16

Isometric Projection

16.1 INTRODUCTION

In engineeriung practice, it is usual to draw two or more than two orthographic projections to give the true shape and size of an object. Such drawings can be correctly interpreted only by those persons, who have a sound knowledge of principles of orthographic projections. To make the drawing more understandable, several forms of one plane projection drawings are used to supplement the orthographic drawings. These are called pictorial drawings, which can be easily understood by everybody without any formal training. Pictorial drawings are mainly used to show complicated shapes such as aircraft, ships and building etc.

16.2 CLASSIFICATION OF PICTORIAL DRAWINGS

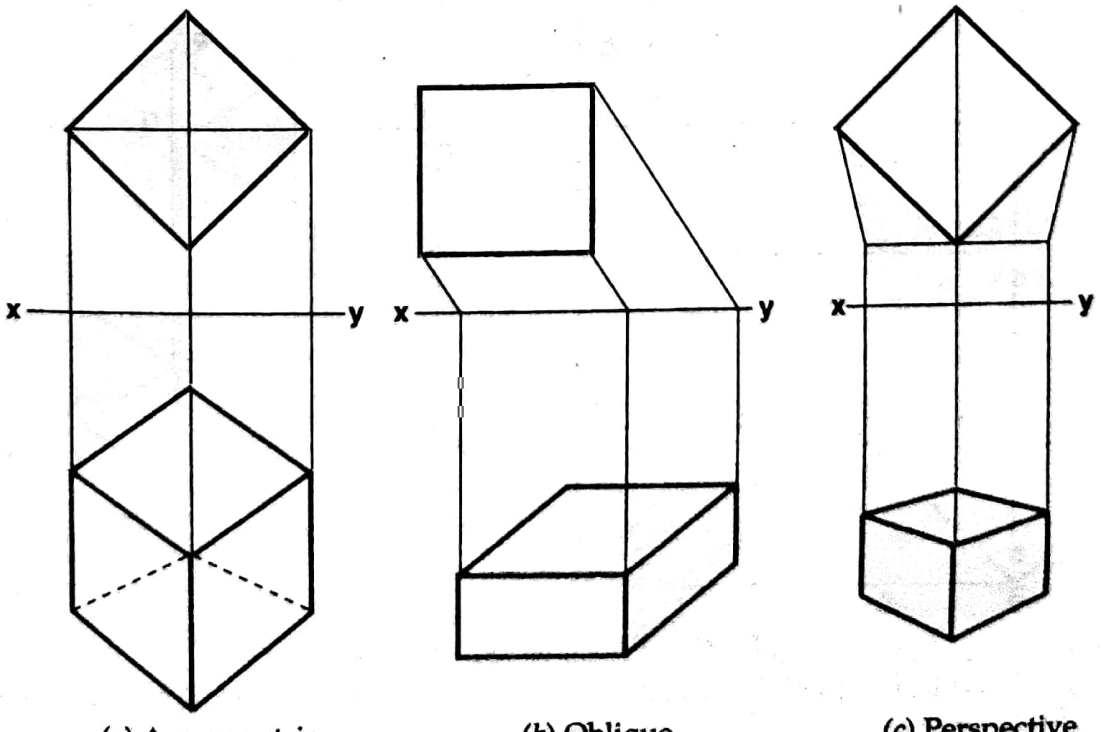
Pictorial drawings are classified into three categories :

(*a*) Axonometric Projection

(*b*) Oblique Projection

(*c*) Perspective Projection

(*a*) **Axonometric Projection :** It is a three dimensional projection of an object as shown in Fig. 16.1 (*a*). It is a form of orthographic projection, since the projectors are perpendicular to the plane of projection and parallel to each other.



(*a*) Axonometric (*b*) Oblique (*c*) Perspective

Fig. 16.1 Types of pictorial projections

(*b*) **Oblique Projection :** It is a three dimensional projection of an object on a projection plane, as shown in Fig. 16.1 (*b*). In this, the projectors are parallel to each other, but are oblique to the picture plane.

(*c*) **Perspective Projection :** It is the most realistic projection. In this, the projectors converge towards the viewer's eye, making different angles to the picture plane, as shown in Fig. 16.1 (*c*).

16.3 AXONOMETRIC PROJECTION

It is a form of orthographic projection and is obtained by projecting an object placed in an oblique position to the plane of projection. Axonometric projection is classified as :

- Isometric Projection
- Dimetric Projection
- Trimetric Projection

Out of these, only isometric projection is dealt here.

16.4 ISOMETRIC PROJECTION

It is a type of pictorial drawing in which the three dimensions of a solid are not only shown in one view, but their actual sizes can be measured directly from it.

If a cube is resting on one of its corners on the HP, with its solid diagonal perpendicular to the VP, the front view of the cube is its isometric projection as shown in Fig. 16.2.

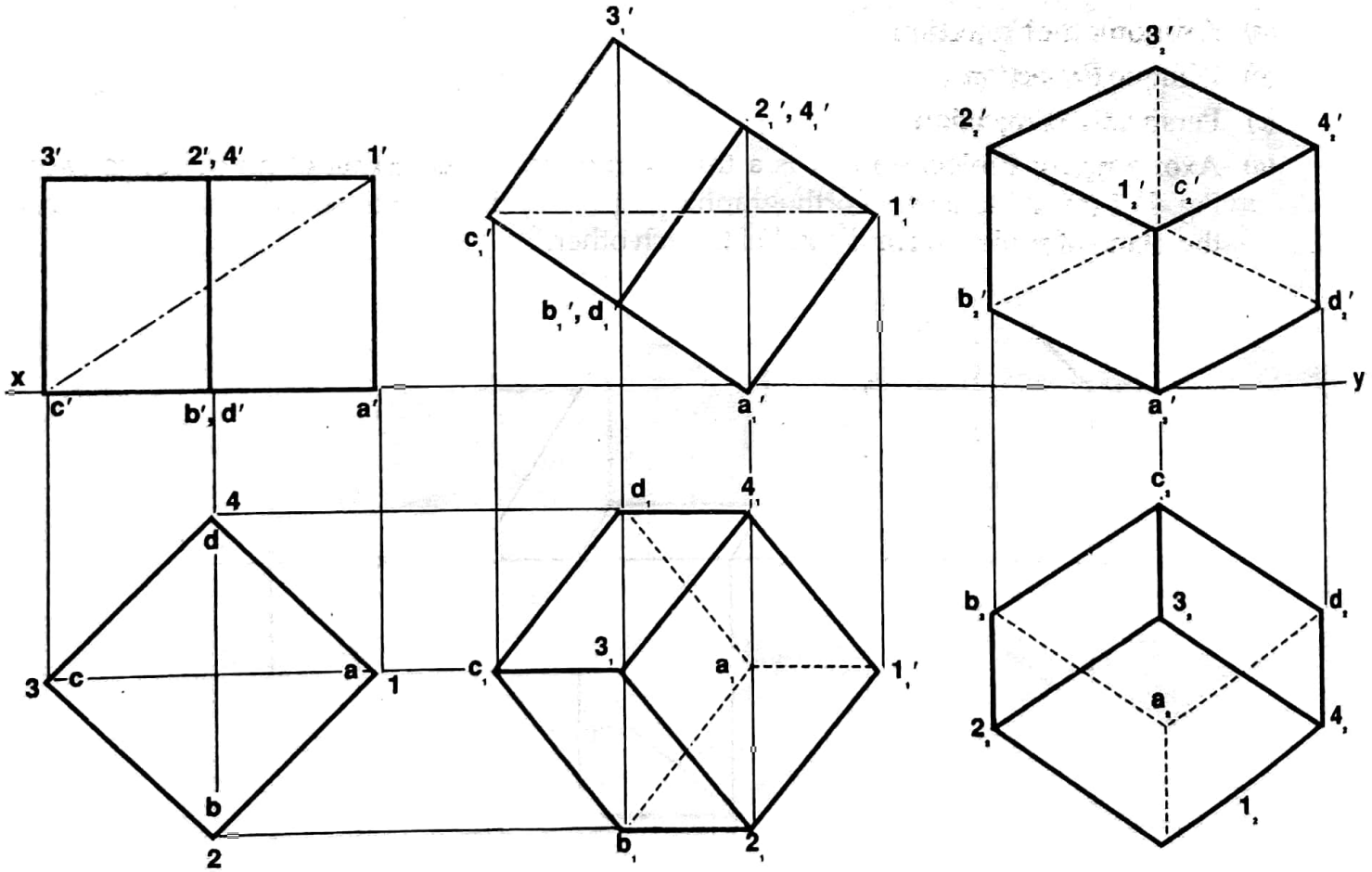


Fig. 16.2 Principles of isometric projection

Fig. 16.3 shows the front view of a cube in the above position, the following conclusions are drawn from it :

- All the faces are equally inclined to the VP.
- The three edges *CB*, *CD* and *CG* make equal angles of 120° with each other.
- All other edges are parallel to either of these three edges. Isometric means equal measurement *i.e.*, each of the three planes of a cube is equally foreshortened.

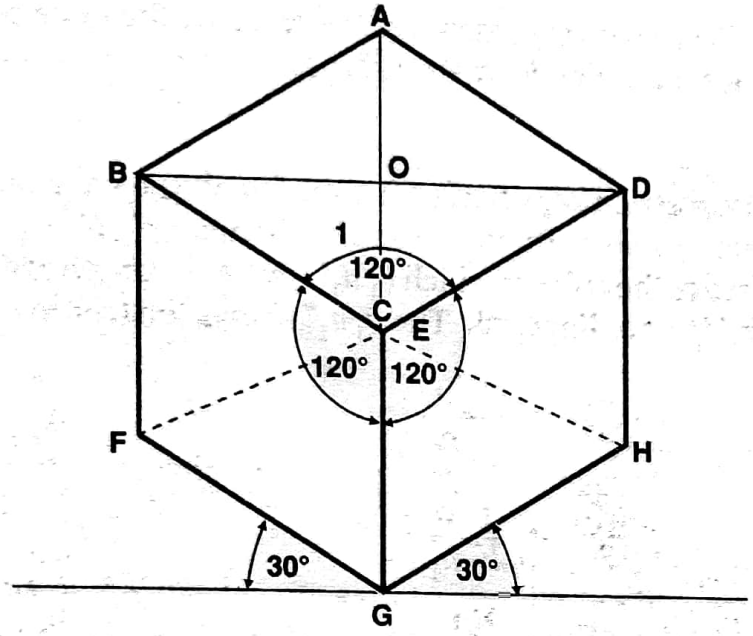


Fig. 16.3 Isometric projection of a cube

16.5 TERMS CONNECTED WITH ISOMETRIC PROJECTION

The following are some important terms used in isometric projection. See Fig. 16.4

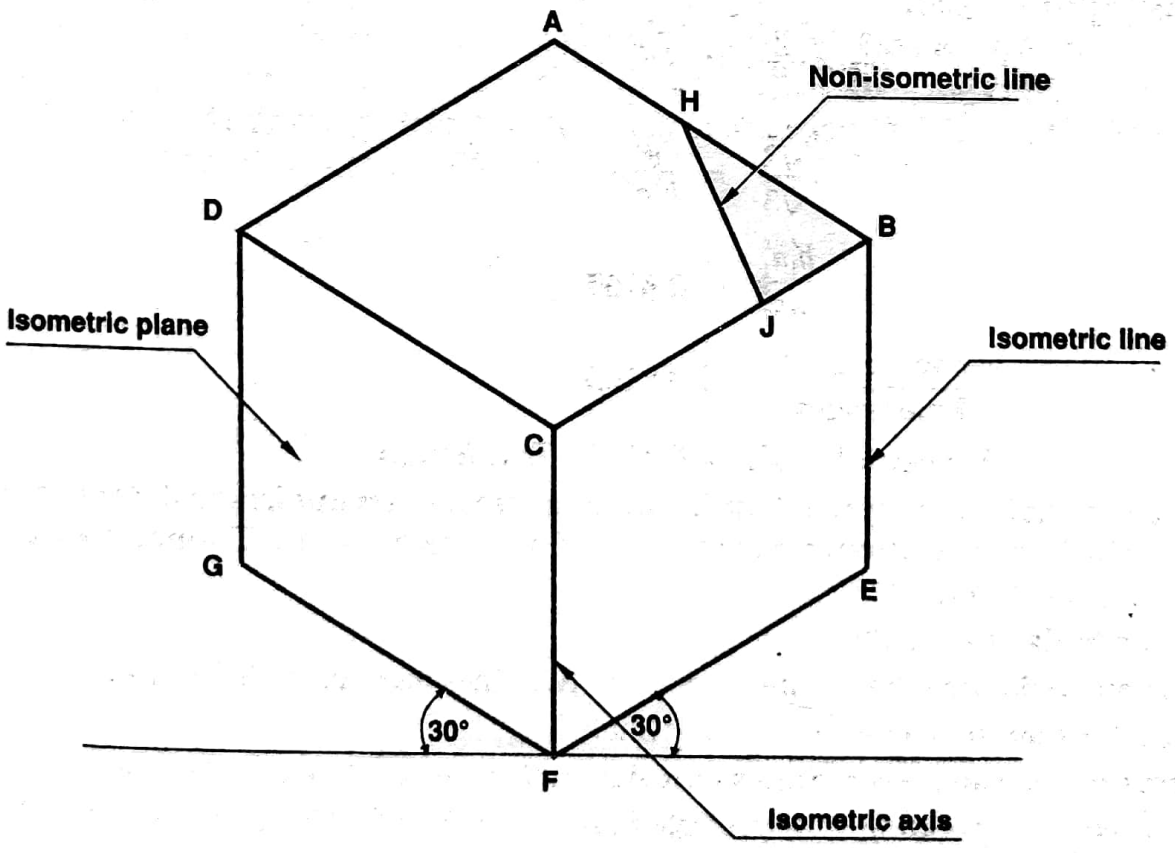


Fig. 16.4 Terms connected with isometric projection

- **Isometric Axes.** The three lines *CB*, *CD* and *CF* meeting at a point *C* and making 120° angles with each other are termed as isometric axes.
- **Isometric Lines.** The lines parallel to the isometric axes are called isometric lines.
- **Non-isometric Lines.** The lines which are not parallel to isometric axes are called non-isometric lines.
- **Isometric Planes.** The planes representing the faces of the cube as well as other planes parallel to these planes are called isometric planes.

16.6 ISOMETRIC SCALE

Fig. 16.5 (*a*) shows the isometric projection of a cube, as all the edges of the cube are equally foreshortened, the square faces appear as rhombuses. The rhombus a'_1, b'_1, c'_1, d'_1 shows the isometric projection of the top square face of the cube in which $b_1'd_1'$ is the true length of the diagonal. Construct a square $b_1'c_1''d_1'a_1''$ around $b_1'd_1'$ as a diagonal. The $b_1'a_1''$ shows the true length of $b_1'a_1'$.

In $\Delta\, a_1'b_1'o$, $\quad \cos 30^\circ = \dfrac{b_1'o}{b_1'a_1'}$

$\Rightarrow \quad \dfrac{\sqrt{3}}{2} = \dfrac{b_1'o}{b_1'a_1'}$ ...(*i*)

In $\Delta\, a_1''b_1'o$, $\quad \cos 45^\circ = \dfrac{b_1'o}{b_1'a_1''}$

$\Rightarrow \quad \dfrac{1}{\sqrt{2}} = \dfrac{b_1'o}{b_1'a_1''}$ ...(*ii*)

Divide (*ii*) by (*i*)

$$\frac{1}{\sqrt{2}} \times \frac{2}{\sqrt{3}} = \frac{b_1'o}{b_1'a_1''} \times \frac{b_1'a_1'}{b_1'o}$$

$$\frac{\sqrt{2}}{\sqrt{3}} = \frac{b_1'a_1'}{b_1'a_1''}$$

$$\frac{b_1'a_1'}{b_1'a_1''} = 0.8165$$

$$\Rightarrow \quad \frac{\text{Isometric length}}{\text{True length}} = 0.8165$$

$$\text{Isometric length} = 0.8165 \times \text{True length}$$

While drawing an isometric projection, it is necessary to convert true lengths into isometric lengths. This is done easily by constructing and making use of an isometric scale. The method of constructing an isometric scale is as follows :

(*i*) Draw a horizontal line of any length

(*ii*) From any point on a horizontal line, draw two lines inclined at 30° and 45° respectively.

(*iii*) Mark divisions of true lengths on 45° line.

