

Rashtreeya Sikshana Samithi Trust

RV Institute of Technology and Management®

(Affiliated to VTU, Belagavi)

JP Nagar, Bengaluru - 560076

Department of Department Engineering



Course Name: ENGINEERING VISUALIZATION

Course Code: 21EV15/25

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Engineering Graphics (Engineering Visualization)

MODULE - II

Orthographic Projection of Solids: Orthographic projection of right regular solids - prisms and pyramids (triangle, square, rectangle, pentagon, hexagon), cones, cubes, tetrahedron. Solids can be resting on HP/VP/PP and axis inclined to HP/ VP/ (HP and VP). Sketching of views for first two stages may be considered for practicing.

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4. Orthographic Projections of Solids

4.1 INTRODUCTION

A solid is a 3D object having length, breadth and thickness. Various types of solids are used in engineering practice. In general, all these solid objects are broadly categorized as a. polyhedral and b. solids of revolutions. Further, they are classified as tetrahedron, hexahedron (cube), prisms, pyramids, cylinder, sphere and cone. It is, therefore, essential to understand the orthographic projections of the above variety of solids in different positions with respect to the reference planes.

In this primer, only regular polyhedral and right circular solids of revolution are considered for drawing orthographic projections using change of position method only.

4.2 ORTHOGRAPHIC PROJECTIONS OF SOLIDS IN DIFFERENT POSITIONS

The position of a solid object in space or resting on the reference planes may be specified by considering the location of its axis, base, corner, edge, diagonal or surfaces, with the reference planes. Following are some of the positions of the solids considered.

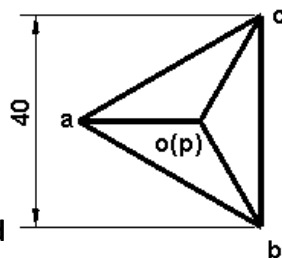
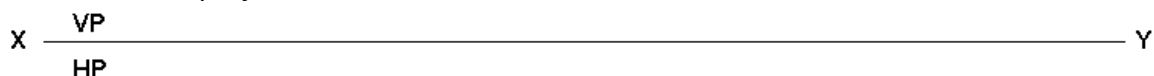
1. Axis parallel to both the reference planes
2. Axis perpendicular to one of the reference planes
3. Axis inclined to one of the reference planes and parallel to the other
4. Axis inclined to both the reference planes and
5. Solid objects freely suspended in space.

Note that all the projections (views) should be drawn uniformly thick (0.4mm)

4.3 ILLUSTRATIVE EXAMPLES

Problem 4.3.1

A tetrahedron of side 40 mm is resting on one of its sides on HP. This side is parallel to VP and 40 mm away from it. It is tilted about resting side such that the base containing this edge is inclined at 30° to HP. Draw the projections of the solid.



Solution

Manual method

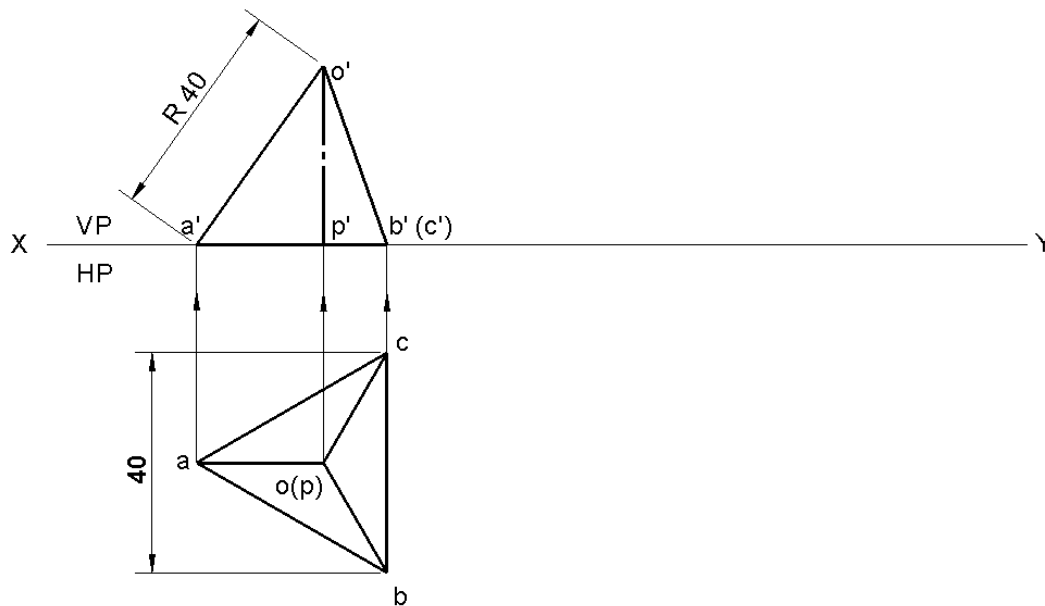
1. Draw XY line. Mark VP above it and HP below it.



2. Draw top view of the tetrahedron a, b, c of 40 mm side with one side, say, bc perpendicular to XY line. Also mark center, top view of tetrahedron o(p) and join a, b and c to this o.
3. Project the front view. With a' as center and radius of 40 mm cut the axis at o', complete the front view a'o'b'(c') p'.
4. Tilt the front view such that the edge b₁' , c₁' , is on XY line and base a₁'b₁'c₁' is inclined at 30° to HP.
5. Project the top view a₁b₁c₁o₁.
6. Redraw this top view in the third stage with edge b₂c₂ parallel to XY line and 40 mm away from it.
7. Project the final view.
8. Make all the top views and the front views uniformly thick.

Computer Aided Drafting Procedure


1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND** from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND** from **ANNOTATION TOOLBAR**.
4. Click on **POLYGON COMMAND**, draw a triangle by giving number of sides as 3 in the property manager tab, below XY line. Give 40 mm dimension to any one side of the polygon using **SMART DIMENSION COMMAND**. Label the vertices as a, b and c using **NOTE COMMAND** (Delete the inscribed circle manually).
5. Draw vertical projector upwards from corners of the top view. Draw base of pyramid on XY line using **LINE COMMAND** represent it as a', b' and (c'). To get the height of tetrahedron draw vertical projector upwards from center **o(p)**, and using **CENTERPOINT ARC COMMAND** with a' as center and 40 mm as radius, draw an arc to cut the vertical

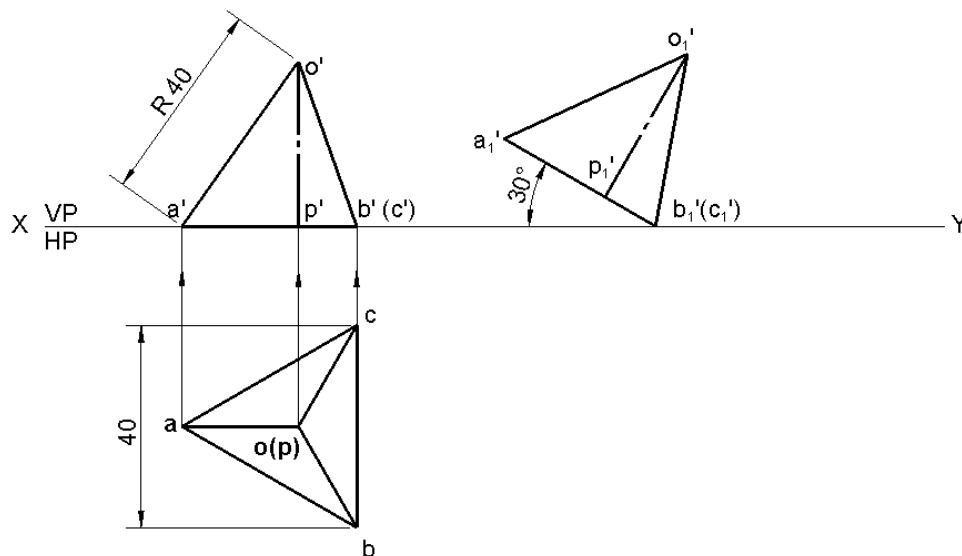
projector drawn from center **o(p)** and represent it as **o'**. Now using **LINE COMMAND** join all corners to **o'** as shown.




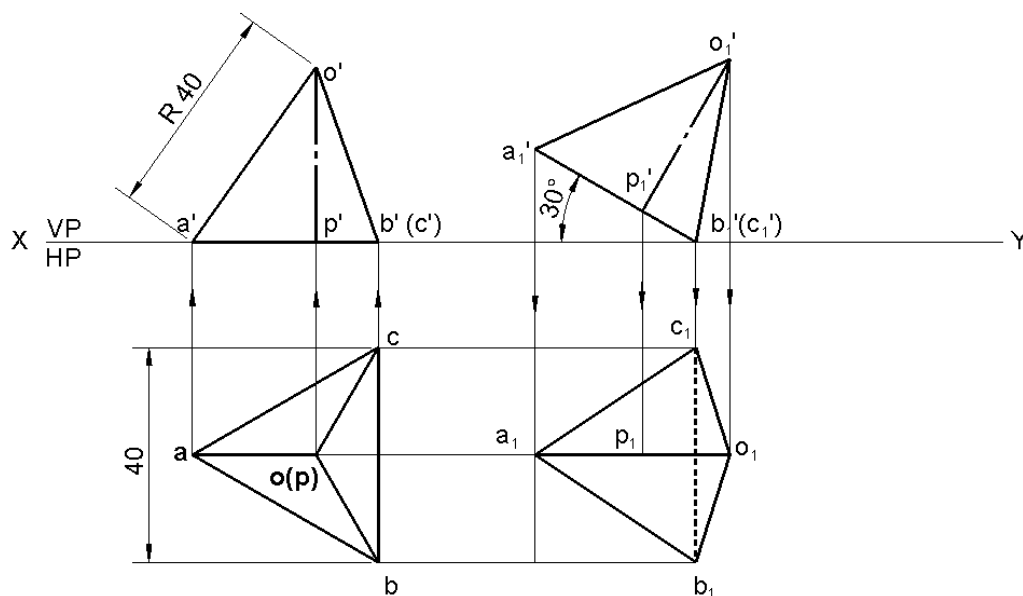
6. Select the front view of the triangle (only lines) copy using **COPY ENTITIES**  making **b'(c')** as starting point and paste on the XY line. Select the copied triangle and make block using **MAKE BLOCK COMMAND**  and make insertion point as b'(c'). and give the rotation angle of 30° by unchecking Lock angle in property manager tab.


OR

Using the **ROTATE COMMAND**  tilt the front view of the solid such that the base is inclined at 30° to XY line as shown.



7. Draw vertical projector downwards from corners of the inclined front view, draw horizontal projector towards right from first top view using **LINE COMMAND**  to get required top view. Note, the edges which are not visible choose **LINE STYLE** as dotted and annotate as shown.




8. Select the entities in the sketch in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK** . Insert the block



using **INSERT BLOCK COMMAND**

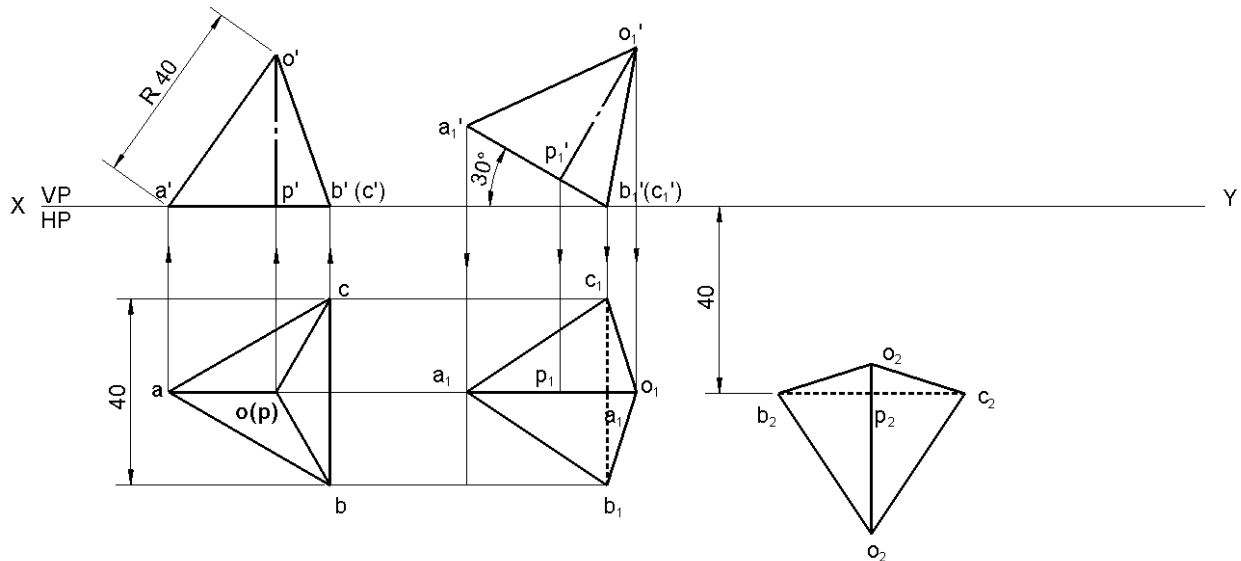
and rotate the angle by unchecking Lock angle in property manager.



OR

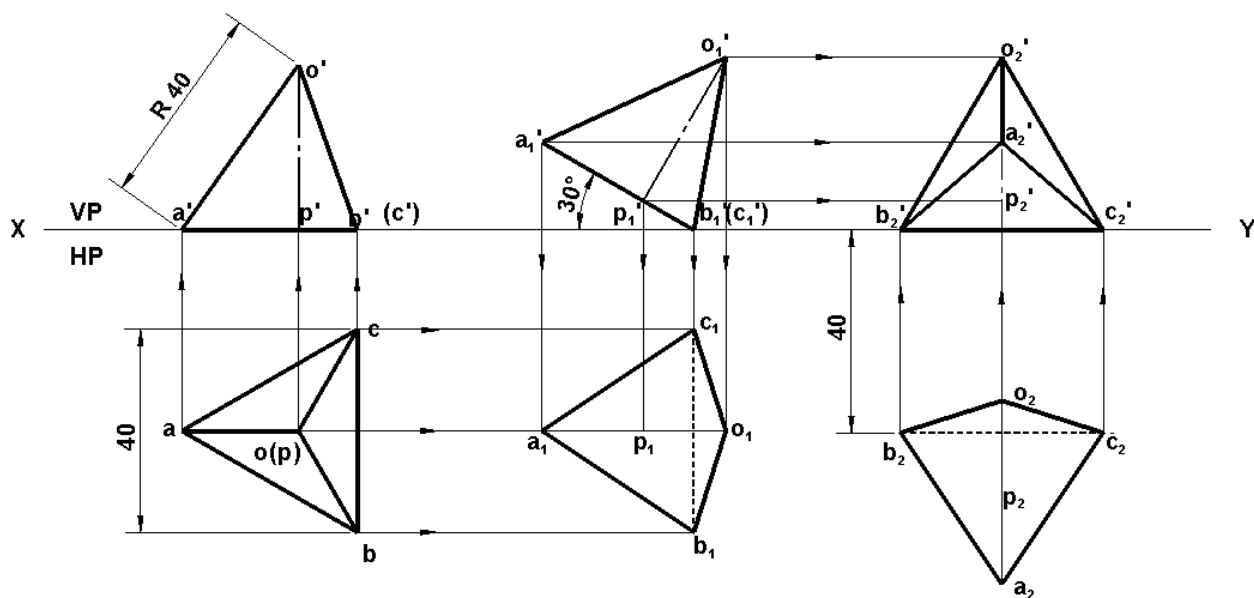
Using **ROTATE COMMAND**  tilt the second top view of the solid such that the base side is parallel and 40 mm away from the XY line as shown.

OR

Give parallel relation between XY line and $b_2 c_2$ line after inserting the block.



9. Draw vertical projector upwards from corners of the third stage top view, draw horizontal projector towards right from second stage front view using **LINE COMMAND**  to get required front view and join the intersection point by using **LINE COMMAND** . Note, the edges which are not visible choose line style as dotted and annotate as shown.



10. To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and the click on **SAVE**.

Problem 4.3.2



A hexahedron of 30 mm sides is resting on one of its corners on HP such that one of its solid diagonals is perpendicular to VP. Draw the projections of the solid.

Solution




Manual Method

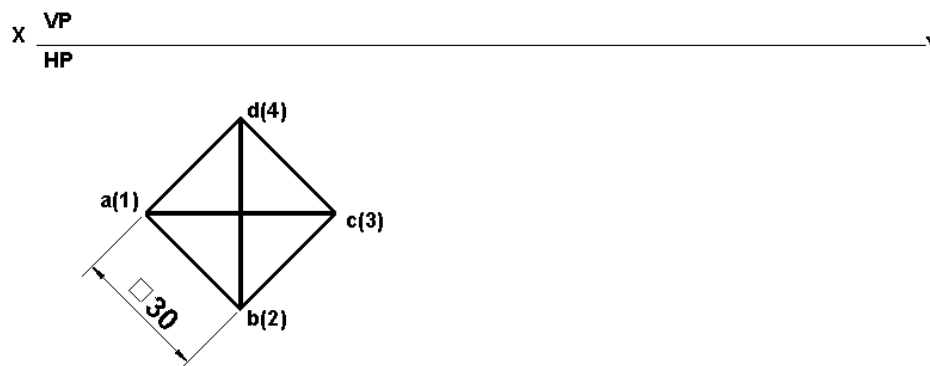
1. Draw XY line. Mark VP above it and HP below it.
2. Draw the top view of the cube of 30 mm side $a(1)$, $b(2)$, $c(3)$ and $d(4)$.
3. Project the front view $a'(1')$, $b'(2')$, $c'(3')$, $d'(4')$ and mark the solid diagonal as $a'3'$.
4. Redraw the front view with $a_1'3_1'$ parallel to XY line corner $1_1'$ on XY line. In this position the cube rests on corner $1_1'$ while diagonal $a_1'3_1'$ is parallel to HP.
5. Project the top view $a(1)$, $b(2)$, $c(3)$, $d(4)$ as shown in second stage. Note that the solid diagonal a_13_1 is parallel to VP and is of true length.
6. Redraw the final top view with the solid diagonal a_23_2 perpendicular to VP.
7. Project the front view.
8. Make the top view and the front view uniformly thick.






Computer Aided Drafting Procedure

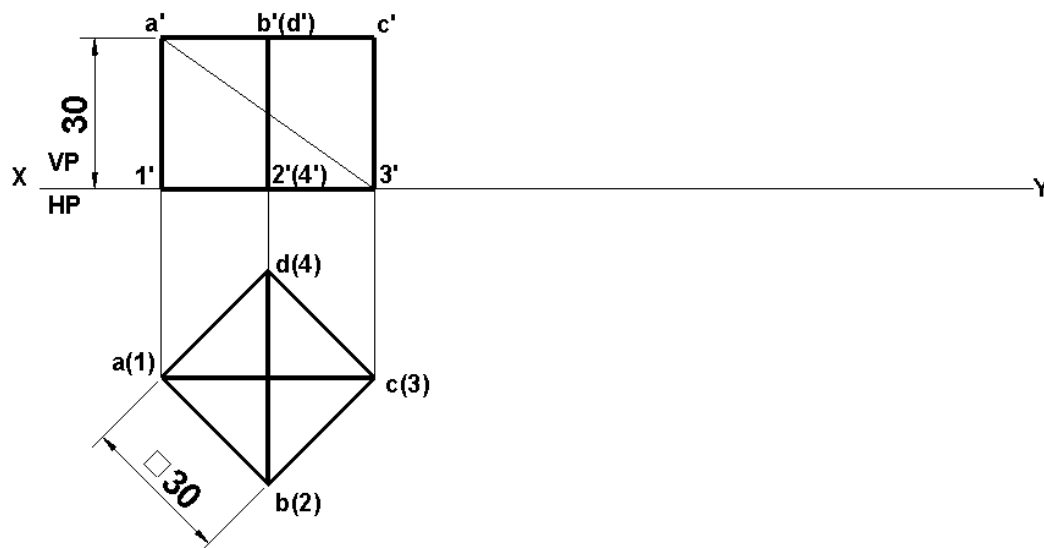
1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND**  from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND**  from **ANNOTATION TOOLBAR**.





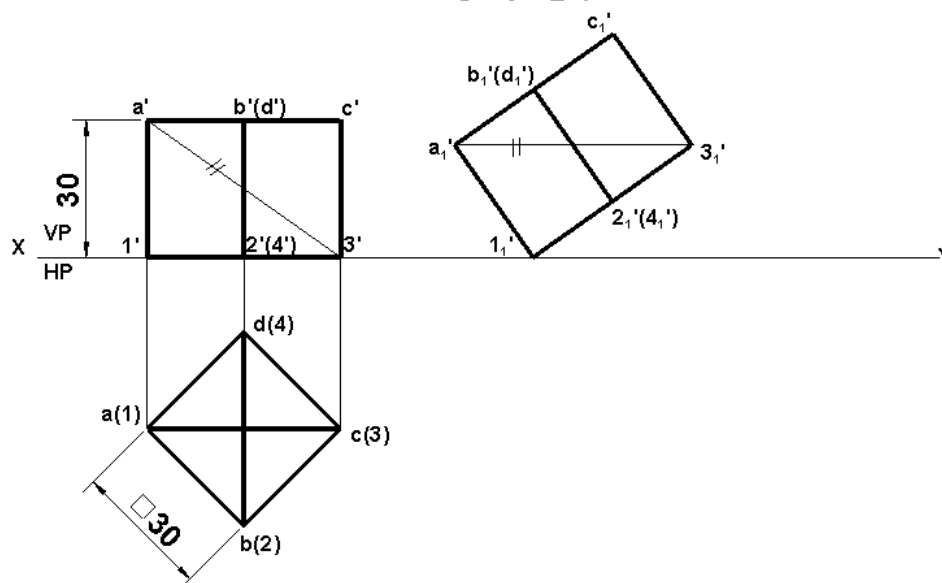
4. Click on **POLYGON COMMAND** , draw a triangle by giving number of sides as 4 in the property manager tab, below XY line. Give 30 mm dimension to any one side of the polygon using **SMART DIMENSION COMMAND** . Label the vertices as a, b and c using **NOTE COMMAND**  (Delete the inscribed circle manually).





