PROJECTION OF SOLIDS

A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the number of which depends on the type of solid and its orientation with respect to the planes of projection. solids are classified into two major groups. (i) Polyhedral, and (ii) Solids of revolution

POLYHEDRAL:

A polyhedral is defined as a solid bounded by plane surfaces called faces. They are: (i)Regular polyhedral (ii) Prisms and (iii) Pyramids

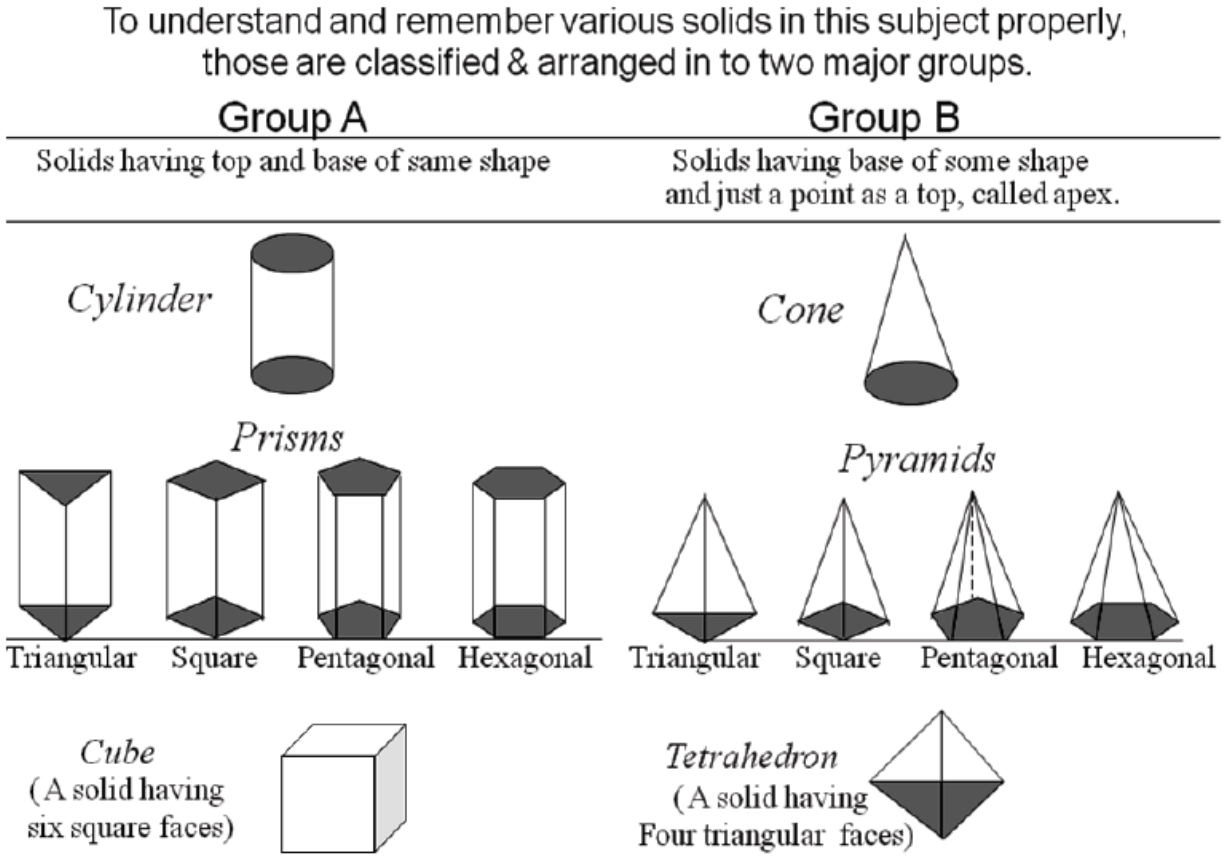
Regular Polyhedral

A polyhedron is said to be regular if its surfaces are regular polygons. The following are some of the regular polyhedral.

SOLIDS

Prisms: A prism is a polyhedron having two equal ends called the bases parallel to each other. The two bases are joined by faces, which are rectangular in shape. The imaginary line passing through the centers of the bases is called the axis of the prism.

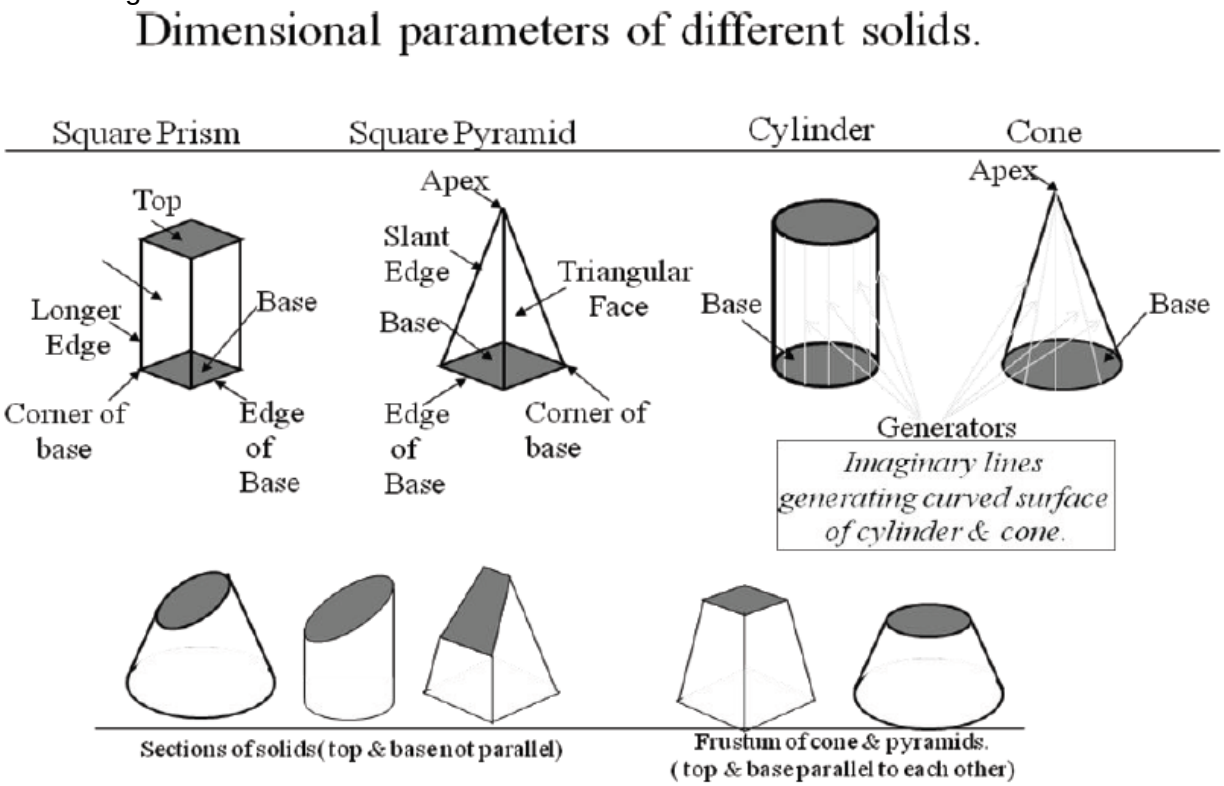
A prism is named after the shape of its base. For example, a prism with square base is called a square prism, the one with a pentagonal base is called a pentagonal prism, and so on (Fig) The nomenclature of the prism is given in Fig.



(a) **Tetrahedron:** It consists of four equal faces, each one being a equilateral triangle.
(b) **Hexa hedron(cube):** It consists of six equal faces, each a square.
(c) **Octahedron**: It has eight equal faces, each an equilateral triangle.
(d) **Dodecahedron**: It has twelve regular and equal pentagonal faces.
(e) **Icosahedrons**: It has twenty equal, equilateral triangular faces.

Pyramids: A pyramid is a polyhedron having one base, with a number of isosceles triangular faces, meeting at a point called the apex. The imaginary line passing through the centre of the base and the apex is called the axis of the pyramid.

The pyramid is named after the shape of the base. Thus, a square pyramid has a square base and pentagonal pyramid has pentagonal base and so on. The nomenclature of a pyramid is shown in Fig.



Types of Pyramids:

There are many types of Pyramids, and they are named after the shape of their base. These are Triangular Pyramid, Square Pyramid, Pentagonal pyramid, hexagonal pyramid and etrahedron.

Solids of Revolution: If a plane surface is revolved about one of its edges, the solid generated is called a solid of revolution. The examples are (i) Cylinder, (ii) Cone, (iii) Sphere.

Frustums and Truncated Solids: If a cone or pyramid is cut by a section plane parallel to its base and the portion containing the apex or vertex is removed, the remaining portion is called frustum of a cone or pyramid.

