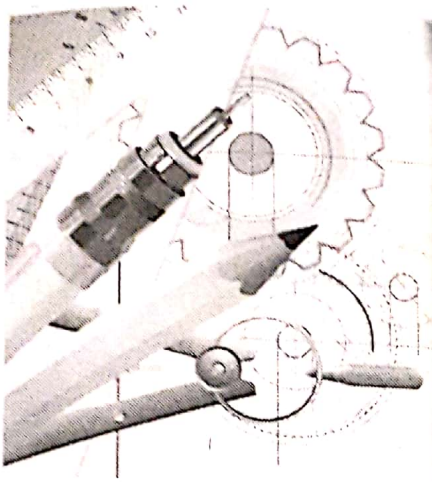


9 PROJECTIONS OF SOLIDS

9.1. INTRODUCTION

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

9.2. CLASSIFICATION OF SOLIDS

are classified as given below :

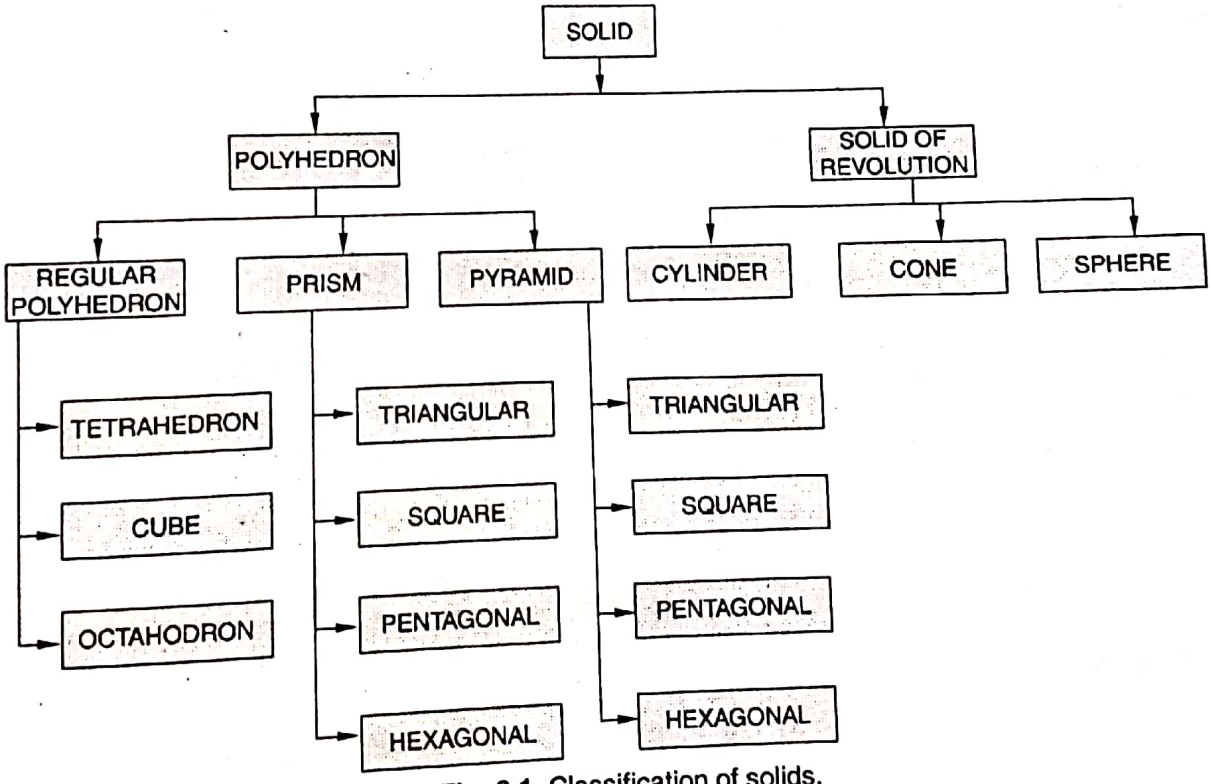


Fig. 9.1. Classification of solids.

9.3. POLYHEDRON

A polyhedron is a solid bounded by planes called faces, which meet in straight lines calle edges. A regular polyhedron has all the faces equal and regular as shown in Fig. 9.2.

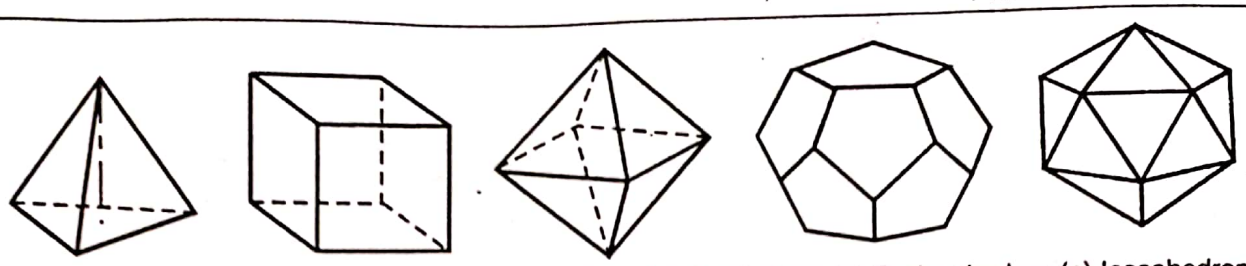


Fig. 9.2. Regular polyhedron (*a*) Tetrahedron (*b*) Cube (*c*) Octahedron (*d*) Dodecahedron (e) Icosahedron.

1. **Tetrahedron :** It has four equal equilateral triangular faces.
2. **Cube :** It has six equal square faces.
3. **Octahedron :** It has eight equal equilateral triangular faces.
4. **Dodecahedron :** It has 12 equal pentagonal faces.
5. **Icosahedron.** It has 20 equal equilateral triangular faces.

