Teaching Aids Required for this Sheet
(The RA should bring them to the class)

- A pair of hinged square acrylic plates; this can be used to denote the quadrants.
- A square acrylic plate to denote auxiliary plane.
- The following shapes in wood or cardboard:
  - Prisms: Cubic, triangular, square, pentagonal, hexagonal, Cylindrical
  - Pyramids: Tetrahedral, Square, pentagonal, hexagonal, Conical.

ME119:
Engineering Drawing & Graphics

6. Projections of Solids

Department of Mechanical Engineering
Indian Institute of Technology Bombay

Outline

- Projections of Solids
- Conclusions

Projections of Solids

Projections of Solids

- We started with projections of points, upgraded to lines and planar features. Now we shall deal with solids.
- Chapters 13 covers the details on Projections of Solids.
- Also refer the two files uploaded on “Solid Modeling”.
- Roughly work out all the problems given to you.

Note:

- For the sake of simplicity and uniformity, we shall use only 1st angle projection.
- Pay attention to hidden features.
- Label the points suitably to avoid confusion.

Definition of Solid

A solid is a volume tightly enclosed (water-tight) by a set of surfaces.

It is a 3D geometry defined by 3 topological parameters. Note that *dimensions* and *topological parameters* are different here.

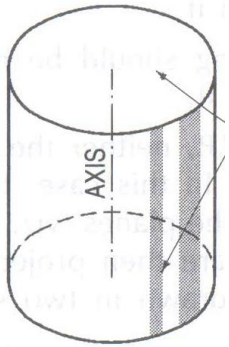
Entity	Number of Parameters	**p**
Point	0	**p** = [x, y, z]
Curve	1	**p**(u) = [x(u), y(u), z(u)]
Surface	2	**p**(u , v) = [x(u, v), y(u , v), z(u, v)]
Solid	3	**p**(u , v , w) = [x(u, v , w), y(u , v , w), z(u, v, w)]
Swept volume	4-1	**p**(u , v , w , t) = [x(u, v , w , t), y(u , v , w , t), z(u, v, w, t)]
…	…	…

Types of Solid

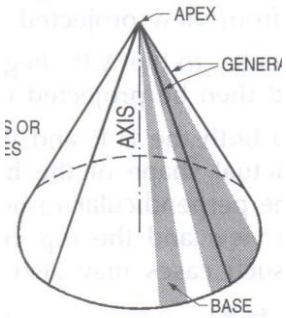
[i] Smooth [ii] Polyhedral/faceted/tessellated	[i] Analytic [ii] Freeform
[i] Prismatic (extrusion) [ii] Pyramidal	[i] Right Prism/ Pyramid [ii] Oblique Prism/ Pyramid
[i] Complete [ii] Frustum (cone generally) [iii] Truncated (for all)	
[i] Manifold [ii] Non-manifold [iii] Self-intersecting	[i] Homogeneous [ii] Gradient (including composites)

Types of Solid

Based on surface quality: (i) Smooth & (ii) polyhedral

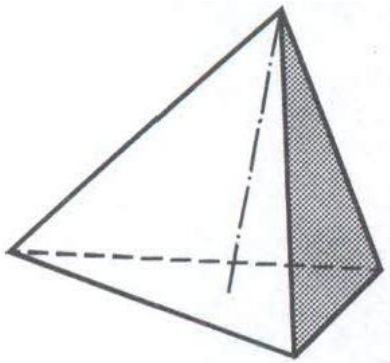


Cylinder

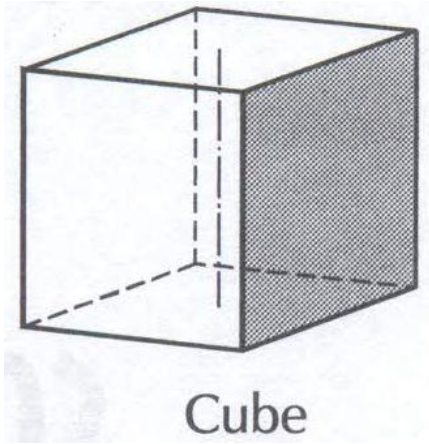


Cone

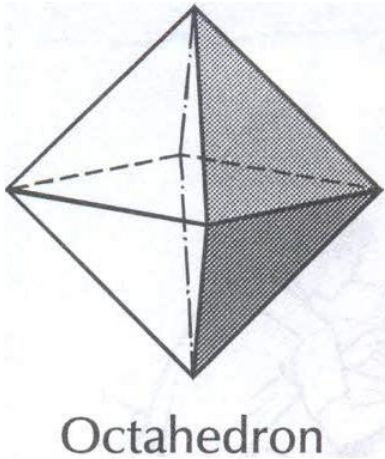
Sphere



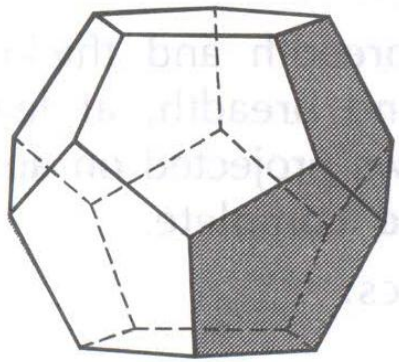
Tetrahedron



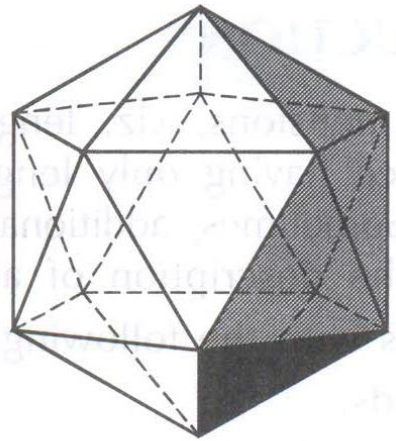
Cube



Octahedron



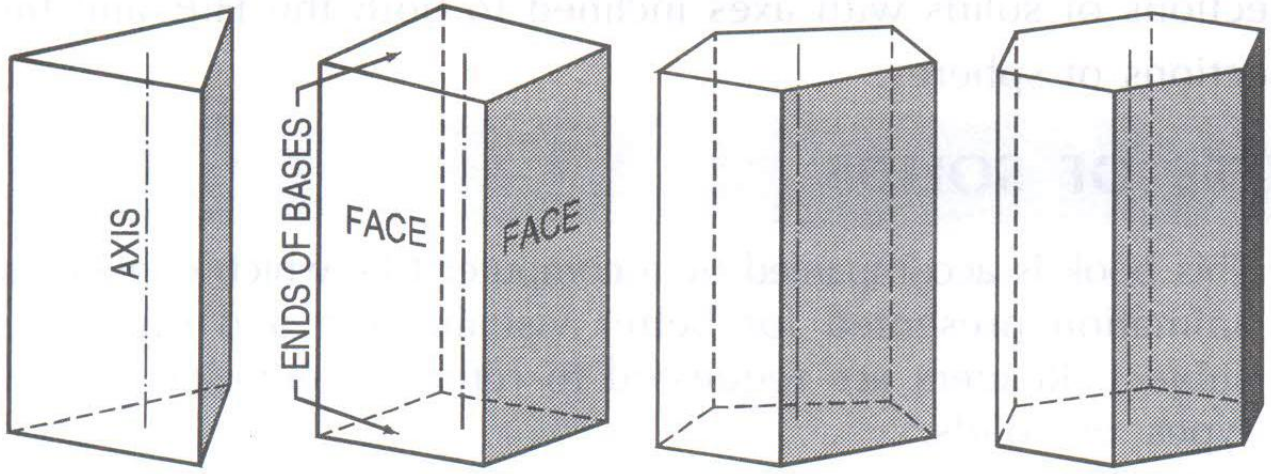
Dodecahedron

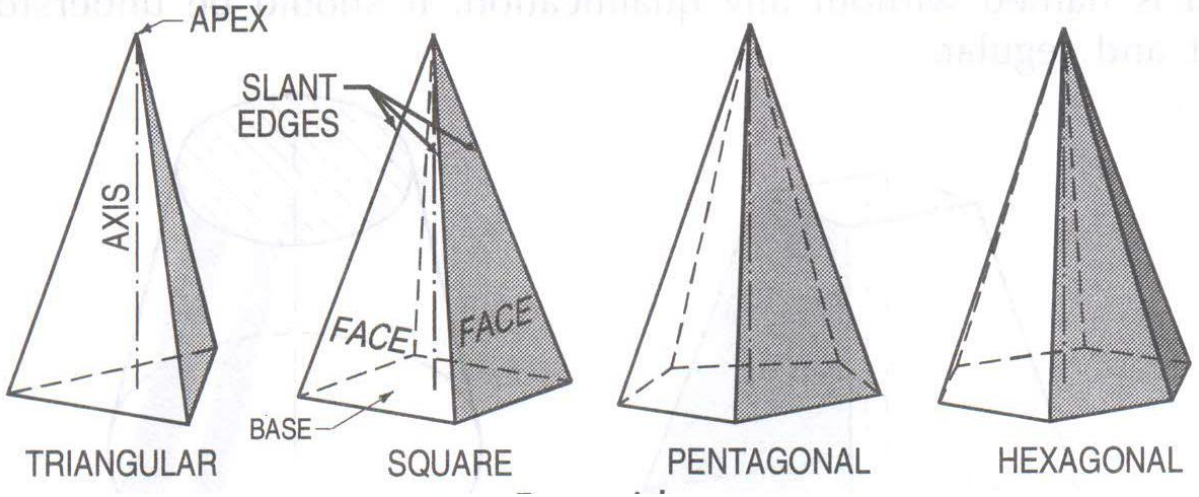


Icosahedron

Types of Solid

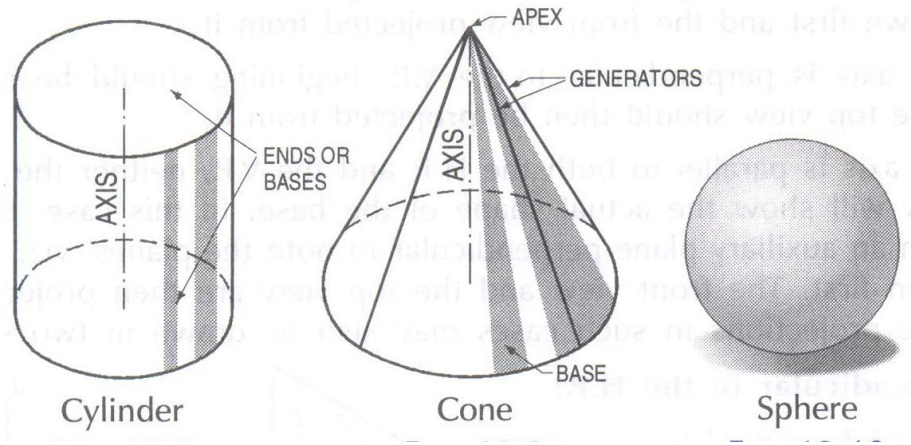
Based on convergence: (i) Prismatic & (ii) pyramidal

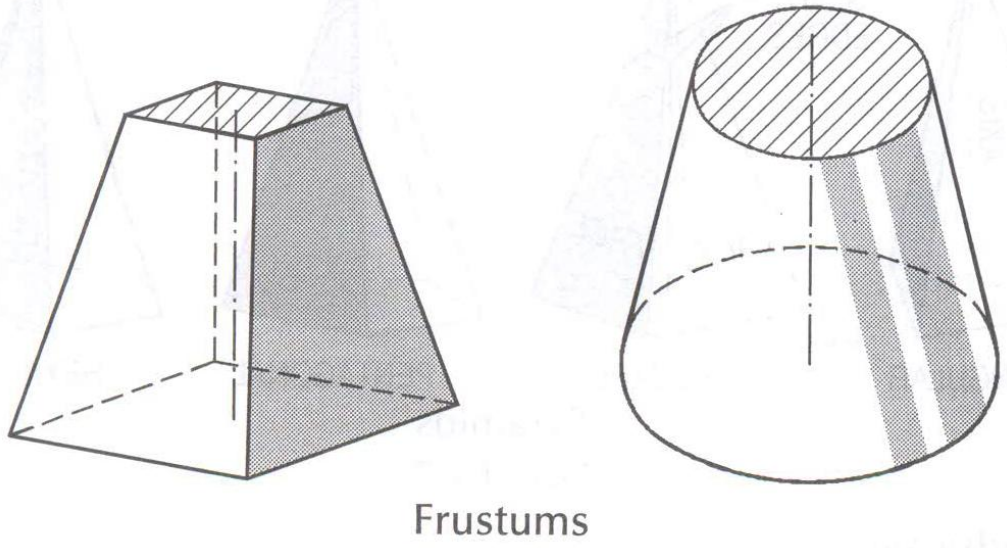




Types of Solid

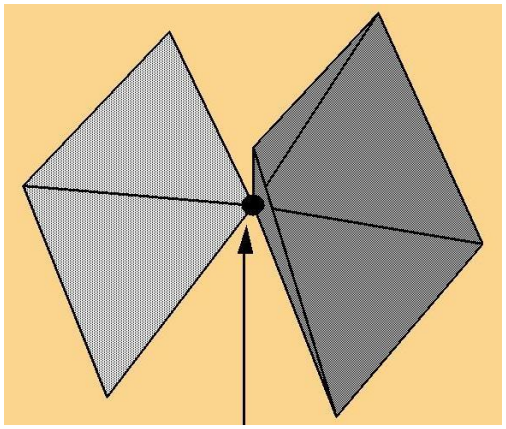
Based on continuity: (i) Full & (ii) truncated

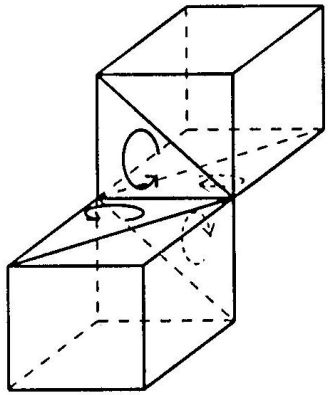


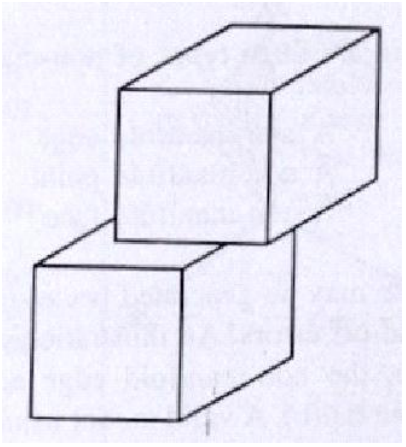


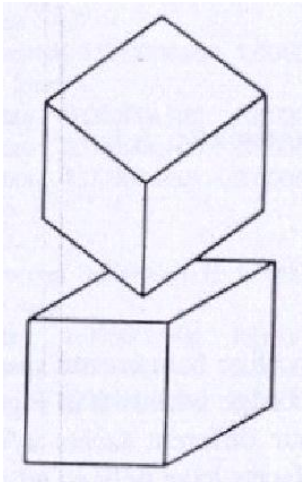
Types of Solid

Based on continuity: (i) Non-manifold, (ii) manifold & (ii) self-intersecting



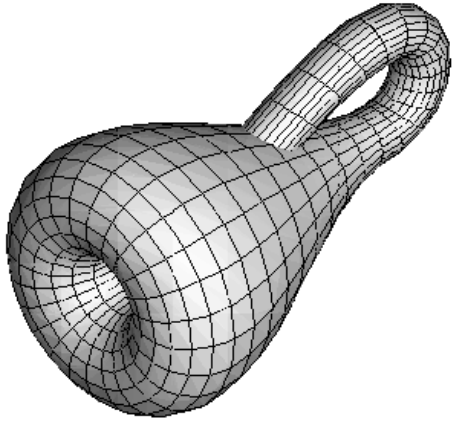




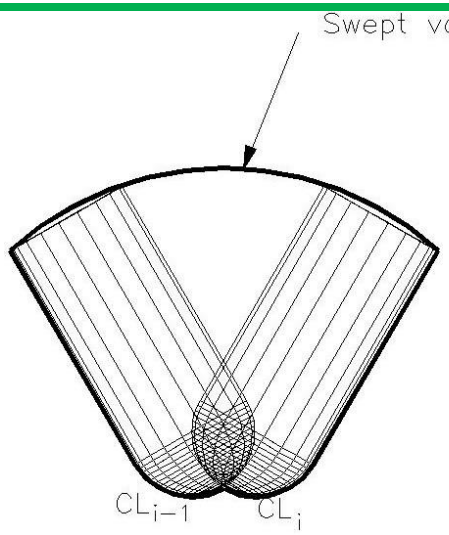


Non-Manifold

Self-intersecting



Klein bottle



Types of Solid

Based on interior filling: (i) Homogeneous & (ii) Gradient

No natural object is homogeneous. Due to human limitations, we define only boundary and assume interior to be homogeneous.

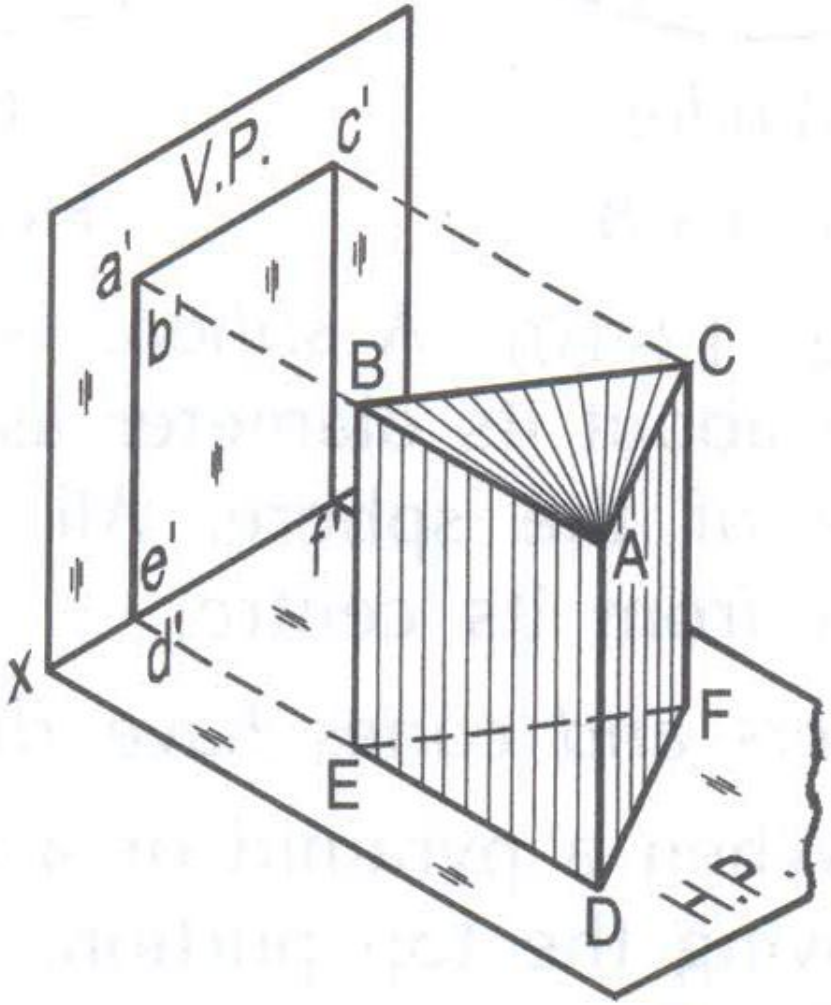
An object has not only shape and size but many other geometric properties such as tolerance, surface finish, color etc. There are also non-geometric properties.