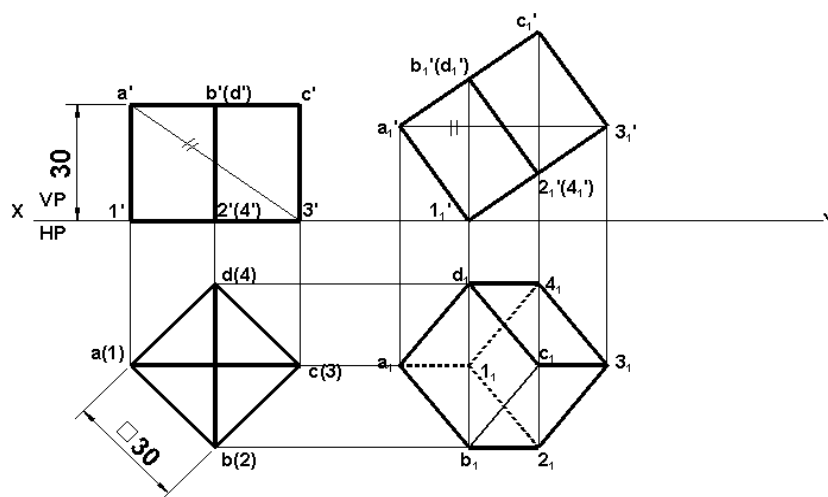
5. Draw a horizontal line at a distance equal to the height of the hexahedron above the XY line using **LINE COMMAND** . Draw the vertical projectors until they intersect the horizontal line drawn using **LINE COMMAND** . Mark the intersection points (between the horizontal and vertical projected line) as a', b', c', (d') for the top face and 1', 2' 3' and (4') for bottom face using **NOTE COMMAND** . Trim all the unwanted construction by using **TRIM COMMAND** . Using **LINE COMMAND**  join 3' and a' which acts as solid diagonal as shown.



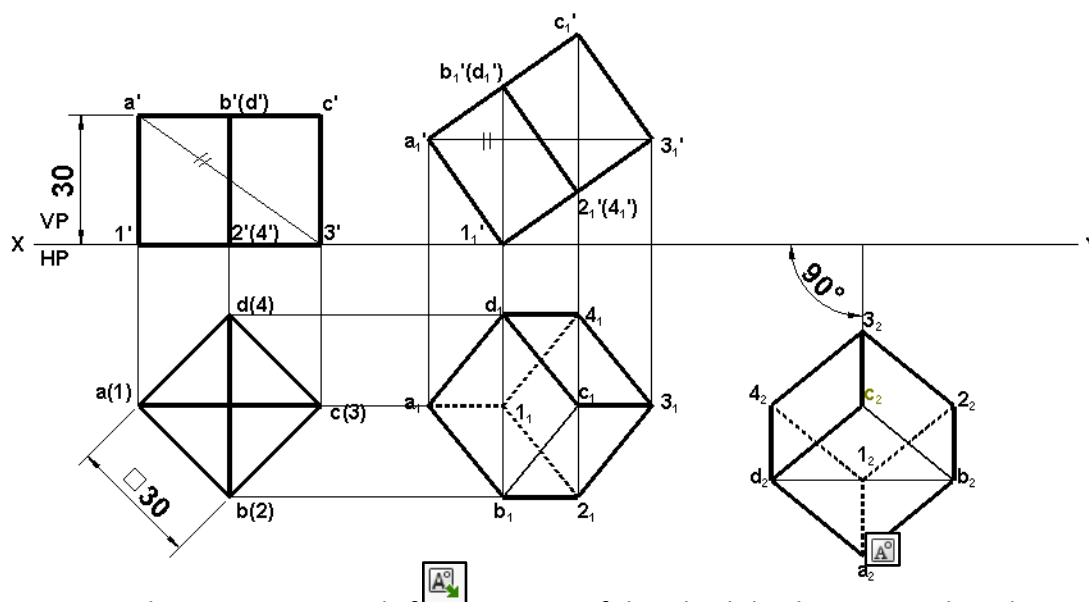
11. Select the front view (only lines) copy using **COPY ENTITIES**  making **1'** as starting point and paste on the XY line. Select the copied front view and make block using **MAKE BLOCK COMMAND**  and make insertion point as **1'** and give the coincident relation between the point at **1'** and XY line. Give parallel relation between line **a₁'3₁'** and **XY** line by selecting two lines.



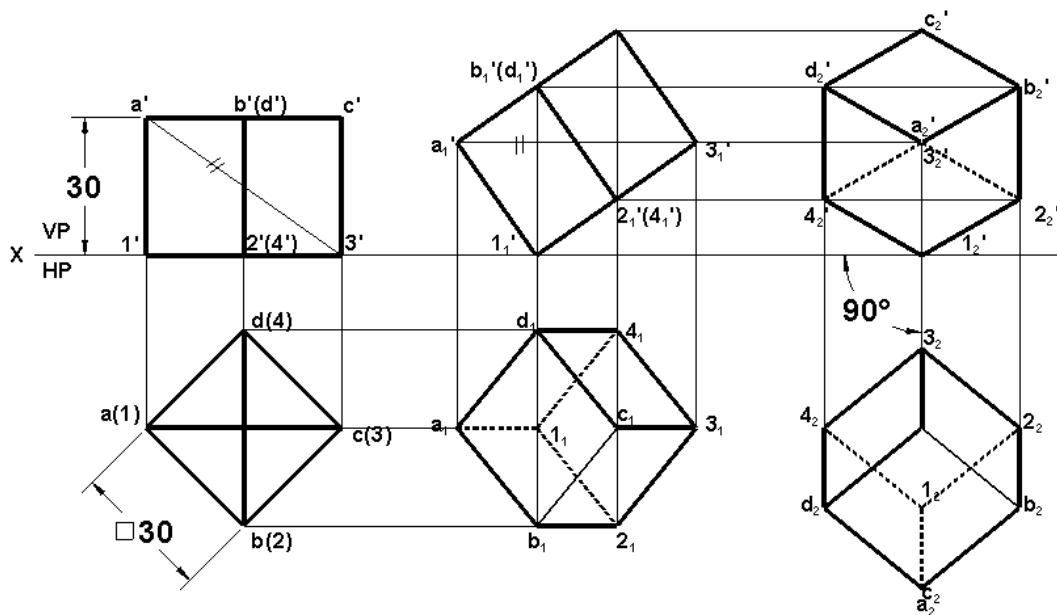
6. Draw vertical projectors downwards from corners of the second stage front view, draw horizontal projectors towards right from first top view using **LINE COMMAND**  to get the required top view in second stage. Note, the edges which are not visible choose line type as dotted and annotate as shown below. Mark the points as **a₁**, **b₁**, **c₁**, (**d₁**) for the top face and **1₁**, **2₁**, **3₁** and (**4₁**) using **NOTE**  **COMMAND** .



7. Select the entities in the sketch in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK** Insert the block using **INSERT BLOCK COMMAND** . Select line 3_2C_2 and make it horizontal by clicking **Horizontal** in property manager. Give angle between by using **SMART DIMENSION**



8. Draw vertical projector upwards from corners of the tilted third top view, draw horizontal projector towards right from second front view using **LINE COMMAND** to get required front view. Join the intersection point using **LINE COMMAND** Note the edges which are not visible choose line type as dotted and annotate as shown.



9. To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and the click on **SAVE**.

Problem 4.3.3

A pentagonal prism of base side 25 mm and height 50 mm is resting on HP on one of its base corners such that the top most edge is at a distance of 60 mm above HP. Draw its projections, when the top view of the axis is inclined at 45° to VP. Also, determine the inclination of the longer edge of the prism to HP which contains the resting corner.



Solution

Manual method




1. Draw the XY line. Mark VP above it and HP below it.
2. Draw the top view of the prism i.e. pentagon a(i), b(j), c(k), d(l), e(m) of side 25 mm, with one of the c'(k'), d'(l'), e'(m').
3. Project the front view above the XY line with a height of 50 mm. Name the corners as a'(i'), b'(j'), c'(k'), d'(l'), e'(m').
4. Draw a line parallel to XY line at a distance of 60 mm and above it. Rotate the first stage front view and adjust it such that edge a₁'e₁' is on the straight line drawn at 60 mm.
5. Project the second stage front view downward. Draw the horizontal projectors from first stage top view until they intersect the vertical projectors. Name the intersection points.

6. Redraw the second stage top view with the axis inclined at 45° to the XY line.
7. Project the second stage top view upward. Draw the horizontal projectors from second stage front view until they intersect the vertical projectors to get the final front view a_2' , b_2' , c_2' , etc.
8. Determine the actual inclination of the longer edge kc of the prism with HP which contains the resting corner k .
9. Make all the top views and the front views uniformly thick.

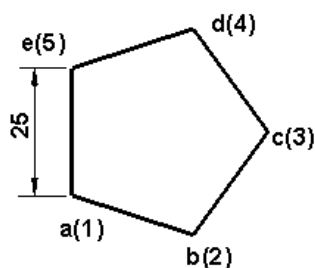
Computer Aided Drafting Procedure





1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND**  from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND**  from **ANNOTATION TOOLBAR**.

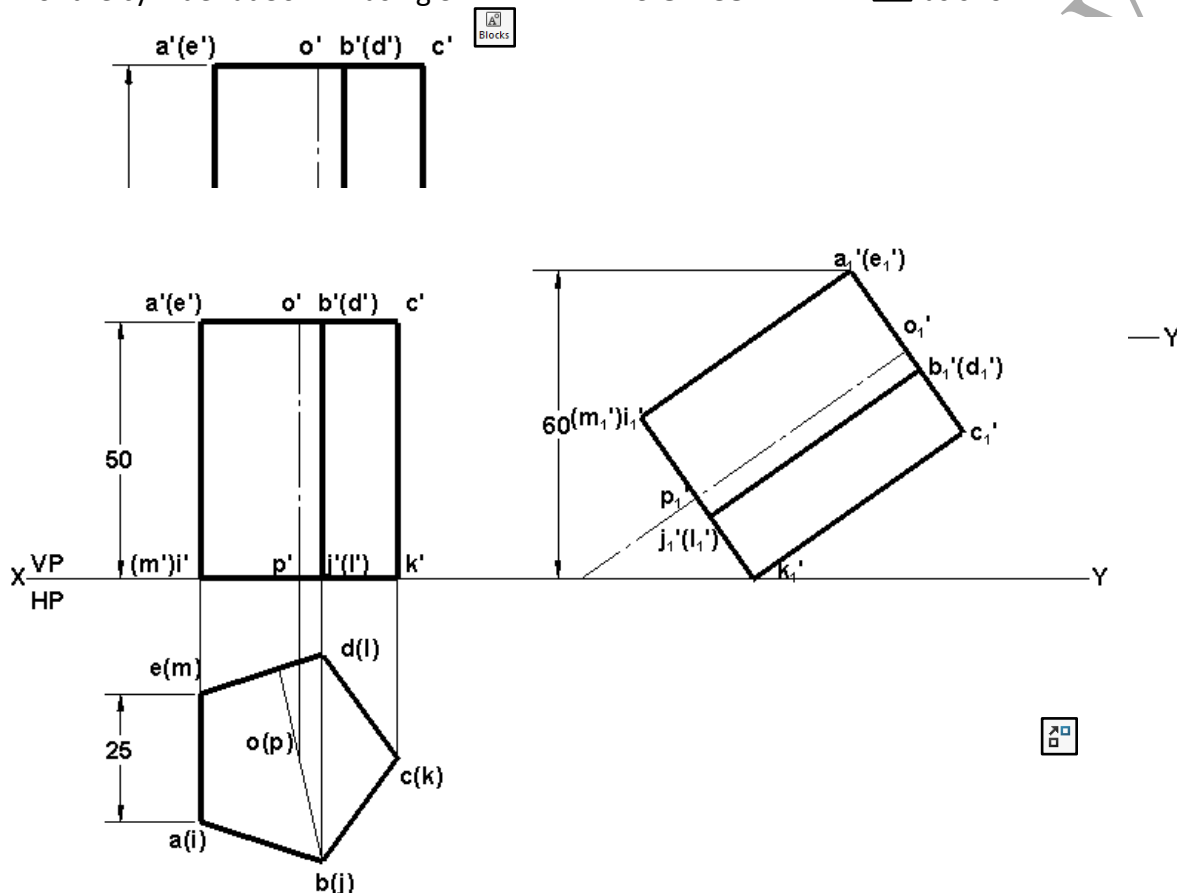
X $\frac{VP}{HP}$ _____ Y

4. Draw the pentagon in the top view with side of 25 mm and one of the side perpendicular to XY line by using **POLYGON COMMAND** , **SMART DIMENSION COMMAND**  to give dimension and mark the corner points of top face as a, b, c, d, e, f, and center as o using **NOTE COMMAND** . Similarly label the bottom face as i, j, k, l, m and center as p as shown below.

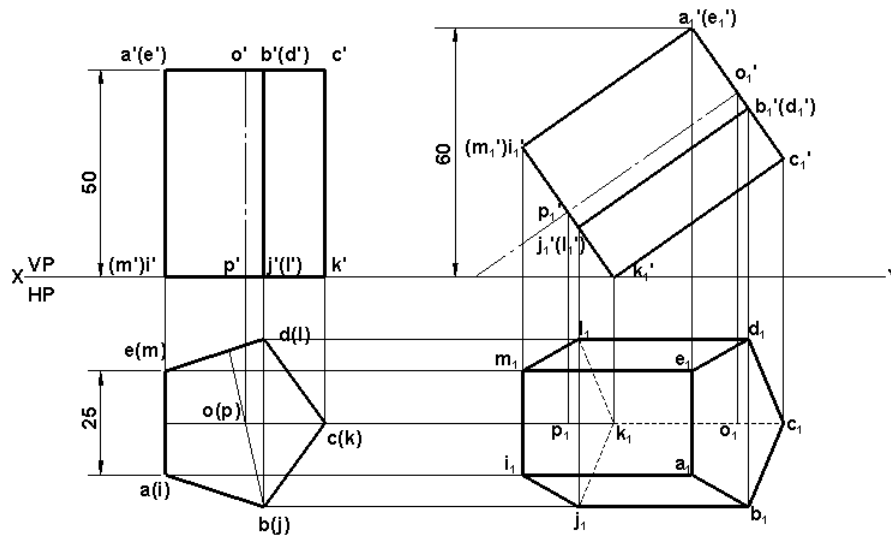
X $\frac{VP}{HP}$ _____ Y





5. Draw the horizontal line at a distance of 50 mm i.e. equal to height of the prism above the XY line. Draw the vertical projectors from top view, until they intersect horizontal line at 50 mm above XY line. Mark the intersection points (between the horizontal and vertical projected lines) as a', b', c', (d'), (e'), (o'), for the top face and i', j', k', (l'), (m'), (p'), using **NOTE COMMAND** . Join all the intersection points by using **LINE COMMAND** . Trim all the unwanted construction lines by using the **TRIM COMMAND** . Mark the height of the cylinder at 50 mm using **SMART DIMENSION COMMAND**  as shown.




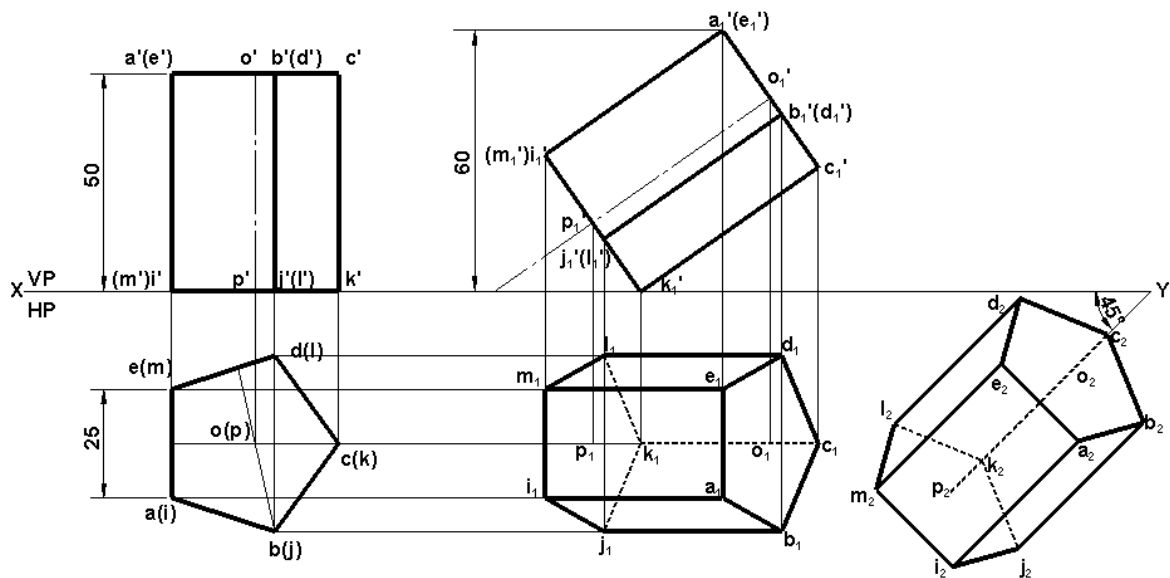
6. Select the front view of the pentagon (only lines) copy using **COPY ENTITIES** making k_1' as starting point and paste on the XY line. Select the copied pentagon and make block using **MAKE BLOCK COMMAND** and make insertion point as k_1' . Draw a horizontal line 60 mm in front view using **SMART DIMENSION COMMAND**. Now using **COINCIDENT RELATION**, make $a_1'(e_1')$ and the 60 mm line coincident by unchecking Lock angle in property manager tab.
7. Draw vertical projector downwards from corners of the inclined front view, draw horizontal projector towards right from first top view using **LINE COMMAND** to get required top view. Note, the edges which are not visible choose **LINE STYLE** as dotted and annotate as shown.





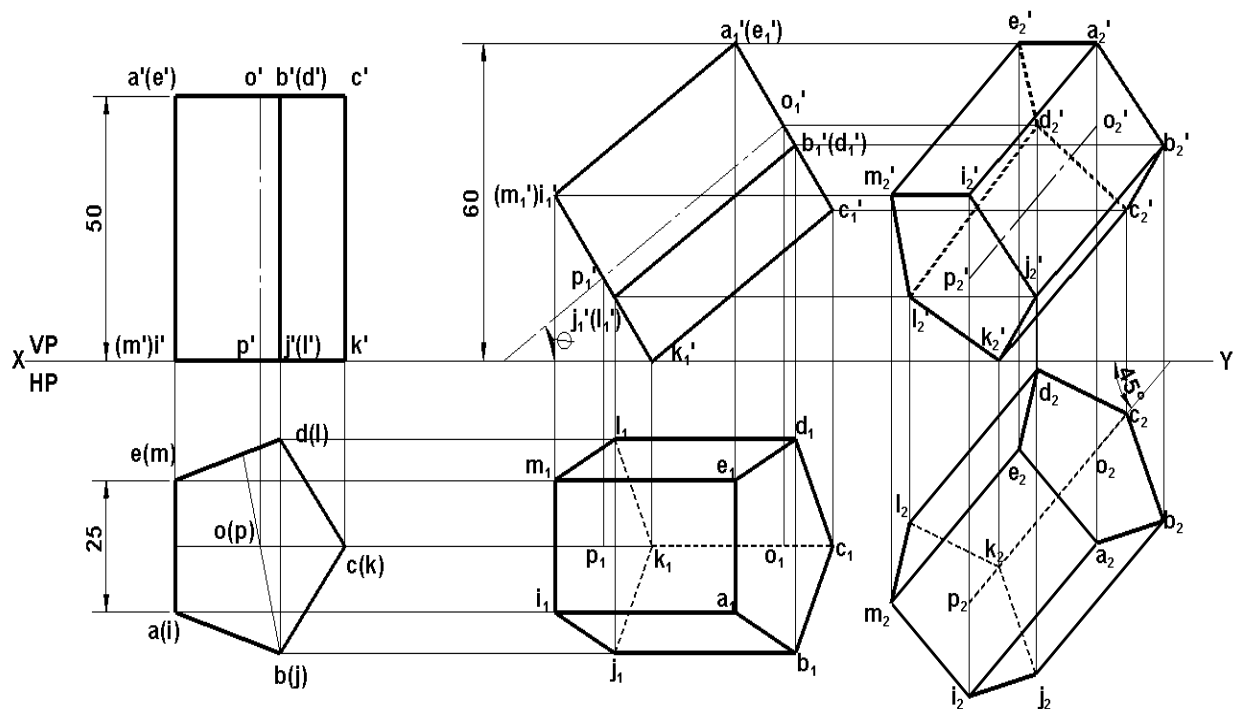
8. Select the entities in the sketch in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK** . Insert the block using **INSERT BLOCK COMMAND**  and rotate the angle by unchecking Lock angle in property manager.

OR

Using **ROTATE COMMAND**  tilt the second top view of the solid such that the centerline of the block is at 45° to the XY line.




9. Draw the horizontal projectors from second stage FV & vertical projectors from third stage TV, to obtain the intersection points on third stage FV. Mark the intersection points using **NOTE COMMAND** . Join all the intersection points by using **LINE COMMAND** .



ANSWER :

$$\phi = 35$$

10. Finally, dimension using **SMART DIMENSION** . The result obtained after measuring is 35°. To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and the click on **SAVE**.



Problem 4.3.4

A square pyramid of base side 30 mm and height 45 mm is suspended by a thread tied to one of the corners of its base. It is then tilted such that the axis makes an angle 45° with respect to the VP. Considering the apex of the solid to be nearer to the observer, draw the projections of the solid.





Solution**Manual method**

1. Draw XY line. Mark VP above it and HP below it.
2. Draw top view of the square pyramid of side 30 mm. Label it as a, b, c, d, o and (p).
3. Project front view $a'b'c'(d')o'(p')$. Mark center of gravity, cg' at a distance of $h/4$ i.e. 11.25 mm from the base of the pyramid. Join a' to cg' .
4. The pyramid is now suspended from corner $a1'$. Redraw the second front view with $a1'cg'$ vertical to XY line.
5. Project the top view and mark it as $a1b1c1d1o1p1$.
6. Redraw the top view in the third position with the axes making an angle of 45° to XY line and the apex towards the observer.
7. Project the final front view and label it as $a2'b2'c2'd2'o2'p2'$.
8. Make all the top views and the front views uniformly thick.




Computer Aided Drafting Procedure

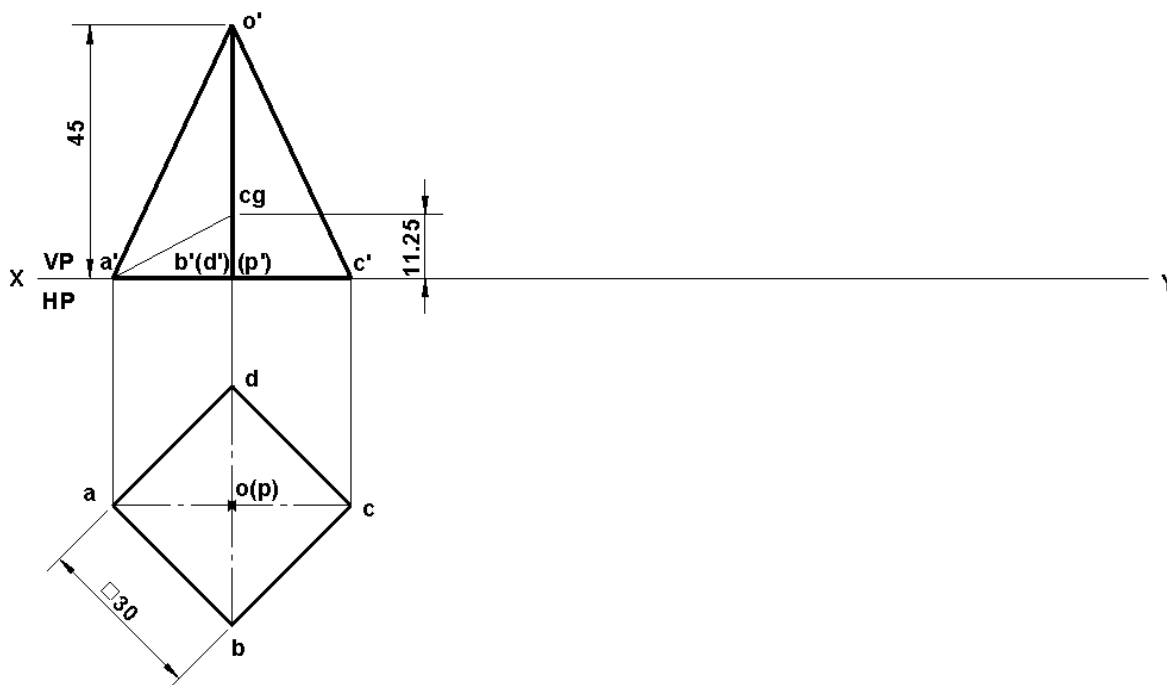
1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND**  from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND**  from **ANNOTATION TOOLBAR**.