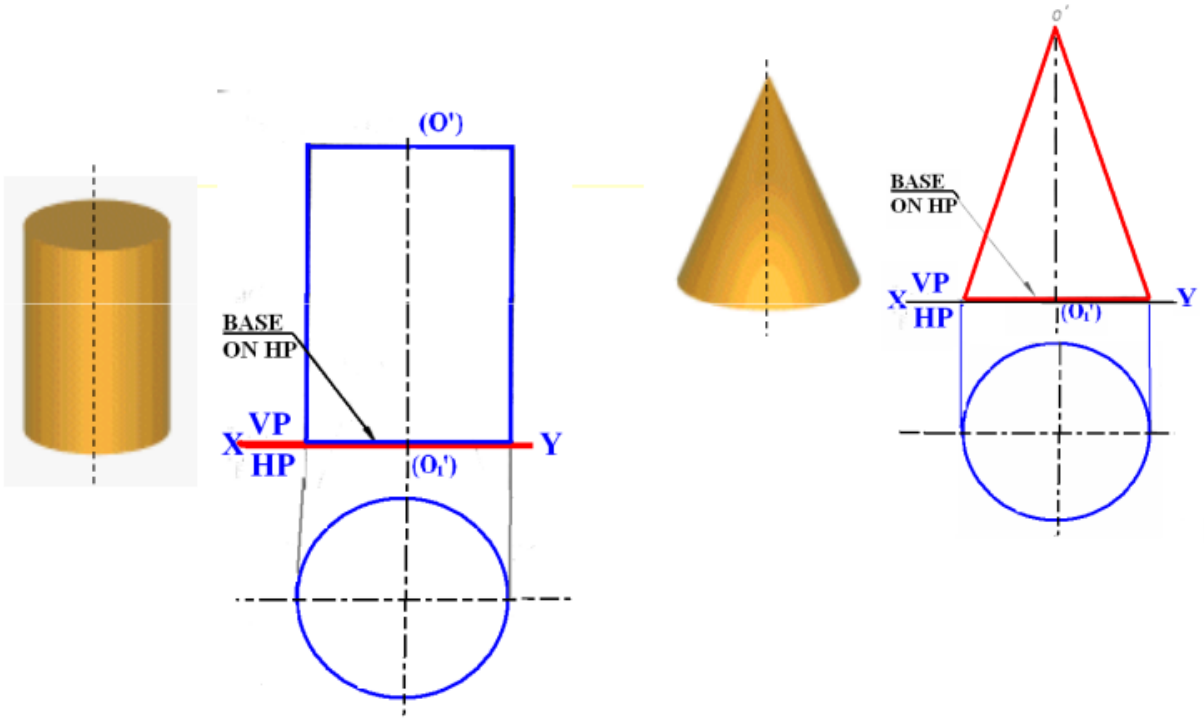
Prisms Position of a Solid with Respect to the Reference Planes: The position of solid in space may be specified by the location of the axis, base, edge, diagonal or face with the principal planes of projection. The following are the positions of a solid considered.

1. Axis perpendicular to HP
2. Axis perpendicular to VP
3. Axis parallel to both the HP and VP
4. Axis inclined to HP and parallel to VP
5. Axis inclined to VP and parallel to HP
6. Axis inclined to both the Planes (VP. and HP)

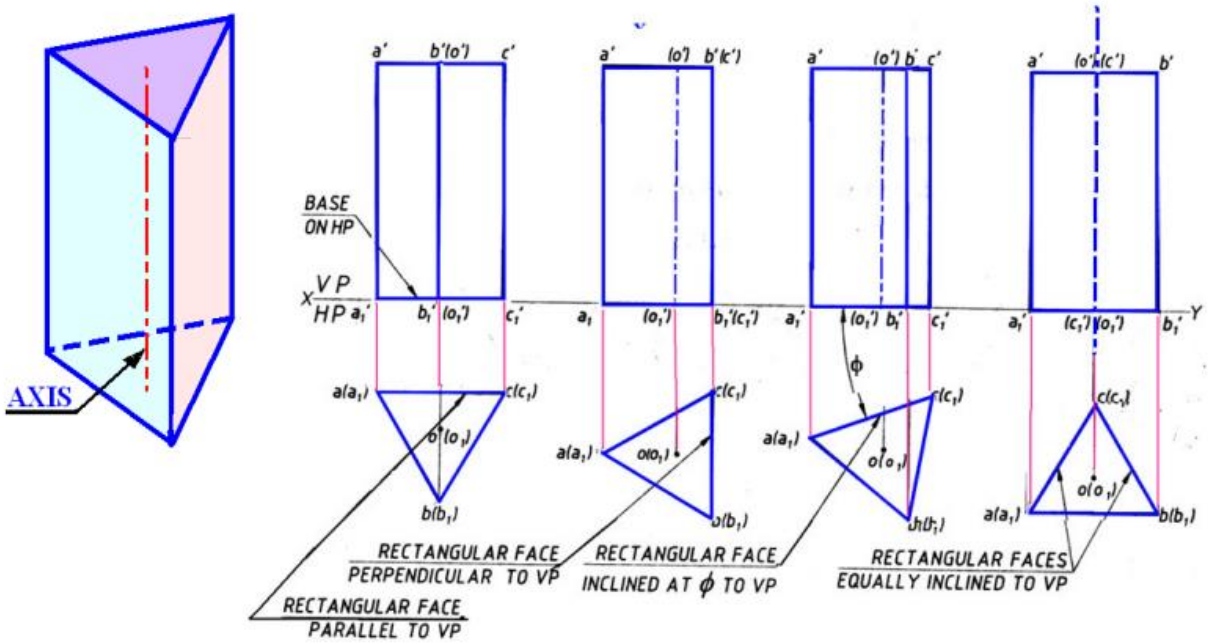
The position of solid with reference to the principal planes may also be grouped as follows:
1. Solid resting on its base.
2. Solid resting on anyone of its faces, edges of faces, edges of base, generators, slant edges, etc.
3. Solid suspended freely from one of its corners, etc.

Simple Problems:
When the axis of solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base. When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from it. Similarly when the axis of the solid is perpendicular to V.P, the front view must be drawn first and then the top view is projected from it.

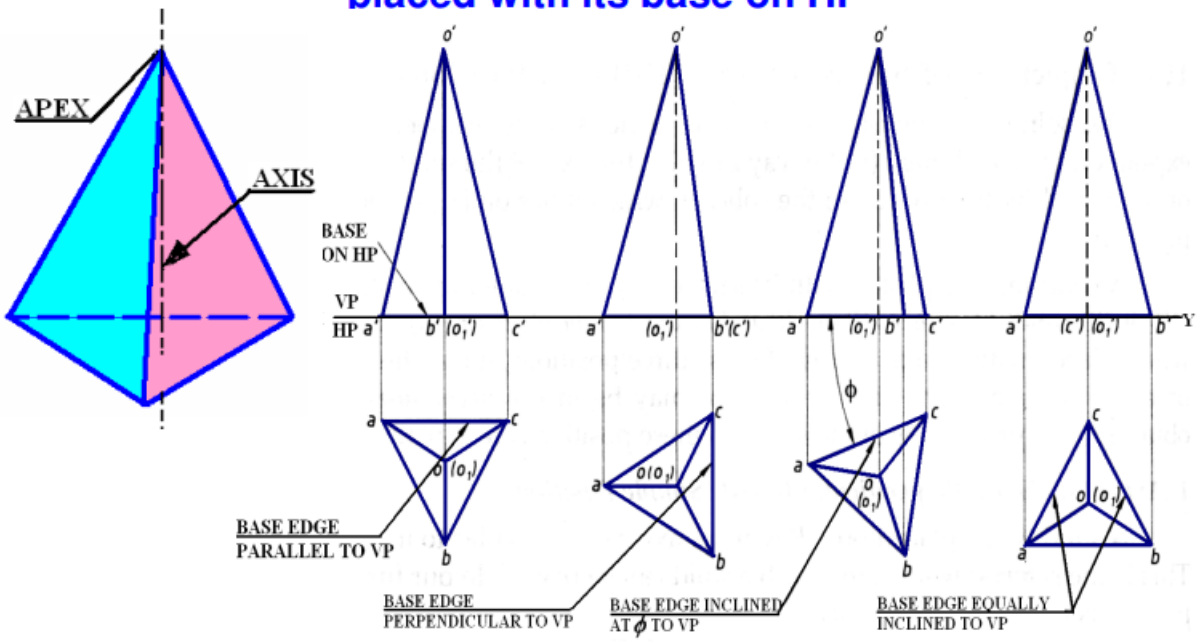
1. Axis perpendicular to HP



Four positions of a prism placed with its base on HP.

