UNIT -4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES

INTRODUCTION

SECTION OF SOILD

An object (here a solid) is cut by some imaginary cutting plane to understand internal details of that object.

The action of cutting is called SECTIONING a solid & the plane of cutting is called SECTION PLANE.

TYPES OF SECTION PLANES

A) Section Plane perpendicular to VP and inclined to Hp. (This is a definition of an Aux. Inclined Plane i.e. A.I.P.)

NOTE: - This section plane appears as a straight line in FV.

B) Section Plane perpendicular to HP and inclined to VP. (This is a definition of an Aux. Vertical Plane i.e. A.V.P.)

NOTE:- This section plane appears as a straight line in TV.

Note:

1. After launching a section plane either in FV or TV, the part toward observer is assumed to be removed.
2. As far as possible the smaller part is assumed to be removed.

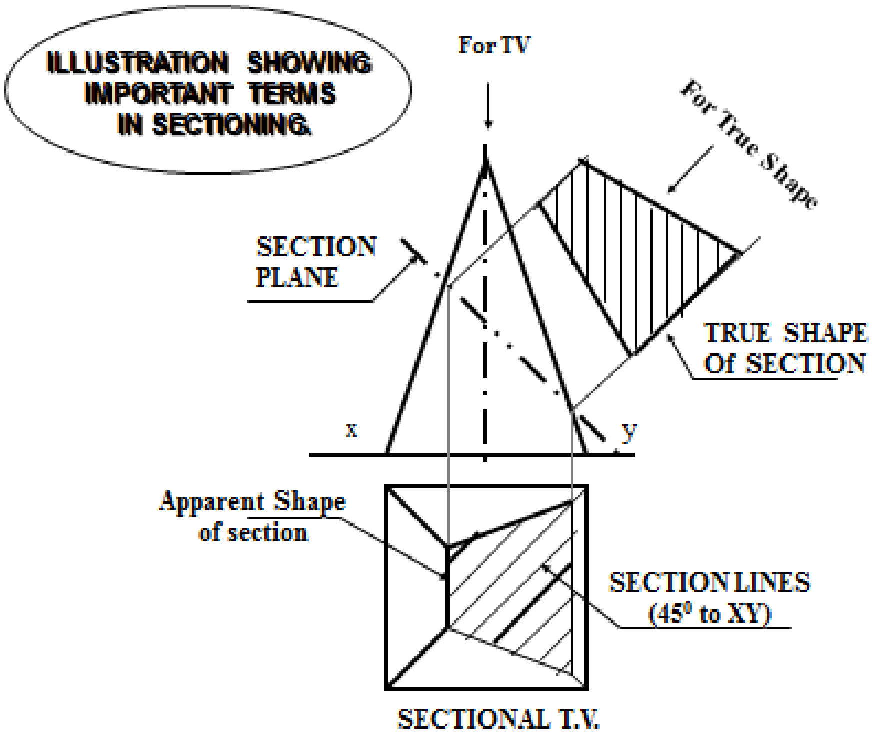
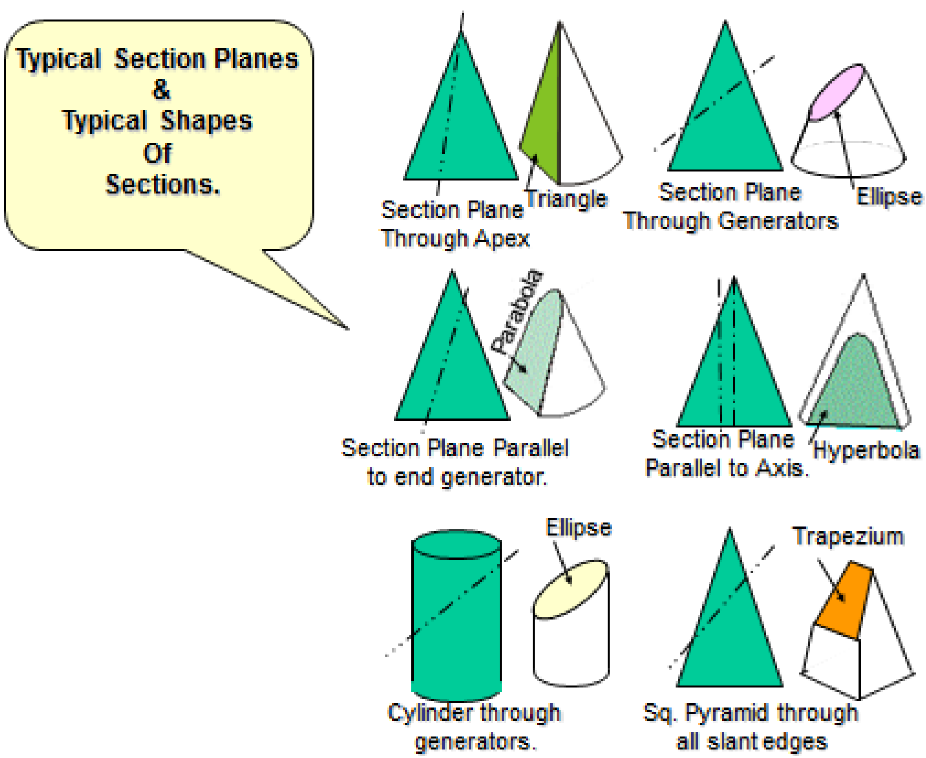
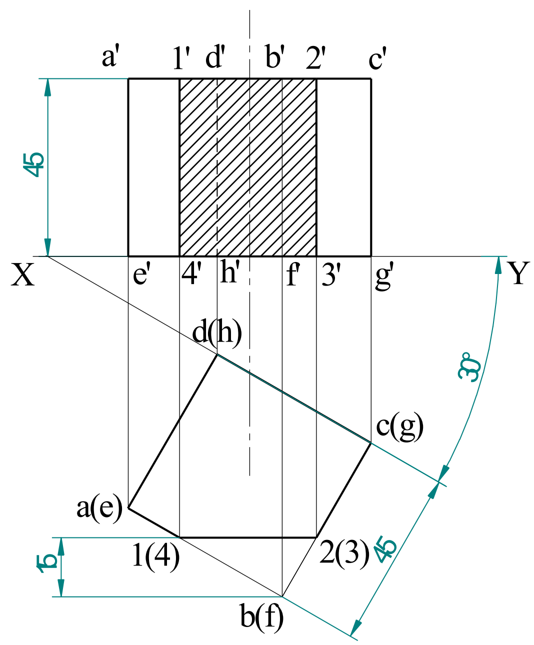


ILLUSTRATION SHOWING IMPORTANT TERMS IN SECTIONING.
For TV
For True Shape
SECTION PLANE
TRUE SHAPE Of SECTION
x
y
Apparent Shape of section
SECTION LINES
(45^0 to XY)
SECTIONAL T.V.

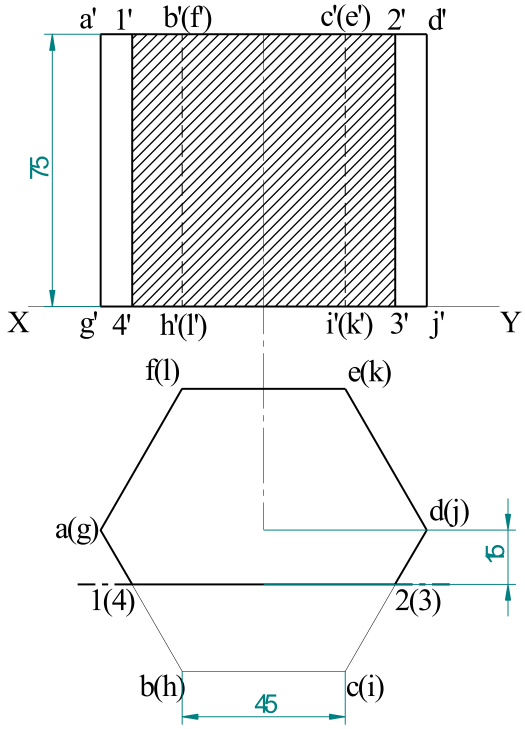

Typical Section Planes & Typical Shapes Of Sections.
Triangle
Section Plane Through Apex
Section Plane Through Generators
Ellipse
Parabola
Section Plane Parallel to end generator.
Section Plane Parallel to Axis.
Hyperbola
Ellipse
Cylinder through generators.
Trapezium
Sq. Pyramid through all slant edges

1. **A cube of 45mm side rests with a face on H.P. such that one of its vertical faces is inclined at 30° to V.P. A section plane, Parallel to V.P. cuts at a distance of 15mm from the vertical edge nearer to the observer. Draw its top and sectional front views. (13.1)**



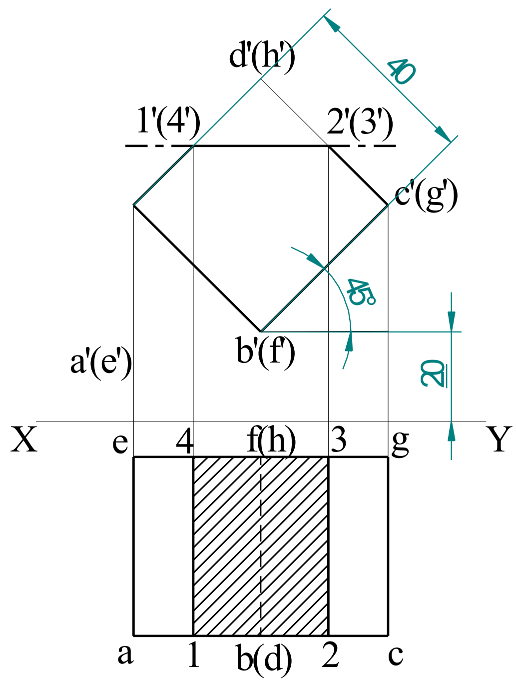
- Draw the top view of the cube which is a square of side 45mm with one of its vertical face is inclined 30° to V.P.
- Draw the corresponding elevation of cube by projecting the points in plan.
- Draw the cutting plane at a distance of 15mm from the vertical edge nearer to the observer and mark the cutting points as 1, 2, 3 and 4. After cutting the solid we have to assume that the portion between the cutting plane and observer is removed other portion of the object is shown by thick continuous line.
- From the cutting points, Draw the vertical projectors to front view and mark the points as 1', 2', 3' and 4' which are the sectioned surface and are distinguished by hatching lines. Thus the hatched area 1', 2', 3' and 4' is the shape of the section.

2. **A hexagonal prism, side of base 45mm and axis 75mm long, rests with its base on H.P. such that one of its rectangular faces is parallel to V.P. A section plane perpendicular to H.P. and parallel to cuts the prism at a distance of 15mm from its axis. Draw its top and sectional front views. (13.2)**



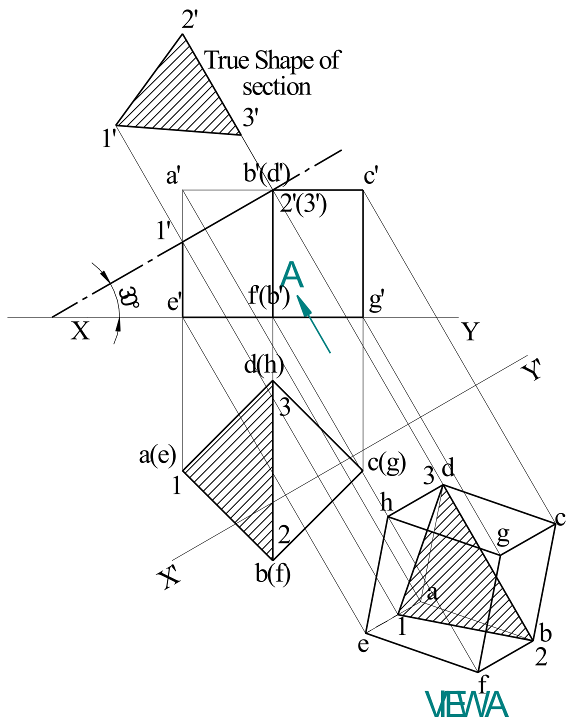
- Draw the top view of the hexagonal prism of base side 45mm with one of its rectangular face is parallel to V.P.
- Draw the corresponding front view with the axis 75mm long and mark the points.
- Draw the cutting plane perpendicular to H.P. a distance of 15mm from its axis and the cutting points as 1,2,3 and4.
- From the cutting points, draw projectors to front view and mark the cutting points which are sectioned surface and are distinguished by hatching. Thus the area 1', 2', 3' and 4' is the true shape of the section.

3. A cube of 40mm side having one of its edge perpendicular to V.P. and 20mm above H.P. and the square faces containing that edge are making equal inclinations with H.P. A horizontal section plane cuts at a distance of 15mm below the horizontal edge nearer to the observer. Obtain the front and sectional top views. (13.4)



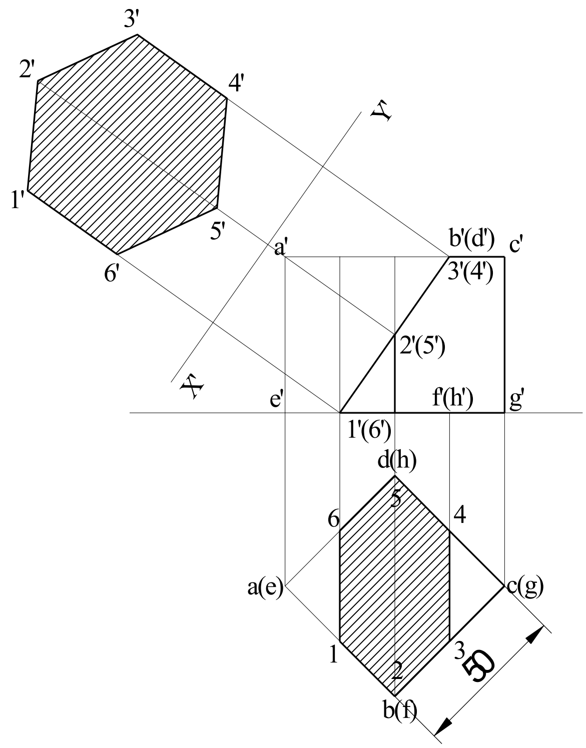
- Draw the front view of cube of side 40mm and the square faces containing the edge make equal inclined with H.P. and draw the corresponding top view.
- Draw the cutting plane at a distance of 15mm below the highest corner of the cube and mark the cutting points where the plane cut the solid as 1',2',3' and 4'.
- Draw the projectors to top view from cutting points and mark the points as 1, 2, 3 and 4.
- Join these projected points in the plan and hatching it, which is the true shape of the section.

4. A cube of 40mm long edges is resting on the ground on one of its faces inclined at 45° to the V.P. It is cut by a section plane, perpendicular to the V.P. inclined at 30° to the H.P. and passing through the top end of the axis. Draw the sectional top view and true shape of section.(13.5)



- Draw the top, front view and cutting plane perpendicular to V.P. inclined at 30^o to the H.P. and passing through the end of the axis.
- Project the cutting points to top view and mark the points 1, 2, and 3. Then complete the sectional top view as in the previous examples.
- To draw the true shape of section, draw the reference plane X'Y' parallel to cutting plane at any convenient distance. Draw the projectors perpendicular to X'Y' from 1', 2' and 3'.
- Measure the distance of the points 1, 2 and 3 as (x_1,x_2,x_3) from XY and transfer the same on corresponding projectors the from X'Y'. Thus the obtained area is hatched which is true shape of the section.

5. A cube of 50mm sides has its base edges equally inclined to the V.P. It is cut by a section plan perpendicular to the V.P., so that the true shape of the cut section is regular hexagon. Locate the plane and determine the angle of inclination of the V.T. with the reference line XY. Draw the sectional top view. (13.6)

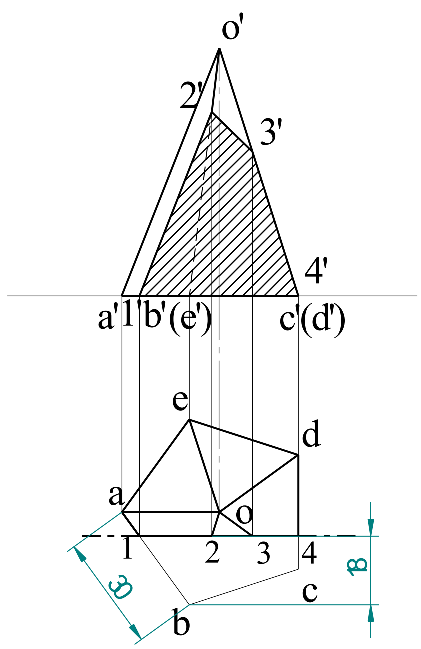


- Draw the top and front view of the cube of base 50mm and its base edges equally inclined to V.P.
- Draw the cutting plane which is perpendicular to V.P. and it should pass through six edges and also should meet the edges at their mid height. Since the true shape of a section will be a regular hexagonal.
- The mid points of e'f',b'f' and b'f' are marked as 1',2' and 3' respectively. The mid points c'd',d'h' and the h'e' are marked as 4',5' and 6' respectively.
- Draw the projectors from cutting points to top view and mark the points 1, 2,3,4,5 and 6 which is the sectional view.
- To get true shape of the section draw a new reference plans X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height of points from XY line in plan.

6. A cube of 40mm long edges is resting on the ground on one of its faces with a vertical face inclined at 30° to the V.P. It is cut by a section plane, inclined at 50°to the V.P. and perpendicular to the H.P. Draw the sectional front view, top view and true shape of the section. (13.8)

- Draw the top and front view of a cube of 40mm long with one of its vertical face inclined at 30° to V.P.
- Draw the cutting plane inclined at 50° to V.P... And mark the cutting points as 1, 2, 3 and 4.
- From the marked cutting points, draw the projectors to front view and locate the points 1',2',3' and 4', Which is the sectional front view.
- To get true shape of the section draw a new reference plans X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height of points from XY line in elevation.

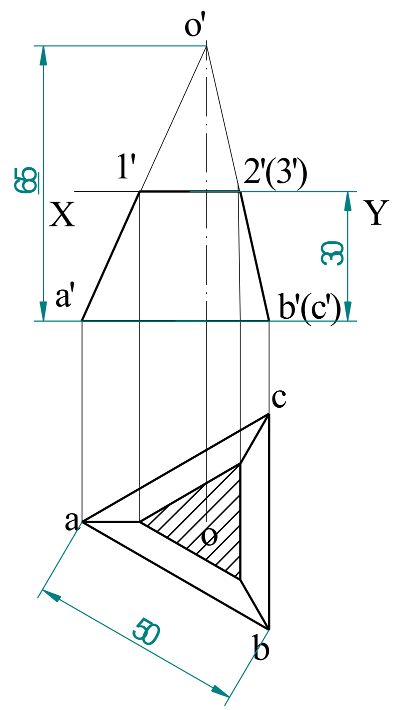
7. A pentagonal pyramid, side of base 30mm and axis 65mm long rests with its base on H.P. such that one of the edges of the base perpendicular to V.P. section plane perpendicular to H.P. and parallel to V.P. cuts the pyramid at a distance of 18mm from the corner of the base nearer to the observer. Draw the top and sectional front view. (13.11)



- Draw the front and top view of pentagonal pyramid of side 30mm and axis 65mm long rest with its base on H.P.
- Draw the cutting plane at a distance of 18mm from the corner of the base nearer to the observer and mark the cutting points 1, 2, 3 and 4.

- From the cutting points, Draw the projectors to front view and mark the points as (1’, 2’, 3’ and 4’).
- Join these points and hatch it, which is the sectional front view.

8. A triangular pyramid of base side 50mm and height 65mm rests on H.P. on its base with a base edges perpendicular to V.P. A plane cuts it parallel to H.P. and perpendicular to V.P., meeting the axis 30mm above the base. Draw the sectional plan. (13.13)

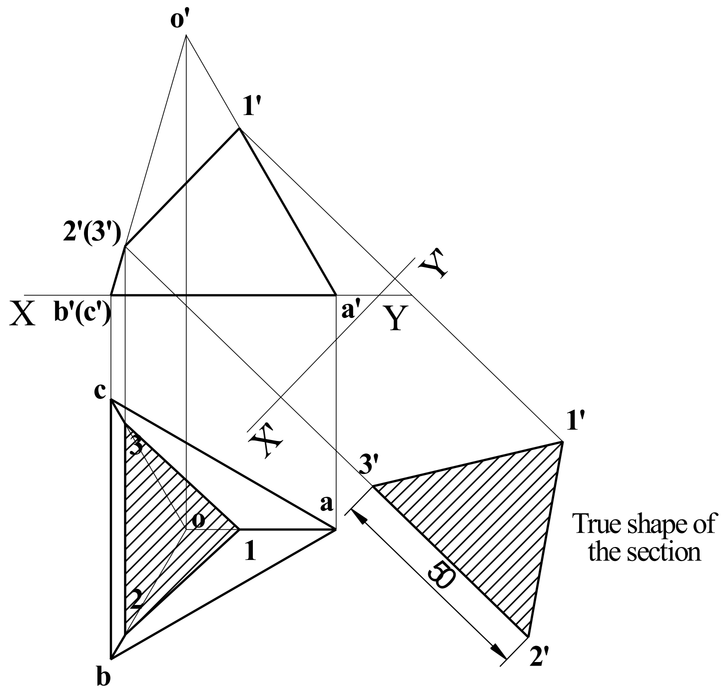


- Draw the top and front triangular pyramid of base side 50mm and height 65mm rests on H.P.
- Draw the cutting plane as being parallel to H.P. which meets with the axis 30mm above the base and mark the cutting points 1’,2’ and 3’.
- From the cutting points, draw the projectors to top view and locate the points as 1,2 and 3.
- Join these points and hatching it, which required sectional plan view.

