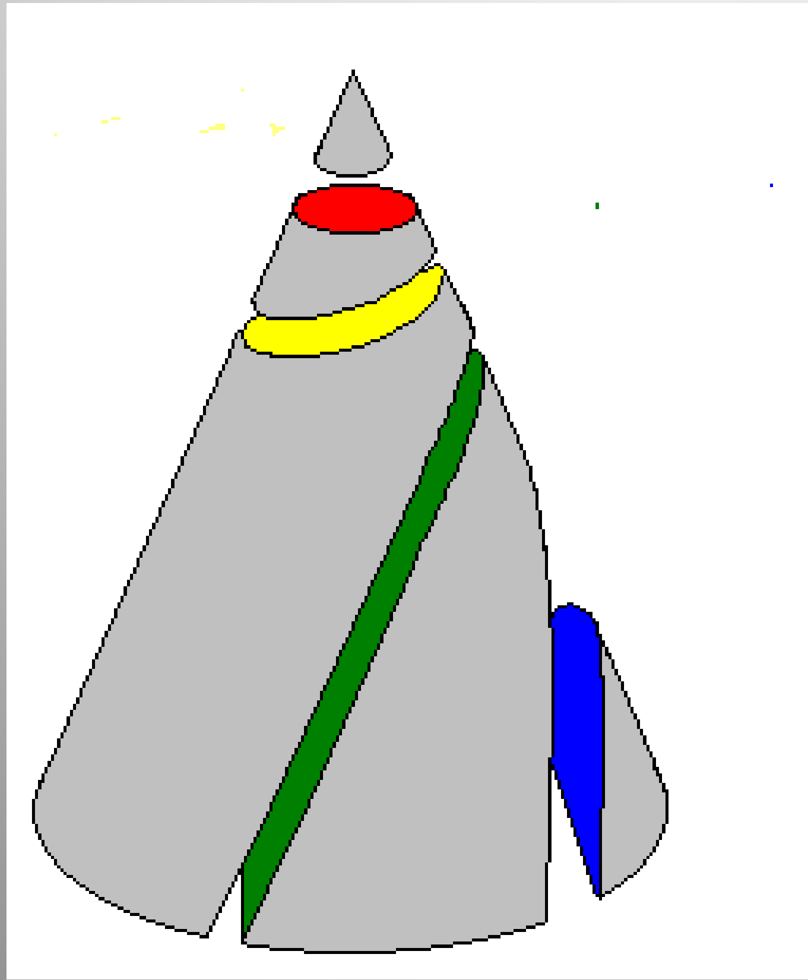
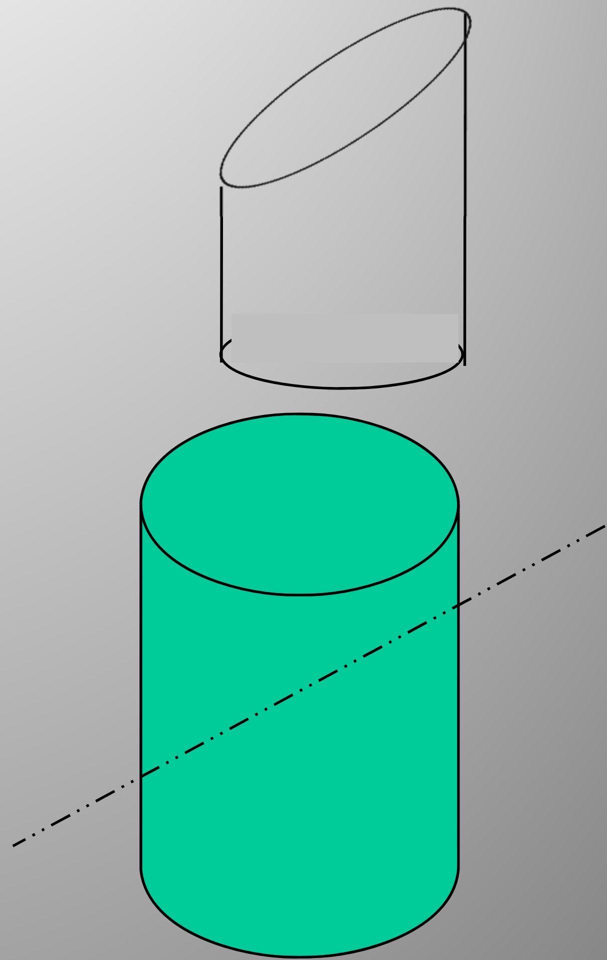
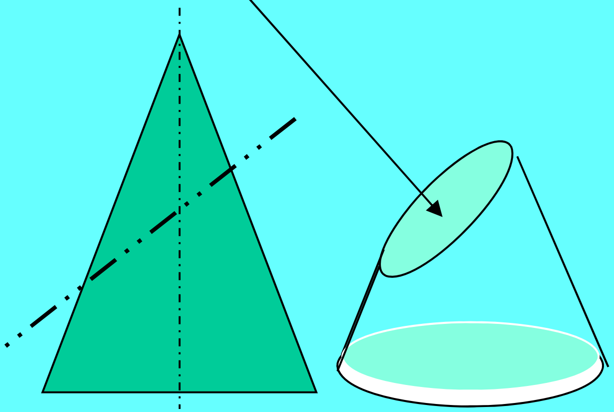
Section of Solid





Conic Sections: Curves appear on the surface of a cone when it is cut by some typical cutting planes

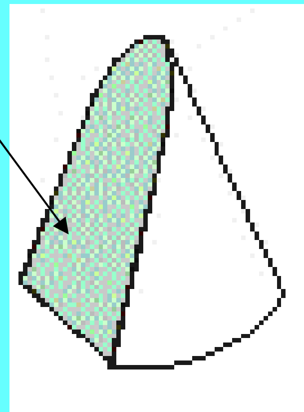
ELLIPSE $\theta > \alpha ; \theta < 90^\circ$

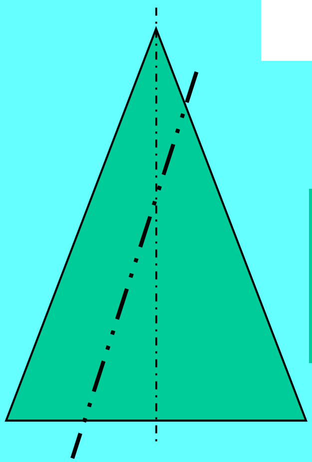


Section Plane
Through Generators

Plane ⊥ axis.
Circles ???

PARABOLA $\theta = \alpha$

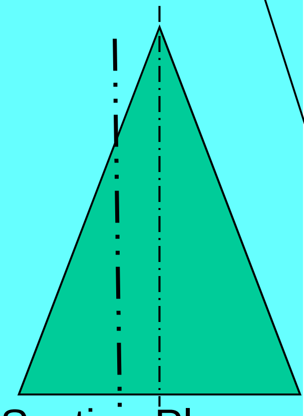


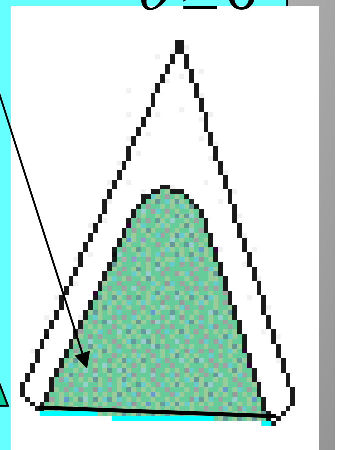


Section Plane
Parallel
to end generator.

HYPERBOLA $\theta < \alpha$

$\theta \geq 0$





Section Plane
Parallel to Axis.

Open / unbounded

How do I identify ELLIPSE, PARABOLA, HYPERBOLA:

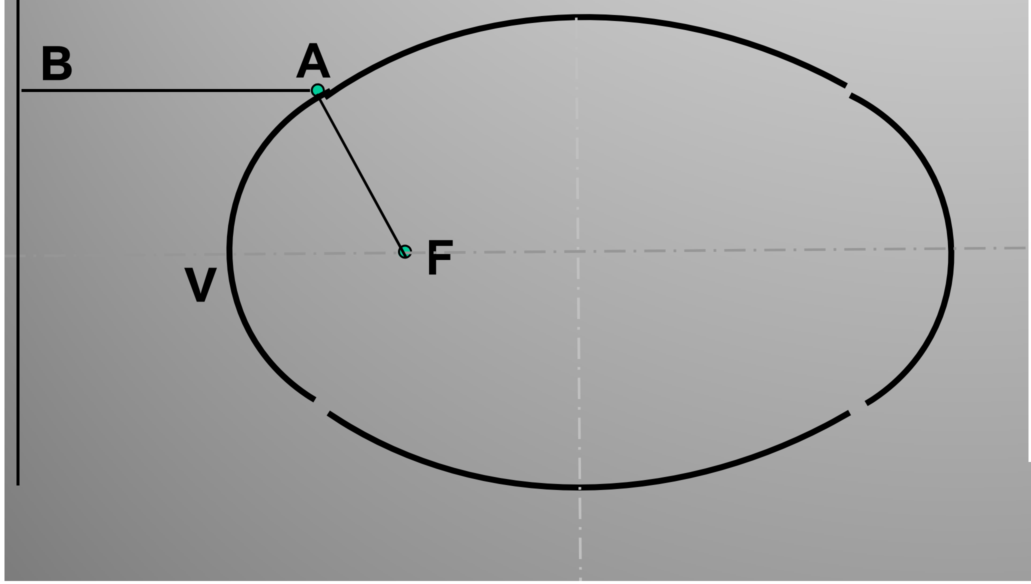
Locus of point moving in a plane such that the ratio of it's distances from a ***fixed point*** (focus) and a ***fixed line*** (directrix) always remains constant. Ratio is called **ECCENTRICITY (E)**

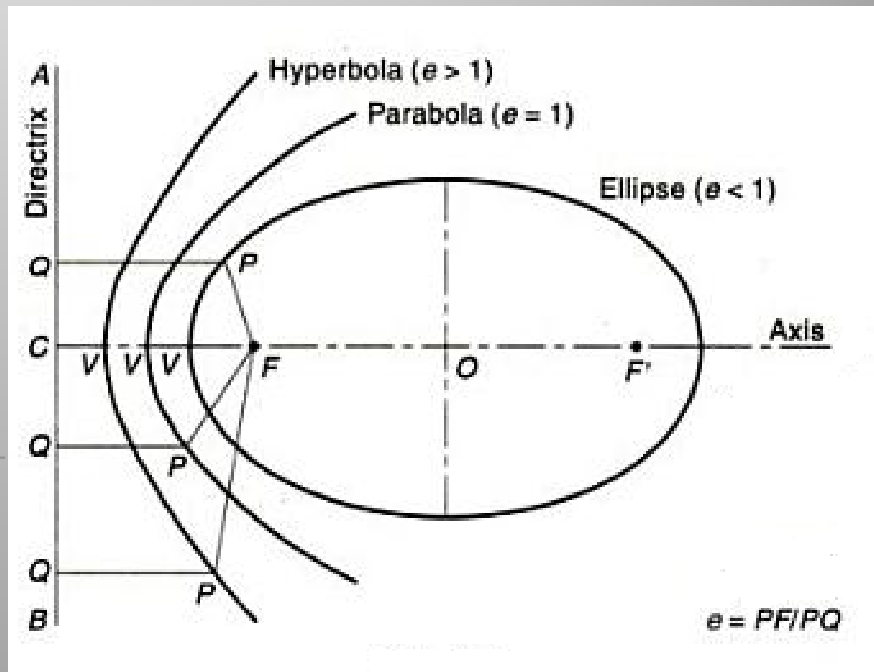
A) For Ellipse E<1
B) For Parabola E=1
C) For Hyperbola E>1

$$\frac{\alpha}{\theta}$$

Assume

A moving point
F Fixed point
Line Fixed line





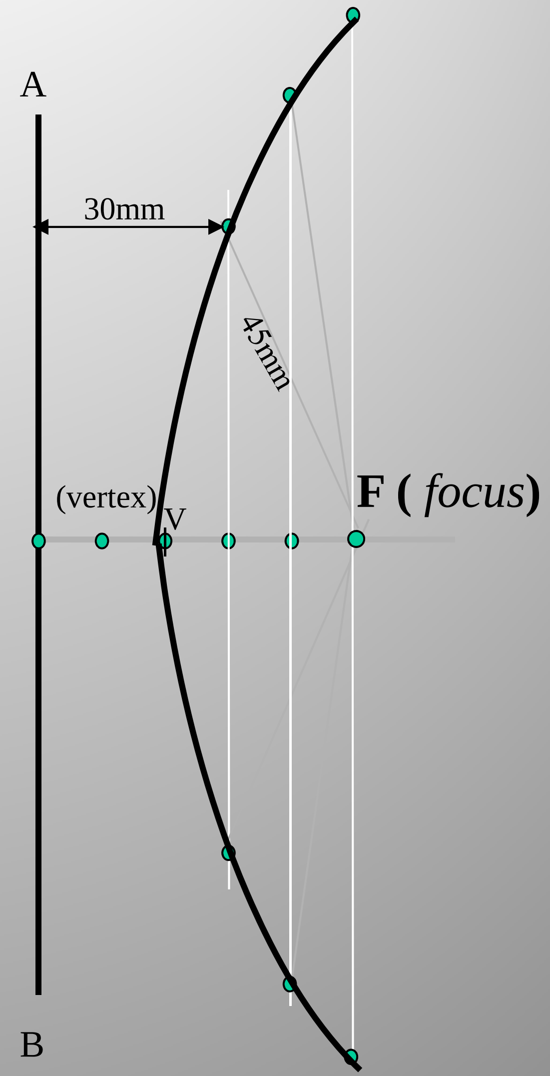
PROBLEM*:-** Point F is 50 mm from a line AB**.** A point **P** is moving in a plane such that the ***ratio of it's distances from F and line AB remains constant and equals to **3/2. D**raw locus of point P**.**

HYPERBOLA
DIRECTRIX
FOCUS METHOD

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.
2 .Divide 50 mm distance in 5 parts.
3 .Name 2nd part from F as V. It is 20mm and 30mm from line AB and point F resp. It is first point giving ratio of it's distances from AB and F 2/3 i.e 20/30
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.
5.Taking distances 30, 40 and 50mm from line AB, draw three vertical lines to the right side of it.
6. Now with 45, 60 and 75mm distances in compass cut these lines above and below, with F as center.
7. Join these points through V in smooth curve.

This is required locus of P. It is an Hyberbola.



PARABOLA
DIRECTRIX-FOCUS METHOD

PROBLEM: Point F is 50 mm from a vertical straight line AB. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AB.

SOLUTION STEPS:

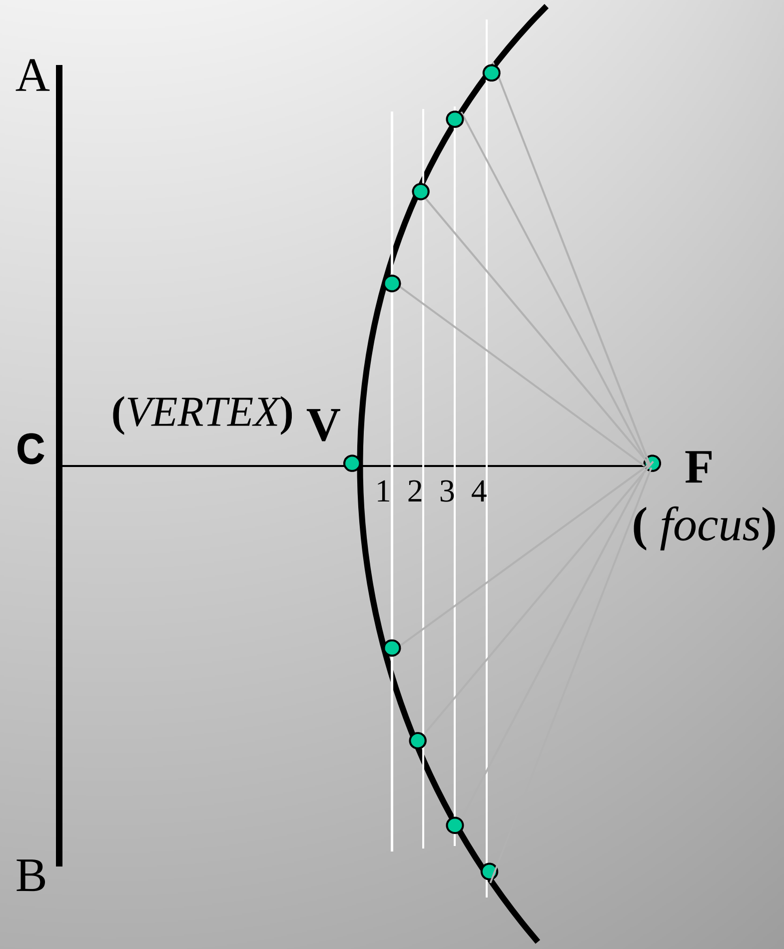
1.Locate center of line (CF), perpendicular to AB. Bisect CF and find vertex V.

2.Mark 5 mm distance to right side of V, name those points 1,2,3,4 and from those draw lines parallel to AB.

4.Take C-1 distance as radius and F as center draw an arc cutting first parallel line to AB. Name upper point P_1 and lower point P_2.

5.Similarly repeat this process by taking again 5mm to right and locate P_3P_4.

6.Join all these points in smooth curve. **It will be the locus of P equidistance from line AB and fixed point F.**



Ellipse

PROBLEM:- POINT **F** is 50 mm from a LINE **AB.** A POINT **P is** MOVING in a PLANE SUCH THAT ***RATIO*** of IT'S DISTANCES (E) FROM **F** and LINE **AB** REMAINS CONSTANT and EQUALS TO **2/3.** DRAW LOCUS OF POINT **P.**

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 2nd part from F as V. It is 20mm and 30mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 2/3 i.e 20/30

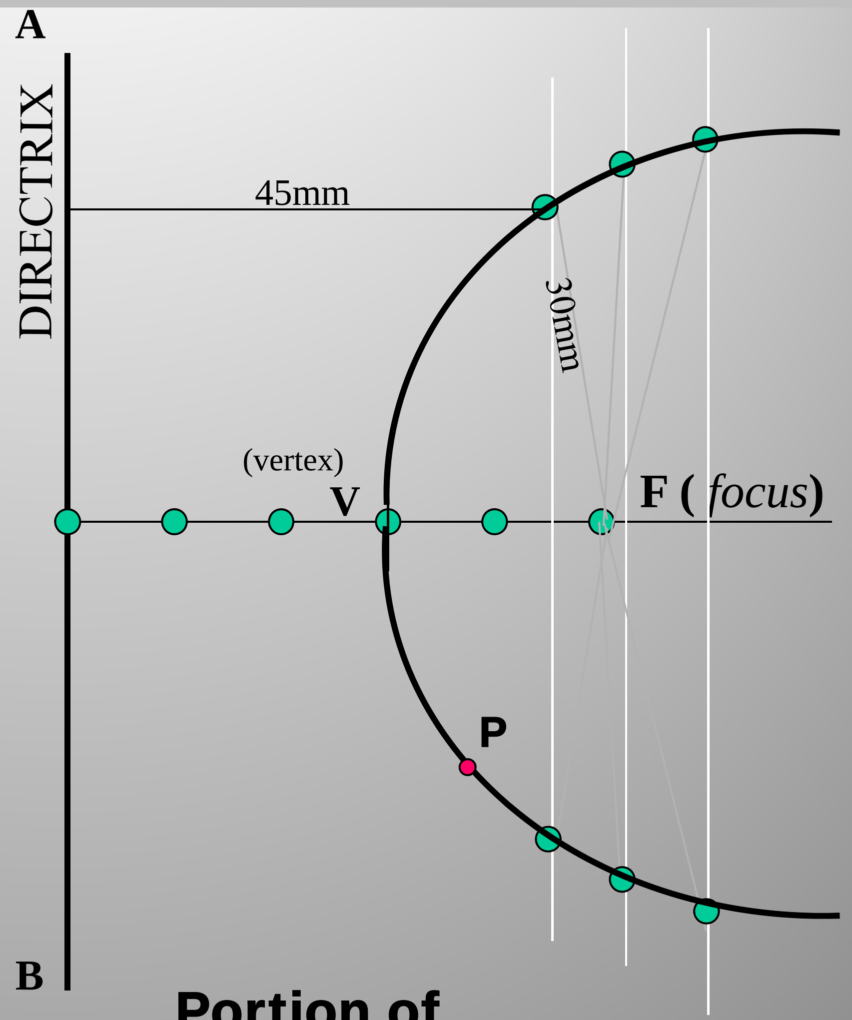
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

5.Taking 45,60 and 75mm distances from line AB, draw three vertical lines to the right side of it.

6. Now with 30, 40 and 50mm distances in compass cut these lines above and below, with F as center.

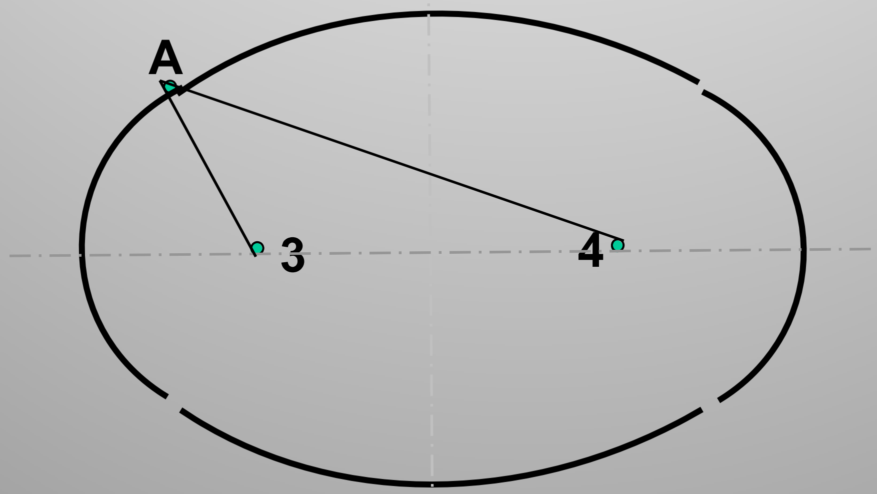
7. Join these points through V in smooth curve.

This is required locus of P.



Portion of Ellipse

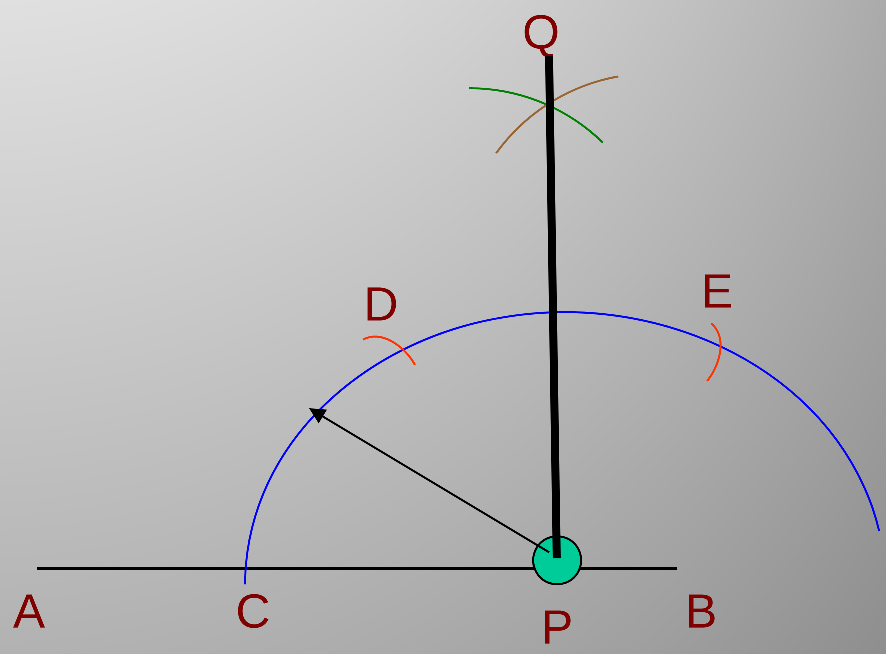
Complete ELLIPSE:- Locus of a point (A) moving in a plane such that the SUM of it's distances from TWO fixed points (FOCUS 1 & FOCUS 2) always remains constant. This ***sum equals*** to the length of ***major axis***.



A3 + A4 = Length of major axis.

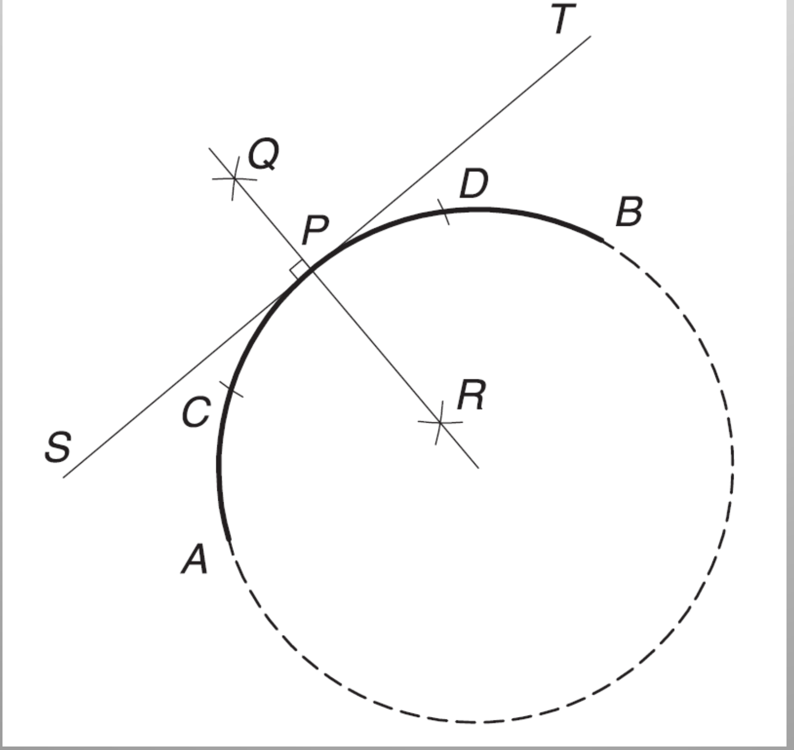
Drawing a perpendicular to a line at a given point

- **Draw the line AB**
- **With P as center and any convenient radius, draw an arc cutting AB at C (shown blue)**
- **With the same radius cut 2 equal divisions CD and DE (shown red)**
- **With same radius and centers D and E, draw arcs (green and brown) intersecting at Q**
- **PQ is the required perpendicular**



To draw a normal and a tangent to an arc or circle at a point P on it

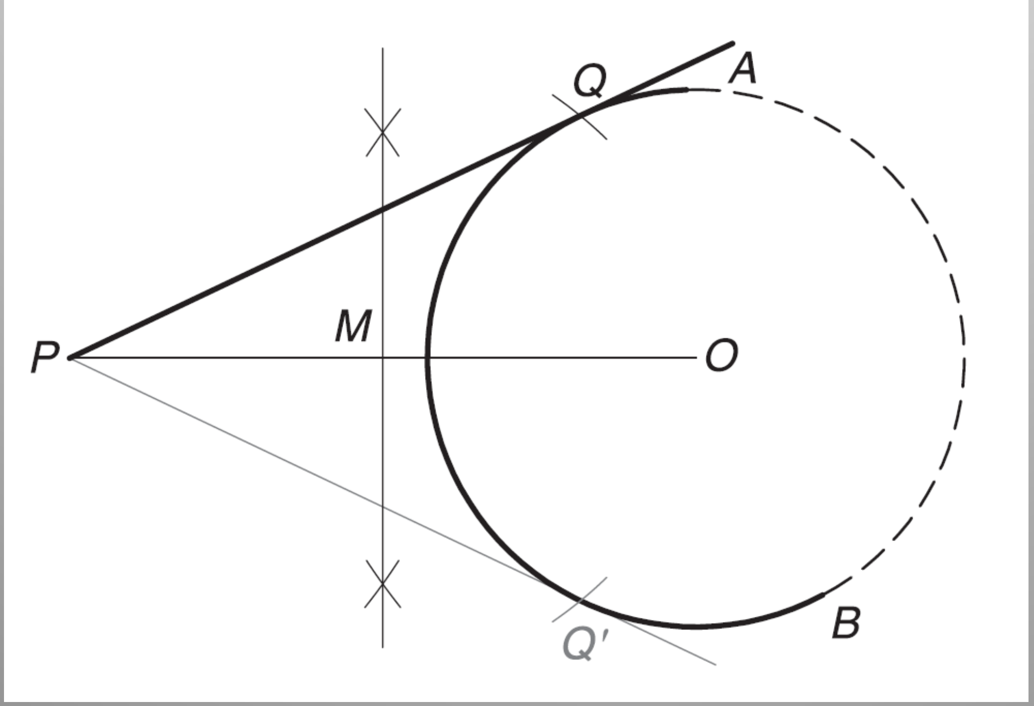
- With centre P and any convenient radius, mark off two arcs cutting the arc/circle at C and D.
- Obtain QR, the perpendicular bisector of arc CD. QR is the required normal.
- Draw the perpendicular ST to QR for the required tangent.



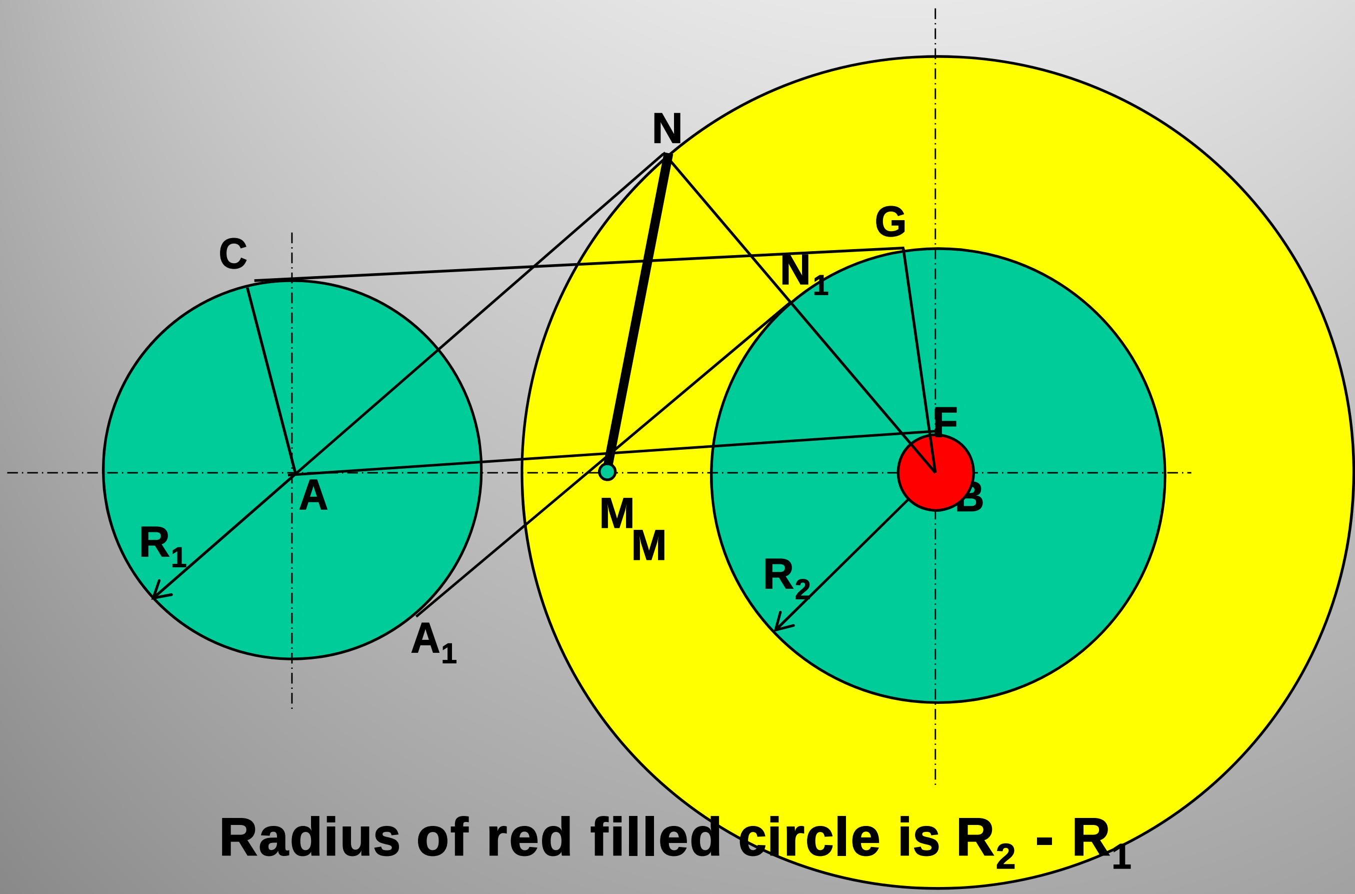
T3

Tangent to a given arc AB (or a circle) from a point P outside it.

- Join the centre O with P and locate the midpoint M of OP.
- With M as a centre and radius = MO, mark an arc cutting the circle at Q.
- Join P with Q. PQ is the required tangent.
- Another tangent PQ’ can be drawn in a similar way.



Tangent to two circles



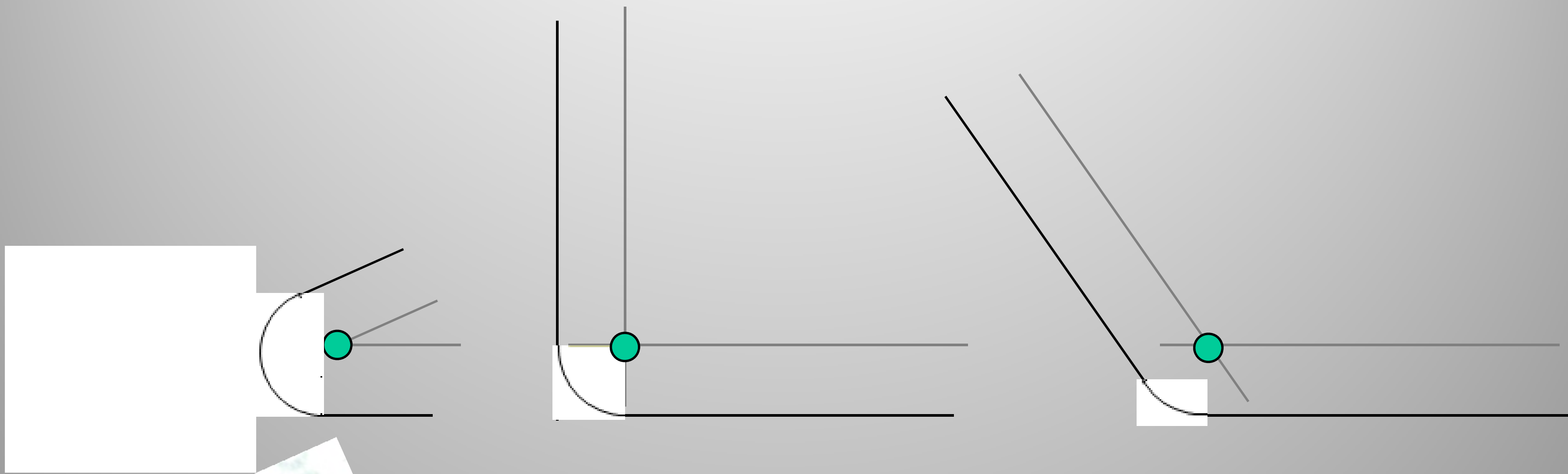
Draw tangent from center A to circle (red colored circle)

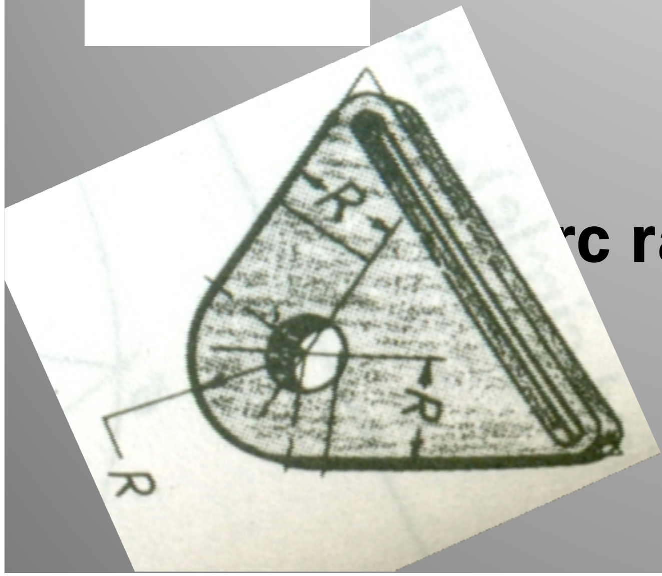
External tangent
Internal tangent

Radius of red filled circle is R_2 - R_1

Arc 1

Drawing Arc between two straight lines





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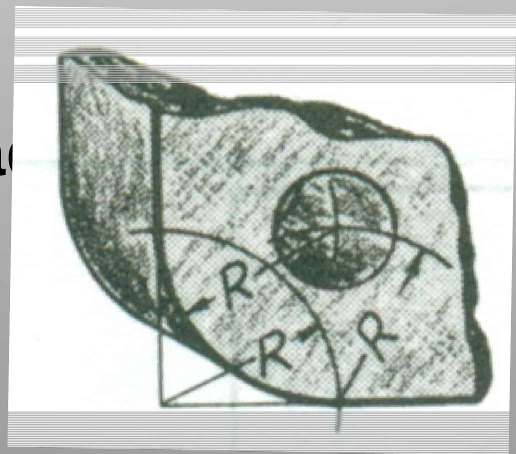
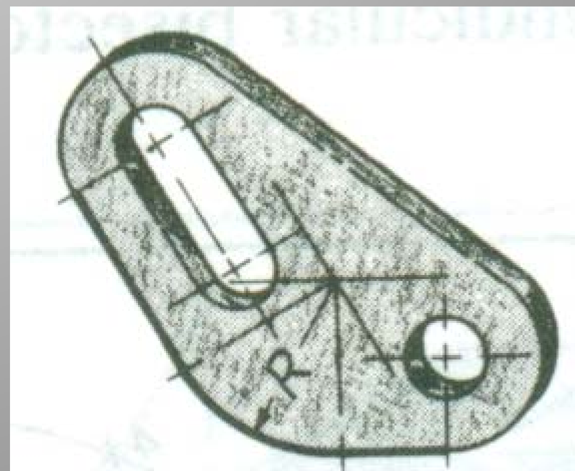
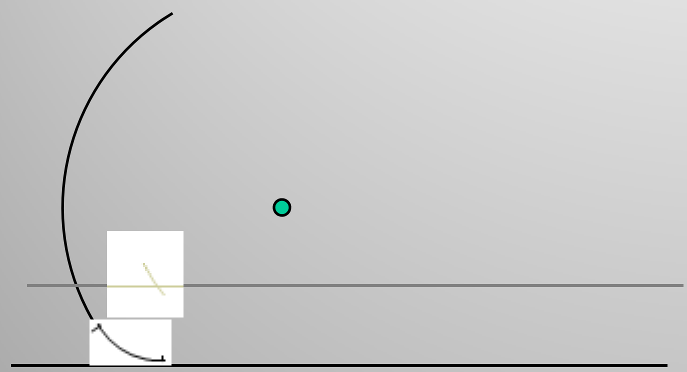
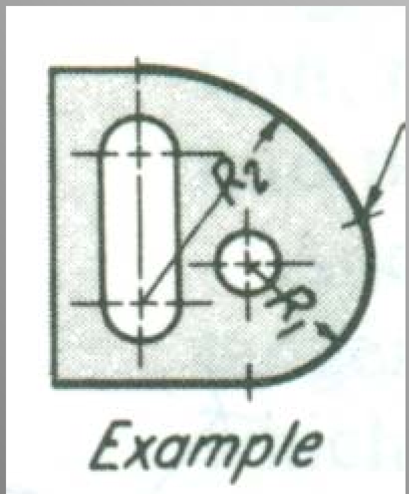
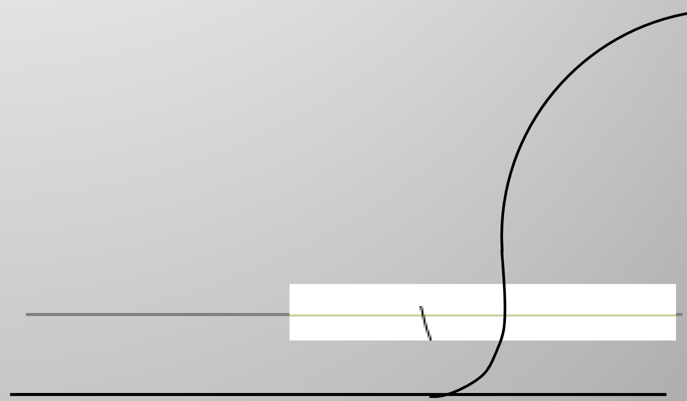


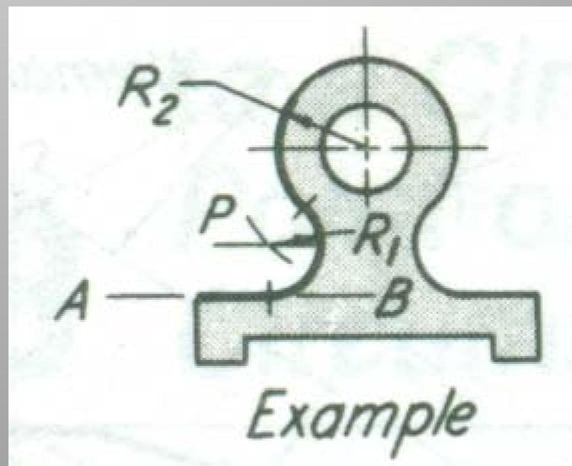


Drawing Arc (R_1) between Line & Arc (R_2)



