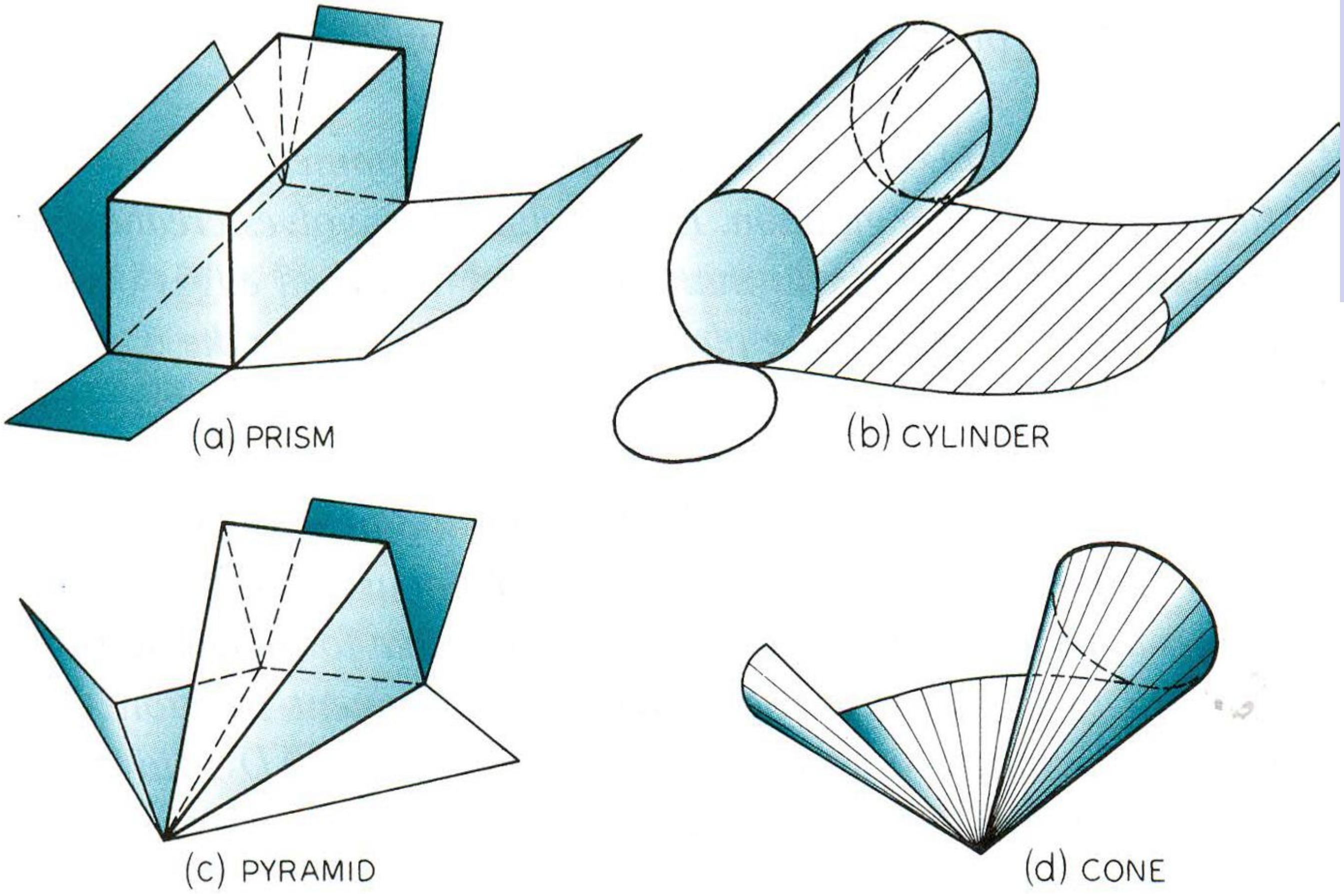
Development of Surfaces

Development is a graphical method of obtaining the area of the surfaces of a solid. When a solid is opened out and its complete surface is laid on a plane, the surface of the solid is said to be developed.

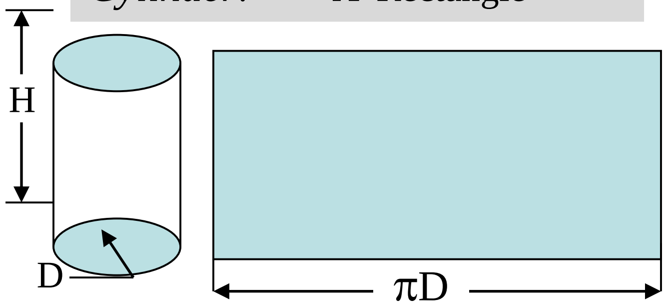


Every line on the development should be true length of the corresponding line on the surface of the solid.

Development of lateral surfaces of different solids.

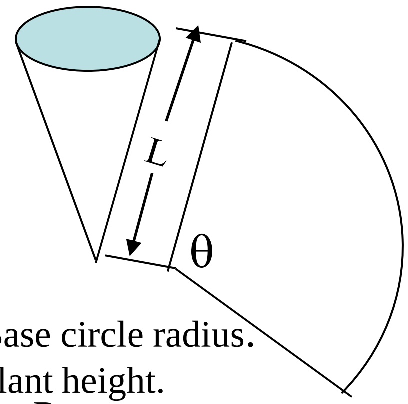
(Lateral surface is the surface excluding top & base)

Cylinder: A Rectangle



H= Height D= base diameter

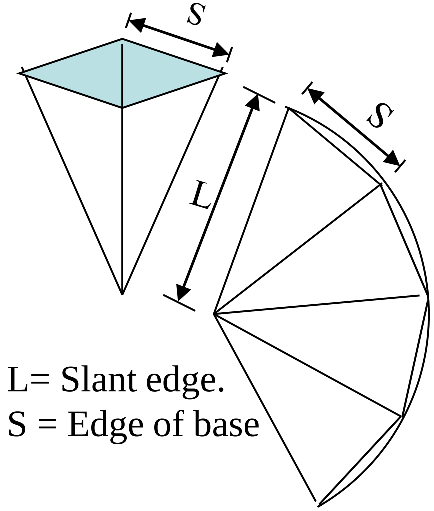
Cone: (Sector of circle)



R=Base circle radius.
L=Slant height.

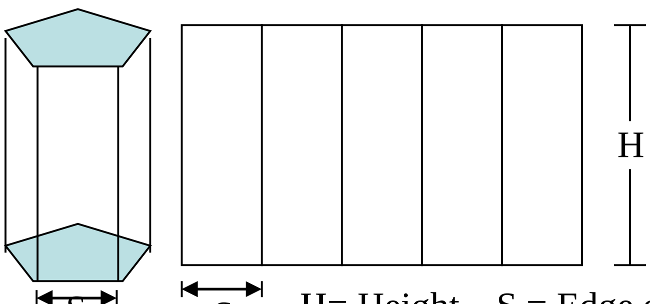
$$\theta = \frac{R}{L} \times 360^0$$

Pyramids: (No.of triangles)



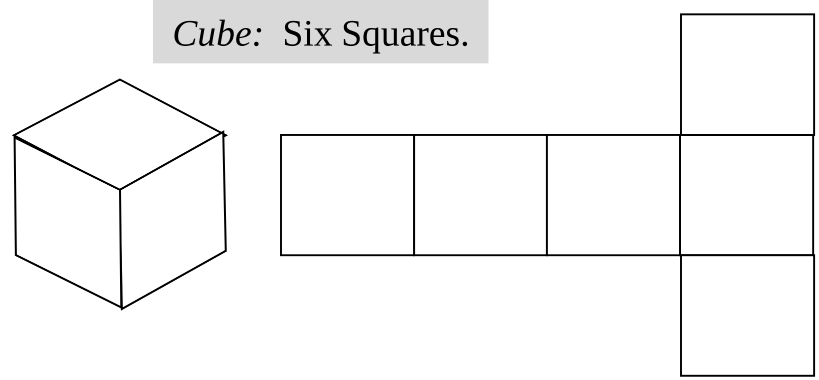
L= Slant edge.
S = Edge of base

Prisms: No.of Rectangles

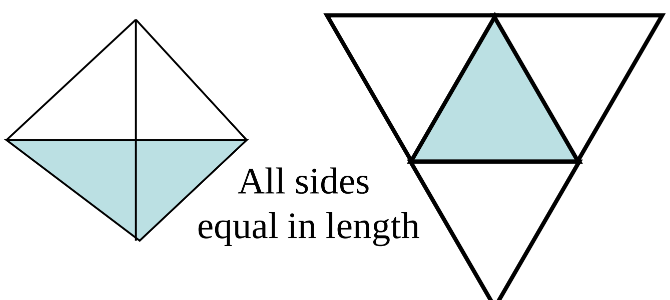


H= Height S = Edge of base

Cube: Six Squares.



Tetrahedron: Four Equilateral Triangles



METHODS OF DEVELOPMENT

1. Parallel line development: This method is employed to develop the surfaces of **prisms and cylinders**. Two parallel lines (called stretch-out lines) are drawn from the two ends of the solids and the lateral faces are located between these lines.

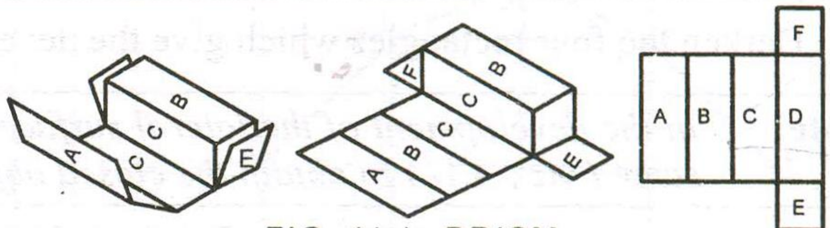


FIG. 1(a) PRISM

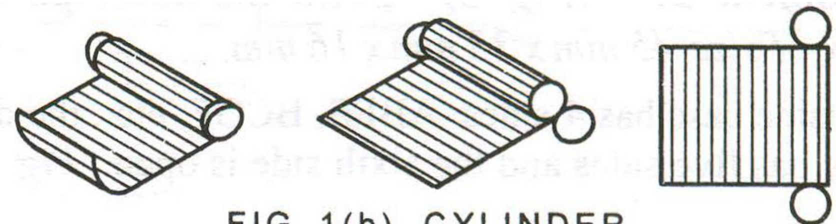


FIG. 1(b) CYLINDER

2. Radial line development: This method is employed to develop the surfaces of **pyramids and cones**. An arc of radius equal to the slant edge/generator is drawn and the lateral faces/curved face are marked properly inside the arc.

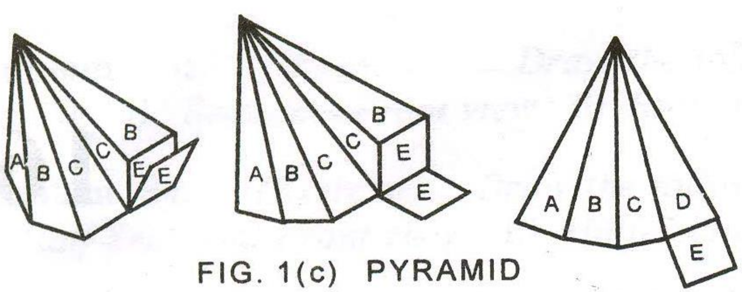


FIG. 1(c) PYRAMID

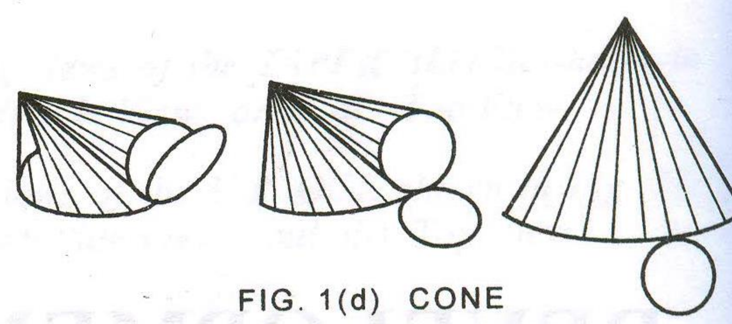
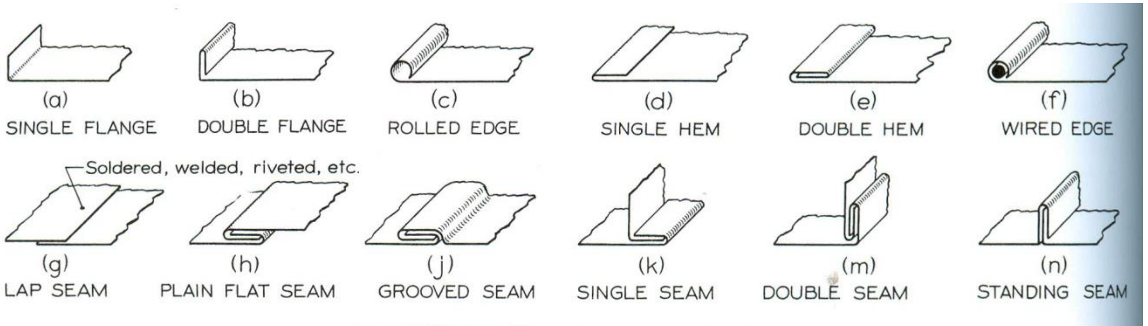


