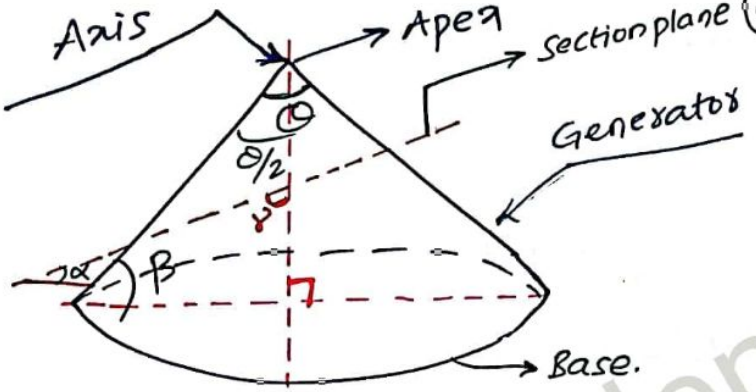
* Engineering Drawing *

1. Basic of Engineering Drawing
   - → conic sections
   - → special curves.
   - → polygons
   - → scales
2. Orthographic projections.
3. projection points.
4. projection of Lines.
5. projection of planes.
6. projection of solids.
7. Section of solids.
8. Development of surfaces.

1) Basic of engineering Drawing :-

(a) Conic Sections :-

When Right circules cone is cut by section plane, Then depending upon Inclination and Location of Section plane, different conic sections are Generated.



θ = Apex Angle

θ/2 = Semi Apex angle.

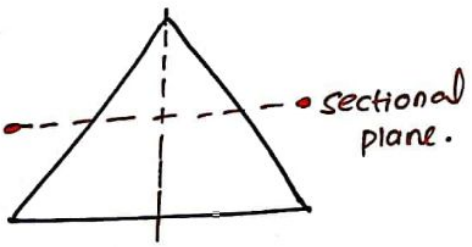
α = Inclination of SP/CP w.r.to base.

β = Inclination of Generator w.r.to base.

γ = Inclination of section plane w.r.to axis.

Conditions for Conic Sections :-

(1) Circle :-



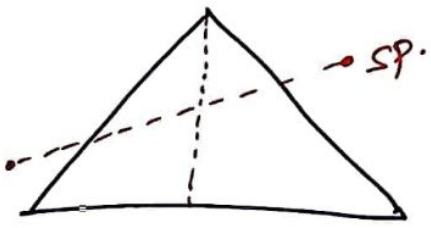
SP parllell to base.

$\alpha = 0$

$\gamma = 90$

$e = 0$

(2) Ellipse



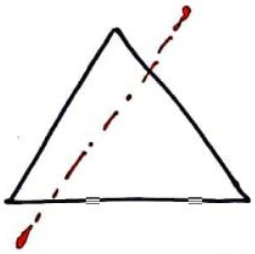
SP cuts all the generators.

$\alpha < \beta$

$\gamma > \theta/2$

$e < 1$

③ Parabola



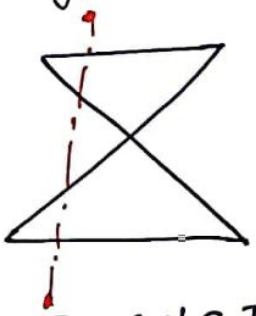
SP parallel to Genesatol.

$\alpha = \beta$

$\gamma = \theta/2$

$e = 1.$

④ hyperbola.



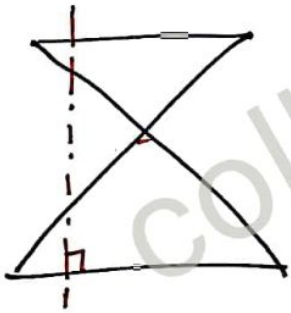
SP cuts the double cone.

$\alpha > \beta$

$\gamma < \theta/2$

$e > 1.$

⑤ Rectangular hyperbola.



i) Apex angle is 90°

ii) SP ⊥er to base.

↳ Asymptotes are ⊥er.

ⓐ. $\theta = 90° \longrightarrow \beta = 45°$

ⓑ $\alpha = 90° \longrightarrow \gamma = 0°$

$e = \sqrt{2}$

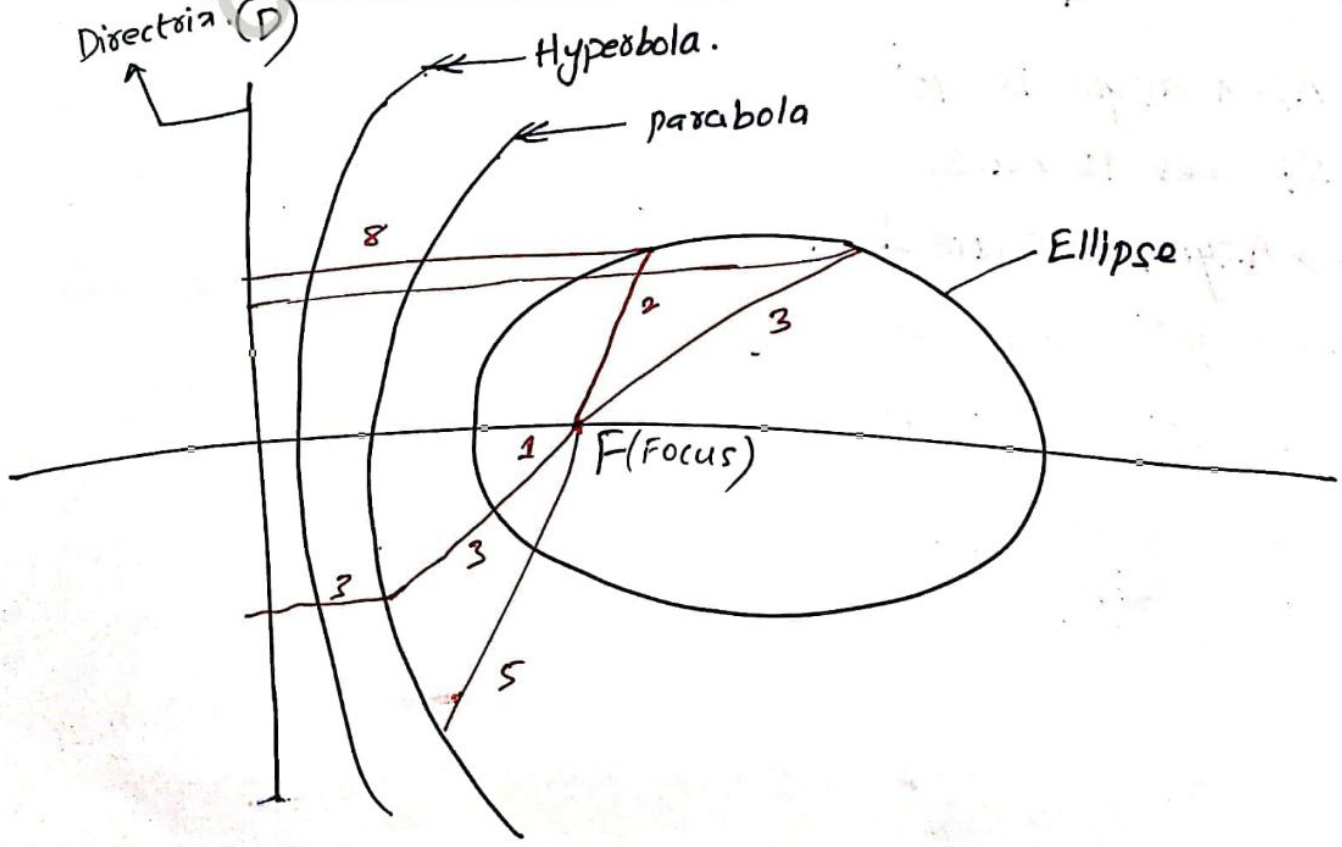
conics may also be defined as the Locus of a point moving in a plane such that the ratio of its distances from a fixed point and a fixed straight line is always constant. The fixed point is called as focus. and fixed straight line is called as directria and the ratio is called as Eccentricity.