(*iv*) From each division point, draw vertical lines thereby meeting at 30° line at various points.

(*v*) Then the corresponding scale projected on 30° line is called the isometric scale, as shown in Fig. 16.5 (*b*).

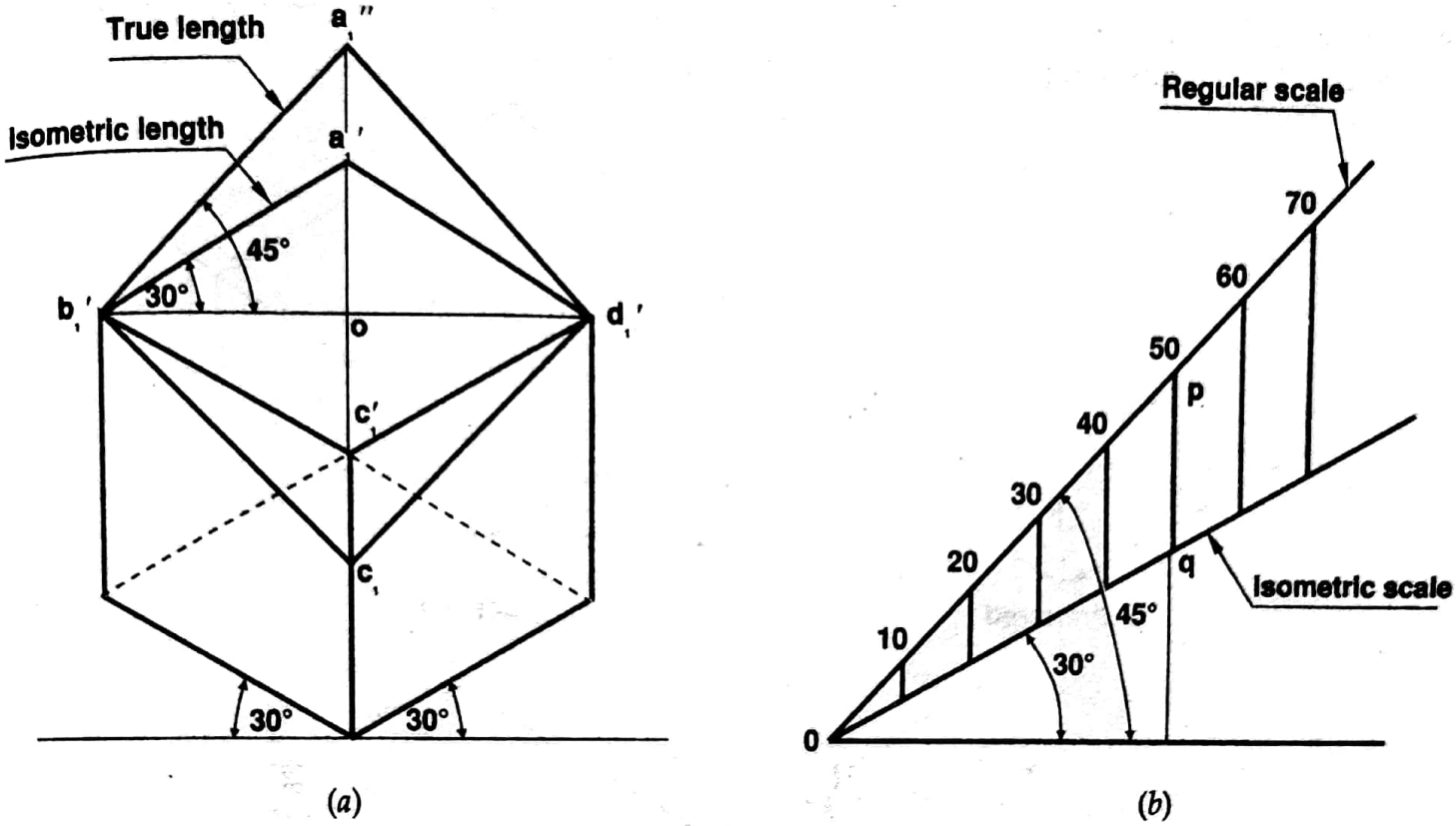


Fig. 16.5 Method of drawing an isometric scale

To obtain the isometric length of any dimensions, say 50 mm, draw a vertical line from p, 50 mm division point. Meeting the isometric scale at *q*. The length *oq* represents the isometric length.

16.7 ISOMETRIC DRAWING

If the foreshortening of the isometric lines in an isometric projection is disregarded and instead, the true length are marked, the view obtained will be exactly of the same shape but larger in proportion (about 22.5%) than that obtained by the use of the isometric scale as shown in Fig. 16.6. To avoid this tedious construction of isometric projection, the true lengths are laid out along the isometric axes, the view obtained is called isometric drawing. It implies that the construction of an isometric drawing is much simpler as compared to the isometric projection.

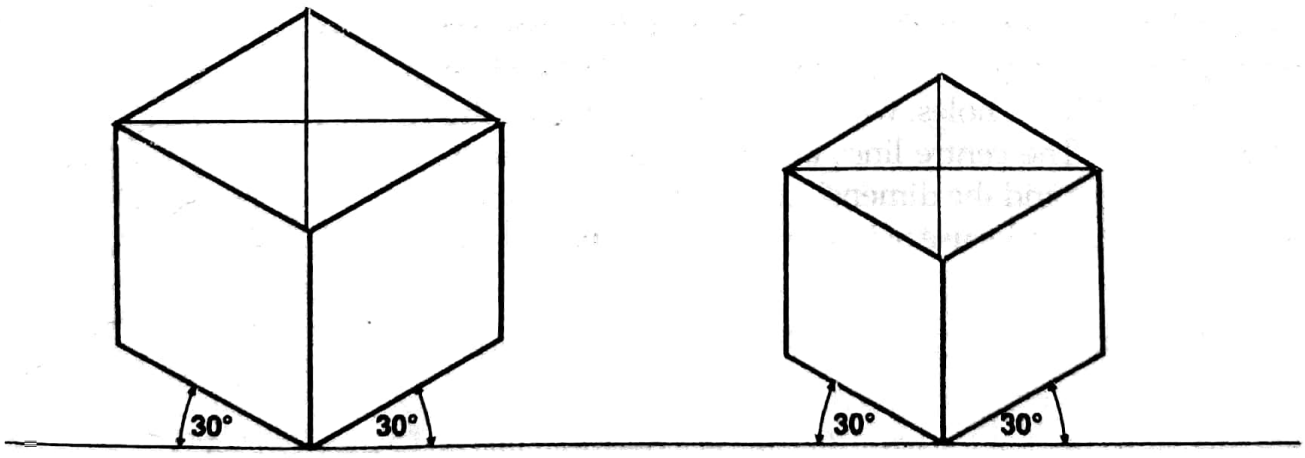


Fig. 16.6 Isometric drawing is 22.5% larger than isometric projection

16.8 ISOMETRIC DIMENSIONING

The general rules for dimensioning have already been discussed in chapter 3. All those rules hold good here too and in addition to those, the following rules must be taken care off.

- Extension lines, dimension lines and numerals for the isometric projection must be placed in the isometric planes of the faces as shown in Fig. 16.7.

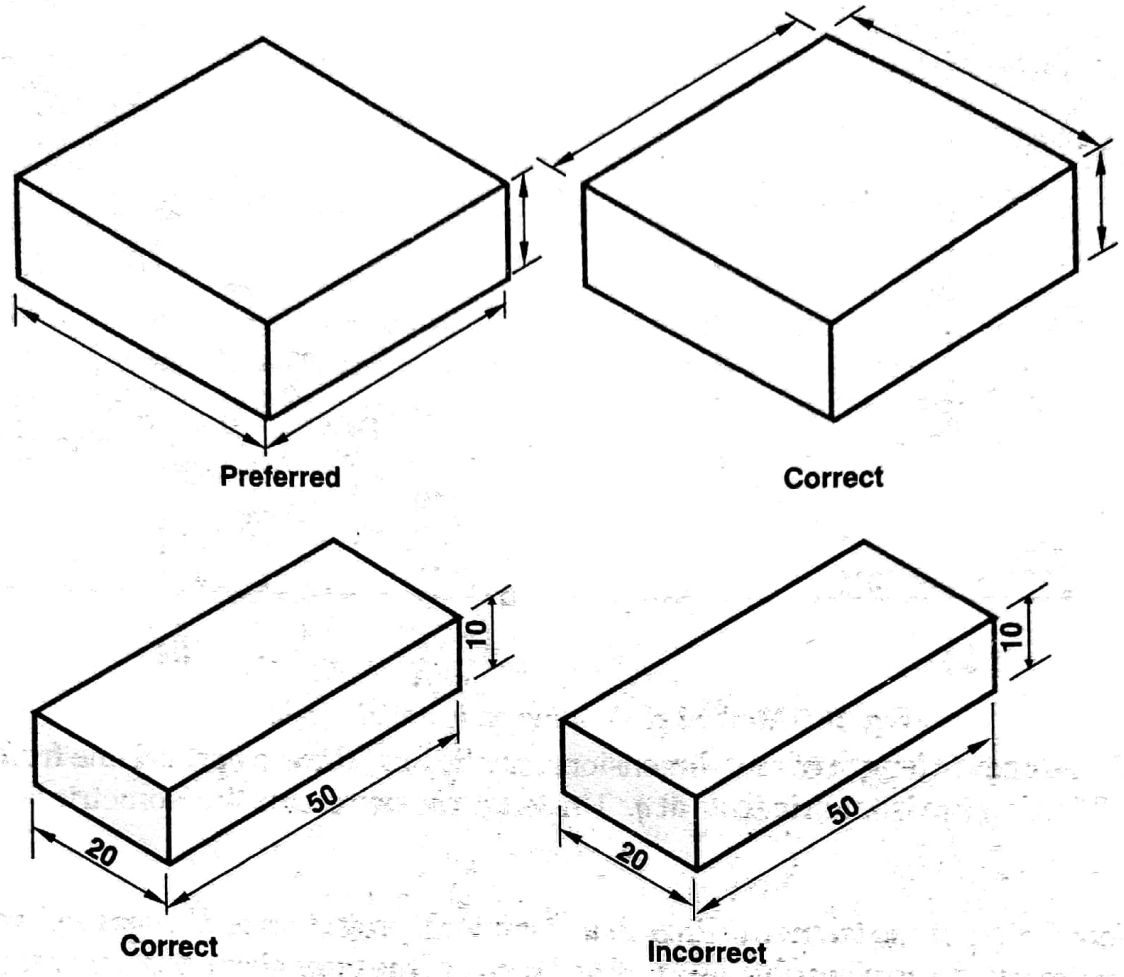


Fig. 16.7 Isometric dimensioning

- If possible, apply the dimensions to visible surfaces.

16.9 HIDDEN AND CENTRE LINES ON AN ISOMETRIC PROJECTION

It is the usual practice to omit the hidden lines unless they are needed to make the drawing clearer. If an isometric projection is to be dimensioned and if it has holes, which much be located, centre lines must be drawn. The centre lines are placed on a plane in which the hole is shown and the dimensions are placed parallel to the planes. Fig. 16.8 shows the use of hidden and centre lines on an isometric projection.

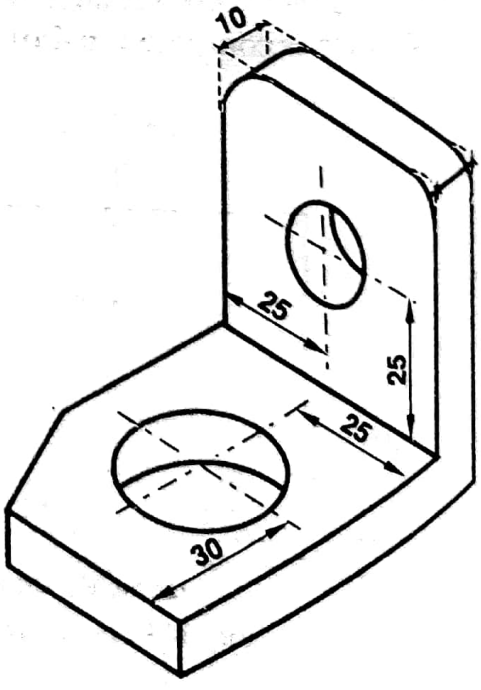


Fig. 16.8 Use of centre lines for dimensioning

16.10 ISOMETRIC DRAWING OR PROJECTION OF PLANE FIGURES

PROBLEM 16.1 *Draw an isometric drawing of a square lamina of 30 mm side.*

SOLUTION. **Case I Vertical Plane**

(*i*) Draw a line at 30° to the horizontal and mark the length on it.

(*ii*) Draw verticals at the ends of the line and mark the length on these parallel lines.

(*iii*) Join the ends of a straight line, which is also inclined at 30°.
As shown in Fig. 16.9, there are two possible positions for the plane.

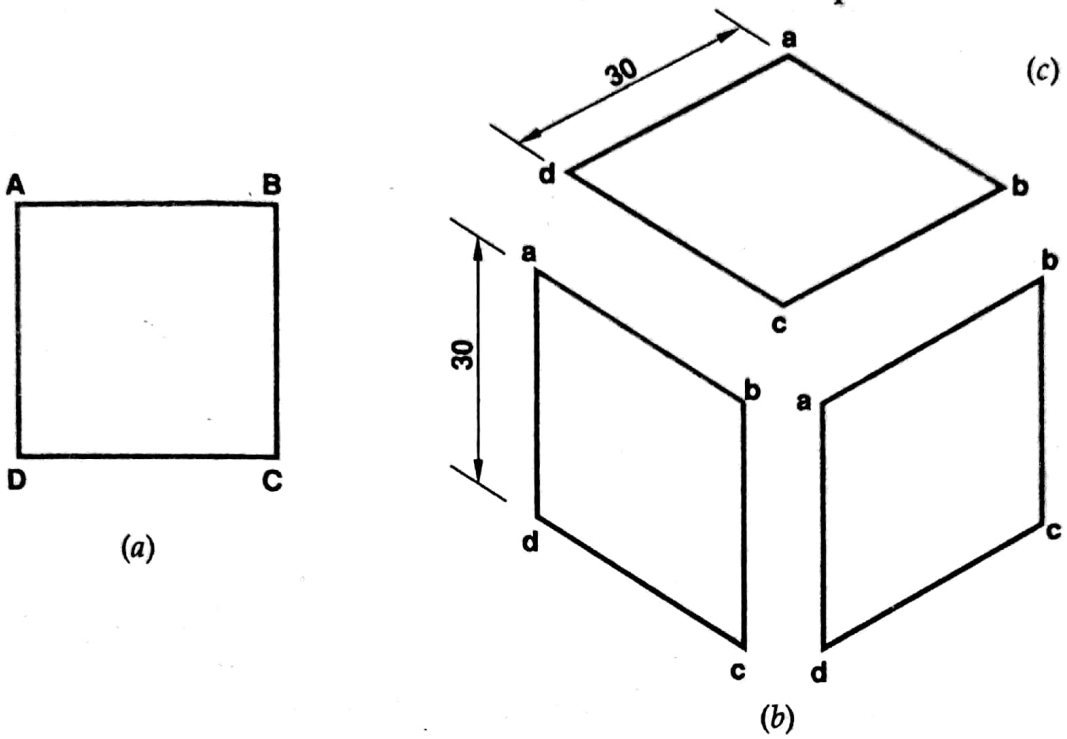


Fig. 16.9 Solution to problem 16.1

Case II Horizontal Plane

(*i*) Draw two lines at 30° to the horizontal and mark the lengths along the same.

(*ii*) Complete the figure by drawing 30° inclined lines at the ends till they intersect as shown in Fig. 16.9. The shape of an isometric drawing of a square lamina is a rhombus.

PROBLEM 16.2 *The front view of a triangle where surface is parallel to VP, is shown in Fig. 16.10 (a). Draw its isometric drawing.*

SOLUTION.

(*i*) Enclose the triangle in the rectangle and draw the isometric drawing of the rectangle.

(*ii*) Mark a point *a* in *de* such that *da* = *DA*. Draw the triangle *abc*, which is the required isometric drawing. In an isometric drawing, angles do not increase or decrease in any fixed proportion. It can also be drawn in the other direction as shown in Fig. 16.10 (*b*).

