CHAPTER-6

SECTIONS OF SOLIDS AND DEVELOPMENT OF SOLIDS

SECTIONS OF SOLIDS

The surface obtained by cutting an object by section plane is called **section** or **cut surface.**
The projection of the section of an object with its remaining portion is called **sectional views**.
The true shape of the section is obtained by viewing the object normal to the cut surface and projecting it on a plane parallel to the section plane.

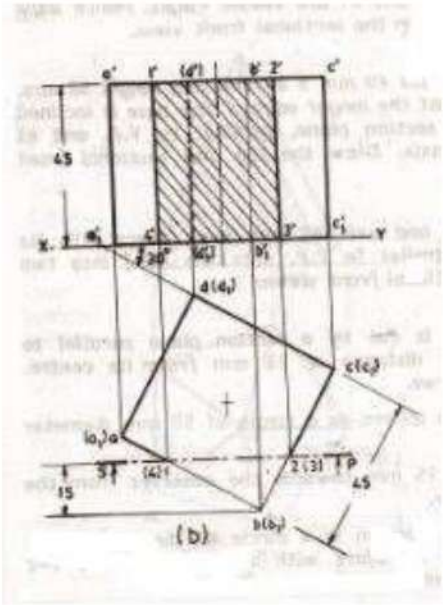
Types of Section Planes:

- Section plane perpendicular to HP and parallel to VP
- Section plane perpendicular to VP and parallel to HP
- Section plane perpendicular to HP and inclined to VP
- Section plane perpendicular to VP and inclined to HP

Section plane perpendicular to HP and parallel to VP

Example: 1

A cube of side 45mm rests on HP with one of its face inclined at 30^0 to VP. A section plane parallel to VP cuts the cube at distance of 15mm from the vertical edge nearer to the observer. Draw the top and sectional front view.



Steps.

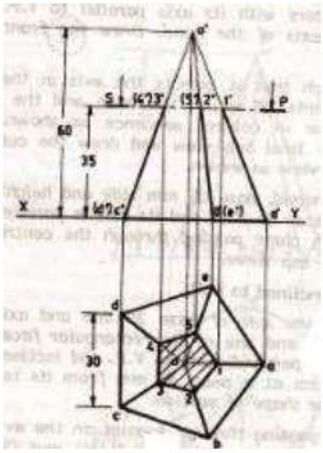
1. Draw the top view as a square abcd ($a_1b_1c_1d_1$) of size 45 mm, with one side inclined at 30^0 to XY and front view of the cube for the given position. Name the corner points.
2. Draw Section plane parallel to XY and 15mm from the vertical edge b(b_1) nearer to the observer in the top view.
3. Name section points 1 and 2 where it cuts edge ab and bc respectively and name (3) and (4) where it cuts the invisible edge (C_1)(b_1) and (b_1)(a_1) respectively. Show the remaining portion of the cube by thick lines.
4. Project the section points on the corresponding edges in the front view i.e. 1' on a'b', 2' on b'c', 3' on c'$_1$b'$_1$ and 4' on b'$_1$a'$_1$ respectively.
5. Join 1'2'3'4' by thick line and hatch this area as cut surface.

Section plane perpendicular to VP and parallel to HP

As plane is perpendicular to the VP the front view is a line and as plane is parallel to HP the top view is the true shape of the plane.

Example: 2

A pentagonal pyramid of side of base 30mm each and height 60 mm rests on HP on its base. One of its edges of base is perpendicular to VP. It is cut by a section plane perpendicular to VP and parallel to HP at 35mm above the base. Draw the sectional top view.

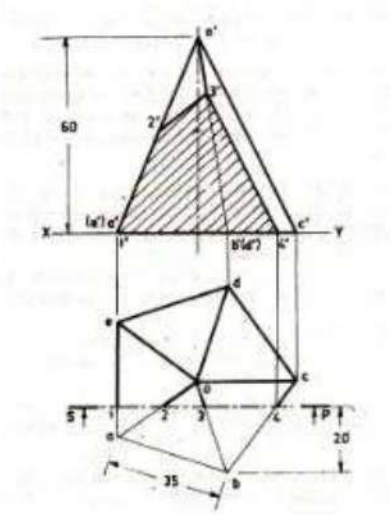


Steps:

1. Draw the top view of the pyramid abcde pentagon with side cd perpendicular to XY. Mark o centre of the pentagon. Join oa,ob,oc,od,oe.
2. Draw the front view a'b'c'd'e' of base corner points on XY. Mark o' at height 60mm on the projector from o. Join o'c'(d'), o'a', o'b'(e').
3. Draw the sectional plane (SP) parallel to XY at height 35mm above XY in the front view. cutting sides of pyramid.
4. Mark points 1',2',3' cutting the visible edges o'a', o'b' and o'c' respectively. Mark (4') and (5') where the SP cuts invisible edges o'(d') and o'(e') respectively.
5. Show the remaining portion of pyramid a'b'c'(d')(e') and the slant edges 1'a',2'b',3'c', (4')(d') and (5')(e') as thick lines in the front view.
6. Project the section points on the corresponding edges in the top view, i.e. mark 1 on oa, 2 on ob and so on.
7. Join 12345 by thick lines and hatch this area. This cut surface is true surface of the section.

Example: 3

A pentagonal pyramid of side of base 35mm each and height 60 mm rests on HP on its base. One of its edges of base is perpendicular to VP. It is cut by a section plane perpendicular to HP and parallel to VP at distance of 20mm from the corner of the base nearer to the observer. Draw the sectional front views.



Steps:

1. Draw the top view and front views of the pyramid as per the position.
2. Draw SP parallel to XY and 20mm from b as shown. Name the points 1,2,3 and 4 where it cuts the visible edges ea, oa, ob and bc respectively.
3. Show the remaining portion of pyramid as thick lines in top view.
4. Project the above section points on the corresponding edges in the front view. Mark 1',2',3', and 4' on a'e', o'a', o'b' and b'c' respectively.
5. Join 1'2'3'4' by thick lines and hatch this area. This is the true shape of the section.

DEVELOPMENT OF SOLIDS

Development of surface of an object means the unrolling or unfolding of all surfaces of the object on a plane.

Every point on the development shows the true length of the corresponding line on the surface which is developed.

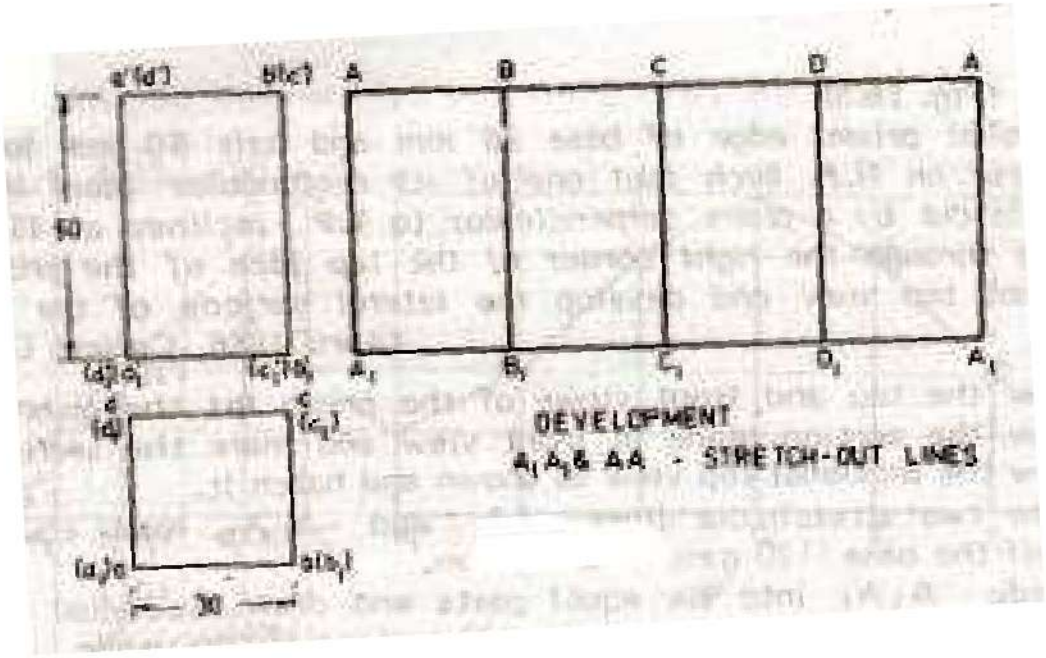
Methods of development

- Parallel –line development: Used for development of prism and cylinder.
- Radial-line development: Used for development of pyramids and cone.
- Triangulation development:
- Approximate development.

Example: 1

Draw the development of the lateral surface of a right square prism of edge of base 30mm and axis 50mm long.

Draw the top view and front view of the prism and name the corners.