FIG. 1(d) CONE

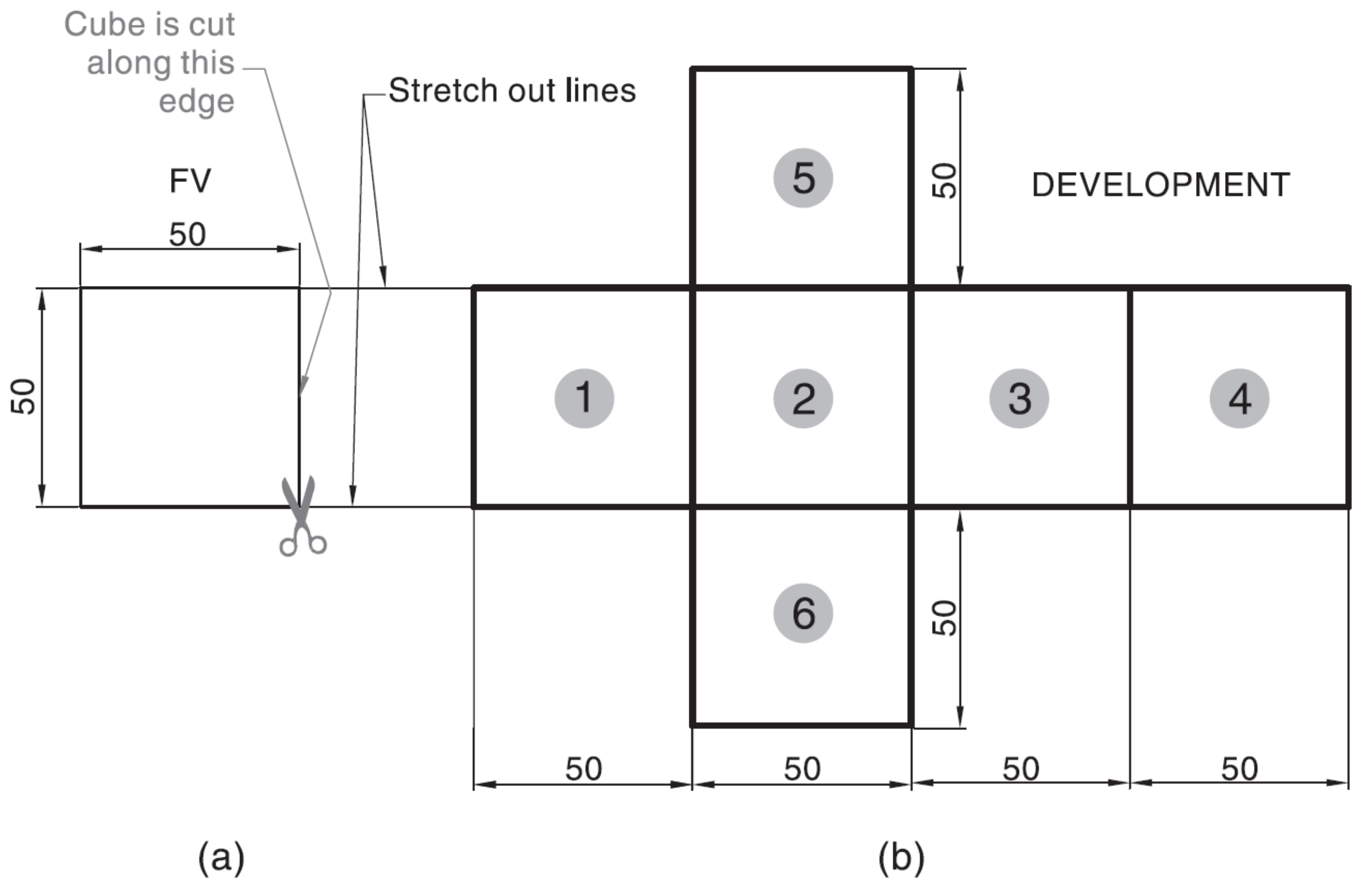
The knowledge of development of surfaces is essential in many industries such as **automobile, aircraft, ship building, packaging and sheet metal work**. In construction of **boilers, bins, process vessels, hoppers, funnels, chimneys** etc, the plates are marked and cut according to the developments which when folded from the desired objects



■ **FIGURE 22.2** ■ Sheet-Metal Hems and Joints.

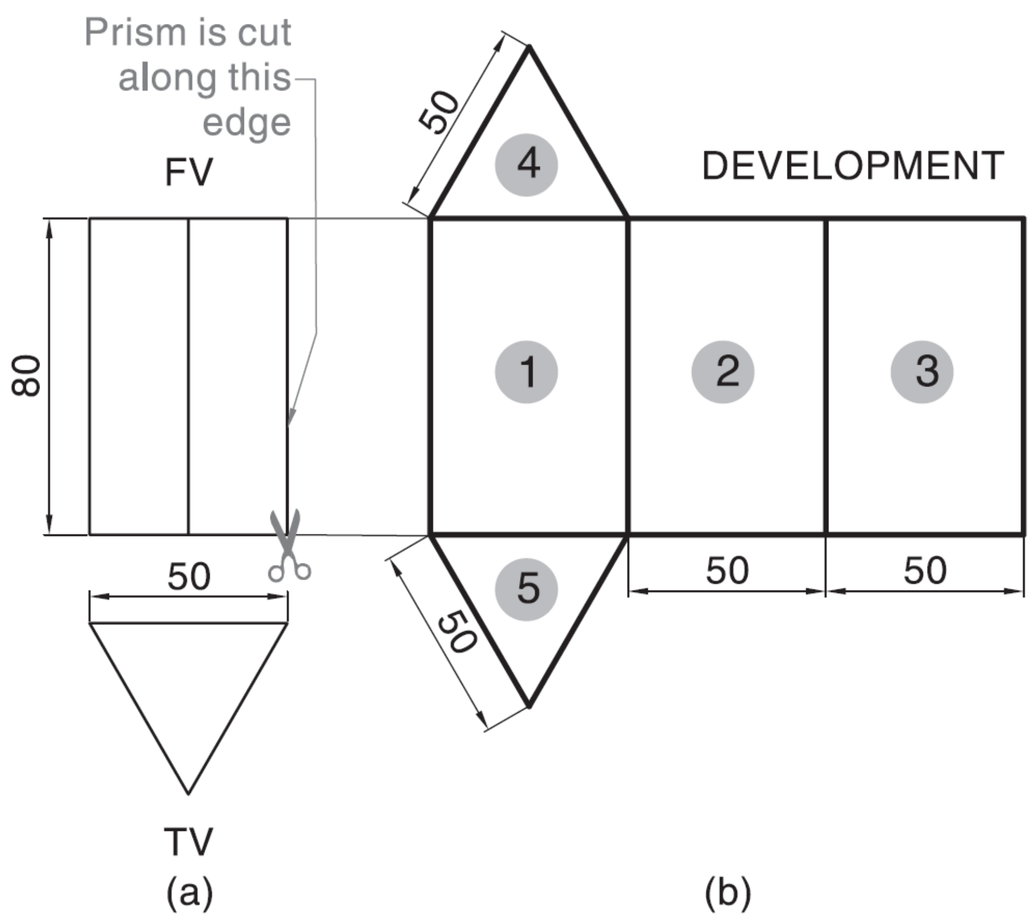
PARALLEL LINE DEVELOPMENT

A cube has six equal square faces. To obtain the development, draw two parallel stretch-out lines, one each from the top and bottom face. Draw four lateral faces 1, 2, 3 and 4 between these lines as shown. The top face 5 and bottom face 6 can be drawn attached to any one lateral face. Note that the sides of all the faces in the development are equal to 50 mm.



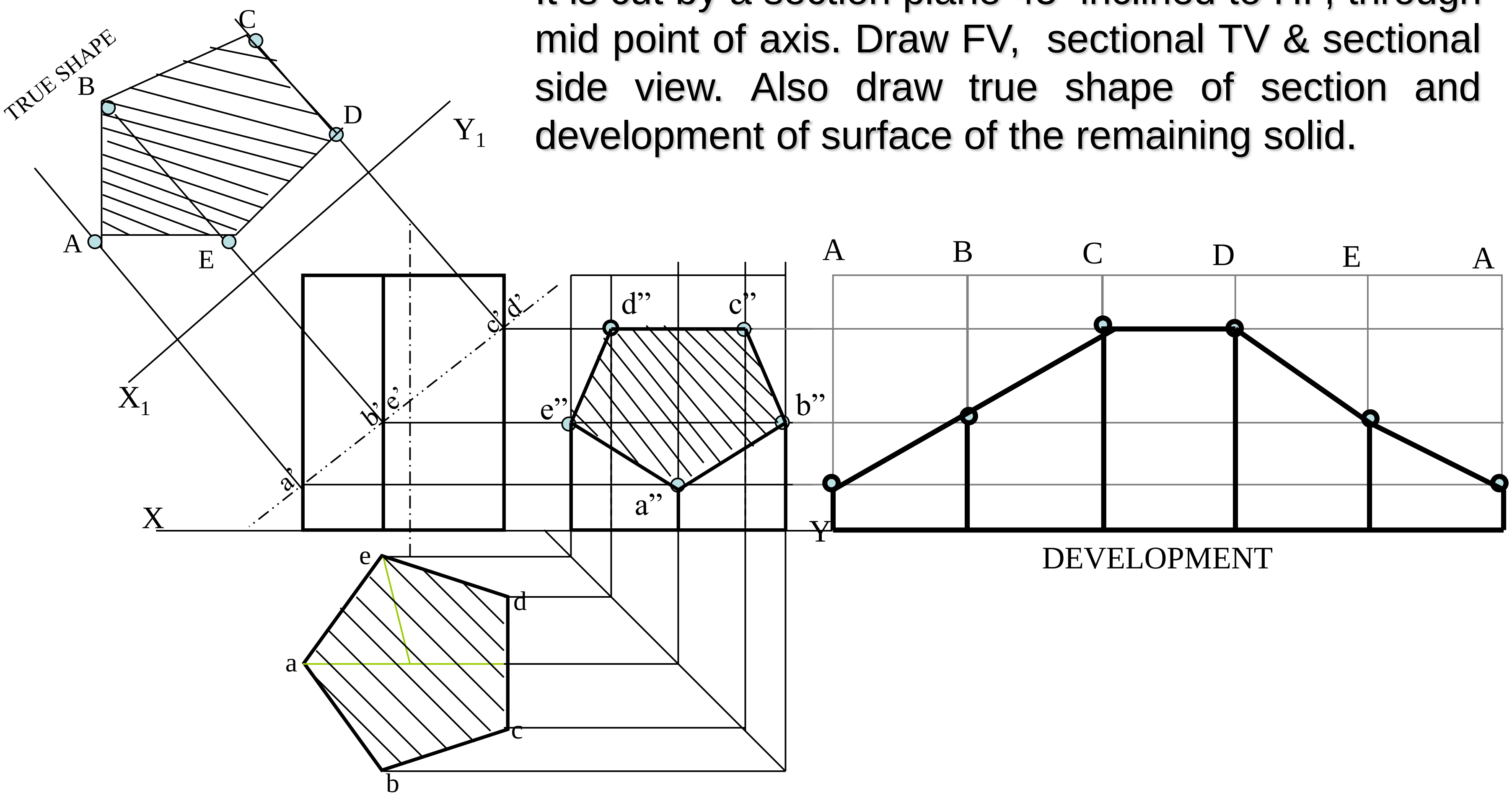
The two views of a triangular prism of side of base 50 mm and length of axis 80 mm are shown in Develop the prism.

A triangular prism has three equal rectangular lateral faces and two equal triangular end faces. In a development, the three lateral faces, 1, 2 and 3, are drawn between the stretch-out lines. The end faces 4 and 5 are attached to a lateral face. All the faces show their true shapes.