$$\text{Eccentricity } (e) = \frac{\text{distance from focus}}{\text{distance from directria.}}$$

$$\boxed{e = \frac{1}{4}}$$

$$\frac{1}{4} = \frac{d\text{-}F \rightarrow \text{distance Focus}}{d\text{-}D \rightarrow \text{directria.}}$$

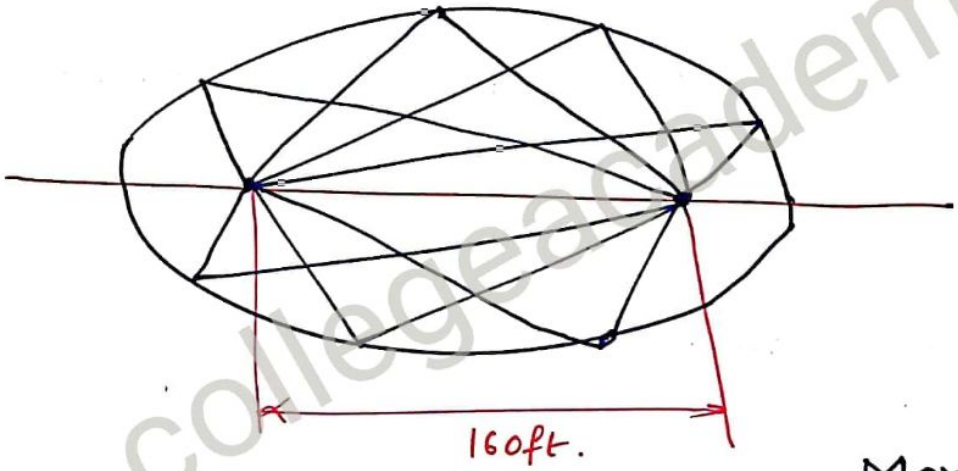
$$\boxed{d\text{-}D = 4 \times d\text{-}F}$$



Engineering Applications of conic sections :-

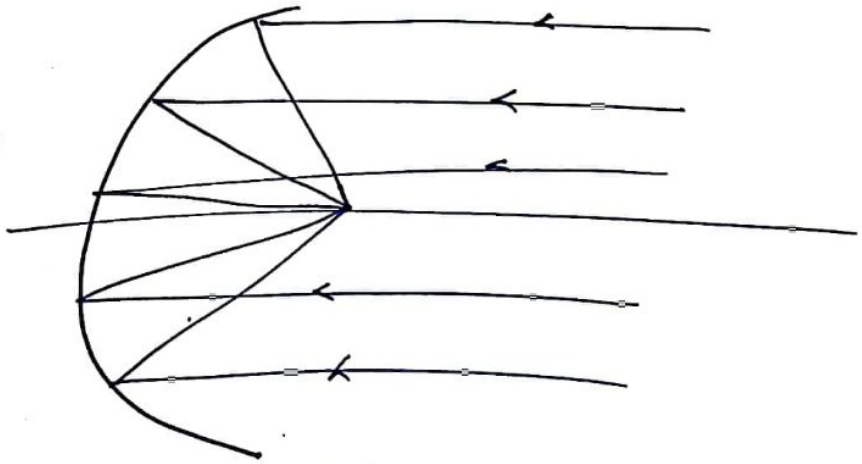
① **Circle:-**
CD, DVD, Lid, manholes covers, Flywheels, Automobile Wh-eels, camera Lenses.

② **Ellipse :-**
heritage buildings, Dams, bridges, Gears of Textile and printing machinery, wispering galleries, rooftops of planets and Satellites.



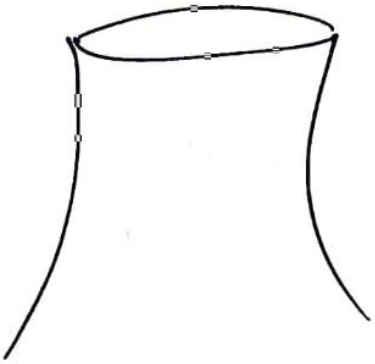
Mormon Tabernacle
Salt Lake city (USA)

③. **Parabola :-**
Solar concentrators, Satellite, And Telecommunications, dishes, search Lights, head Lamps of motor vechicles, Sound Reflectors etc.



④ hyperbola :-

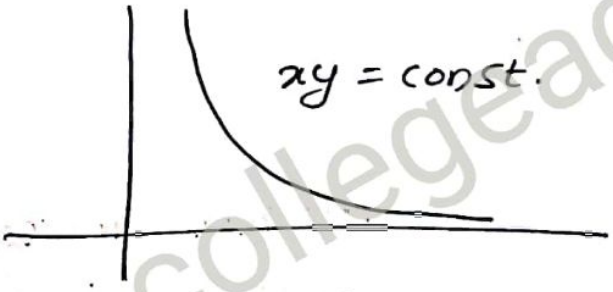
cooling Towers.