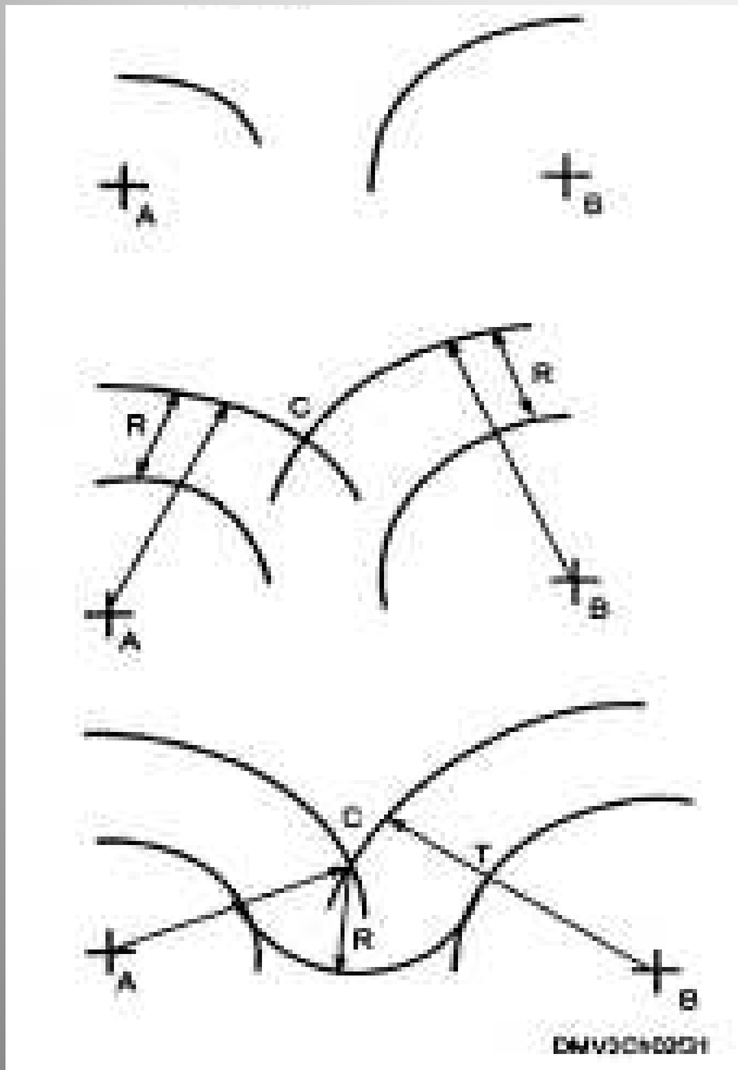


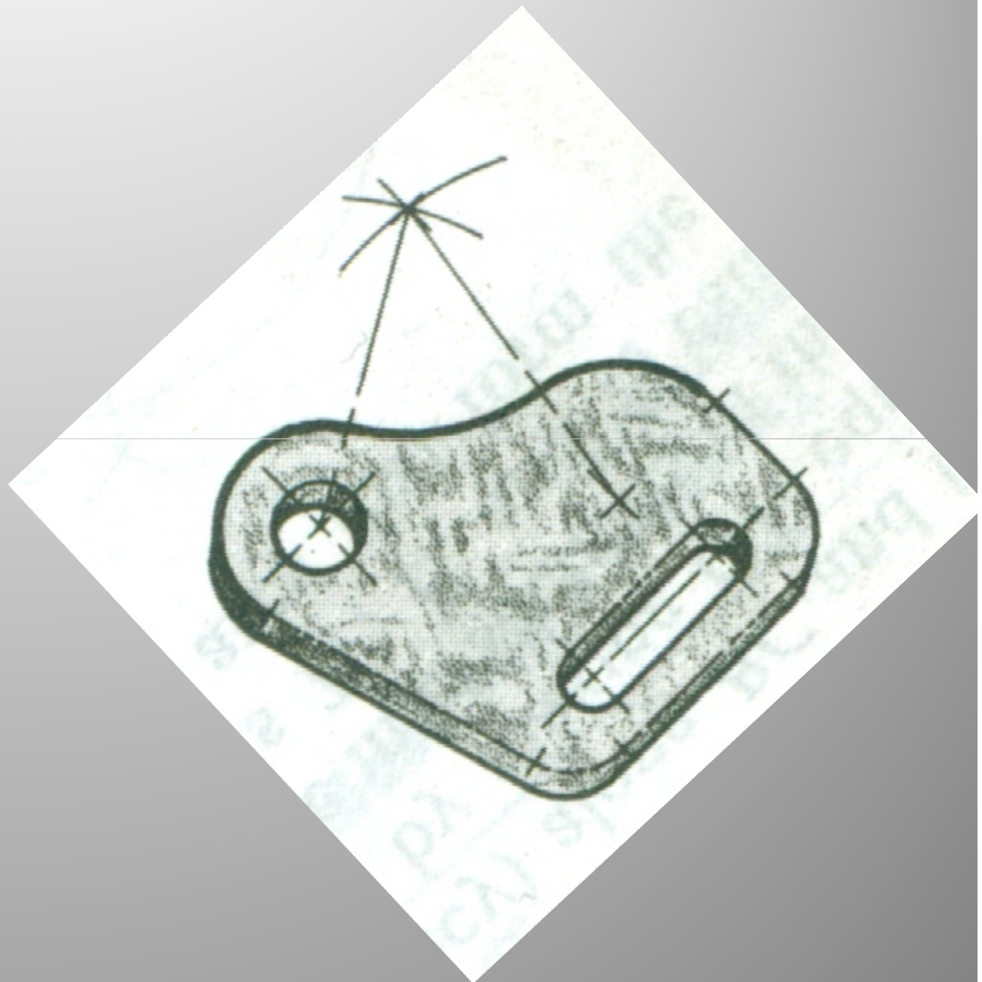




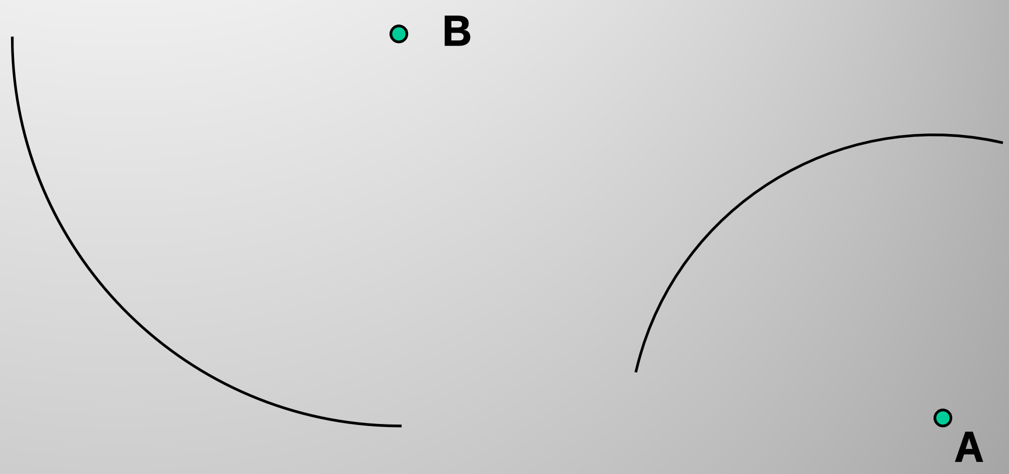
Arc 3

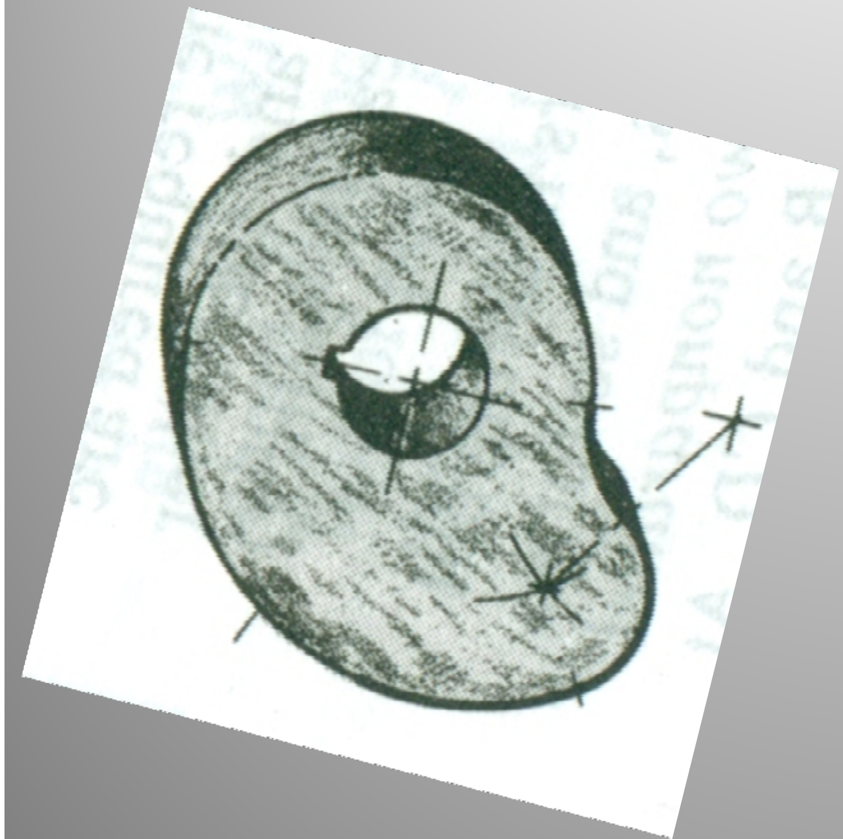
Drawing Arc (R) between two Arc (R_A & R_B)



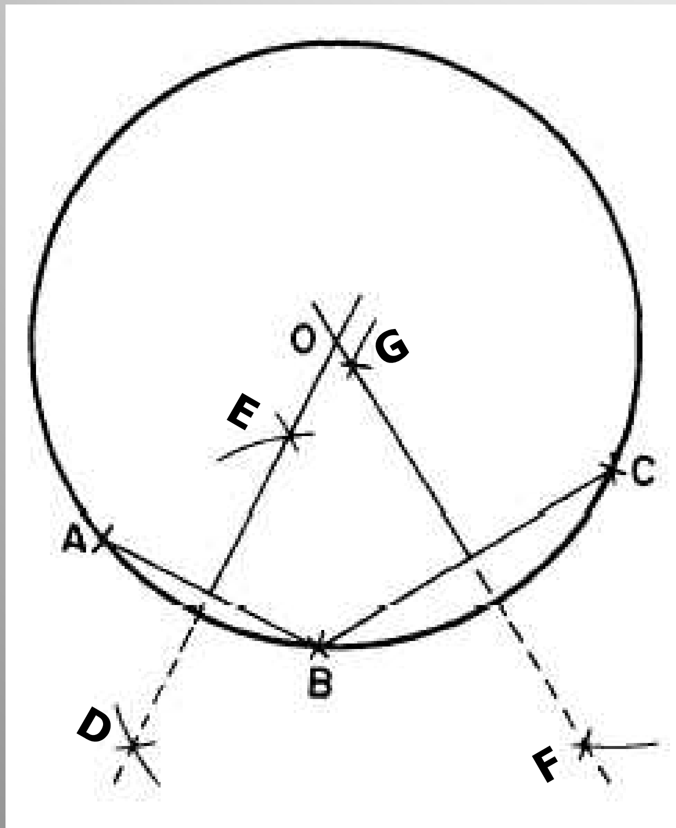


Drawing Arc (R) between two Arc (R_A & R_B)





Arc/Circle passing through 3 points

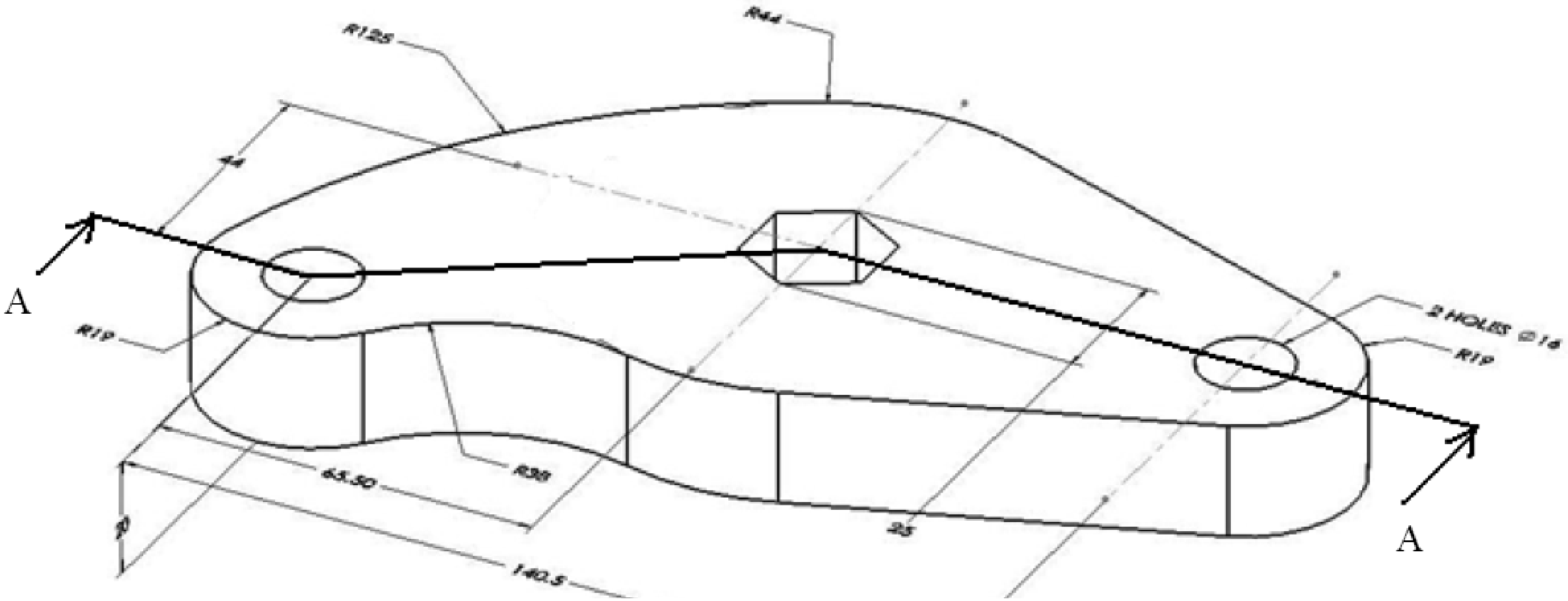


Q No. 1:- Construct an equilateral triangle, regular hexagon and regular heptagon on a common base of 40 mm side (all in one figure). **(1.5 MARKS)**

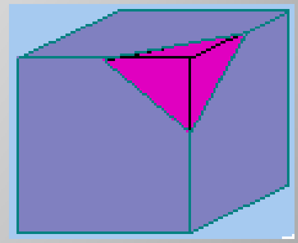
Q No. 2:- A heptagon prism with a base side of 45mm and height 90mm has its axis perpendicular to the ground. One of the sides of the base is inclined at 30° to the vertical plane. A section plane inclined at 70° to the ground and perpendicular to the vertical plane and passing through the midpoint of the axis cuts the prism. Draw TV, FV and the side view of the sectioned prism. (**2.5 MARKS)**

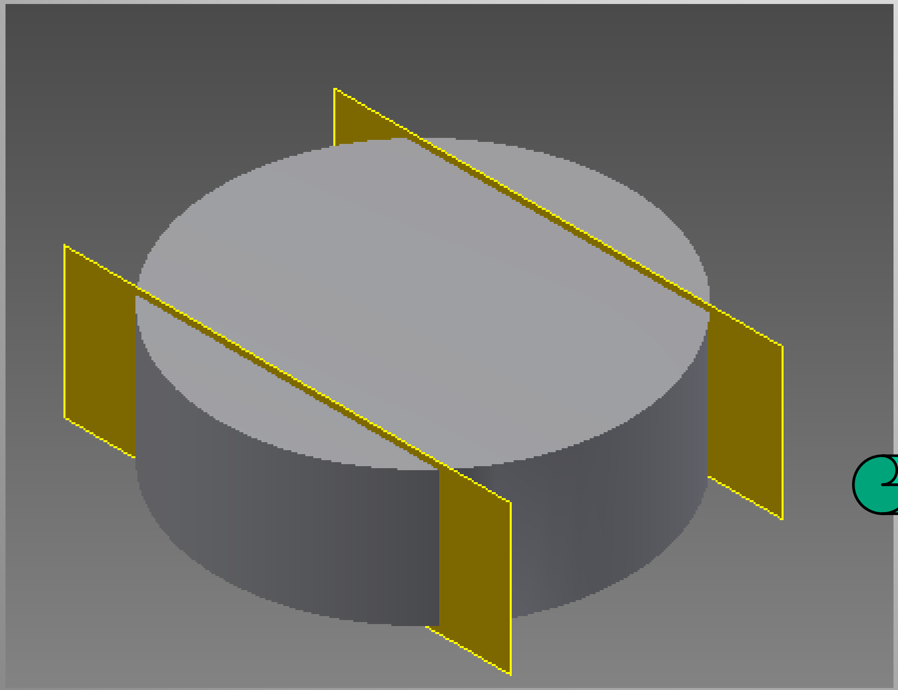
Q No. 3:- Two fixed points are 100mm apart. A point P moves in such a way that the sum of its distances from the two fixed points is always constant and equal to 150mm. Trace the path of the point and name the curve. **(1.0 MARK)**

Q No. 4:- A cone with a base diameter of 70mm and a height of 80mm is placed coaxially on a circular disc with a diameter of 120 mm and thickness of 35mm. An auxiliary plane inclined to the



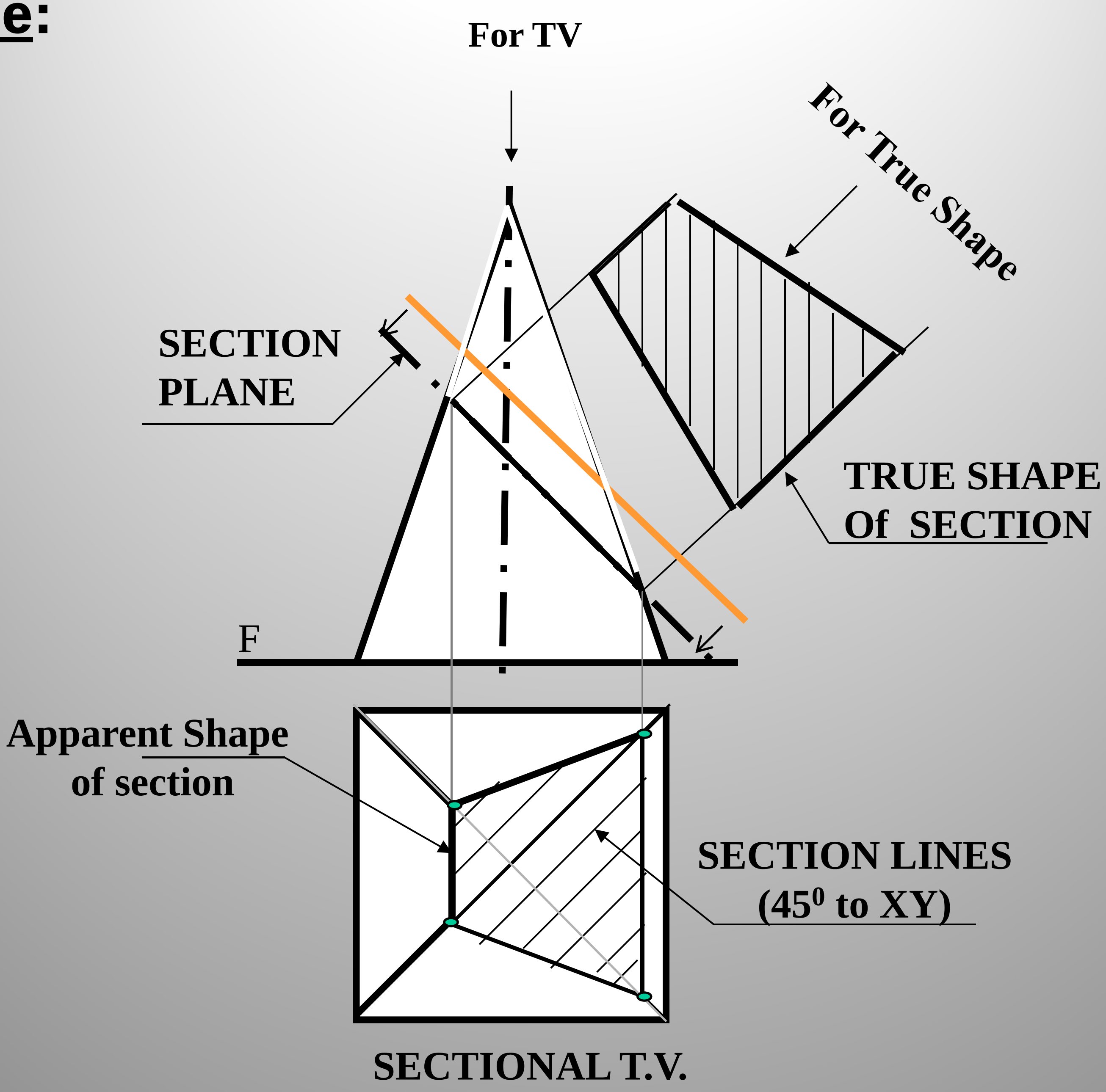
Section of Solids





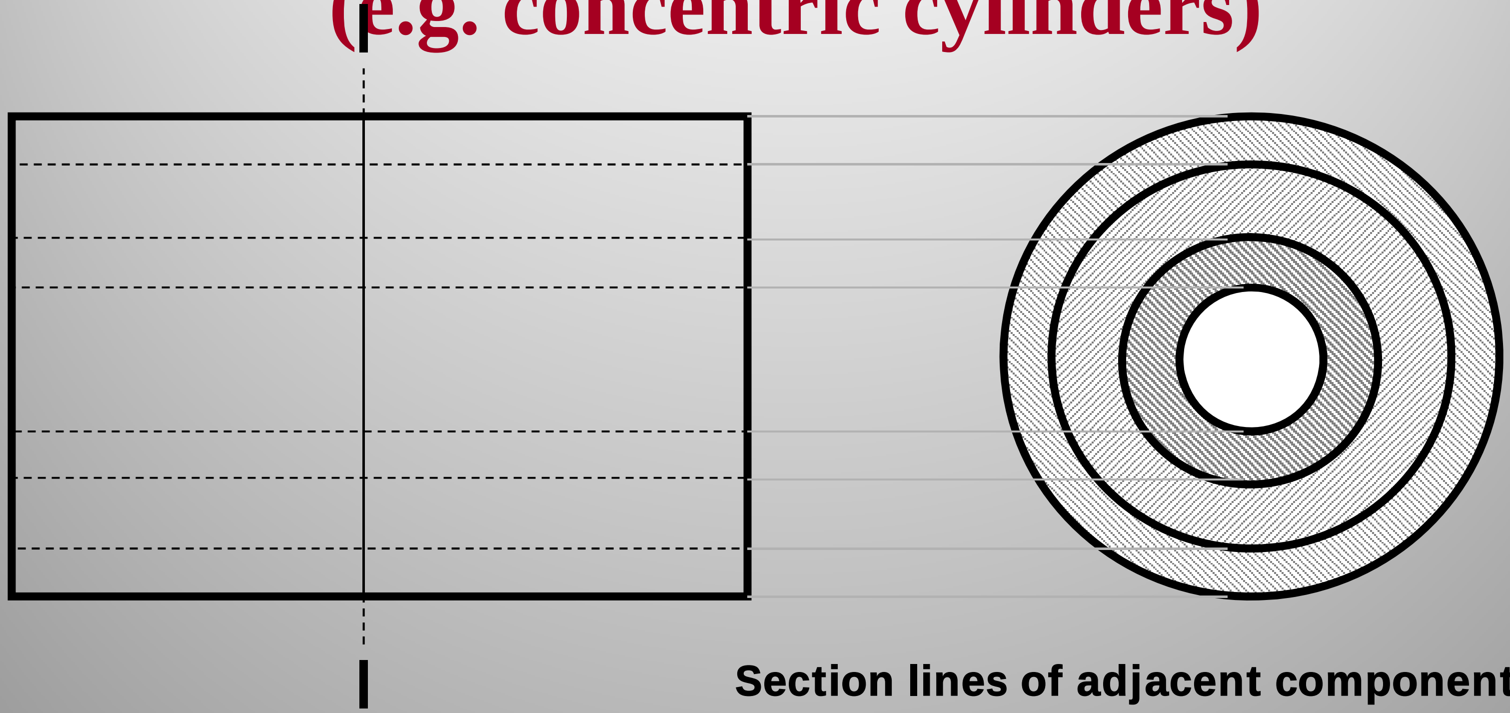
Orthographic Projections
Projection of solids
Section (Hatching)
True Shape / Auxiliary view

Example:


For TV
For True Shape
SECTION PLANE
TRUE SHAPE Of SECTION
F
Apparent Shape of section
SECTION LINES (45^0 to XY)
SECTIONAL T.V.

Section more than one component in the same drawing

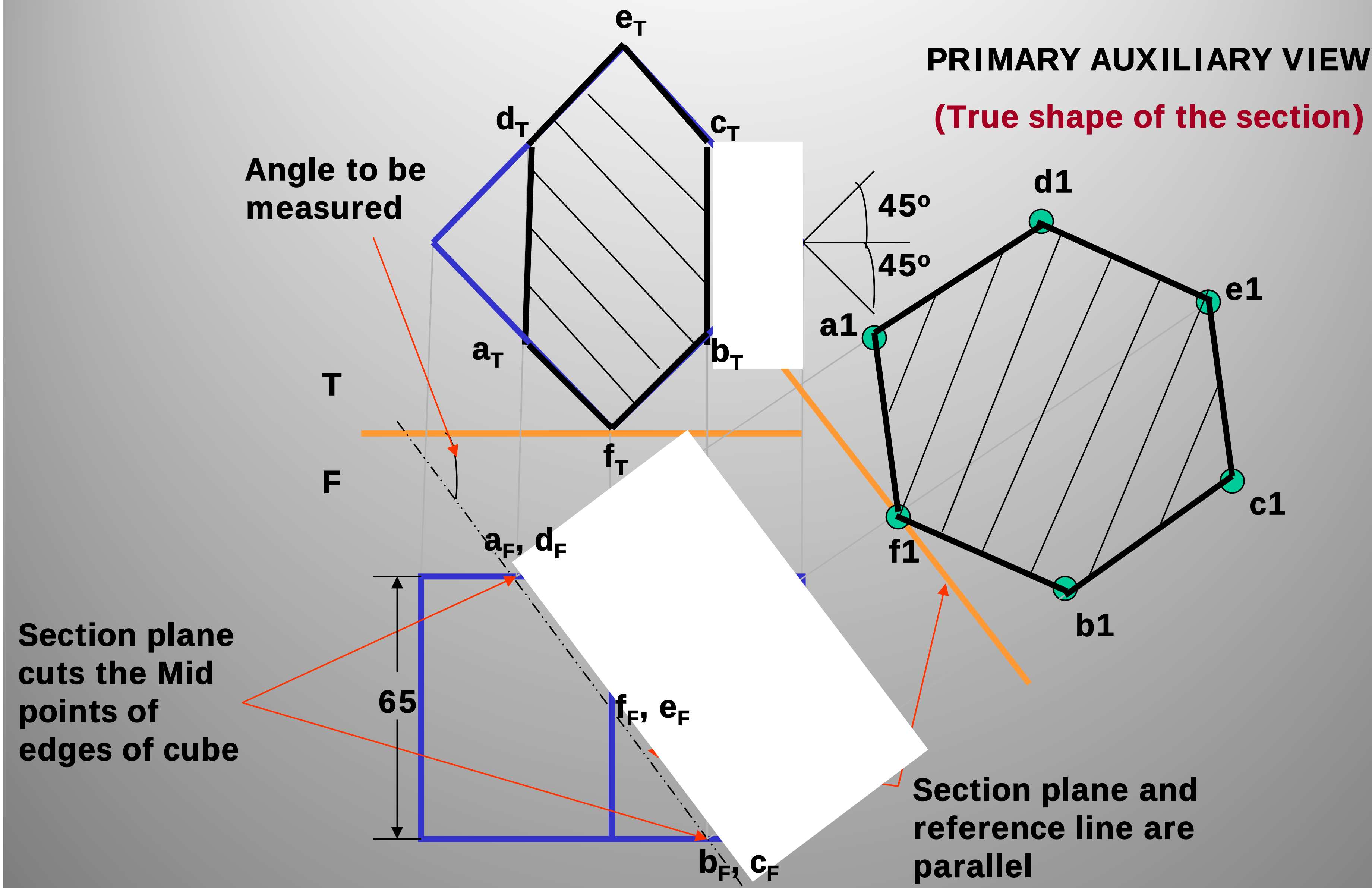
(e.g. concentric cylinders)



Section lines of adjacent components are drawn in different directions

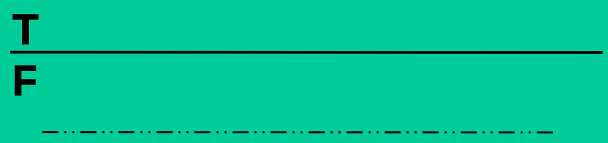
Section lines for alternate components can be drawn in the same direction but with different spacing between section lines

A cube of 65 mm long edges has its vertical faces equally inclined to the FP. It is cut by a section plane, perpendicular to the FP so that the true shape of the section is a regular hexagon. Determine the inclination of the cutting plane with the HP and draw the sectional top view and true shape of the section

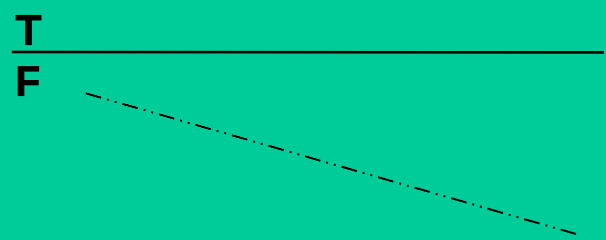


Location of Section Planes

Horizontal Plane

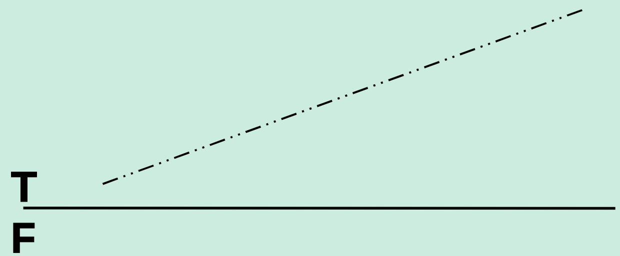


Inclined Plane to H.P. (A.I.P.)



Vertical Plane

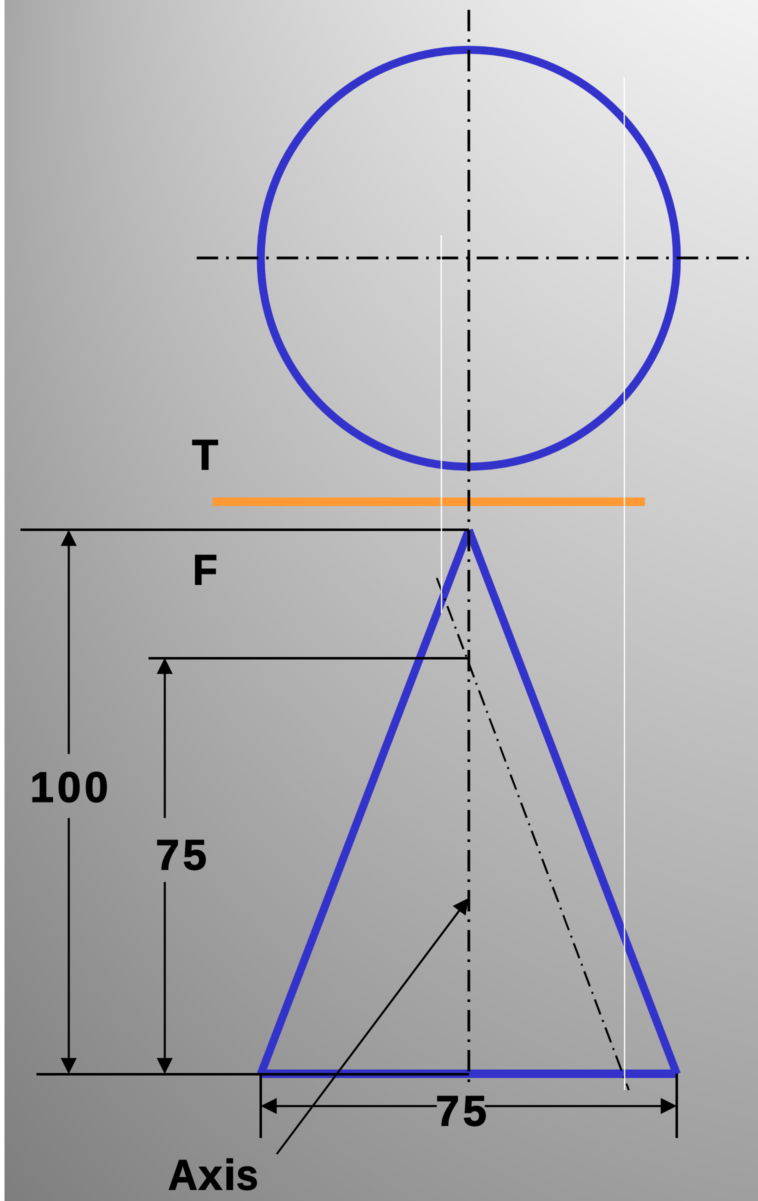
Auxiliary V. P.

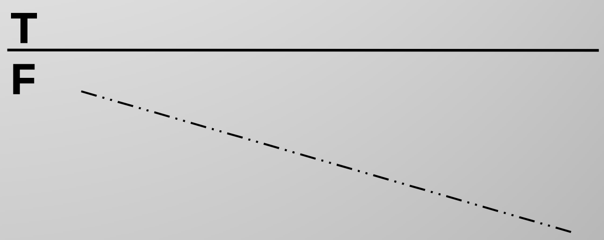


P.P. cutting plane ??

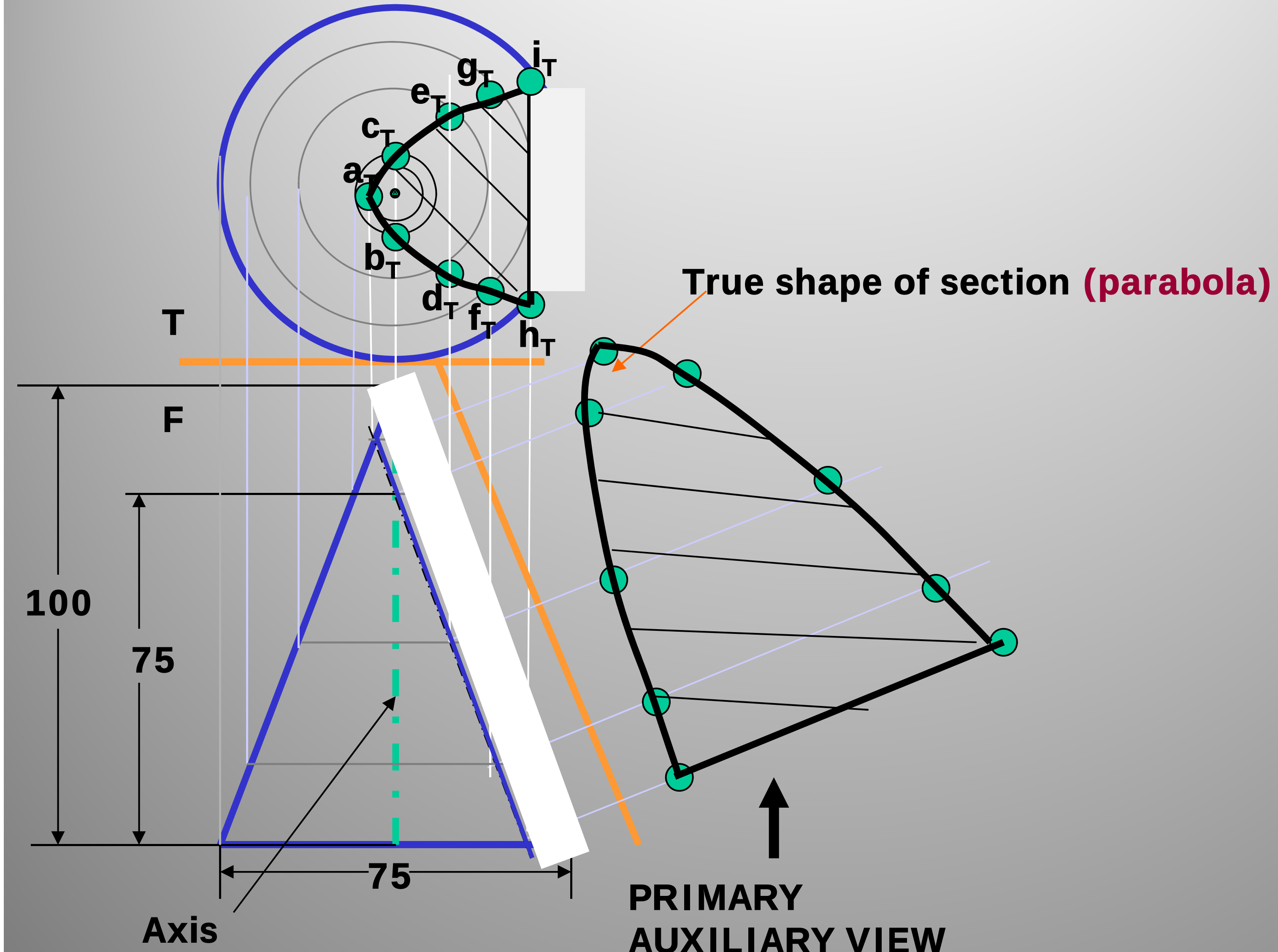
Oblique cutting plane

A cone, base 75 mm diameter and height 100 mm , has its base on the HP. **A section plane parallel to one of the end generators and perpendicular to the FP cuts the cone intersecting the axis at a point 75 mm from the base.** Draw the sectional Top View and the true shape of the section

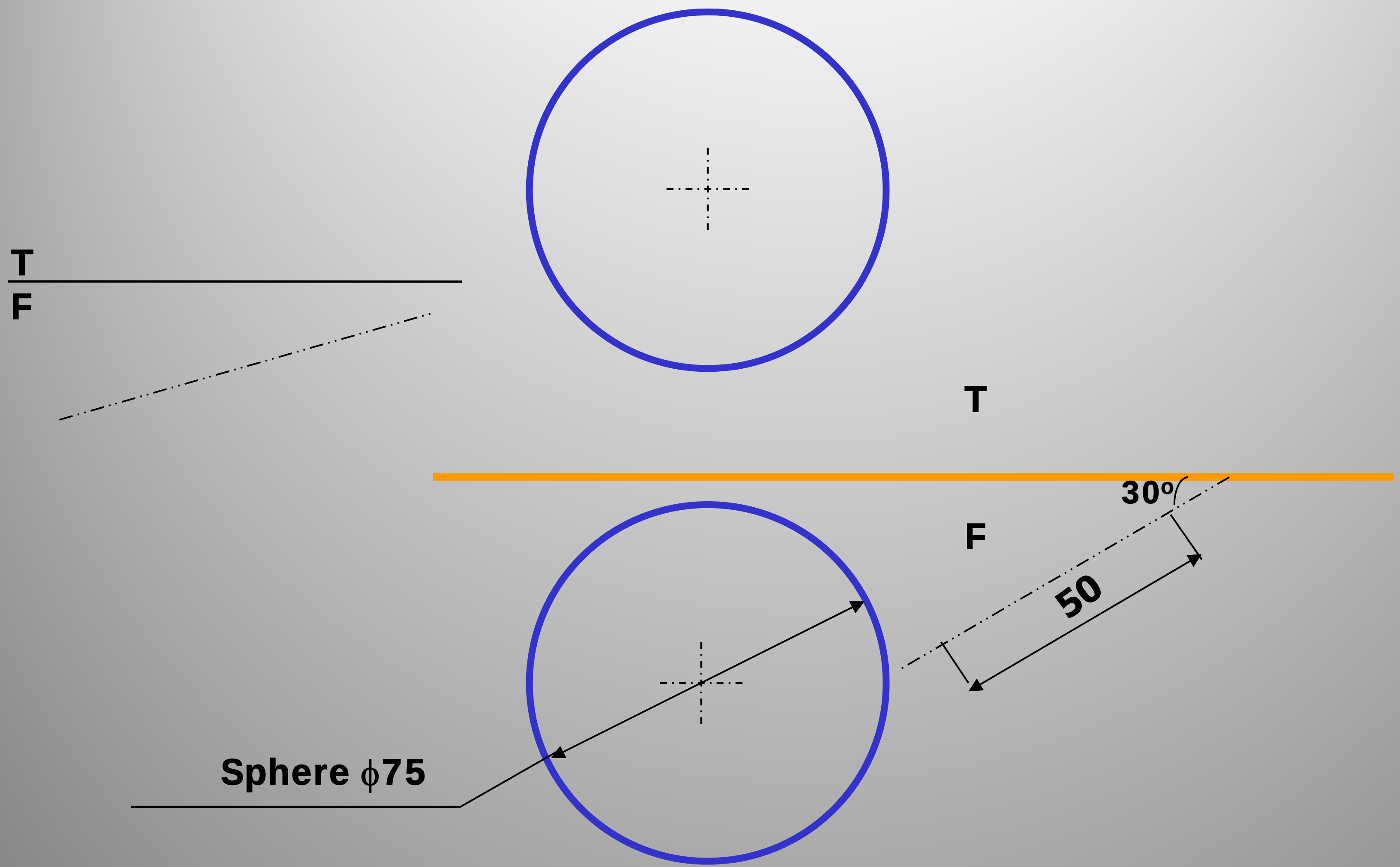


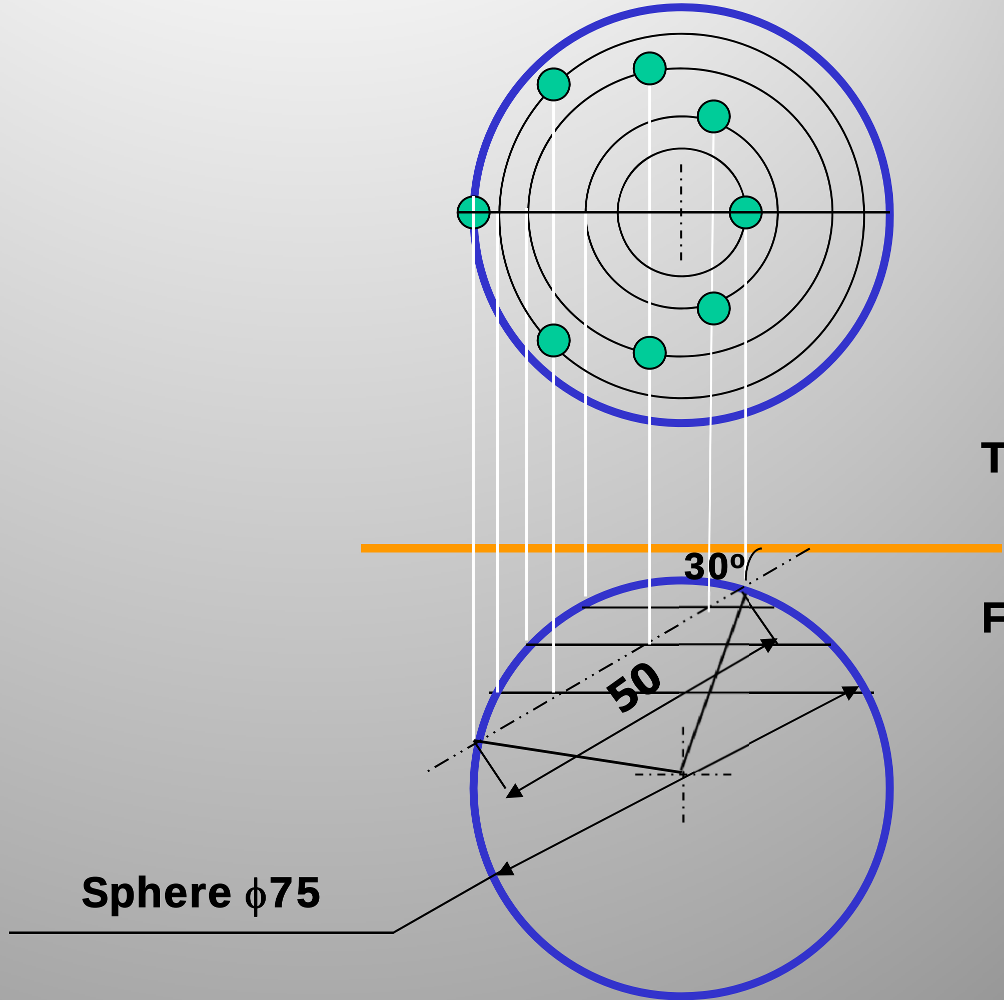


A cone base 75 mm diameter and axis 100 m long, has its base on the HP. A section plane parallel to one of the end generators and perpendicular to the FP cuts the cone intersecting the axis at a point 75 mm from the base. Draw the sectional Top View and the true shape of the section

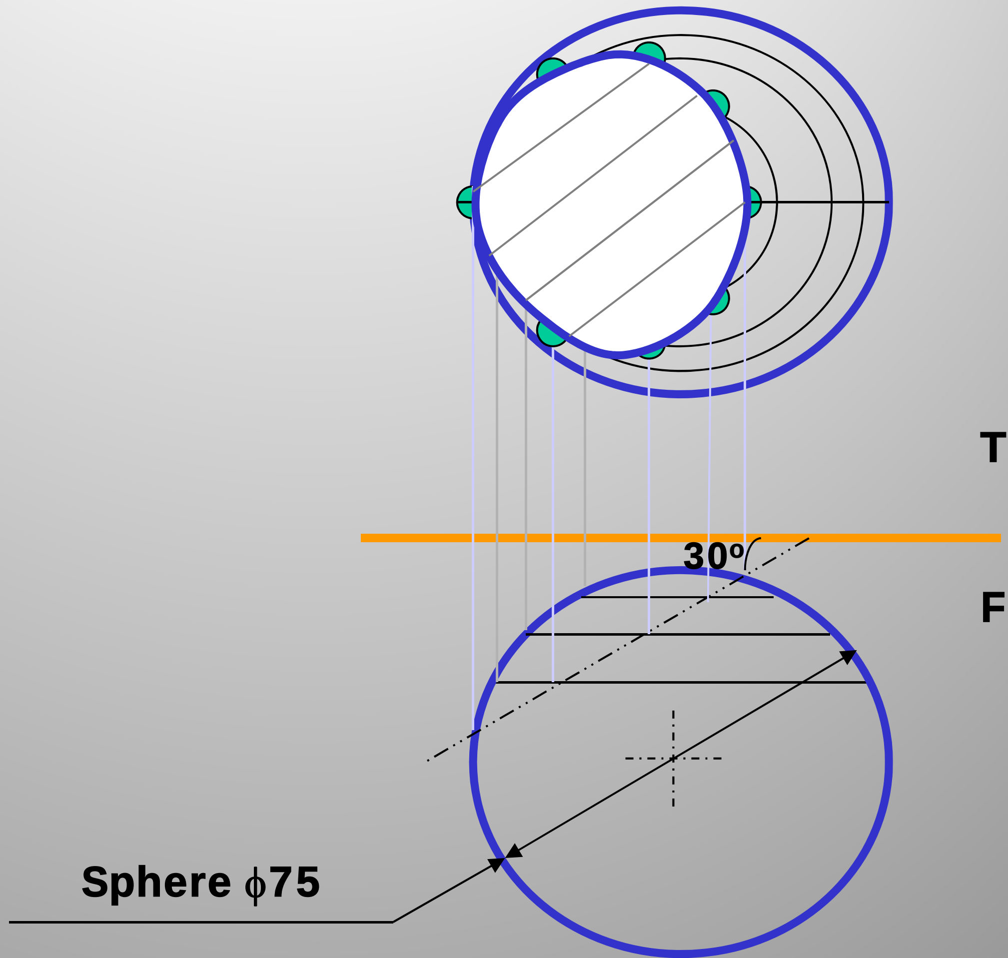


A sphere of 75 mm diameter is cut by a section plane, perpendicular to the FP and inclined at 30° to the HP in such a way that the True Shape of the section is a circle of 50 mm dia. Draw its front view and sectional top view.