X $\frac{VP}{HP}$ _____ Y

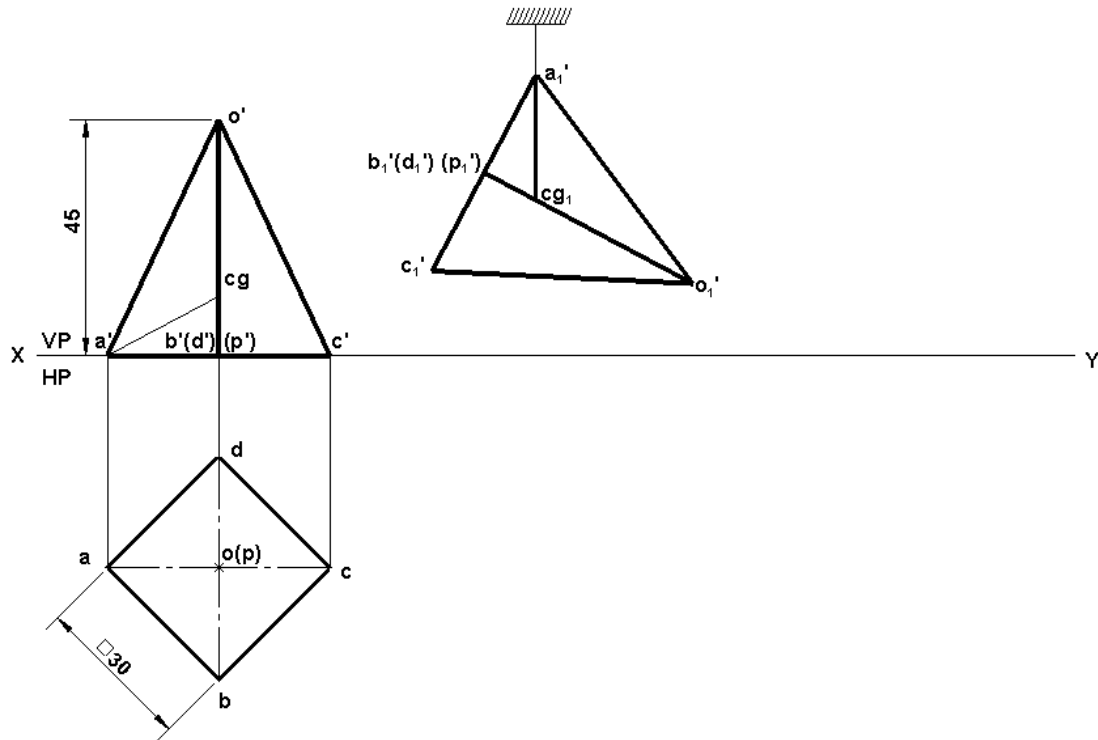
4. Click on **POLYGON COMMAND** , draw a triangle  giving number of sides as 4 in the property manager tab, below XY line. Give 30 mm dimension to any one side of the polygon using **SMART DIMENSION COMMAND** . Label the vertices as a, b and c using **NOTE COMMAND**  (Delete the inscribed circle manually). Join ac and bd which shows the slant edges of pyramid in top view represent apex as o as shown.




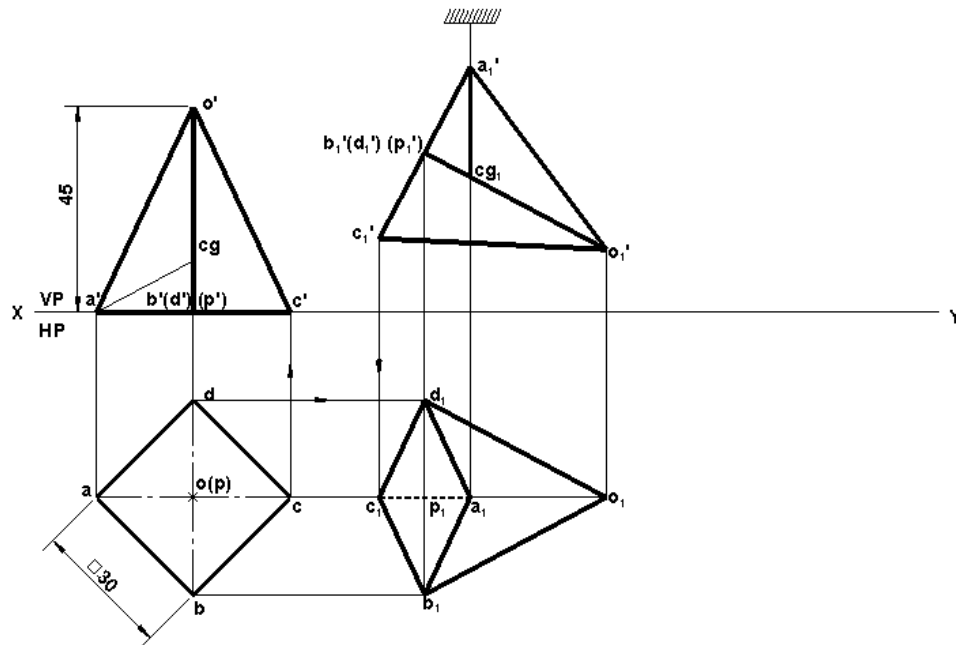
5. Draw vertical projections upwards from corners of the top view. Draw the base of pyramid on XY line using **LINE COMMAND**  represent it as a' , b' , c' , (d') . Using **CENTER LINE** draw axis which is equal to height of pyramid (45 mm). Represent apex as o' . Join all the corners to the apex using **LINE COMMAND**  to get front view of pyramid as shown. Since the pyramid is suspended from one of the corners of its base. Identify the center of gravity of the pyramid ($1/4$ of the height from base). Mark a point represents it as cg with the help of **LINE COMMAND** . Join the cg and a' as shown.






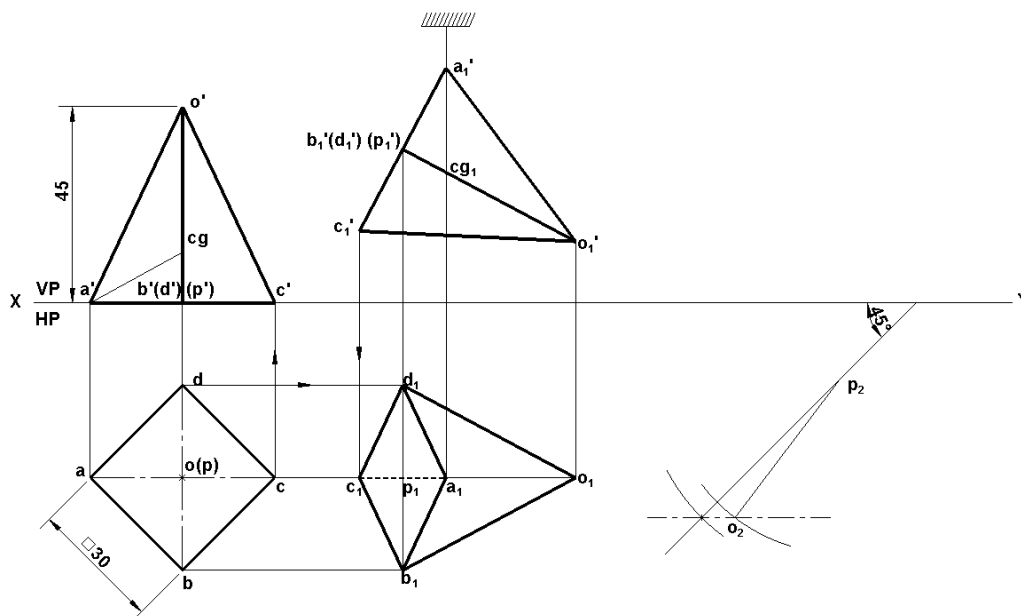
12. Select the front view (only lines) copy using **COPY ENTITIES**  making a' as starting point and paste beside the first front view. Select the copied front view and make block using **MAKE BLOCK COMMAND**  and make insertion point as a' . Select the line $a'cg'$ and make it as **Horizontal** in property manager.





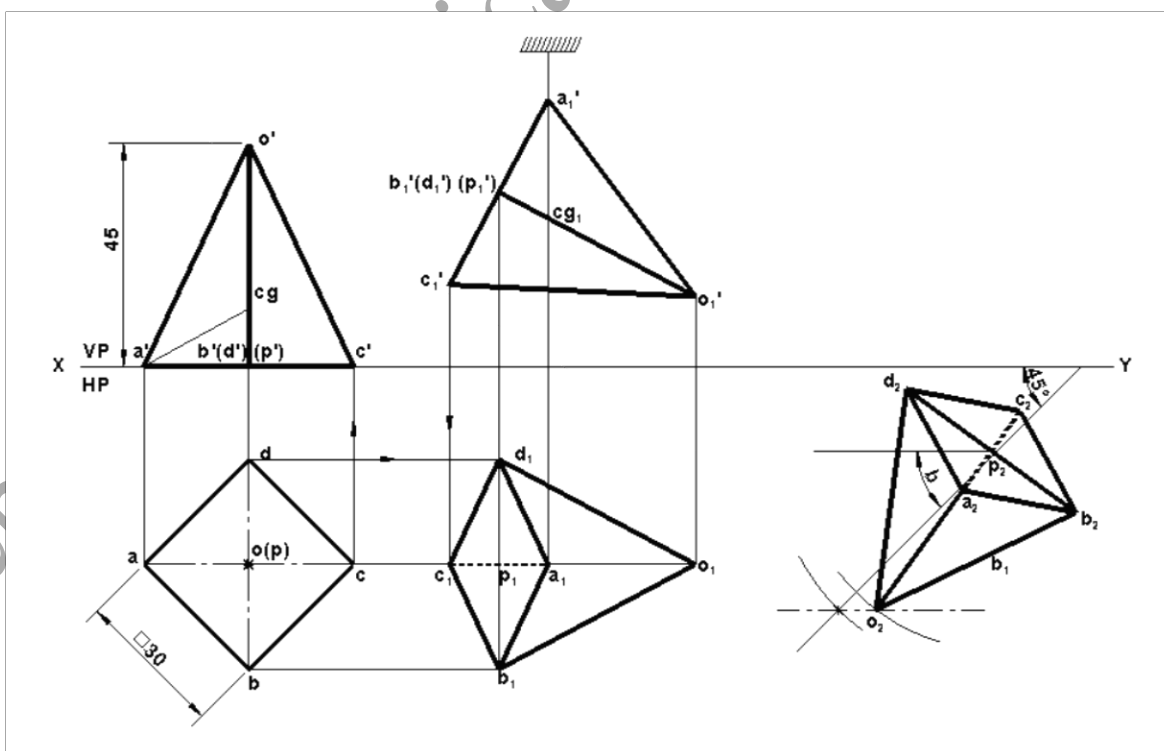
6. Draw vertical projectors downwards from corners and apex of the second stage. Draw horizontal projector towards right from stage top view using **LINE COMMAND**  to get required top view. Note, the edges which are not visible choose line type as dotted and annotate as shown.




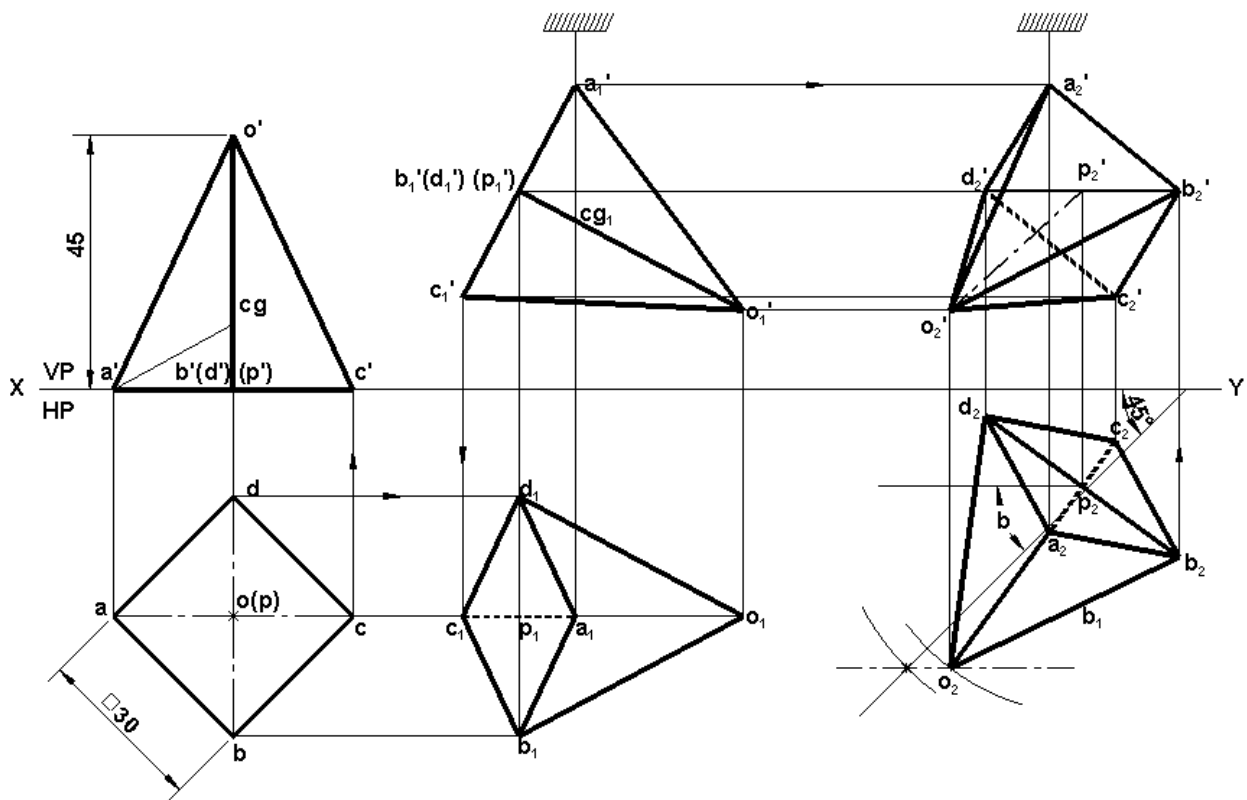
7. Using **LINE COMMAND**  and **SMART DIMENSION**  draw a 45° line to XY. Mark on this line p_2o equal to $o'p'$ from first stage FV. Using **CENTERPOINT ARC COMMAND**  taking p_2 as center and radius equal to p_1o_1 draw an arc to cut the locus o_1 . Mark this as p_2o_2 .



13. Select the entities in the sketch in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK**  Insert the block using **INSERT BLOCK COMMAND**  Rotate the copied second stage TV until its p_1o_1 coincides with p_2o_2 by giving collinear relation between lines .



8. Draw vertical projectors upwards from corners and apex of the third stage top view. Draw horizontal projectors towards right from second stage front view using **LINE COMMAND** to get required third stage front view. Join the corresponding intersection points by using **LINE COMMAND** . Note, the edges which are not visible choose **LINE STYLE** as dashed line and annotate as shown below.



9. To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and then click on **SAVE**.

Problem 4.3.5




A cylinder of 40 mm diameter and height 60 mm is resting on HP on one of its rim or base points such that the axis is inclined at 40° to HP and 50° to VP. Draw the projections of the solid.

Solution

Manual Method

1. Draw the XY line. Mark VP above it and HP below it.
2. IN the initial position the cylinder is placed with its base on the HP. Draw the top view which is a circle. Draw 8 generators on the surface of the cylinders and name them. The top face is labelled a, b, c, ...h and bottom face p, q, r, ...w.
3. Project the front view
4. Redraw the front view in the second stage with point f1' on the circumference of the base resting on XY line and the axis making an angle of 40° with XY line.
5. Project the top view.
6. Redraw the top view in the third stage with the axis inclined at apparent inclination ' β ' corresponding to true inclination of 50° with VP.
7. Project the final front view.
8. Make all the top views and the front views uniformly thick.



Computer Aided Drafting Procedure

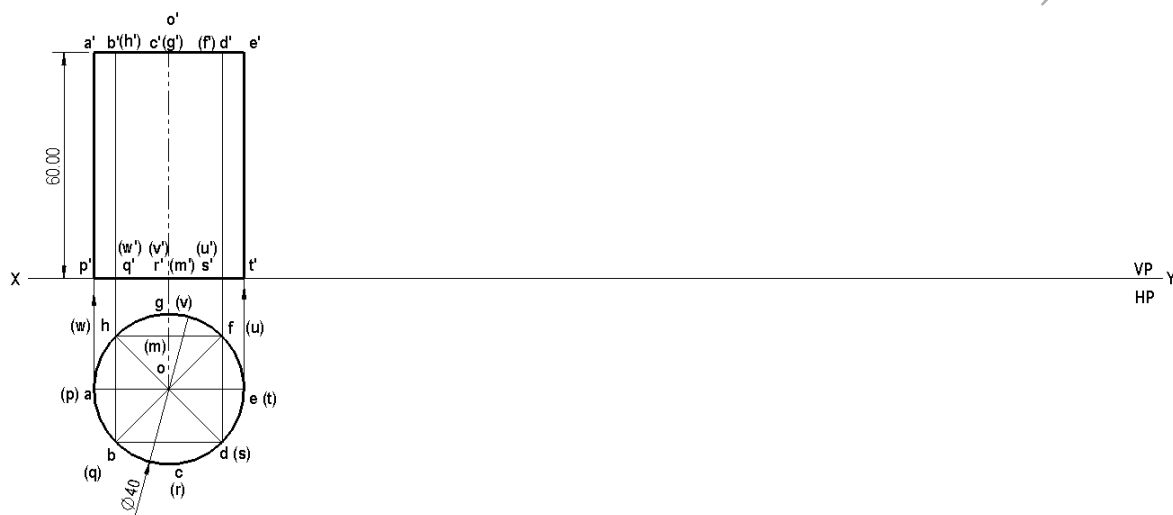
1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND**  from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND**  from **ANNOTATION TOOLBAR**.
4. Using **CIRCLE COMMAND**  draw a circle of radius 20 mm below XY line divide the circle into any number of parts say eight as shown.





NOTE: TO Divide a circle into 8 equal parts.


Create a vertical line from the center of the circle to the circumference using **LINE COMMAND** and use command **CIRCULAR SKETCH PATTERN** and pattern the line and keep center of the circle as the reference point and give the **instances** as 8 select **LINE** constructed as the **entities to pattern** and click **OK**. The circle will be having 8 divisions as per the requirement.

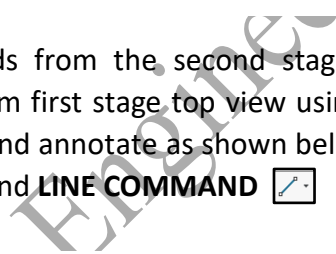
5. Draw the horizontal line at a distance equal to height of the cylinder above the XY line. Mark the intersection points between the horizontal and vertical lines. Join all the intersection points by using **LINE COMMAND** . Trim all the unwanted construction lines by using **TRIM COMMAND**  as shown.



6. Select the front view (only lines) copy using **COPY ENTITIES**  making **t'** as starting point and paste on the XY line. Select the copied front view and make block using **MAKE BLOCK COMMAND**  by making insertion point as **t'**. Uncheck the lock angle from the property manager and give angle of 40° .

OR

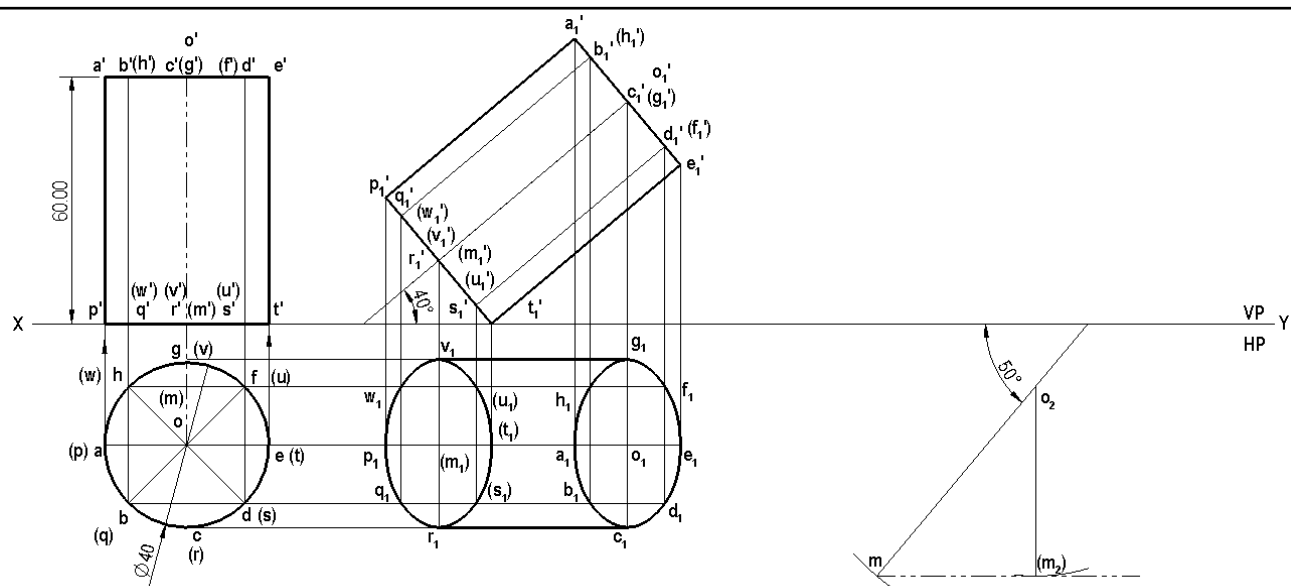
Using **ROTATE COMMAND**  rotate the block by making **t₁'** as center of rotation, give angle of 40° .