⑤ Rectangular hyperbola :-

It is used to represent boyles law expansion curve.

$$PV = const$$



Degenerate conics :-

When the section plane passes through Apex of the cone then the conics obtained is called as degenerate cones.

S.NO	condition	conic	Degenerate conic.
1)	$\alpha = 0$	circle	point
2)	$\alpha < \beta$	ellipse	point
3).	$\alpha = \beta$	parabola	straight Line.
4).	$\alpha > \beta$	Hyperbola	Triangle / Two intersecting Lines.
5).	$\alpha = 90; \theta = 90$	Rectangular hyperbola.	Right angle Isoseles Δle.

Special curves :-

(1) cycloidal curves → (i) cycloid (ii) Epicycloid (iii) Hyper cycloid.

(2) Trochoidal curves → (i) Trochoid (ii) Epitrochoid (iii) hypotrochoid

(3) Involutes → (i) Involute of a ole (ii) Involute of a polygon.

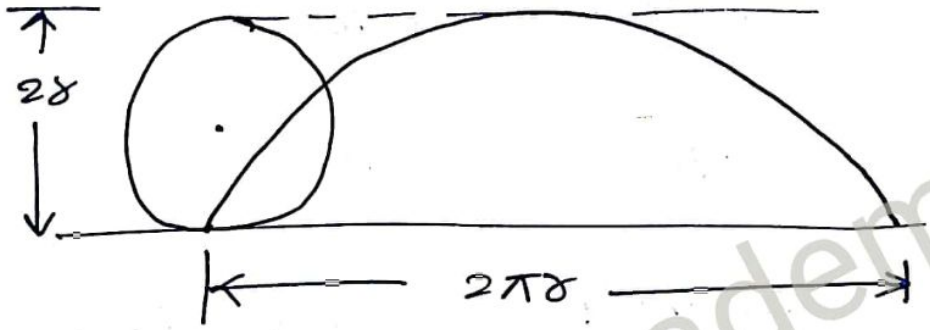
(4) spiral → (i) Archimedian spiral (ii) Logarithemic spiral.

(5) Helix → (i). cylindrical helix (ii) Conical helix.

① cycloidal curves :-

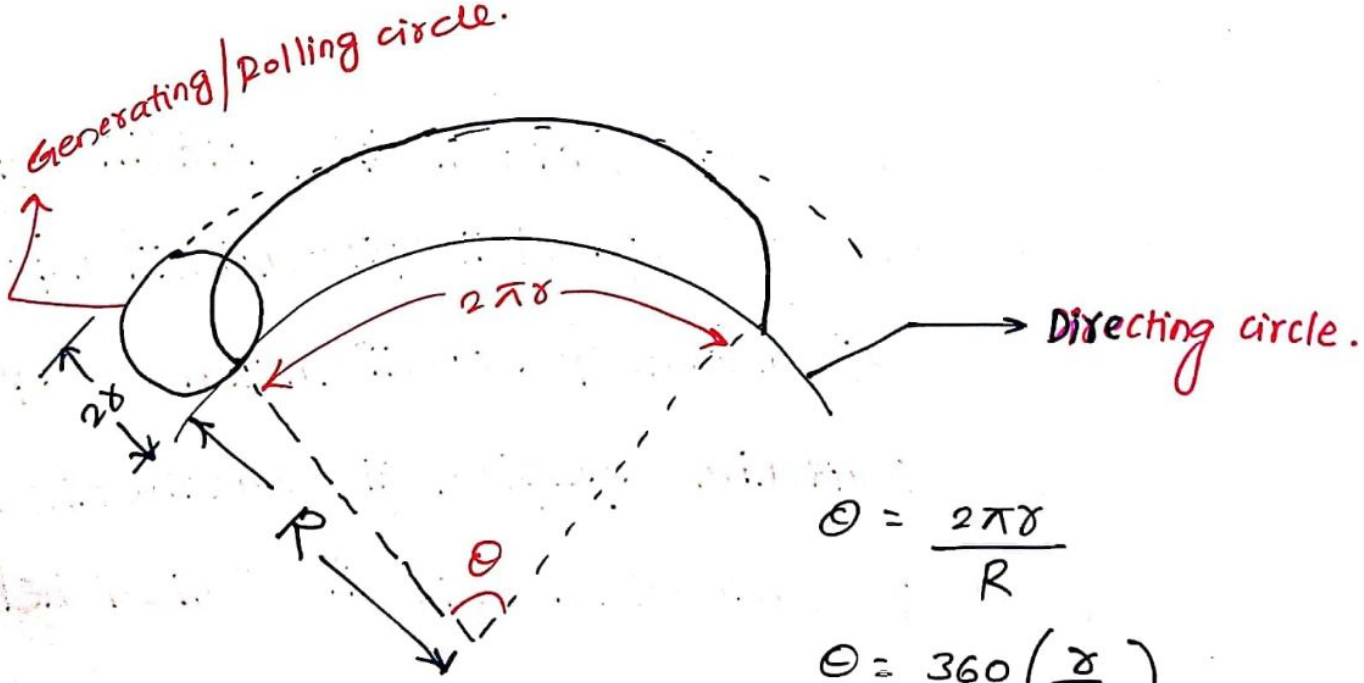
(a). cycloid :-

when a ole rolls on a straight Line without slipping Then The motion of a point on The circumfesence of circle is cycloid.



(b) Epicycloid :-

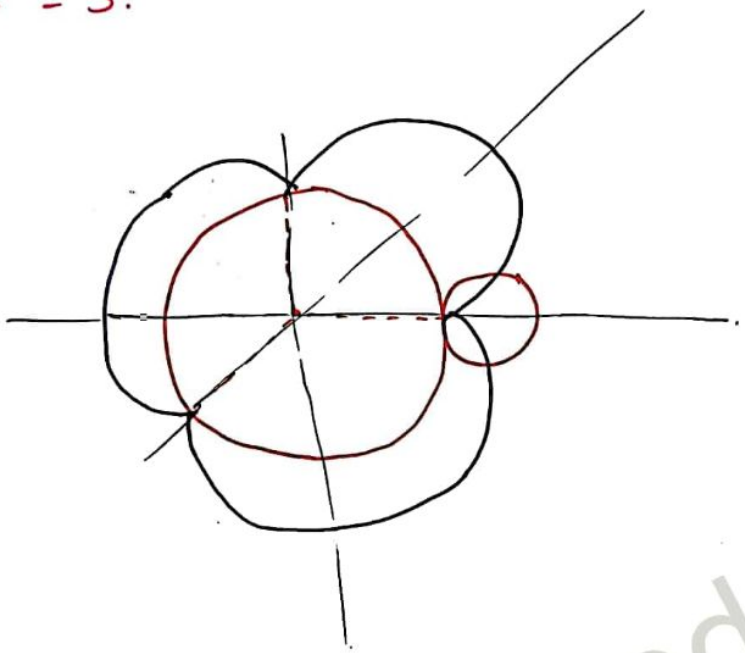
when The circle rolls on another circle from The out-side Then The motion Traced by a point on Rolling circle is called as Epicycloid.