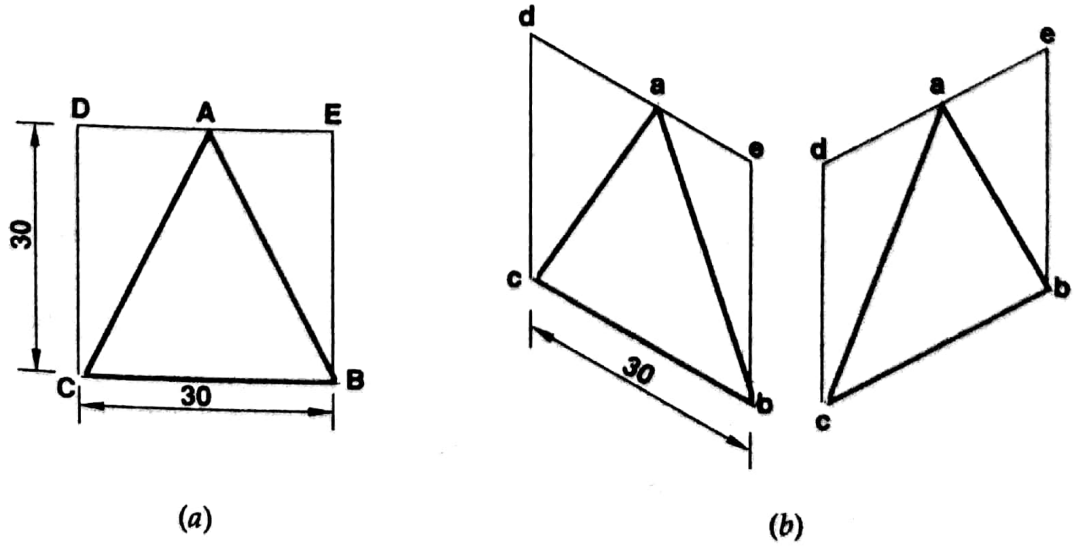


Fig. 16.10 Solution to problem 16.2

PROBLEM 16.3 *Draw an isometric drawing of a regular pentagon of 30 mm side.*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.11.

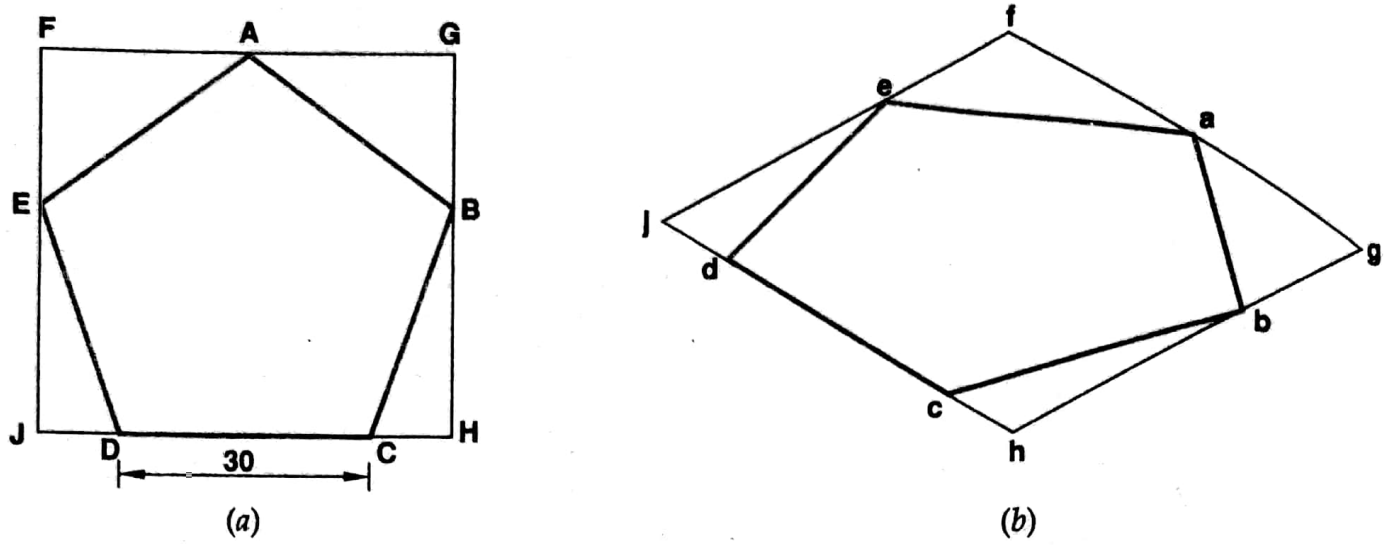


Fig. 16.11 Solution to problem 16.3

PROBLEM 16.4 *The front view of a hexagon where surfaces is parallel to HP, is shown in Fig. 16.12 (a). Draw its isometric drawing.*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.12 (*b*)

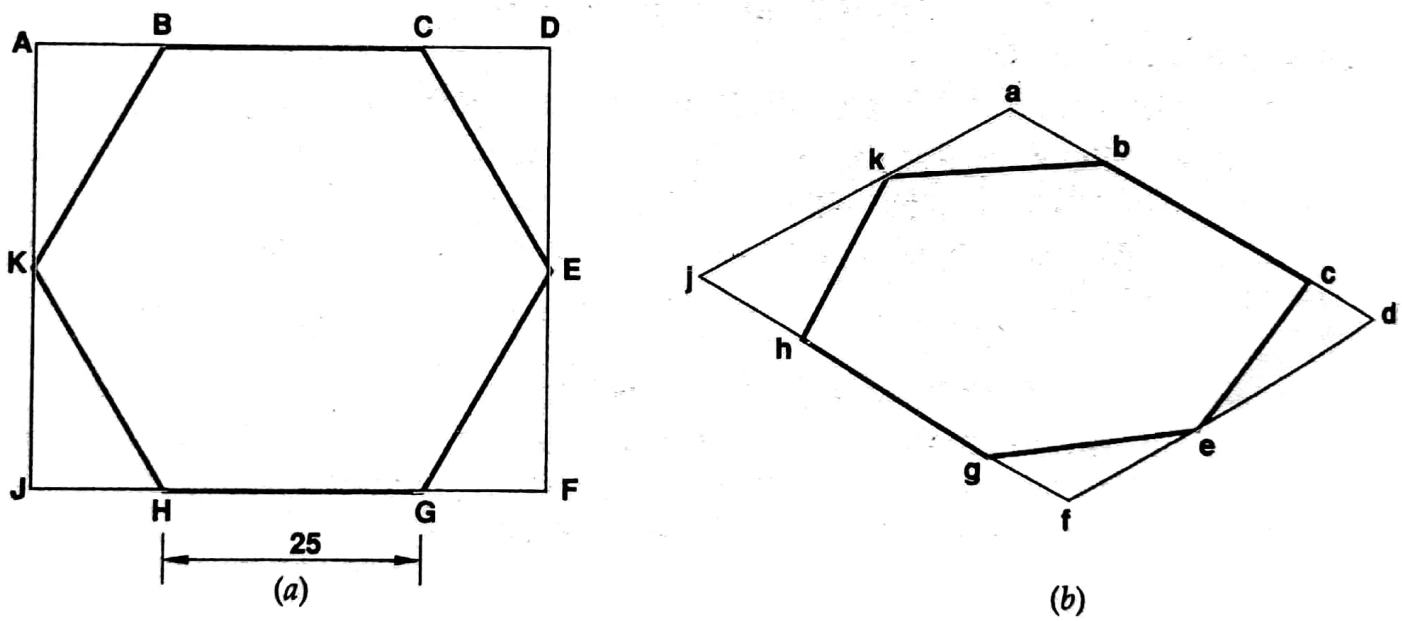


Fig. 16.12 Solution to problem 16.4

PROBLEM 16.5 *Draw the isometric drawing of a circle of 50 mm diameter.*

SOLUTION. **Offset Method**

(*i*) Divide the circle into convenient number of equal parts, after enclosing it in a square, as shown in Fig. 16.13 (*a*).

(*ii*) Determine the distances of the division points from the edges of the square, as shown in Fig. 16.13 (*b*).

(*iii*) Draw the isometric drawing of the square and mark the off-sets corresponding to the division points of the circle.

(*iv*) Join these points by a smooth curve.

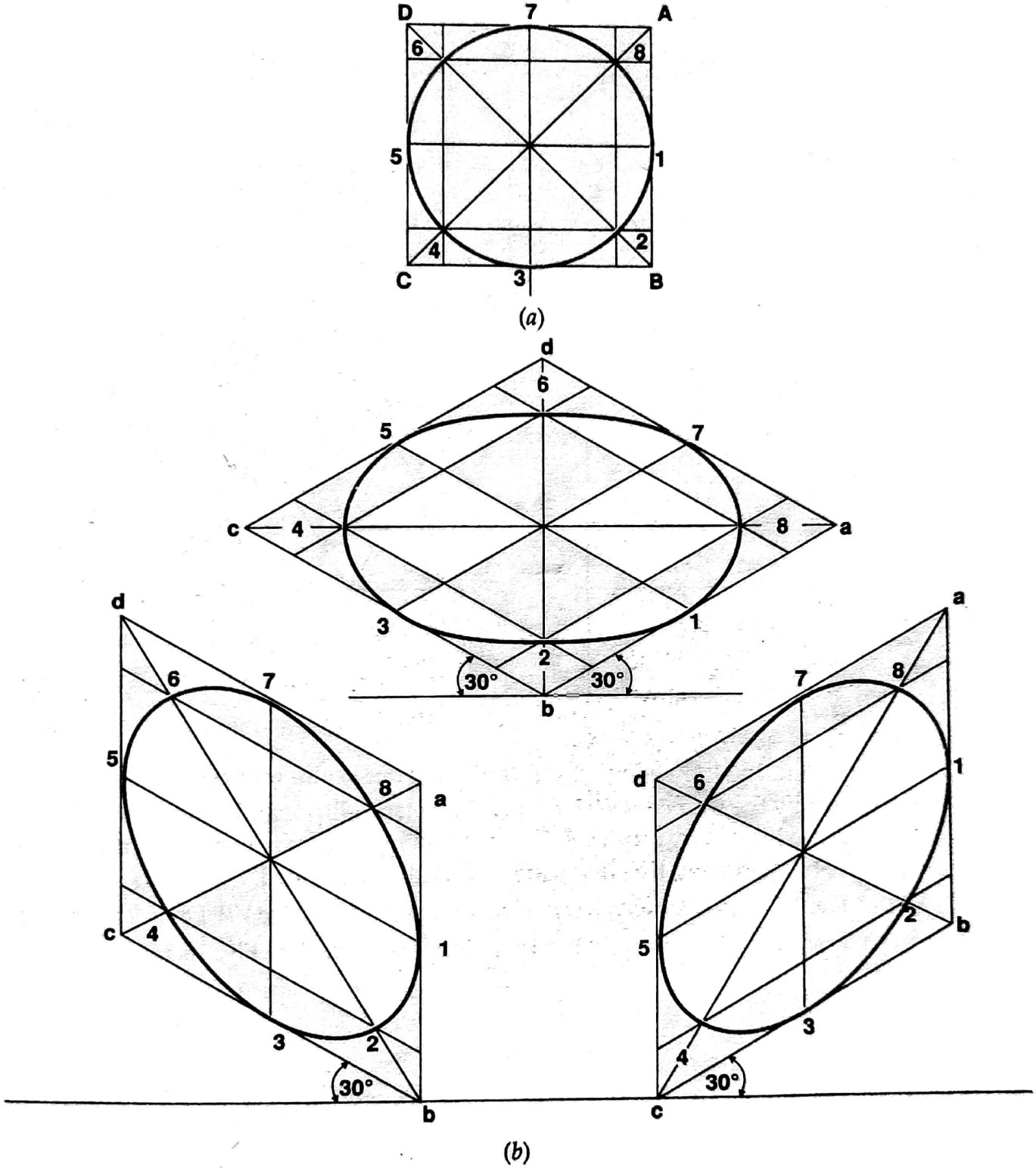


Fig. 16.13 Solution to problem 16.5 (Offset method)

Four Centre Method

(*i*) Enclose the circle in a square, as shown in Fig. 16.13 (*a*).

(*ii*) Construct the isometric drawing of the square, which is a rhombus.

(*iii*) Locate the midpoints of the sides of the rhombus.

(*iv*) Join these midpoints to the nearest corners of the rhombus intersecting at c_1 and c_2.

(*v*) With centres c_1 and c_2 and radius $c_1 1$ ($c_2 2$) draw two arcs as shown in Fig. 16.14.

(*vi*) With centres c_3 and c_4 and radius $c_3 3$ ($c_4 4$) draw two arcs meeting the above axes tangentially.

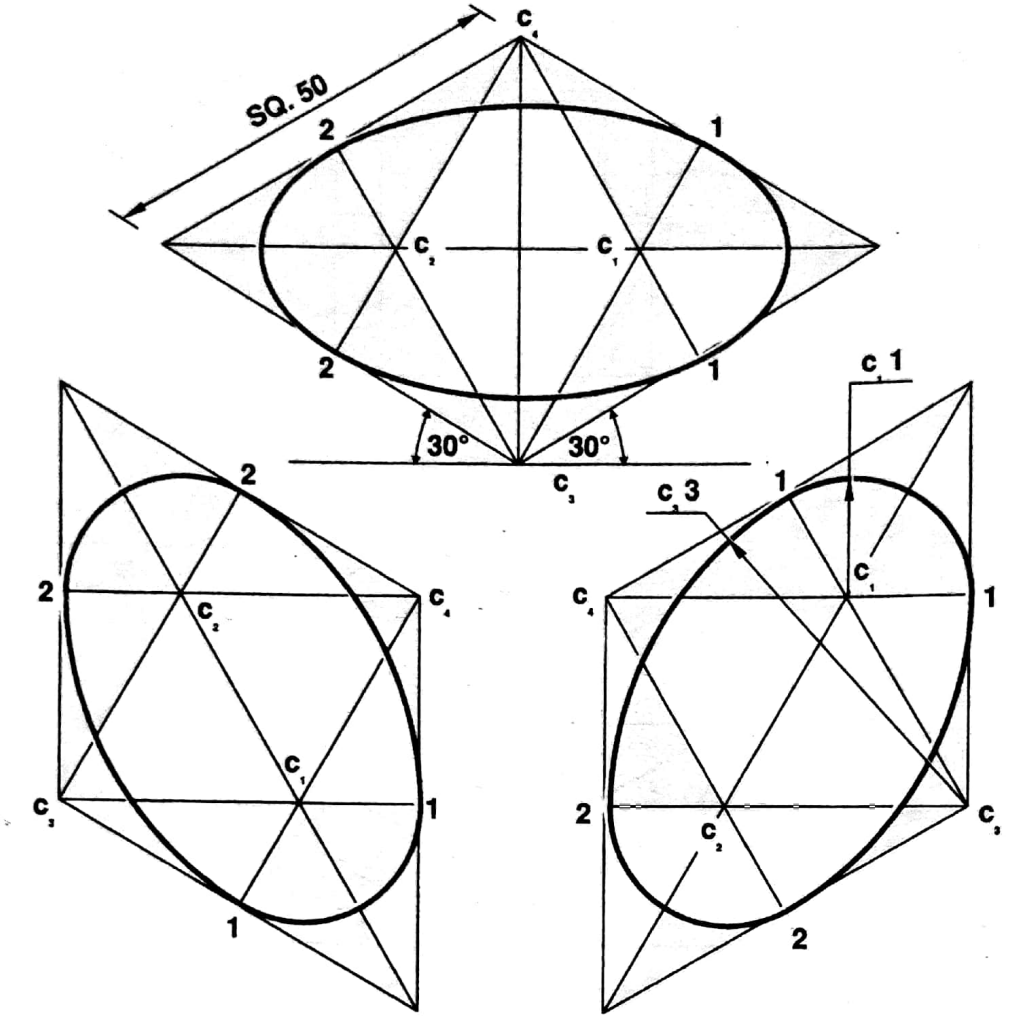


Fig. 16.14 Solution to problem 16.5 (Four centre method)

The ellipse obtained by the four centre method is not a true ellipse and differs considerably in size and shape from the ellipse plotted by offset method. But owing to ease in construction and to avoid the labour of drawing free hand curves, this method is generally employed.

PROBLEM 16.6 *Fig. 16.15 (a) shows the front view of a plane parallel to the VP. Draw its isometric drawing.*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.15 (*b*).