-



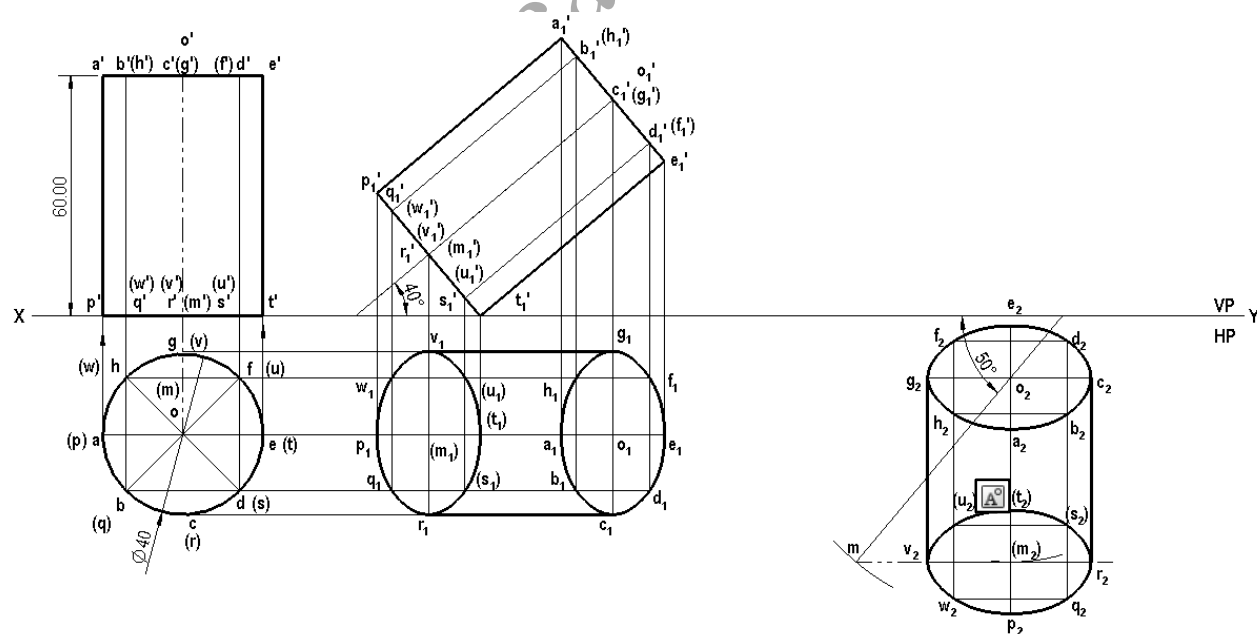
- | | |
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| | 0 |
| | d |
| | |





14. Select the entities in the sketch  in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK**. Insert the block using **INSERT BLOCK COMMAND** and rotate the angle by unchecking Lock angle in property manager.

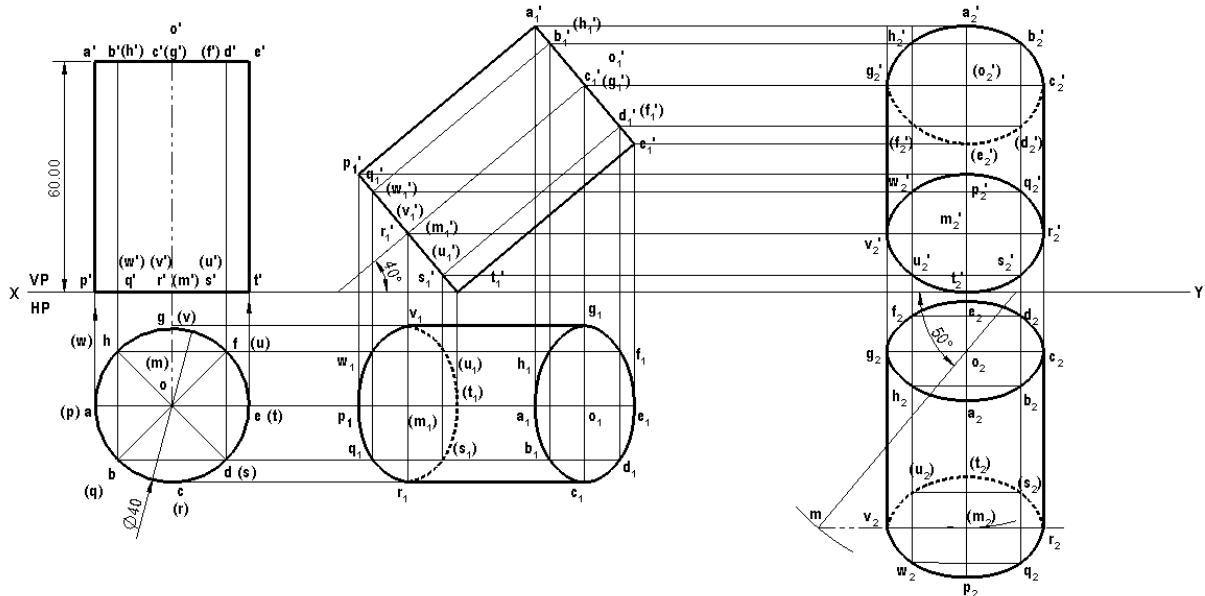
OR

Give colinear relation between line **om** and **o₂m₂** line after inserting the block.



9. Draw vertical projectors upwards from the third stage top view. Draw horizontal projectors towards right from second stage front view using **LINE COMMAND**  to get

required front view. Trim all the unwanted construction lines by using **TRIM COMMAND** . Join the intersection points using **SPLINE COMMAND** and **LINE COMMAND** . Note, the lines which are not visible choose line type as dotted and annotate as show below.



10. To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and the click on **SAVE**.

Note: This problem can also be solved starting with side view, because the axis is inclined to both HP and VP such that, $(\theta + \phi) = 90^\circ$ and the axis is contained in a plane which is perpendicular to both HP and VP (or parallel to profile plane.)

Problem 4.3.6



A cone of base diameter 40 mm and axis length 50 mm is resting on HP on a point on the circumference of its base such that its apex is at 40 mm above the HP and the top view of its axis is inclined at 60° to VP. Draw the top and front views of the solid. Also, determine the inclination of the axis when the base is nearer to the observer.

Solution




Manual Method

1. Draw the XY line. Mark VP above it and HP below it.
2. In the initial position the cone is placed with its base on HP. Draw the top view. Construct 8 generators and name them, as a, b,...h.
3. Project the front view.
4. Draw a line parallel to XY line at a distance of 40 mm above it. Redraw the first stage front view in the second stage, such that the apex $o1'$, lies on the locus line and point of the base $e1'$, lies on the XY line.
5. Project the top view.
6. Redraw the second stage top view in the third stage with the axis making 60° with XY and the base towards the observer.
7. Project the final front view.
8. In the second stage front view measure angle θ which is the true inclination of the axis with HP.
9. Make all the top views and the front views uniformly thick.




Computer Aided Drafting Procedure

1. Open the **SOLIDWORKS SOFTWARE**. Click on the **DRAWING** in the **WELCOME** dialog box.
2. Set up the sheet format by selecting the standard sheet format from **SHEET FORMAT** dialog box. Select "**A4 LANDSCAPE**" size for this problem.
3. Draw the line by using the **LINE COMMAND**  from **SKETCH TOOL BAR**. Represent it as X-Y line & make annotations X-Y, HP and VP to the line by using **NOTE COMMAND**  from **ANNOTATION TOOLBAR**.



X $\frac{VP}{HP}$ _____ Y

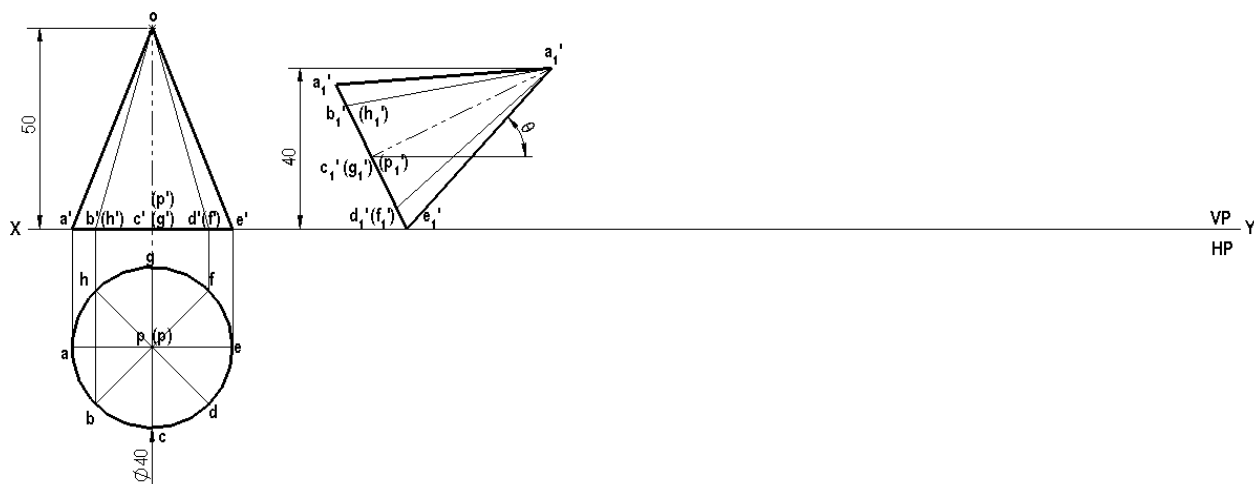
4. Click on **CIRCLE COMMAND**  , draw a circle of radius 20 mm below XY line divide the circle into any number of parts say eight as shown. Represent them as a, b, etc., and center as o(p) using **NOTE COMMAND**  . With center o(p) of circle join all the points to center which represents the generator of the cone using **LINE COMMAND**  as shown.



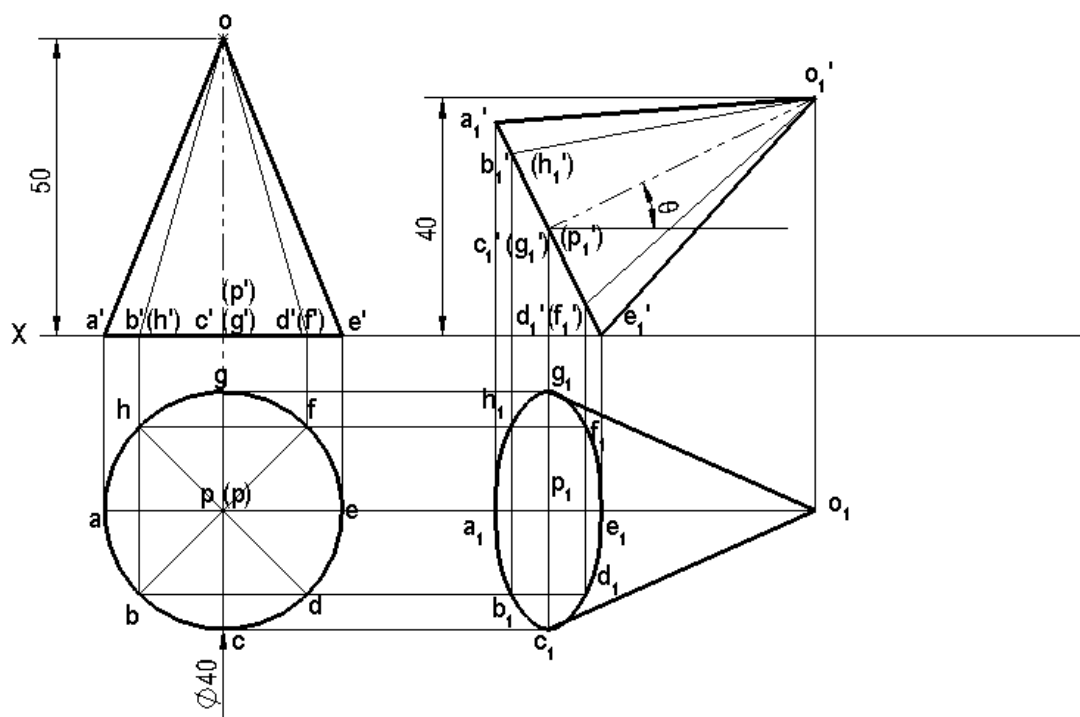
5. Draw vertical projectors upwards from the top view, draw base of cone on XY line using **LINE COMMAND**  represent it a', b' etc. To get the height of the cone draw vertical projector upwards from center o(p) of height 50 mm, using **SMART DIMENSION COMMAND**  , fix the height of cone and represent apex as o. Now using **LINE COMMAND**  join from all points to o' as shown below.



6. Draw a line parallel to XY line at a distance of 40 mm above XY line. Select the front view of the triangle (only lines) copy using **COPY ENTITIES**  making e' as starting point and paste on the XY line. Select the copied triangle and make block using **MAKE BLOCK COMMAND**  and make insertion point as e'. and select c₁'(g₁') and the 40 mm line and give **COINCIDENT RELATION** by unchecking Lock angle in property manager tab.



7. Draw vertical projectors from corners of the second stage front view. Draw horizontal projector towards right from first stage top view using **LINE COMMAND** . To get required second stage top view and annotate them as shown. Join the intersection points using **LINE COMMAND** and **SPLINE COMMAND** .



8. Select the entities in the sketch in the second top view and go to **BLOCK COMMAND (ANNOTATIONS-BLOCKS-MAKE BLOCK)** and click on **MAKE BLOCK** . Insert the block




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using **INSERT BLOCK COMMAND**

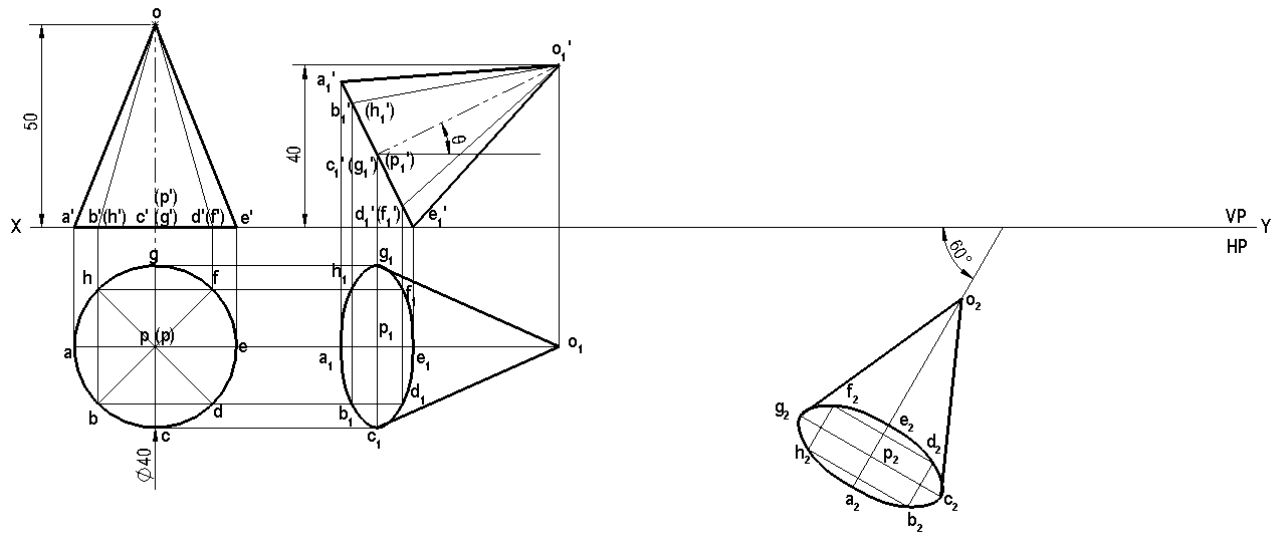
and rotate the angle by unchecking Lock angle in property manager.




OR

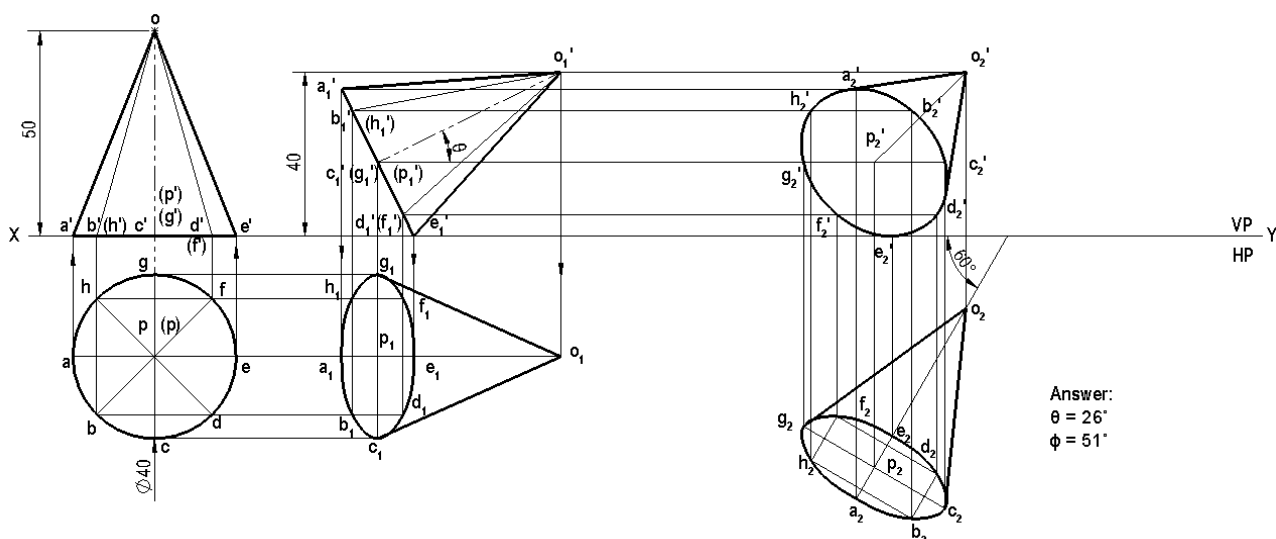
Using **ROTATE COMMAND**  tilt the second top view of the solid such that axis is at an angle of 60° from the XY line as shown.

OR

Using **SMART DIMENSION COMMAND** , make angle between the axis and XY line is 60° .



9. Draw vertical *projectors* upwards from corners of the third stage top view, draw horizontal projector towards right from second stage front view using **LINE COMMAND**  to get required third stage front view. Join the intersection points using **LINE COMMAND**  and **SPLINE COMMAND**  .



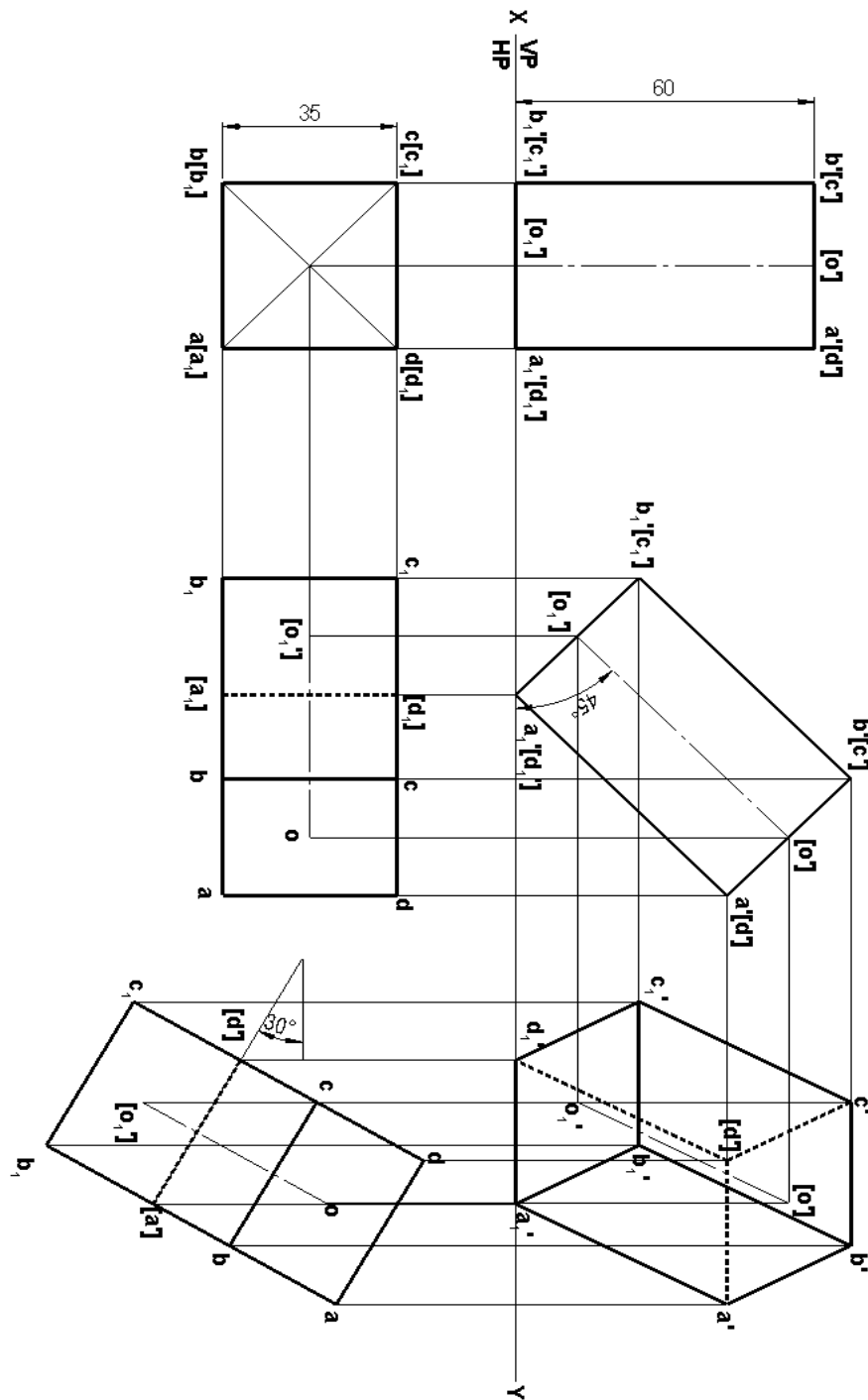
10. Using **SMART DIMENSION COMMAND**  . To save this drawing click on **FILE** and then click on **SAVE AS**, give a file name and the click on **SAVE**.

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PROBLEMS WITH SOLUTIONS

Problem 1. A square prism 35 mm sides of base and 60 mm axis length rests on HP on one of its edges of the base which is inclined at VP at 30° . Draw the projections of the prism when the axis inclined to HP at 45° .

