

GE 6152 – ENGINEERING GRAPHICS

UNIT - 4	<i>DEVELOPMENT OF SURFACES</i>
	<i>Development of lateral surfaces of simple and truncated solids – prisms, pyramids, cylinders and cones - Development of lateral surfaces of solids with square and cylindrical cutouts, perpendicular to the axis.</i>

INTRODUCTION:

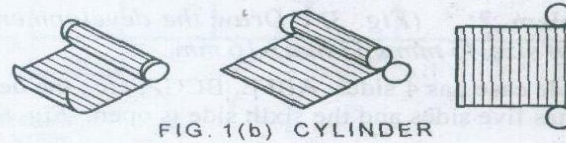
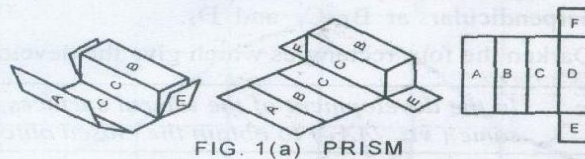
Surface generated by moving a straight line is called plane surface and that generated by a curve is called curved surface.

Solids bounded by plane surface: Prism, Pyramid, Tetrahedron

Solids bounded by single-curved surfaces: Cylinder, Cone

METHODS OF DEVELOPMENT OF LATERAL SURFACES

Parallel Line Development
See Figs. 1(a) and (b). This method is used to develop cubes, prisms and cylinders, in which all the edges / generators of lateral surfaces are *parallel* to each other. Prism and cylinder roll out into rectangular stretch-outs by this method.



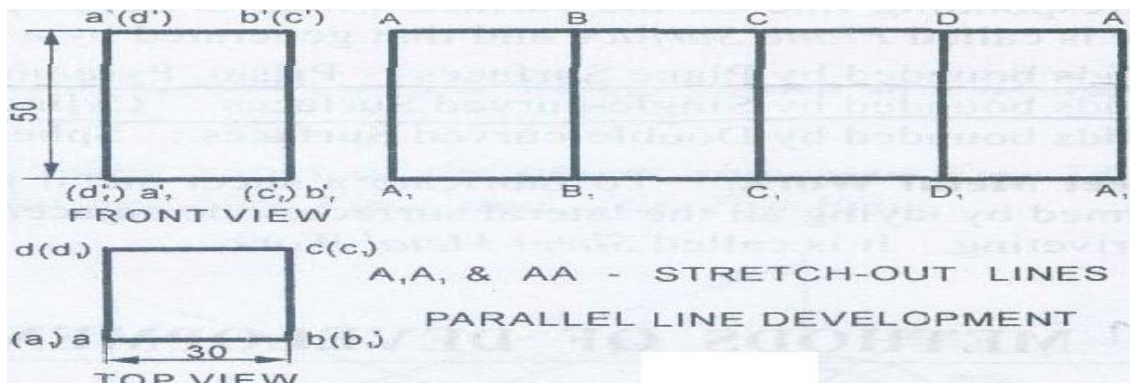
Radial Line Development

See Figs. 1(c) and (d). Radial This method is employed for *pyramids* and *cones* in which the apex is taken as center and the true length of the slant edge or generator as radius for its development.

PRISMS & CYLINDERS

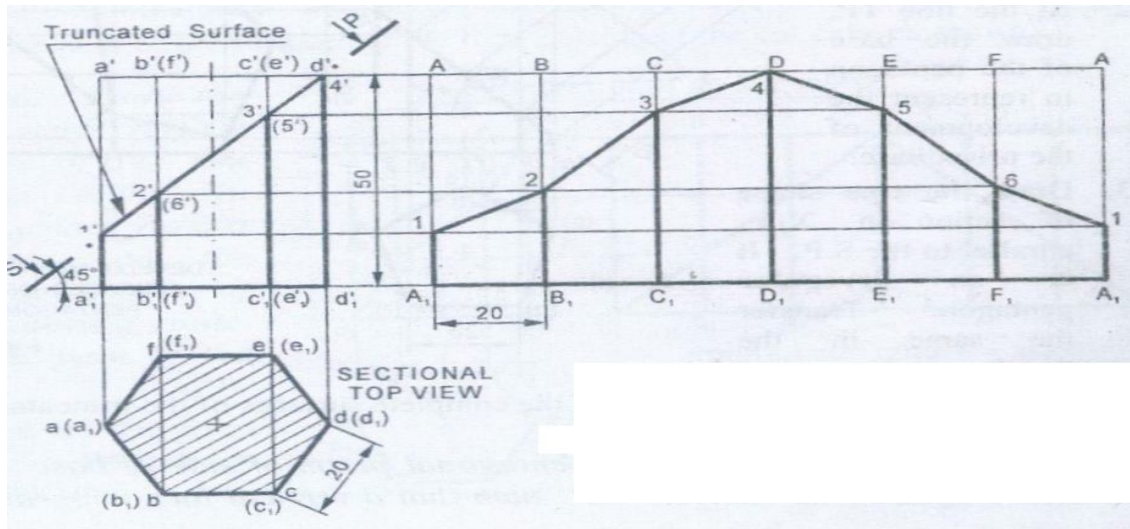
Parallel Line Development:

For a prism development consist of equal rectangles of known dimensions i.e. base dimension * no. of sides. For a cylinder development is formed by the formula $2\pi r$.