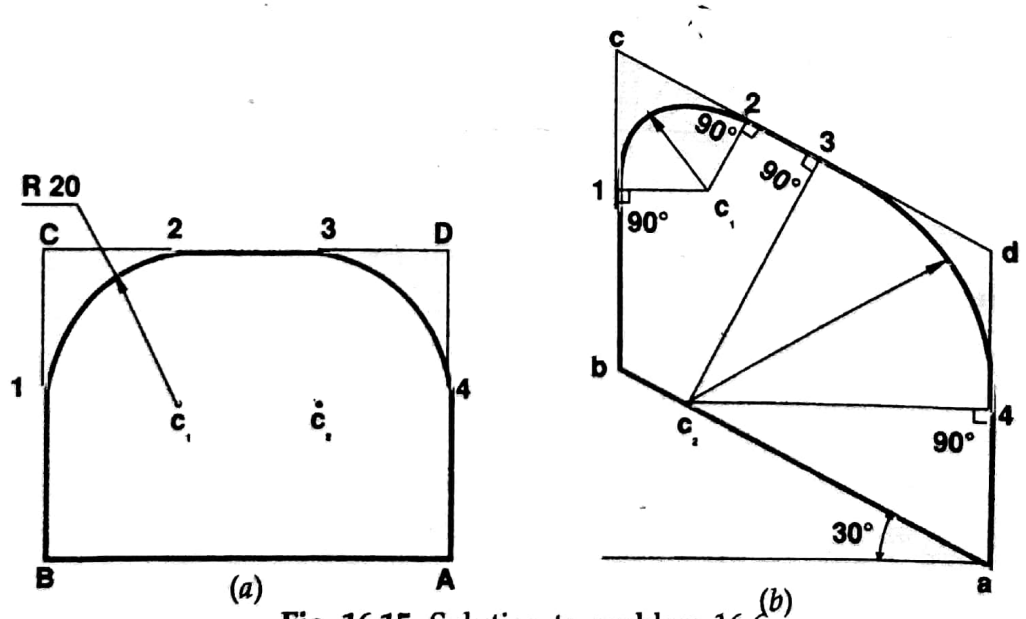


Fig. 16.15 Solution to problem 16.6

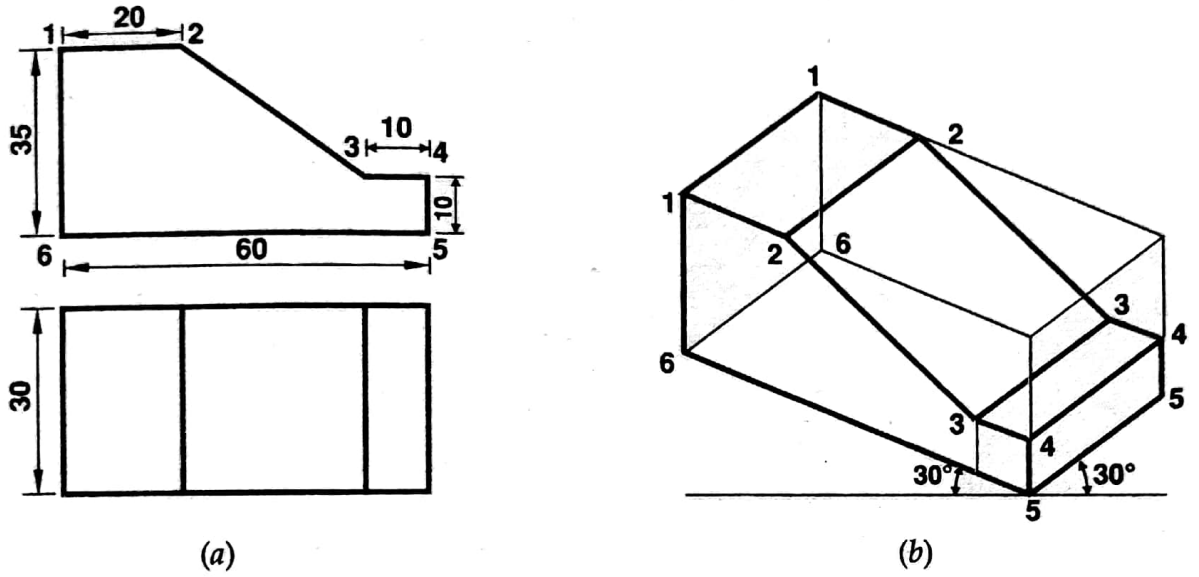
16.11 ISOMETRIC DRAWINGS OR PROJECTIONS OF PRISMS, PYRAMIDS, CYLINDERS AND CONES

PROBLEM 16.7 *Two views of a block are given in Fig. 16.16 (a). Draw its isometric drawing.*

SOLUTION.

(*i*) Draw the isometric drawing of the block.

(*ii*) Provide the notch at the corner as shown in Fig. 16.16 (*b*).



(*a*) (*b*)

Fig. 16.16 Solution to problem 16.7

PROBLEM 16.8 *Draw an isometric projection of the frustum of a right regular hexagonal pyramid, side of base hexagon is 30 mm, side of top hexagon is 15 mm and height of the frustum is 40 mm.*

SOLUTION.

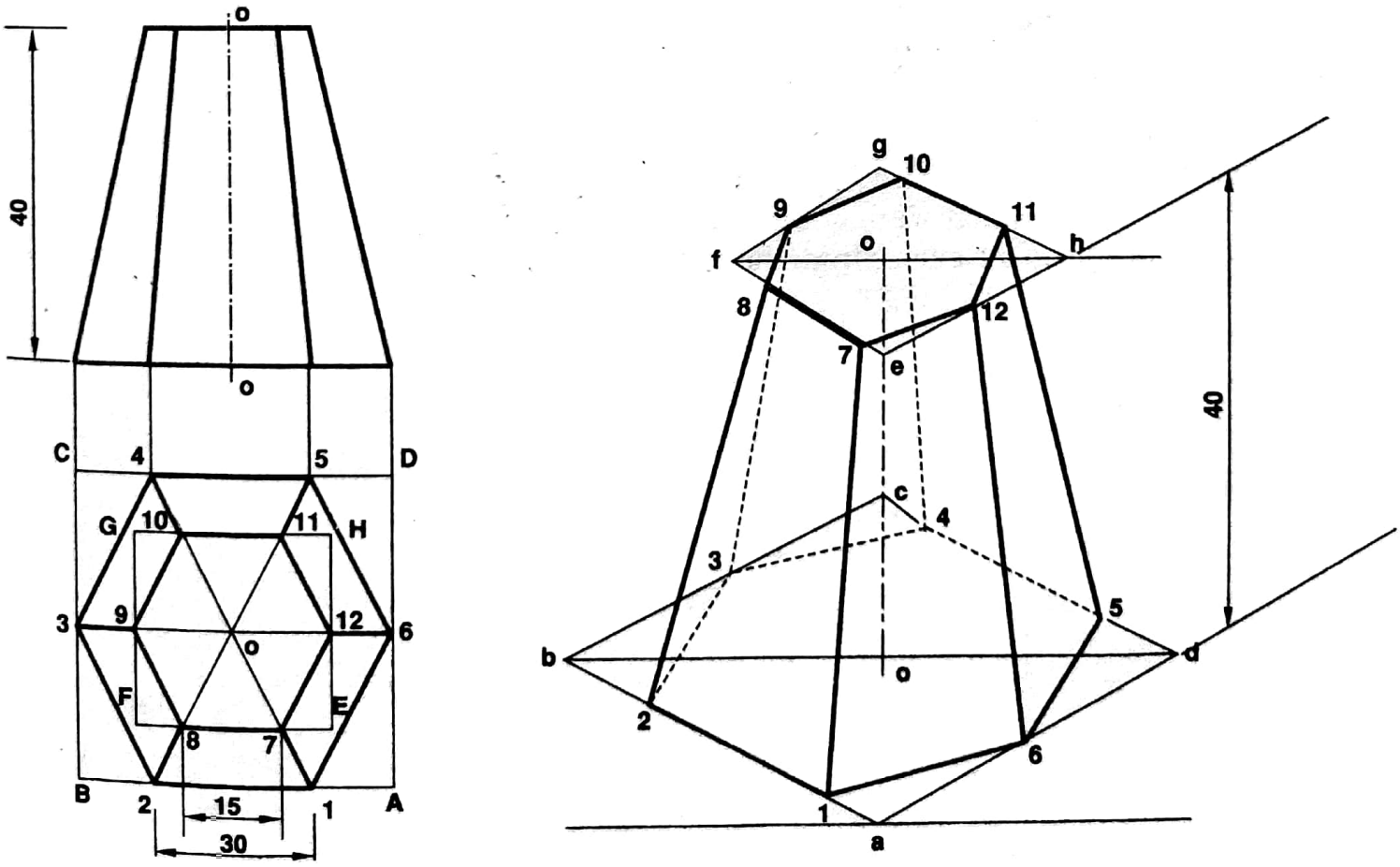


Fig. 16.17 Solution to problem 16.8

(*i*) Draw front and top views of the hexagon (using isometric scale) and enclose it in rectangles as shown in Fig. 16.17 (*a*).

(*ii*) Draw the isometric projection of the enclosing boxes and locate the corners of the two hexagon bases.

(*iii*) Join the corners and compete the isometric projection as shown in Fig. 16.17 (*b*).

PROBLEM 16.9 *Front and top views of a right circular cylinder are shown in Fig. 16.18 (a). Draw the isometric drawing of the solids.*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.18 (*b*).

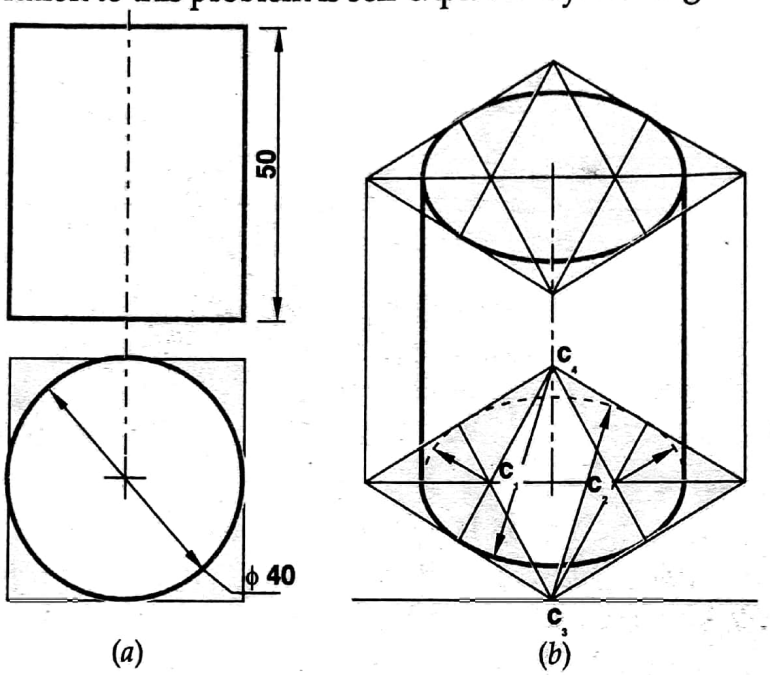


Fig. 16.18 Solution to problem 16.9

PROBLEM 16.10 *Draw the isometric projection of a cone, base 50 mm diameter and axis 60 mm long when its axis is vertical.*

SOLUTION.

(*i*) Draw an ellipse for the base (using isometric scale)

(*ii*) Determine the position of apex or vertex.

(*iii*) Draw tangents to the ellipse from the apex as shown in Fig. 16.19.

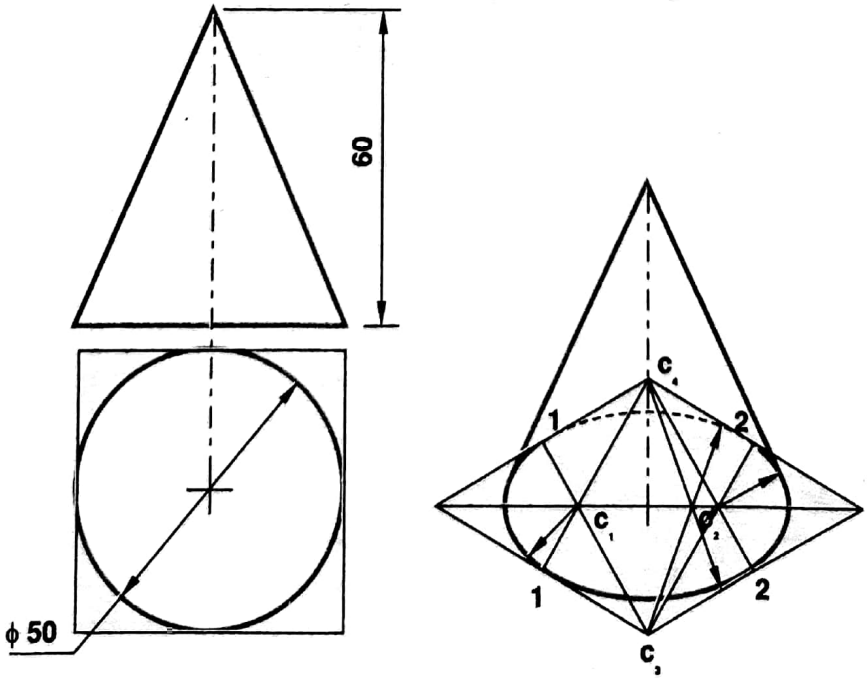


Fig. 16.19 Solution to problem 16.10

PROBLEM 16.11 *Draw the isometric drawing of the frustum of a cone as shown in Fig. 16.20 (a).*

(PTU, Jalandhar May 2013)

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.20 (*b*).

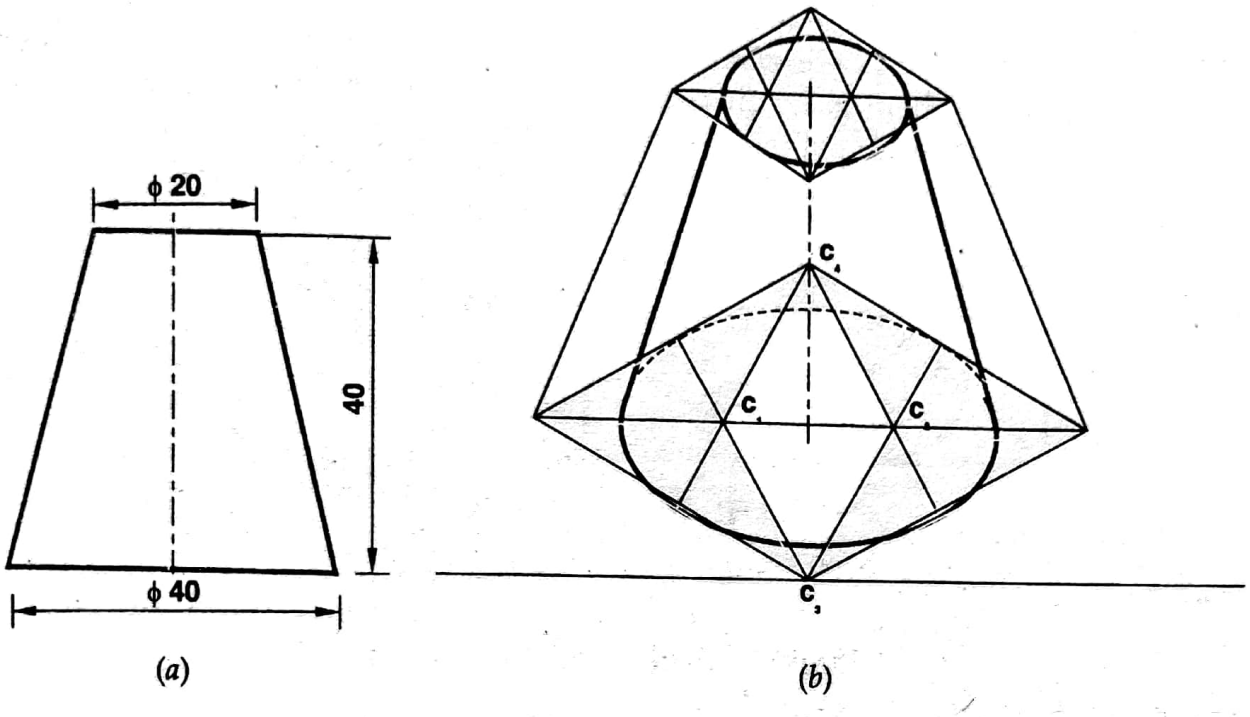


Fig. 16.20 Solution to problem 16.11

16.12 ISOMETRIC PROJECTION OF A SPHERE

A sphere appears as a circle of diameter equal to the diameter of sphere when seen from any direction. Hence, the isometric projection of a sphere is also a circle of diameter equal to the diameter of the sphere.