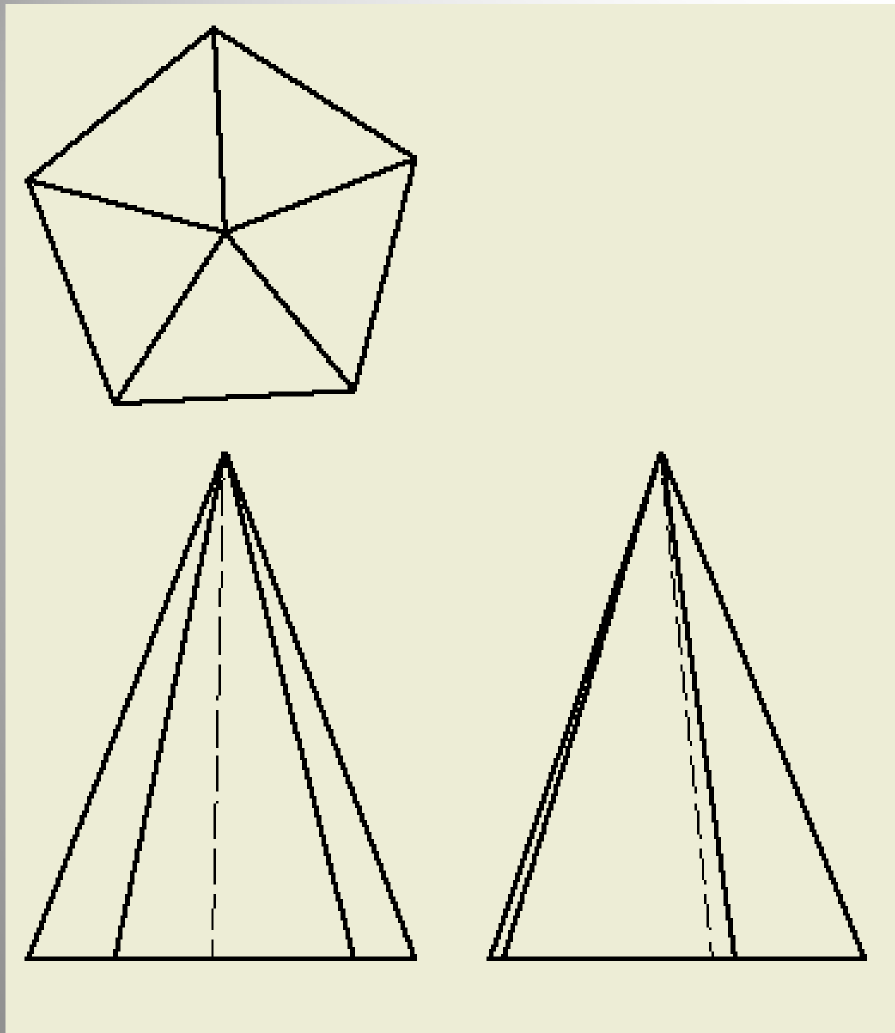


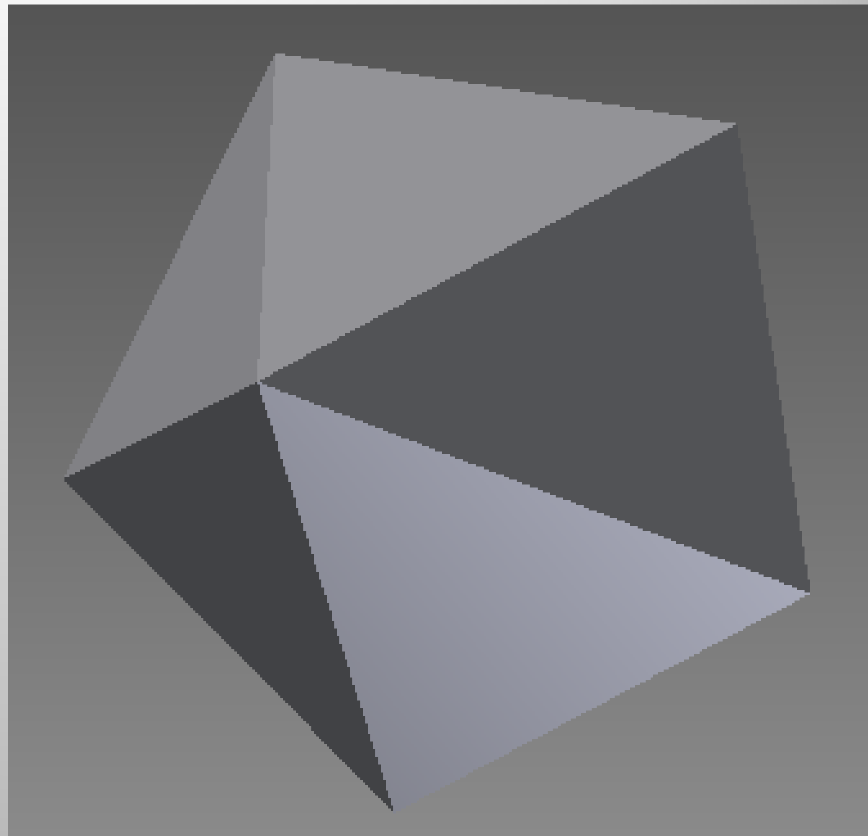


T
F
30º
50
Sphere ϕ75

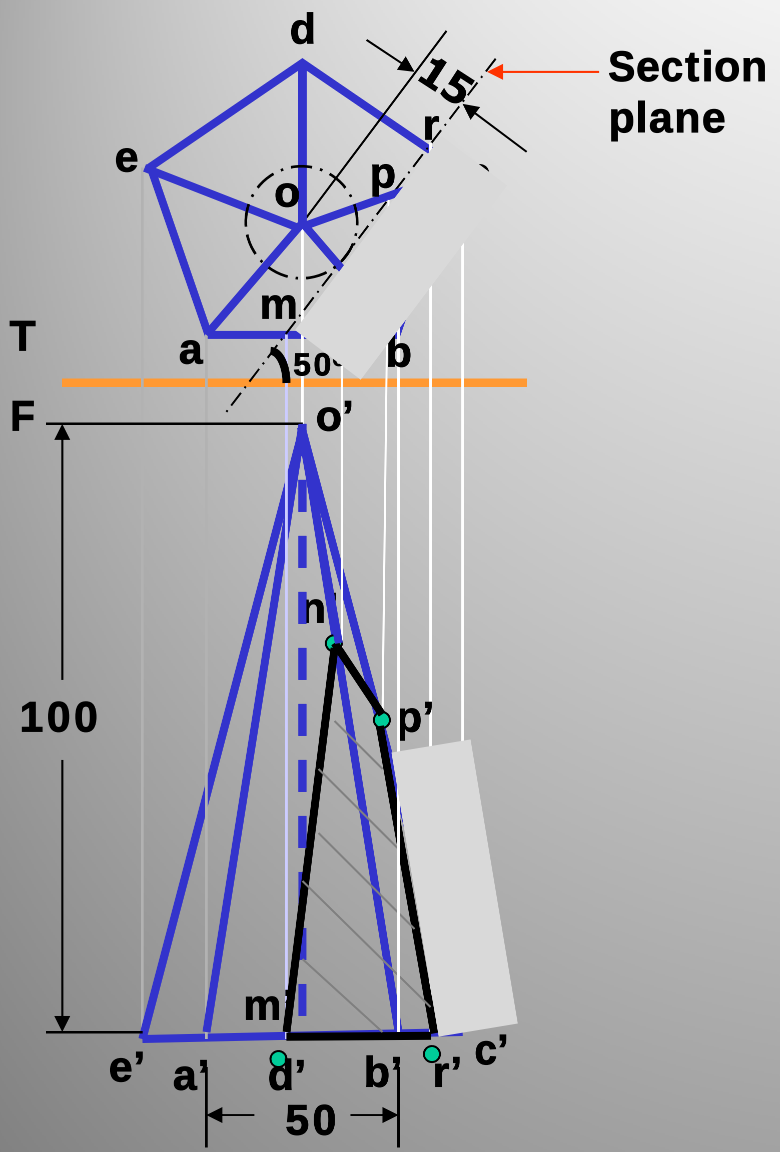

T
30°
F
Sphere ϕ75

Section of Pyramid

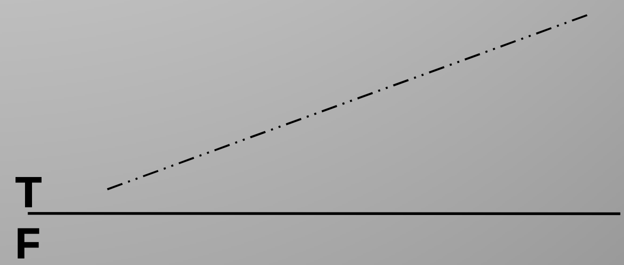


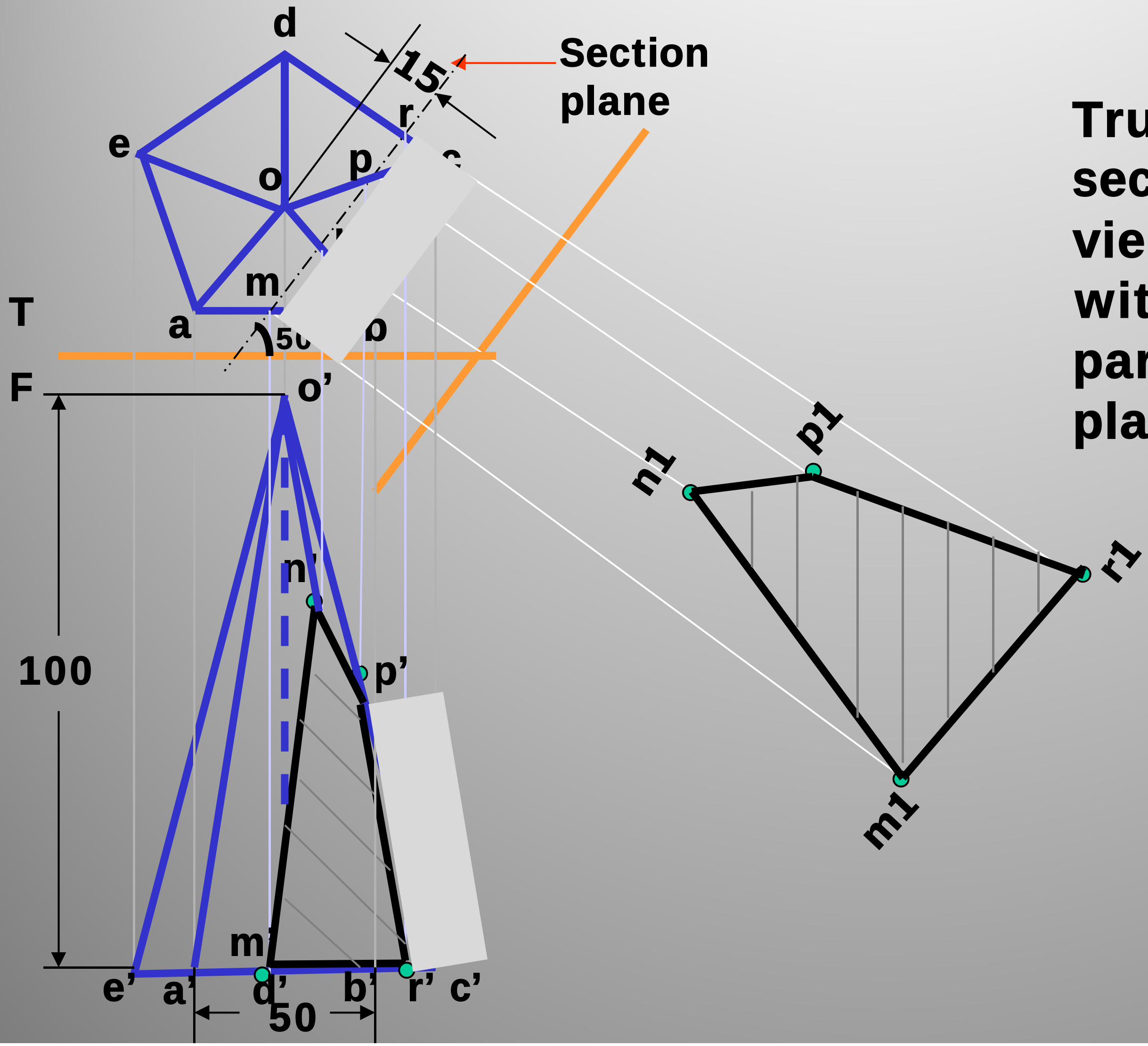


Pentagonal pyramid base 30 mm and height 65mm.



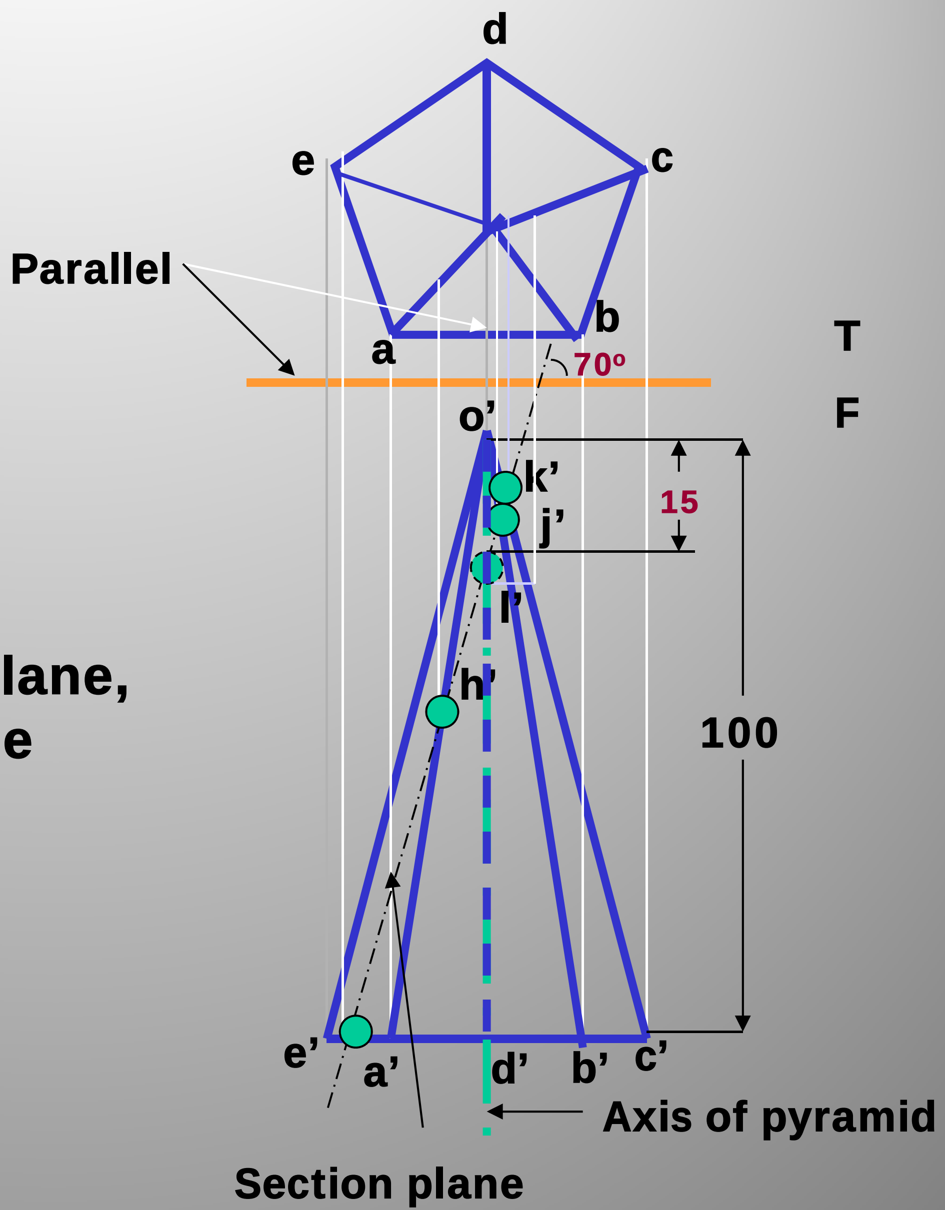
A pentagonal pyramid (side of base = 50 mm and height = 100 mm) is resting on its base on the ground with axis parallel to frontal plane and perpendicular to the top plane. One of the sides of the base is closer and parallel to the frontal plane. A vertical section plane cuts the pyramid at a distance of 15 mm from the axis with section plane making an angle of 50° with FP. Draw the remaining part of the pyramid and the true shape of the cut section





True shape of the section → Auxiliary view to the top view with the reference line parallel to the section plane

Given pyramid is cut by plane, ⊥ to the frontal plane and inclined at 70º to the top plane. The cutting plane cuts the axis of the pyramid at 15mm from the apex. Draw the projections of the remaining part of the pyramid and the true shape of the cut section



Since the section plane is perpendicular to the frontal plane, the section line is drawn in the front view

How to locate the point "l"

Draw an imaginary horizontal line from the axis to the edge oc intersecting at z

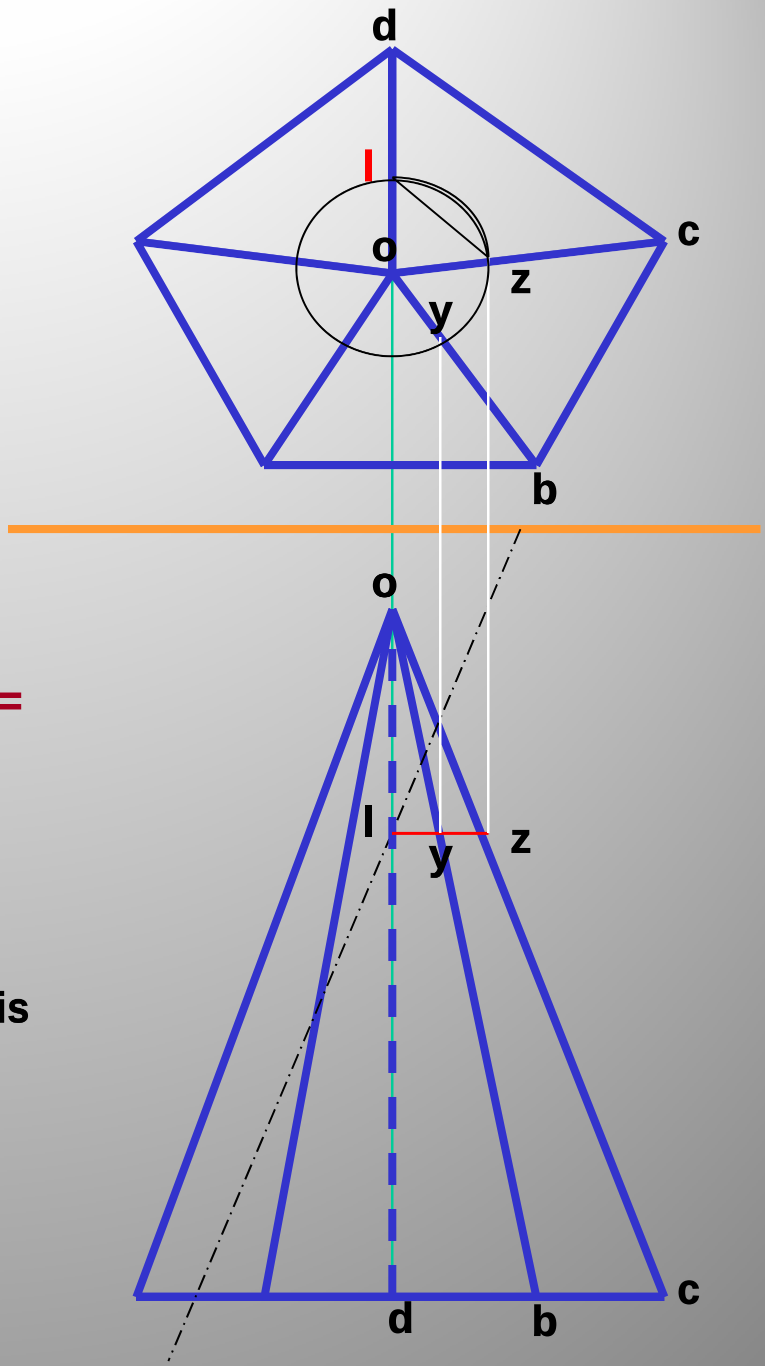
Project the point z into the Top view (oz is TL here)

With o as center and oz as radius draw an arc cutting od at l

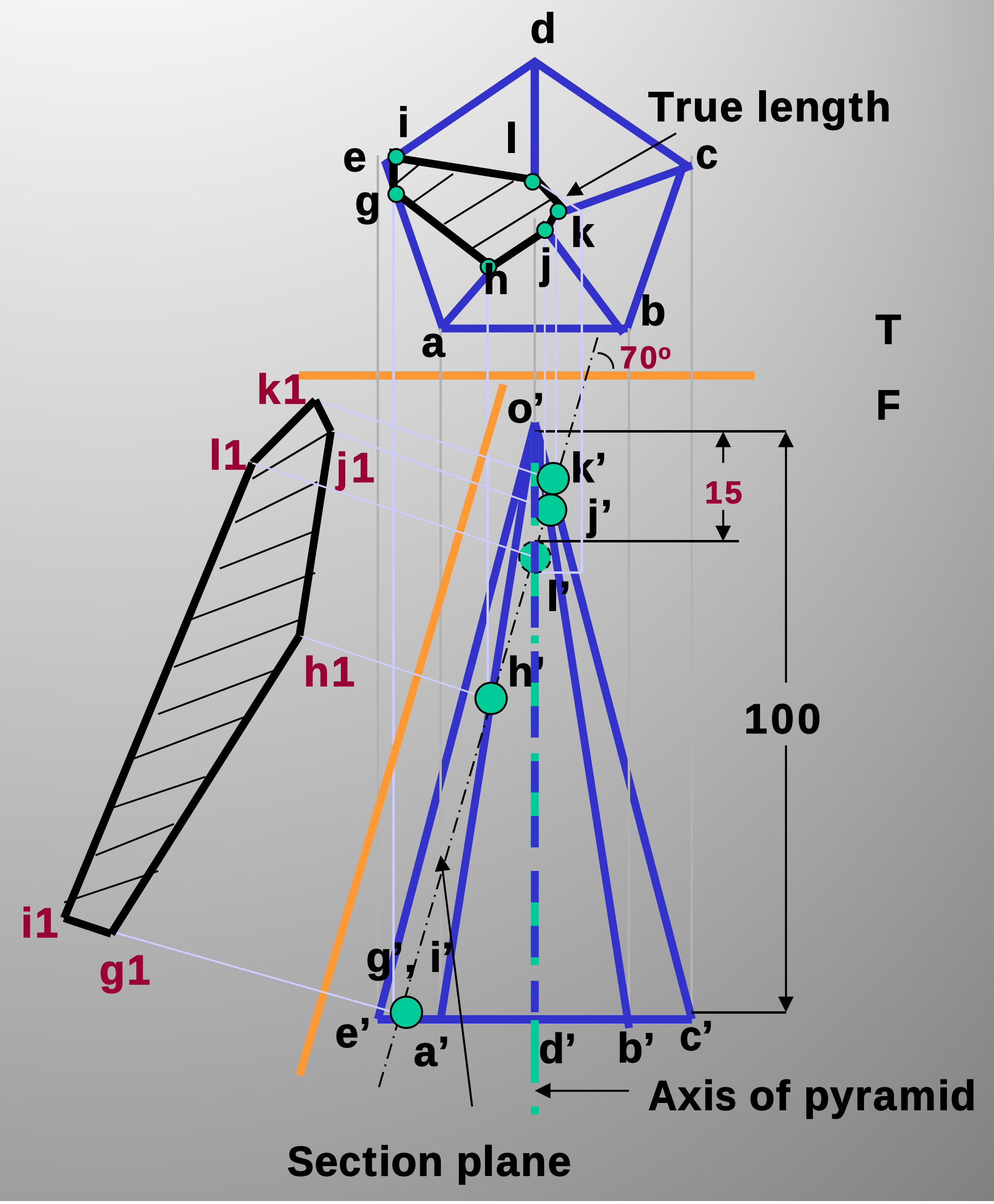
This can also be done by projecting onto ob at y and rotating.

Basically the imaginary line with length oz = oy is rotating inside the pyramid from one edge to another

This can also be obtained by drawing a line from z in the Top view parallel to dc (as dc is TL here)

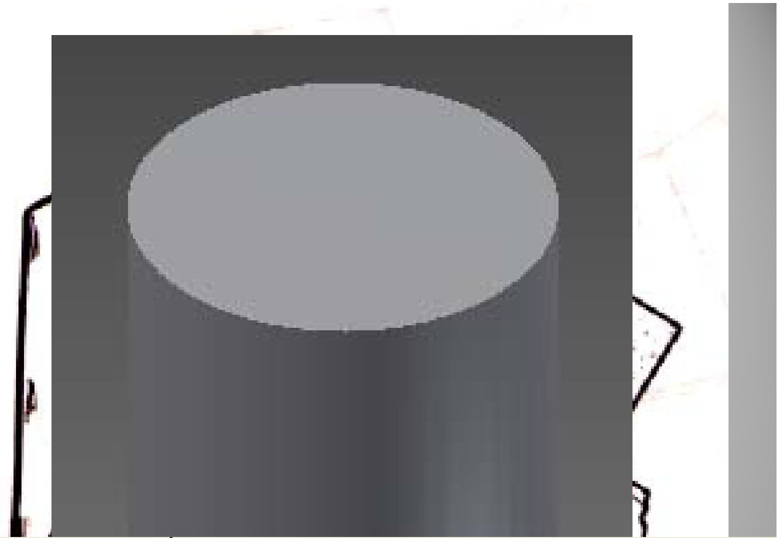


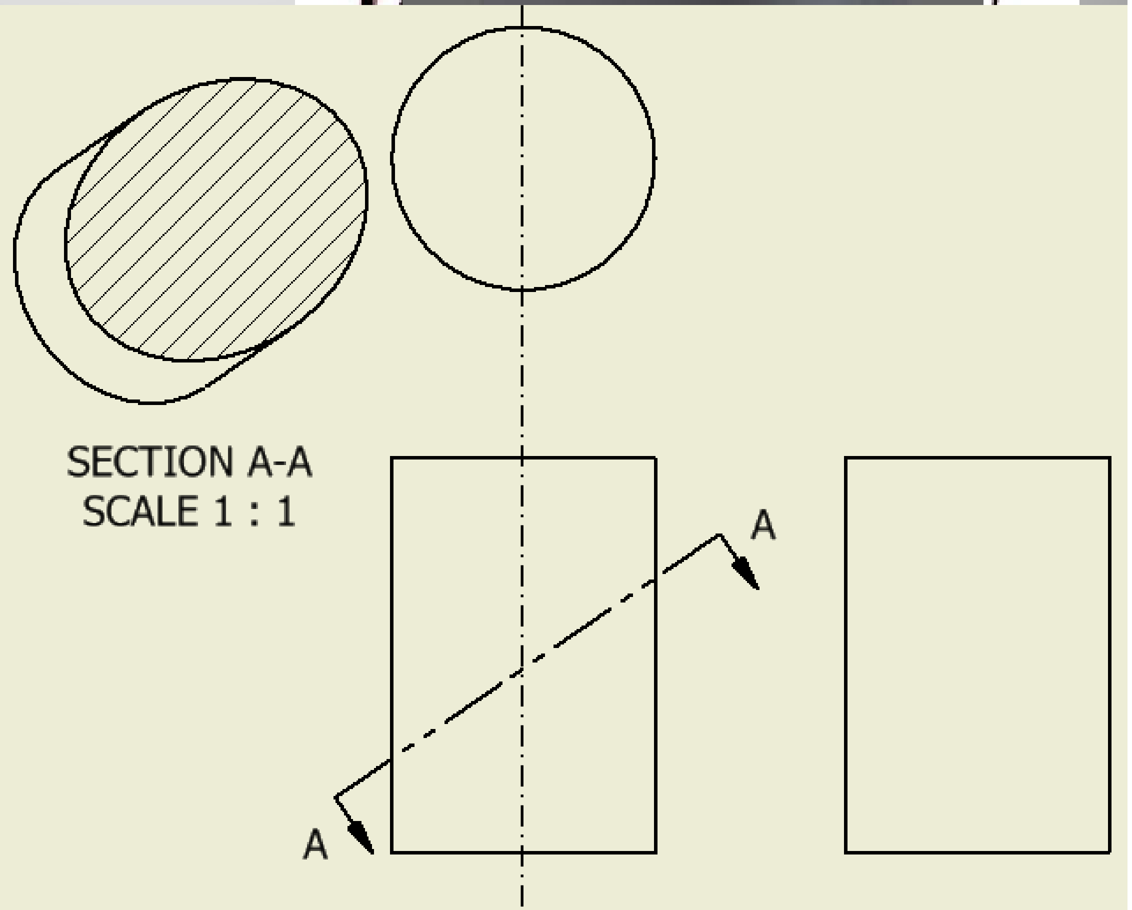
How to locate the point "l"



Section of Cylinder

- Cylinder dia = 40 mm.
- Height = 60mm.
- Axis is vertical.
- Section plane perpendicular to VP, but inclined to 45 degree to the HP and intersecting the axis 32 mm above the base.

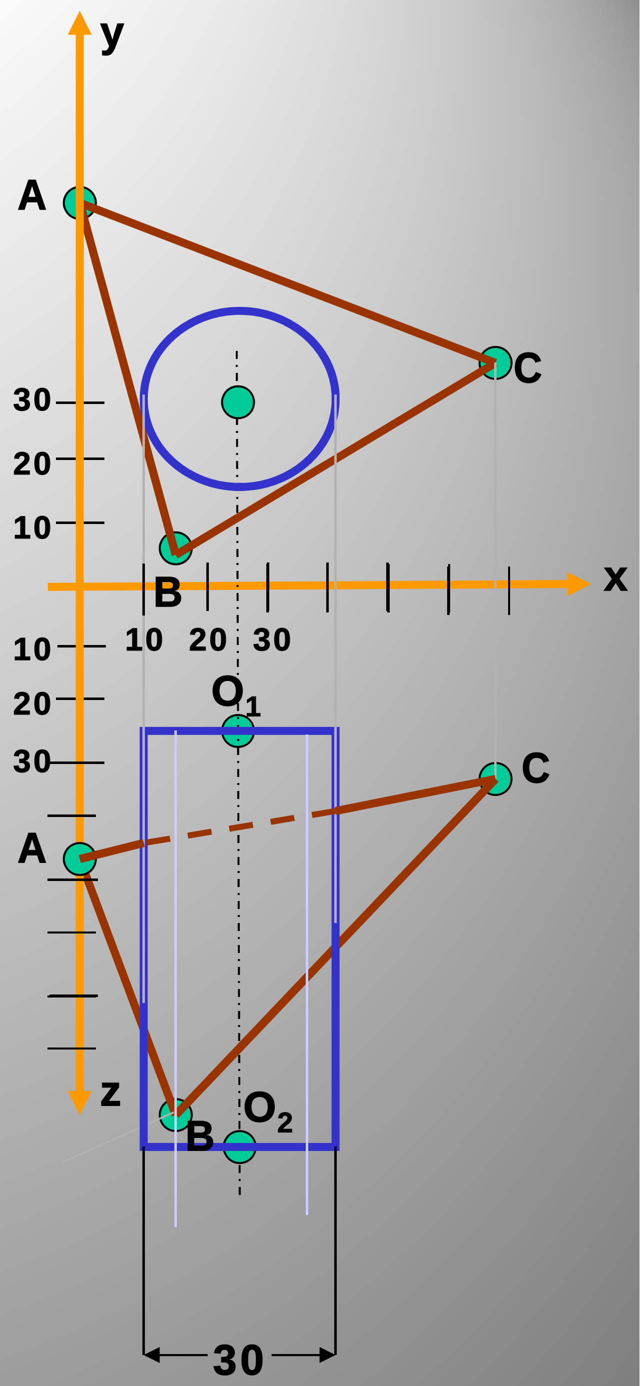




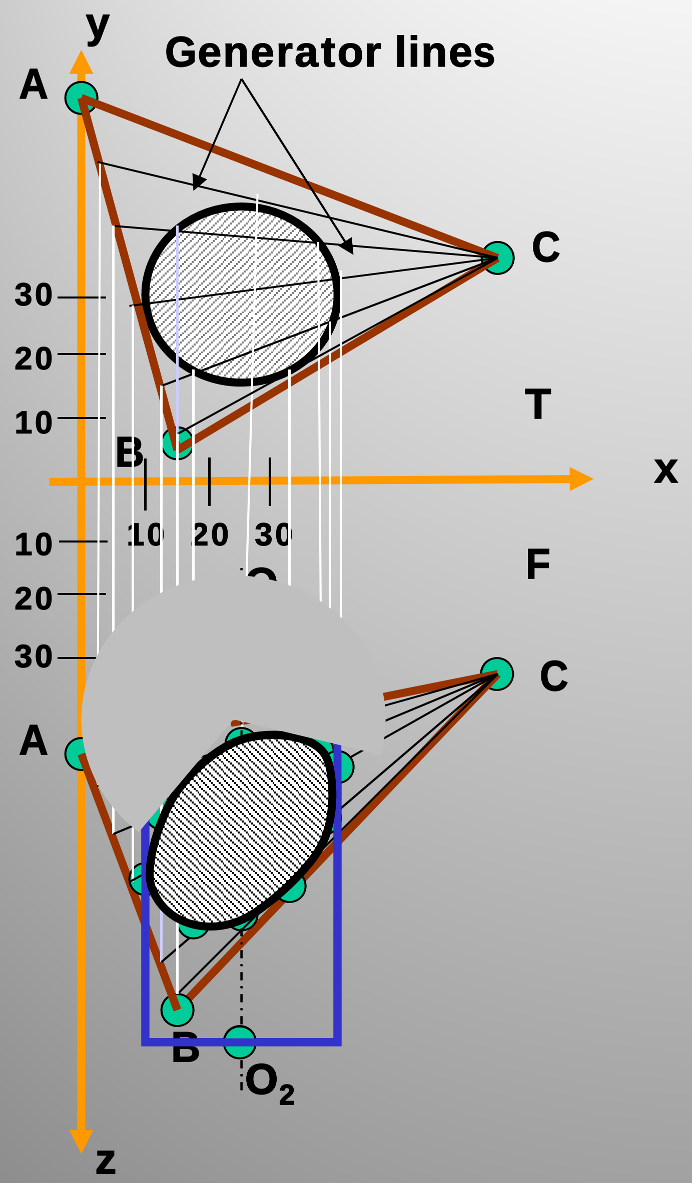
A cylinder, diameter of base 30 mm is standing on its base on ground and positioned in third quadrant. The position of center of upper base is O_1 (25, 30, 25) and the center of the lower base is O_2 (25, 30, 85).

Points A (0,60,45), B(15, 5, 80) and C(65, 35, 35) lie on a plane that cuts the cylinder in two parts. Draw the two orthographic views of the cut portion of the cylinder.

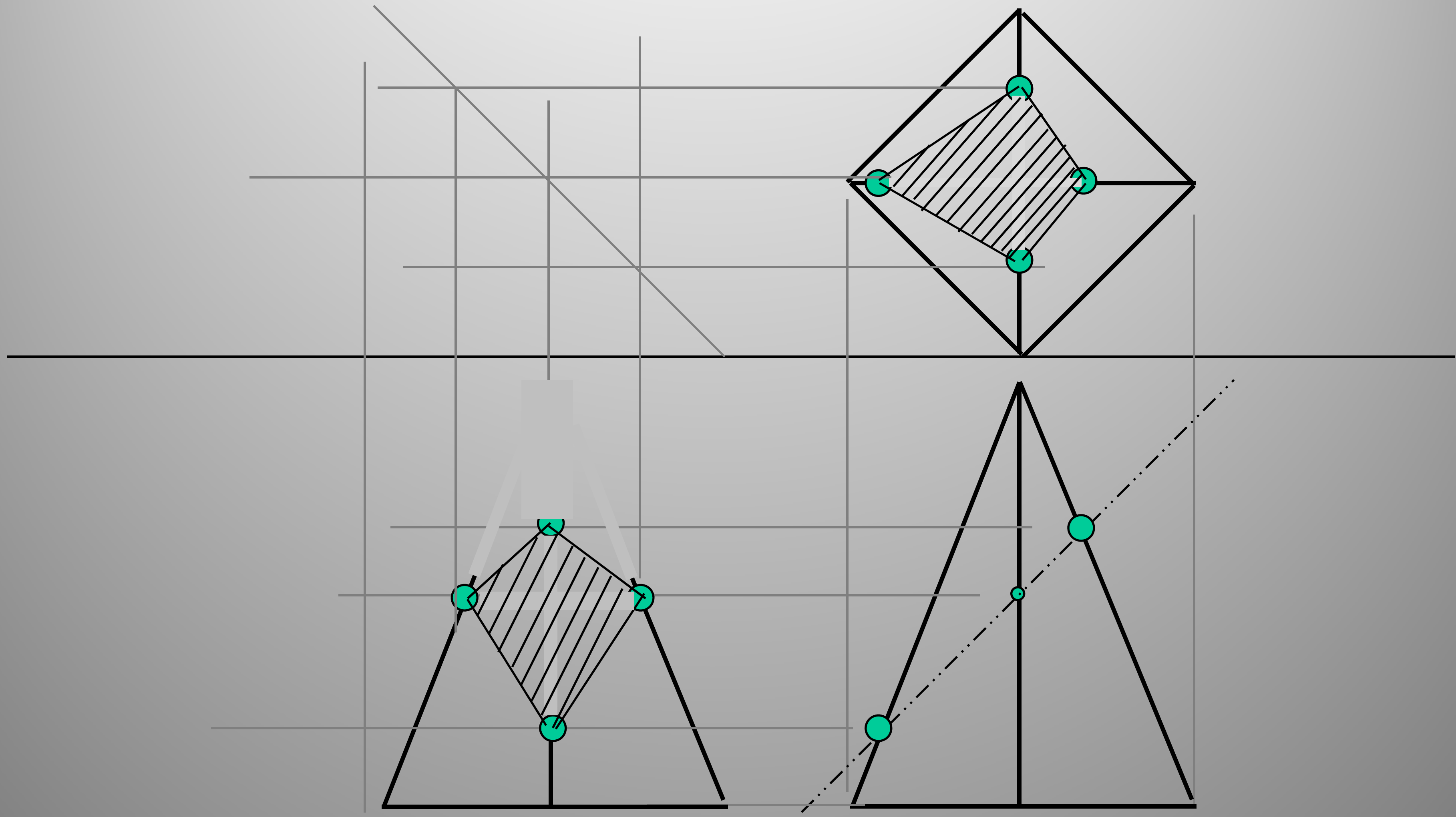
Oblique cutting plane



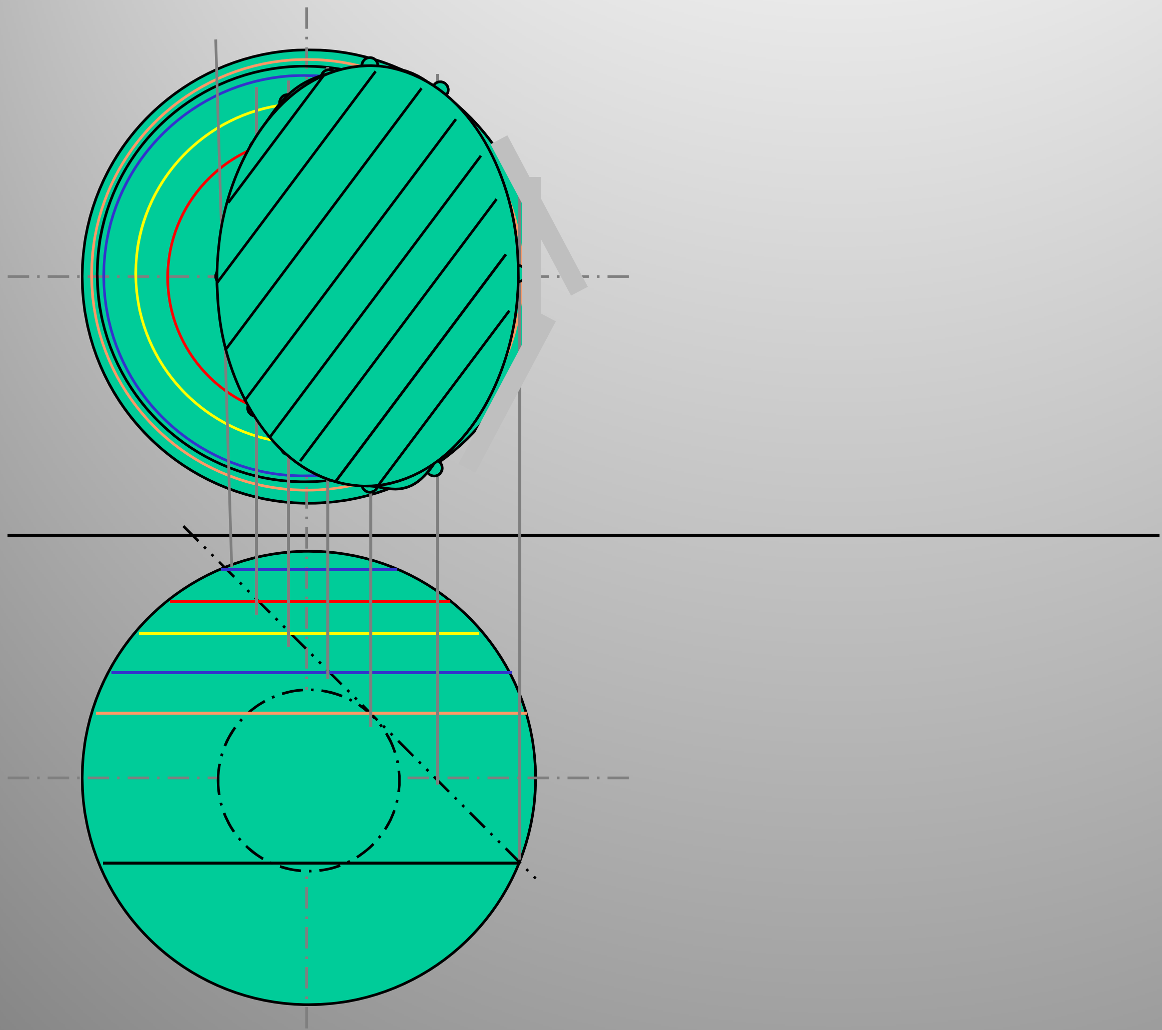
When cutting plane is oblique→



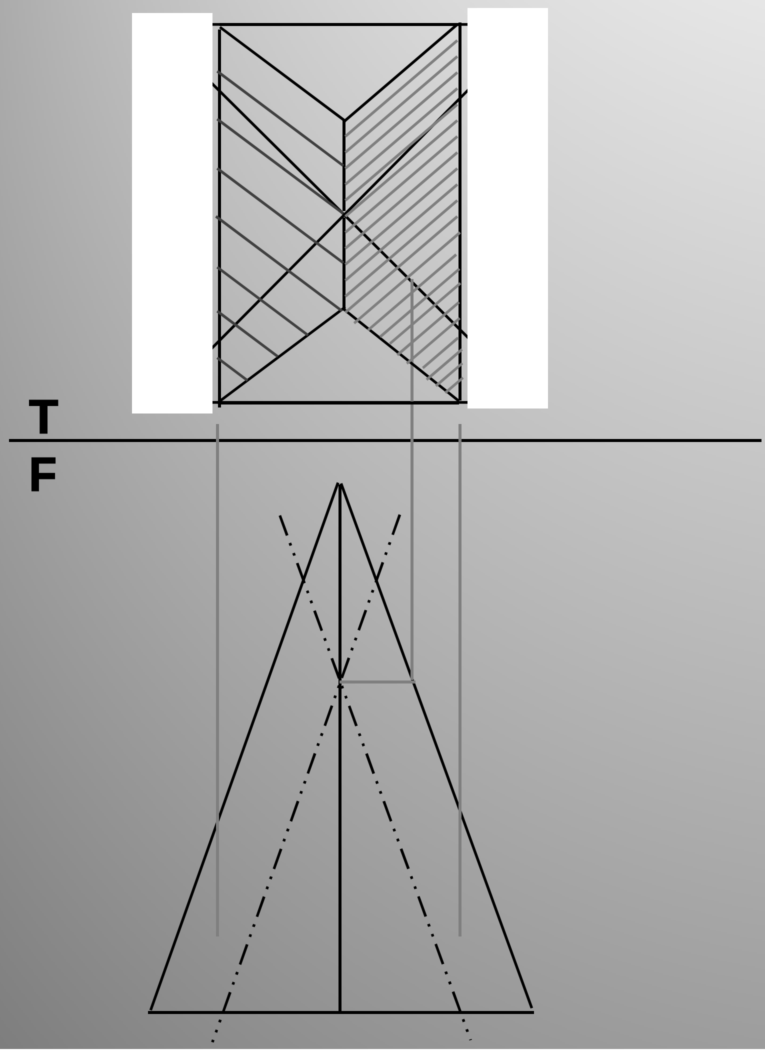
Problem: A square (side 40 mm) pyramid (height 70mm) stands on its base on H.P. and all the base sides are equally inclined to the V.P. A section plane (⊥ to V.P. and inclined at 45° to H.P.) bisects the axis of pyramid. Draw sectional top and sectional side views.



Problem: A sphere of 60 mm diameter is cut by a section plane perpendicular to the V.P., inclined at 45° to H.P. and at a distance of 12 mm from its center. Draw sectional top view.