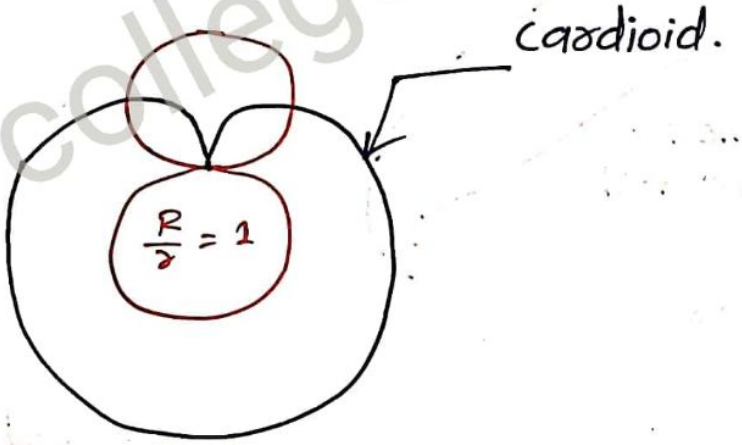
$$\theta = \frac{2\pi r}{R}$$

$$\theta = 360\left(\frac{r}{R}\right)$$

$\frac{R}{\gamma} = 3.$

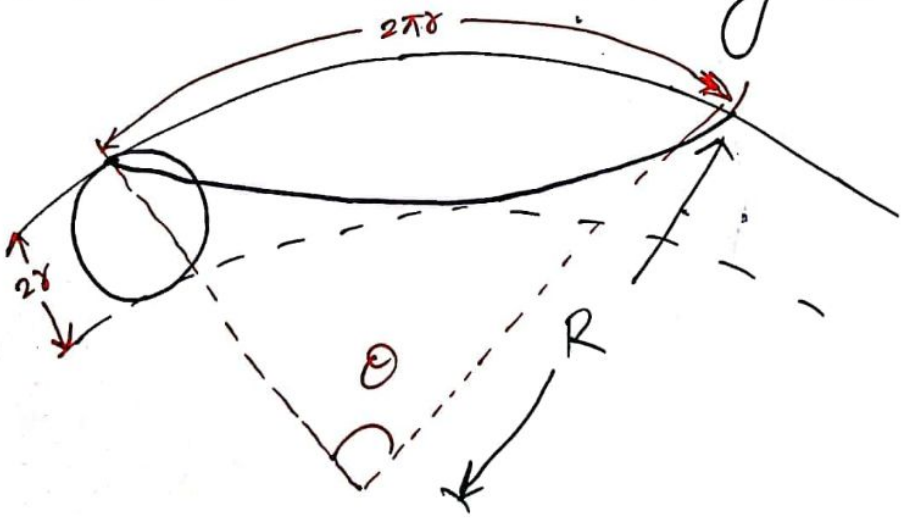


Special case of epicycloide :-



(c) hypocycloid :-

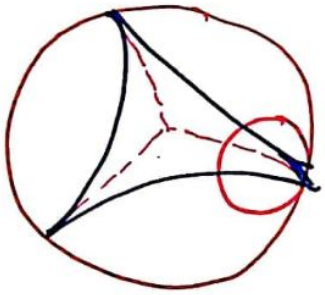
When a circle rolls on another circle from inside then the path of the point on rolling circle is Hypocycloid.



$$\theta = \frac{2\pi\gamma}{R}$$

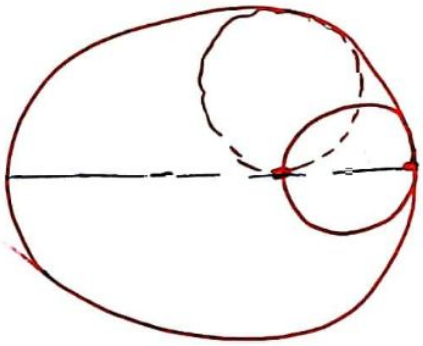
$$= 360\left(\frac{\gamma}{R}\right)$$

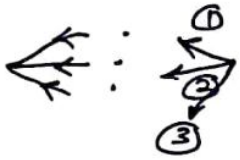
$\frac{R}{r} = 3$



when $\frac{R}{r} = 3$.

