark |
|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| 1. | | 0 & 95.0 | (95.0 - 0) = 95.0 | 0 & 18.0 | $\frac{18.0+0}{2}$ = 9.0 | 855.0 | - | |
| 2. | | 95.0 & 105.20 | 10.20 | 18.0 & 0 | = 9.0 | 91.80 | - | |
| 3. | | 105.20 & 70.00 | 35.20 | 0 & 20.6 | 10.30 | 362.6 | - | |
| 4. | | 70.0 & 30.0 | 40.00 | 20.6 & 15.0 | 17.80 | 712.0 | | |
| 5. | | 30.0 & 0.00 | 30.0 | 15.0 & 0 | 7.50 | 225.0 | | |
| | | | | | Total area | 2246 360 $m^2$ | | |
| | | | | | Net area | 2246. 36 $m^2$ | | |

**Q39.Plot the following cross-staff survey of field and calculate its area in m² as shown in fig.** [JUT-2017]




Ans.






| Fig. | Chainages (m) From | Chainages (m) To | Base (m) | Offsets No.1 | Offsets No.2 | Mean area (m) | Area sq.m. |
|---|---|---|---|---|---|---|---|
| ABG | 0 | 15 | 15 | 0 | 30 | 15 | 225 |
| GBCI | 15 | 45 | 30 | 30 | 40 | 35 | 1050 |
| CID | 45 | 90 | 45 | 40 | 0 | 20 | 900 |
| DJE | 70 | 90 | 20 | 0 | 48 | 24 | 480 |
| EJHF | 70 | 30 | 40 | 48 | 36 | 42 | 1680 |
| FHA | 30 | 0 | 30 | 36 | 0 | 18 | 540 |
| | | | | | | Total Area=4875 $m^2$ | |

Note : Area = base × mean offset

**Q40.Calculate the area of a field from the following cross -staff survey.**

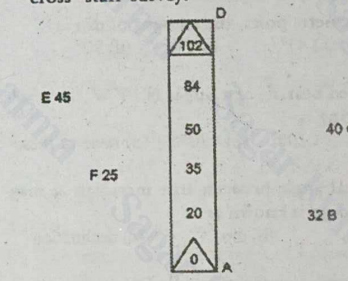
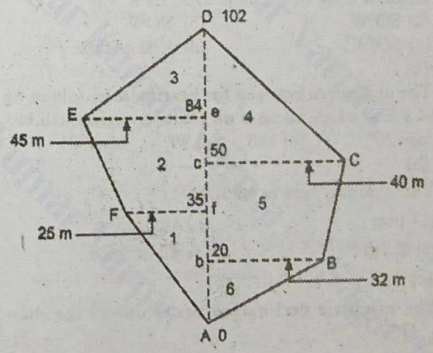



Figure : (a)

Ans. From the field data of fig. (a) the area ABCDEF is sketched as shown in the Fig. (b).




It is divided into right angled triangles and trapeziums. The chainages and offsets are entered in the following tubular form to compute the area.

**Area Table**

| Figure | Chainage in m. | Base in m. | Off-set in m. $O_1$ $O_2$ | Mean offset $\frac{O_1+O_2}{2}$ | Area in $m^2$ = (base × mean offset) + ve |
|---|---|---|---|---|---|
| 2 | 3 | 4 | 5 | 6 | 7 |
| △ AfF | 0 and 35 | 35 | 0 and 25 | 12.5 | 437.50 |
| ▱ FfeE | 35 and 84 | 49 | 25 and 45 | 35.00 | 1715.00 |
| △ EeD | 84 and 102 | 18 | 45 and 0 | 22.50 | 405.00 |
| △ DCc | 50 and 102 | 52 | 40 and 0 | 20.00 | 1040.00 |
| ▱ cCBb | 20 and 50 | 30 | 32 and 40 | 36 | 1080.00 |
| △ ABb | 0 and 20 | 20 | 0 and 32 | 16 | 320.00 |

Area of the field is 4997.5 m².

**NOTE**

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# Chapter 3

# Compass Survey

## MULTIPLE CHOICE QUESTION

1. The quadrantal bearing of a line is N40°W. Its whole bearing is
   (a) 320° (b) 300° (c) 305° (d) 330°

Ans.(a)

2. In prismatic compass graduations are engraved :
   (a) erect (b) inverted
   (c) both (a) and (b) (d) none of these

Ans.*(b)*

3. In surveyors compass graduations are in :
   (a) whole circle bearing system
   (b) quadrantal bearing system
   (c) arbitrary bearing system
   (d) none of these

Ans.*(b)*

4. If bearing of AB = N10°W and bearing of BC = S80°W then ∠ABC =
   (a) 80° (b) 90° (c) 100° (d) none of these

Ans.*(b)*

5. Which of the following compass may be used without a tripod for observing bearings ?
   (a) prismatic compass (b) surveyor's compass
   (c) both (a) and (b) (d) none of these

Ans.*(a)*

6. If the fore bearing of a line is 100°, its back bearing is:
   (a) 250° (b) 260° (c) 270° (d) 280°

Ans. *(d)*

7. If the back bearing of a line is N 30° W its fore bearing is
   (a) S 30° W (b) N 30° E
   (c) S 30° E (d) N 30° W

Ans.(b)

8. Latitude of a line is defined as
   (a) orthographic projection of a survey line on the E-W line.
   (b) orthographic projection of a survey line on the reference meridian.
   (c) length of survey line corrected for various chain/tape corrections.
   (d) None of the above.

Ans.(c)

9. Prismatic & Surveyor compass reads
   (a) WCB & RB (b) RB & WCB
   (c) Both WCB (d) Both RB

Ans.(a)

10. In a traverse survey closing error means
    (a) the error in the closing of the traversing operation.
    (b) the actual distance by which the traverse fail to close.
    (c) the distance between the starting and end point of an open traverse.
    (d) the bearings observed are unaffected by local atraction.

Ans.(a)

11. The zero of the graduated circle of a prismatic compass is located at
    (a) north end (b) east end
    (c) south end (d) west end

Ans.(c)

12. The amount of dip at north pole is -
    (a) 0° (b) 60° (c) 90° (d) 180°

Ans.(c)

13. The reduced bearing of a line is N 81°W, its whole circle bearing is -
    (a) 81° (b) 99° (c) 9° (d) 279°

Ans.(d)

14. The least count of a prismatic companies is -
    (a) 15' (b) 30' (c) 15" (d) 30"

Ans.(c)

15. At the magnetic poles, the amount of dip is -
    (a) 0° (b) 45° (c) 60° (d) 90°

Ans.(d)

16. The reduced bearing of a line is N 10° W, the whole circle bearing is -
    (a) 10° (b) 100° (c) 170° (d) none of these

Ans.(d)

17. The vertical angle between true meridian & magnetic meridian is known as -
    (a) bearing (b) dip (c) declination

Ans.(c)

18. At the equator the dip of needle is -
    (a) 180° (b) 0° (c) 90° (d) 360°

Ans.(b)

19. If the W.C.B. of a line is 270°, its R.B is -
    (a) SO°W (b) NO°W
    (c) SO°W (d) none of these

Ans.(b)

20. The difference between for bearing & back bearing of a line where there is no local attraction will be -
    (a) 120° (b) 180° (c) 90° (d) 150°

Ans.(b)

21. The compass box is made of
    (a) Iron (b) Aluminium
    (c) Brass (d) All of these

Ans.(c)

22. The magnetic declination varies due to the rotation of the earth on its own axis in 24 hrs
    (a) Annual (b) Secular
    (c) Irregular (d) Diurnal

Ans.(d)

23. When the north end of the magnetic needle is pointed towards the west side ot the true meridian the position is...
    (a) Declination west (b) Declination east
    (c) Both a and b (d) None of these

Ans.(a)

24. The horizontal angle between the true meridian and magnetic meridian at aplace is called
    (a) Azimuth (b) Declination
    (c) Local attraction (d) Magnetic bearing

Ans.(b)

25. The graduation in prismatic compass
    (i) Are inverted
    (ii) Are upright
    (iii) Run clockwise having 0° at south
    (iv) Run clockwise having 0° at north
    The correct answer is
    (a) (i) and (iii) (b) (i) and (iv)
    (c) (ii) and (iii) (d) (ii) and (iv)

Ans.(a)

26. Agate cap is fitted with a
    (a) Cross staff (b) Level
    (c) Chain (d) Prismatic compass

Ans.(d)

27. The temporary adjustments of a prismatic compass are
    (i) Centering
    (ii) Levelling
    (iii) Focusing the prism
    The correct order is
    The correct orrder is
    (a) (i), (iii), (ii) (b) (i), (ii), (iii)
    (c) (ii), (iii), (i) (d) (iii), (i), (ii)

Ans.(b)

28. The amount of correction due to local attraction at a place:
    (a) Varies with bearing (b) As timee varies
    (c) Is constant for all bearing
    (d) None of these

Ans.(c)

29. The bearing of a line in the direction of the _____ of survey is called fore bearing.
    (a) Opposite (b) Progress
    (c) Between (d) None of these

Ans.(b)

30. Fore bearing of line is 208°37. Find back bearing of line.
    (a) 208°37' (b) 317°40'
    (c) 28°37' (d) 27°36'

Ans.(c)

31. The line passing through point of zero declination are known as
    (a) Agonic line (b) Isogonic line
    (c) Contour line (d) Survey line

Ans.(a)

32. The prismatic compass and surveyors compass
    (a) Give whole circle bearing (WCB) of a line and quadrantal bearing (QB) of a line respectively
    (b) Both give QB of a line and WCB of a line
    (c) Both give QB of a line
    (d) Both give WCB of a line

Ans.(a)

## LONG QUESTION ANSWER

Q1. State the priciple of Compass surveying. [JUT-2017]

Ans. The principle of compass surveying is traversing, which involves a series of connected lines. The magnetic bearings of the lines are measured by prismatic connected lines. The magnetic bearing of the lines are measured by prismatic compass and the distance of the lines are measured by chain. Such survey does not require the formation of a network of triangles.

Q2.Define Traversing?State the different types of traverse ?

Ans.Traversing:Surveying which involves a series of connected lines is known as 'traversing'.
There are two types of traverse :
(1) Open traverse, (2) Closed traverse

(1) Open traverse : It is defined as a traverse in which first station and last station are different i.e. starting and end stations never meet. Road and railway lines are the good examples of open traverse.
When a sequence of connected lines extends along a general direction and does not return to the starting point,

it is known as 'open traverse' or 'unclosed traverse'. Here, ABCDE represents an open traverse (Fig. below). Open traverse is suitable for the survey of roads, rivers, coast lines etc.

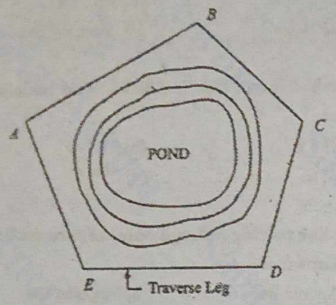



Figure :Closed Traverse

(2) **Closed traverse :** When traverse starts and ends at the same station, traverse is called as closed traverse. Fields, ponds,forests are the good examples of closed traverse. When a series of a connected lines forms a closed circuit, i.e. when the finishing point coincides with the starting point of a survey, it is called a 'closed traverse'. Here ABCDEA represents a closed traverse (Fig. below). Closed traverse is suitable for the survey of boundaries of ponds, forests, estates, etc.

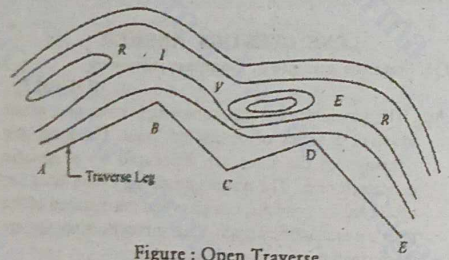
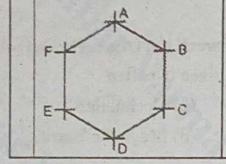
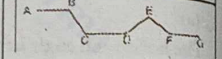



Figure : Open Traverse

Q3.Distinguish between closed traverse and open traverse? [JUT-2018, 2019]

Ans.

| Closed Traverse | Open Traverse |
|---|---|
| When a traverse forms closed polygon it is called traverse. | When a traverse does not form a closed polygon it is called as 'open traverse'. |
| It is a series of lines which begins and ends at the same point. | It is a series of lines which extend in the same direction but not returns to the starting point. |
| It is suitable for locating boundaries like ponds, forest etc. | It is suitable for long narrow strips of ground like river, valley, road etc. |
|  |  |

Q4.Explain the following terms : [JUT-2014]
(i) Local attraction.
(ii) Magnetic declination.
(iii)Whole circle bearing
(iv) Reduced bearing

Ans.(i) Local attraction : The magnetic needle indicates the north direction when freely suspended or pivoted But if the needle comes near same magnetic substance such as iron, steel structures, electric cables conveying current etc., it is found to be deflected from its true direction, and does not show the actual north. This disturbing influence of magnetic substances is known as 'local attraction'.

To detect the presence of local attraction, the fore and back bearing of a line should be taken. If the difference of the fore and back bearing of the line is exactly 180° then there is no local attraction.

If the FB and BB of a line do not differ by 180° then needle is said to be affected by local attraction, provided there is no instrumental error.

To compensate for the effect of local attraction, the amount of error is found out and is equally distributed between the fore back bearing of the line.

Ans.(ii) Magnetic declination: The horizontal angle between the magnetic meridian and true meridian is known as 'magnetic declination'.

When the north end of the magnetic needle is pointed towards the west side of the true meridian, the position is termed declination west ($\theta$ W).

When the north end of the magnetic needle is pointed towards the east side of the true meridian the position is termed declination east ($\theta$ E) shown in figure.



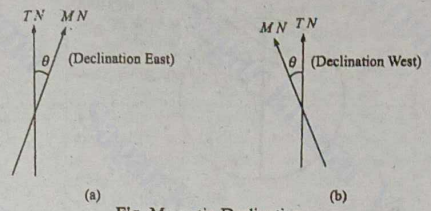



Fig. Magnetic Declination

Ans.(iii)Whole circle bearing: The magnetic bearing of a line measured clockwise form the north pole towards the line, is known as the whole circle bearing, of that line. Such a bearing may have any value between 0° and 360° The whole circle bearing of a line is obtained by prismatic compass

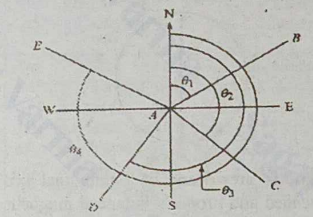



Fig. Whole Circle Bearing (WCB)

For example, in Fig below

WCB of AB = $\theta$
WCB of AC = $\theta_2$
WCB of AD = $\theta_3$
WCB of AE = $\theta_4$

Ans.(iv)Reduced Beraing (RB): When the whole circle bearing of a line is converted to quadrantal bearing it is termed the reduced bearing' Thuse the reduced bearing is similar to the quadrantal bearing.Its value lies between 0° and 90° but the should be mentioned for proper designation.

