DS1005: Engineering Graphics

Projection of Solids

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(An Institute of National Importance (INI) established by MHRD, Govt. of INDIA)

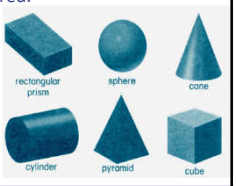
Definition of Solid:

A solid is a three dimensional object having length, breadth and thickness. It is completely bounded by a surface or surfaces which may be curved or plane.

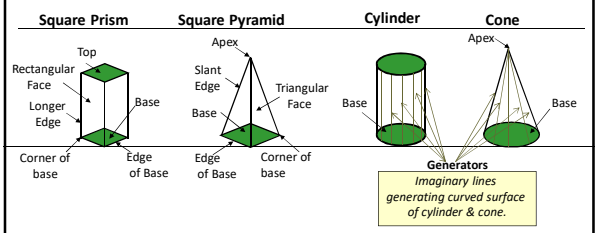
-The shape of the solid is described by drawing its two orthographic views usually on the two principle planes i.e. H.P. & V.P.

-For some complicated solids, in addition to the above principle views, side view is also required.

-A solid is an aggregate of points, lines and planes and all problems on projections of solids would resolve themselves into projections of points, lines and planes.



Dimensional parameters of different solids.



Classification of Solids:

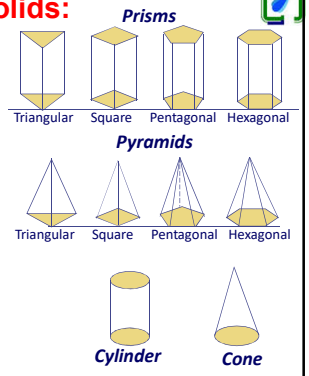
Solids may be divided into two main groups;

(A) Polyhedra

A *Polyhedra* is defined as a solid bounded by planes called *faces* which meet in straight lines called *edges*.

(B) Solids of revolution

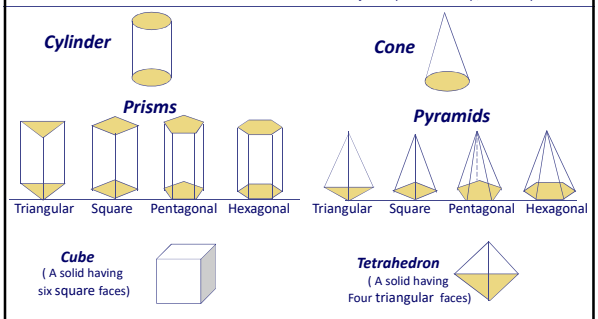
Solids formed by revolution of linear figures such as cylinder, cone and sphere



Classification of Solids:

Solids may be divided into two main groups;

Group A	Group B
Solids having top and base of same shape	Solids having base of some shape and just a point as a top, called apex.



Classification of Solids:

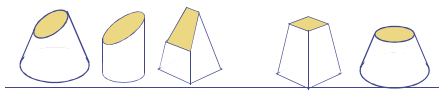
Solids may be divided into two main groups;

Truncated Solid :

When a *Pyramid* or a *Cone* is cut by a Plane inclined to its base, thus removing the top portion, the remaining *lower portion* is said to be truncated.

Frustum of Solid:

When a *Pyramid* or a *Cone* is cut by a Plane parallel to its base, thus removing the top portion, the remaining *lower portion* is called its frustum.



Sections of solids (top & base not parallel)

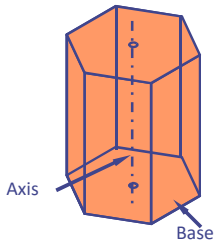
Frustum of cone & pyramids. (top & base parallel to each other)

Classification of Solids:

Solids may be divided into two main groups;

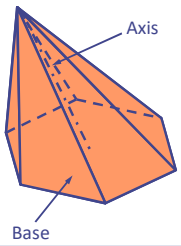
Right Solid:

A solid is said to be a *Right Solid* if its axis is perpendicular to its base.



Oblique Solid:

A solid is said to be a *Oblique Solid* if its axis is inclined at an angle other than 90° to its base.