9. A tetrahedron of 60mm long edges rests with one of its face on H.P. and an edge is perpendicular to V.P. A section plane perpendicular to V.P. cuts the tetrahedron

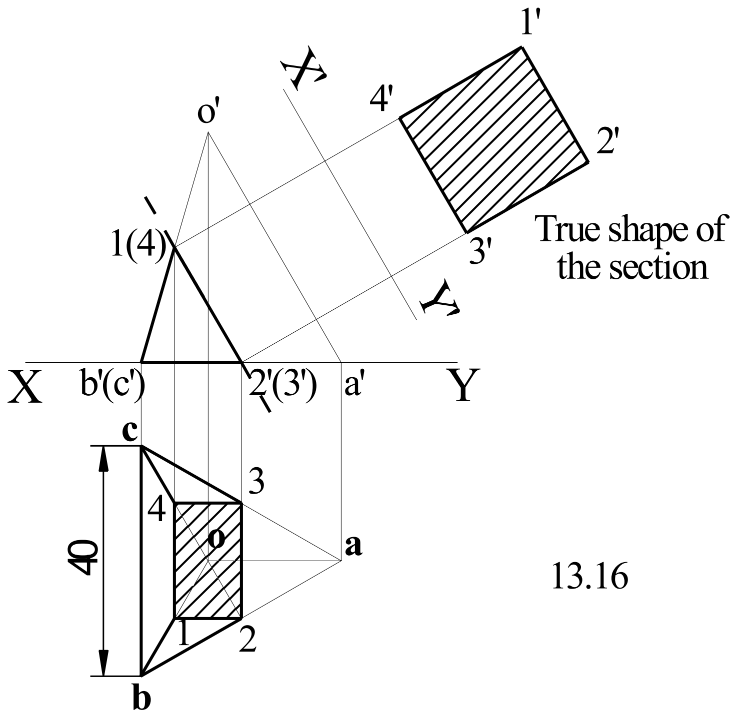
such that the true shape of section is an isosceles triangle of base 50mm and altitude 36mm. Draw the front view, sectional top view and the true shape of section. Also find the inclined of the section plane with H.P.(13.15)

13.15



- Draw the top and front view of the tetrahedron of 60mm long edges with one of its face on H.P. and an edge perpendicular to V.P.
- Draw the cutting plane perpendicular to V.P. which should meet the three points, length should be 36mm and angle $\tan^{-1}(36/25)$ such that the true shape of the section, an isosceles triangle of base 50mm and altitude 36mm can be achieved and mark the cutting points 1',2' and 3'.
- From the cutting points, draw the projectors to top view and mark the points as 1,2 and 3.
- To get the true shape of the section. Draw the reference line (X'Y') parallel to the cutting plane and project the lines from cutting points as in the drawing.
- Measure the distance from XY plane to sectional plan transfer line X'Y'. Then mark the points (1', 2'and 3') and join these points which are true shape of the sectional view.

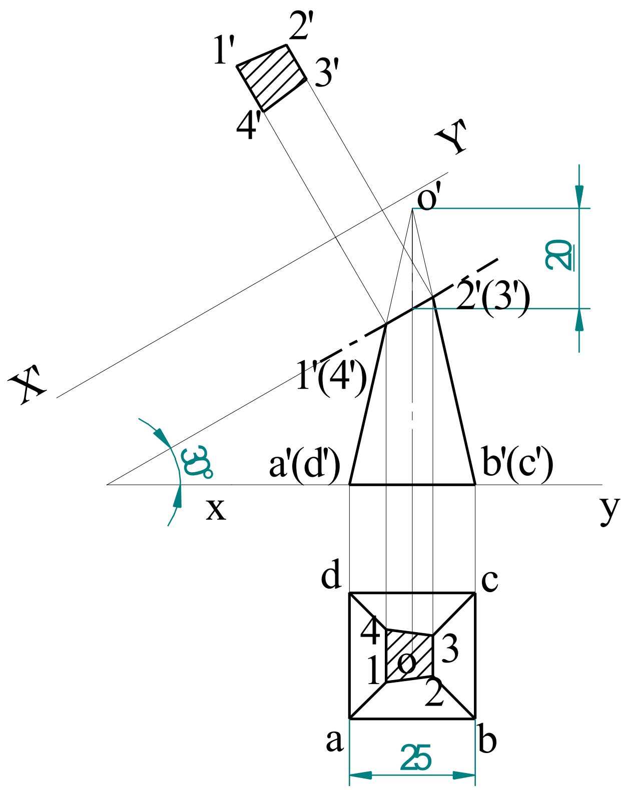
10. Draw the projection and the apparent section of a tetrahedron of side 40mm, which is cut by a plane perpendicular to V.P. and inclined to H.P. such that true shape of the section is a square. (13.16)



13.16

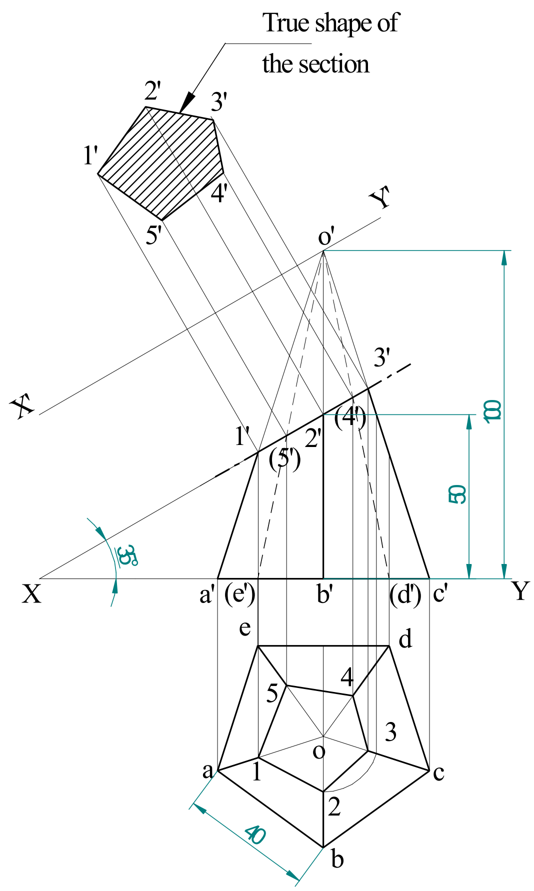
- Draw the top and front view of the tetrahedron of side 40mm.
- Locate the center point of the lines a'b', o'b',a'c' and o'c' in the front view.
- Draw the cutting plane which is passing through these points and is inclined to H.P. such that true shape of the section will be a square.
- Draw the projectors to plan from cutting points and mark the points as in the drawing.
- Join these points and hatch it which is the sectional top view.
- To get true shapes of the section draw a new reference plane X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points .On these lines mark the points with respect to X'Y' by measure height of points from XY line in plan.

11. A square pyramid of base side 25mm and height 55mm rests on H.P. on its base with a base edge perpendicular to V.P. it is cut by a plane perpendicular to V.P. inclined at 30° to H.P. The cutting plane meets the axis at 20mm from the vertex. Draw the elevation, sectional plan and true shape of section. (13.17)



- Draw the top and front view of the square pyramid of base 25mm and height 55mm.
- Draw the cutting plane which is inclined at 30° to H.P. and it meets with the axis at 20mm from the vertex, mark the cutting points 1',2',3' and 4'.
- Draw the projectors from cutting points to top view and mark the points 1, 2, 3 and 4.
- To get true shape of the section draw a new reference plans X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points on these lines mark the points with respect to X'Y' by measuring height of points from XY line in plan.

12. A pentagonal pyramid of base side 40mm and altitude 100mm rests with its base on H.P. with a side of base parallel to V.P. it is cut by a section plane perpendicular to V.P. and inclined at 35° to H.P. and bisecting the axis. Draw the sectional plan of the pyramid and the true shape of section. (13.18)

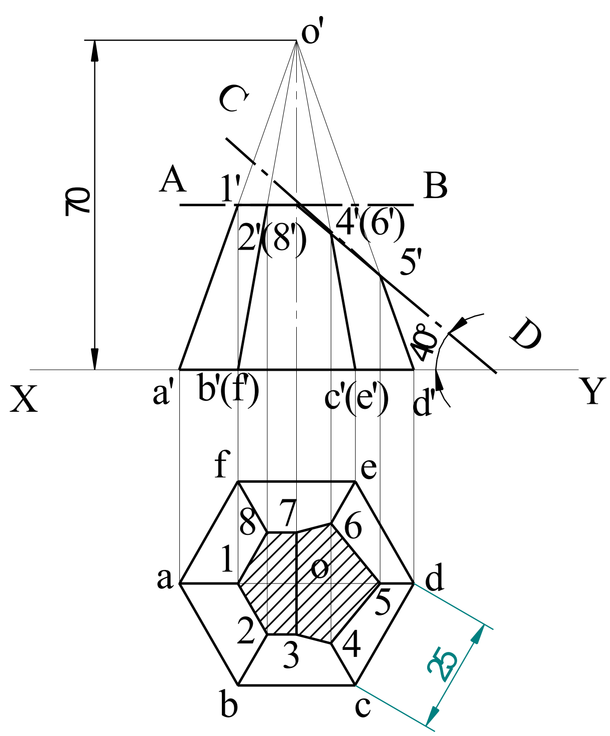


- ➢ Draw the top and front view of the pentagonal pyramid.
- ➢ Draw the cutting planes which are inclined at 35o to H.P. and mar the cutting points 1', 2', 3', 4' and 5'.
- ➢ Draw the projectors from cutting points to top view and to locate the points 2'. Draw the parallel line to XY plane from 2' to meet the line o'c' and mark it as 2_1'.
- ➢ Draw the projectors from 2_1' to OC in the top view and from this draw the arc to meet ob. line which is the point 2.
- ➢ To get true shapes of the section draw a new reference plane X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height of points from XY line in plan.

13. A hexagonal pyramid of base side 35mm and axis length 100mm is resting on H.P. on its base with two sides of base perpendicular v to V.P. it is cut by a plane inclined at 45° to V.P. and perpendicular to H.P and is 10mm away from the axis. Draw its top view, sectional front view and true shape of section. (13.20)

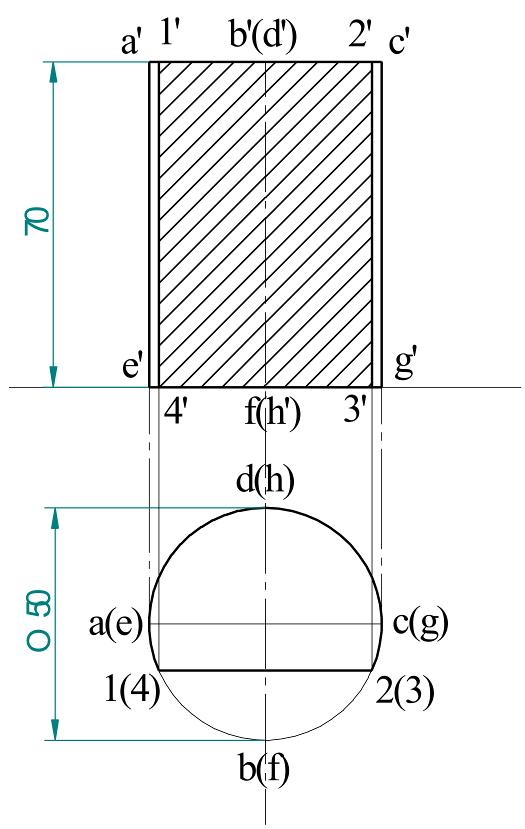
- Draw the top and front view of the hexagonal pyramid.
- Draw the cutting plane which is inclined at 45° to V.P., 10mm from the axis and mark the points (1, 2, 3 and4).
- Draw the projectors from cutting points to front view to get the points (3’) draw the arc to OC line with radius o3 and o as center and project it up to o’c’(d’) line mark the intercept point (3_1’) and draw the parallel line to XY plane to o’b’(e’) line .Join all the points and hatch it.
- To get shape of the section draw a new reference plane X’Y’ parallel to cutting plane Draw the perpendicular lines to X’Y’ from cutting points on these lines mark the points with respect to X’Y’ by measuring height of points from XY line in elevation.

14. A hexagonal pyramid of base side 25mm and axis 70mm is resting on the ground on its base with a base edge parallel to V.P. it cut by two cutting planes starting from a point on the axis 35mm above the base. One is perpendicular to V.P. and parallel to H.P. and the other is perpendicular to V.P. and 40° to the H.P. Draw sectional plan. (13.21)



- Draw the top view of the hexagonal pyramid.
- Draw the cutting planes, one 40° to the H.P. and perpendicular to V.P. and the other parallel to H.P. And perpendicular to V.P. Both the planes passing through the axis is 3mm above the base.
- Draw the projectors from cutting points to top view and mark the points (1, 2, 3, 4,5,6,7 and 8).
- Join these points and hatch it, which is the sectional top view.

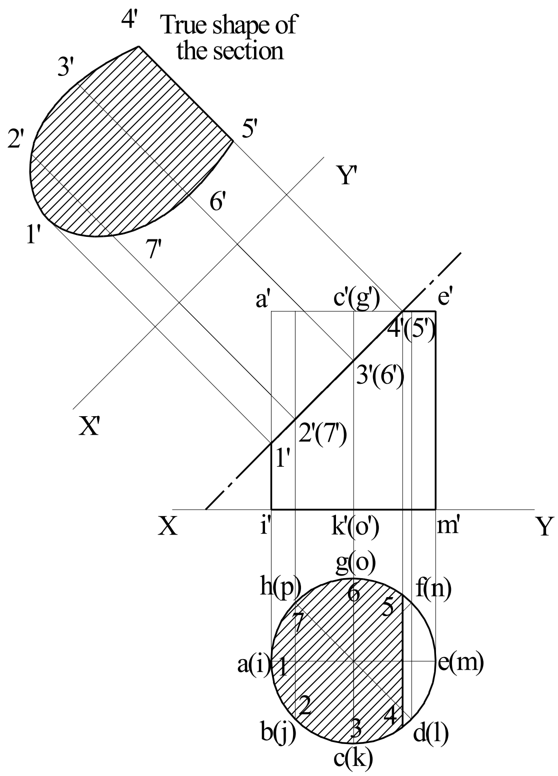
15. A cylinder of 50mm diameter and 70mm height stands vertically with its base on H.P. it is cut by a section plane perpendicular to H.P. and parallel to V.P. and at a distance of 10mm from the axis. Draw its top and sectional front views. (13.23)



- Draw the top and front view of the cylinder.
- Draw the cutting plane which is parallel to V.P. at a distance of 10mm from the axis, and mark the cutting points 1, 2, 3 and 4.
- Draw the projectors from cutting points to front view and mark the points 1’,2’,3’ and 4’.

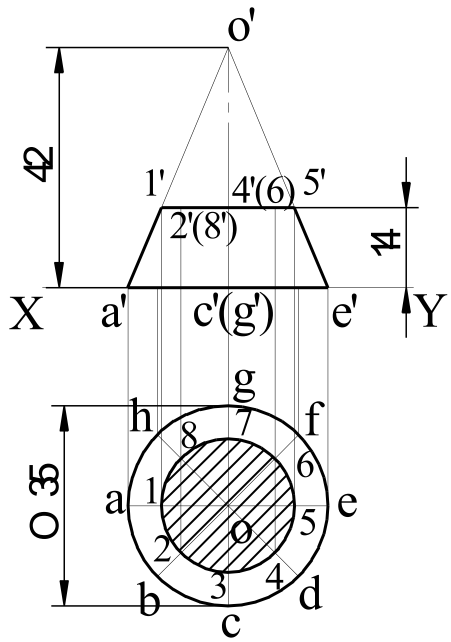
- Join these points and hatching it, which is the sectional view of the cylinder.

16. A cylinder of diameter 50mm and height 60mm rests on its base on H.P. it is cut by a plane perpendicular to H.P. and inclined at 45° to H.P. The cutting plane meets the axis at a distance of 15mm from the top. Draw the sectional plan and true shape of section. (13.25)



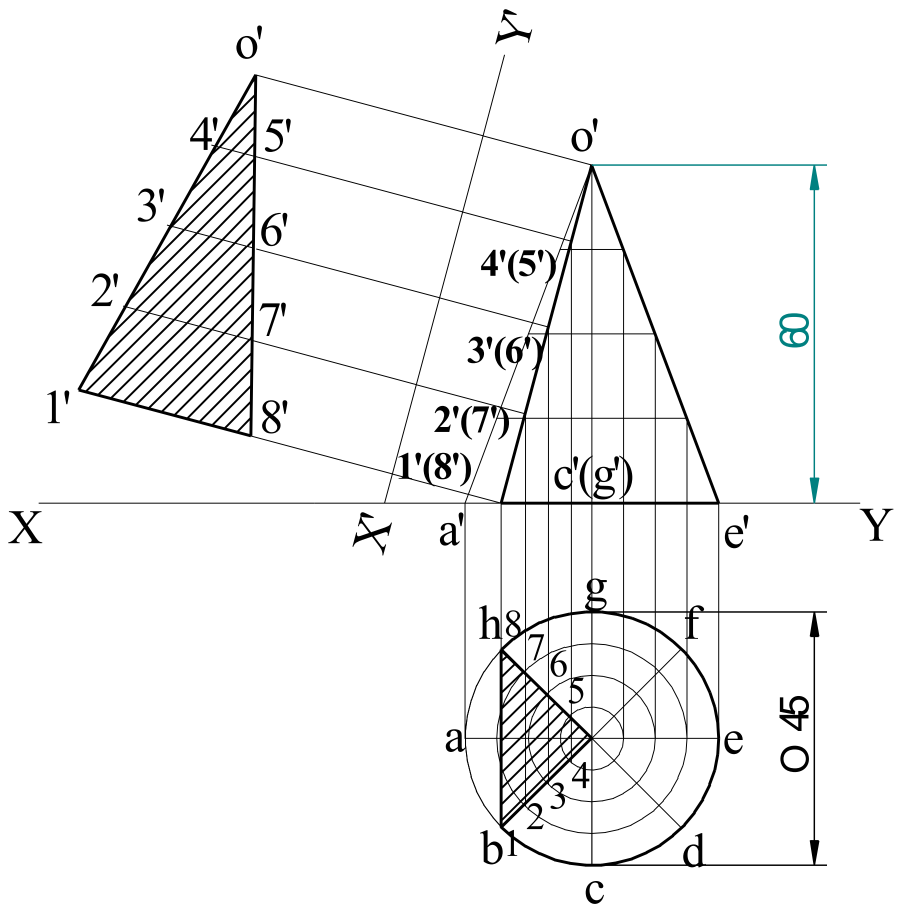
- Draw the top and front view of the cylinder of diameter 50mm and height 60mm rests on its base on H.P.
- Draw the cutting plane which is inclined at 45° to H.P. and it meets the axis at a distance of 15mm from the top.
- Draw the projectors from the cutting points to top view and mark the points (1, 2…..7).
- To get the true shape of the section. Follow the same procedure as in the previous examples.

17. A cone diameter of base 35mm and axis 42mm long is resting on its base on the ground. It is cut by a section plane perpendicular to V.P. parallel to H.P. and 14mm above the base of the cone. Draw the sectional top view. (13.26)



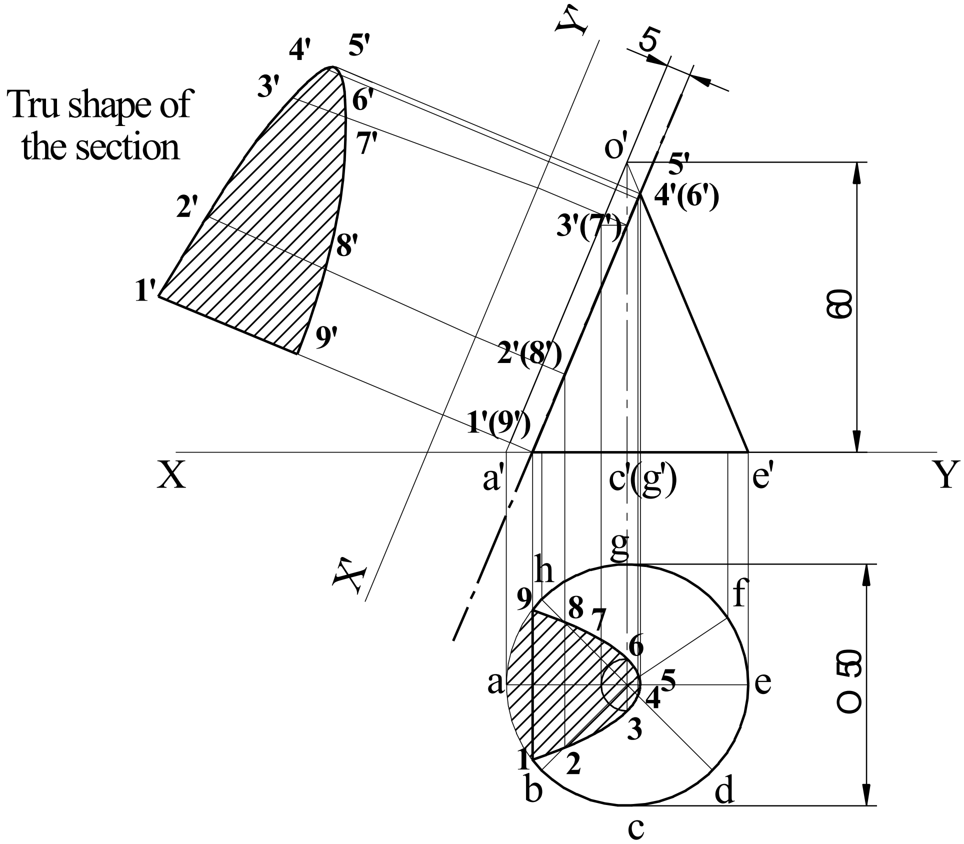
- Draw the top and front view of the cone of diameter of base 35mm and axis 42mm long.
- Draw the cutting plan which is parallel to H.P. and 14mm above H.P., mark the cutting points 1’, 2’….8’.
- Draw the projectors from the cutting points to top view and mark the points (1, 2….8).
- Join these points and hatching it which is the sectional view of the cone.

18. A cone, diameter of base 45mm and axis 60mm long is resting on its base on the ground it is cut by a section plane perpendicular to the V.P. inclined at 75^{o} to the H.P. and passing through the apex. Draw its front view, sectional top view and true shape of the section. (13.29)



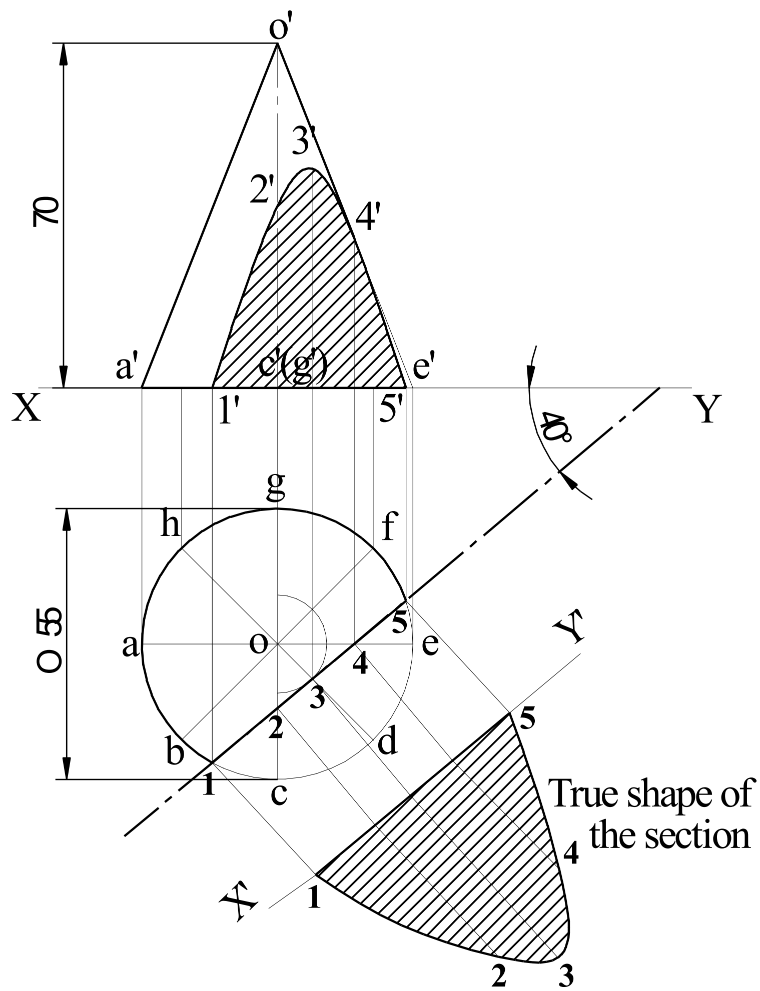
- Draw the top and front view of the cone of base diameter 45mm and axis 60mm long.
- Draw the cutting plane which is perpendicular to V.P. and inclined at 75° to H.P. and mark the cutting points 1',2'..3'.
- From the cutting points, Draw horizontal lines to O' e' line and project it downwards to meet the line oe and draw the circles by taking corresponding radius.
- Draw the projectors from the cutting points to top view and mark the points where it meets with the circle.
- Join these points and hatching it which is the sectional top view.
- To get true shapes of the section draw a new reference plane X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height if points from XY line in plan.