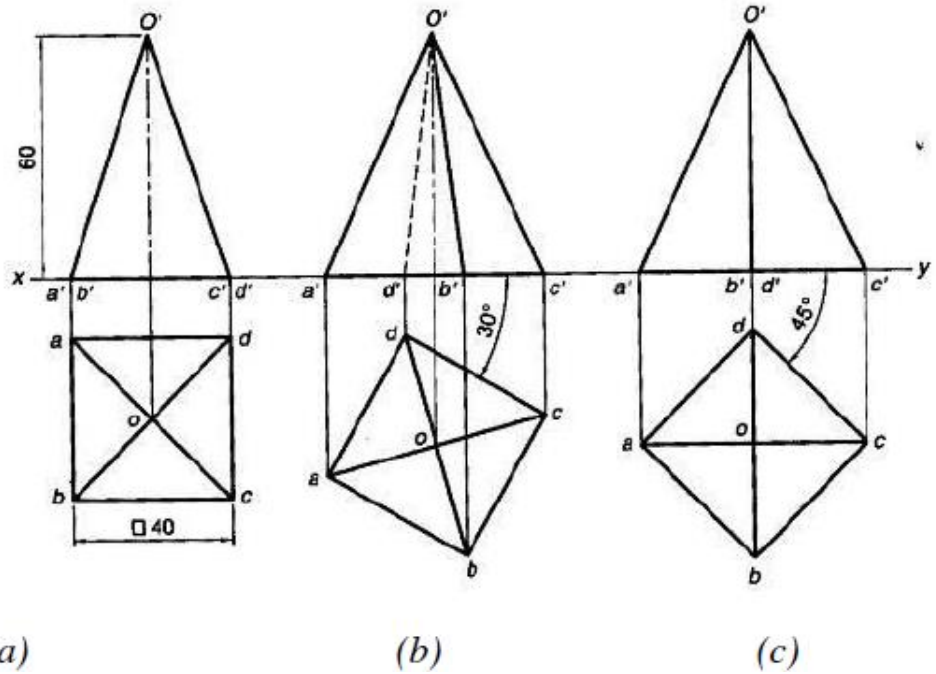


Four positions of a triangular pyramid placed with its base on HP



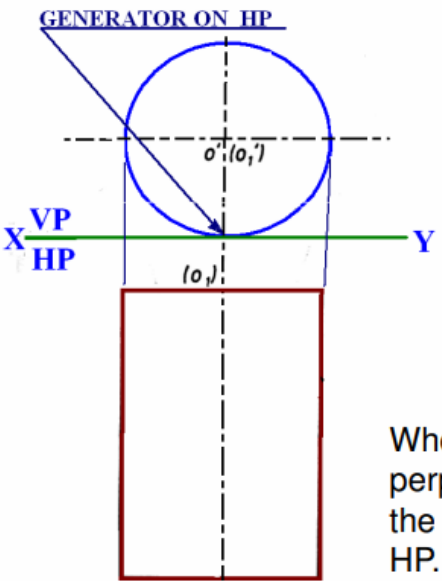
Problem:- A Square Pyramid, having base with a 40 mm side and 60mm axis is resting on its base on the HP. Draw its Projections when (a) a side of the base is parallel to the VP. (b) A side

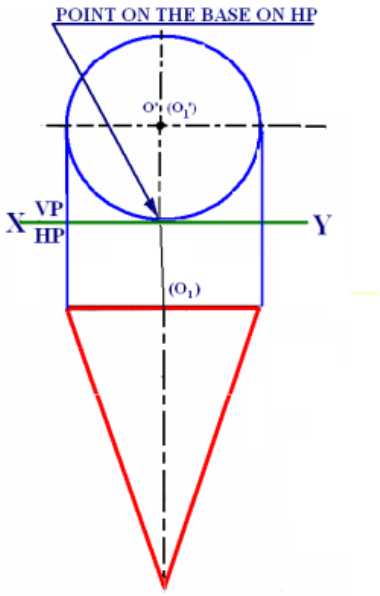
of the base is inclined at 30° to the VP and (c) All the sides of base are equally inclined to the VP. Solution:



2. Axis perpendicular to VP

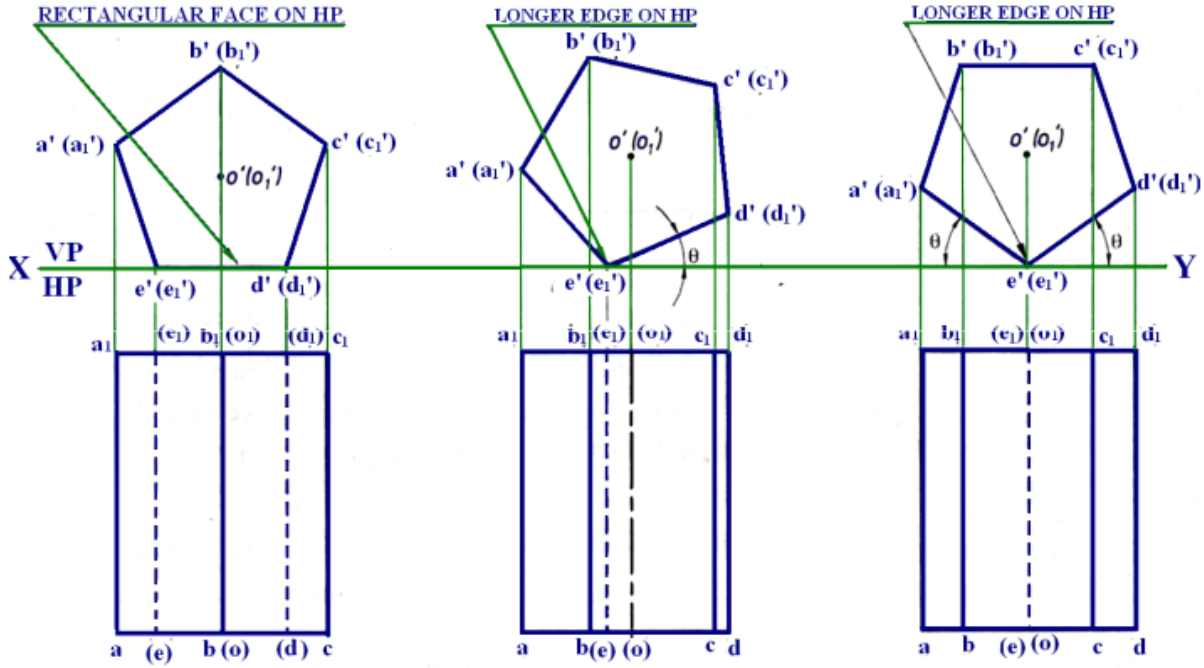
When a cylinder rests on HP with its axis perpendicular to VP, one of its generators will be on HP.



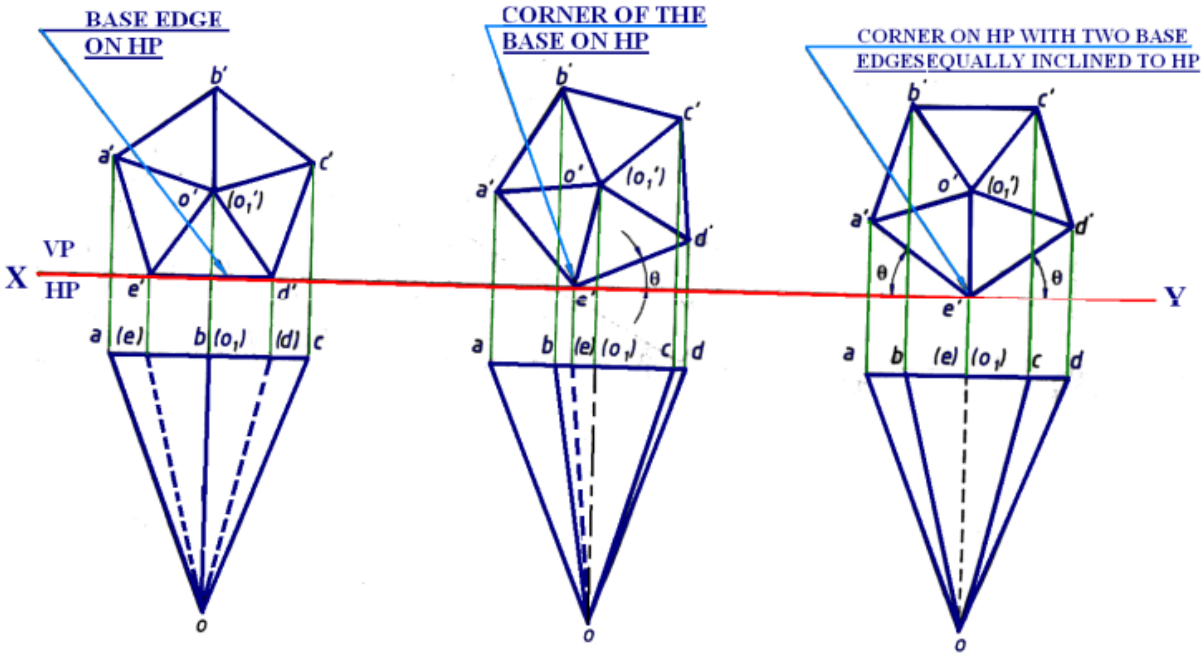


When a cone rests on HP with its axis perpendicular to VP, one of the points on the circumference of the base will be on HP.