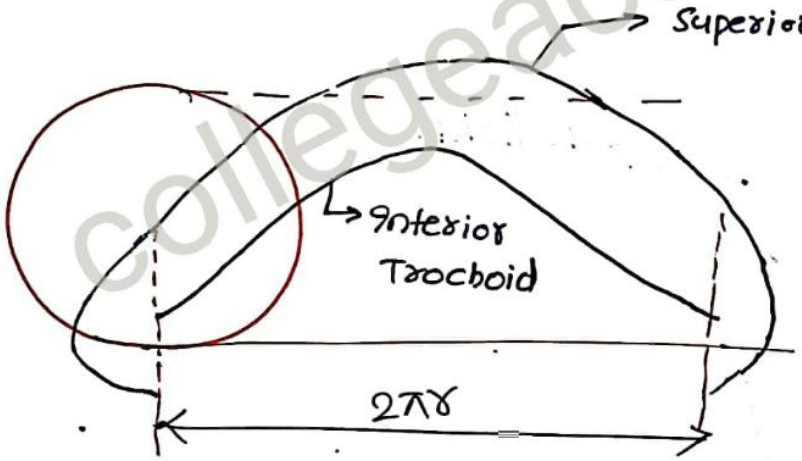
when $\frac{R}{r} = 2$



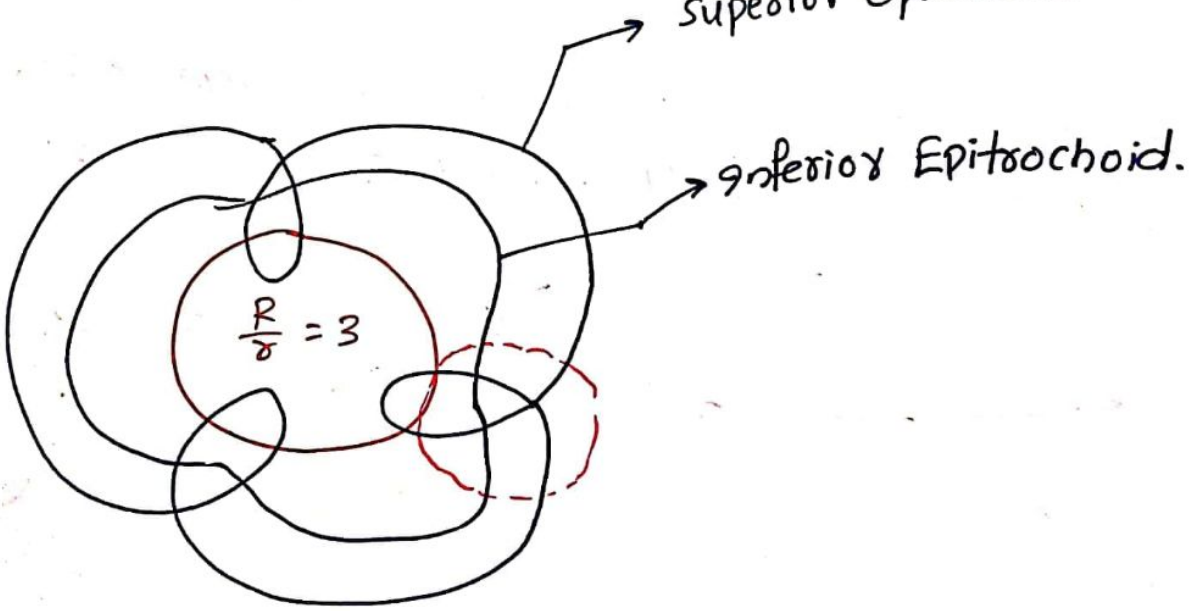


2) Trochoidal curves :-

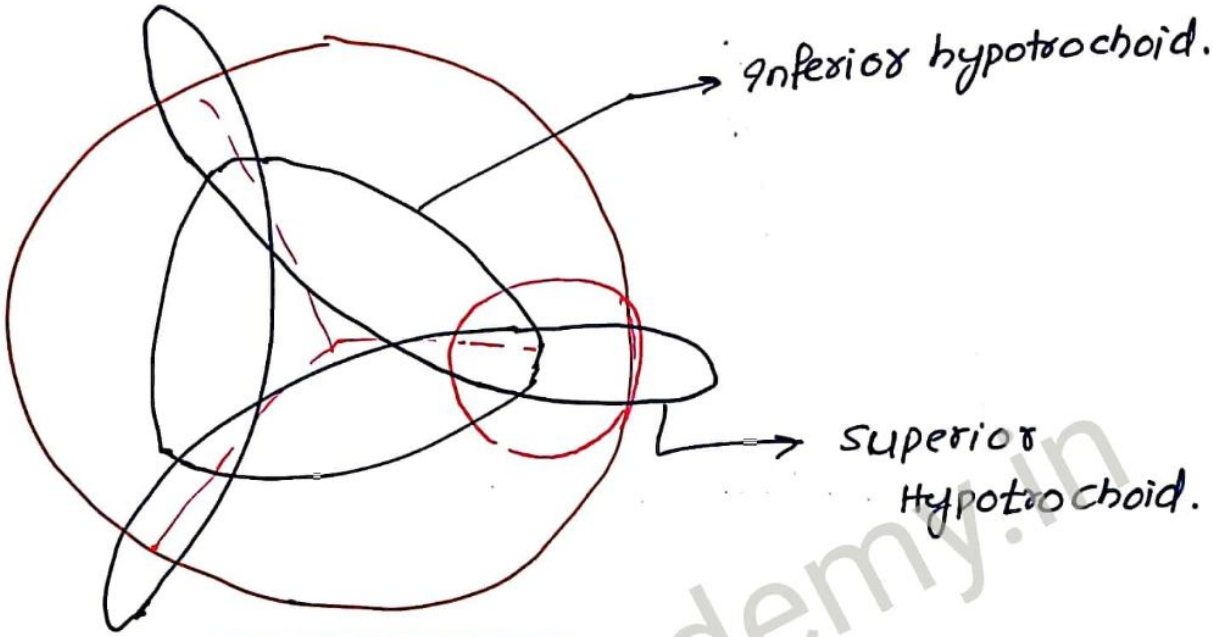
(a) Trochoid :-



(b) Epitrochoid :-



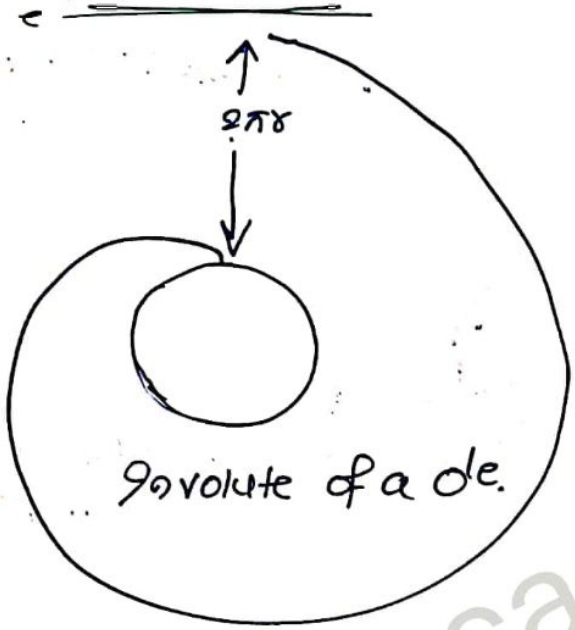
(c). Hypotrochoid :-

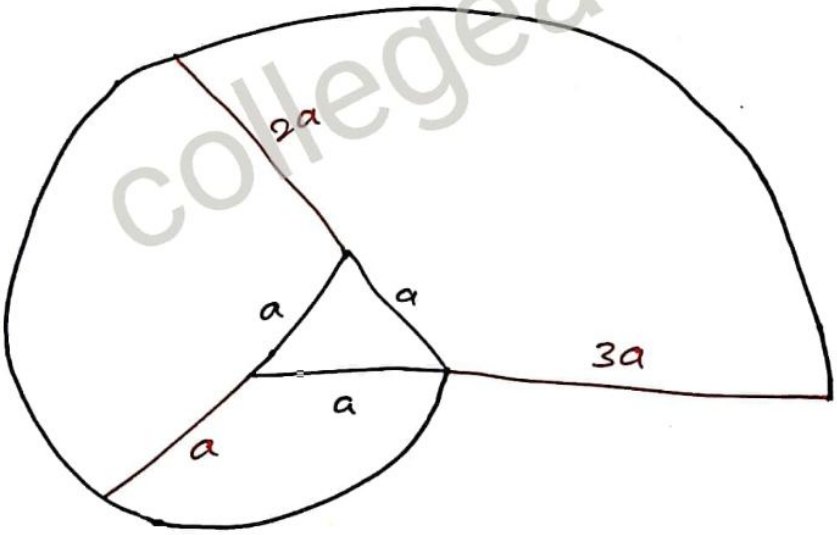


$$\frac{R}{r} = 3$$

(3) Involute :-

Involute of a circle :-





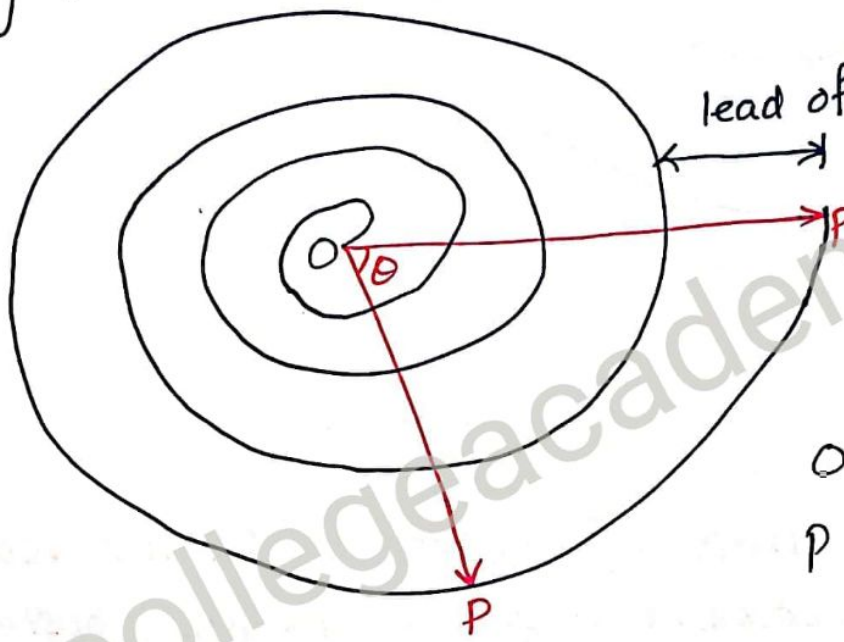
Involute of a Δ^{le}.

NOTE:-

Involute and cycloidal curves are used in Tooth profile of Gears.

④ Spiral :-

when a straight Line Rotets about a fixed point in a plane and at The same time a point moves along The Line in one direction Then The path traversed by The moving point is spiral.