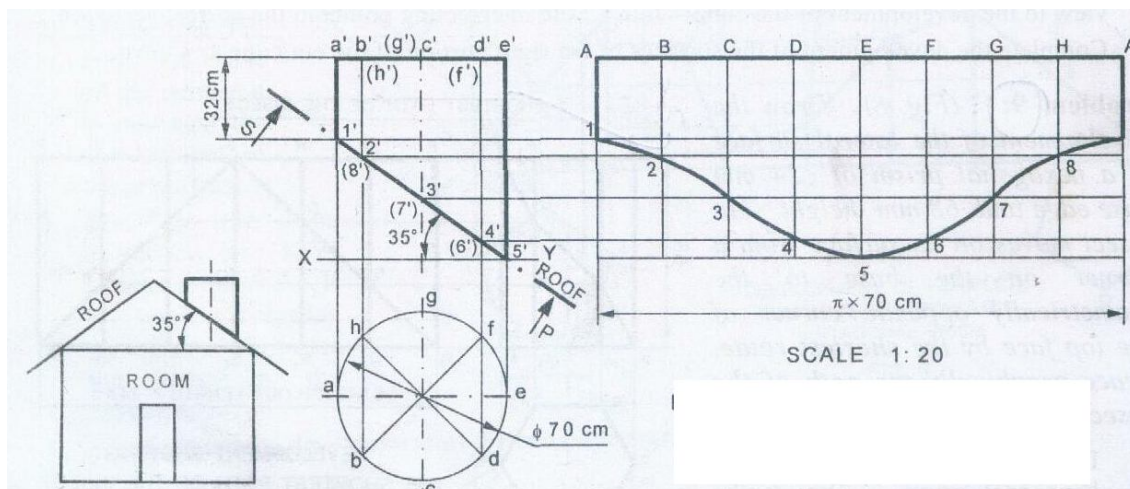


TRUNCATED PRISMS & CYLINDERS

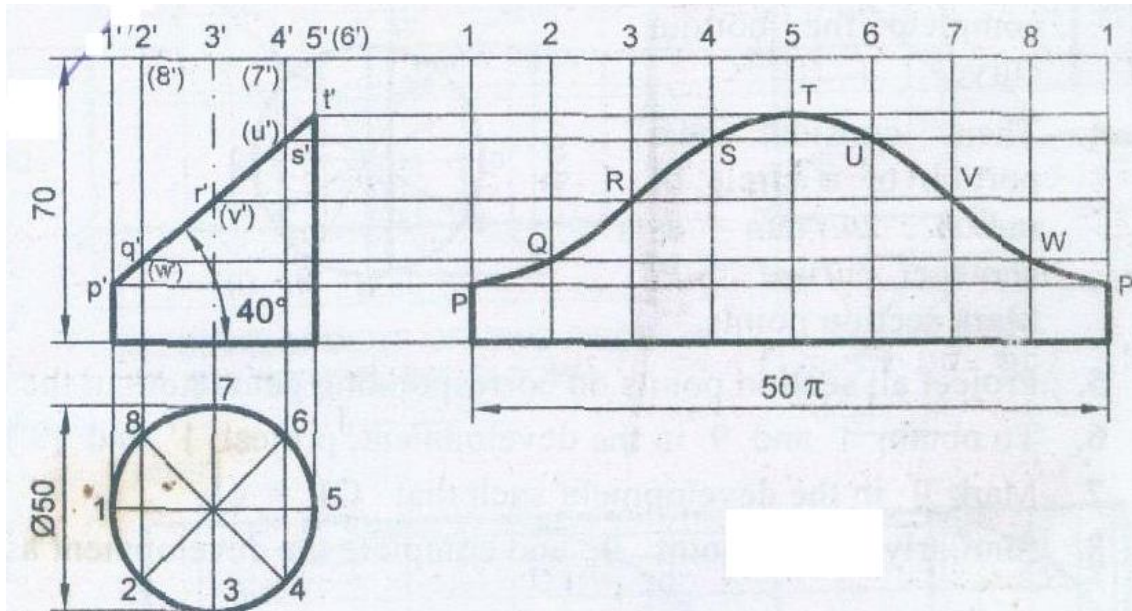
Solved Problems – 1: A hexagonal prism, edge of base 20mm and axis 50mm long, rests with its base on HP such that one of its rectangular faces is parallel to VP. It is cut by a plane perpendicular to VP, inclined at 45° to HP and passing through the right corner of the top face of the prism. Draw the sectional top view and develop the lateral surfaces of the truncated prism. (UQ)



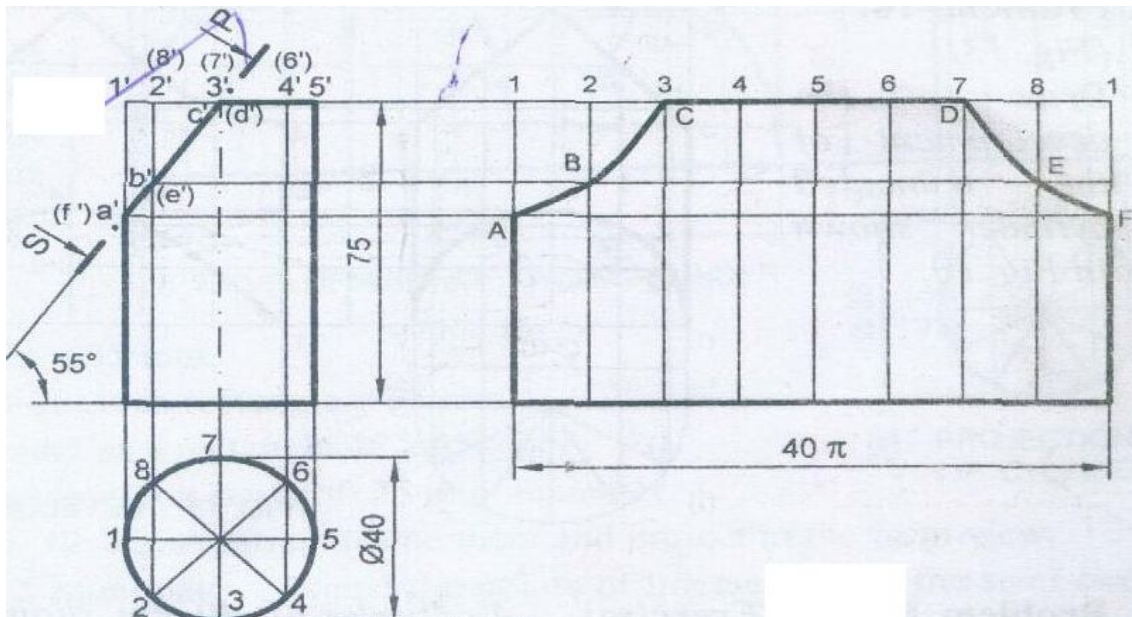
Solved Problems – 2: A vertical chimney of 70cm diameter joins a roof sloping at 35° with horizontal. The shortest portion over the roof is 32cm. Obtain the shape of the sheet metal from which chimney can be fabricated.



Solved Problems – 3: Draw the development of the lateral surface of the lower portion of the lower portion of a cylinder of diameter 50mm and axis 70mm when sectioned by a plane inclined at 40° to HP and perpendicular to VP and bisecting the axis. (UQ)

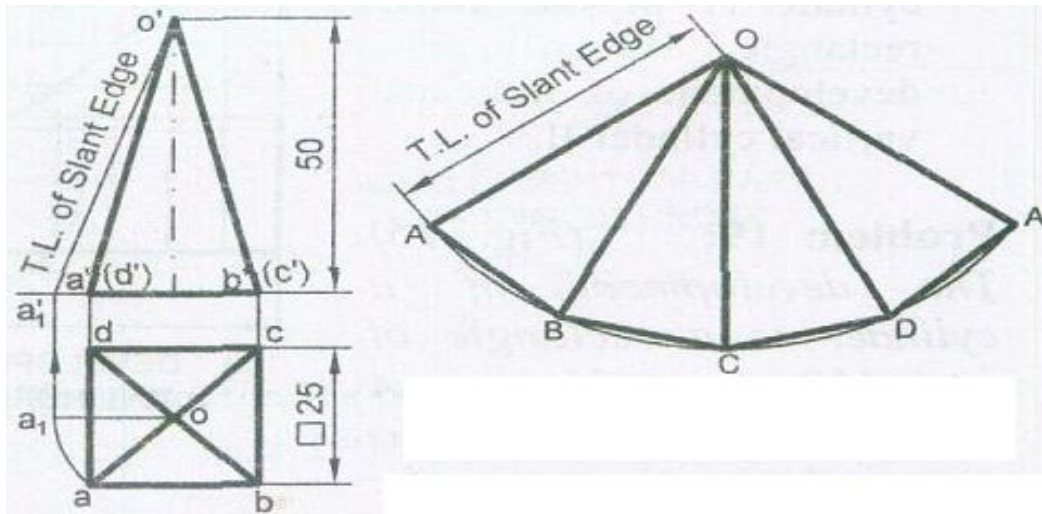


Solved Problem – 4: A cylinder of diameter 40mm, height 75mm is cut by a plane inclined at 55° to HP and perpendicular to VP is meeting the axis at top face. Draw the lateral development of the solid. (UQ)

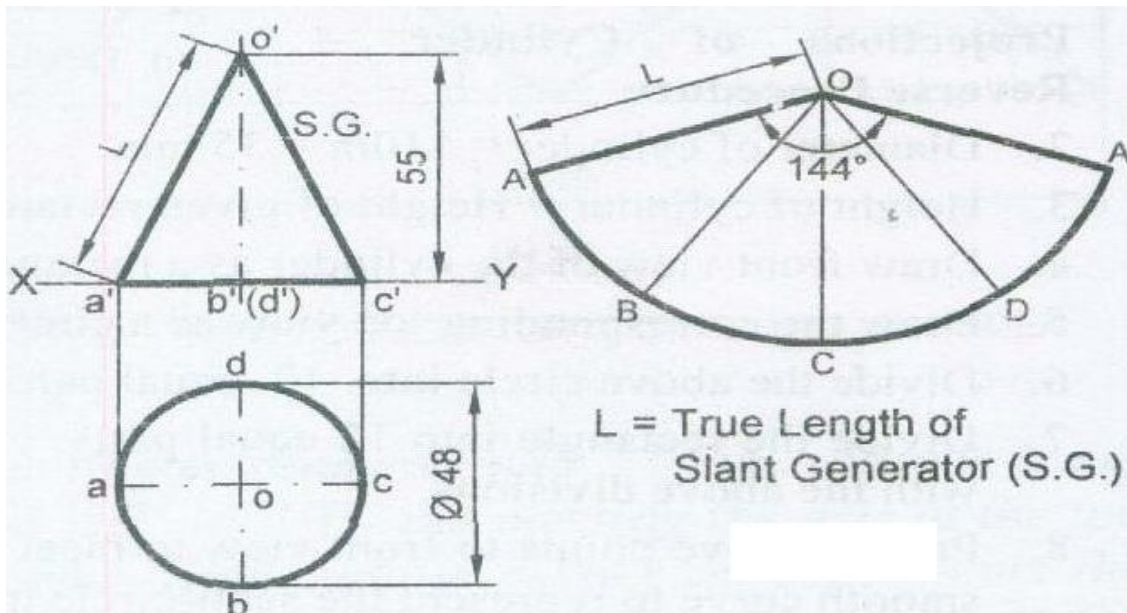


PYRAMIDS & CONES

For a pyramid development is formed by measuring the true slant edge from the simple position.