9.4. PRISM

A prism is a polyhedron with two *n*-sided polygonal bases which are parallel and congruent and lateral faces are rectangles. All cross-sections parallel to the bases are congruent with the bases. An imaginary line that joins the centre of the bases is called an axis. A right and regular prism has regular polygonal bases, axis perpendicular to the bases and all the faces are equal rectangles, as shown in Fig. 9.3. Prisms are named according to the shape of their base, so a prism with a triangular base is called a triangular prism; a square base is called a square prism and so on.

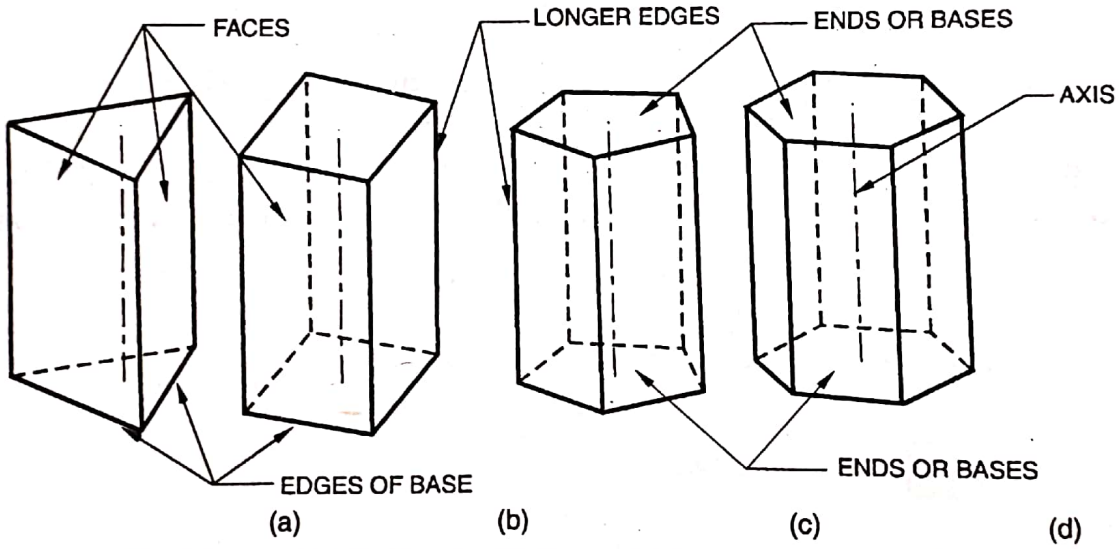


Fig. 9.3. Prisms (*a*) Triangular (*b*) Square (*c*) Pentagonal (*d*) Hexagonal.

9.5. PYRAMID

A pyramid is a polyhedron with *n*-sided polygonal base and lateral faces are triangles meeting at a point called the vertex or apex. An imaginary line that joins the apex with the centre of the base is known as the axis. A right and regular pyramid has a regular polygon base, axis perpendicular to the base and all the faces are equal isosceles triangles, as shown in Fig. 9.4. Pyramids are named according to the shape of their base, so a pyramid with a triangular base is called a triangular pyramid; a square base is called a square pyramid and so on. The centre of gravity of pyramids lies on the axis at one-fourth of its height from the base.

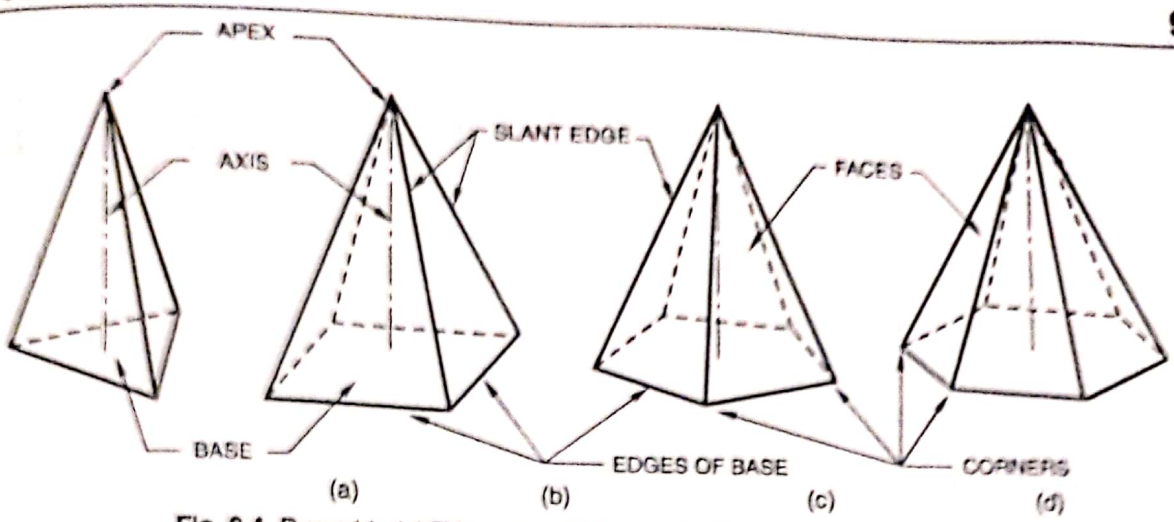


Fig. 9.4. Pyramids (*a*) Triangular (*b*) Square (*c*) Pentagonal (*d*) Hexagonal.

9.6. SOLID OF REVOLUTION

These solids are obtained by revolving a plane figure like rectangle, triangle or a semi-circle about a fixed line.