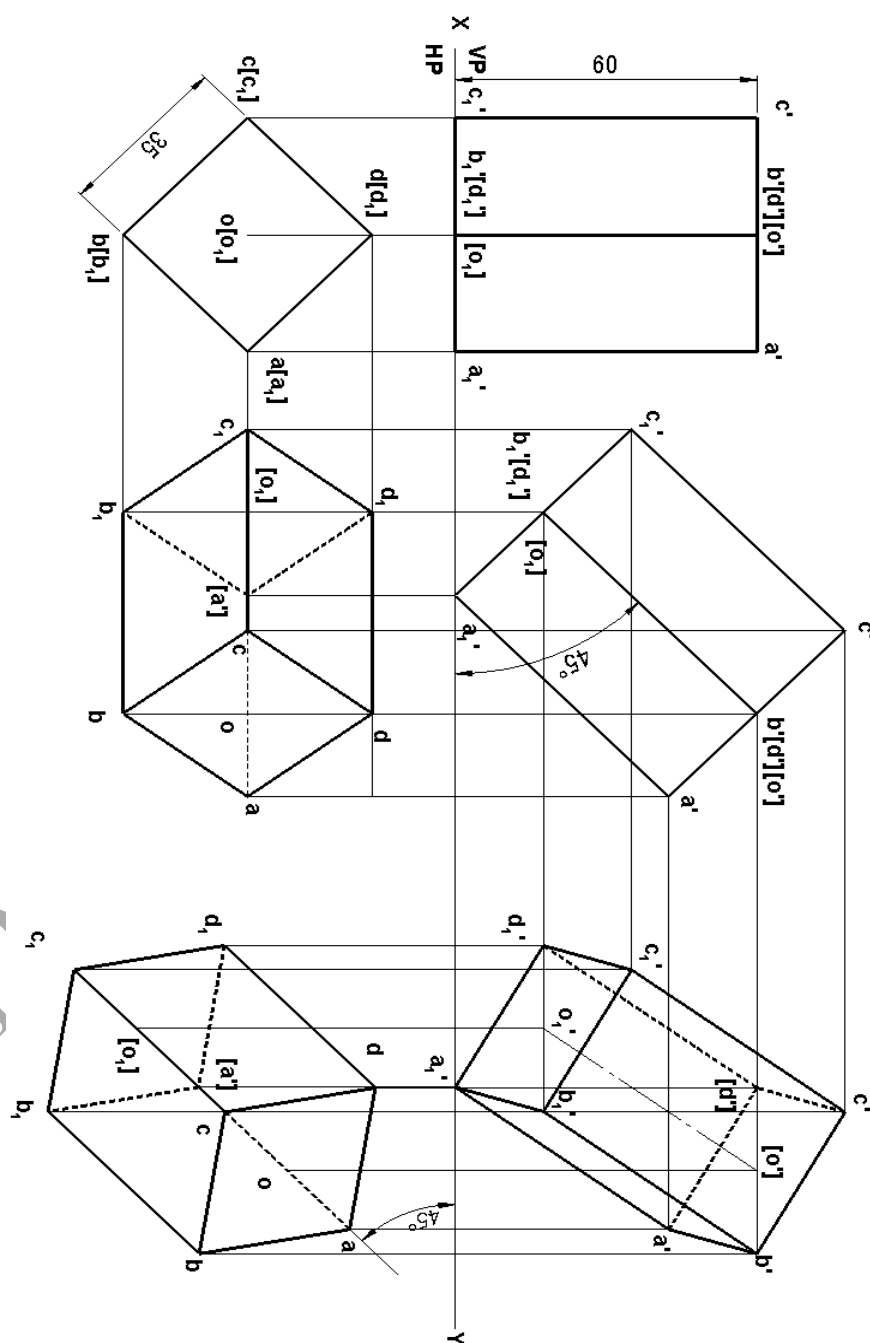
Solution



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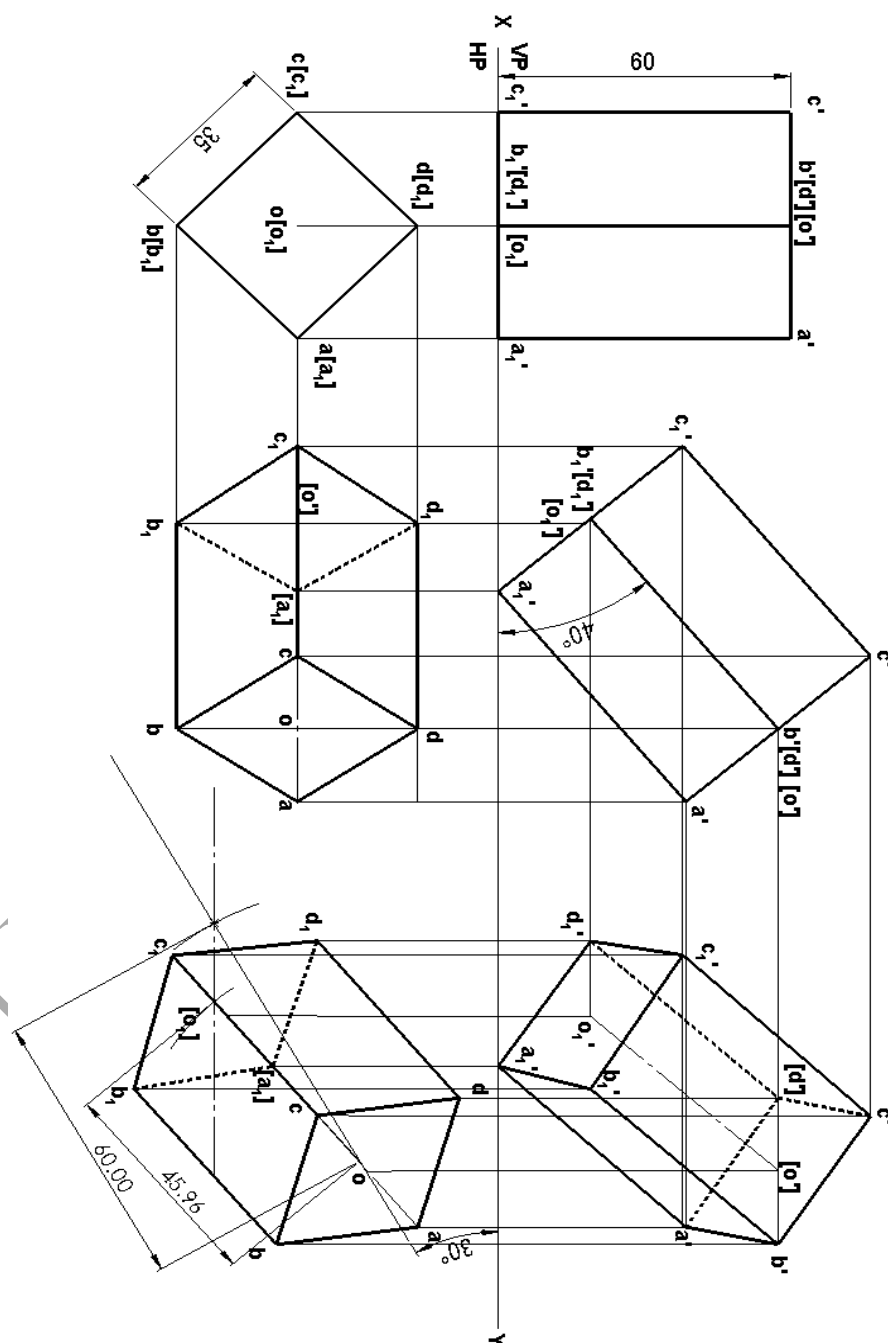
Problem 2. A square prism 35 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and appears to be inclined to VP at 45° .

Solution



Problem 3. A square prism 35 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and appears to be inclined to VP at 45° .

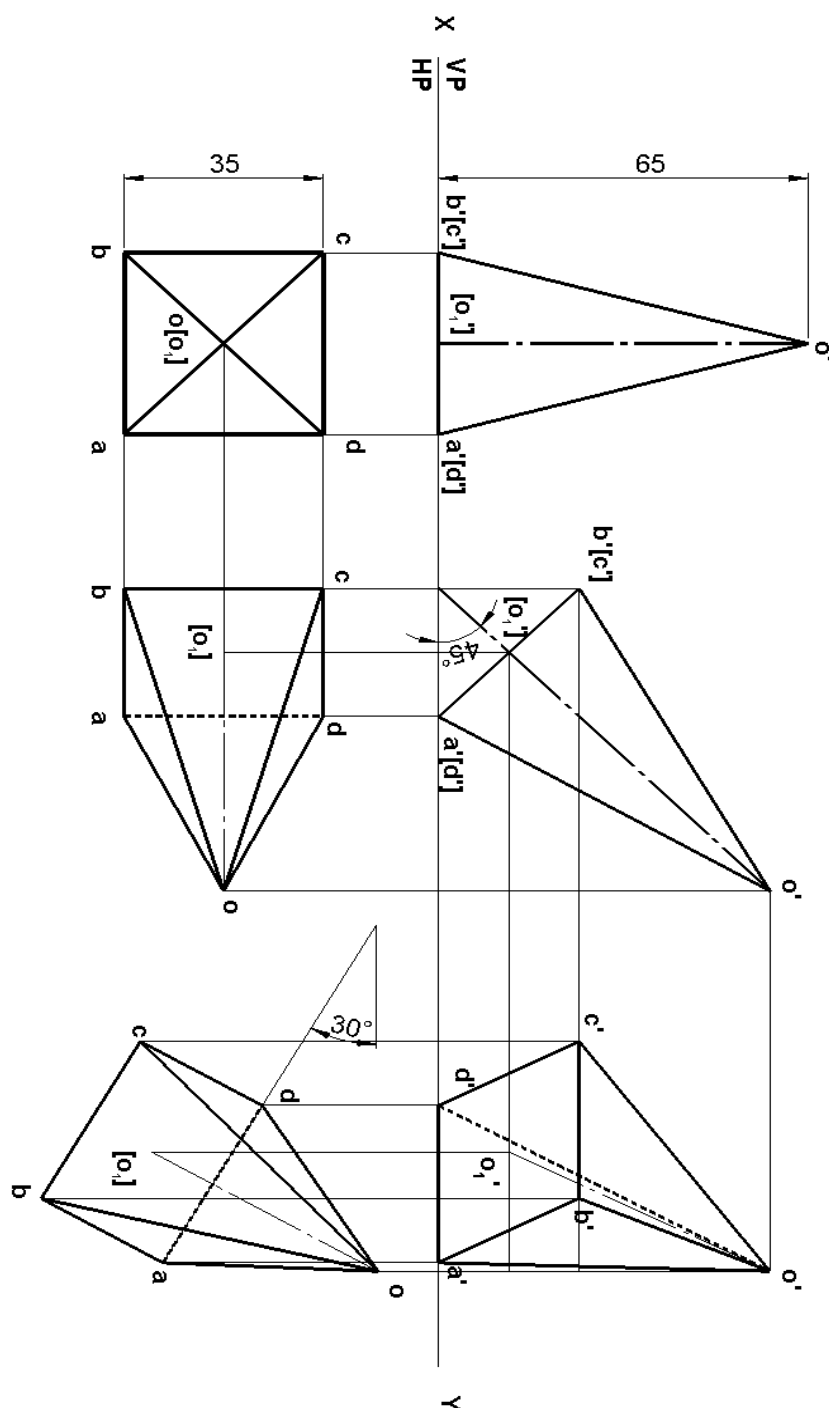
Solution



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Problem 4. A square pyramid 35 mm side of base and 65 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30° . Draw the projections of the pyramid when the axis is inclined to HP at 45° .

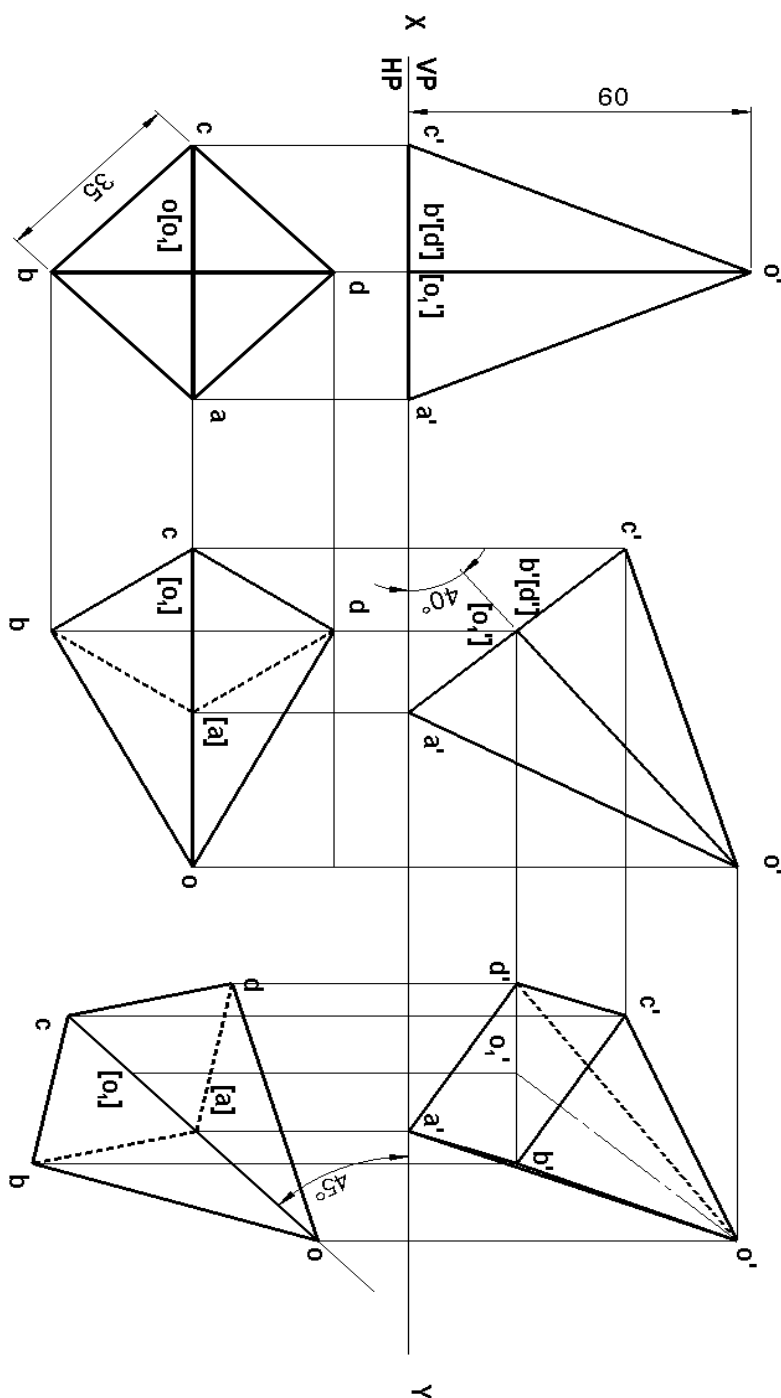
Solution



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Problem 5. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corners on which it rests make equal inclinations with HP. Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and appears to be inclined to VP at 45° .

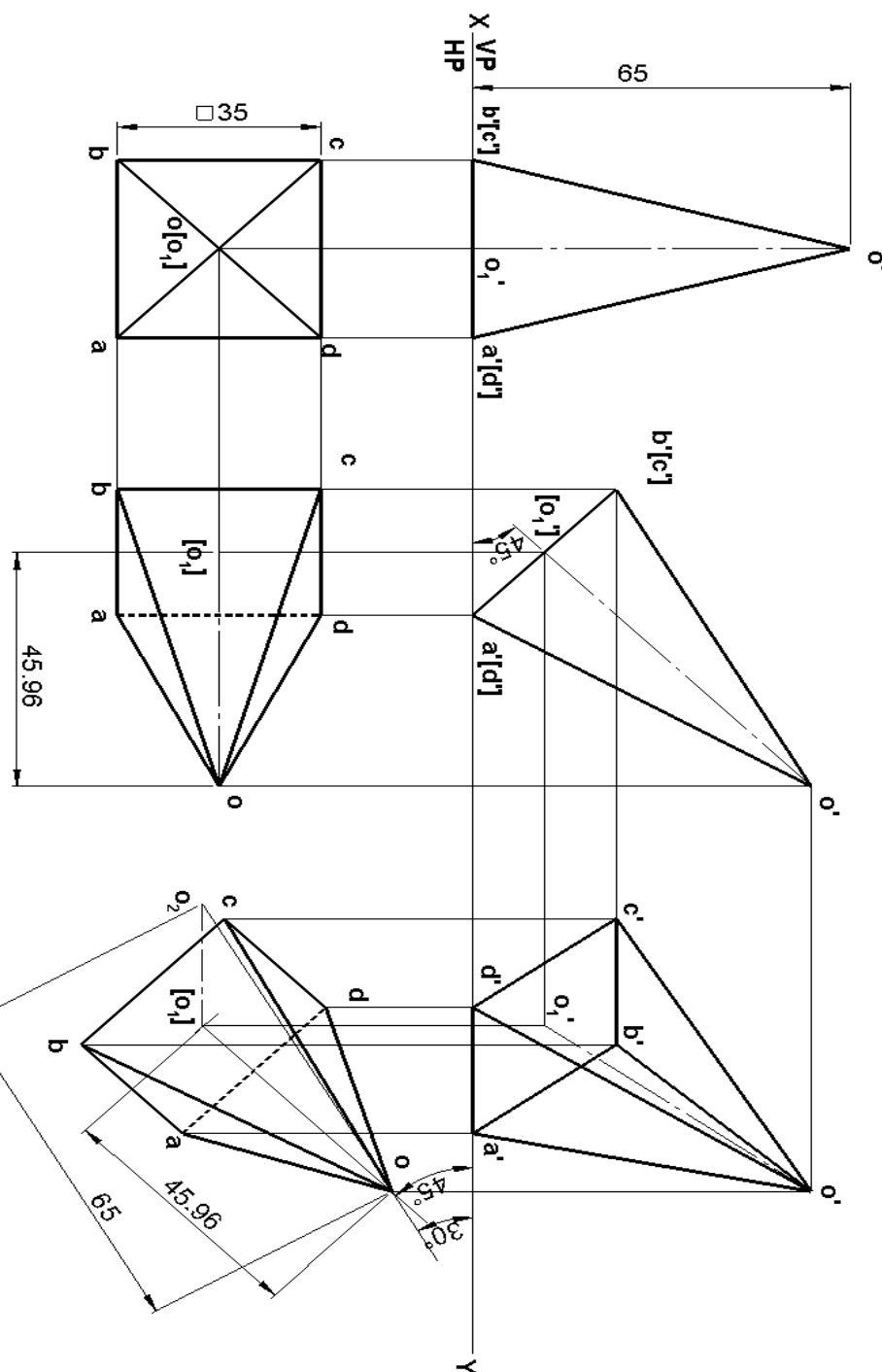
Solution



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Problem 6. A square pyramid 35 mm side of base and 65 mm axis length rests on HP on one of its edges of the base. Draw the projections of the pyramid when the axis is inclined to HP at 45° and VP at 30° .

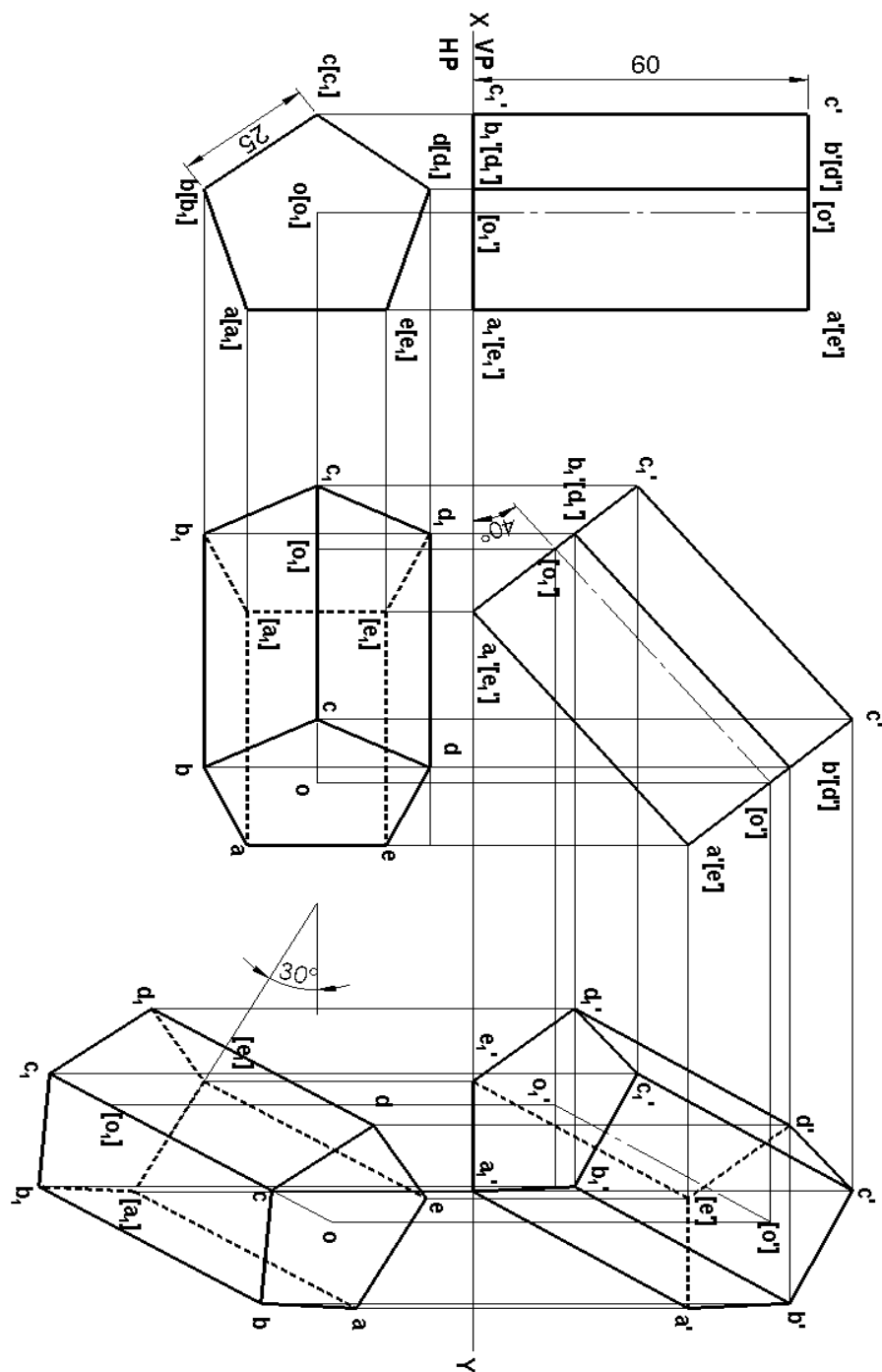
Solution



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Problem 7. A pentagonal prism 25 mm sides of base and 60 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30° . Draw the projections of the prism when the axis is inclined to HP at 40° .