The isometric projection of any curved surface is evidently the envelop of all lines which can be drawn on that surface. The great circles (circles cut by any plane passing through the centre) are the lines drawn on the surface of the sphere and these are nothing but ellipses having equal major axis. Therefore, the major axis is equal to the diameter of the sphere. Hence, the envelope is a circle, whose diameter is equal to the diameter of the sphere as shown in Fig. 16.21.

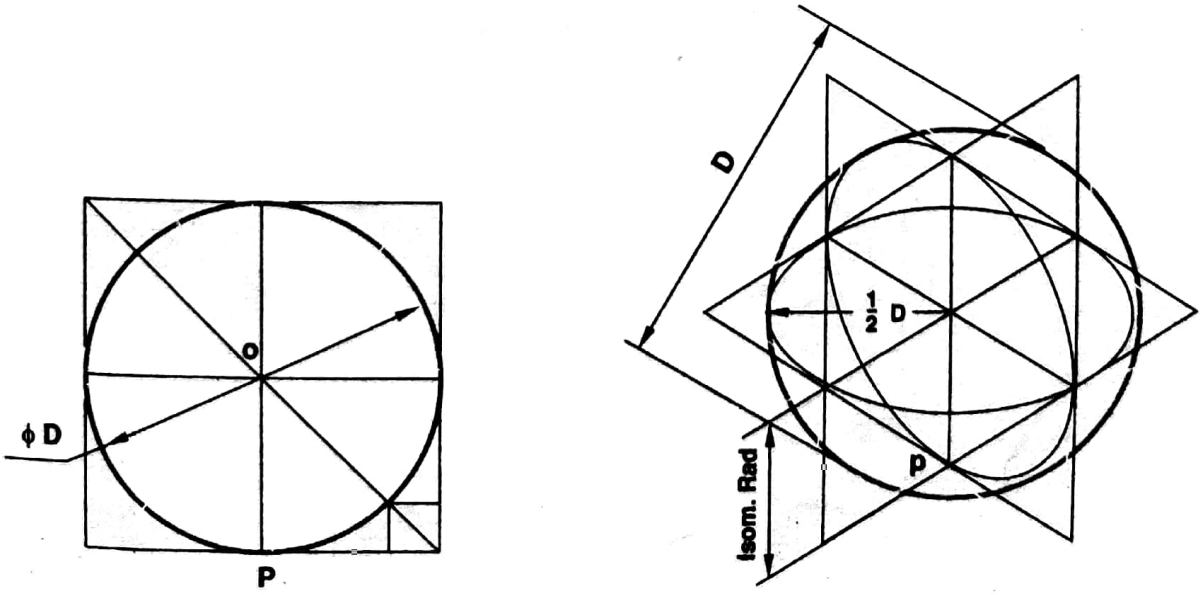


Fig. 16.21 Isometric projection of a sphere

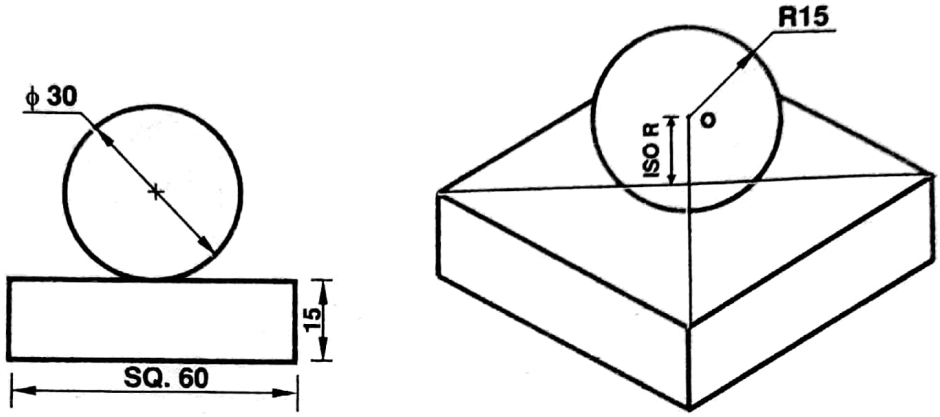
PROBLEM 16.12 *Draw the isometric projection of a sphere resting centrally on the top of a square block, the front view of which is shown in Fig. 16.22 (a).*

SOLUTION.

(*i*) Draw the isometric projection (using isometric scale) of the square block and locate the centre of its top surface.

(*ii*) Mark the centre of the sphere, such that it is equal to the isometric radius of the sphere.

(*iii*) With centre of the sphere and radius equal to the radius of the sphere, draw a circle which will be the isometric projection of the sphere, as shown in Fig. 16.22 (*b*).



(*a*) (*b*)

Fig. 16.22 Solution to problem 16.12

ADDITIONAL PROBLEMS

PROBLEM 16.13 *A cube of 40 mm edge is placed centrally on the top of a square block of 60 mm edge and 20 mm thick. Draw the isometric projections of the two solids with the edges of the two block mutually parallel to each other.* (*PTU, Jalandhar May 2004, May 2005, May 2007, May 2012, December 2014*)

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.23.

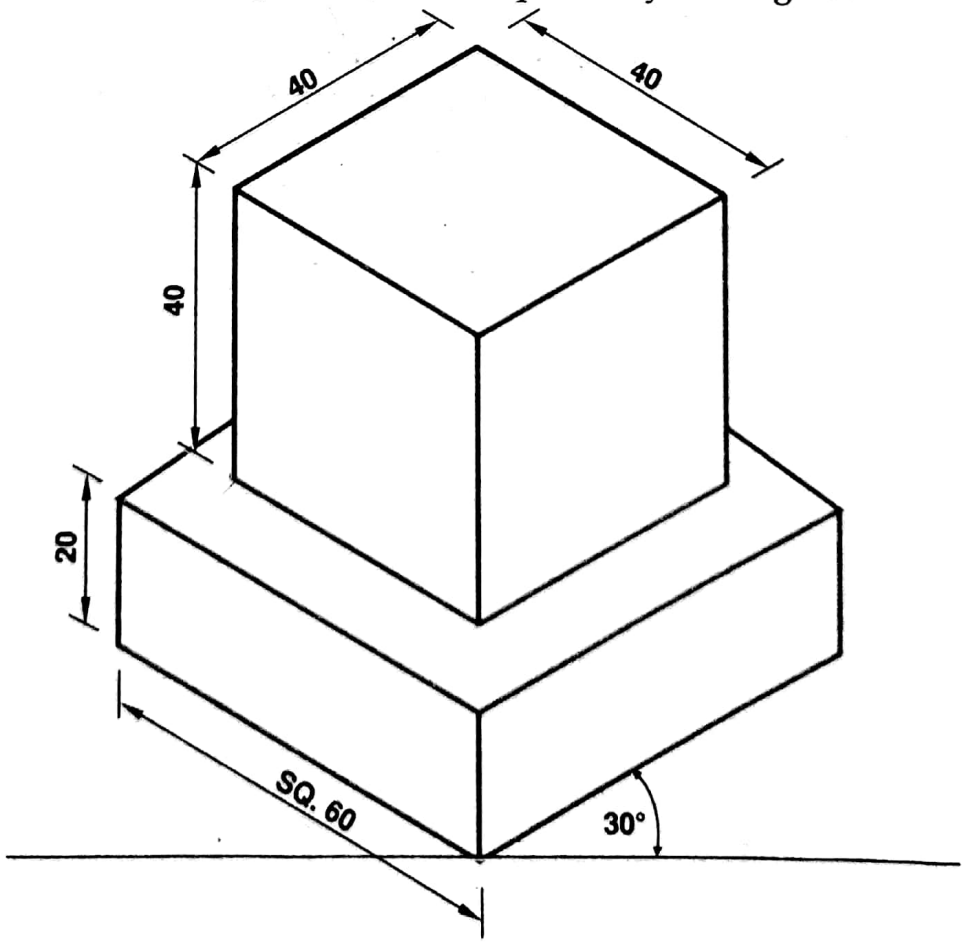


Fig. 16.23 Solution to problem 16.13

PROBLEM 16.14 *Draw the isometric projection of an object as shown in Fig. 16.24 (a).*

SOLUTION. The solution to this problem is self-explanatory, Fig. 16.24 (*b*).

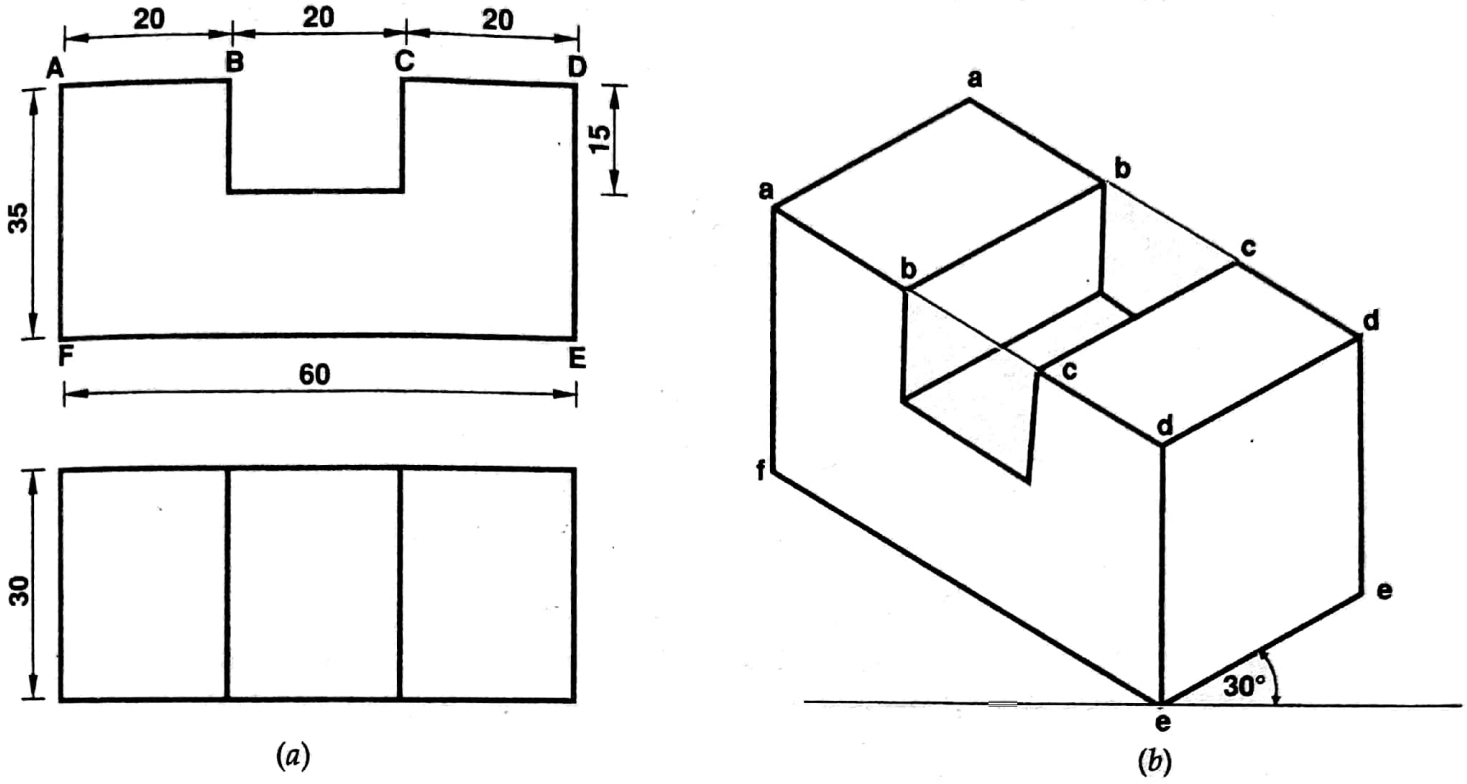


Fig. 16.24 Solution to problem 16.14

PROBLEM 16.15 *A right circular cone of ϕ 30 mm base and height 40 mm rests centrally on the top of a square block of 40 mm side and 15 mm thick. Draw the isometric projections of the solids.*

SOLUTION.

(*i*) Draw the isometric projection of the block (using isometric scale).

(*ii*) Draw the rhombus systematically about the centre point of the top surface of the block as shown in Fig. 16.25.

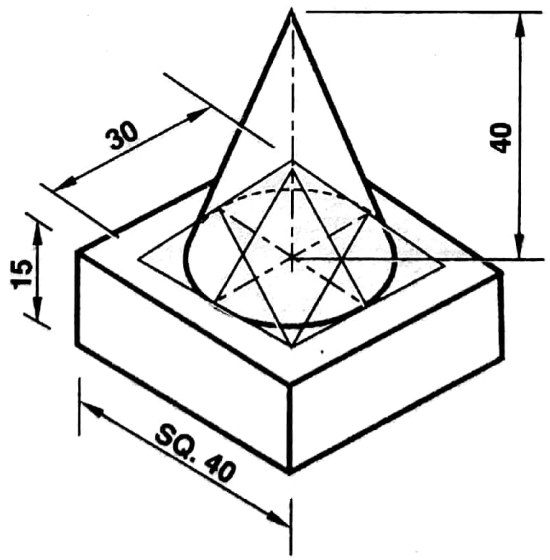


Fig. 16.25 Solution to problem 16.15

(*iii*) Draw the ellipse for the cone base.

(*iv*) Determine the position of apex or vertex.

(*v*) Draw tangents to the ellipse from the apex or vertex.

(*vi*) Complete the view by making the visible postions of the lines firm.

PROBLEM 16.16 *A sphere of ϕ 30 mm rests centrally on the top of a cube of 30 mm side. Draw the isometric projections of the solids.* (*PTU, Jalandhar May 2011, May 2014*)

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.26.

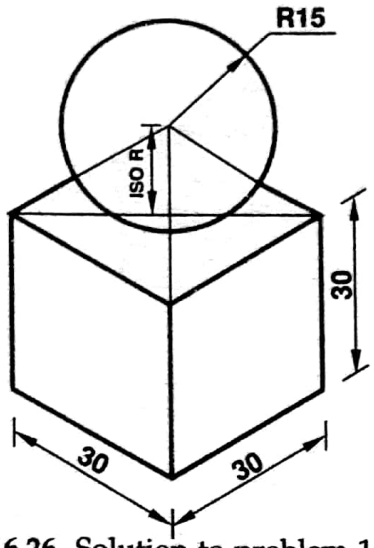


Fig. 16.26 Solution to problem 16.16

PROBLEM 16.17 *One view of an object is shown in Fig. 16.27 (a). Draw its isometric projection.*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.27 (*b*).

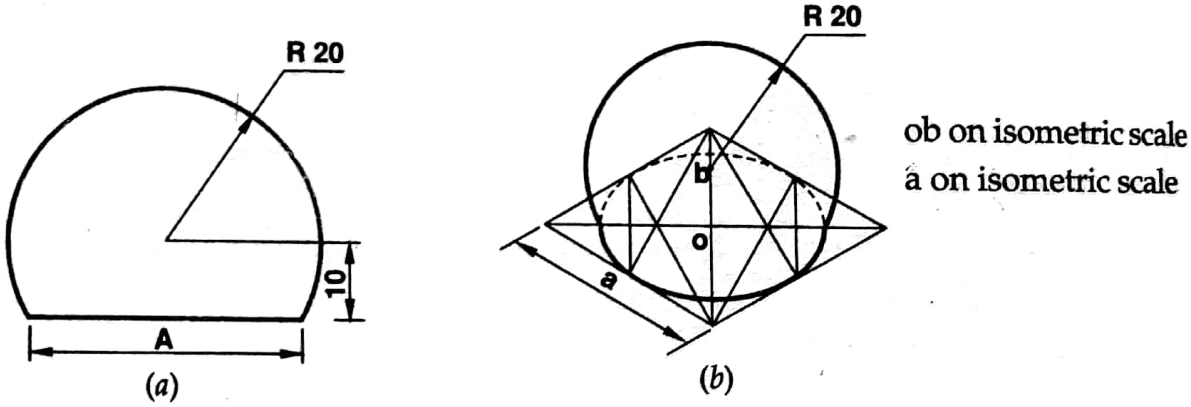


Fig. 16.27 Solution to problem 16.17

PROBLEM 16.18 *Three cubes of 40 mm, 30 mm and 20 mm are placed centrally such that the biggest cube at the bottom whereas the smallest on the top. Draw the isometric drawing of the solids.*

(*PTU, Jalandhar, June 2003, May 2011*)

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.28.