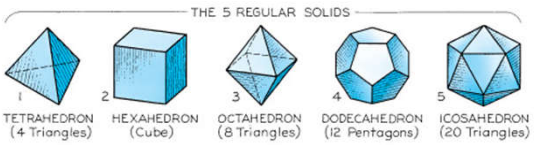


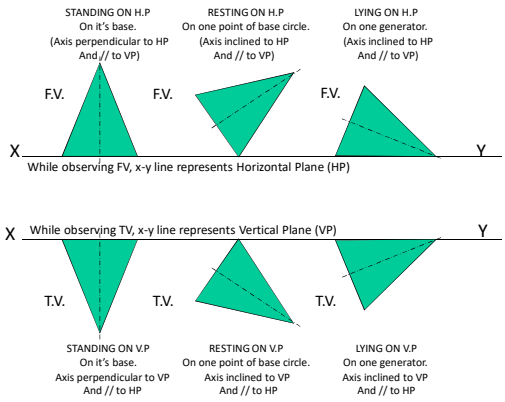
Regular Solid:

There are *Five* regular Polyhedra:

A solid is said to be a *Regular Solid* if all the edges of the base or the end faces of a solid are equal in length and form regular plane figures

1. *Tetrahedron*
2. *Cube or Hexahedron*
3. *Octahedron*
4. *Dodecahedron*
5. *Icosahedron*





- When the axis of the solid inclined to any of the projection plane, first assume the axis is perpendicular to that plane.
- Draw the projection in simple position
  - Top view first if the axis is perpendicular to HP
    Front view first if the axis is perpendicular to VP
- Change position of the view to the given inclination
  - Tilt the front view, if the axis inclined to the HP
  - Tilt the top view, if the axis inclined to the VP
- Project from this view to get the final view
  - Project from the front view, to get the top view if the axis inclined to the HP
  - Project from the **top view**, to get the **front view** if the axis inclined to the **VP**
- Ensure all the points are named in an appropriate manner
  - Lower case letters with a (') dash for the front views
  - Lower case letters alone for the top views

STEPS TO SOLVE PROBLEMS IN SOLIDS

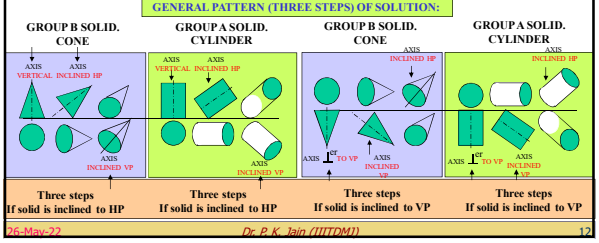
Problem is solved in three steps:

Step 1: assume solid standing on the plane with which it is making inclination.
(If it is inclined to HP, assume it standing on HP)
(If it is inclined to VP, assume it standing on VP)
If standing on HP - it's TV will be true shape of it's base or top:
If standing on VP - it's FV will be true shape of it's base or top.
Begin with this view:
It's other view will be a rectangle (if solid is *cylinder or one of the prisms*):
It's other view will be a triangle (if solid is *cone or one of the pyramids*):
Draw FV & TV of that solid in standing position:

Step 2: Considering solid's inclination (axis position) draw it's FV & TV.

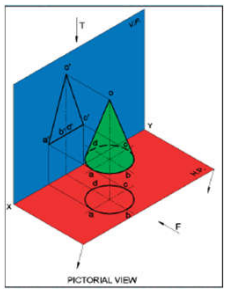
Step 3: In last step, considering remaining inclination, draw it's final FV & TV.

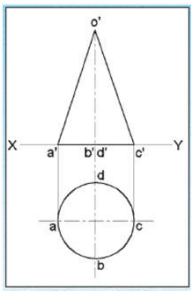
GENERAL PATTERN (THREE STEPS) OF SOLUTION:



PROJECTION OF SOLIDS WHEN ITS AXIS PERPENDICULAR TO ONE REFERENCE PLANE AND PARALLEL TO THE OTHER

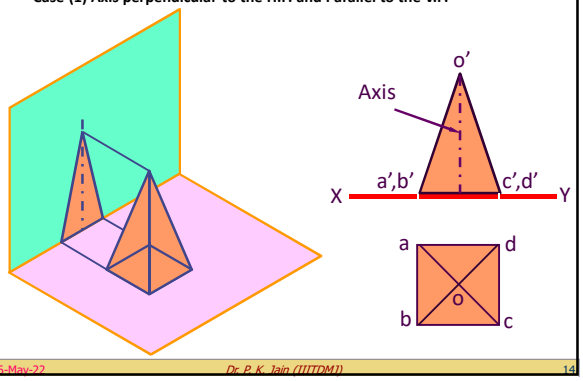
Case (1) Axis perpendicular to the H.P. and Parallel to the V.P.





