AIR-1 Notes

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Surveying

Handwritten notes by

Kartikay Kaushik

AIR-1 ESE 2021

IES Master classroom Student

SURVEYING

CONTENT

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Surveying [3-4 marks - 7-8 Q - 50-60M]

GATE Objective Conventional

Chapters

1. Fundamentals of Surveying
2. Linear Measurement
3. Compass Surveying ✓
4. Theodolite
5. Traversing
6. Levelling ✓
7. Tacheometry ✓
8. Trigonometric Levelling ✓
9. Measurement of Area Volume. ✓
10. Photogrammetry ✓
11. Curve ✓
12. Field Astronomy
13. Theory of Errors.
14. Plane Table Surveying
15. Contour

1. Fundamental of Surveying

→ Surveying is the art of determining relative position of points on, above and below the earth surface, and presenting it graphically or numerically.

→ Objective of Surveying

1. To determine relative position of points
2. To layout or markout the proposed structure on the ground
3. To determine relative quantities like Area and Volume.

→ Methods of Presentation

AB = 10 km } Numerical representation

A ——— 10 km ——— B } Graphical representation. { Plan or Map }

→ 1) Numerical Representation (AB = 10 km)

2) Graphical Representation (A ——— 10 km ——— B)

→ Graphical representation is done in the form of Plan or map:

(i) Plan – Large Scale
(ii) Map – Small Scale.

NOTE:
→ Vertical distance on a map can be presented with the help of contour or spot level.
→ Contour is an imaginary line joining the points of same elevation on the earth surface (Natural contour : Water surface)
→ Spot levels are height of individual points.
→ Contour is preferred over spot levels because it gives better visualisation over spot levels.

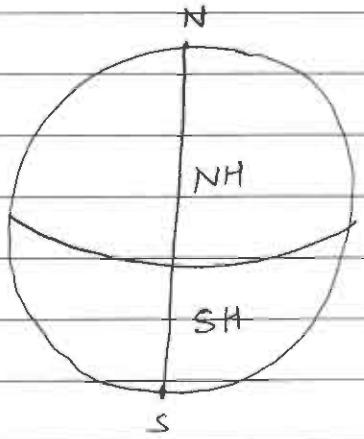
→ Basic definition

1) → Shape of Earth

(a) Oblate Spheroid : Slightly flat at poles.
Polar Axis is 43.5 km smaller than equatorial axis.

(b) Ellipsoid : Equatorial section is elliptical in nature

(c) Ovalloid : Southern Hemisphere is slightly longer than Northern Hemisphere.

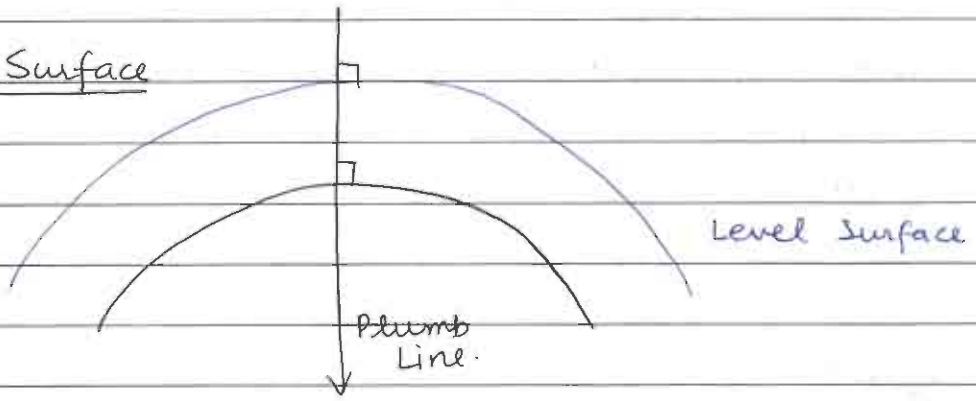


GEOID.

→ We can observe that no geometrical figure completely defines the shape of earth, hence a new name is given to the shape of earth i.e. GEOID

NOTE:
For calculation purpose, we'll assume earth to be spherical in nature.