The following table should be remembered for conversion of WCB to RB:

| WCB between | Corresponding RB | Quadrant |
|---|---|---|
| 0° and 90° | RB = WCB | NE |
| 90° and 180° | RB = 180° - WCB | SE |
| 180° and 270° | RB = WCB - 180° | SW |
| 270° and 360° | RB = 360° - WCB | NW |

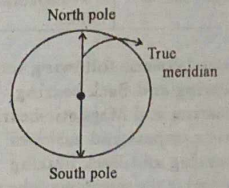
Every line has two bearings: one is observed along the progress of the survey or forward direction, and is called fore bearing , and the second is observed in the reverse or opposite direction and is called back bearing.

Q5.Explain the following terms : [JUT-2016,2015]
(i) Back bearing
(ii)True Meridian
(iii)Magnetic meridian
(iv)Declination (v)Dip of the magnetic needle

Ans.(i) Back bearing : Every line has two bearings one is observed along the progress of the survey or forward direction and is called 'fore bearing', and the second is observed in the reverse or opposite direction and is called 'back bearing'.

Ans.(ii) True Meridian : The line of intersection of the earth surface by a plane containing north pole, south pole and the observer's position is called **true meridian** or geographical meridian.It represents true north-south direction at the place. The inclination of survey line with trur meridian is known as True bearing of a line.

In figure N-S be a true meridian




Ans.(iii) Magnetic meridian:The longitudinal axis of a freely suspended and properly balanced magnetic needle unaffected by local attractive force, defining the magnetic north-south line which is called **magnetic meridan** . If does not coincide with the true meridian. The inclination of survey line with manetic meridian is known as Magnetic bearing.

Ans.(iv) Declination : The difference between magnetic meridian and true meridian , is termed as declination .The declination of earth is approximately 11°.

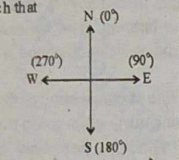
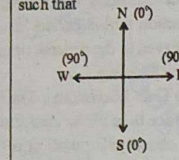
T.B = M.B ± declination

Use +ve when declination is toward east and use negative when delination is toward west

Ans.(v) Dip of the magnetic needle : If the needle is perfectly balanced before magnetisation it does not remain in the balanced position after it is magnetised. This is due to the magnetic iniluence of the earth. The needle is found to be inclined towards the pole. This inclination of the needle with the horizontal is known as the dip of the magnetic needle.

Q6. Compare whole circle bearing system and quadrantal bearing system with necessary sketch. [SBTE-2017]

Ans.

| W.C.B | R.B |
|---|---|
| It stands for Whole circle Bearing. | It stands for Reduced Bearing. |
| W.C.B. is modern system of measurement. | R.B. is ancient system of measurement. |
| The graduation should be such that   | The graduation should be such that   |
| North is considered as 0° East is considered as 90° South is considered as 180° West is considered as 270° | North and South is considered as 0° East and West is considered as 90°. |
| It is simple and less tedious. | It is complicated and more tedious. |

**Q7. Differentiate between following terms[JUT-2017]**

**(a) Fore bearing and Back bearing**

**(b) True bearing and Magnetic bearing**

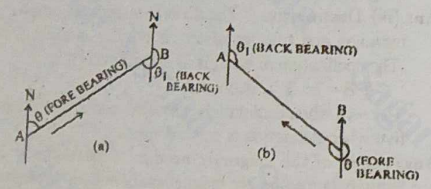
**(c)Prismatic compass and surveyor compass**

**Ans.(a) Fore bearing and Back bearing :** The bearing of a line measured in the direction of the proportion of survey is called the 'fore bearing' (FB) of the line. The bearing of line measured in the direction opposite to the survey is called bearing' (BB) of the line (fig.)

For example, in fig. (a), $FB = AB = \theta$, $BB\ of\ AB = \theta_1$

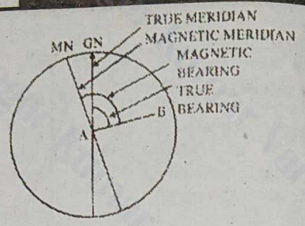
In fig. (b), FB of BA = $\theta$

BB of BA = $\theta_1$




The angle between the true meridian and a line is known as 'true bearing of the line. It is also known as the 'azimuth' (fig.).

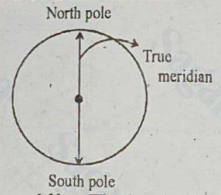
The angle between the magnetic meridian and a line is known as the 'magnetic bearing' or simply the 'bear ing' of the line (fig.).




**Ans.(b)True bearing and Magnetic bearing :**

**True Meridian :** The line of intersection of the earth surface by a plane containing north pole, south pole and the observer's position is called **true meridian** or geographical meridian.It represents true north-south direction at the place. The inclination of survey line with true meridian is known as True bearing of a line.

In figure N-S be a true meridian




**Magnetic meridian:**The longitudinal axis of a freely suspended and properly balanced magnetic needle unaffected by local attractive force, defining the magnetic north-south line which is called **magnetic meridian** does not coincide with the true meridian. The inclination of survey line with manetic meridian is known as Magnetic bearing.

| Magnetic bearing | True bearing |
|---|---|
| *The angle made by the survey line with the magnetic meridian- i.e. north-south line is called magnetic bearing.* | *The horizontal angle between the line and true meridian is called true bearing of line.* |
| *There is variation in magnetic bearing.* | *True bearing at a point remains constant.* |

**Ans.(c)Prismatic compass and surveyor compass :** [SBTE-2013]

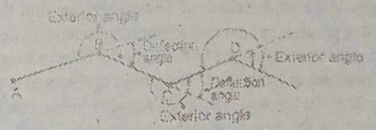


| Item | Prismatic Compass | Surveyors Compass |
|---|---|---|
| Magnetic Needle | The needle is of board needle. The needle does not act as index | The needle is of edge bar type. The needle acts as the index also. |
| Graduated Card | The graduated card ring is the ached with the needle. The ring does not rotate a long with the line of sight. The graduations are in W.C.B. system, having 0° at south end, 90° at a west, 180° at north and 270° atleast. | The graduated card is attached to the box and not to the needle. The card rotates along with the line of sight. The graduations are in Q.B system, having 0° at N and S & 90° at least and West East and west are interchanged. |
| | The graduations are engraved inverted. | The graduations are engraved erect. |
| Sighting Vanes | The object vane consists of metal vane with a vertical hair. The eye vane consists of a small metal vane with vertical hair. The eye vane consists of small metal vane with slit. | The objecti vane consists of. metal vane with a vertical hair. The eye vane consists of a metal vane with a fine slit. |
| Tripod | Tripomay or may not be provided. The instrument can be used even by suitably in hand. | The instrument can not be used without a tripod. |
| Reading | The reading is taken with the help of a prism provided at the eye slit. Sighting and reading taking can be done simultaneously from one position the observer. | The reading is a taken by directly seeing through the top of the glass Sighting and reading taking can not be done simulataneously from one position of the observer |

**Q8. Distinguish between deflection angle and exterior angle of traverse with sketech.**

**Ans.Deflection angle :** It is defined as an angle made by following survey line with extension or prolongation of preceding line and is equal to (180 – θ ° is an included interior angle. It is denoted by $\alpha$ or $\delta$.

**Exterior angle :** It is defined as an angle made by preceding line with following line, in such a way that it is equal to (360–θ °) where θ ° is an interior angle. It is denoted by θ °.




**Q9.State the function of following components of prismatic compass.Draw the labelled sketch of a section of prismatic compass showing its different components.** [JUT-2013,2012]

**Ans.Prismatic compass ;**

In this compass , the readings are taken with the help of a prism. The following are the essential parts of this compass :

The components of prismatic compass are :

(i) Box (ii) Needle

(iii) Graduated ring (iv) Object vane

(v) Eye vane (vi) Prism

(vii) Mirror (viii)Pivot etc.

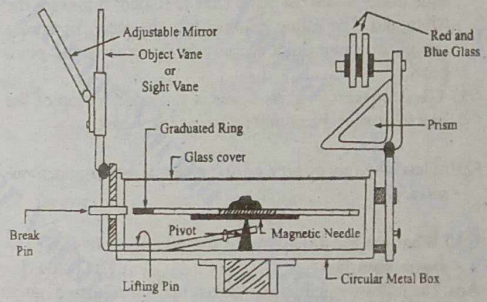



**Fig.** Prismatic Compass

**(i) Compass Box :** The compass box is a circular metallic box (the metal should be non-magnetic of 8 to 10 cm diameter. A pivot with a sharp point is provided at the centre of the box.

**(ii) Magnetic Needle and Graduated Ring :** The magnetic needle is made of a broad, magnetised iron bar. The bar is pointed at both ends. The magnetic needle is attached to graduated aluminium ring.

The ring is graduated from 0° to 360° clockwise, and the graduations begin from the south end of the needle. Thus, 0° is marked at the south, 90° at the west, 180° at the north and 270° at the east. The degrees are again subdivided into half-degrees. The figures are written upside down. The arrangement of the needle and ring contains an agate cap pivoted on the central pivot point. A rider of brass or silver coil is provided with the needle

to counterbalance its dip.

**(iv) Sight Vane and Prism** : The sight vane and the reflecting prism are fixed diametrically opposite to the box. The sight vane is hinged with the metal box and consists of horsehair at the centre. The prism consists of a sighting slit at the top and two small circular holes, one at the bottom of the prism and the other at the side of the observer's eye.

**(v) Dark Glasses :** Two dark glasses are provided with the prism. The red glass is meant for sighting luminous objects at night and the blue glass for reducting the stain on the observer's eye in bright daylight.

**(vi) Adjustable mirror :** A mirror is provided with the sight vane can be lowered or raised, and can also be inclined. If any object is too low or too high with respect to the line of sight, the mirror can be adjusted to observe it through reflection.

**(vii) Brake pin :** A brake pin is provided just at the base of the sight vane. If pressed gently, it stops the oscillations of the ring.

**(viii) Lifting pin :** A lifting pin is provided just below the sight vane. When the sight vane is folded, it presses the lifting pin. The lifting pin then lifts the magnetic needle out of the pivot point to prevent damage to the pivot head.

**(ix) Glass cover :** A glass cover is provided on top of the box to protect the aluminium ring form dust.

**Q10.Describe temporary adjustment of prismatic compass?**

OR

**Q10.What are the adjustrment usually necessary in prismatic compass.** [JUT-2011]

**Ans.**The following temporary adjustments are carried out at every set up of the instrument before taking any observations.

**(1) Centering :** Centering is the process of keeping the instrument exactly over the station. It is carred out by dropping a small piece of stone from the underneath of the compass, so that is falls on the top of the peg fixed at the station point.

**(2) Levelling :** It is levelled by means of ball and socket arrangement provided to the tripod stand so that the graduated ring may swing freely. The instrument is then clamped.

**(3) Focussing the prism:** The reflecting prism is adjusted to the eye sight of the observer. by raising of or owering the stud, until the graduations are seen sharp and clear. The sighting of the object and reading of graduated circle are done simultaneously.

**(4) Observing bearings:** Suppose bearing of a line AB is to be observed (i) Set up the instrument at station A and carry out all the above temporary adjustments. Fix ranging rod at B Fig 1.

(ii) Turn the compass box until the ranging rod at statio is bisected by the horse hair when seen through the tical slit above the prism.

(iii) When the needle comes to rest, bisect ranging rod a exactly and note the reading.It gives the bearing of line AB Thus in figure 1. the reading is 62°30'

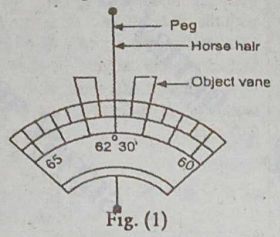



Fig. (1)

**Q11.Enlist any eight precutions to be observed wh using primatic compass.**

**Ans.**The following precautions should be taken while us a compass.

(1) Alway take reading after the needle has come to r if not it may be done so by gently pressing the brake provided for this purpose.

(2) Before taking the final reading, the compas top sh be gently tapped to destroy the effect of any sluggish on pivot either due to friction or otherwise.

(3) To avoid local attraction, articles made of steel su bunch of keys, iron buttons or studs, arrows, cha frames of spectacles, shoe of ranging rods axes should not be placed in the closed proximity of magnetic needle. The mobile phone should be kept a from it.

(4) Some times magnetic may adhere to the glass co which gets charge of electricity when dusted wi piece of cloth, in which case a moistened finger or cl may be pressed against the glass to remove st charges.

(5) The compass should be set away from the telegra poles carrying wires. electric lines carrying currrent a other steel structures.

(6) The compass should be set properly and roughly tes with the help of a small cirular pencil by placing it on top so that it should be horizontal. Also the obser should not stand over the tripod.

(7) When the compass is not in use, the magnetic nee should be raised off the pivot by closing down the obj vane so as to avoid wear and tear of the pivot point.

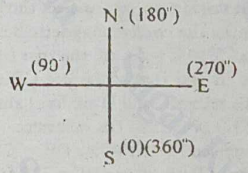
(8) The reading in case of prismatic compass should taken simultaneously after seeing the object and check by reading preceding and forward figures.



(9) For accurate results, duplicate readings may be taken. To detect local attraction fore and back bearings of each line should be taken.

**Q12.Why zero graduation on graduation ring of prismatic compass is marked on South end ? Explain.**

**Ans.**A magnetic meedle is attached to the circular ring or compass card made of aluminium, a non-magnetic substance. When the needle is an the pivot, it will orient itself in the magnetic meridian and, the N and S ends of the ring will be lie in this direction. When an object is sighted, the sight vanes will rotate with respect to the NS end of ring through an angle which makes with the magnetic meridian. A triangular prism is fitted below the eye slit, having suitable arrangement for focusing to suit different eye sights. The prism has both horizontal and vertical faces convex. So that a magnified image of the ring graduation is formed. When the line of sight is also in the magnetic meridian, the south end of the ring comes vertically below the horizontal face of the prism. The 0° or 360° reading is, therefore, engraved on the south end of the ring. So that bearing of the magnetic meridian is read as 0° with the help of the prism which is vertically above south end in this particular position.




**Q13.Define closing error in a closed traverse. How will you adjust them graphicaly.** [SBTE-2014]

OR

**Q13.Give the process of graphical adjustment of closing error.**

**Ans.Closing error :** When a closed traverse is plotted, the starting and end points may not coincide. The distance by which the traverse fails to close is called closing error. It may occur due to mistakes in measurement of lengths and directions of the lines of traverse. It is adjusted graphically by Bow ditch's rule as explained here :Suppose a traverse $AB_1C_1D_1A_1$ is plotted according to any suitable scale. In this case the traverse fails to close by a distance $AA_1$ which is the closing error. To adjust the traverse, a horizontal line $AA_1$ is drawn to represent the perimeter of the traverse on same or different scale than the scalp of plotting of traverse. On this line, distances $AB_1$, $B_1C_1$, $C_1D_1$, $D_1E_1$ and $E_1A_1$ are set off as per the measured lengths of these legs. A perpendicular $A_1a$ is drawn equal to the amount of closing error. Then $A_1a$ is joined.