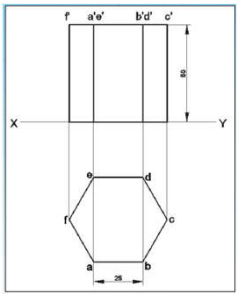
PROJECTION OF SOLIDS WHEN ITS AXIS PERPENDICULAR TO ONE REFERENCE PLANE AND PARALLEL TO THE OTHER

Case (1) Axis perpendicular to the H.P. and Parallel to the V.P.



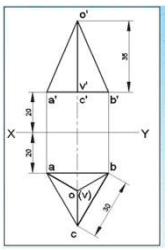
EXAMPLE:-

Project the front view and top view of a hexagonal prism of 25 mm base edges and 50 mm height, having two of its vertical rectangular faces parallel to V.P.; and its base resting on H.P.



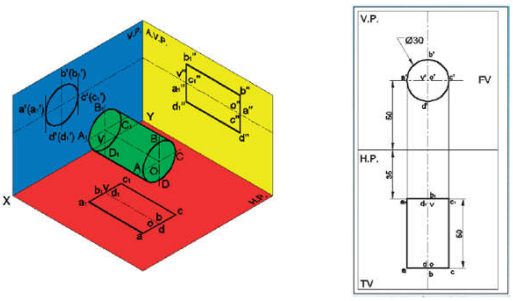
EXAMPLE:-

A triangular pyramid with 30 mm edges at its base and 35 mm long axis resting on its base with an edge of the base near the V.P, parallel to and 20 mm from the V.P; Draw the projections of the pyramid, if the base is 20 mm above the H.P.



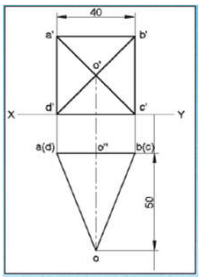
PROJECTION OF SOLIDS WHEN ITS AXIS PERPENDICULAR TO ONE REFERENCE PLANE AND PARALLEL TO THE OTHER

Case (2) Axis perpendicular to the V.P. and Parallel to the H.P.



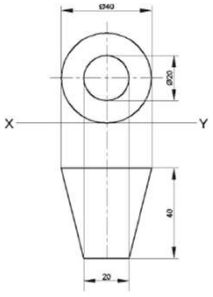
EXAMPLE:-

Draw the front view and top view of a square pyramid of base edge 40 mm and axis 50 mm long, which is perpendicular to V.P., and the vertex is in front.



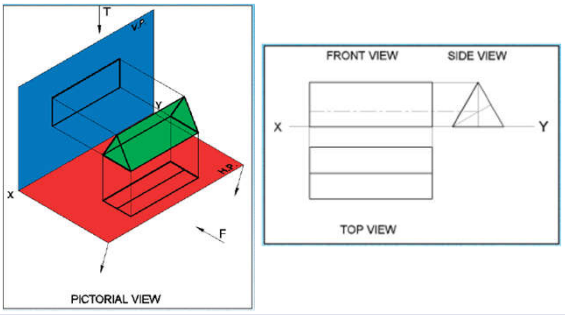
EXAMPLE:-

The frustum of the cone of 40 mm base diameter and 20 mm cut face diameter, rests on H.P with its 40 mm long axis parallel to H.P. and at right angles to V.P., the cut face is in front. Project its **front view** and **top view.**



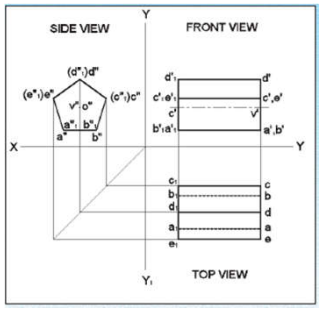
PROJECTION OF SOLIDS WHEN ITS AXIS IS PARALLEL TO BOTH THE REFERENCE PLANES

Case (3) Axis Parallel to both the V.P. and the H.P.



