CHAPTER 1

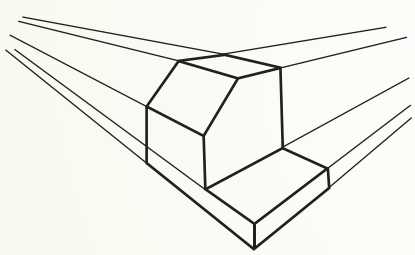
ISOMETRIC PROJECTION

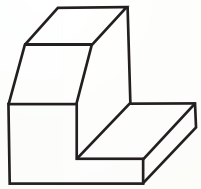
1.1 INTRODUCTION

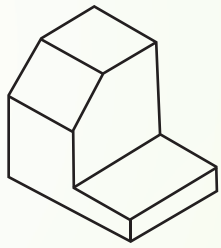
The objects we look, around us, are in 3-Dimensional form. When we try to communicate the structure of objects to others then we take the help of pictures / pictorial drawings. These pictorial drawings are 'one plane' drawings because our mode of communication is paper which has only two dimensions and these drawings show the object approximately as it appears to the viewer.

In engineering, one plane drawings are extensively used in addition to the orthographic views of an object to give the best understanding. So the practice of drawing the objects in one plane, pictorial view, from the orthographic views is essential. There are three methods to draw the pictorial drawings i.e.

1. Perspective Projection
2. Oblique Projection
3. Axonometric Projection







Perspective projection is mostly used by the artists, professional designers and architects to show the views as it appears to the human eye. It appears to converge at a point, called vanishing point. The ***Oblique projection*** is mostly used by the mathematicians and furniture manufacturers. They impart third dimension at an angle to the two dimensional images, to show the depth. The ***Axonometric projection*** differs from the other one plane views on the basis of rotation angle along one or more of its axes relative to the plane of projection. It is extensively used in mechanical engineering to show the blocks, machine parts, assemblies etc. It shows an image of an object from a skew direction.

On the basis of inclination angle of the three principal axes to the plane of projection, the axonometric projection is classified among, isometric projection, diametric projection and trimetric projection.In isometric projection, all the angles between principal axes are equal while in diametric projection, only two angles between three principal axes are equal and over 90°and in trimetric projection, all the three angles are unequal and not less than 90°. As the principal axes are inclined to the plane of projection so the measurement along them are also foreshortened. But the most advantageous point of isometric projection is that it needs a single scale to measure along each of the three axes. So in general, we use only isometric projection in engineering practice.

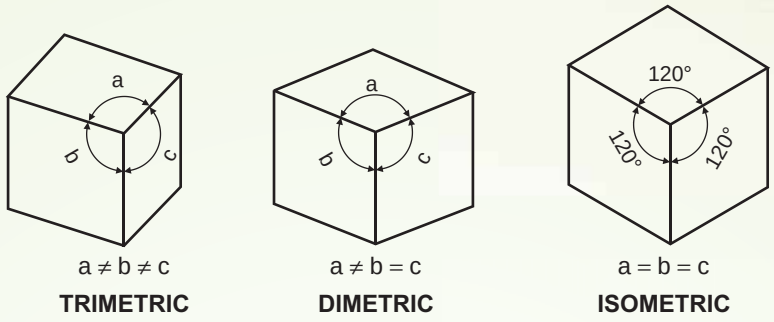
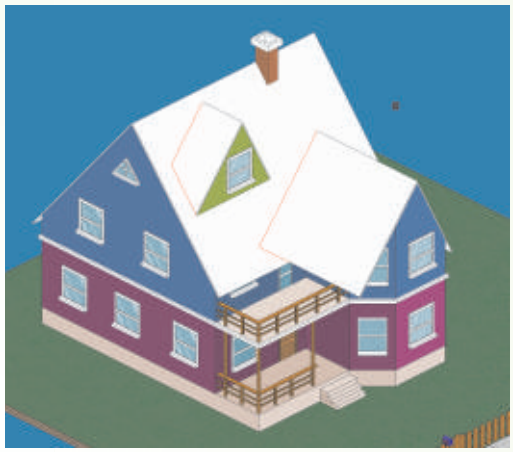


Fig 1.1 Types of Axonometric Projections

1.2 ISOMETRIC PROJECTION



The isometric projection of an object is a one plane view drawn with the object so placed with respect to the plane of projection that all the three principal axes appear to be inclined to each other at an equal angle of 120°.

1.2.1 ISOMETRIC SCALE

The isometric scale is used to measure the foreshortened length of dimensions of any object to draw the isometric projection. The steps of construction of isometric scale are given below ; refer Fig. 1.2

(i) Draw a horizontal line PQ.

(ii) Draw the true lengths on a line PM inclined at 45° to the horizontal line (say up to 70 mm)

(iii) Draw another line PA at 30° to the horizontal line.

(iv) Draw the vertical projection of all the points of true length from PM to PA.

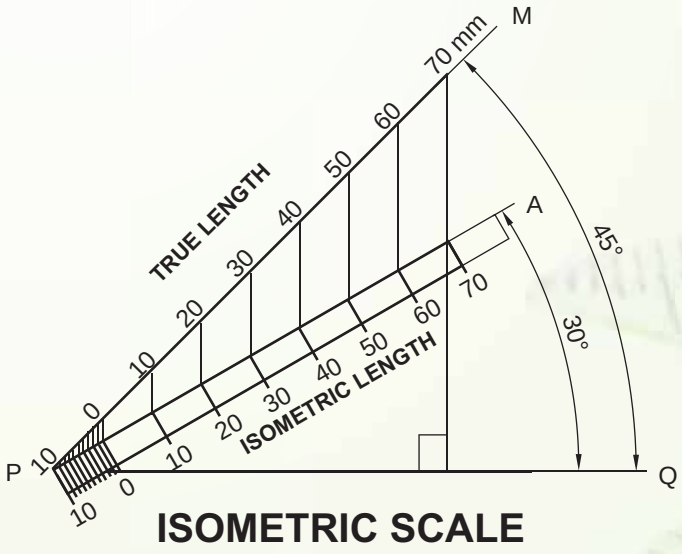


Fig 1.2

(v) Complete the scale with the details as shown in the figure.

The lengths shown at the line PA are the isometric lengths to be used to draw the isometric projection.

1.2.2 POSITIONING OF SOLID

The solids are mostly drawn by placing them as per their specific position with respect to vertical plane (V.P.) and horizontal plane (H.P.), as discussed earlier in orthographic projections. If not specified then they are drawn by placement in such a position which describes the shape of the object in best manner. Here after drawing the isometric projection we can observe the two planes i.e. vertical plane and profile plane on two sides of the object, so to specify the direction of viewing we mark an arrow towards the assumed Front of object as per conditions.

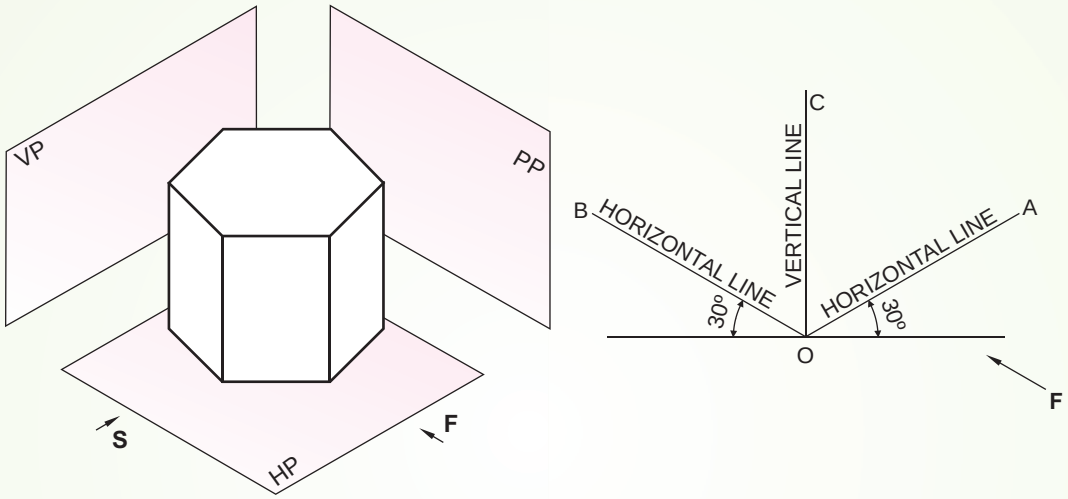


Fig 1.3

1.2.3 STEPS TO DRAW THE ISOMETRIC PROJECTION

1. Draw the base of the solid "with isometric scale" as per specified condition with respect to V.P. and H.P. as per the rules of orthographic projection. It is called Helping Figure.
2. Draw the centre of the helping figure and enclose the helping figure in a suitable rectangle. Transfer the co-ordinates of centre to the sides of the enclosing rectangle with centre lines.
3. Draw the three principal axes at 30°, 90° and 30° to the horizontal base line.
4. Copy the length of sides of helping figure's rectangle on the respective principal axis and the height or length of the object on the third principal axis. It will give a box in which the object will be perfectly/snugly fitted.
5. Copy the co-ordinates of centre and the vertices of the base on this box.
6. Join the visible edges by thick lines and Axis line by the centre line.
7. Complete the isometric projection with dimensioning and direction of viewing.

Now let us draw the isometric projection of regular solids.

1.3 DRAWING OF ISOMETRIC PROJECTION

The isometric projection of different solids is drawn by keeping the three principal axis at 120° to each other. The solids are drawn as per the specified condition with respect to V.P. and H.P. In earlier class we have studied to draw the isometric projection of two dimensional laminae of regular shapes. Here we will study to draw the isometric projection of single regular solids and combination of two solids. As per the characteristics of regular solids, we can classify them as follows:-

(i) Prisms

(ii) Pyramids

(iii) Cylinder and Cone

(iv) Frustum of Pyramids

(v) Sphere and Hemisphere

1.3.1 PRISMS

Prisms are the solids with two bases and rectangular faces. They can be kept horizontal by resting on face or Vertical by resting on base. Let us consider some examples to understand it better.

Example 1: A hexagonal prism of base side 30 mm and height of 70 mm resting on its base on H.P. with two of its base side parallel to V.P.

Solution : Refer Fig. 1.4

Steps (i) Draw the hexagon with isometric length of 30 mm.

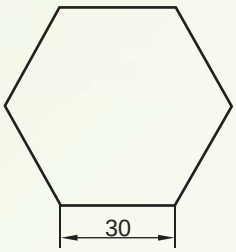
(ii) Complete the helping figure by enclosing hexagon in snugly fitted rectangle and centre lines of hexagon.

(iii) Draw the isometric box with OA length at the side of direction of viewing, OB length at the opposite side and OC equal to 70mm, is length of height of prism on vertical line.

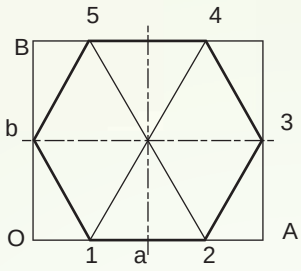
(iv) Copy all the points of hexagon and centre on the box.

(v) Join the visible edges by thick lines and axis by centre lines.

(vi) Complete the isometric projection of hexagonal prism with dimensioning and direction of viewing.

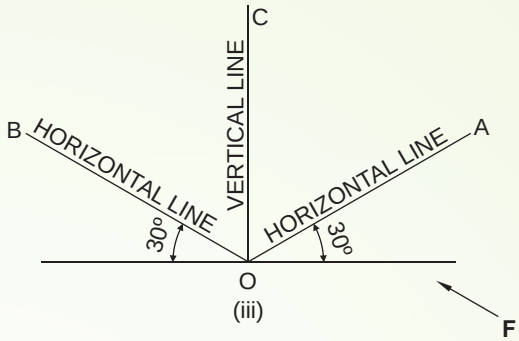


(i)

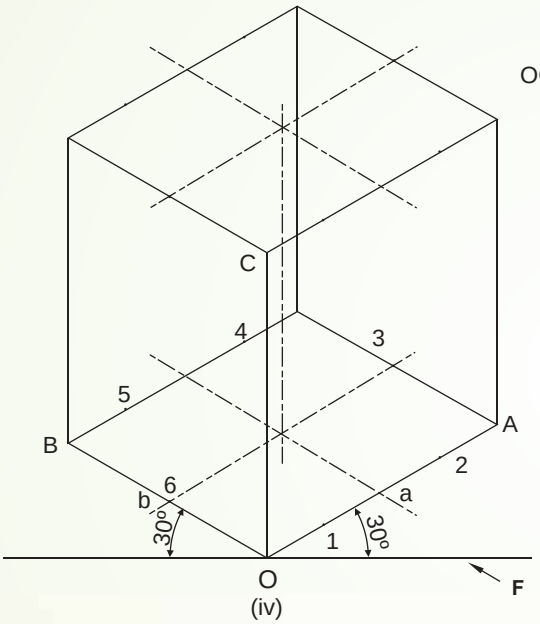


HELPING FIGURE

(ii)

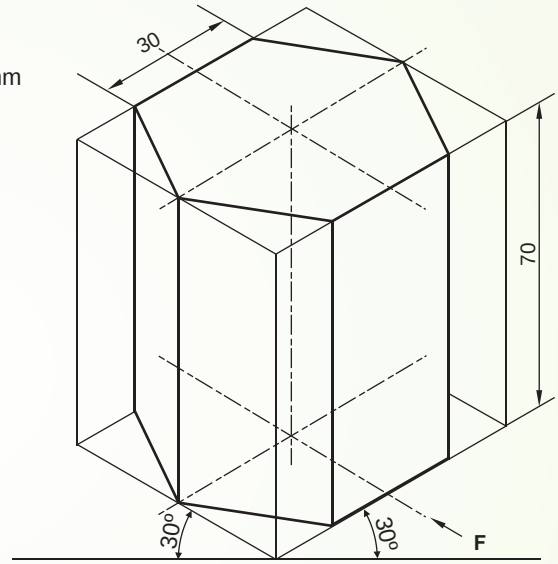


(iii)



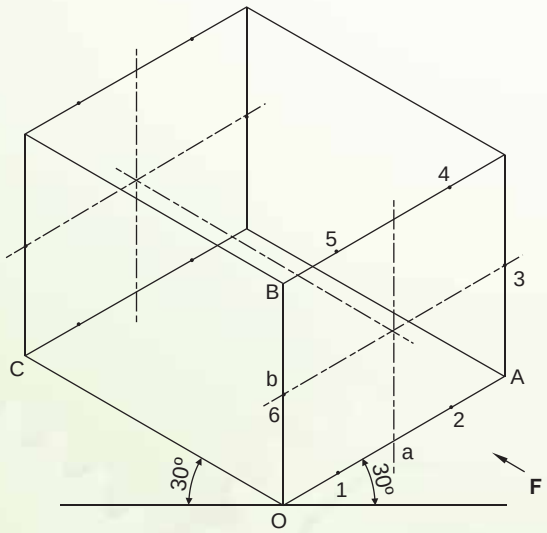
(iv)

OC = ISO 70mm

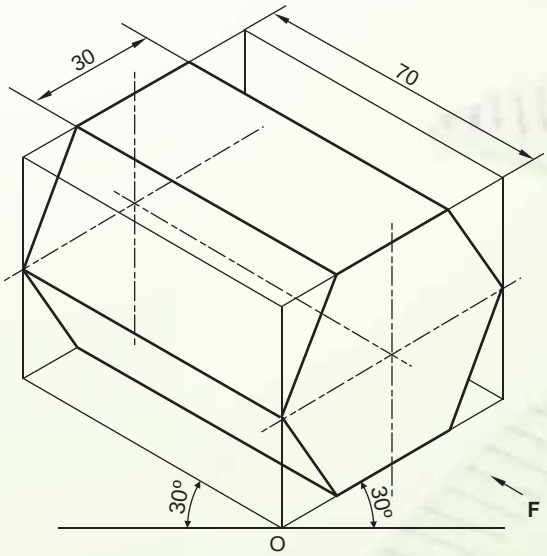


ISOMETRIC PROJECTION

(v)



(v)



ISOMETRIC PROJECTION

(vi)

Fig 1.4

Example 2 : A hexagonal prism of base side 30 mm and height of 70 mm resting on its face on H.P. with two of its bases are parallel to V.P. Then the isometric projection will be drawn as under.