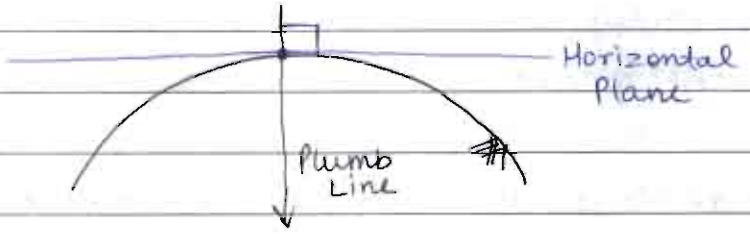
2) → Level Surface



→ Level Surface is a curved surface ||el to the spherical ~~flat~~ surface of earth and hence every point on it is equidistant from the centre of the earth.

→ Every element on level surface is perpendicular to plumb line.

3) - Horizontal Plane

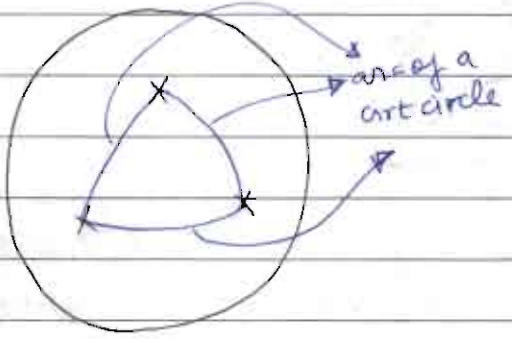


→ It is a tangential plane to the earth surface which is also perpendicular to plumb line.

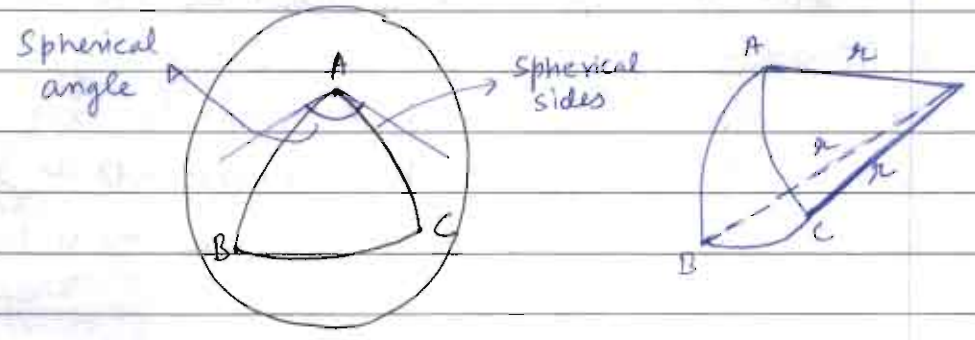
4) - Great circle

→ It is a imaginary circle passing through the centre of the earth.
→ A great circle divides earth surface into 2 equal parts.

5) Spherical Triangle

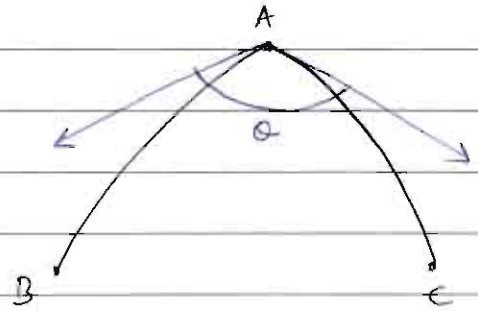


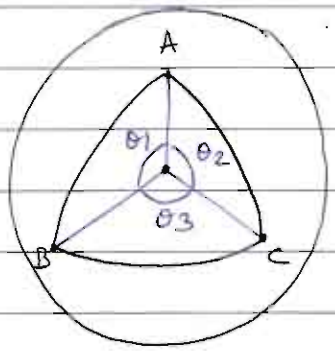
A spherical Δ is a Δ which is formed on the surface of a sphere by intersection of 3-arcs of different great circles.



→ The arc enclosing spherical Δ are called as spherical sides and the angles in which these arc intersect are called as spherical angle.

→ Spherical angle is defined as angle between the tangent to the great circles at the point of intersection of 2 spherical sides





$\overset{\frown}{AB} = R\theta_1$

$\overset{\frown}{BC} = R\theta_3$

$\overset{\frown}{CA} = R\theta_2$

We can neglect R and compare on basis of θ.

→ Length of a side of a spherical Δ is defined as the angle subtended by that side at the centre of the sphere.