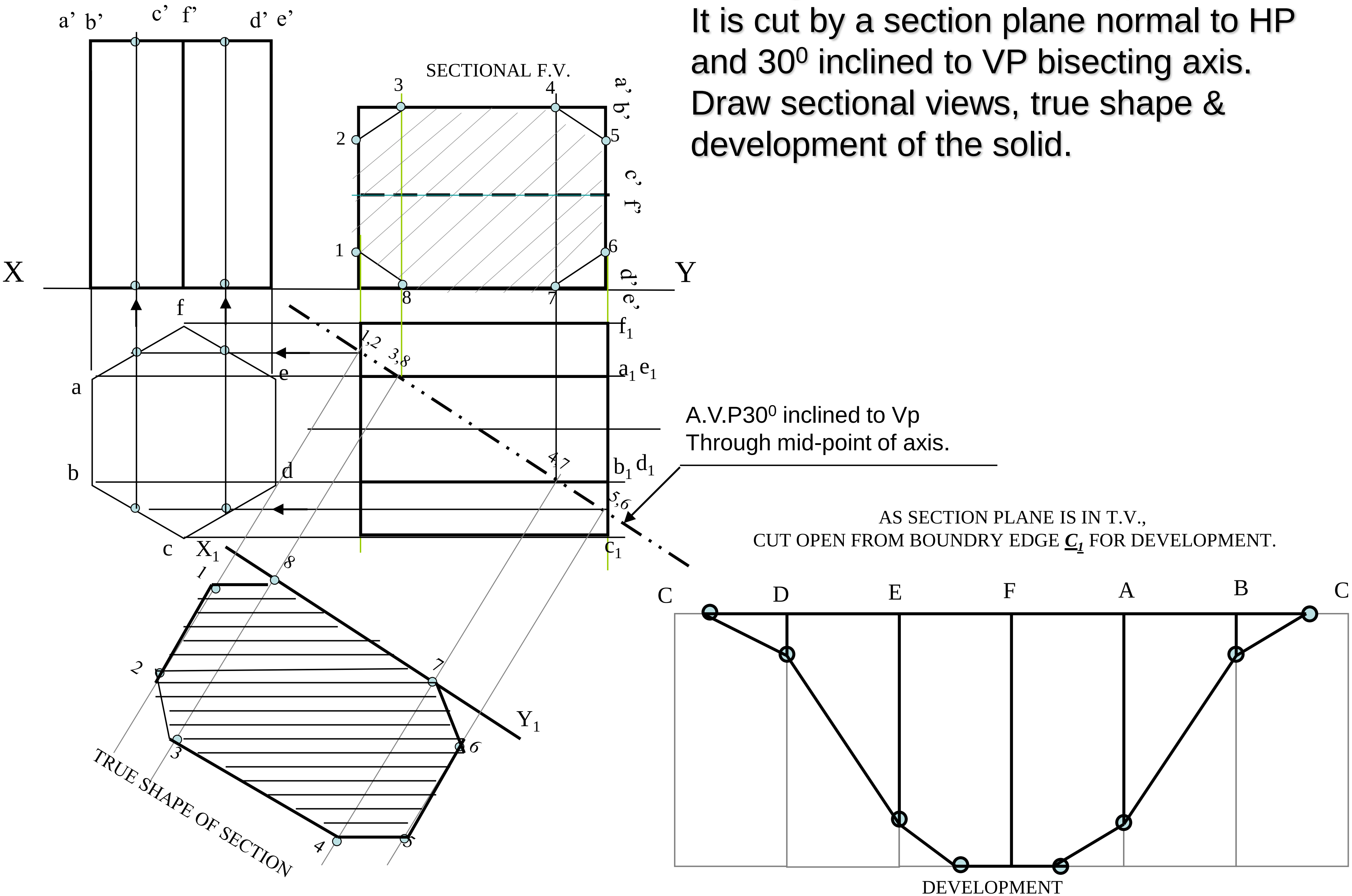


A pentagonal prism, 30 mm base side & 50 mm axis is standing on HP on it's base whose one side is perpendicular to VP.

It is cut by a section plane 45^0 inclined to HP, through mid point of axis. Draw FV, sectional TV & sectional side view. Also draw true shape of section and development of surface of the remaining solid.



A hexagonal prism, 30 mm base side & 55 mm axis is lying on HP on it's rectangular face with axis is parallel to VP. It is cut by a section plane normal to HP and 30^0 inclined to VP bisecting axis. Draw sectional views, true shape & development of the solid.



Divide the circle in TV into 12 equal parts. Project the division points to the FV and draw the generators. Mark points p1', p2', p3', etc., at the intersection of the inclined plane and the generators.

Draw the development of the lateral surface of the whole cylinder. The length of the line 1–1 is equal to π x 50 = 157 mm (circumference of the circle). Divide the length of 157 mm into 12 equal parts. Draw lines 2– B, 3– C, 4– D, etc.

Draw horizontal lines through points p1', p2', p3', etc., to cut the corresponding generators (i.e., 2–B, 3– C, D–4, etc.) in points P1, P2, P3, etc. Draw a smooth curve through these points. The figure A– P1– P2– P3 … P11– A–1–1– A is the required development.

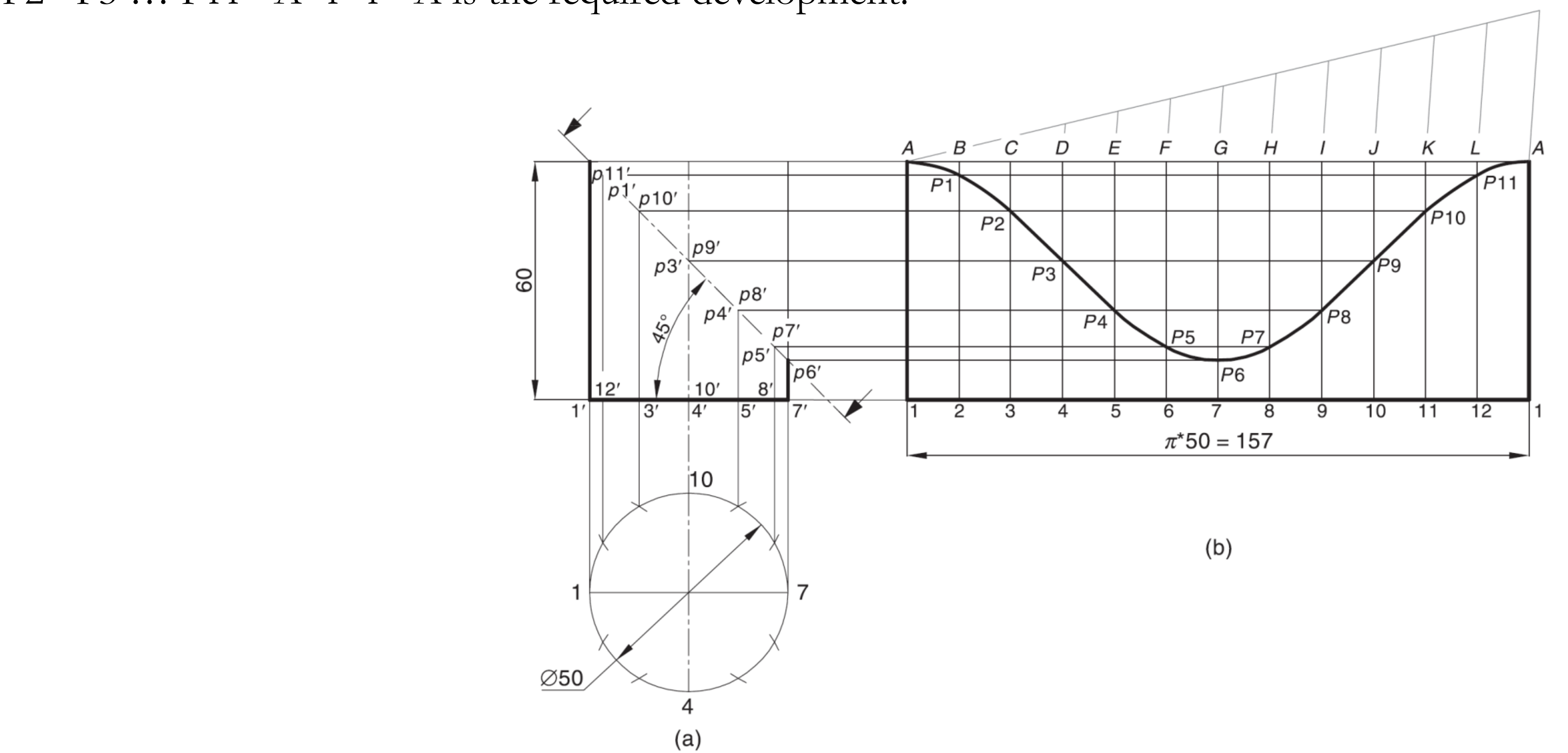
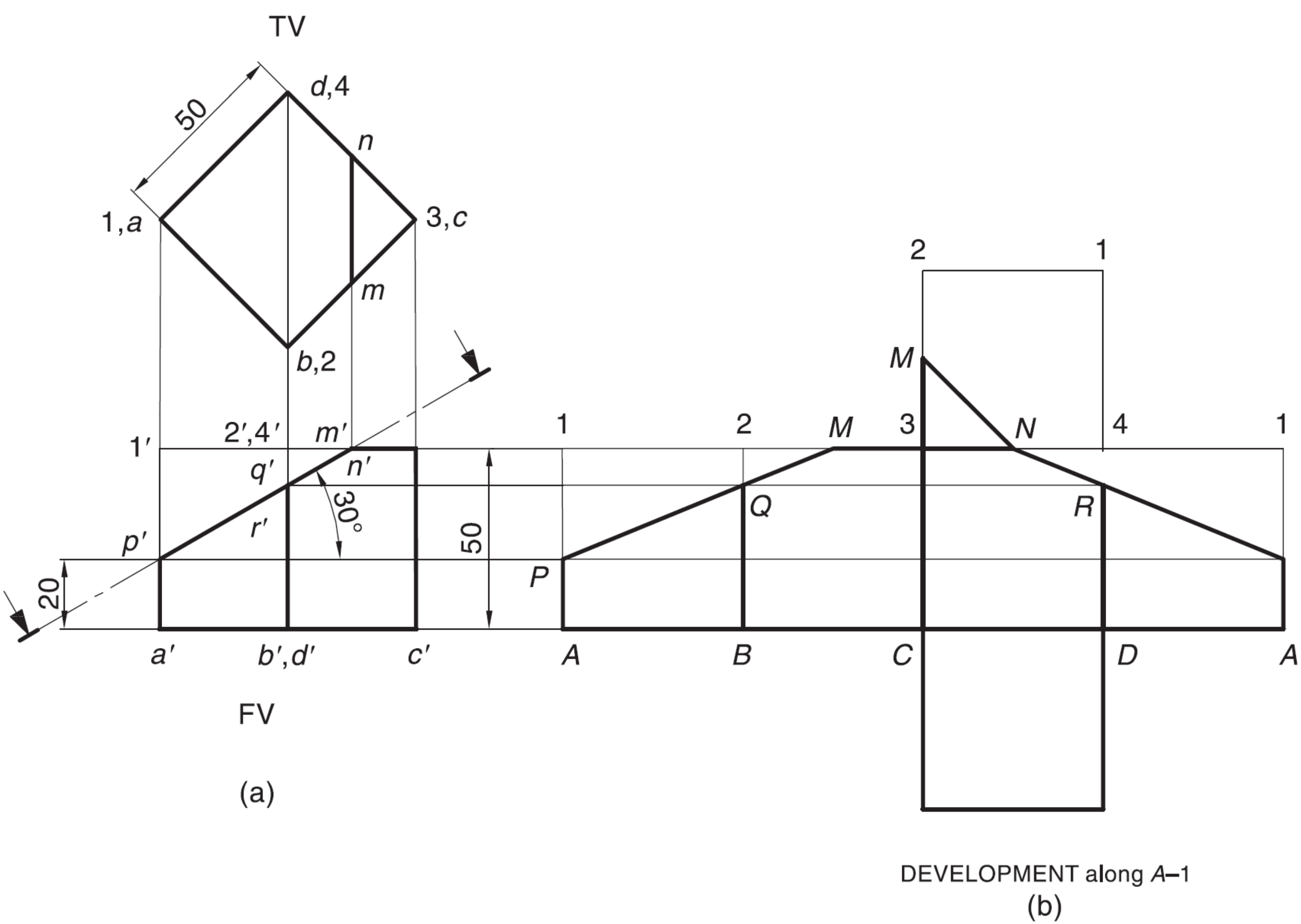


Figure shows the FV and TV of a cube (in the third-angle method of projection) cut by an AIP as shown. Draw the development of the remaining part of the cube.