Solution : Refer Fig 1.4

Steps (i) and (ii) will be same as above in example 1.

(iii) Draw the box with OA length at the side of direction of viewing, OB length on the vertical line and OC length equal to isometric length of height of prism on the third principal axis.

(iv), (v) & (vi) will be same as above in example 1.

Let us consider more examples of the prisms with the same steps of construction.

Example 3: Draw the isometric projection of a cube of side 50 mm.

Solution : Refer Fig. 1.5

In cube all the sides have equal length. So take isometric 50 mm on each principal axis and complete the cube with thick lines, dimensioning, center line and direction of viewing.

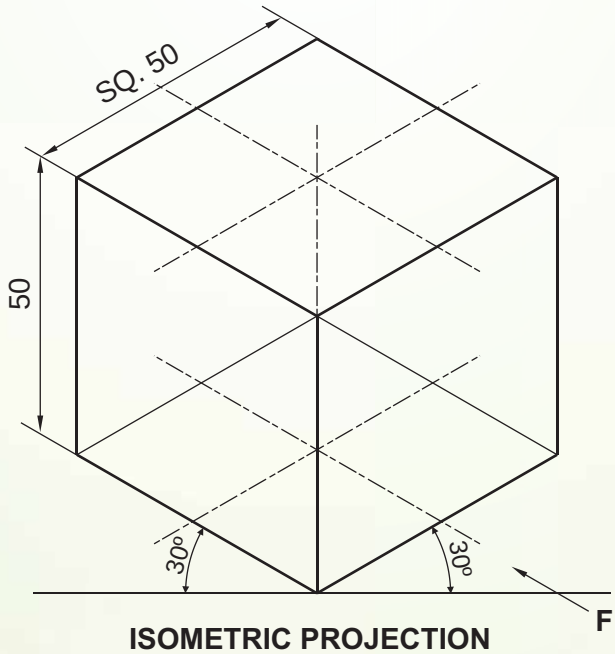


Fig 1.5

Example 4 : Draw the isometric projection of square prism of 40 mm base edge and 60 mm axis resting;

(a) On its base on H.P. keeping one of its base edge parallel to V.P.

(b) On its face on H.P. keeping its base perpendicular to V.P.

Solution : (a) Refer Fig. 1.6 (a)

To draw the isometric projection of a vertical square prism with vertical axis and one base side parallel to V.P. take OA & OB equal to 40 mm on each horizontal line and OC equal to is 60 mm, on vertical line. Complete the isometric projection with thick lines, dimensioning, center lines and direction of viewing.

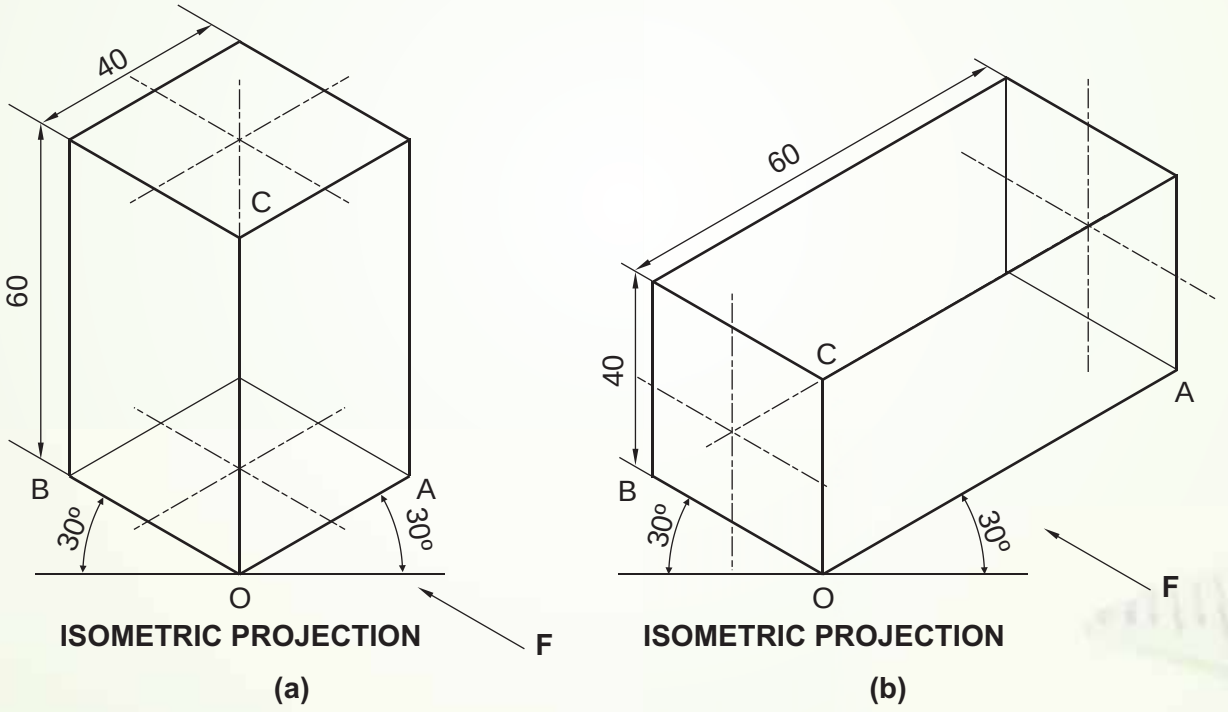


Fig 1.6

(b) Refer fig 1.6(b)

To draw the isometric projection of a square prism with horizontal axis and base perpendicular to V.P. take OB equal to 40 mm on the horizontal line on the side of direction of viewing, OA equal to 60 mm on another horizontal line and OC equal to 40 mm on vertical line. Complete the isometric projection with thick lines, dimensioning, center lines and direction of viewing.

Example 5: Draw the isometric projection of an equilateral triangular prism of 50 mm base side and 75 mm axis resting on its base in H.P. with one of its base edge parallel to V.P. in front.

Solution : Refer Fig 1.7

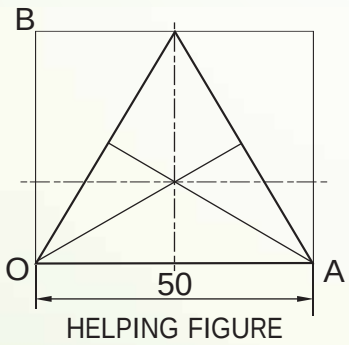
Steps (i) Draw the helping figure of triangle with iso 50 mm length with one of its base edge parallel to V.P. in front.

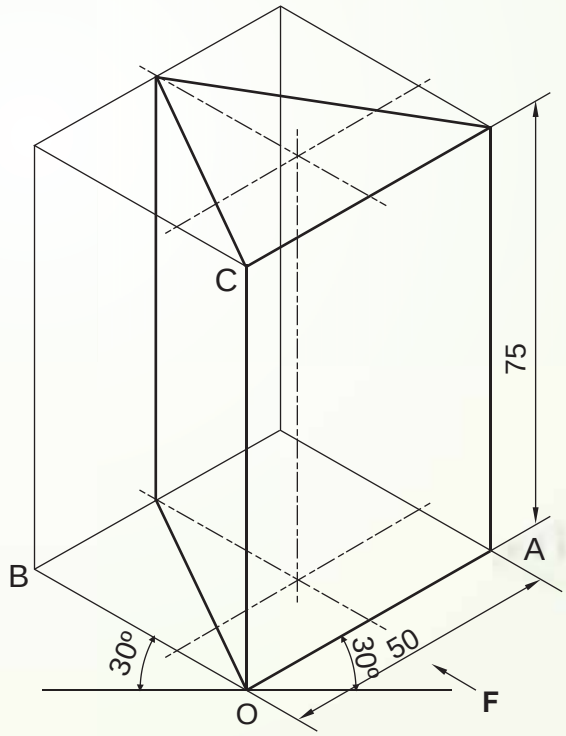
(ii) Draw the isometric box with OA and OB from helping figure and OC equal to isometric 75 mm.

(iii) Copy the points of triangle and co-ordinates of center to isometric box.

(iv) Join the visible edges by thick lines and axis by center lines.

(v) Complete the isometric projection with dimensioning and direction of viewing.





ISOMETRIC PROJECTION
Fig 1.7

Example 6: An equilateral triangular prism of 50 mm base side and 70 mm long resting on one of its face on H.P. with axis of it perpendicular to V.P. Draw its isometric projection.

Solution: Refer Fig. 1.8

Steps (i) Draw the helping figure of triangle with iso 50 mm length with one of its base edge in H.P.

(ii) Draw the isometric box with OA on the horizontal line towards the direction of viewing, OB on the vertical line and OC equal to isometric 70 mm on another horizontal line.

(iii) Copy the points of triangle and co-ordinates of centre to isometric box.

(iv) Join the visible edges by thick lines and axis by centre line.

(v) Complete the isometric projection with dimensioning and direction of viewing.

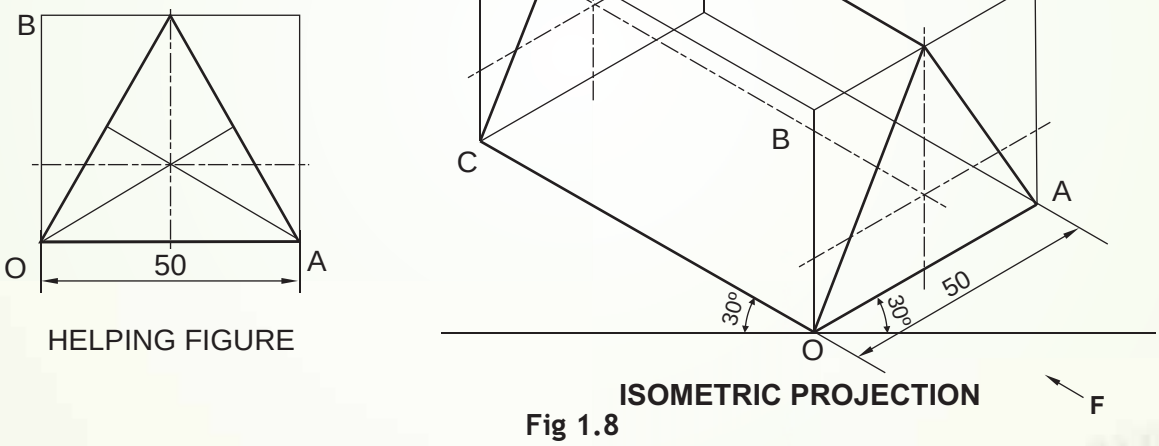


Fig 1.8

Example 7: Draw the isometric projection of a pentagonal prism of 30 mm base side and 65 mm of axis. The axis of the prism is perpendicular to H.P. and one of its base edge is perpendicular to the V.P.

Solution: Refer Fig. 1.9

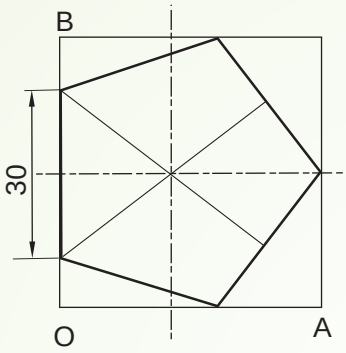
Steps (i) Draw the helping figure of pentagon with iso 30 mm of its base edge perpendicular to V.P.

(ii) Draw the isometric box with OA & OB from helping figure and OC equal to iso 65 mm.

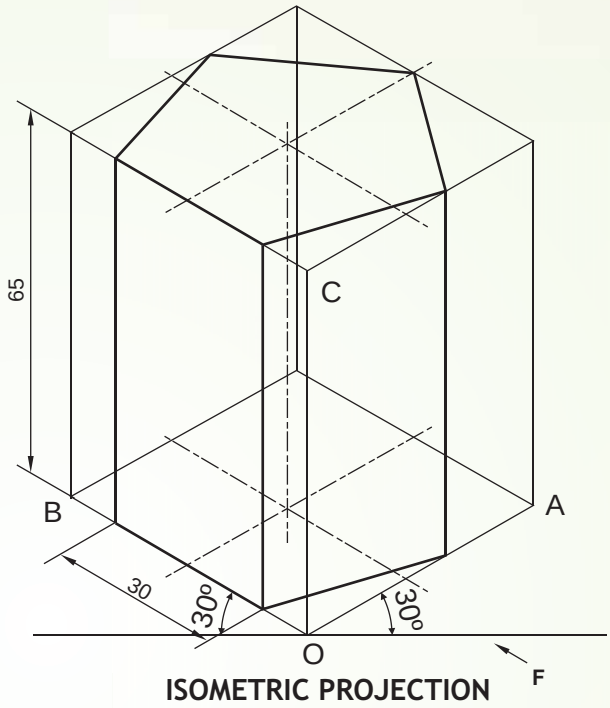
(iii) Copy the points of pentagon and co-ordinates of centre to isometric box.

(iv) Join the visible edges by thick lines and axis by center line.

(v) Complete the isometric projection with dimensioning and direction of viewing.



HELPING FIGURE

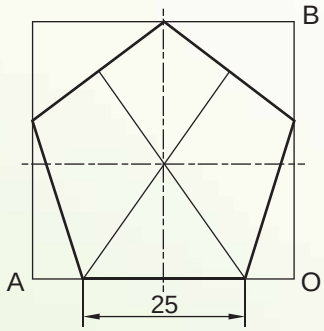


ISOMETRIC PROJECTION

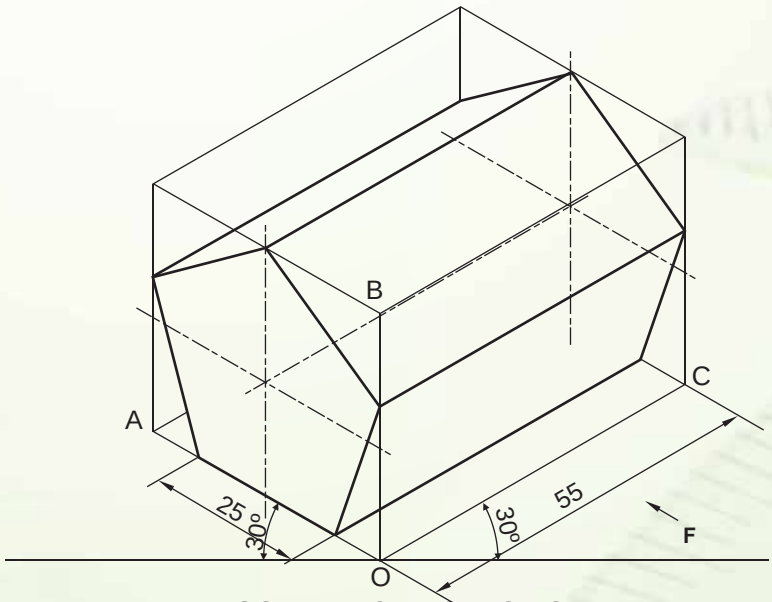
Fig 1.9

Example 8: A Pentagonal prism of base side of 25 mm and axis length of 55 mm is resting on its face with its axis parallel to both H.P and V.P. Draw its isometric projection.

Solution: Refer fig 1.10



HELPING FIGURE



ISOMETRIC PROJECTION

Fig 1.10

Steps (i) Draw the helping figure of pentagon with iso 25 mm length as one of its base edge in H.P.

(ii) Draw the isometric box with OA on the horizontal line parallel to the direction of viewing, OB on the vertical line and OC equal to iso 55 mm on another horizontal line.

(iii) Complete the isometric projection of pentagonal prism in this isometric box by the same step discussed in earlier examples.