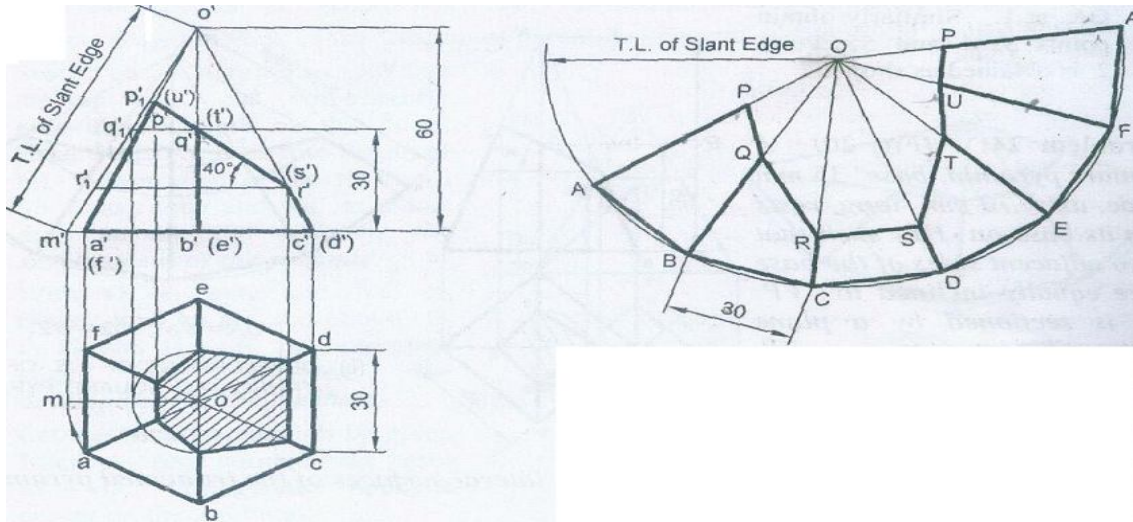


For a cone development is formed by using the formula $\theta = 360 * r/L$ where r = radius of the cone, L = true length of slant edge.

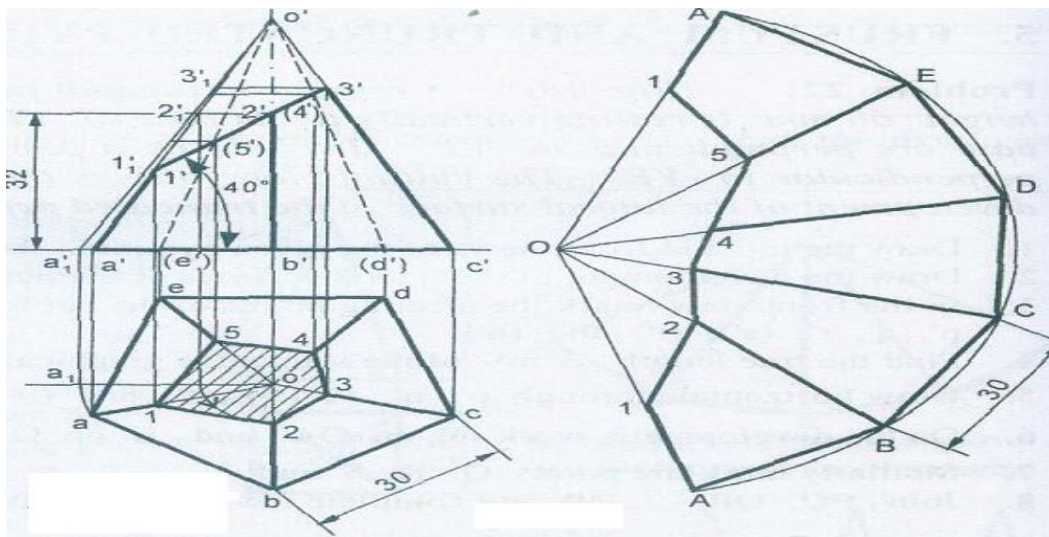


FRUSTUM & TRUNCATED PYRAMIDS & CONES

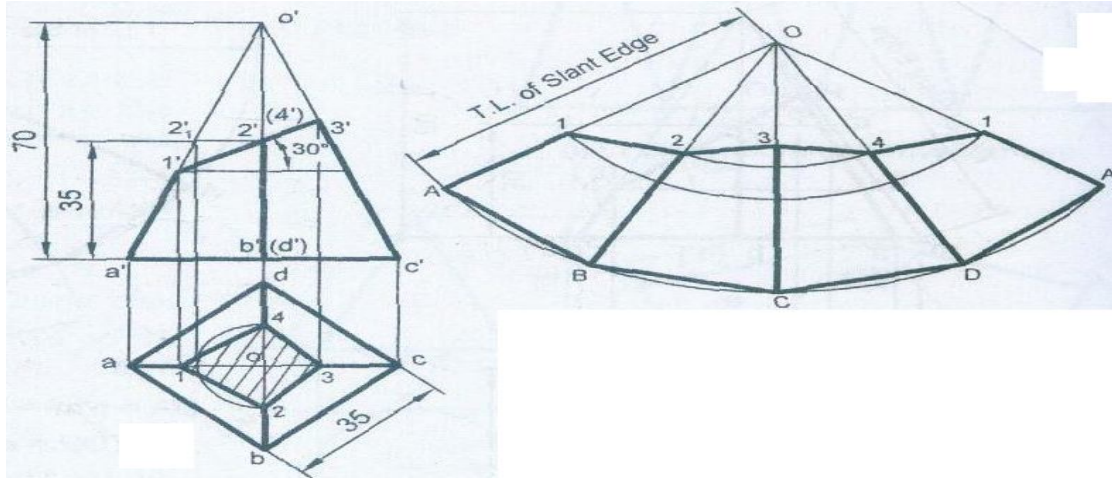
Solved Problems – 5: A regular hexagonal pyramid of side of base 30mm and height 60mm is resting vertically on its base on HP such that two of the sides of the base are perpendicular to VP. The cutting plane bisects the axis of the pyramid. Obtain the development of the lateral surface of the truncated pyramid. (UQ)



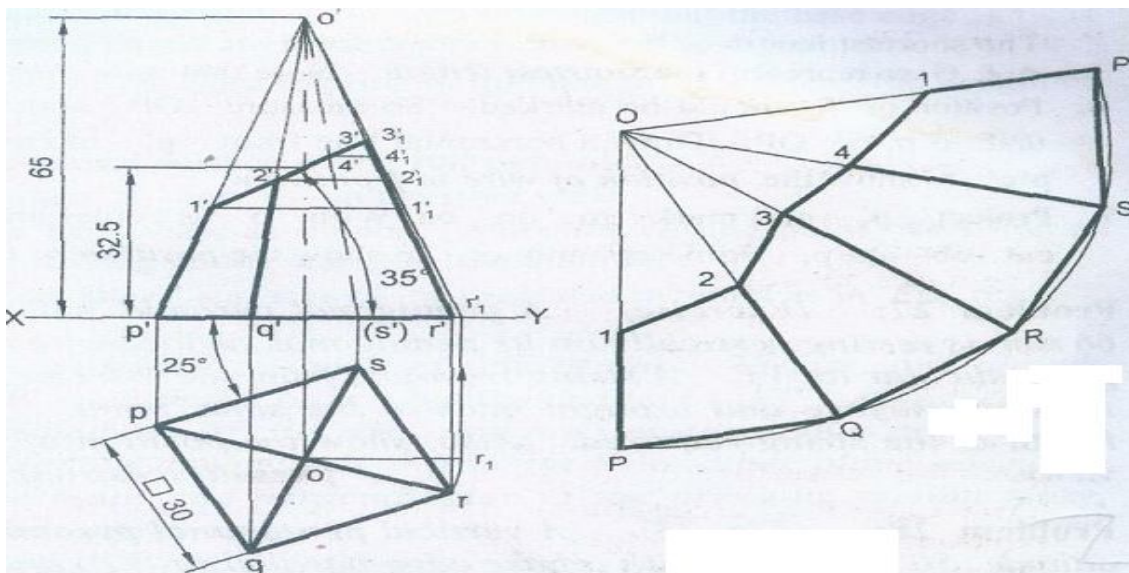
Solved Problems – 6: A pentagonal pyramid, side of base 30mm and height 52mm, stands with its base on HP and an edge of the base is parallel to VP and nearer to it. It is cut by a plane perpendicular in VP, inclined at 40° to HP and passing through a point on the axis, 32mm above the base. Draw the sectional top view, develop the lateral surface of truncated pyramid. (UQ)