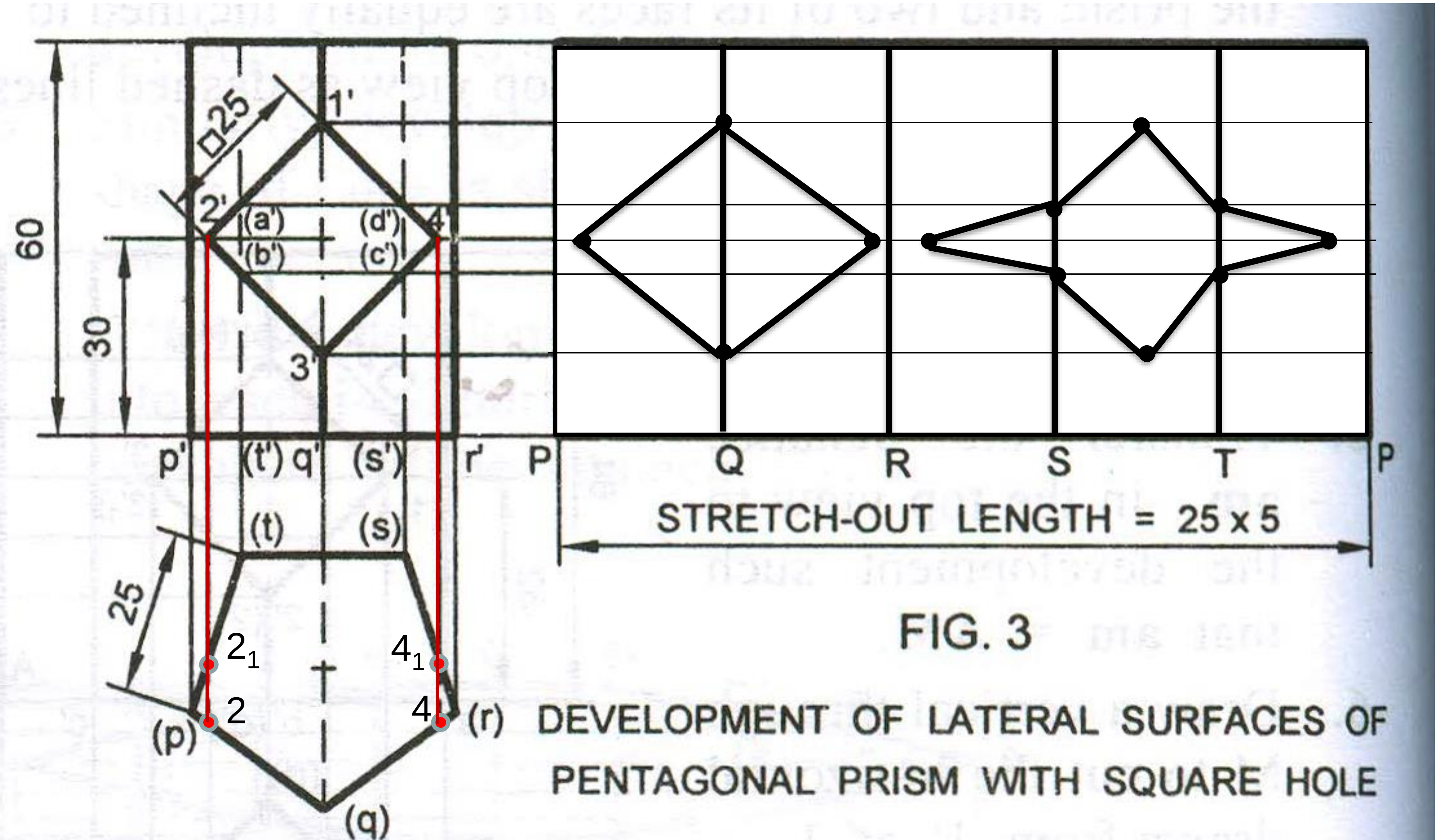
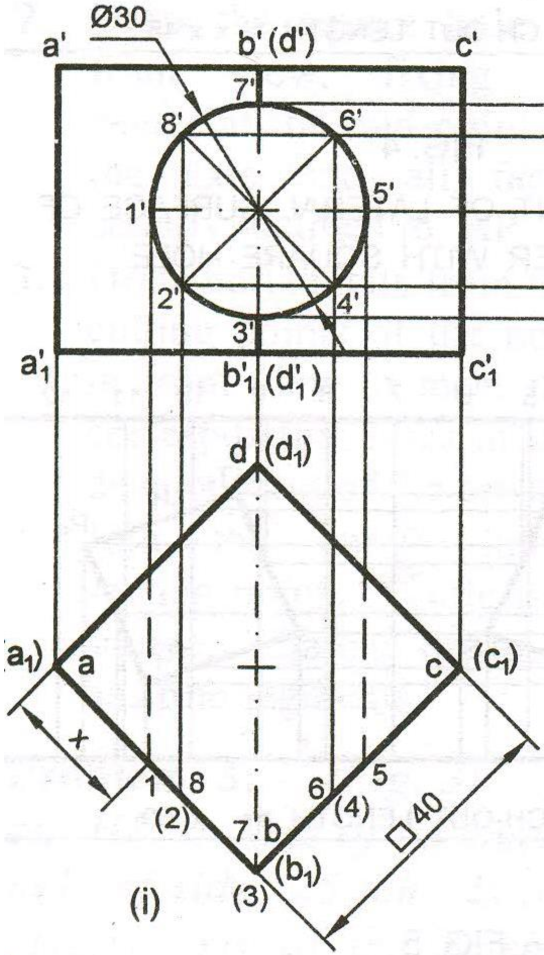
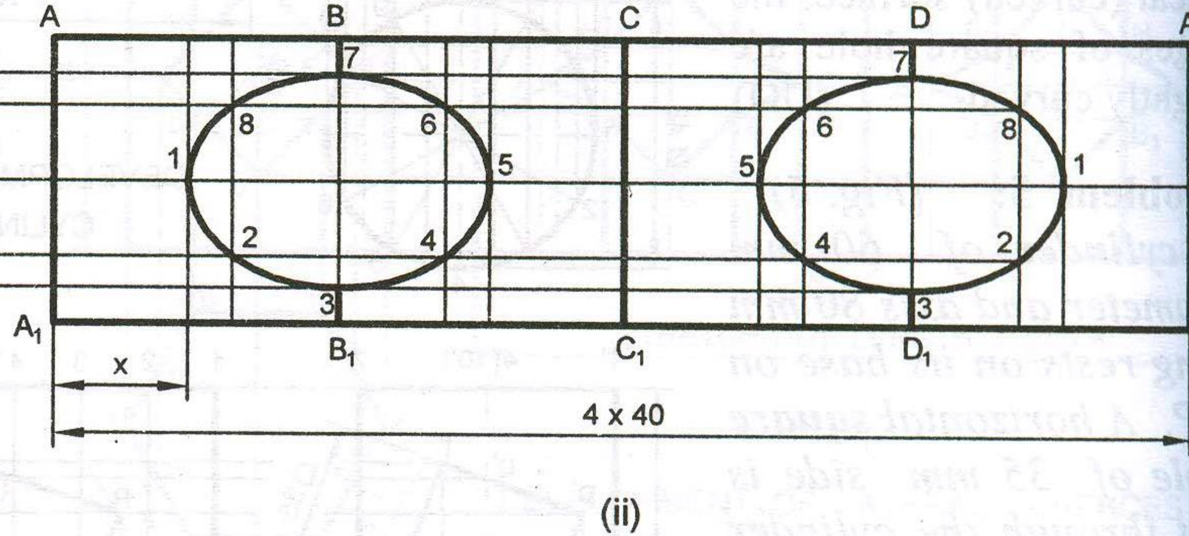


FIG. 3

DEVELOPMENT OF LATERAL SURFACES OF PENTAGONAL PRISM WITH SQUARE HOLE



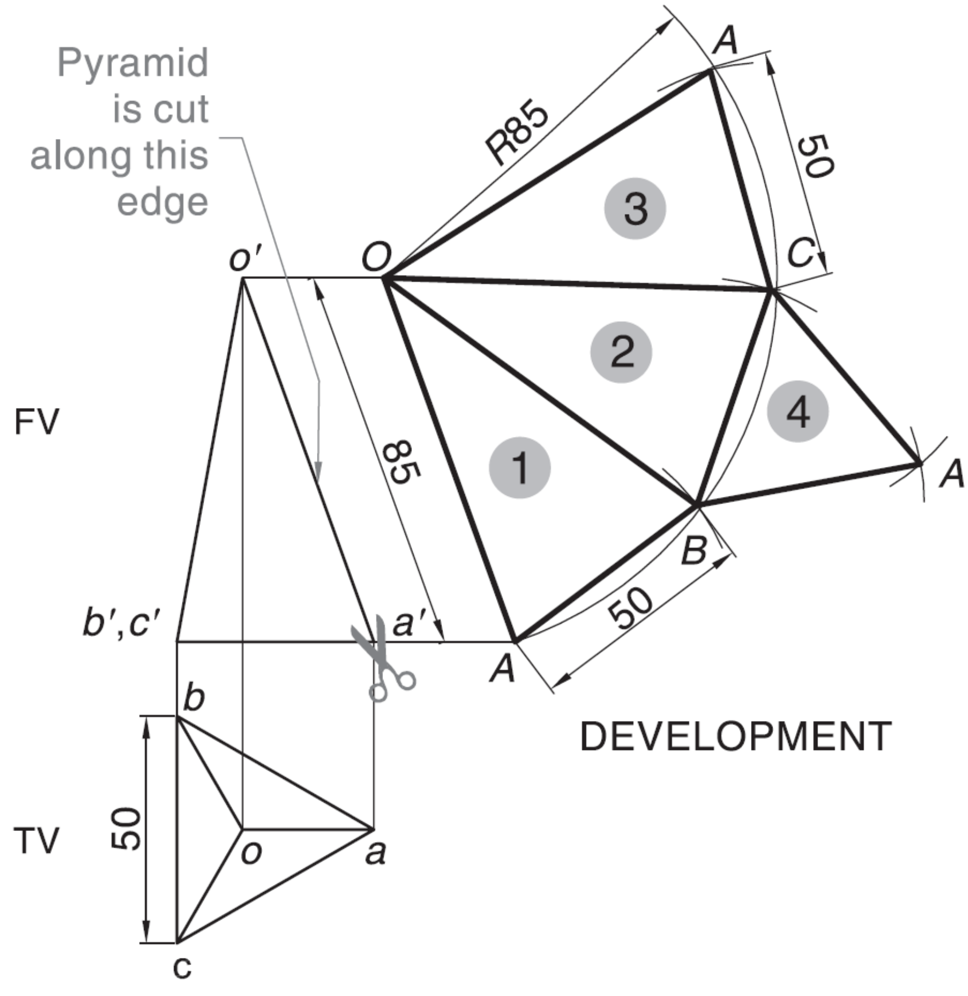


PARALLEL LINE DEVELOPMENT OF CUBE WITH CYLINDRICAL HOLE

<u>RADIAL LINE DEVELOPMENT</u>: Obtain the development of the triangular pyramid of base side 50 mm and slant height 85 mm.

A triangular pyramid has three equal lateral triangular faces and an equilateral triangular base face. To draw the development, first draw OA parallel and equal to slant height o'a'. Then, with O as a centre and radius = OA, draw an arc. Obtain the three sides of the base of the pyramid inside this arc. This is done by cutting the arcs of radius 50 mm, subsequently with the centres A, B and C on the bigger arc. Join AB, BC and CA. Also join these sides with O to obtain faces 1, 2 and 3 in development. Attach the base face 4 to any one of the lateral faces as shown.

Note that the pyramid is opened from the edge o'a', hence OA will appear twice in the development.