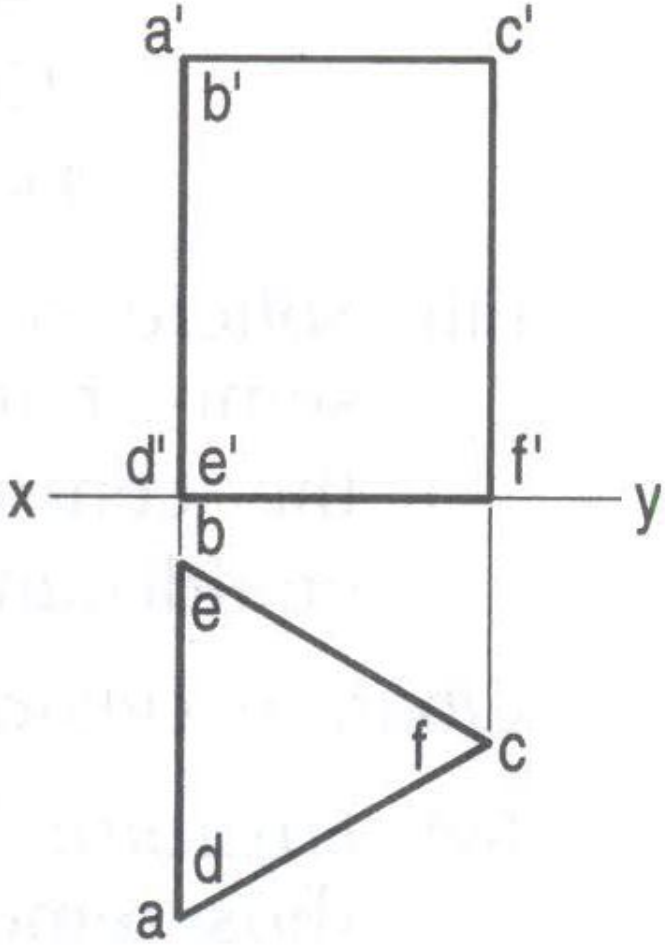
Projections of Solids: Simple Cases

Projections of Solids

Example-1 (Solved Pb. 13-1, pp. 274)

A triangular prism of 40mm side and 50mm long rests on H.P. on the triangular base. One of its rectangular faces is perpendicular to V.P. Draw its projections.

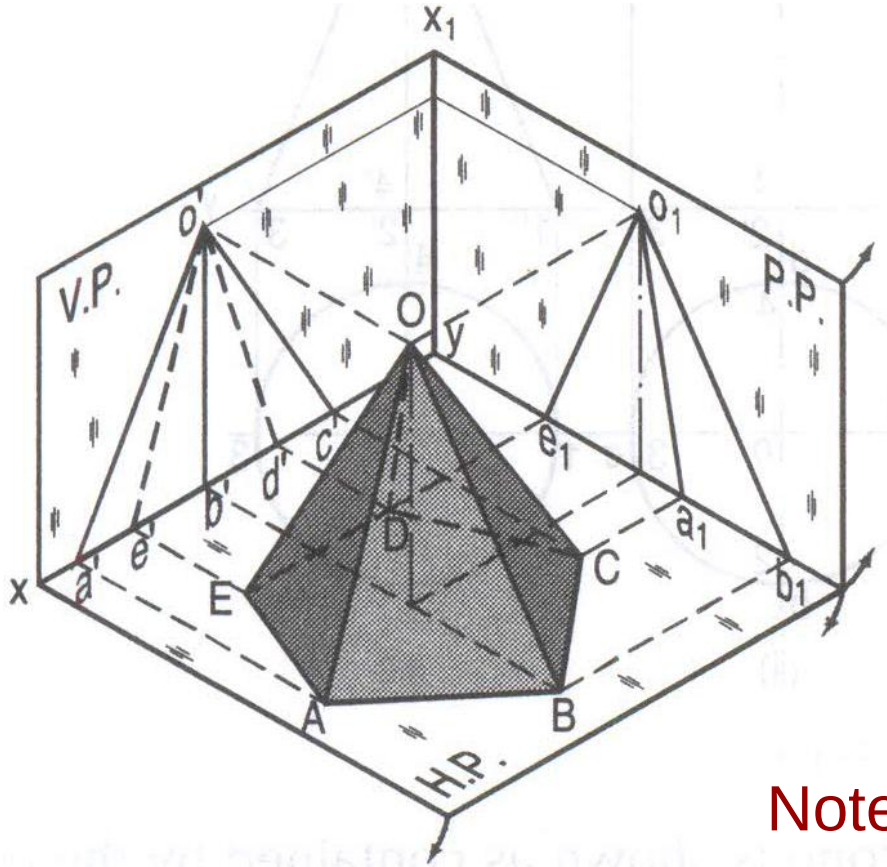


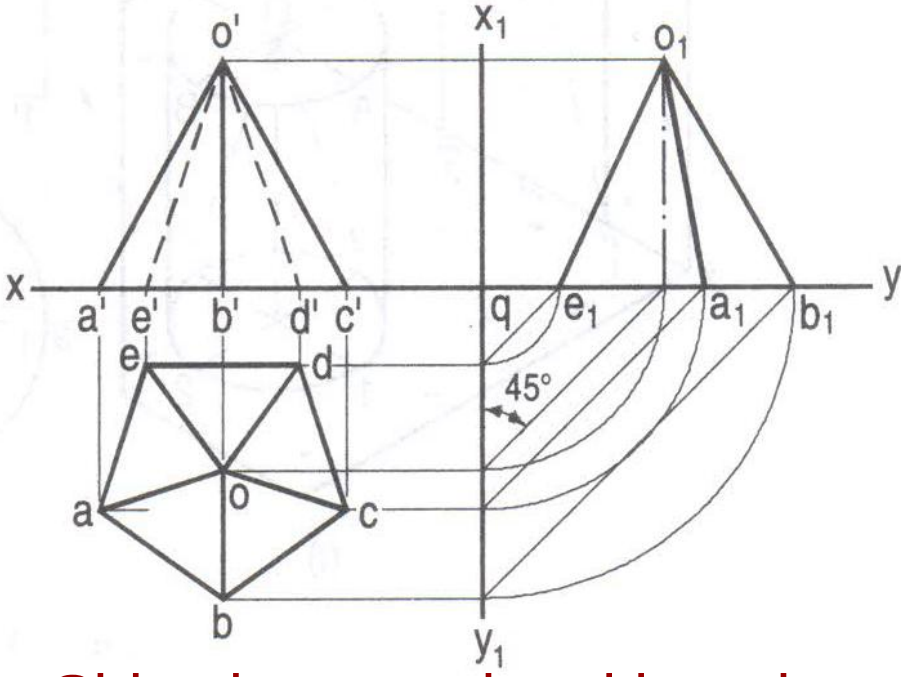


Projections of Solids

Example-2 (Solved Pb. 13-2, pp. 275)

A pyramid of pentagonal base of 30mm side and 50mm high rests on its base on H.P. One edge of the base is parallel to V.P. Draw its projections.



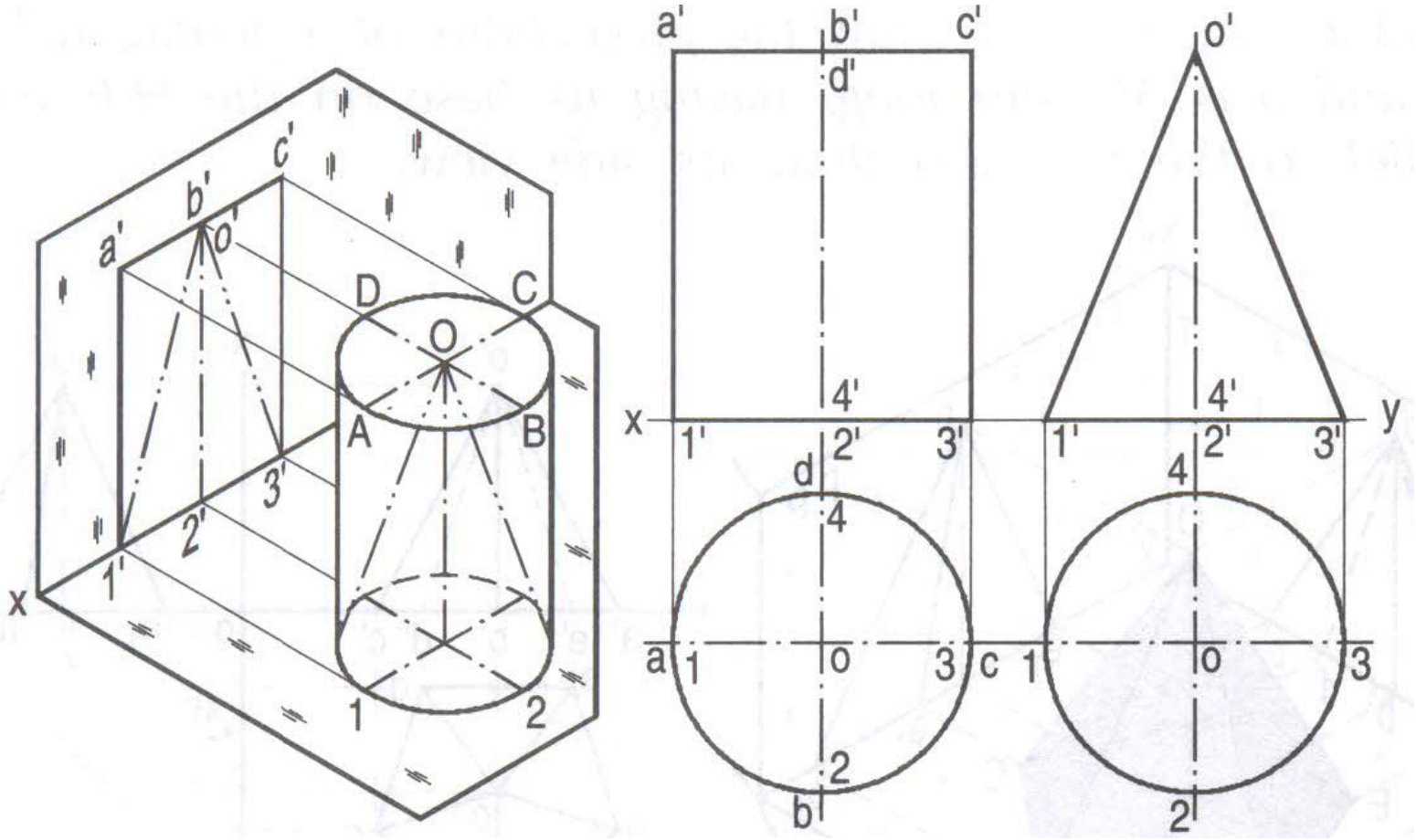


Note: Side view may be skipped.

Projections of Solids

Example-3 (Solved Pb. 13-3, pp. 275)

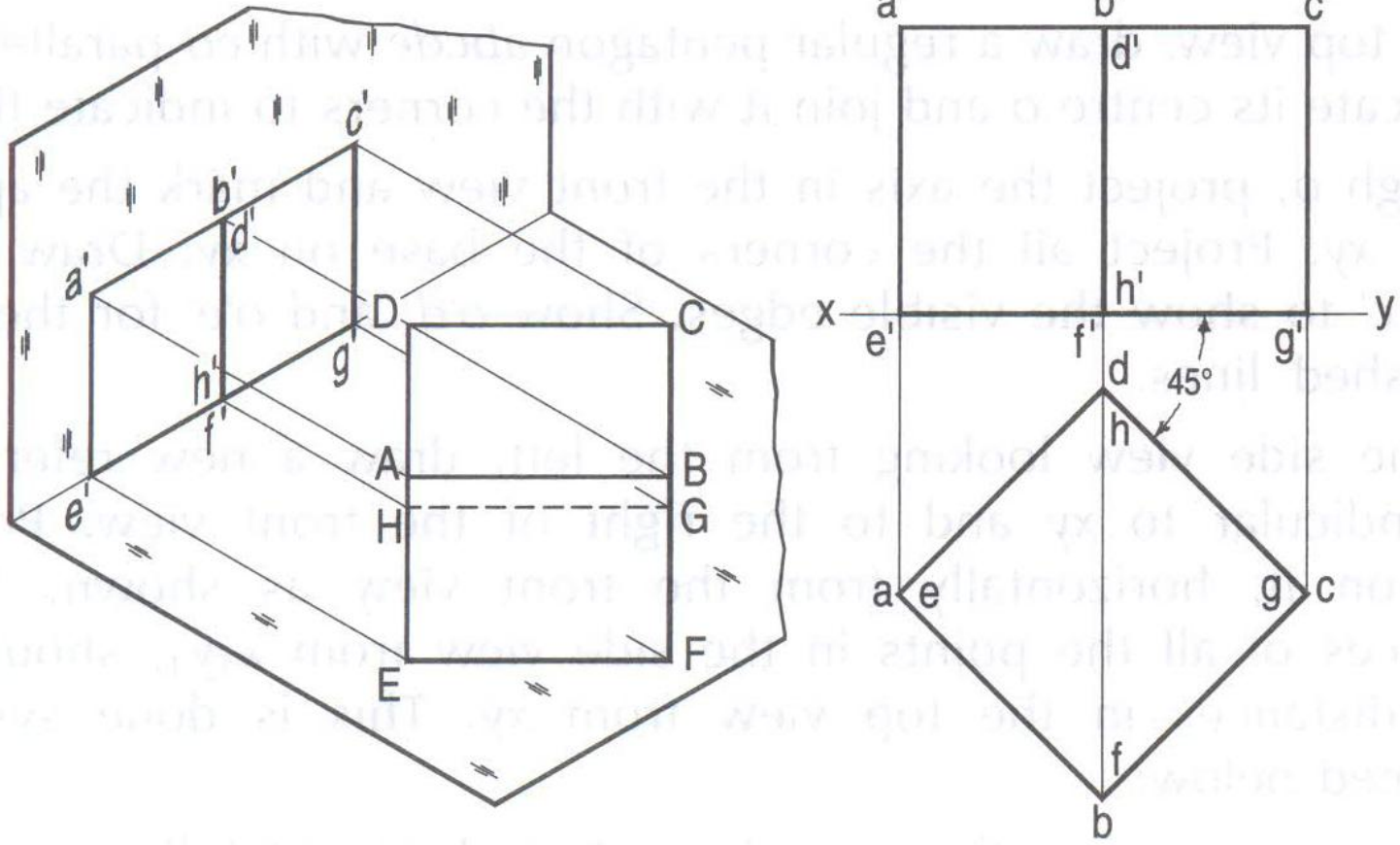
Draw the projections of (i) a cylinder and (ii) cone, both of 40mm base diameter and 50mm height, resting on its base on H.P.



Projections of Solids

Example-4 (Solved Pb. 13-4, pp. 276)

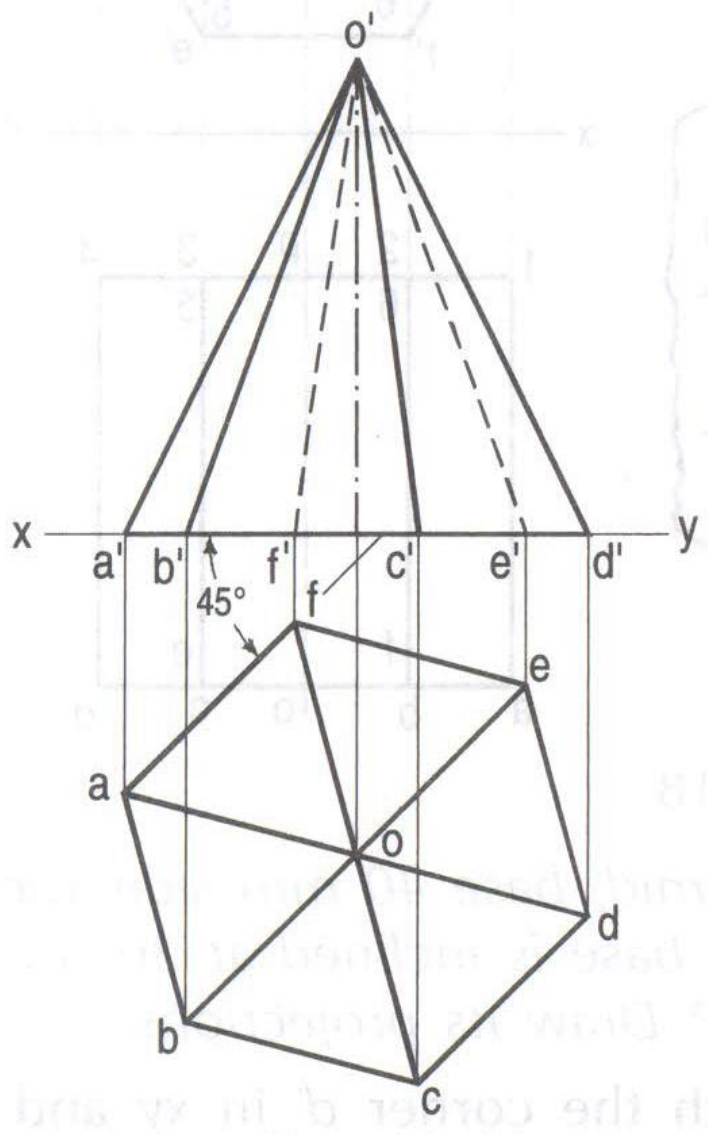
A cube of 50mm side rests on H.P. on one of its faces and its vertical faces are equally inclined with V.P. Draw its projections.