19. A cone, diameter of base 50mm and axis is 60mm long is cut by a section plane perpendicular to the V.P. and parallel to and 5mm away from one of its end generators. Draw its front view, sectional top view and true shape of the section. (13.31)



- Draw the top and front view of the cone of diameter 50mm and 60mm height.
- Draw the cutting plane which is perpendicular to V.P. and 5mm away from one of its end generators and mark the cutting points 1', 2'….9'.
- Draw the projectors to top view from cutting points and mark the points (1,2,…9)
- Join these points and hatch it, which is the sectional top view.
- To get shape of the section draw a new reference plane X'Y' parallel to cutting plane .Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height of points from XY line in plan.

20. A right circular cone of base diameter 55mm and height 70mm and rests on its base on H.P. section plane perpendicular to H.P. and inclined at 40° to V.P., cuts the cone at a distance of 10mm from the axis and in front of it. Draw its top view, sectional front view and true shape of the section. (13.32)

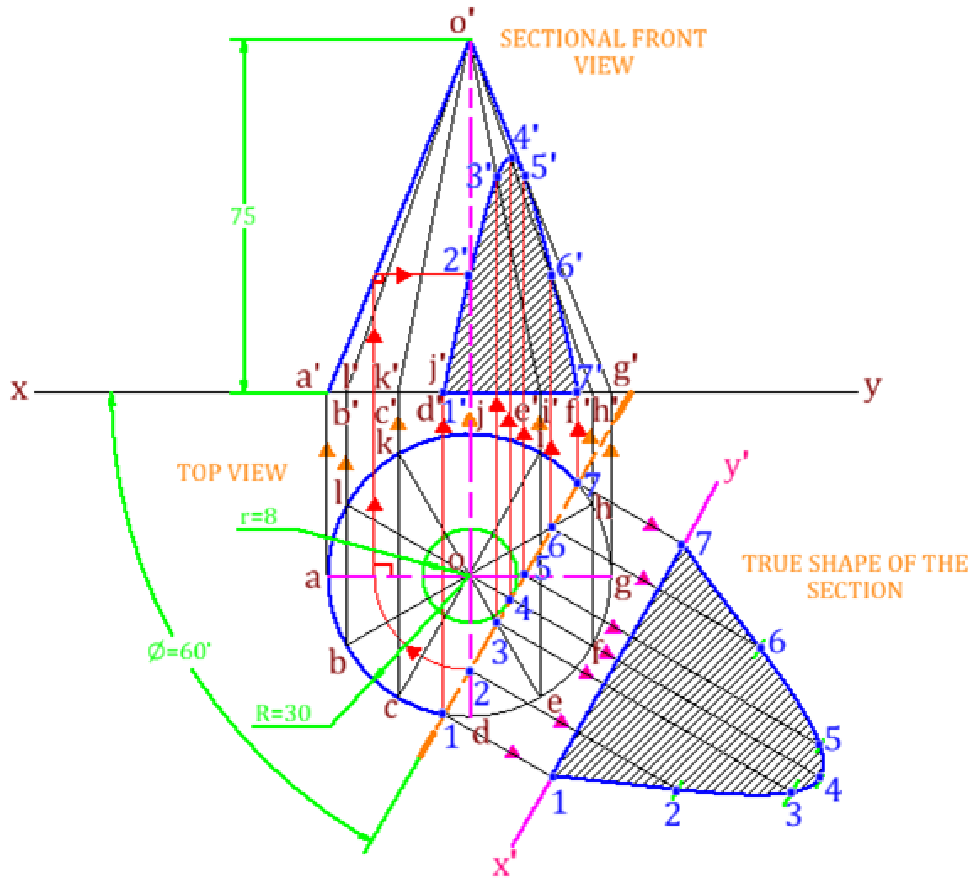


- Draw the top and front view of cone of base diameter 55mm and height 70mm.
- Draw the cutting plane which is inclined at 40^o toV.P.10mm from the axis and mark the points 1,2,3,4 and.
- From the cutting points, draw projectors to front view and mark the points (1', 2', 3', 4' and 5').
- Join these points and hatching it which is the sectional front view.
- To get true shapes of the section draw a new reference plane X'Y' parallel to cutting plane. Draw the perpendicular lines to X'Y' from cutting points. On these lines mark the points with respect to X'Y' by measuring height of points from XY line in elevation.

Section of Solids

1. **A cone with base circle diameter 60 mm and axis length 75 mm is kept on its base on the ground. It is cut by a sectional plane perpendicular to H.P. and inclined at 60^0 to**

V.P. at a distance of 8 mm away from the top view of axis. Draw sectional elevation and true shape of the section.

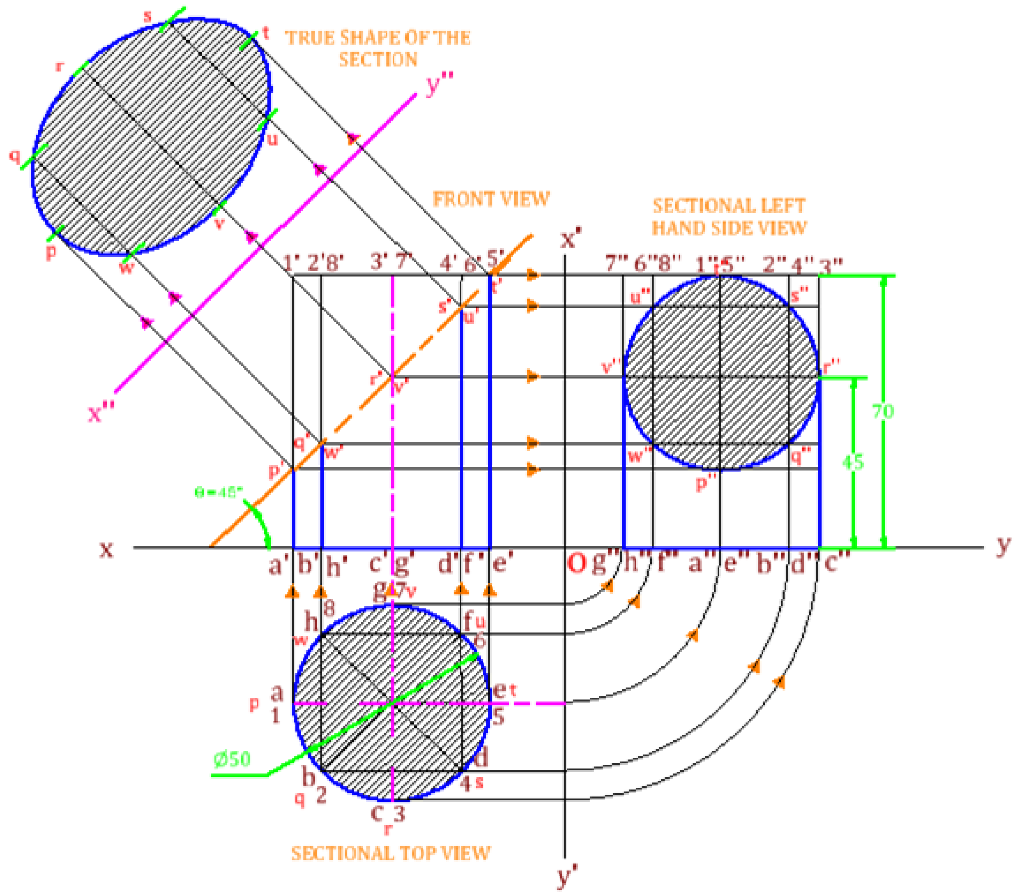


Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of diameter 60 mm below the x-y line at some suitable distance from it. And divide this circle into 12 equal divisions as shown into the figure. Give notations on it.
3. From the center of the circle, draw a vertical center line of length 75 mm from the x-y line as shown into the figure. And from these notations of the circle draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the cone (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw a circle of radius 8 mm from the center of the circle in the top view, and draw a cutting plane line i.e., Long chain line thick at ends and thin elsewhere, such that this cutting plane line should be inclined at an angle 60° with the x-y line and tangent to the circle of the radius 8 mm.

5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the divisional lines of the circle & periphery of the circle, i.e., 1,2,3, etc. as shown into the figure.
6. From these cutting points draw vertical projectors such that these projectors will intersect at the respective generators in the front view. And give the name of these cutting points in the front view as shown into the figure. From these cutting points draw a medium dark smooth free hand curve and draw hatching lines in it as shown into the figure. It is the Sectional Front View.
7. Now draw a line x'-y', parallel with the cutting plane line in the top view, which should be outside of the boundary of the top view as shown into the figure. From the cutting points in the top view draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Front View and transfer the same at the respective projectors drawn from the cutting points in the top view, on the previously drawn x'-y' line, which is parallel to the cutting plane line in the top view.
9. From these transferred points draw a medium dark smooth free hand curve and draw hatching lines in it. It is the True Shape of the section.
10. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

2. A cylinder diameter of base 50 mm and height 70 mm is resting on H.P. on its base. It is cut by A.I.P. in such a way that it makes an angle of 45^0 with H.P. and passing 10 mm above the center of its height. Draw elevation, sectional top view, Sectional side view and true shape of the section.



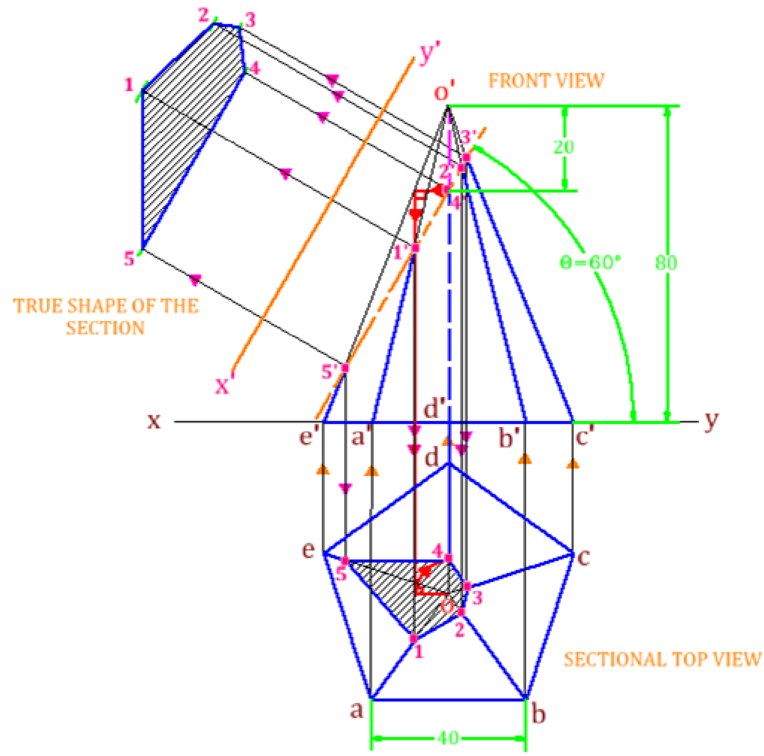
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of diameter 50 mm below the x-y line at some suitable distance from it. And divide this circle into 8 equal divisions as shown into the figure. Give notations on it.
3. From the center of the circle, draw a vertical center line of length 70 mm from the x-y line as shown into the figure. And from these notations of the circle draw vertical projectors of the length equal to its height i.e., 70 mm. It is a rectangular shape & front view. And Give the notations on it.
4. Draw a cutting plane line passing at the distance 40 mm from the base & on the center line of the cylinder in front view, such that its inclination with the x-y line should be equal to 45°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the circle in front view, i.e., p', q', r' etc. as shown into the figure.
6. Now as it is clear from the figure that the projectors in downward direction from the cutting points on the cutting plane line are exactly coinciding with the vertical projectors,

and so that it covers the full circle in the top view as a sectional top view. That's why draw hatching lines in the full circle in the top view. It is the Sectional Top View.

7. Now draw a line x''-y'', parallel with the cutting plane line in the front view, which should be outside of the boundary of the front view as shown into the figure. From the cutting points, (i.e., p', q', r' etc., in the front view) draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Top View and transfer the same at the respective projectors drawn from the cutting points in the front view, on the previously drawn x''-y'' line, which is parallel to the cutting plane line in the front view.
9. From these transferred points draw a medium dark smooth free hand curve and draw hatching lines in it. It is the True Shape of the section.
10. Now draw an x'-y' line perpendicular to the x-y line and on the right of the front view. Then draw horizontal projectors from the all notations and cutting points on the cutting plane line in right side of the x'-y' line of some sufficient length as shown into the figure. And transfer the all notations form the sectional top view in the right side of the line x'-y', such that these all the points will intersect with each other at respective points.
11. Now from theses points of intersection of cutting points draw a smooth medium dark free hand curve, as shown into the figure. And form the notations points of intersection draw vertical lines as shown into the figure. It is the Sectional Left Hand Side View.
12. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

3. A pentagonal pyramid, side of base 40 mm and height 80 mm is resting on H.P. on its base with one of the edges of the base away from V.P. is parallel to V.P. It is cut by an A.I.P. which is inclined at 60^0 with H.P. and passing 20 mm below the apex. Draw its elevation, sectional plan and true shape of section.



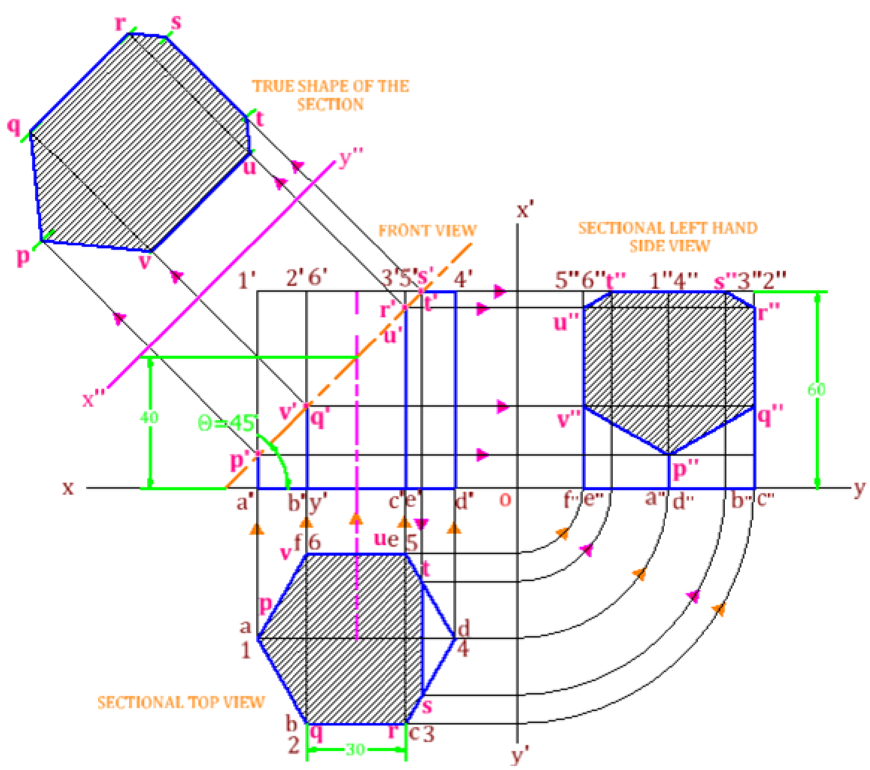
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a pentagon of side of base 40 mm below the x-y line at some suitable distance from it, such that the one of the sides of the pentagon should be parallel with x-y line and away from it. Then find the center point of the pentagon, and connect all the corners of the pentagon to the center of the pentagon by straight lines as shown in the figure. Give notations on it.
3. From the center of the pentagon, draw a vertical center line of length 80 mm from the x-y line as shown into the figure. And from these notations of the pentagon draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the pentagon (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw a cutting plane line passing at the distance 20 mm below the apex & on the center line of the cylinder in front view, such that its inclination with the x-y line should be equal to 60°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the pentagon in front view, i.e., 1', 2', 3' etc. as shown into the figure.
6. From these points of intersections, draw vertical downward projectors in the top view such that these projectors will intersect with the respective lines in the top view. Now

connects all these points in sequence by giving notations with straight lines, as shown in the figure. And draw hatching lines in the shape obtained. It is Sectional Top View.

7. Now draw a line x'-y', parallel with the cutting plane line in the front view, which should be outside of the boundary of the front view as shown into the figure. From the cutting points, i.e., 1', 2', 3' etc., in the front view draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Top View and transfer the same at the respective projectors drawn from the cutting points in the front view, on the previously drawn x'-y' line, which is parallel to the cutting plane line in the front view.
9. Connects all the points in sequence with medium dark straight lines as shown in the figure, and draw hatching lines in it. It is the True Shape of the section.
10. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

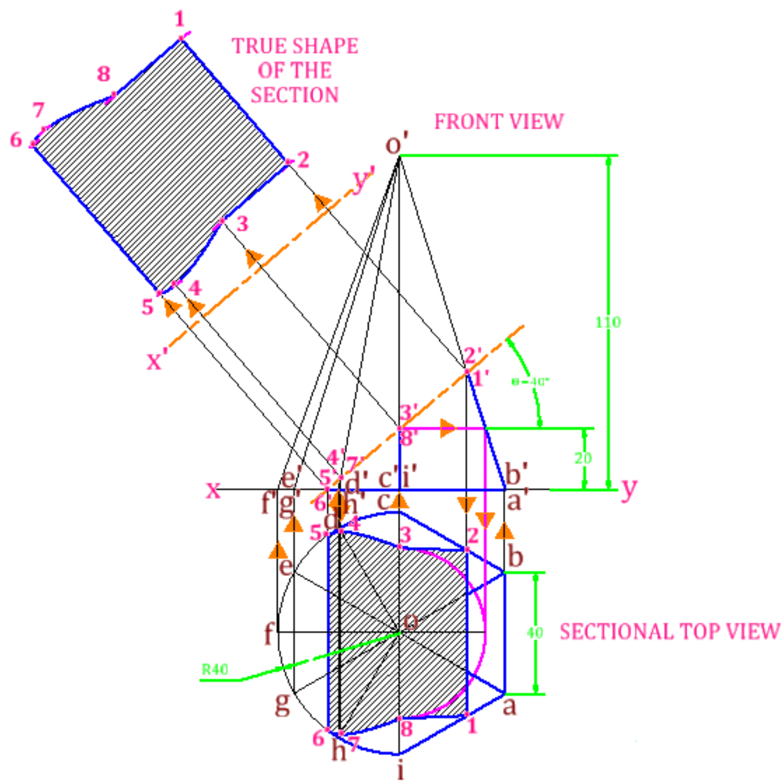
4. A hexagonal prism is resting on H.P. on its base with two edges of base parallel to V.P. It is cut by an A.I.P. which is perpendicular to V.P. and inclined to H.P. by 45^0 and passing through a point 40 mm above the base & on axis. Draw elevation, sectional plan, sectional side view and true shape of section. Take side of base 30 mm and height 60 mm.



Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a hexagon of side of base 30 mm below the x-y line at some suitable distance from it, such that two sides of the hexagon should be parallel with x-y line. Give notations on it.
3. From the center of the hexagon, draw a vertical center line of length 60 mm from the x-y line as shown into the figure. And from all notations of the hexagon draw vertical projectors of the length equal to its height i.e., 60 mm. It is a rectangular shape & front view. And Give the notations on it.
4. Draw a cutting plane line passing at the distance 40 mm from the base & on the center line of the hexagon in the front view, such that its inclination with the x-y line should be equal to 45°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the circle in front view, i.e., p', q', r' etc. as shown into the figure.
6. Now from these cutting points on the cutting plane line, draw vertical downward projectors in the top view, such that these projectors will intersect at respective points in the top view, as shown in the figure. Then draw hatching lines in the region bounded by these projectors in the top view. It is the Sectional Top View.
7. Now draw a line x''-y'', parallel with the cutting plane line in the front view, which should be outside of the boundary of the front view as shown into the figure. From the cutting points, (i.e., p', q', r' etc., in the front view) draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Top View and transfer the same at the respective projectors drawn from the cutting points in the front view, on the previously drawn x''-y'' line, which is parallel to the cutting plane line in the front view.
9. Connects all the points in sequence with medium dark straight lines as shown in the figure, and draw hatching lines in it. It is the True Shape of the section.
10. Now draw an x'-y' line perpendicular to the x-y line and on the right of the front view. Then draw horizontal projectors from the all notations and cutting points on the cutting plane line in right side of the x'-y' line of some sufficient length as shown into the figure. And transfer the all notations form the sectional top view in the right side of the line x'-y', such that these all the points will intersect with each other at respective points.
11. Now connect all the points in sequence with medium dark straight lines as shown in the figure, and draw hatching lines in it. It is the Sectional Left Hand Side View.
12. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

5. **A solid is a combination of half cone with base diameter 80 mm and half hexagonal pyramid with side of bade 40 mm & axis height 110 mm is resting on its base on H.P. such that one of the sides of the half hexagonal pyramid is perpendicular with V.P. It is cut by one AIP with inclination of 40° with the H.P. and passing at the distance 20 mm above the base & on the vertical axis. Draw front view, sectional top view and true shape of the section.**

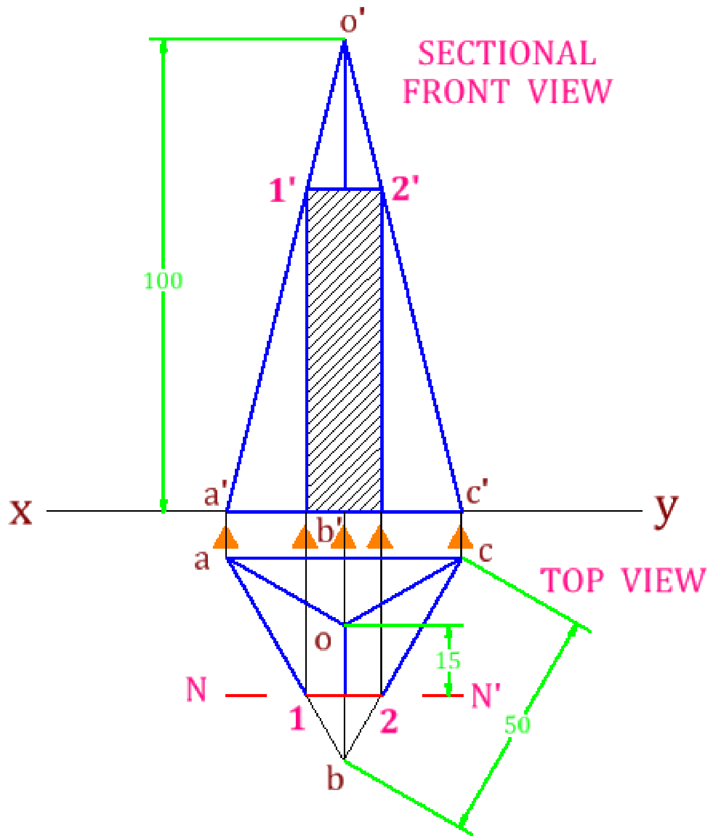


Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a half hexagon of side of base 40 mm below the x-y line at some suitable distance from it, such that the one of the sides of the hexagon should be perpendicular with x-y line. And draw a half circle of diameter 80 mm such that it should be attached with the previously drawn half hexagon. Then find the center point of the assembly and connect all the corners of the hexagon to the center of the assembly by straight lines as shown in the figure. Give notations on it.
3. From the center of the assembly, draw a vertical center line of length 110 mm from the x-y line as shown into the figure. And from these notations of the assembly draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the front view (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.