O → pole

P → Tracing point (or) Generating point

$\overrightarrow{OP}$ → Radius vector.

θ = Vectorial angle.

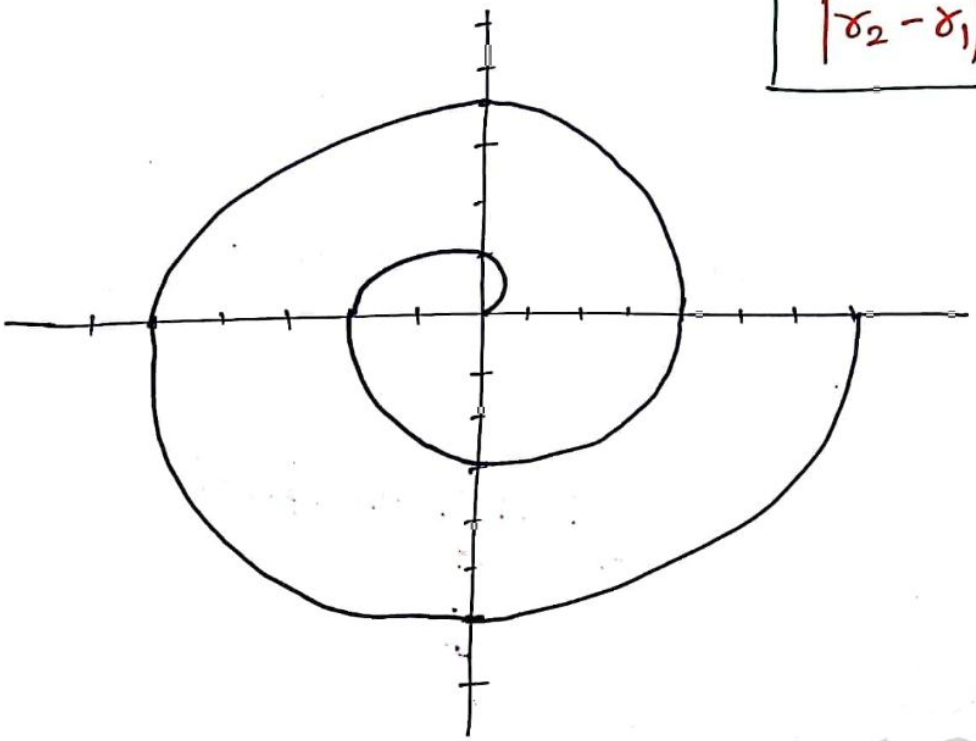
ⓐ Archimedian (Arithmatic) Spiral :-

when The Line is Rotating about The cone with constant angular velocity and at The same time The Tracing point is moving along The Line with constant linear velocity. Then Archimedian spiral is formed.

→ In Archimedian spiral The Lead of The spiral Rem-ains constant.

→ for equal vectorial angles The difference of corresponding Radius vector is const.