Projections of Solids

Example-5 (Solved Pb. 13-5, pp. 276)

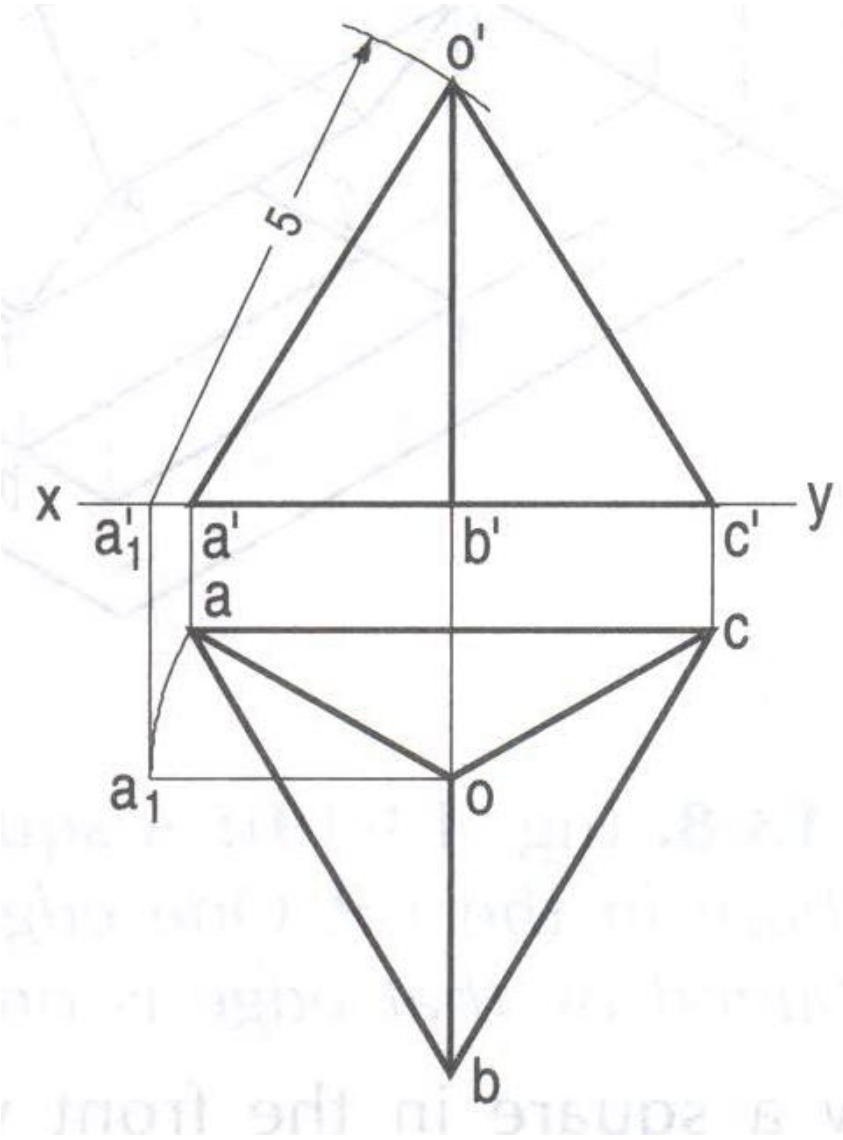
A hexagonal pyramid of 30mm side and 60mm high rests on its base on H.P. One edge of its base is inclined at 45° to V.P. Draw its projections.



Projections of Solids

Example-6 (Solved Pb. 13-6, pp. 277)

A regular tetrahedron of 50mm long edges rests on one of its faces on H.P. One of the base edges is parallel to V.P. Draw its projections.

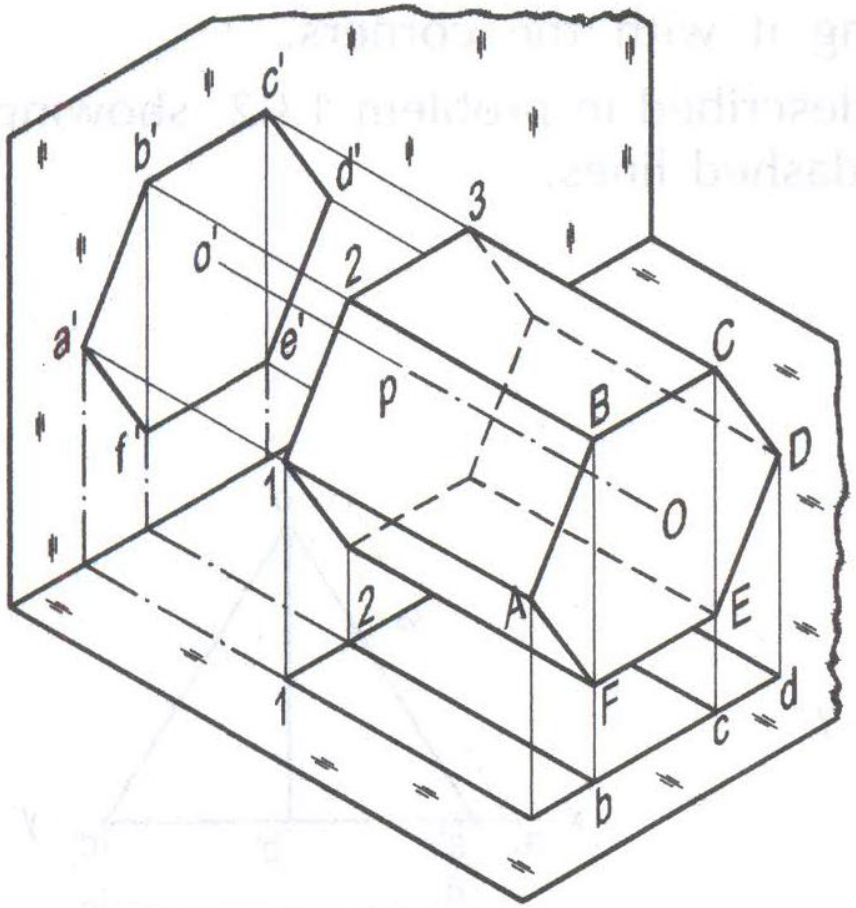


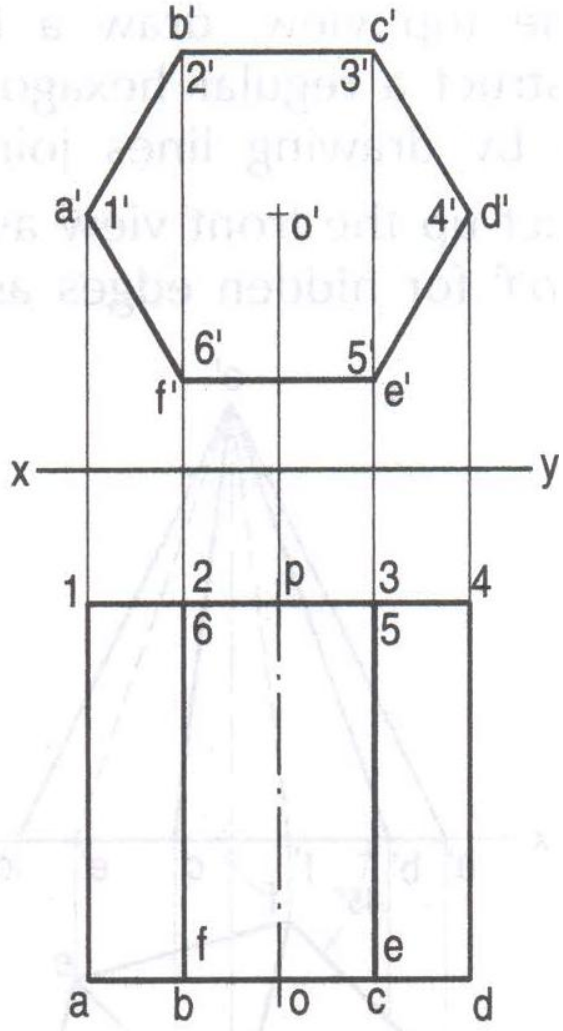
Notice how the height of the pyramid is obtained using the “true length” construction of the slant edge.

Projections of Solids

Example-7 (Solved Pb. 13-7, pp. 277)

A hexagonal prism, of 25mm side and 50mm height, has one of its rectangular faces parallel to and 35mm above H.P. Its axis is perpendicular to V.P. and its hexagonal face nearest to V.P. is 20mm in front of it. Draw its projections.

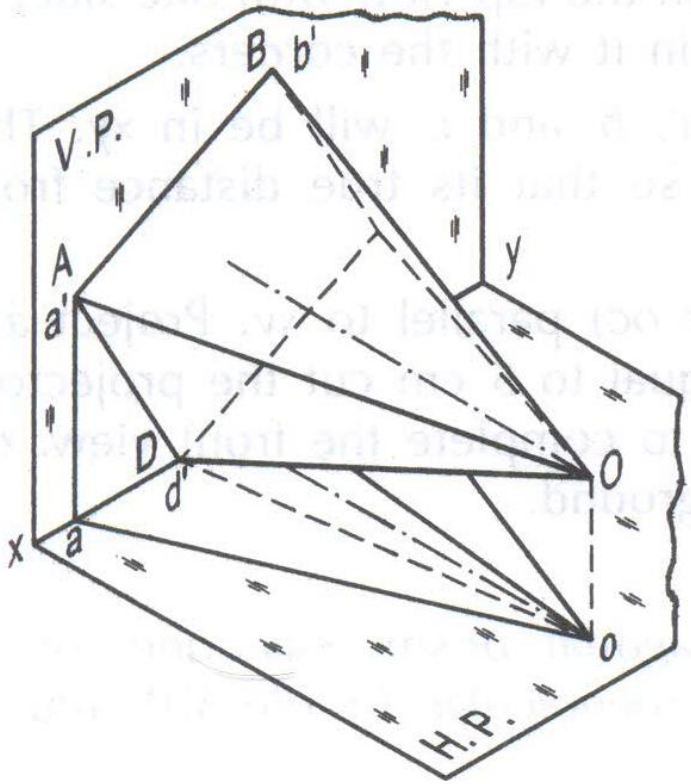


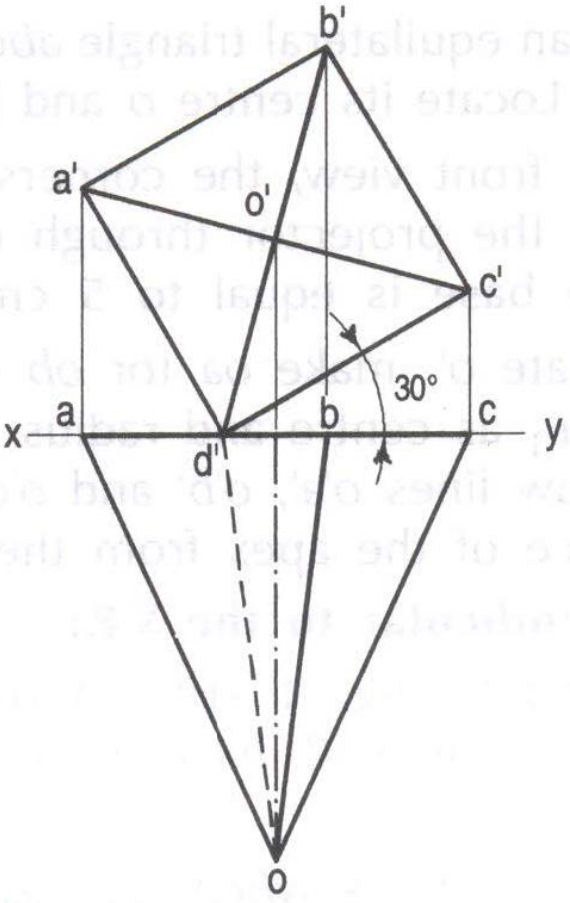


Projections of Solids

Example-8 (Solved Pb. 13-8, pp. 278)

A square pyramid, base of 40mm side and 65mm height, has its base in the V.P. One edge of the base is inclined at 30° to H.P. and a corner contained by that edge is on H.P. Draw its projections.



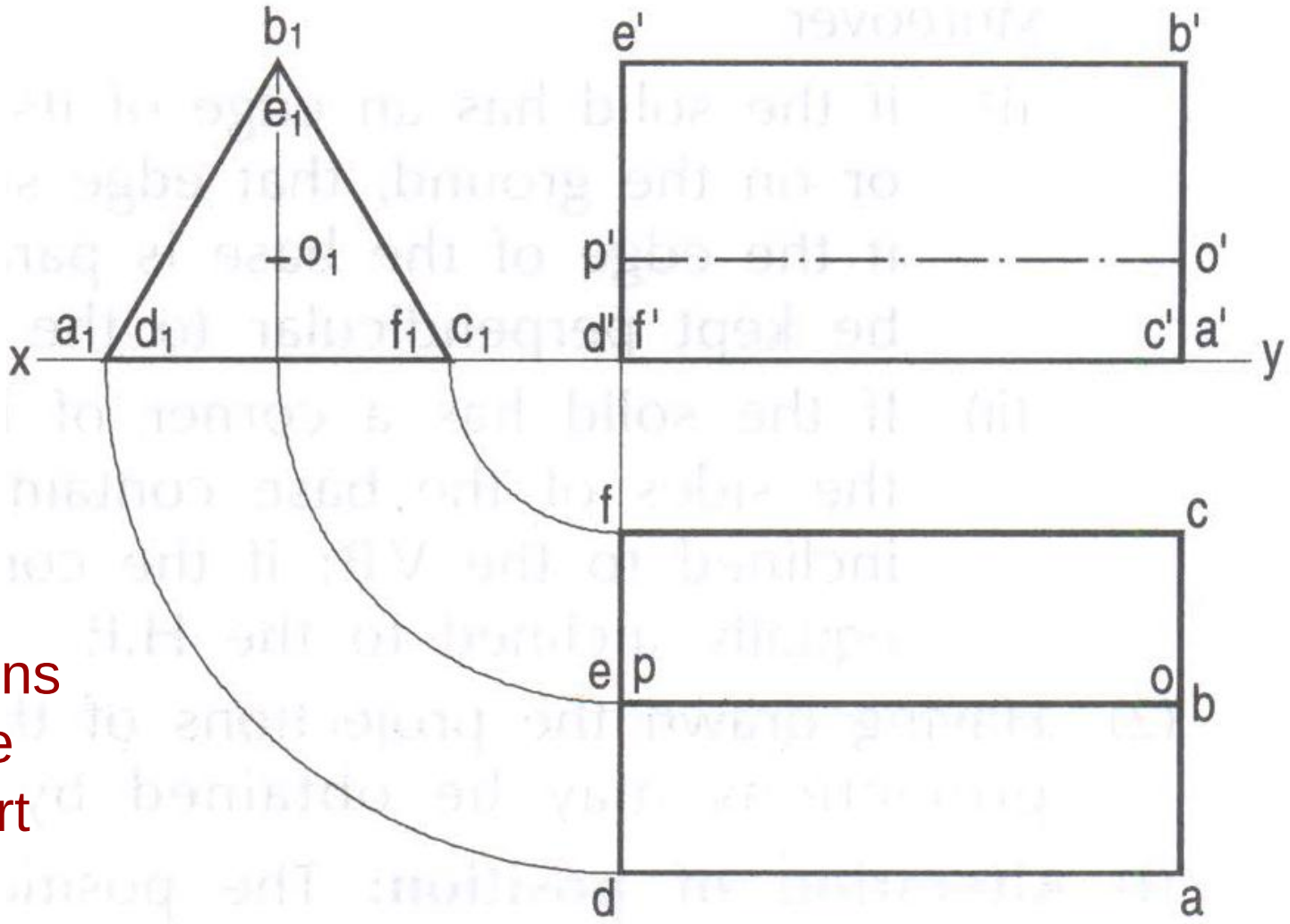


Projections of Solids

Example-9 (Solved Pb. 13-9, pp. 278)

A triangular prism, base of 40mm side and 65mm height, is resting on H.P. on one of its rectangular faces with its axis parallel to V.P. Draw its projections.

As the true dimensions are visible in the side view, we need to start from side view.

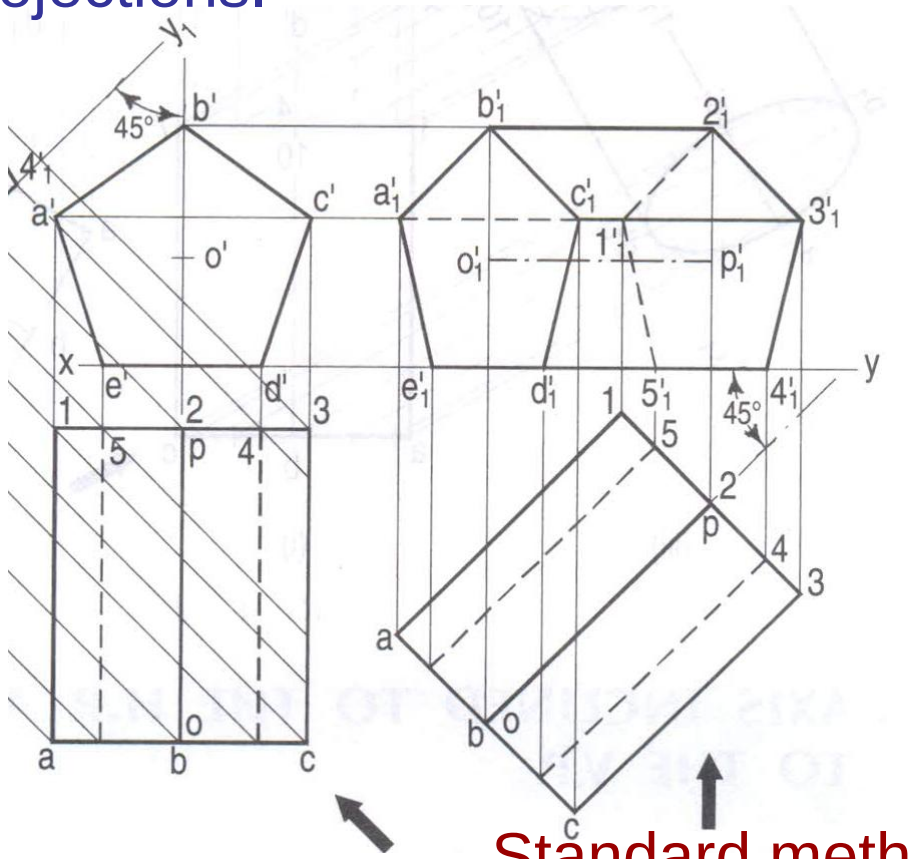


Projections of Solids: Inclined to H.P. or V.P.

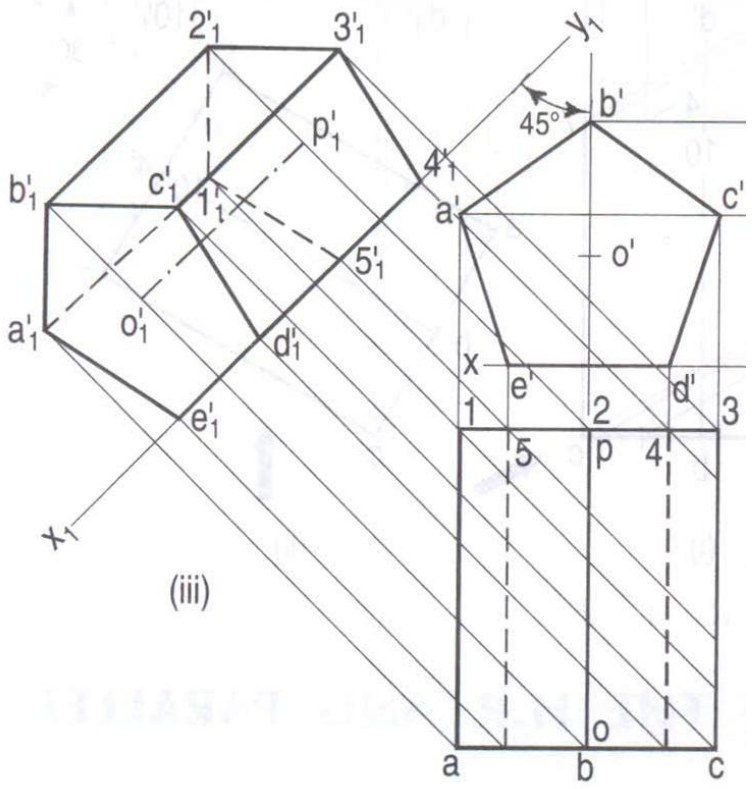
Projections of Solids

Example-10 (Solved Pb. 13-10, pp. 280)

A pentagonal prism, base of 25mm side and 50mm long, is resting on H.P. on a rectangular face with its axis inclined at 45° to V.P. Draw its projections.