4. Draw a cutting plane line passing at the distance 20 mm above the base & on the center line of the assembly in front view, such that its inclination with the x-y line should be equal to 40°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the assembly in front view, i.e., 1', 2', 3' etc. as shown into the figure.
6. From these points of intersections, draw vertical downward projectors in the top view such that these projectors will intersect with the respective lines in the top view. Now connects all these points in sequence by giving notations with straight lines or smooth free hand curve as per the shape of the cutting section, as shown in the figure. And draw hatching lines in the shape obtained. It is Sectional Top View.
7. Now draw a line x'-y', parallel with the cutting plane line in the front view, which should be outside of the boundary of the front view as shown into the figure. From the cutting points, i.e., 1', 2', 3' etc., in the front view draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Top View and transfer the same at the respective projectors drawn from the cutting points in the front view, on the previously drawn x'-y' line, which is parallel to the cutting plane line in the front view.
9. Connects all the points in sequence with medium dark straight lines or smooth free hand curve as per the shape of the cutting section, as shown in the figure, and draw hatching lines in it. It is the True Shape of the section.
10. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

6. A triangular pyramid of side of base 50 mm and height of axis 100 mm resting on its base on the H.P. such that one of the edges of the base parallel to V.P. and near to V.P. The pyramid is cut by a cutting plane parallel to V.P. and perpendicular to H.P. by passing through the distance 15 mm form the axis of the pyramid. Draw sectional front view and top view of the triangular pyramid.



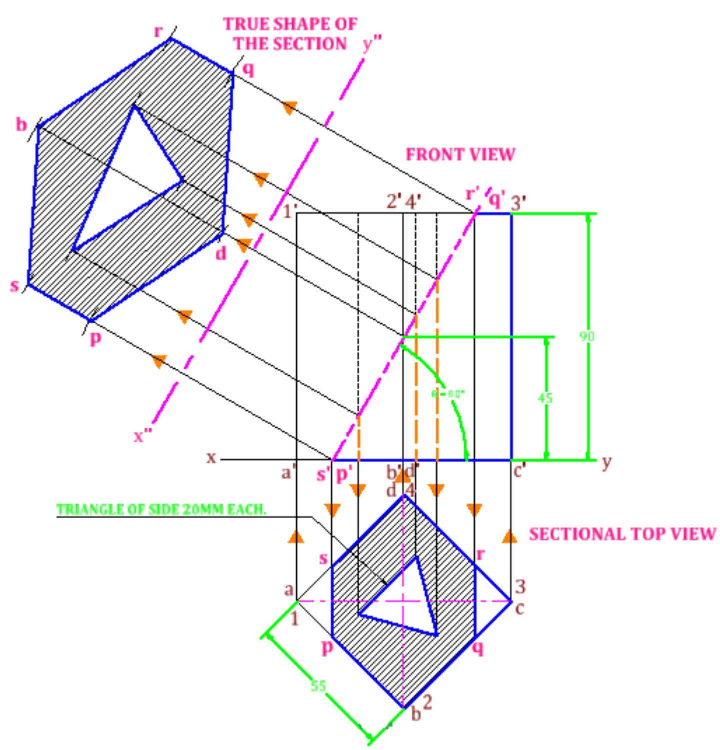
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a triangle of side of base 50 mm below the x-y line at some suitable distance from it, such that the one of the sides of the triangle should be parallel with x-y line and near to it. Then find the center point of the triangle, and connect all the corners of the triangle to the center by straight lines as shown in the figure. Give notations on it.
3. From the center of the triangle, draw a vertical center line of length 100 mm from the x-y line as shown into the figure. And from the notations of the triangle in top view, draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the pyramid (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw a cutting plane line passing at the distance 15 mm below the horizontal center line of the triangle in top view, such that it should be parallel with the x-y line, as shown in the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the edges of the triangle in top view, i.e., 1, 2, as shown into the figure.
6. From these points of intersections, draw vertical upward projectors in the front view such that these projectors will intersect with the respective lines in the front view. Now

connects all these points in sequence by giving notations with straight lines, as shown in the figure. And draw hatching lines in the shape obtained. It is Sectional Front View.

7. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

7. A square prism of side of base 55 mm and axis height 90 mm is resting on H.P. on its base such that all the edges of the base are equally inclined with the V.P. One triangular hole of side of base 30 mm is cut through the square prism such that the axis of the square prism and the triangular hole are the same and one of the sides of the triangular hole is parallel with the one of the sides of the square prism. One cutting plane which is perpendicular to V.P. and inclined at an angle 60° with H.P. and bisecting the axis of the prism is cutting the object. Draw front view, sectional top view and true shape of the prism.



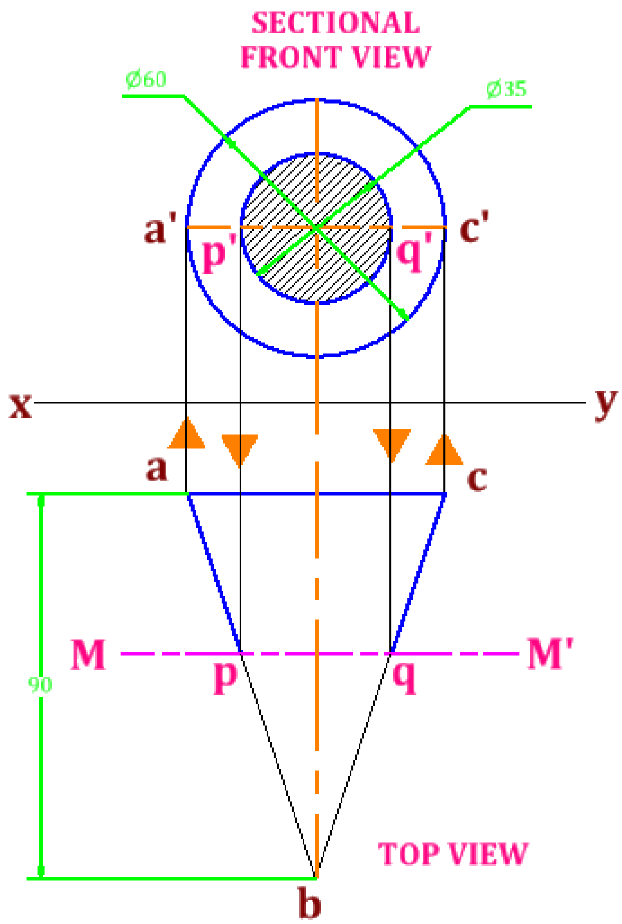
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a square of side of base 55 mm below the x-y line at some suitable distance from it, such that all sides of the square should be equally inclined with x-y line. Give notations on it.
3. From the center of the square, draw a vertical center line of length 90 mm from the x-y line as shown into the figure. And from all notations of the square draw vertical

projectors of the length equal to its height i.e., 90 mm. It is a rectangular shape & front view. And Give the notations on it.

4. Draw a cutting plane line passing at the distance 45 mm from the base & on the center line of the front view, such that its inclination with the x-y line should be equal to 60°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the square prism in front view, i.e., p', q', r' etc. as shown into the figure.
6. Now from these cutting points on the cutting plane line, draw vertical downward projectors in the top view, such that these projectors will intersect at respective lines in the top view, as shown in the figure. Then draw hatching lines in the region bounded by these projectors in the top view. But the triangular shape in the top view will be blank since it is hollow triangular hole. It is the Sectional Top View.
7. Now draw a line x''-y'', parallel with the cutting plane line in the front view, which should be outside of the boundary of the front view as shown into the figure. From the cutting points, i.e., p', q', r' etc., in the front view draw projectors which should be perpendicular to the cutting plane line and should be of some suitable length as shown into the figure.
8. Now measure the distance of the cutting points from the x-y line, into the Sectional Top View and transfer the same at the respective projectors drawn from the cutting points in the front view, on the previously drawn x''-y'' line, which is parallel to the cutting plane line in the front view.
9. Connects all the points in sequence with medium dark straight lines as shown in the figure, and draw hatching lines in it. And triangular shape in this view is blank because of triangular hole. It is the True Shape of the section.
10. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

8. A cone of base diameter 60 mm and axis height 90 mm is resting on its base on V.P. One cutting plane parallel with V.P. and perpendicular to H.P. is cutting the cone such that true shape of the section of the cone is a circle of diameter 35 mm. Draw sectional front view and top view of the cone.

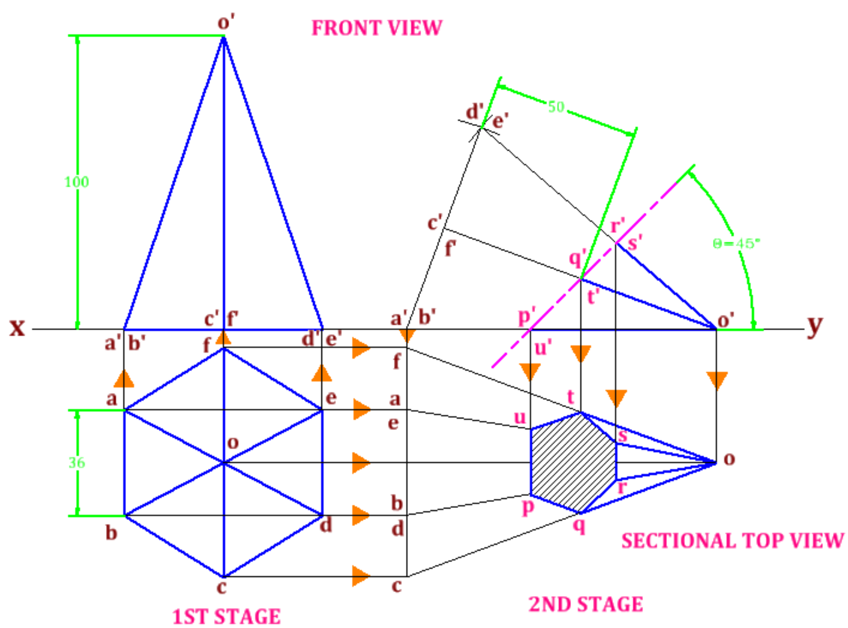


Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of diameter 60 mm above the x-y line at some suitable distance from it as shown into the figure. Give notations on it.
3. From the center of the circle, draw a vertical downward center line of length 90 mm from the x-y line as shown into the figure. And from the notations of the circle i.e., a', b'; draw vertical downward projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the cone (point b) as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw a circle of diameter 35 mm from the center of the circle in the front view, and draw hatching lines within the circle of diameter 35 mm; because it is true shape of the section as per the data given in the problem. And form the end points of the circle i.e., p', q'; draw vertical downward projectors such that they will intersect the respective projectors in the top view. And give the notation on it. i.e., p, q.
5. Then draw a cutting plane line passing from the points p & q such that it is parallel to x-y line. As shown in the figure. Give notation on it. It is top view of the object.

6. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

9. **A hexagonal pyramid of side of base 40 mm and height of axis 110 mm is resting on one of its inclined vertical surface on H.P. such that its axis remains parallel to the V.P. It is cut by a cutting plane which is inclined at an angle 45° with H.P. and bisecting the axis of the pyramid. Draw front view, sectional top view.**

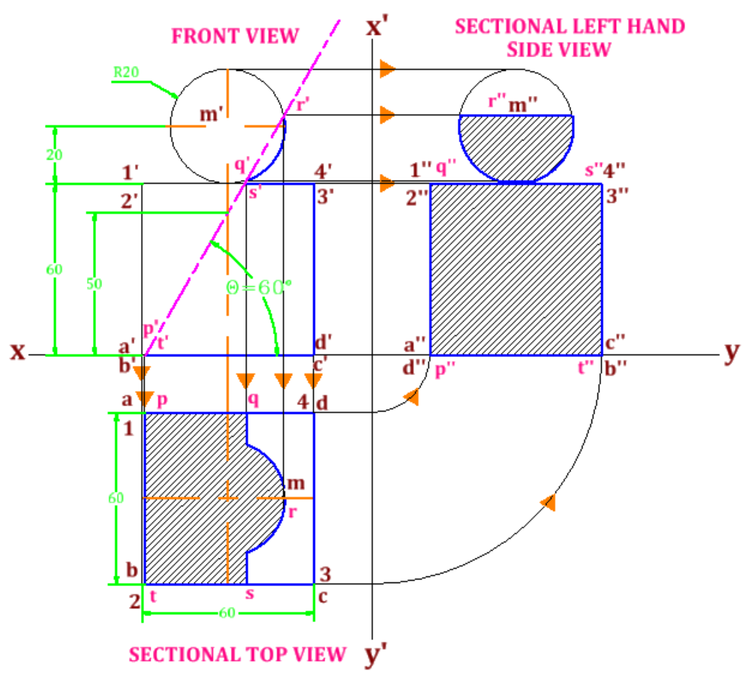


Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a hexagon of length of side 36 mm such that two sides of the hexagon should be perpendicular to x-y line. And find out the center of the hexagon and connect all the corner of the hexagon to the center of the hexagon by straight lines as shown in the figure. And give the notation on it. It is top view of the hexagon in 1st stage.
3. From the center of the hexagon, draw a vertical center line of length equal to 100 mm from the x-y line and from all the corners of the hexagon in the top view, draw straight vertical projectors up to x-y line and then converge all the projectors at the end of the vertical center line i.e., point o'. And give the notations on it. It is front view in the 1st stage.
4. Now mark a point a' at some suitable distance on the x-y line and with this point as center draw two arcs of length equal to a'-o' and a'-d' respectively as shown in the figure. Now connects the point a'-o'-d' with straight lines. And also transfer all other points on this view from the front view of the 1st stage respectively. And give the notations on it. It is front view of the 2nd stage.

5. Draw down straight projectors from the front view of the 2nd stage and horizontal straight projectors from the top view of the 1st stage such that these all the projectors will intersect with each other at respective points, as shown in the figure. And connect these points of intersections with straight lines and give the notations on it.
6. Now draw a cutting plane line passing at the distance 50 mm from either end of the front view of the 2nd stage on the center axis and inclined at the angle 45° with x-y line, as shown in the figure. And give the cutting points i.e., p', q' etc. as shown in the figure in the 2nd stage front view.
7. Form these cutting points i.e., p', q' etc. draw vertical downward projectors such that these will intersect in the top view of the 2nd stage at respective lines as shown in the figure. And connects these points of cutting with straight lines and draw hatching lines within it. And give the other notations in this view. It is Section Top View of the 2nd stage.
8. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

10. A sphere of diameter 40 mm is resting on a cube of side 60 mm. The cube is resting on H.P. and the assembly is cut by a cutting plane which is perpendicular to V.P. inclined to H.P. by the angle 60° and bisecting the full axis of the assembly. Draw front view, sectional top view and sectional left hand side view.



Procedure:

1. Draw a horizontal x-y line of some suitable length.

2. Draw a square of side of base 60 mm below the x-y line at some suitable distance from it, such that two sides of the square should be parallel with x-y line. Give notations on it.
3. From the center of the square, draw a vertical center line of length 60 mm from the x-y line as shown into the figure. And from all notations of the square draw vertical projectors of the length equal to its height i.e., 60 mm. It is a square shape &draw a circle of diameter 40 mm such that the vertical center line of the circle and the square should be same and it should rests on it, as shown in the figure. It is front view. And Give the notations on it.
4. Draw a cutting plane line passing at the distance 50 mm from the base & on the center line of the square and circle in the front view, such that its inclination with the x-y line should be equal to 60°, as shown into the figure.
5. Give the cutting points name at the intersection of the previously drawn cutting plane line with the vertical projectors of the square & circumference of the circle in front view, i.e., p', q', r' etc. as shown into the figure.
6. Now from these cutting points on the cutting plane line, draw vertical downward projectors in the top view, such that these projectors will intersect at respective points in the top view, as shown in the figure. Then draw hatching lines in the region bounded by these projectors in the top view. It is the Sectional Top View.
7. Now draw an x'-y' line perpendicular to the x-y line and on the right of the front view. Then draw horizontal projectors from the all notations and cutting points on the cutting plane line in right side of the x'-y' line of some sufficient length as shown into the figure. And transfer the all notations form the sectional top view in the right side of the line x'-y', such that these all the points will intersect with each other at respective points.
8. Now Connects all the points in sequence with medium dark straight lines and smooth curve as per the shape of the cut section, as shown in the figure, and draw hatching lines in it. It is the Sectional Left Hand Side View.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

DEVELOPMENT OF SURFACES OF SOLIDS.

MEANING:-
ASSUME OBJECT HOLLOW AND MADE-UP OF THIN SHEET. CUT OPEN IT FROM ONE SIDE AND UNFOLD THE SHEET COMPLETELY. THEN THE SHAPE OF THAT UNFOLDED SHEET IS CALLED DEVELOPMENT OF LATERLAL SUEFACES OF THAT OBJECT OR SOLID.

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

ENGINEERING APLICATION:
THERE ARE SO MANY PRODUCTS OR OBJECTS WHICH ARE DIFFICULT TO MANUFACTURE BY CONVENTIONAL MANUFACTURING PROCESSES, BECAUSE OF THEIR SHAPES AND SIZES. THOSE ARE FABRICATED IN SHEET METAL INDUSTRY BY USING DEVELOPMENT TECHNIQUE. THERE IS A VAST RANGE OF SUCH OBJECTS.

EXAMPLES:-
Boiler Shells & chimneys, Pressure Vessels, Shovels, Trays, Boxes & Cartons, Feeding Hoppers, Large Pipe sections, Body & Parts of automotives, Ships, Aeroplanes and many more.

WHAT IS OUR OBJECTIVE IN THIS TOPIC ? → To learn methods of development of surfaces of different solids, their sections and frustums.

*But before going ahead, note following **Important** points.*

1. Development is different drawing than PROJECTIONS.
2. It is a shape showing AREA, means it's a 2-D plain drawing.
3. Hence all dimensions of it must be TRUE dimensions.
4. 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 OF SURFACES OF SOLIDS.

1. INTRODUCTION

Need for Study

- Advanced Production technologies like Ship building, aircraft construction and fabrication of their components require this technique of cutting the metallic sheets.
- Using this technique the exact requirements for the purpose can be determined.

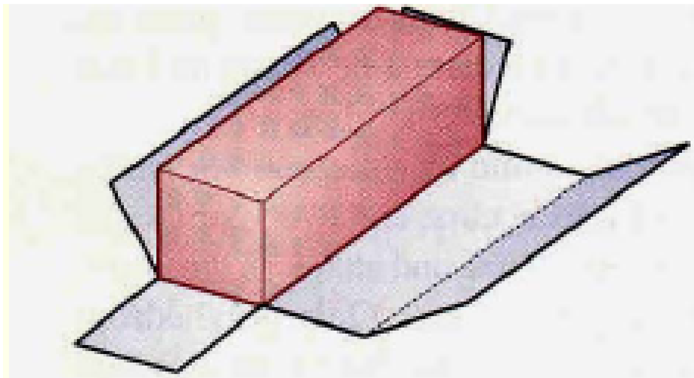
Assume object hollow and made-up of thin sheet. Cut open it from one side and unfold the sheet completely. Then the shape of that unfolded sheet is called development of lateral surfaces of that object or solid.

Lateral surface is the surface excluding solid's top & base.

Developments

- A development is the unfold/ unrolled flat/ plane figure of a 3-D object.
- Called a pattern, the plane may show the true size of each area of the object.

- When the pattern is cut, it can be rolled or folded back into the original object.



2. ENGINEERING APLICATION

There are so many products or objects which are difficult to manufacture by conventional manufacturing processes, because of their shapes and sizes. Those are fabricated in sheet metal industry by using development technique. There is a vast range of such objects.

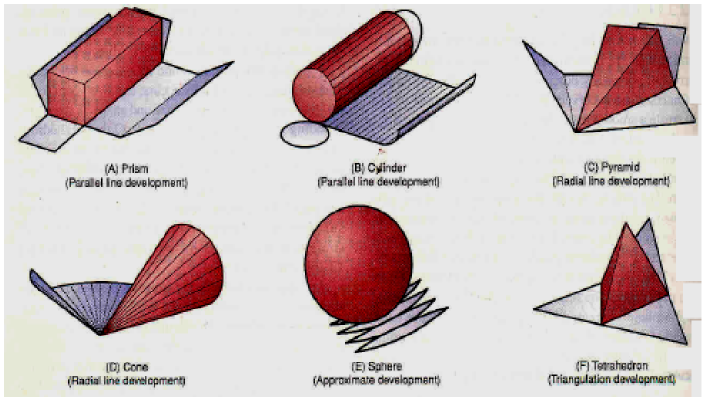
EXAMPLES

Boiler Shells & chimneys, Pressure Vessels, Shovels, Trays, Boxes & Cartons, Feeding Hoppers, Large Pipe sections, Body & Parts of automotive, Ships, Airplanes and many more.

3. Methods of Development

- Parallel line method: Used for developing prisms and single curved surfaces like cylinders
- Radial line method: Employed for development of pyramids and single curved surfaces
- Triangulation method: Employed for developing transition pieces
- Approximate method: Used for theoretically undevelopable surfaces like cylinders

Examples of Development

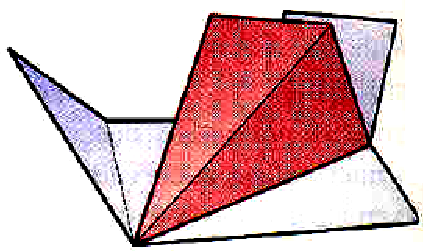


True Development

- A true development is one in which no stretching or distortion of the surfaces occurs and every surface of the development is the same size and shape as the corresponding surface on the 3-D object.
- Only polyhedrons and single curved surfaces can produce true developments.