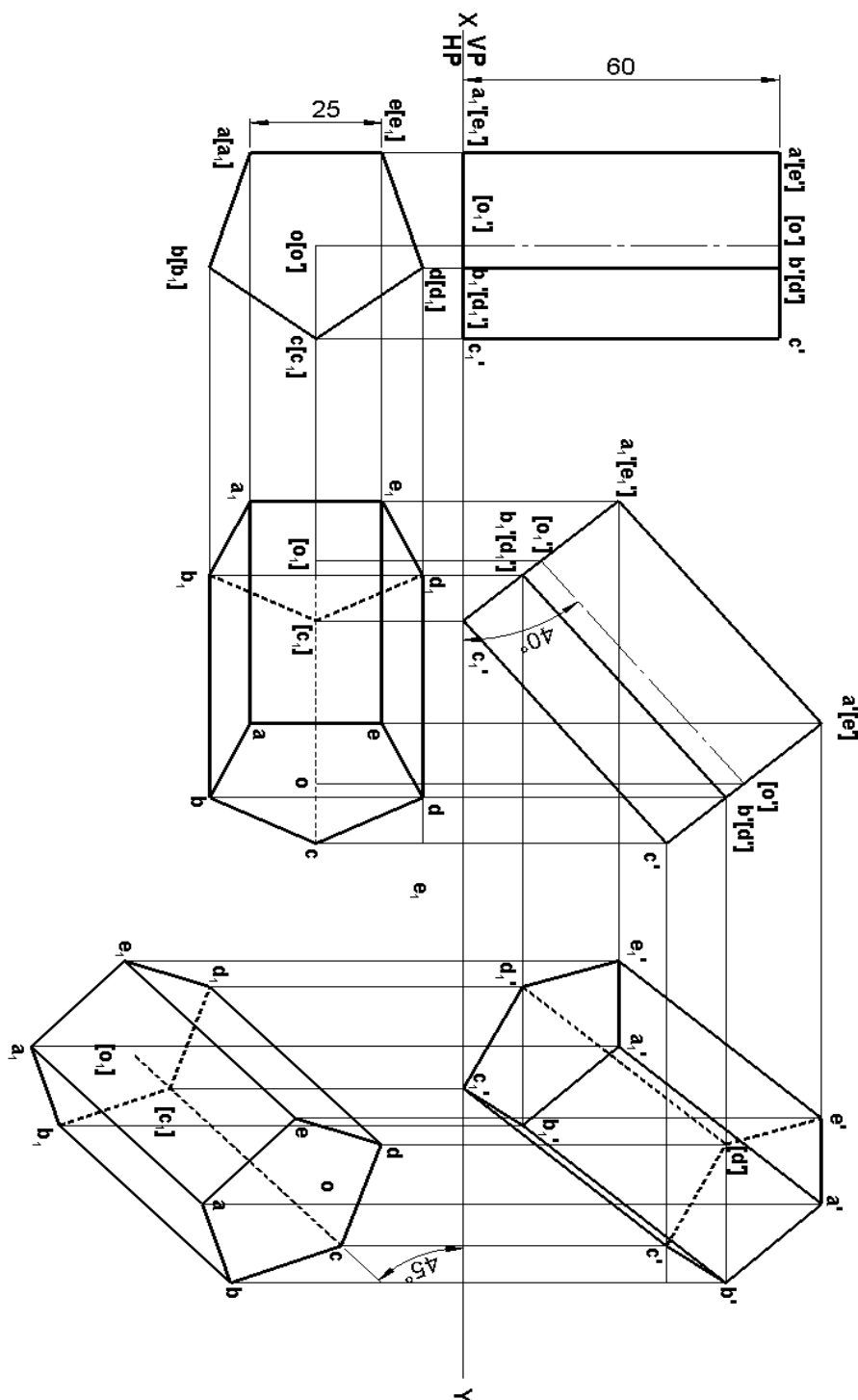
Solution



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Problem 8. A pentagonal prism 25 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and appears to be inclined to VP at 45° .

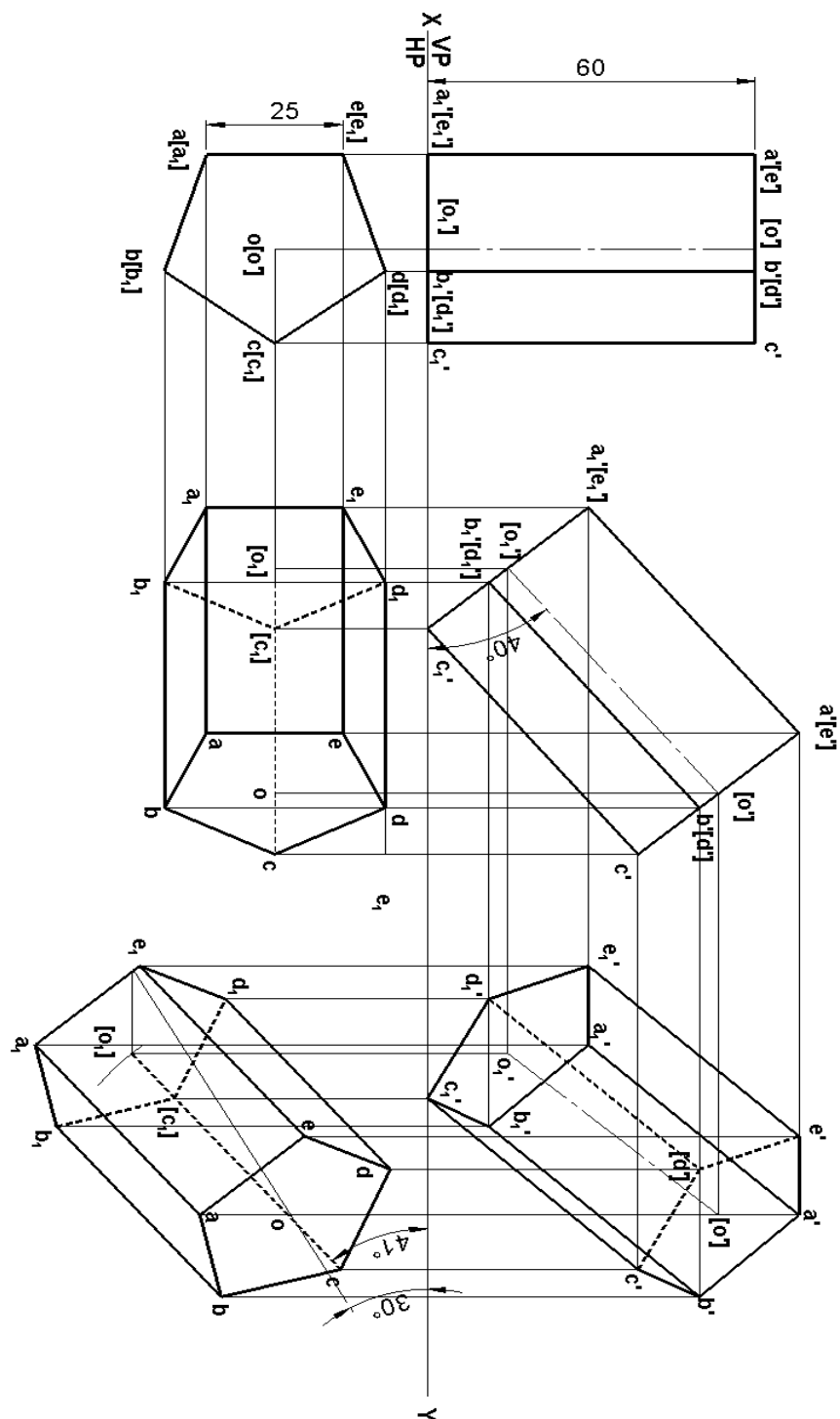
Solution



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Problem 9. A pentagonal prism 25 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and to VP at 30° .

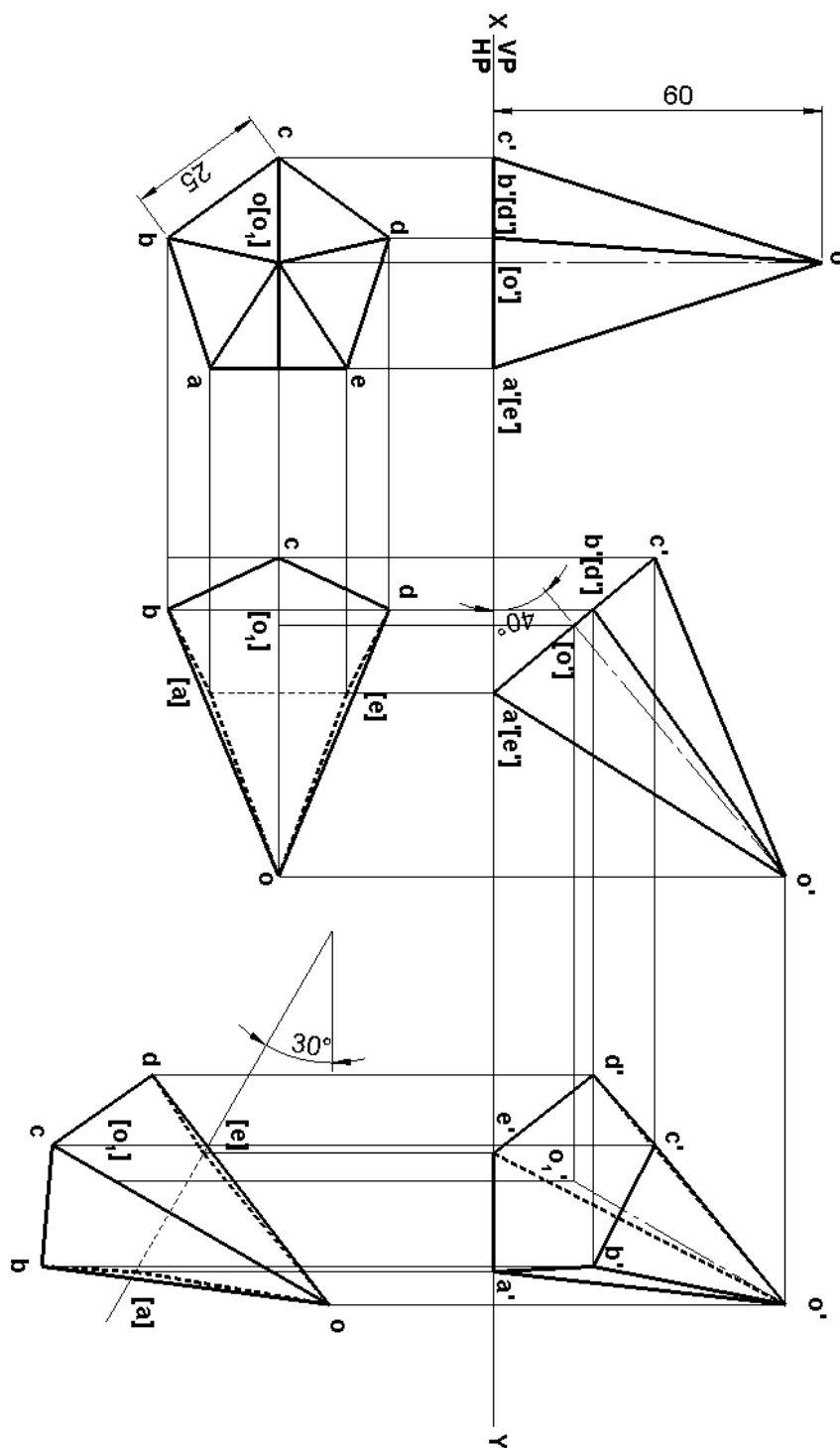
Solution



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Problem 10. A pentagonal pyramid 25 mm side of base and 60 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30° . Draw the projections of the pyramid when the axis is inclined to HP at 40° .

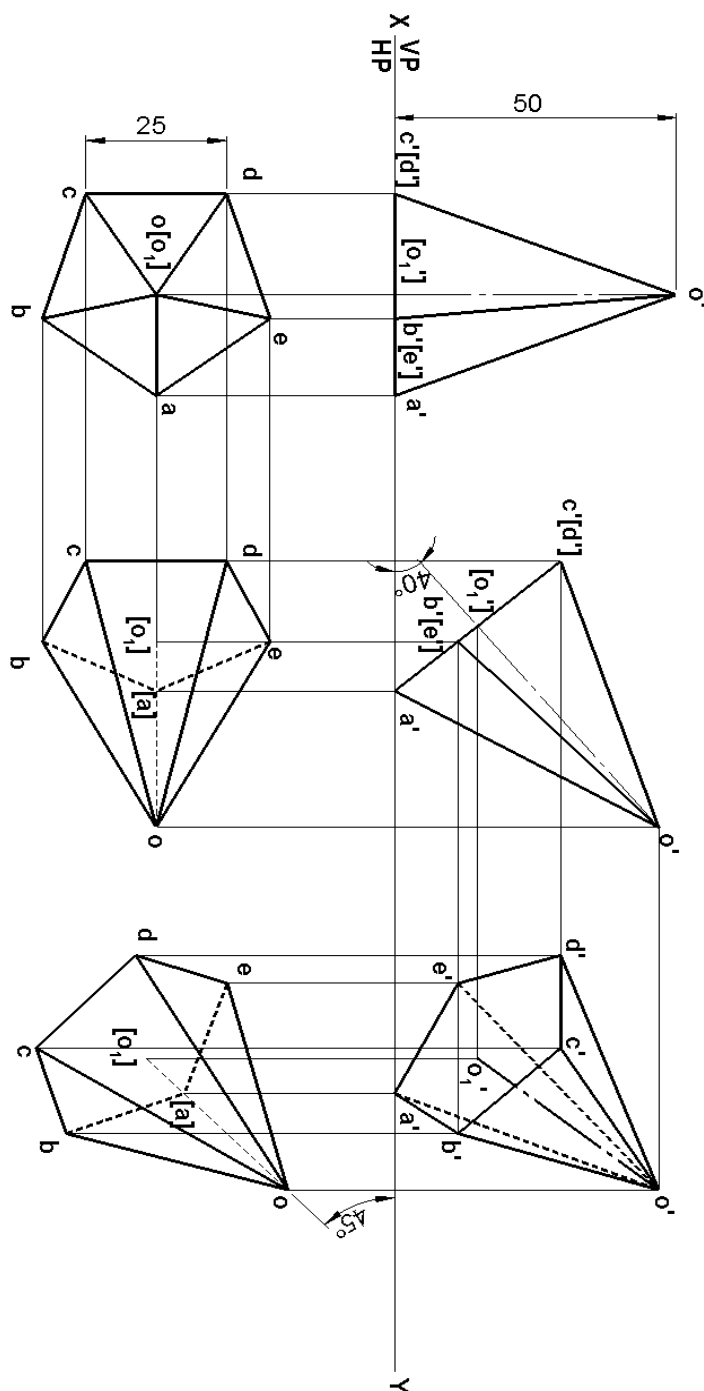
Solution



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Problem 11. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and appears to be inclined to VP at 45° .

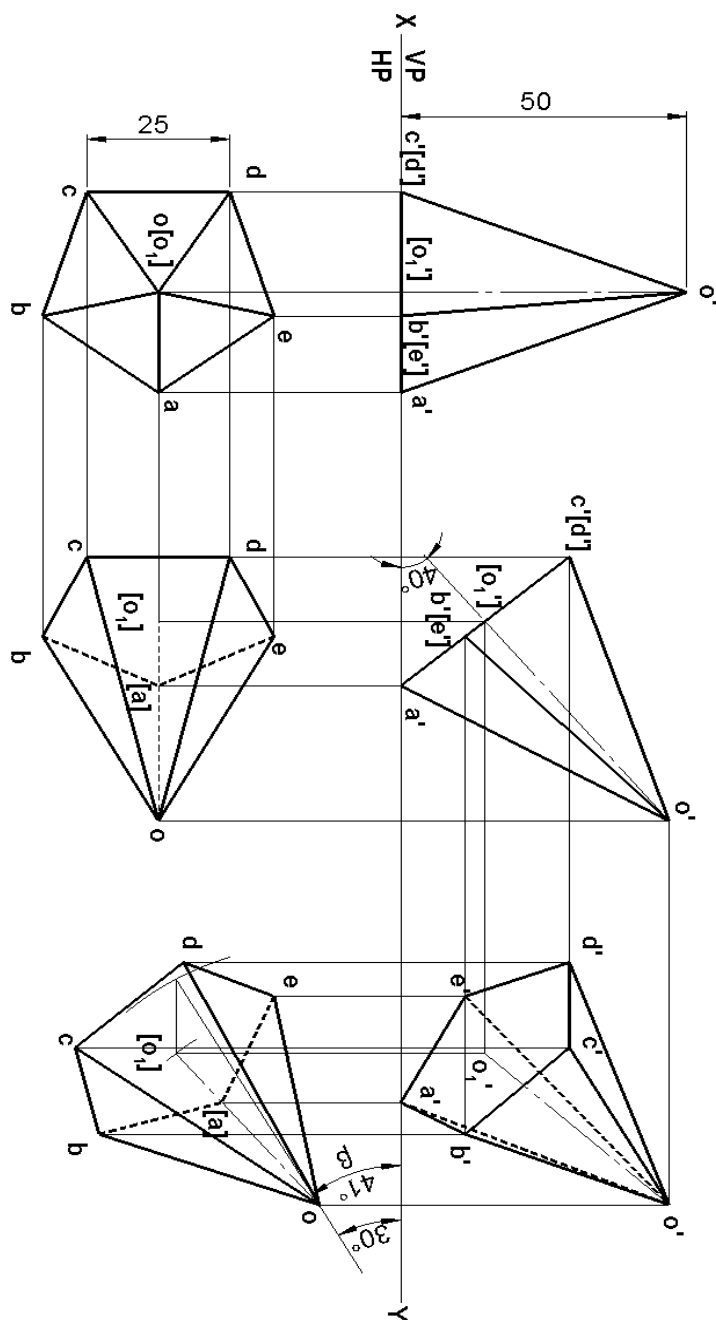
Solution



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Problem 12. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and to VP at 30° .

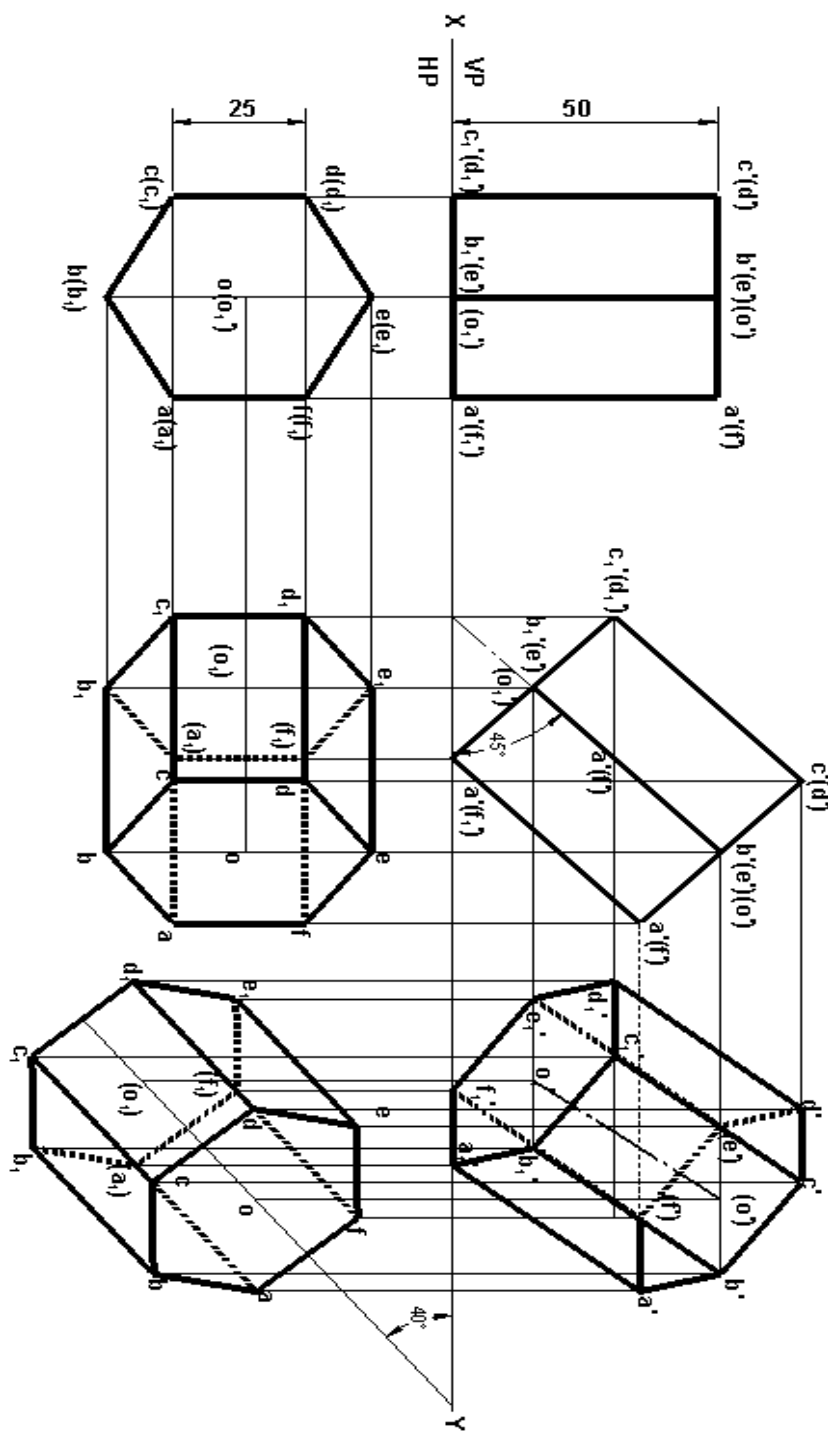
Solution



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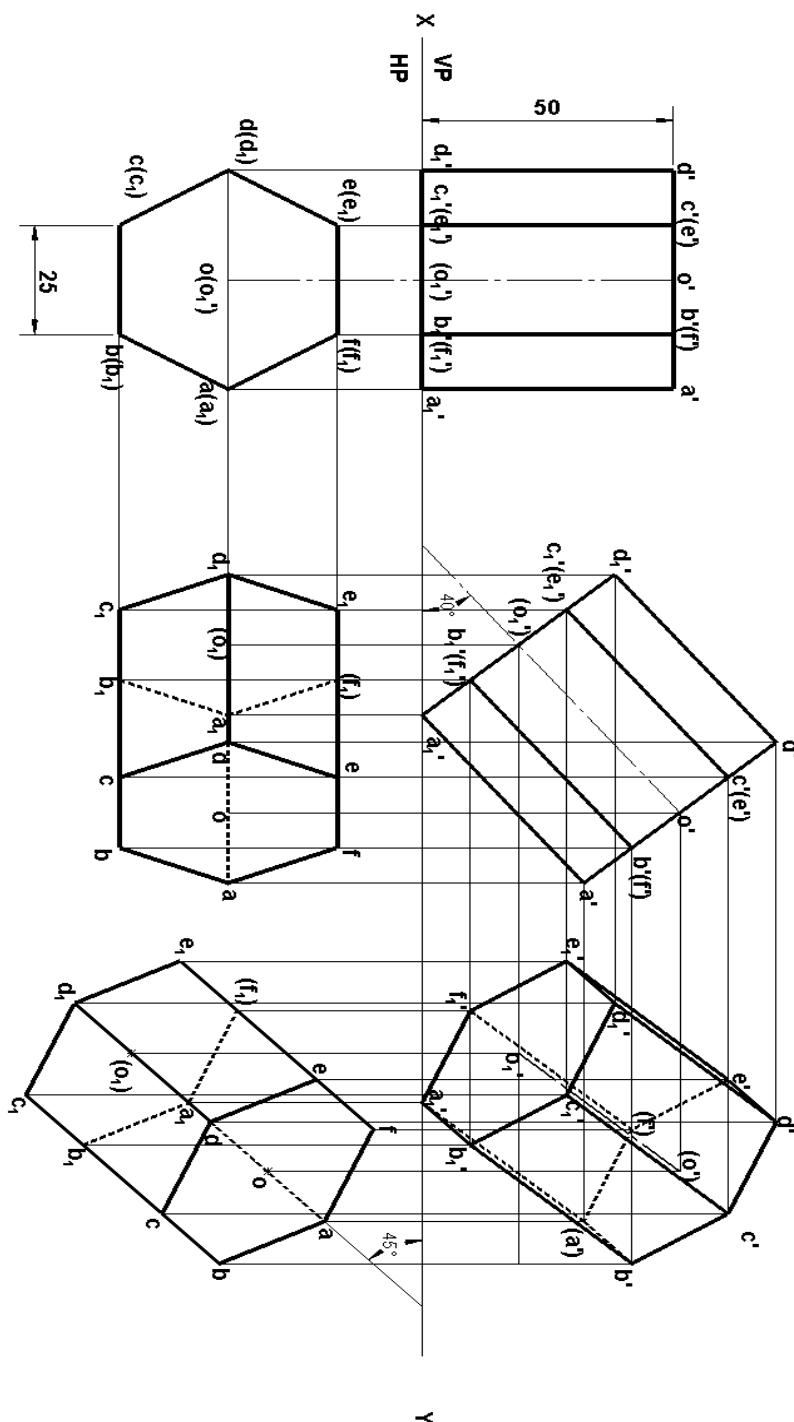
Problem 13. A hexagonal prism 25 mm side of base and 50 mm axis length rests on HP on one of its edges. Draw the projections of the prism when the axis is inclined to HP at 45° and appears to be inclined to VP at 40° .