→ Properties of Spherical Δ

1. Each side of a spherical Δ must be less than equal to π.
2. Each angle of a spherical Δ must be less than π.
3. Sum of 3 sides must be between $(0 \text{ to } 2\pi)$.
4. Sum of 3 angles of a spherical Δ must be between $[\pi \text{ to } 3\pi)$.

NOTE:

$$\begin{array}{r} 182^\circ\ 57'\ 39'' \\ -\ 180^\circ\ 0'\ 0'' \\ \hline 2^\circ\ 57'\ 39'' \end{array}$$

→ Sum of spherical Angles

→ Spherical Excess

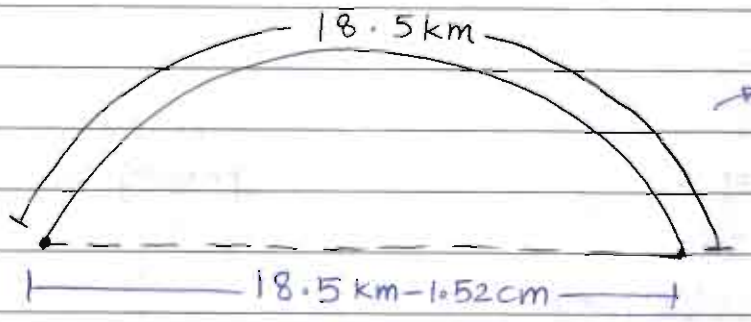
Amount by which sum of angles of a spherical Δ exceed by 180° is called as Spherical Excess.

5. Surface Area of a spherical Δ must be less than $2\pi R^2$
6. Greater angle is opposite to greater side.

→ Classification of Surveying

→ Surveying can be classified into various means eg- instrument used, purpose, place of survey etc. But mainly is surveying is classified into 2 types:

1) Geodetic surveying
2) Plane Surveying.



→ curved area can be assumed to be plane as long as it is small.

Geodetic Survey ⩾ 195.5 km^2 > Plane Survey

⇓

S.E. ⇒ 1"

Geodetic Survey	Plane survey
1. Geodetic survey is done for large area and we consider earth's surface as curved.	1. Plane Surveying is done for small area and earth surface is considered as flat surface i.e. curvature of earth is neglected.
2. Area greater than equal to 195.5 km^2	2. Area less than 195.5 km^2
3. It is done by SOI - Survey of India to establish control points throughout the Country.	3. It is done for local survey.
4. It uses spherical trigonometry	4. It uses plane trigonometry.

NOTE:

→ In Plane surveying plotted measurements are projected on a horizontal plane.

→ For Area = 195.5 km^2, spherical Excess = 1"

→ Classification of Surveying based on purpose of survey

1. Topographical Survey

These survey are used to obtain maps which show details of natural and man-made features on the earth surface including elevation information.

Scale: 1:25,000 to 1:10,00,000

2. Engineering Survey

These surveys are used for engineering works, eg - dams, sewer, railway, roads etc

Building work: 1:50 to 1:200
Bridges and other civil engg works: 1:500 to 1:2500
Highway: 1:1250 to 1:50000

3) Cadastral Survey
These are used to represent property boundaries.
1:1000 to 1:5000

4) Hydrographic Survey
These survey are done on or near the water body such as lake, river, bay etc.

5) Astronomic Survey
With the help of astronomic survey we can determine latitude, longitude and Local Mean time of any place

6) Geological Survey
It is used to obtain information about different strata of earth surface.

→ Classification based on Instrument

1) Chain surveying
→ It is simplest type of surveying in which only linear measurements are done with the help of chain or tape.
→ No angular measurement is done.

2) Compass surveying
→ In compass surveying, directions and horizontal angles are measured with the help of compass and distances are measured with the help of chain or tape.

NOTE:
Trough compass is the only non-circular compass.

→ 1 Vernier division is slightly smaller than 1 division of main scale.

$$n v = (n-1) S$$

$$L.C = S - v$$

$$= S - \left(\frac{n-1}{n}\right) S$$

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

→ L.C. of main scale

→ no. of division on vernier scale.

→ Retrograde Vernier

→ n divisions on vernier scale are equal to (n+1) divisions on main scale

→ 1 vernier division is slightly larger than 1 division of main scale.