Standard method

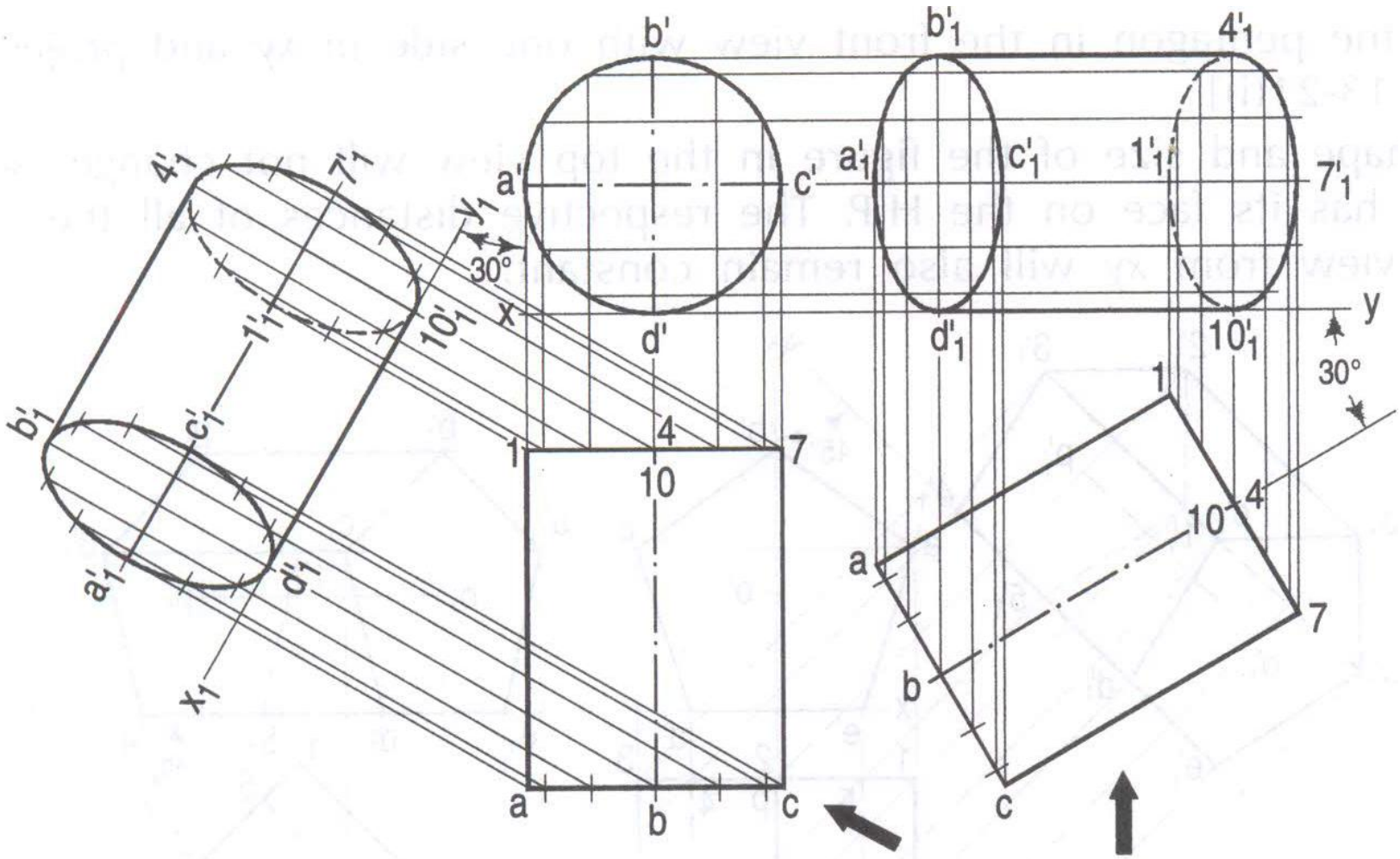


Aux. Plane method

Projections of Solids

Example-11 (Solved Pb. 13-11, pp. 281)

A cylinder, of 75mm diameter and 100mm long, is resting on the ground with its axis inclined at 30° to V.P. Draw its projections.



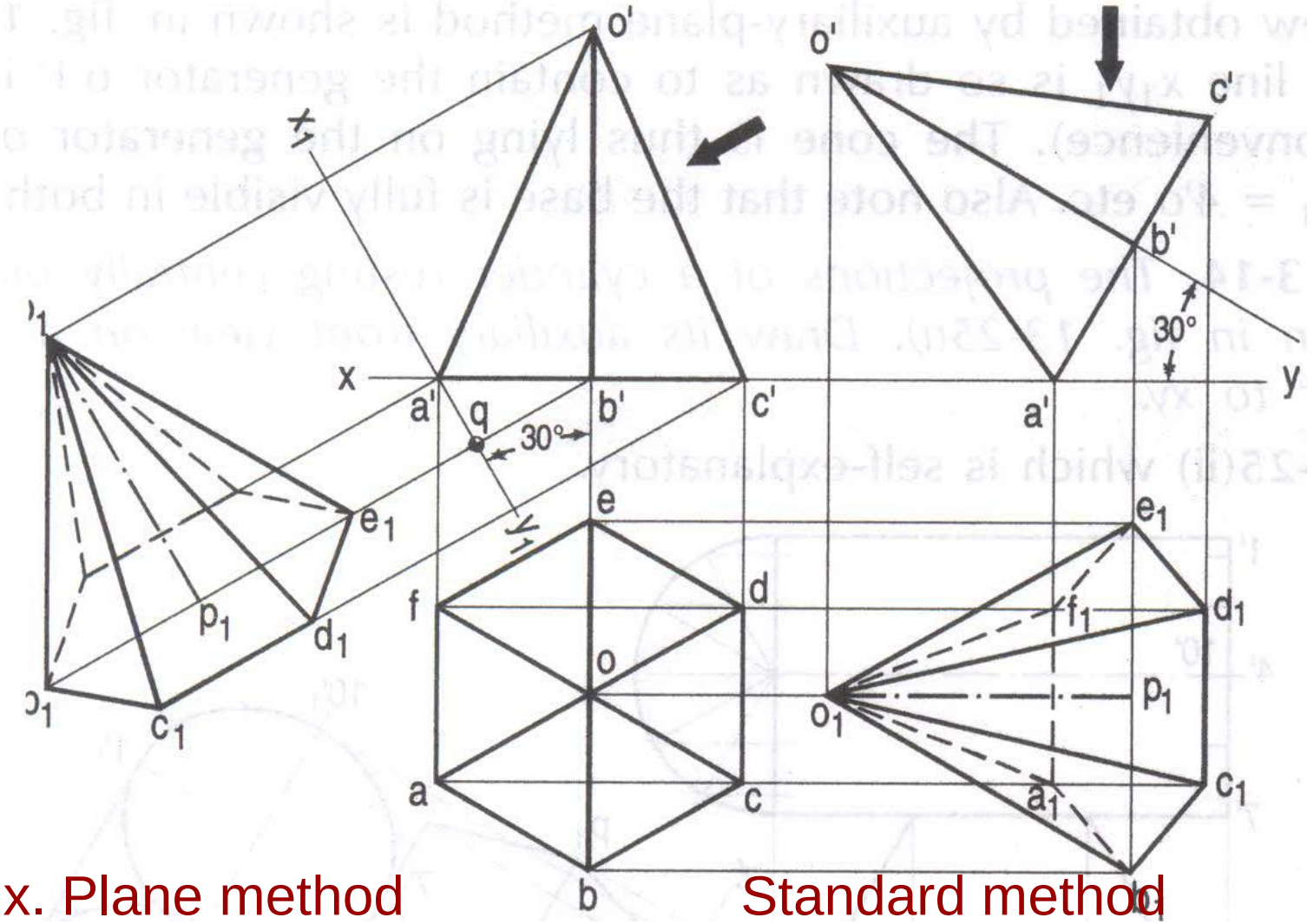
Aux. Plane method

Standard method

Projections of Solids

Example-12 (Solved Pb. 13-12, pp. 282)

A hexagonal pyramid, base of 25mm side and of 50mm height, has an edge of its base on the ground. Its axis is inclined at 30° to ground and parallel to V.P. Draw its projections.



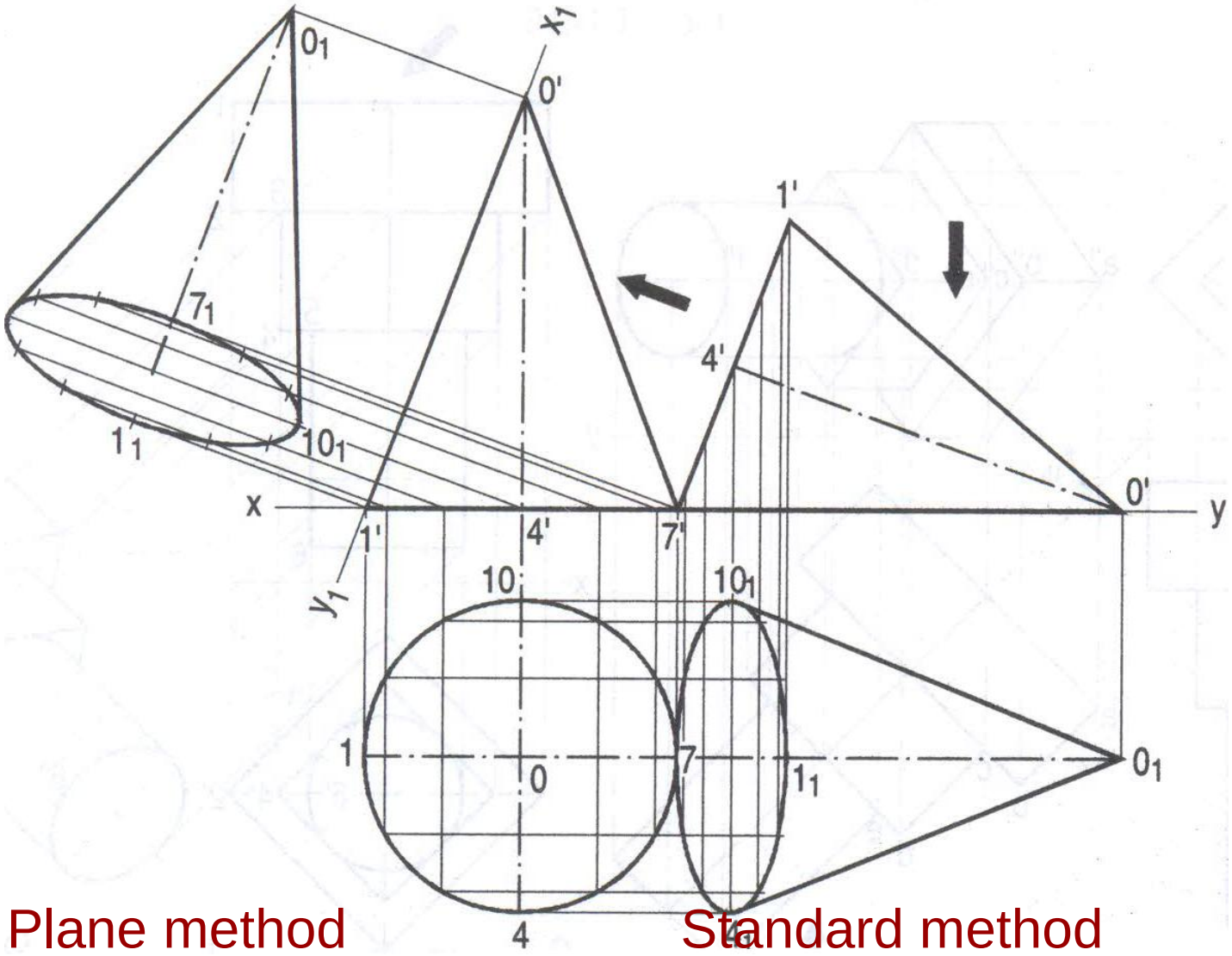
Aux. Plane method

Standard method

Projections of Solids

Example-13 (Solved Pb. 13-13, pp. 280)

A cone, of 75mm base diameter and 100mm long axis, is resting on H.P. on one of its generators with its axis parallel to V.P. Draw its projections.



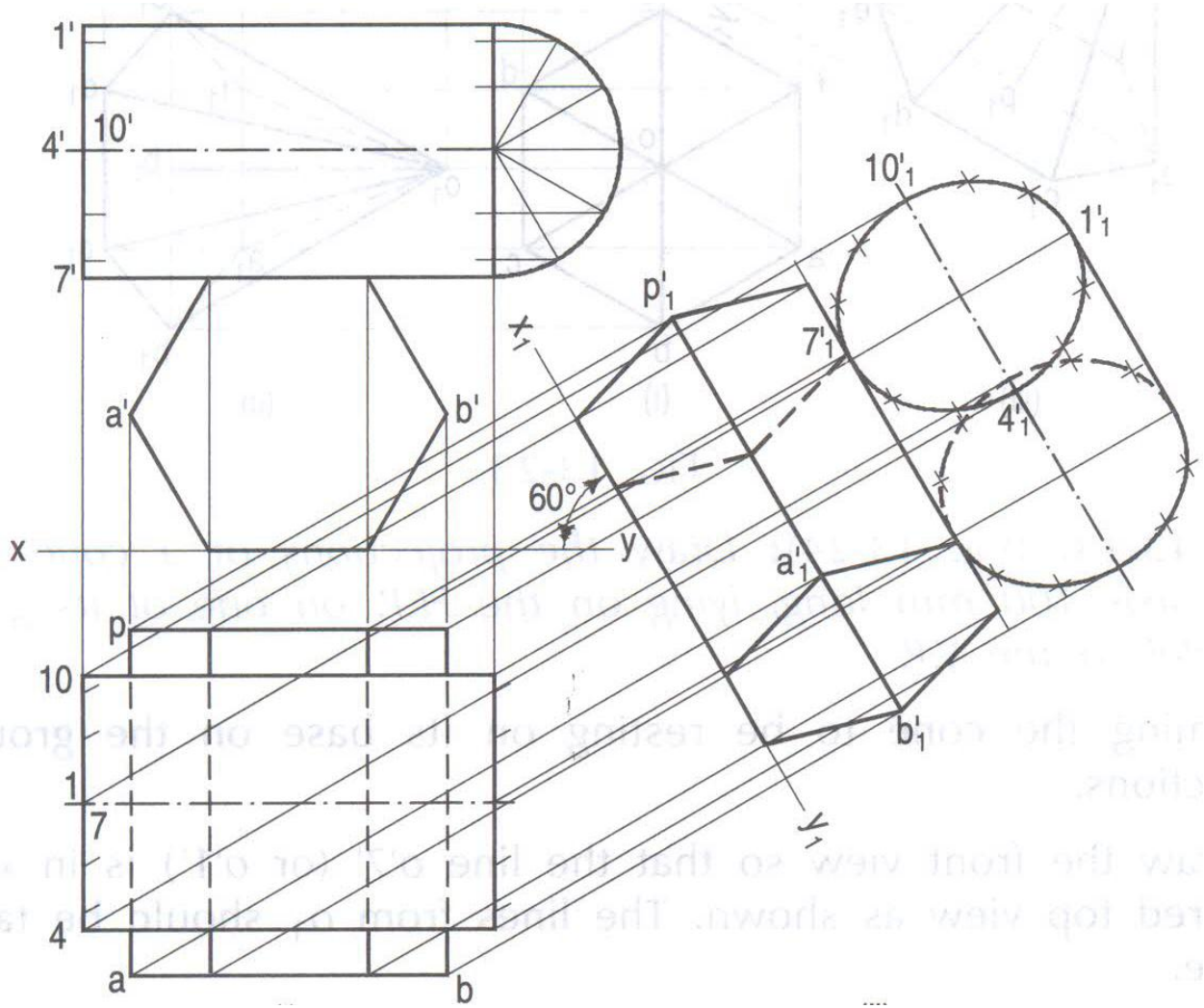
Aux. Plane method

Standard method

Projections of Solids

Example-14 (Solved Pb. 13-14, pp. 284)

The projections of a cylinder resting centrally on a hexagonal prism are given. Draw its aux. front view on a reference line inclined at 60° to *xy*.