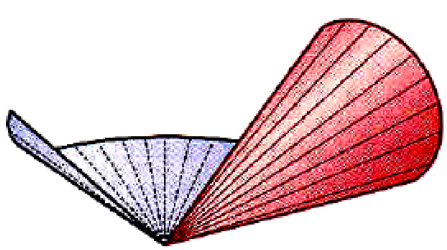
Polyhedrons

Polyhedrons are composed entirely of plane surfaces that can be flattened true size onto a plane in a connected sequence.



Single Curved Surfaces

Single curved surfaces are composed of consecutive pairs of straight-line elements in the same plane.



Approximate Development

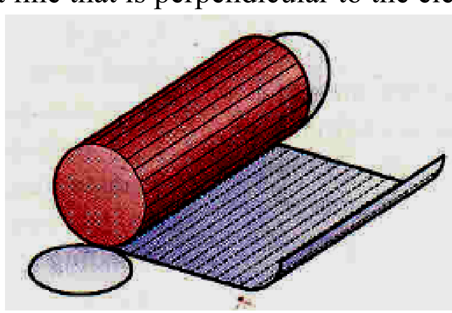
- An approximate development is one in which stretching or distortion occurs in the process of creating the development.
- The resulting flat surfaces are not the same size and shape as the corresponding surfaces on the 3-D object.
- Wrapped surfaces do not produce true developments, because pairs of consecutive straight-line elements do not form a plane.
- Also double-curved surfaces, such as a sphere do not produce true developments, because they do not contain any straight lines.

Parallel Line Development

- Parallel-line developments are made from common solids that are composed of parallel lateral edges or elements.
- Prisms and cylinders are solids that can be flattened or unrolled into a flat pattern and all parallel lateral surfaces or elements will retain their parallelism.

Right Circular Cylinder

- The cylinder is positioned such that one element lies on the development plane.
- The cylinder is then unrolled until it is flat on the development plane.
- The base and top of the cylinder are circles, with a circumference equal to the length of the development.
- All elements of the cylinder are parallel and are perpendicular to the base and the top.
- When cylinders are developed, all elements are parallel and any perpendicular section appears as a stretch-out line that is perpendicular to the elements.



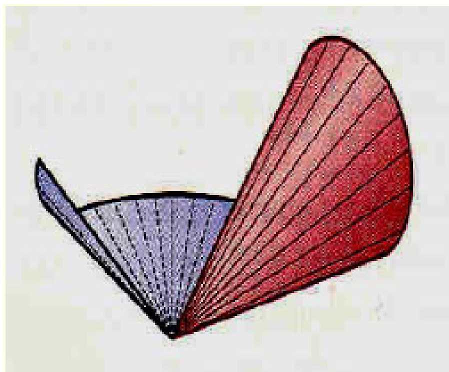
Radial Line Development

- Radial-line developments are made from figures such as cones and pyramids in the development.

- In the development, all the elements of the figure become radial lines that have the vertex as their origin.

Radial Line Development of Cone

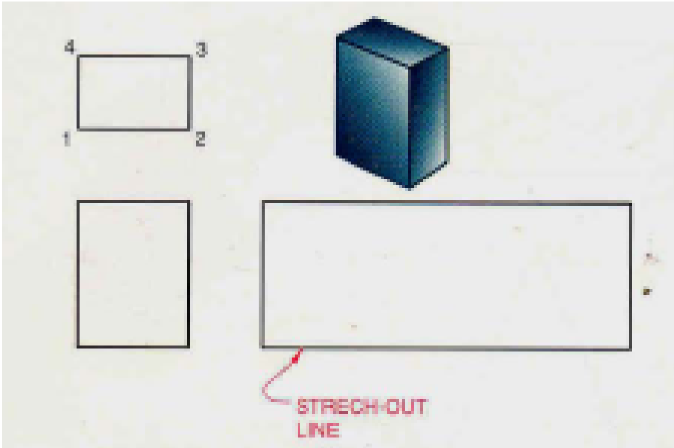
- The cone is positioned such that one element lies on the development plane.
- The cone is then unrolled until it is flat on the development plane.
- One end of all the elements is at the vertex of the cone. The other ends describe a curved line.
- The base of the cone is a circle, with a circumference equal to the length of the curved line.



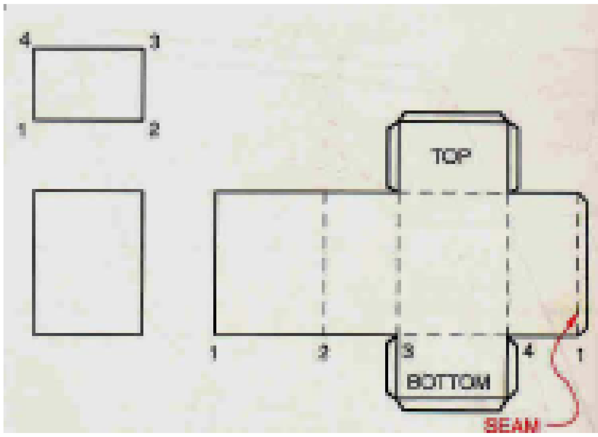
4. Development of lateral surfaces of different solids.(Lateral surface is the surface excluding top & base)

Development of a Rectangular Prism

1. To start the development, draw the stretch-out line in the front view, along the base of the prism and equal in length to the perimeter of the prism.
2. Draw another line in the front view along the top of the prism and equal in length to the stretch-out line.
3. Draw vertical lines between the ends of the two lines, to create the rectangular pattern of the prism.

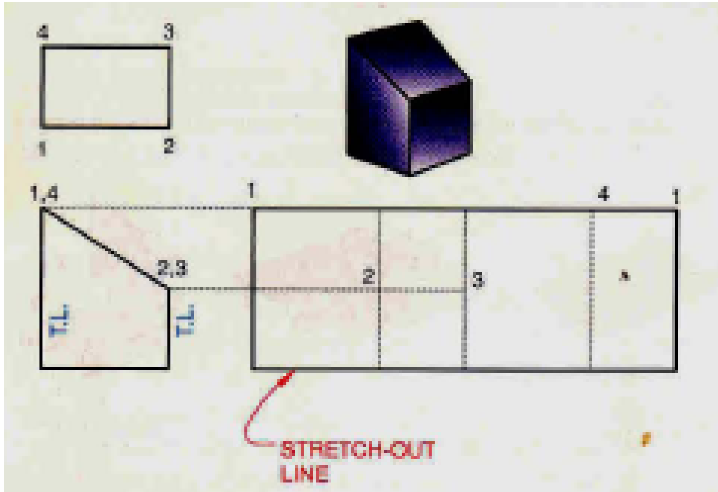


4. Locate the fold line on the pattern by transferring distances along the stretch-out line in length to the sides of the prism, 1-2, 2-3, 3-4, 4-1.
5. Draw thin, dashed vertical lines from points 2, 3, and 4 to represent the fold lines.
6. Add the bottom and top surfaces of the prism to the development, taking measurements from the top view. Add the seam to one end of the development and the bottom and top.

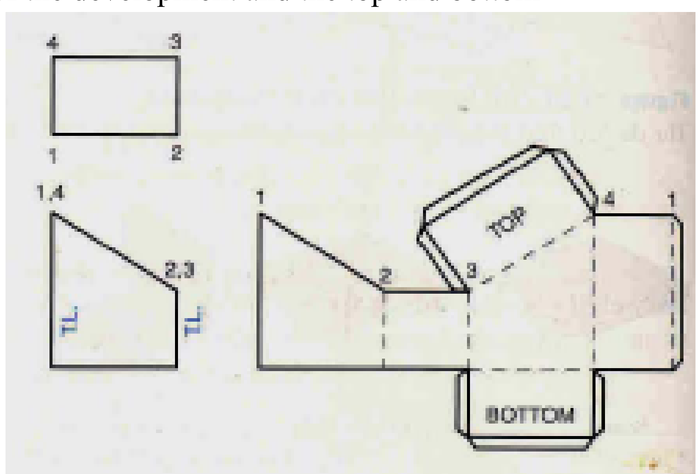


Development of a Truncated Prism

1. Draw the stretch-out line in the front view, along the base of the prism and equal in length to the perimeter of the prism.
2. Locate the fold lines on the pattern by transferring distances along the stretch-out line equal in length to the sides of the prism, 1-2, 2-3, 3-4, and 4-

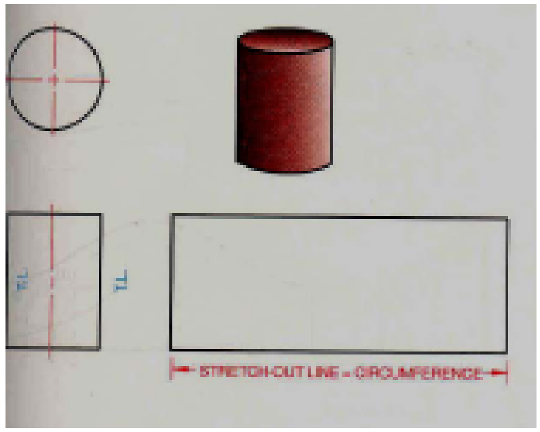


3. Draw perpendicular construction lines at each of these points.
4. Project the lengths of lines 1, 2, 3, and 4 from the front view to the pattern
5. Darken lines 1, 2, 3 and 4. Construct the bottom and top, as shown in Figure, and add the seam to one end of the development and the top and bottom

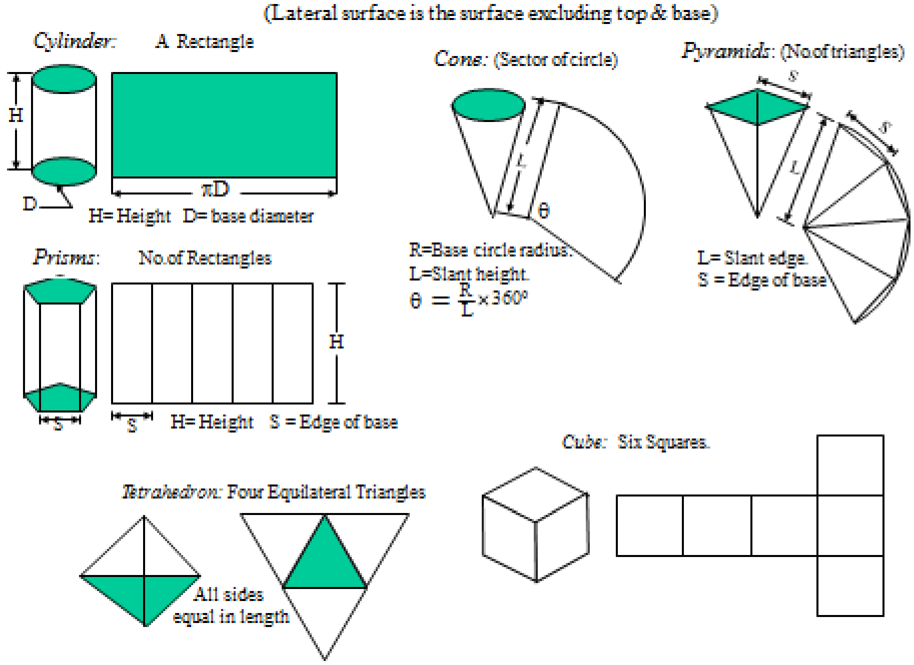


Development of a Right Circular Cylinder

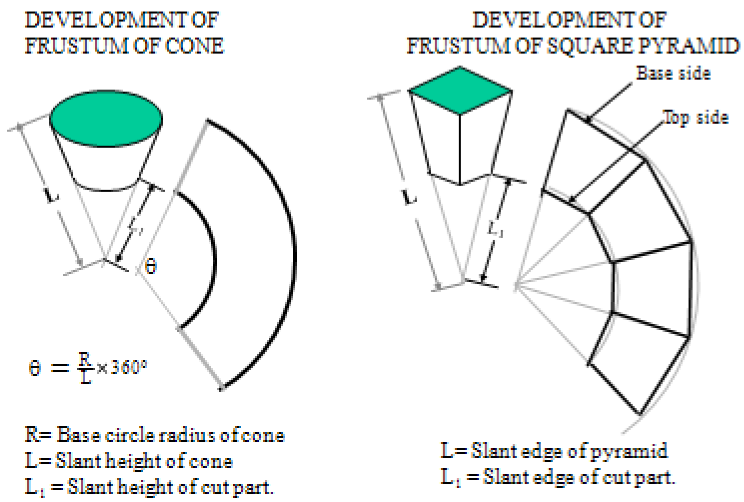
1. In the front view, draw the stretch-out line aligned with the base of the cylinder and equal in length to the circumference of the base circle.
2. At each end of this line, construct vertical lines equal in length to the height of the cylinder.
3. Add the seam to the right end of the development, and add the bottom and top circles.



Development of lateral surfaces of different solids.
(Lateral surface is the surface excluding top & base)

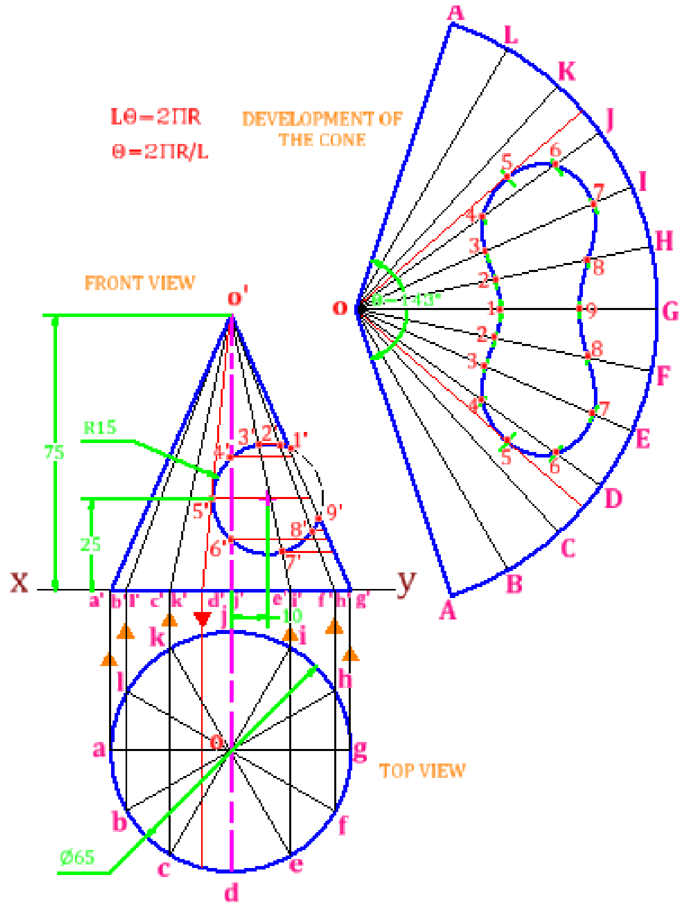


FRUSTUMS



<u>Development of Surfaces of Solids</u>

1. **A cone made up of Aluminum sheet with base circle diameter 65 mm and axis length 75 mm is kept on its base on the ground. A circular hole of 30 mm diameter is cut through the cone such that its axis remains perpendicular to V.P.; 10 mm to the right of the axis of cone and 25 mm above the base of cone. Develop the surface of the cone.**



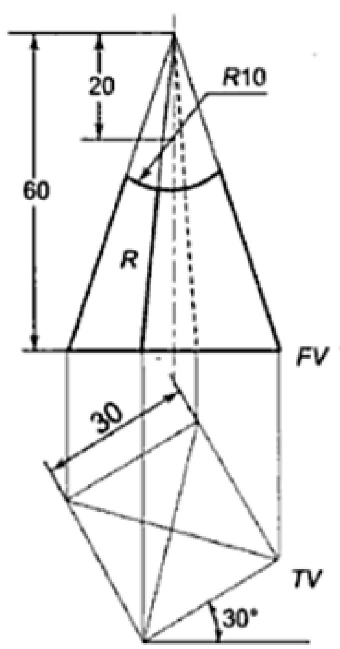
Procedure:

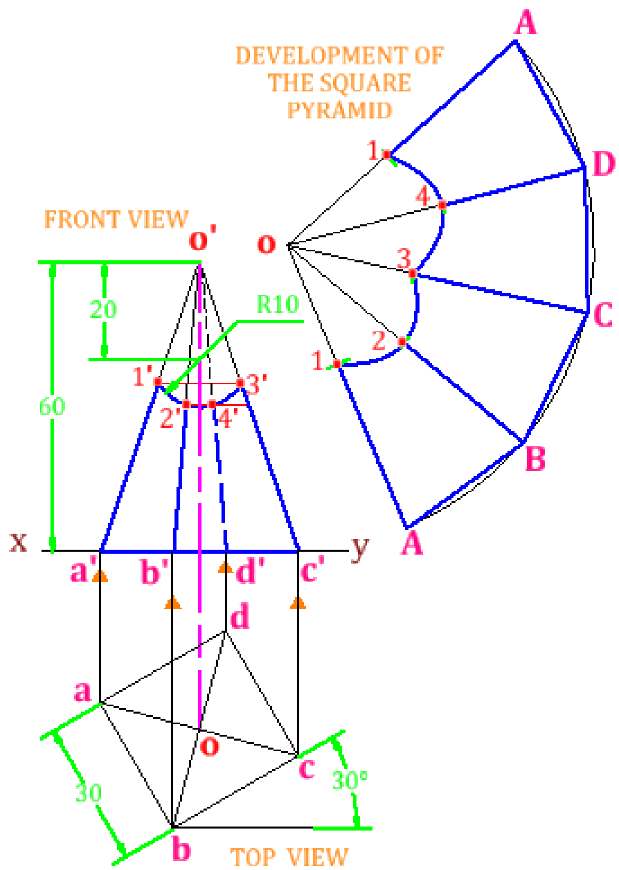
1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 32.5 mm below the x-y line at some suitable distance from it. Divide this circle into 12 equal divisions as shown in the figure. Give notations on it. It is top view of the cone.
3. From the center of the circle in the top view, draw a vertical center line of length 75 mm from the x-y line as shown in the figure. And from these notations of the circle draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the cone (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw a horizontal center line at the distance 25 mm above the x-y line, and a vertical center line at the distance 10 mm on the right of the vertical center line as shown in the figure. From the intersection of the above two center lines, draw a circle of radius 15 mm.
5. Give the cutting points name at the intersection of the previously drawn circle with the vertical projectors of the circle in front view, i.e., 1', 2', 3' etc. as shown into the figure.
6. Now find out the angle covered by the cone when it is opened completely, by the equation, where L = Length of the last generator i.e., o'-a' or o'-g'. = Angle subtended

by the two extreme generators of the cone, when it is opened completely. r = Radius of the base circle of the cone. From this equation find out the value of in degree.

7. Draw a line parallel to and equal to the length of the last generator i.e., o’-g’, at some suitable distance from the front view. Give that line the name O-A as shown in the figure. With O as center and radius equal to OA, draw an arc such that the angle subtended by the arc should be equal to, which you have found out from the previous equation. This is the full development of the vertical surface of the cone.
8. Divide this developed surface of the cone in 12 equal divisions, angle wise, as shown in the figure. And give the notations in capital letters. i.e., A, B, C etc.
9. Now in the front view, from the cutting points on the small circle of radius 15 mm, draw horizontal lines, parallel with x-y line, such that these lines should meet with the last generator i.e., o’-g’, in the front view.
10. Then measure the distances of the end points of previously drawn respective lines from the point o’, and transfer these distances in the developed surface of the cone on respective generators, as shown in the figure.
11. Now Connects all the points in sequence with medium dark smooth curve, as shown in the figure, and draw the boundary of the cone with dark curve with the use of a compass. This is the Development of the vertical surface of the cone.
12. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

2. The square pyramid with the length of side of base 30 mm and length of axis 60 mm as shown in the fig. 1 below. Develop the surface of the pyramid.





Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a square of side of base 30 mm below the x-y line at some suitable distance from it, and in such a way that one of the sides of the square should be inclined at the angle 30° with the horizontal line, as shown in the figure. Then give notations on it, and from these notations draw lines meeting at the center of the square. It is top view of the square pyramid.
3. From the center of the square in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from all other notations of the square in the top view, draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the square pyramid (point o') as shown into the figure. It is the front view of the square pyramid. And Give the notations on it.
4. Mark a point at the distance 20 mm on the vertical center line, from the apex of the pyramid. Make this point as a center and draw an arc with the radius 10 mm between the last two edges of the pyramid. And mark cutting points at the intersections of the arc with the vertical edges i.e., 1', 2', 3' etc.