1.3.2 PYRAMIDS

Pyramids are the solids with a base and slant triangular faces. These faces meet at a point called apex of the pyramid. In pyramids if they are kept on their base then they are called upright / vertical pyramids but if they are kept on their vertex on H.P. then they are called inverted pyramids.

Let us draw some examples.

Example 9:

Draw the isometric projection of a pentagonal pyramid of base side 30 mm and axis of 60 mm resting on its base on H.P. with one of its base side parallel to V.P. and nearer to the observer.

Solution : Refer Fig. 1.11

Steps (i) Draw the pentagon with iso 30 mm and one of its base edge parallel to V.P. and nearer to the observer.

(ii) Complete the helping view figure by enclosing rectangle and center lines of pentagon.

(iii) Copy the dimensions of helping figure i.e. OA and OB on the horizontal line as shown and draw the center lines of Pentagon in it.

(iv) Draw the vertical axis in upright position from the center of pentagon equal to iso 60 mm.

(v) Join the visible edges, starting from the vertex to base corners by thick lines.

(vi) Complete the isometric projection of pentagonal pyramid with direction of viewing and dimensioning.

Example 10: Draw the isometric projection of an inverted pentagonal pyramid of base side 30 mm and axis of 60 mm resting on its base on H.P. with one of its base side parallel to V.P. and nearer to the observer.

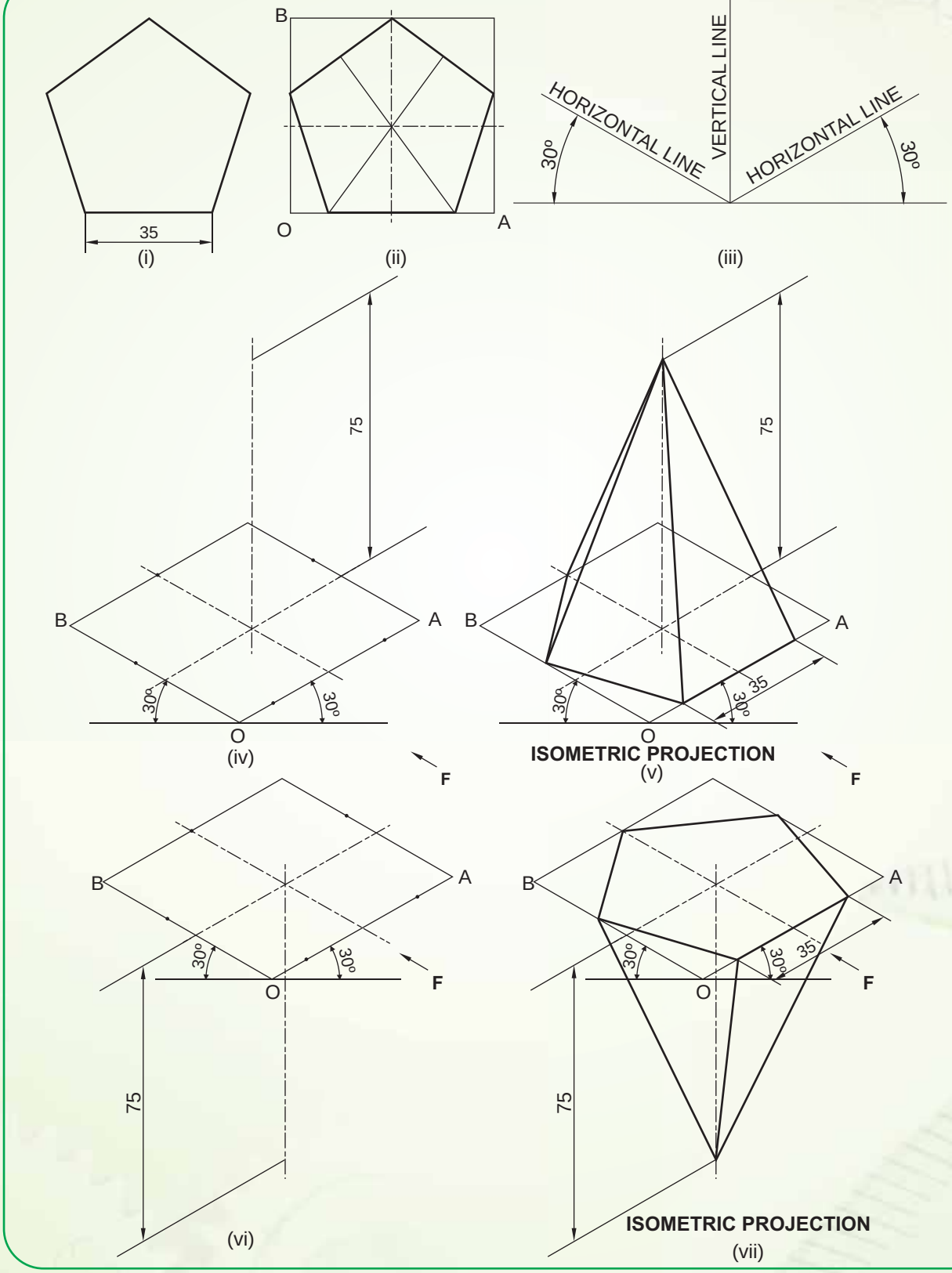

35
(i)
B
O
A
(ii)
HORIZONTAL LINE
VERTICAL LINE
HORIZONTAL LINE
30°
30°
(iii)
75
B
A
30°
30°
O
(iv)
F
75
B
A
30°
35
30°
O
ISOMETRIC PROJECTION
(v)
F
B
A
30°
30°
O
F
75
(vi)
B
A
30°
35
30°
O
F
75
ISOMETRIC PROJECTION
(vii)

Fig. 1.11

Solution : Refer Fig. 1.11

Steps (i) to (iii) will be same as above.

(iv) Draw the vertical axis in downward direction from the center of pentagon equal to iso 60 mm.

(v) & (vi) will be same.

Example 11: Draw the isometric projection of a square pyramid of base edge 50 mm and axial height of 80 mm kept in inverted position with two of its base side parallel to V.P.

Solution : Refer Fig 1.12

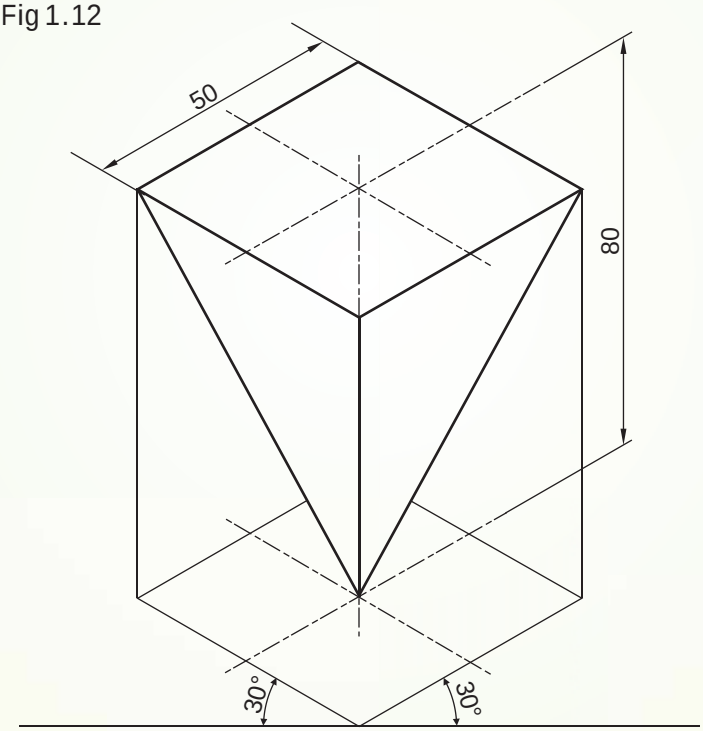
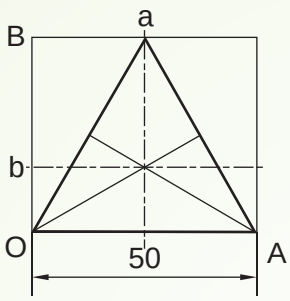


Fig 1.12

Example12: A right triangular pyramid of base edge 50 mm and axial height of 80 mm is kept on its base keeping one of its base side parallel to V.P. and away from it. Draw its isometric projection.

Solution: Refer Fig. 1.13



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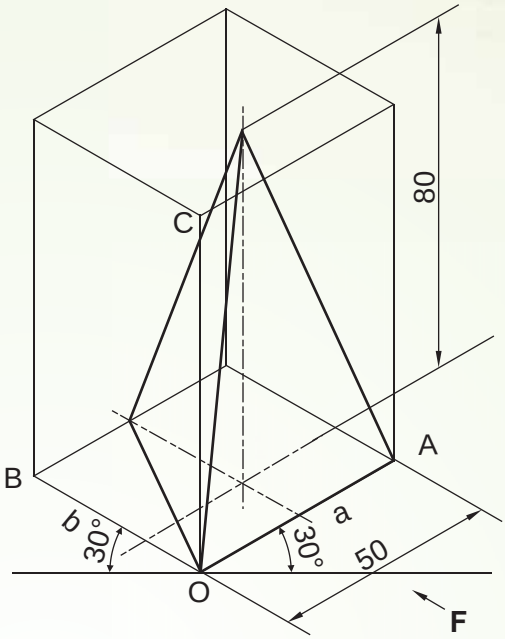
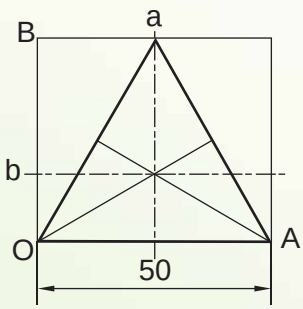


ISOMETRIC PROJECTION

Fig 1.13

Example:13: Draw the isometric projection of an inverted triangular pyramid of base side 50 mm and axis of 80 mm keeping one of its base side parallel to V.P. and nearer the observer.

Solution : Refer Fig. 1.14



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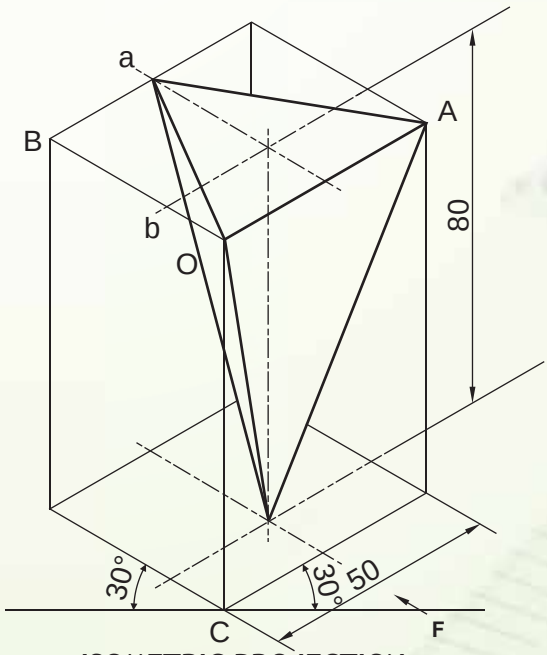
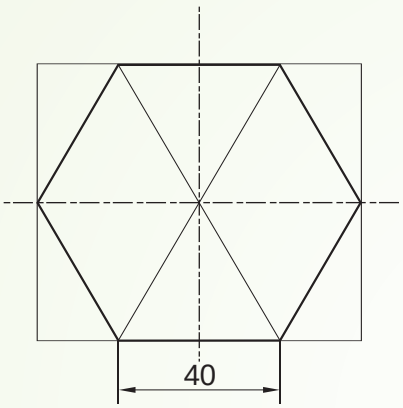


ISOMETRIC PROJECTION

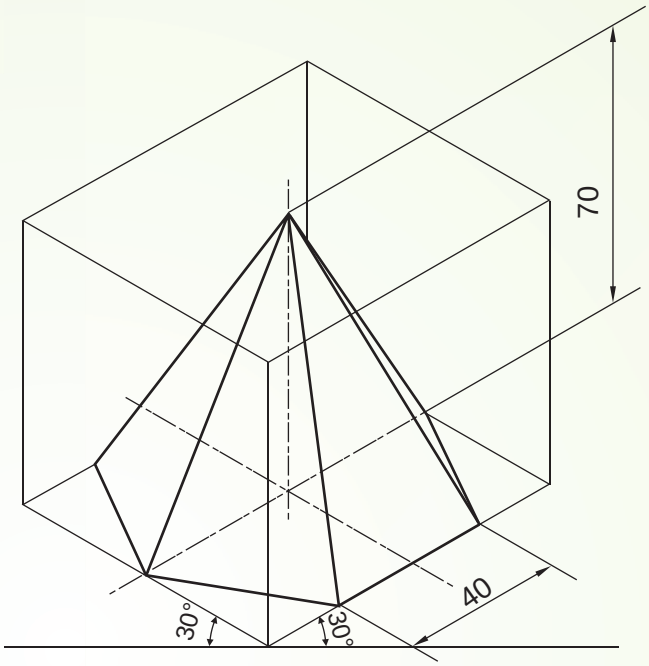
Fig 1.14

Example 14: Draw the isometric projection of a hexagonal pyramid having base edge of 40 mm and axis 70 mm resting on its base keeping two of its base side parallel to the V.P.

Solution: Refer Fig. 1.15



HELPING FIGURE

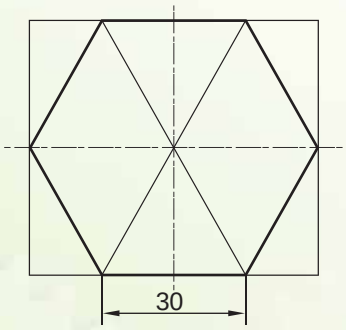


ISOMETRIC PROJECTION

Fig 1.15

Example 15 : Draw the isometric projection of an inverted hexagonal pyramid of base edge 30 mm and height of 60 mm keeping two of its base side parallel to the V.P.

Solution: Refer Fig. 1.16



HELPING FIGURE

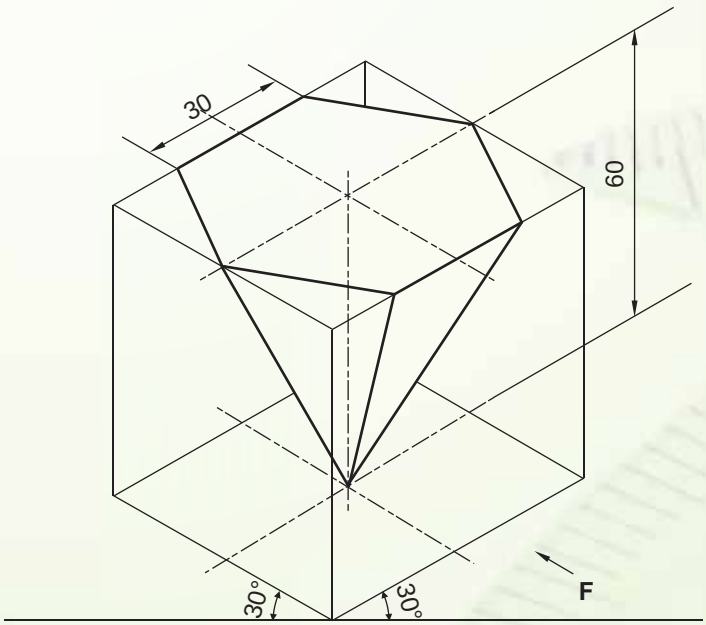


Fig 1.16 ISOMETRIC PROJECTION

1.3.3 FRUSTUM OF PYRAMID

We are well aware about the frustum of pyramids that they are the truncated lower portion of the pyramid. So frustum of pyramid is having one shorter base edge end and another longer base edge end. To draw the isometric projection of the frustum of pyramid, we have to draw the helping views for both the ends.

Let us draw some examples.