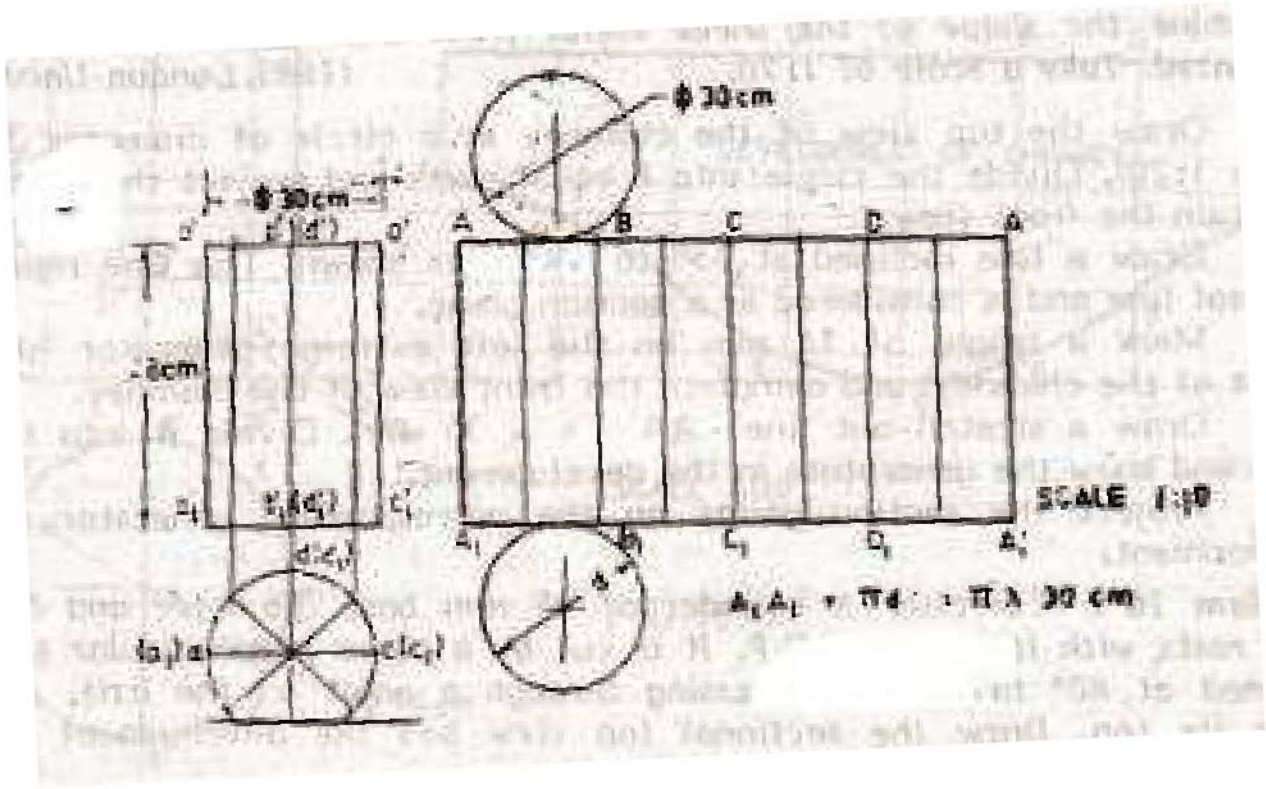


Steps:

1. Draw the top view and front view of the prism and name the corners.
2. It consists of four equal rectangles of size 50mm X 30mm in contact and in sequence. So draw a rectangle $A_1\ A_1AA$ such that $A_1\ A_1$ = perimeter of the base of the prism and AA_1= 50mm height
3. On the line $A_1\ A_1$ mark four equal divisions A_1B_1,B_1C_1, etc. each equal to the side of base=30mm
4. Erect perpendiculars at B_1,C_1 and D_1. Darken the four rectangles which give the development of the lateral surface of the prism.

Example:

Draw the development of the complete surface of a cylindrical drum with lid. Diameter is 30cm and the height is 1.6 times the diameter.

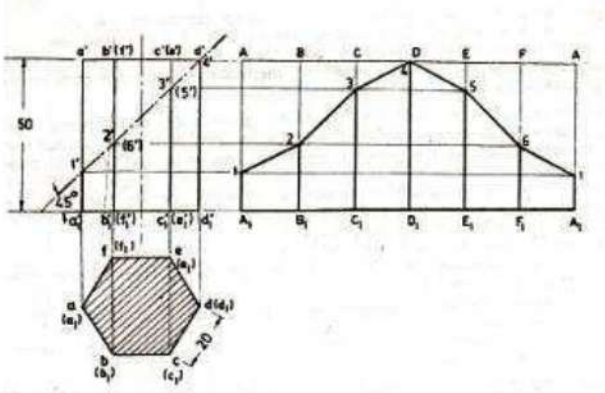


Steps:

1. Draw the top view and front view of the cylinder.
2. Draw a rectangle of size π X 30cm and divide it into eight equal parts and mark points accordingly.
3. Draw the circle at top and bottom at the extreme ends.