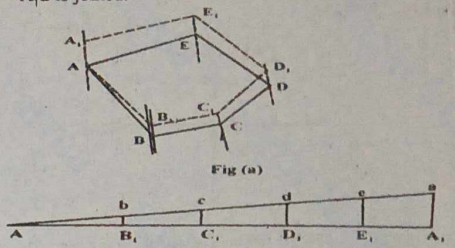



Fig (a)

Fig (b)

Now, from the points $B_1$, $C_1$, $D_1$ and $E_1$, the lines $B_1b$, $C_1c$, $D_1d$ and $E_1e$ are drawn parallel to $A_1a$. These intercepts represent the amount by which the respective stations are to be shifted.

As shown in figure (a), lines are drawn parallel to the closing error through stations $B_1$, $C_1$, $D_1$ and $E_1$.

Then the intercepts $B_1b$, $C_1c$, $D_1d$ and $E_1e$ are set off along the parallel lines drawn through the respective stations. In this manner, the adjusted traverse ABCDEA is obtained.

**Q14.Convert WCB into Q.B and vice-versa.** [JUT-2016]
170°12', 211°54', N12°24'E, S68°6'W, N5°42'W

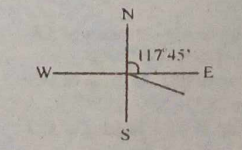
**Ans.:** Q.B of 170°12'=180°0'–170°12'
= S9° 48'E
QB of 211°54'= 211°54'–180°0'
= 531°54'W
WCBof N12°24'E = 12°24'
WCB of S68°6'W = 180°0'+68°6'
= 248°6'

**Q15.Determine the true bearing of a line PQ when its bearing is 45°15' and magnetic declination is 5°45'W .**

**Ans.** True bearing of PQ
= Magnetic bearing – declination
= 45°15'–5°45'= 39°30'

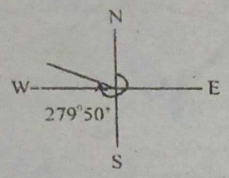
**Q16.Convert following whole circle bearing (W.C.B) into quadriental bearing (Q.B.) and Q.B. into W.C.B.**
**(i)** 117°45' **(ii)** 279°50'
**(iii)** $S42°30'E$ **(iv)** $N51°48'W$ [JUT-2015]

**Ans.(i)** 117°45'



$S(180^0 - 117^0 45')E = S62^0 15'E$

Ans.(ii) $279^0 50'$




$N(360^0 - 279^0 50')W = N80^0 10'W$

Ans.*(iii)* $S42^0 30'E$

$= 180^0 - 42^0 30' = 137^0 30'$

Ans.*(iv)* $N51^0 48'W$

$= 360^0 - 51^0 48' = 308^0 12'$

**Q17.The following bearing were observed while traversing with a compass. At what stations do you suspect local attraction ? Find the correct bearing of lines.**

| Line | F.B. | B.B. |
|---|---|---|
| *AB* | *124°30'* | *304°30'* |
| *BC* | *68°15'* | *246°00'* |
| *CD* | *310°30'* | *135°15'* |
| *DA* | *200°15'* | *17°45'* |

[JUT-2017]

Ans.

| Line | Observed | | Correction | Corrected | | Remarks |
|---|---|---|---|---|---|---|
| AB | 124°30' | 304°30' | 0 ° at A | 124°30' | 304°30' | Stations A&B are Force from Local attraction |
| BC | 68°15' | 246° | 0° at B | 68°15' | 248°15' | |
| CD | 310°30' | 135°15' | +2°15' at C | 312°45' | 132°45' | |
| DA | 200°15' | 170°45' | -2°30' at D | 197°45' | 17°45' | |

**Q18.The follwoing bearings were observed in traversing with a compass.**

| Line | Fore bearing |
|---|---|
| AB | 45° |
| BC | 80° |
| CD | 200° |
| DA | 280° |

**Calculate the interior angles of the traverse and apply the necessary check.** [JUT-2017]

Ans. Interior angle = Bearing of previous line - Bearing of next line

LA = Bearing of AD - Bearing of AB

$= (280^0 - 180^0) - 4.5^0 = 55^0$

LB = Bearing of BA - Bearing of BC

$= (45^0 + 180^0) - 80^0 = 145^0$

LC = Bearing of CB - Bearing of CD

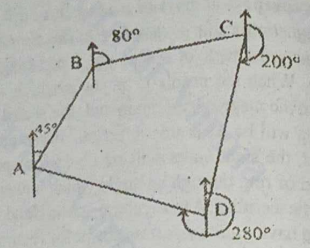
$= (80^0 + 180^0) - 200^0 = 60^0$

LD = Bearing of DC - Bearing of DA

$= (200^0 - 180^0) - 280^0 + 360^0 = 100^0$

Sum = LA + LB + LC + LD = $360^0$

Check : $(2n - 4) = (2 \times 4 - 4)\ 90^0 = 360^0$




**Q19.The following bearing were observed in running closed traverse:**

| Line | F.B | B.B. |
|---|---|---|
| AB | 75°5 | 254°20 |
| BC | 115°5 | 296°20 |
| CD | 165°35 | 345°35 |
| DE | 224°50 | 44°5 |
| EA | 304°50 | 125°5 |

**At what station do you suspect the local attractio Defermine the correct magnetic bearing . If defle tion was 5°10 E waht are the true bearing?**

Ans.As the FB and B.B of the line CD differ exactly by $180^0$, the statins C and D are local attraction free.

So, the FB of the line DE is correct.

So, Corrected FB of the line DE = 224°50'

Corrected BB of the line DE = 224°50' - 180°

= 44°50'

But the given B.B of the line DE = 44°5'

Hence, the correction of E = 44°50' - 44°5'

= + 0°45'

The given FB of the line EA= 304°50'

The correction at E = + 0°45'

Corrected FB of the line EA = 304°50' + 0°45'

= 305°35'

Corrected BB of the line EA = 305°35' - 180°

= 125°35'

But given BB of the line EA = 125°5'

Hence, the correction at A = 125°35' - 125°5'

= + 0°30'

The correcte FB of the line AB= 75°5'+ 0°30'

= 75°35'

Corrected BB of the line AB= 75°35'+ 180°

= 255°35'

But the given B.B of the line Ab = 254°20'

Hence, the correction at B = 255°35' - 254°20'



= + 1°15'

The Corrected FB of the line BC = 115°5'+1°15'

= 116°20'

Corrected BB of the line BC= 116°20' + 180°

= 296°20'check

and given B.B of the line BC = 296°20'

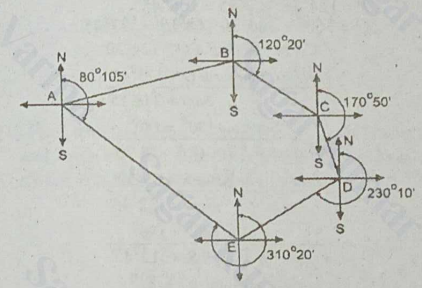
Hence Checked.

**Q20.The following are bearing taken on a closed compass traverse:** [JUT-2013]

| Line | F.B | B.B |
|---|---|---|
| AB | 80°10 | 259°0 |
| BC | 120°20 | 310°50 |
| CD | 170°50 | 350°50 |
| DE | 230°10 | 49°30 |
| EA | 310°20 | 130°15 |

**Compute the in terior angles and correct then for observational errors. Assuming the observed bearing of the line CD to be corrected, adjust the bearing of the remaining sides.**

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




Ans. Included angles

$\angle A$ = B.B of EA - F.B of AB

$= 130^0 15' - 0^0 15' - 80^0 10' = 80^0 05'$

$\angle B$ = B.B of AB - F.B of BC

$= 259^0 0' - 120^0 20' = 138^0 40'$

$\angle C$ = B.B of BC - F.B. of CD

$= 301^0 50' - 170^0 50' = 131^0 0'$

$\angle D$ = B.B of CD - F.B of DE

$= 350^0 50' - 230^0 10' = 120^0 40'$

$\angle E$ = F.B of EA - B.B of DE

$= 310^0 20' - 49^0 30' = 260^0 50'$ ( Exteropr amgle)

$= 360^0 - 260^0 50' = 99^0 10$ (Interior angle)

Sum of all included angles

$\angle A + \angle B + \angle C + \angle D + \angle E$

$= 50^0 05' + 138^0 40' + 131^0 0' + 120^0 40' + 99^0 10' = 538^0 95'$

$= 539^0 35'$

Theoretical sum = $(2n - 4) \times 90^0 = 540^0$

Error = $540^0 - 539^0 35' = 0^0 25'$

It is equally divided among 5 stations i.e + 05' at each angle station.

Hence corrected included angles are :

$\angle A = 50^0 10'$ $\angle B = 138^0 45'$, $\angle C = 131^0 05'$ $\angle D = 120^0 45'$

$\angle E = 99^0 15'$

$\therefore$ Sum total = $540^0$

For correction of bearings:

Commencing from the bearings of unaffected line CD

Bearing of CD = Bearing of CD + $\angle C$

$= 170^0 50' + 131^0 05' = 301^0 55'$

Bearing of BC = $301^0 55' - 180^0 = 121^0 55'$

Bearing of BA = Bearing of BC + $\angle B$

$= 121^0 55' + 138^0 45' = 260^0 40'$

Bearing of AB = $260^0 40' - 180^0 = 80^0 40'$

Bearing of AE = Bearing of AB + $\angle A$

$= 80^0 40' + 50^0 10' = 130^0 50'$

Bearing of EA = $130^0 50' + 180^0 = 310^0 50'$

Bearing of ED = Bearing of EA + $\angle E$

$= 310^0 50' + 99^0 15' = 410^0 05'$

Bearing of DE = $410^0 05' - 180^0 = 230^0 05'$

Bearing of DC = Bearing of DE + $\angle D$

$= 230^0 05' + 120^0 45' = 350^0 50$

Bearing of CD = $350^0 50' - 180^0 = 170^0 50'$ (Check)

**Q21.The following bearing were observed while travelling with a compass :**

| Line | FB | BB |
|---|---|---|
| AB | 45°45' | 226°10' |
| BC | 96°55' | 277°5' |
| CD | 29°45' | 209°10' |
| DE | 324°48' | 144°48' |

**Mention which station were affected by local attraction and determine the corrected bearings.**

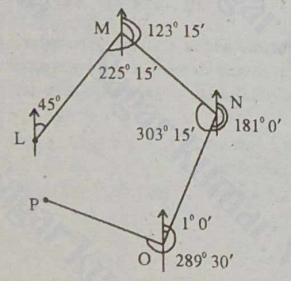
Ans.The results may be tabulated as under :

| Line | Observed bearing | Correction | Corrected bearing | Remarks |
|---|---|---|---|---|
| AB | 45° 45' | 0 at A | 45° 45' | Stations B and C are affected by local attraction |
| BA | 226° 10' | - 25' at B | 225° 45' | |
| BC | 96° 55' | - 25' at B | 96° 30' | |
| CB | 277° 5' | - 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' | |

**Q22.The followings were the observed bearing in running a compass traverse.**

| LINE | FORE BEARING | BACK BEARING |
|---|---|---|
| LM | 45° 15' | 225° 15' |
| MN | 123° 15' | 303° 15' |
| NO | 181° 0' | 1° 0' |
| OP | 289° 30' | 109° 30' |

**Calculate the interior angle of the traverse.**




Ans.

∠LMN = BACK BEARING OF LM − FORE BEARING OF MN

$= 225^0 15' - 123^0 15'$

$= 102^0 0'$

∠MNO = BACK BEARING OF MN − FORE BEARING OF NO

$= 303^0 15' - 181^0 0'$

$= 122^0 15'$

OP = 360° − FORE BEARING OF OP + BACK BEARING OF NO

$= 360^0 - 289^0 30' + 1^0 0'$

$= 71^0 30'$

**Q23.The following bearing were observed in a closed traverse PQRS. [JUT-2012]**

| Traverse | Line | F.B. | B.B |
|---|---|---|---|
| PQRS | PQ | 124° 30 | 304° 30 |
| | QR | 68° 15 | 246° 0 |
| | RS | 310° 30 | 135° 15 |
| | SP | 200° 15 | 17° 45 |

**At what stations do you suspect local attraction? Find the corrective bearing of the line.**

Ans.Calculation of included angles

$\angle P = 124^0 30' - 17^0 45' = 106^0 45'$

$\angle Q = 360^0 - 304^0 30' + 68^0 15' = 123^0 45'$

$\therefore$ Correct F.B. of PQ = 124° 30'

Add c/w angle at Q = 123° 45'

Sum = 248° 15'

Subtract 180° = 180°

Correct F/B of QR = 68° 15'

Add c/w angle at R = 64° 30'

Sum = 132° 45'

Add 180° = 180°

Correct F.B. of RS = 312° 45'

add c/w angle at S = 65°

Sum = 377° 45'

Substract 180° = 180°

Correct F.B. of SP = 197° 45'

add c/w angle at A = 106° 45'

Sum = 304° 30'

Substract 180° = 180°

Correct F.B. of PQ = 124° 30' (checked)

Difference in F.B and B.B of lines

Line P.Q = 304° − 30' − 124° 30' − 180°

Line Q.R = 246° − 68° 15' = 177° 45'

Line R.S = 310° 30' − 135° 15' = 175° 15'

Line S.P = 200° 15' − 17° 45' = 182° 30'

Here station P and Q are free from local attraction



| Line | Observed F.B. | Bearing B.B. | Corrected F.B. | Bearing B.B. | Included Angle observed or correct | Remarks |
|---|---|---|---|---|---|---|
| PQ | 124° 30' | 304° 30' | 124° 30' | 304° 30' | 106° 45' | Stations P & Q are free from local attraction |
| QR | 68° 15' | 246° 00' | 68° 15' | 248° 15' | 123° 45' | |
| RS | 310° 30' | 135° 15' | 312° 45' | 132° 45' | 64° 30' | |
| SP | 200° 15' | 17° 45' | 197° 45' | 377° 45' | 65° | |

**Q24.The whole circle bearings of sides of a closed traverse are 290°30., 250°30., 196°30., 175°30., 112°0. and 30°0.. Calculate the included angles. [JUT-2011]**