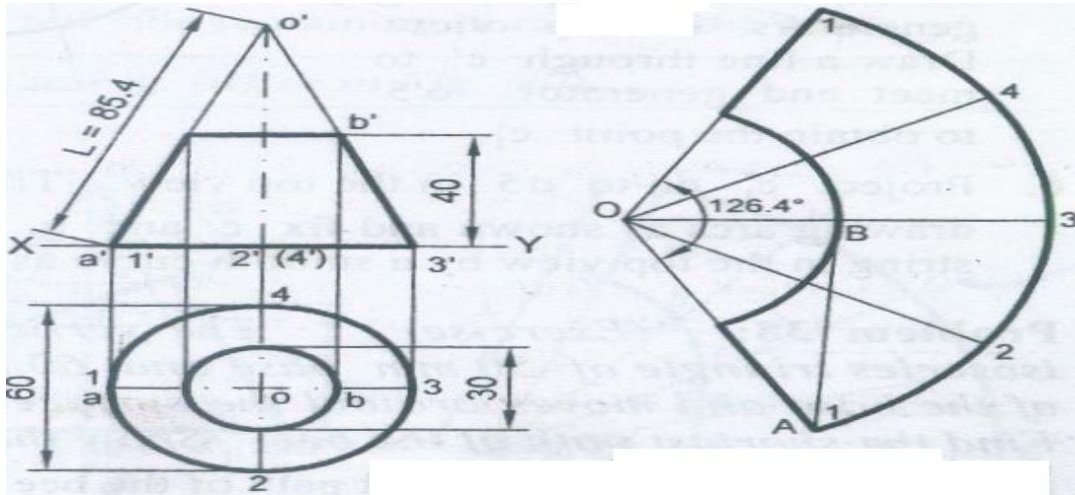
Solved Problems – 7: A square pyramid, base 35mm side, axis 70mm long, rests on its base on HP such that two adjacent sides of the base are equally inclined to VP. It is sectioned by a plane perpendicular to VP, inclined at 30° to HP and passing through the midpoint of the axis. (UQ)



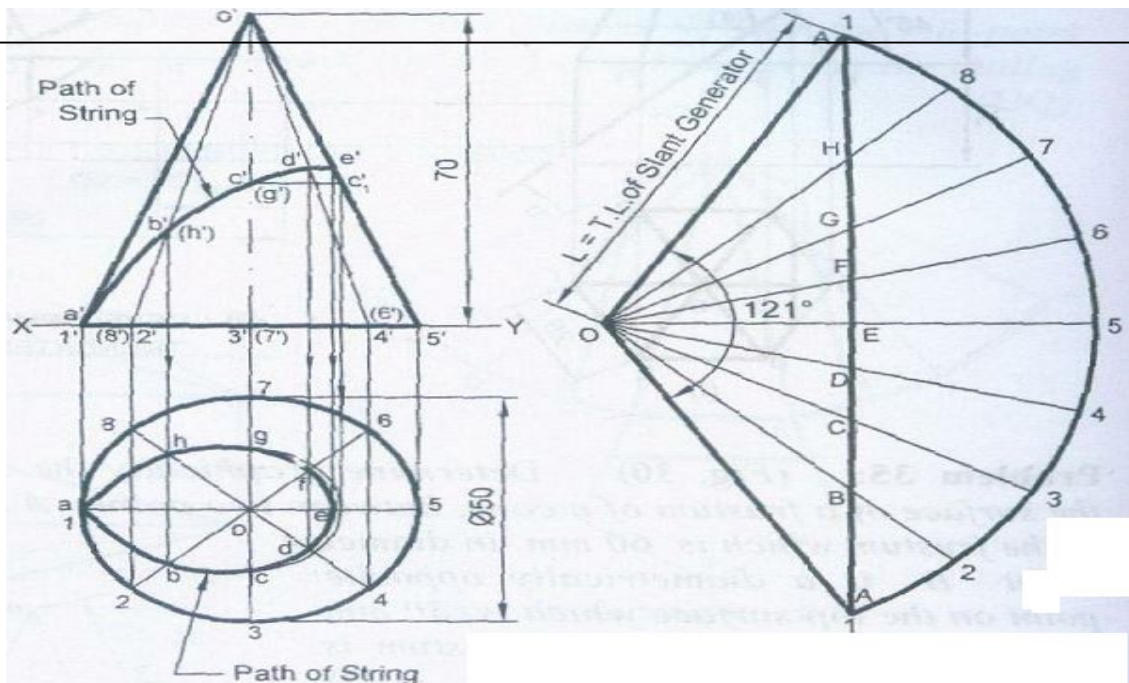
Solved Problem – 8: A square pyramid of base side 30mm and altitude 65mm is resting on HP on its base with a side of base inclined at 25° to VP. It is cut by a plane inclined at 35° to VP and bisecting the axis. Develop the lower portion of the pyramid. (UQ)



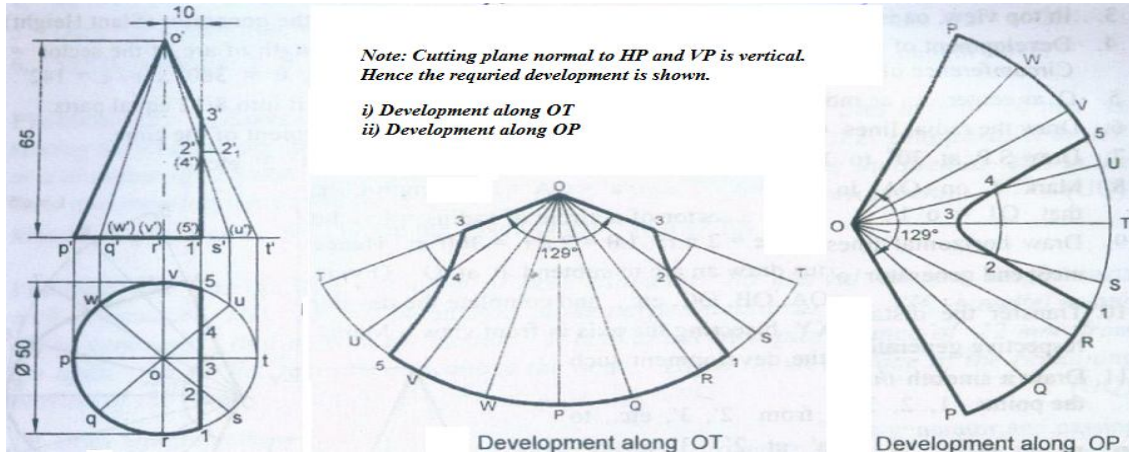
Solved Problems – 9: Determine the shortest length measured along the surface of frustum of a cone, between two points A and B. Point A is on the base of the frustum which is 60mm in diameter. Point B is a diametrically opposite point on the top surface which is 30mm in diameter. Height of the frustum is 40mm. (UQ)