(a) (b)

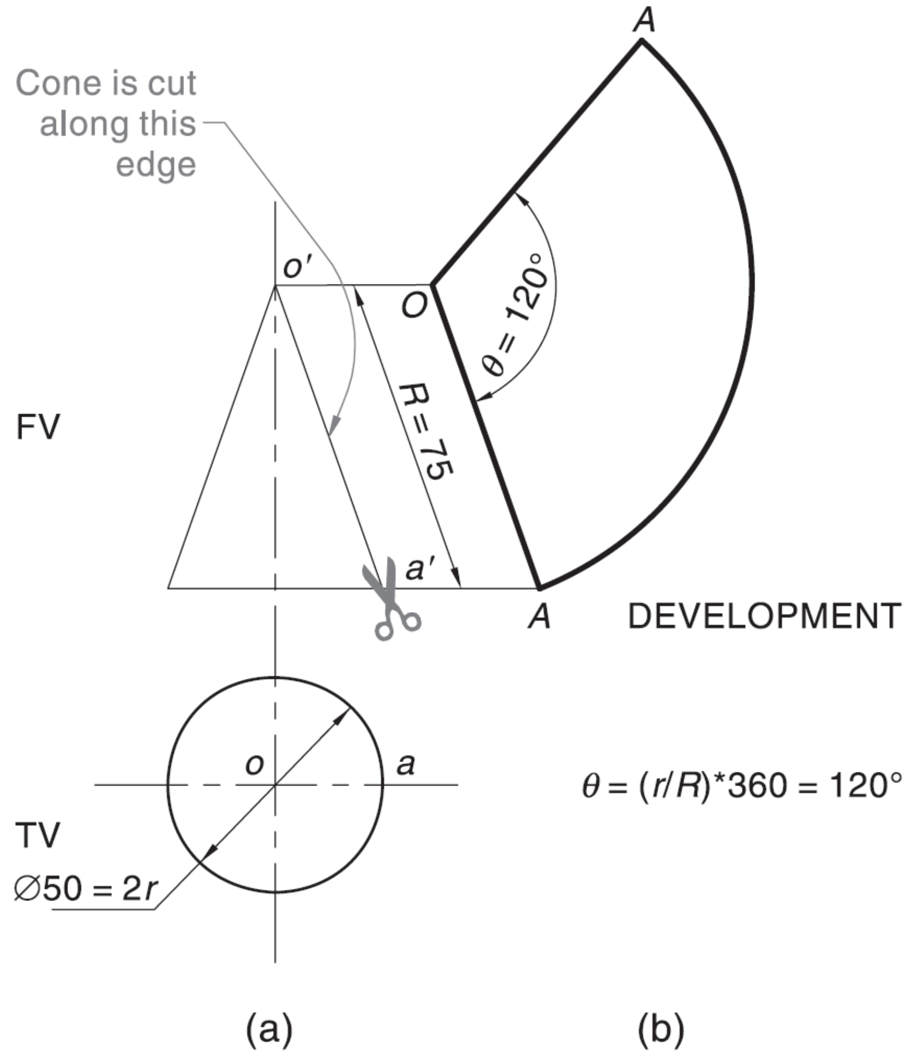
Draw the development of its curved surface of cone base diameter 50 mm and slant height 75 mm.

When the curved surface of a cone is opened and laid on a plane, it shows the shape of a sector. The included angle of the sector depends on the slant height, R and the radius of the base of the cone, r. The radius of the sector will be equal to the slant height of the cone. The length of the arc will be equal to the circumference of the base of the cone, i.e., $2\pi r$. If θ is the included angle (in radian) of the sector, then, $R\theta = 2\pi r$.

i.e., $\theta = 2\pi(r/ R)$

i.e., θ (in degree) $= 360(r/ R)$

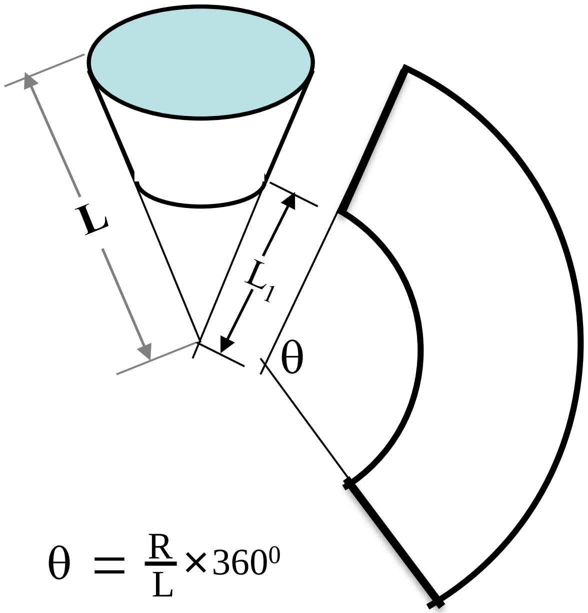
As the cone is opened from the edge o'a', OA will appear twice in the development.



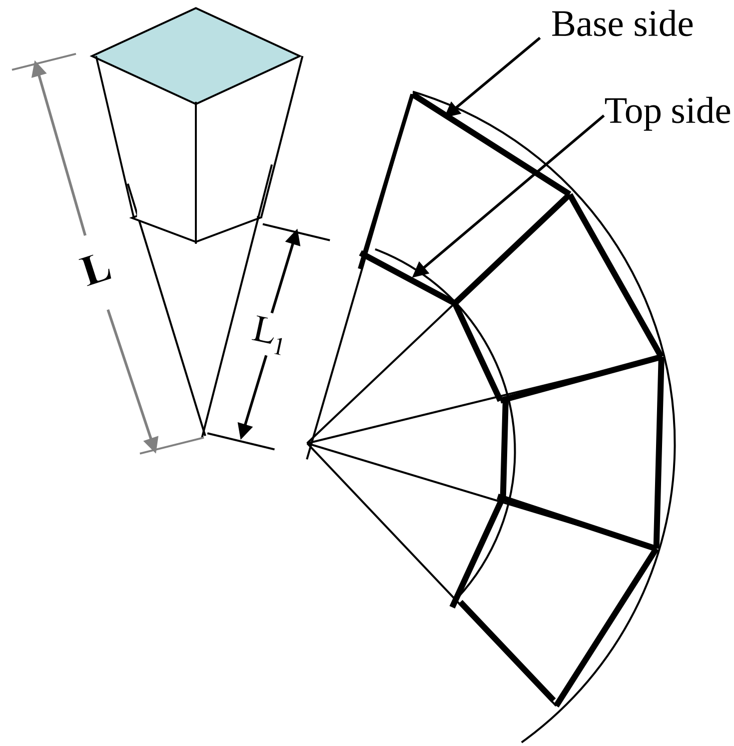
FRUSTUMS

DEVELOPMENT OF
FRUSTUM OF CONE

DEVELOPMENT OF
FRUSTUM OF SQUARE PYRAMID



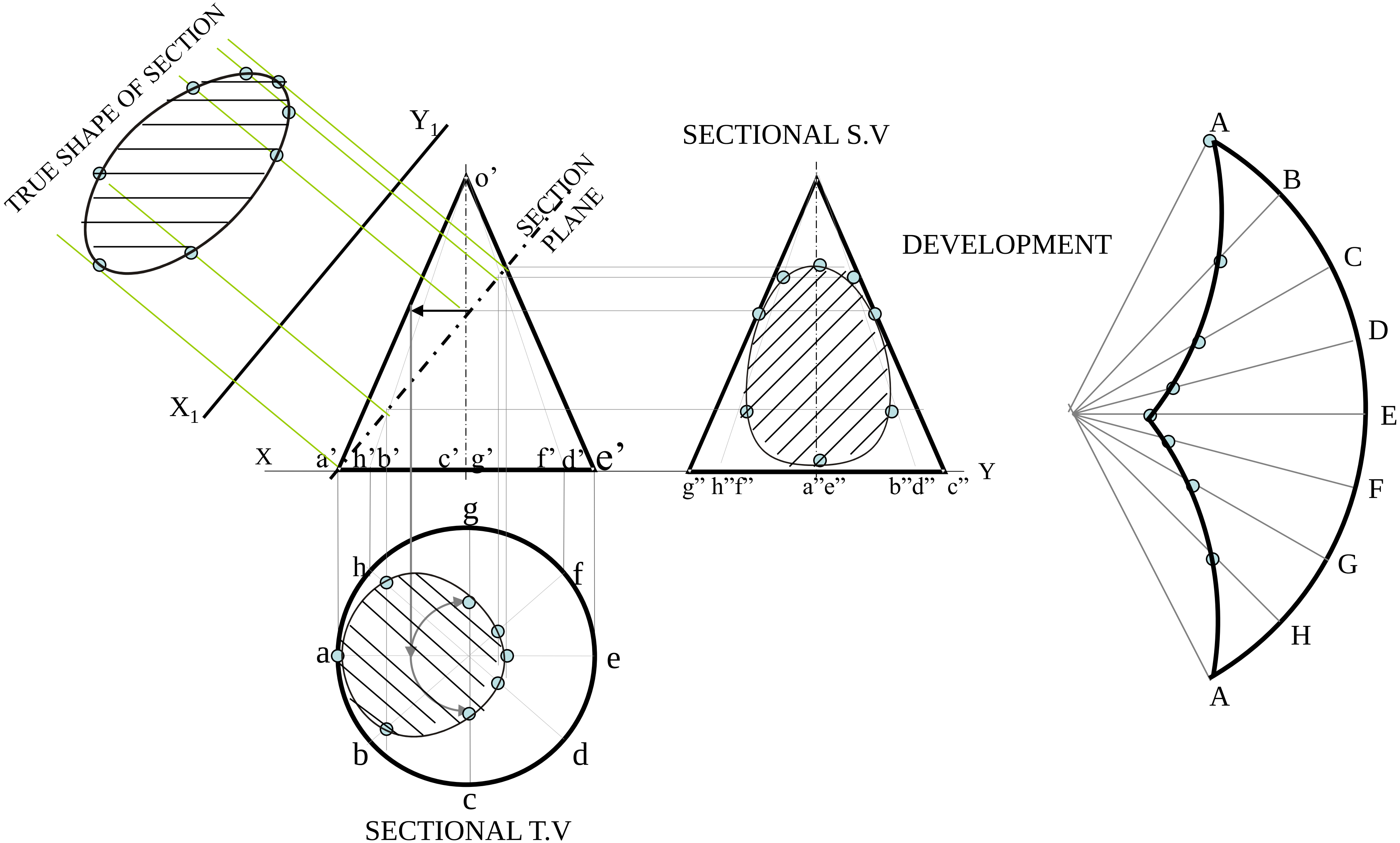
$$\theta = \frac{R}{L} \times 360^0$$

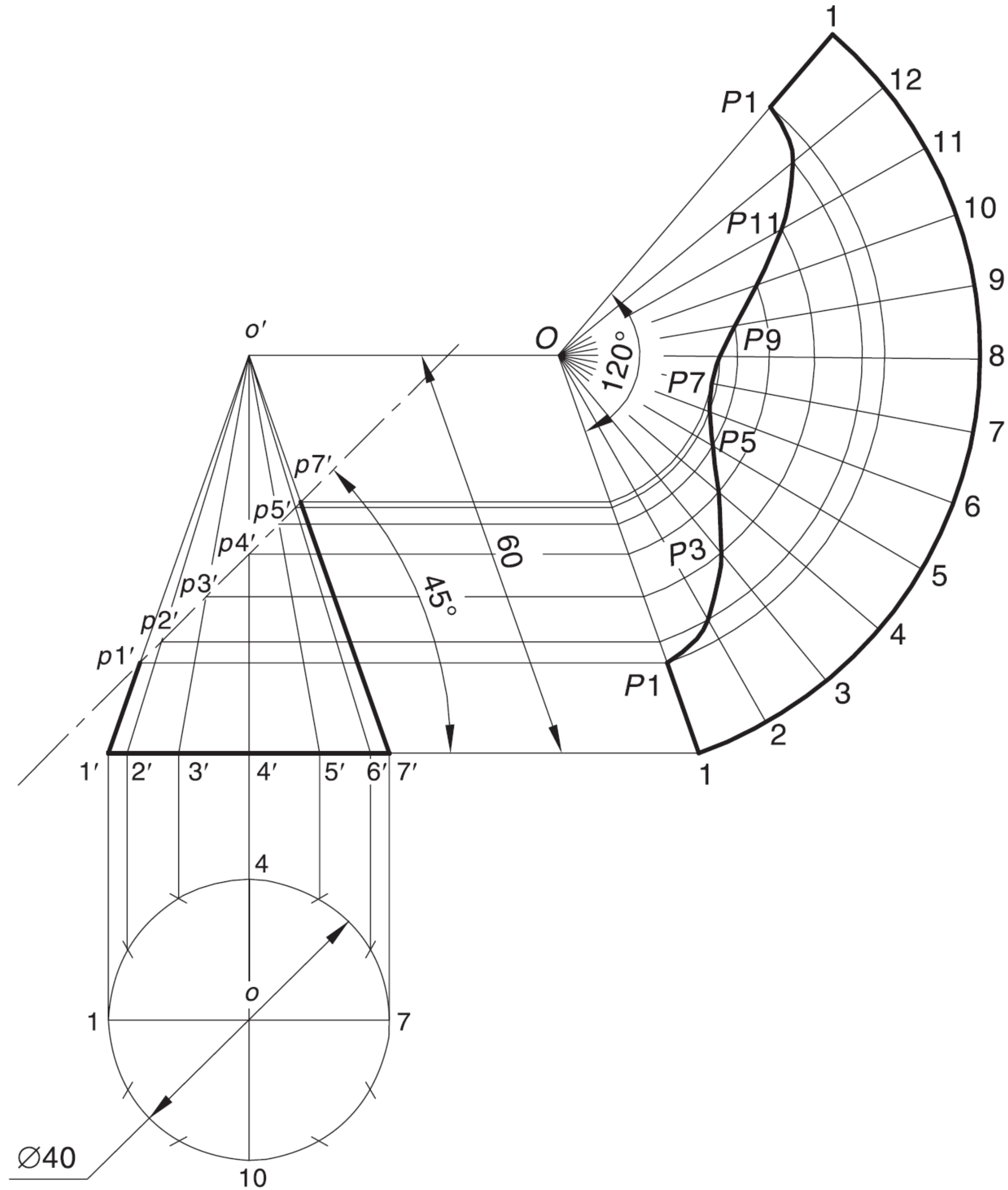


R= Base circle radius of cone
L= Slant height of cone
L_1 = Slant height of cut part.