1. Cylinder : A cylinder is a solid of revolution obtained by revolving a rectangle about one of its fixed side called an axis. It can be imagined as a prism of infinite number of lateral faces. Any line on the surface of a cylinder is called its generator. Thus, a cylinder has an infinite number of generators. A right cylinder has all the generators and the axis perpendicular to the base, as shown in Fig. 9.5 (*a*).

2. Cone : A cone is obtained by revolving a triangle about its fixed side called an axis. A cone can be imagined as a pyramid with infinite number of lateral faces. Any line on the surface of a cone is called its generator. Thus, a cone has an infinite number of generators. A right cone has all generators of equal length and the axis perpendicular to the base, as shown in Fig. 9.5 (*b*).

3. Sphere : A sphere is obtained by revolving a semi-circle around its diameter, as shown in Fig. 9.5 (*c*).

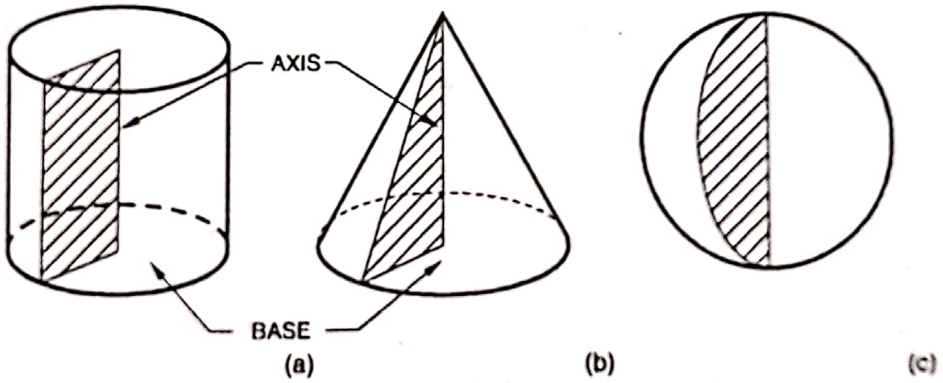


Fig. 9.5. Solids of revolution (*a*) Cylinder (*b*) Cone (*c*) Sphere.

9.7. OBLIQUE SOLID

An oblique solid such as oblique prism, pyramid, cylinder or cone has its axis inclined to its base as shown in Fig. 9.6. The faces of an oblique prism are parallelograms of different sizes. The faces of an oblique pyramid are triangles of different sizes. The generators in an oblique

cylinder have equal lengths whereas those in an oblique cone have unequal lengths.

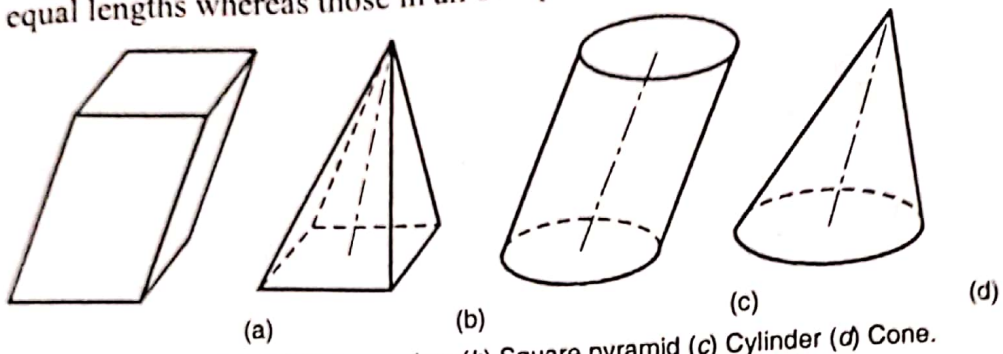


Fig. 9.6. Oblique solids (*a*) Square prism (*b*) Square pyramid (*c*) Cylinder (*d*) Cone.

9.8. FRUSTUM OF PYRAMID AND CONE

When a regular pyramid or a cone is cut by a plane parallel to its base and the portion of the solid containing apex is removed, the remaining portion of the solid is called the frustum of that pyramid or cone, as shown in Fig. 9.7.

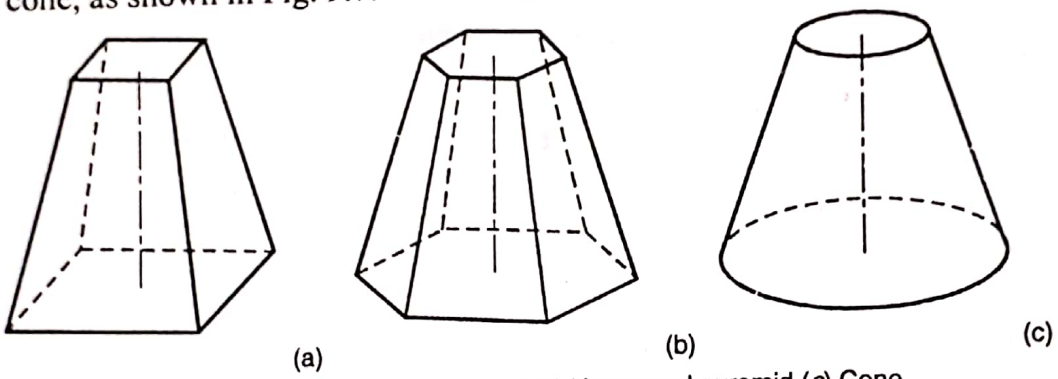


Fig. 9.7. Frustum (*a*) Square pyramid (*b*) Hexagonal pyramid (*c*) Cone.