Example-3

A hexagonal prism of 20 mm base edges and 50 mm height, having two of its vertical rectangular faces parallel to V.P; and its base resting on H.P. It is cut by a plane perpendicular to VP inclined at 45^0 to HP and passing through the right corner of the top face of the prism. Draw the sectional top view and develop the lateral surface of the truncated prism.

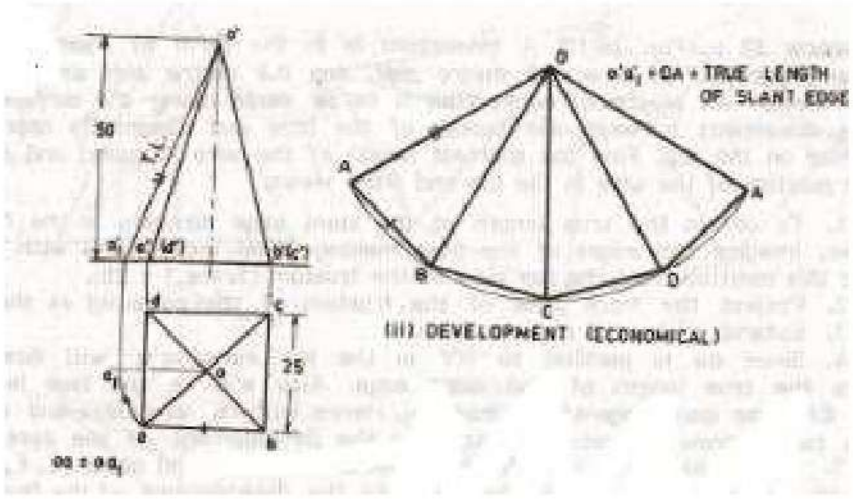


Steps:

1. Draw the top view and front view of the cylinder.
2. Draw the sectional plane in the front view and mark the section points.
3. Draw the sectional top view as shown and hatch.
4. Draw the two stretch-out lines AA and A_1A_1 each equal to the perimeter of the base (120mm)
5. Divide A_1A_1 into six equal parts an draw six equal rectangles to represent development of the lateral surface of the prism.
6. From the section point 1 draw a horizontal line and mark 1 on AA_1. Simillarly obtain points 2,3,4,5, 6 I the development.
7. Join 12, 23, 34,……61 as straight lines and darken the development of the lateral surface of the truncated prism.

Example 4

Draw the development of the lateral surface of a square pyramid, side of base 25mm and height 50mm, resting on HP on base. One edge of the base is parallel to VP.