Given standard views

Desired aux. view

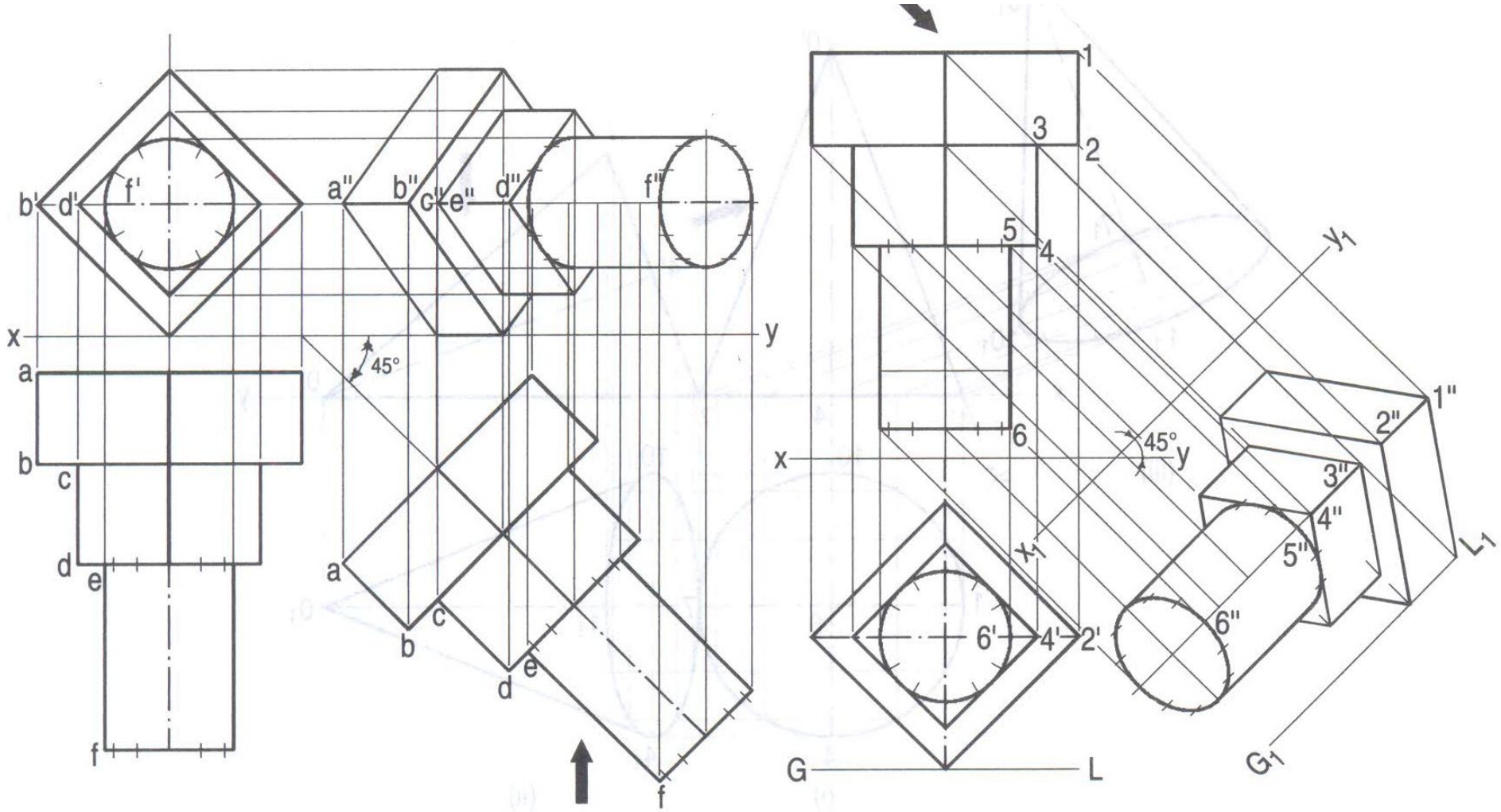
Projections of Solids

Example-15 (Solved Pb. 13-15, pp. 285)

A square headed bolt of 25mm diameter and 125mm long and having a square neck has its axis parallel to H.P. and inclined at 45° to V.P. All the faces of the square head are equally inclined to H.P. Draw its projections.

Projections of Solids

Example-15 (Solved Pb. 13-15, pp. 285) …

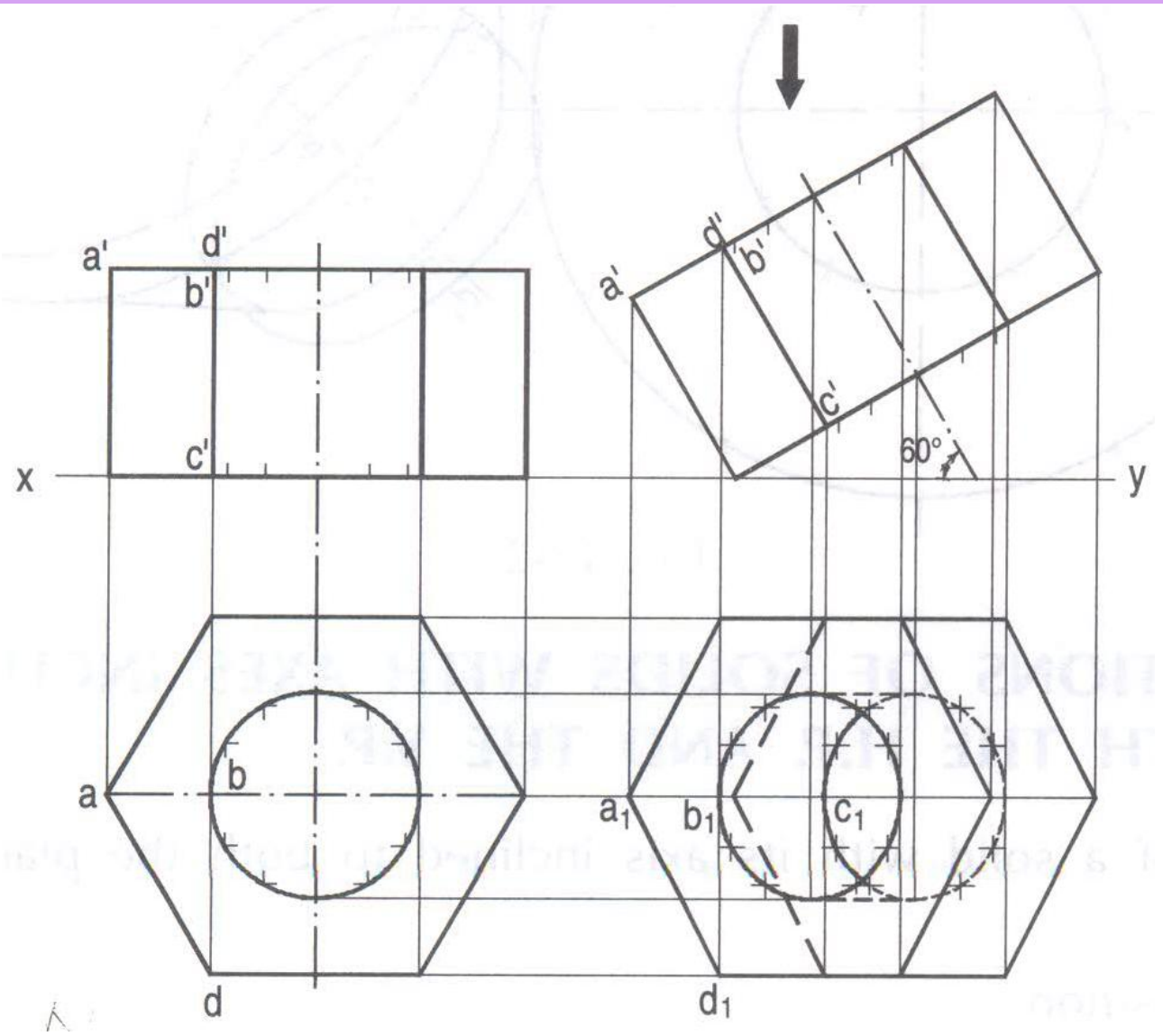


Standard method Aux. Plane method

Projections of Solids

Example-16 (Solved Pb. 13-16, pp. 285)

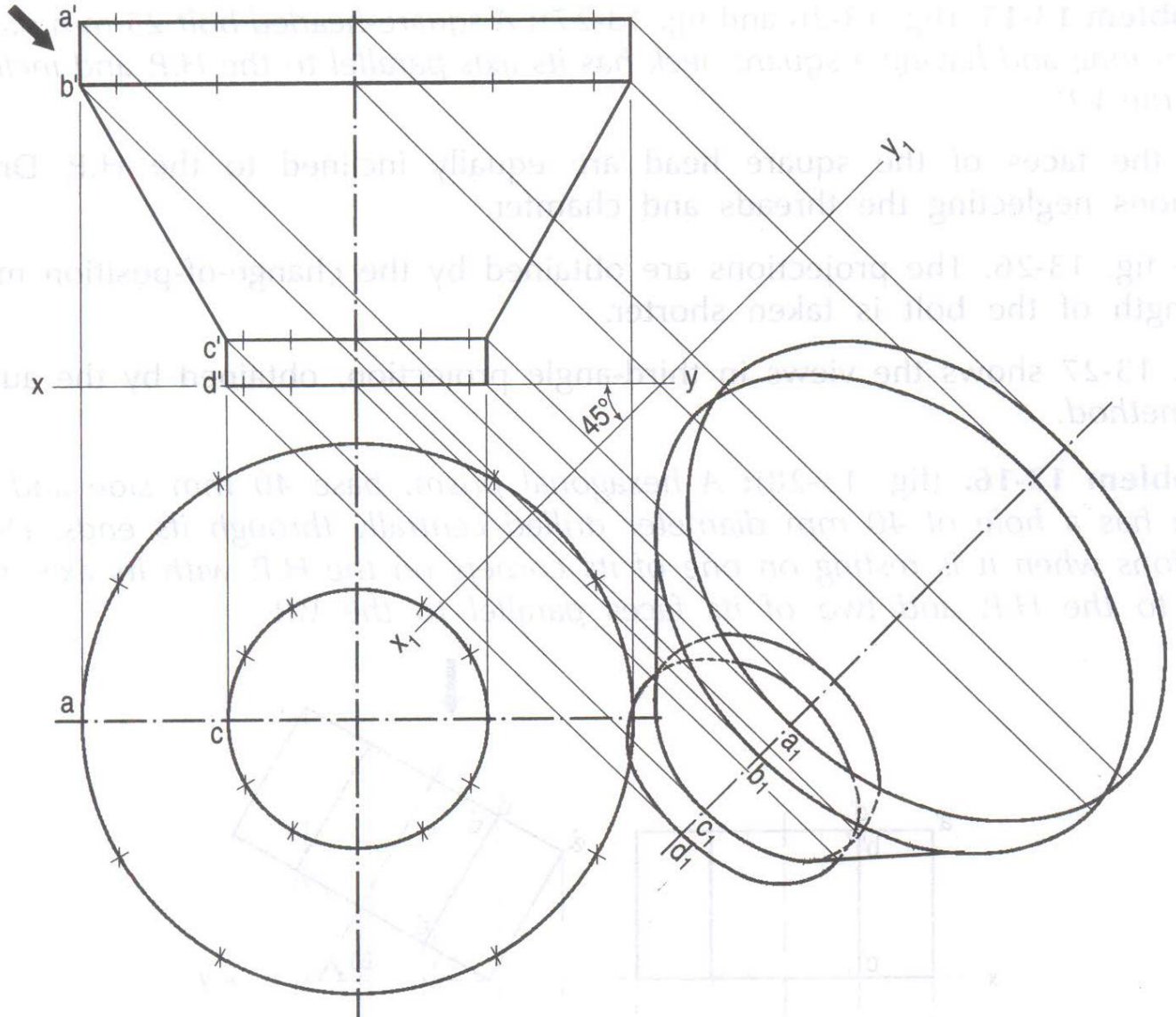
A hexagonal prism, base of 40mm side and height of 40mm has a through-hole of 40 mm diameter at the centre. It is resting on one of its corners on the H.P. with its axis inclined at 60° to the H.P. and two of its faces parallel to the V.P. Draw its projections.



Projections of Solids

Example-17 (Solved Pb. 13-17, pp. 285)

The projections of a hopper made of tin sheet are given. Project another top view on an auxiliary inclined plane making 45° angle with the H.P.



Projections of Solids: Inclined to Both

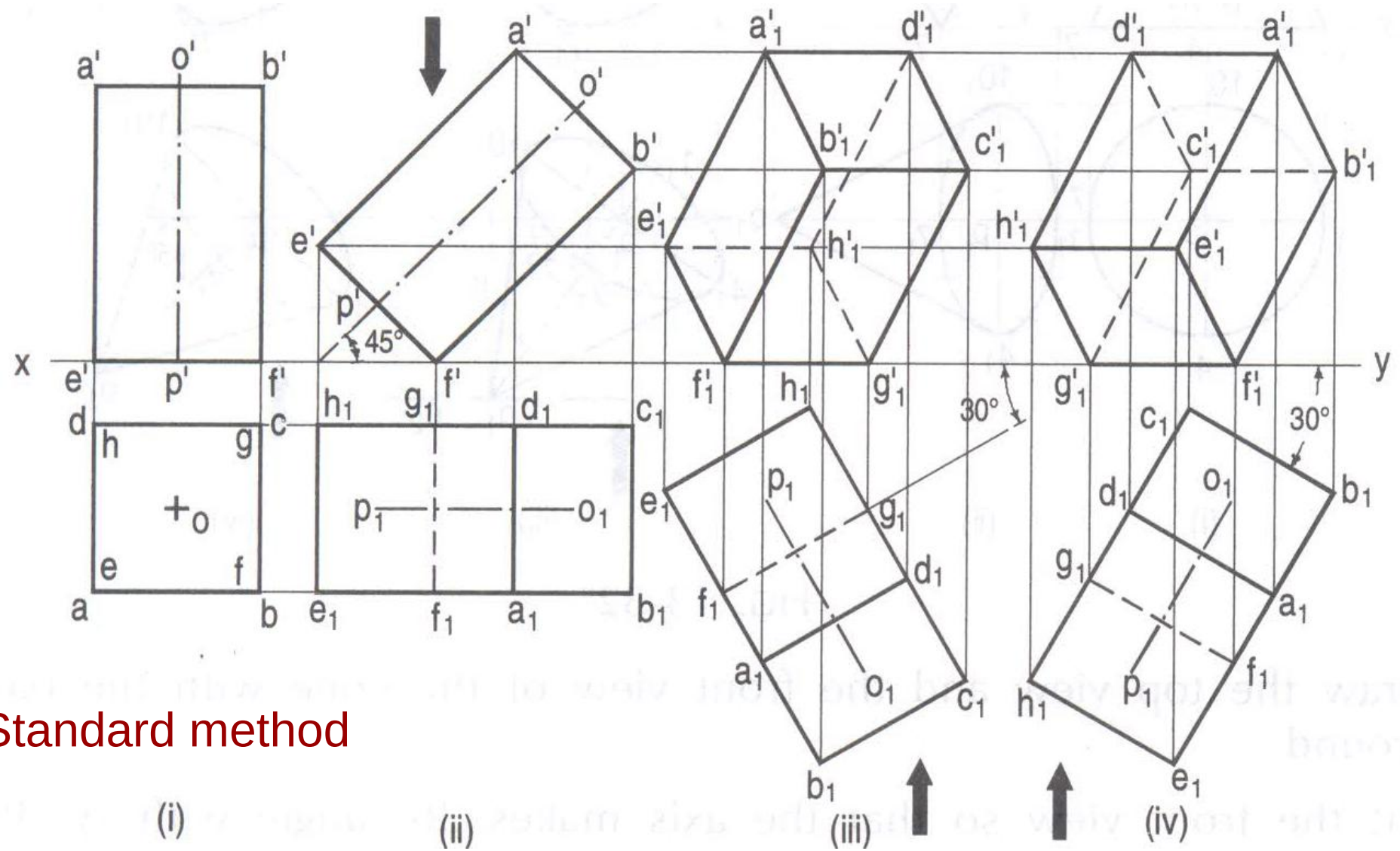
Projections of Solids

Example-18 (Solved Pb. 13-18, pp. 286)

A square prism, base of 40 mm side and height of 65 mm, has its axis inclined at 45° to the H.P. and has an edge of its base, on the H.P. and inclined at 30° to the V.P. Draw its projections.

Projections of Solids

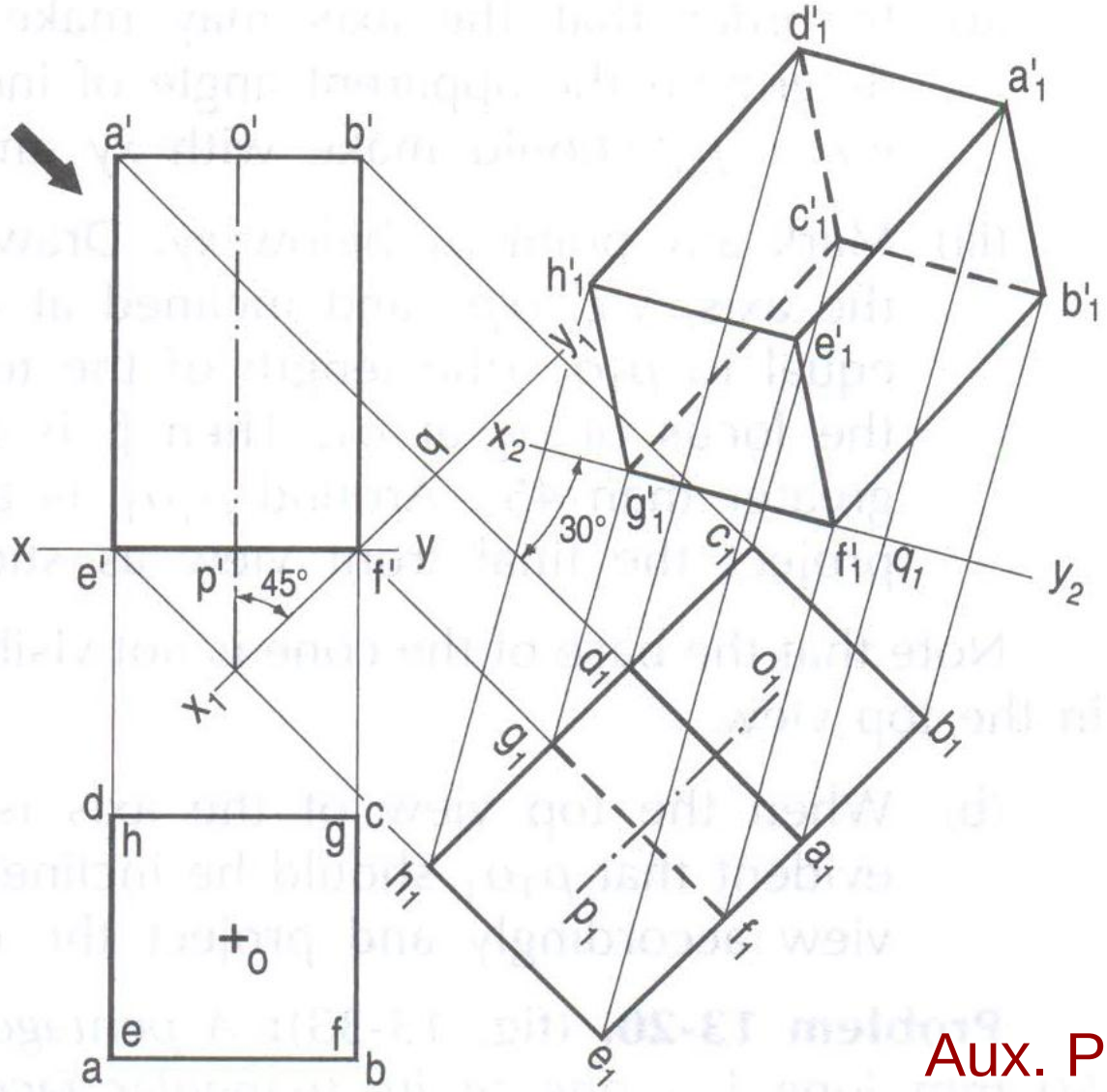
Example-18 (Solved Pb. 13-18, pp. 286) …