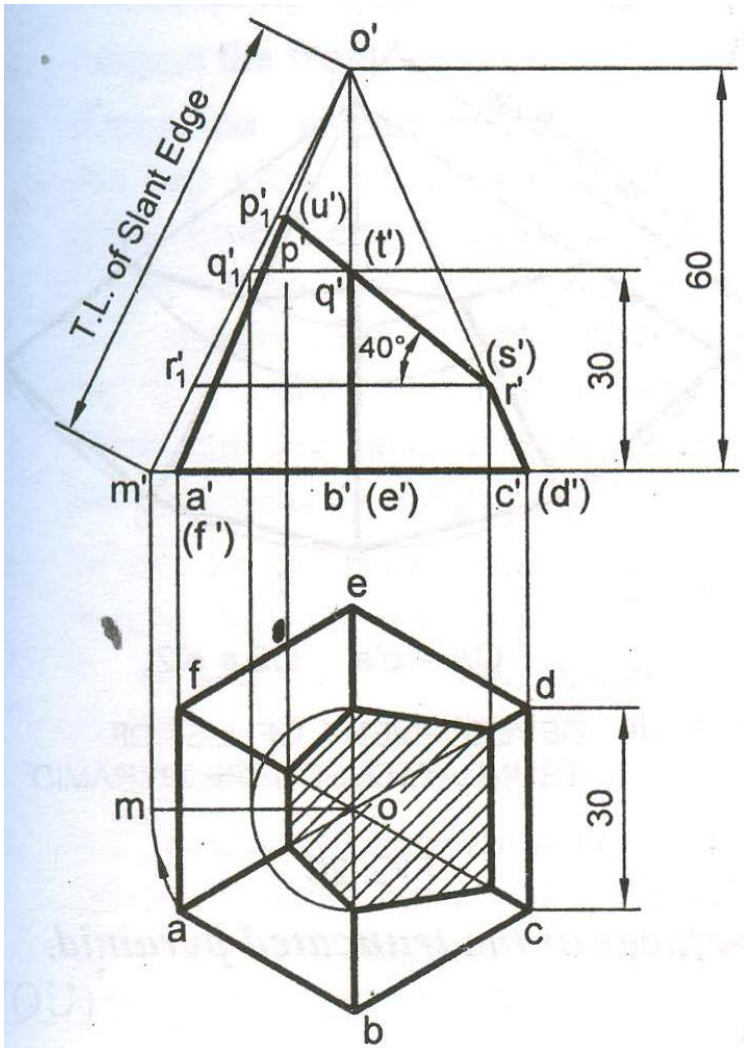
L= Slant edge of pyramid
L_1 = Slant edge of cut part.

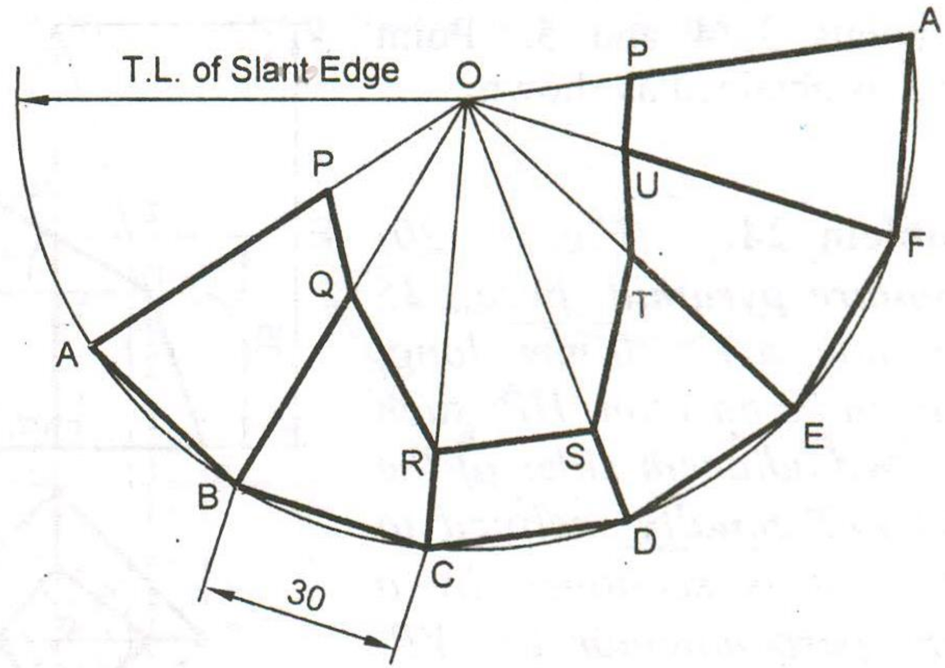
A cone, 50 mm base diameter and 70 mm axis is standing on it's base on Hp. It cut by a section plane 45^0 inclined to Hp through base end of end generator. Draw projections, sectional views, true shape of section and development of surfaces of remaining solid.





1
12
P1
11
10
P11
9
O
P9
8
120°
P7
7
P5
p7′
6
p5′
p4′
60
P3
5
p3′
45°
p2′
4
p1′
P1
3
2
1′
2′
3′
4′
5′
6′
7′
1
o′
4
o
1
7
∅40
10

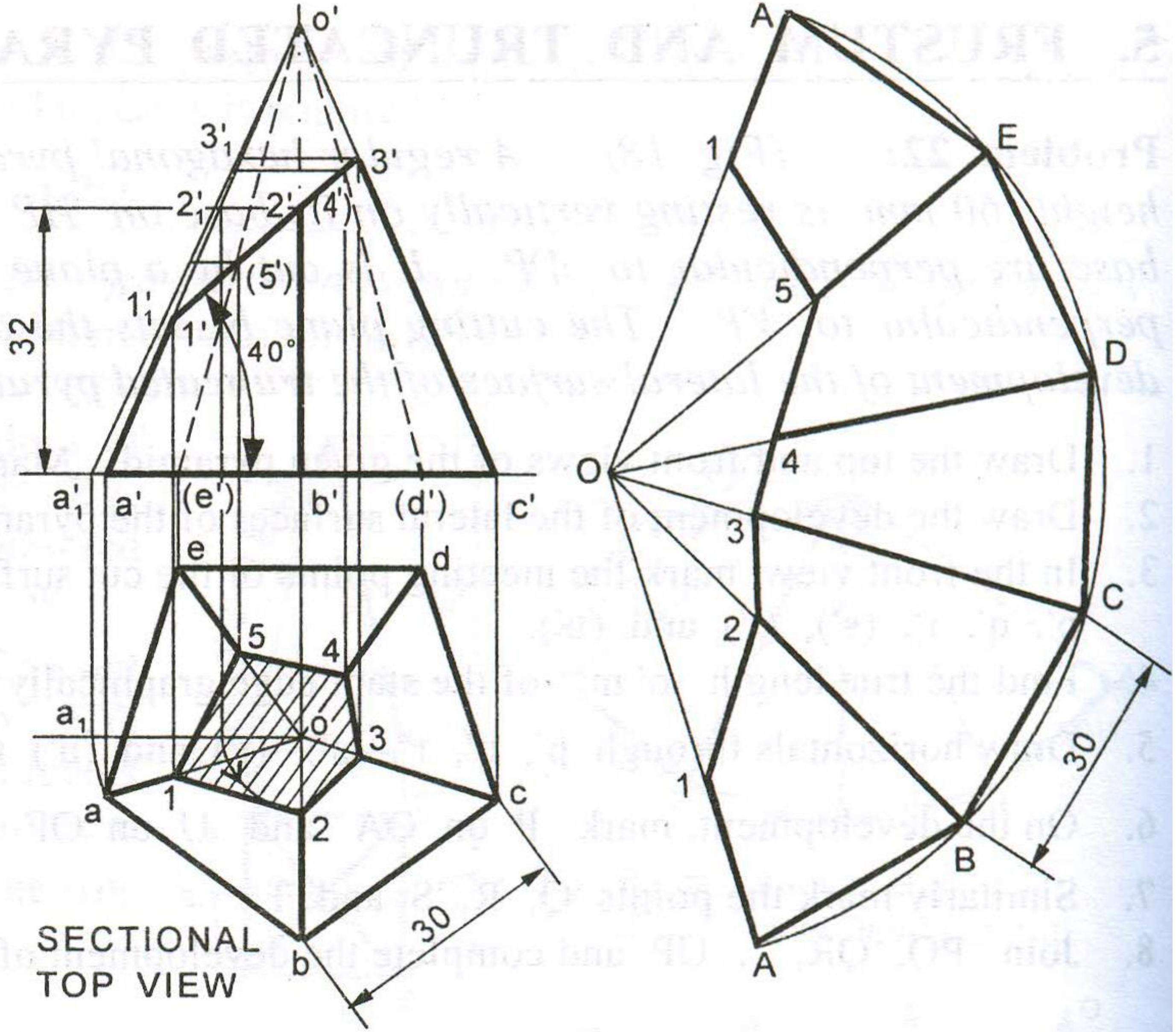




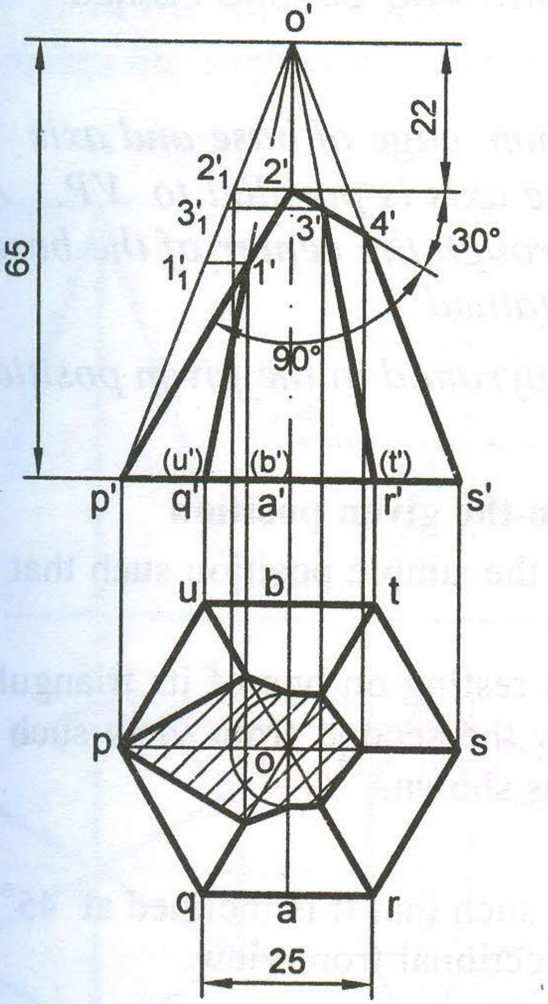
OA = o'm' = TRUE LENGTH OF SLANT EDGE

OP = $o'p'_1$, OQ = $o'q'_1$, OR = $o'r'_1$

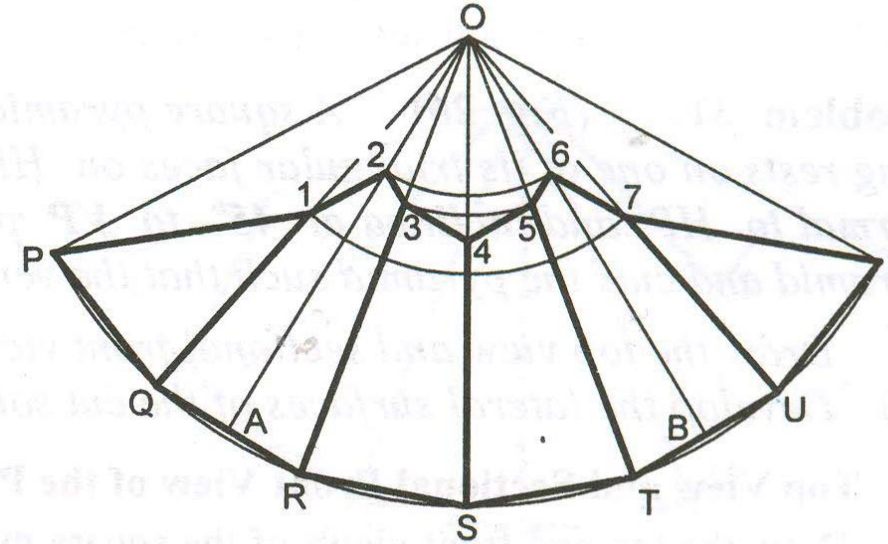
DEVELOPMENT OF L.S. OF TRUNCATED PYRAMID



o'
$3'_1$
3'
$2'_1$
2'
(4')
(5')
$1'_1$
1'
40°
32
a'_1
a'
(e')
b'
(d')
c'
e
d
5
4
a_1
o
3
1
a
2
c
b
30
SECTIONAL
TOP VIEW
A
1
E
5
D
4
O
3
C
2
30
1
B
A