Ans. $\angle P = 250^0 30' - 110^0 50' = 140^0$

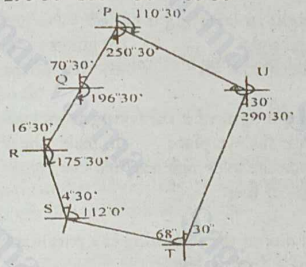
$\angle Q = 196^0 30' - 70^0 30' = 126^0 0'$

$\angle R = 175^0 30' - 16^0 30' = 159^0$

$\angle S = 112^0 + 4^0 30' = 116^0 30'$

$\angle T = 98^0$

$\angle U = 290^0 30' - 180^0 - 30^0 = 80^0 30'$




**Q25.Find which station is affected by local attraction and work out the correct bearing of the lines of a closed traverse ABCDEA.**

| Line | F.B | B.B |
|---|---|---|
| AB | 191°30' | 13° |
| BC | 69°30' | 246°30' |
| CD | 32°15' | 210°30' |
| DE | 262°45' | 80°45' |
| EA | 230°15' | 53° |

Ans.Observation of included angles

$\angle A = 191^0 30' - 53^0 = 138^0 30'$

$\angle B = 69^0 30' - 13^0 = 56^0 30'$

$\angle C = 360^0 246^0 30' + 32^0 15' = 145^0 45'$

$\angle D = 262^0 45' - 210^0 30' = 52^0 15'$

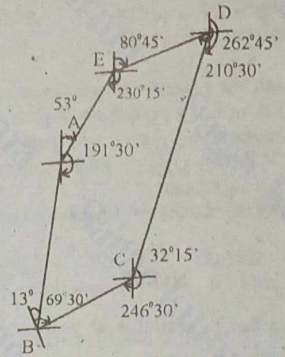
$\angle E = 230^0 15' - 80^0 45' = 149^0 30'$

Sum = 542° 30'

Since, sum should be 540°

Total error = 2° 30'

Correction applied in each angle $= -\frac{2^0 30'}{5} = -0^0 30'$




∴ Corrected included angles

$\angle A = 138^0 30' - 0^0 30' = 138^0$

$\angle B = 56^0 30' - 0^0 30^0 = 56^0$

$\angle C = 145^0 45^0 - 0^0 30' = 145^0 15'$

$\angle D = 52^0 15' - 0^0 30' = 51^0 45'$

$\angle E = 149^0 30' - 0^0 30' = 149^0$

Sum = 540°

Observation of difference of B.B. and F.B of different lines

Line AB = 191° 30' − 13° = 178° 30'

Line BC = 246° 30' − 69° 30' = 177°

Line CD = 210° 30' − 38° 15' = 178° 15'

Line DE = 262° 45' − 80° 45' = 182°

Line EA = 230° 15' − 53° = 177° 15'

Here, we are observing the condition, the difference in B.B. and F.B. of line AB is nearest of 180° among all

| Line | Observed F.B. | Bearing B.B. | Corrected F.B. | Bearing B.B. | Included observed | Angle corrected | Remarks |
|---|---|---|---|---|---|---|---|
| AB | 191°30' | 13° | 192°15' | 12°15' | 138°30' | 138° | Nostation |
| BC | 69°30' | 246°30' | 68°15' | 148°15' | 56°30' | 56° | arefreefrom |
| CD | 32°15' | 210°30' | 33°30' | 213°30' | 145°45' | 145°15' | local |
| DE | 262°45' | 80°45' | 265°15' | 85°15' | 52°15' | 51°45' | Attraction |
| EA | 230°15' | 53° | 234°15' | 54°15' | 149°30' | 149° | |

So, Correct F.B. of AB = 191° 30' + $\frac{1^0 30'}{2}$ = 192° 15'

add C.W. at B = 56°

Sum = 248° 15'

Substract 180° = 180°

Correct F.B. of BC = 68° 15'

add C.W. angle at C = 145° 15'

Sum = 213° 30'

Subtract 180° = 180°

Correct F.B. of CD = 33° 30'

add C.W. angle at D = 51° 45'

Sum = 85° 15'

Add 180° = 180°

Correct F.B. of DE $= 265^0 15'$
Add C.W. angle at E $= 149^0$
Sum $= 414^0 15'$
Subtract $180^0 = 180^0$
Correct F.B. of EA $= 234^0 15'$
add C.W angle at A $= 188^0$
Sum $= 372^0 15'$
Subtract $180^0 = 180^0$
Correct F.B. of A $= 192^0 15'$ Checked.

## NOTE

- Question Bank available at your nearest book store.
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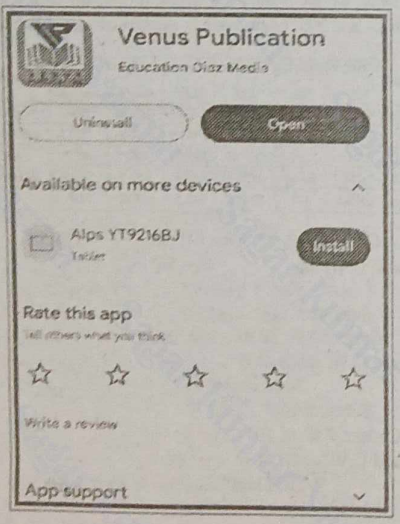



# Chapter 4

# LEVELLING

## MULTIPLE CHOICE QUESTION

1. The still water surface of a pond represents
(a) level surface (b) Horizontal surface
(c) Curved surface (d) none of these

Ans. (a)

2. At every turning point, which of the following sig is taken ?
(a) back sight (b) fore sight
(c) both (a) and (b) (d) none of these

Ans.(c)

3. Fore sight in levelling is called
(a) plush sight (b) minus sight
(c) both (a) and (b) (d) none of these

Ans.(b)

4. The diaphragm of a surveying telescope is held
(a) inside the eye place (b) inside the objective
(c) inside the telescope near the eye place
(d) none of these

Ans.(c)

5. Which one of the following is a paramanent adjus ment of a dumpy level?
(a) Eye-piece adjustment (b) Levelling up
(c) Parallex remove (d) Cross-hair adjustme

Ans.(a)

6. Which of the following readings are taken on change point?
(a) Fore sight, back sight, and intermidiate sight
(b) Fore sight and back sight
(c) Fore sight only
(d) Back sight only

Ans.(d)

7. The rise and fall method of levelling provides a com plete check on
(a) back sight (b) intermediate sight
(c) fore sight (d) all of the above

Ans.(b)

8. Sensitiveness of bubble tube is increased by
(a) Decreasing the temparature
(b) Increasing the temparature
(c) Does not depend upon the temparature
(d) None of the above

Ans.(b)

9. A level surface is
(a) Curved surface perpendicular to the direction of gravity at each point
(b) Any surface parallel to the mean spherical surface of earth
(c) The surface parallel to still water surface
(d) All the above

Ans. (b)

10. The datum adopted for India is the
(a)MSL at Madras (b)MSL at Bombay
(c)MSL at Karachi

Ans.(c)

11. The BM established by the survey of India is known as the
(a) permanent BM (b) GTS BM
(c) arbitary BM

Ans.(b)

12. The surface tangential to a level surface is said to be a
(a)vertical surface (b)horizontal surface
(c)ground surface

Ans.(b)

13. The line of collimation and axis of the telescope should
(a)concide (b)be parallel (c)be perpendicular

Ans.(a)

14. When there is relative movement between the cross-hairs and staff reading ,it is known as
(a)parallax (b)collimation error (c)refractive error

Ans.(a)

15. The internal focussing telescope is focussed by moving the
(a)convex lens (b)double concave lens
(c)planoconvex lens

Ans.(b)

16. The operation of levelling to determine the elevation between two points is known as
(a) simple levelling (b) fly levelling
(c) differential levelling

Ans.(c)

17. The operation of levelling from the finishing point to the starting point at the end of a days work is known as
(a)check levelling (b)longitudinal levelling
(c)cross-sectional levelling

Ans.(a)

18. The operation of levelling across any river is termed
(a) longitudinal levelling (b) fly levelling
(c) continuous levelling

Ans.(b)

19. The tangent to the longitudinal surface of the bubble tube is known as the
(a) axis of the bubble (b) centre line of the bubble
(c) profile of the bubble

Ans.(a)



20. The correction due to curvature in levelling is
(a)$d^2/2R$ (b) $2/5(d^2/2R)$
(c)$d^2/R$ (d) $d^2/4R$

Ans.(a)

21. The imaginary line joining the points of equal elevation is known as :
(a) isogonic line (b) agonic line
(c) contour line (d) all of the above

Ans. (c)

22. Closed contour lines with lower value inside represent :
(a) pond (b) hill
(c) both (a) and (b) (d) none of these

Ans. (a)

23. In the case of rising ground
(a) Lower contour encircles the higher contour
(b) Higher contour encircles the lower contour
(c) Lower and higher contour are equal
(d) Can't be said

Ans. (b)

24. Contour interval is
(a) the vertical distance between two consecutive contour.
(b) the horizontal distance between two consecutive contour.
(c) the vertical distance between two points on same contour.
(d) None of the above

Ans.(b)

25. Two contour lines having the same elevation
(a) can unite together
(b) can not unite together
(c) can cross each other
(d) name of the above

Ans.(a)

26. In a contour map a series of straight, parallel and equally spaced contours represent.
(a) Level surface (b) Gentle slope
(c) Contour gradient (d) Plane surface

Ans.(d)

27. When the contours unite at a place then that place is known as -
(a) cliff (b) ridge
(c) valley (d) over hanging cliff

Ans.(a)

28. The boundary of a water of a still lake represents -
(a) a level surface (b) a horizontal surface
(c) contour line (d) a concave surface

Ans.(c)

29. The ring contours having higher values inwards represent-
(a) hill (b) lake (c) flat surface (d) valley

Ans.(a)

30. A series of closed contour lines having lower values insides indicates-
(a) depression (b) a summit (c) none of these
Ans.(a)

31. The line joining points of equal elevation is known as-
(a) horizontal line (b) contour line (c) level line
Ans.(b)

32. When consecutive contour lines run close together. It indicates -
(a) steep slope (b) flatter slope (c) vertical surface
Ans.(a)

33. The vertical distance between two adjacent contour line is called -
(a) slope (b) flatter slope
(c) vertical surface (d) none
Ans.(d)

34. When contours of different elevation cross each other, it indicates a/an -
(a) vertical cliff (b) saddle (c) overhanging cliff
Ans.(c)

35. Two contour lines having the same elevation -
(a) cannot cross each other (b) can cross each other
(c) cannot unite together (d) can unite together
Ans.(d)

36. When lower values are inside the loop, it indicates -
(a) High ground (b) Level ground (c) A depression
Ans.(a)

37. When the higher values are inside the loop, it indicates-
(a) Hill (b) Pond (c) Sloping surface
Ans.(a)

38. When consecutive interval is fixed between 0.25 m and 0.50 m, it indicates -
(a) A steep slope (b) Flattish slope
(c) Almost level ground
Ans.(b)

39. A contour line intersects a ridge line or valley line -
(a) Obliquely (b) Perpendicularly
(c) Vertically
Ans.(b)

40. The contour interval for a particular map is -
(a) Kept constant (b) Made variable
(c) Made irregular (d) None of these
Ans.(a)

41. A contour or contour line is a line joining -
(a) points having the same elevation
(b) a set of points having different elevation
(c) a set of equidistant points having different elevations
(d) joining points of traversed survey
Ans.(a)

## LONG QUESTION ANSWER

**Q1. What is levelling ? State its purpose . [JUT-2015]**

**Ans.Levelling :** Levelling is an art of determining relative heights or elevations of different points on the earth's surface so that the same may be represented on a plan or map' it is essentially a process dealing with the measurements in vertical plane.

**Uses**

Levelling is done for the following purposes :

1. To prepare a contour map for fixing sites for reservoirs, dams, barrages, etc., and to fix the alignment of roads, railways, irrigation canals, and so on.
2. To determine the altitudes of different important points on a hill or to know the reduced levels of different points on or below the surface of the earth.
3. To prepare a longitudinal section and cross-sections of a project (roads, railways, irrigation canals, etc.) in order to determine the volume of earth work.
4. To prepare a layout map for water supply, sanitary or drainage schemes.

**Q2. State the Principle of levelling.**

**Ans.** The Principle of levelling is to obtain horzontal line of sight from which vertical distance of the points above or below of this line are found.

**Q3. Define Horizontal Surface & Horizontal line?**

**Ans.(i) Horizontal Surface :** The surface through a point which is tangential to the level surface at that point is know as Horizontal Surface. It is perpendicular to a plumb line at that point.

**(ii) Horizontal Line :** Any line lying in the horzontal surface and perpendicular to plumb line at the point is know as Horizontal Line.

**Q4. Define Level Surface & Level Line.**

**Ans. (i) Level Surface :** The curved surface which is parallel to the mean spheroidal surface of earath is know as Level Surface.

**(ii) Level Line :** Any line lying in level surface and which is normal to the plumb line at all points. The surface of a still water in a lake is truly level Surface.

**Q5. Define Vertical Line or Vertical Axis.**

**Ans. Vertical Surface :** A vertical surface through any point surface normal to the level surface at that point.

**Vertical Line or Plumb Line or Vertical Axis :** Any line in the vertical surface is know as vertical line and is normal to the level line.



**Q6. Define Datum Surface**

**Ans.** Any level surface from which vertical distances of the points above or below this surface are measured is knows as datum. In India, mean sea level (MSL) at Karachi (in Pakistan) is considered as datum, which is taken as 0.000 hr for references. (VIP s M.S.L. is now shifted to Bombay Port as Datum and this location is shown on a G.T.S map.)

**Q7. What is meant by Reduced Level?**

**Ans. Reduced Level :** The height or depth of any point above or below any datum is called as reduced Level of that point sometimes it is also known as level or Elevation of a point.

The difference in elevation of the two points is vertical distance between tham.

**Q8. Define each type of Bench Mark.**

**(i) GTS Bench Mark (ii) Permanet B.M.**
**(iii) Temporary B.M. (iv) Arbitray B.M**

**Ans.(i) G.T.S. Bench Mark :** These are the Bench Marks Fixed with high precision at a regular interval throughout the country by the Great Trigonmetrical. Survey Dept. of India with reference to Mean Sea Level at karachi, (Recently at Bombay Port)

The position and R.L. or value of these G.T.S. B.M are published in a book form by the department. These are also shown on G.T.S. maps.

**Ans.(ii) Permanent Bench mark :** These B.M. which are fixed in between the G.T.S. bench marks by Government or authorized agencies are know as Permanet Bench Marks. The government agencies are P.W.D. C.P.W.D. or MES which are authorized to carry Permanent B.M. These B.M are marked on clearly well defined permanet points such as parapet wall of cuvert or bridge base or top of a kilometer stone, plinth of building, platfrom of railway station etc. They are of permanent nature and are marked on a flat surface by a rectangles and on a vertical surface by a broad arrow. The RL of P.B.M is written and their position is recorded future references and checking purposes.