9.9. ORIENTATION OF SOLID

The solid may be in one of the following positions :

1. Axis perpendicular to the H.P. and parallel to the V.P.
2. Axis perpendicular to the V.P. and parallel to the H.P.
3. Axis parallel to both the H.P. and V.P. or perpendicular to the profile plane.
4. Axis inclined to the H.P. and parallel to the V.P.
5. Axis inclined to the V.P. and parallel to the H.P.
6. Axis inclined to both the H.P. and the V.P.

9.10. AXIS PERPENDICULAR TO THE H.P. AND PARALLEL TO THE V.P.

If the axis of a right solid is perpendicular to the H.P. and parallel to the V.P., the true shape and size of the base can be viewed in the top view. Therefore, first obtain the top view of the solid and then project it to obtain front view.

Problem 9.1. A square pyramid of base side 40 mm and axis 70 mm is resting on its base on the H.P. Draw its projections when (*i*) a side of the base is parallel to V.P., (*ii*) a side of the base is inclined at 30° to the V.P., and (iii) all the sides of the base are equally inclined to the V.P.

Solution. A square pyramid a situated in a first quadrant.

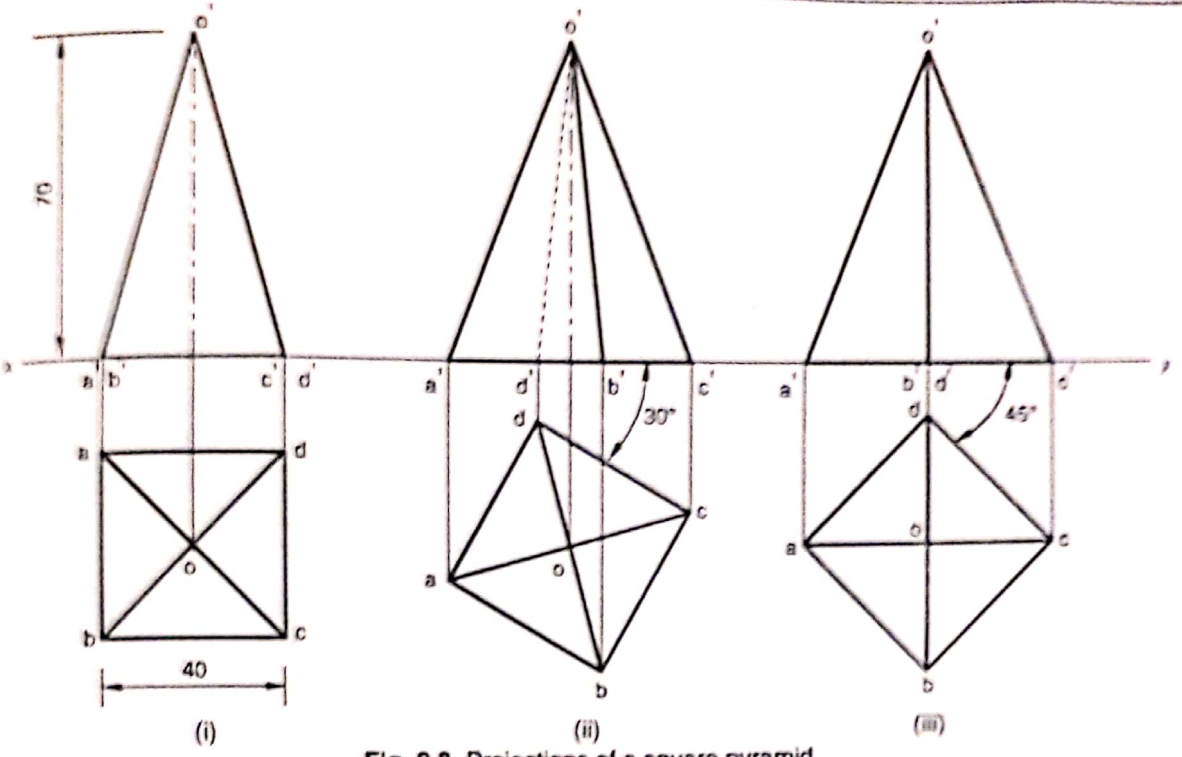


Fig. 9.8. Projections of a square pyramid.

Problem 9.2. A square prism of base side 40 mm and axis 70 mm is resting on its base on the H.P. Draw its projections when (*i*)a face is perpendicular to the V.P. (*ii*) a face is inclined at 30° to the V.P. and (*iii*)all the faces are equally inclined to the V.P.

Solution. A square prism is situated in first quadrant.