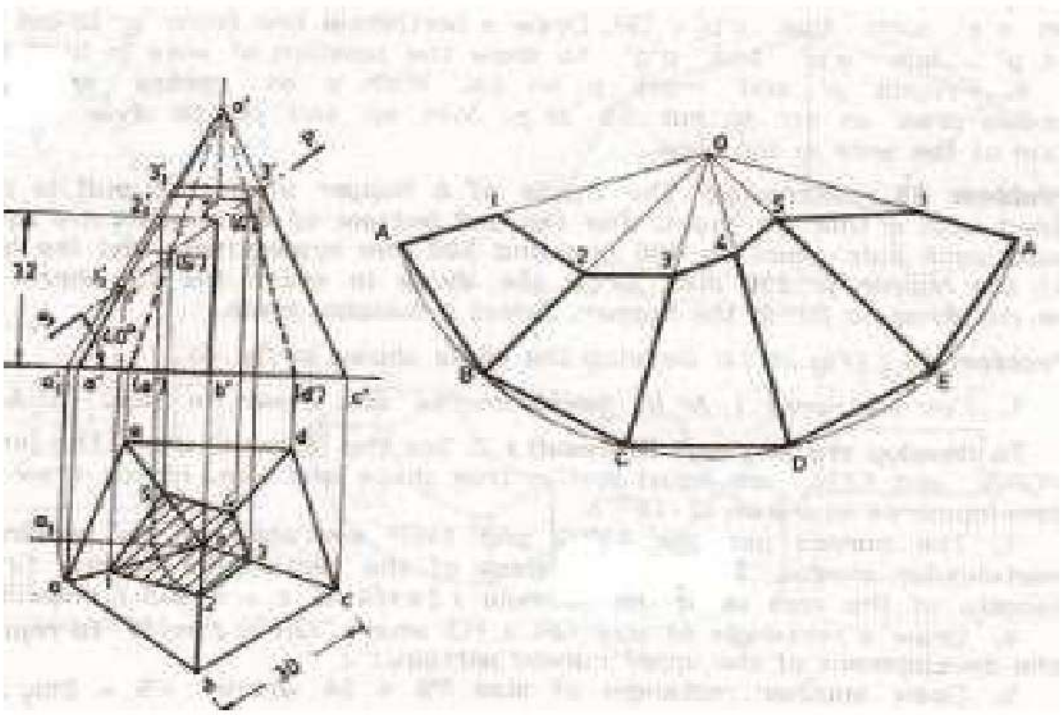


Steps:

1. Draw the top view and front view of the pyramid.
2. The true length of the slant edge is required for its development, since none of the slant edge is parallel to VP true length cannot be obtained directly from front view. To get the true length of slant edge (say OA), make oa parallel to XY and draw an arc with o as centre and oa as radius to cut the horizontal line at a_1. So $o'a'_1$ is the true length of the slant edge OA.
3. With O as centre and $o'a'_1$ as radius draw an arc. On this arc mark 4 equal divisions, i.e., chord AB=BC=CD=DA=25mm. Complete the triangles OAB,OBC,OCD and ODA by thick lines which gives the development of the lateral surface of a square pyramid.

Example: 5

A pentagonal pyramid, side of base 30mm and height 52mm, stands on its base on HP and one edge of the base is parallel to VP. It is cut by a section plane perpendicular to VP and inclined at 40^0 to HP and passing through a point on the axis 32mm above the base. Draw the sectional top view and the development of the lateral surface of a truncated pyramid

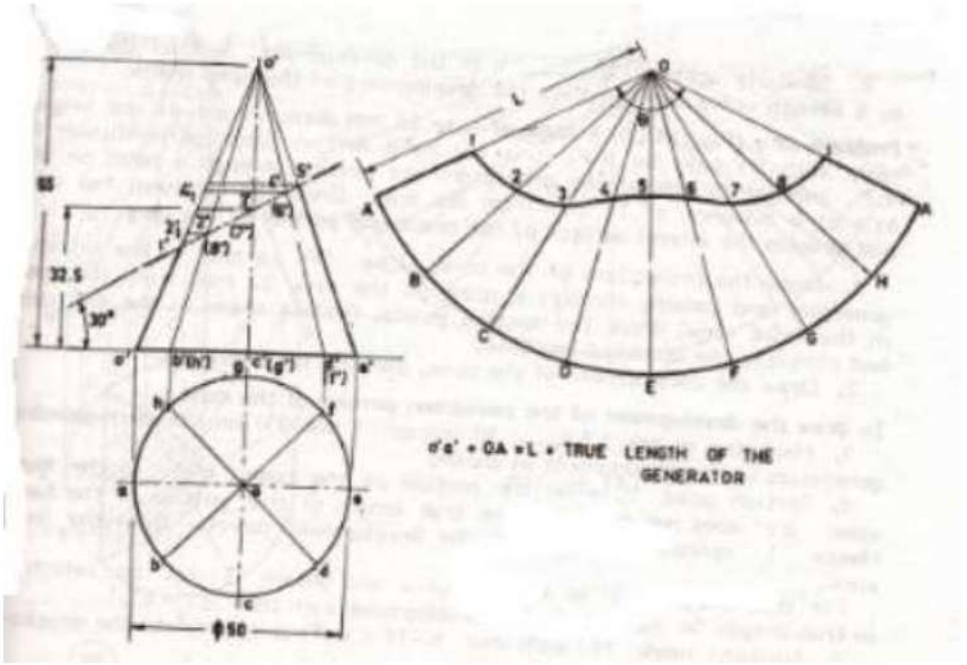


Steps:

1. Draw the top view and front view of the pyramid.
2. Find the true length of the slant edge and draw the development of lateral surface of the pyramid.
3. Draw the section plane in front view and mark the section points.
4. Draw the sectional top view and hatch the cut surface.
5. To find the true length of the remaining portion of the slant edges draw horizontal lines through the section points 1', 2', 3', 4', etc to cut o'a'$_1$(True legth of slant edge OA) at 1_1',$2'_1$, $3'_1$.
6. With O as centre and o'1'$_1$as radius draw an arc to cut OA at 1. Similarly obtain points 2, 3, 4, 5, and complete the development of the truncated pyramid.