→ vernier division and main scale division increase in opposite direction, whereas in direct vernier both increase in same direction

$$n v = (n+1) S$$

$$L.C. = v - S$$

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

Q → The main plate of a Theodolite is divided into 1080 equal parts and 60th division of vernier scale coincides with 59th division of main scale. Determine L.C. of theodolite.

$$L.C. = S - v$$

$$= \frac{360^\circ}{1080} S - \frac{59}{60} S$$

$$= \frac{S}{60} = \frac{360^\circ}{1080 \times 60} = \frac{6 \times 60 \times 60''}{1080} = 20''$$

$$60 v = 59 S$$

$$v = \frac{59}{60} S$$

→ Special Types of Vernier

1) Double Vernier

→ If graduations of main scale increases in one direction only we have a single vernier whereas when main scale is graduated in both the directions a double vernier is used. eg.- Theodolite.

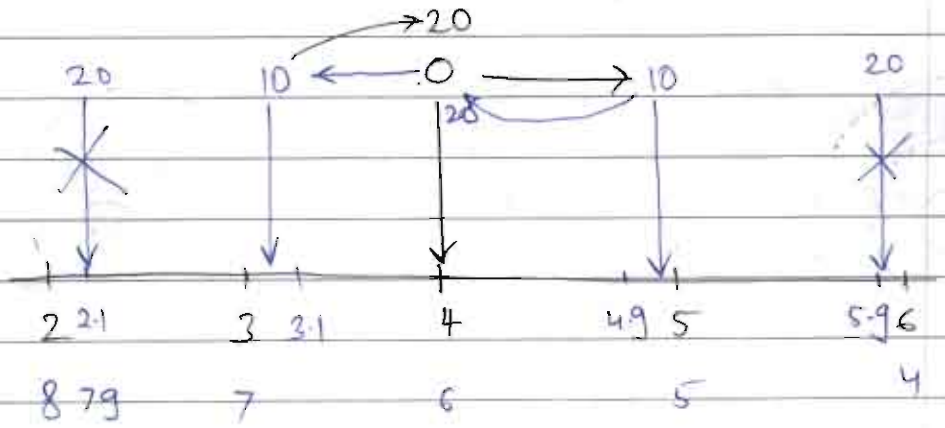
→ Double vernier consists of 2 direct verniers extendending in both the direction with index mark in the centre.

2) Double Folded Vernier

→ A double folded vernier is a special type of double vernier whose total length is exactly half of combined length of corresponding double vernier

→ A double folded vernier is used when it is required to reduce the length of vernier scale eg - sextant to measure vertical angles of elevation or depression.

→ In double folded vernier the vernier is read from index mark (0 mark) towards either of the extreme division and then from other extreme division towards centre in the same direction.



→ Extended Vernier

→ When divisions of main scale are very close and it becomes very difficult to determine exact graduation where coincidence occurs, If vernier of normal length is used.

→ Hence, extended vernier is very useful when available length of vernier scale is small and it is required to have small least count without making vernier divisions very close.

→ In extended vernier, n divisions of vernier scale are equal to (2n-1) divisions of main scale.

$$n\,v = (2n-1)\,S$$

$$v = \frac{(2n-1)}{n}\,S$$

$$L.C. = 2S - v$$

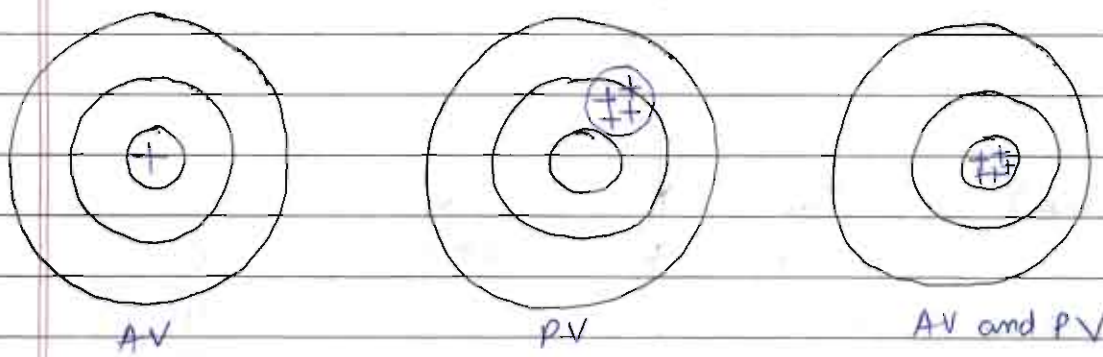
$$= 2S - \frac{(2n-1)S}{n} = \frac{S}{n}$$