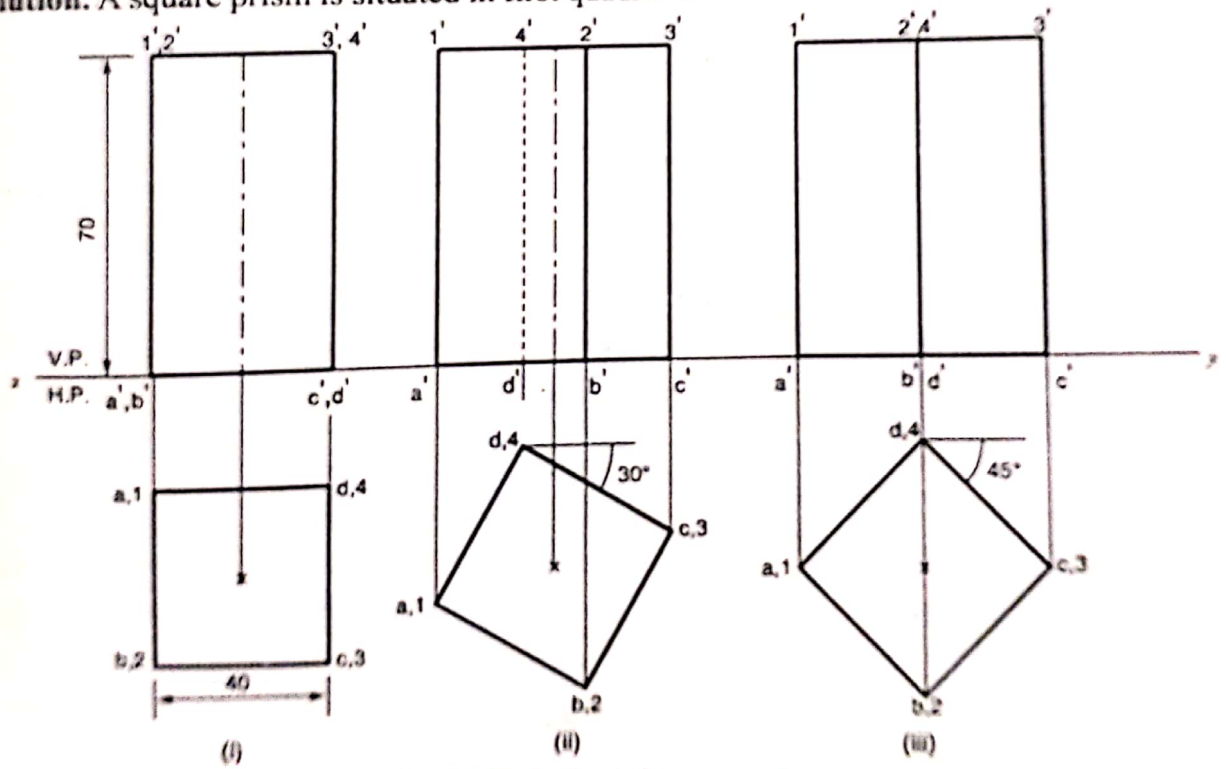


Fig. 9.9. Projections of a square prism.

Problem 9.3. A triangular pyramid, base 50 mm side, axis 70 mm, is resting on its base on H.P. One side of the base is inclined at 15° to V.P. Draw its projections.

Solution. A triangular pyramid is situated in a first quadrant.

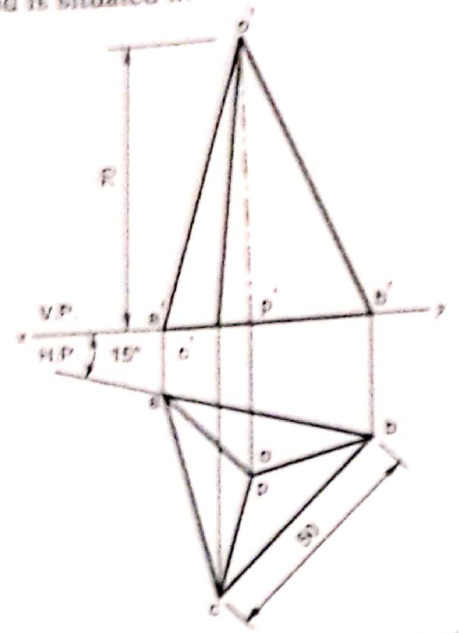


Fig. 9.10. Projections of a triangular pyramid

Problem 9.4. A square prism, base 40 mm, axis 70 mm long, is resting on its base on H.P. One side of the base is inclined, at 60° to V.P. Draw its projections.

Solution. A square prism is situated in a first quadrant.

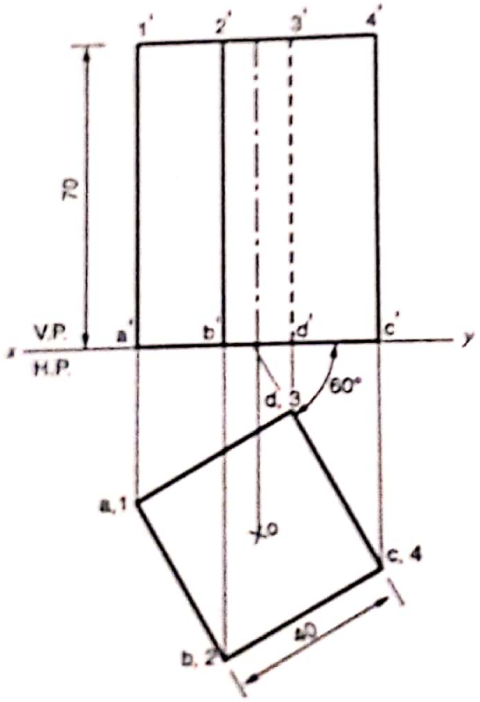


Fig. 9.11. Projections of a square prism.

9.11. AXIS PERPENDICULAR TO THE V.P. AND PARALLEL TO THE H.P.

If the axis of a right solid is perpendicular to the V.P. and parallel to the H.P., the true shape and size of the base can be viewed in the front view. Therefore, first obtain the front view of the

solid and then project it to obtain the top view.

Problem 9.5. A pentagonal prism of base side 30 mm and axis 60 mm has one of its bases in the V.P. Draw its projections when (*i*) a rectangular face is parallel to and 15 mm above the H.P., (*ii*) a face is perpendicular to the H.P., and (*iii*) a face is inclined at 45° to the H.P.

Solution. A pentagonal prism is situated in a first quadrant.