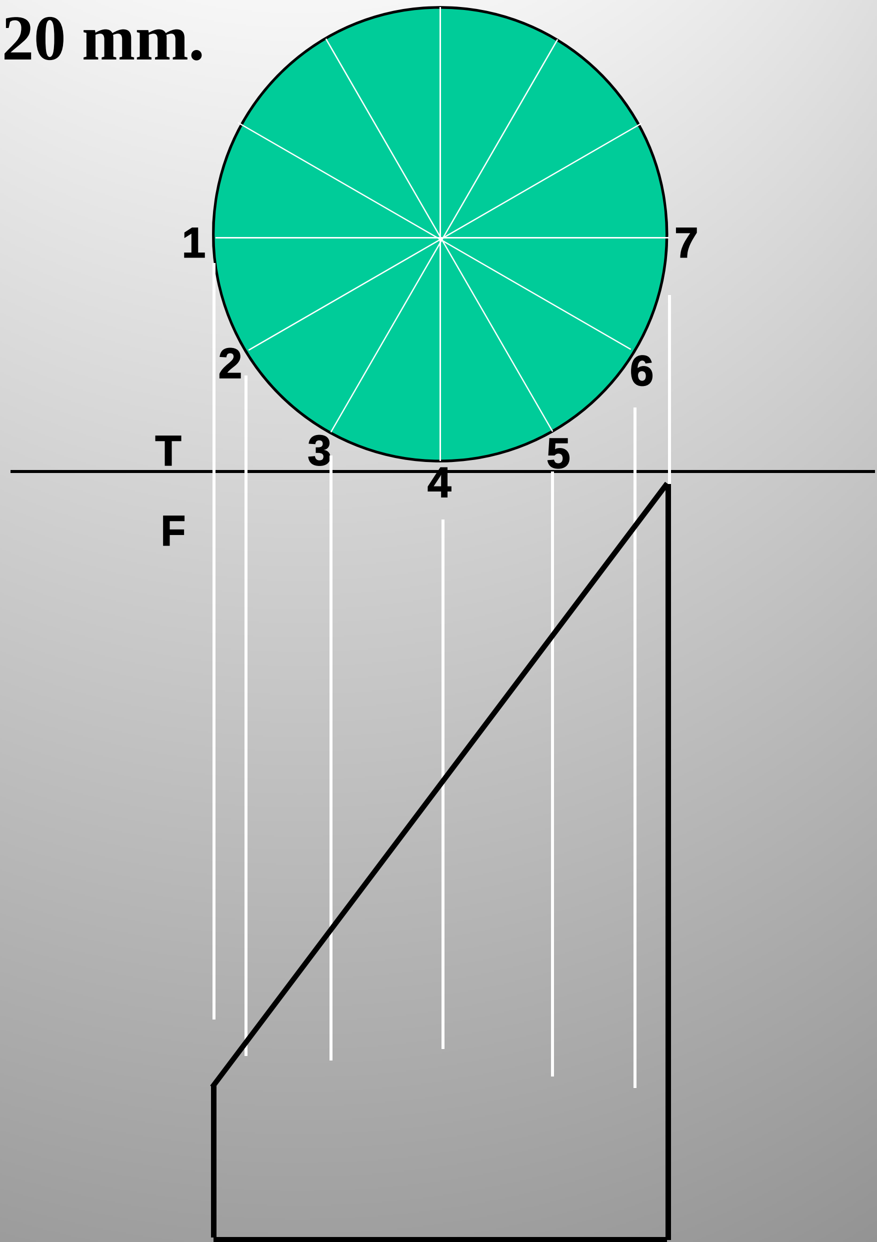
Ex: A square pyramid of 50 mm side of base and 80 mm length of axis is resting on its base on the H.P., having a side of base ⊥ to V.P. It is cut by 2-cutting planes. One plane is parallel to its extreme right face and 10 mm away from it, while other is parallel to the extreme left face and intersects first cutting plane on the axis of pyramid. Draw FV and sectional TV.



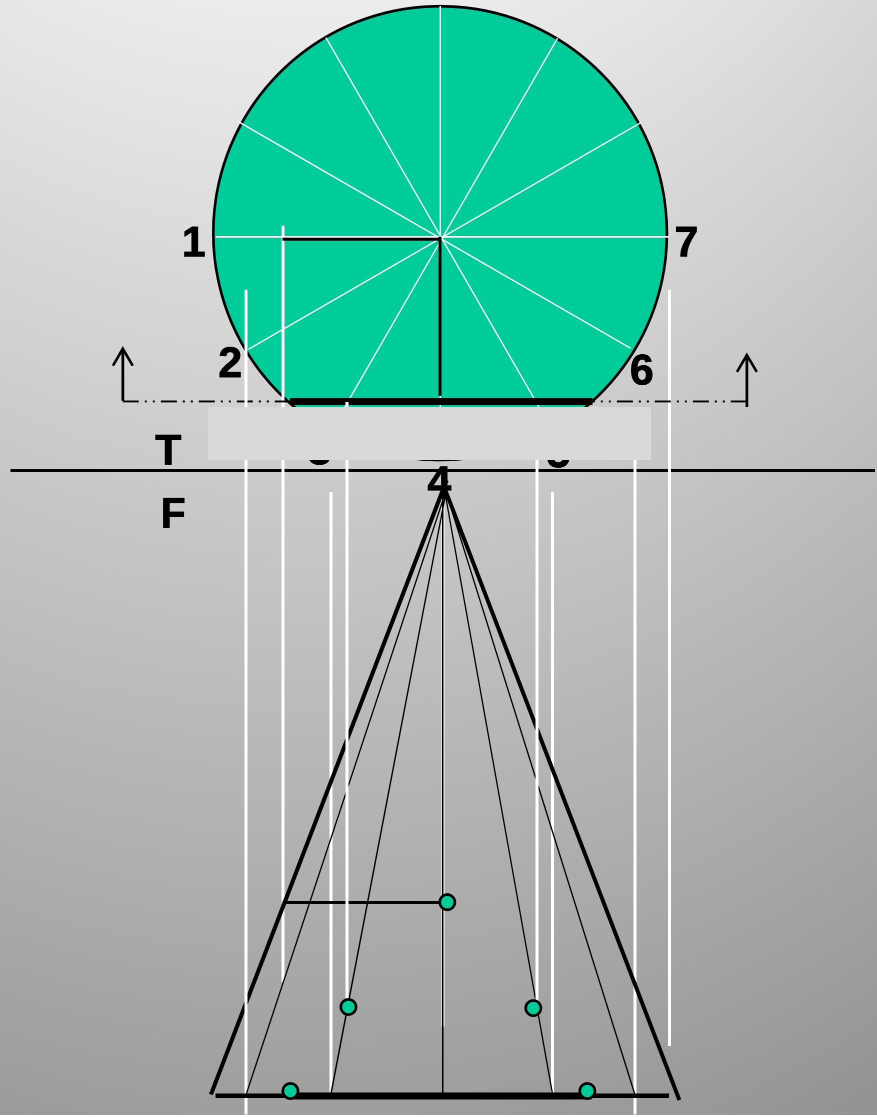
Ex: A cylinder is cut by an auxiliary plane such that true shape of section is an ellipse of major and minor axes of length 100 mm and 60 mm respectively. The smallest generator of the truncated cylinder is 20 mm. Find inclination (with axis) of the section plane.

Ex: A cone, having base dia of 60 mm and height of 80 mm is resting on its base on HP. It is cut by a section plane such that the true shape of the section in front view is a rectangular hyperbola with a base of 40mm. Find front and top views.

Cylinder is cut by plane such that true section shape of section is an ellipse (100 mm by 60 mm). Smallest generator of the truncated cylinder is 20 mm.

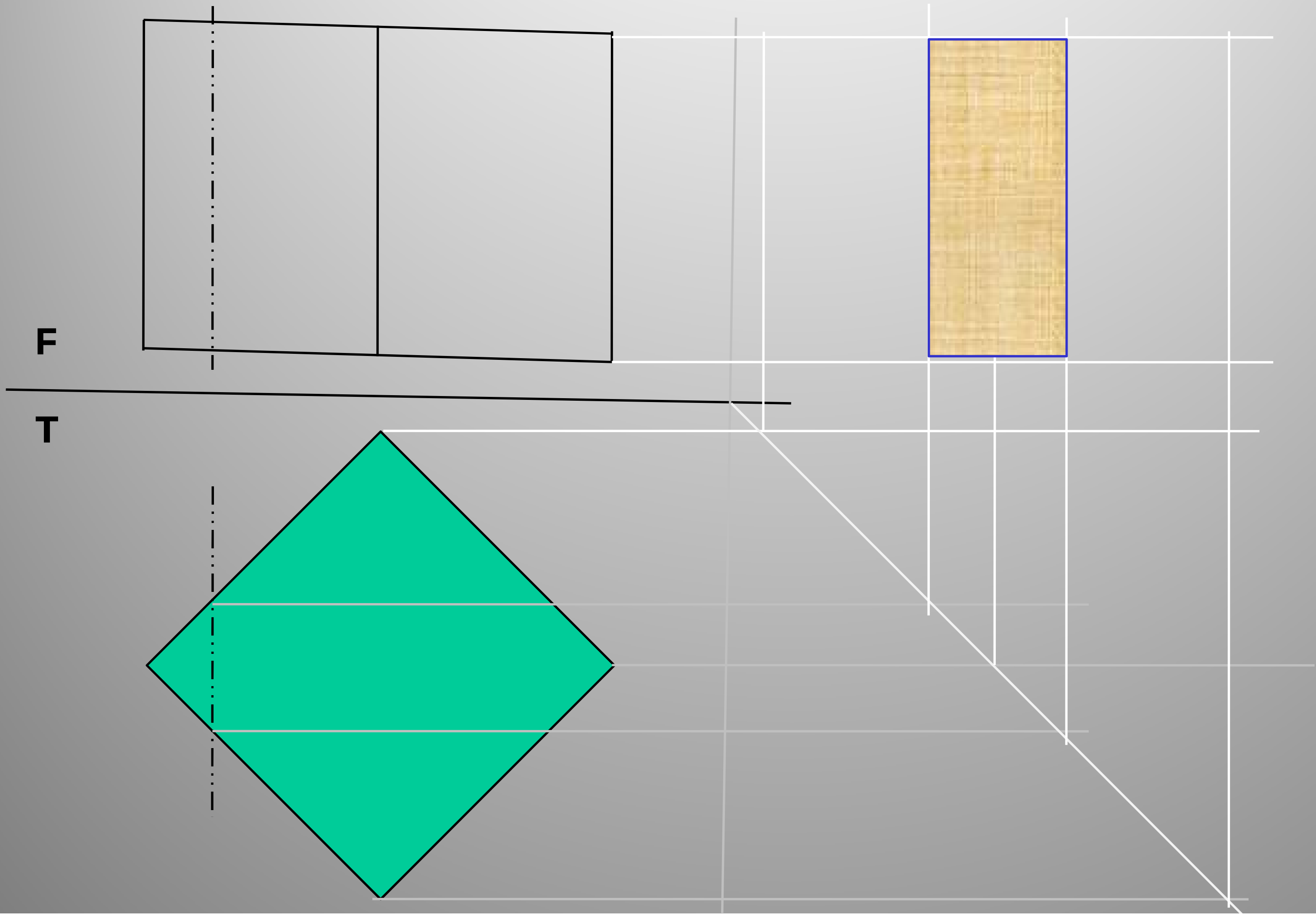


Ex: A cone, having base dia of 60 mm and height of 80 mm is resting on its base on HP. It is cut by a section plane such that the true shape of the section in front view is a rectangular hyperbola with a base of 40mm. Find front and top views.



Section plane ⊥ to HP & VP

Section will not be visible either in TV or FV ➔ Side view



ENGINEERING CURVES

Point undergoing two types of displacements

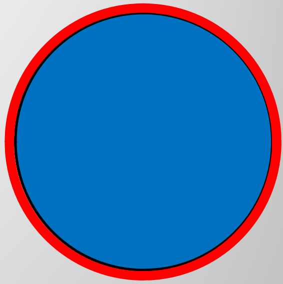
INVOLUTE: **Locus of a free end of a *string* when it is wound round a (circular) pole**

CYCLOID: **Locus of a *point* on the periphery of a circle which rolls on a straight line path.**

SPIRAL: **Locus of a *point* which revolves around a fixed point and at the same time moves towards it.**

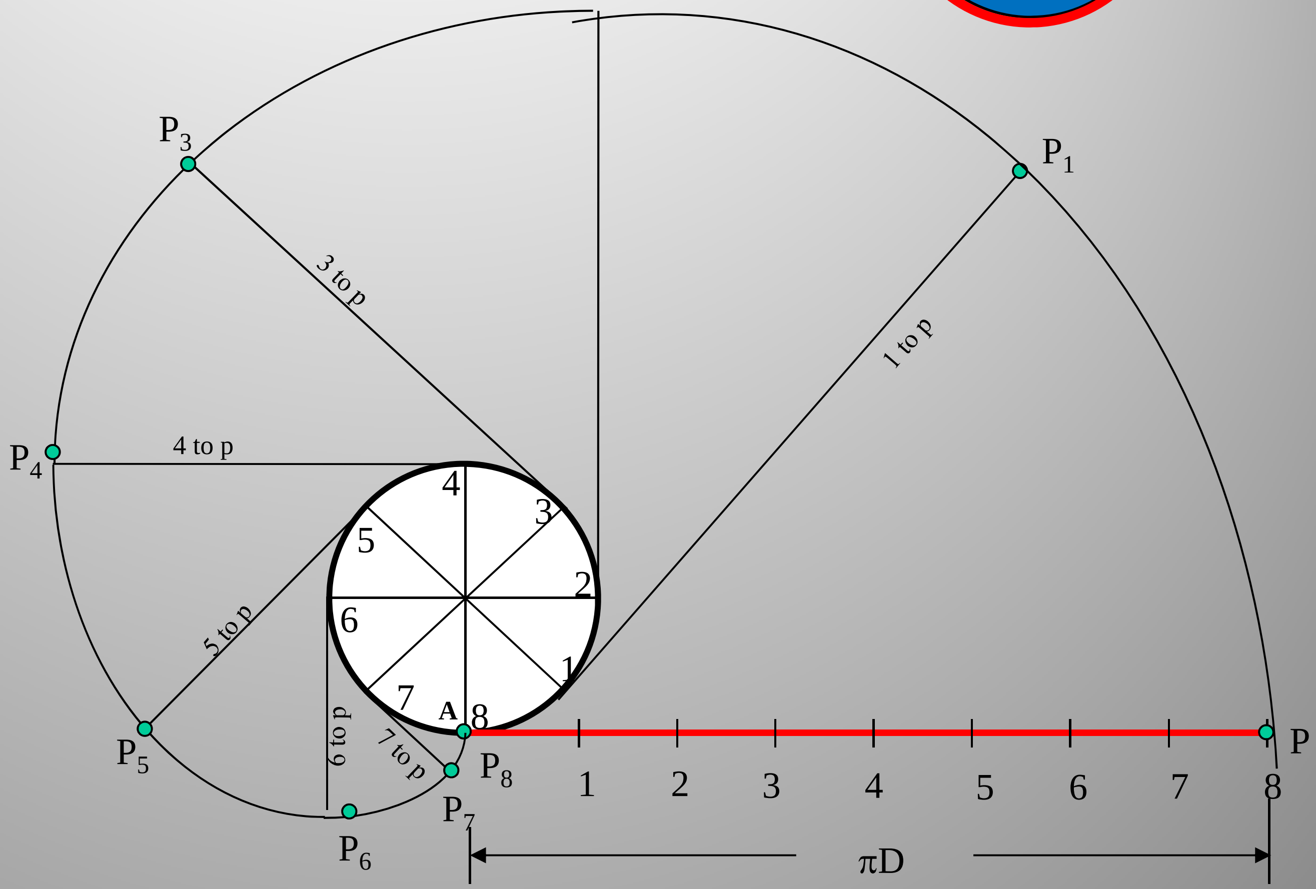
HELIX: **Locus of a point which moves around the surface of a right circular cylinder / cone and at the same time advances in axial direction at a speed bearing a constant ratio to the speed of rotation.**

INVOLUTE OF A CIRCLE



- Problem:

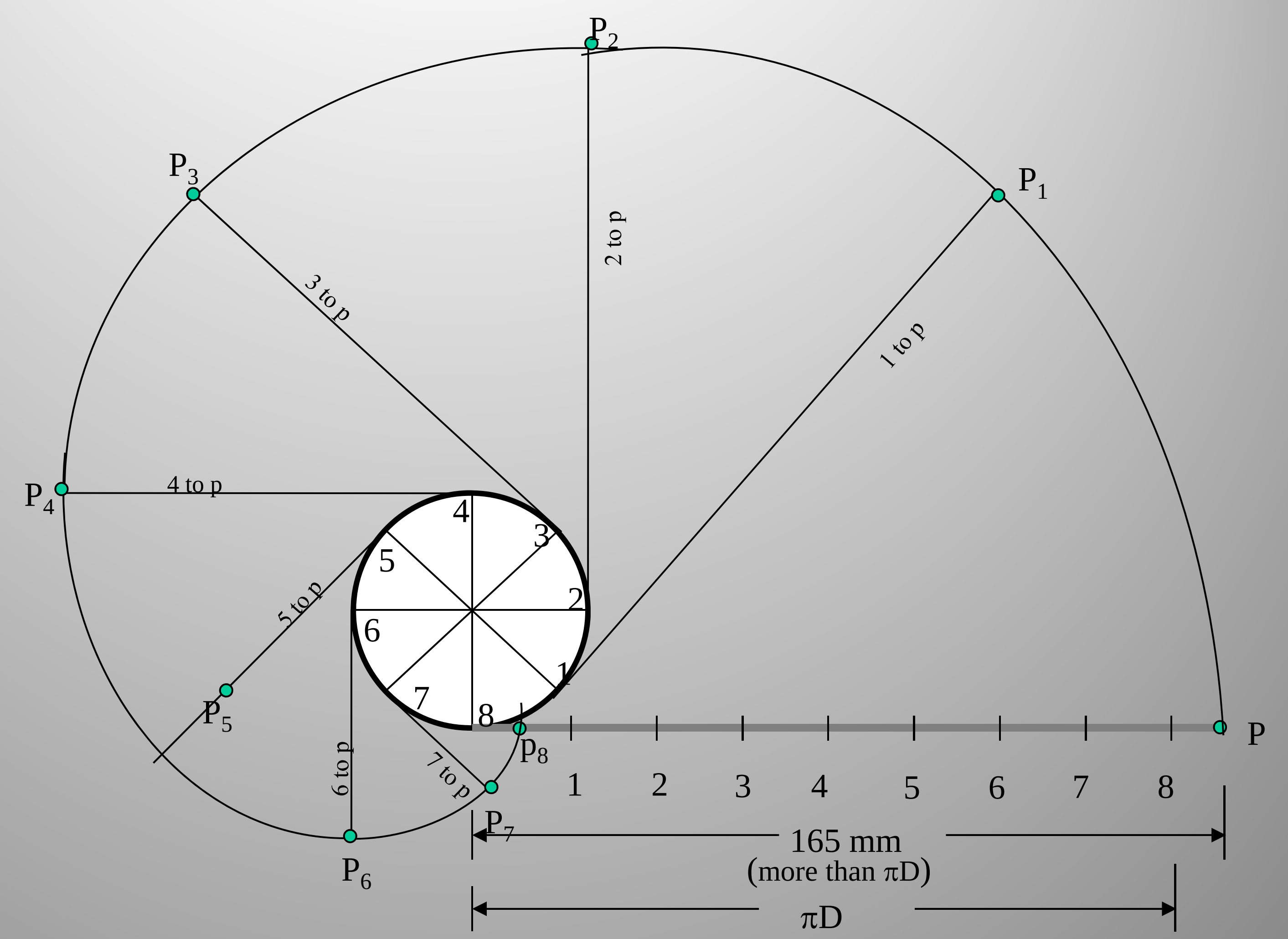
Draw Involute of a circle. String length is equal to the circumference of circle.



Problem: Draw Involute of a circle. String length is MORE than the circumference of circle.

INVOLUTE OF A CIRCLE

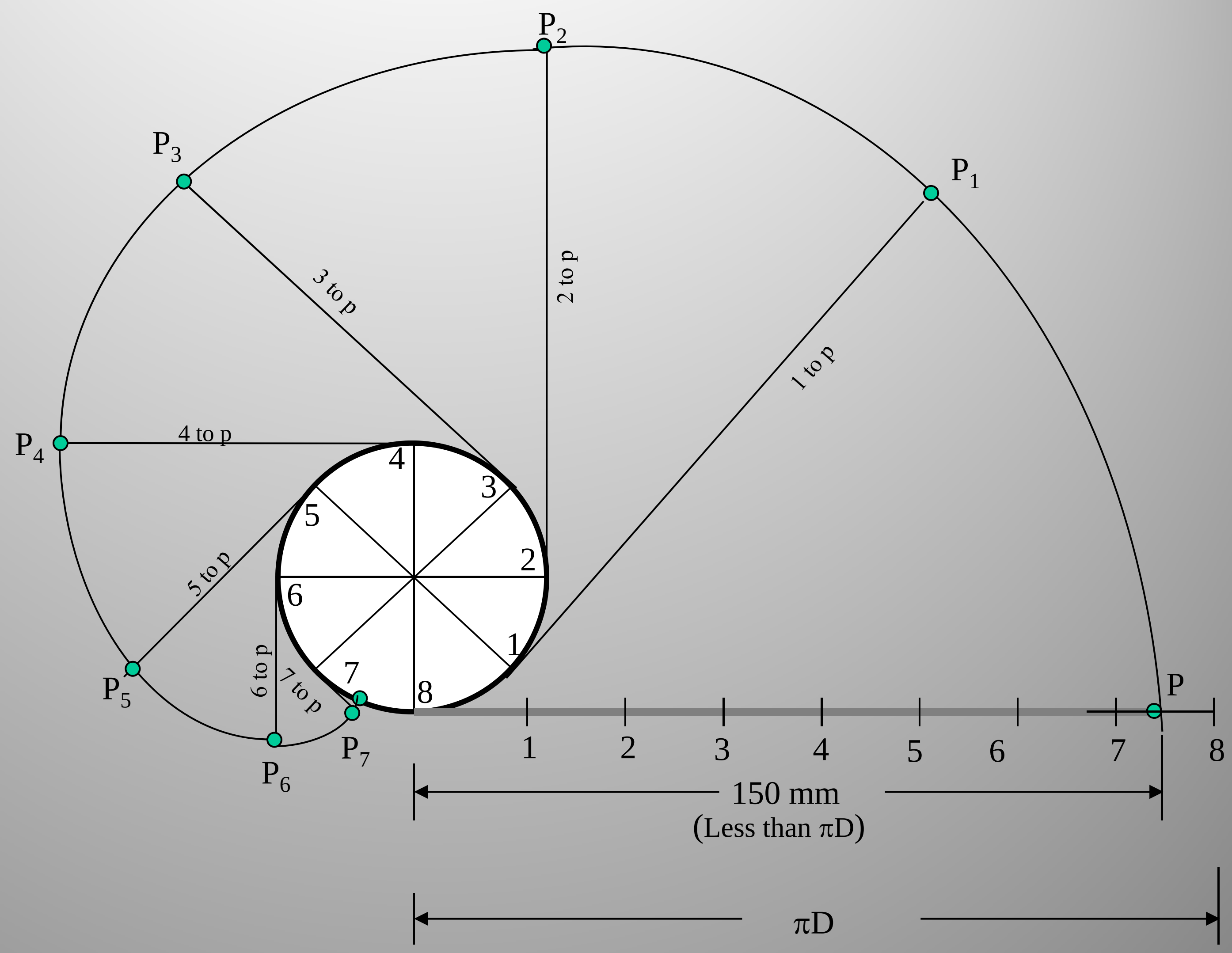
String length MORE than πD



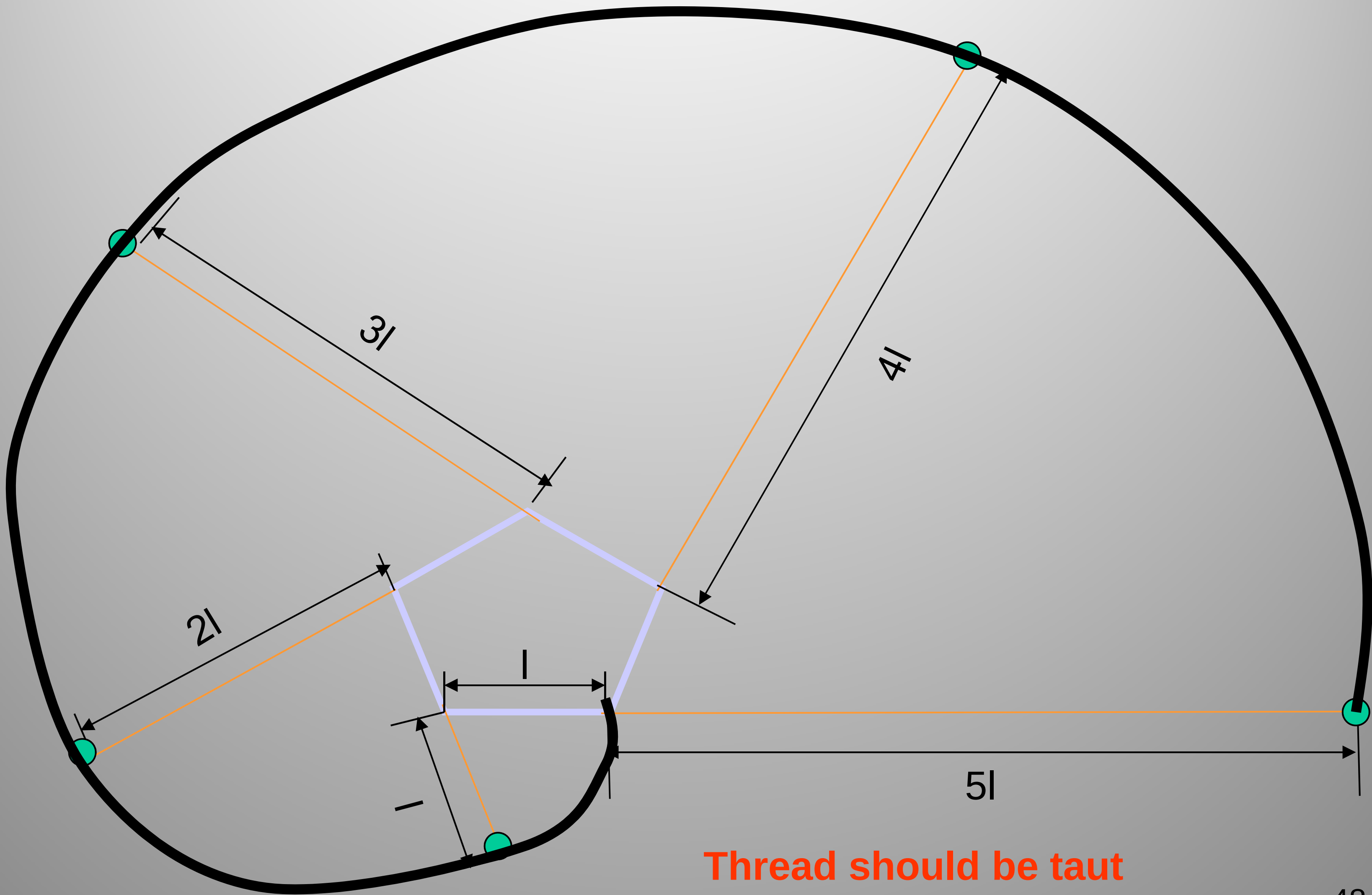
Problem: Draw Involute of a circle.
String length is LESS than the circumference of circle.

INVOLUTE OF A CIRCLE

String length LESS than πD



INVOLUTE OF A PENTAGON

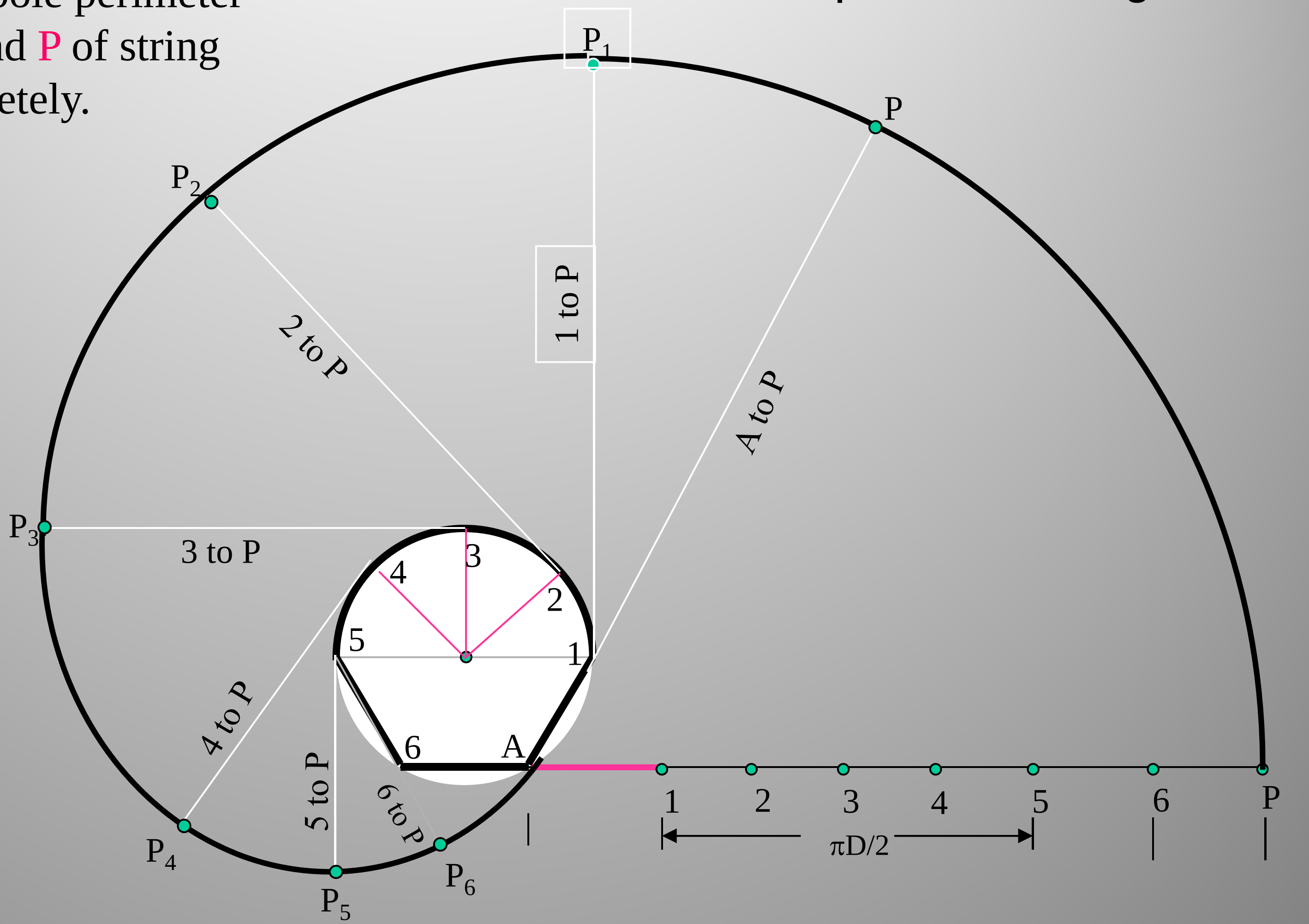


Thread should be taut

Problem : A pole is of a shape of half hexagon (side 30 mm) and semicircle (diameter 60 mm). A string is to be wound having length equal to the pole perimeter draw path of free end P of string when wound completely.

INVOLUTE OF COMPOSIT SHAPED POLE

Calculate perimeter length



DEFINITIONS

CYCLOID:

LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON A STRAIGHT LINE PATH.

SUPERIOR TROCHOID:

If the point in the definition of cycloid is <u>outside the circle</u>

INFERIOR TROCHOID.:

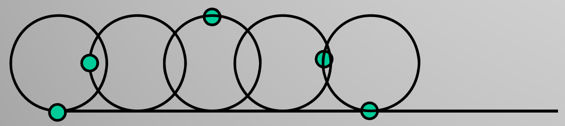
If it is <u>inside the circle</u>

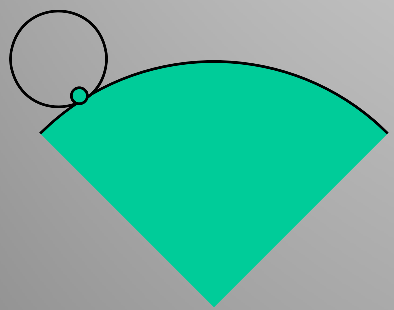
EPI-CYCLOID

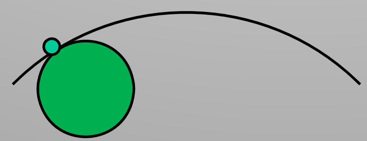
If the circle is *<u>rolling on another circle from outside</u>*

HYPO-CYCLOID.

If the *<u>circle is rolling from inside the other circle</u>*,

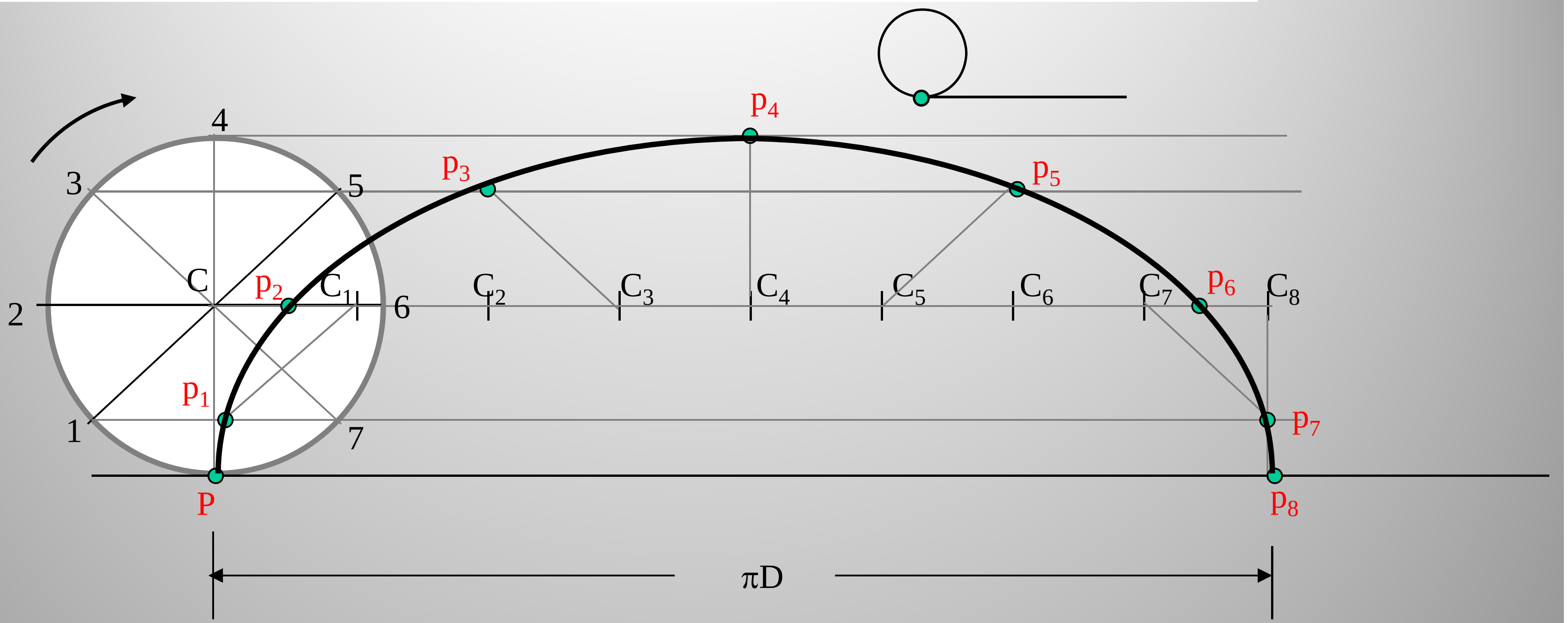






PROBLEM: Draw locus (one cycle) of a point (P) on the periphery of a circle (diameter=50 mm) which rolls on straight line path.

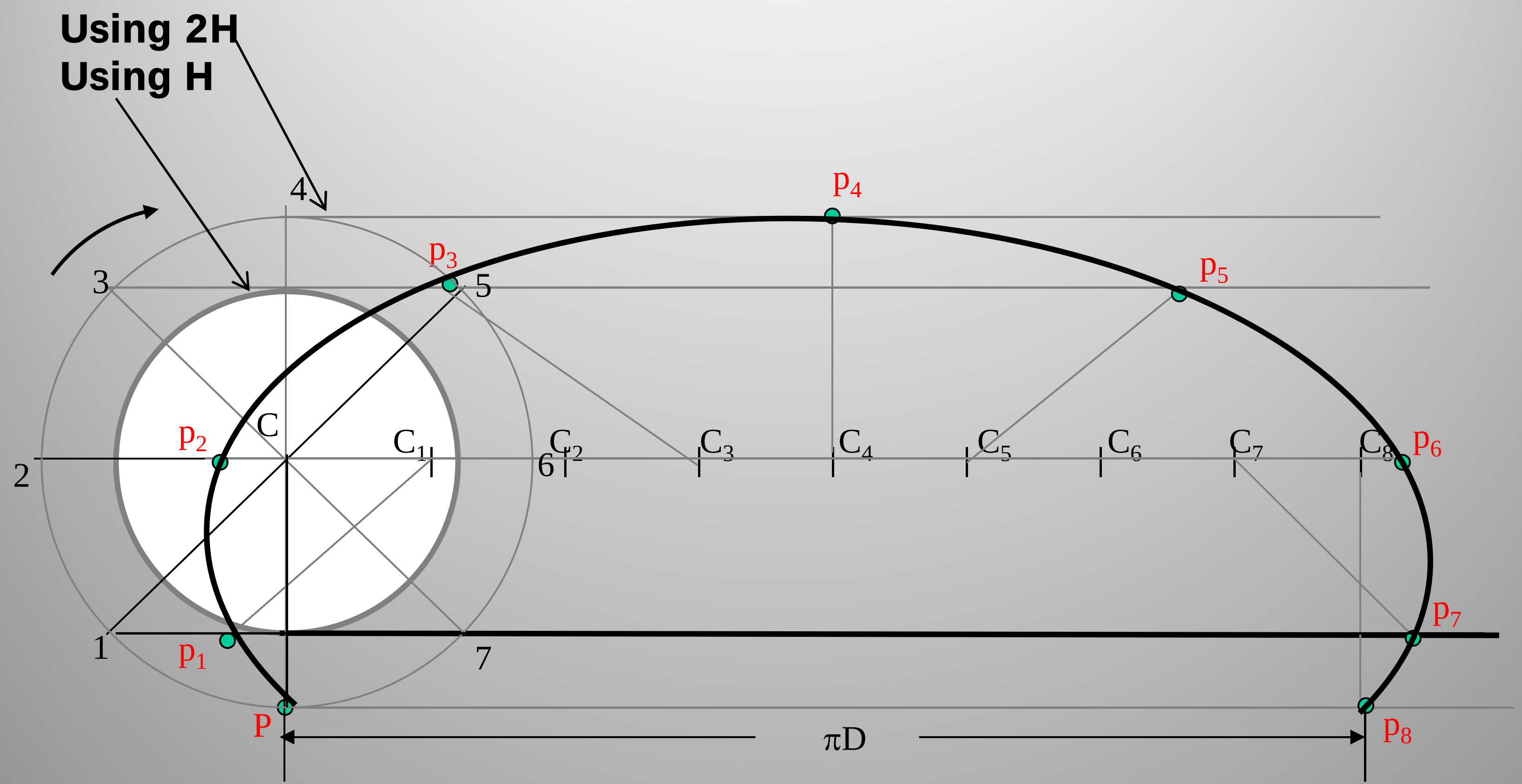
CYCLOID



Point C (zero radius) will not rotate and it will traverse on straight line.

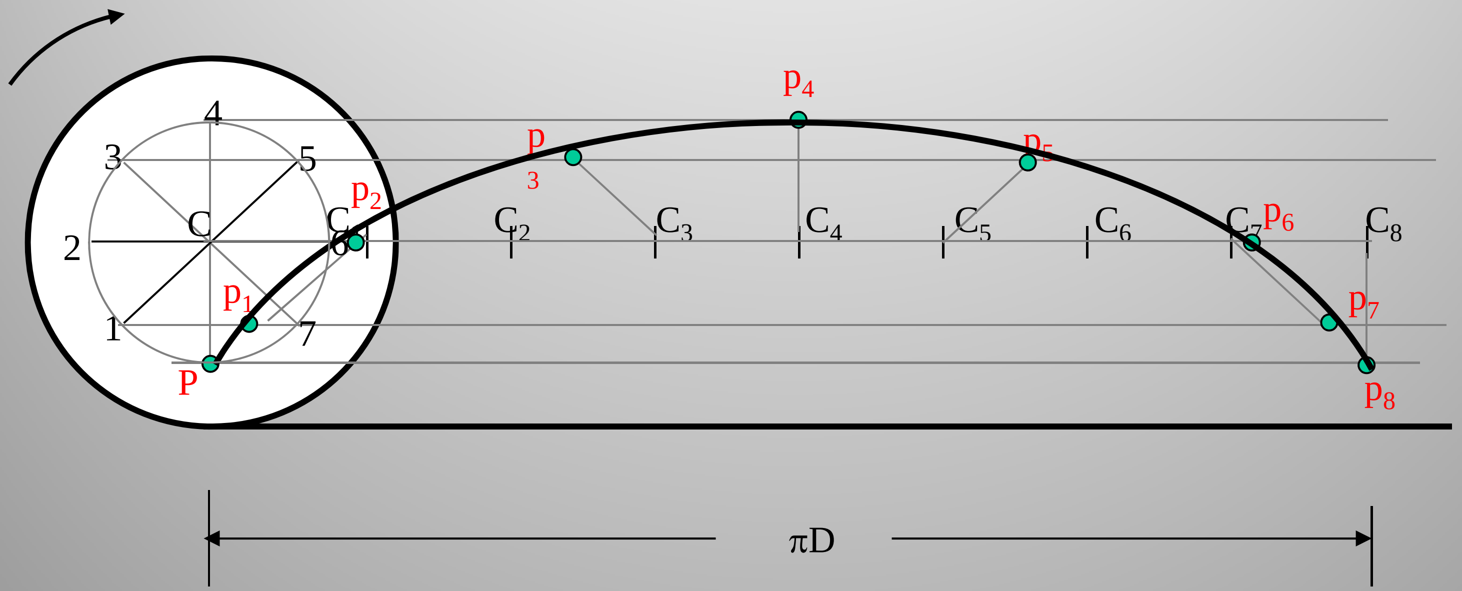
PROBLEM: Draw locus of a point (P), **5 mm** away from the periphery of a Circle (diameter=50 mm) which rolls on straight line path.

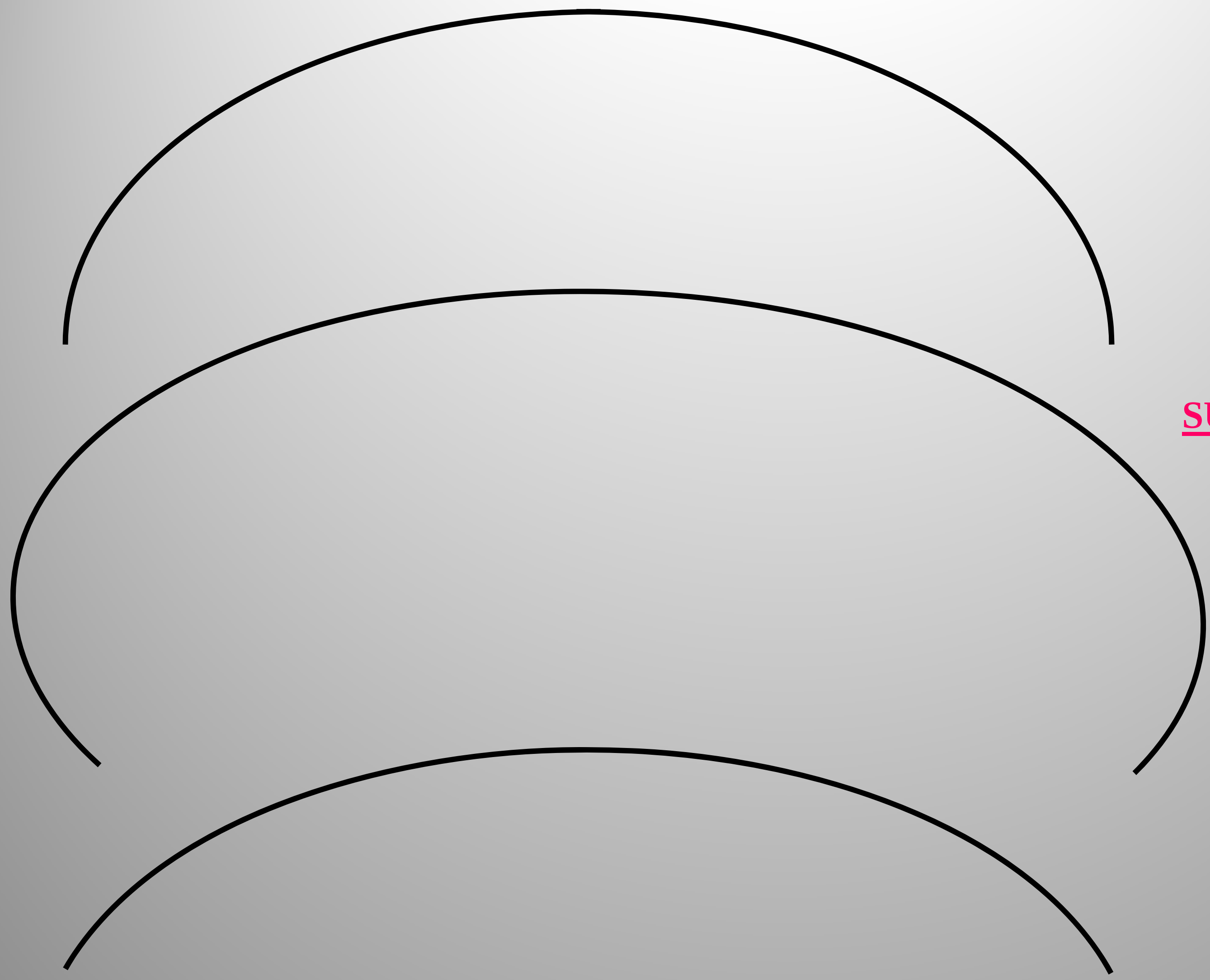
SUPERIOR TROCHOID



PROBLEM: Draw locus of a point , **5 mm** inside the periphery of a Circle which rolls on straight line path. **Take circle diameter as 50 mm**

INFERIOR TROCHOID





CYCLOID

SUPERIOR TROCHOID

INFERIOR TROCHOID

EPI CYCLOID :

PROBLEM: Draw locus of a point on the periphery of a circle (dia=50mm) which rolls on a curved path (radius 75 mm).