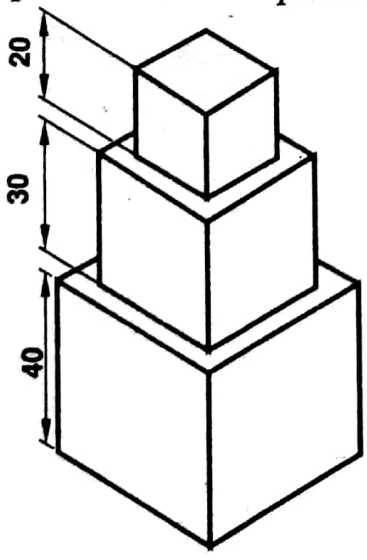


Fig. 16.28 Solution to problem 16.18

PROBLEM 16.19 *Two cubes of sides 20 mm and 30 mm are resting one upon another such that their vertical axes are in same line. Draw the isometric projection of the cubes assuming small cube is resting on bigger one.* *(PTU, Jalandhar December 2004, December 2013)*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.29

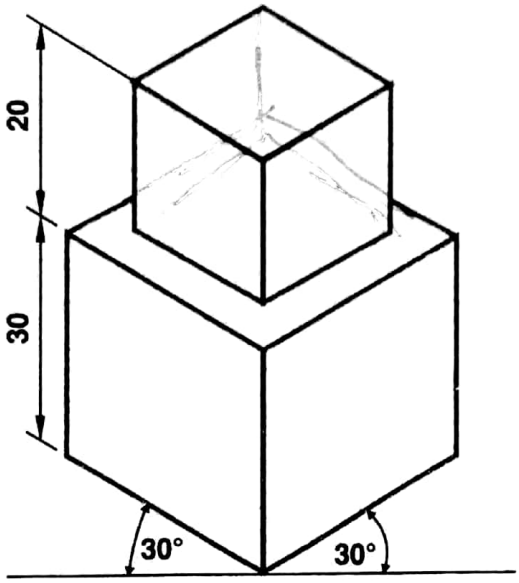


Fig. 16.29 Solution to problem 16.19

PROBLEM 16.20 *A cube of 30 mm side rests on the top of a cylindrical slab of 60 mm diameter and 25 mm thick. The axes of the solids are in same straight line. Draw an isometric projection of the solid.* *(PTU, Jalandhar December 2004, May 2005, May 2010, December 2015)*

SOLUTION.

(*i*) Draw the isometric projection of the cylindrical slab using the isometric scale by four centre method.

(*ii*) Draw a cube of side 30 mm on the top of the cylindrical slab as shown in Fig. 16.30, such that the axes of the two solids are in a straight line.

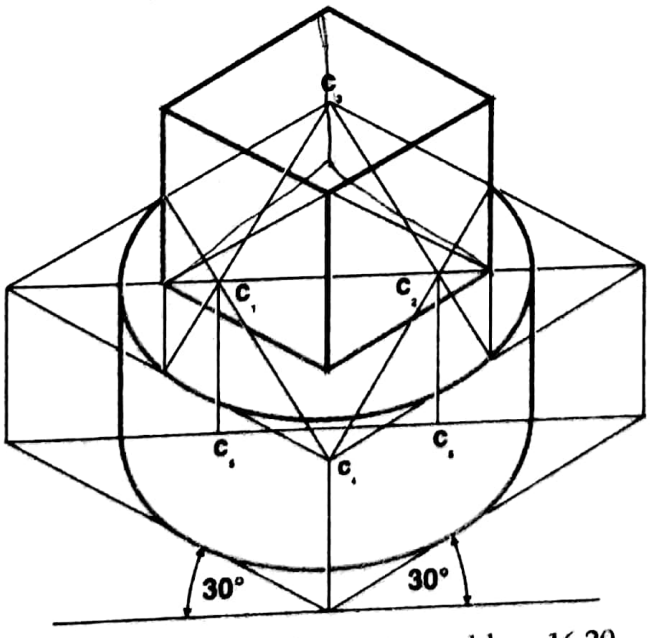


Fig. 16.30 Solution to problem 16.20

PROBLEM 16.21 *A cylindrical block of 45 mm diameter and 25 mm height is placed centrally on a cube of 45 mm side. The axes of the two solids are in the same straight line. Draw the isometric drawing of the solids.* *(PTU, Jalandhar May 2004, December 2012)*

SOLUTION. All construction lines are retained to help in understanding the solution. See Fig. 16.31.

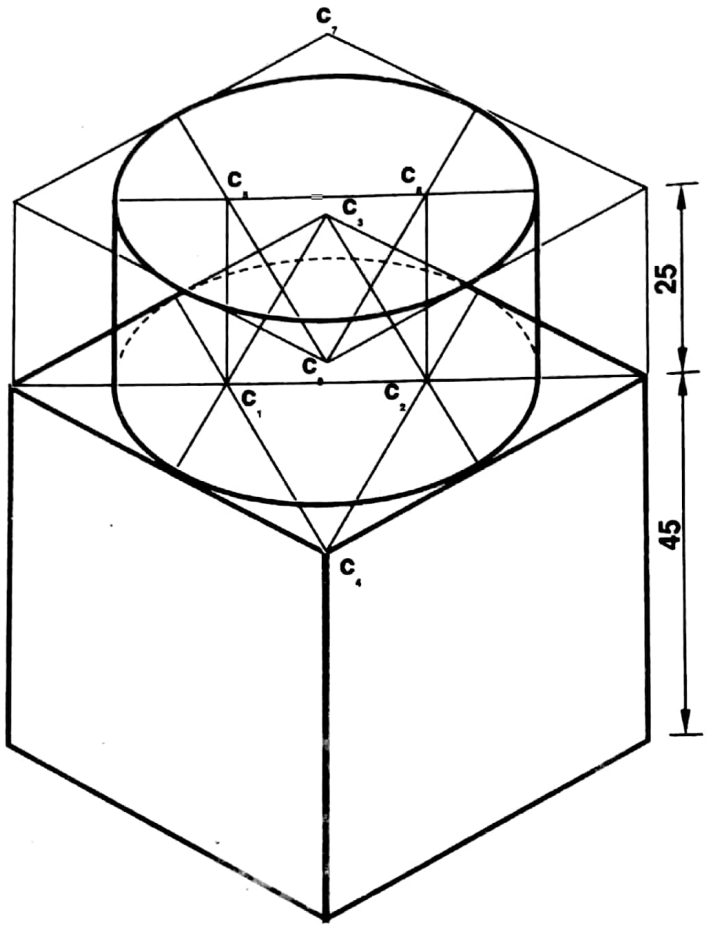


Fig. 16.31 Solution to problem 16.21

PROBLEM 16.22 *A hemi-sphere of 40 mm diameter rests on its circular base on the top of a cube of 40 mm. Draw the isometric projection of the solids.* (*PTU, Jalandhar December 2003*)

SOLUTION.

(*i*) Draw the isometric projection of the cube using the isometric scale.

(*ii*) Draw the ellipse for the circular base of the hemisphere, using the four-centre method.

(*iii*) Draw a circular arc of 20 mm radius tangential to the ellipse as shown in Fig. 16.32.

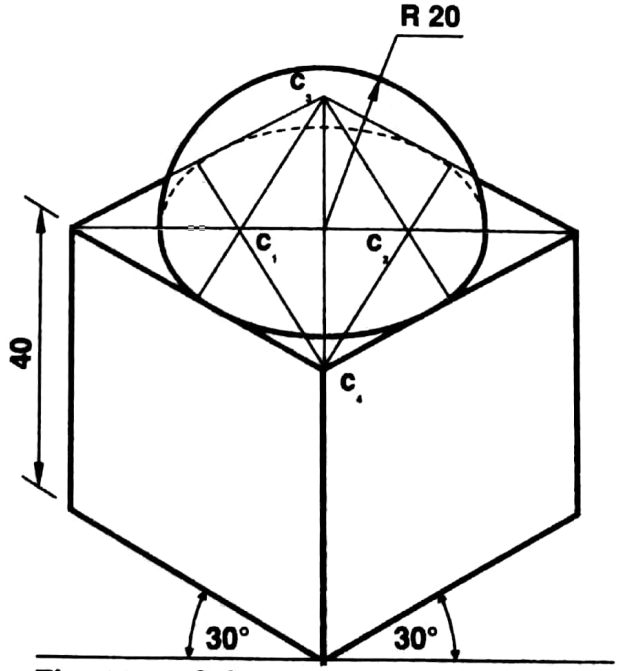


Fig. 16.32 Solution to problem 16.22

PROBLEM 16.23 *A square prism of side 30 mm and 40 mm high is resting on HP. A vertical square base of 10 mm side is cut through its face reaching other square face of the prism. Draw the isometric projection of the prism.* *(PTU, Jalandhar December 2003, December 2006, May 2008)*

SOLUTION.

(*i*) Draw the isometric projection of the square prism using the isometric scale.

(*ii*) Draw a square base of 10 mm vertically as shown in Fig. 16.33. Complete the problem showing hidden edges by dotted lines.

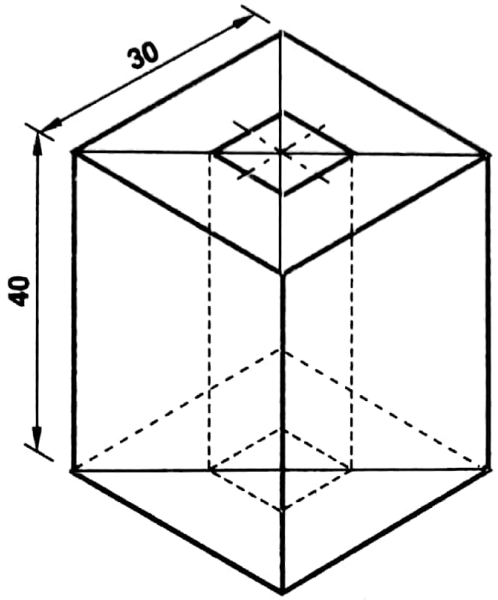


Fig. 16.33 Solution to problem 16.23

PROBLEM 16.24 *A right circular cone of ϕ 20 mm base and height 30 mm rests centrally on the top of a cube of 40 mm side. Draw the isometric projection of the two solids.*

SOLUTION. All the construction lines are retained to make the understanding of the solution easily. See Fig. 16.34.

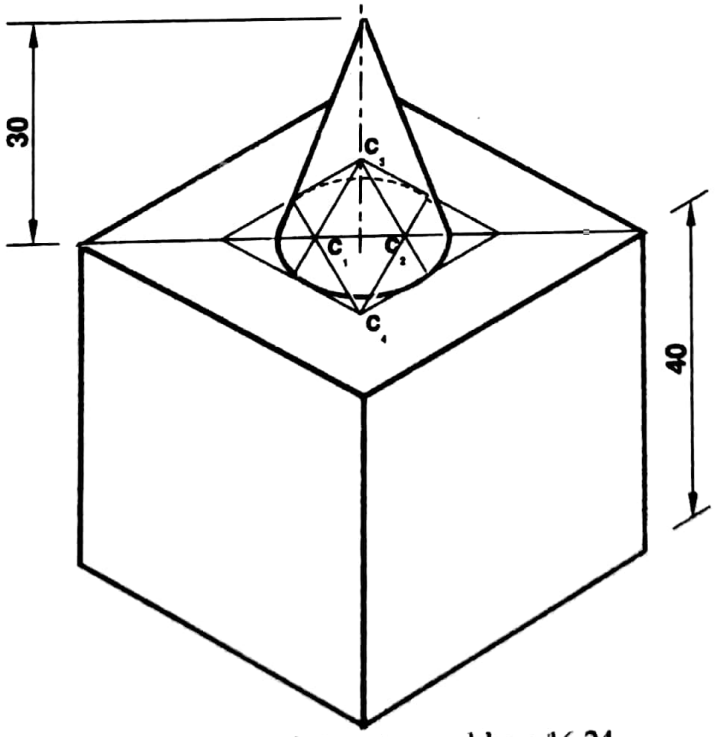


Fig. 16.34 Solution to problem 16.24

PROBLEM 16.25 *A cylindrical slab 60 mm diameter and 20 mm thick is surmounted by a cube of 28 mm edge. On the top of a cube, rests a square pyramid, attitude 30 mm and side of base 15 mm. The axes of the two solids are in the same straight line. Draw isometric projections of the solids.*

(PTU, Jalandhar December 2009)

SOLUTION. For its solution, see Fig. 16.35.

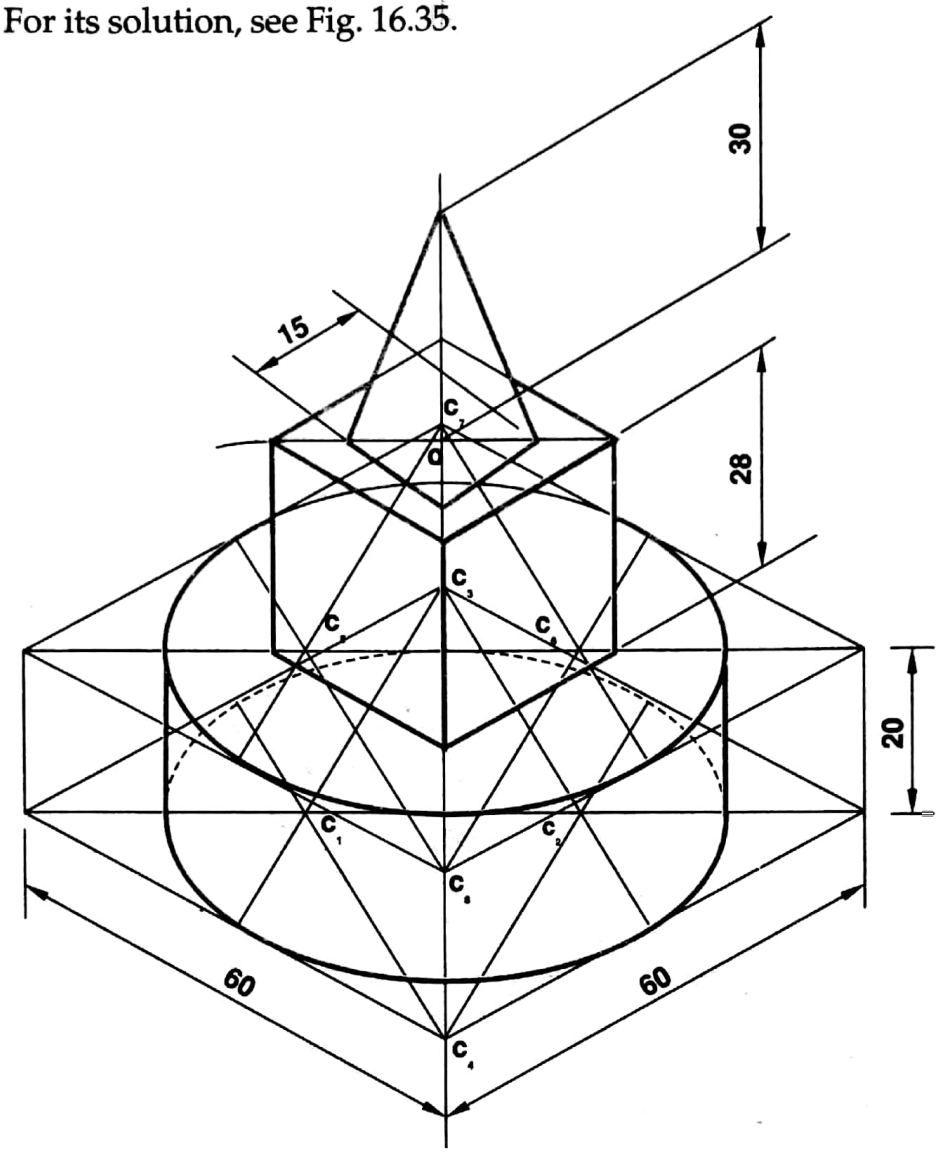


Fig. 16.35 Solution to problem 16.25

PROBLEM 16.26 *Draw the isometric projection of the three bricks of size 30 mm × 30 mm × 15 mm from the given front view and top view as shown in Fig. 16.36 (a).*

SOLUTION. For its solution, see Fig. 16.36 (*b*).