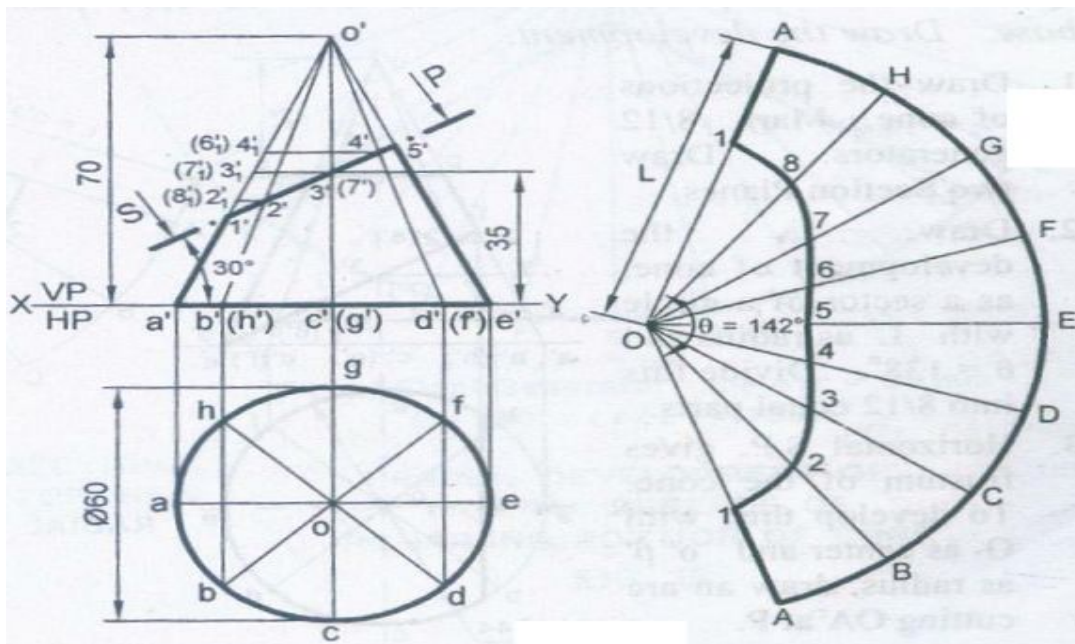
Solved Problems – 10: A cone of base diameter 50mm and height 70mm rests on its base on ground. A string is wound round the curved surface of the cone starting from left extreme point and ending at the same point. Find the shortest length of the string required. Trace the path of string in front and top views. (UQ)



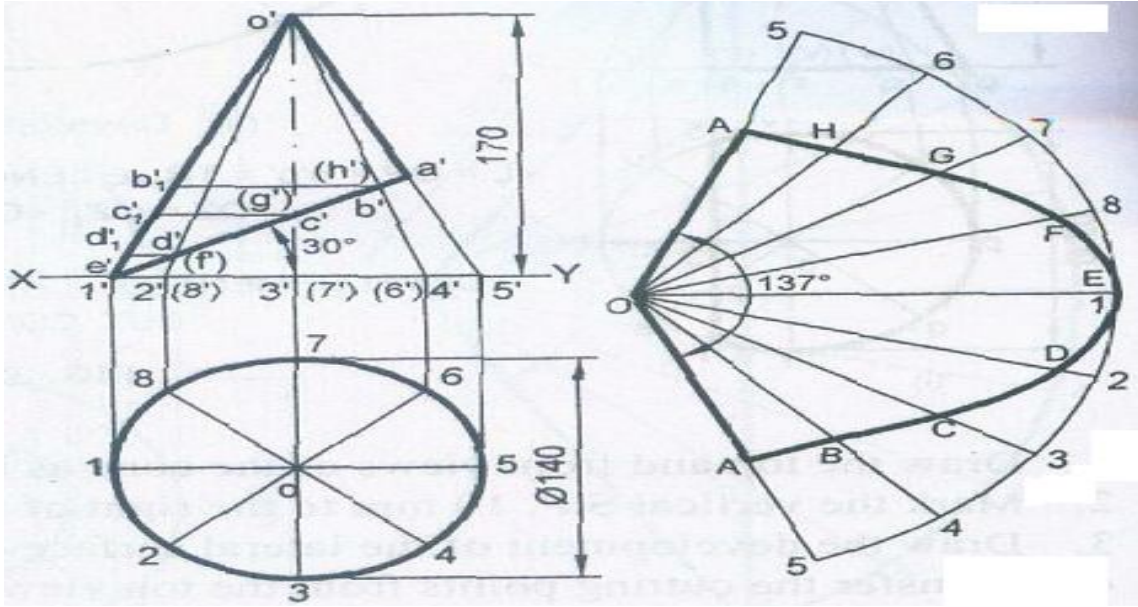
Solved Problems – 11: A cone of diameter of base 50mm and altitude 65mm is lying on its base on HP. It is sectioned by a plane normal to both HP and VP at a distance of 10mm to the right of the axis of the cone. Develop the lateral surface of the left side remaining portion. (UQ)



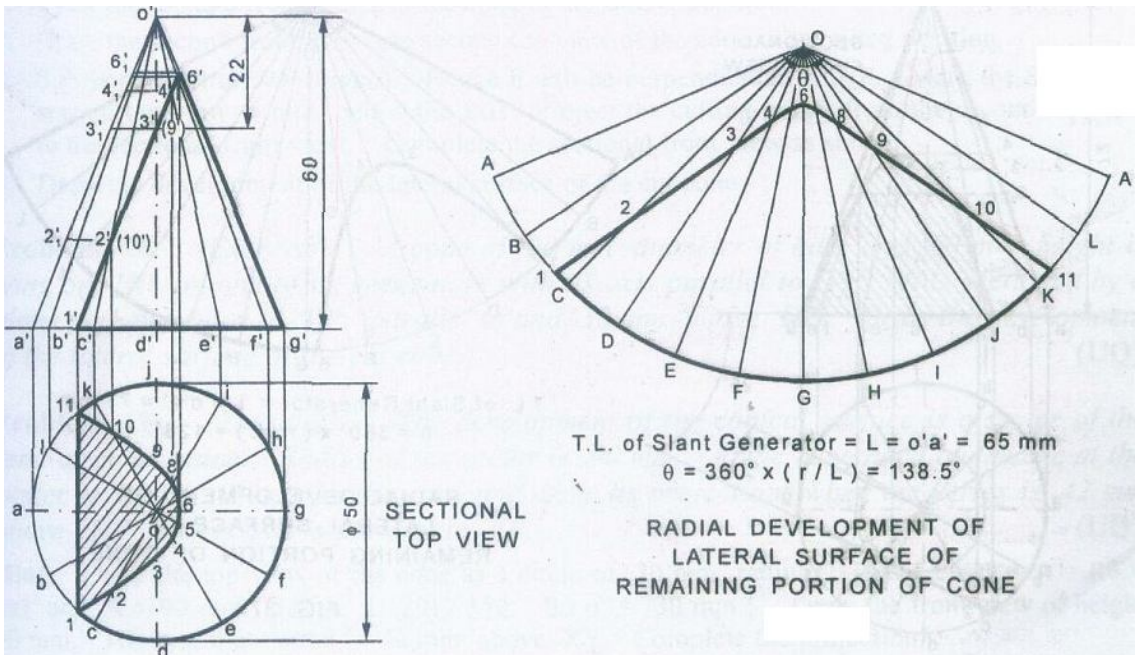
Solved Problems – 12: A cone of base diameter 60mm and height 70mm is resting on HP on its base. It is cut by a plane perpendicular to VP and inclined at 30° to HP. The plane bisects the axis of the cone. Develop its lateral surface. (UQ)



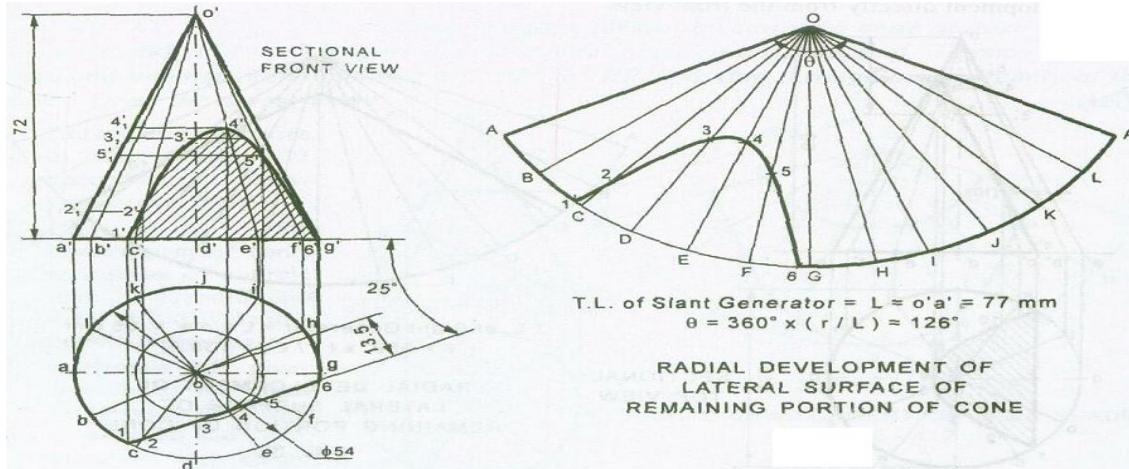
Solved Problems – 13: A lamp shade is formed by cutting a cone of base 140mm diameter and 170mm height by a horizontal plane inclined at 30° to HP is passing through one extremity of the base. Develop its lateral surface of the cone. (UQ)