Distance by smaller circle = Distance on larger circle

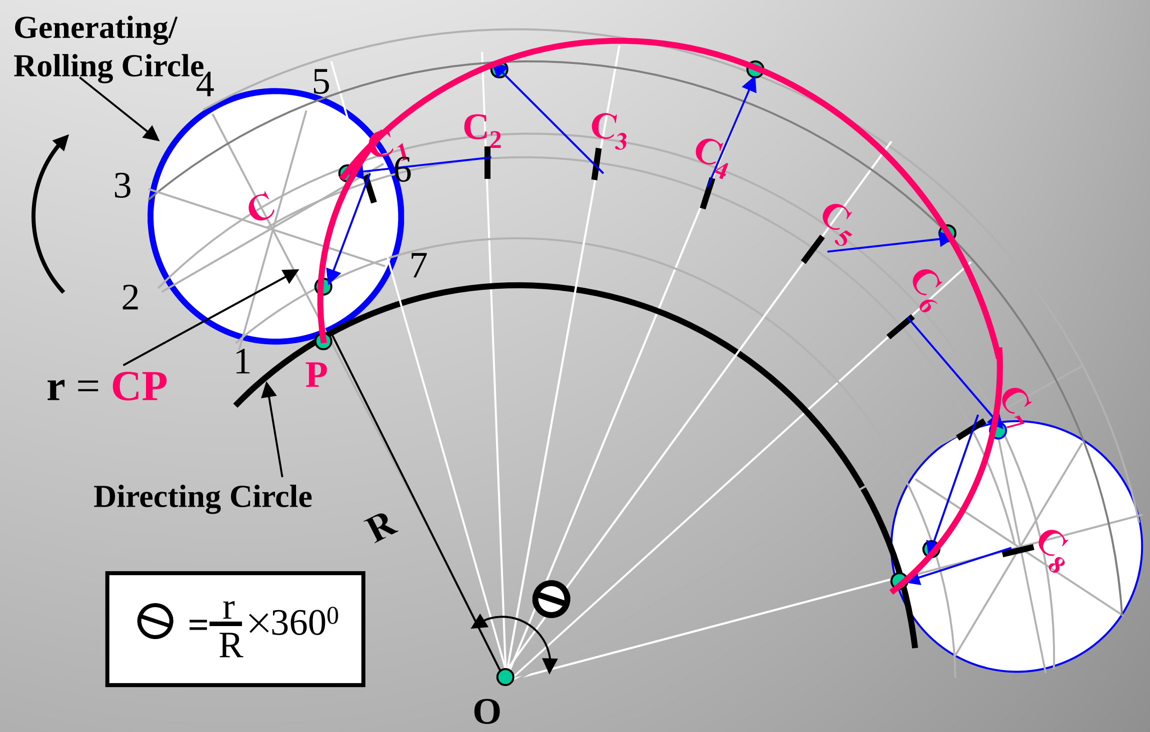
Solution Steps:

1. When smaller circle rolls on larger circle for one revolution it covers Π D distance on arc and it will be decided by included arc angle θ.
2. Calculate θ by formula $\theta = (r/R) \times 360°$.
3. Construct a sector with angle θ and radius R.
4. Divide this sector into 8 number of equal angular parts.

EPI CYCLOID

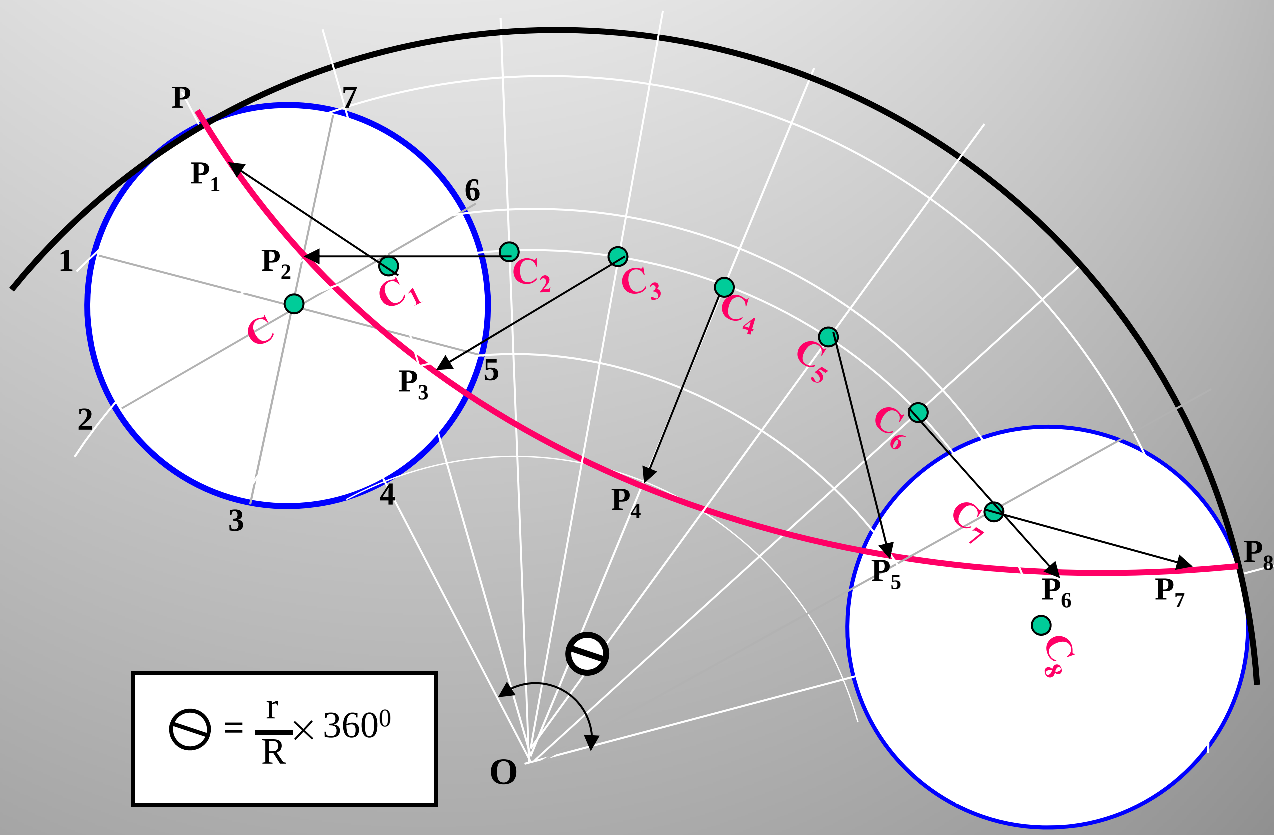
EPI-CYCLOID

If the circle is *__rolling on another circle from outside__*



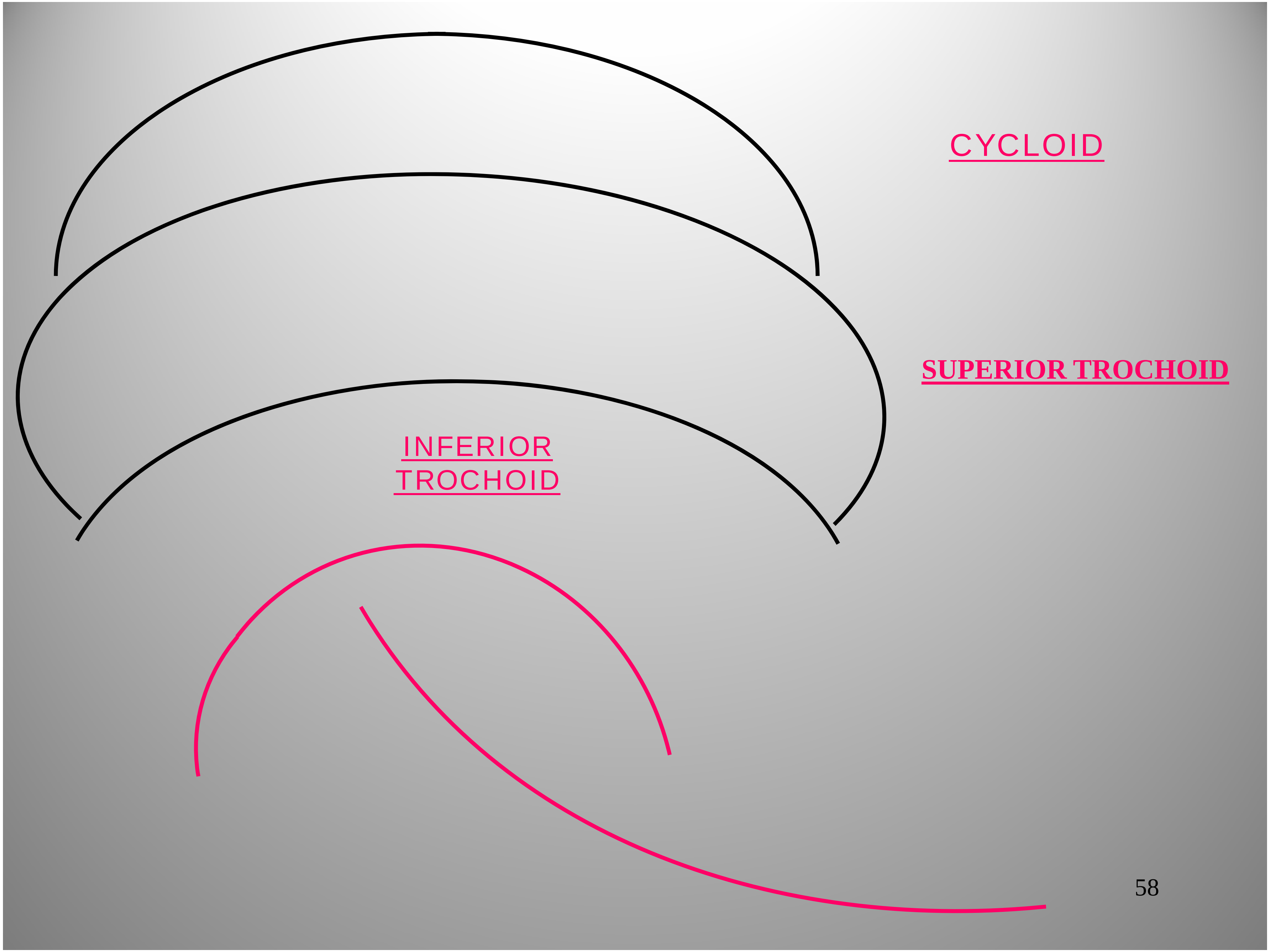
PROBLEM : Draw locus of a point on the periphery of a circle which rolls from the inside of a curved path. **Take diameter of Rolling circle 50 mm and radius of directing circle (curved path) 75 mm.**

HYPO CYCLOID

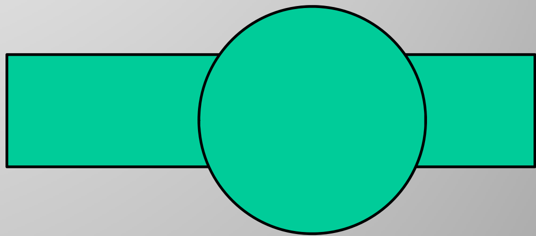


$$\theta = \frac{r}{R} \times 360^0$$

OC = R (Radius of Directing Circle)
CP = r (Radius of Generating Circle)


CYCLOID
SUPERIOR TROCHOID
INFERIOR
TROCHOID

Interpenetration of Solids / Intersection of Surfaces / Lines & Curves of Intersection

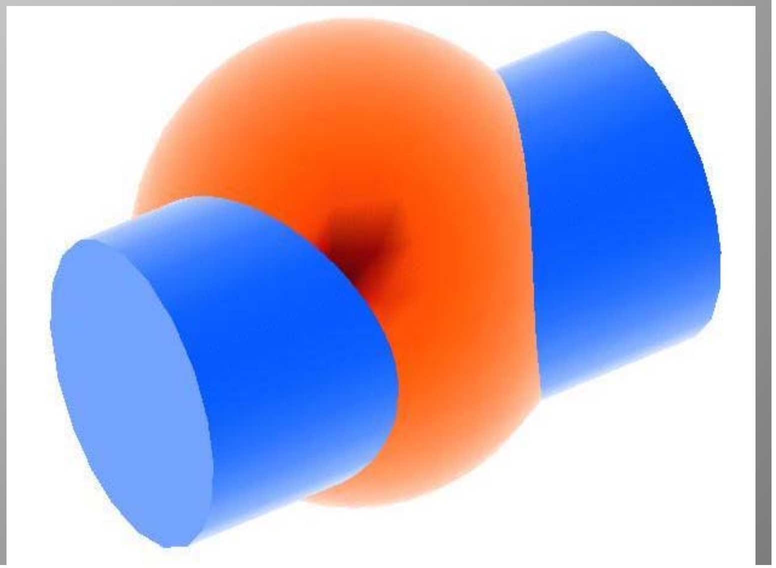


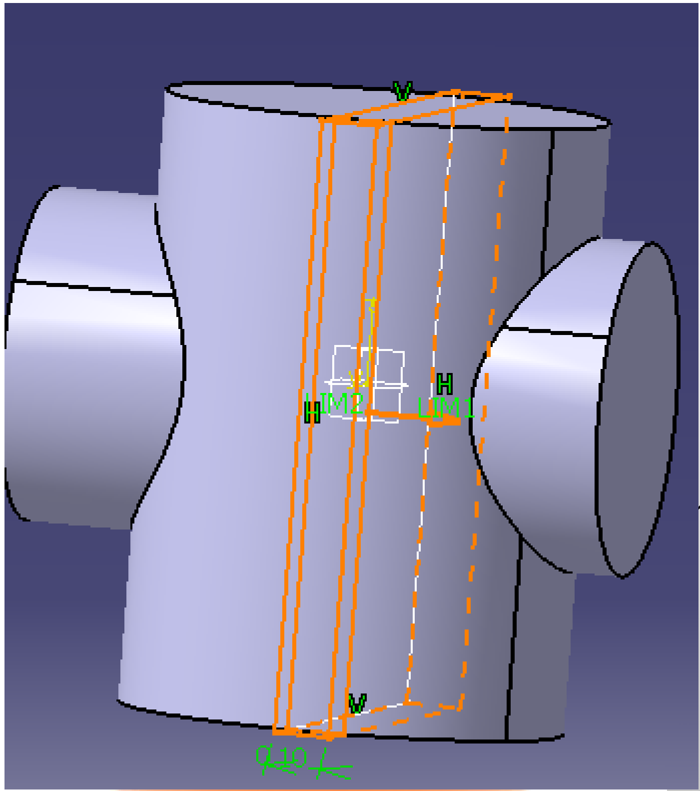
More points common to both the solids

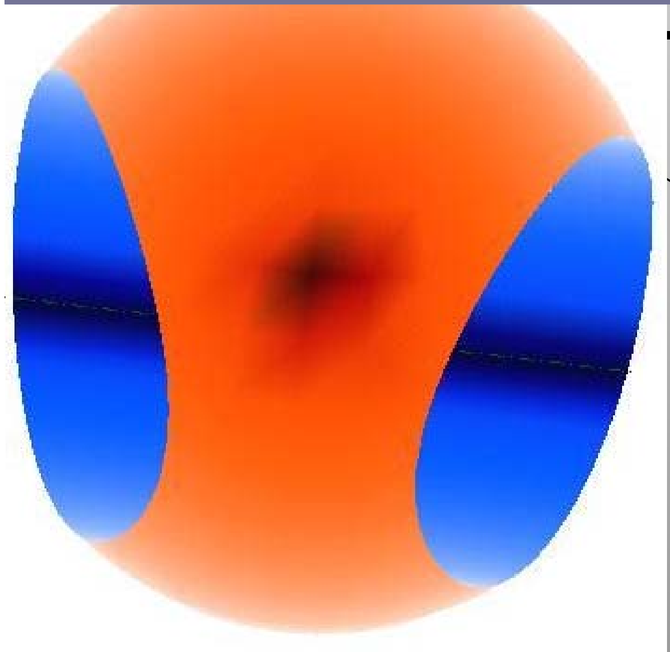
Basic required knowledge:

~ Projections of Solid

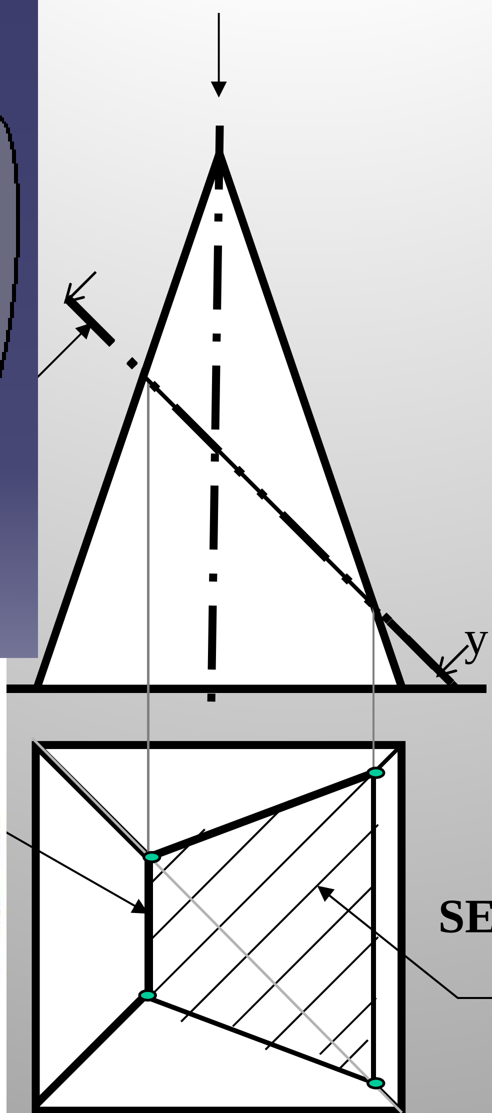
~ Section of Solid





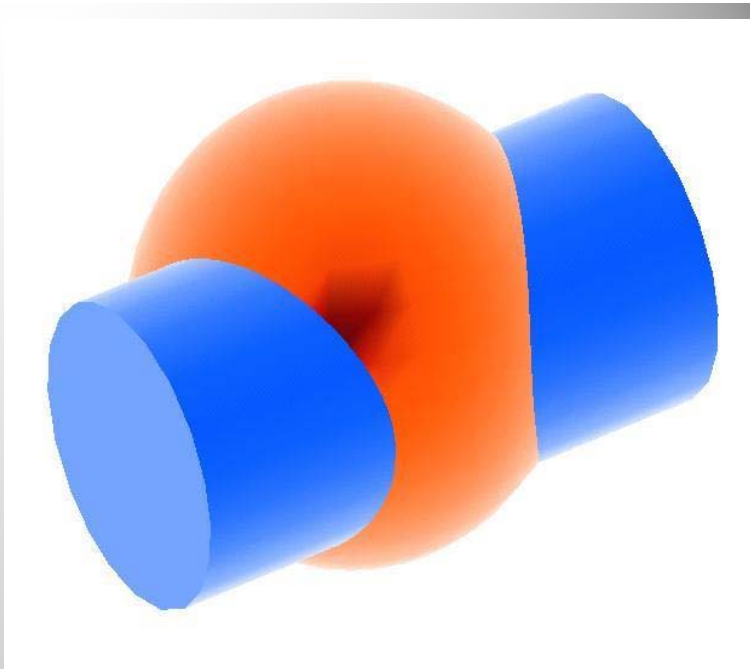


For TV



SECTION LINES
(45^0 to XY)

SECTIONAL T.V.

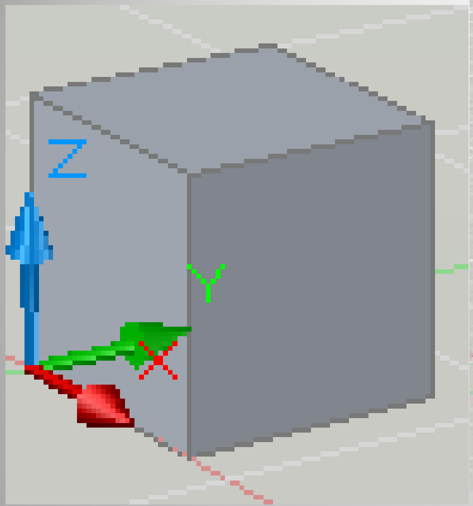


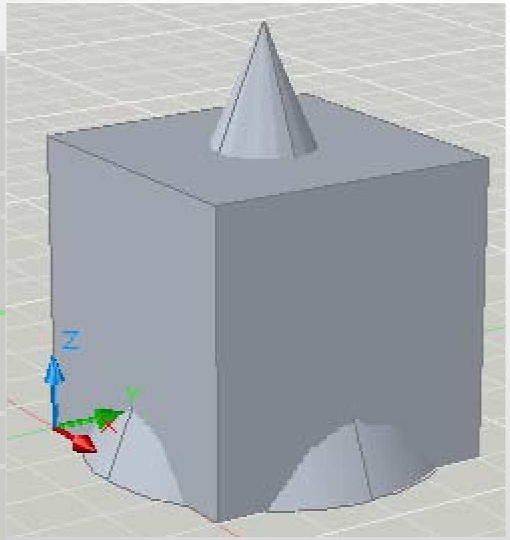
Interpenetration of Solids

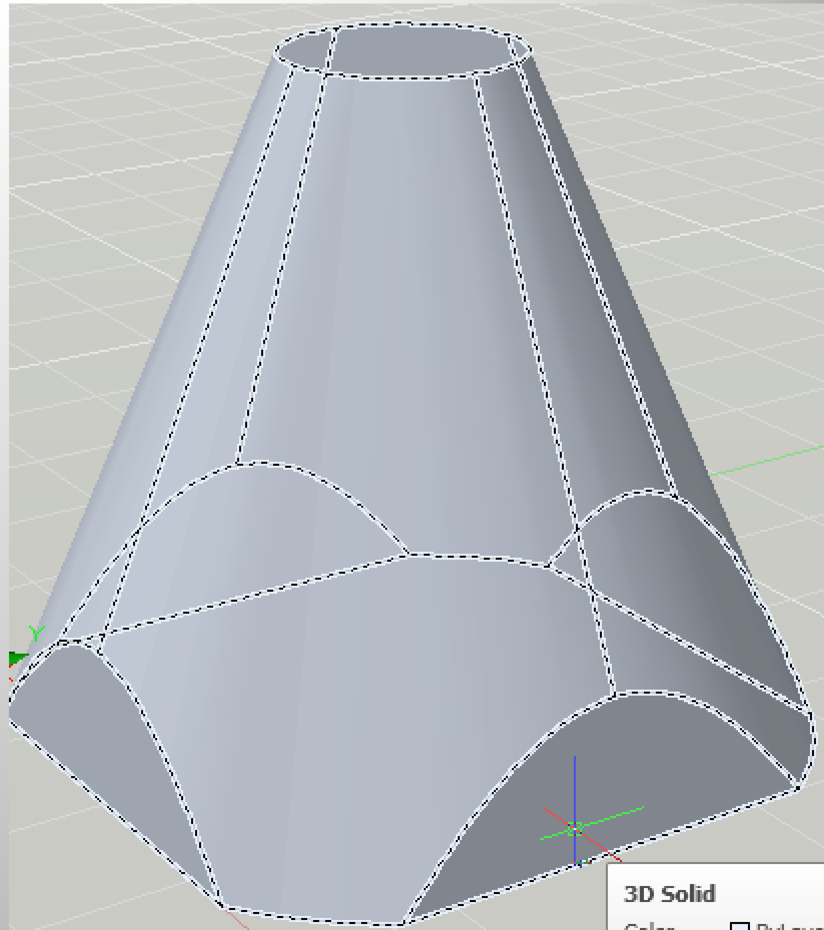
Intersection of Surfaces

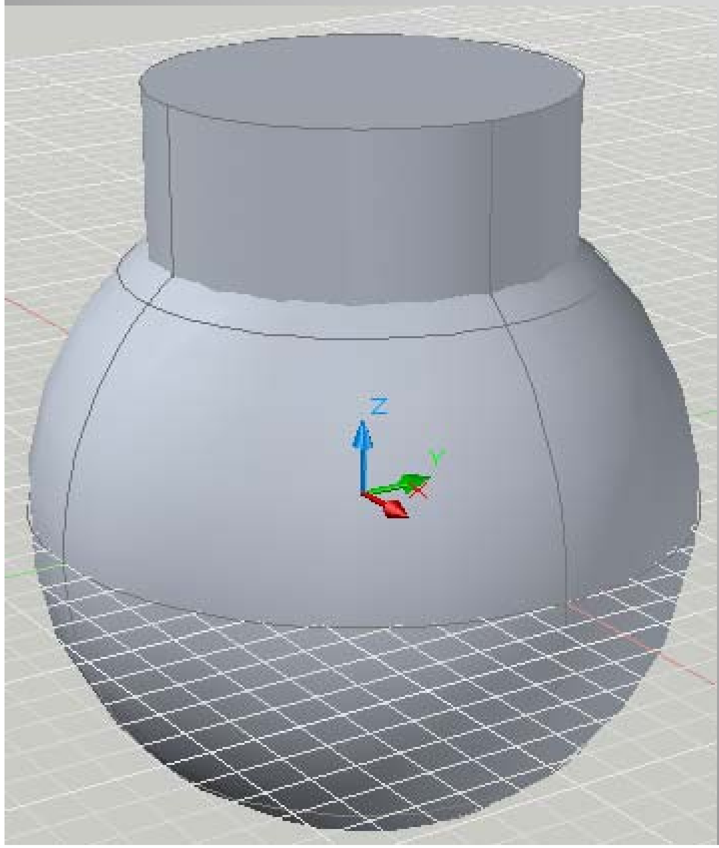
Lines & Curves

of Intersection


Z
Y


Z
Y


3D Solid


Z
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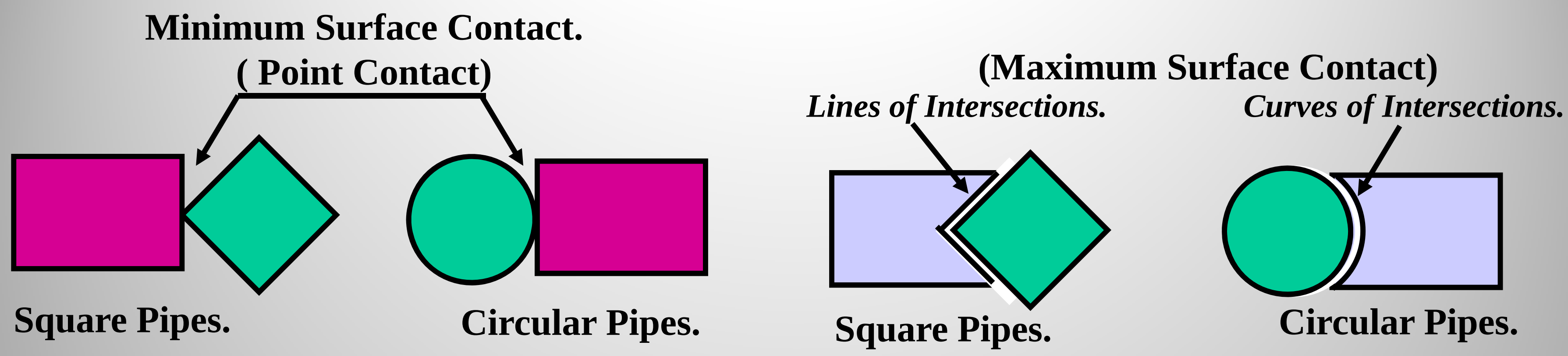


MAXIMUM SURFACE CONTACT A BASIC REQUIREMENT FOR STRONGEST & LEAK-PROOF JOINT.

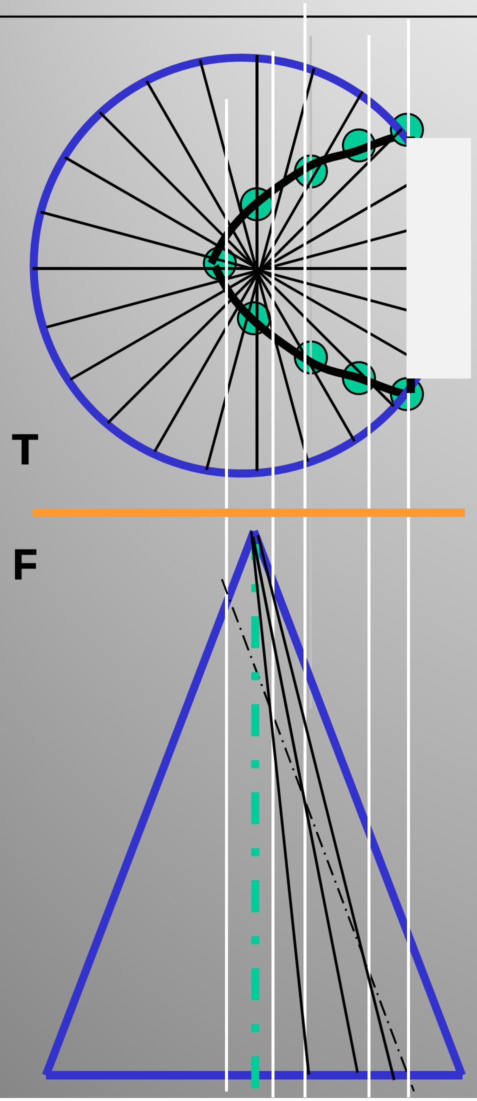
Two plane surfaces (e-g. faces of prisms and pyramids) intersect in a straight line.

The line of intersection between two curved surfaces (e-g. of cylinders and cones) or between a plane surface and a curved surface is a curve.

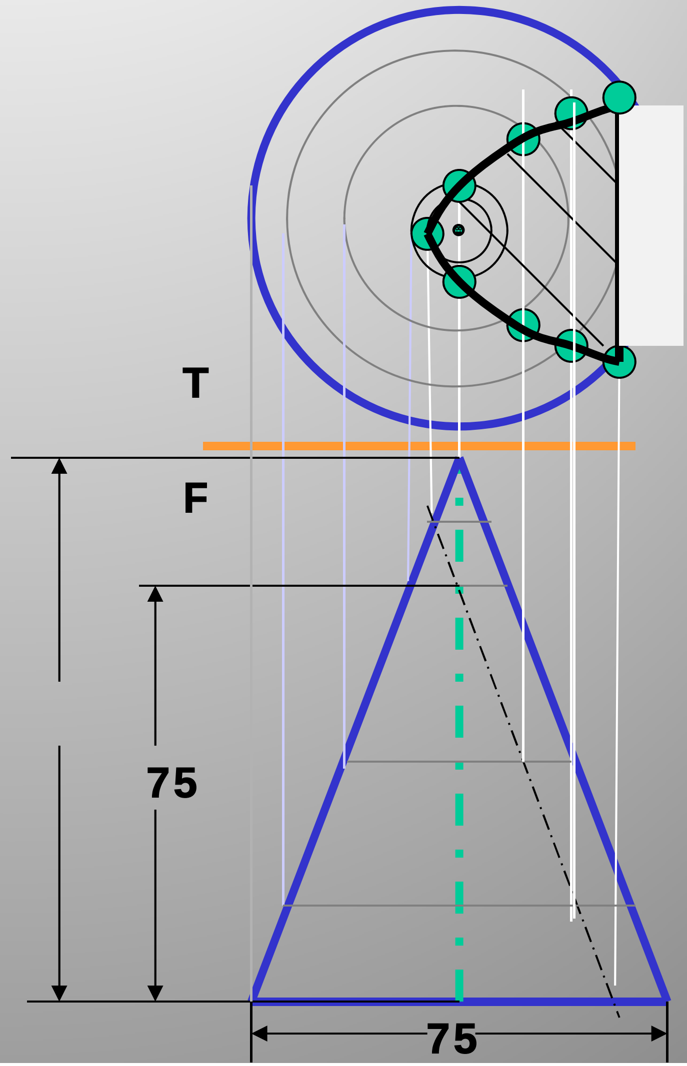
More points common to both the solids

How to find Lines/Curves of Intersection

Generator line Method



Cutting Plane Method



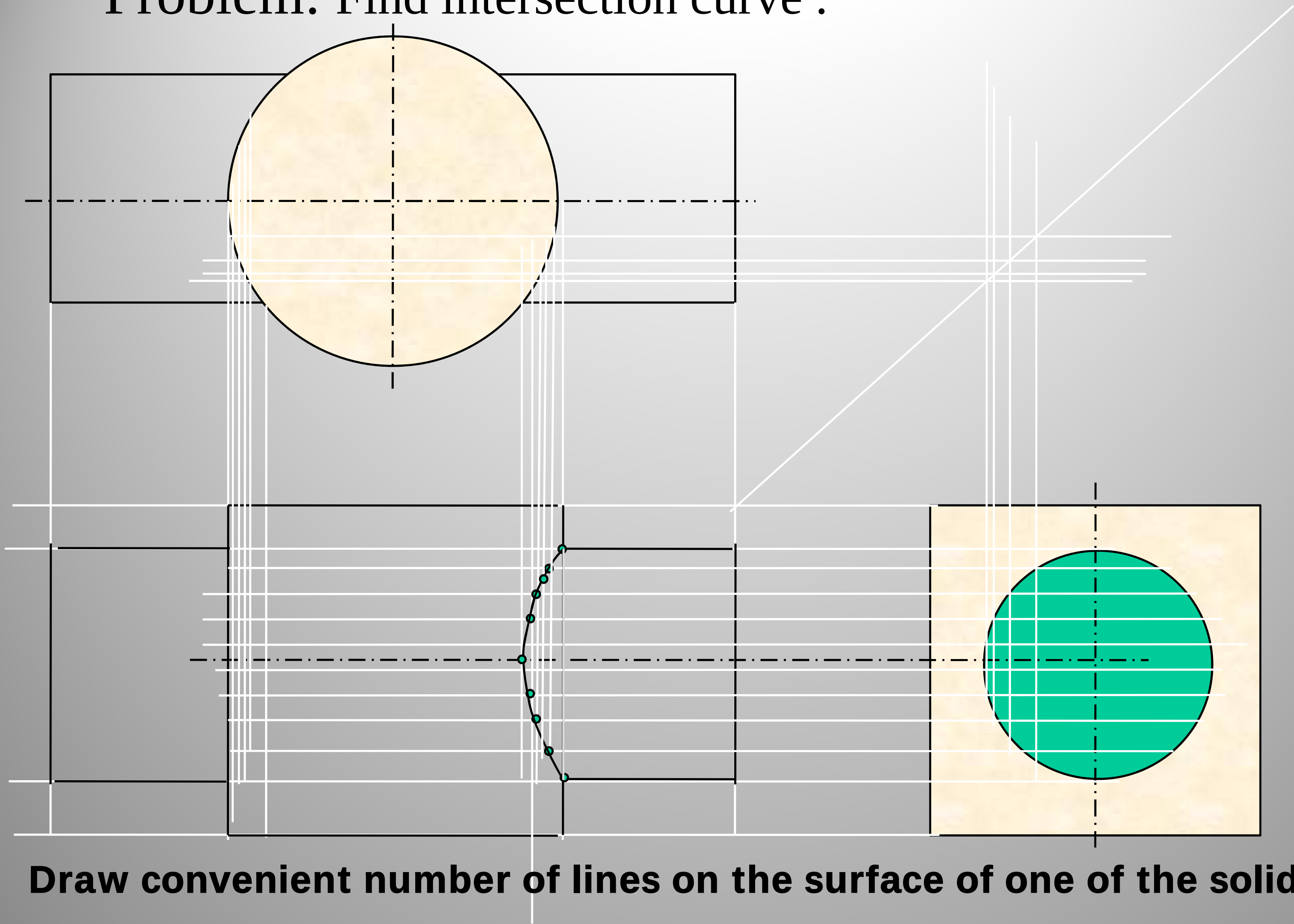
Guidelines

- Interpenetration of solids produce closed loops which may be made straight lines or curves.
  - Two lines intersect at a point common to both the lines.
  - Two surfaces intersect along a line/curve common to both surfaces.
- Interpenetration of solids containing plane surfaces (prism with prism, pyramid with pyramid, prism with pyramid) results in a polygon.
- Solids having curved surfaces results in closed curve.

What is expected?

- Projection of solid 1.
- Projection of solid 2 with given position w.r.t. solid.
- Finding common points on solid 1 and solid 2.
- Joining common points in proper sequence to get desired line/curve of intersection.
- Correcting/finalizing the orthographic projections.

Problem: Find intersection curve .

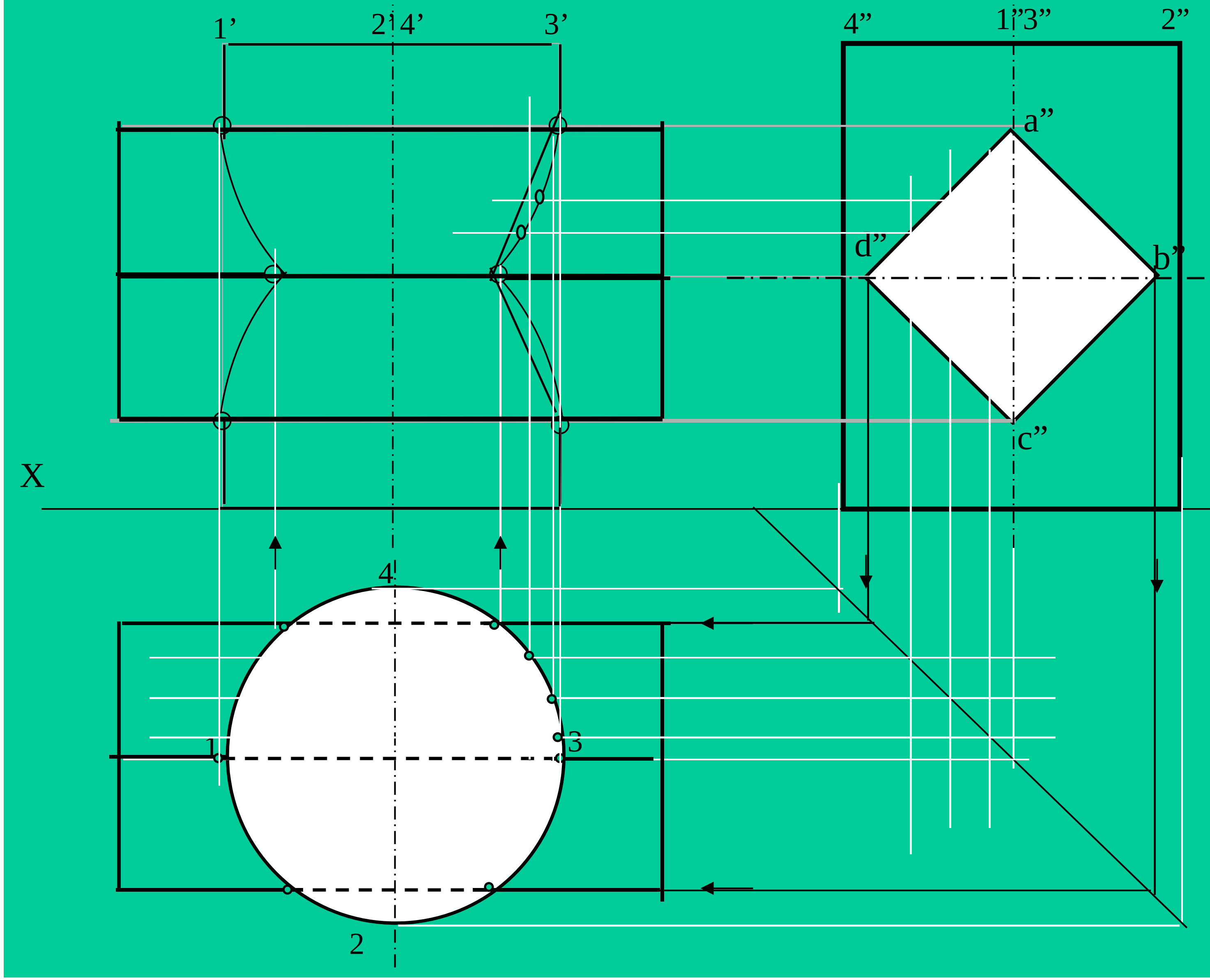


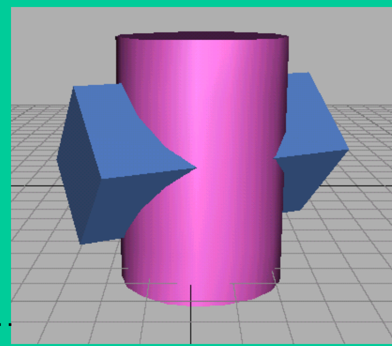
Draw convenient number of lines on the surface of one of the solids.

Transfer point of intersection to their corresponding positions in other views.

When one solid completely penetrates another, there will be two curves of intersection.

Problem: CYLINDER (50mm dia.and 70mm axis) STANDING & SQ.PRISM (25 mm sides and 70 mm axis) PENETRATING. Both axes Intersect & bisect each other. All faces of prism are equally inclined to Hp. Draw projections showing curves of intersections. (I-angle)

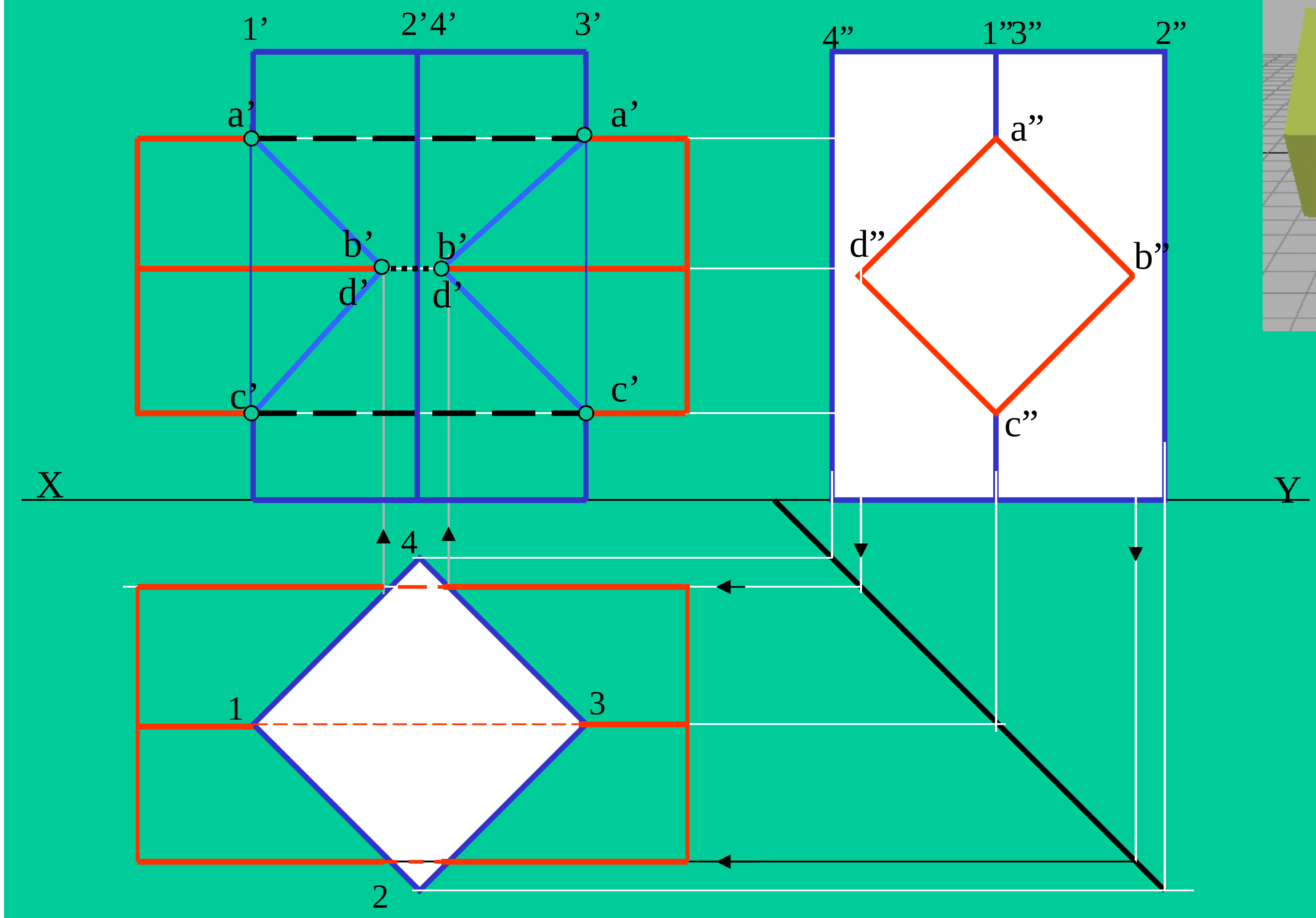


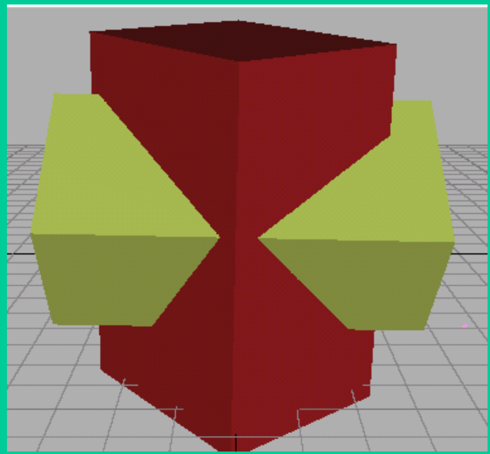


Find lines of

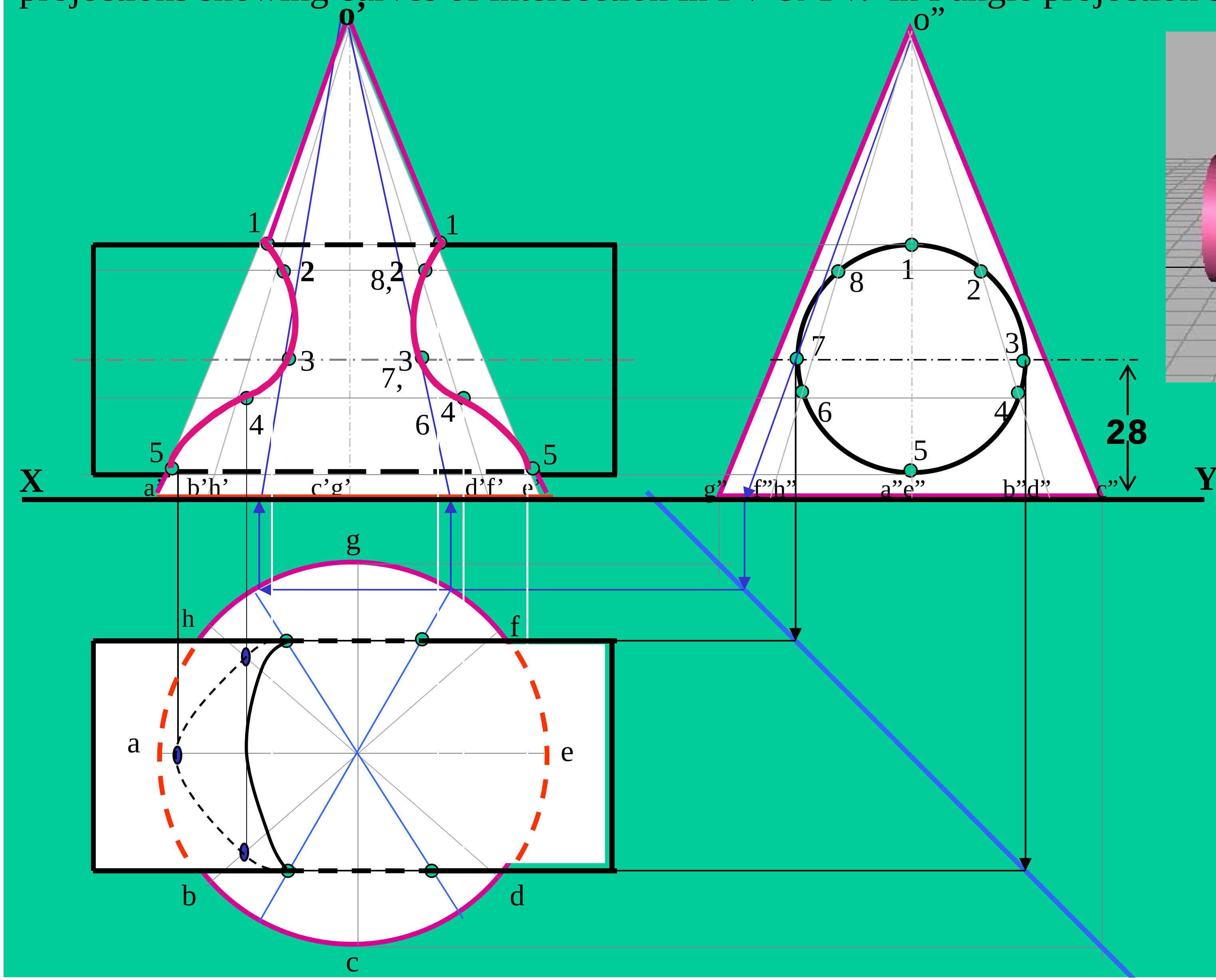
Missing critical points at which curve changes direction.