5. Draw a line parallel to and equal to the length of the last generator i.e., o’-c’, at some suitable distance from the front view. Give that line the name O-A as shown in the figure. With O as center and radius equal to OA, draw an arc of some suitable length, then cut this arc into four division of the length equal to the length of the side of the base which is 30 mm, as shown in the figure. Then give the notations on it and connect these points i.e., A, B, C, D, A in sequence with straight lines. This is the full development of the vertical surface of the square pyramid.
6. From the cutting points in the front view i.e., 1’, 2’, 3’ etc. , draw horizontal lines up to the last generator i.e., o’-c’,
7. Then measure the distances of the end points of previously drawn respective lines from the point o’, and transfer these distances in the developed surface of the pyramid on respective generators, which are 1,2,3,4,1, as shown in the figure.
8. Now Connect all the cutting points i.e., 1,2,3,4,1 in sequence with medium dark smooth curve, as shown in the figure, and draw the generators which are below the smooth curve as medium dark straight lines. This is the Development of the vertical surface of the square pyramid.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

3. **The cylinder with diameter Ø 50 mm and height 60 mm as shown in the fig. 2 below. Develop the surface of the cylinder.**

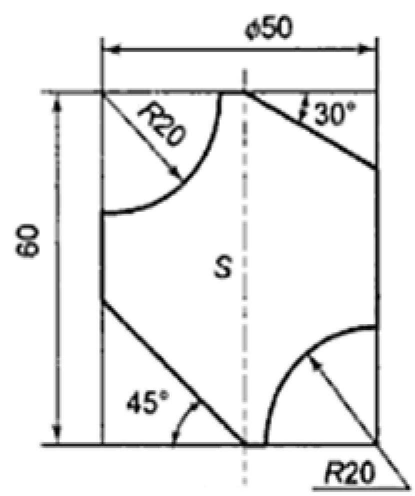
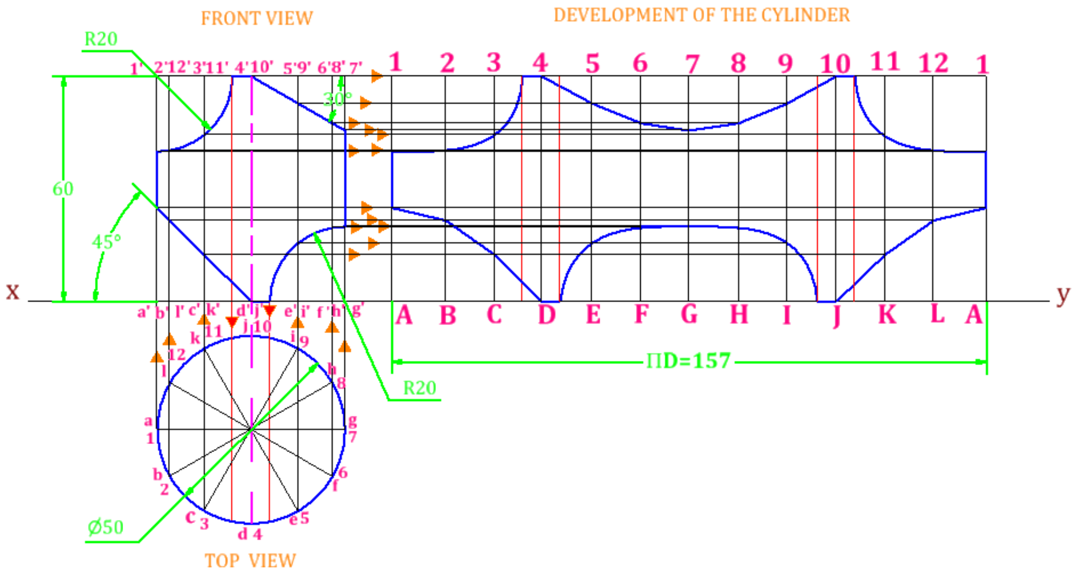


Fig. 2



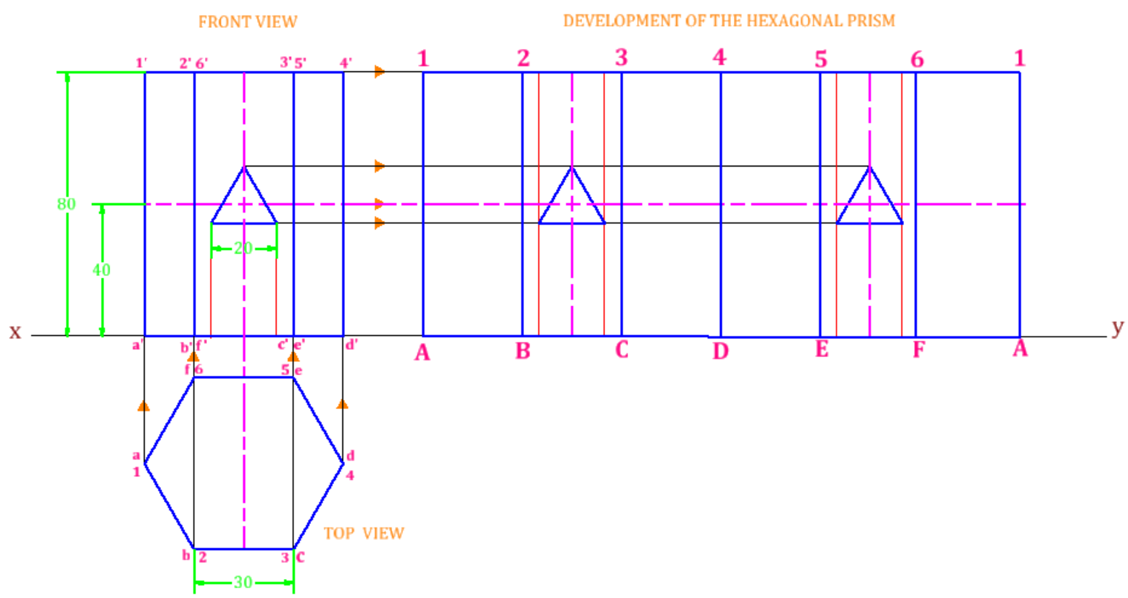
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 25 mm below the x-y line at some suitable distance from it. Divide this circle into 12 equal divisions as shown in the figure. Give notations on it. It is top view of the cylinder.
3. From the center of the circle in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from the all notations of the circle draw vertical projectors of length 60 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cylinder.
4. Draw a profile with medium dark lines and curves as per dimensions given in the front view of the cylinder.
5. Draw a line from the top of the cylinder in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the cylinder at some suitable distance from the line g'-7', as shown in the figure. And give the notations 1-A on it as per the figure given above. From the point A draw another vertical line at the distance equal to πD, where D= Diameter of the circle in the top view.
6. Then divide this rectangle in 12 equal divisions, because of the 12 divisions of the circle. Then give the notations on it in capital letters like, A-1, B-2, C-3, etc. as shown in the figure, connects these all the points with light straight lines, these are the generators of the cylinder. It is a rectangle. And it is the development of the vertical surface of the cylinder.
7. Now from the cutting points of the profile with the respective vertical generators of the cylinder in the front view, draw horizontal light parallel lines, up to the respective generators in the development of the vertical surface of the cylinder. Then connect the

respective points either with medium dark straight lines or medium dark free hand curves, depending on the profile of the cylinder given in the front view.

8. This is the development of the vertical surface of the cylinder.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

4. A hexagonal prism is resting on H.P. on its base with two edges/sides of base parallel to V.P. One equilateral triangular shape of size 20 mm is cut from the prism such that the axis of the triangle is perpendicular to V.P. & parallel to H.P. & passing through the center of the height & width of the prism. Develop the surface of the prism. Take side of base 30 mm and height of axis 80 mm of the prism.



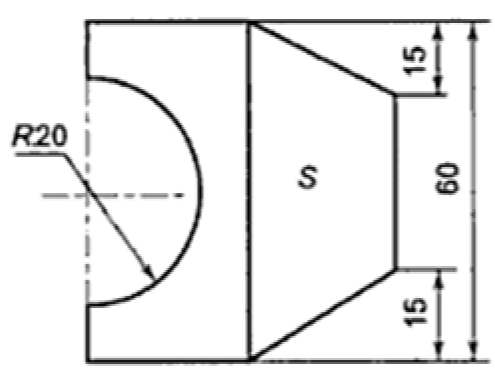
Procedure:

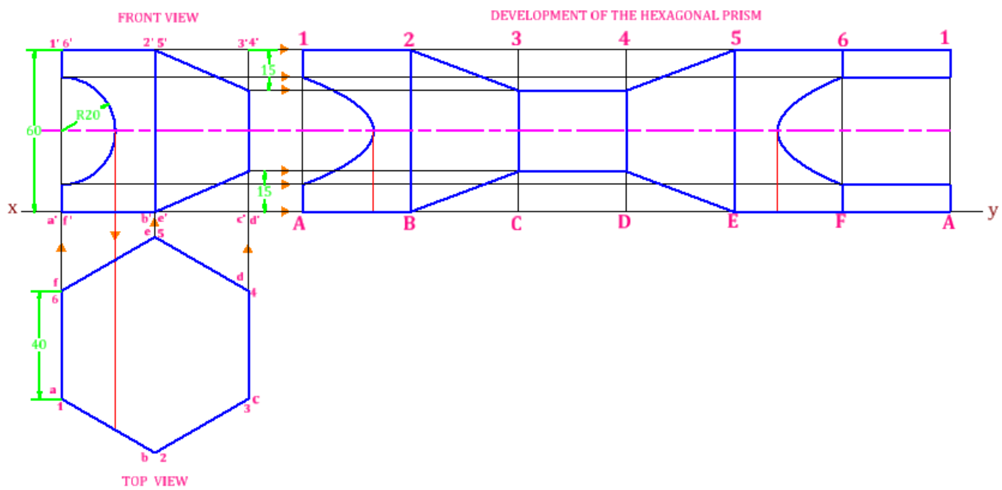
1. Draw a horizontal x-y line of some suitable length.
2. Draw a hexagon of side of base 30 mm below the x-y line at some suitable distance from it, such that two of the sides of the hexagon should be parallel with the x-y line as shown in the figure. Give notations on it. It is top view of the Hexagonal prism.
3. From the center of the hexagon in the top view, draw a vertical center line of length 80 mm from the x-y line as shown in the figure. And from the all notations of the hexagon draw vertical projectors of length 80 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cylinder.
4. Draw an equilateral triangle of length 20 mm in the middle of the length and height of the front view of the hexagonal prism in such a way that the center of the triangle should be

at the distance 40 mm either from the bottom or the top of the front view of the hexagonal prism as shown in the prism.

5. Draw a line from the top of the hexagon in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the cylinder at some suitable distance from the line d'-4', as shown in the figure. And give the notations 1-A on it as per the figure given above. From the point A, divide the x-y line in the 6 divisions in such a way that the distance between two consecutive divisions should be equal to the length of a side of the base of the hexagonal prism, which is 30 mm.
6. Then give the notations on it in capital letters like, A-1, B-2, C-3, etc. as shown in the figure, connects these all the points with light straight lines, these are the vertical edges of the hexagonal prism. It is a rectangle. And it is the development of the vertical surface of the hexagonal prism.
7. Now transfer the distances of the sides of the triangle in the development of the hexagonal prism at appropriate places, which can be known by the notations of the vertical edges, as shown in the prism. Then connects these points in sequence by medium dark straight lines and make the boundary and the vertical edges of the development of the hexagonal prism as dark lines as shown in the figure.
8. This is the development of the vertical surface of the hexagonal prism.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

5. A hexagonal prism with 40 mm sides of its base is resting on H.P. and two sides of its base are perpendicular with V.P. It is cut as per the figure given below. Develop the lateral surface of the hexagonal prism.



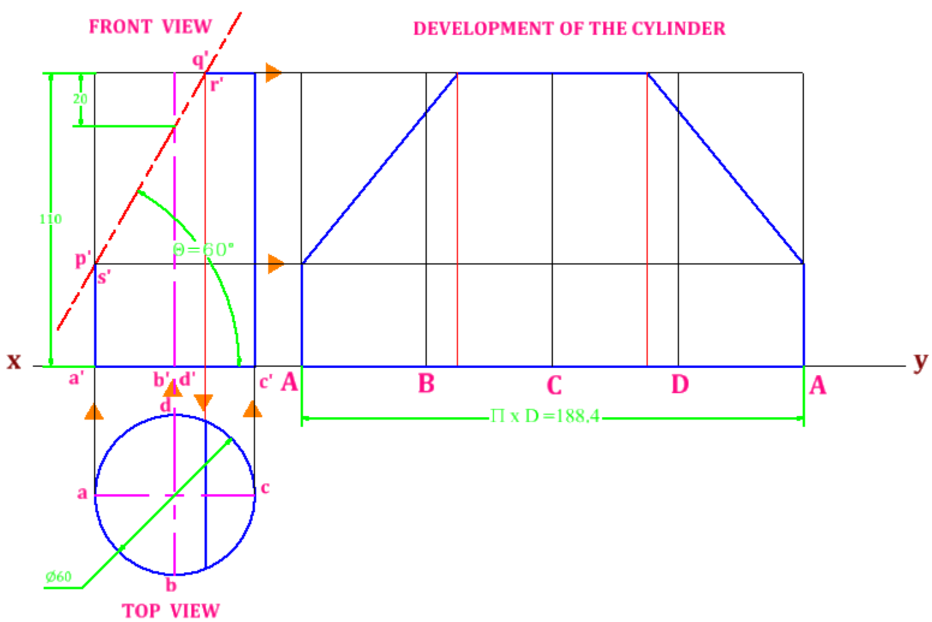


Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a hexagon of side of base 40 mm below the x-y line at some suitable distance from it, such that two of the sides of the hexagon should be perpendicular with the x-y line as shown in the figure. Give notations on it. It is top view of the Hexagonal prism.
3. From the center of the hexagon in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from the all notations of the hexagon draw vertical projectors of length 60 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the hexagon.
4. Draw the shape as per the dimensions given in the figure with medium dark lines and medium dark smooth circle.
5. Draw a line from the top of the hexagon in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the hexagonal prism at some suitable distance from the line d'-4', as shown in the figure. And give the notations 1-A on it as per the figure given above. From the point A, divide the x-y line in the 6 divisions in such a way that the distance between two consecutive divisions should be equal to the length of a side of the base of the hexagonal prism, which is 40 mm.
6. Then give the notations on it in capital letters like, A-1, B-2, C-3, etc. as shown in the figure, connects these all the points with light straight lines, these are the vertical edges of the hexagonal prism. It is a rectangle. And it is the development of the vertical surface of the hexagonal prism.

7. Now transfer the distances of all other points from the front view in the development of the hexagonal prism at appropriate places, which can be known by the notations of the vertical edges, as shown in the prism. Then connects these points in sequence by medium dark straight lines or medium dark smooth curve and make the boundary and the vertical edges of the development of the hexagonal prism as dark lines as shown in the figure.
8. This is the development of the vertical surface of the hexagonal prism.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

6. A cylinder of diameter of base 60 mm and axis height 110 mm is resting on its base on H.P. It is cut by a cutting plane perpendicular to V.P. and inclined at an angle 60° with the H.P. and passing through the distance of 20 mm form the top end of the cylinder and on the axis. Develop the lateral surface of the cylinder.

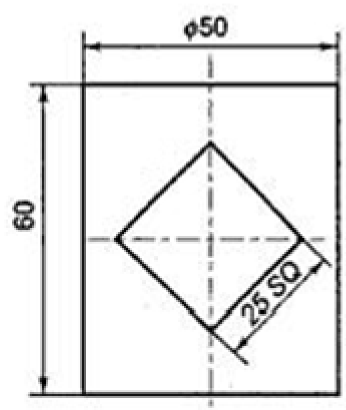


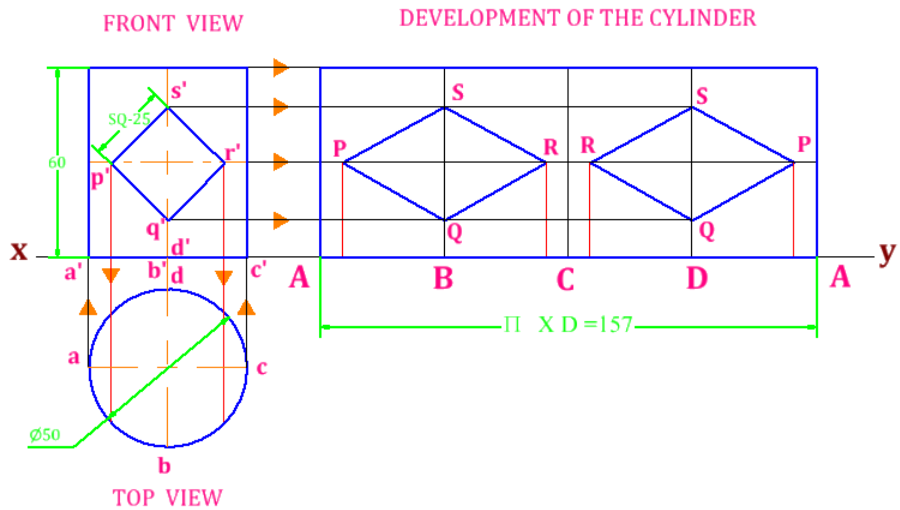
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 30 mm below the x-y line at some suitable distance from it. Divide this circle into 4 equal divisions as shown in the figure. Give notations on it. It is top view of the cylinder.
3. From the center of the circle in the top view, draw a vertical center line of length 110 mm from the x-y line as shown in the figure. And from the all notations of the circle draw vertical projectors of length 110 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cylinder.

4. Draw a cutting plane line passing through the distance 15 mm below the top end of the cylinder and on the center vertical axis and should be inclined at an angle of 60° with the x-y line as shown in the figure. And because of the cutting of the cylinder in this profile, draw the lower half of the front view of the cylinder with medium dark lines, as shown in the front view.
5. Draw a line from the top of the cylinder in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the cylinder at some suitable distance from the line c', as shown in the figure. And give the notations A on it as per the figure given above. From the point A draw another vertical line at the distance equal to πD, where D= Diameter of the circle in the top view.
6. Then divide this rectangle in 4 equal divisions, because of the 4 divisions of the circle. Then give the notations on it in capital letters like, A, B, C etc. as shown in the figure, connects these all the points with light straight lines, these are the generators of the cylinder. It is a rectangle. And it is the development of the vertical surface of the cylinder.
7. Now from the cutting points of the profile with the respective vertical generators of the cylinder in the front view, draw horizontal light parallel lines, up to the respective generators in the development of the vertical surface of the cylinder. Then connect the respective points either with medium dark straight lines or medium dark free hand curves, depending on the cutting profile of the cylinder given in the front view.
8. This is the development of the vertical surface of the cylinder.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

7. A cylinder of diameter 50 mm and axis height 60 mm is resting on its base on H.P. And one square hole of size 25 mm is cut through the cylinder such that the axis of the square hole is parallel to H.P. perpendicular to V.P. and in the center of the vertical axis of the cylinder. And the sides of the square hole are equally inclined with the H.P. Develop the lateral surface of the cylinder.



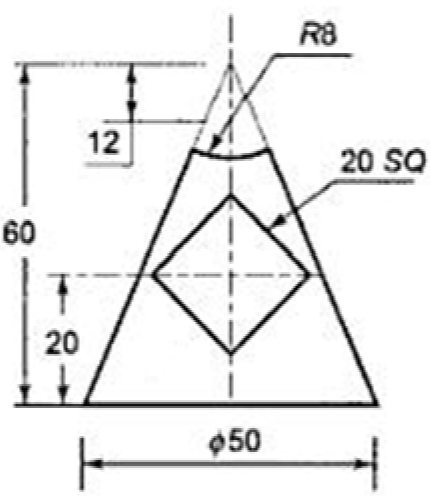


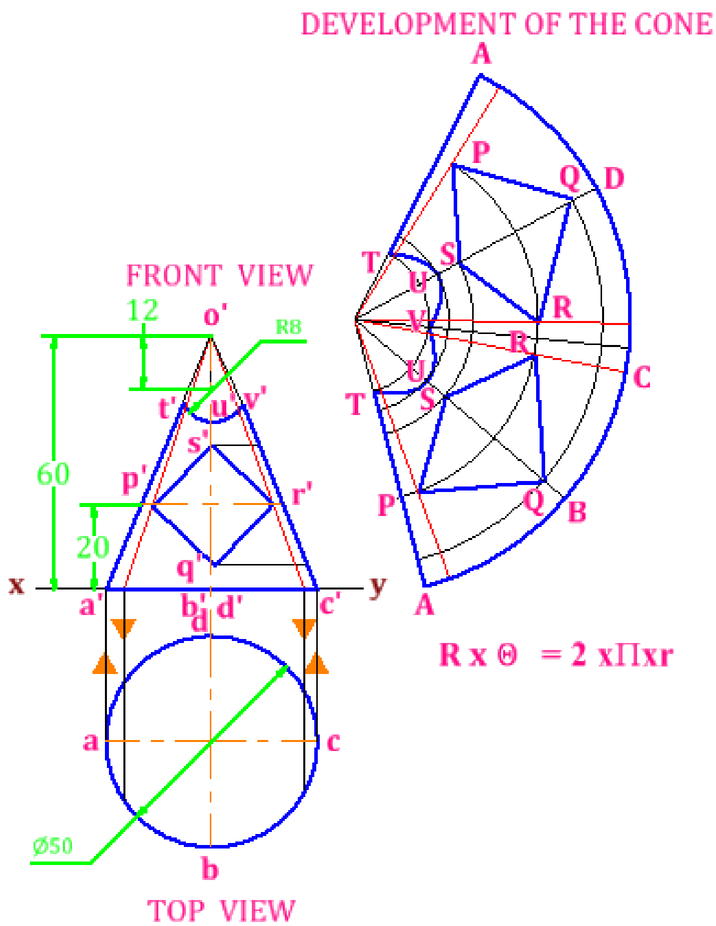
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 25 mm below the x-y line at some suitable distance from it. Divide this circle into 4 equal divisions as shown in the figure. Give notations on it. It is top view of the cylinder.
3. From the center of the circle in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from the all notations of the circle draw vertical projectors of length 60 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cylinder.
4. Draw a square of length of side 25 mm and in such a way that all the sides of the square should be equally inclined with the x-y line. And the horizontal center line should be passing though the midpoint of the vertical center line of the cylinder.
5. Draw a line from the top of the cylinder in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the cylinder at some suitable distance from the line c', as shown in the figure. And give the notations A on it as per the figure given above. From the point A draw another vertical line at the distance equal to πD, where D= Diameter of the circle in the top view.
6. Then divide this rectangle in 4 equal divisions, because of the 4 divisions of the circle. Then give the notations on it in capital letters like, A, B, C etc. as shown in the figure, connects these all the points with light straight lines, these are the generators of the cylinder. It is a rectangle. And it is the development of the vertical surface of the cylinder.

7. Now from the cutting points of the profile with the respective vertical generators of the cylinder in the front view, draw horizontal light parallel lines, up to the respective generators in the development of the vertical surface of the cylinder. Then connect the respective points either with medium dark straight lines or medium dark free hand curves, depending on the cutting profile of the cylinder given in the front view.
8. This is the development of the vertical surface of the cylinder.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

8. The cone of diameter of base 50 mm and axis height 60 mm is resting on its base on H.P. as shown in the figure below. One square hole of size 20 mm is cut through the cone as per the figure given below. Develop the surface of the cone.





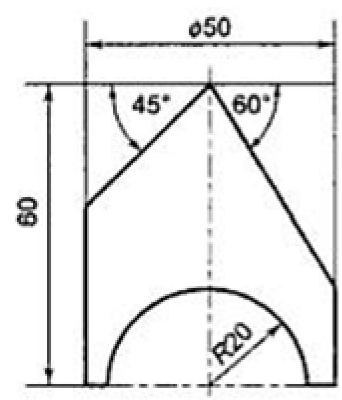
Procedure:

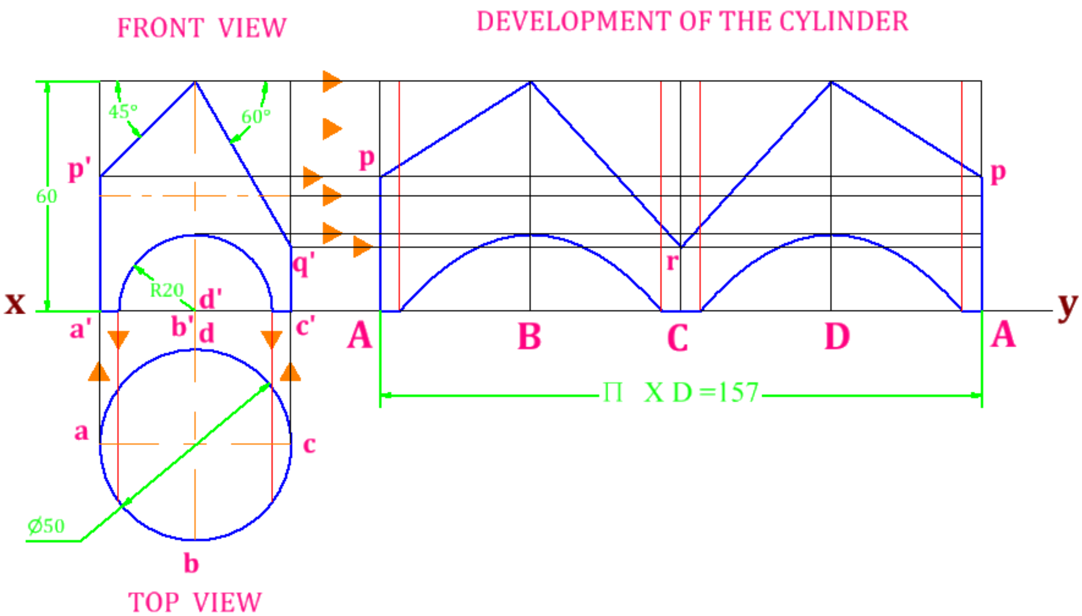
1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 25 mm below the x-y line at some suitable distance from it. Divide this circle into 4 equal divisions as shown in the figure. Give notations on it. It is top view of the cone.
3. From the center of the circle in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from these notations of the circle draw vertical projectors up to x-y line, and then converge all these projectors at the end of the center line i.e. apex of the cone (point o') as shown into the figure. It is a triangular shape. And Give the notations on it.
4. Draw the shown profile as per the dimensions given in the figure above.
5. Give the cutting points name at the intersection of the previously profile with the vertical projectors of the circle in front view, i.e., p', q', r' etc. as shown into the figure.
6. Now find out the angle covered by the cone when it is opened completely, by the equation, where L = Length of the last generator i.e., o'-a' or o'-c'. = Angle subtended

by the two extreme generators of the cone, when it is opened completely. r = Radius of the base circle of the cone. From this equation find out the value of in degree.