Example 16 : Draw the isometric projection of a frustum of square pyramid of shorter base edge 30 mm and longer base edge 50 mm with the axial height of 60 mm, kept on H.P. on its longer end and two of its base edges are parallel to V.P.

Solution : Refer Fig 1.17

Steps (i) Draw the helping figures of both the base ends with iso 30 mm and iso 50 mm.

(ii) Complete the helping figures by enclosing rectangle and centre lines.

(iii) Draw the isometric box with OA length on the side of direction of viewing, OB length on the another horizontal line and OC equal to iso 60 mm, height of frustum of pyramid on vertical line.

(iv) Draw the center lines on the upper end of the isometric box and mark centre as M.

(v) Copy the lengths of helping figures of shorter end 'oa' and 'ob' by placing 'm' on 'M'.

(vi) Mark all the points of shorter end helping figure on the upper end of isometric box and all the points of longer end helping figure on the lower end of isometric box.

(vii) Join the visible edges by thick lines and axis by center line.

(viii) Complete the isometric projection of frustum of square pyramid with dimensioning and direction of viewing.

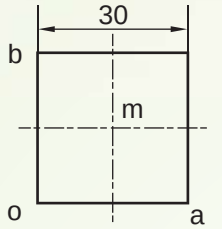
Example 17 : Draw the isometric projection of a frustum of square pyramid of shorter base edge 30 mm and longer base edge 50 mm with the axial height of 60 mm, kept on H.P. on its shorter end and two of its base edges are parallel to V.P.

Solution: Refer Fig 1.17

Steps (i) to (iii) will be same as above.

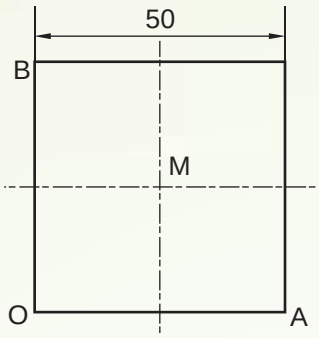
(iv) Draw the center lines of the lower end of the isometric box as the shorter end of the given frustum of pyramid is at lower end and mark center as M.

(v) to (viii) will be same as above.



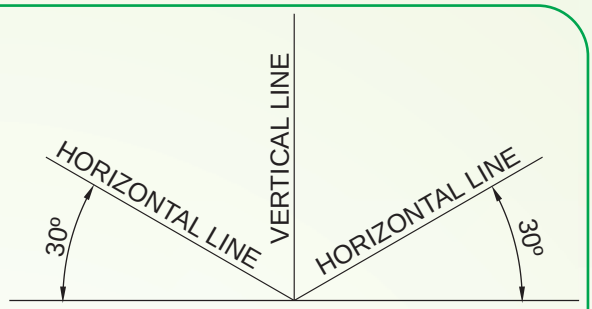
HELPING FIGURE

(i)

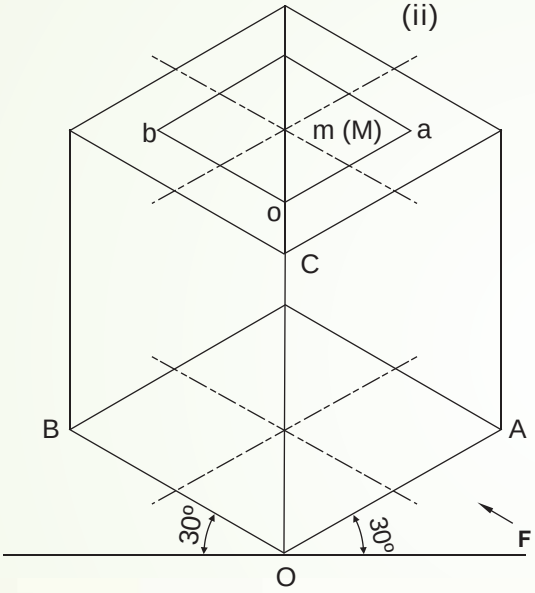


HELPING FIGURE

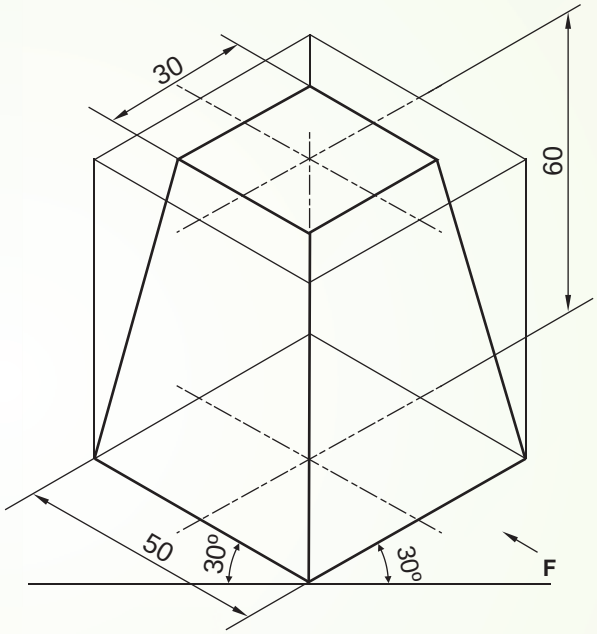
(ii)



(iii)

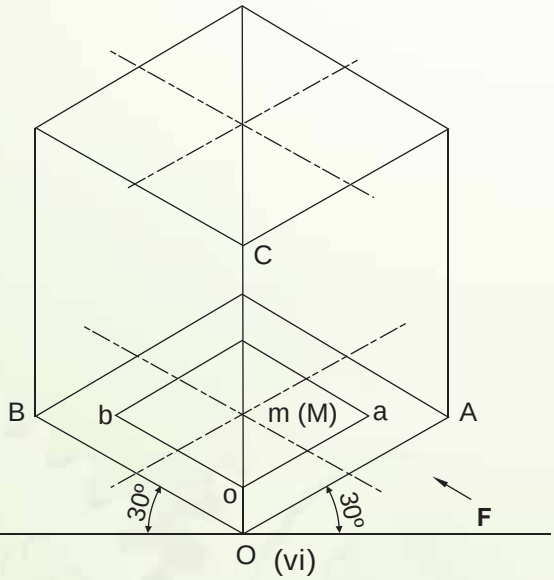


(iv)

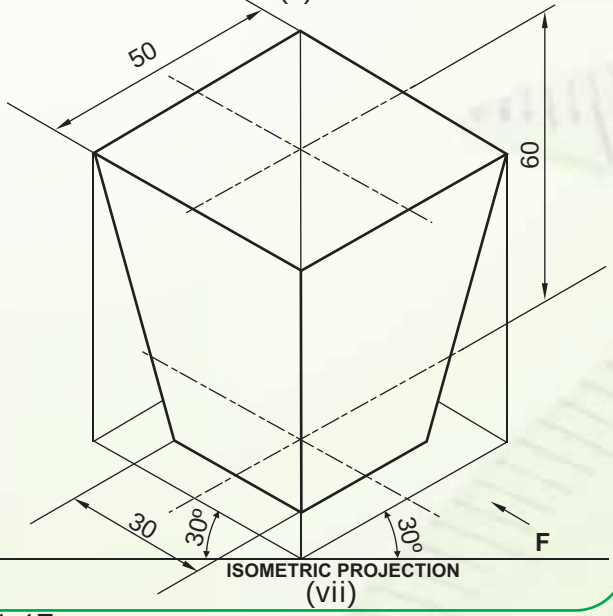


ISOMETRIC PROJECTION

(v)



(vi)



ISOMETRIC PROJECTION

(vii)

Fig 1.17

Example 18 : Draw the isometric projection of the frustum of triangular pyramid having top base edge 40 mm and bottom base edge 50 mm with a height of 75 mm resting on its longer base keeping one of its base side parallel to the V.P. and nearer to the observer.

Solution: Refer Fig 1.18

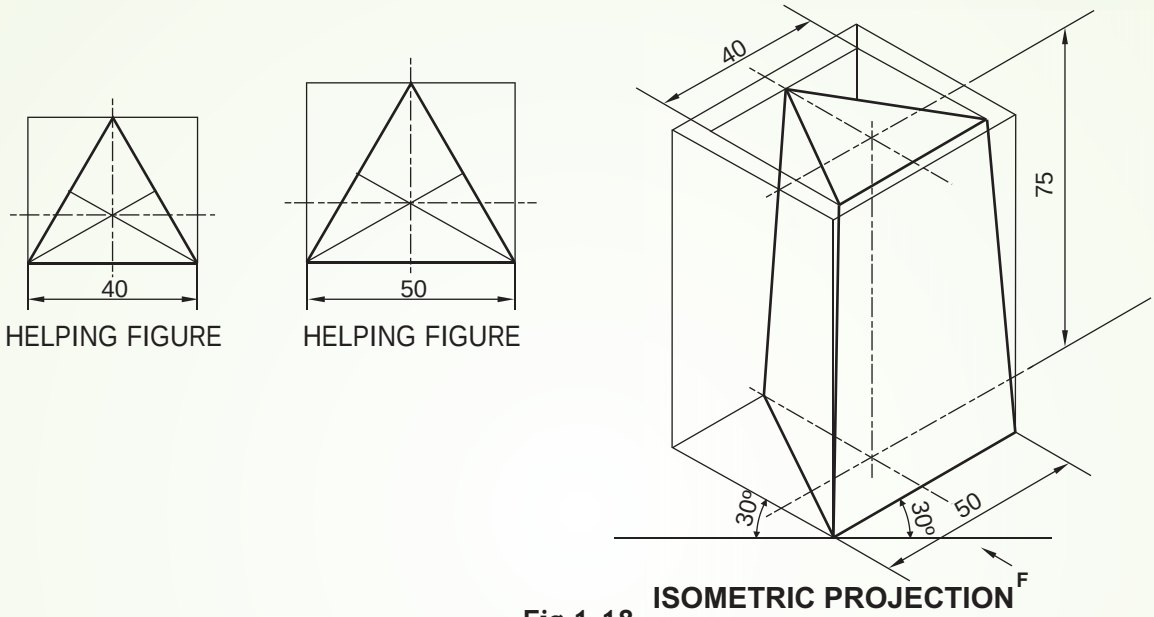


Fig 1.18

Example 19 : A frustum of an inverted hexagonal pyramid of shorter base side 20 mm and longer base side 40 mm and axial height of 65 mm resting on its shorter end on H.P. with two of its base sides perpendicular to the V.P. Draw its isometric projection.

Solution: Refer Fig 1.19

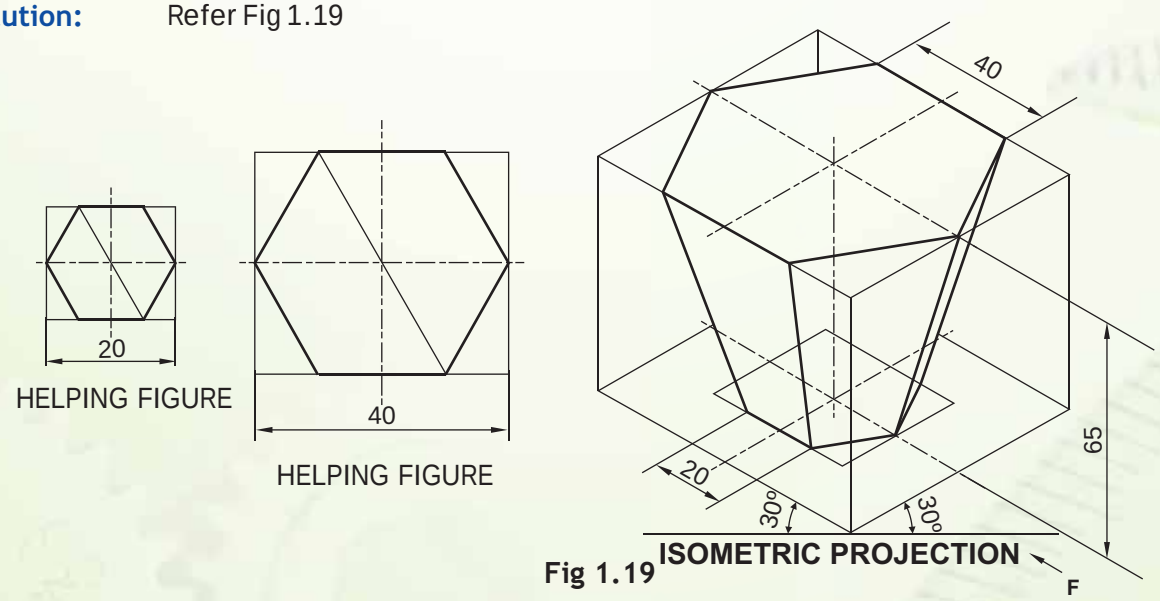


Fig 1.19

Example 20 : Draw the isometric projection of frustum of pentagonal pyramid having longer base side 40 mm and shorter base side 30 mm with axis of 70 mm resting on its longer side base keeping one of its base side parallel to the V.P. and nearer to the observer.

Solution : Refer Fig. 1.20

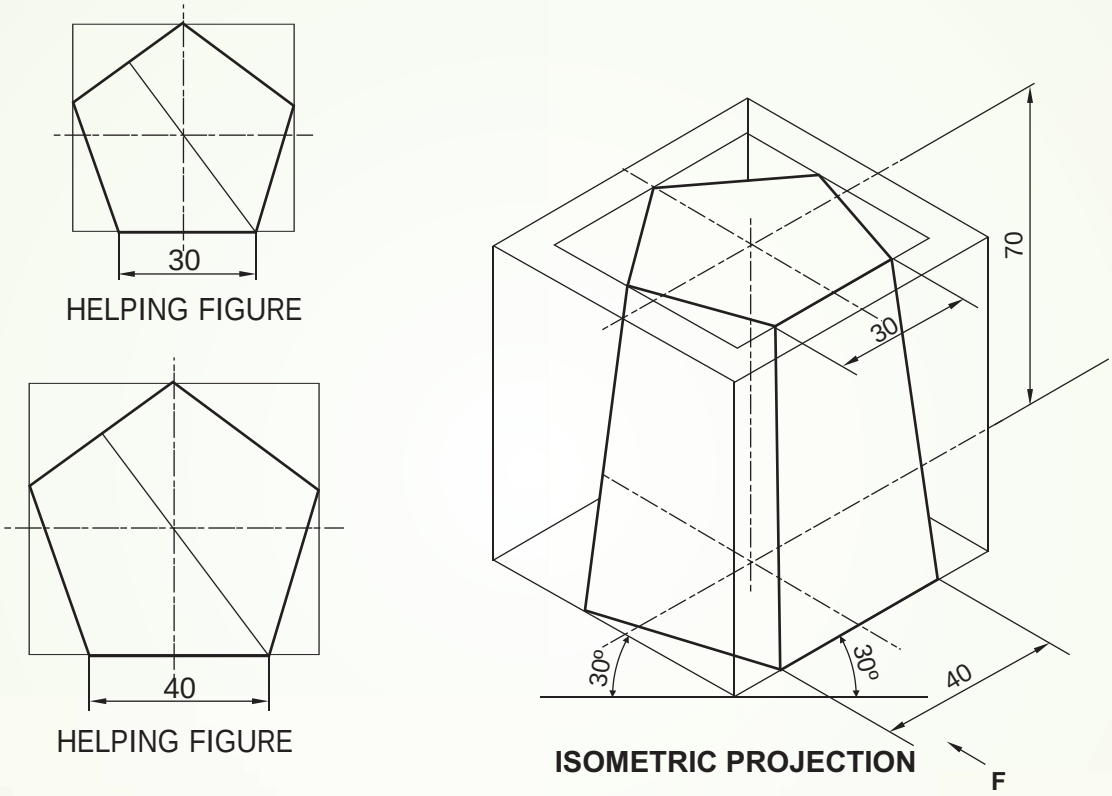


Fig 1.20

1.3.4 CYLINDER AND CONE

Cylinder and cone are the solids in which base is a circle. In our earlier class we have studied that the circle is drawn in isometric projection by different methods. We can use the "four centre method" or "circular arc method" to draw the circle in isometric projection. The cylinders and cones are drawn with the same steps of prism and pyramids except one additional step for drawing the circle.