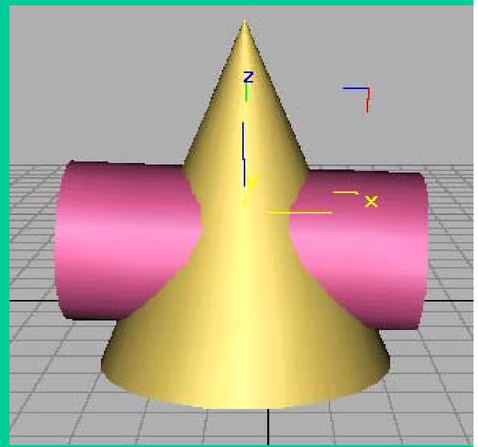
Problem. SQ.PRISM (30 mm base sides and 70mm axis) STANDING & SQ.PRISM (25 mm sides and 70 mm axis) PENETRATING. Both axes intersects & bisect each other. All faces of prisms are equally inclined to Vp. Draw projections showing curves of intersections.





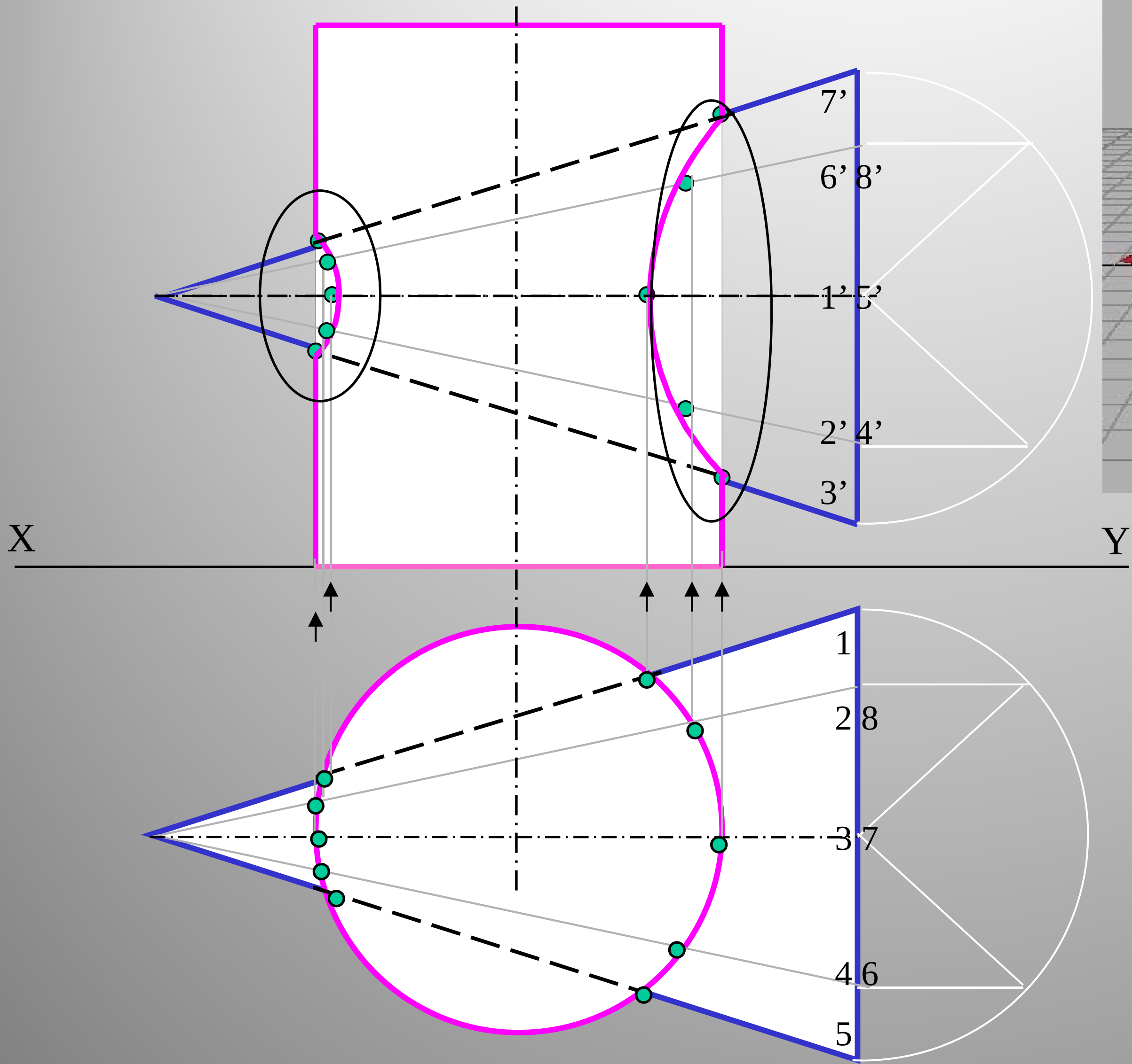
Problem: A vertical cone, base diameter 75 mm and axis 100 mm long, is completely penetrated by a cylinder of 45 mm diameter and axis 100 mm long. The axis of the cylinder is parallel to Hp and Vp and intersects axis of the cone at a point 28 mm above the base. Draw projections showing curves of intersection in FV & TV. in I angle projection system

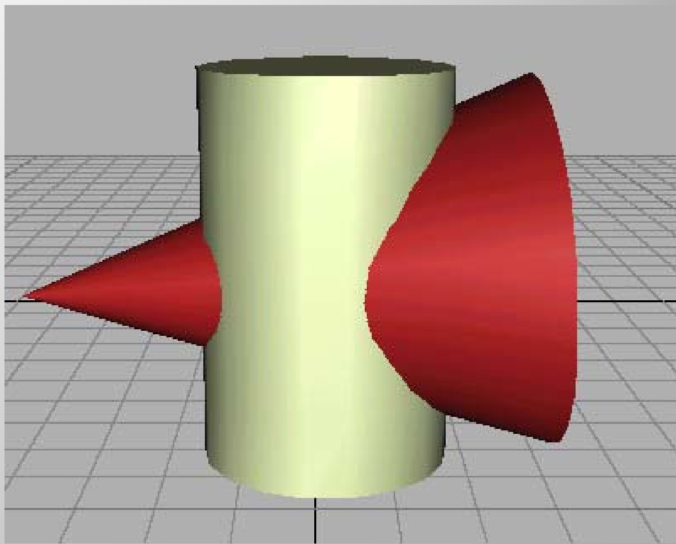




Mistakes !!

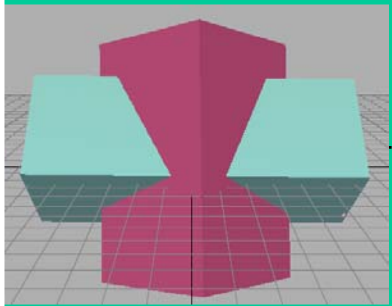
Problem: Vertical cylinder (80 mm diameter & 100 mm height) is completely penetrated by a horizontal cone (80 mm diameter and 120 mm height). Both axes intersect & bisect each other. Draw FV & TV projections showing curve of intersections in I angle projection system.

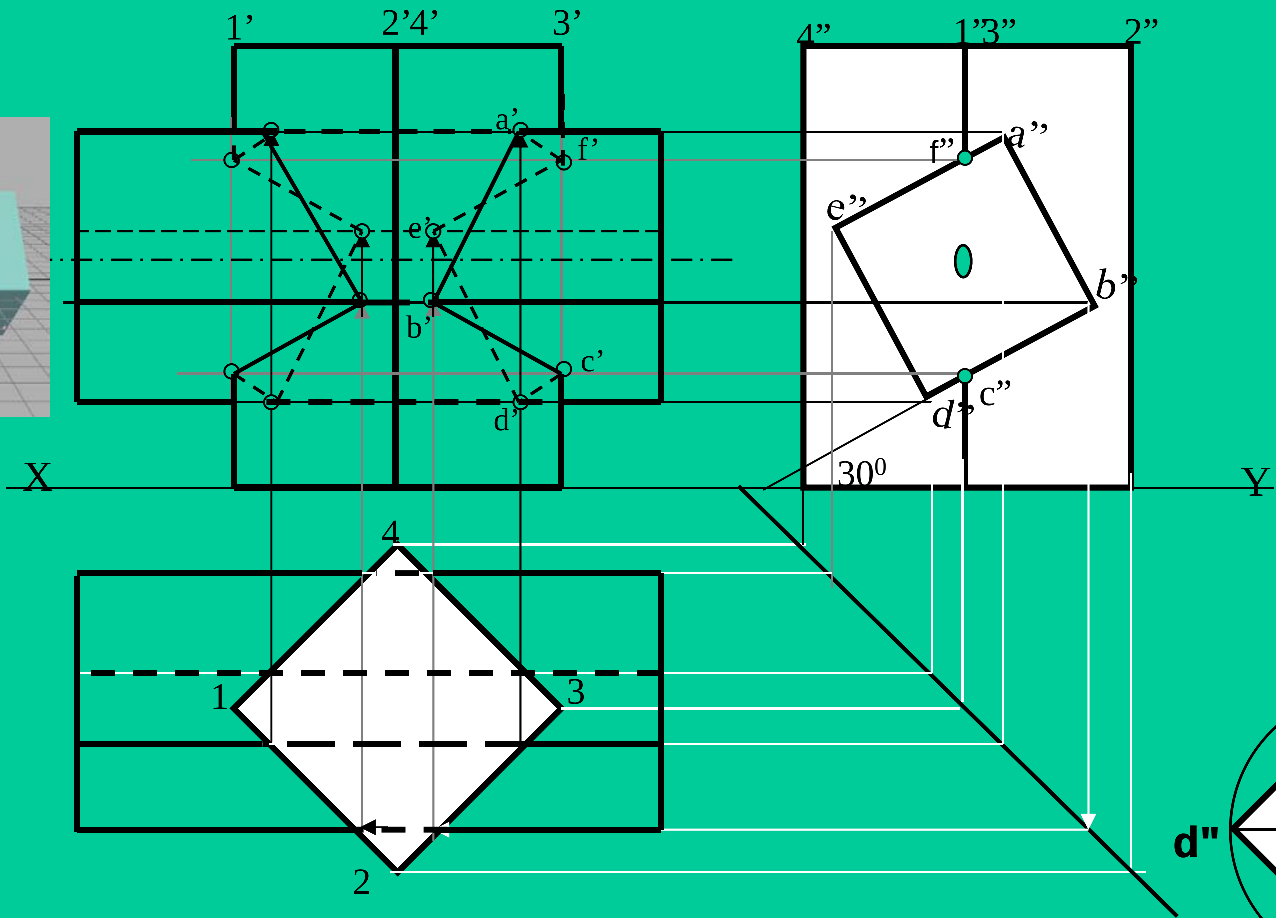


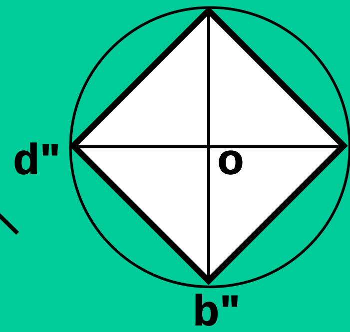


Intersection of a curve with another !!!! Generator lines..

Problem. SQ.PRISM (30 mm base sides and 70mm axis; faces equally inclined to VP) STANDING & SQ.PRISM (25 mm sides and 70 mm axis) PENETRATING. Both axes Intersect & bisect each other. Two faces of penetrating prism are 30^0 inclined to Hp. Draw projections showing curves of intersections in I angle projection system.

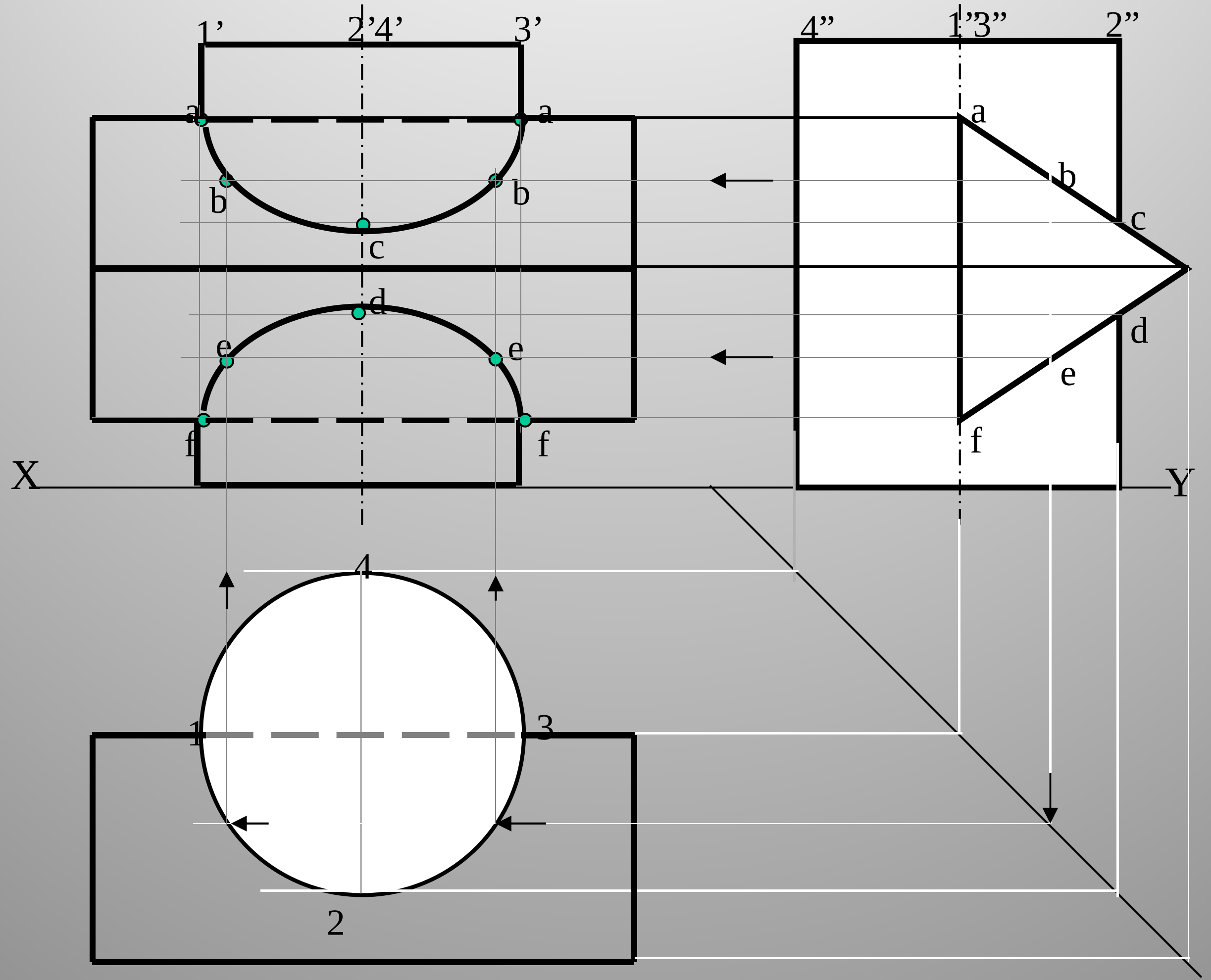




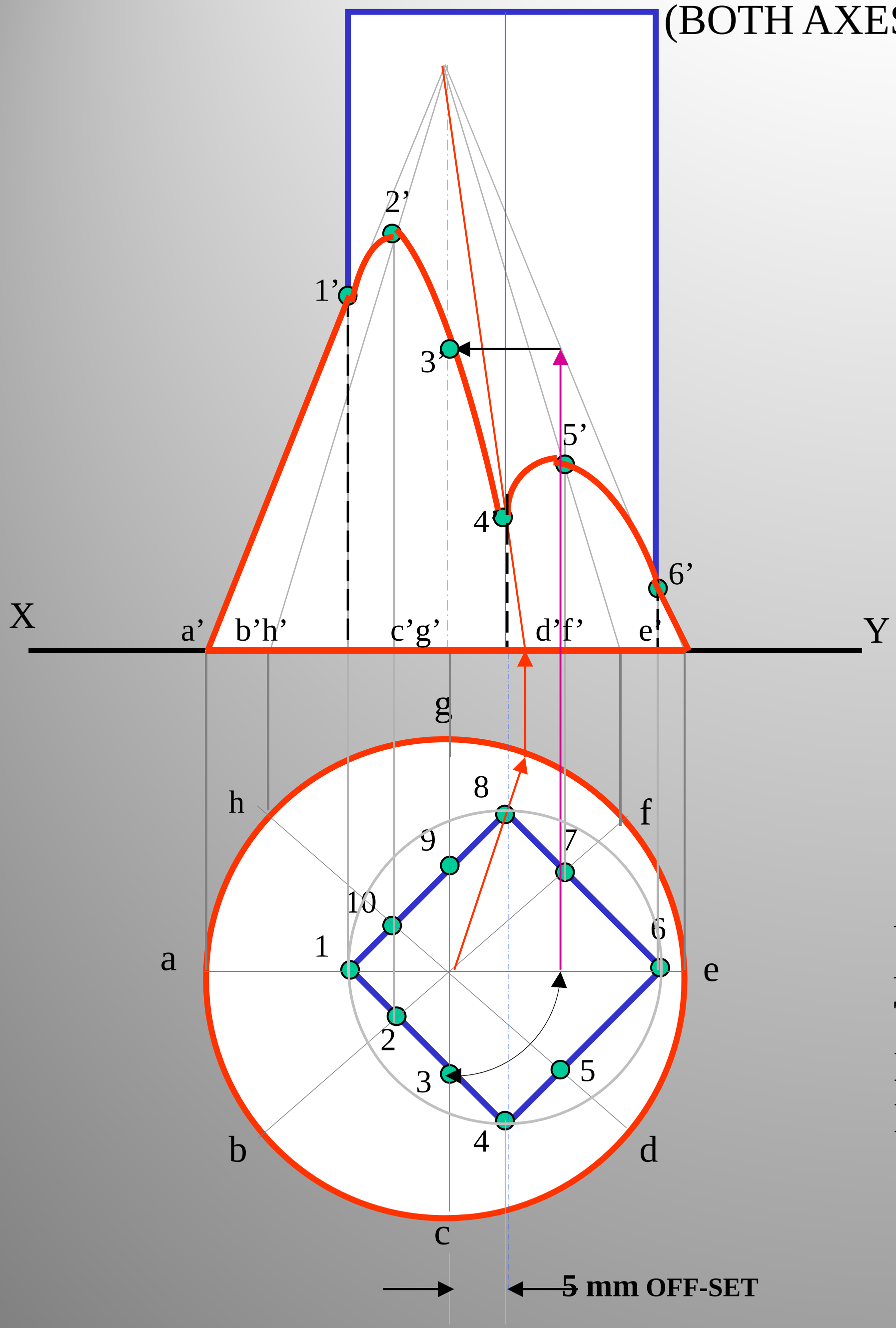


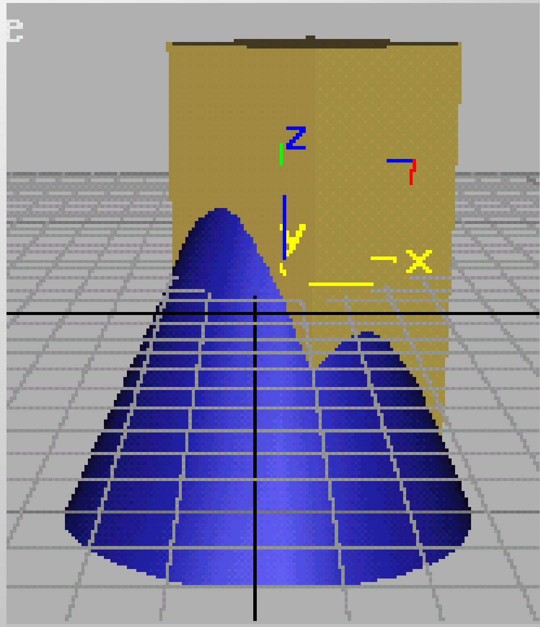
Other possible arrangements ????

Problem: A vertical cylinder 50mm dia. and 70mm axis is completely penetrated by a horizontal triangular prism of 45 mm sides and 70 mm axis. One flat face of prism is parallel to Vp and Contains axis of cylinder. Draw projections showing curves of intersections in I angle projection system.



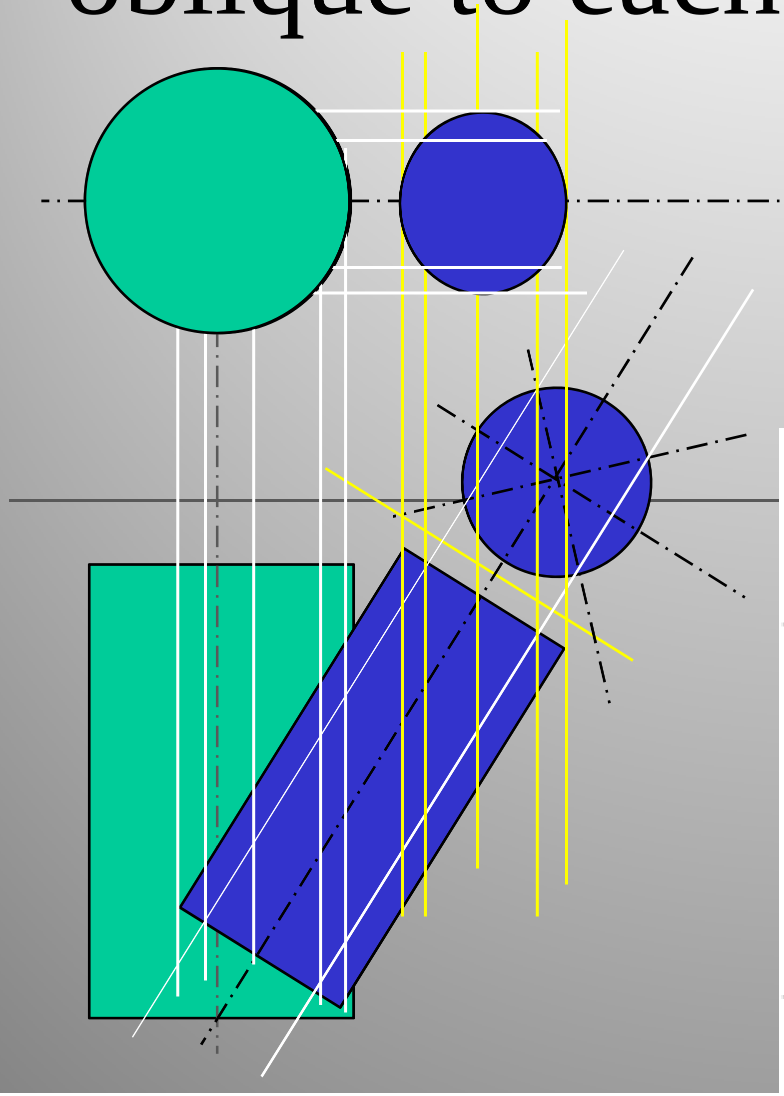
Problem: CONE (cone70 mm base diameter and 90 mm axis) STANDING & SQ.PRISM PENETRATING (BOTH AXES VERTICAL)



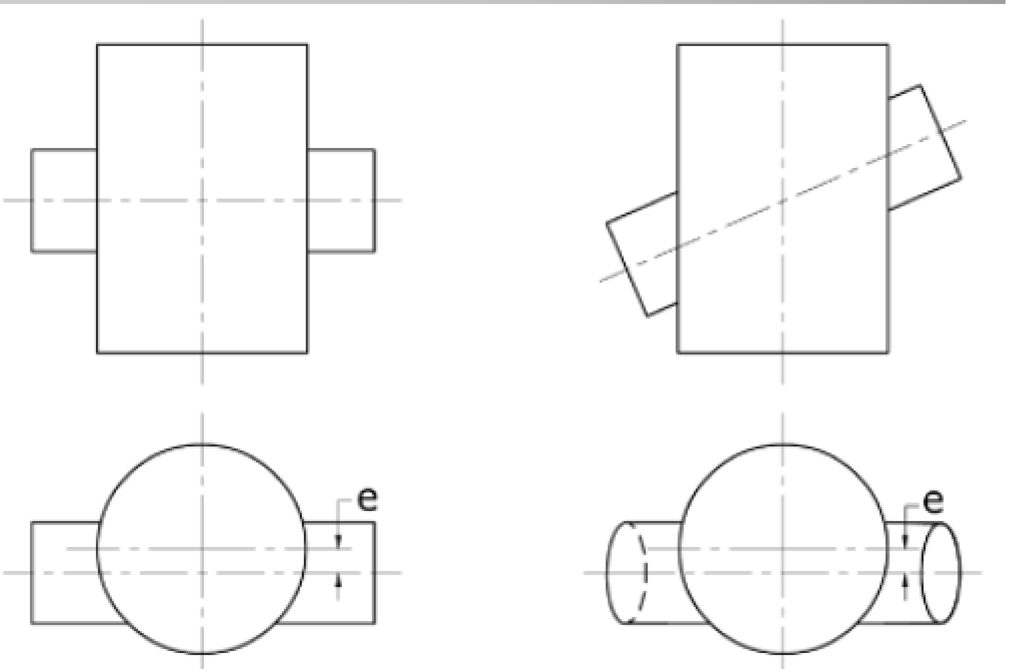


Axis of prism is // to cone's axis and 5 mm away from it.
A vertical plane containing both axes is parallel to Vp.
Take all faces of sq.prism equally inclined to Vp.
Base Side of prism is 30 mm and axis is 100 mm long.
Draw projections showing curves of intersections.

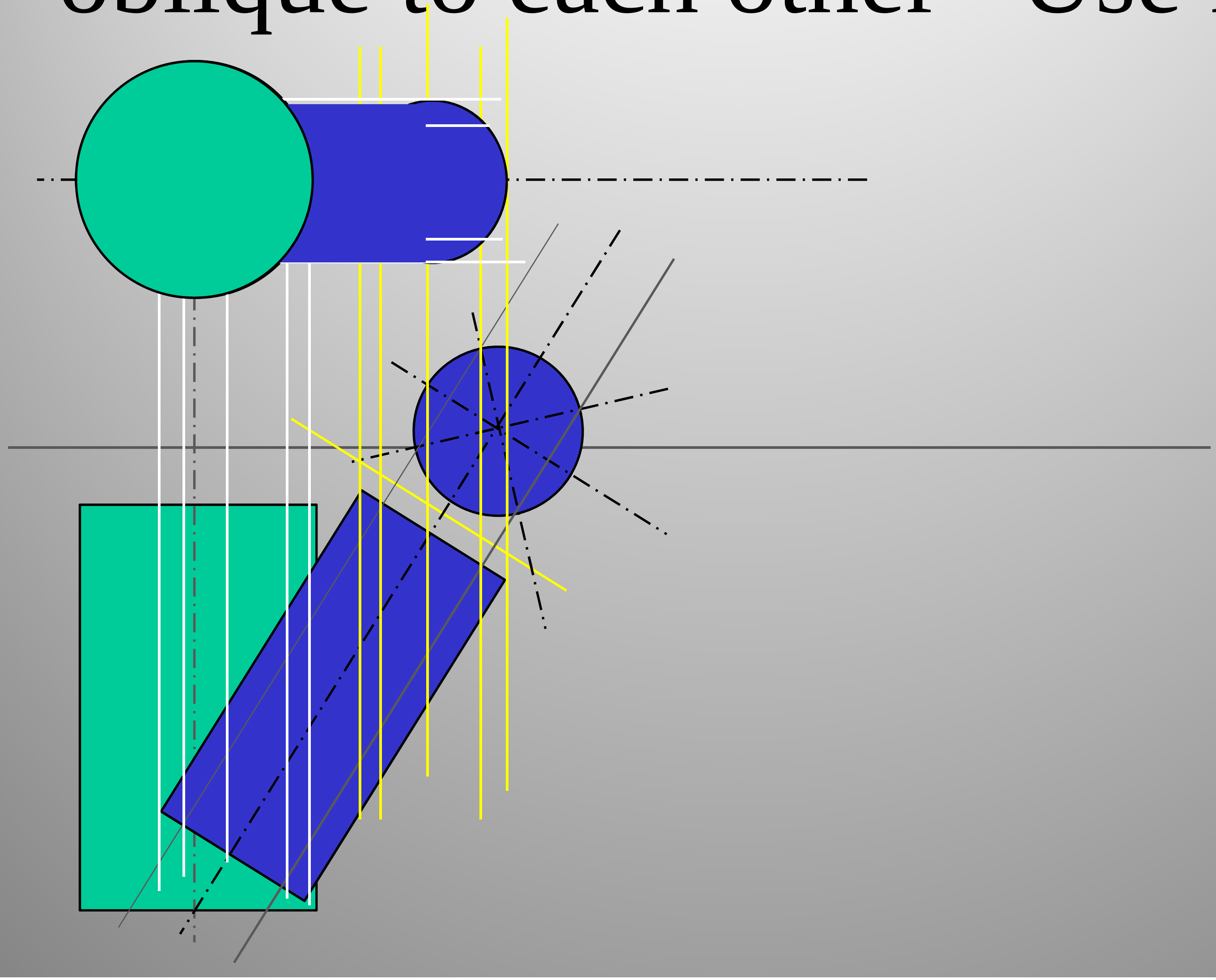
Intersection of two cylinders oblique to each other –Use PAV



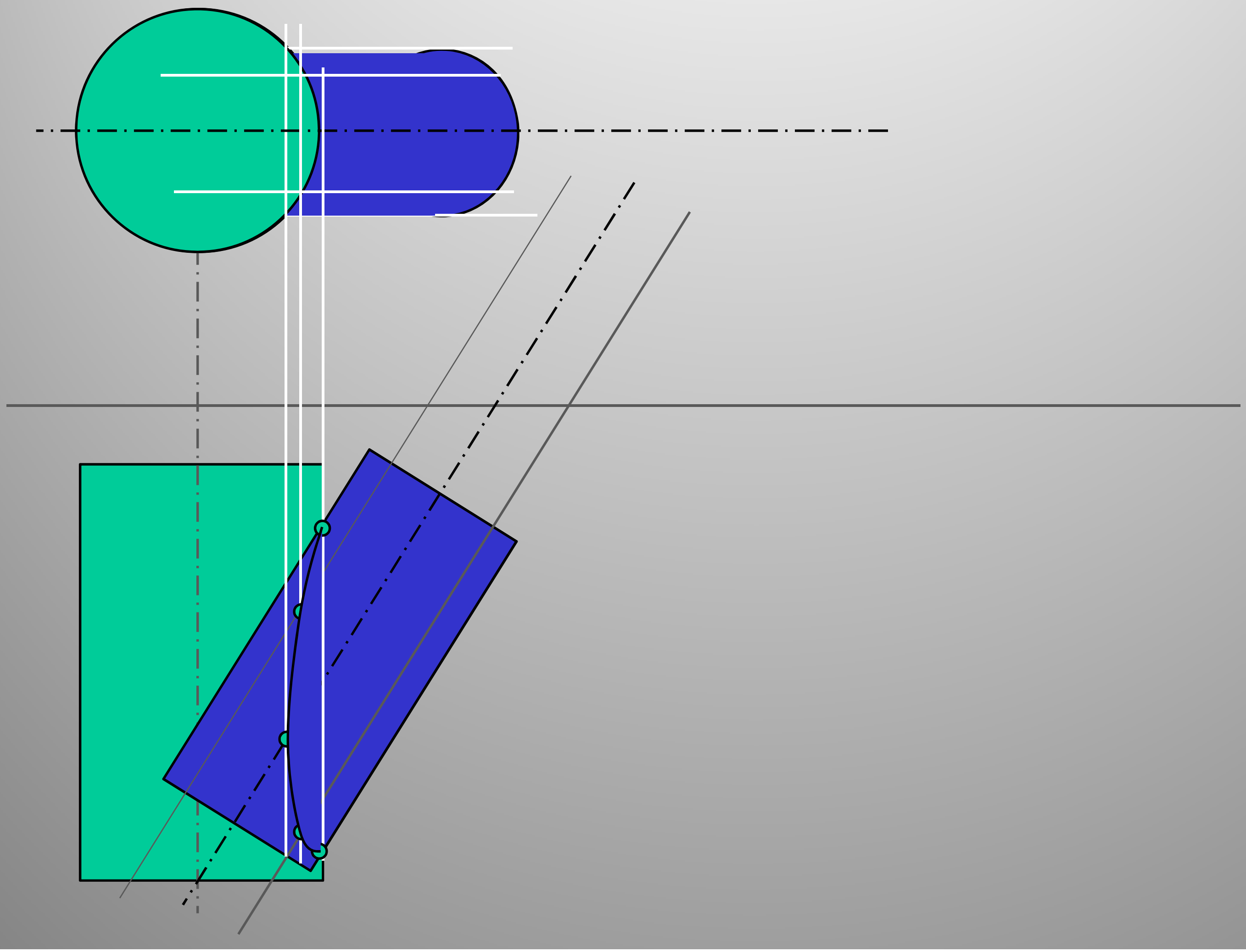
III angle projection



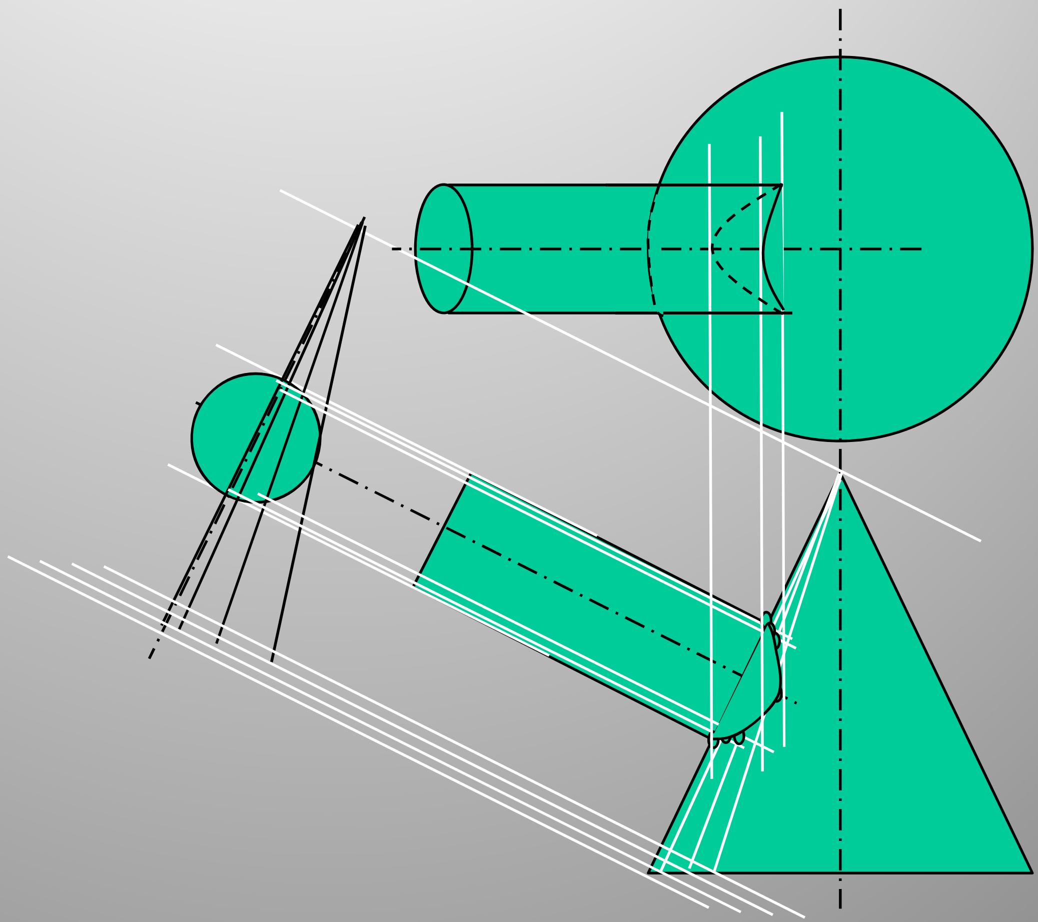
Intersection of two cylinders oblique to each other –Use PAV



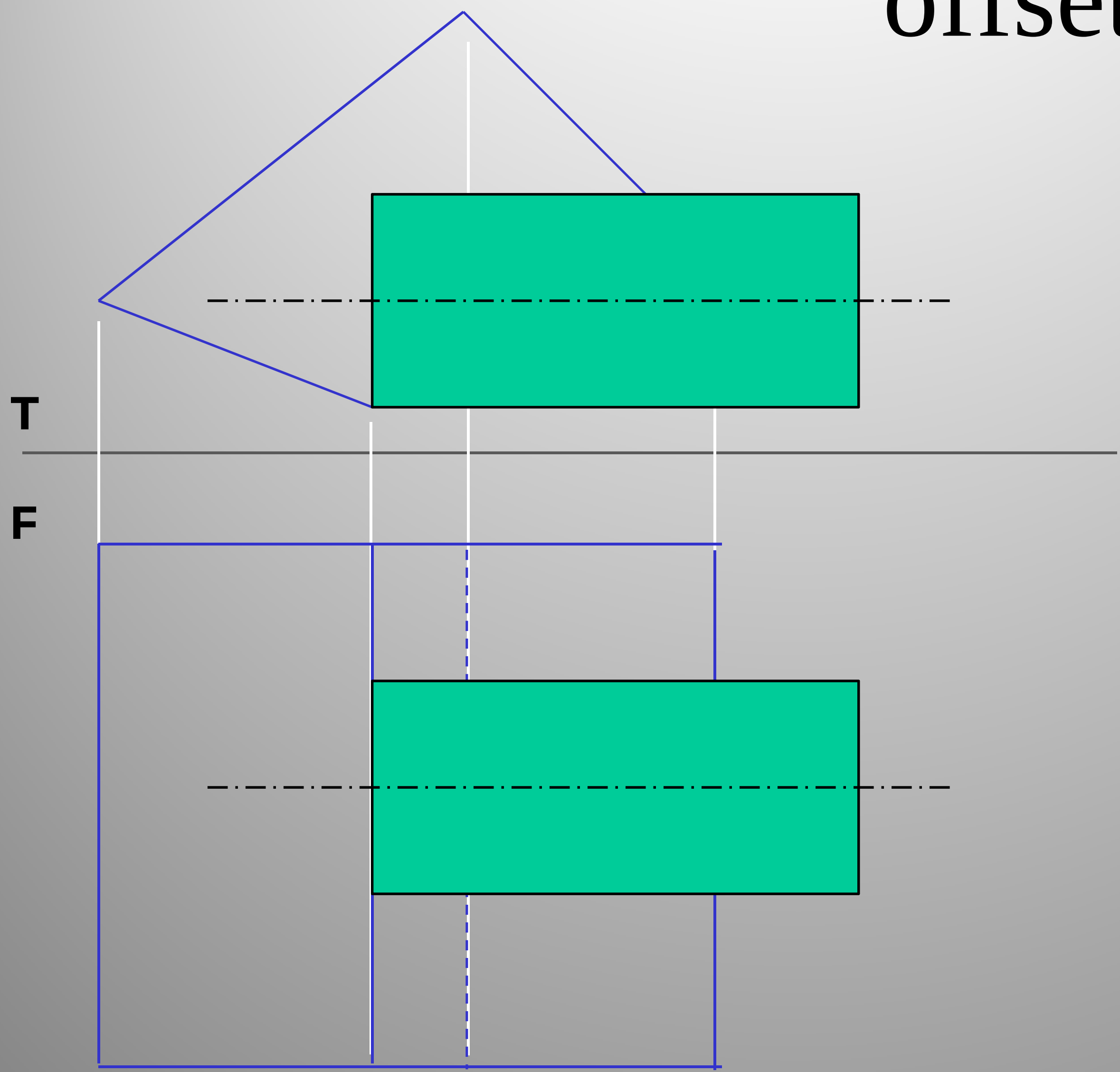
Intersection of two cylinders oblique to each other –Use AV