Example: 6

A cone of base 50mm diameter and height 65mm rests with its base on HP. A section plane perpendicular to VP and inclined at 30^0 to HP bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone.

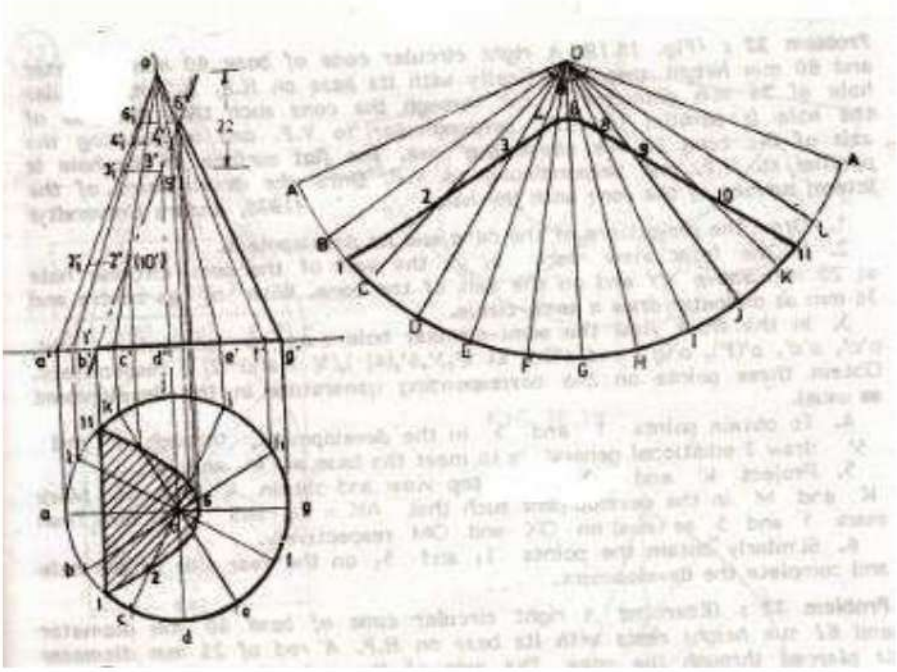


Steps:

1. Draw the top and front views of the cone. Divide the base circle into 8equal parts and show the generators oa,ob,oc, …. and oh in top view and corresponding lines o'a','o'b', o'c', ….. and o'h' in front view.
2. In top view oa is parallel to XY, hence o'a' is equal to the true length L of the generator.
3. Development of the cone is a sector of a circle of radius equal to the length L of the generator. Length of the arc of the sector is equal to the circumference of the base circle ($2\pi r$) and the angle subtended by the arc at the centre is Θ.
    a. The $L\Theta = 2\pi r' = 360^0 X\ r$. Hence, $\Theta = 360^0 X\ r/L$.
4. O as centre and L as radius draw an arc subtending angle Θ at O.
5. Divide Θ into 8 equal parts, draw the radial lines OA, OB, OC etc. and complete the development of the cone.
6. Draw the section plane at 30^0 to XY bisecting the axis in front view. Mark the points 1',2', 3' etc.
7. Mark 1 on OA in the development such that O1= o'1'.
8. To mark points2,3, etc draw horizontal line from 2',3' etc on the end generator o'a' at 2_1','3_1' etc. Transfer the distances o'2_1', o'3_1' etc on the respective generators in the development as O2,O3 etc on OB,OC etc respectively.
9. Draw a smooth curve passing through the points 1,2,3, etc and complete the development of the lateral surface of the truncated cone.

Example:

A cone of base 50mm diameter and height 60mm rests with its base on HP. It is cut by a section plane perpendicular to VP, parallel to one of its generator of the cone and passing through a point on the axis at 22mm from the apex. Draw the sectional top view and develop the lateral surface of the remaining portion of the cone.