Let us draw some examples.

Example 21: Draw the isometric projection of a cylinder of diameter 40 mm and axial length of 70 mm lying on the H.P. keeping its axis parallel to H.P. and V.P. both.

Solution: Refer Fig 1.21

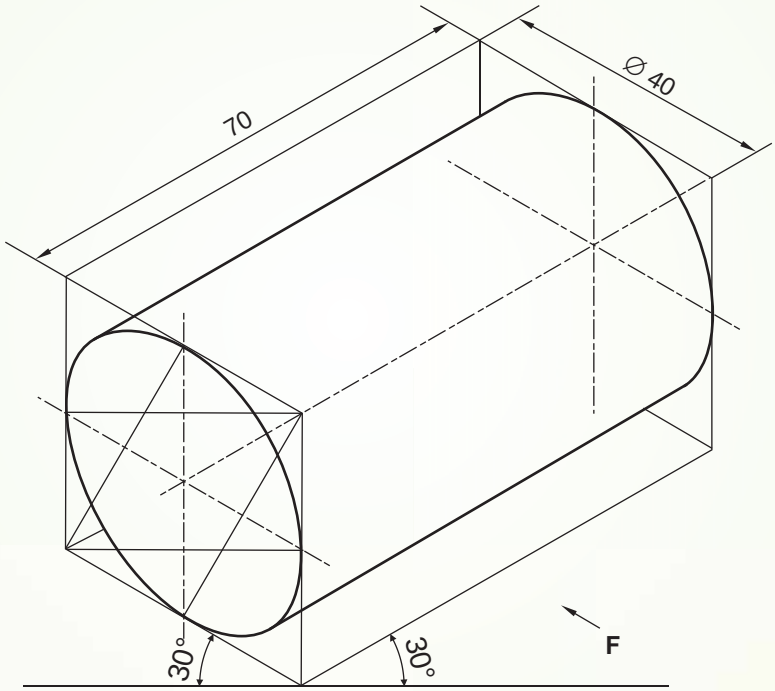
Steps (i) Draw the isometric box of a square prism of 40 mm base side and 70 mm axis by keeping the axis parallel to both H.P. and V.P.

(ii) In the two rhombuses draw the ellipse by four center method.

(iii) Draw two common tangents to the two ellipses.

(iv) Draw the visible lines and curves by thick lines.

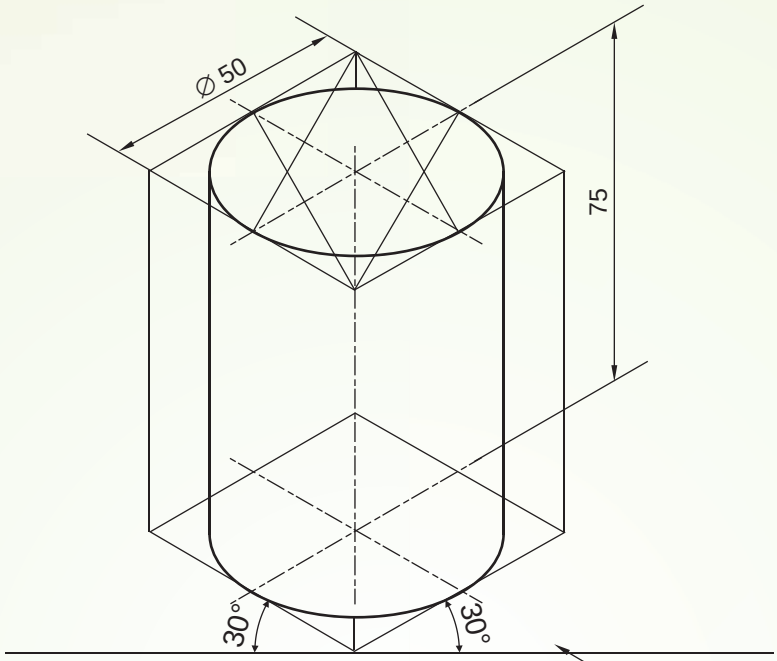
(v) Complete the isometric projection of cylinder with dimensioning and direction of viewing.



ISOMETRIC PROJECTION
Fig 1.21

Example 22 : Draw the isometric projection of a cylinder of height of 75 mm and diameter of 50 mm resting on its base keeping the axis parallel to V.P.

Solution: Refer Fig 1.22

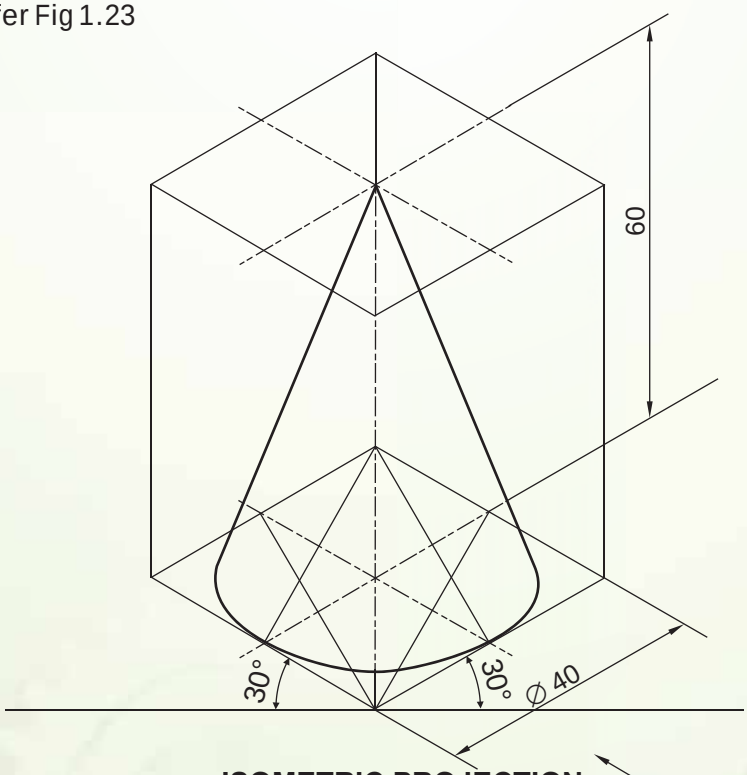


ISOMETRIC PROJECTION

Fig 1.22

Example 23 : Draw the isometric projection of cone of diameter 40 mm and axis of 60 mm resting on its base perpendicular to H.P.

Solution : Refer Fig 1.23



ISOMETRIC PROJECTION

Fig 1.23

Example24 : Draw the isometric projection of an inverted cone of diameter 50 mm and axis of 80 mm keeping its axis perpendicular to H.P.

Solution: Refer Fig 1.24

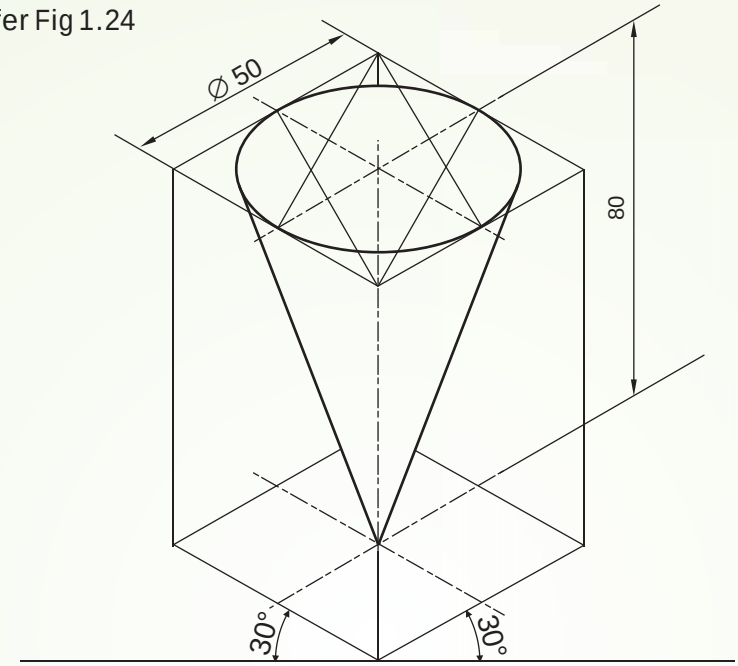


Fig 1.24

Example 25 : Draw the isometric projection of a frustum of a cone of diameter 30 mm at smaller end, diameter 50 mm at bigger end and the axial height is 70 mm. It is resting on its bigger end on H.P. keeping its axis vertical.

Solution: Refer Fig 1.25

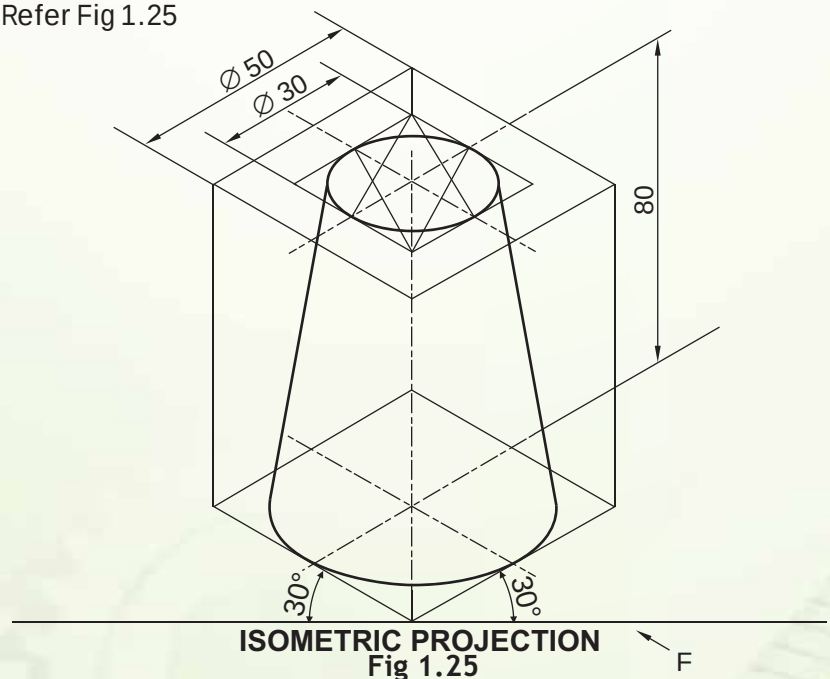


Fig 1.25

1.3.5 SPHERES AND HEMISPHERES

Spheres are the solids without any edge or vertex. When they are visualized from any direction they look like a circle. Due to this unique characteristic of sphere, they have only one point of contact with the plane of rest. This point of contact will not be visible in isometric projection of sphere.

Let us draw some examples.

Example 26 : Draw the isometric projection of a sphere of diameter 50 mm.

Solution : Refer Fig. 1.26

Steps (i) Draw isometric projection of square in horizontal plane with side of iso 50 mm length.

(ii) Draw the center lines of this square.

(iii) Take a point O in vertically upward direction equal to iso 25 mm i.e. Isometric length of radius of spheres from the center of the square drawn in step 2.

(iv) Taking this point O as a center and true 25 mm as the radius, draw a circle.

(v) This drawn circle is the isometric projection of the given sphere.

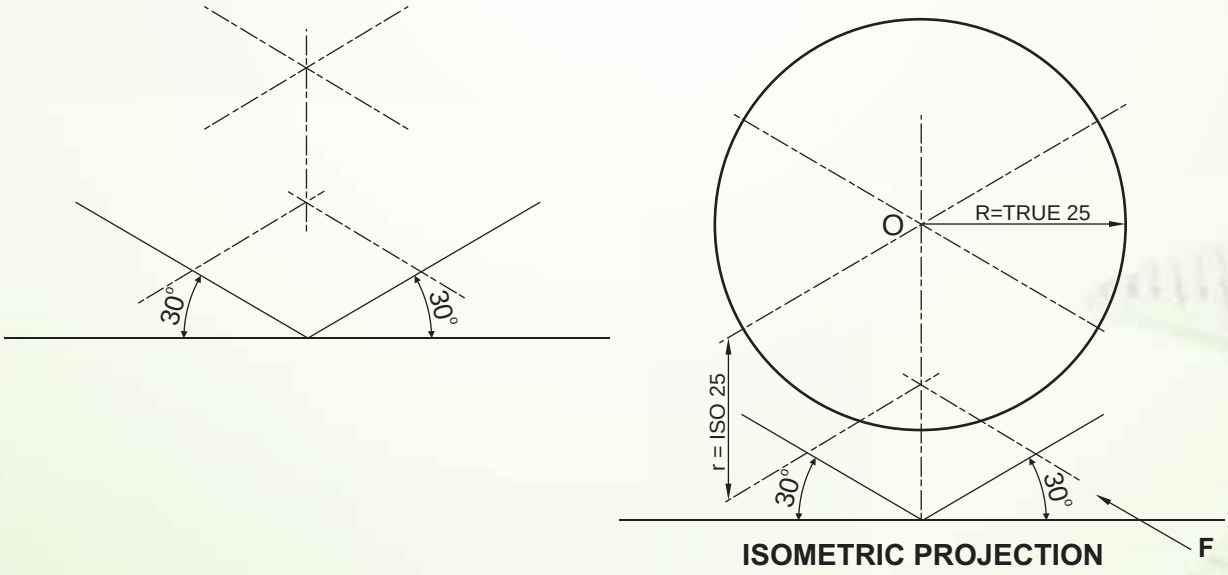


Fig 1.26

Note: Isometric view of a sphere is always a circle of true-radius whose centre is obtained with isometric radius height.

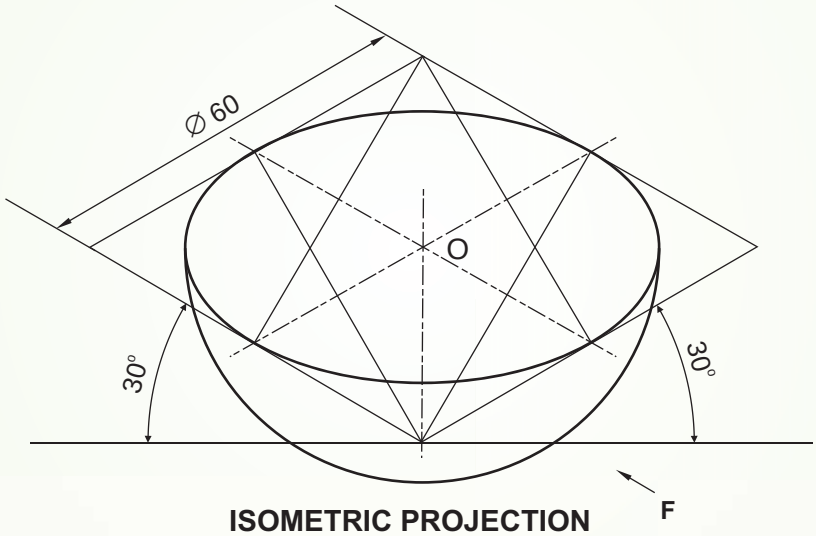
Example 27 : Draw the isometric projection of a hemisphere of 60 mm diameter resting on its curved surface on H.P.

Solution: Refer Fig 1.27

Steps (i) Draw the isometric projection of a circle of 60 mm diameter ie. ellipse by four center method in H.P. (as learnt in class XI).

(ii) Draw an arc with O as center and half of the major axis of ellipse as radius towards lower half of the ellipse.

(iii) Complete the hemisphere with dimensioning, center lines and direction of viewing. Using conventional lines.



ISOMETRIC PROJECTION
Fig 1.27

EXERCISE

1. Draw an isometric projection of a triangular prism having base edge of 65 mm and axial height of 85 mm, resting on one of its rectangular faces on H.P. keeping its base perpendicular to V.P.