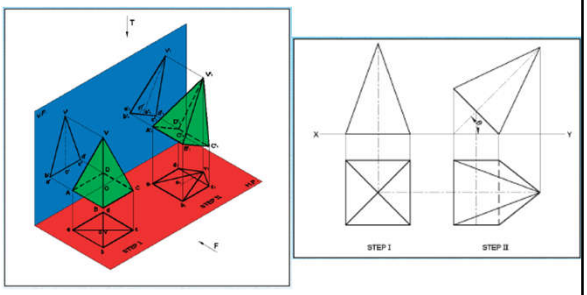
EXAMPLE:-

A pentagonal prism having a 20 mm edge of its base and an axis of 50 mm length is resting on one of its rectangular faces with the axis perpendicular to the side plane. Draw the projections of the prism.



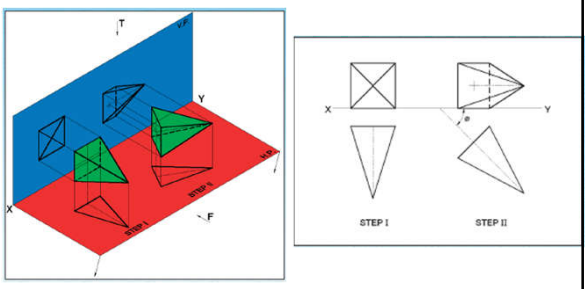
PROJECTION OF SOLIDS WHEN ITS AXIS PARALLEL TO REFERENCE PLANE AND INCLINED TO THE OTHER

Case (1) Axis inclined to H.P. and Parallel to V.P.



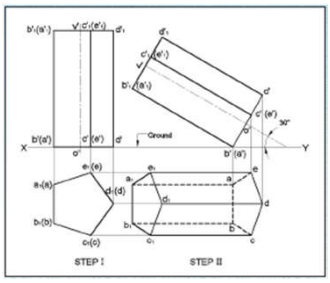
PROJECTION OF SOLIDS WHEN ITS AXIS PARALLEL TO REFERENCE PLANE AND INCLINED TO THE OTHER

Case (2) Axis inclined to V.P. and Parallel to H.P.



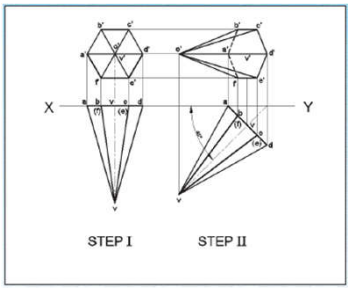
EXAMPLE:-

A pentagonal prism having a 20 mm edges at its base and axis of 70 mm length is resting on one of the edges of its base with its axis parallel to the V.P. and inclined at 30° to the H.P.



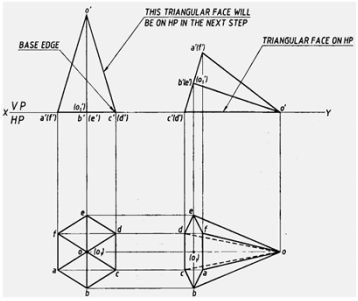
EXAMPLE:-

A hexagonal pyramid having 20 mm sides at its base and an axis 70 mm long has one of the corners of its base in the V.P and its axis inclined at 45° to the V.P. and parallel to the H.P.



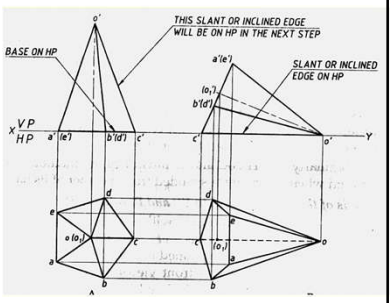
When a pyramid lies on one of its triangular faces on HP

– If a pyramid has to be placed on one of its triangular faces on HP, then initially let the pyramid be placed with its base on HP.



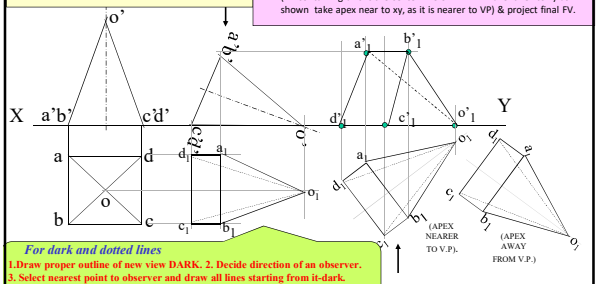
When a pyramid lies on one of its slant edges on HP

– When a pyramid lies with one of its slant edges on HP, then two triangular faces containing the slant edge on which it rests make either equal inclinations or different inclinations with HP.