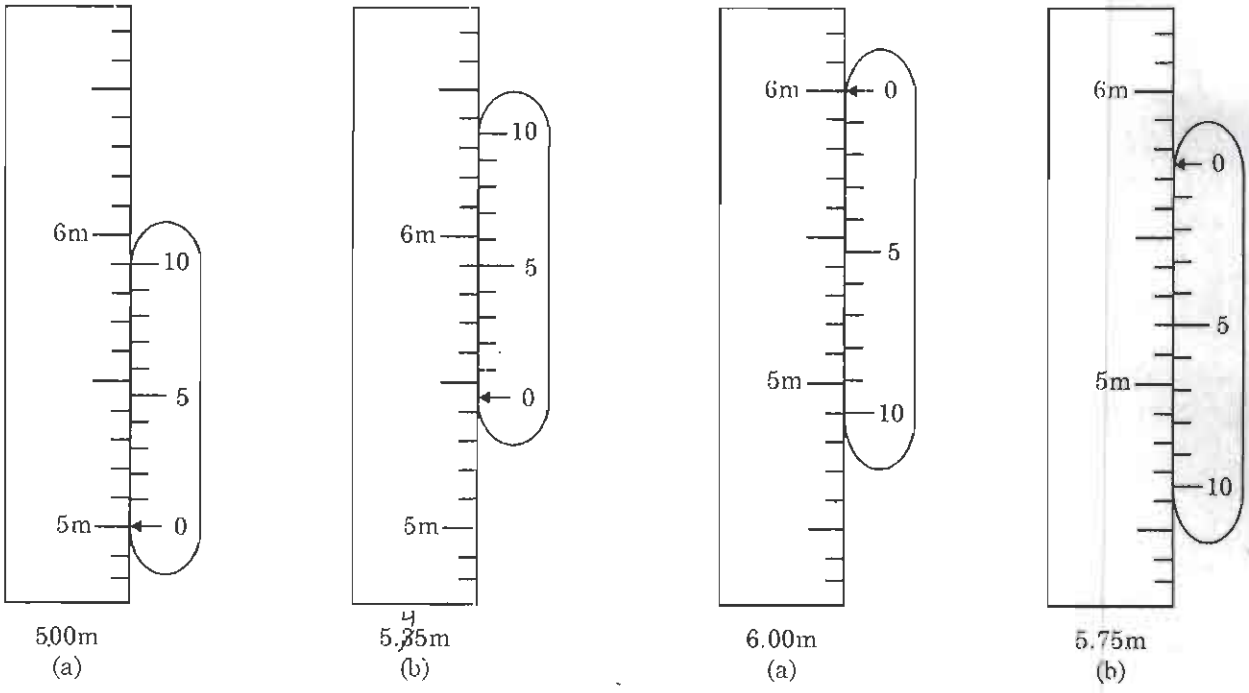
**

NOTE:

Extended Vernier is used in an instrument called Abney Level used to find vertical angles