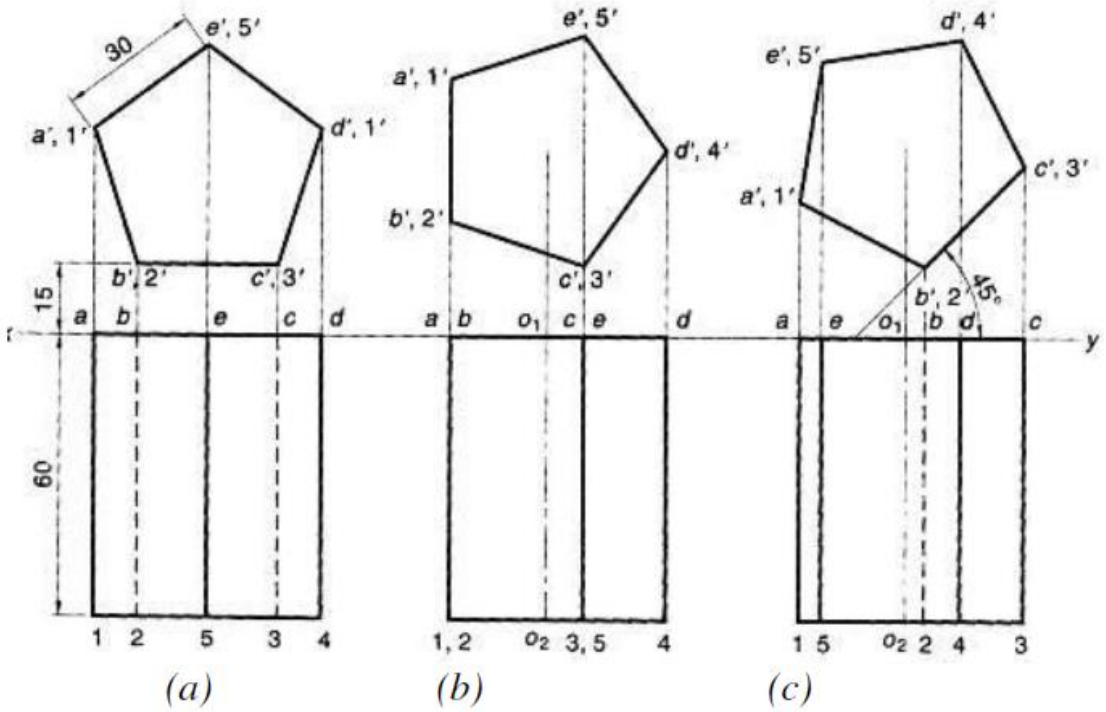
Prism placed with their axis perpendicular to VP in three different positions.



Pyramid placed with their axis perpendicular to VP in three different positions.

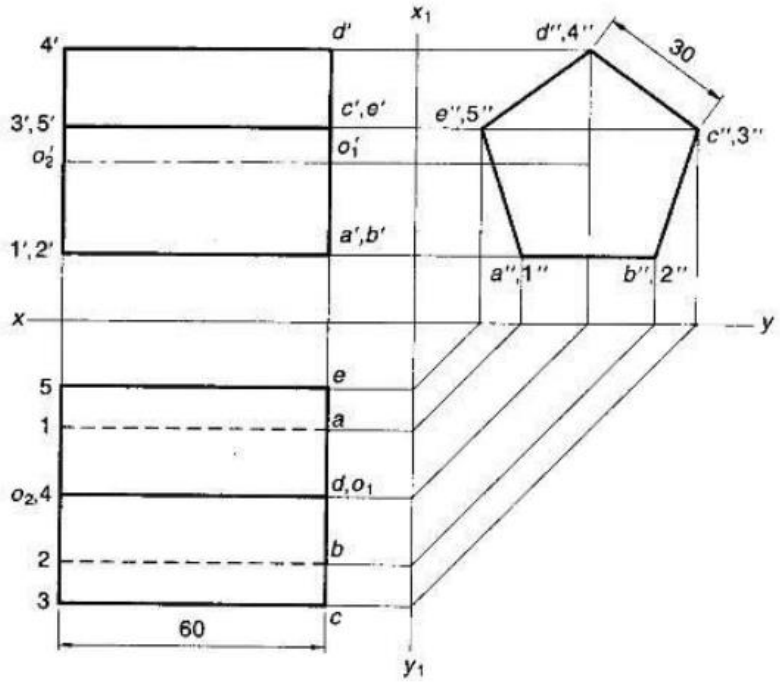


Problem:- A pentagonal Prism having a base with 30 mm side and 60mm long Axis, has one of Its bases in the VP. Draw Its projections When (a) rectangular face is parallel to and 15 mm above the HP (b) A rectangular face perpendicular to HP and (c) a rectangular face is inclined at 45_0 to the HP.



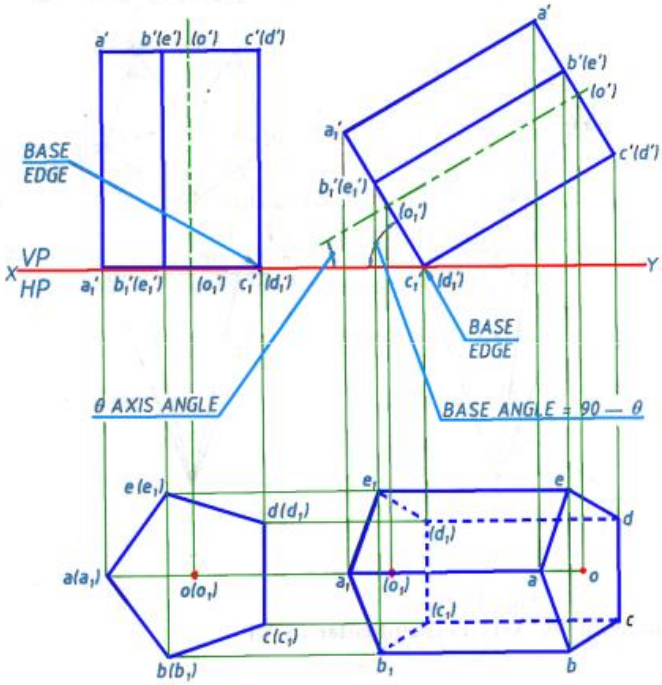
3. Axis parallel to both the HP and VP

Problem:- A pentagonal Prism having a base with a 30 mm side and 60mm long axis, is resting on one of its rectangular faces on the HP. with axis parallel to the VP. Draw its projections?



4. Axis inclined to HP and parallel to VP

When the solid lies with an edge of base on HP



When a **pentagonal prism** has to be placed with **an edge of base on HP** such that the **base or axis is inclined to HP**, then initially, **the prism is placed with its base on HP with an edge of the base perpendicular to VP and the lying on the right side.**

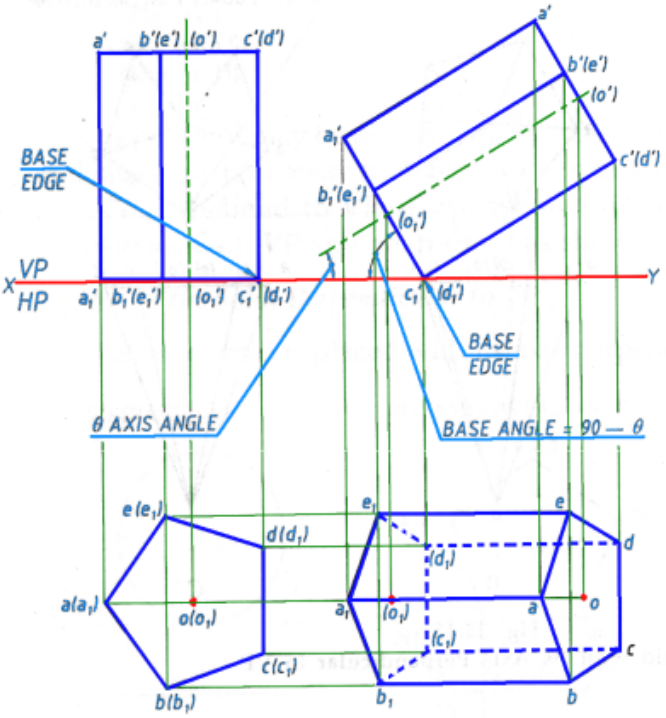
In this position, the first set of top and front views are drawn with the base edges **$(c_1)(d_1)$** perpendicular to **XY** line in the top view. In the front view, this edge **$c_1'(d_1')$** appears as a point.