Problem 1: A square pyramid, 40 mm base sides and axis 60 mm long, has a triangular face on the HP and the vertical plane containing the axis makes an angle of 45^0 with the VP. Draw its projections. Take apex nearer to VP.

Solution Steps :
Triangular face on HP, means it is lying on HP:
1. Assume it standing on HP.
2. It's TV will show True Shape of base (square)
3. Draw square of 40mm sides with one side vertical 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'c'd' face on xy. And project it's TV.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with VP (VP containing axis ic the center line of 2nd TV. Make it 45^0 to xy as shown take apex near to xy, as it is nearer to VP) & project final FV.

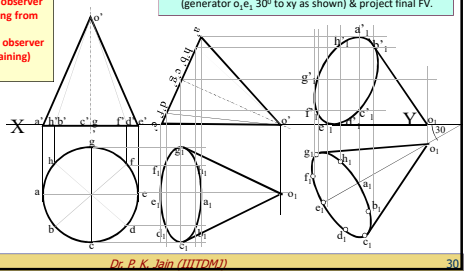


For dark and dotted lines
1.Draw proper outline of new view DARK. 2. Decide direction of an observer.
3. Select nearest point to observer and draw all lines starting from it-dark.
4. Select farthest point to observer and draw all lines (remaining) from it- dotted.

Problem 2:
A cone 40 mm diameter and 50 mm axis is resting on one generator on HP which makes 30^0 inclination with VP Draw it's projections.

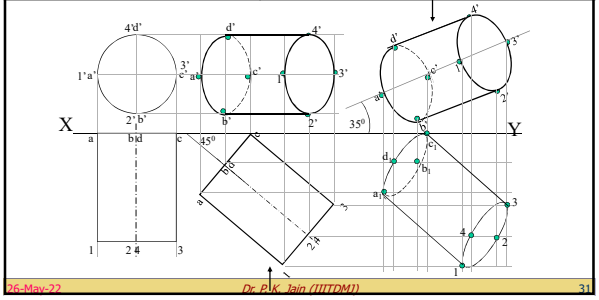
For dark and dotted lines
1. Draw proper outline of new view DARK.
2. Decide direction of an observer.
3. Select nearest point to observer and draw all lines starting from it-dark.
4. Select farthest point to observer and draw all lines (remaining) from it- dotted.

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.



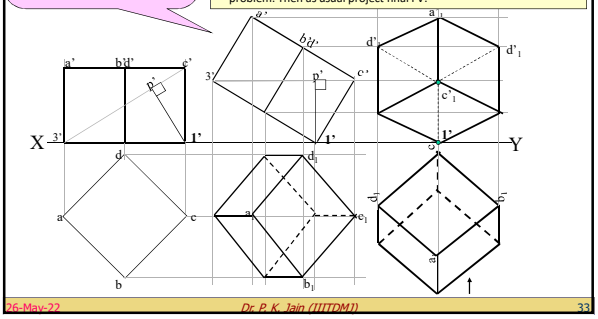
Problem 3:
A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on VP while it's axis makes 45^0 with VP and FV of the axis 35^0 with HP. Draw projections.

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 40 mm 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 TV.



Problem 5: 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 it's projections.

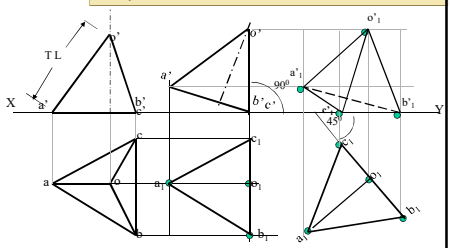
Solution Steps:
1. Assuming standing on HP, begin with TV, a square with all sides equally inclined to xy. Project FV and name all points of FV & TV.
2. Draw a body-diagonal joining c' with 3'(This can become // to xy)
3. From 1' drop a perpendicular on this and name it p'
4. Draw 2nd FV in which 1'-p'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



Problem 6: A tetrahedron of 50 mm long edges is resting on one edge on HP while one triangular face containing this edge is vertical and 45^0 inclined to VP. Draw projections.

IMPORTANT:
Tetrahedron is a special type of triangular pyramid in which base sides & slant edges are equal in length. Solid of four faces. Like cube it is also described by One dimension only. Axis length generally not given.