Solution



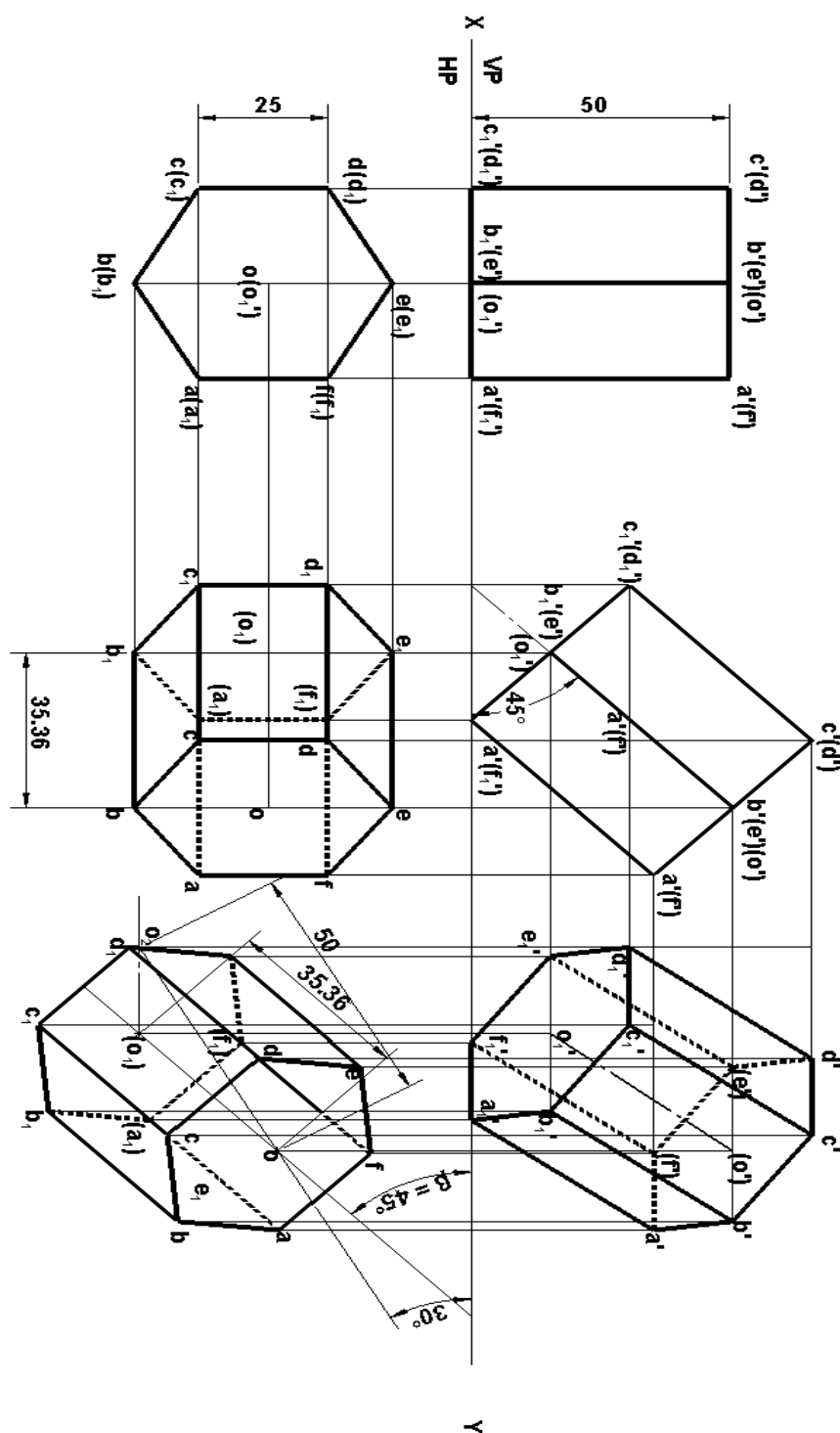
Problem 14. A hexagonal prism 25 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and appears to be inclined to VP at 45° .

Solution



Problem 15. A hexagonal prism 25 mm side of base and 50 mm axis length rests on HP on one of its edges of the base. Draw the projections of the prism when the axis is inclined to HP at 45° and VP at 30° .

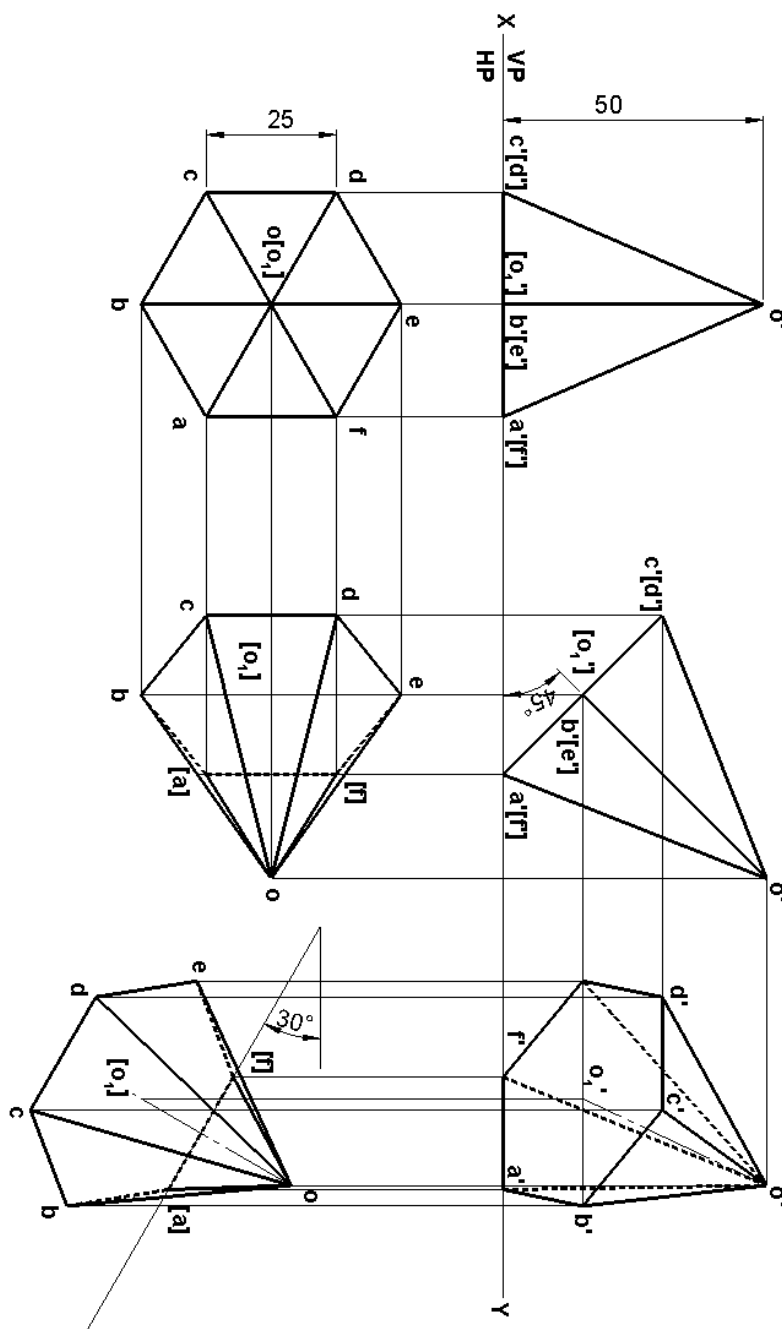
Solution



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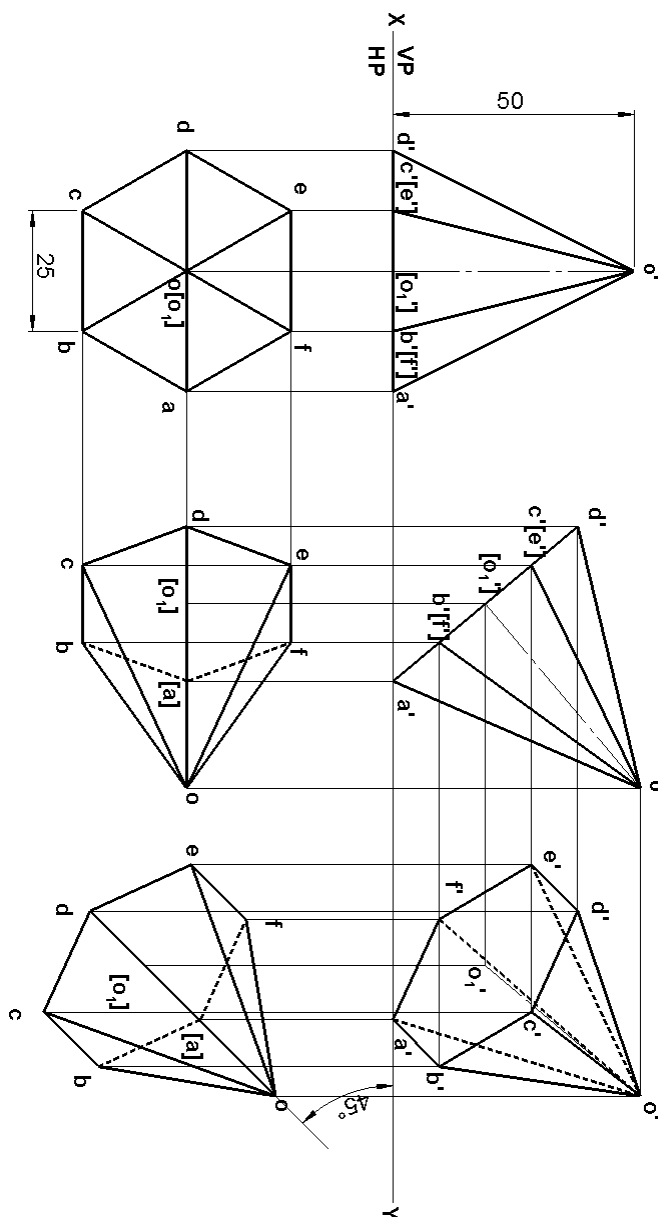
Problem 16. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30° . Draw the projections of the pyramid when the axis is inclined to HP at 45° .

Solution



Problem 17. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP, Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and appears to be inclined to VP at 45° .

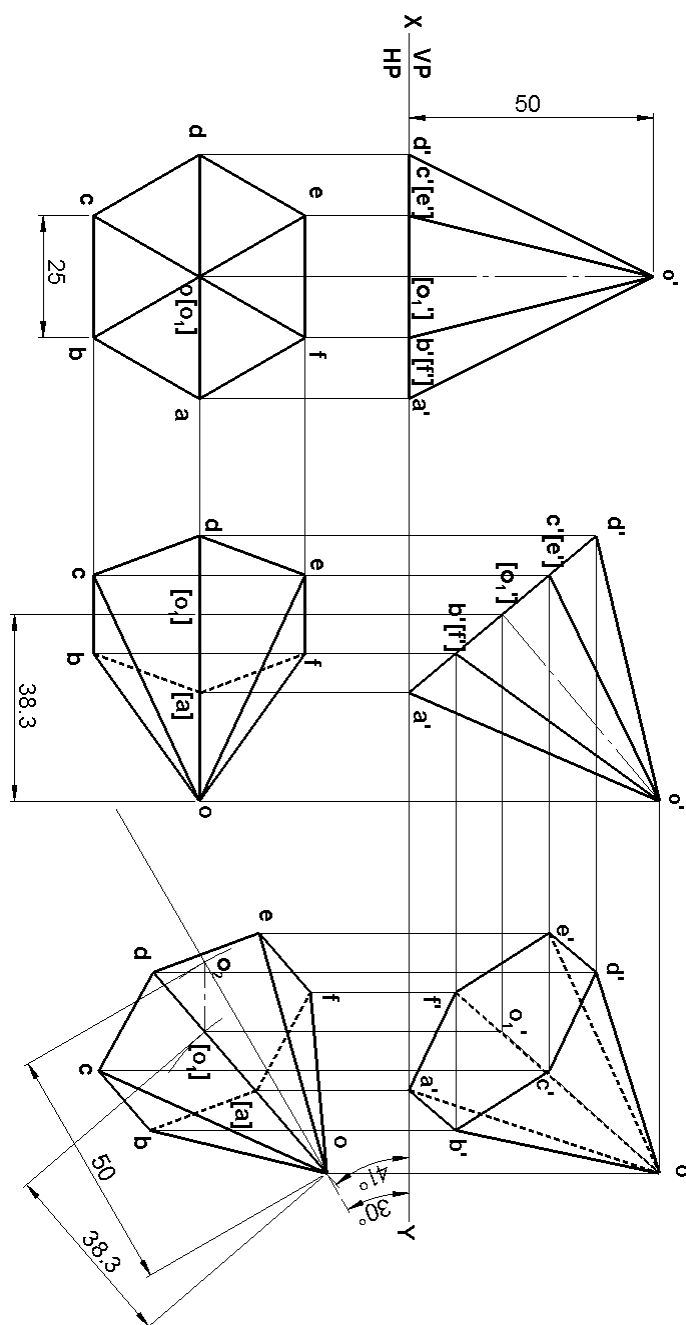
Solution



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Problem 18. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and to VP at 30° .

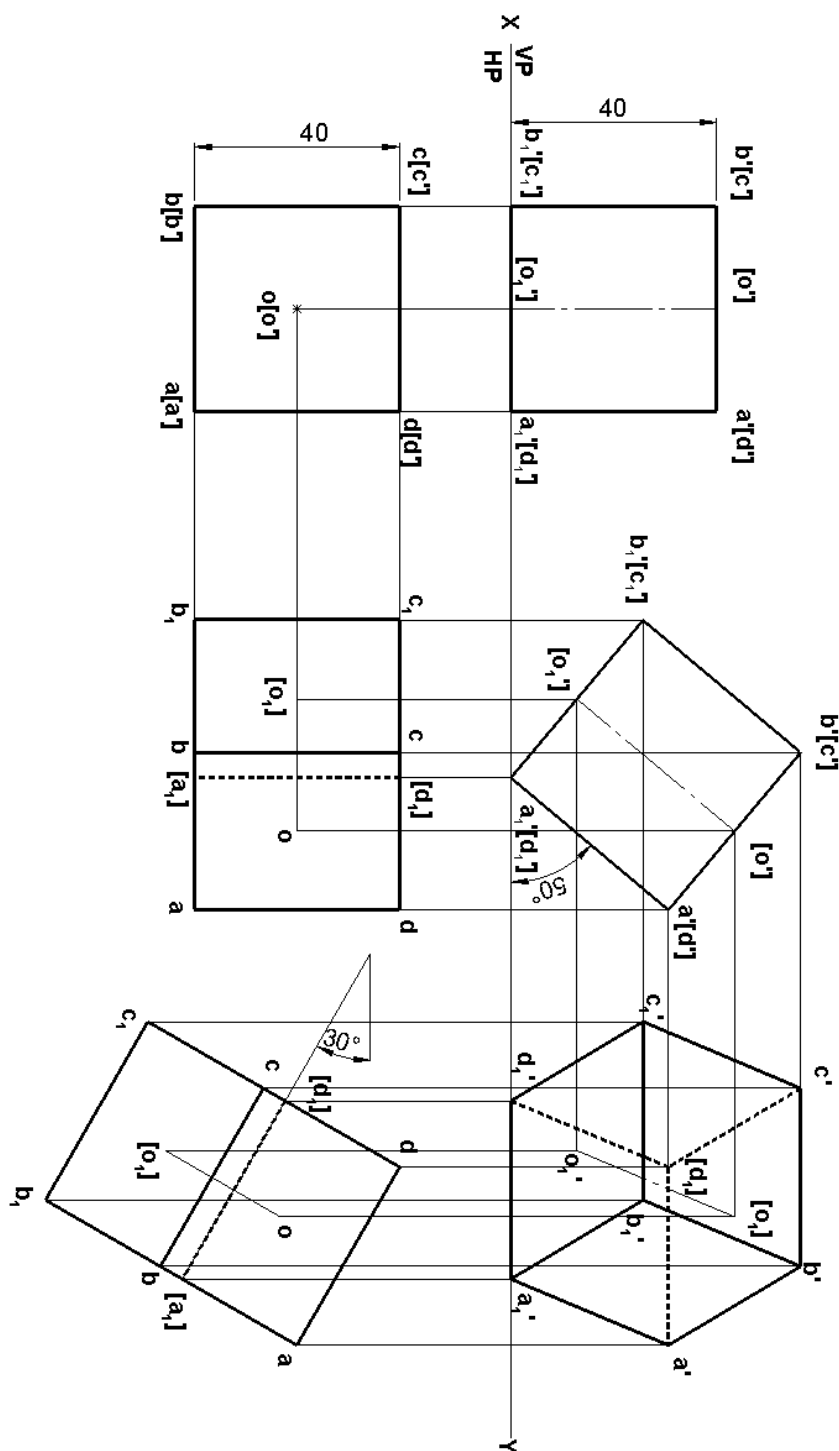
Solution



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Problem 19. A cube of 40 mm side rests on HP on an edge which is inclined to VP at 30° . Draw the projections when the lateral surface face containing the edges on which it rests makes an angle of 50° to HP.

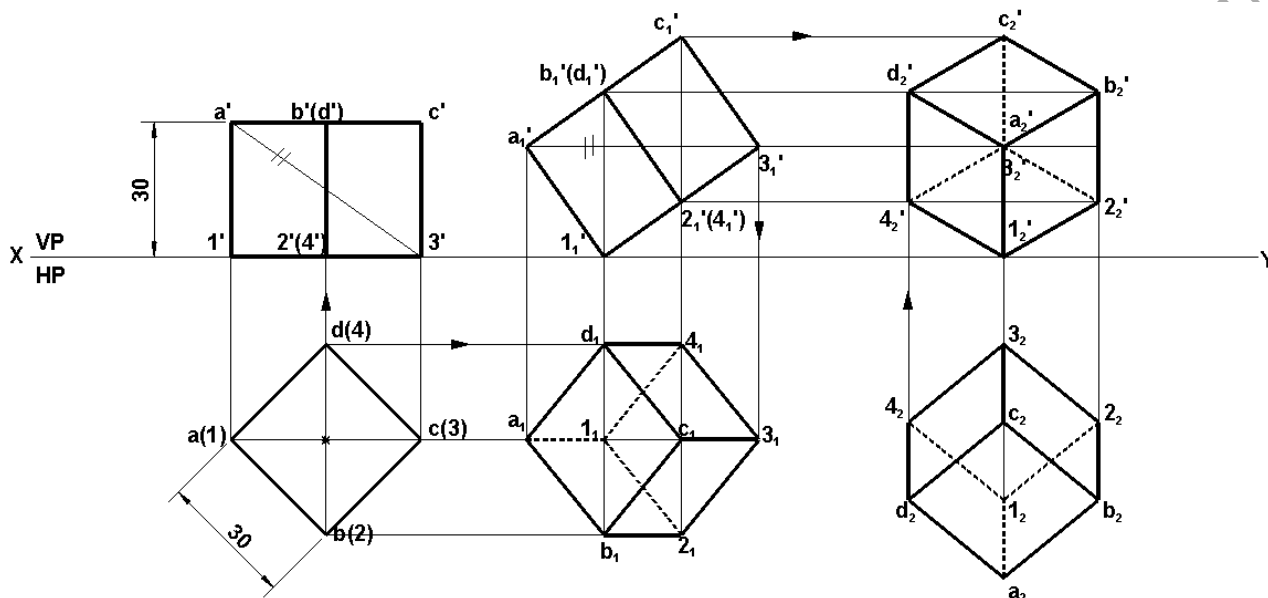
Solution



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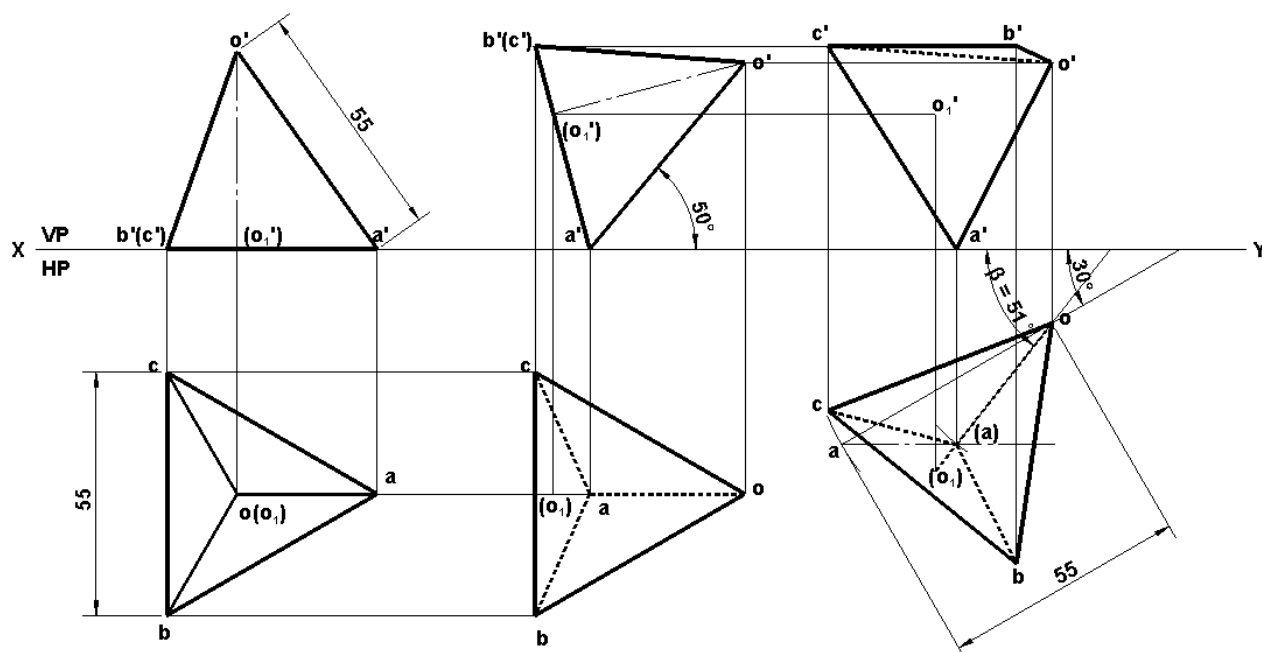
Problem 20. A hexahedron of 30 mm side is resting on one of its corners on HP such that one its solid diagonals is perpendicular to VP. Draw the projections of the solid.