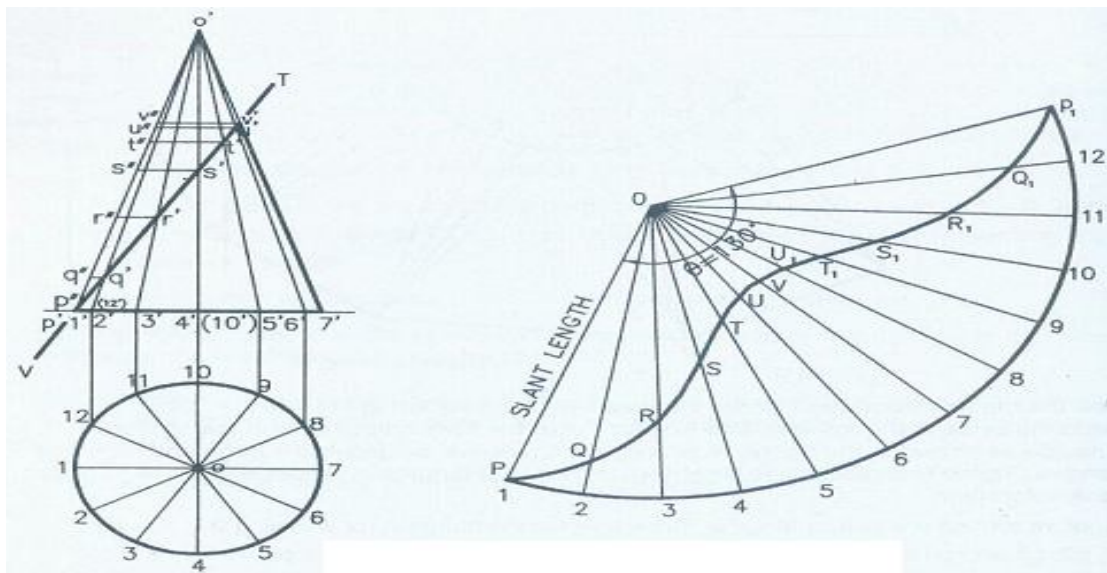
Solved Problems – 14: A cone of base 50mm diameter and 60mm height, rest with its on base on HP. It is cut by a section plane perpendicular to VP parallel to one of the generators and passing through a point on the axis at a distance of 22mm from the apex. Draw the sectional top view and develop the lateral surface of the remaining portion of the cone (UQ)



Solved Problems – 15: A cone, base 54mm diameter and height 72mm, rests with its base on HP. A section plane perpendicular to HP and inclined at 25° to VP cuts the cone at a distance of 13.5mm from the axis. Draw the sectional front view and develop the lateral surface of the remaining portion of the cone. (UQ)



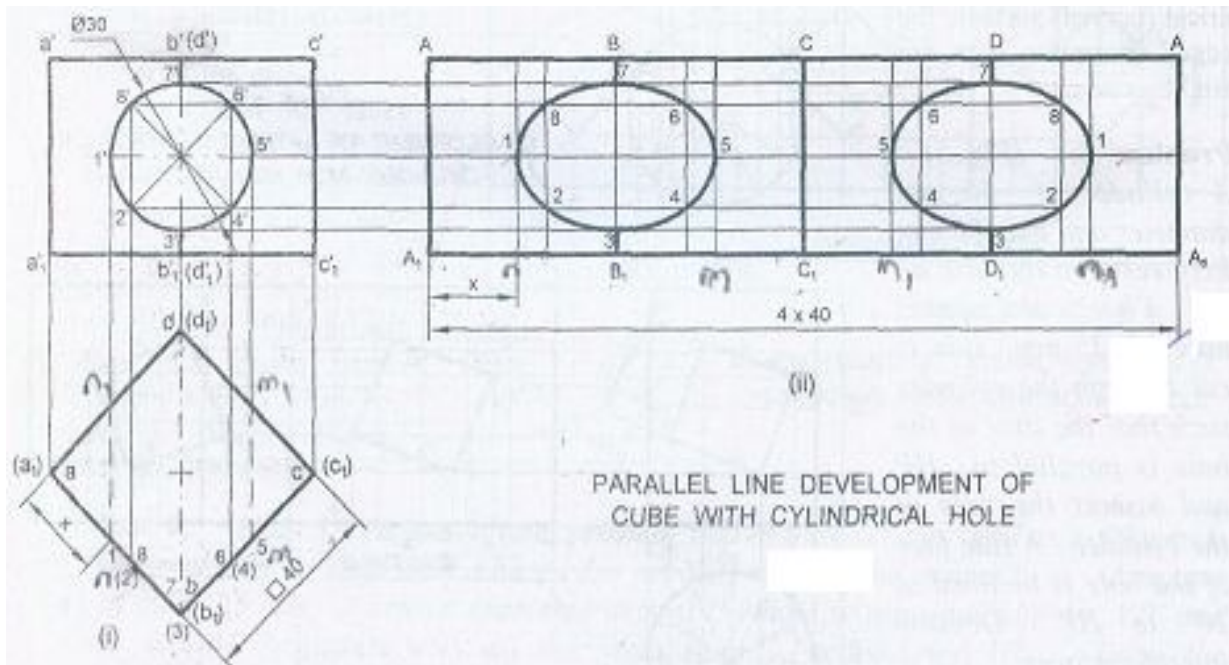
Solved Problems – 16: A cone of base diameter 70mm and axis length 90mm rests on its base on the HP. A cutting plane perpendicular to VP and inclined to the HP cuts the cone and passes through left extreme base point of the cone and the mid point of the axis. Draw the development of the lateral surface of the truncated cone. (UQ)



DEVELOPMENT OF SURFACE OF SOLIDS WITH CUTOUTS

PRISMS & CYLINDERS WITH CYLINDRICAL CUTOUTS

Solved Problems – 1: A cube of 40mm edge stands on one of its face on HP with a vertical face making 45° to VP. A horizontal cylindrical hole 30mm diameter is drilled centrally through the cube such that the hole passes through the opposite vertically edges of the cube. Develop the lateral surface of the cube having the hole. (UQ)



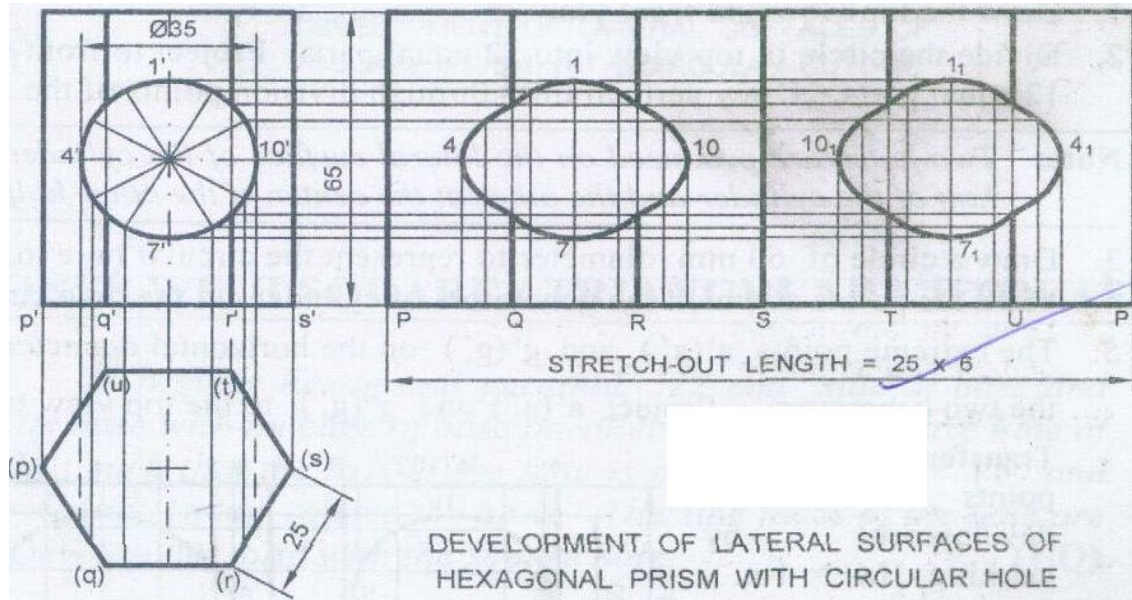
PARALLEL LINE DEVELOPMENT OF CUBE WITH CYLINDRICAL HOLE