7. Draw a line parallel to and equal to the length of the last generator i.e., o'-c', at some suitable distance from the front view. Give that line the name O-A as shown in the figure. With O as center and radius equal to OA, draw an arc such that the angle subtended by the arc should be equal to, which you have found out from the previous equation. This is the full development of the vertical surface of the cone.
8. Divide this developed surface of the cone in 4 equal divisions, angle wise, as shown in the figure. And give the notations in capital letters. i.e., A, B, C etc.
9. Now in the front view, from the cutting points in the front view, draw horizontal lines, parallel with x-y line, such that these lines should meet with the last generator i.e., o'-c', in the front view.
10. Then measure the distances of the end points of previously drawn respective lines from the point o', and transfer these distances in the developed surface of the cone on respective generators, as shown in the figure.
11. Now Connects all the points in sequence with medium dark smooth curve or medium dark straight lines, as shown in the figure, and draw the boundary of the cone with dark curve with the use of a compass. This is the Development of the vertical surface of the cone.
12. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

9. The cylinder of diameter of base 50 mm and axis height 60 mm is resting on its base on H.P. as shown in the figure below. Develop the surface of the cylinder.





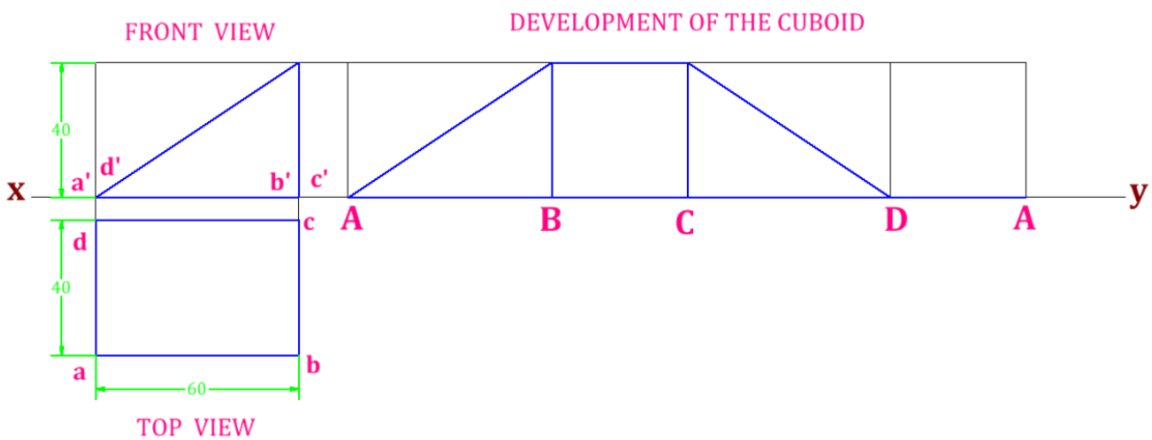
Procedure:

1. Draw a horizontal x-y line of some suitable length.
2. Draw a circle of radius 25 mm below the x-y line at some suitable distance from it. Divide this circle into 4 equal divisions as shown in the figure. Give notations on it. It is top view of the cylinder.
3. From the center of the circle in the top view, draw a vertical center line of length 60 mm from the x-y line as shown in the figure. And from the all notations of the circle draw vertical projectors of length 60 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cylinder.
4. Draw a profile given in the front view, as per the dimension given in it.
5. Draw a line from the top of the cylinder in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the cylinder at some suitable distance from the line c', as shown in the figure. And give the notations A on it as per the figure given above. From the point A draw another vertical line at the distance equal to πD, where D= Diameter of the circle in the top view.
6. Then divide this rectangle in 4 equal divisions, because of the 4 divisions of the circle. Then give the notations on it in capital letters like, A, B, C etc. as shown in the figure, connects these all the points with light straight lines, these are the generators of the cylinder. It is a rectangle. And it is the development of the vertical surface of the cylinder.
7. Now from the cutting points of the profile with the respective vertical generators of the cylinder in the front view, draw horizontal light parallel lines, up to the respective generators in the development of the vertical surface of the cylinder. Then connect the

respective points either with medium dark straight lines or medium dark free hand curves, depending on the cutting profile of the cylinder given in the front view.

8. This is the development of the vertical surface of the cylinder.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

10. One cuboid of side of 40 mm x 60 mm x 40 mm is resting on its longer side on H.P. & one of the longer surfaces of the cuboid is parallel to V.P .It is cut by a cutting plane which is perpendicular to V.P. and inclined to H.P. such that it passes diagonally from one corner of the top to the opposite corner of the bottom. Develop the lateral surface of the cuboid.



Procedure:

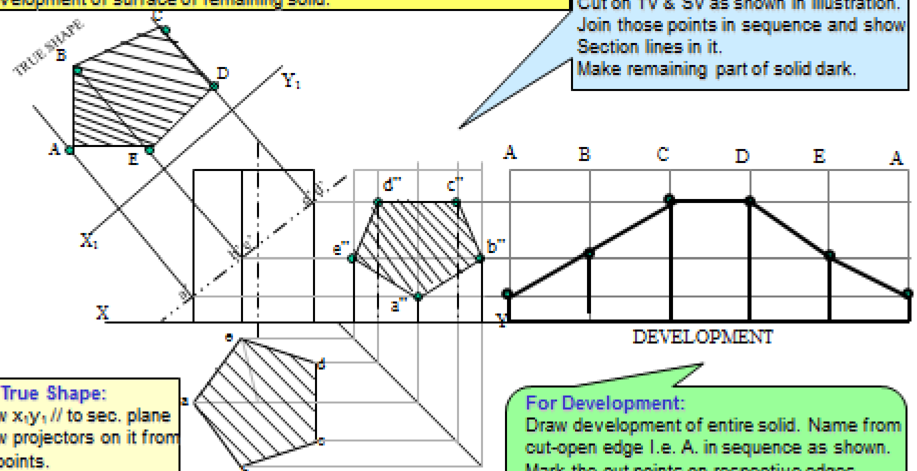
1. Draw a horizontal x-y line of some suitable length.
2. Draw a rectangle of side of 60 mm x 40 mm below the x-y line at some suitable distance from it, such that two shorter sides of the rectangle should be perpendicular with the x-y line as shown in the figure. Give notations on it. It is top view of the cuboid.
3. From the center of the rectangle in the top view, draw a vertical center line of length 40 mm from the x-y line as shown in the figure. And from the all notations of the rectangle draw vertical projectors of length 40 mm from the x-y line as shown in the figure. It is a rectangular shape. And Give the notations on it. It is front view of the cuboid.
4. Draw a diagonal form one corner of the top to the opposite corner of the bottom of the rectangle as shown in the front view.
5. Draw a line from the top of the rectangle in the front view exactly parallel with the x-y line, and make a vertical line between the x-y line and the line drawn from the top of the

rectangle at some suitable distance from the line d’-c’, as shown in the figure. And give the notations A on it as per the figure given above. From the point A, divide the x-y line in the 4 divisions in such a way that the distance of first part should be of 60 mm and then 40 mm, 60 mm and 40 mm respectively.

6. Then give the notations on it in capital letters like, A, B, C etc. as shown in the figure, connects these all the points with light straight lines, these are the vertical edges of the cuboid. It is a rectangle. And it is the development of the vertical surface of the cuboid.
7. Now transfer the distances of the cutting portion of the front view in the development of the cuboid at appropriate places, which can be known by the notations of the vertical edges, as shown in the prism. Then connects these points in sequence by medium dark straight lines as shown in the figure.
8. This is the development of the vertical surface of the cuboid.
9. Give the dimensions by any one method of dimensions and give the notations as shown into the figure.

Problem 1: 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 45º inclined to Hp, through mid point of axis. Draw Fv, sec.Tv & sec. Side view. Also draw true shape of section and Development of surface of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing prism.
Locate sec.plane in Fv as described.
Project points where edges are getting Cut on Tv & Sv as shown in illustration.
Join those points in sequence and show Section lines in it.
Make remaining part of solid dark.

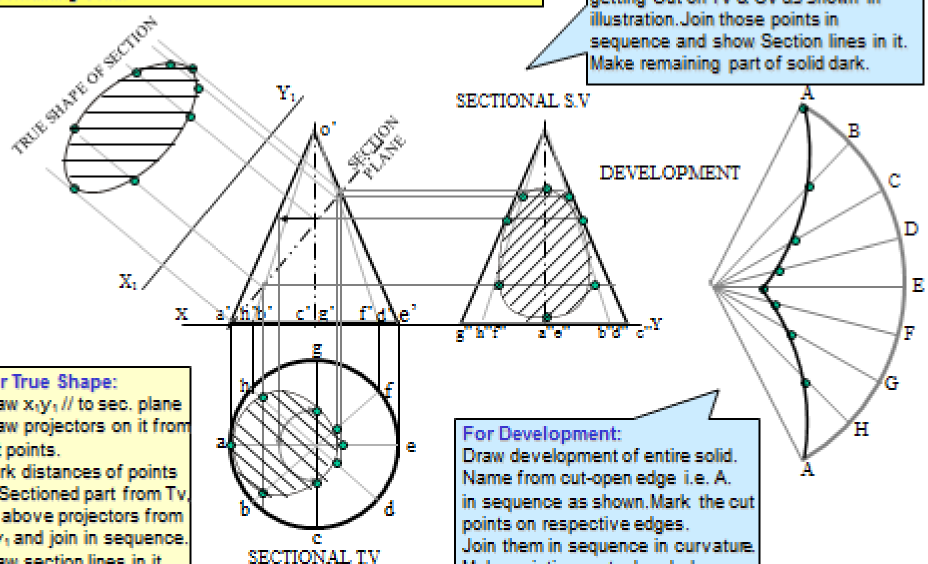


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid. Name from cut-open edge I.e. A. in sequence as shown.
Mark the cut points on respective edges.
Join them in sequence in st. lines.
Make existing parts dev.dark.

Problem 2: A cone, 50 mm base diameter and 70 mm axis is standing on it's base on Hp. It cut by a section plane 45º inclined to Hp through base end of end generator.Draw projections, sectional views, true shape of section and development of surfaces of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing cone.
Locate sec.plane in Fv as described.
Project points where generators are getting Cut on Tv & Sv as shown in illustration.Join those points in sequence and show Section lines in it.
Make remaining part of solid dark.

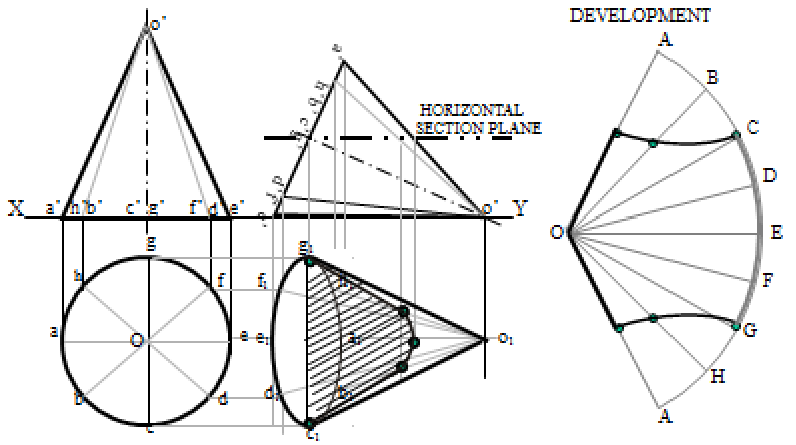


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid.
Name from cut-open edge i.e. A.
in sequence as shown.Mark the cut points on respective edges.
Join them in sequence in curvature.
Make existing parts dev.dark.

Problem 3: A cone 40mm diameter and 50 mm axis is resting on one generator on Hp(lying on Hp) which is // to Vp.. Draw it's projections.It is cut by a horizontal section plane through it's base center. Draw sectional TV, development of the surface of the remaining part of cone.

Follow similar solution steps for Sec.views - True shape – Development as per previous problem!

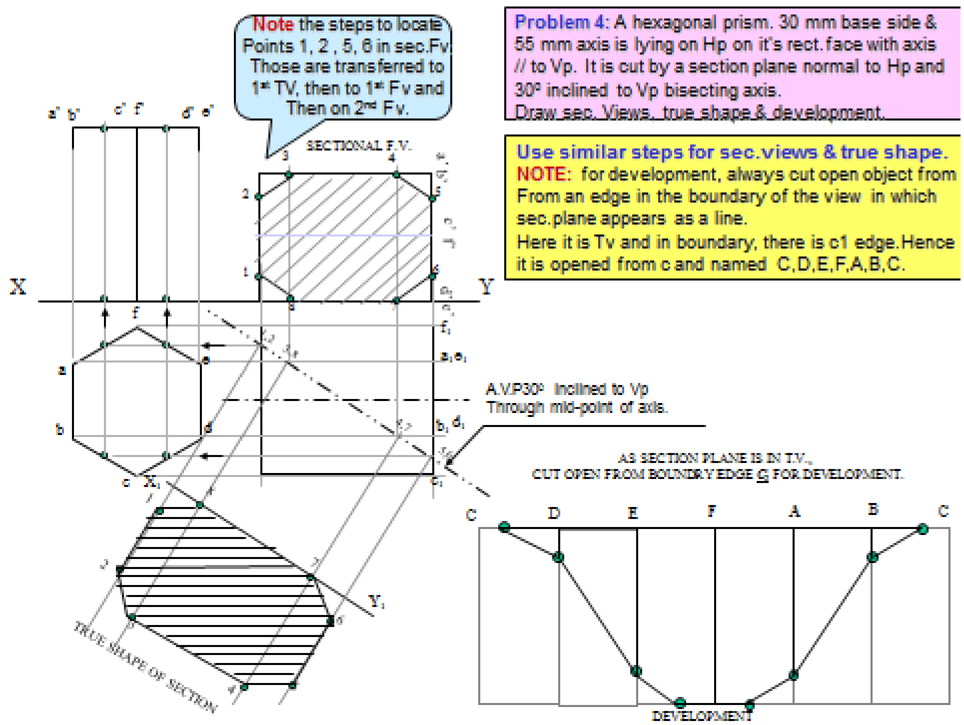


SECTIONAL T.V

(SHOWING TRUE SHAPE OF SECTION)

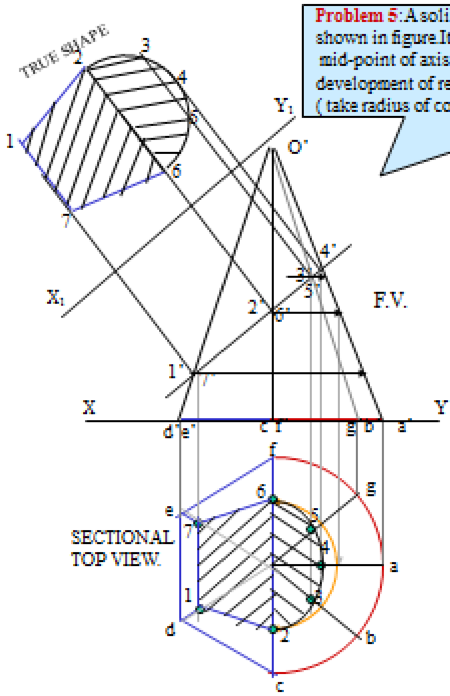
Problem 4: A hexagonal prism. 30 mm base side & 55 mm axis is lying on Hp on it's rect.face with axis // to Vp. It is cut by a section plane normal to Hp and 30º inclined to Vp bisecting axis. Draw sec. Views, true shape & development.

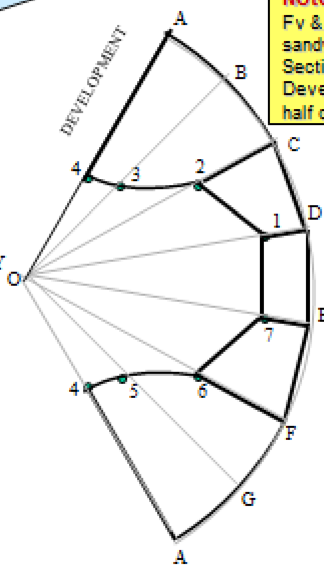
Use similar steps for sec.views & true shape.
NOTE: for development, always cut open object from From an edge in the boundary of the view in which sec.plane appears as a line. Here it is Tv and in boundary, there is c1 edge.Hence it is opened from c and named C,D,E,F,A,B,C.



Problem 5: A solid composed of a half-cone and half- hexagonal pyramid is shown in figure.It is cut by a section plane 45º inclined to Hp, passing through mid-point of axis.Draw F.v., sectional T.v.,true shape of section and development of remaining part of the solid.
(take radius of cone and each side of hexagon 30mm long and axis 70mm.)

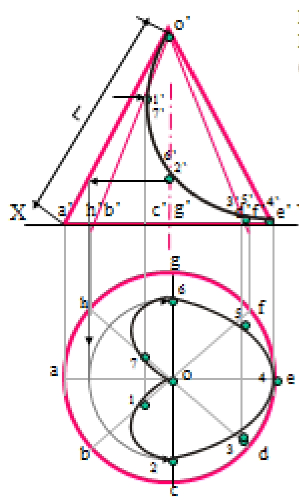
Note:
Fv & TV 8f two solids sandwiched
Section lines style in both:
Development of
half cone & half pyramid:



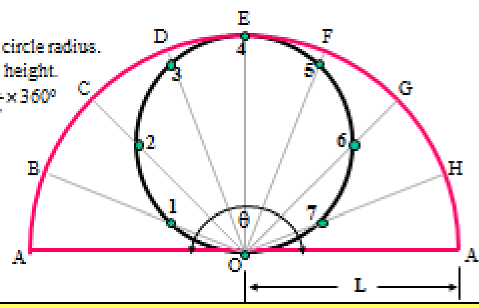


Problem 6: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest circle.If the semicircle is development of a cone and inscribed circle is some curve on it, then draw the projections of cone showing that curve.

TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.



R=Base circle radius.
L=Slant height.
$\theta = \frac{R}{L} \times 360^{\circ}$

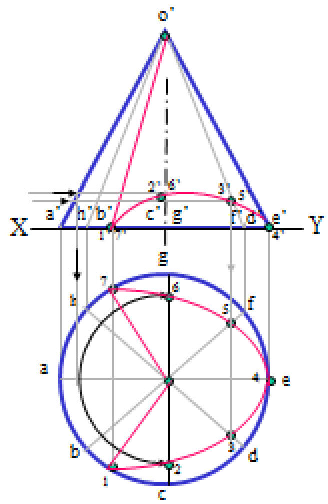


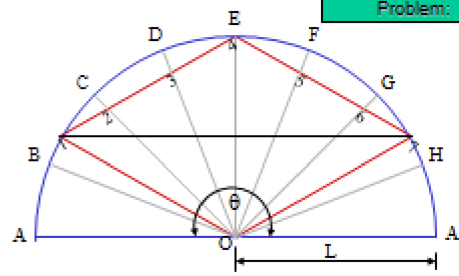
Solution Steps:
Draw semicircle of given diameter, divide it in 8 Parts and inscribe in it a largest circle as shown.Name intersecting points 1, 2, 3 etc.
Semicircle being dev.of a cone it's radius is slant height of cone.(L)
Then using above formula find R of base of cone. Using this data draw Fv & Tv of cone and form 8 generators and name.
Take o -1 distance from dev.,mark on TL i.e.o'a' on Fv & bring on o'b' and name 1' Similarly locate all points on Fv. Then project all on Tv on respective generators and join by smooth curve.

Problem 7: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest **rhombus**. If the semicircle is development of a cone and rhombus is some curve on it, then draw the projections of cone showing that curve.

TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.

Solution Steps:
Similar to previous Problem:

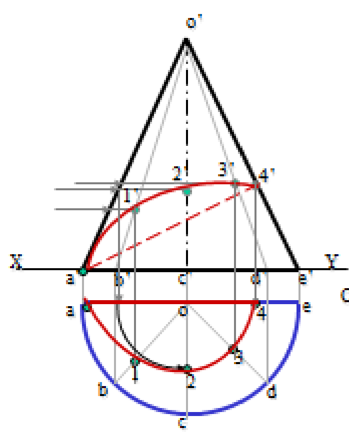


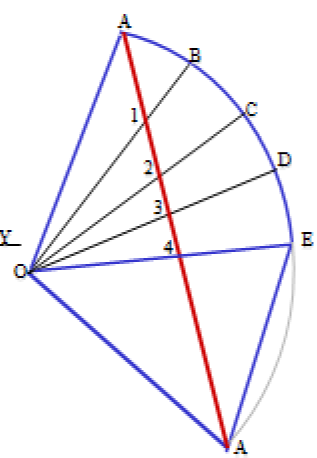


R=Base circle radius.
L=Slant height.
$\theta = \frac{R}{L} \times 360^{0}$

Problem 8: A half cone of 50 mm base diameter, 70 mm axis, is standing on it's half base on HP with it's flat face parallel and nearer to VP. An inextensible string is wound round it's surface from one point of base circle and brought back to the same point. If the string is of ***shortest length***, find it and show it on the projections of the cone.

TO DRAW A CURVE ON PRINCIPAL VIEWS FROM DEVELOPMENT.

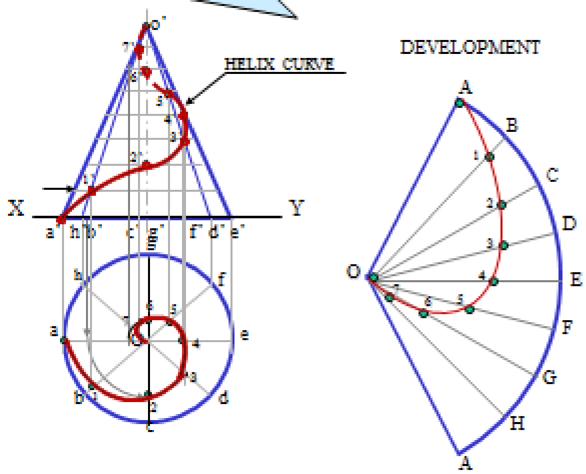




Concept: A string wound from a point up to the same Point, of shortest length Must appear st. line on it's Development.