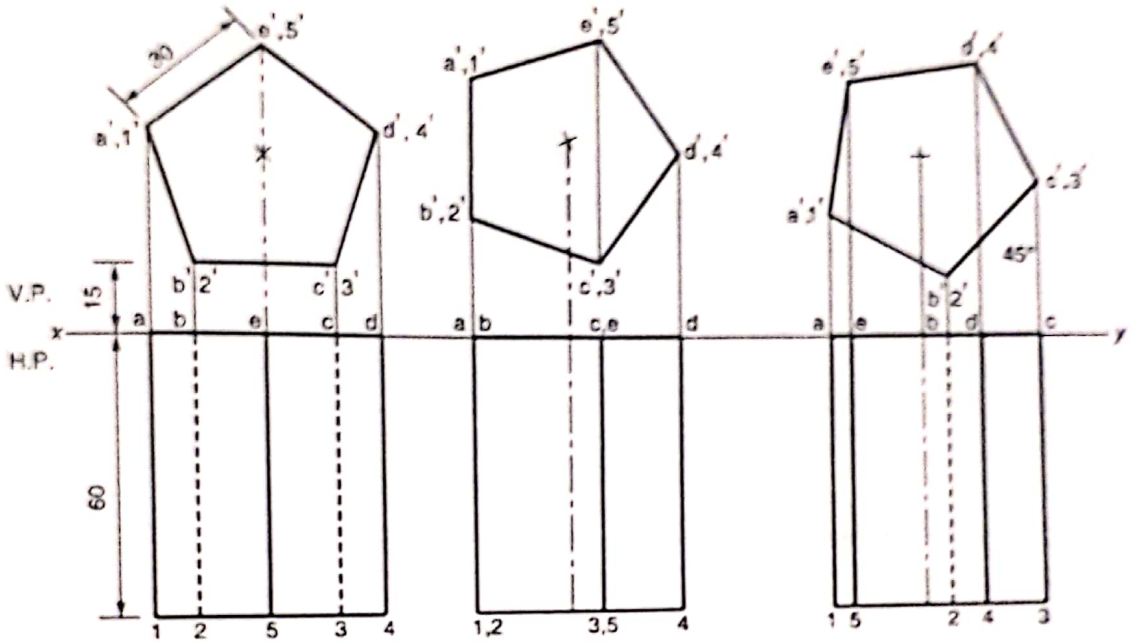


Fig. 9.12. Projections of a pentagonal prism.

Problem 9.6. A triangular pyramid base 50 mm side, axis 70 mm long, resting on one edge of base in H.P. having the axis perpendicular to V.P. Draw its projections when the base is near to the V.P. and 20 mm from it.

Solution. A triangular pyramid is situated in first quadrant.

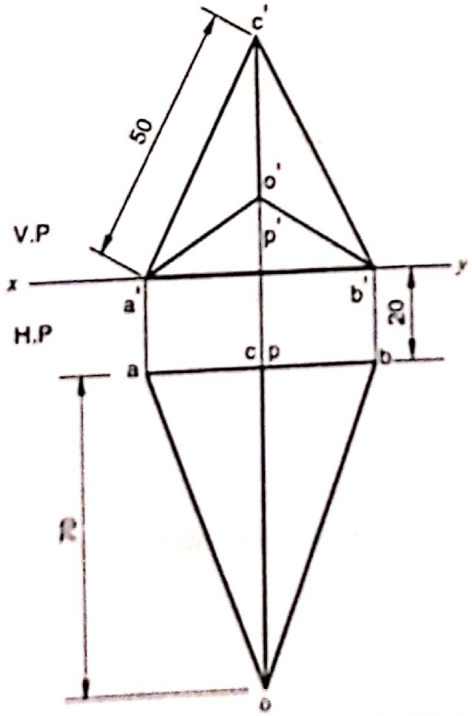


Fig. 9.13. Projections of a triangular pyramid.

9.12. AXIS PARALLEL TO BOTH THE H.P. AND THE V.P. OR PERPENDICULAR TO THE PROFILE PLANE

If the axis of right solids is parallel to both the H.P. and V.P., the base of the solid will perpendicular to the reference planes and parallel to the profile plane. The true shape and size of the base can be viewed on the side view. Therefore, first obtain the side view of the solid and then project it to obtain the front and the top views.

Problem 9.7. A pentagonal prism of base side 40 mm and axis 60 mm is resting on one of its rectangular face on

the H.P. with axis parallel to both the H.P. and the V.P. Draw its projections.

Solution. A pentagonal prism is situated in a first quadrant.

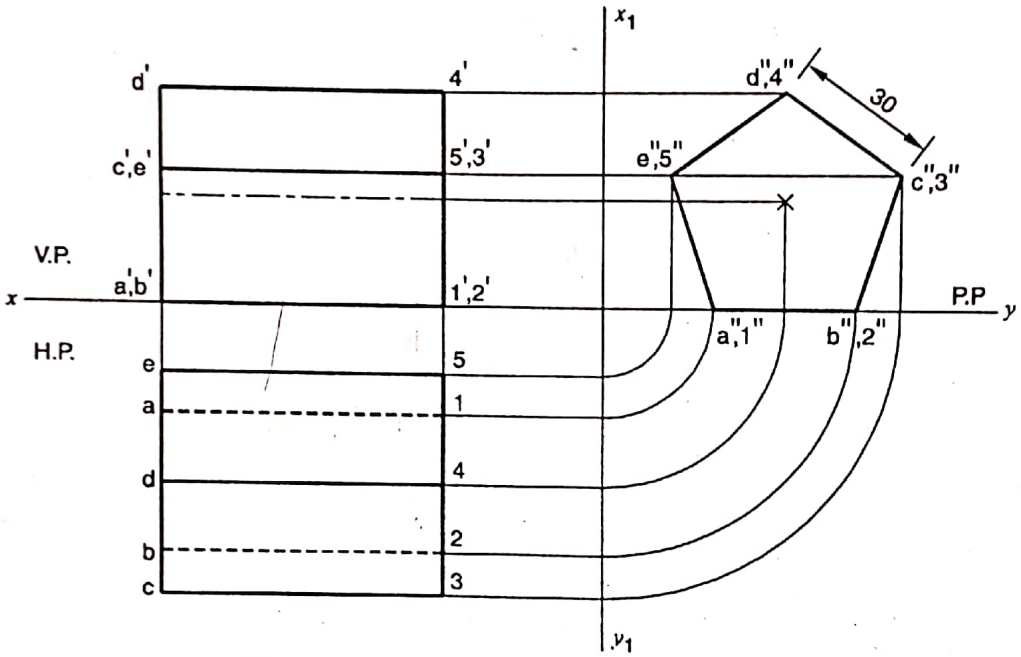


Fig. 9.14. Projections of a pentagonal prism.