**Ans.(iii) Arbitray Bench Mark :** In order to know the relative elevation of various points (i.e.to determine the relative fall or rise) some permanent points are considered and elevation or RL of such points are assumed. Then the levelling operation is started from such points which are called as Arbitrary B.M. or Assumed B.M.

**Ans.(iv) Temporary B.M :** When levelling operation is carried out, the whole work cannot be completed in a day.

Hence at the end of days work some reference points are fixed the R.L. of which is know or calculated, such B.M. are know as Temporary Mark (T.B.M.)

**Q9. Define Axis of bubble tube or Bubble tube axis**

**Ans.** Axis of bubble tube : An imaginary line tengential to longitudinal curve of the bubble tuble at its mid point is know as axis of the bubble tube. It always Horizontal when the bubble is in the centre of its seen.

**Q10. What is Change Point ?**

**Ans.** During the process of levelling sometimes, some staff readings are not possible to obtain from same position of instrument, under such circumstances with respect to last staff position (after taking all possible staff reading), instrument is to be shifted to new position. So that maximum or all remaining staff reading can the taken from this new position of intrument. Such a levelling staff position is called as change point and generally written as C.P.

'Change Point's is defined as position of staff station with respect to which instrument is shifted to new position for further porcess of levelling. At change point FS as well as BS, both staff readings are taken compulsory.

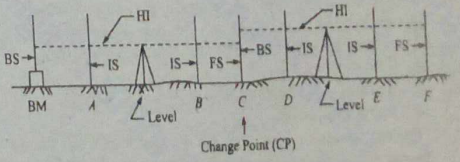
**Q11. Define the following term : [JUT-2017,2016]**

**(a) Bench mark (b) Line of collimation**
**(c) Back sight (d) Fore sight**
**(e) Reduced level (f) Datum**

**Ans.(a) Bench Mark :** These are fixed points or marks of known RL determined with reference to the datum line. These are very important marks. They serve as reference points for finding the RL of new points or for conducting levelling operations in projects involving roads, railways, etc.

**Ans.(b) Line of collimation :** It is an imaginary line passing through the intersection of the cross-hairs at the diaphragm and the optical centre of the object glass and its continuation. It is also known as the line of sight.

**Ans.(c) Back sight :** This is the first staff reading taken in any set up of the instrument after the levelling has been perfectly done. This reading is always taken on a point of known RL, i.e, on a bench mark or change point.




**Ans.(d) Fore sight :** It is the last staff reading in any set up of the instrument, and indicates the shifting of the latter.

**Ans.(e) Reduced level :** The vertical distance of a point above or below the datum line is known as the reduced level (RL) of that point. The RL of a point may be positive or negative according as the point is above or below the datum.

**Ans.(f) Datum :** Any level surface from which vertical distances of the point above or below this surface are measured is known as datum.

**Q12.Define the following term** [JUT-2012,2014]
**(i) Back Sight**
**(ii) Fore sight**
**(iii) Turning point**
**(iv) Intermediate point** **(v) Height of instrument**

**Ans.(i)Back Sight:** This is the first staff reading taken in any set up of the instrument after the levelling has been perfectly done. This reading is always taken on a point of known RL, i.e, on a bench mark or change point.

**Ans.(ii) Fore sight:** It is the last staff reading in any set up of the instrument, and indicates the shifting of the latter.

**Ans.(iii) Turning point :** An intervening point between BMs or TBMs upon which a backsight and a foresight are taken. It is a point temporarily located and marked in order to establish the elevation or position of a surveying instrument at a new station.

**Ans.(iv) Intermediate point:** Measuring a survey line, the chain has to be laid out on the ground between the stations. If the line is short, the chain could be put in alignment easily but if it is long or the end station is not clearly visible, then intermediate points has to be established in line with end points to know the directions of the line by ranging.

**Ans.(v) Height of instrument :** It is the elevation (R.L) of the plane of collimation with respect to the datum when the instrument is correctly levelled. It does not mean the height of the center of the telescope above the groung where the level stands.

**Q13. What are the various types of level? Explain the dumpy level.** [JUT-2016]

**Ans.** There are various types of levels viz.
1. Dumpy level
2. Wye level
3. Cooke's reversible level
4. The cushing's level
5. Tilting level (Modern tilting or I.O.P. Level)
6. Automatic levels,

The two types of levels viz (i) dumpy levels (ii) tilting levels are commonly used in Civil Engineering practice. Automatic level or self aligning level is a recent development.

**Dumpy level :** The dumpy level is simple, compact and stable instrument. The leveling head consists of two parallel plates with three foot screws, which bring the instrument in a proper level by bringing the bubble in its center of its run. The telescope is rigidly fixed to its supports. Hence, it cannot be rotated about its longitudinal axis or cannot be removed from its supports. The circular glass with cross- wires fixed infront of the eye piece. Before observing, cross - wires of diaphragm are made clear and distinct by rotating eye piece clockwise or anti - clockwise. The name dumpy is because of its compact and stable construction. The axis of telescope is perpendicular to the vertical axis of the level. The level tube is permanently placed so that its axis lies in the same vertical plane of telescope but it is adjustable by means of capstan headed nuts at one end.

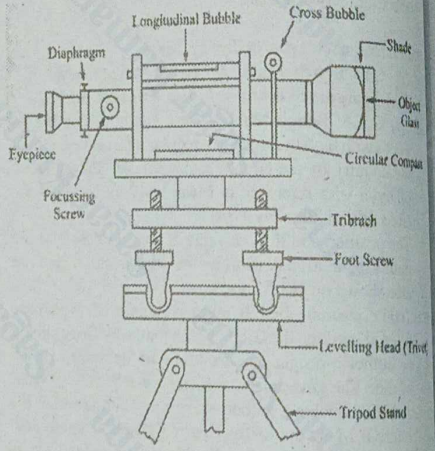



Fig 1. Dumpy level

1. Levelling head
2. Telescope
3. Eye piece
4. Diaphragm
5. Focussing screw
6. Ray Shade
7. Bubble tube
8. Capstan headed nut
9. Cross bubble tube
10. Level compass

There is a focussing screw provided on the telescope. It makes the images of the object clear and distinct. It can also helps to bring image in the plane of the cross - hairs.

A ray shade is provided to protect the object glass. A clammp and slow motion screw are provided in modern levels to control the movement of spindle, about the vertical axis. The telescope has a magnifying power of about thirty diameters. The level tube is graduated to 2mm division and it has normally a sensitiveness of 20 seconds. of arc per graduation. The telescope may be internal focussing or external type.



**Q14.Enumerate advantage of Auto Level over dumpy level.**

**Ans.** The advantages of Auto-level over dumpy level :
(i) Auto-level is of modern technology while dumpy level is of ancient technology.
(ii) In dumpy level, inuerted image is formed while in auto level erect image is formed.
(iii) In dumpy level, single lense is used while in auto-level double lenses is used.
(iv) Auto-level is used here accuracy is required.

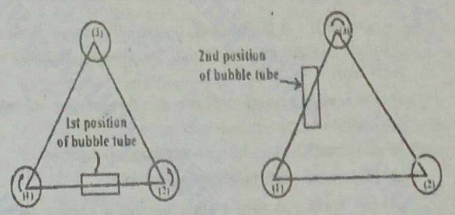
**Q15.What do you mean by temporary adjustment of dumpy level ? Give the process applied for temporary adjustment.** [JUT-2010]

**Ans.Permanent adjustment :** Permanent adjustment of dumpy level consists in setting its various fundamental lines in their correct relationship. These adjustments are the following :
(a) The axis of the bubble tube should be perpendicular to the vertical axis.
(b) The horizontal cross hairs should lie in a plane perpendicular to vertical axis.
(c) The line of collimation should be parallel to the axis of the bubble tube.

**Temporary adjustment :** These are the adjustments which have to be performed at each setup of the dumpy level before taking any observation with it. These adjustments are the following :

1. **Selection of suitable position :** The level should be set-up at a fairly level and firm ground.
2. **Fixing level with tripod stand :** The tripod stand is placed at the required position with its legs well apart and pressed firmly into the ground. The level is fixed on top of it.
3. **Approximately leveling by tripod legs :** The foot screws are brought to the centre of their run. Two legs of the tripod stand are firmly fixed into the ground. Then the third leg is moved to the left or right, in or out until the bubble is approximately at the center of its run.
4. **Perfect leveling by foot screws :** Accurate leveling of dumpy level is done with the help of foot screws and the bubble tube attached to it. It is done as :

**Step I :** The telescope is placed parallel to any two foot screws and by turning both these screws either in or out as required. The bubble is brought to the center of its run.




**Step -2:** The telescope is brought over the third foot screw by rotating it through 90°. The bubble is brought to the center by turning the third foot screw only.

**Step- 3:** The telescope is again placed in the original position and the bubble is brought to the center by using both foot screws.

**Step- 4:** The telescope is again placed over the third foot screw and bubble is again brought to the center.

**Step- 5 :** The process is repeated till the bubble remains in the center in both the positions.

5. **Focusing or Elimination of parallax :** Focusing of telescope is done in two stages :
(a) Focusing the eye piece
(b) Focusing the objective lens

**(a) Focusing the eye piece :** It is essential for distinct vision of cross hairs. For this, hold a white sheet of paper in front of the objective lens. Rotate the eyepiece in and out until the cross hairs are distinctly visible. Eye piece is now focused.

**(b) Focusing the objective lens :** For this, direct the telescope towards the staff, looking through the eyepiece, the focusing screw is turned clockwise or anti clockwise until the graduation of the staff is distinctly visible. The telescope is now in perfect focus.

**Q16.What is levelling staff ?Briefly explain the types of levelling staff .**

OR

**Q16.Write relative merits of self-reading staff and target staff.** [JUT-2017]

**Ans.Levelling staff :** A levelling staff is a straight rectangular rod having graduations, the foot of the staff reading representing zero reading. The purpose of a level is to establish a horizontal line of sight. The purpose of the levelling staff is to determine the amount by which the station is above or below the line of sight.

Levelling staff is of two types :
(i) Self reading staff (ii) Target staff

**(i) Self reading staff :** A self - reading staff is the one which can be read directly by the instrument through

the telescope

(ii) **Target staff :** A target staff, on the other hand contains a moving target against which the reading is taken by staff man.

(i) **Self - reading staff :** There are three types of self-reading staff.

(a) solid staff (b) folding staffand

(c) Telescopic staff (sopwith pattern).

(ii) **Target staff :** A target staff having a sliding target equipped with vernier. The rod consists of two sliding lengths the lower one of approx 7ft and upper one of 6ft. The rod is graduated in feet, tengths and hundredths, and the vernier of the target enables the readings to taken upto a thousandth part of a foot.

Relative merits and demerits of self - reading and target staff.

(i) With the self-reading staff readings can be taken quicker than with the target staff.

(ii) In case of target staff, the duties of target staff-man are as important as those of the leveller and demand the services of a trained man. In the case of a self-reading staff on the other hand, ordinary man hold the staff concentrating more on keeping the staff in plumb.

(iii) The reading with target staff can be taken with greater fineness. However, the refinement is usually more apparent than real as the target man may not be deirected accurately to make the line of sight bisect the target.

**Q17.What are the different methods of levelling? Explain any one of them.** [JUT-2015]

**Ans.**There are six methods of levelling :

(i) Simple levelling
(ii) Differential levelling
(iii) Fly levelling
(iv) Longitudinal or profile levelling
(v) Cross-sectional levelling
(vi) Check levelling

**Simple levelling :** When the difference of level between two points is determined by setting the levelling instrument midway between the points, the process is called simple leveling.

Suppose A and B are two points whose difference of level is to be determined. The level is set up at 0. exactly midway A and B. After proper temporary adjustment, the staff readings on A and B are taken. The difference of these readings gives the difference of level between A and B (Fig. 1).

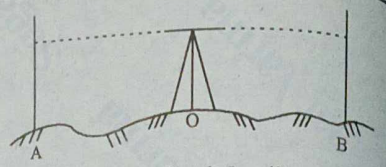



Figure 1 : Simple Levelling

**Differential levelling :** Differential levelling is adopted when (i) the point are a great distance apart, (ii) the difference of elevation between the points is large (iii) there are obstacles between the points.

This method is also known as compound levelling or continuous levelling. In this method, the level is set up at several suitable position and staff readings are taken on all of these.

Consider figure 2, suppose it is required to know the difference of level between A and B. The level is set up at points $O_1$, $O_2$, $O_3$ etc. After temporary adjustment staff readings are taken at every set up. The points $C_1$, $C_2$ and $C_3$ are known as change points. Then the difference of level between A and B is found out. If the difference is positive, A is lower than B. If it is negative, A is higher than B.

Knowing the RL of A, that of B can be calculated.

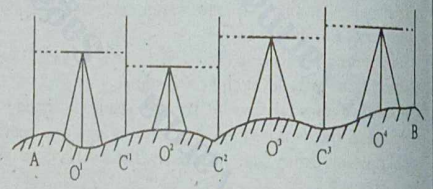



Figure 2 : Differential levelling

**Q18.Describe profile levelling in short. [JUT-2017]**

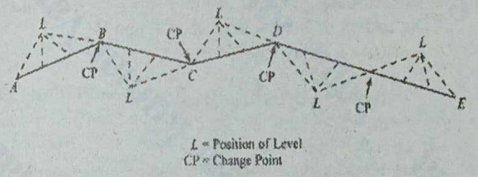
OR

**Q18.Explain the procedure of profile levelling for construction of a road.**

**Ans.Profile Levelling :** Profile levelling is the process of determining the elevations of points at short measured intervals along a fixed line such as the centre line of a railway, highway, conal or sewer. The fixed line may be single straight line or it may be composed of succession of straight lines or of a series of straight lines connected by curves. It is also known as longitudinal sectioning. By means of such sections the engineer is enabled to study the relationship between the existing ground surface and the levels of the proposed construction in the direction of its length.



**Procedure :**Profile levelling, like differential levelling, levelling, requires the establish of turning points on which both back and foresights are taken. In addition, any number of intermediate sights may be obtained on points along the line from each set up of the instrument. It is generally best to set up the level to one side of the profile line to avoid too short sights on the points near the instrument for each set up intermediate sights should be taken after the foresight on the next turning station has been taken. The level is then set up in an advanced position and a backsight is taken on that turning point. The position of intermediate points on the profile are simultaneously located by chaining long the profile and noting their distances from the point of commencement. When the vertical profile of the land in proportional should be chosen nearer, for the purpose of the chelling and future refrence,temporary B.M. should be established along the section.




L = Position of Level
CP = Change Point

Figure : Profile Levelling

**Q19. What is fly levelling ? State the purpose of it.**

**Ans.Fly levelling :** It is defined as an operation of leveling in which a line of levels run a (1) To determine the approximate elevations. (2) To determine the elevation of the points with some distance apart. (3) To establish a bench mark.