2. Draw an isometric projection of a pentagonal prism of base side of 35 mm and axial length of 60 mm kept on one of its face on H.P. with one rectangular face parallel to H.P. on top and axis is perpendicular to V.P.

3. A square pyramid is resting on its base, having base edge 60 mm and axial height of 70 mm with its base edge parallel to V.P. Draw its isometric projection.

4. Draw an isometric projection of a hexagonal pyramid having base edge 35 mm and axis of 65 mm resting on its base on H.P. Keep two of its base side perpendicular to V.P.

5. Draw an isometric projection of a frustum of hexagonal pyramid of shorter base side of 25 mm and longer base side of 45 mm and height of 75 mm resting on its larger base on H.P. with two of its base sides parallel to V.P.

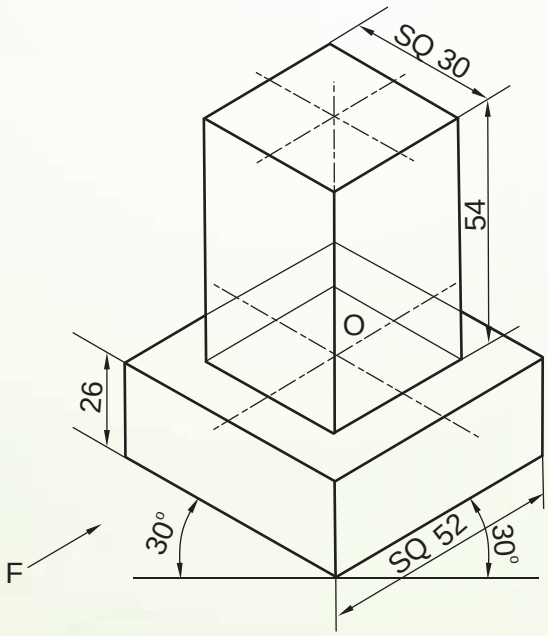
6. Draw an isometric projection of a hemisphere of 50 mm diameter kept with circular face on H.P.

1.4 COMBINATION OF TWO SOLIDS

We have already studied and learnt the isometric projection of single geometrical solids in vertical position and horizontal position by using box method from the helping view of the solid. Now we will learn the two geometrical solids placed together i.e. one resting (either vertical or horizontal) on top of the other solid in isometric position (either vertical or horizontal). This is known as 'combination of solids'. As per the course content in our syllabus we are going to restrict our combination using two solids only.

The study of the combination of solids will help us in understanding the machine blocks to be done in isometric position and assembly drawings of the functional machine components at a later stage in Engineering Graphics.

Example : 1.21 Draw an Isometric Projection of a square prism having side of the square = 30 mm and height = 54 mm standing (upright) and centrally on a flat square slab of thickness = 26 mm and its base side = 52 mm.



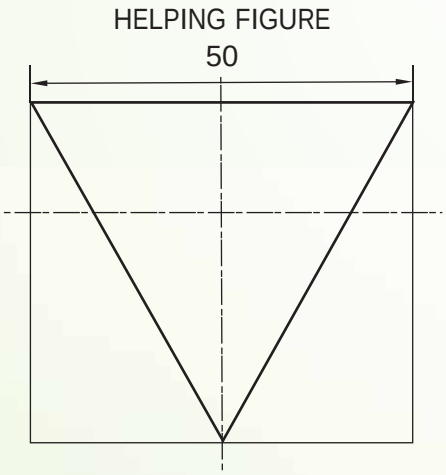
ISOMETRIC PROJECTION

Fig 1.28

Steps:

1. Draw an isometric projection of the square slab.
2. Indicate the center of the top face with centre lines.
3. Around the centre 'O' draw the rhombus of the square prism and lift it upto its required height.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using convention lines.

Example: 1.22 Draw an Isometric Projection of 32 mm cube resting centrally on the top face of an equilateral triangular prism having 50 mm base side and height = 30 mm. One rectangular face of the prism is away from the observer and kept parallel to the V.P.



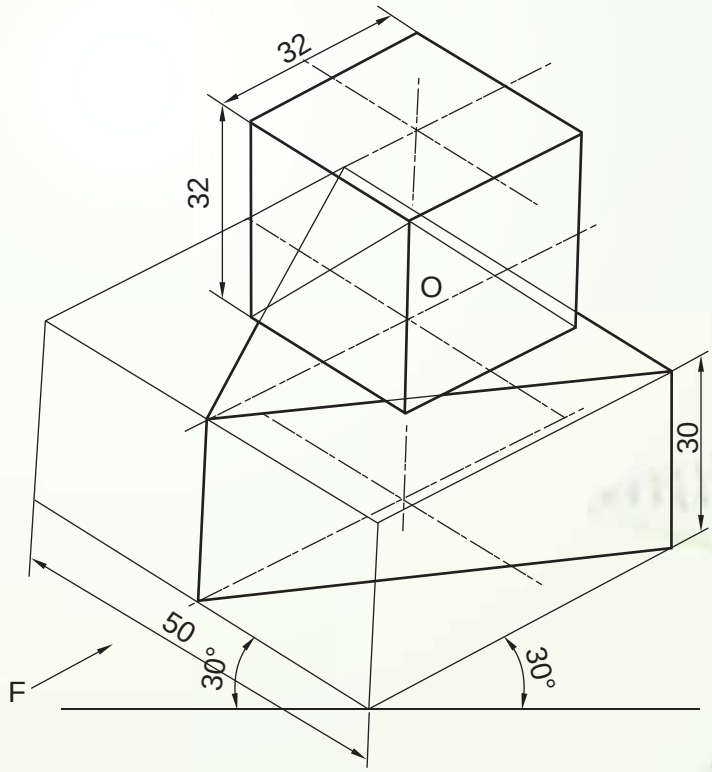
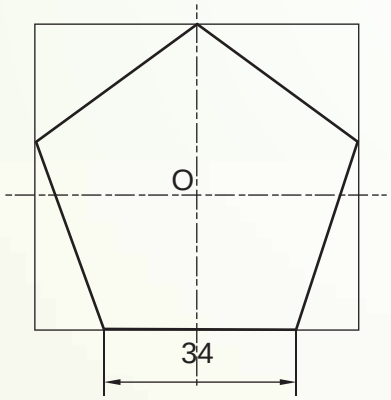


Fig 1.29

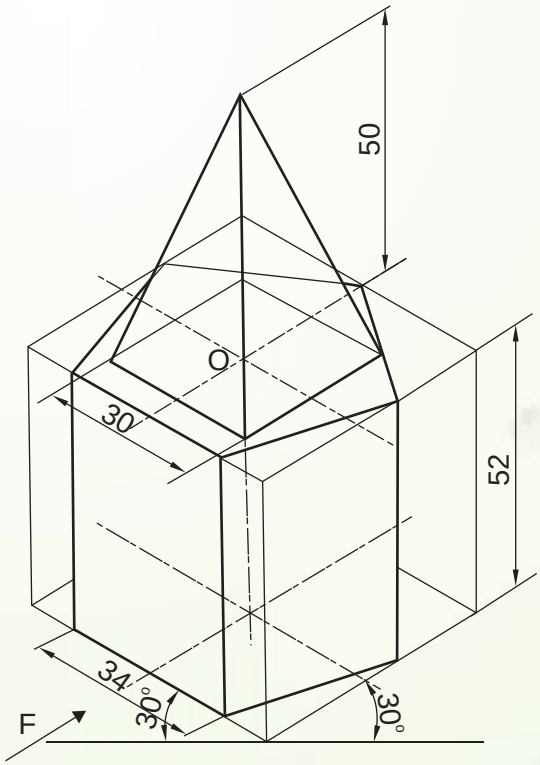
Steps:

1. Draw an isometric projection of the box that encloses an equilateral triangular prism having one of its rectangular face at the back.
2. Indicate the centre of the top face with convention lines.
3. Around the centre 'O' draw the rhombus of the square of cube and lift it upto its height equal to the side of cube.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using conventional lines.

Example: 1.23 Draw an Isometric Projection of a square pyramid resting vertically and centrally on the top pentagon face of a pentagonal prism, having one rectangular face parallel to V.P. while closer to the observer. Side of the square base = 30 mm, height of pyramid = 50 mm, side of the pentagon = 34 mm and height of the prism = 52 mm.



HELPING FIGURE



ISOMETRIC PROJECTION

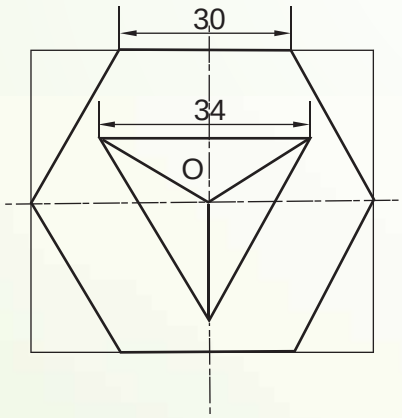
Fig 1.30

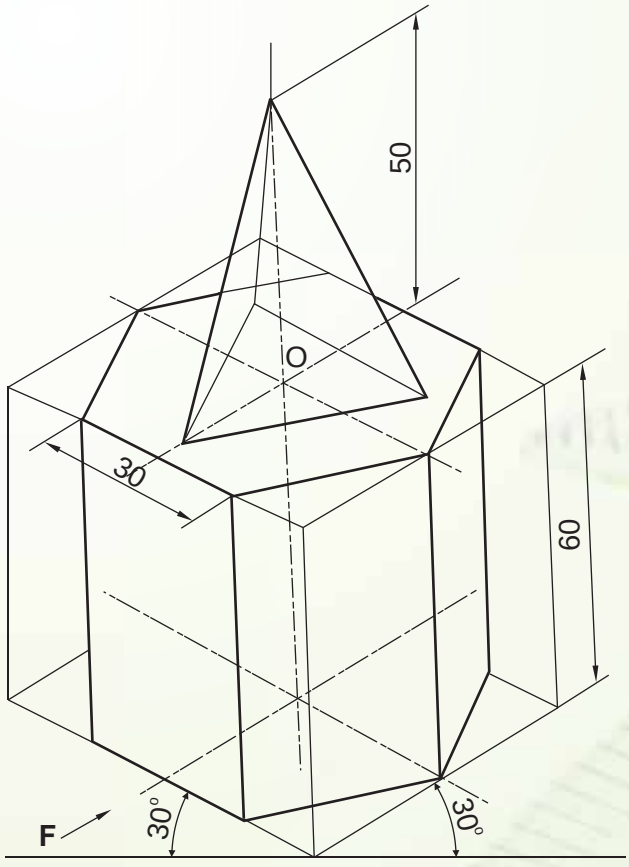
Steps:

1. Draw an isometric projection of the box that encloses pentagonal prism having one of its rectangular face, in front, parallel to V.P.
2. Indicate the centre of the top face with conventional lines.
3. Around the centre 'O' draw the rhombus of the square base of the pyramid. Draw the axis of the pyramid from the centre to apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using conventional lines.

Example:1.24 Draw an Isometric Projection of an equilateral triangular pyramid resting vertically and centrally with one base edge, at the back, parallel to V.P. on the top face of a hexagonal prism having two of its rectangular faces parallel to V.P. Side of the triangle = 34 mm, height of pyramid = 50 mm, side of the hexogen = 30 mm and height of the prism = 60 mm.

HELPING FIGURE





ISOMETRIC PROJECTION

Fig 1.31

Steps:

1. Draw an isometric projection of the box that encloses hexagonal prism having two faces parallel to V.P.
2. Indicate the centre of the top hexagon face with conventional lines.
3. Around the centre 'O' draw the equilateral triangle base of the pyramid. Raise the axis of the pyramid from the center to apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using conventional lines.

Example: 1.25 Draw an Isometric Projection of a vertical regular pentagonal pyramid resting centrally, having one base edge away from the observer parallel to V.P., on top of a vertical cylinder. Side of the pentagon = 32 mm, height of pyramid = 50 mm, diameter of cylinder = 76 mm and height of cylinder = 40 mm.

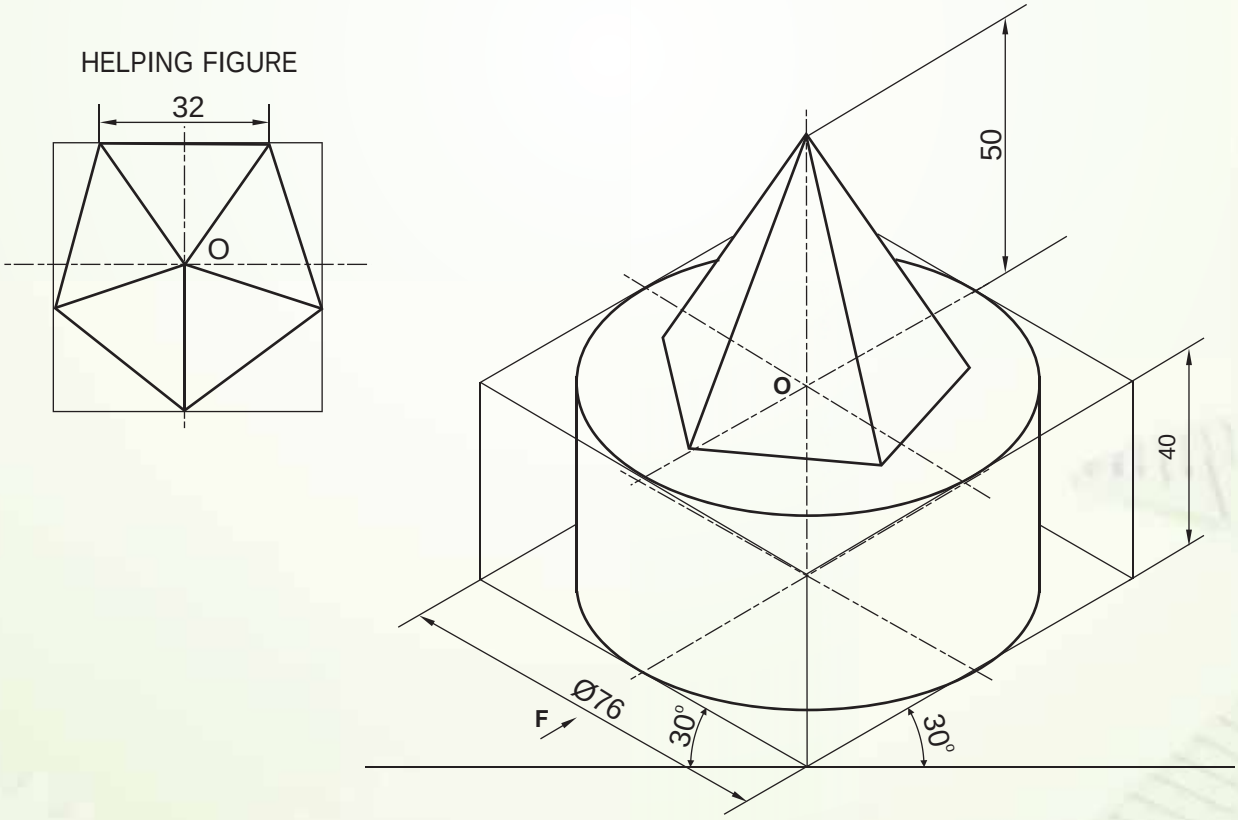


Fig 1.32

Steps:

1. Draw an isometric projection of the box that encloses a cylinder. Use four centre method to form the top elliptical face of the cylinder.
2. Indicate the centre of the top face with conventional lines.
3. Around the centre 'O' draw a pentagonal base of the pyramid. Draw the axis of the pyramid from the centre to apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using conventional lines.

Example: 1.26 Draw an Isometric Projection of a right circular cone resting vertically and centrally on the top of pentagonal slab having one of its rectangular face perpendicular to the observer. Side of pentagon = 46 mm, thickness of slab = 30 mm, diameter of cone = 40 mm and height of cone = 60 mm.