9.13. AXIS INCLINED TO H.P. AND PARALLEL TO V.P.

When the axis of a right solid is inclined to the H.P. and parallel to the V.P., then the true shape and size can be viewed in the front view. The projections of this orientation are drawn in two stages.

Problem 9.8. A pentagonal prism of base edge 30 mm and axis 60 mm rests on an edge of its base in the H.P. Its axis is parallel to V.P. and inclined at 45° to the H.P. Draw its projections.

Solution. A pentagonal prism is situated in first quadrant.

Construction explanation :

Stage-I. Draw a pentagon *a*1, *b*2, *c*3, *d*4, *e*5 keeping side *c*3 - *d*4 perpendicular to the reference line *xy*. This represent the top view. Project all the corners and obtain *a'*, *b'*, *e'*, *c'*, *d'* and 1', 2', 5', 3', and 4' to represent the front view.

Stage-II. Reproduce the front view of the stage-I keeping *c'd'* on reference line *xy* and *c'd'*, 3'4' inclined at 45° to it. Obtain $a_1, b_1, c_1, d_1, e_1, 1_1, 2_1, 3_1, 4_1$, and 5_1 in the top view as the intersecting points of the projectors from the front view of the stage-II with the corresponding locus lines

from the top view of the stage-I. Join the outlines $a_1, b_1, b_1 2_1, 2_1 3_1, 3_1 4_1, 4_1 5_1, 1_1 5_1, a_1 1_1, a_1 e_1$ and $e_1 5_1$ using continuous line. Join $e_1 d_1, d_1 c_1, b_1 c_1, c_1 3_1$ and $d_1 4_1$ using dashed lines.

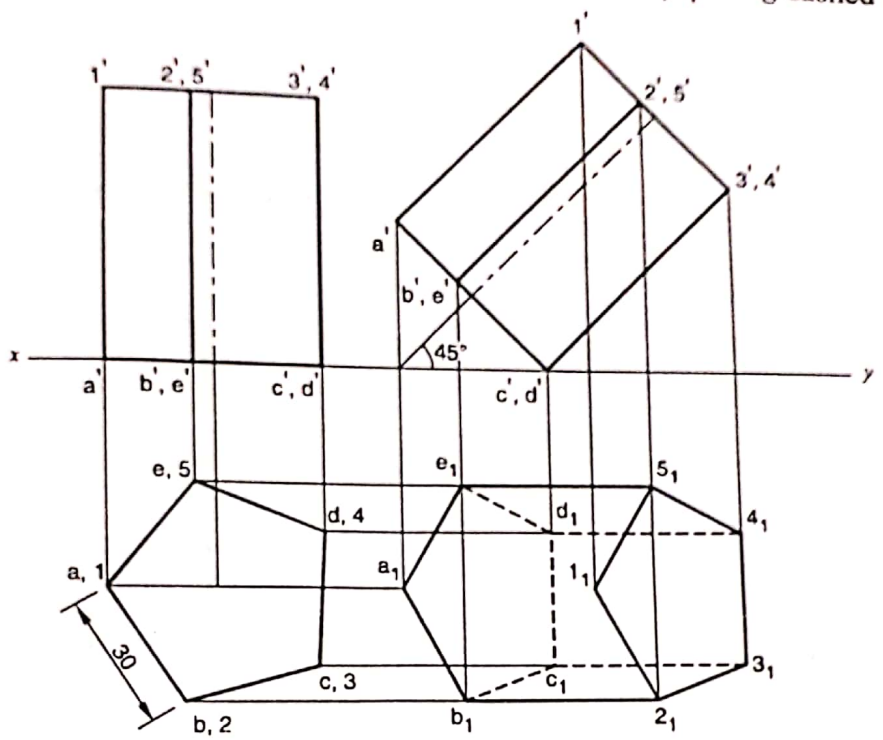


Fig. 9.15. Projection of a pentagonal prism.

Problem 9.9. A hexagonal pyramid of base side 30 mm and axis 60 mm has an edge of its base on the H.P. Its axis is inclined at 30° to the H.P. and parallel to the V.P. Draw its projections.

Solution. A hexagonal pyramid is situated in a first quadrant.