Since the prism has to lie with an edge of the base on **HP**, the front view of the prism is tilted on the edge **$c_1'(d_1')$** such that the axis is inclined at **θ** to **HP**.

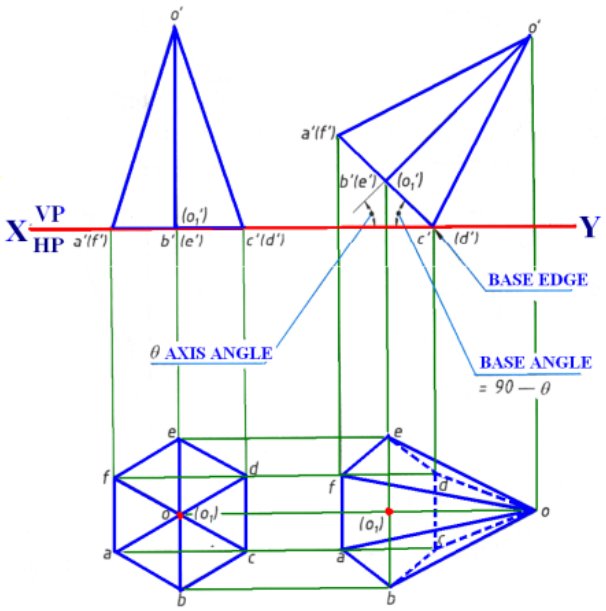
Redraw the first front view in the tilted position.

Whenever the inclination of axis **θ** with **HP** is given, first the base is drawn at **(90- θ)** in the front view, otherwise improper selection of the position of the axis may result in the base edge **$c_1'(d_1')$** lying above or below the **XY** line.

The second top view is projected by drawing the vertical projectors from the corners of the second front view and the horizontal projectors from the first top view.



Top and the front views of a hexagonal pyramid when it lies on HP on one of its base edges with its axis or the base inclined to HP.

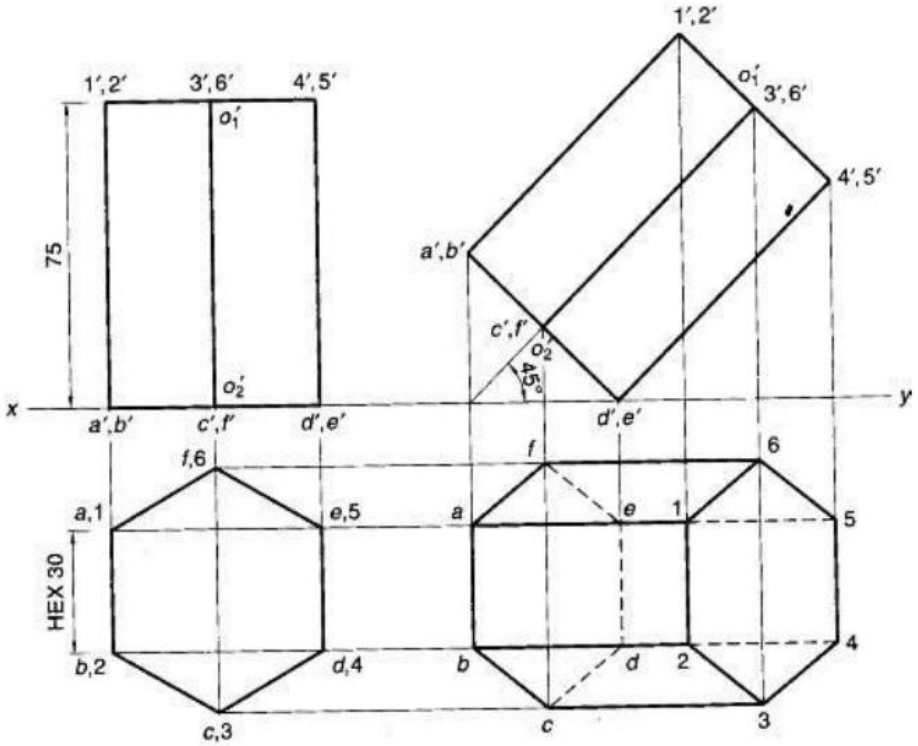


Problem: - A Hexagonal Prism having a base with a30 mm side and 75 mm long axis, has an edge its base on the HP. Its axis is Parallel to the VP and inclined at 45$_0$ to the HP Draw its projections?

1.Axis inclined to HP and Parallel to VP ⟶ have to solve in two stages

Stage(i) assume axis perpendicular to HP then draw Top and Front view

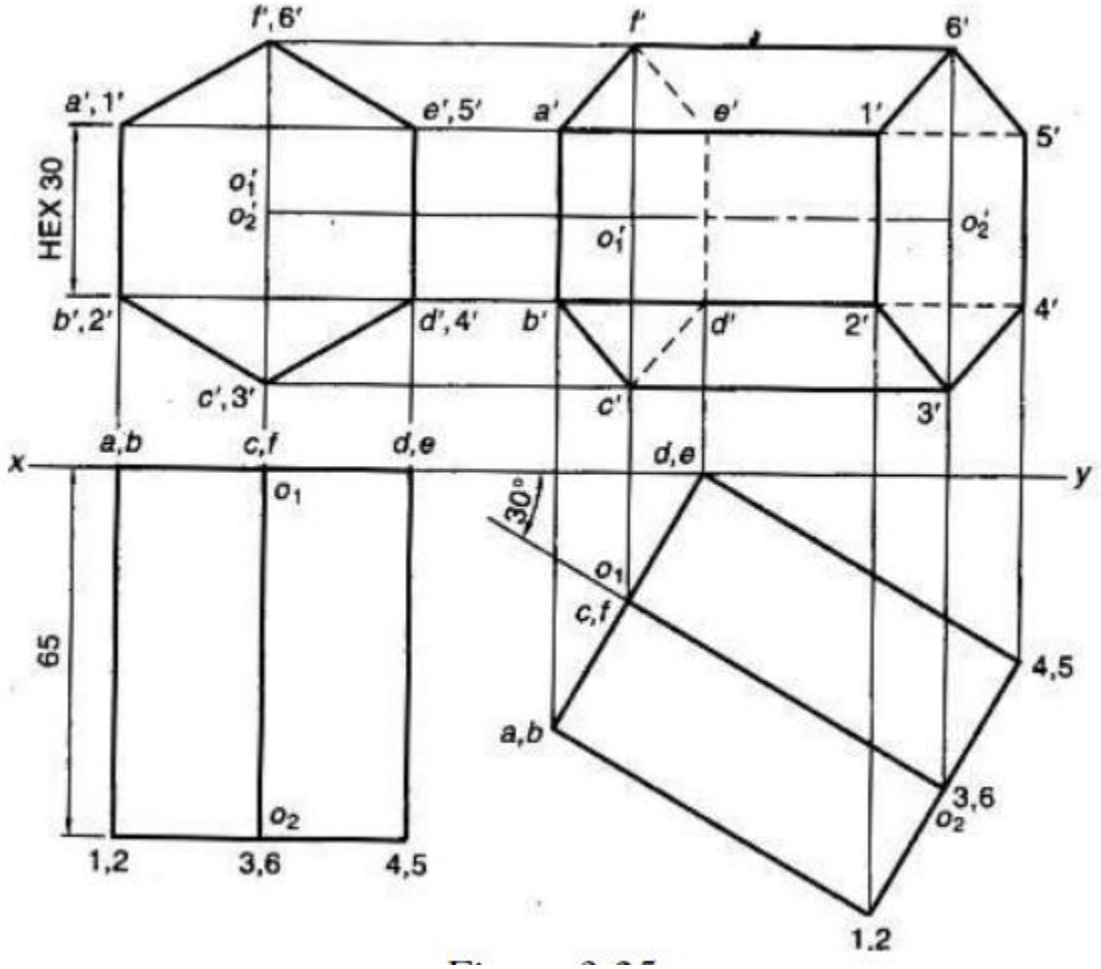
Stage(ii) Tilt the Front view according to given angle. Then project all the points will get Final Top view



5. Axis inclined to VP and parallel to HP

Problem:- An Hexagonal Prism, having a base with a 30 mm side and 65 mm long axis, has an edge it's base in the VP Such that the axis is inclined at 30$_0$ to the VP and Parallel to the HP. Draw its Projections?