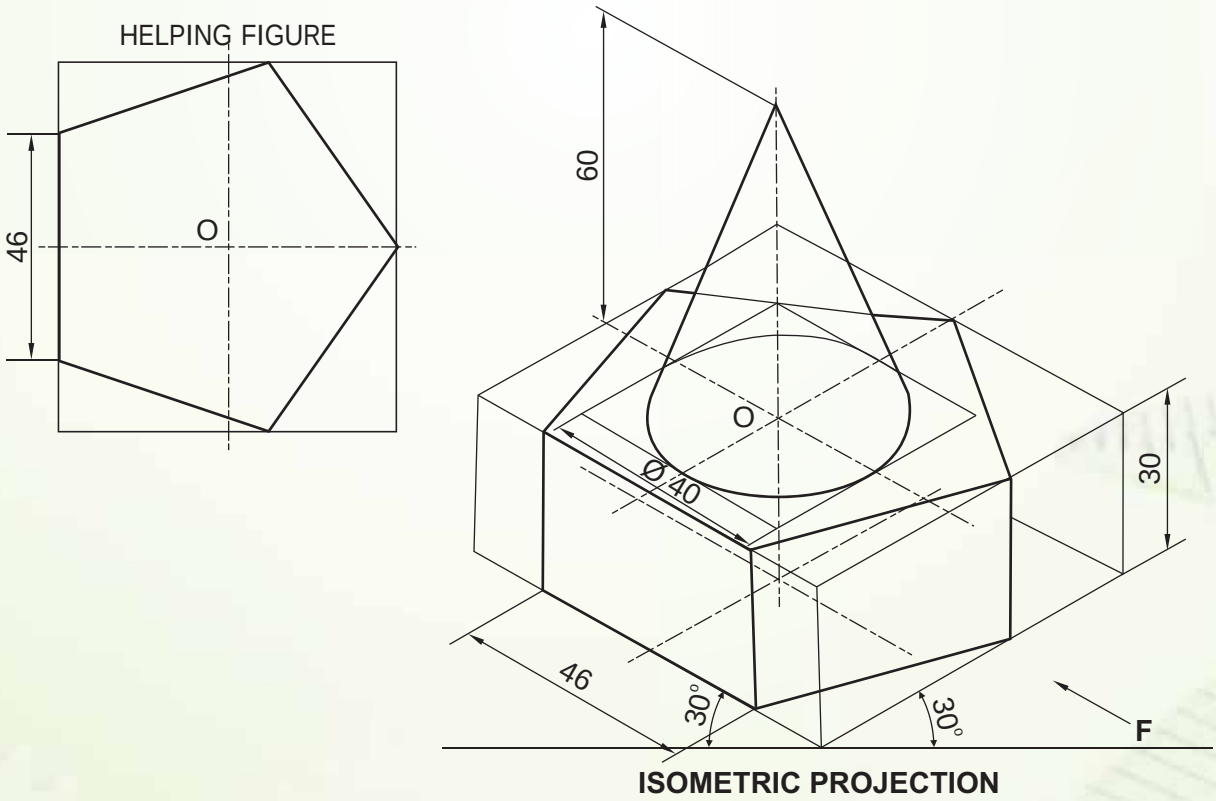


Fig 1.33

Steps:

1. Draw an isometric projection of the box that encloses a pentagonal prism having one rectangular face perpendicular to V.P.
2. Indicate the centre of the top pentagonal face with conventional lines.
3. Around the centre 'O' draw a rhombus for the circular base of cone. Using four centre method draw an ellipse inside. Draw the axis of the cone from the centre of base to apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their common axis using conventional lines.

Exmple : 1.27 Draw an Isometric Projection of hemisphere resting centrally on its curved surface, on the top horizontal rectangular face of an equilateral triangular prism, keeping two triangular faces parallel to the V.P. Side of equilateral triangle = 50 mm, length of the prism = 70 mm and diameter of the hemisphere = 60 mm.

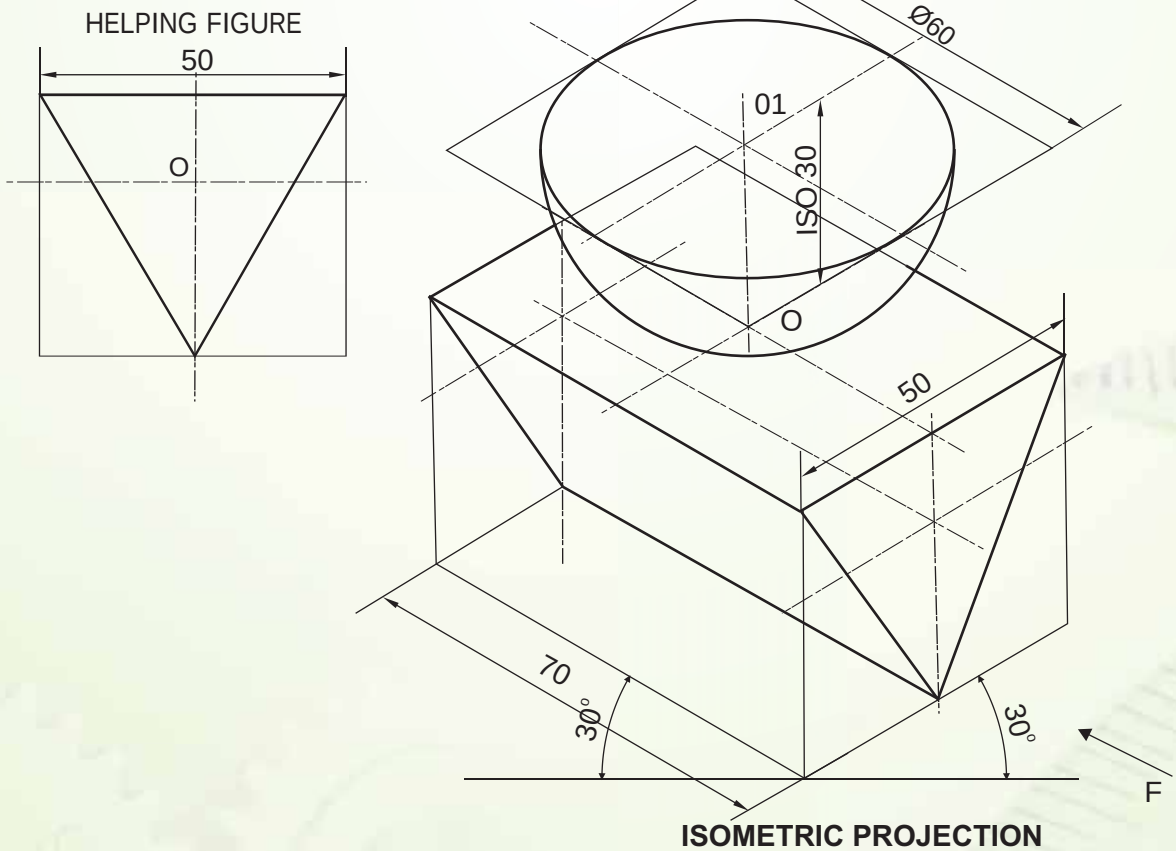
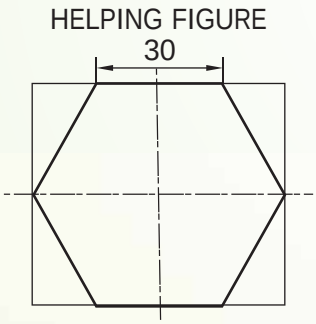


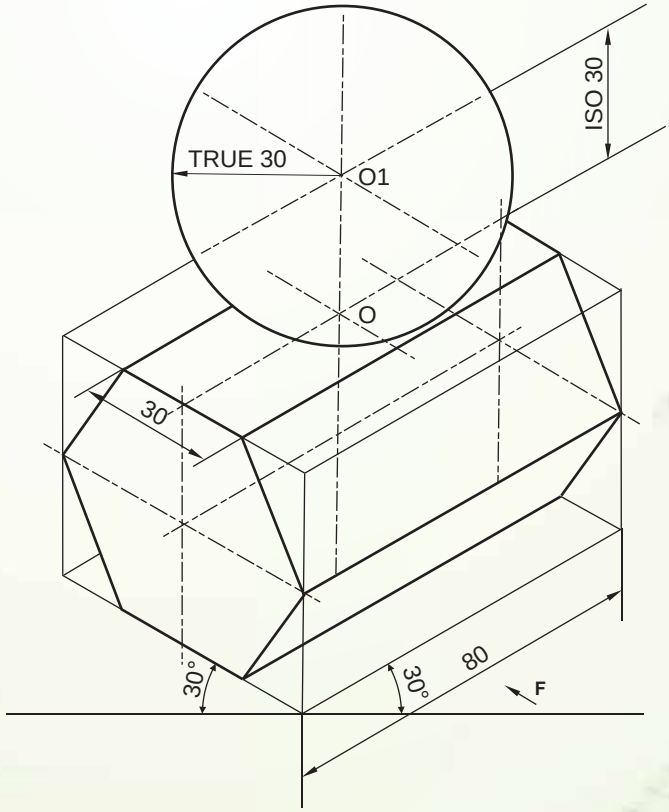
Fig 1.34

Steps:

1. Draw an isometric projection of the horizontal box that encloses an equilateral triangular prism with a rectangular face on top.
2. Indicate the centre of the top rectangular face with conventional lines.
3. From the centre 'O' draw the axis equal to isometric radius of the hemishphere to 01. Around the centre 'O' 1 draw rhombus. Use four center method to form the top elliplical face. Draw an arc to complete the curved surface.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their axes as applicable, using conventional lines.

Example: 1.28 Draw an Isometric Projection of a sphere resting centrally on a rectangular face of a horizontal hexagonal prism having its hexagonal ends perpendicular to V.P.. Side of hexagon = 30 mm, length of the prism = 80 mm and diameter of sphere = 60 mm.





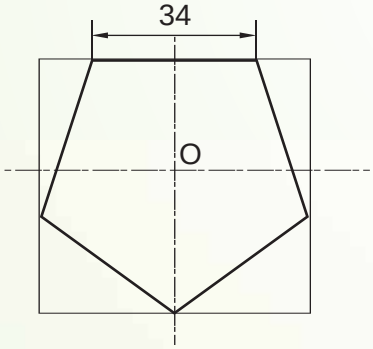
ISOMETRIC PROJECTION
Fig 1.35

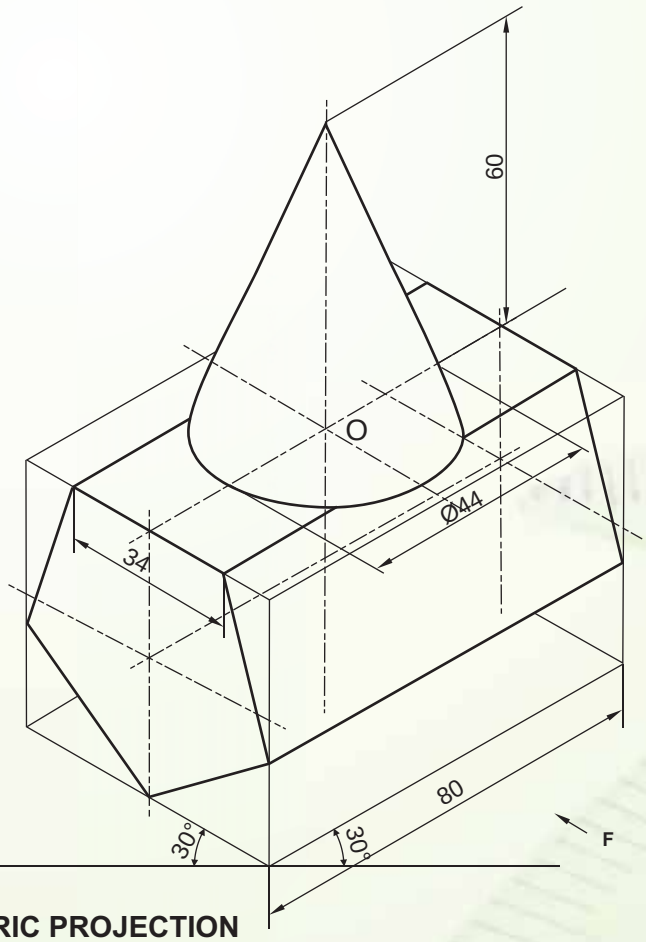
Steps:

1. Draw an isometric projection of the horizontal box that encloses a hexagonal prism having rectangular face on top.
2. Indicate the centre of the top rectangular face with conventional lines.
3. Form the centre 'O' draw the axis equal to isometric radius of sphere to point 'O1'. From the centre 'O1' draw a full circle equal to true radius of sphere.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their axes, as applicable, using conventional lines.

Example: 1.29 Draw an Isometric Projection of a right circular cone resting vertically and centrally on the top horizontal rectangle of a pentagonal prism having its axis parallel to H.P. and V.P. both. Side of pentagon = 34 mm, length of the prism = 80 mm, diameter of the cone = 44 mm and height of cone = 60 mm.

HELPING FIGURE





ISOMETRIC PROJECTION

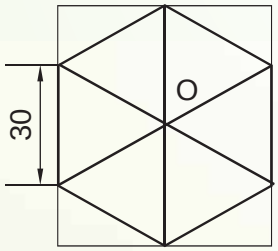
Fig 1.36

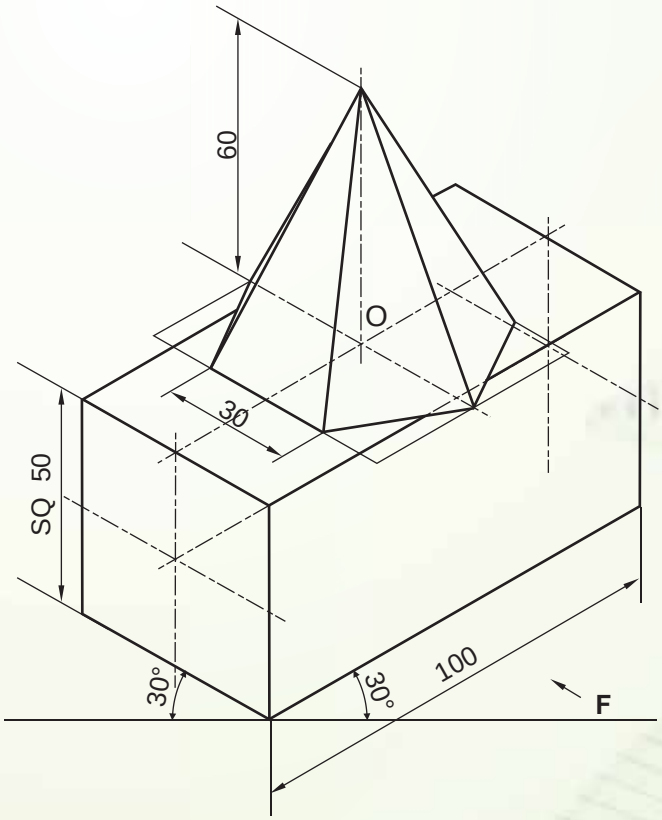
Steps:

1. Draw an isometric projection of horizontal box that encloses a pentagonal prism having one rectangular face on top.
2. Indicate the centre of the top rectangular face with conventional lines.
3. Around the centre 'O' draw a rhombus of the circular base of cone. Using four centre method draw an ellipse inside. Draw the axis of cone from the centre of apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their axes as applicable, using conventional lines.