It is also known as continuous levelling. In this process, only BS and FS are taken and no IS are considered.

It is also carried out for reconnainssance of the area.

**Q20.What is reciprocal levelling ?Describe the method along with a sketch.**

**Ans**In reciprocal levelling, the level is set up on both banks of the river or valley and two sets of staff readings are taken by holding the staff on both banks. In this case, it is found that the errors are completely eliminated and the true difference of level is equal to the mean of the two apparent differences of level.

The principle is explained as follows :

Procedure

1. Suppose A and B are two points on the opposite banks of a river. The level is set up very near A and after proper temporary adjustment, staff readings are taken at A and B. Suppose the readings are $a_1$ and $b_1$.
2. The level is shifted and set up very near B and after proper adjustment, staff readings are taken at A and B. Suppose the readings are $a_2$ and $b_2$.

Let h = true difference of level between A and B

e = combined error due to curvature, refraction and collimation (The error may be positive or negative, here the error is assumed positive)

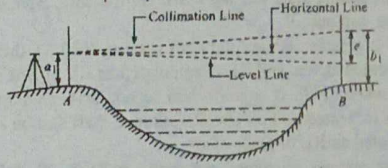
**In the first case,**

Correct staff reading at A=$a_1$ (as the level is very near A)

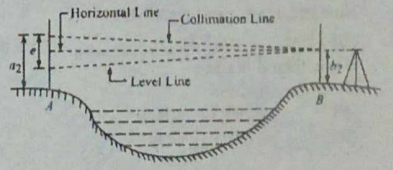
Correct staff reading at B = $b_1$ - e

True difference of level between A and B,

$h = a_1 - (b_1 - e)$ (fall from B to A) ..... (i)




(a)




**In the second case,**

Correct staff reading at B=$b_2$ (as level is near B)

Correct staff reading at A=$a_2$ + e

So, true difference of level,

$h = (a_2 - e) - b_2$ ..... (ii)

From (i) and (ii)

$2h = a_1 - (b_1 - e) + (a_2 - e) - b_2$

$= a_1 - b_1 + e + a_2 - e - b_2 = (a_1 - b_1) + (a_2 - b_2)$

$$h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$$

It may be observed that the error is eliminated and that the true difference is equal to the mean of the two, apparent differences of level between A and B.

**Q21. What are the method of Reduction of levels ?**

OR

**State and explain the methods of calculating the Reduced levels ?**

**Ans.**There are two method of reducing the levels or calculating the RL from staff readings taken during levelling process.

(1) Height of instrument method or plane of collimation

method

(2) Rise and fall method.

(1) **Height of Instrument (HI) Method** :In this method.

(i) R.L. of line of collimation (HI) is calculated first –from 1" staff reading (BS) on bench mark and RL o BM. i.e. HI = RL of BM + (BS) at bench mark.

(ii) Then for that set of observations,
RL at each point of staff observation is calculated w.r. to RL of line of collimation, i.e.
R.L. at staff station = HI –(IS/FS) at staff station.

(2) **Rise and fall method** :In this method,

(i) RL at next staff position is calculated by comparing the staff reading with staff reading at previous staff position. i.e. For second staff reading (IS/FS), first staff reading (BS) is compared.
If BS is greater than second staff reading (IS/FS), then it is treated as rise and RL is calculated as RL of BM + Rise, while of BS is smaller than second staff reading, then it is treated as Fall and R.L at next staff station is calculated as RL of BM – Fall.

(ii) Similar process is carried out between 2nd & 3rd staff reading then for further 3rd & 4th and so on.
Numerically it, can be shown as
(BS) $BM_{BM}$ – (IS/FS) $_{\text{At 2nd staff reading}} = \pm$ Value
If+ve, then it is rise
If–ve, then it is fall.
$(RL)_{\text{2nd staff}} = (RL)_{BM}$ + Rise
$(RL)_{\text{2nd staff}} = (RL)_{BM}$ –Fall

**Q22.Differentiate between H.I method & Rise & fall method.** [JUT-2013]

**Ans.**Following difference in between H.I. method and Rise and Fall method - .

| | H.I. Method | Rise and fall Method |
|---|---|---|
| 1. | The H.I. method is less tedious, easy and rapidable. | Rise and fall method is more tedious, complicated and slowly. |
| 2. | Check on the calculations for intermediate sight is not available, the mistakes n their level pass un-noticed | The rise and fall method though more tedious, provides a full check in calculations for all sights. |
| 3. | The H.I. method is more suitable in case, where it required to take a number of readings from the same instrument such as for const work profile levelling etc. | The rise and fall method is less suitable, in given constructional work etc. |

**Q23.Define collimation error. Explain the need of balancing BS & FS to eliminate closing error.**

**Ans.Collimation Error** :The error produce due to wrong sight line is called collimation error. Its may either by instrumental error, personal error, etc.
If B.S. and F.S. are taken simultaneously by same station, then error can be produce due to non-parallelism of ligle of sight at both observations.
**Balancing B.S. and F.S:**When the difference in elevation between any two points is determined from a single set-up by backsighting on one point and axis of the bubble tube when the bubble is in the centre of the run and also correction due to clavature and refraction may be eliminated by taking both the sight in equal length.

$$A\alpha = \frac{y_1}{D_1}; \qquad y_1 = D_1 \tan\alpha$$

The reading taken at staff A = $x$,
But correct reading of staff $A = (x_1 - y_1)$
$= (x_1 - D_1 \tan\alpha)$
Rreading taken of staff $B = x_2$
But correct reading of staff $B = (x_2 - y_2) = (x_2 - D_2 \tan\alpha)$
The correct difference in level of A and B
$= (x_1 - y_1) - (x_2 - y_2)$
$= (x_1 - x_2) - y_1 + y_2$
$= (x_1 - x_2) - D_1 \tan\alpha + D_2 \tan\alpha$
$= (x_1 - x_2) - \tan\alpha (D_1 - D_2)$
If $D_1 = D_2$ , then $= x_1 - x_2$
Thus, if backsight and foresight distances are balanced, the differences in elevation between two points can be directly calculated by taking difference of the two readings and no correction for the inclination of the line of sight is necessary.

**Q24.The following staff reading were obserned successivety with a kvel. The instrument having been moved after third, sixth and eighth readings. 2. 228, 1.606, 0.988, 2.090, 2.864, 1.262, 0.602, 1.982, 1.044, 2.684 meters. calculate the R.L of points if the first reading was taken with a staff hed on a bench mark of 432.384 m.** [JUT-2016]

**Ans.**



| Sl.No. | B.S | I.S | F.S | H.I | R.L | Remark |
|---|---|---|---|---|---|---|
| | 2.228 | | | 434.612 | 432.384 | B.M |
| 2 | | 1.606 | | | 433.006 | |
| 3 | | | 0.988 | | 433.624 | Cp1 |
| 4 | 2.090 | | | 435.714 | 433.624 | Same point same R.L |
| 5 | | 2.864 | | | 432.85 | |
| 6 | | | 1.262 | | 434.452 | Cp2 |
| 7 | 0.602 | | | 435.054 | 434.452 | Same point Same R.L |
| 8 | | | 1.982 | | 433.072 | Cp3 |
| 9 | 1.044 | | | 434.116 | 433.072 | Same point Same R.L |
| 10 | | | 2.684 | | 431.432 | |
| | ? BS = 5.964 | | ? FS = 6.916 | | Last R.L – Initial R.L | |

Check = $\sum BS - \sum FS = Last\ R.L. - Initial\ R.L.$
$= 5.967 - 6.916 = 431.432 - 432.384$
$= -0.952 = -0.952$ Proved

**Q25.The following staff readings were observed successively with a level. The level having been moved forward. After fourth and eight readings : 0.875, 1.235, 2.310, 1.385, 2.930, 3.125, 4.125, 0.120, 1.875, 2.030, 3.765 metres. The R.L. of first point was 166.300m. Rule out a page of level look in your answer book and inter the readings. Calculate the R.L. of points apply the usual check.[JUT-2017]**

**Ans.**

| Station Point | B.S | I.S | F.S | Rise | Fall | R.L | Remark |
|---|---|---|---|---|---|---|---|
| 1 | 0.875 | | | | | 166.300 | |
| 2 | 2.310 | | 1.235 | | 0.360 | 165.940 | C.P |
| 3 | 2.930 | | 1.385 | 0.995 | | 166.865 | C.P |
| 4 | | 3.125 | | | 0.195 | 166.670 | |
| 5 | | 4.125 | | | 1.000 | 165.670 | |
| 6 | 1.875 | | 0.120 | 4.005 | | 169.675 | C.P |
| 7 | | 2.030 | | | 0.155 | 169.520 | |
| 8 | | | 3.765 | | 0.735 | 167.785 | |
| Total = | 7.990 | | 6.505 | 4.930 | 3.445 | | |

Check
$\sum B.S - \sum F.S = \sum Rise - \sum Fall = Lost\ R.L - First\ R.L$
$7.990 - 6.505 = 4.930 - 3.445 = 167.785 - 166.300$
$1.485 = 1.485 = 1.485$ Checked

**Q26.The following consecutive readings were taken with a dumpy level : 3.864, 3.648, 2.932, 1.952, 0.854, 3.679, 2.639, 1.542, 1.964, 0.876, 0.666. The level was shifted after the 5th and 8th readings. The first readings was taken an B.M. of R.L 120.250. Calculate the RLS of the change points and difference of level between the first and last point.** [JUT-2015]

**Ans.**Ethrimatic check
$\sum BS - \sum FS$
$\sum Rise - \sum Fall$
$= 9.507 - 3.062 = 6.445$ $= 6.445 - 0$
$= 6.445$ $= 6.445$

| Station | BS | IS | FS | Rise | Fall | RL | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 3.864 | | | | | 120.250 | BM |
| 2 | | 3.648 | | 0.216 | | 120.466 | |
| 3 | | 2.932 | | 0.716 | | 121.182 | |
| 4 | | 1.952 | | 0.980 | | 122.162 | |
| 5 | 3.679 | | 0.854 | 1.098 | | 123.260 | CP |
| 6 | | 2.639 | | 1.040 | | 124.300 | |
| 7 | 1.964 | | 1.542 | 1.097 | | 125.397 | CP |
| 8 | | 0.876 | | 1.088 | | 126.485 | |
| 9 | | | 0.666 | 0.210 | | 126.695 | |
| | 9.507 | | 3.062 | 6.445 | | | |

Last RL – Ist RL
$= 126.695 - 120.250 = 6.445$
The difference of level between the first and last point = 6.445.

**Q27.The following consecutive readings were taken with a level and 5m levelling staff on continuously sloping ground at a common interval 20m; 1.035; 1.930; 2.815; 3.730; 4.865; 0.635; 2.010; 3.110; 4.625. The reduced level of the first point was 208.125. Rule out a page of level boot and enter the above readings. Calculate the RL$^s$ and gradient of the line joining first and last point.**

**Ans.** *Arithmetic check*
$\sum B.S - \sum F.S = Last\ R.L - First\ R.L$
$= \sum Rise - \sum Fall$

| S.No | B.S. | I.S. | F.S. | H.I | R.L | Remarks |
|---|---|---|---|---|---|---|
| 1. | 1.035 | | | 209.16 | 208.125 | Benchmask |
| 2 | | 1.93 | | | 207.23 | |
| 3. | | 2.815 | | | 206.345 | |
| 4. | | 3.73 | | | 205.43 | |
| 5 | 0.635 | | 4.865 | 204.93 | 204.295 | C.P |
| 6. | | 2.01 | | | 202.92 | |
| 7. | | 3.11 | | | 201.82 | |
| 8 | | | 4.625 | | 200.305 | |
| | $\sum BS = 1.67$ | | $\sum FS = 9.49$ | | | |

$\therefore 1.67 - 9.49 = -7.82 = \sum BS - \sum FS$
*Last R.L* *First R.L = 200.305* *268.125*

$= -7.82$

**Q28. Followingis the page of a level book where some readings are missing. Find the missing readings and apply arithmatic check.** [JUT-2013]

| Stn | BS | IS | FS | HI | RL | Remarks |
|---|---|---|---|---|---|---|
| A | X | | | 100.585 | 100.000 | BM |
| | | 0.935 | | | X | |
| | | X | | | 99.355 | |
| | | 2.845 | | | X | |
| | | X | | | 98.650 | |
| B | | | X | | 97.225 | Last Point |

**Ans.**

| Stn | BS | IS | FS | HI | RL | Remarks |
|---|---|---|---|---|---|---|
| A | 0.585 | | | 100.585 | 100 | BM |
| | | 0.935 | | | 99.65 | |
| | | 1.23 | | | 99.355 | |
| | | 2.845 | | | 97.74 | |
| | | 1.935 | | | 98.65 | |
| B | | | 3.36 | | 97.225 | Last Point |

$\Sigma B.S = 0.585 \qquad \Sigma F.S = 3.36$

$\Sigma B.S - \Sigma F.S = 0.585 - 3.36 = -2.775$

*Last RL First RL = 97.225 100 = 2.775*

**Q29. The following reading are taken n a levelling work : 0.255, 0.385, 0.520, 1.785, 1.895, 2.300, 1.785, 0.335, 0.858, 1.255. The positin of the instrument was changed after 3rd & 6th reading. If the RL of 1st point is 80m, calculate the RL of all remaing points.**

**Ans.**

| Sl | B.S | I.S | F.S | H.I | R.L(m) | Remarks |
|---|---|---|---|---|---|---|
| 1. | 0.255 | | | 80.255 | 80 | Bench mark |
| 2. | | 0.385 | | | 79.87 | |
| 3. | | 0.520 | | | 79.735 | |
| 4. | 1.895 | | 1.786 | 80.365 | 78.47 | C.P |
| 5. | | 2.30 | | | 78.065 | |
| 6. | 0.335 | | 1.785 | 78.95 | 78.58 | C.P |
| 7. | | 0.858 | | | 78.057 | |
| 8. | | | 1.25 | | 77.665 | |
| | $\Sigma B.S =$ 2.485 | | $\Sigma F.S =$ 4.82 | | | |

*Arithmetic check :*

$\Sigma B.S - \Sigma F.S$ = last R.L. – first R.L

$\Rightarrow 2.485 - 4.82 = 77.665 - 80$

$\Rightarrow -2.335 = -2.335$ *checked.*

**Q30. Define the following terms :** [JUT-2017]
(a) Contour - Interval
(b) Horizontal Equivalent
(c) Contour interval
(d) Contour gradient

**Ans.(a) Contour - Interval :** The vertical distance betwe any two consecutive contoors is known as a cont interval.

**Ans.(b) Horizontal Equivalent :** The horizontal equival is define as the horizontal distance between any t consecutive contours.