2 Axis inclined to VP and Parallel to HP ⟶ have to solve in two stages
Stage(i) assume axis perpendicular to VP then draw front and Top view
Stage(ii) Tilt the Top view according to given angle. Then project all the points will get Final Front view



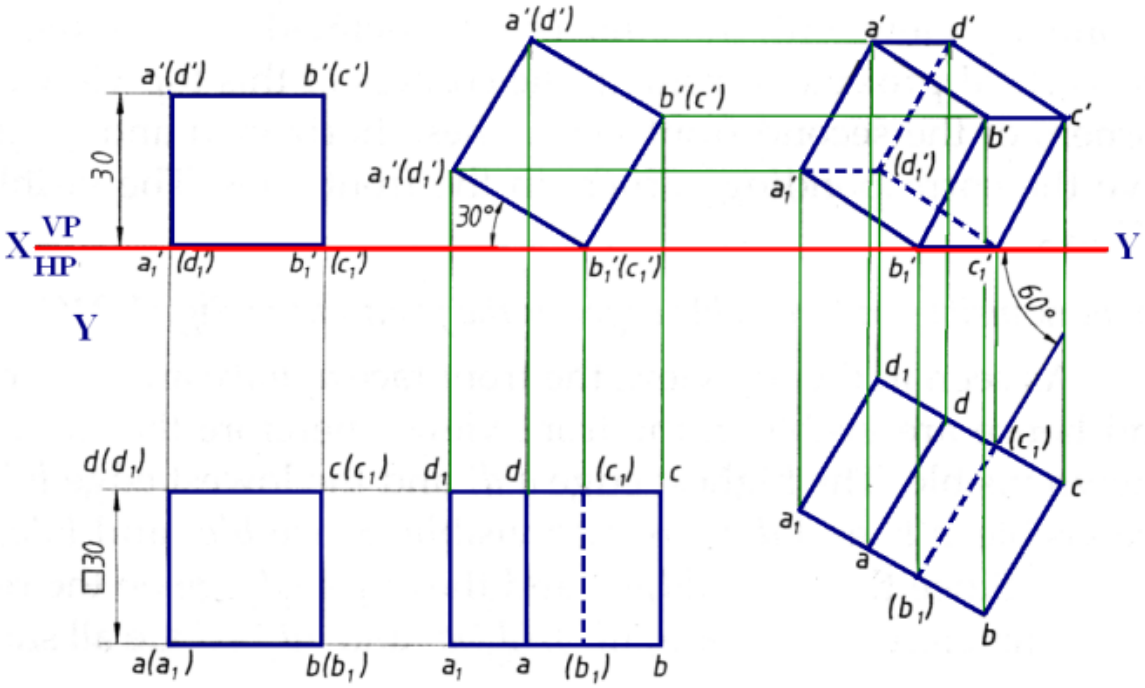
6. Axis inclined to both the principal planes (HP and VP)

A solid is said to be inclined to both the planes when (i) the axis is inclined to both the planes, (ii) the axis is inclined to one plane and an edge of the base is inclined to the other. In this case the projections are obtained in three stages.

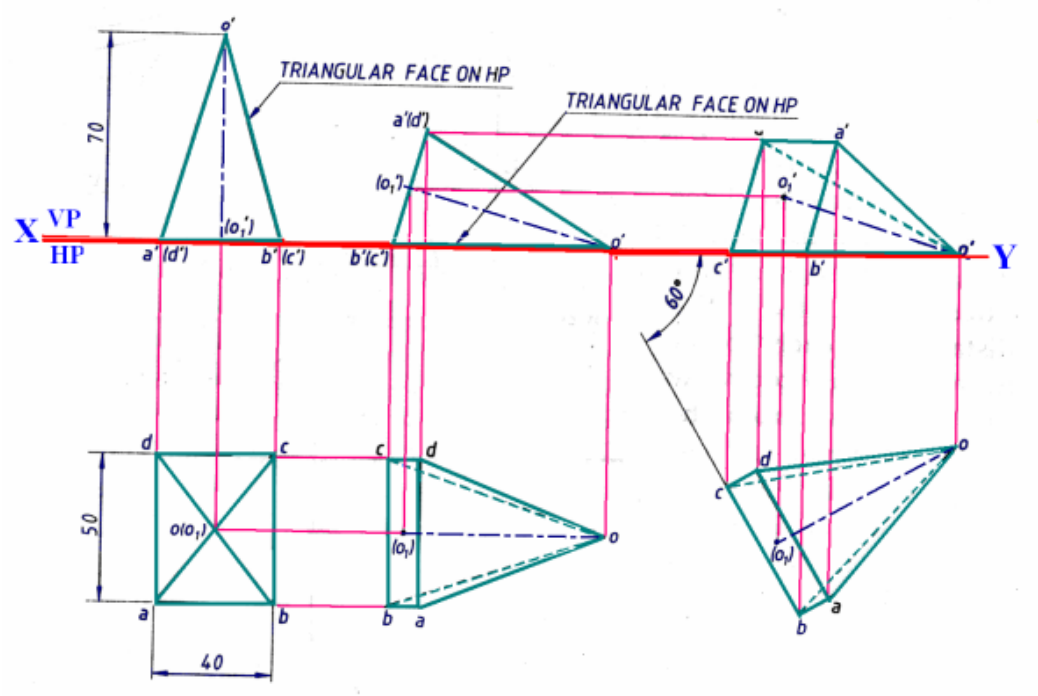
- Stage I: Assume that the axis is perpendicular to one of the planes and draw the projections.
- Stage II: Rotate one of the projections till the axis is inclined at the given angle and project the other view from it.

- Stage III: Rotate one of the projections obtained in Stage II, satisfying the remaining condition and project the other view from it.

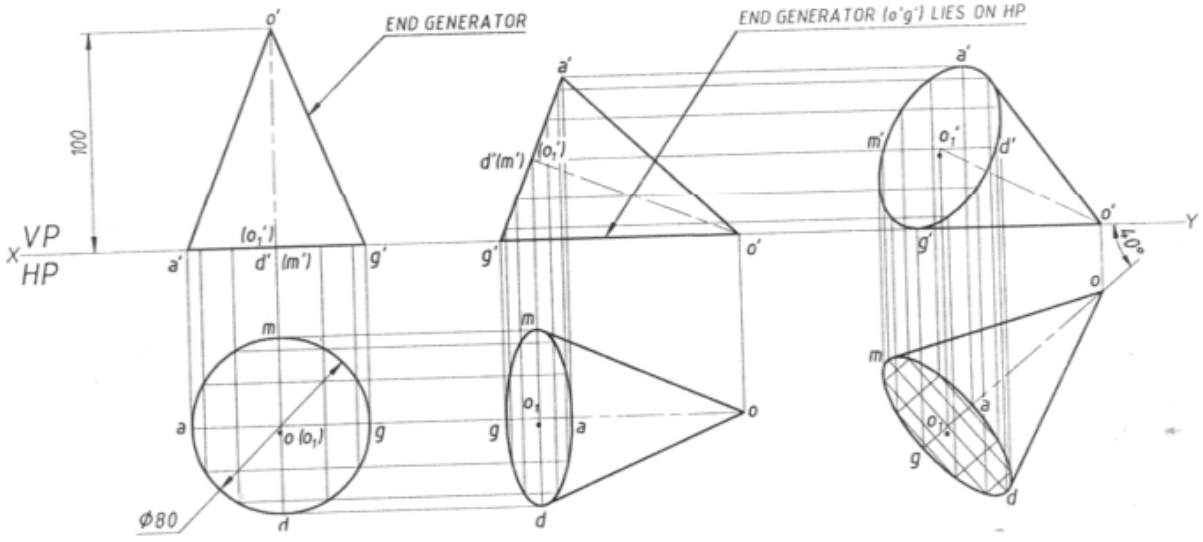
Problem.1 A cube of 30 mm side rests with one of its edges on HP such that one of the square faces containing that edge is inclined at 30^0 to HP and the edge on which it rests being inclined to 60^0 to VP. Draw its projections.