Example: 1.30 Draw an Isometric Projection of a vertical regular hexagonal pyramid resting vertically and centrally having two of its base edges perpendicular to V.P.. On the top rectangular face of a horizontal square prism with its square ends perpendicular to V.P.. Side of the square = 50 mm, length of the prism =100 mm, side of the hexagon = 30 mm and height of the pyramid = 60 mm

HELPING FIGURE





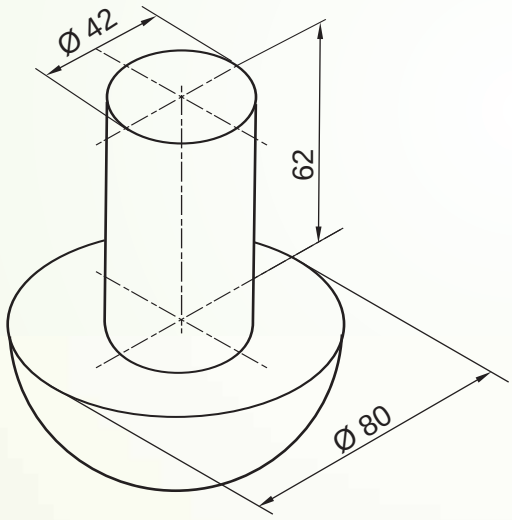
ISOMETRIC PROJECTION

Fig 1.37

Steps:

1. Draw an isometric projection of square prism in horizontal position.
2. Indicate the centre of the top rectangular face with conventional lines.
3. Around the centre 'O' draw hexagonal base of the pyramid. Draw the axis of the pyramid from the centre to the apex.
4. Join all the visible edges (no hidden lines) of the two solids by using thick lines.
5. Complete the isometric projection of the two solids with dimensioning, direction of viewing and their axes, as applicable, using conventional lines.

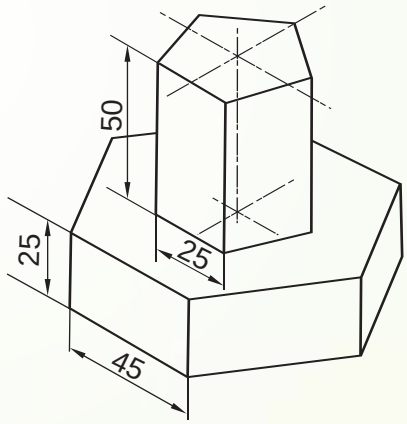
MORE TO DO



1. **BELOW:** HEMISPHERE

   ABOVE: CYLINDER

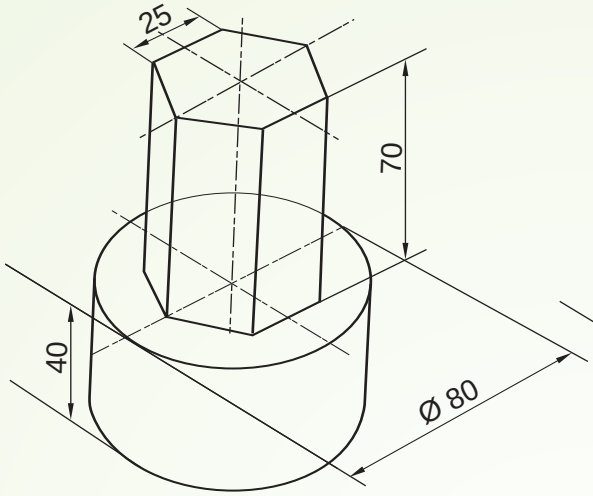
   COMMON AXIS: VERTICAL



2. **BELOW:** HEXAGONAL SLAB

   ABOVE: PENTAGONAL PRISM

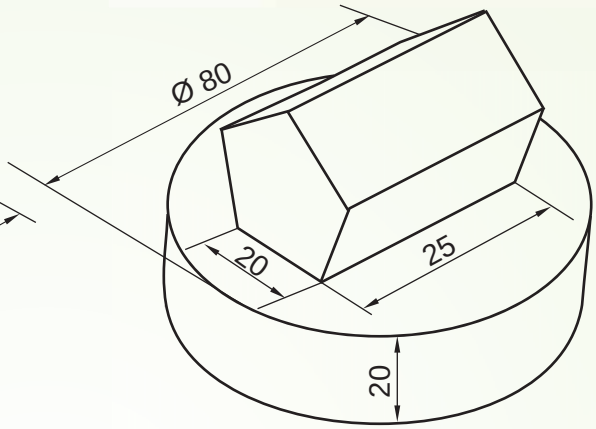
   COMMON AXIS: VERTICAL



3. **BELOW:** CIRCULAR SLAB

ABOVE: HEXAGONAL PRISM

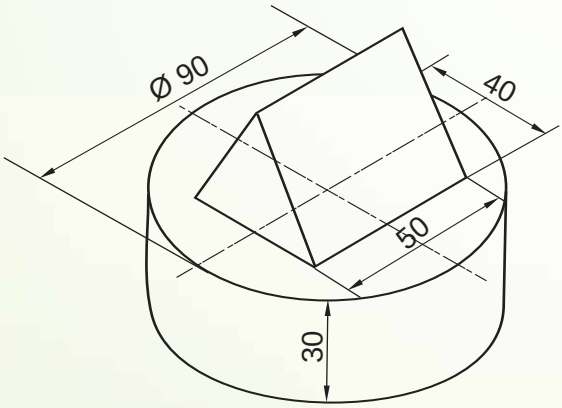
COMMON AXIS : VERTICAL



4. **BELOW:** CIRCULAR SLAB

ABOVE: PENAGONAL PRISM

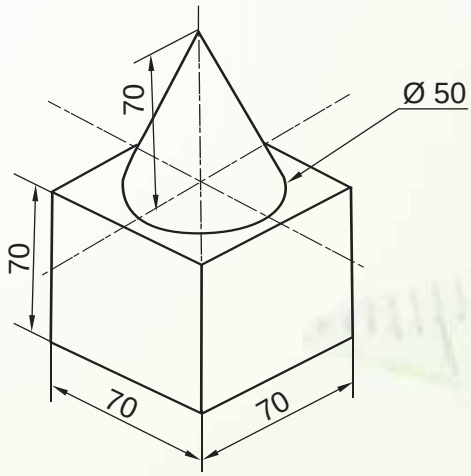
AXIS: VERTICAL AND HORIZONTAL



5. **BELOW:** CIRCULAR SLAB

ABOVE: EQUILATERAL TRIANGULAR PRISM

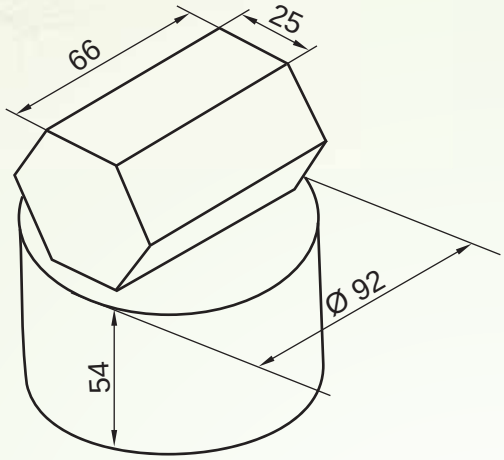
AXIS: VERTICAL AND HORIZONTAL



6. **BELOW:** CUBE

ABOVE: CONE

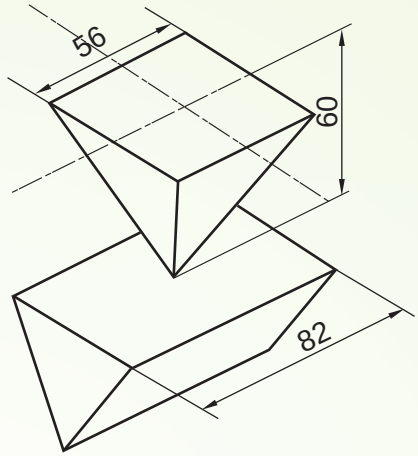
COMMON AXIS: VERTICAL



7. **BELOW:** CIRCULAR SLAB

ABOVE: HEXAGONAL PRISM

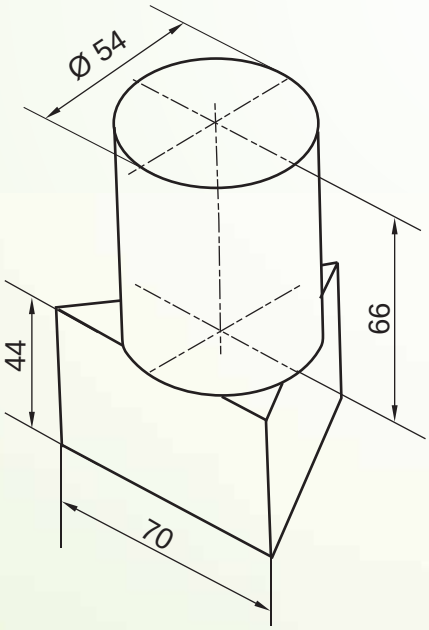
AXIS: VERTICAL AND HORIZONTAL



8. **BELOW:** EQUILATERAL HORIZONTAL TRIANGULAR PRISM

ABOVE: SQUARE PYRAMID

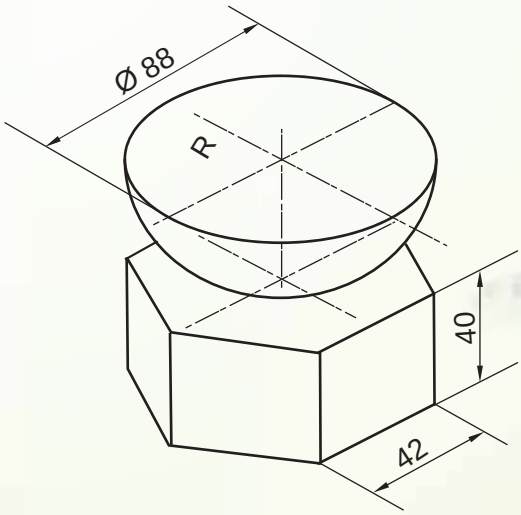
AXIS: HORIZONTAL AND VERTICAL



9. **BELOW:** EQUILATERAL TRIANGULAR SLAB

ABOVE: CYLINDER

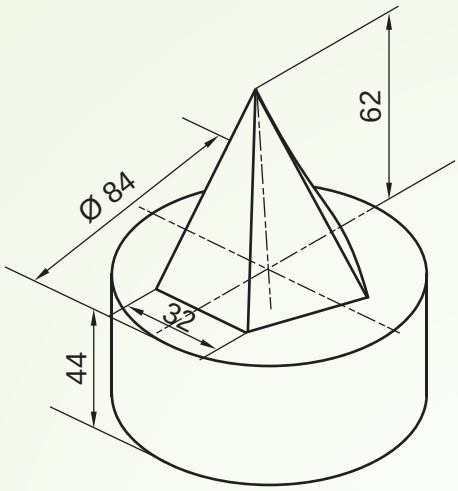
COMMON AXIS : VERTICAL

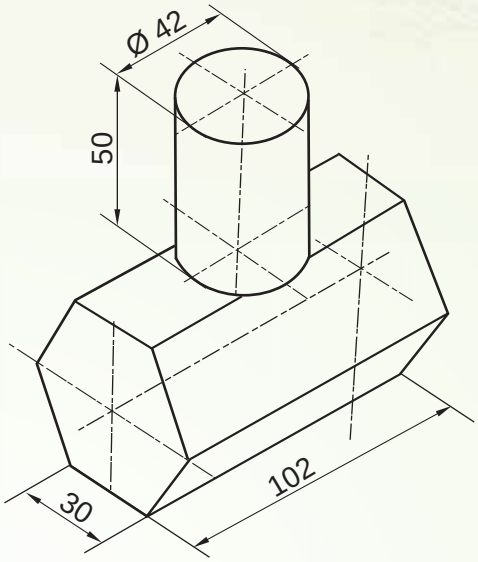


10. **BELOW:** HEXAGONAL SLAB.

ABOVE: HEMISPHERE

COMMON AXIS : VERTICAL





11. **BELOW:** CIRCULAR SLAB

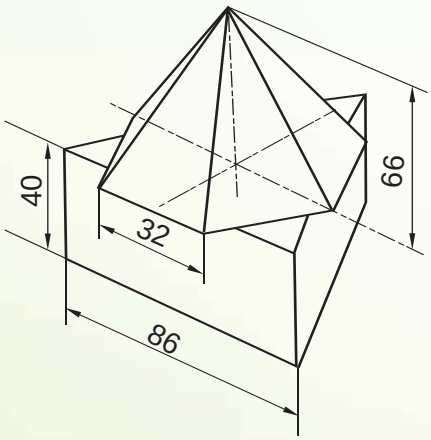
ABOVE: PENTAGONAL AND PYRAMID

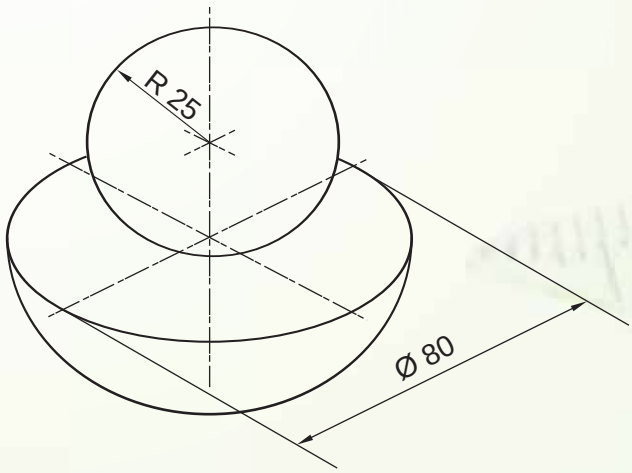
COMMON AXIS : VERTICAL

12. **BELOW:** HORIZONTAL HEXAGONAL PRISM

ABOVE: CYLINDER

AXIS: HORIZONTAL AND VERTICAL





13. **BELOW:** EQUILATERAL TRIANGULAR SLAB

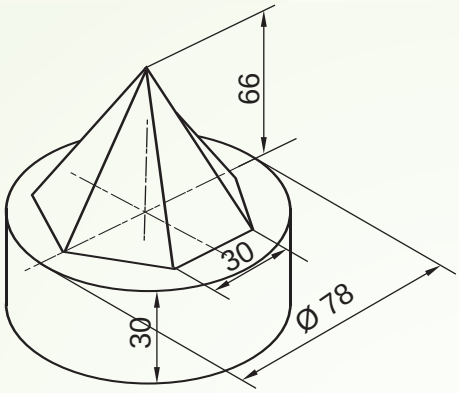
ABOVE: HEXAGONAL PYRAMID

COMMON AXIS : VERTICAL

14. **BELOW:** HEMISPHERE

ABOVE: SPHERE

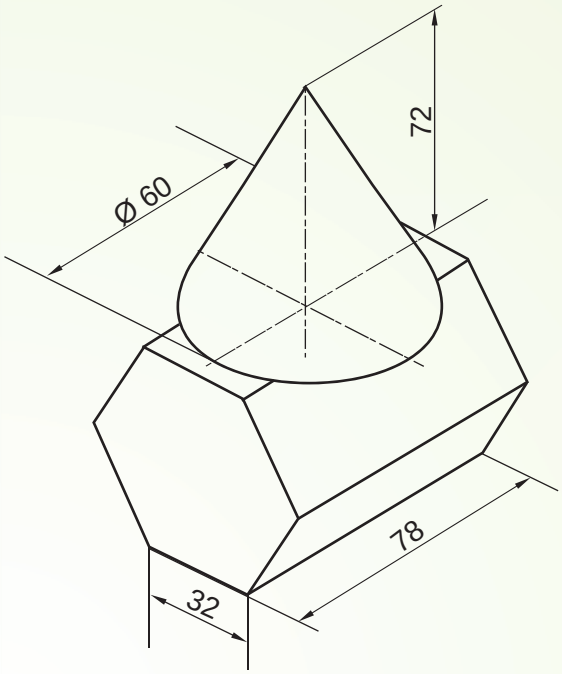
COMMON AXIS : VERTICAL



15. **BELOW:** CIRCULAR SLAB

ABOVE: HEXAGONAL PYRAMID

COMMON AXIS : VERTICAL



16. **BELOW:** HORIZONTAL HEXAGONAL PRISM

ABOVE: RIGHT CIRCULAR CONE

AXIS: HORIZONTAL AND VERTICAL