1. Draw top and front views of the cube with circular hole.
2. Draw the development of the cube as a rectangle of length equal to the perimeter of the base and breadth equal to the side of the cube and show the vertical edges.

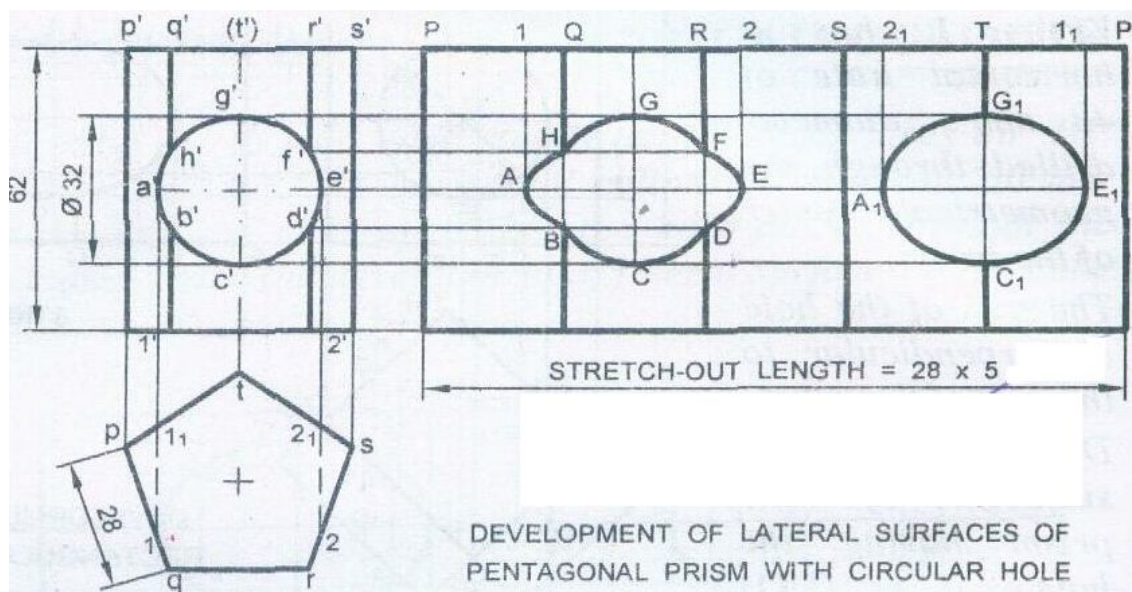
Development of Cylindrical Hole

3. Point $1'$ is on the face $a'b'b_1a_1'$ which is *not* in true size. Hence 1 in the development cannot be obtained directly from the front view.
4. To mark 1 in the development, project $1'$ to the top view and obtain 1 on ab which is in True Length.
5. Mark 1_1 on AA_1 such that $AA_1 = a_1a = x$.
6. Draw a vertical line from 1_1 to cut the horizontal line drawn from $1'$ at 1.
7. Similarly obtain other points and join them by a smooth curve (*Ellipse* in this case). This ellipse represents the development of the circle in the front.
8. Draw a similar curve (*Ellipse*) in the development to represent the hole in the rear side. This second curve is the mirror reflection of the first ellipse.

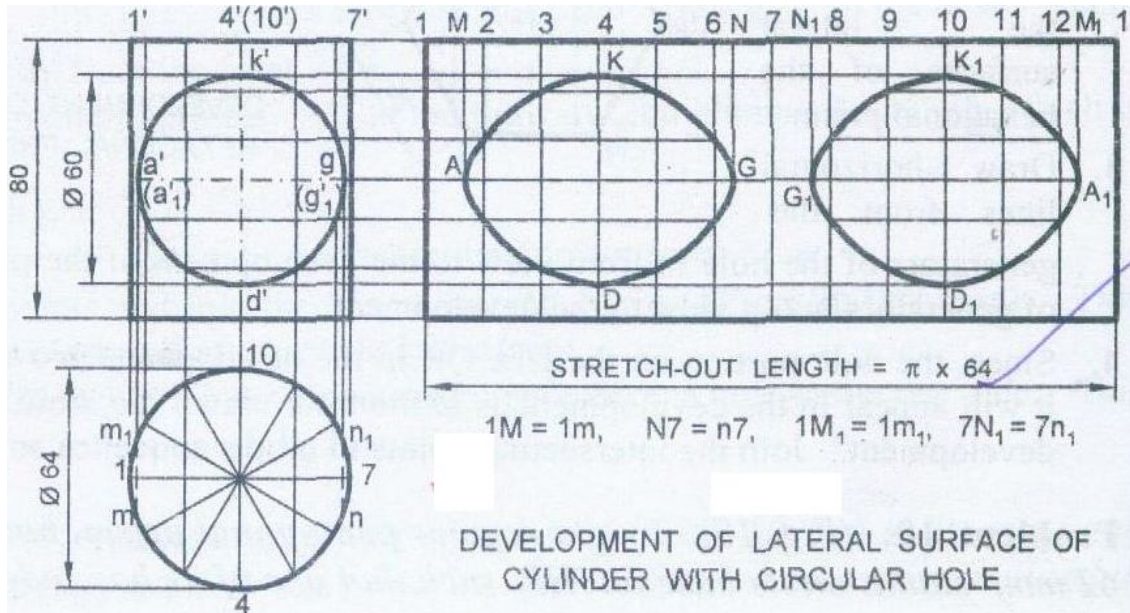
Solved Problems – 2: A hexagonal prism of side of base 25mm and altitude 65mm rests on its base on HP, having a rectangular face of the prism parallel to VP. A horizontal hole of 35mm diameter is centrally drilled in such that the axis of the hole is normal to VP. Develop the lateral surfaces of the prism with the prism with the shape of the hole. (UQ)



Solved Problems – 3: A right regular pentagonal prism, base edge 28mm & altitude 62mm stands on its base on HP such that one of its base edge is parallel to VP and nearer to the observer. Through the centre of rectangular face containing the base edge, a hole of 32mm diameter is drilled through, such that the hole axis is horizontal. Develop the lateral surface. (UQ)