$|r_2 - r_1| = \text{constant}$



(2). Logarithmic spiral :-

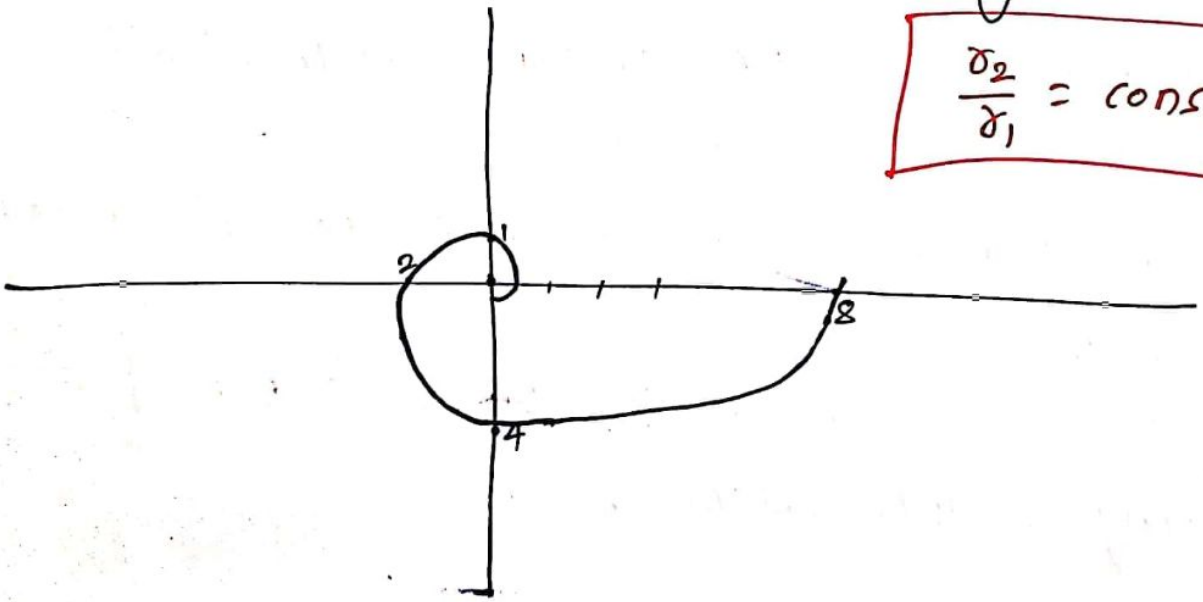
→ In this spiral the Ratio of consective Radius vector containing equal vectorial angles is always constant.

→ if the consecutive vectorial angles are in arithmatic progression then the Ratio of corresponding Radius vectors are in Geometric progression.

→ It is also called as equiangular spiral, self Similar spiral and marvellous spiral.

→ Golden spiral is an example of Logarithmic spiral.

$\frac{r_2}{r_1} = \text{constant}.$



④. A ole of Radius 20mm is Rolling on another ole of radius 60mm from the outside. Name the curve that is formed by a point, whose distance from the centre from rolling circle. is

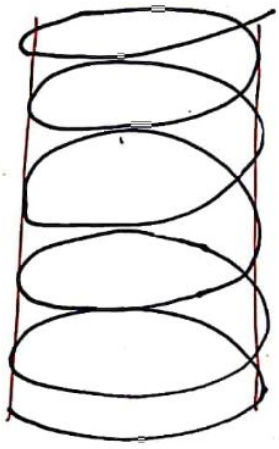
(i) 0mm → ole ($r = 80mm$)

(ii) 10mm → Inferior Epitrochoid

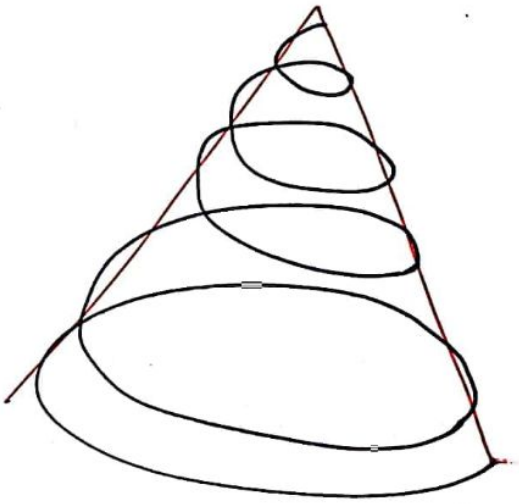
(iii) 20mm → epicycloid

(iv) 30mm → Superior Epitrochoid.

(5) Helix :-



(a) cylindrical Helix

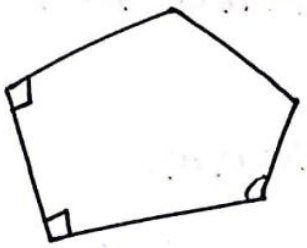


(b) conical Helix.

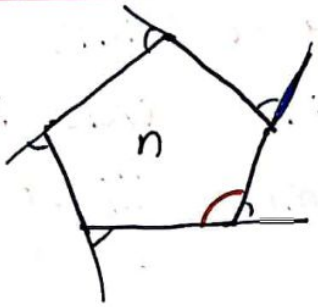
ESE-2017

(6) The path travelled by a point moving along pendulum from one end to another cohen the pendulum oscillates is Spiral.

* Polygons *



Irregular polygon.



Regular polygon.

Properties of Regular polygons:-

1. Sum of all external angles = 360°
2. Each external angle = $\frac{360^\circ}{n}$
3. each internal angle = $180^\circ - \frac{360}{n}$

   $= \frac{180^\circ}{n}(n-2)$
4. Sum of all internal angles = $180^\circ(n-2)$

Scales:-

Engineering objects have to be increased (or) Reduced in size to draw them on drawing sheet. The Ratio (or) proportion in which the Lengths of these objects is Reduced (or) increased is called as Scale.

Mathematically it represented as Representative Factor (or) Representative fraction (RF).

$$RF = \frac{\text{Drawing Length}}{\text{Actual Length}}$$ (in same units)

Conversion factors :-

10 mm = 1 cm

10 cm = 1 dm (dicimeter).

10 dm = 1 m

10 m = 1 dam (decameter)

10 dam = 1 hm (hecta meter).

10 hm = 1 Km.

2.54 cm = 1 inch

12 inches = 1 foot

3 feet = 1 yard.

220 yards = 1 furlong.

8 furlongs = 1 mile

1.61 Km = 1 mile

1 hectare = $10^4 m^2$

depending upon the value of RF scales are classi-fied onto three categories.

(1) Reduced scale :- (RF < 1)

Drawing Length < Actual Length.

→ used for Larger objects.