**Ans.(c) Contour interval:** The vertical distance betwe anytwo consecutive contour is called contour interva

**Ans.(d) Contour Gradient :** During preliminary survey f roads in a hilly area, the required points are first esta lished along the gradient. The line joining these points known as the contour gradient or grade contour. Initially, the points are eastablished approximately b an abney level, and then accurately fixed by a levelli instrument.

**Q31. Differentiate between Contour - Interval and Hor zontal Equivalent.**

**Ans.**

| Contour Interval | Horizontal Equivalent |
|---|---|
| *The vertical distance between two successive contours is called contour interval.* | *The horizontal distance betwee any two consecutive contours i called horizontal equivalent.* |
| *The difference between R.L.s of two contours is a contour interval.* | *Horizontal distance is measured o the map and is then converted wit the help of scale used in map.* |
| *Contour interval is same throughout the survey.* | *Horizontal distance depends o steepness or slope of the ground* |

**Q32. Why the horizontal equivalent of a contour map i not constant ?**

**Ans.** Horizontal equivalent is defined as the horzontal distanc between any two points on two consecutive contours Due to undulated or uneven nature of ground on earth surface, surface contour elevation is not of the sam intensity along the straght line between the points i.e the horozontal distance between points varies accordin to the variation of slpe.

As the slope of the ground between two consecutive contour is not constant in all direction, the horizonta equivalent is not constant.

**Q33. Write any six characteristics of contour lines wit sketches.** [JUT-2017,2016]

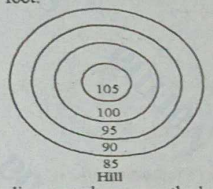
OR

**Q33. Explain the characteristics of contours.**

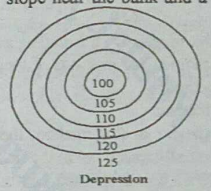
**Ans.** Characteristics of contours



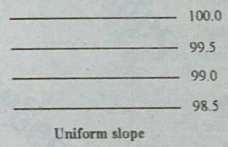
(i) The contour lines are closer near the top of a hill or high ground and wide apart near the foot. This indicates a very steep slope towards the peak and a flatter slope towards the foot.



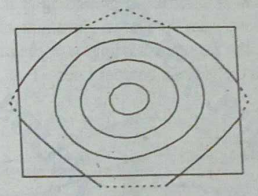

(ii) The contour lines are closer near the bank of a pond or depression and wide apart towards the centre. The indicates a step slope near the bank and a flatter slope at the centre.



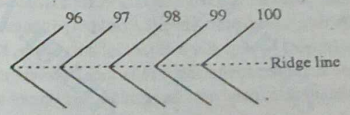

(iii) Uniformly spaced, contour lines indicate a uniformly slope.



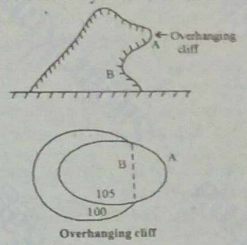

(iv) Contour lines always form a closed circuit. But these lines may be within or outside the limit of the map.



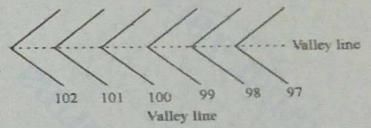

(v) When the higher values are inside the loop, it indicates a ridge line. Contour line cross ridge lines at right angles.



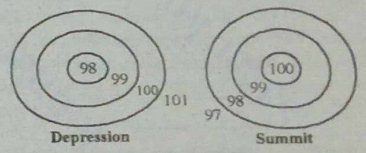

(vi) Contour lines can not cross one another, except in the case of an overhanging cliff. But the over lapping portion must be shown by a dotted line



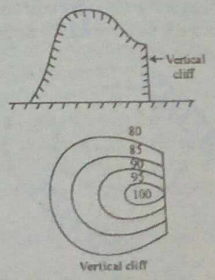

(vii) When the lower values are inside the loop it indicates a valley line. Contour lines cross the valley line at right angles.



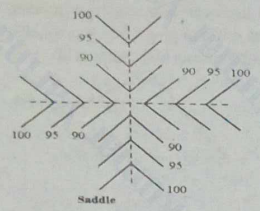

(viii) A series of closed contours always indicates a depression or summit. The lower values being inside the loop indicates a depression and the heigher values being inside the loop indicates a summit.




(ix) Depressions between summit are called saddles.



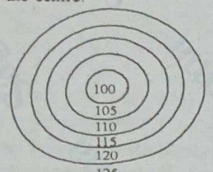

(x) Contour lines meeting at a point indicate a vertical cliff.



Saddle

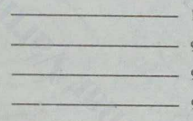
**Q34.Show with sketches the contour arrangements of following characteristics [JUT-2017]**
**(a) Pond (b) Flat land (c) Hill (d) Overhanging cliff**

**Ans.(a) Pond:** The contour lines are closer near the bank of a pond or depression and wide apart towards the centre. The indicates a step slope near the bank and a flatter slope at the centre.



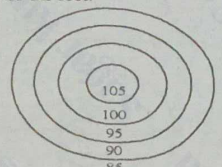
Depression

**(b) Flat land:** Uniformly spaced, contour lines indicate a uniformly slope.



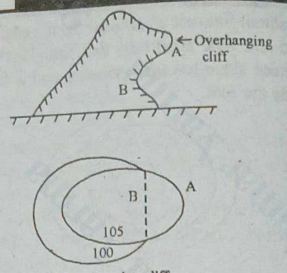
Uniform slope

**(c) Hill :** The contour lines are closer near the top of a hill or high ground and wide apart near the foot. This indicates a very steep slope towards the peak and a flatter slope towards the foot.



Hill

**(d) Overhanging cliff:** Contour lines can not cross one another, except in the case of an overhanging cliff. But the over lapping portion must be shown by a dotted line



Overhanging cliff

**Q35.State the various methods of contouring .Describe in detail. [JUT-2015]**

OR

**Q35.Explain the methods of locating contours.**

**Ans.** There are mainly two methods of locating contours:
1. Direct method
2. Indirect method.

**Direct method :** In this method, the contours to be plotted are actually traced out in the field with a level by marking various points on each contour. These points are then surveyed, plotted and appropriate but most accurate contours are marked through them. It is used for contouring small areas and where great accuracy is required.

The field work consists of :
(a) Location of contours,
(b) Plotting

**(a) Location of contours :** To begin with, fly levels are taken from the nearest permanent bench mark to establish a bench mark near the site of survey. The level is then set up to command as much ground as possible. A back site is taken on bench mark and the height of the instrument is determined by adding it at R.L of bench mark. Now, from the known elevations of contours and the H.I, the required readings are obtained to fix the points on the various contour lines.

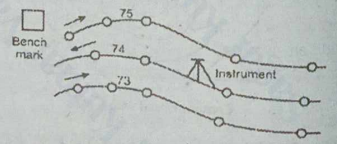


Fig. 1.Direct Contouring.

Thus, required reading = H. I. - R.L of Contour.

**(b) Plotting of points :** The positions of the contour points are located by suitable methods of surveying. It can be done simultaneously with levelling or later on by usually a plane table, compass, theodolite, The points are then



plotted on the plan and contours are drawn by joining them by dotted lines.

The method is suitable for contouring hilly areas particularly when the area to be contoured is not large.

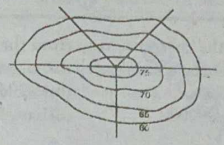


Fig.2. Method of Radial Lines

**Indirect Method :** The indirect method of contouring are cheaper, quicker and less tedious than direct method. Indirect methods are :

1. **By cross - section (Fig. 3.) :** This method is most commonly used in route survey such as a road, railways, canal etc.A longitudinal line is run along the center line of a proposed route. Cross - sections are laid at right angles to the above line.

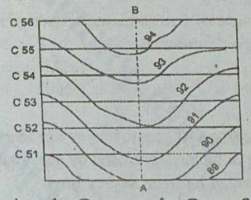


Fig.3. Locting the Contours by Cross- Section

2. **By squares (Fig. 4.) :** This method is suitable when the area is small and the ground is almost uniform. The whole area is divided into series of squares and their corners are marked with pegs.

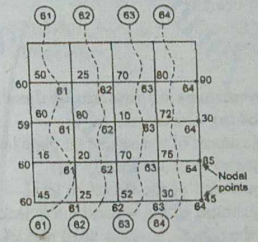


Fig.4. Contouring by Squares

The size of square varies form 5m to 20 m side depending upon the surface of the grounds. The squares need not be of the same size throughout. Now, with the help of level, elevations of the corners of the square are determinced. The intermediate points within the squares may be taken and located on the diagonals or by the measurement from the corners. These squares are plotted and the reduced levels are written at their corners upto two decimal points, and the contour lines are then interpolated.

3. **Tacheometric Contouring method (Fig. 5.) :** This method is most suitable when a contoured map of a hill is requred. In this method, the instrument used is a tacheometer or a transit theodolite fitted with stadia diaphragm. To begin with, a number of lines are set out at a given angular intrval and the representative points are located in the field by observing
(i) the vertical angles
(ii) the vertical angles, i.e top, lower and bottom readings on the staff.

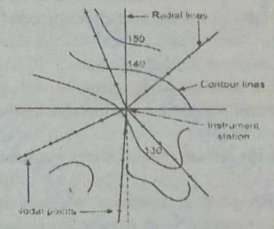


Fig.5. Tacheometric Contouring

The horizontal distance between the instrument and staff station is calculated by multiplying the difference between the upper and lower stadia hair readings by the stadia constant which is usually 100. The reduced levels of the points are determined by using theodolite as a level. The survey is plotted and then contour lines are interpolated.

**Q36. What are the use of contour maps. [JUT-2013]**

**Ans.** The following are the specific uses of the contour map:
1. The nature of the ground surface of a country can be understood by studying a contour map. Hence, the possible route of communication between different places can be demarcated.
2. A suitable site or an economical alignment can be selected for any engineering project.
3. The capacity of a reservoir or the area of a catchment can be approximately computed.
4. The intervisibility or otherwise of different points can be established.
5. A suitable route for a given gradient can be marked on the map.
6. A section of the ground surface can be drawn in any direction from the contour map.
7. Quantities of earth work can be approximately computed.

Q37.Describe the importance of contour maps in civil engineering. [JUT-2011]

Ans.Importance in civil engineering : The uses of contour maps which are made by contours :

(i) Drawing of Sections : From a given contour plan, the section along any direction can be drawn to know the general shape of the ground or to use it for earth work calculations a given communication line in the direction of the section.

(ii) Determination of Intervisibility between two points : The distance between the triangulation stations are generally several kilometers and before selecting their position it is necessary to determine their intervisibility.

(iii) Tracing of contour gradients and location of route : A contour plan is very much useful in locating the route of a highway, railway, canal or any other communication.

(iv) *Measurement of drainage areas.*

(v) *Calculation,of reservoir capacity.*

(vi) *Intersection of surfaces and measurement of earth work.*

Q38.State the advantages of direct contouring. [JUT-2011]

Ans. Following are the advantages of direct contouring.

(i) Direct method gives result great accurately.

(ii) Direct method shows the topography of the area accurately.

(iii) Interpolation is less required.

(iv) Direct method is applicable at higher standard contouring.



## Jharkhand 3rd Sem-2019

## Surveying

Q1.Choose the correct option from the following:

(i) Which of the following is the largest one?
(a)1cm=50m (b)1:42000
(c)R.F=1/300000 (d)1cm=50km

Ans.(a)

(ii) A well conditioned triangle should not have angle more than
(a) 30° (b)45°
(c)60° (d)90°

Ans.(d)

(iii) The error due to bad ranging is
(a)Cumulative (+ve) (b)Vertical surface
(c)in any surface (d)None of these

Ans.(a)

(iv) The angle of intersection of two plain mirrors of the optical square is
(a)30° (b)45°
(c)60° (d)90°

Ans.(b)

(v) Man stations of chain survey are the points
(a)lying in the area enclosed by survey lines.
(b)connected by main survey lines.
(c)on main survey lines to cover the local details.
(d)on main survey lines to check the accuracy of survey work.

Ans.(d)

(vi) The whole circle bearing of a line is 300°.Its quadrantal bearing is
(a)S60°E (b)N60°W
(c)N30°W (d)N60°E

Ans.(b)

(vii) The permanent adjustments of theodolite consists of following operations:
(I) Adjustment of the horizontal plate level.
(II) Adjustment of horizontal axis
(III)Adjustment of the telescope level
(IV)Adjustment of the vertical circle index
(a) All the above (b)II and III only
(c) I and III only (d)III and IV only

Ans.(a)

(viii) The datum adopted in India is the mean sea level at
(a) Kolkata (b)Chennai
(c) Mumbai (d)Karachi

Ans.(c)



Q2.(a)Describe the principles of surveying.

Ans.Refers to Chapter 1

Q2.(b)What are the different methods of plain table surveying?Explain one of them with sketch.

Ans.Out of Syllabus

Q3.(a)Describe the various methods of chaining on a slope along with their advantages and diadvantages.

Ans.Refers to Chapter 2

Q3.(b)What are causes and source of local attraction?How it is defected?

Ans.The presence of local attraction at any station may be detected by observing the fore and back bearing of the line. If the difference between fore and back bearing is 180 degree, both end stations are free from the local attraction. If not, the discrepancy may be due to :

(a) An error in observation of either fore or back bearing or both.

(b) Presence of local attraction at either station.

(c) Presence of local attraction at both the stations.

Correcting method:

1) Method of elimination of local attraction by included angles:

- Compute the included angle at each station from the observed bearings .
- Starting from the unaffected line, rub down the correct bearing of the successive sides.

2) Method of elimination of local attraction by applying correction in bearing

- Calculate the magnitude and direction of the error due to local attraction at each affected station.
- Run down the bearings, starting from the bearing unaffected by local attraction.

Q4.(a) The following angles were observed in the clockwise direction in a open traverse:

$\angle ABC = 124°15'$

$\angle BCD = 156°30'$

$\angle CDE = 102°00'$

$\angle DEF = 95°15'$

$\angle EFG = 215°45'$

The magnetic bearing of the line AB was 241°30.What would be the bearing of the line FG?

Ans.Bearing of the line BC = Bearing of the line AB+ $\angle B + 180°$

$= 241° 30' + 124° 15' - 180° = 185° 45'$

Bearing of the line CD = Bearing of the line BC + $\angle C + 180°$

$= 185° 45' + 156° 30' - 180° = 162° 15'$

Bearing of the line DE = Bearing of the line CD + $\angle D + 180°$

$= 162° 15' + 102° - 180° = 84° 15'$

Bearing of the line EF = Bearing of the line D E + $\angle E + 180°$

$= 84° 15' + 95° 15' - 180° = 359° 30'$

Bearing of the line FG = Bearing of the line E F + $\angle F + 180°$

$= 359° 30' + 215° 45' - 360° - 180° = 35° 15'$

Q4.(b) Describe characteristics of contouring.