Intersection of Cone and Oblique cylinder using PAV

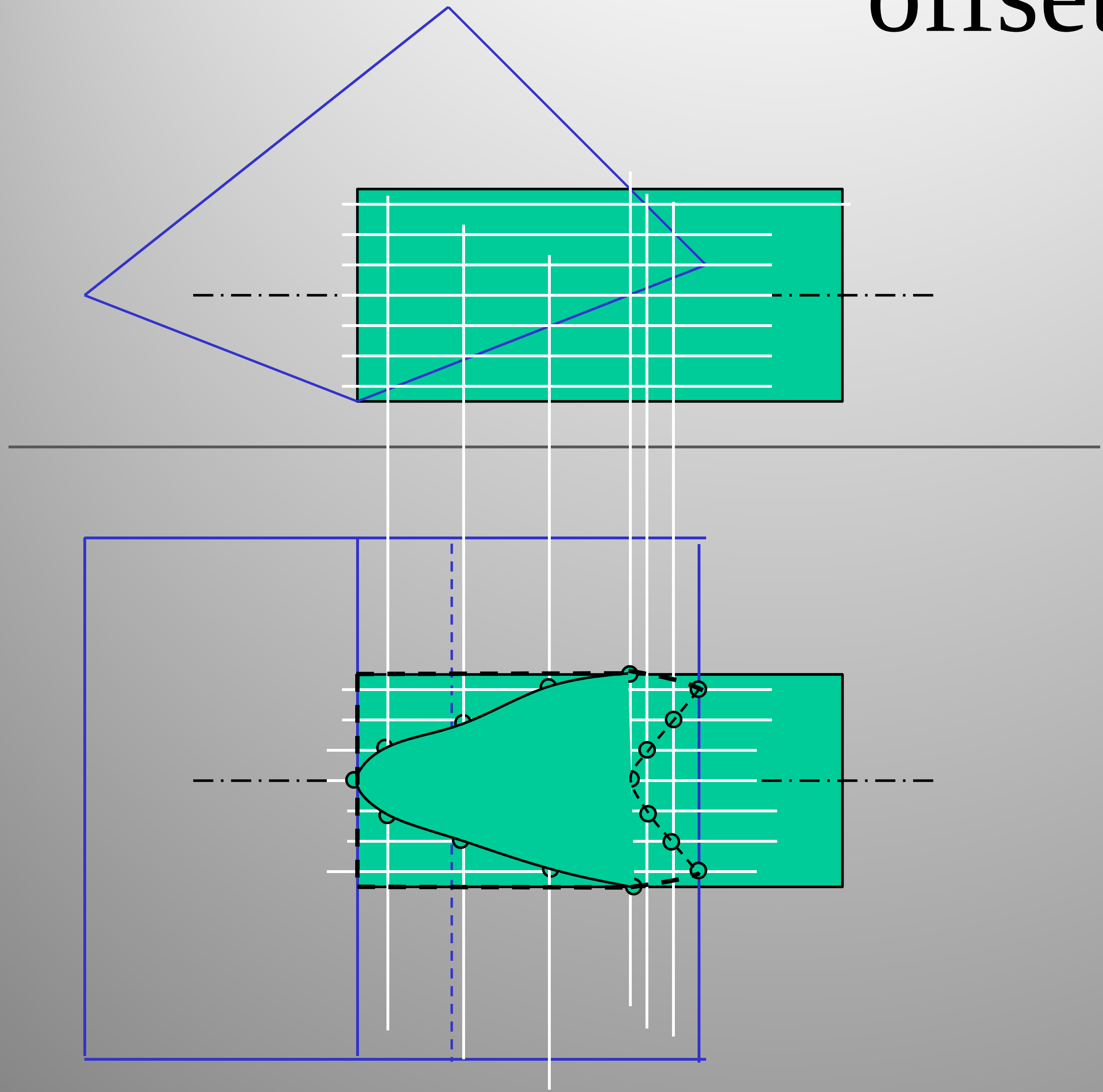


Intersection of irregular Prism & offset Cylinder



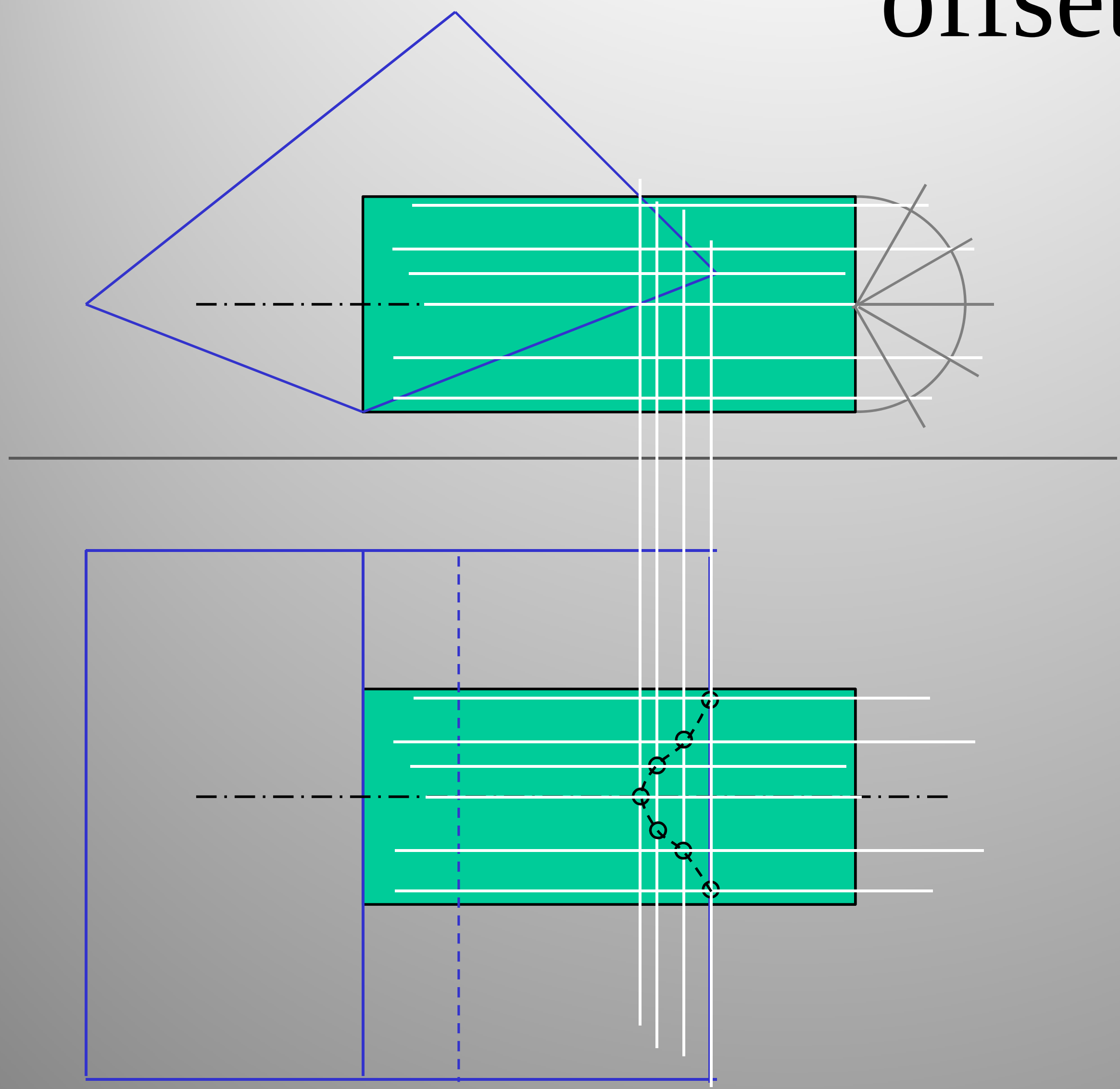
III angle projection

Intersection of irregular Prism & offset Cylinder



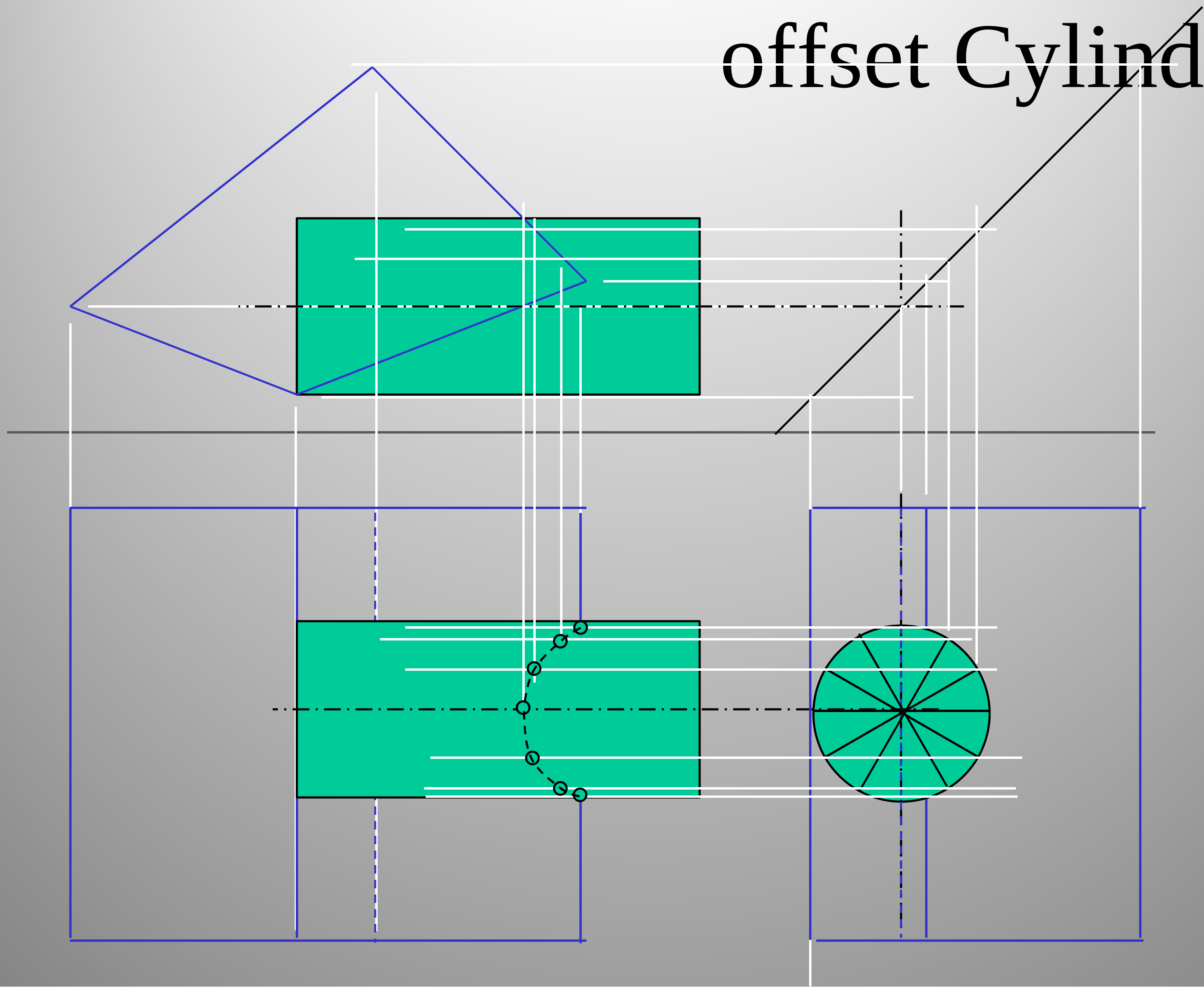
Invisible
Visible

Intersection of irregular Prism & offset Cylinder



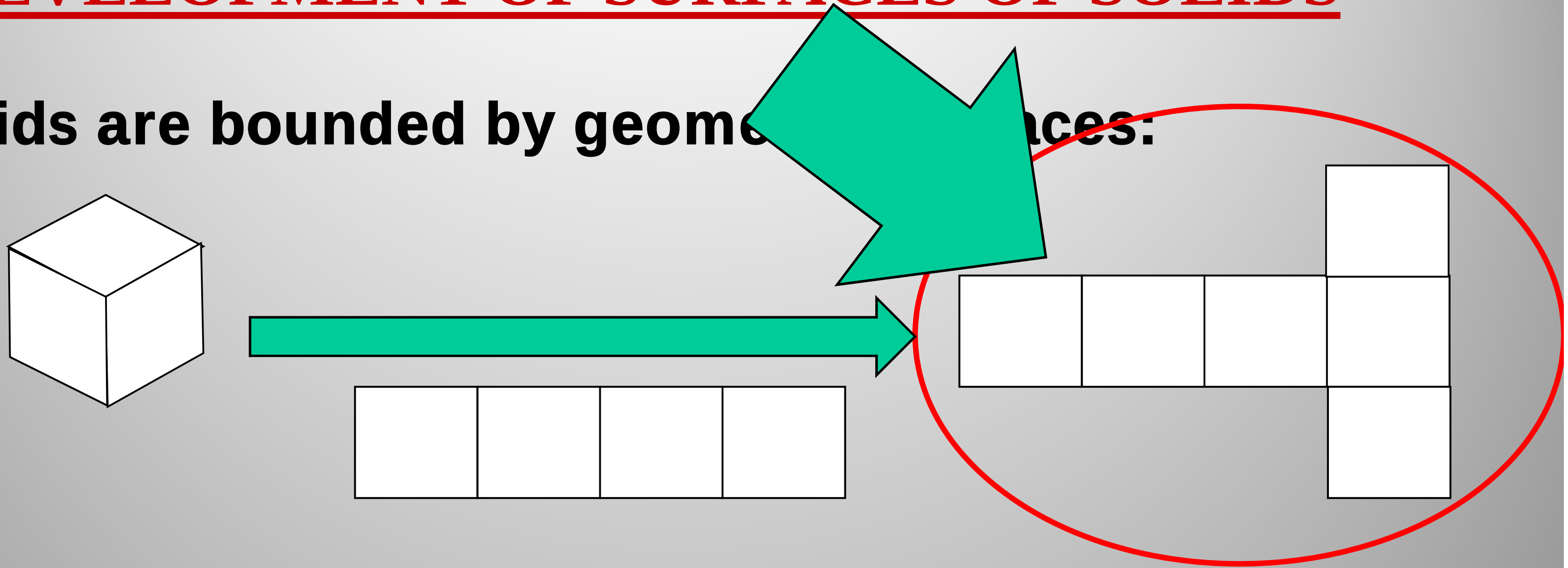
Invisible
Visible

Intersection of irregular Prism & offset Cylinder



DEVELOPMENT OF SURFACES OF SOLIDS

Solids are bounded by geome aces:



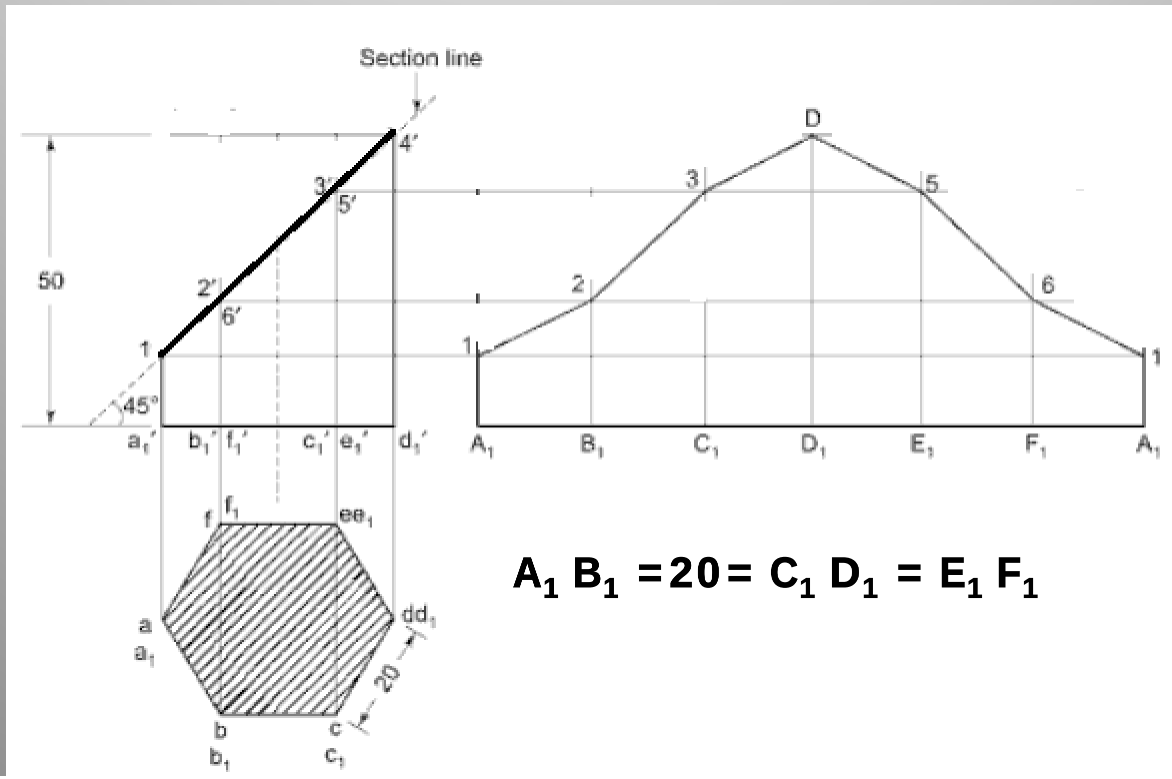
LATERLAL SURFACE IS SURFACE EXCLUDING SOLID'S TOP & BASE.

Development ~ obtaining the area of the surfaces of a solid.

- **Plane → Prism, Pyramid**
- **Single curved → Cone, Cylinder**
- **Double curved → sphere**

Surface Development of Hollow Solids

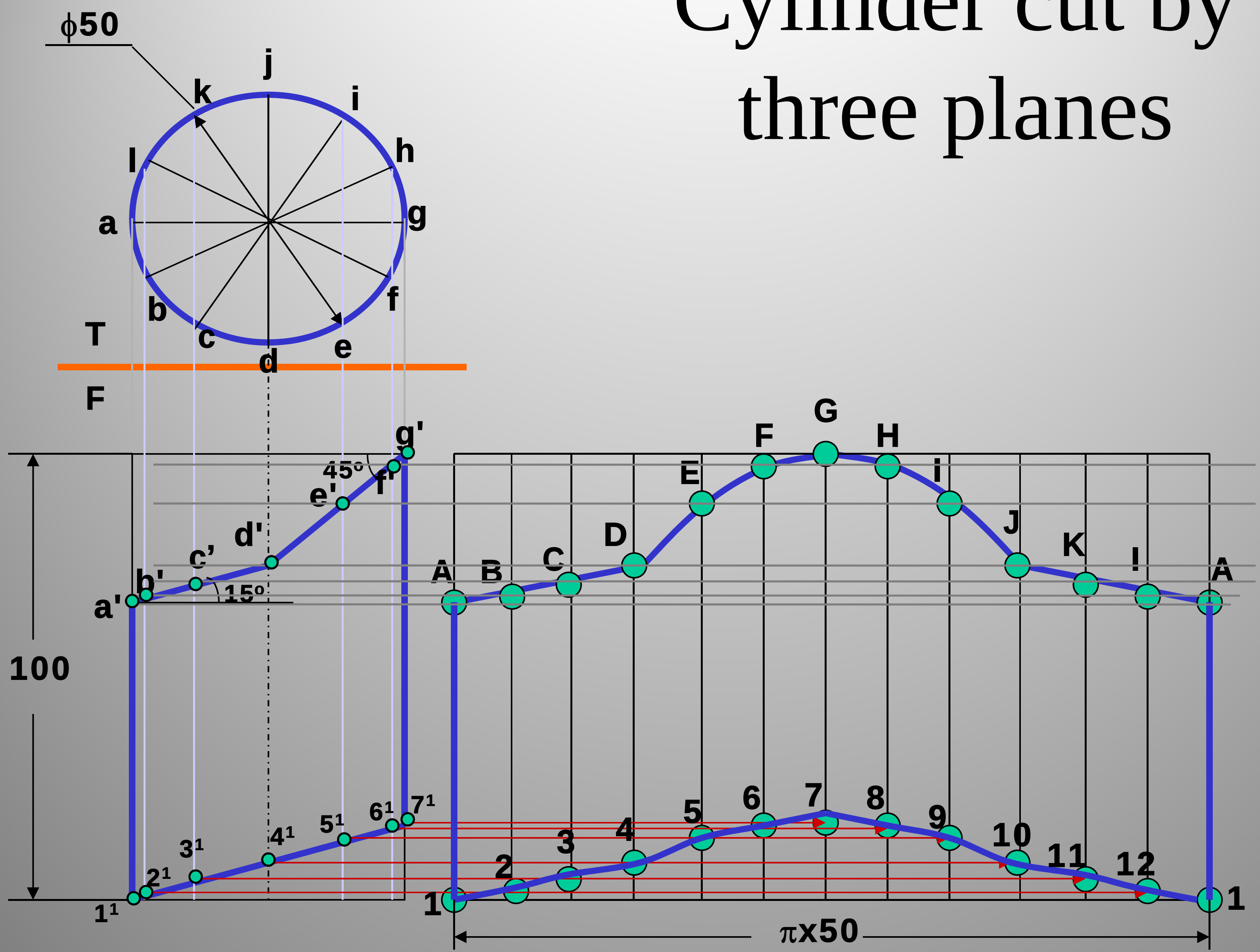
- Negligible thickness.
- Cutting hollow solid along any of its edge/generator and spreading it as sheet of paper.
  - All dimensions of the developed surface MUST be of TRUE LENGTH.



$A_1 B_1 = 20 = C_1 D_1 = E_1 F_1$

Front view may be utilized for development

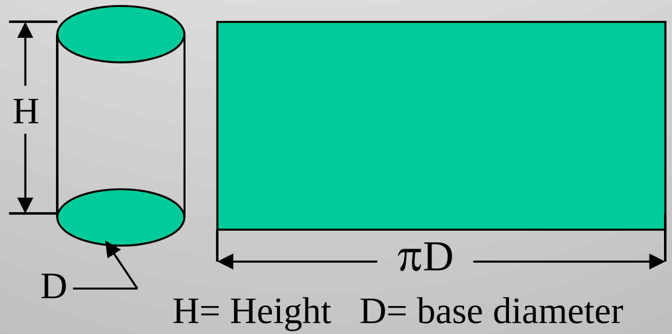
Cylinder cut by three planes



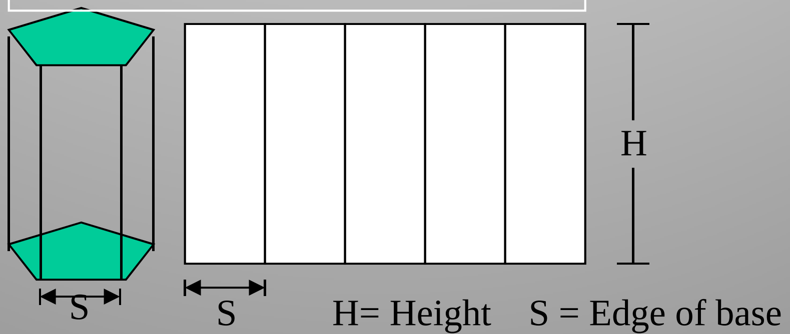
Methods to Develop Surfaces

1. **Parallel-line development:** **Used for prisms (full or truncated), cylinders (full or truncated). Parallel lines are drawn along the surface and transferred to the development**

Cylinder: A Rectangle

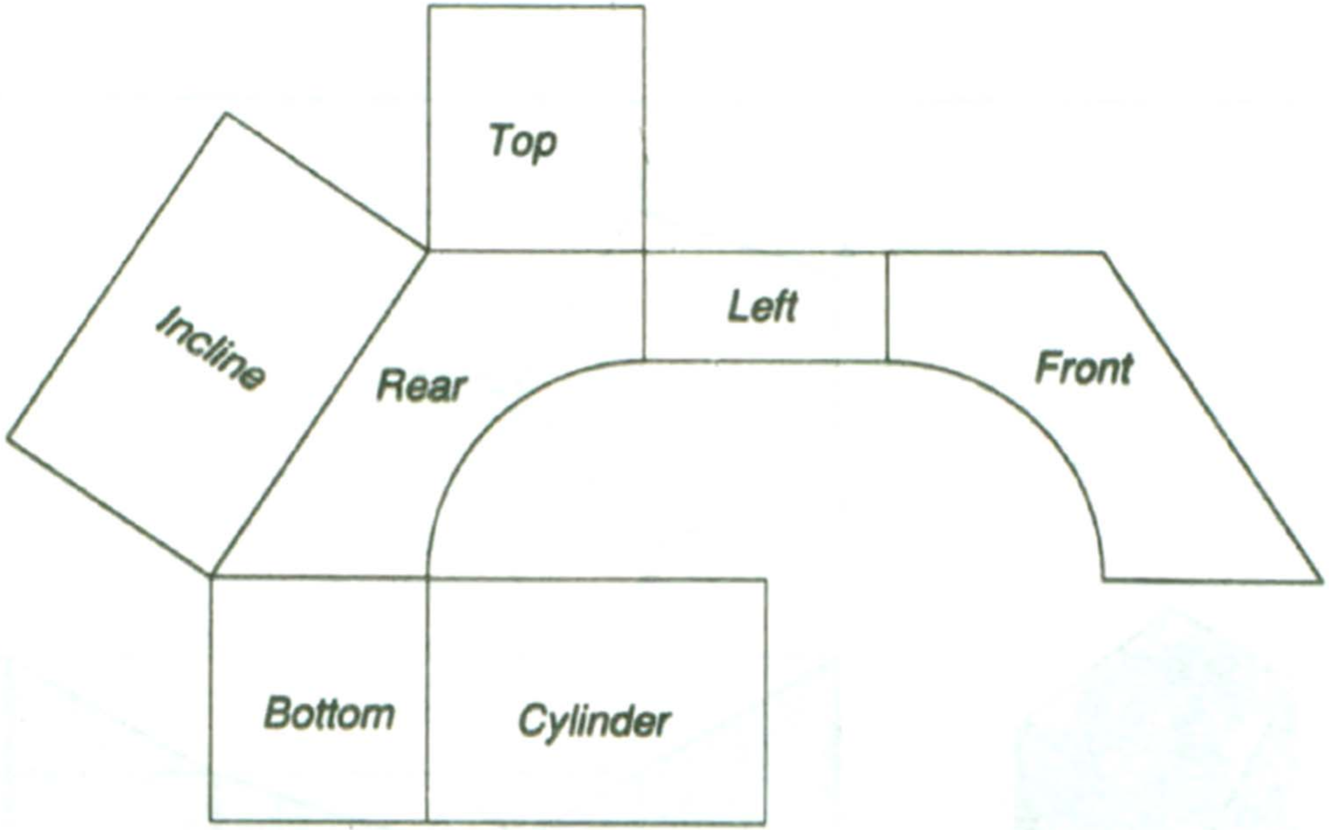


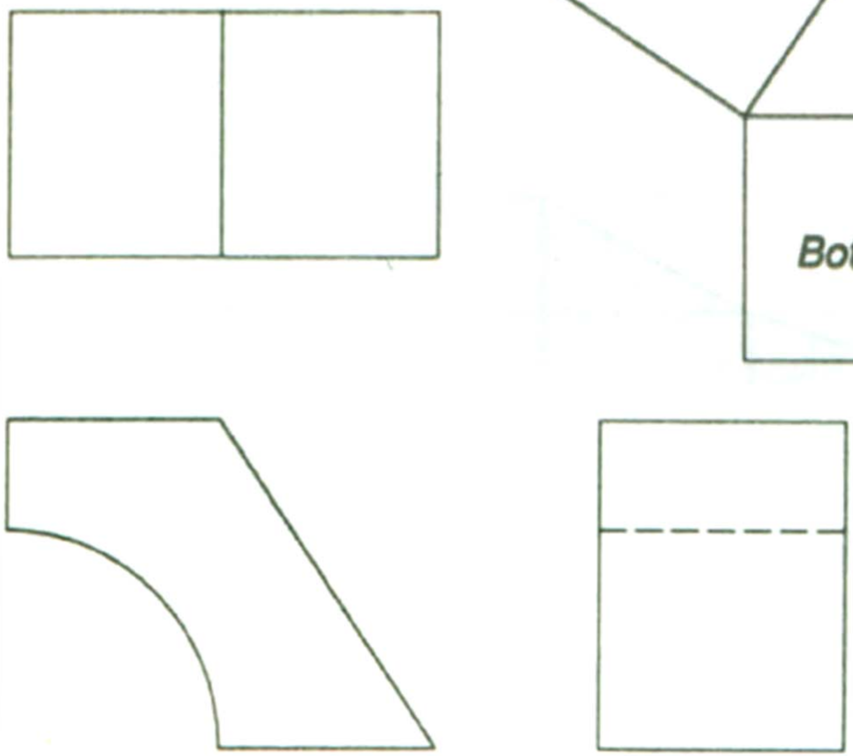
Prisms: No.of Rectangles



Ex:

Development by Faces:
Front (Rear)
Right (Left..Symmetry)
Top (Bottom.. Symmetry)





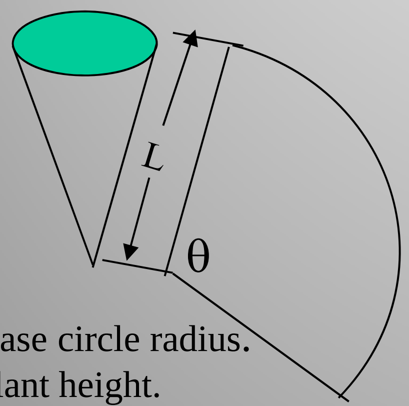
Complete development. DOTTED LINES are never shown on development

Methods to Develop Surfaces

1. **Parallel-line development**

2. **Radial-line development:** **Used for pyramids, cones etc. in which the true length of the slant edge or generator is used as radius**

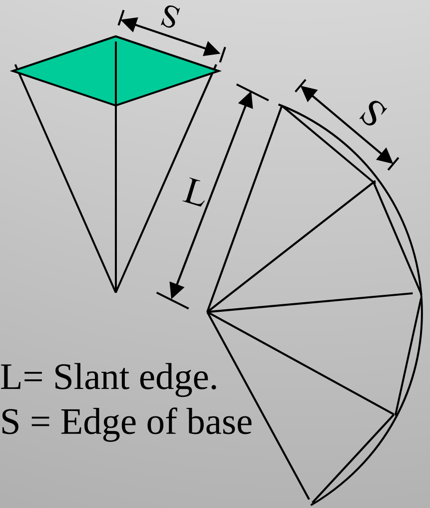
Cone: (Sector of circle)



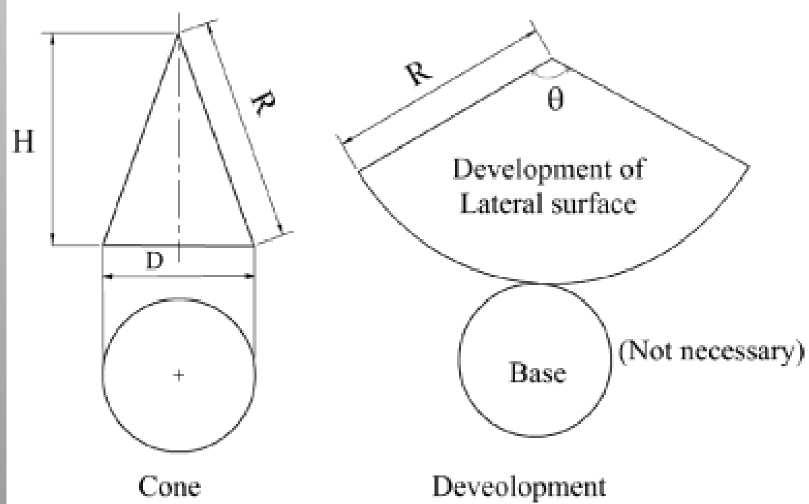
R=Base circle radius.
L=Slant height.

$$\theta = \frac{R}{L} \times 360^0$$

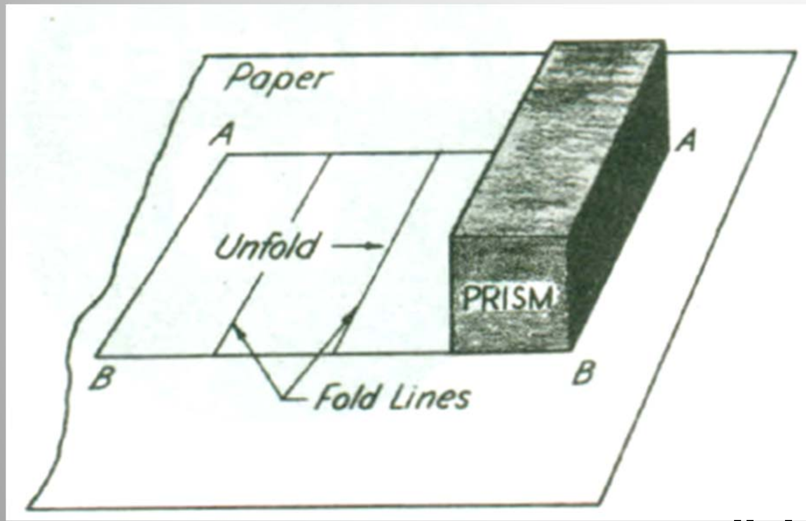
Pyramids: (No.of triangles)

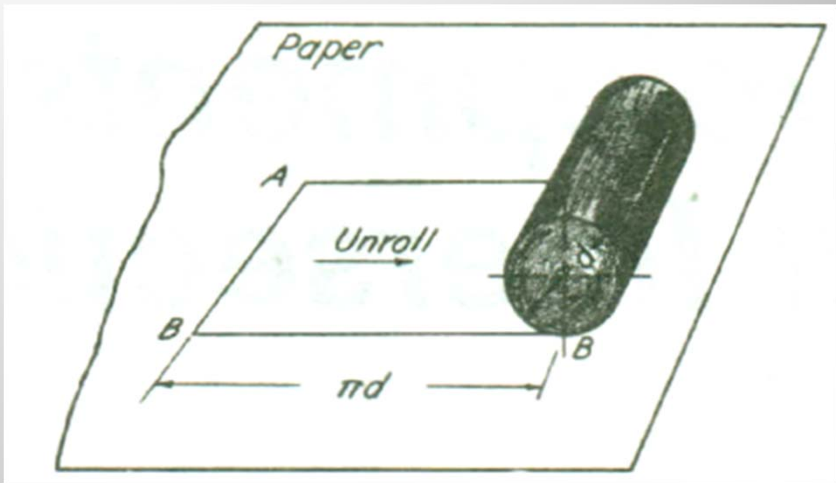


L= Slant edge.
S = Edge of base

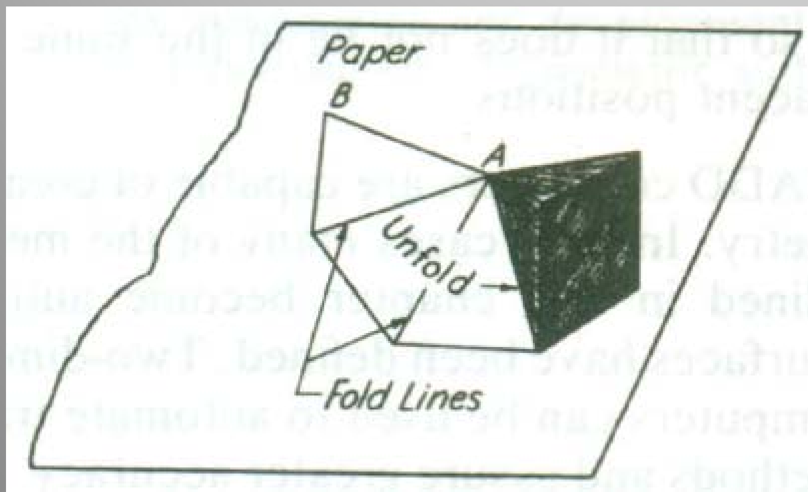


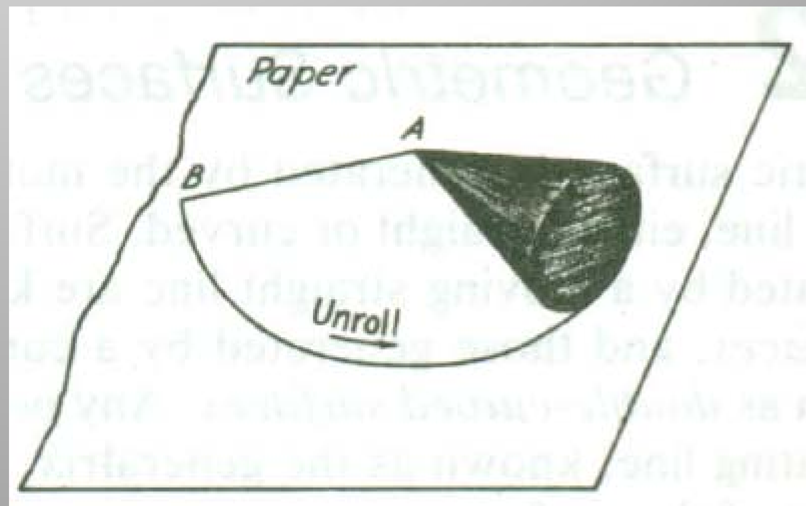
Parallel vs Radial line method





Parallel line method

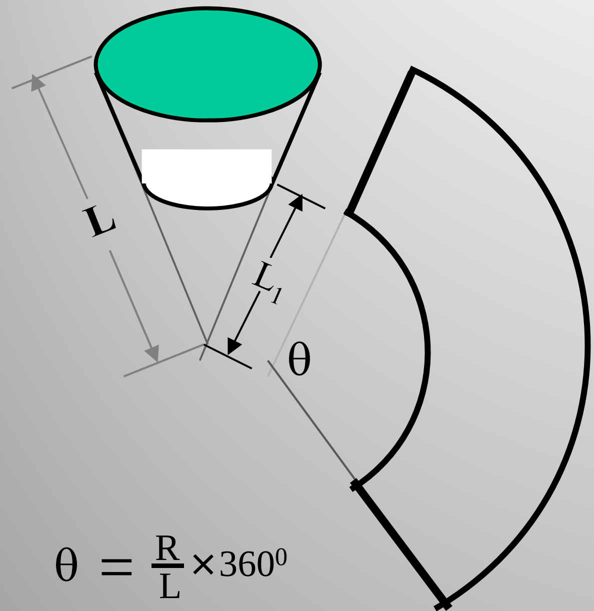




Radial line method

FRUSTUMS

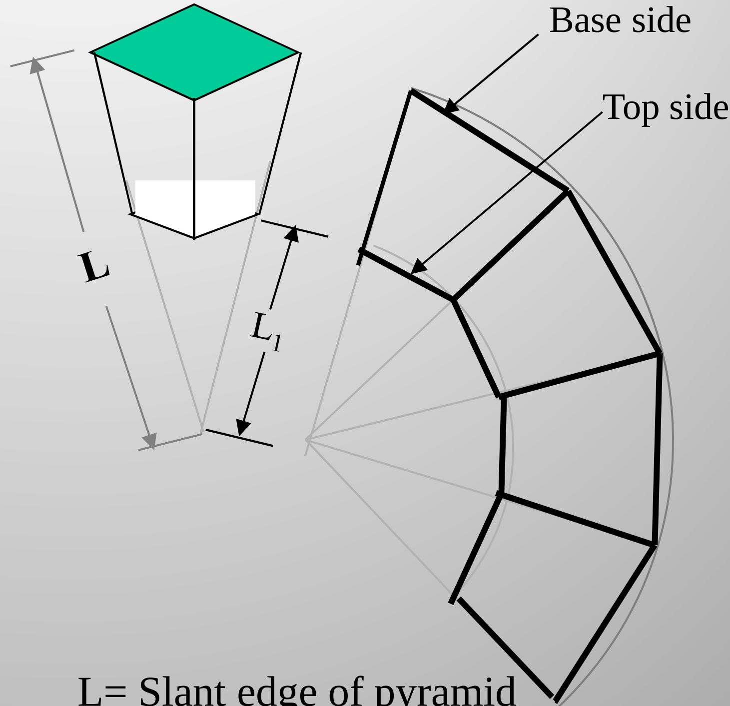
DEVELOPMENT OF
FRUSTUM OF CONE



$$\theta = \frac{R}{L} \times 360^0$$

R= Base circle radius of cone
L= Slant height of cone
L_1 = Slant height of cut part.

DEVELOPMENT OF
FRUSTUM OF SQUARE PYRAMID

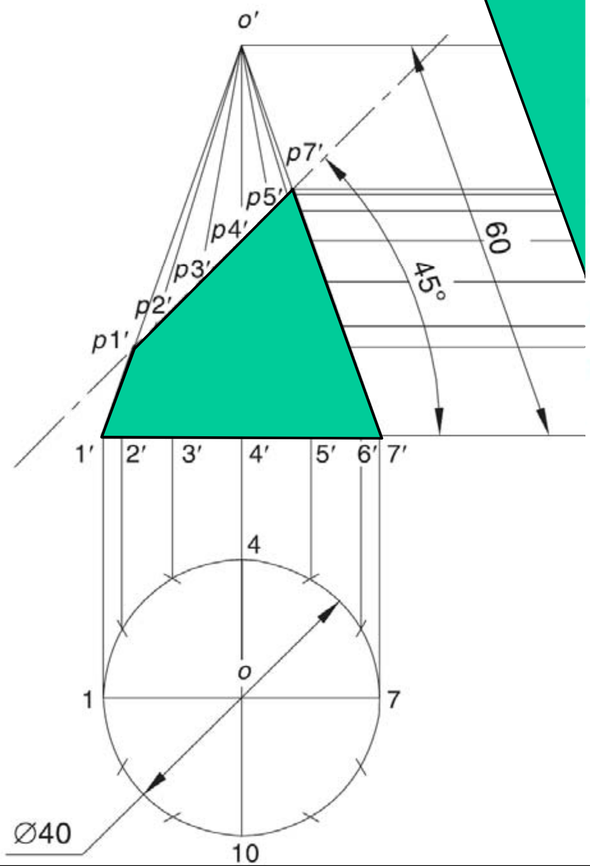


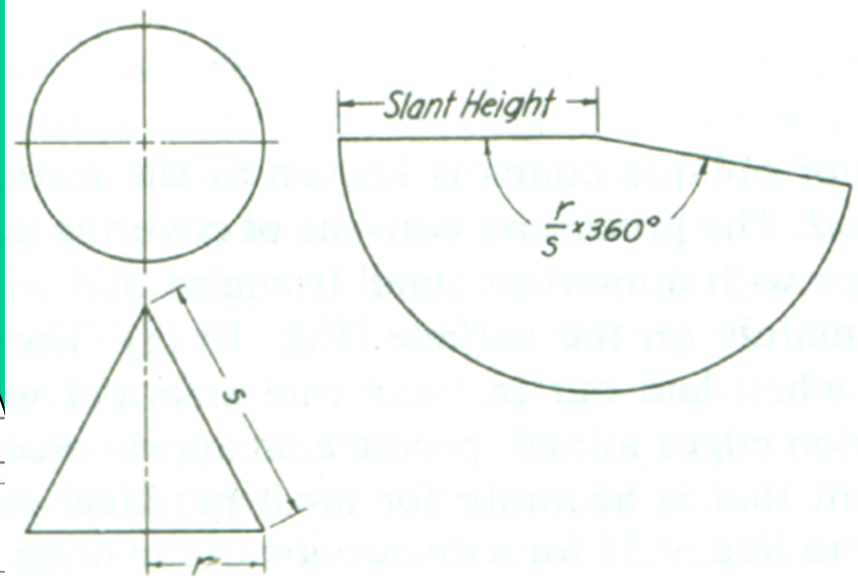
L= Slant edge of pyramid
L_1 = Slant edge of cut part.

***Important** points.*

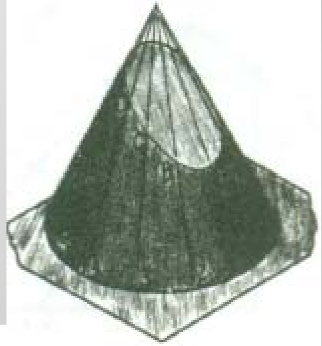
1. Development is a shape showing AREA, means it's a 2-D plain drawing.
2. All dimensions of it must be TRUE dimensions.
3. As it is representing shape of an un-folded sheet, no edges can remain hidden and hence DOTTED LINES are never shown on development.

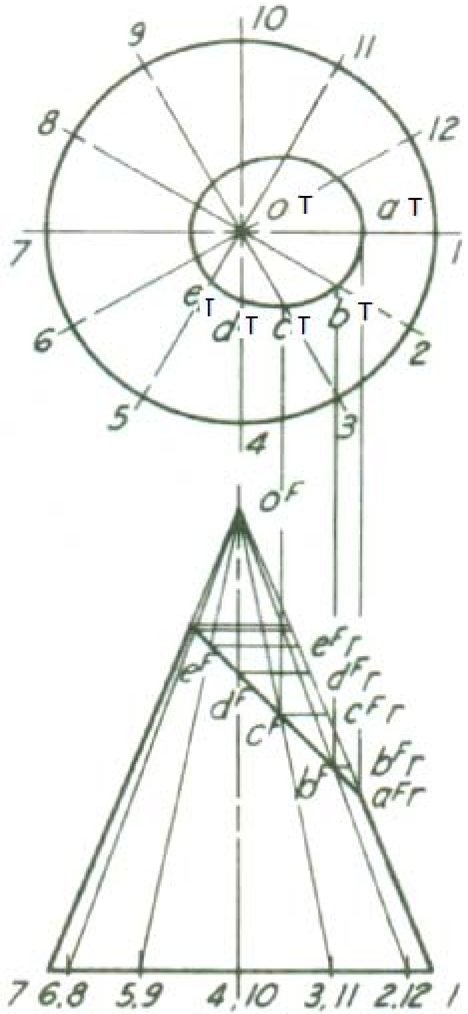
Development by Radial Method→ Pyramids (full or Truncated) & Cones (full or Truncated).