Solution steps:
Hence draw development, Name it as usual and join A to A This is shortest Length of that string.
Further steps are as usual.
On dev. Name the points of Intersections of this line with Different generators. Bring Those on Fv & Tv and join by smooth curves.
Draw 4' a' part of string dotted As it is on back side of cone.

Problem 9: A particle which is initially on base circle of a cone, standing on Hp, moves upwards and reaches apex in one complete turn around the cone. Draw it's path on projections of cone as well as on it's development.
Take base circle diameter 50 mm and axis 70 mm long.



It's a construction of curve Helix of one turn on cone:

Draw Fv & Tv & dev.as usual
On all form generators & name.

Construction of curve Helix::

Show 8 generators on both views
Divide axis also in same parts.
Draw horizontal lines from those points on both end generators.
1' is a point where first horizontal Line & gen. b'o' intersect.
2' is a point where second horiz. Line & gen. c'o' intersect.
In this way locate all points on Fv.
Project all on Tv.Join in curvature.

For Development:

Then taking each points true Distance From resp.generator from apex, Mark on development & join.

INTERPENETRATION OF SOLIDS

WHEN ONE SOLID PENETRATES ANOTHER SOLID THEN THEIR SURFACES INTERSECT
AND
AT THE JUNCTION OF INTERSECTION A TYPICAL CURVE IS FORMED,
WHICH REMAINS COMMON TO BOTH SOLIDS.

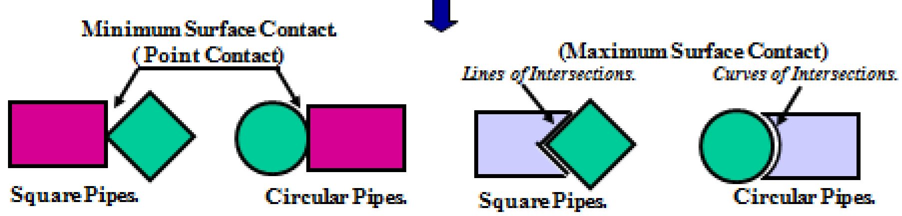
THIS CURVE IS CALLED CURVE OF INTERSECTION
AND
IT IS A RESULT OF INTERPENETRATION OF SOLIDS.

PURPOSE OF DRAWING THESE CURVES:-

WHEN TWO OBJECTS ARE TO BE JOINED TOGATHER, MAXIMUM SURFACE CONTACT BETWEEN BOTH BECOMES A BASIC REQUIREMENT FOR STRONGEST & LEAK-PROOF JOINT.

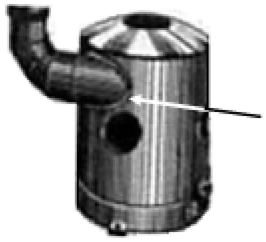
Curves of Intersections being common to both Intersecting solids, show exact & maximum surface contact of both solids.

Study Following Illustrations Carefully.



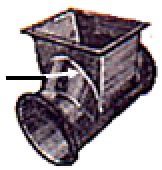
SOME ACTUAL OBJECTS ARE SHOWN, SHOWING CURVES OF INTERSECTIONS. BY WHITE ARROWS.

A machine component having two intersecting cylindrical surfaces with the axis at acute angle to each other.

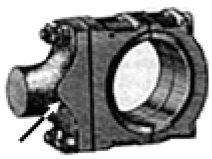


An Industrial Dust collector. Intersection of two cylinders.

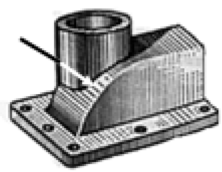
Intersection of a Cylindrical main and Branch Pipe.



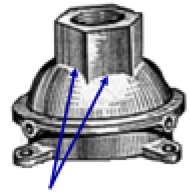
A Feeding Hopper In industry.



Forged End of a Connecting Rod.



Two Cylindrical surfaces.



Pump lid having shape of a hexagonal Prism and Hemi-sphere intersecting each other.

FOLLOWING CASES ARE SOLVED. REFFER ILLUSTRATIONS AND NOTE THE COMMON CONSTRUCTION FOR ALL

1. CYLINDER TO CYLINDER2.
2. SQ.PRISM TO CYLINDER
3. CONE TO CYLINDER
4. TRIANGULAR PRISM TO CYLNDER
5. SQ.PRISM TO SQ.PRISM
6. SQ.PRISM TO SQ.PRISM (SKEW POSITION)
7. SQARE PRISM TO CONE (*from top*)
8. CYLINDER TO CONE

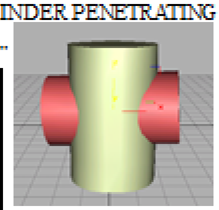
COMMON SOLUTION STEPS

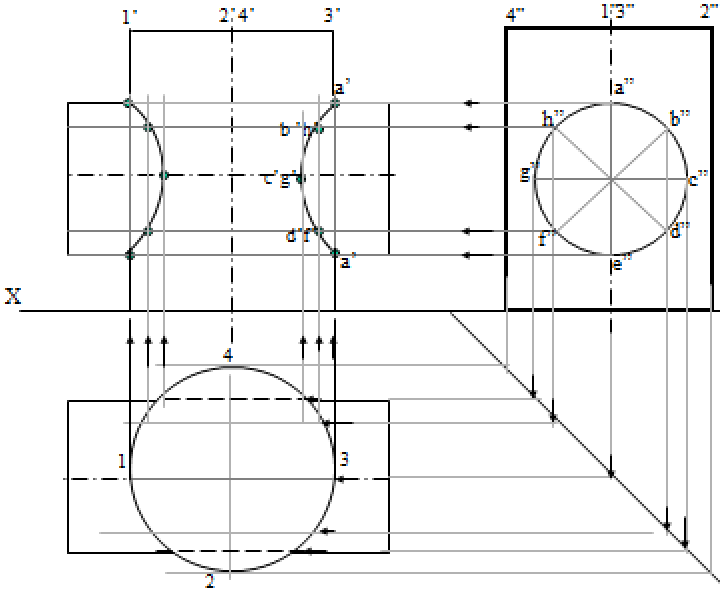
One solid will be standing on HP
Other will penetrate horizontally.
Draw three views of standing solid.
Name views as per the illustrations.
Beginning with side view draw three Views of penetrating solids also.
On it's S.V. mark number of points And name those(either letters or nos.)
The points which are on standard generators or edges of standing solid, (in S.V.) can be marked on respective generators in Fv and Tv. And other points from SV should be brought to Tv first and then projecting upward To Fv.
Dark and dotted line's decision should be taken by observing side view from it's right side as shown by arrow.
Accordingly those should be joined by curvature or straight lines.

Note:
Incase cone is penetrating solid Side view is not necessary.
Similarly in case of penetration from top it is not required.

Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by another of 40 mm dia.and 70 mm axis horizontally Both axes intersect & bisect each other. Draw projections showing curves of intersections.

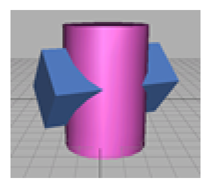
CASE 1.
CYLINDER STANDING
&
CYLINDER PENETRATING

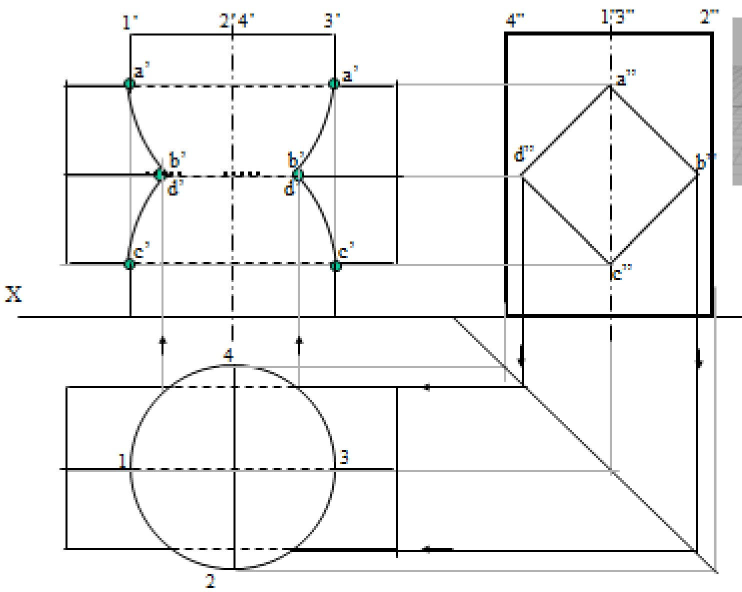




Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersect & bisect each other. All faces of prism are equally inclined to Hp. Draw projections showing curves of intersections.

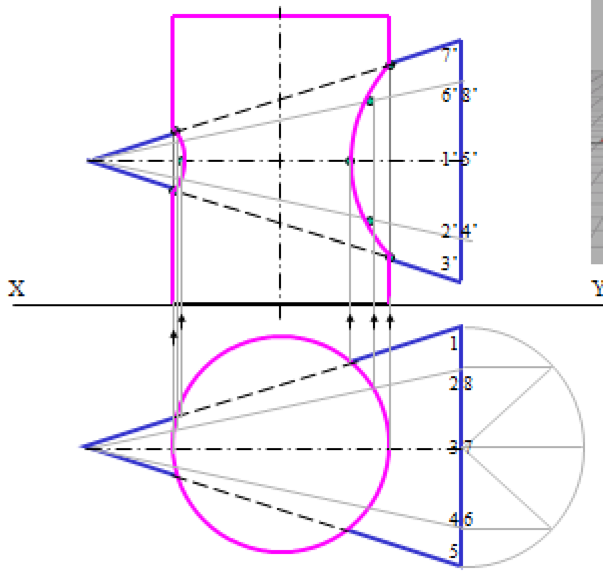
CASE 2.
CYLINDER STANDING
&
SQ.PRISM PENETRATING

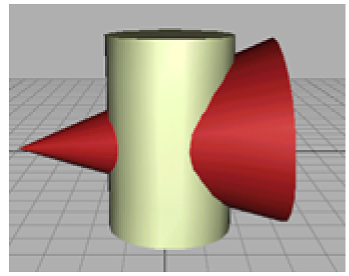




CASE 3.
CYLINDER STANDING
&
CONE PENETRATING

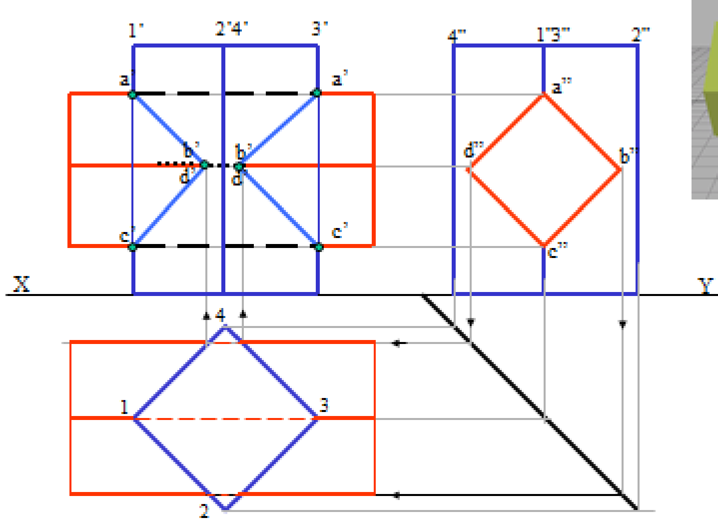
Problem: A cylinder of 80 mm diameter and 100 mm axis is completely penetrated by a cone of 80 mm diameter and 120 mm long axis horizontally.Both axes intersect & bisect each other. Draw projections showing curve of intersections.

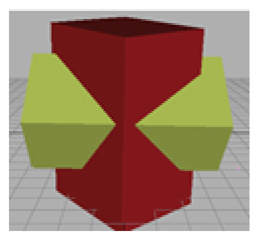




CASE 4.
SQ.PRISM STANDING
&
SQ.PRISM PENETRATING

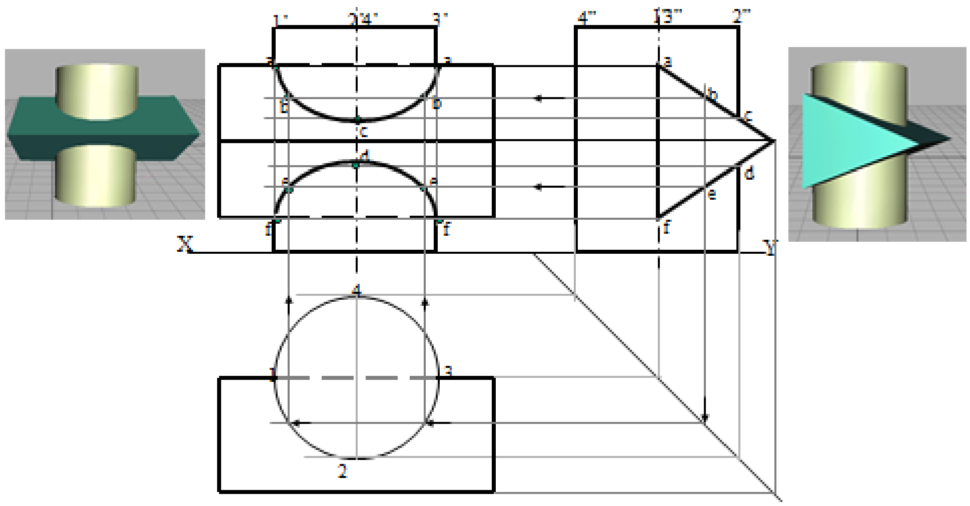
Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersects & bisect each other. All faces of prisms are equally inclined to Vp. Draw projections showing curves of intersections.





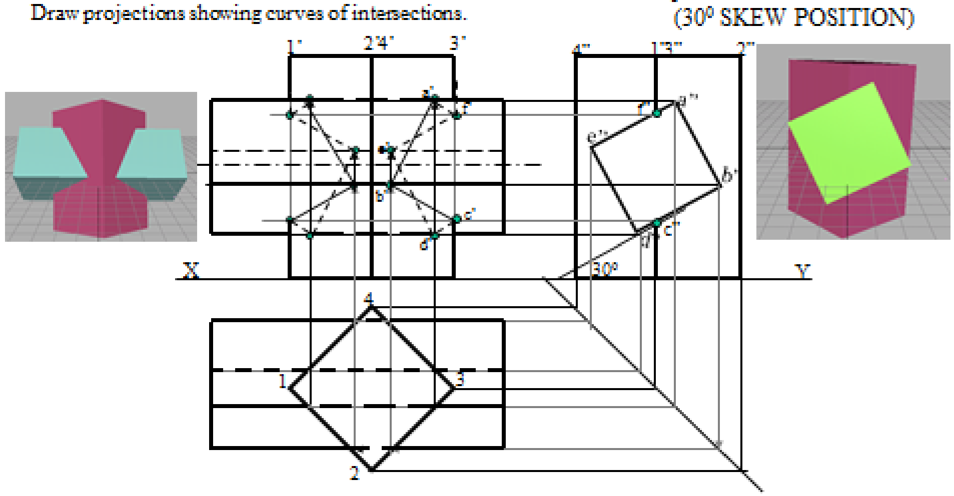
Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a triangular prism of 45 mm sides.and 70 mm axis, horizontally. One flat face of prism is parallel to Vp and Contains axis of cylinder. Draw projections showing curves of intersections.

CASE 5. CYLINDER STANDING & TRIANGULAR PRISM PENETRATING

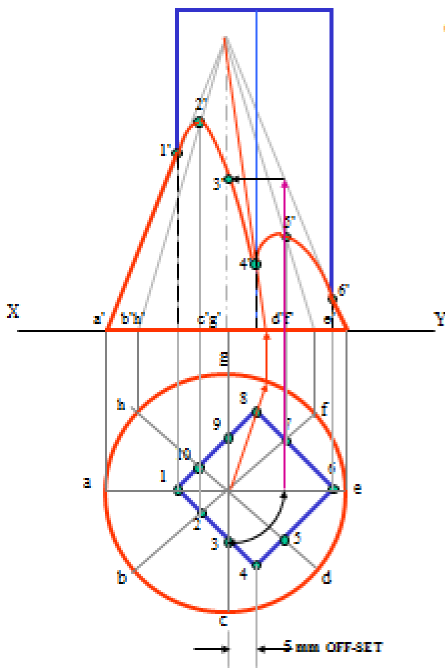


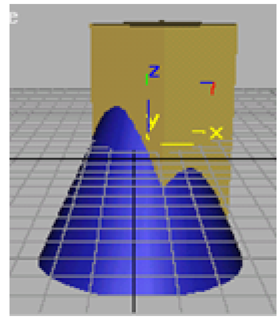
Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm side s.and 70 mm axis, horizontally. Both axes Intersect & bisect each other. Two faces of penetrating prism are 30^0 inclined to Hp. Draw projections showing curves of intersections.

CASE 6.
SQ.PRISM STANDING
&
SQ.PRISM PENETRATING
(30^0 SKEW POSITION)



CASE 7.
CONE STANDING & SQ.PRISM PENETRATING
(BOTH AXES VERTICAL)

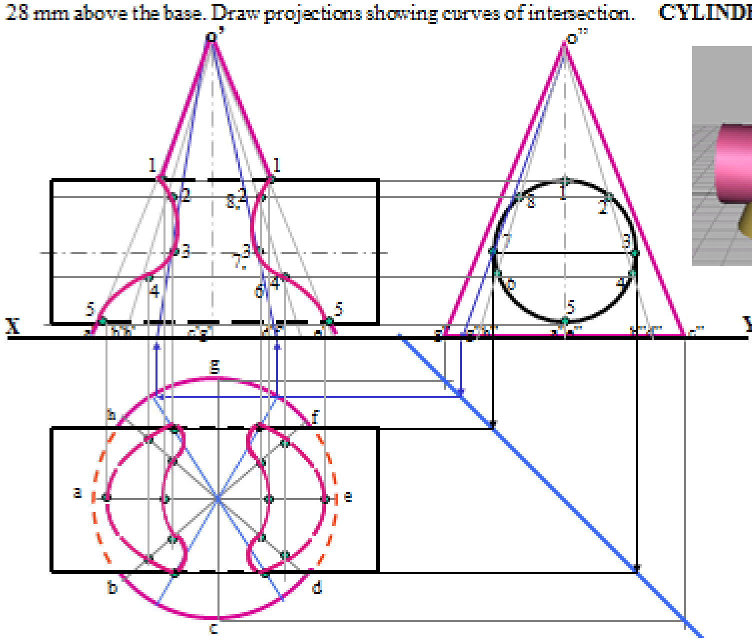


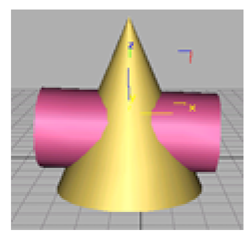


Problem: A cone 70 mm base diameter and 90 mm axis is completely penetrated by a square prism from top with it's axis // to cone's axis and 5 mm away from it. a vertical plane containing both axes is parallel to Vp. Take all faces of sq.prism equally inclined to Vp. Base Side of prism is 0 mm and axis is 100 mm long. 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. 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.

CASE 8.
CONE STANDING
&
CYLINDER PENETRATING





SECTION & DEVELOPMENT

1) A square pyramid of 30mm base sides and 50mm long axis is resting on its base in HP. Edges of base is equally inclined to VP. It is cut by section plane perpendicular to VP and inclined at 450 to HP. The plane cuts the axis at 10mm above the base. Draw the projections of the solid and show its development.

2) A hexagonal pyramid, edge of base 30mm and axis 75mm, is resting on its edge on HP which is perpendicular to VP. The axis makes an angle of 30^0 to HP. the solid is cut by a section plane perpendicular to both HP and VP, and passing through the mid-point of the axis. Draw the projections showing the sectional view, true shape of section and development of surface of a cut pyramid containing apex.

3) A cone of base diameter 60mm and axis 80mm, long has one of its generators in VP and parallel to HP. It is cut by a section plane perpendicular HP and parallel to VP. Draw the sectional FV, true shape of section and develop the lateral surface of the cone containing the apex.

4) A cube of 50mm long slid diagonal rest on ground on one of its corners so that the solid diagonal is vertical and an edge through that corner is parallel to VP. A horizontal section plane passing through midpoint of vertical solid diagonal cuts the cube. Draw the front view of the sectional top view and development of surface.

5) A vertical cylinder cut by a section plane perpendicular to VP and inclined to HP in such a way that the true shape of a section is an ellipse with 50mm and 80mm as its minor and major axes. The smallest generator on the cylinder is 20mm long after it is cut by a section plane. Draw the projections and show the true shape of the section. Also find the inclination of the section plane with HP. Draw the development of the lower half of the cylinder.

6) A cube of 75mm long edges has its vertical faces equally inclined to VP. It is cut by a section plane perpendicular to VP such that the true shape of section is regular hexagon. Determine the inclination of cutting plane with HP. Draw the sectional top view and true shape of section.

7) The pyramidal portion of a half pyramidal and half conical solid has a base of three sides, each 30mm long. The length of axis is 80mm. The solid rest on its base with the side of the pyramid base perpendicular to VP. A plane parallel to VP cuts the solid at a distance of 10mm from the top view of the axis. Draw sectional front view and true shape of section. Also develop the lateral surface of the cut solid.

8) A hexagonal pyramid having edge to edge distance 40mm and height 60mm has its base in HP and an edge of base perpendicular to VP. It is cut by a section plane, perpendicular to VP and passing through a point on the axis 10mm from the base. Draw three views of solid when it is resting on its cut face in HP, resting the larger part of the pyramid. Also draw the lateral surface development of the pyramid.

9) A cone diameter of base 50mm and axis 60mm long is resting on its base on ground. It is cut by a section plane perpendicular to VP in such a way that the true shape of a section is a parabola

having base 40mm. Draw three views showing section, true shape of section and development of remaining surface of cone removing its apex.

10) A hexagonal pyramid, base 50mm side and axis 100mm long is lying on ground on one of its triangular faces with axis parallel to VP. A vertical section plane, the HT of which makes an angle of 300 with the reference line passes through center of base, the apex being retained. Draw the top view, sectional front view and the development of surface of the cut pyramid containing apex.

11) Hexagonal pyramid of 40mm base side and height 80mm is resting on its base on ground. It is cut by a section plane parallel to HP and passing through a point on the axis 25mm from the apex. Draw the projections of the cut pyramid. A particle P, initially at the mid-point of edge of base, starts moving over the surface and reaches the mid-point of apposite edge of the top face. Draw the development of the cut pyramid and show the shortest path of particle P. Also show the path in front and top views

12) A cube of 65 mm long edges has its vertical face equally inclined to the VP. It is cut by a section plane, perpendicular to VP, 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.