Standard method

Projections of Solids

Example-18 (Solved Pb. 13-18, pp. 286) …



Aux. Plane method

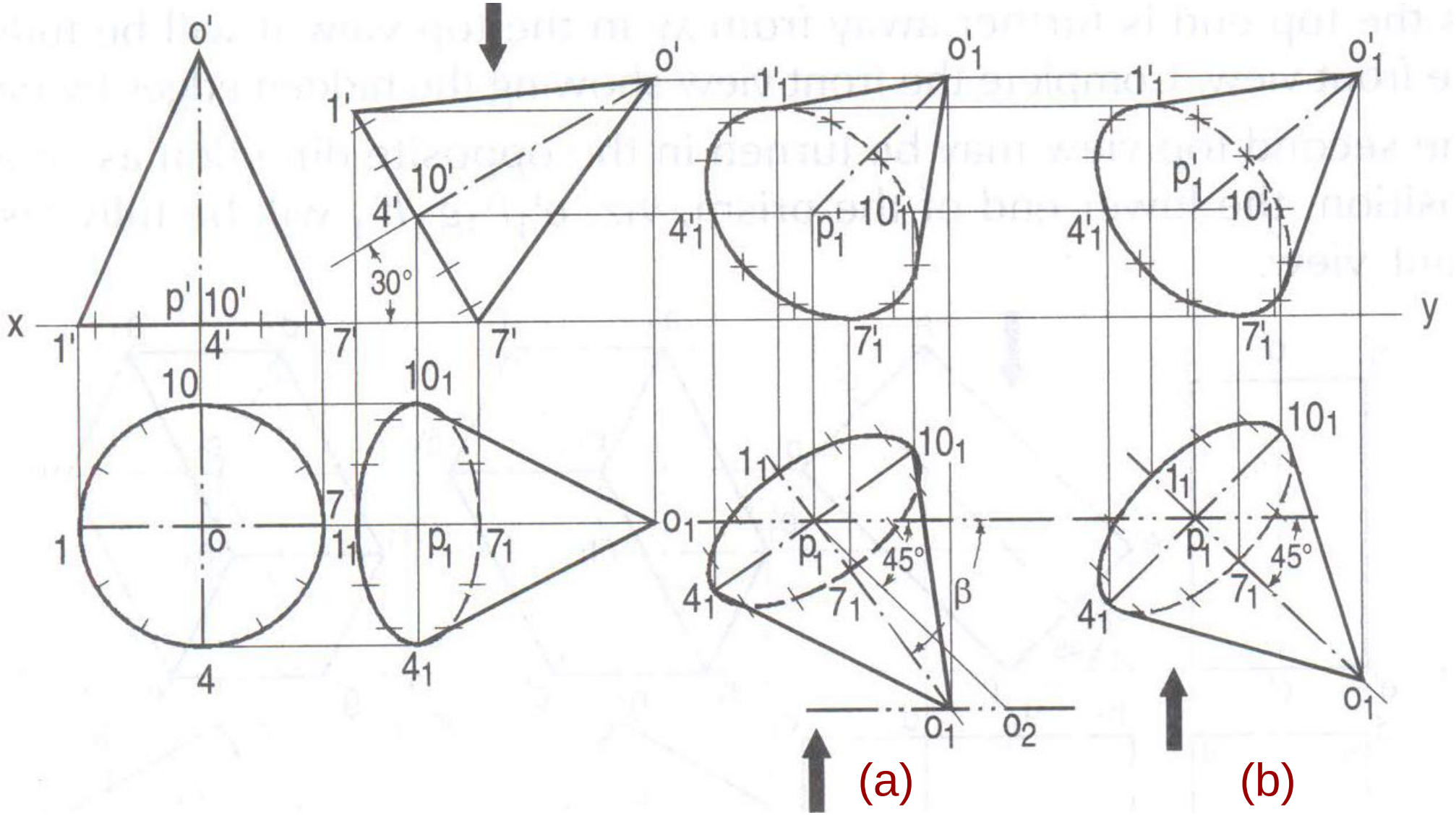
Projections of Solids

Example-19 (Solved Pb. 13-19, pp. 288)

Draw the projections of a cone, of 45mm diameter base and axis of 50 mm long, when it is resting on the ground on a point on its base circle with (a) the axis making an angle of 30° with the H.P. and 45° with the V.P. (b) the axis making an angle of 30° with the H.P. and its top view making 45° with the V.P.

Projections of Solids

Example-19 (Solved Pb. 13-19, pp. 288)



Projections of Solids

Example-19 (Solved Pb. 13-19, pp. 288)

Auxiliary view method

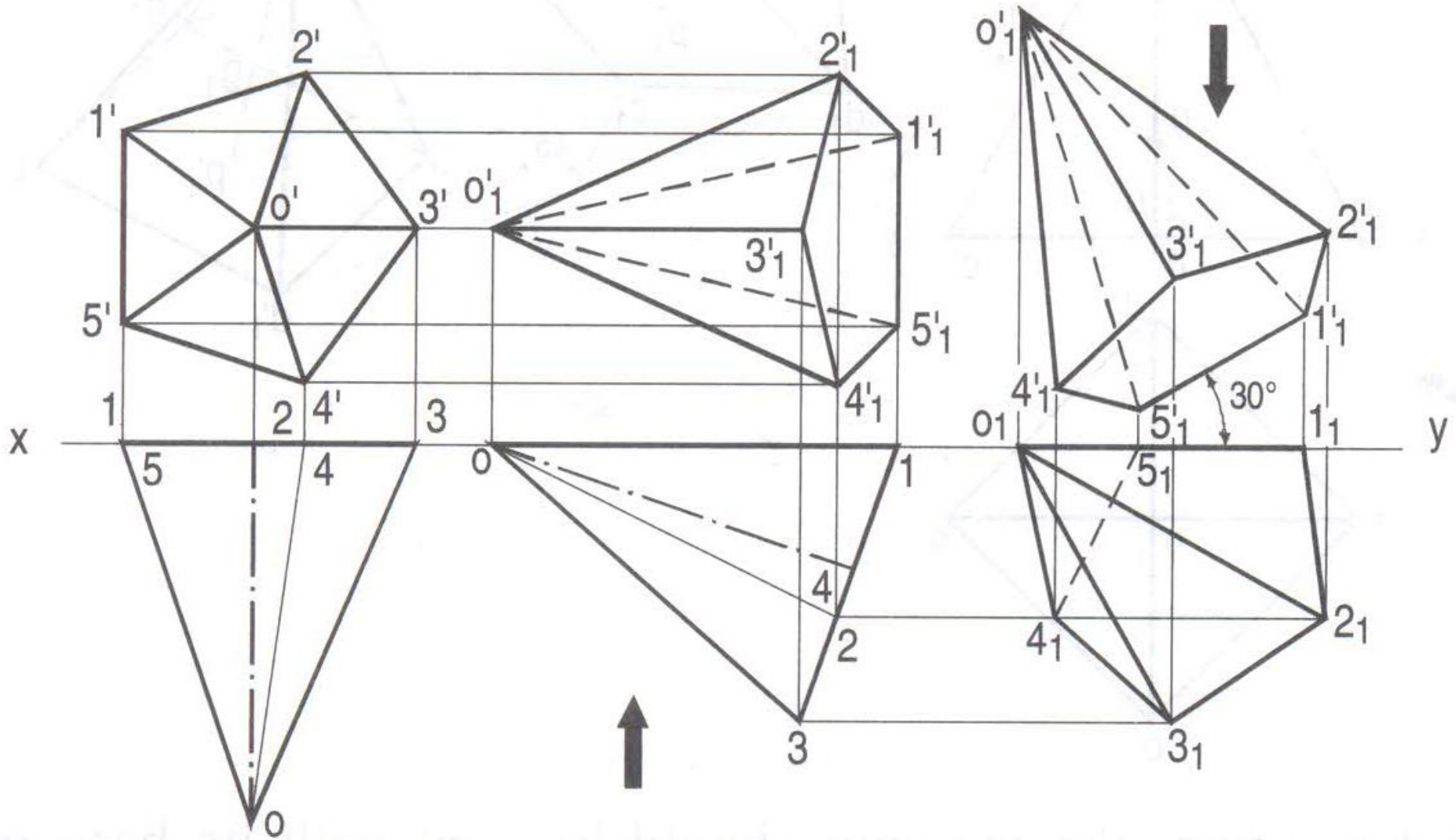
Projections of Solids

Example-20 (Solved Pb. 13-20, pp. 288)

A pentagonal pyramid, base 25 mm side and axis 50 mm long has one of its triangular faces in the V.P. and the edge of the base contained by that face makes an angle of 30° with the H.P. Draw its projections.

Projections of Solids

Example-20 (Solved Pb. 13-20, pp. 288) …



Projections of Solids

Example-20 (Solved Pb. 13-20, pp. 288) …

Auxiliary view method

Projections of Solids

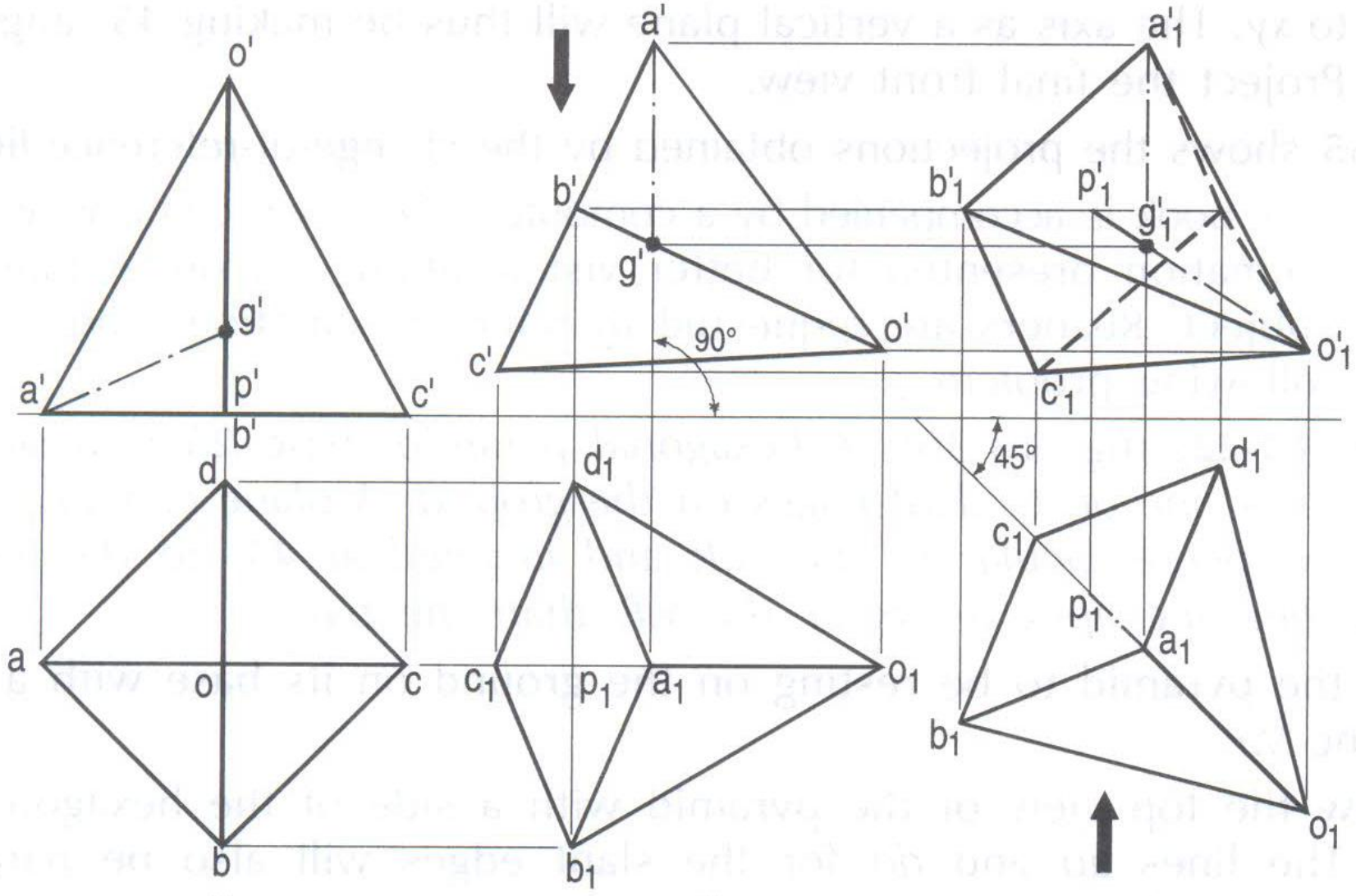
Example-21 (Solved Pb. 13-21, pp. 289)

A square pyramid, base 38 mm side and axis 50 mm long, is freely suspended from one of the corners of its base. Draw its projections, when *the axis as a vertical plane makes an angle of 45°* with the V.P.

Hint: When a pyramid is suspended freely from a corner of its base, the imaginary line joining that corner with the centre of gravity of the pyramid will be vertical.

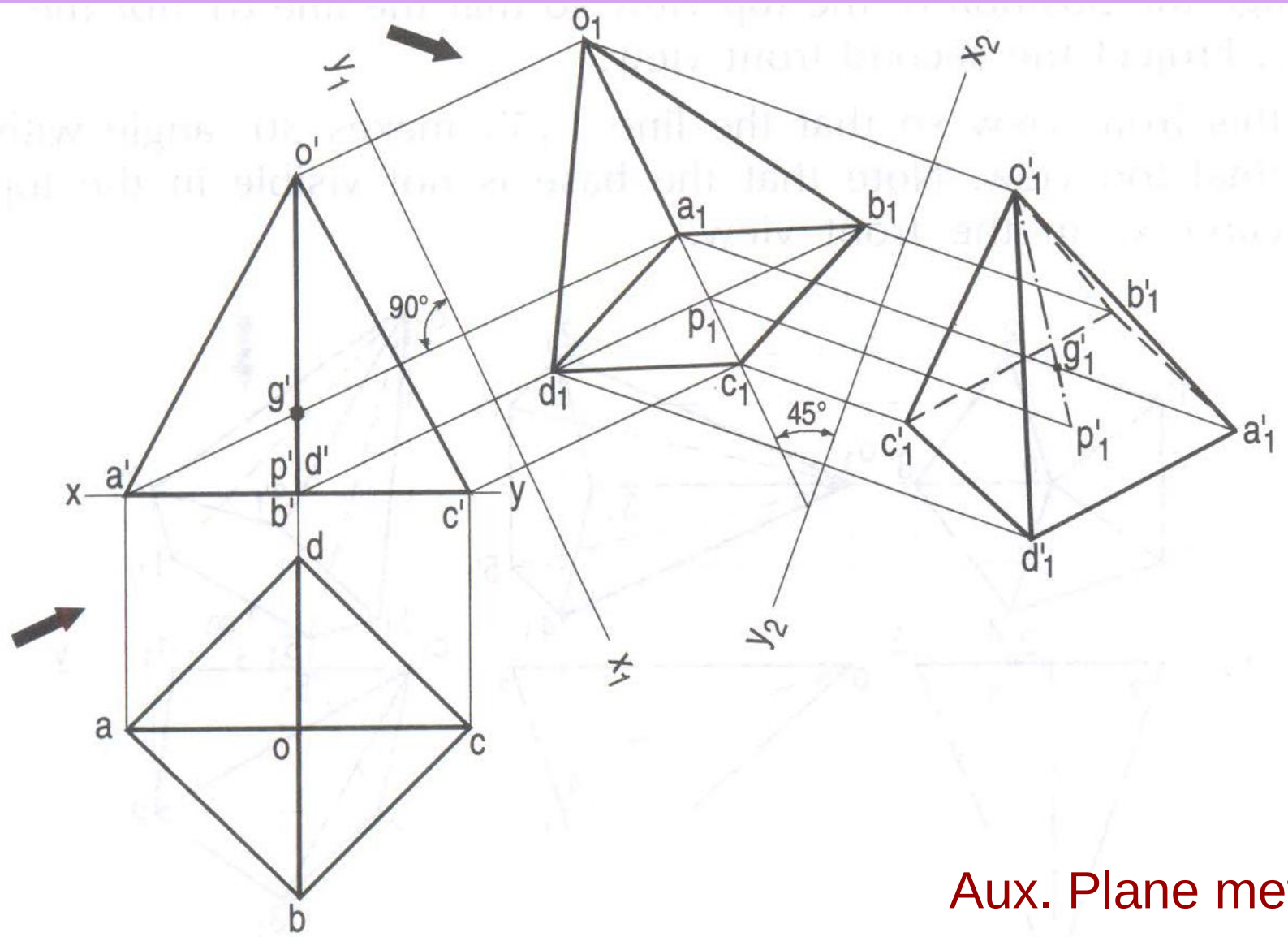
Projections of Solids

Example-21 (Solved Pb. 13-21, pp. 289) …



Projections of Solids

Example-21 (Solved Pb. 13-21, pp. 289) …



Aux. Plane method

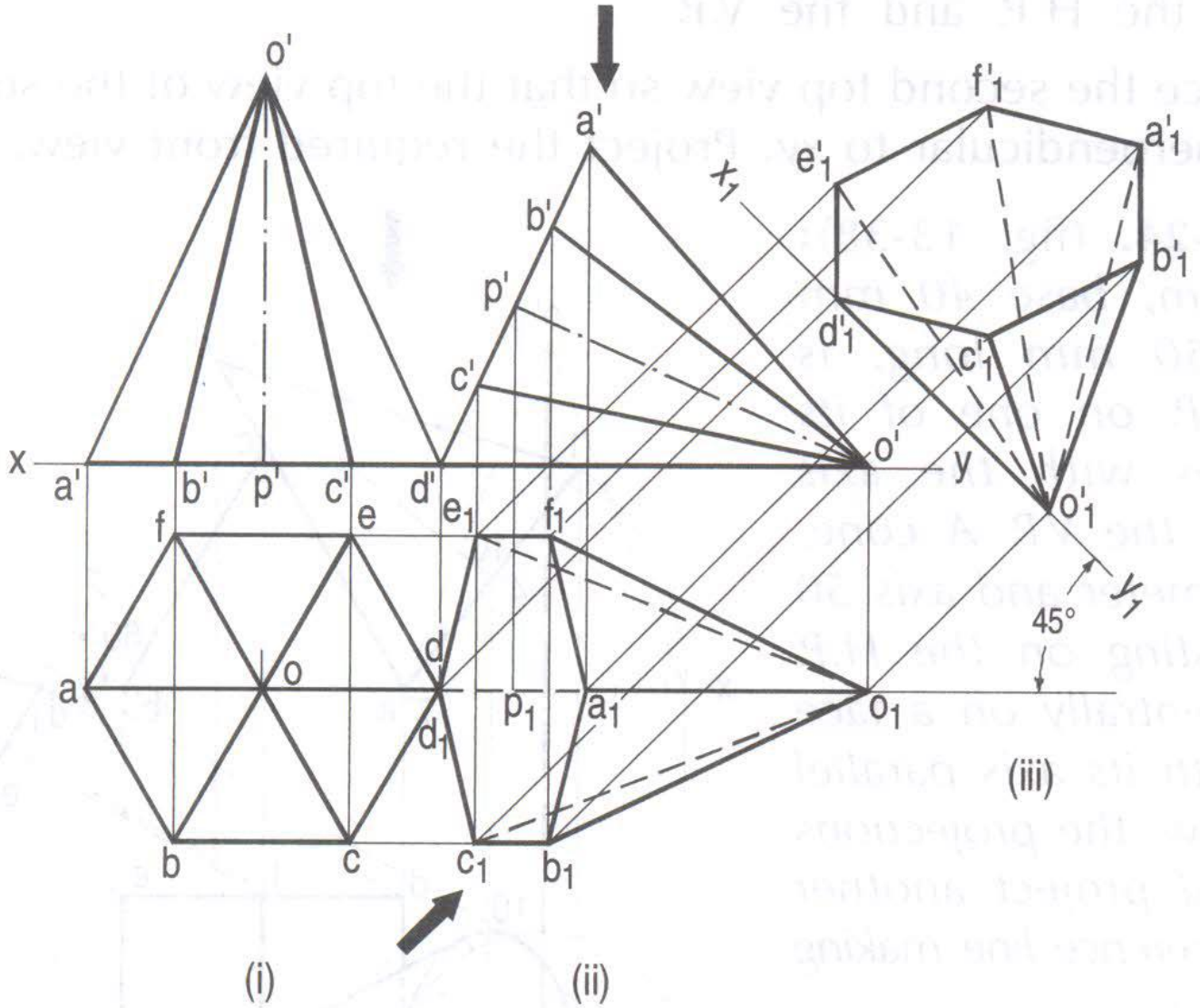
Projections of Solids

Example-22 (Solved Pb. 13-22, pp. 290)

A hexagonal pyramid, base 25mm side and axis 55mm long, has one of its slants edges on the ground. A plane containing that edge and the axis is perpendicular to the H.P and inclined at 45° to the V.P. Draw its projections when the apex is nearer the V.P. than the base.