Solution Steps
1. As one side is resting, assume it standing on HP.
2. Begin with TV, an equilateral triangle of side 50 mm.
3. First project base points of FV on xy, name those & axis line.
4. From a' with TL of edge, 50 mm, cut on axis line & mark o' (as axis is not known, o' is finalized by slant edge length)
5. Then complete FV.
6. In 2nd FV make face o'b'c' vertical as said in problem.
7. Then project 2nd TV.
8. Draw 3rd TV with b1c1 making 450 inclined with xy.
9. Project final FV.



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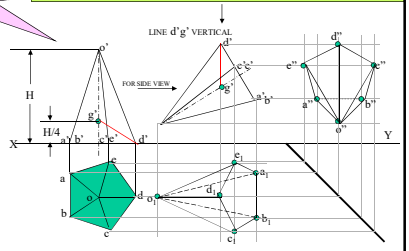
Problem 7: A pentagonal pyramid 30 mm base sides & 60 mm long axis, is freely suspended from one corner of base so that a plane containing it's axis remains parallel to VP. Draw it's three views.

IMPORTANT:
When a solid is freely suspended from a corner, then line joining point of contact & C.G. remains vertical. (Here axis shows inclination with HP.) So in all such cases, assume solid standing on HP initially.)

Solution Steps:
In all suspended cases axis shows inclination with HP.
1. Hence assuming it standing on HP, draw TV - a regular pentagon, corner case.
2. Project FV & locate CG position on axis – (¼ H from base.) and name g' and Join it with corner d'
3. As 2nd FV, redraw first keeping line g'd' vertical.
4. As usual project corresponding TV and then Side View looking from.



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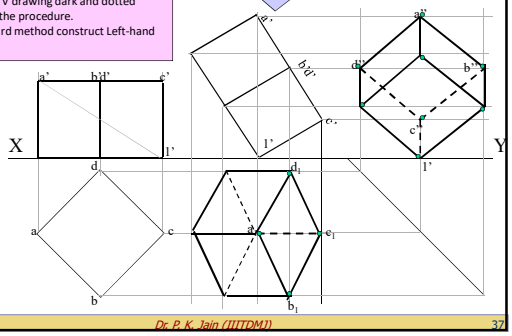
Solution Steps:
1. Assuming it standing on HP begin with TV, a square of corner case.
2. Project corresponding FV. & name all points as usual in both views.
3. Join a'1' as body diagonal and draw 2nd FV making it vertical (l' on xy)
4. Project it's TV drawing dark and dotted lines as per the procedure.
5. With standard method construct Left-hand side view.

Problem 8:
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 it's three views.



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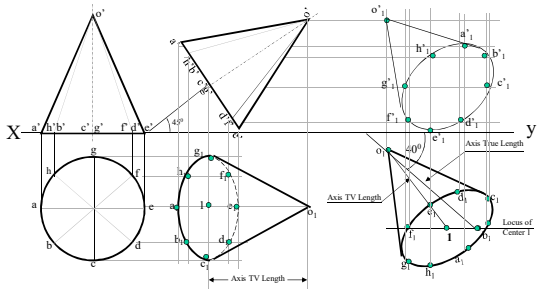
Problem 9: A right circular cone, 40 mm base diameter and 60 mm long axis is resting on HP on one point of base circle such that it's axis makes 45^0 inclination with HP and 40^0 inclination with VP. Draw it's projections.

In previous all cases 2nd inclination was done by a parameter not showing TL. Like TV of axis is inclined to VP etc. But here it is clearly said that the axis is 40^0 inclined to VP. Means here TL inclination is expected. So the same construction done in those Problems is done here also. See carefully the final TV and inclination taken there.
So assuming it standing on HP begin as usual.



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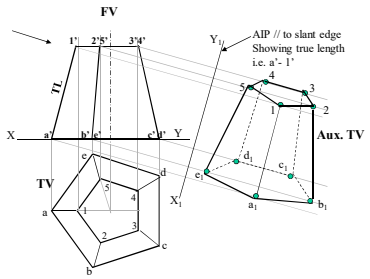
Problem 10: A frustum of regular pentagonal pyramid is standing on it's larger base on HP with one base side perpendicular to VP. Draw it's FV & TV.
Project it's Auxiliary TV on an AIP parallel to one of the slant edges showing TL.
Base side is 50 mm long , top side is 30 mm long and 50 mm is height of frustum.



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