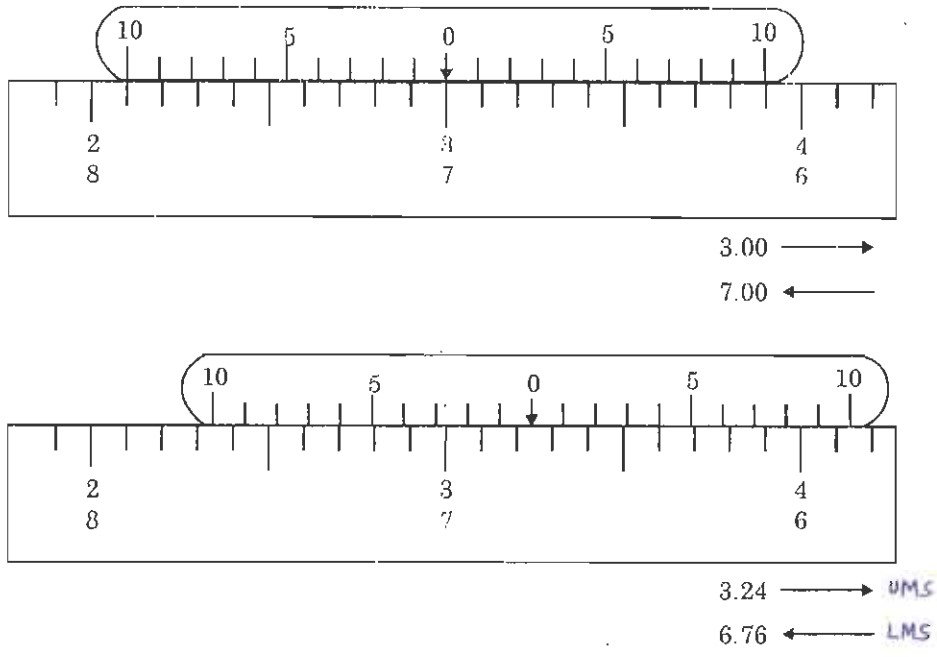
→ Precision and Accuracy



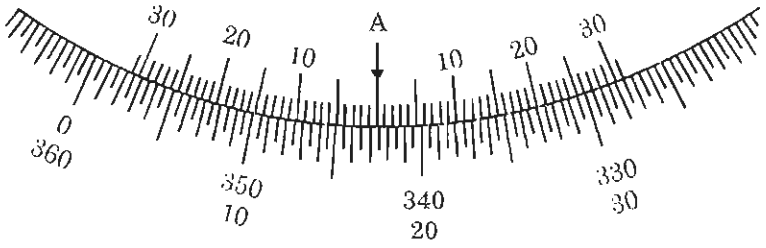


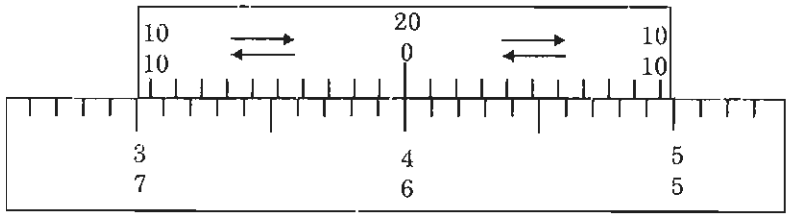
5.00m (a) 5.35m (b) 6.00m (a) 5.75m (b)

Direct Vernier Retrograde Vernier

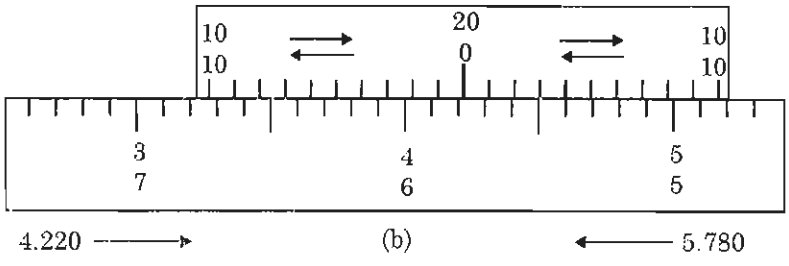


Double Vernier

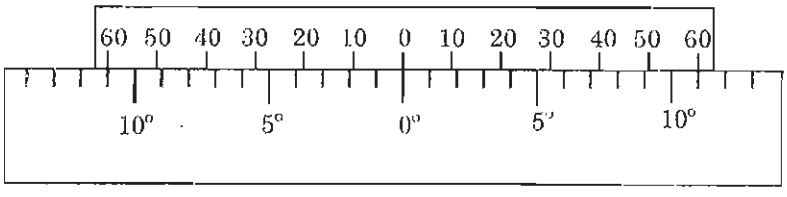




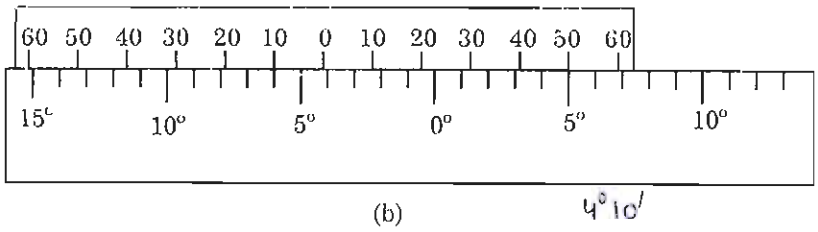
(a)



Double Folded Vernier



(a)



(b) 4° 10'

Extended Vernier