Projections of Solids

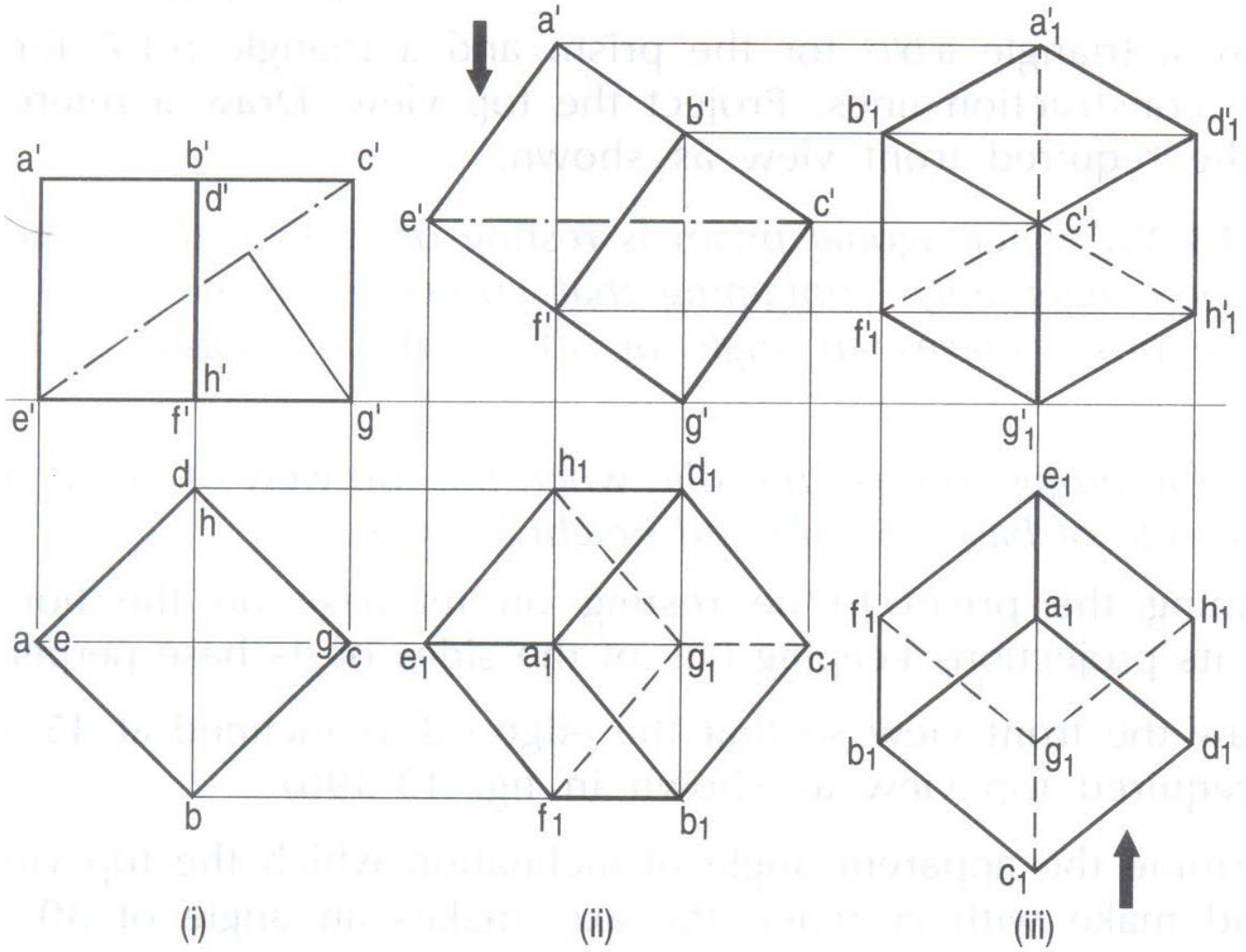
Example-22 (Solved Pb. 13-22, pp. 290) …



Projections of Solids

Example-23 (Solved Pb. 13-23, pp. 291)

Draw the projections of a cube of 25mm long edges resting on the H.P. on one of its corner with a solid diagonal perpendicular to V.P.



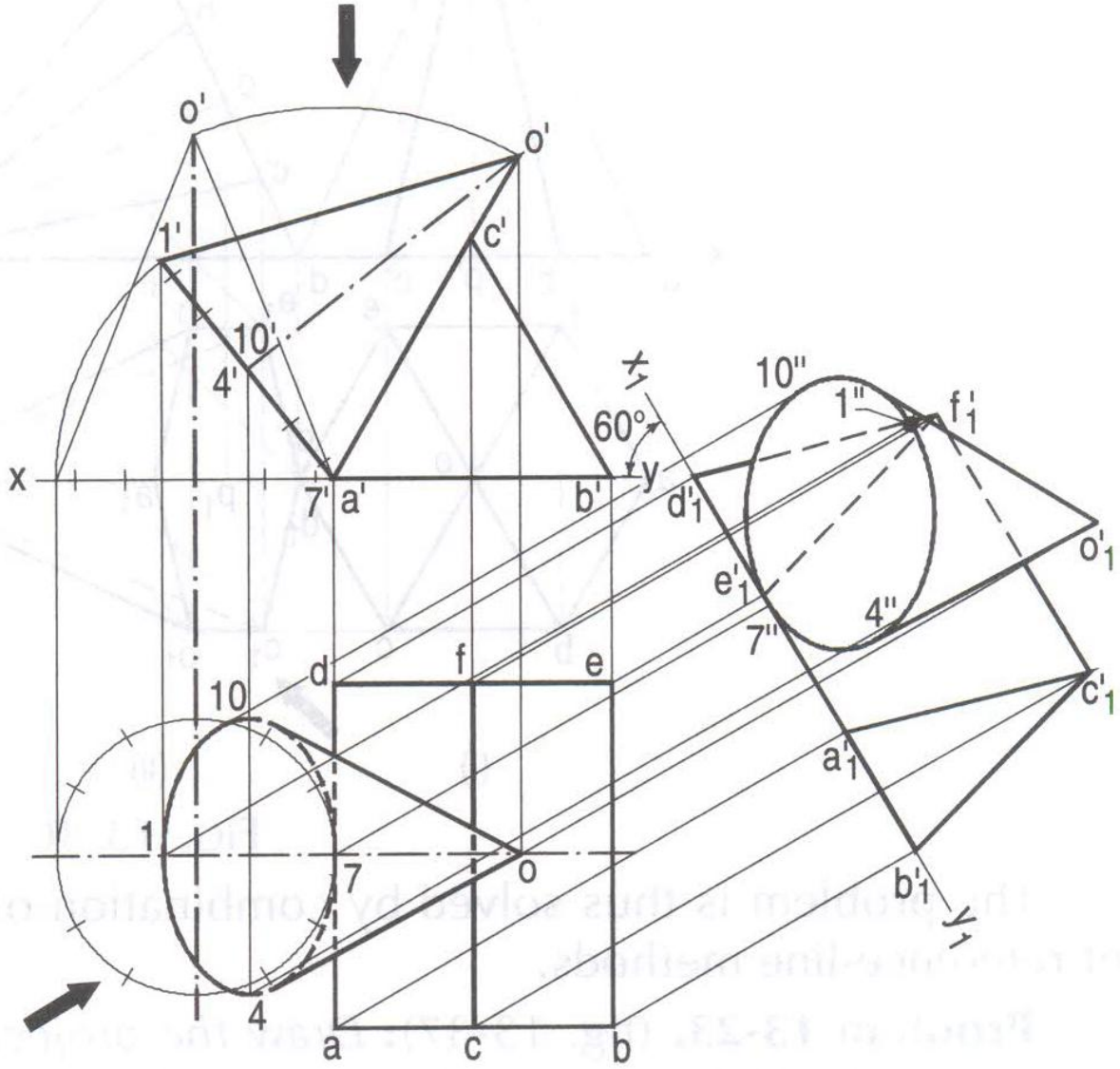
Projections of Solids

Example-24 (Solved Pb. 13-24, pp. 292)

A triangular prism base 40mm side and axis 50mm long is lying on the H.P. on one of its rectangular faces with the axis perpendicular to the V.P. A cone base 40mm diameter and axis 50mm long is resting on the H.P. and is leaning centrally on a face of the prism with its axis parallel to the V.P. Draw the projections of the solid and project another front view on a reference line making 60° angle with xy.

Projections of Solids

Example-24 (Solved Pb. 13-24, pp. 292) …



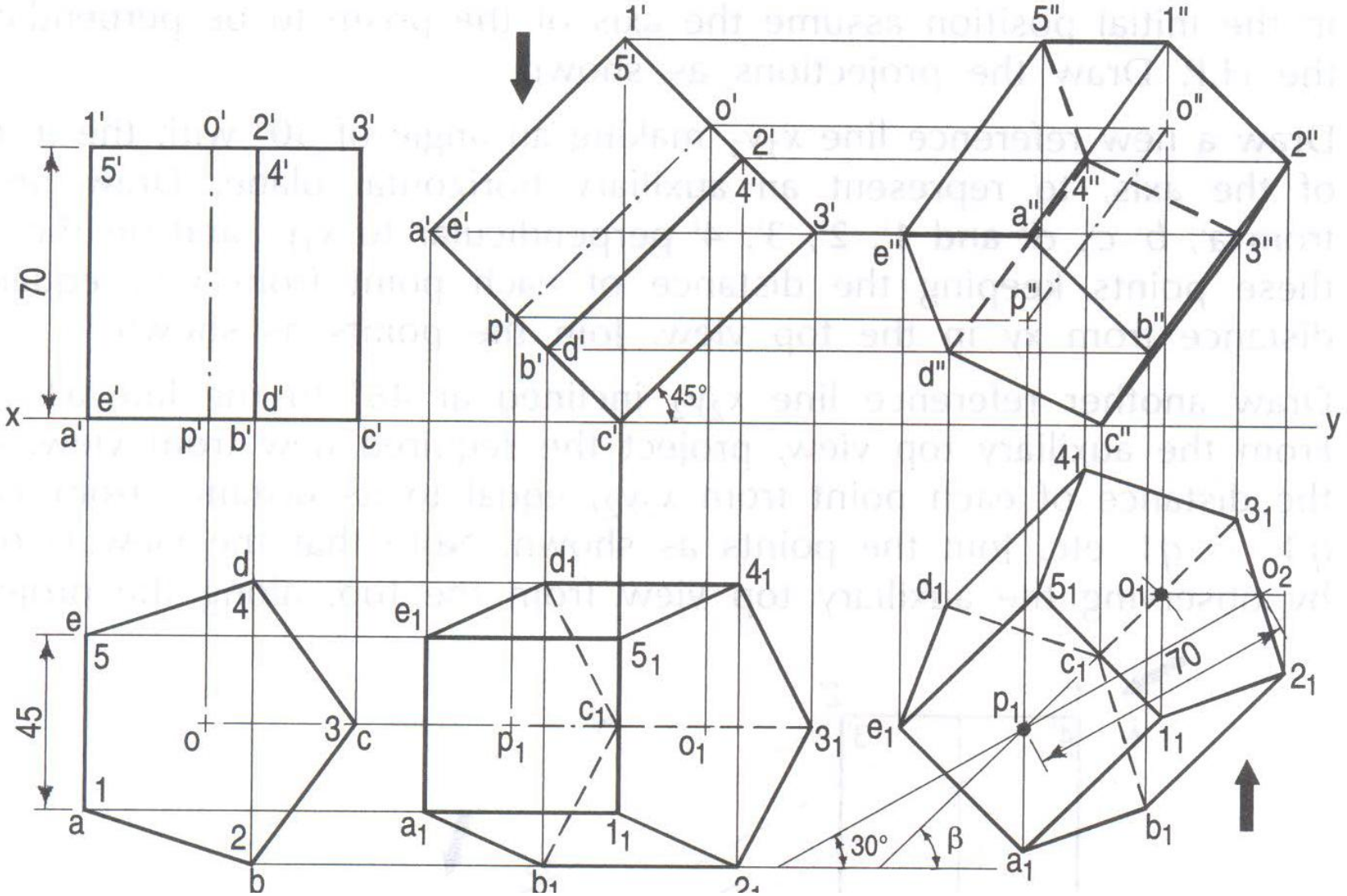
Projections of Solids

Example-25 (Solved Pb. 13-25, pp. 292)

A pentagonal prism is resting on one of the corners of its base on the H.P. The longer edge containing that corner is inclined at 45° to the H.P. The axis of the prism makes an angle of 30° to the V.P. Draw the projections of the solid. Also draw the projections of the solid when the top view of axis is inclined at 30° to xy. Take the side of base 45mm and height 70mm.