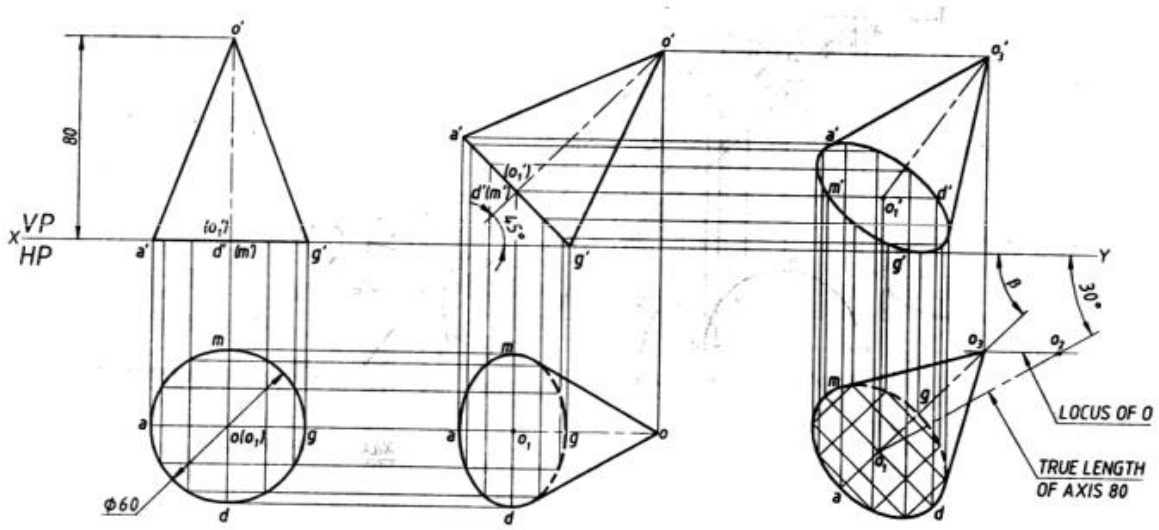
Problem2. **Draw the top and front views of a rectangular pyramid of sides of base 40x 50 mm and height 70 mm when it lies on one of its larger triangular faces on HP. The longer edge of the base of the triangular face lying on HP is inclined at 60^0 to VP in the top view with the apex of the pyramid being nearer to VP.**



Problem4. **A cone of base 80 mm diameter and height 100 mm lies with one of its generators on HP and the axis appears to be inclined to VP at an angle of 40^0 in the top view. Draw its top and front views.**



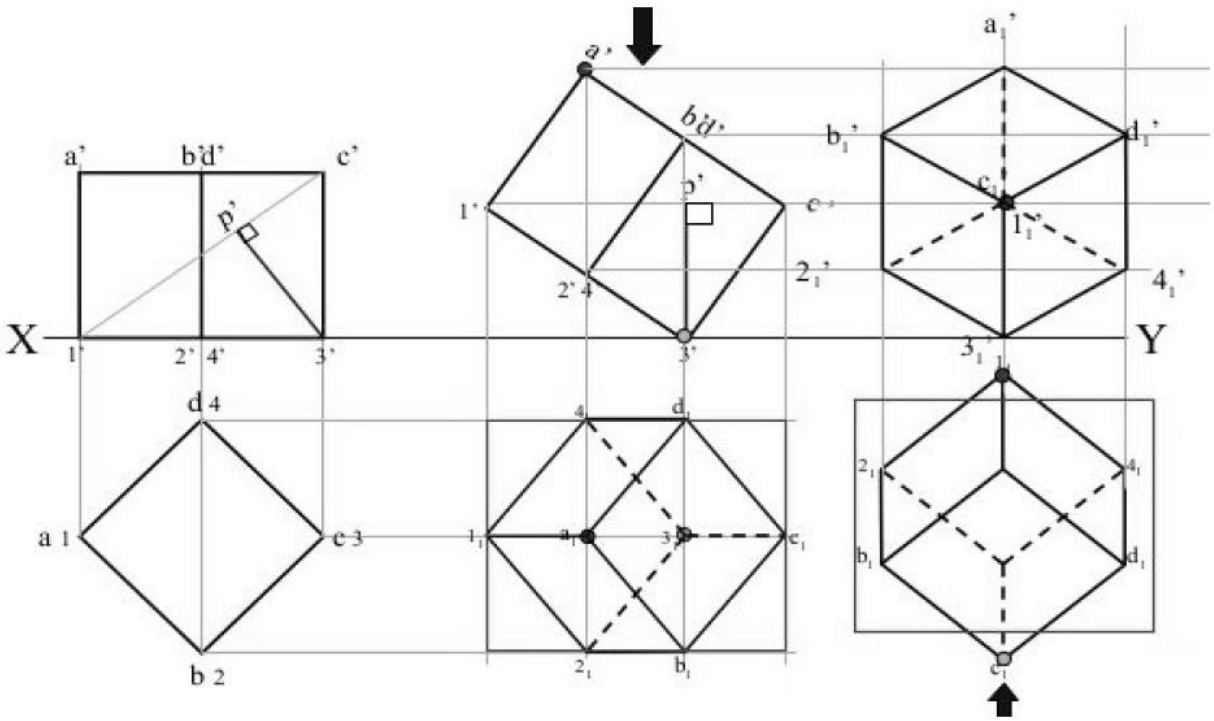
- A cone of base 60 mm diameter and the axis 80 mm long lies on HP with its axis inclined at 45^0 and 30^0 to HP and VP, respectively. Draw the top and front views of the cone.



Problem: A cube of 50 mm long edges is so placed on HP on one corner that a body diagonal is parallel to HP and perpendicular to VP. Draw its projections.

Solution Steps:

1. Assuming standing on HP, begin with TV, a square with all sides equally inclined to xy .Project Fv and name all points of FV & TV.
2. Draw a body-diagonal joining c' with 3' (This can become Parallel to xy)
3. From 1' drop a perpendicular on this and name it p'
4. Draw 2nd Fv in which 1'-p' line is vertical means c'-3' diagonal must be horizontal. .Now as usual project TV..
5. In final TV draw same diagonal is perpendicular to VP as said in problem. Then as usual project final FV.



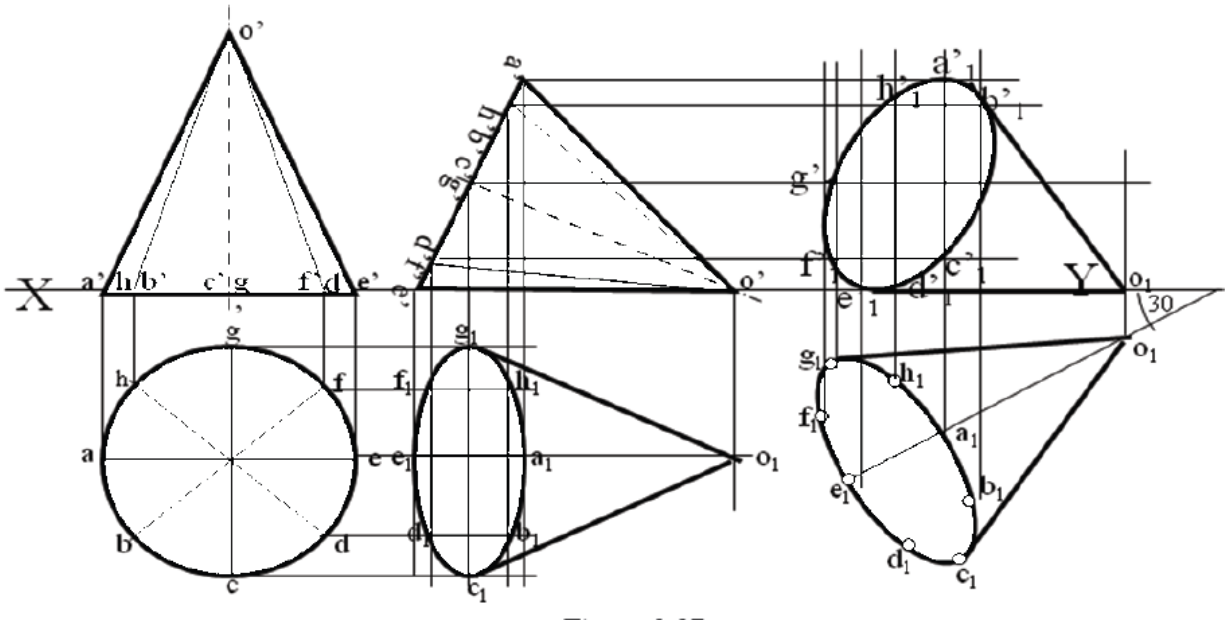
Problem:

A cone 40 mm diameter and 50 mm axis is resting on one of its generator on HP which makes 30^0 inclinations with VP. Draw its projections?

Solution Steps:

Resting on HP on one generator, means lying on HP

1. Assume it standing on HP.
2. It's TV will show True Shape of base(circle)
3. Draw 40mm dia. Circle as TV& taking 50 mm axis project FV. (a triangle)
4. Name all points as shown in illustration.
5. Draw 2nd FV in lying position I.e. o'e' on xy. And project it's TV below xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with VP (generator o_1e_1 30^0 to xy as shown) & project final FV.