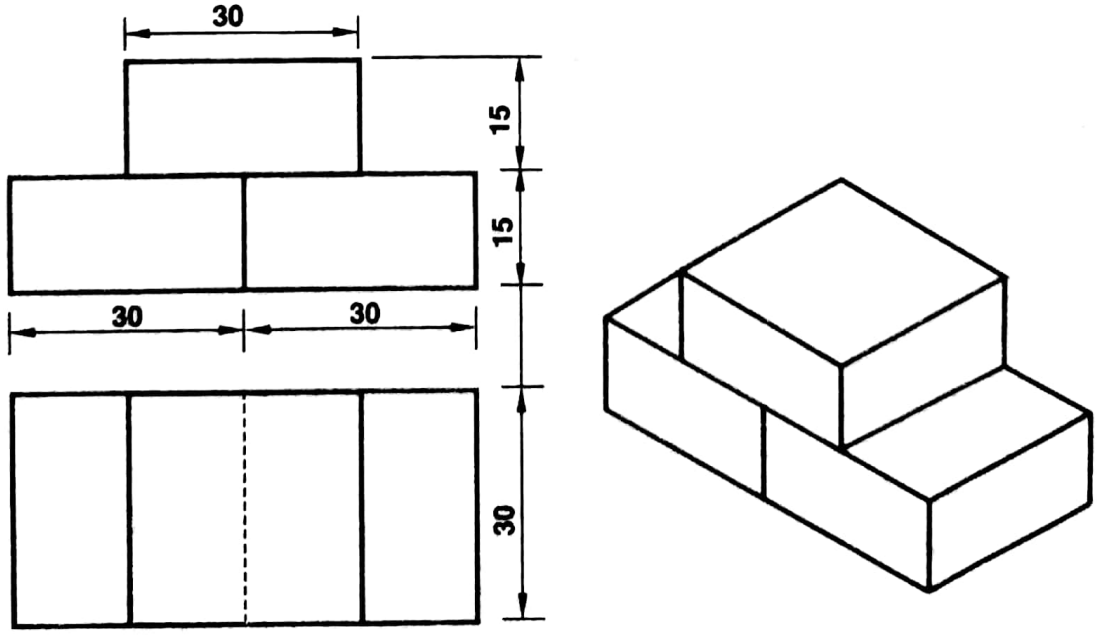
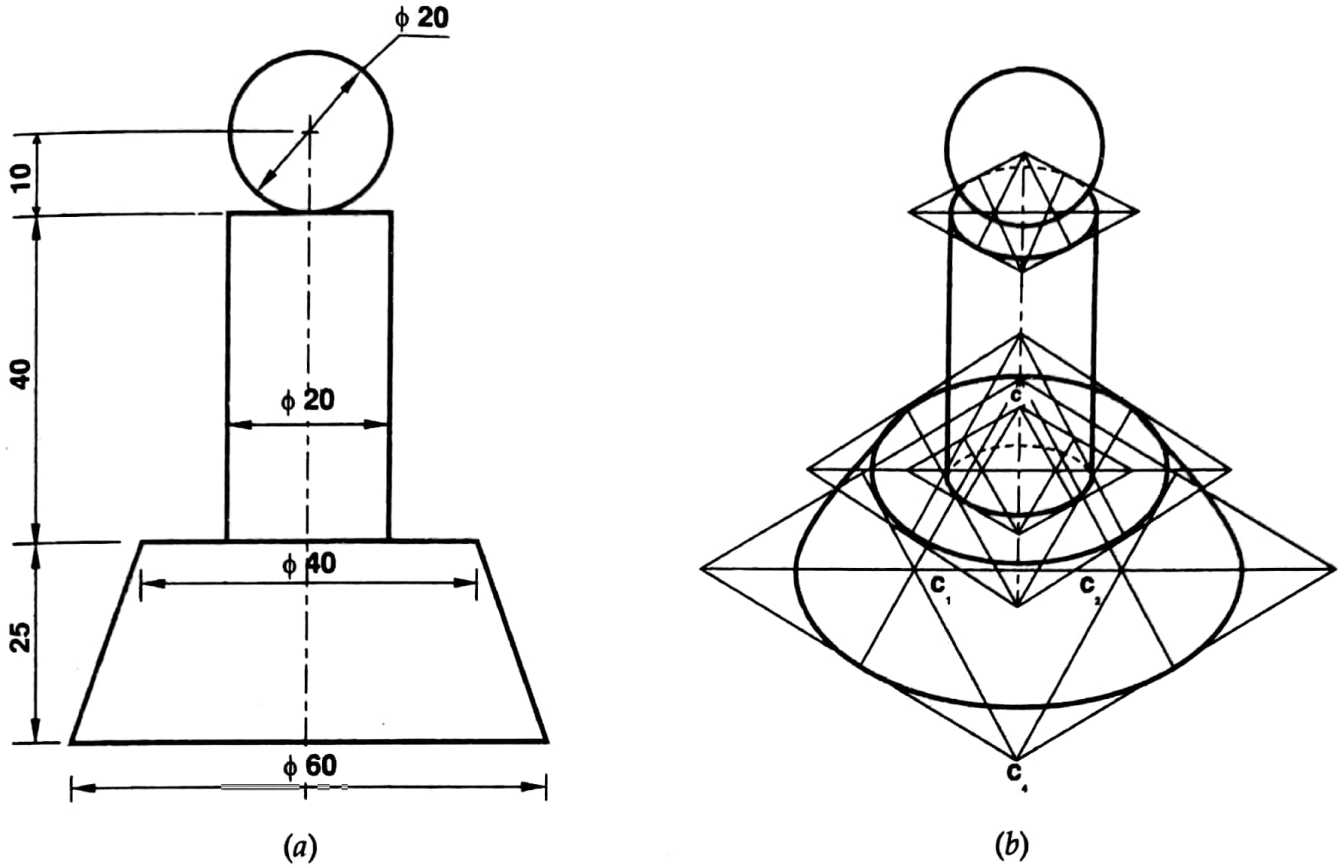


Fig. 16.36 Solution to problem 16.26

PROBLEM 16.27 *Front view of a given Fig. 16.37 (a) is shown. Draw its isometric projection.*

SOLUTION. For its solution, see Fig. 16.37 (*b*).

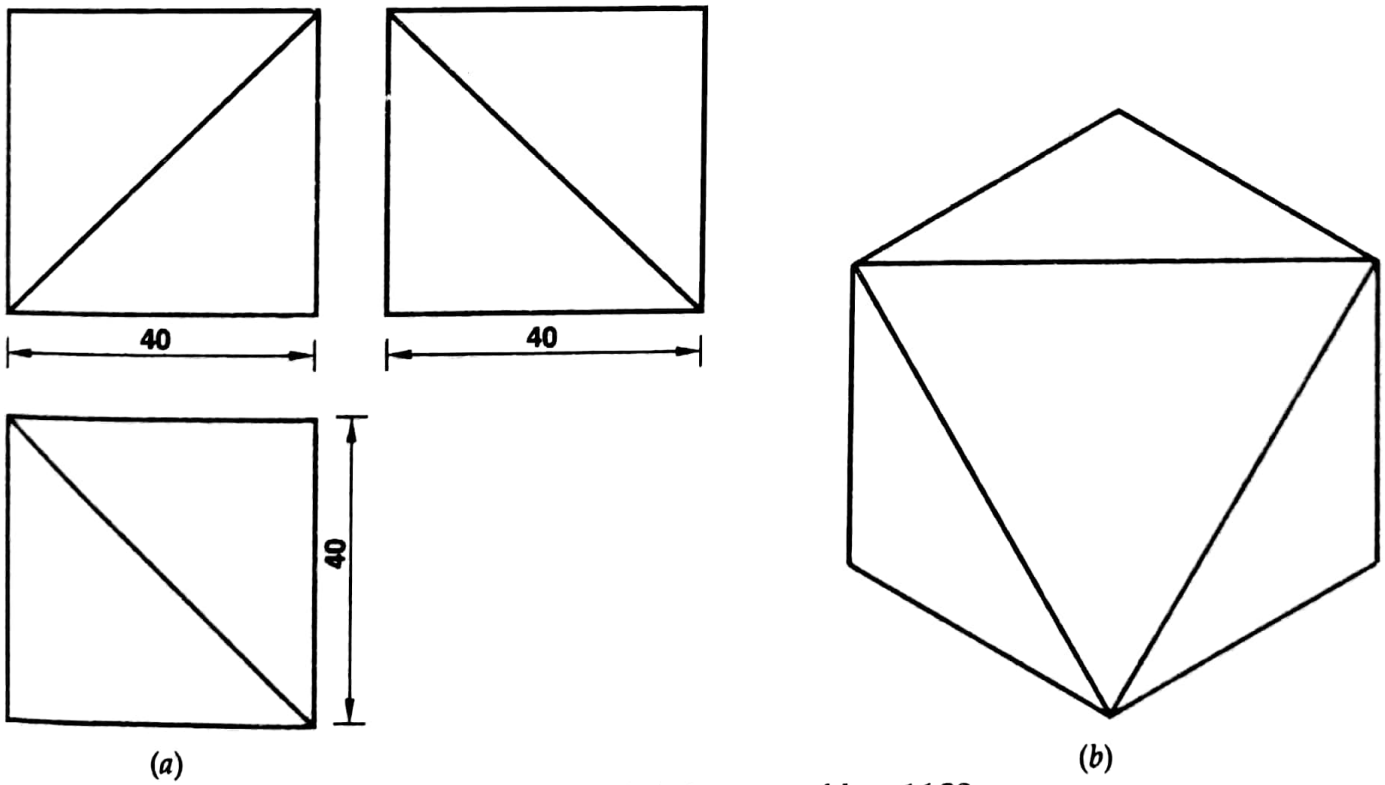


(*a*) (*b*)

Fig. 16.37 Solution to problem 16.27

PROBLEM 16.28 *Fig. 16.38 (a) shown three views of a cube cut by an oblique plane. Draw its isometric drawing.*

SOLUTION. For its solution, see Fig. 16.38 (*b*).

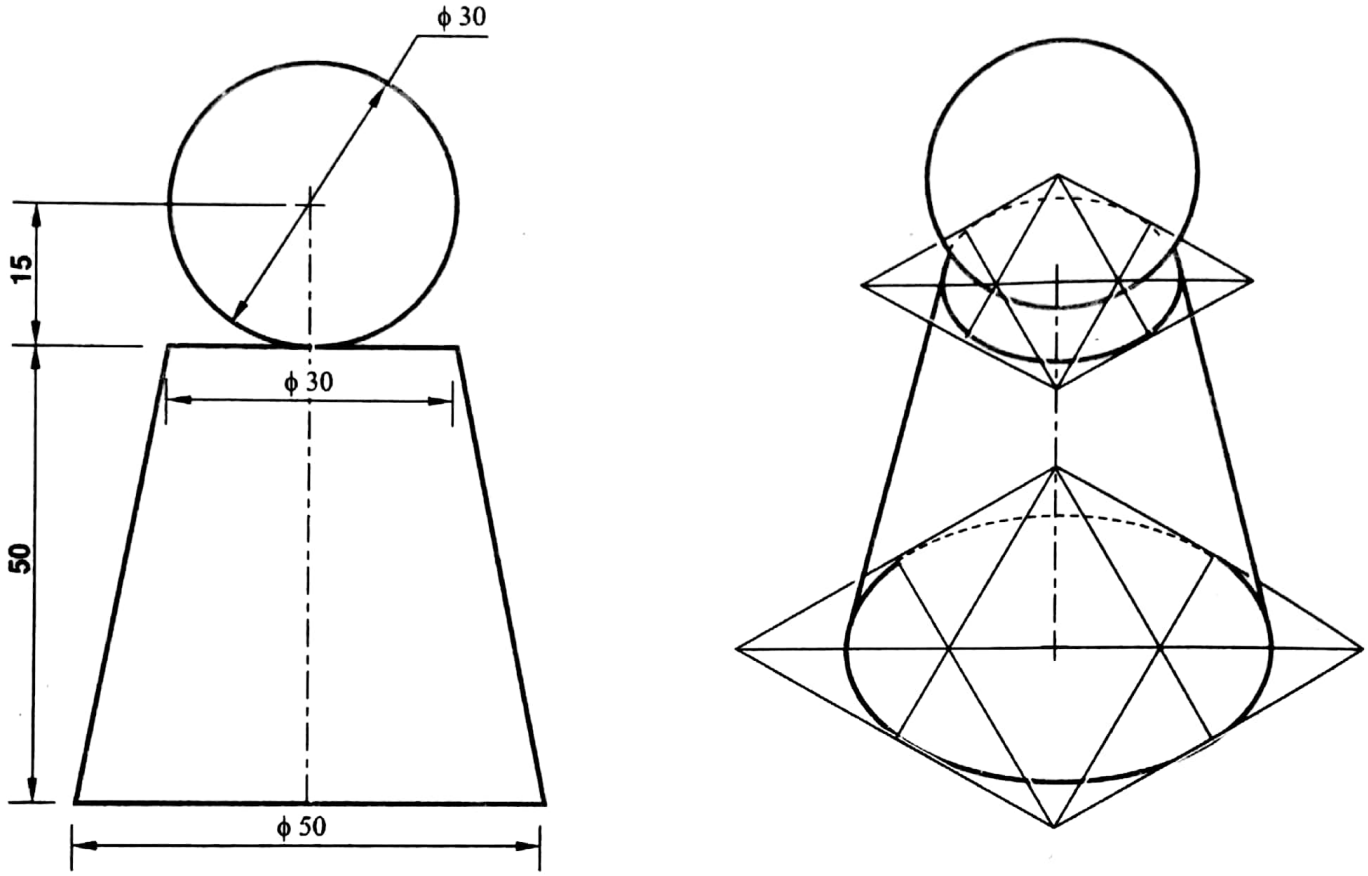


(*a*) (*b*)

Fig. 16.38 Solution to problem 16.28

PROBLEM 16.29 *Front view of a given Fig. 16.39 (a) is shown. Draw its isometric projection.*

SOLUTION. For its solution, see Fig. 16.39 (*b*).



(*a*) (*b*)

Fig. 16.39 Solution to problem 16.29

PROBLEM 16.30 *A sphere of 60 mm diameter is placed centrally on the top of a frustum of a square pyramind. The base of the frustum is 60 square, top 40 square and its height is 50 mm. Draw the isometric projection of the arrangement.* (*PTU, Jalandhar May 2001*)

SOLUTION. For its solution, see Fig. 16.40.

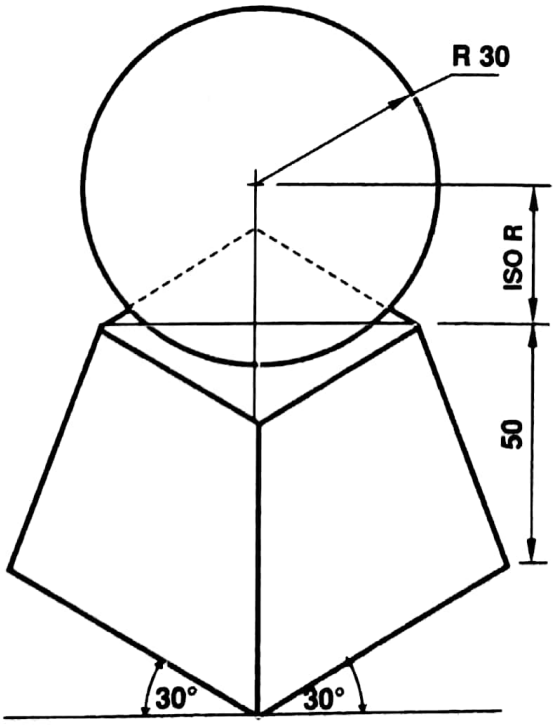


Fig. 16.40 Solution to problem 16.30

PROBLEM 16.31 *A right regular hexagonal prism, edge of base 20 mm and height 50 mm, has a circular hole of 20 mm diameter drilled centrally through it, along its axis. Draw its isometric projection.*

(PTU, Jalandhar December 2003)

SOLUTION. For its solution, see Fig. 16.41.