(1 : n)

(2) Full size scale :- (RF = 1) (1 : 1)

Drawing Length = Actual Length (1 : 1)

(3) Enlarged scale :- (RF > 1) Drawing Length > Actual length (n : 1)

It is used for small objects.

Scales are further classified into two categories.

1) Engineers scale :-

In this the Relation b/w Drawing Length and Actual Length is mentioned Numerically.

Eg:- 10cm = 1m.

2) Graphical scale :-

In this the scale is Actually constructed on the drawing sheet. It is superior to Engineers scale. As it take care of shrinkage of sheet.

Graphical scales are further classified to five categories.

i) plane scale

ii) Diagonal scale

iii) Vernier scale.

iv) scale of chords :→ It is used to measure the angle without protractor.

v) comparative Scale → It is convert one system of unit to another keeping the same RF.

(i) plane scale :-

It shows Relation b/w 2 consecutive units (or) a unit and Its subdivisions.

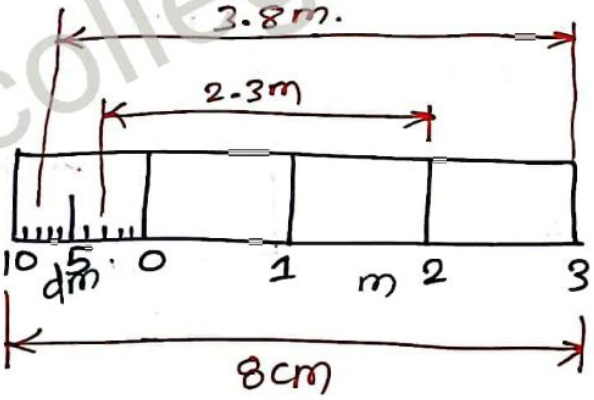
Eg:- 2.3 m

- 2 → Main unit (m)
- 3 → Subdivisions (dm)

In other words we can say that a plane scale measures a Unit correct upto 1 decimal place.

Eg:- RF = 1 : 50

Max Length = 4m.



To construct any scale following Three parameters are Required.

1. Representative factor.
2. Maximum length of the object that is to be measured using proposed scale.

$$\text{RF} = \frac{\text{DL}}{\text{AL}} \quad \text{DL} \rightarrow \text{LOS}, \quad \text{AL} \rightarrow \text{Max. Length}$$

$$\text{LOS} = \text{RF} \times \text{Maximum Length.}$$

3. Units in which measurments are made.

(8) The height of Gateway of India is 25m. It is represented by Line of Length 10cm in the elivation of drawing. Determine (i) RF (ii) LOS (Length of scale) for measuring upto 40m.

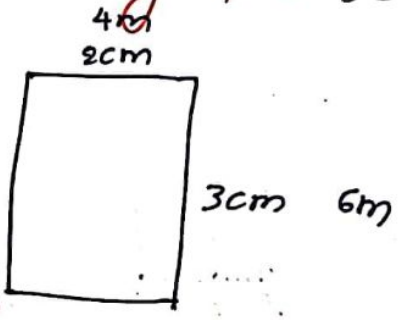
Sol $RF = \frac{10}{25.3 \times 100} = \frac{1}{253} = 1.253$.

$LOS = \frac{1}{253} \times 40 \times 100 = 15.8$ cm.

(9) A wave house of dimension 9m × 12m × 16m is represented by a volume of 216 cm^3 in the drawing. Determine RF and LOS for measuring upto 50m.

Sol $RF = \frac{2cm}{400cm} = \frac{1}{200}$

$RF = \frac{2cm \times 3cm}{4m \times 6m}$



$RF = \frac{1}{40000}$

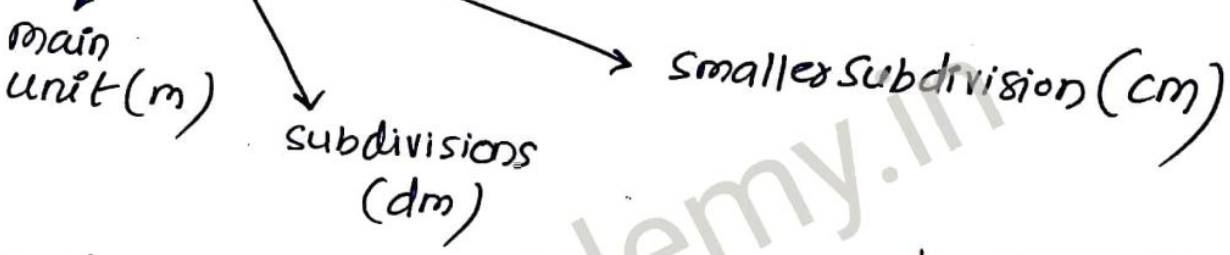
$RF = \sqrt{\frac{\text{Drawing Area}}{\text{Actual Area}}}$

$RF = \sqrt[3]{\frac{\text{Drawing Volume}}{\text{Actual volume.}}}$

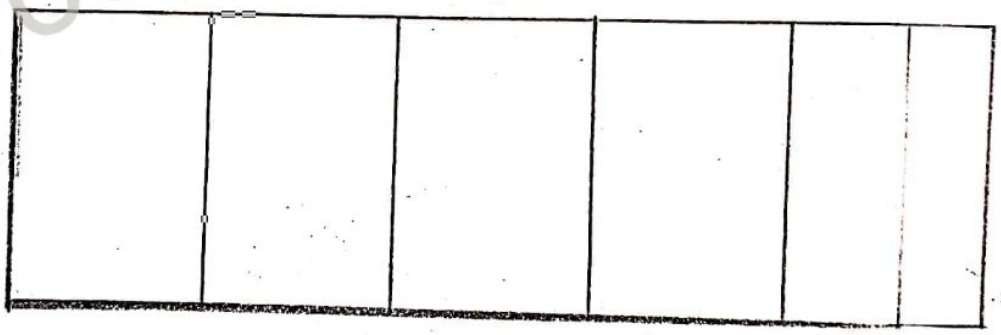
ii) Diagonal scale :-

It shows Relationship b/w Three consecutive unit in other words It can measure units correct upto '2' decimal places.

Eg:- 2.26 m



(6) construct a scale with RF = 1:50000 to measure a Max distance of upto 5 km. mark a distance of 3.56 km on the scale.



(iii) Vernier Scale :-

It can measure a unit correct upto 2 decimal places.

$$\text{Least count} = |\text{Main Scale division} - \text{vernier scale division}|$$