Ans.Refers to Chapter 4

Q5.(a)The following staff readings were taken with a level, the instrument having been shifted after the 4th, 7th and 10th readings .R.L of the starting B.M is 100.00 enter the readings in the form of a level book page and reduce the levels by the rise and fall method .Apply usual checks. The readings are, 2.500, 3.700, 3.850, 3.250, 3.650, 0.370, 0.950, 1.650, 2.850, 3.480, 3.680 and 3.270m.

Ans.Since the instrument was shifted after the 4th, 7th and 10th readings, 3.250, 0.950,and 3.480 are the fore sights and the readings immediately following them viz. 3.650,1.650 and 3.680are the respective back sights. The readings are tabulated and levels are reduced as shown below.

| Station | B.S | I.S | F.S | Rise | Fall | R.L | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | 2.500 | | | | | 100.000 | B.M |
| 2 | | 3.700 | | | 1.200 | 98.800 | |
| 3 | | 3.850 | | | 0.150 | 98.650 | |
| 4 | 3.650 | | 3.250 | 0.600 | | 99.250 | C.P1 |
| 5 | | 0.370 | | 3.280 | | 102.530 | |
| 6 | 1.650 | | 0.950 | | 0.580 | 101.950 | C.P2 |
| 7 | | 2.850 | | | 1.200 | 100.750 | |
| 8 | 3.680 | | 3.480 | | 0.630 | 100.120 | C.P3 |
| 9 | | | 3.270 | 0.410 | | 100.530 | |
| Total | 11.480 | | 10.950 | 4.290 | 3.760 | | |

$\sum B.S = 11.480$

$\sum F.S = 10.950$

$\sum Rise = 4.290$

$\sum Fall = 3.760$

Last R.L = 150.530

First R.L = 150.00

Arithmetical Check

$\sum B.S - \sum F.S = 11.480 - 10.950 = 0.530$

$\sum Rise - \sum Fall = 4.290 - 3.760 = 0.530$

Last R.L – First R.L = 100.530 – 100.00 = 0.530

$\sum B.S - \sum F.S = \sum Rise - \sum Fall$

= Last R.L - First R.L = 0.530

Hence Checked.

Q5.(b)Compare HI and Rise/Fall method.
Ans.Refers to Chapter 4

Q6.(a) A Tacheometer was set up at a station P and the following readings were obtained on a vertically held staff .

| Station | Staff Station | Vertical Angle | Hair Reading | Remarks |
|---|---|---|---|---|
| P | B.M<br>Q | -4°20'<br>410°0' | 1.050,1.10,<br>1.156<br>0.952,1.05,<br>1.158 | R.L of B.M =1958.300 |

The constant of instrument were 1w & 0.10.Find horizontal distance between P & Q and RL of Q.
Ans.Out of Syllabus

Q6.(b)What are methods and levelling?
Ans.Refers to Chapter 4

Q7.Short notes on any four:
(a) Errors in chaining
(b)Temporary adjustments of theodolite.
(c) Characteristics of contouring
(d) Total station
(e)Bowditch Rule of closing error
(f)Principle of Tacheometry.
Ans.(a)Refers to Chapter 2
Ans.(b)Out of Syllabus
Ans.(c)Refers to Chapter 4
Ans.(d)Out of Syllabus
Ans.(e)Out of Syllabus
Ans.(f)Out of Syllabus

## Jharkhand 3rd Sem-2020

## Surveying

Q1.Choose the correct answer:
(i) The following sights are taken on a turning point
(a) for sight (b) Back sight
(c) For sight and back sight
(d) Fore sight and intermediate sight
Ans.(c)
(ii) The following consecutive readings were taken with a dumpy level 0.695, 1.525,2.395,0.635,0.605,0.805 and 0.125.The instrument was shifted after the third and fifth readings.The number of stations is :
(a) 2 (b) 5 (c) 6 (d) 7
Ans.(b)
(iii) Number of links in a 30m metric chain is
(a) 100 (b) 150 (c) 180 (d) 200
Ans.(b)
(iv)For a well-conditioned triangle, no angle should be less than
(a) 20° (b) 30° (c) 45° (d) 60°
Ans.(b)
(v) The horizontal angle between the true meridian and magnetic meridian at a place is called
(a) azimuth (b) declination
(c) local attractrion (d) magnetic bearing
Ans.(b)
(vi)Theodolite is an instrument used for
(a) tightening the capstan-headed nuts of level tube
(b) measurement of horizontal angles only
(c) measurement of vertical angles only
(d) measuremenrt of both horizontal angles and vertical angles.
Ans.(d)
(vii) The instrument used for accurate centering in plane table survey is
(a) Spirit level (b) alidade
(c) plumbing fork (d) trough compass
Ans.(c)
(viii) Bodwitch rule is applied for
(a) an open traverse for graphical adjustment
(b) a closed transverse for adjustment of closing error
(c) determining the effect of local attraction
(d) None of the above
Ans.(b)
Q2.Attempt any five of the following :

Q2.(a) Discuss in brief the principle of surveying.
Ans.Refers to Chapter 1



Q2.(b) The length of a survey line was measured with a 20m chain and was found to be equal to 1000m. As a check the length was again measured with a 25m chain and was found to be 1212m.On computing the 20m chain with the gauge, it was found to be 1 decimeter too long.Find the actual length of the 25 m chain used.

Ans. L = 20m

Measured length = 1000m

L' = 20 + 0.1m = 20.10 m

True length of line $= \frac{20.10}{20} \times 1000 = 1005m$

Case II:

L = 25m

Measured length = 1212m

True length $= \frac{L'}{25} \times 1212$

$1005 = 48.48L'$

$\therefore L' = 20.73m$

Q2.(c) Define the term:
(i) Survey line (ii) Tie line
(iii) Base line (iv) Check line
(v) Perpendicular offset (vi) Oblique offset
Ans.(i) to (iv) Refers to Chapter 2
Ans.(v) Perpendicular offset: The offsets which are taken perpendicular to the chain line are termed as perpendicular offsets. These offsets are taken by holding zero end of the tape at the object and swinging the tape on the chain line. The shortest distance measured from object to the chain line is usually the perpendicular offset.
Ans.(vi) Obliqueoffsets: Oblique distance is always greater than perpendicular distance. All the offsets which are not taken at the right angle to chain line are known as oblique offsets.

Q2.(d) Explain the temporary adjustment of theodolite .
Ans.Out of Syllabus

Q2.(e) What is local attraction ? How is the detected and eliminated ?
Ans.Local attraction :The magnetic needle indicates the north direction when freely suspended or pivoted. But if the needle comes near same magnetic substances such as iron, steel structures, electric cables conveying current etc., it is found to be deflected from its true direction, and does not show the actual north. This disturbing influence of magnetic substances is known as 'local attraction'.
The occurrence of local attraction can be detected by observing the difference between the fore and back bearings. If there is no influence of local attraction and other error, this difference will be 180. So we can then conclude that both stations are free from local attraction.
Local attraction can be minimized using following methods:
Method 1:This method is based on the difference of fore and back bearings. We already know that the difference between fore and back bearing of a line will be 180° if there is no errors in measurement. So based on this error free observation of bearings, corrections for other lines can be calculated.
However if there is no two bearing has a difference of 180°, we can calculate the correction from the mean value of that bearings which may have least error.
Method 2:This method is more faster method for applying correction. This is based on the interior angles of the closed traverse formed. The interior angles measured will be correct on the basis of the fact that these angles are not affected by the local attraction whereas the stations are. So the sum of total interior angles for a closed traverse will be (2n-4) 90°.
If there is any error exists both sum will not be same. The total error can be distributed among the angles equally because equal error will occur on each interior angle. So starting from the correct observation of bearing which has a difference in fore and back bearing is 180°, we can calculate all other corrected bearings.

Q2.(f) Discuss the various method of orienting the plane table.
Ans.Out of Syllabus

Q3.Attempt any two of the following :
Q3.(a) Define contour, contour interval and horizontal equivalent.Explain with sketches the use of contour maps.
Ans.Refers to Chapter 4

Q3.(b) Define backsight, Fore sight , Intermidiate sight and line of sight.The following consecutive readings were taken with a level and 5 meter levelling staff on continuously sloping ground at a common interval of 20 metres 0.385, 1.030, 2.825, 3.730, 4.685, 0.625, 2.005, 3.110 and 4.485.The reduced level of the first point was 208.125 m.Rule out a page of a level field book and enter the above reading .Calculate the reduced levels of the point.
Ans.Back Sight:This is the first staff reading taken in any set up of the instrument after the levelling has been per-

fectly done. This reading is always taken on a point of known RL, i.e, on a bench mark or change point.

**Fore sight:** It is the last staff reading in any set up of the instrument, and indicates the shifting of the latter.

**Intermediate sight:** The foresight taken on a levelling staff held at a point between two turning points, to determine the elevation of that point, is known as intermediate sight.

**Line of sight:** An imaginary straight line running through the aligned sights of a firearm, surveying equipment, etc.

| Changing | BS | IS | FS | Rise | Fall | R.L | Remarks |
|---|---|---|---|---|---|---|---|
| 0 | 0.385 | | | | | 208.125 | |
| 20 | | 1.030 | | | 0.645 | 207.480 | |
| 40 | | 2.825 | | | 1.795 | 205.685 | |
| 60 | | 3.730 | | | 0.905 | 204.780 | |
| 80 | 0.625 | | 4.685 | | 0.955 | 203.825 | C.P |
| 100 | | 2.003 | | | 1.380 | 202.445 | |
| 120 | | 3.110 | | | 1.105 | 201.340 | |
| 140 | | | 4.485 | | 1.375 | 199.965 | |
| Total | 1.010 | | 9.170 | 0 | 8.160 | | |

Check: $\Sigma FS - \Sigma BS = \Sigma Fall - \Sigma Rise$ – First RL – Last R.L

9.170 – 1.010 = 8.160 – 0 = 208.125 – 199.965

8.16 = 8.16 = 8.16 checked **Ans.**

**Q3.(c) The following bearing were observed while traversing with a compass.**

| Line | F.B | B.B. |
|---|---|---|
| AB | 45°45′ | 226°10′ |
| BC | 96°55′ | 277°5′ |
| CD | 29°45′ | 209°10′ |
| DF | 324°48′ | 144°48′ |

**Mention which station were affected by local attraction and corrected bearing.**

**Ans.** The following bearing were observed while traversing with a compass.

| Line | F.B | B.B. |
|---|---|---|
| AB | 45°45' | 226°10' |
| BC | 96°55' | 277°5' |
| CD | 29°45' | 209°10' |
| DF | 324°48' | 144°48' |

Mention which station were affected by local attraction and corrected bearing.

| Line | FB | BB | Correction | Corrected FB | Corrected BB | Remarks |
|---|---|---|---|---|---|---|
| AB | 45°45' | 226°10' | 0° at A | 45°45' | 225°45' | Stations B & C are affected by local attraction |
| BC | 96°55' | 277°5' | –25' at B | 069°30' | 276°30' | |
| CD | 29°45' | 209°10' | –35' at C | 29°10' | 209°10' | |
| DE | 324°48' | 144°48' | 0° at D | 324°48' | 144°48' | |

**Q4. Write short notes on any four of the following:**

**(a) Closing error** **(b) Use of total station**

**(c) True and magnetic bearing**

**(d) Principle of Reciprocal levelling.**

**(e) Well conditional triangle**

**(f) Planimeter**

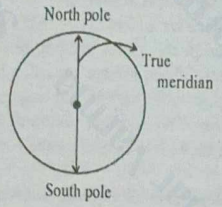
**Ans.(a) Closing error:** Refers to Chapter 3

**Ans.(b) Use of total station :** Out of Syllabus

**Ans.(c) True and magnetic bearing**

**True Bearing :** The line of intersection of the earth surface by a plane containing north pole, south pole and the observer's position is called **true meridian** or geographical meridian. It represents true north-south direction at the place. The inclination of survey line with trur meridian is known as True bearing of a line.

In figure N-S be a true meridian




**Magnetic Bearing:** The longitudinal axis of a freely suspended and properly balanced magnetic needle unaffected by local attractive force, defining the magnetic north-south line which is called **magnetic meridan** . If does not coincide with the true meridian. The inclination of survey line with manetic meridian is known as Magnetic bearing.

**Ans.(d) Principle of Reciprocal levelling:** Refers to Chapter 4

**Ans.(e) Well conditioned triangle :** A triangle is said to be well - conditioned when no angle in it is less than $30^0$ or greater than $120^0$. An equilateral triangle is considered to be the best - conditioned or ideal triangle.

Well-conditioned triangles are preferred because their



apex points are very sharp and can be located by a single 'dot'. In such a case, there is no possibility of relative displacement of the plotted point.

**Ans.(f) Planimeter:** Planimeter is an instrument used in surveying to compute the area of any given plan. Planimeter only needs plan drawn on the sheet to calculate area. Generally, it is very difficult to determine the area of irregular plot. So, by using planimeter we can easily calculate the area of any shape.

**Parts of Planimeter:**

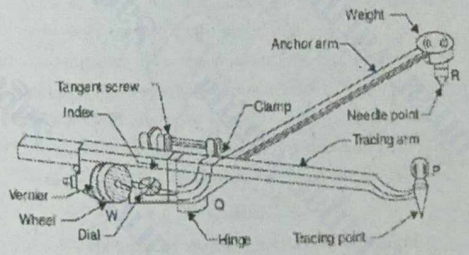
**Tracing Arm:** Tracing arm is an arm which manages the position of tracing point at one end with the help of hinge.

**Tracing Point:** Tracing point is the movable needle point which is connected to tracing arm. This point is moved over the outline of area to be measured.

**Anchoring Arm and Weight:** Anchor arm is used to manage the anchor position or needle point position on the plan. Its one end is connected to weight and needle point and other end to the integrating unit. It is also called as anchor. A fine needle point is located at the base of heavy block.

**Hinge:** The tracing arm and anchor arm are connected by hinge to the integrating unit. With the help of this hinge the arms can rotate about their axes.

**Index:** Index is a location where all the measuring arrangements like wheel, dial are located. Wheel is fixed in the integrating unit which helps to measure the tracing length. It is used to set zero on the scale.




**Working:**

- In the first step anchor point is to be fixed at one point. If the given plan area is small, then anchor point is placed outside the plan. Similarly, if the given plan area is large then it is placed inside the plan.
- After placing the anchor point, place the tracing point on the outline of the given plan using tracing arm. Mark the tracing point and note down the reading on Vernier as initial reading A.
- Now move the tracing needle carefully over the outline of the given plan till the first point is reached. The movement of tracing needle should be in clockwise direction. Note down the reading on Vernier after reaching the first point and it is the final reading B.
- Note the area of the plan which boundary is traced by the planimeter is shown on the screen. Convert your reading according to the scale you have drawn the plan in your sheet.

## NOTE

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