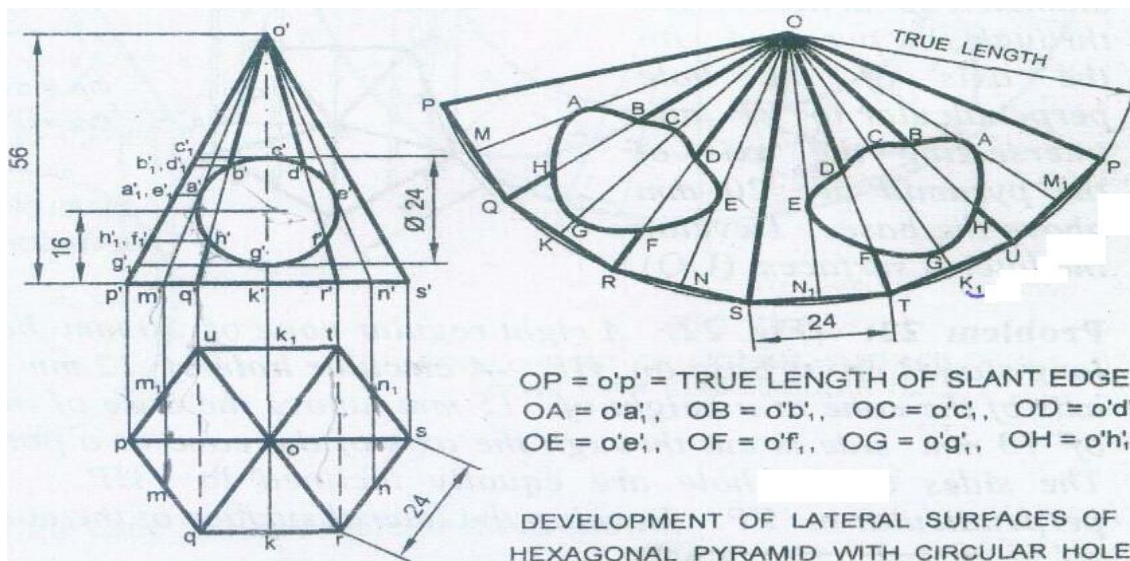


Solved Problems – 4: A cylinder of base diameter 64mm and axis length 80mm rests on its base. A hole of 60mm diameter is drilled on the surface of cylinder. The axis of the hole intersects with the axis of the cylinder at the right angles and bisects the axis of the cylinder. Draw the development.

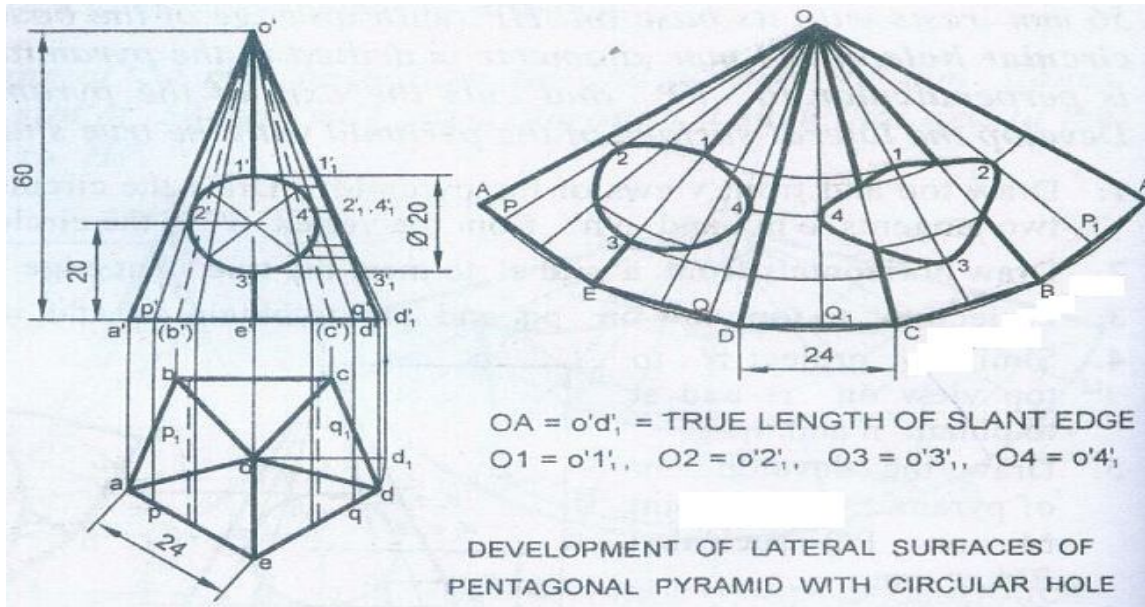


PYRAMIDS & CONES WITH CYLINDRICAL CUTOUTS

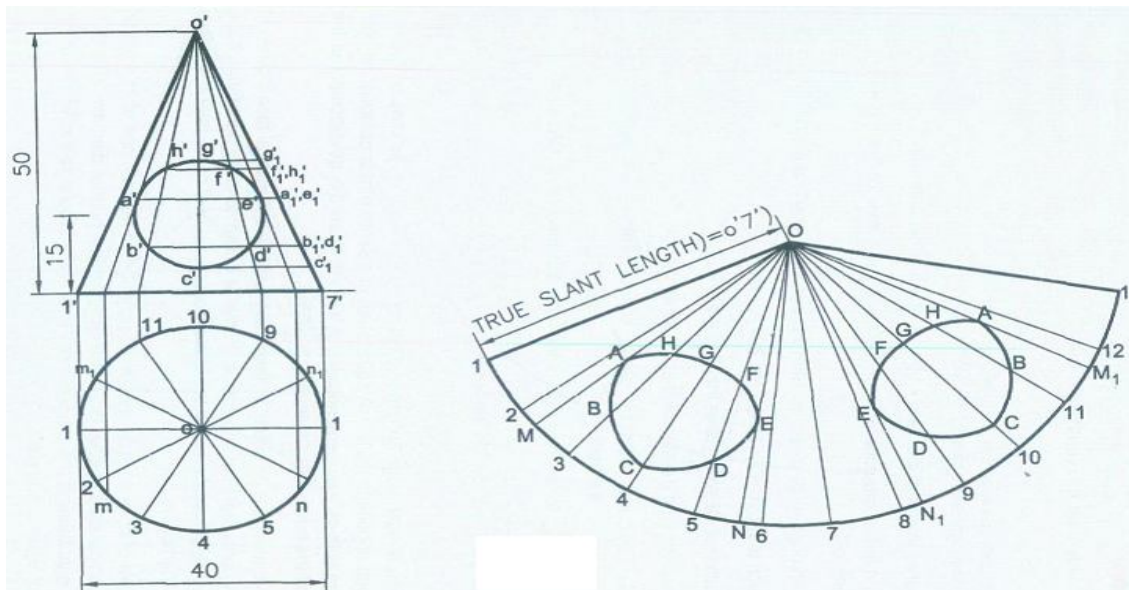
Solved Problems – 5: A hexagonal pyramid of side of base 24mm and altitude 56mm rests with its base on HP with an edge of the base parallel to VP. A hole of 24mm diameter is drilled through the pyramid such that the axis of the hole is perpendicular to VP and cuts the axis of the pyramid 16mm above the base. Develop the lateral surface of pyramid with the true shape of the hole cut in it. (UQ)



Solved Problems – 6: A pentagonal pyramid of base edge 24mm and axis 60mm long rests on its base on HP with a base edge parallel to VP and away from the observer. A hole of 20mm diameter is drilled right through pyramid with the axis of the hole perpendicular to VP and intersecting the axis of the pyramid at 20mm above the base. Draw the development of the pyramid. (UQ)



Solved Problems – 7: A cone of base diameter 40mm and height 50mm stands on its base on the HP. A cylindrical hole of diameter 20mm is drilled through the cone. The axis of the hole is perpendicular to the VP and meets the axis of the cone at 15mm above the base of the cone. Draw the development of the lateral surface of the cone with the hole.



Exercise Problem:

- *Draw the development of the lateral surface of a hexagonal prism of 24mm base edge and 68mm height. An insect moves on its surface from a corner on the base to the diametrically opposite corner of the top face by the shortest route. Trace graphically the path of the insect in front view. (UQ)*
- *A square pyramid of base side 35mm and axis 60mm rests on its base on the ground with one of the sides of the base inclined at 30° to the VP. A string is wound round the surfaces of the pyramid starting from left extreme point on the base and ending at the same point. Find the shortest length of the string required. Also trace the path of the string in the front and top views.*
- *A right circular cone of base diameter 60mm and height 70mm is resting on its base on the ground. It is cut by a plane perpendicular to the VP and inclined at 30° to the HP. The cutting plane bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone.*
- *A lamp shade is formed by cutting a cone of base 144mm diameter and 174mm height by a horizontal plane at a distance of 72mm from the apex and another plane inclined at 30° to HP, passing through one extremity of the base. Draw the development.*
- *A pentagonal prism, side of base 25mm and altitude 50mm, rests on its base on the HP such that an edge of the base is parallel to VP and nearer to the observer. It is cut by a plane inclined at 45° to HP, perpendicular to VP and passing through the center of the axis. Draw the true shape of the section.*