Solution



Problem 21. A tetrahedron of 55 mm side rests on one of its corners such that an edge containing that corner is inclined at 50° and VP at 30° . Draw the projections.

Solution

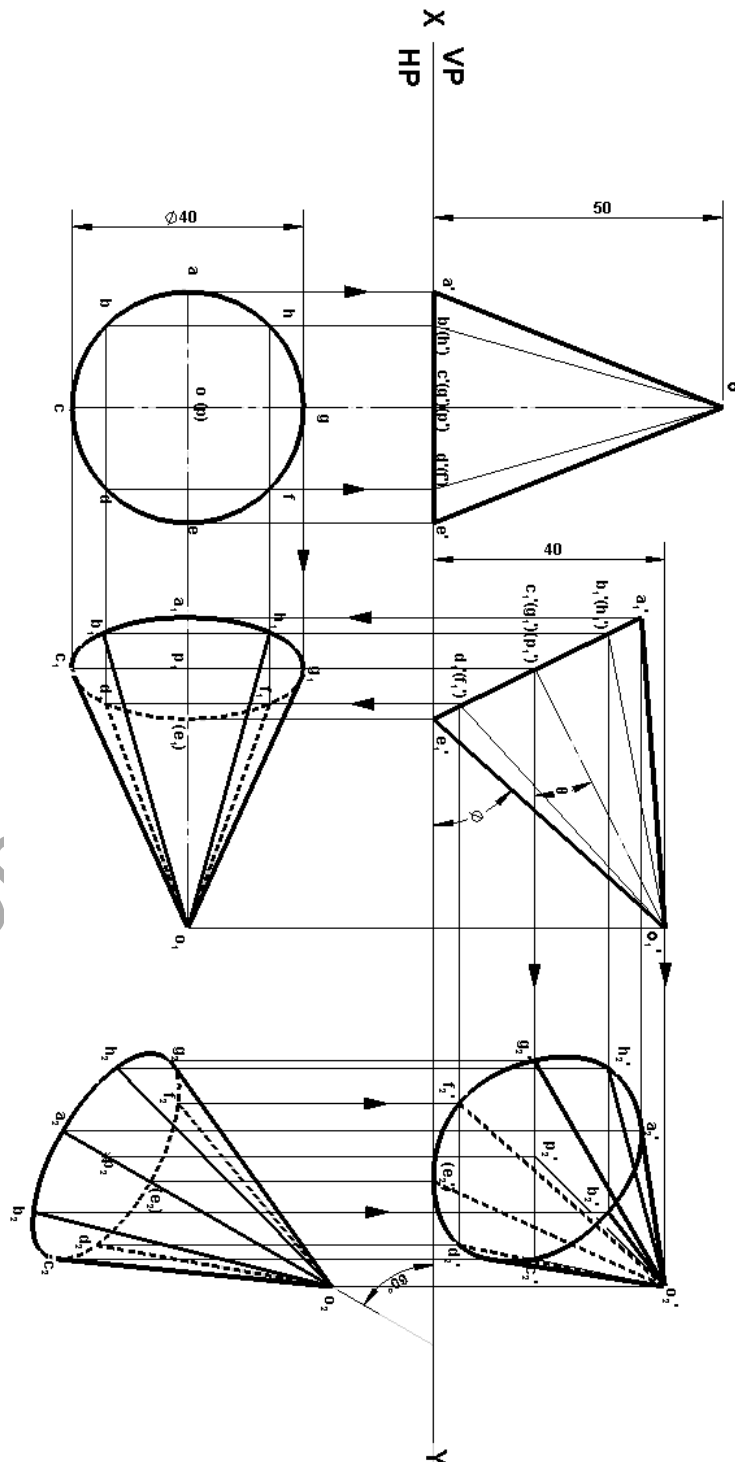


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Problem 22. A cone of base diameter 40 mm and axis length 50 mm is resting on HP on a point on the circumference of its base such that its apex is at 40 mm above the HP and its top view of the axis is inclined at 60° to VP. Draw the top and front views of the solid. Also, determine the inclinations of the axis when the base is nearer to the observer.

Solution

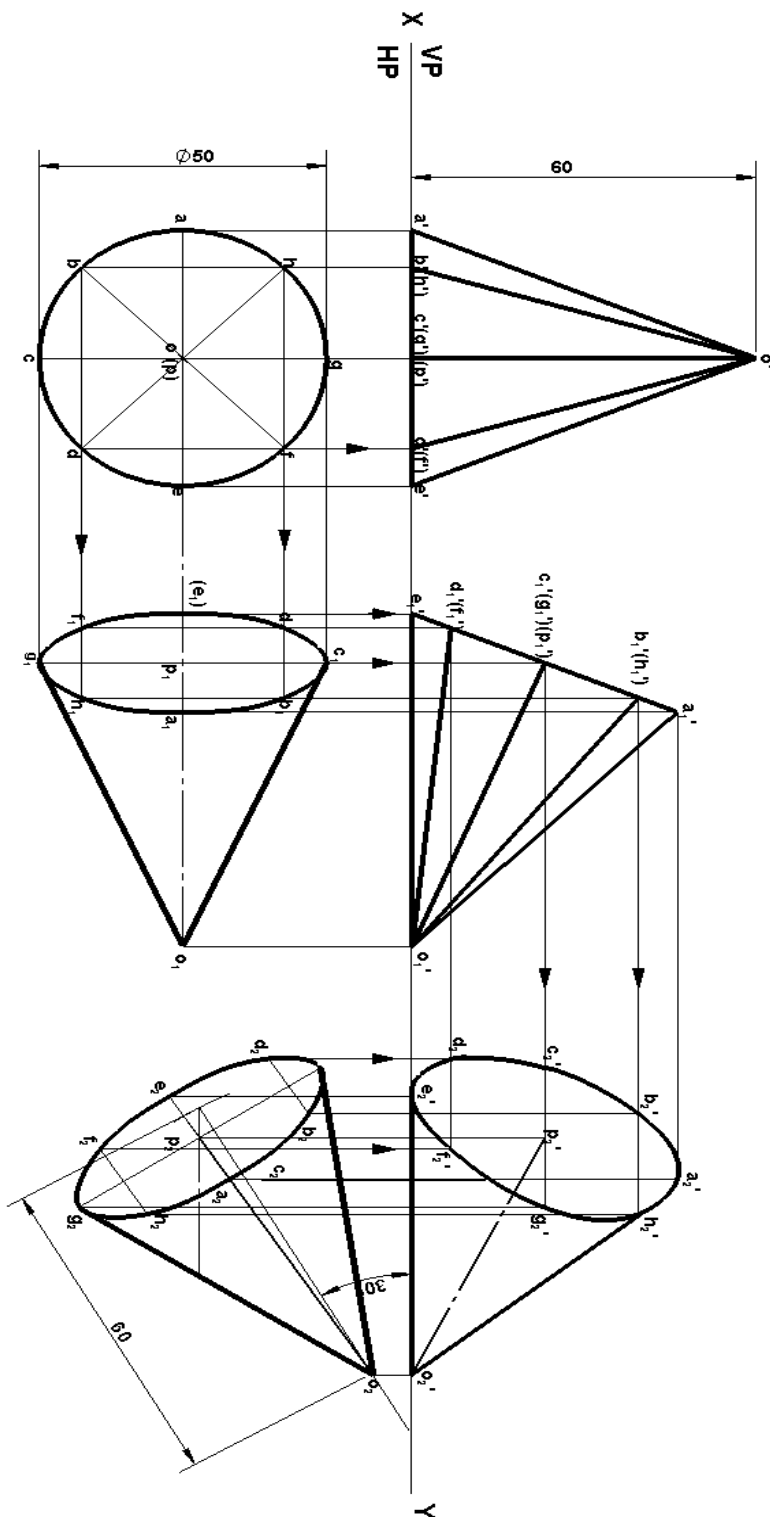
Answers
 $\phi = 51^\circ$
 $\theta = 27^\circ$



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Problem 23. A cone of 50 mm base diameter and 60 mm axis length rests on HP on one of its generators. Draw its projections when the axis is inclined at 30° .

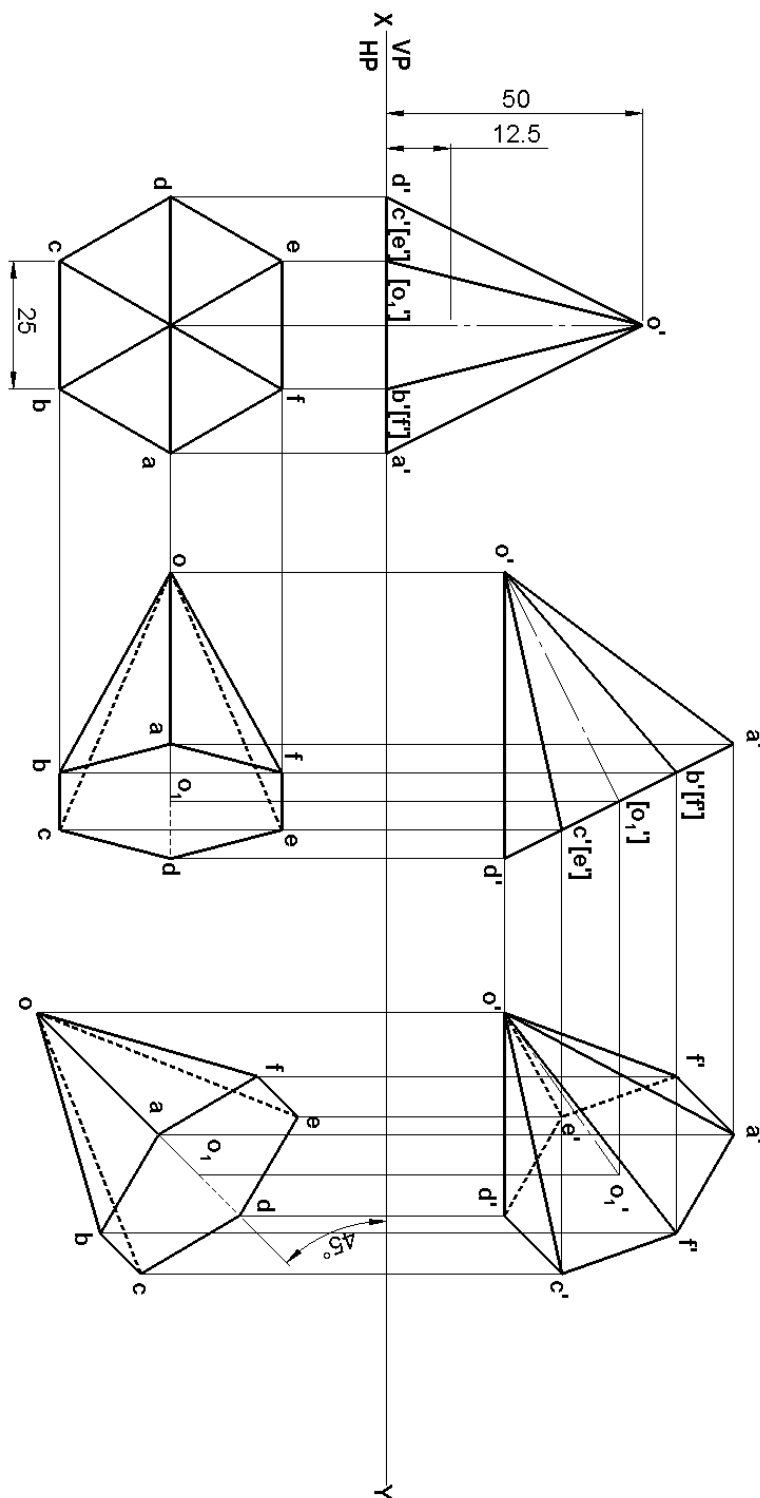
Solution



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Problem 24. A hexagonal pyramid 25 mm side of base and 50 mm axis length is suspended freely from a corner of its base. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .

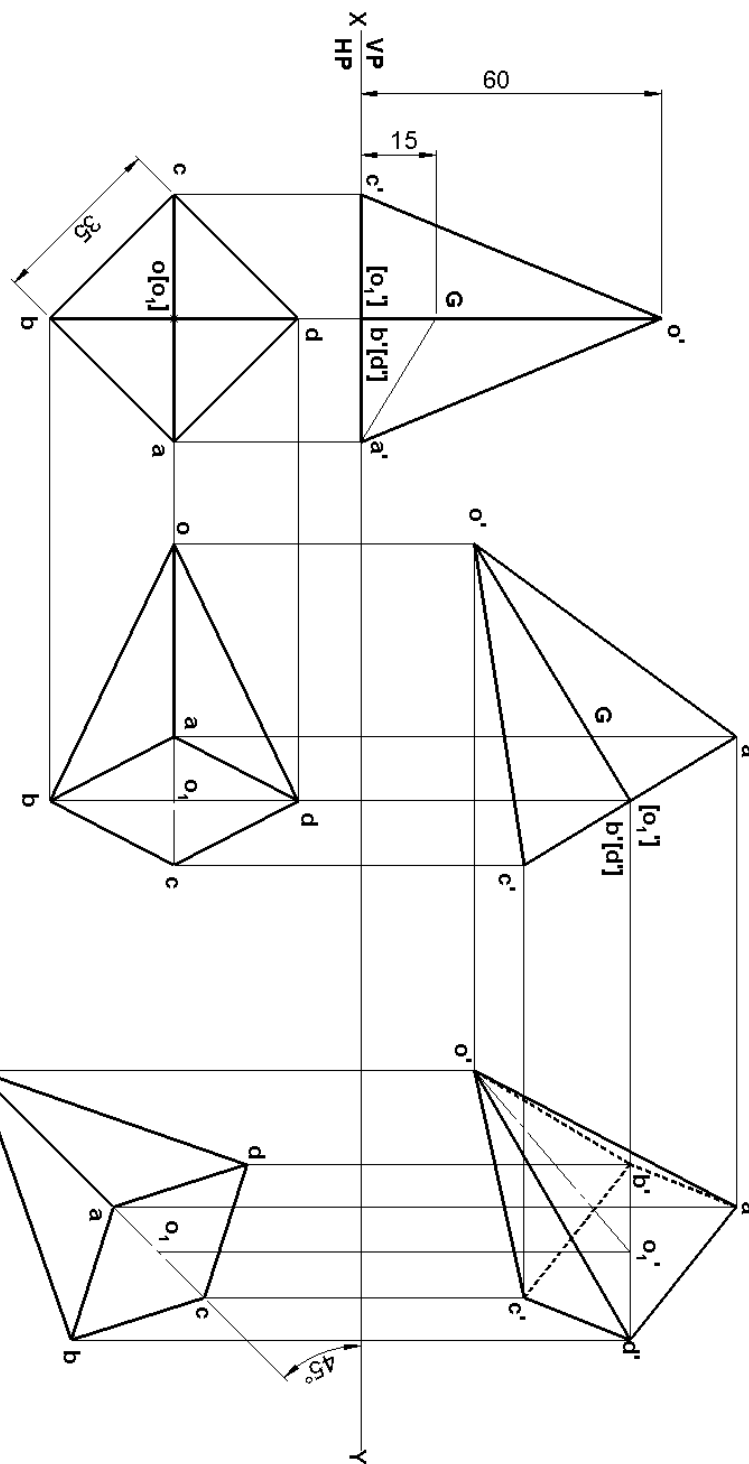
Solution



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Problem 25. A square pyramid 35 mm side of base and 60 mm axis length is suspended freely from the a corner of its base. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .

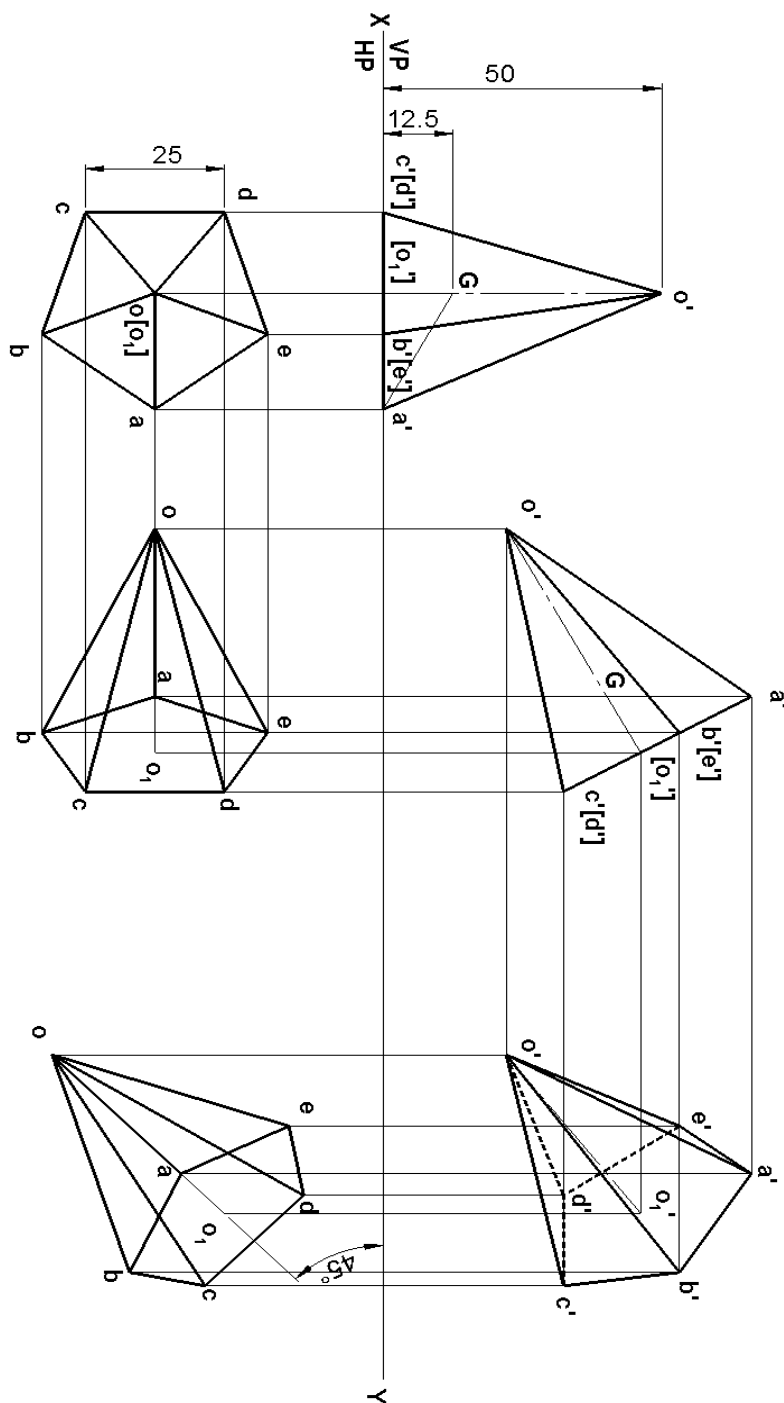
Solution



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Problem 26. A pentagonal pyramid 25 mm side of base and 50 mm axis length is suspended freely from a corner of its base. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .

Solution



Problems for practice

1. A square prism 35 mm side of base and 60 mm axis length rests on HP on one of its edges of the base. Draw the projections of the prism when the axis is inclined to HP at 45° and VP at 30° .
2. A pentagonal prism 25 mm side of base and 60 mm axis length rests on HP on one of its edges of the base. Draw the projections of the prism when the axis is inclined to HP at 40° and VP at 30° .
3. A hexagonal prism 25 mm side of base and 60 mm side of base and 50 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the prism when the axis of the prism is inclined to HP at 40° and to VP at 30° .
4. A square prism 35 mm side of base and 60 mm axis length is suspended freely from a corner of its base. Draw the projections of the prism when the axis appears to be inclined to VP at 45° .
5. A pentagonal prism 25 mm side of base and 60 mm axis length is suspended freely from corner of its base. Draw the projections of the prism when the axis appears to be inclined to VP at 45° .
6. A hexagonal prism 25 mm side of base and 50 mm axis length is suspended freely from a corner of its base. Draw the projections of the prism when the axis appears to be inclined to VP at 45° .
7. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its corners of the base such that the two base edges containing the corner on which it rests make equal inclinations with HP. Draw the projections of the pyramid when the axis of the pyramid is inclined to HP at 40° and to VP at 30° .
8. A pentagonal pyramid 25 mm side of base and 60 mm axis length rests on HP on one its edges of the base. Draw the projections of the pyramid when the axis is inclined to HP at 40° and VP at 30° .
9. A hexagonal pyramid 25 mm side of base and 60 mm axis length rests on HP on one of its edges of the base. Draw the projections of the pyramid when the axis is inclined to HP at 45° .
10. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
11. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis is inclined to VP at 45° .
12. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its slant triangular faces. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .

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13. A square pyramid 35 mm side of base and 60 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
14. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
15. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis is inclined to VP at 45° .
16. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant triangular faces. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
17. A pentagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant triangular faces. Draw the projections of the pyramid when the axis is inclined to VP at 45° .
18. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
19. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant edges. Draw the projections of the pyramid when the axis is inclined to VP at 45° .
20. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant triangular faces. Draw the projections of the pyramid when the axis appears to be inclined to VP at 45° .
21. A hexagonal pyramid 25 mm side of base and 50 mm axis length rests on HP on one of its slant triangular faces. Draw the projections of the pyramid when the axis is inclined to VP at 45° .
22. A tetrahedron of side 40 mm is resting on one of its sides on HP. This side is parallel to VP and 40 mm away from it. It is tilted about resting side such that the base containing this edge is inclined at 30° to HP. Draw the projections of the solid.
23. A pentagonal prism of base side 25 mm and height 50 mm is resting on HP on one of its base corners such that the top most edge is at a distance of 60 mm above HP. Draw its projections, when its top view of the axis is inclined at 45° to VP. Also, determine the inclination of the longer edge of the prism to HP which contains the resting corner.
24. A square pyramid of base side 30 mm and height 45 mm is suspended by a thread tied to one of the corners of its base. It is then tilted such that the axis makes an angle of 45° with respect to the VP. Considering the apex of the solid to be nearer to the observer, draw the projections of the solid.