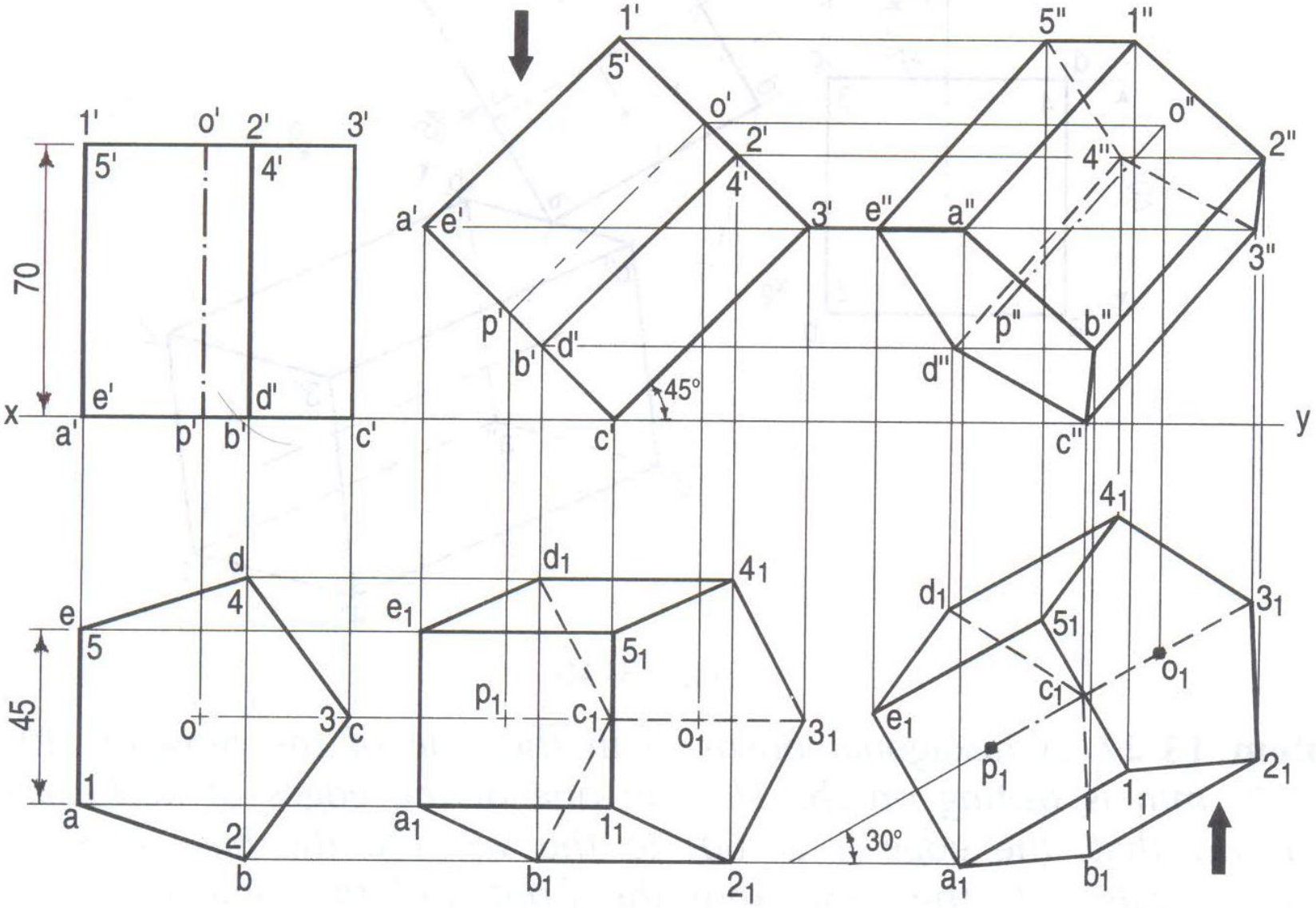
Projections of Solids

Example-25 (Solved Pb. 13-25, pp. 292) …



Projections of Solids

Example-25 (Solved Pb. 13-25, pp. 292) …



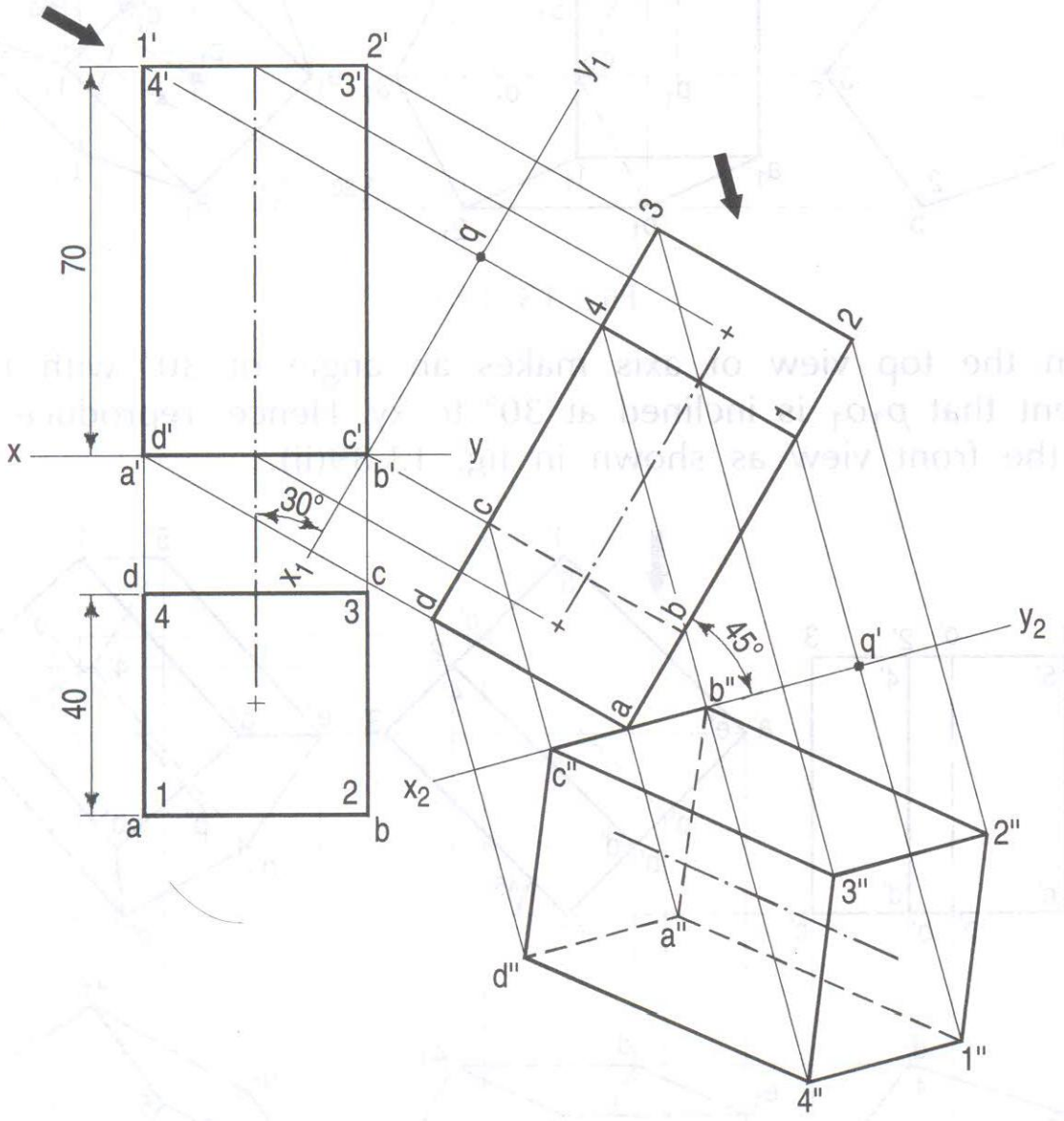
Projections of Solids

Example-26 (Solved Pb. 13-26, pp. 293)

A square prism with the side of its base 40mm and axis 70mm long is lying on one of its base edges on the H.P. in such a way that this base edge makes an angle of 45° with the V.P. and the axis is inclined at 30° to the H.P. Draw the projections of the solid using the auxiliary plane method.

Projections of Solids

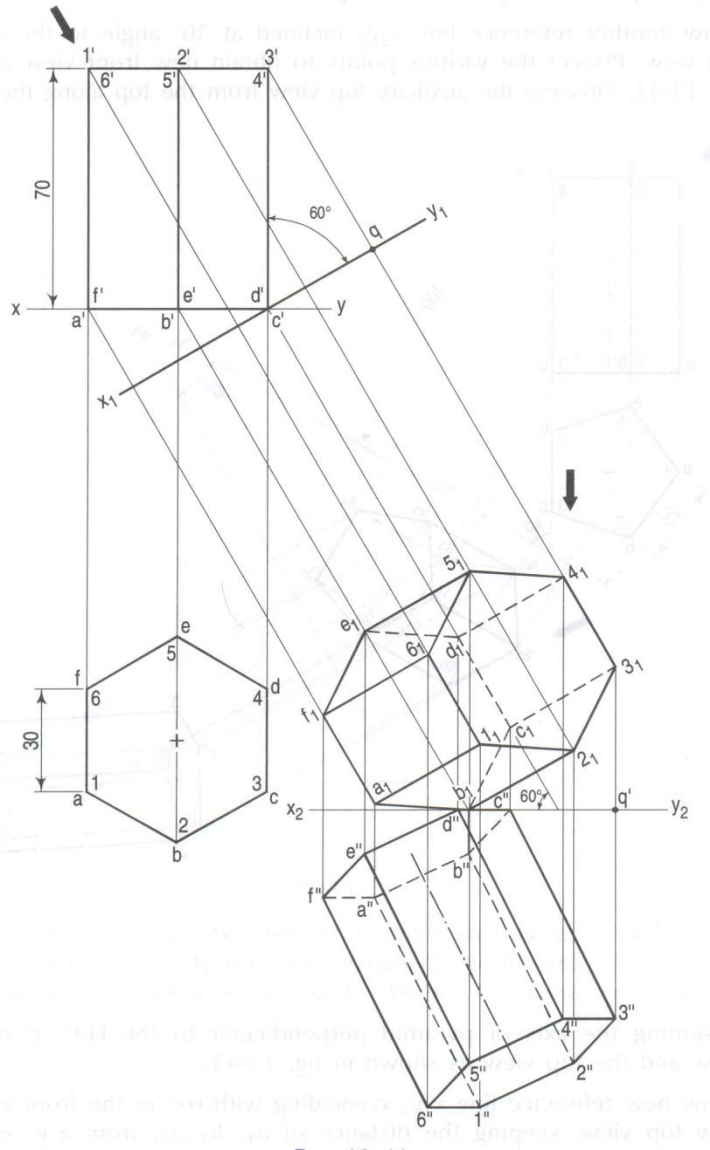
Example-26 (Solved Pb. 13-26, pp. 293) …



Projections of Solids

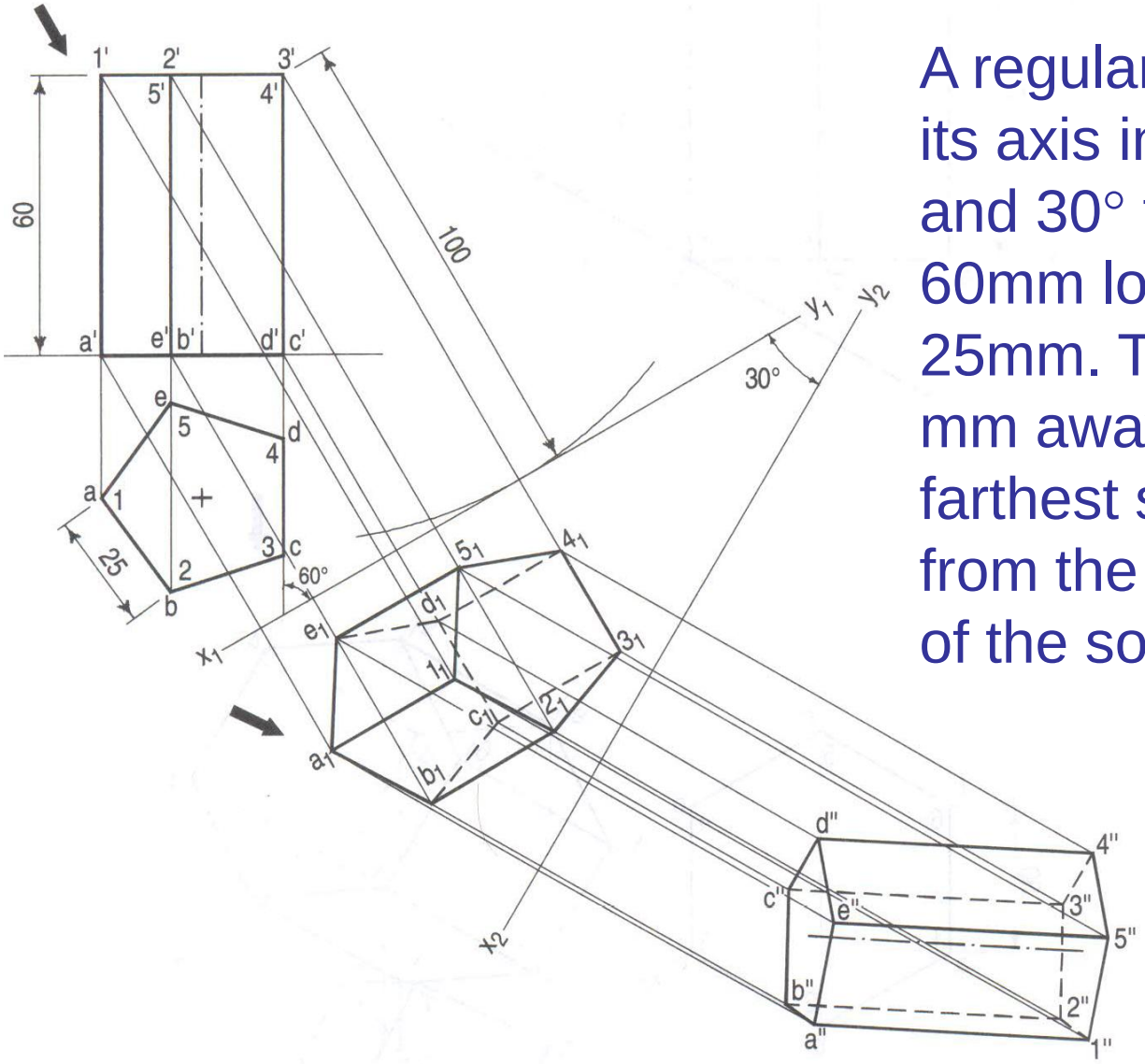
Example-27 (Solved Pb. 13-27, pp. 294)

A hexagonal prism with the side of the hexagon 30mm and height of 70mm is resting on the H.P. on one of edges of its hexagonal base in such a way that the edge is at 60° to the V.P. and the base is at 30° to the H.P. Draw to scale 1:1 the view from the front and the view from the top.



Projections of Solids

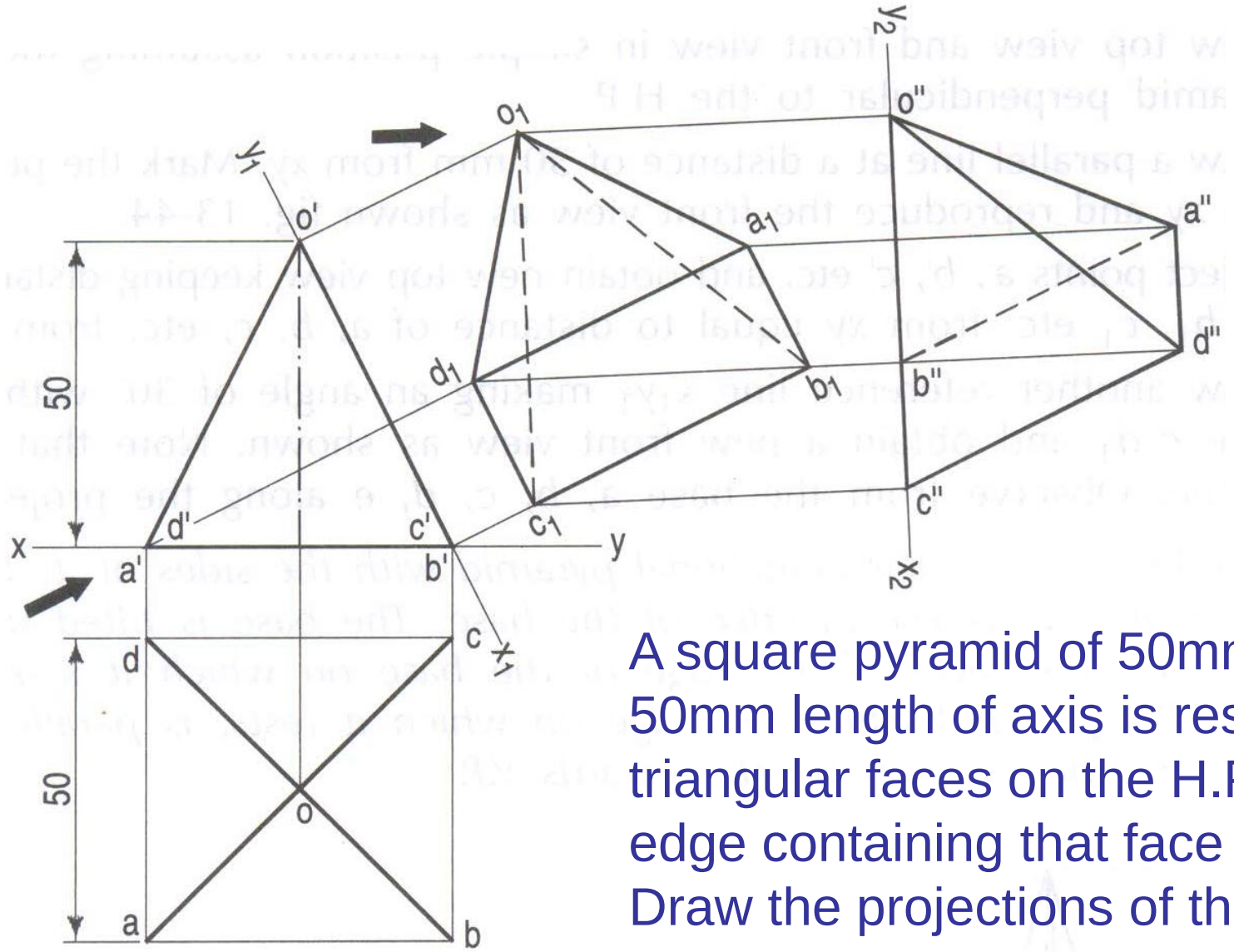
Example-28 (Solved Pb. 13-28, pp. 296)



A regular pentagonal prism lies with its axis inclined at 60° to the H.P. and 30° to the V.P. The prism is 60mm long and has a face width of 25mm. The nearest corner is 10 mm away from the V.P. and the farthest shorter edge is 100mm from the H.P. Draw the projections of the solid.

Projections of Solids

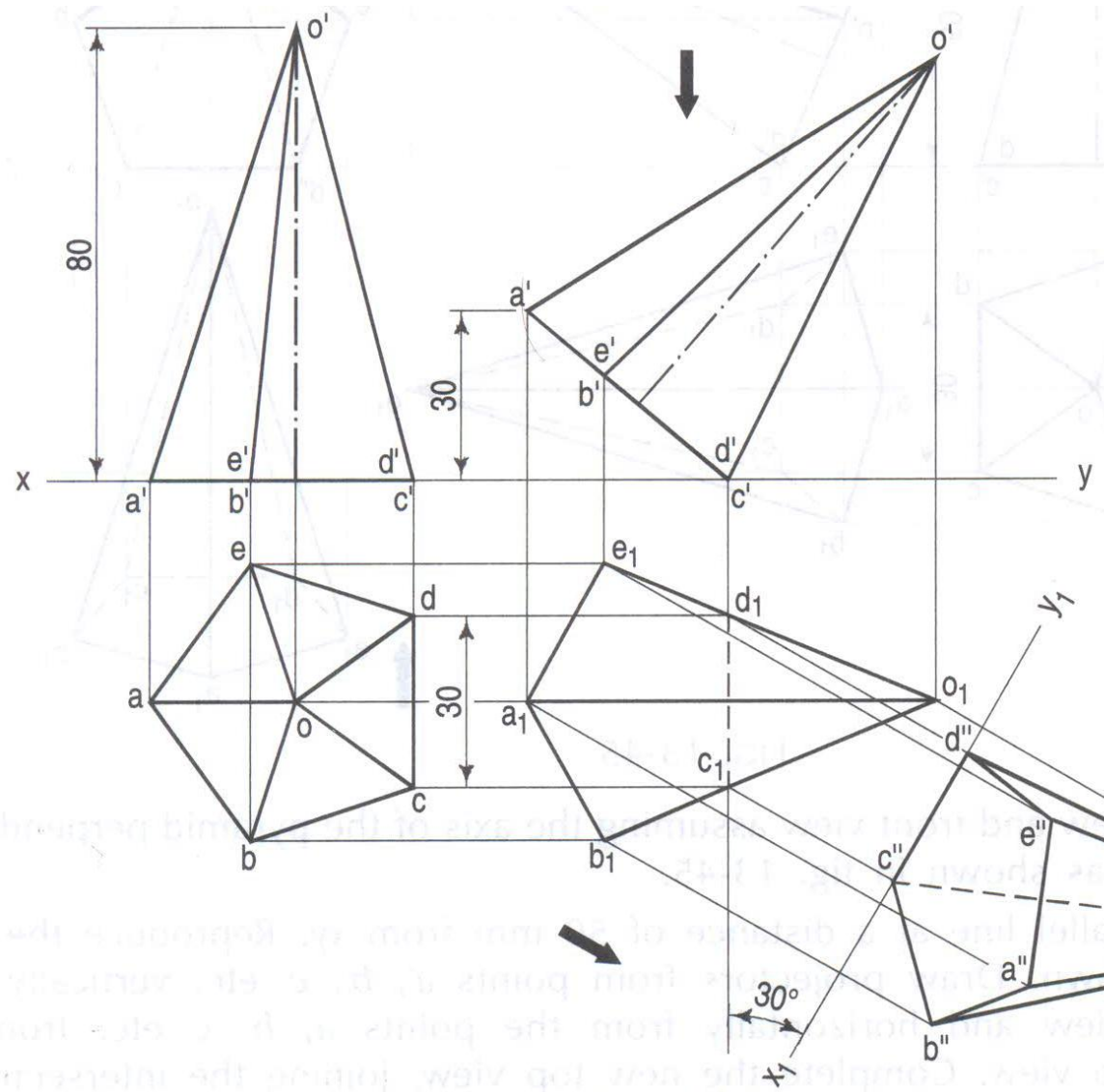
Example-29 (Solved Pb. 13-29, pp. 296)



A square pyramid of 50mm side of base and 50mm length of axis is resting on one of its triangular faces on the H.P. having a slant edge containing that face parallel to the V.P. Draw the projections of the pyramid.

Projections of Solids

Example-30 (Solved Pb. 13-30, pp. 297)



A regular pentagonal pyramid base 30mm side and height 80mm rests on one edges of its base on the ground so that the highest point in the base is 30mm above the ground. Draw its projection when the axis is parallel to the V.P. Draw another front view on a reference line inclined at 30 to the edge on which it is resting so that the base is visible.

Conclusions

- Roughly work out all the problems given to you. Only if you come prepared, you will be able to complete all problems of the sheet in the drawing session.


Thank You!