Steps:

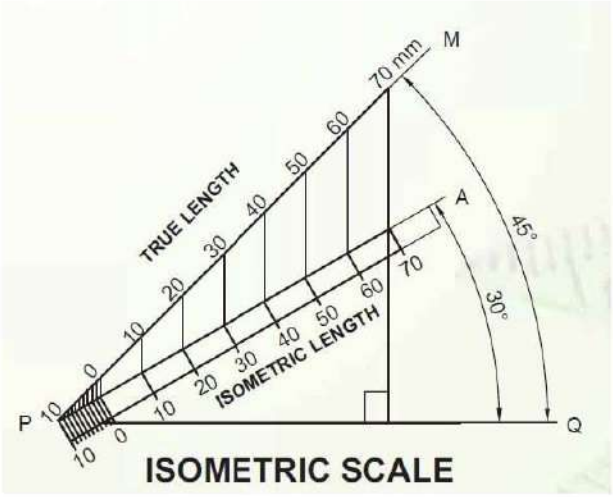
1. Draw the projection of the cone. Draw SP parallel to the extreme generator o'a' passing at appoint on the axis 22mm below the apex o' in the front view. Mark the section points1',2',3',4',5',6' ….10'. Project them to the top view. Complete the sectional top view.
2. Draw the development of the cone showing 12 generators as in the above figure.
3. Mark the points 2,3,4,….. 10 on the corresponding generators in the development as described in the previous example.
4. Marked point 1' on the portion of base b'c' in the front view does not represent the true length of that portion of the base. Hence 1 can't be marked in the development directly from the front view. Project 1' to the top view and obtain 1 on bc which is the true length. So mark 1 on the development such that B1=b1.
5. Similarly mark 11 such that K-11=k-11 and complete the development.

Chapter-7

ISOMETRIC PROJECTION

The isometric projection of an object is a one plane view drawn with the object so placed with respect to the plane of projection that all the three principal axes appear to be inclined to each other at an equal angle of 120°.

ISOMETRIC SCALE



The isometric scale is used to measure the foreshortened length of dimensions of any object to draw the isometric projection. The steps of construction of isometric scale are given below;

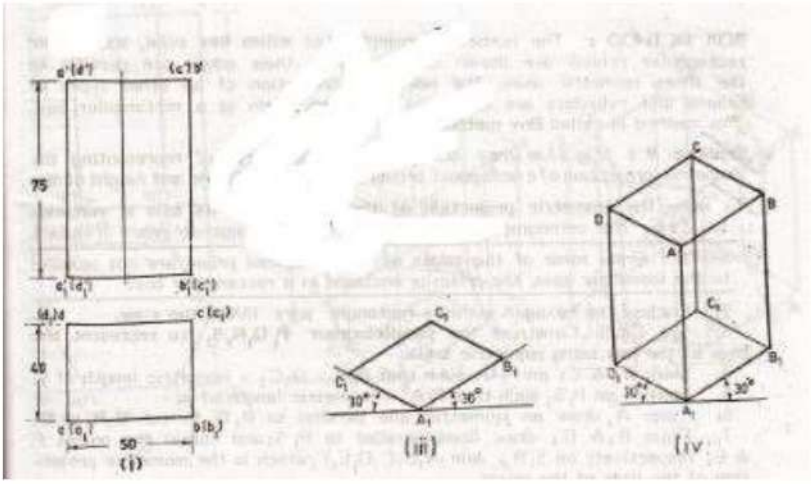
(i) Draw a horizontal line PQ.
(ii) Draw the true lengths on a line PM inclined at 45° to the horizontal line.
(iii)Draw another line PA at 30° to the horizontal line.
(iv)Draw the vertical projection of all the points10, 20, 30, 40 etc. on PM to PC .
(v) Complete the scale with the details as shown in the figure.
The lengths shown at the line AB are the isometric lengths to be used to draw the isometric projection.

Difference between Isometric View and Isometric Projection

Isometric View	Isometric Projection
Drawn to actual length	Drawn to Isometric length
When lines are drawn parallel to isometric axes true lengths are drawn	When lines are drawn parallel to isometric axes 0.81 times the true lengths are drawn

Example: 1

Draw the isometric view of a square prism of side of base 35mm and height 65 mm when the axis is vertical.