(i) SECTIONAL TOP VIEW



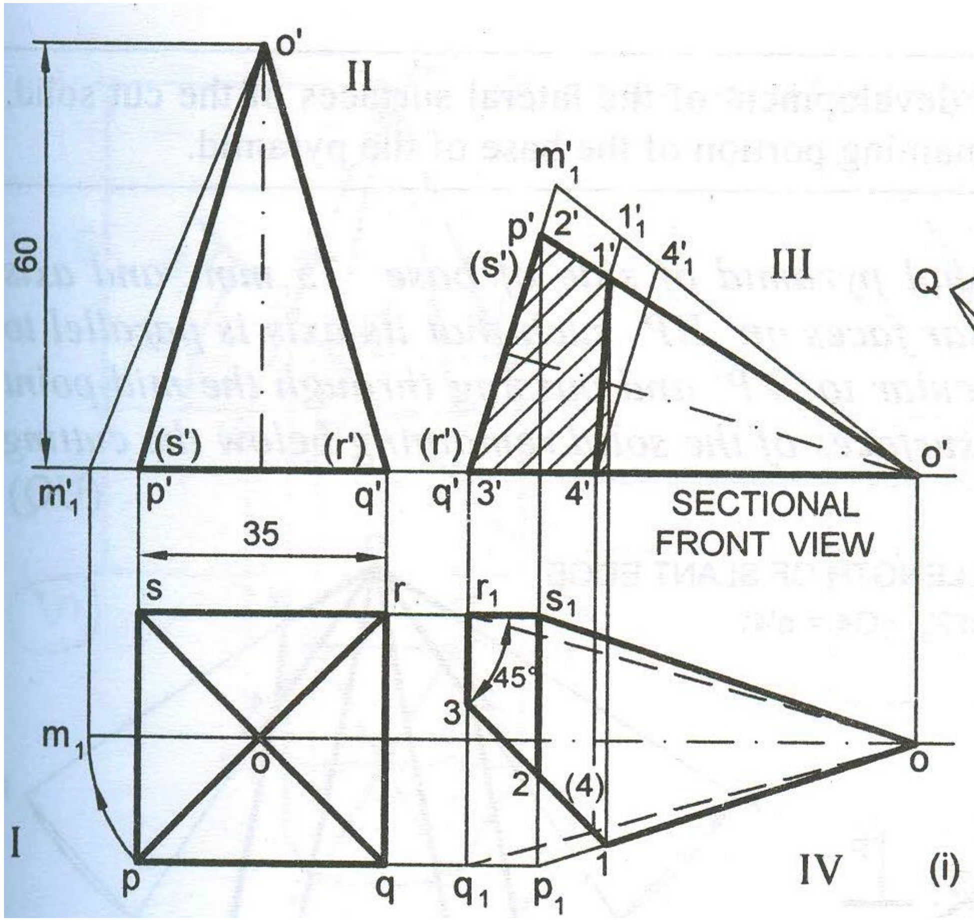
OP = o'p' = TRUE LENGTH OF SLANT EDGE

O1 = $o'1'_1$, O2 = $o'2'_1$, O3 = $o'3'_1$

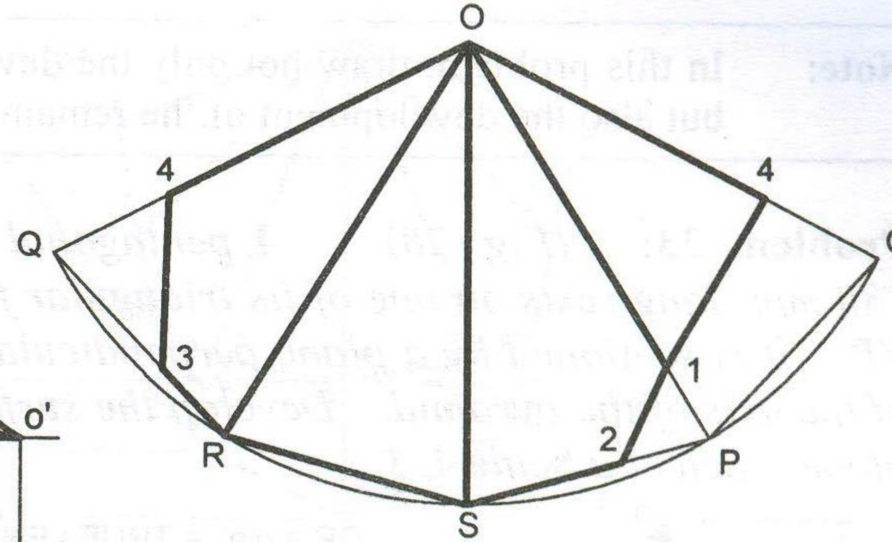
(ii)

DEVELOPMENT OF L.S. OF TRUNCATED HEXAGONAL PYRAMID WITH TWO CUTTING PLANES

(DEVELOPED SURFACE IS SYMMETRICAL)



(i)



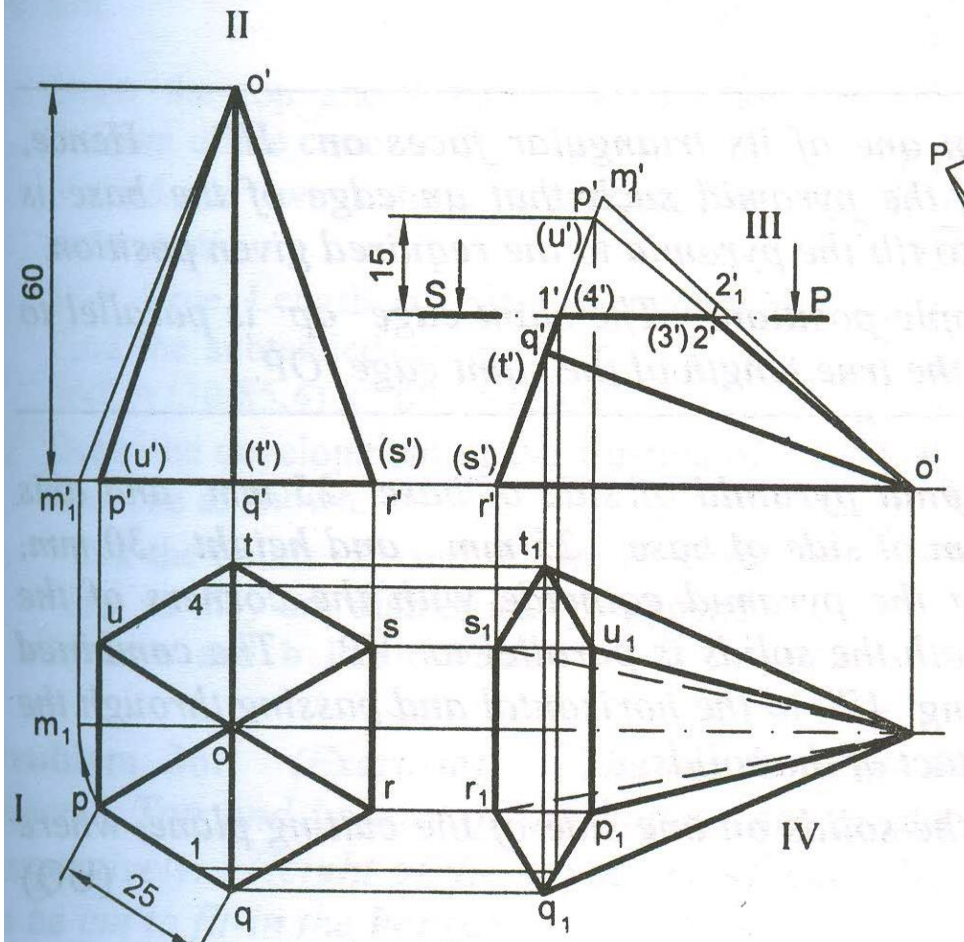
OP = $o'm'_1$ = TRUE LENGTH OF SLANT EDGE

$O1 = o'1'_1$, $O4 = o'4'_1$

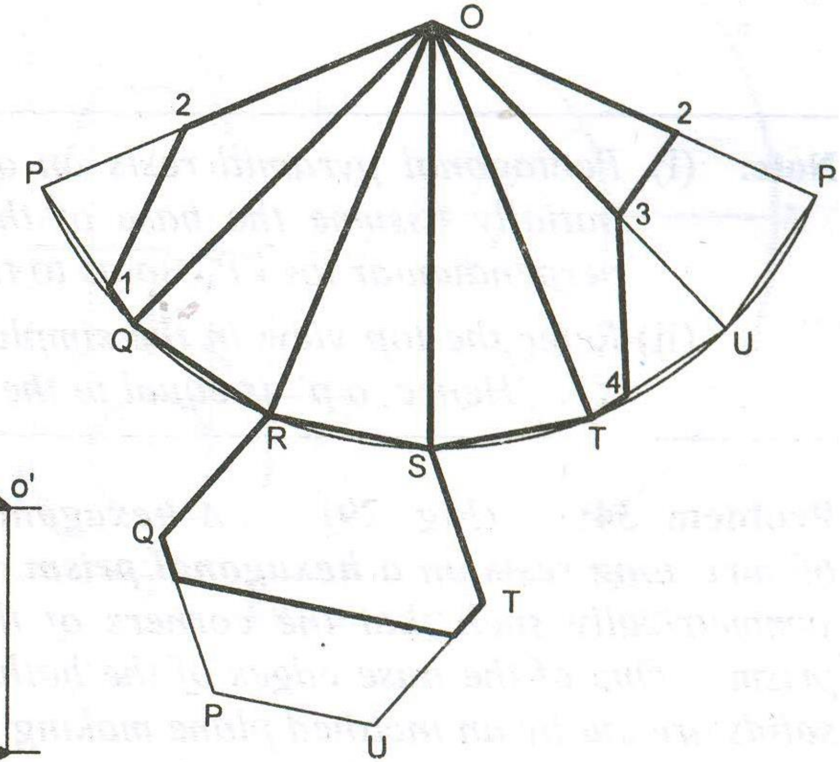
(ii)

DEVELOPMENT OF LATERAL SURFACES

OF CUT SQUARE PYRAMID



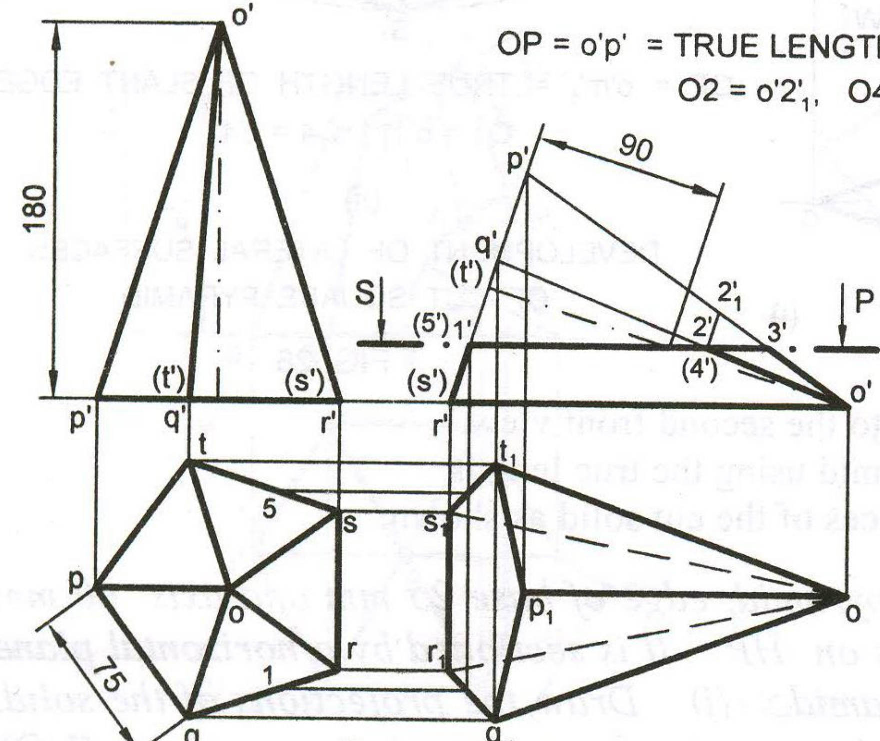
(i)