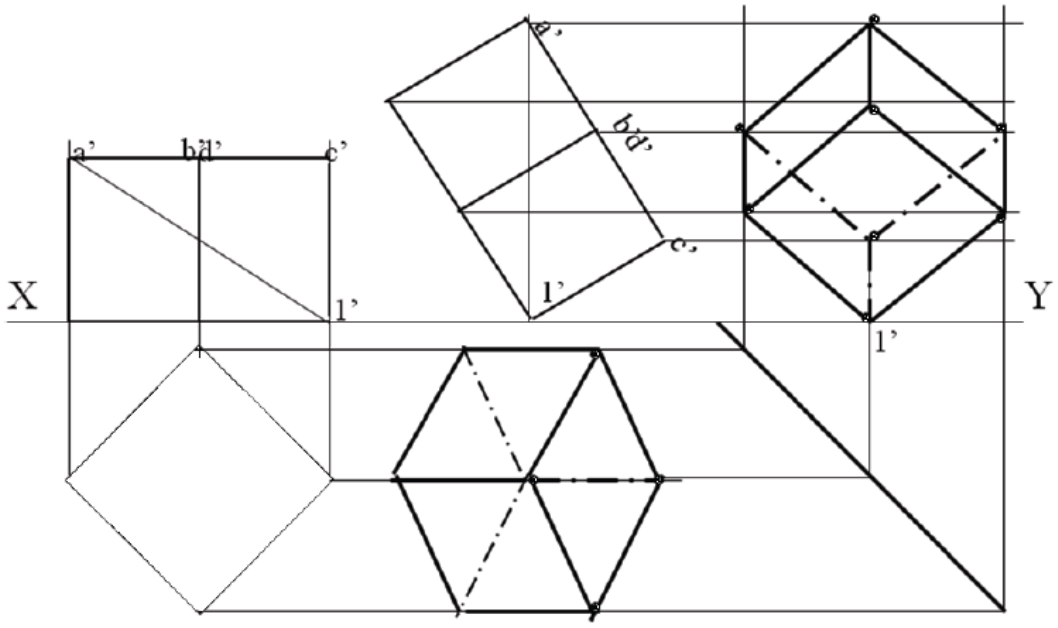


Problem:

A cube of 50 mm long edges is so placed on HP on one corner that a body diagonal through this corner is perpendicular to HP and parallel to VP. Draw its three views.

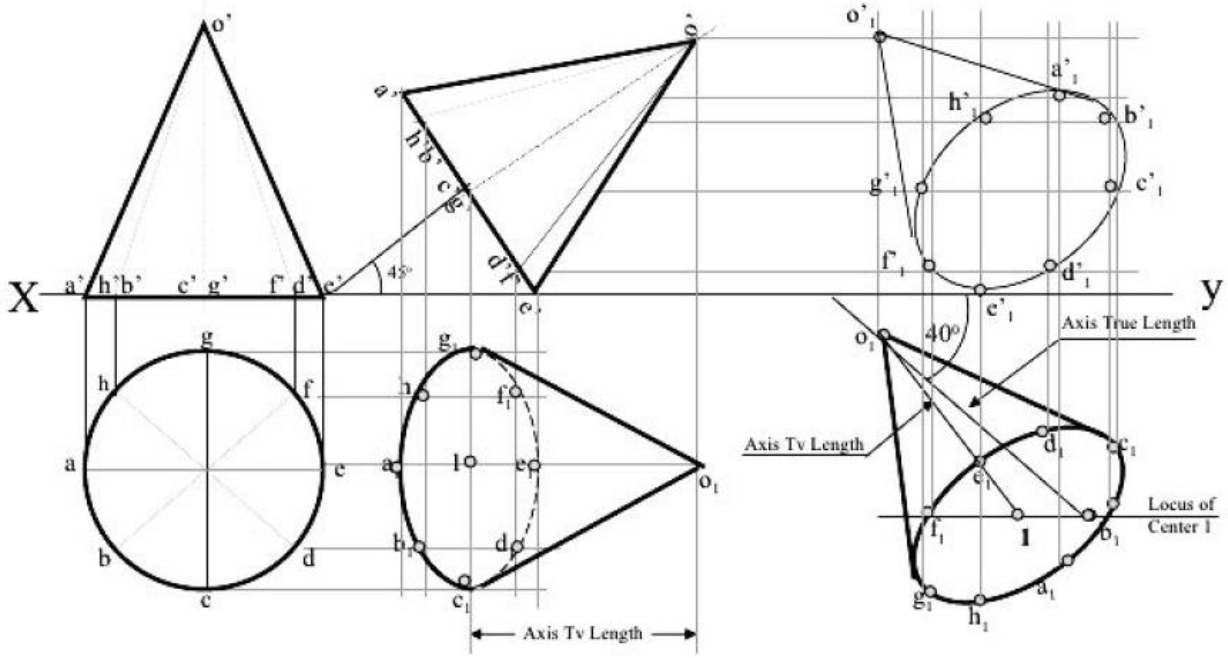
Solution Steps:

1. assuming it standing on HP begin with TV, a square of corner case.
2. Project corresponding FV. & name all points as usual in both views.
3. Join a'1' as body diagonal and draw 2nd FV making it vertical (l' on xy)
4. Project its TV drawing dark and dotted lines as per the procedure.
5. With standard method construct Left-hand side view.(Draw a 45^0 inclined Line in Tv region (below xy). Project horizontally all points of Tv on this line and reflect vertically upward, above xy. After this, draw horizontal lines, from all points of Fv, to meet these lines. Name points of intersections and join properly. For dark & dotted lines locate observer on left side of Fv as shown.)



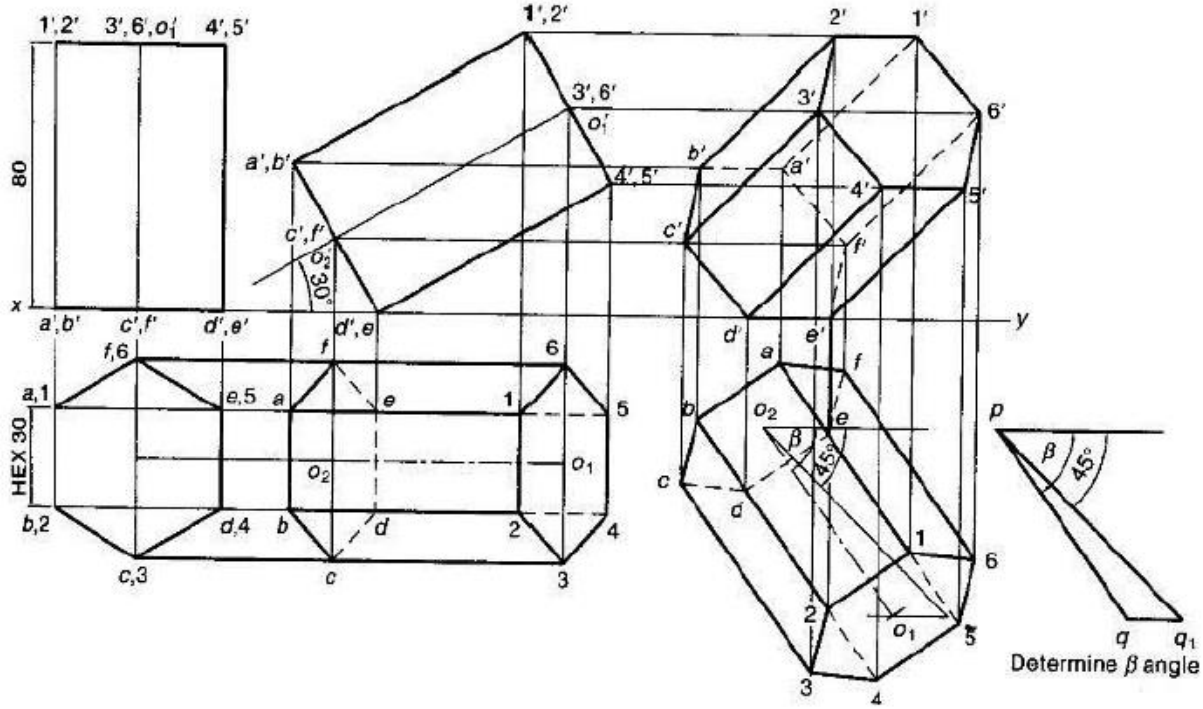
Problem:

A circular cone, 40 mm base diameter and 60 mm long axis is resting on HP, on one point of base circle such that its axis makes 45° inclination with HP and 40° inclination with VP. Draw its projections.



Problem:

A hexagonal prism, having a base with a 30mm side and an 80mm long axis, rests on one of its base edges in the H.P such that the axis is inclined at 30° to the HP and 45° to the VP. Draw its projections?



Problem:

A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on VP while its axis makes 45^0 with VP and FV of the axis 35^0 with HP. Draw its projections.

Solution Steps:

Resting on VP on one point of base, means inclined to VP:

1. Assume it standing on VP
2. It's FV will show True Shape of base & top(circle)
3. Draw 40mm dia. Circle as FV & taking 50 mm axis project TV. (a Rectangle)
4. Name all points as shown in illustration.
5. Draw 2nd TV making axis 45^0 to xy and project it's FV above xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with HP (FV of axis i.e. center line of view to xy as shown) & project final.