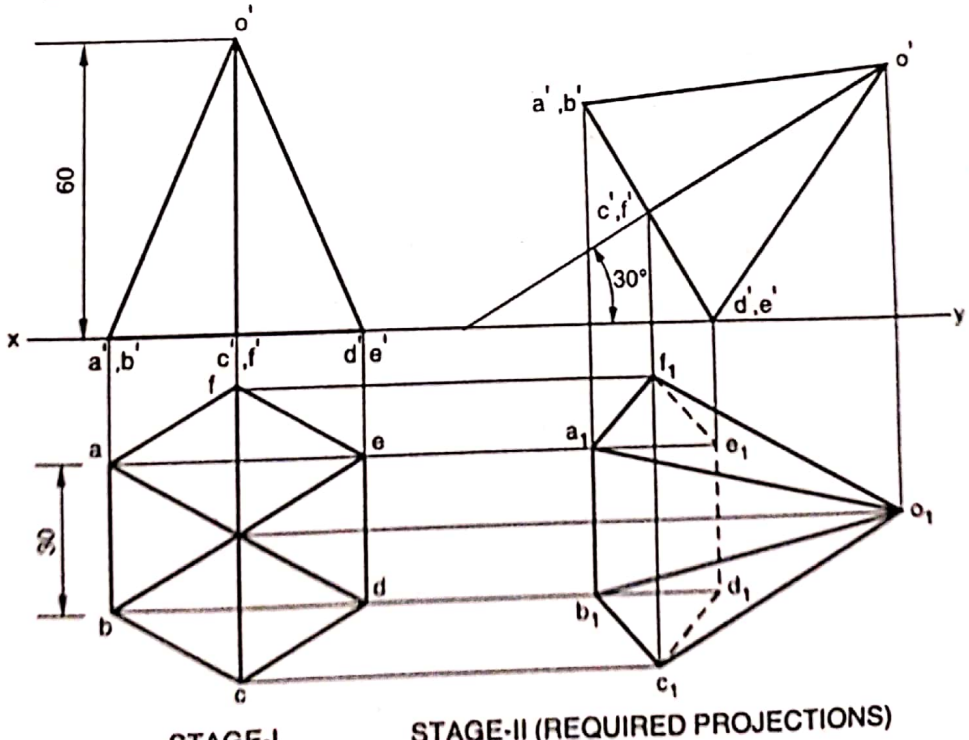
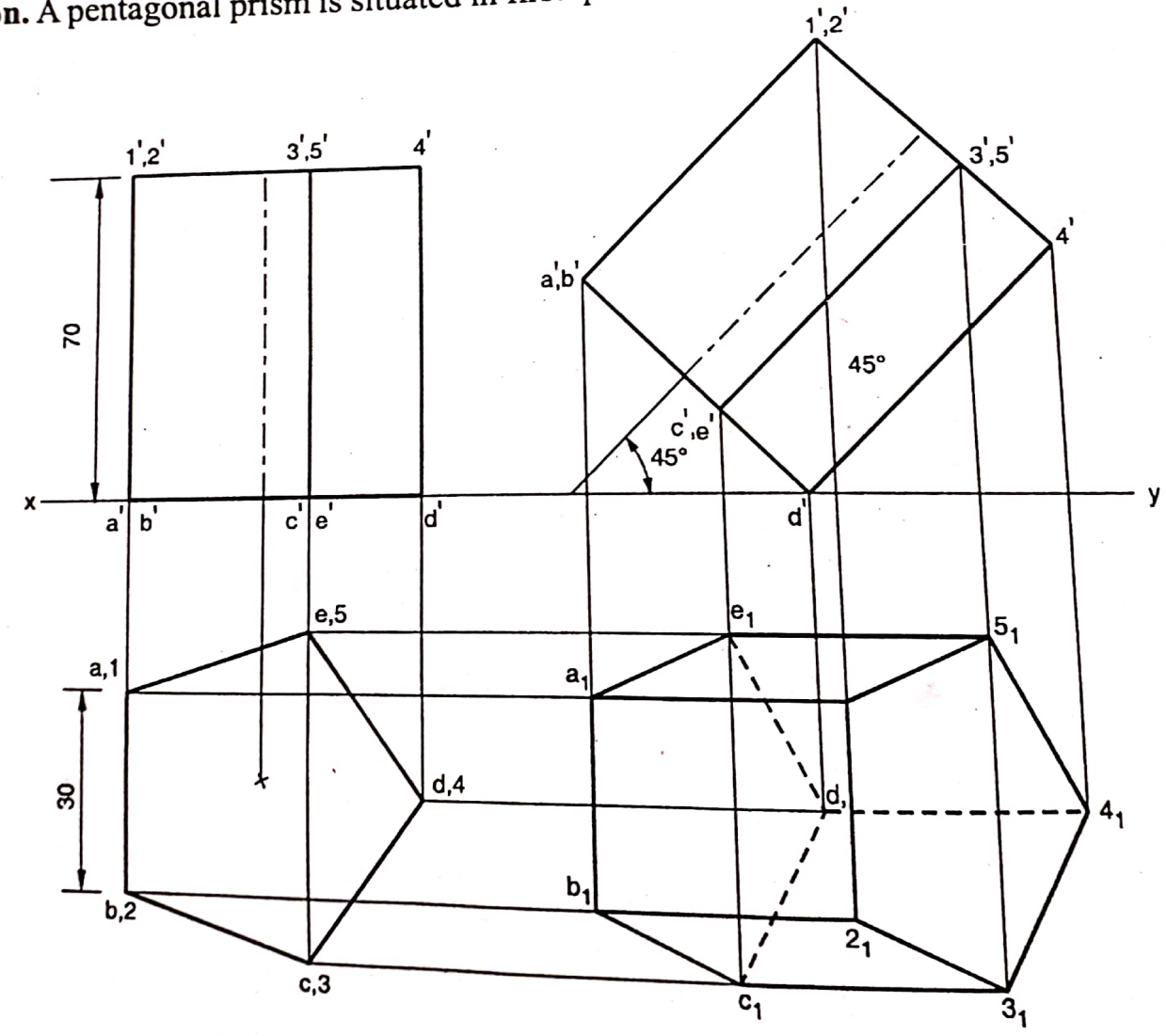


Fig. 9.16. Projections of a hexagonal pyramid.

9-10

Problem 9.10. A pentagonal prism of base side 30 mm and axis 70 mm has a corners on the H.P. and the axis is inclined at 45° to the H.P. Draw its projection when the plane containing the resting corner and the axis is parallel to the V.P.

Solution. A pentagonal prism is situated in first quadrant.



STAGE -I