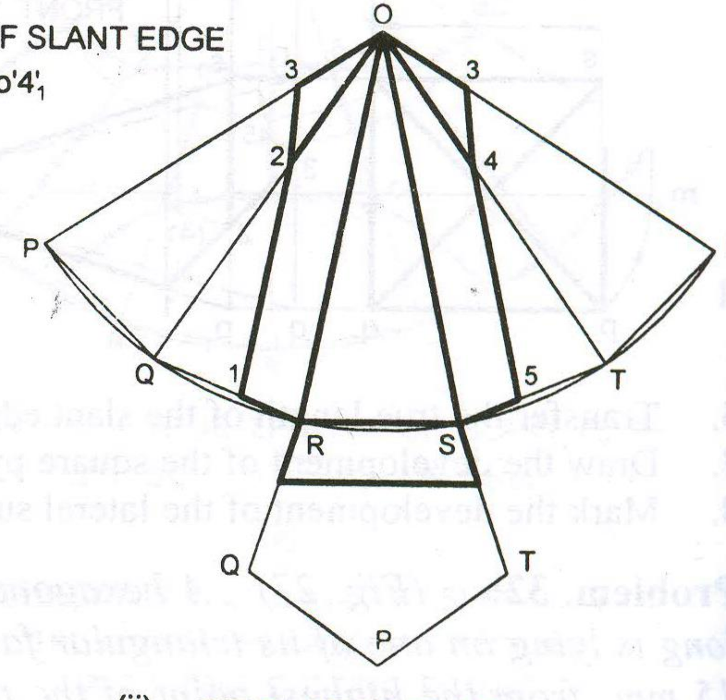
$OP = o'm'_1$ = TRUE LENGTH OF SLANT EDGE

$O2 = o'2'_1, \quad O3 = o'3'_1$

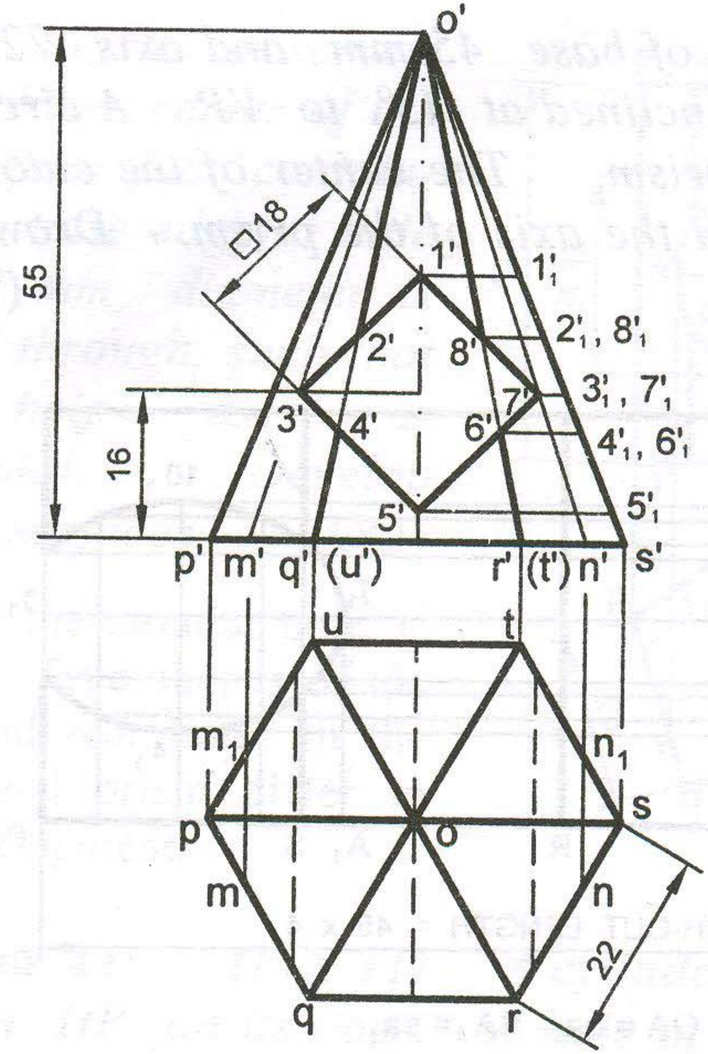
(ii) DEVELOPMENT OF CUT HEXAGONAL PYRAMID

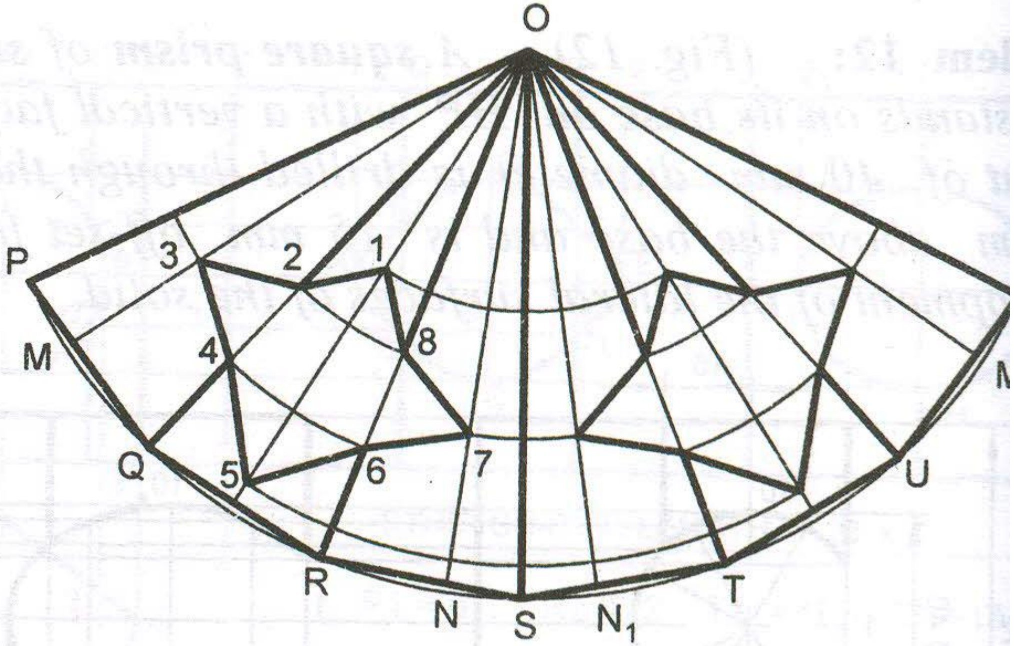


(i)



(ii) DEVELOPMENT OF CUT PENTAGONAL PYRAMID



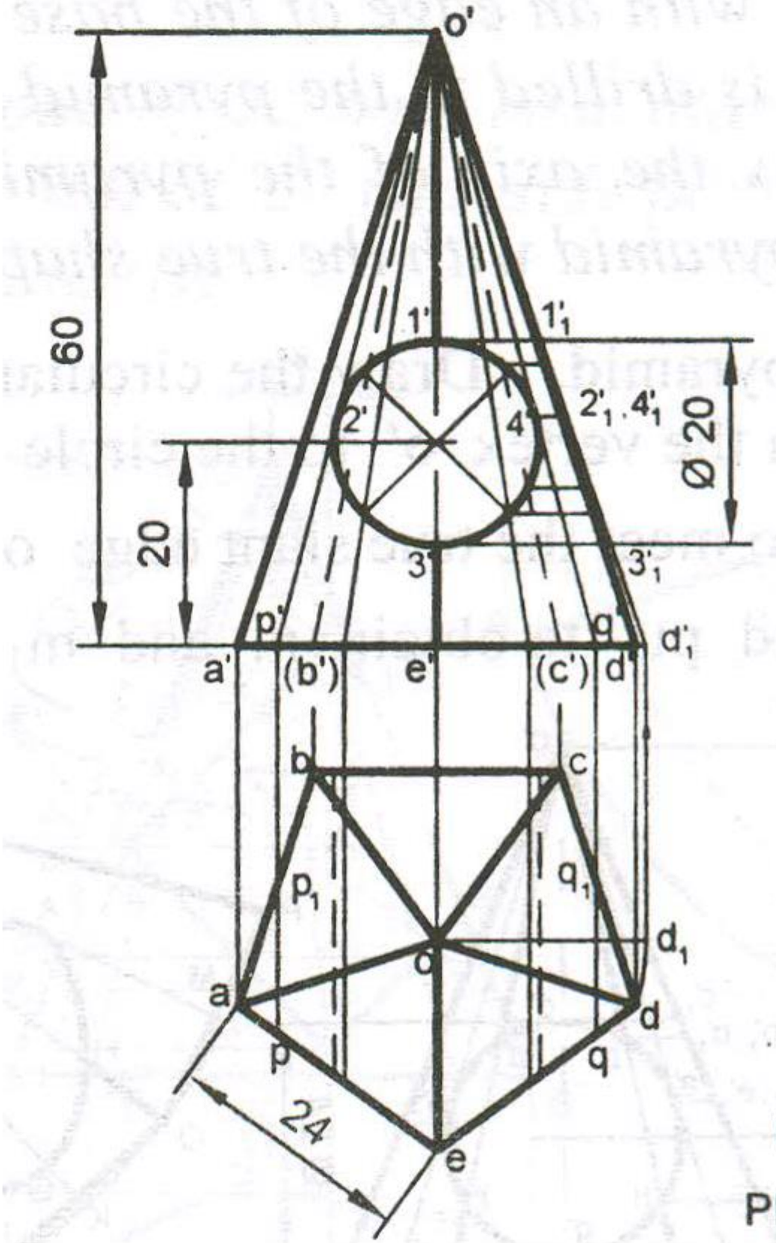


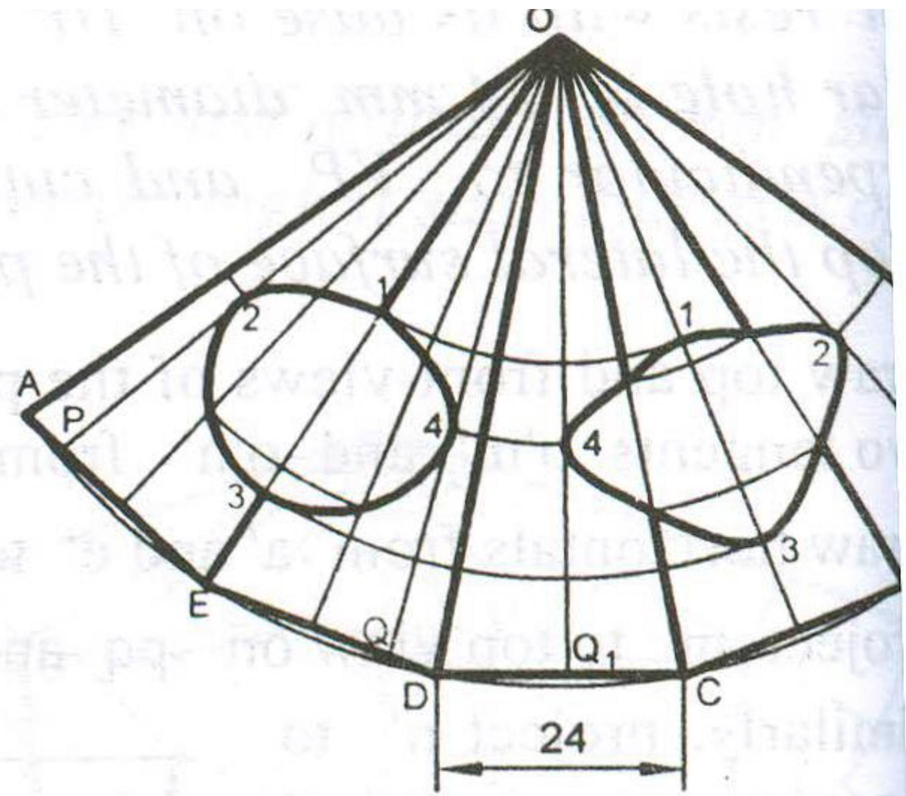
OP = o'p' = TRUE LENGTH OF SLANT EDGE

O1 = $o'1'_1$, O2 = $o'2'_1$, O3 = $o'3'_1$, O4 = $o'4'_1$

O5 = $o'5'_1$, O6 = $o'6'_1$, O7 = $o'7'_1$, O8 = $o'8'_1$

DEVELOPMENT OF LATERAL SURFACES OF HEXAGONAL PYRAMID WITH SQUARE HOLE





$OA = o'd'_1$ = TRUE LENGTH OF SLANT

$O1 = o'1'_1$, $O2 = o'2'_1$, $O3 = o'3'_1$, O4

DEVELOPMENT OF LATERAL SURFACES

PENTAGONAL PYRAMID WITH CIRCULAR