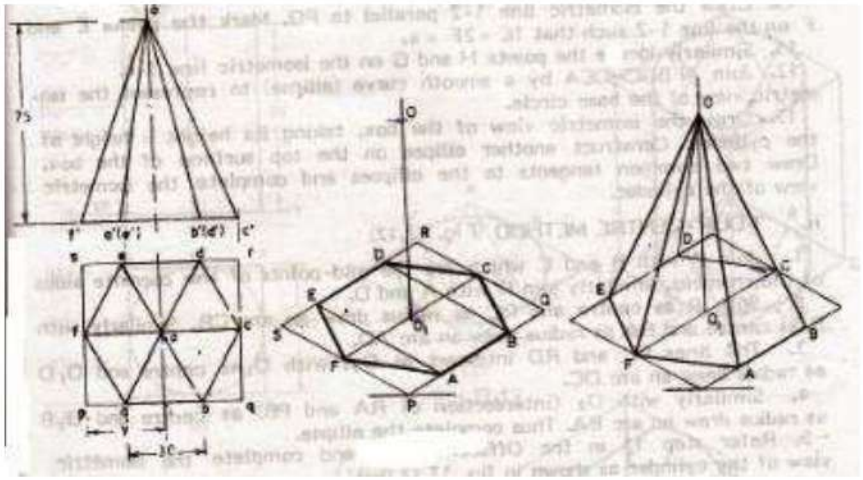


Steps:

1. Draw the top view abcd($a_1b_1c_1d_1$) square of side 35mm each and front view $a'_1(d'_1)$ $b'_1(c'_1)$ b'(c')a'(d') of the prism.
2. Draw a horizontal line mark A_1 on it.
3. Draw two lines at 30^0 with horizontal at A_1 as Isometric axes.
4. Mark B_1 and D_1 such that $A_1B_1=A_1D_1$
5. From B_1 draw a line parallel to A_1D_1 and from D_1 draw a line parallel to A_1B_1. Both meet at C_1.Draw vertical at A_1 to represent 3rd axis. Mark the point A on it at height 65mm above A_1.
6. From B_1, C_1 and D_1 draw vertical lines and mark B, C and D at height 65mm on these respectively.
7. Join ABCD, AA_1, BB_1, DD_1 to get the isometric view of the prism.

Example: 2

Draw the isometric view of a hexagonal pyramid of side of base 30mm and height 75 mm resting on HP with one of its side of base parallel to VP.

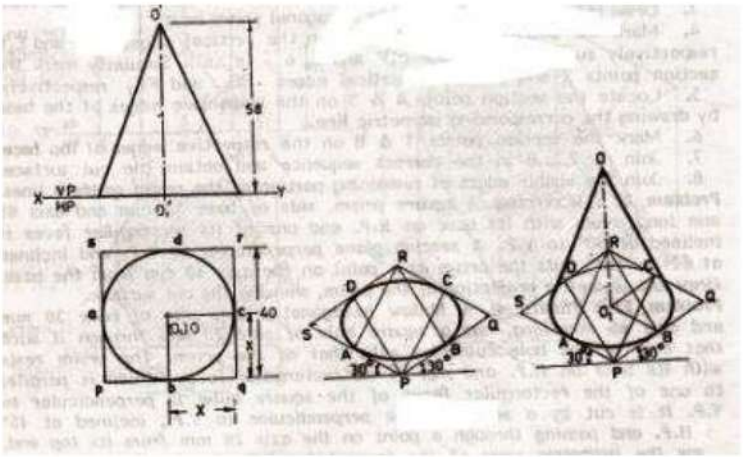


Steps:

1. Draw the top view as hexagonal (i.e. the shape of the base top) and the hexagon abcdef is to be drawn with ab and de sides parallel to XY. Join diagonals to get the centre o.
2. Draw the front view a'b'c'd'e'f' on XY by drawing projectors from respective points and draw o' at height 75mm above XY on the projector from o.
3. Enclose the hexagon in a rectangle pqrs.
4. Draw the isometric view of the base of the pyramid in the parallelogram PQRS.
5. Mark the O_1 on the isometric line FC.
6. From O_1 erect vertical line and mark O such that OO_1= 75mm
7. Join OA,OB,OC,OE and OF to get the isometric view.

Example: 3

Draw the isometric view of the cone of base diameter 40mm and height 58mm when it rests with its base on HP.



Steps:

1. Draw the top view and front view of the cone.
2. Enclose the circle in the top view in square.
3. Draw the rhombus PQRS.
4. Draw the base of the cone as an ellipse by four centre method.
   4.1 Join P with C and D which are the mid points of the opposite sides. Similarly join R with A and B the mid points of opposite sides.
   4.2 With P as centre PC as radius draw arc CD. Like this draw arc AB with R as centre and RA as radius.
   4.3 Find out the intersection point of RA and PD, taking this as centre and radius upto C or B draw the arc BC. Like this find the intersection point of RB and PC, taking this as centre and radius upto A or D, draw the arc BC
5. From B and C draw lines parallel to the isometric axes and obtain O_1.
6. From O_1 draw a vertical line and mark O such that OO_1=58mm.
7. From O draw two tangents to the ellipse and complete the isometric view.