Ex:




10
9
11
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12
o T
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1
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c T
b T
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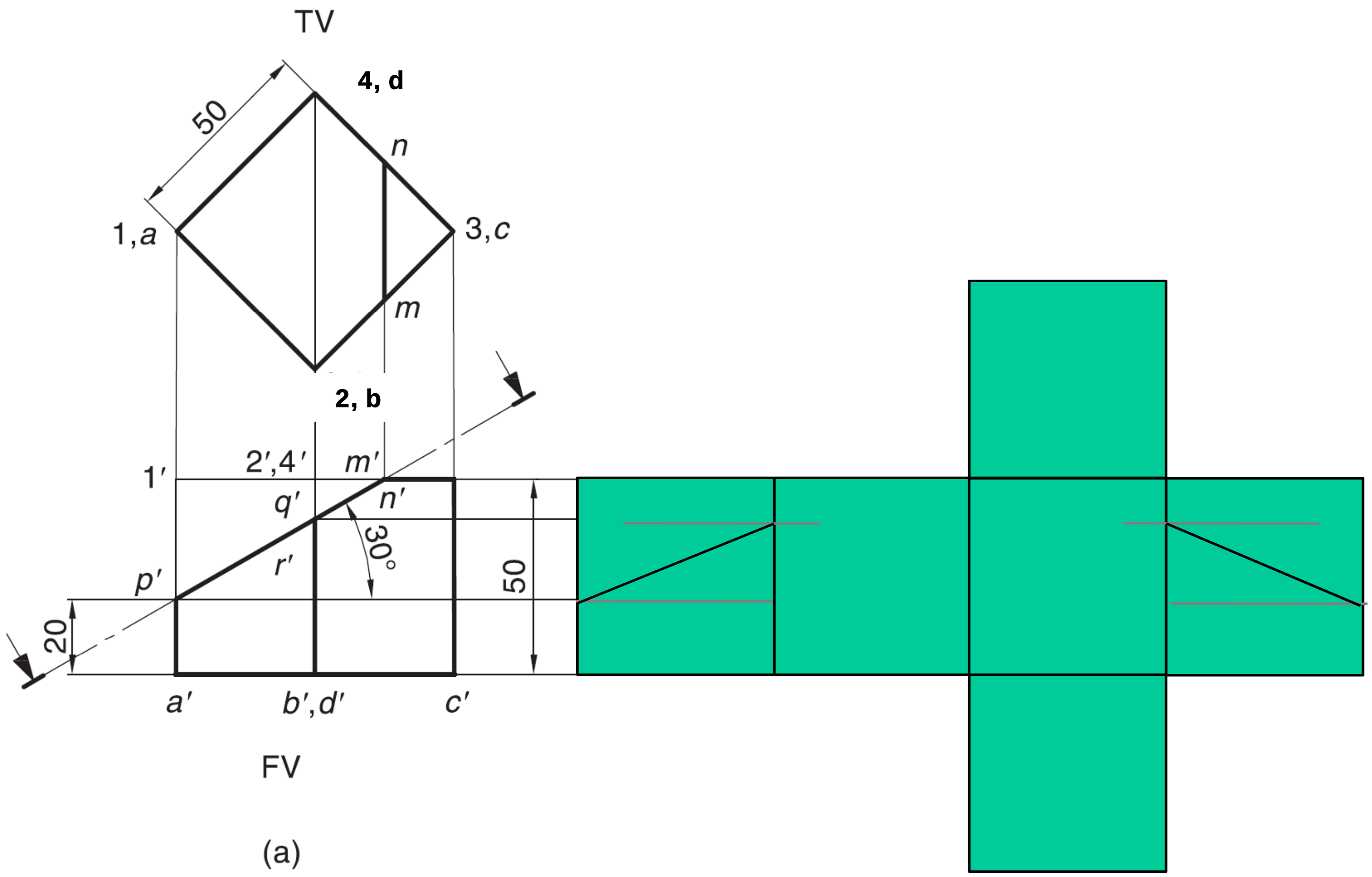
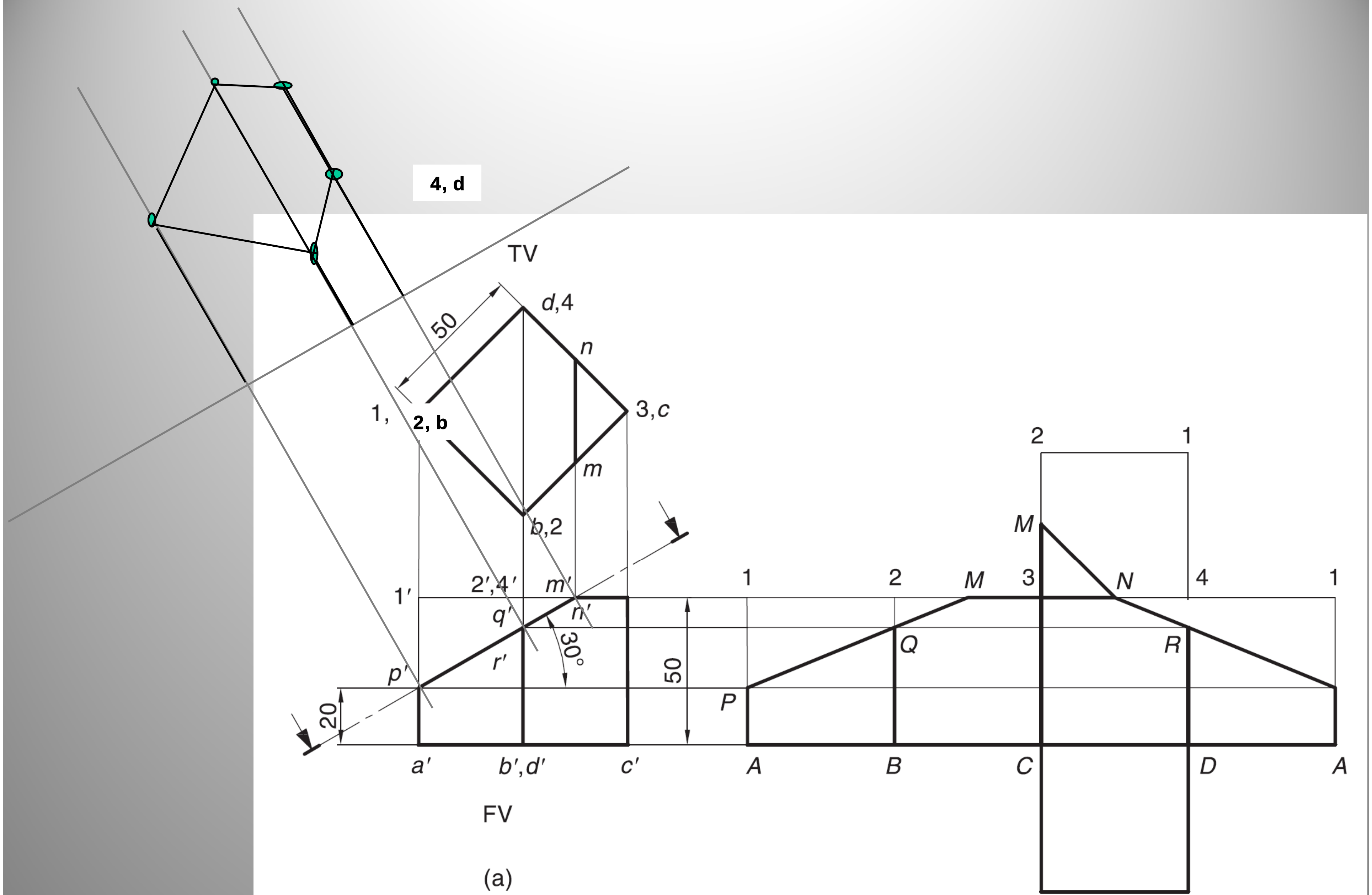
d F r
c F r
b F r
a F r
7 6.8 5.9 4,10 3,11 2.12 1



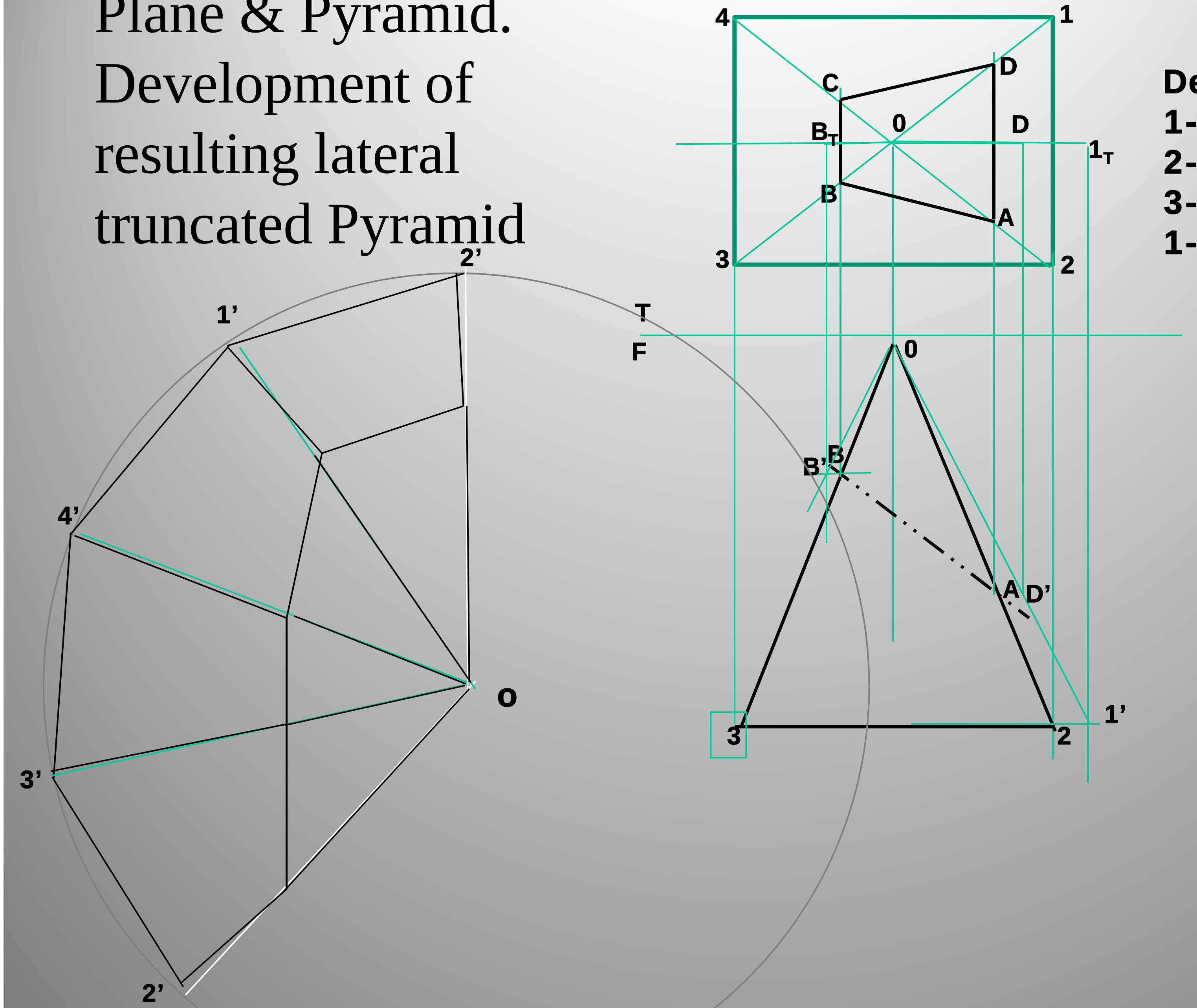
Complete development of cube cut by cutting plane (inclined to HP at 30 degrees and perpendicular to VP)



4, d
TV
d,4
50
n
1,
2, b
3,c
m
b,2
2
1
M
1′
2′,4′
m′
q′
n′
30°
r′
p′
20
50
1
2
M
3
N
4
1
Q
R
P
a′
b′,d′
c′
A
B
C
D
A
FV

(a)

Intersection of Plane & Pyramid. Development of resulting lateral truncated Pyramid

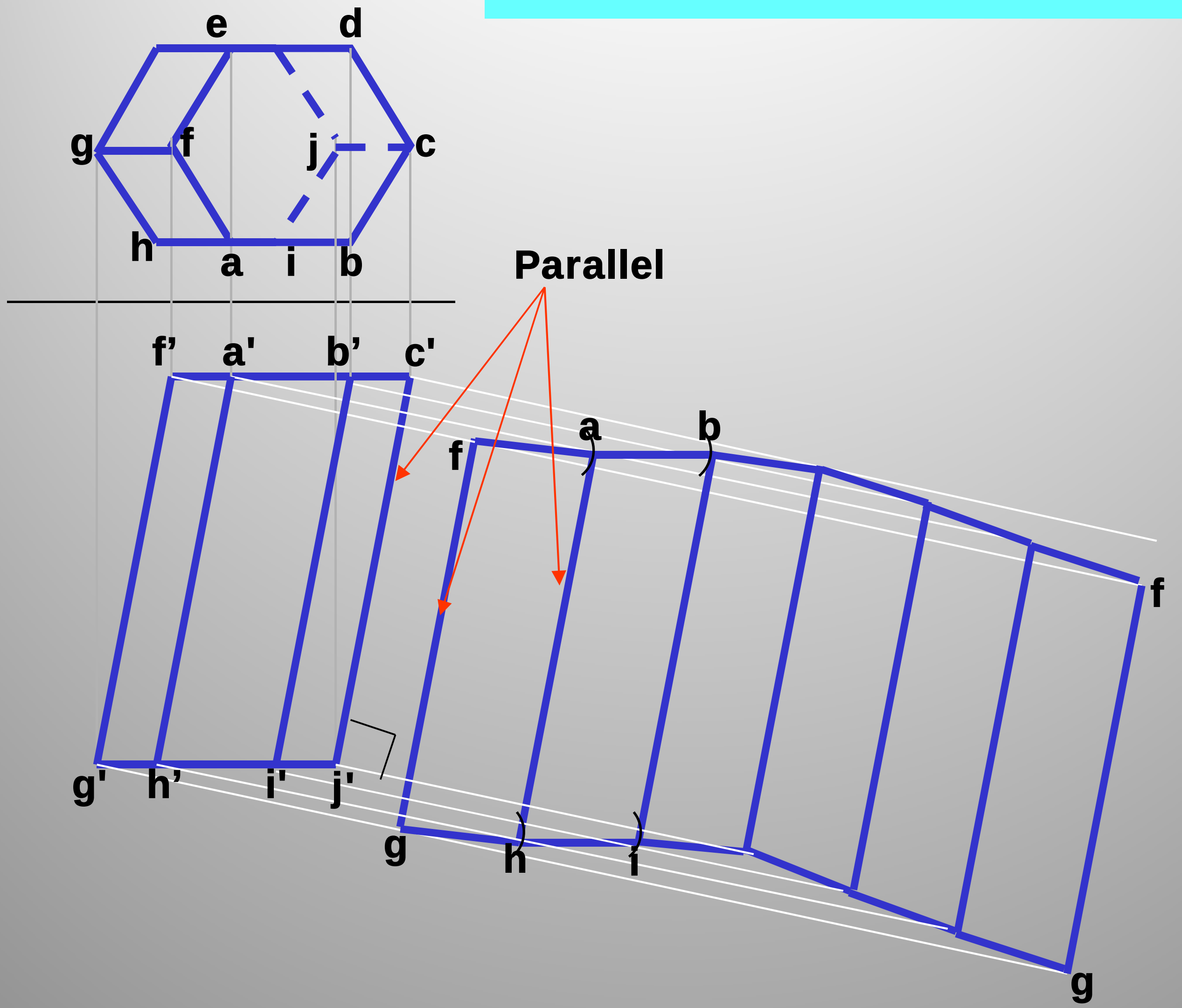


Develop
1-D-A-2-1
2-A-B-3-2
3-B-C-4-3
1-D-C-4-1

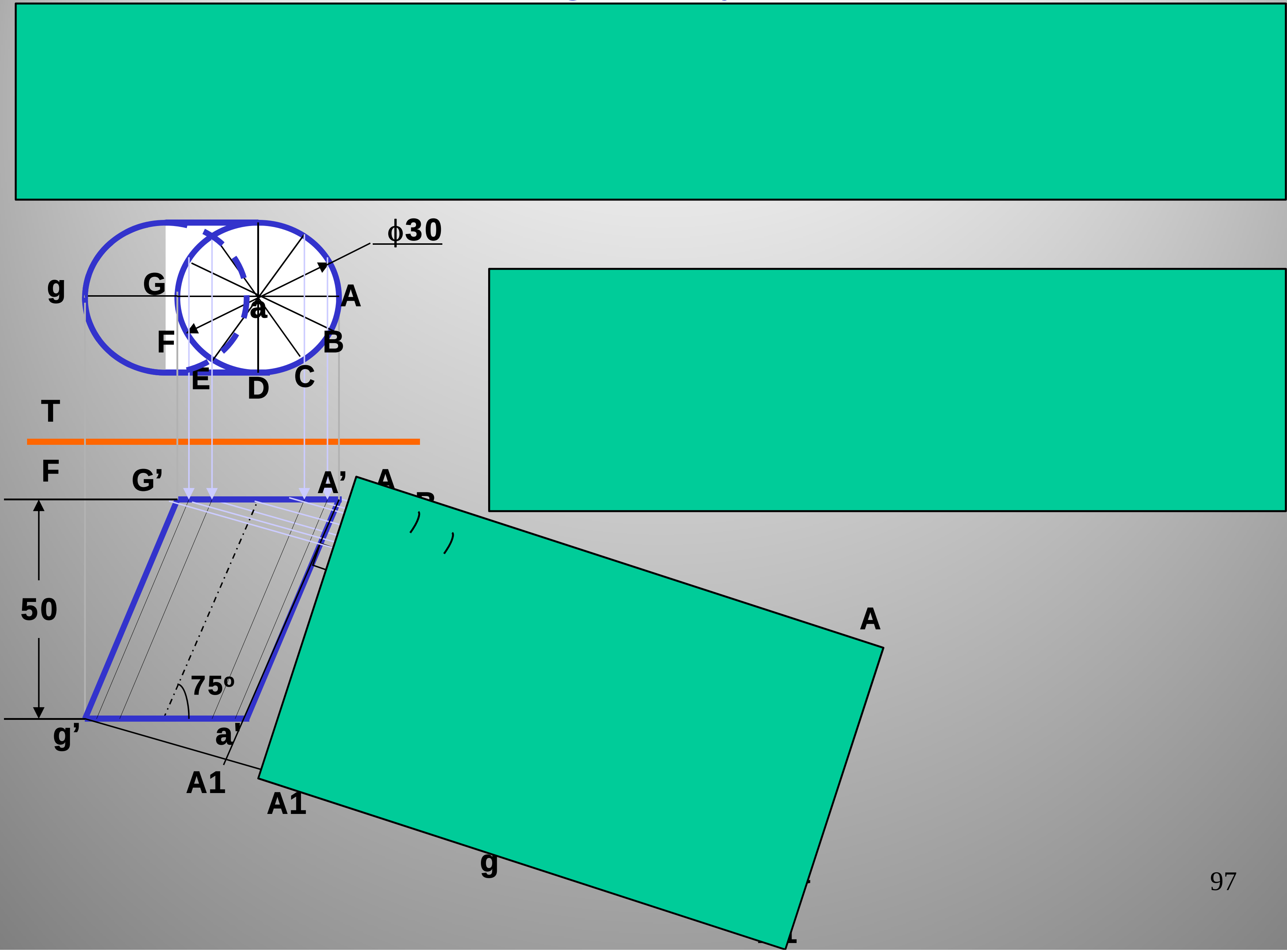
Development of Oblique Objects

- Right regular objects – Axis of object perpendicular to base.
- Axis of any regular object (prism, pyramid, cylinder, cone, etc.) inclined at angle other than right angle – Oblique OBJECT. Use ARC method.

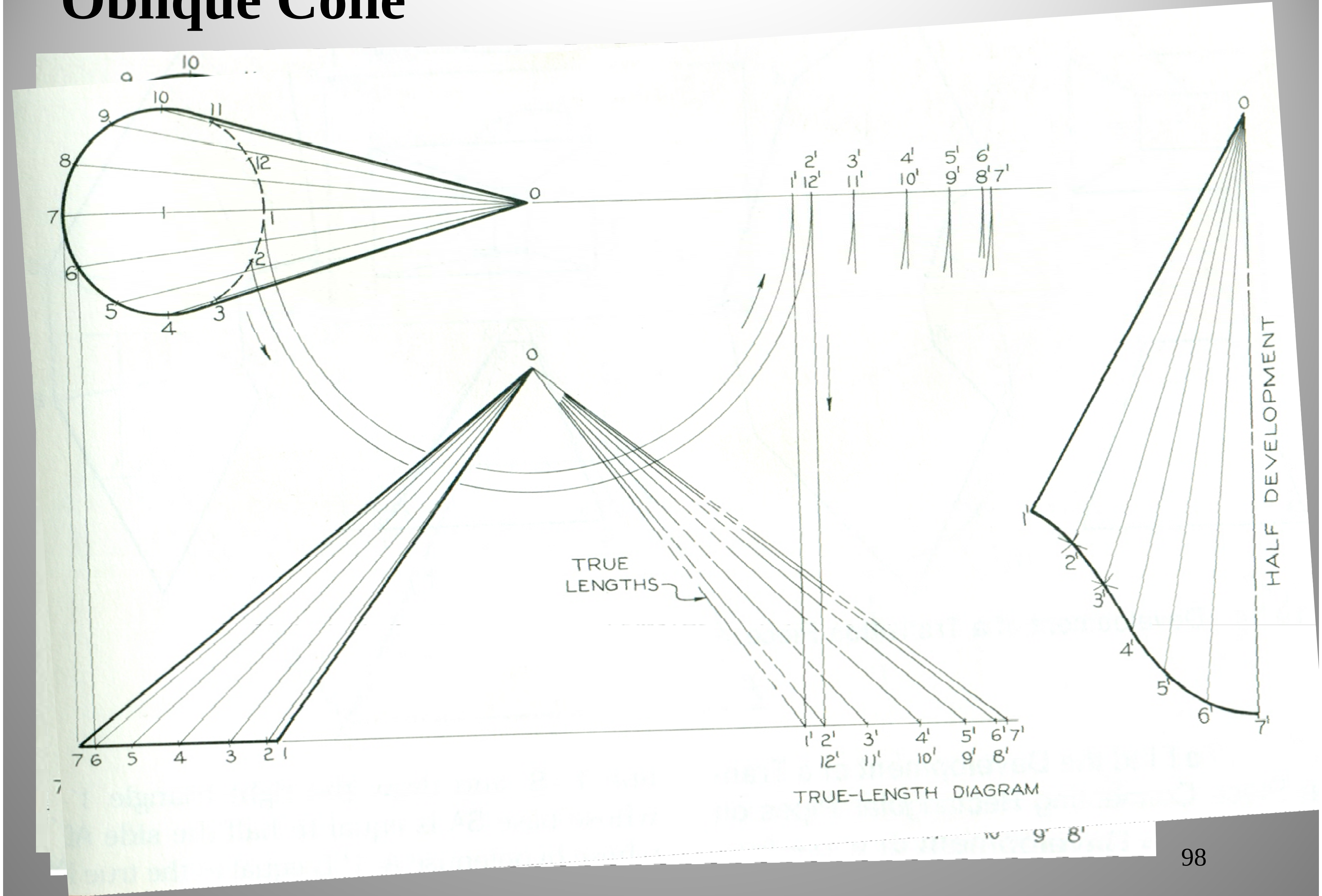
Oblique prism



Draw the development of an oblique circular cylinder with base diameter 30 mm and axis inclined at 75^o with the base. Height of the cylinder is 50 mm

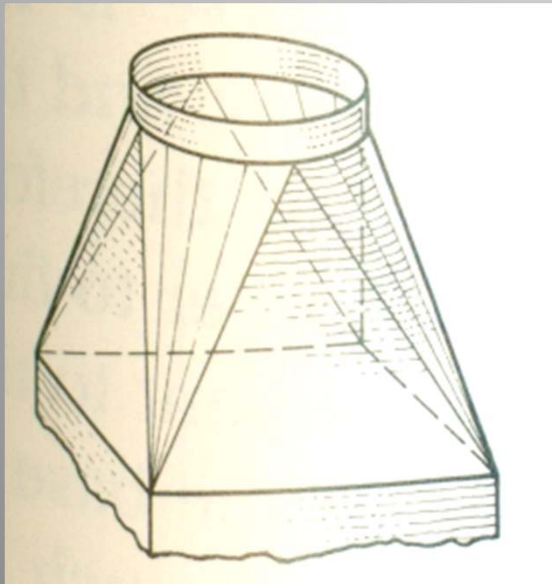


Oblique Cone



Methods to Develop Surfaces

1. **Parallel-line development:** **Prismatic objects (cylinder, prism)**
2. **Radial-line development:** **Non-prismatic objects (cone, pyramid).. Apex as center and slant edge as radius.**
3. **Triangulation development:** **Complex shapes are divided into a number of triangles and transferred into the development**

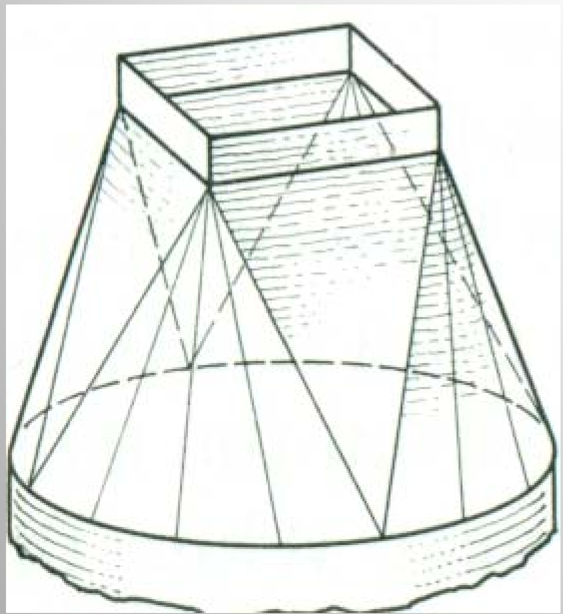


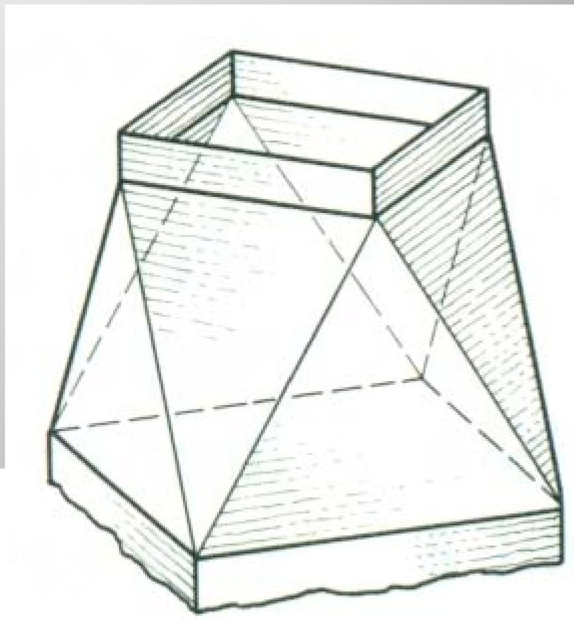
EXAMPLES:-

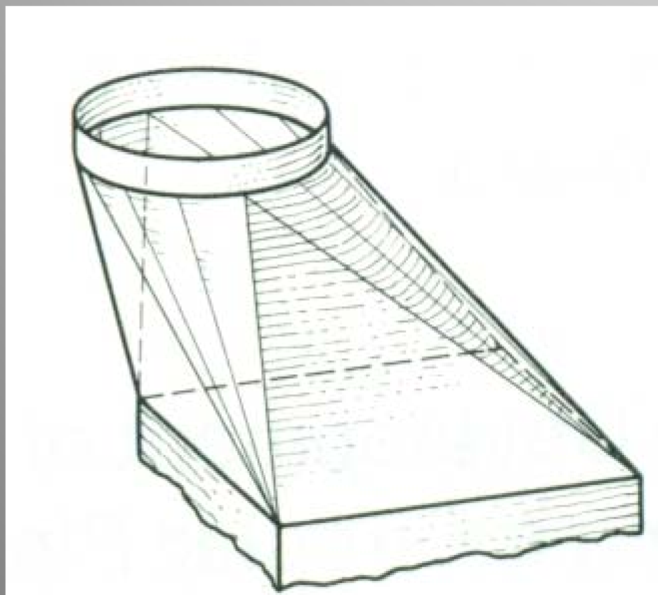
Boiler Shells & chimneys, Pressure Vessels, Shovels, Trays, Boxes & Cartons, Feeding Hoppers, Large Pipe sections, Body & Parts of automotives, Ships, Aero planes.

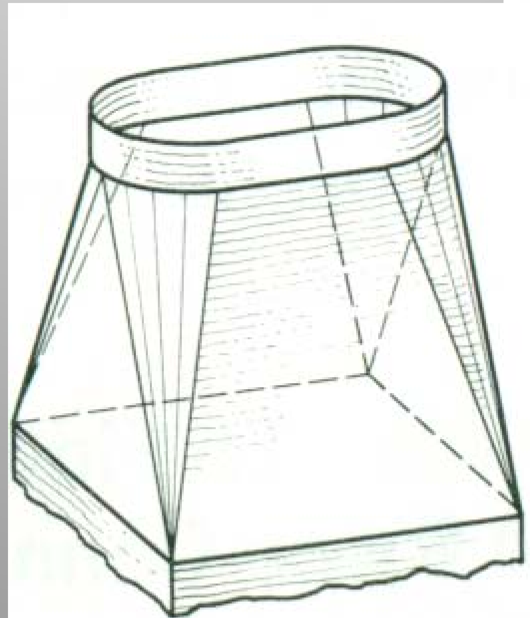
Connect two hollow objects having different base.

Transition Pieces



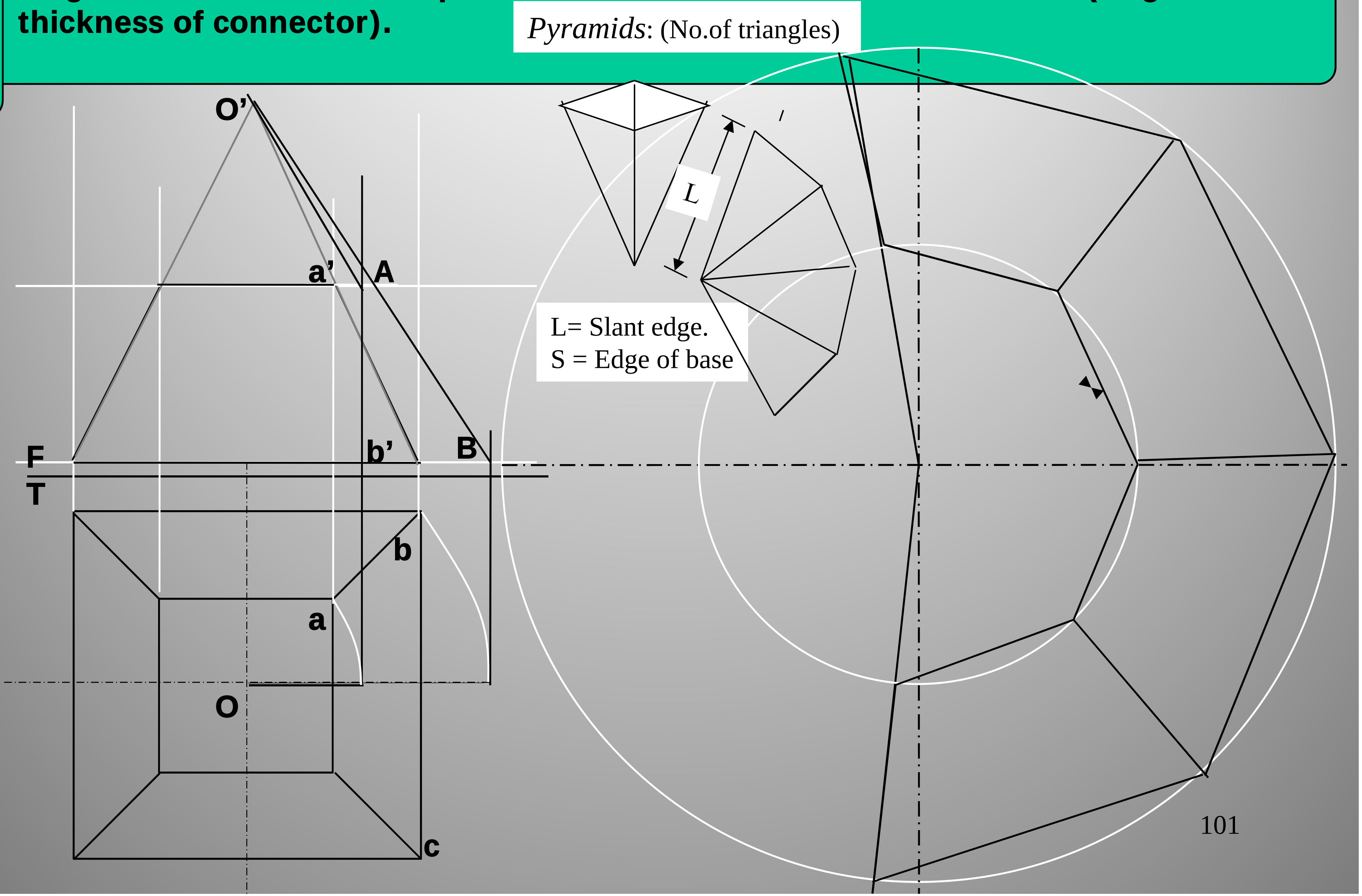




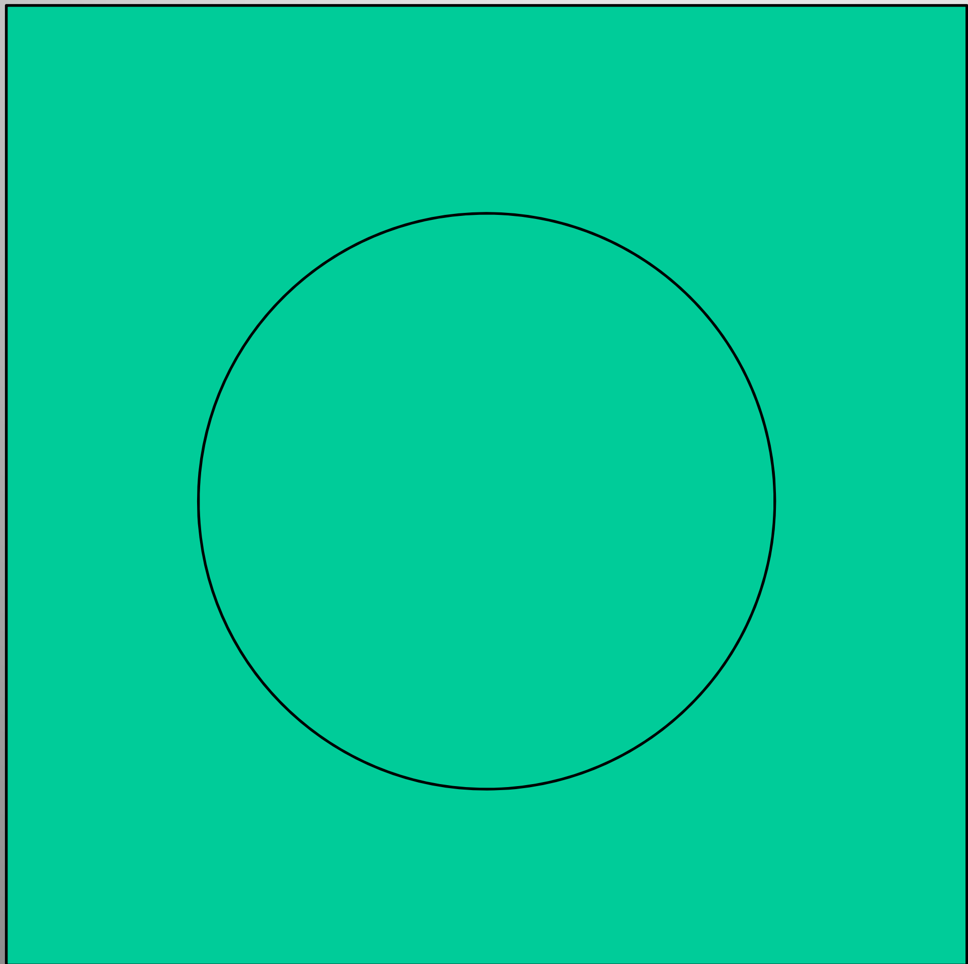


Triangulation Method: Dividing a surface into a number of triangles and transfer them to the development.

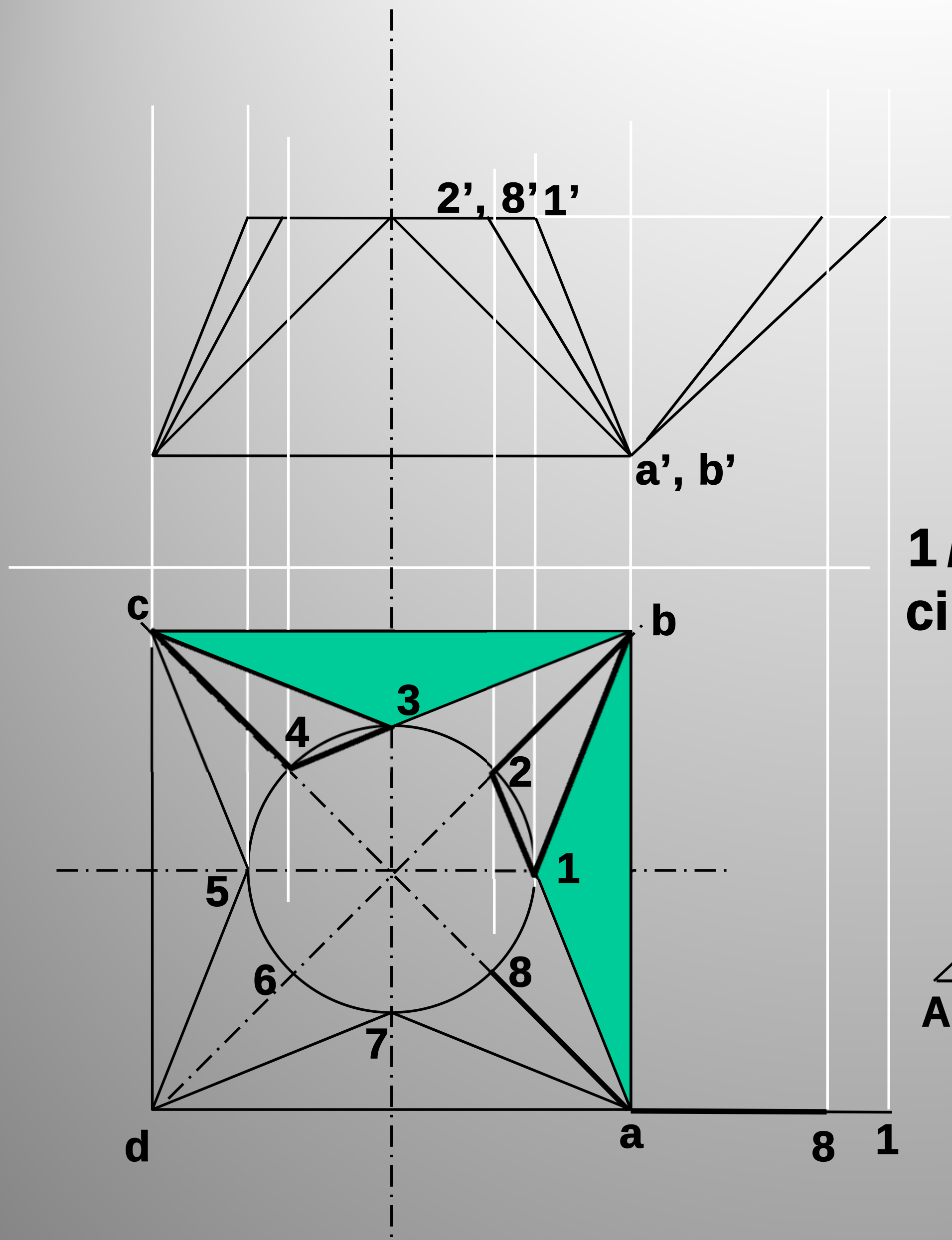
Ex: In air conditioning system, a square duct of 50mm by 50mm is connected to another square duct of 25mm by 25 mm by using a connector (transition piece) of height 25mm. Draw development of lateral surface of the connector (Neglect thickness of connector).



Development of Transition Piece for Difference Shapes and Sizes



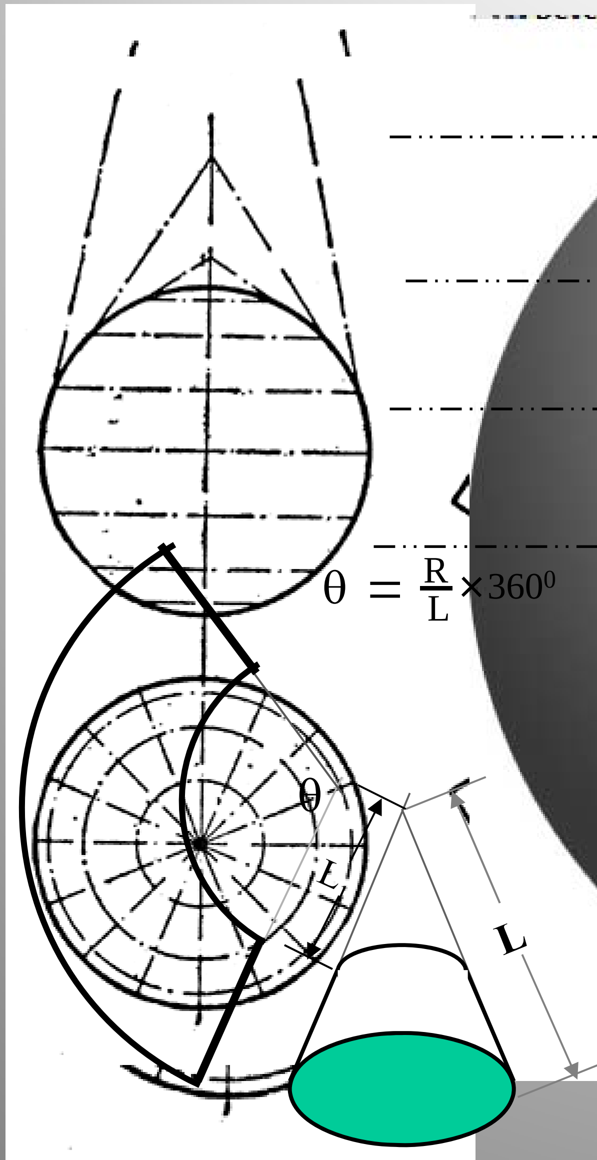
- circular pipe.
- ce (height = 25) uare cross ircular pipe of rojections and e transition



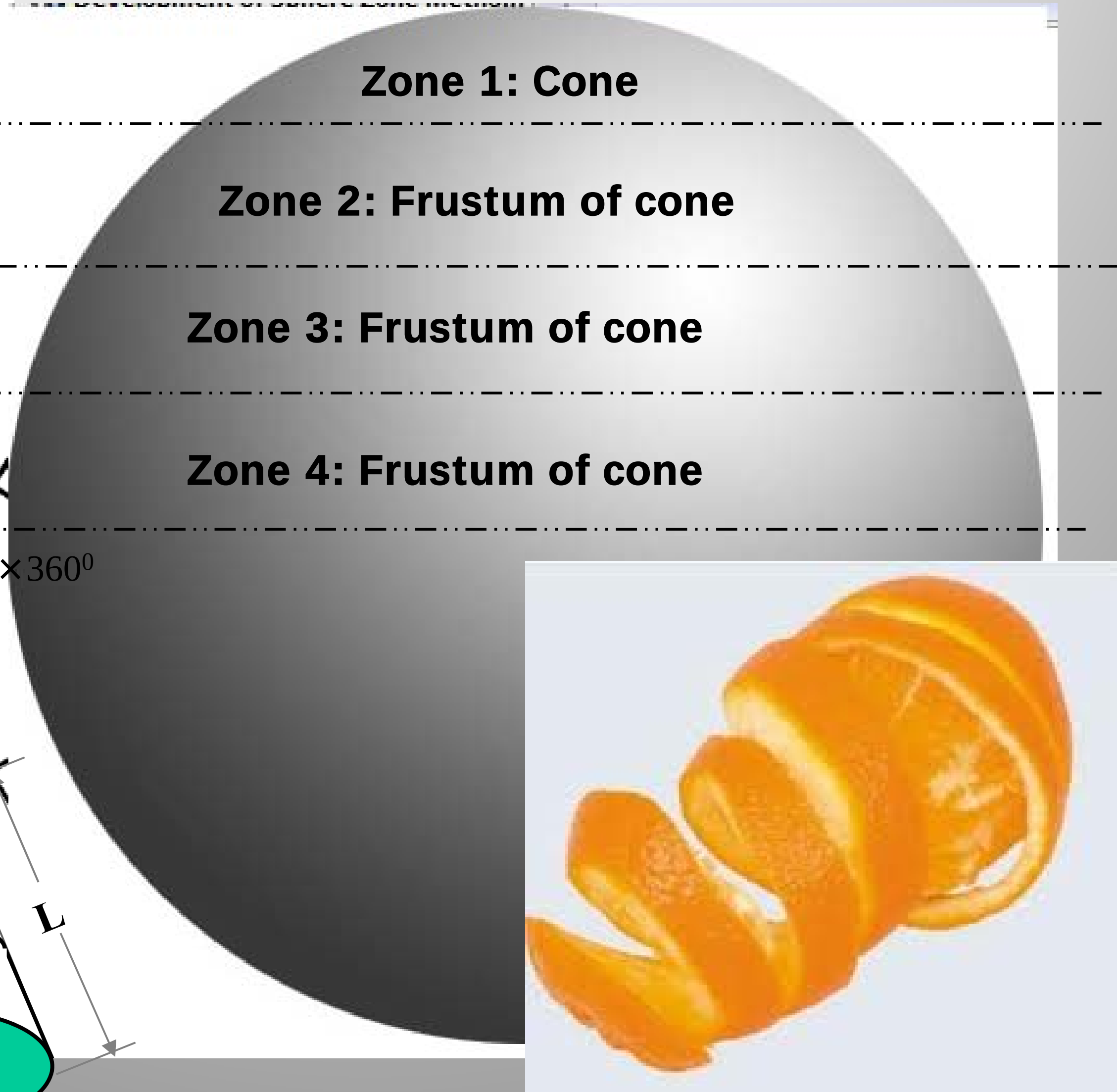
1/8 of
circumference

I angle projection

Development of Sphere using Frustum of Cones: Zone Method



$$\theta = \frac{R}{L} \times 360^0$$



Development of Sphere/Hemisphere using Lune Method