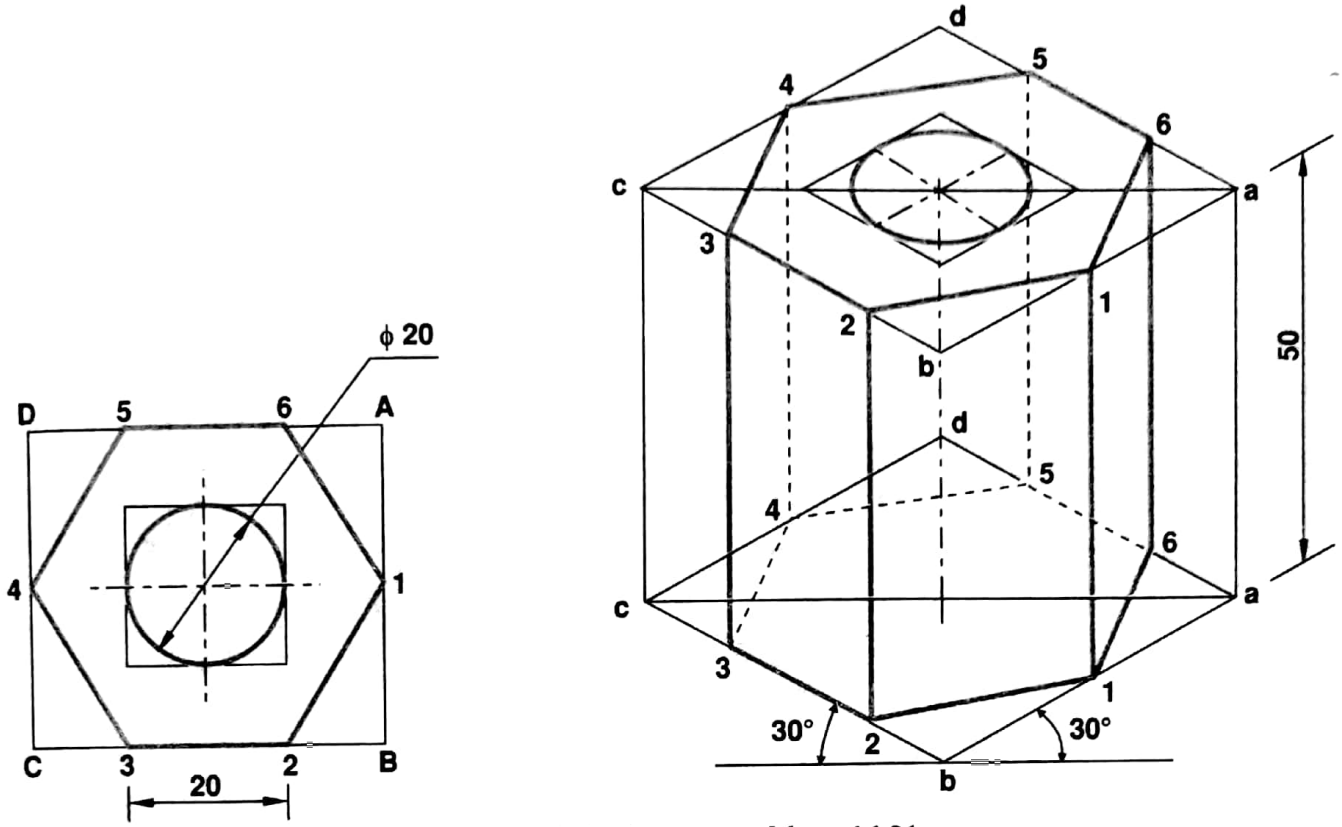


Fig. 16.41 Solution to problem 16.31

PROBLEM 16.32 *Draw isometric drawing of a pentagonal prism of base side 25 mm and axis 50 mm long rests on HP on one of its rectangular faces with its axis perpendicular to the VP.*

SOLUTION. The solution to this problem is self – explanatory. See Fig. 16.42.

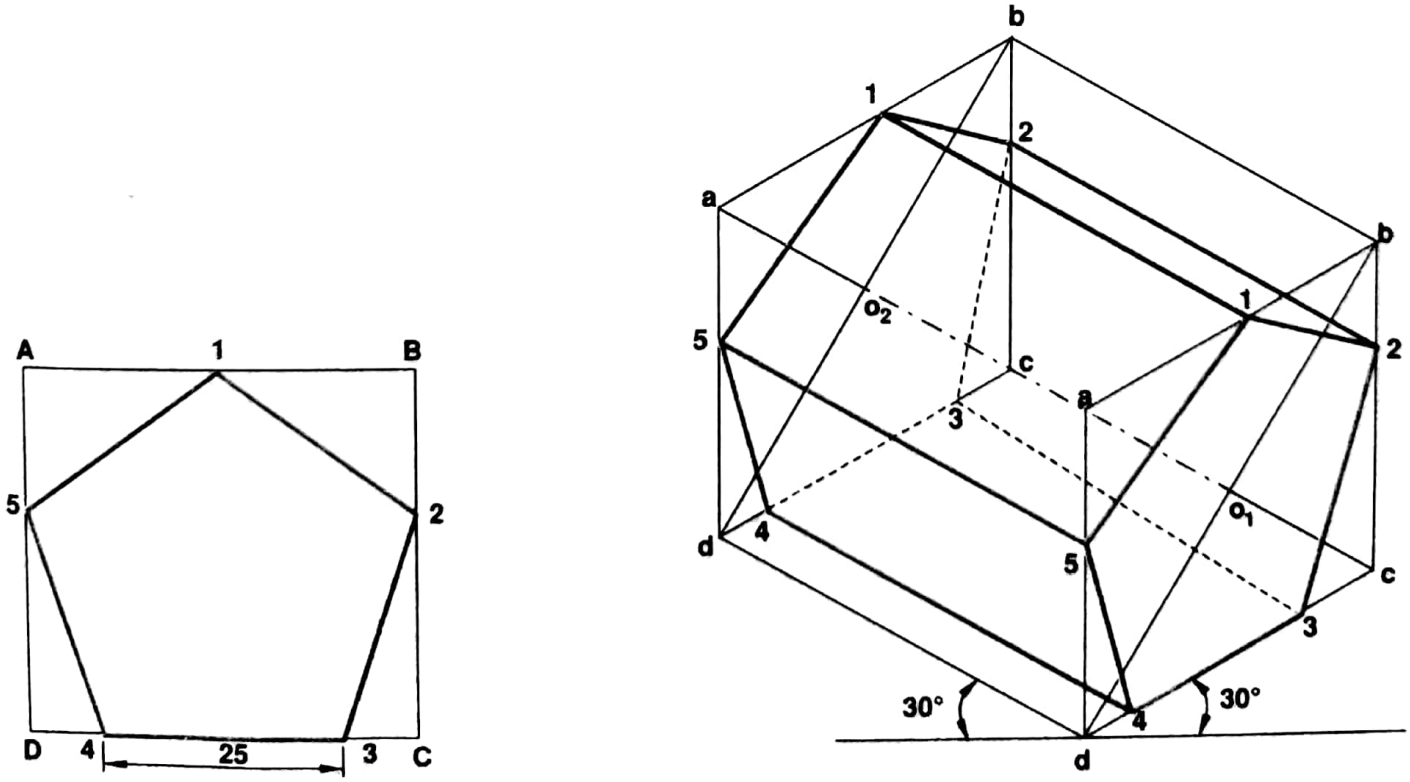


Fig. 16.42 Solution to problem 16.32

PROBLEM 16.33 *Draw isometric projection of a hexagonal prism of side of base 30 mm and height 50 mm surmounting a square pyramid of side 20 mm and height 45 mm such that the axes of the two solids are collinear and atleast one of the edges of the two solids is parallel.*

SOLUTION. All the construction lines are retained to make the solution self-explanatory. See 16.43.

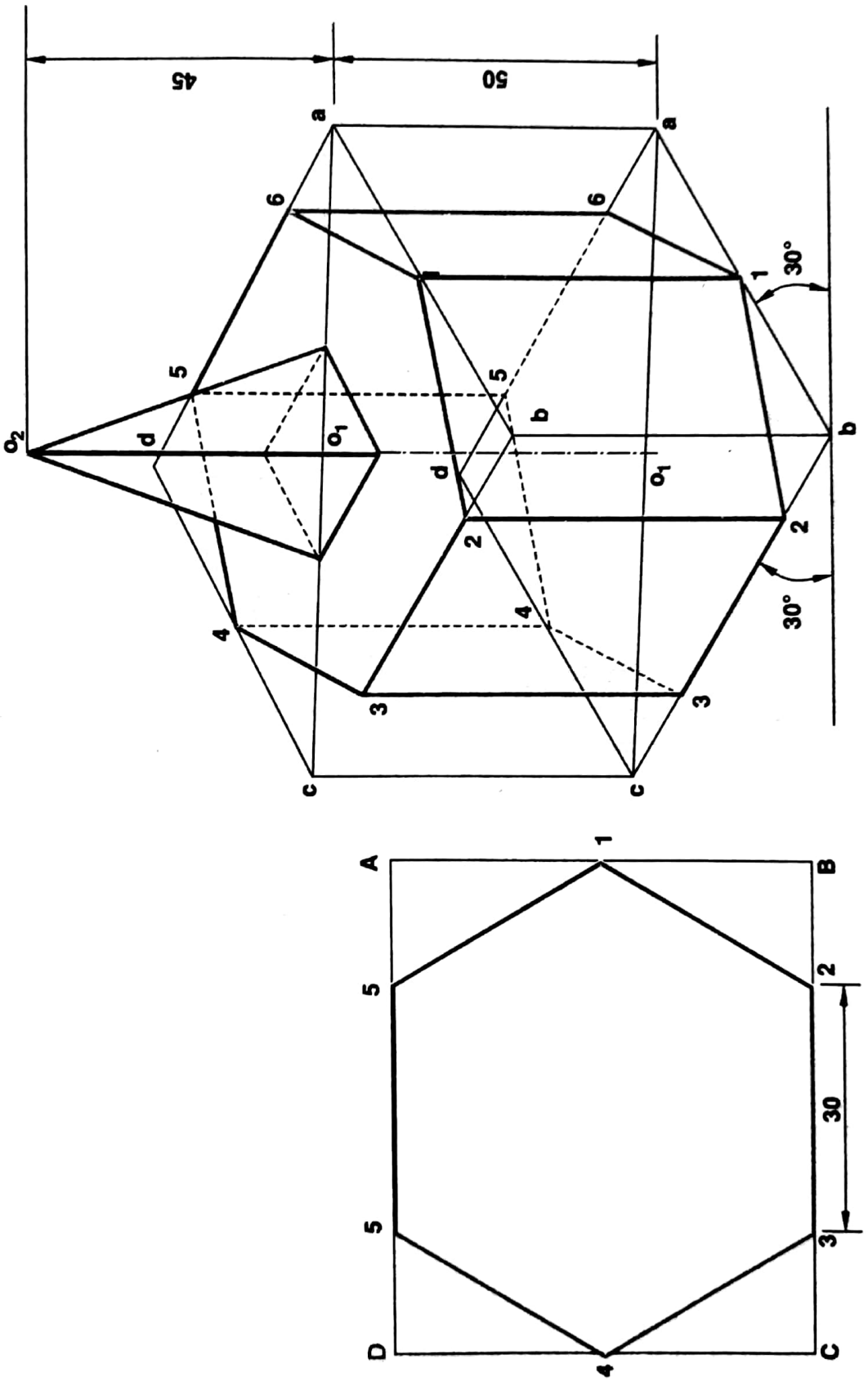


Fig. 16.43 Solution to problem 16.33

PROBLEM 16.34 *Draw isometric drawing of a funnel consisting of a cylinder and a frustum of a cone. The diameter of the cylinder is 30 mm and top diameter of the frustum is 50 mm. The height of frustum of a cone and cylinder are both equal to 40 mm.*

SOLUTION.

(*i*) Draw isometric drawing of the cylinder.

(*ii*) Draw a frustum of a cone as shown in Fig. 16.44. Complete the problem showing hidden edges by dotted lines.

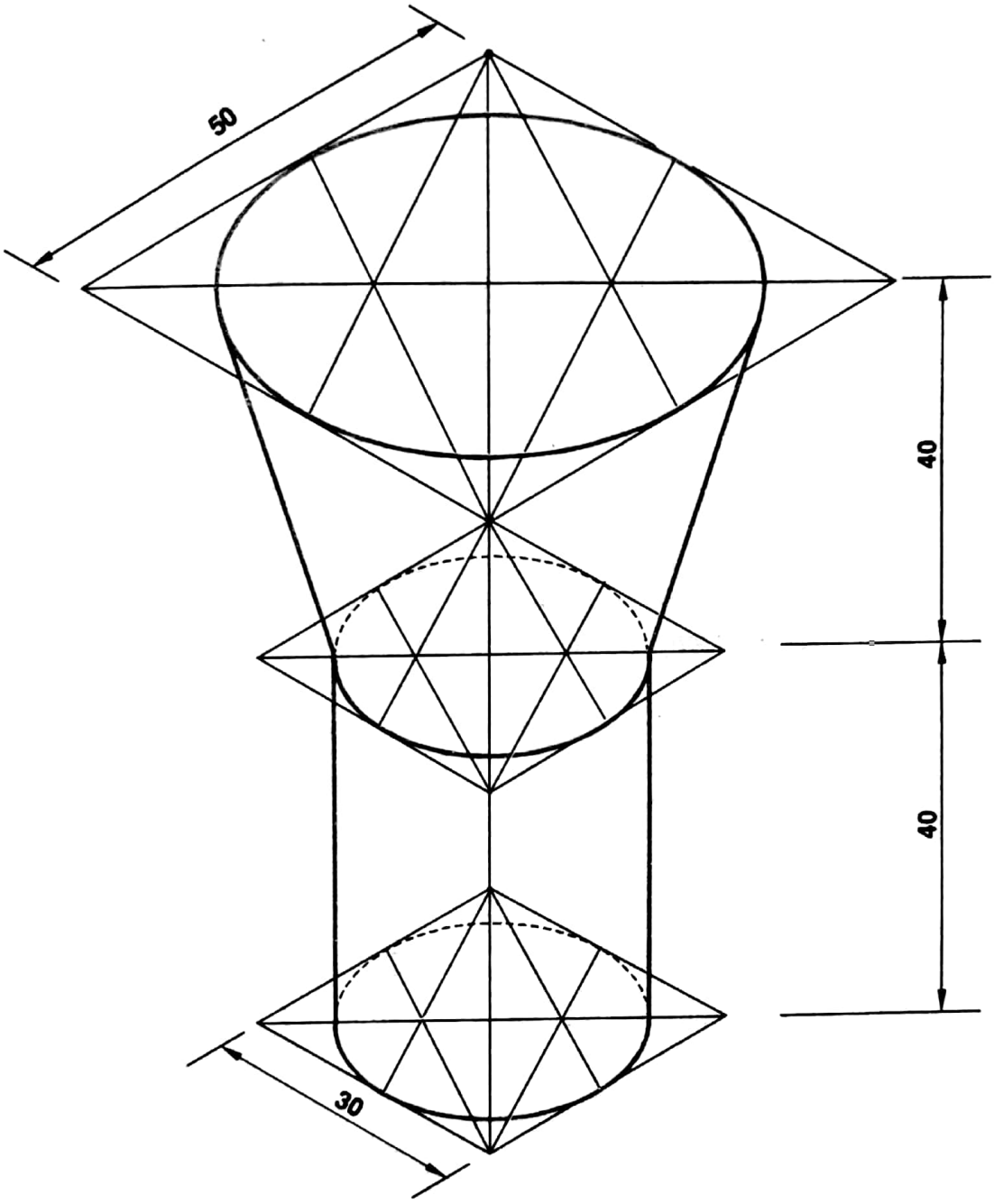


Fig. 16.44 Solution to problem 16.34

PROBLEM 16.35 *A right regular pentagonal prism, edge of base 30 mm and height 50 mm, has a circular hole of diameter 25 mm, drilled centrally through it, along its axis. Draw its isometric projection.*

SOLUTION.

(*i*) Draw the top view of the solid using the isometric scale.

(*ii*) Enclose the top view in a rectangular box.

(*iii*) Locate the various positions of the corner points of the pentagon.

(*iv*) Add the ellipse for the circular hole as shown in Fig. 16.45 and complete the isometric projection.

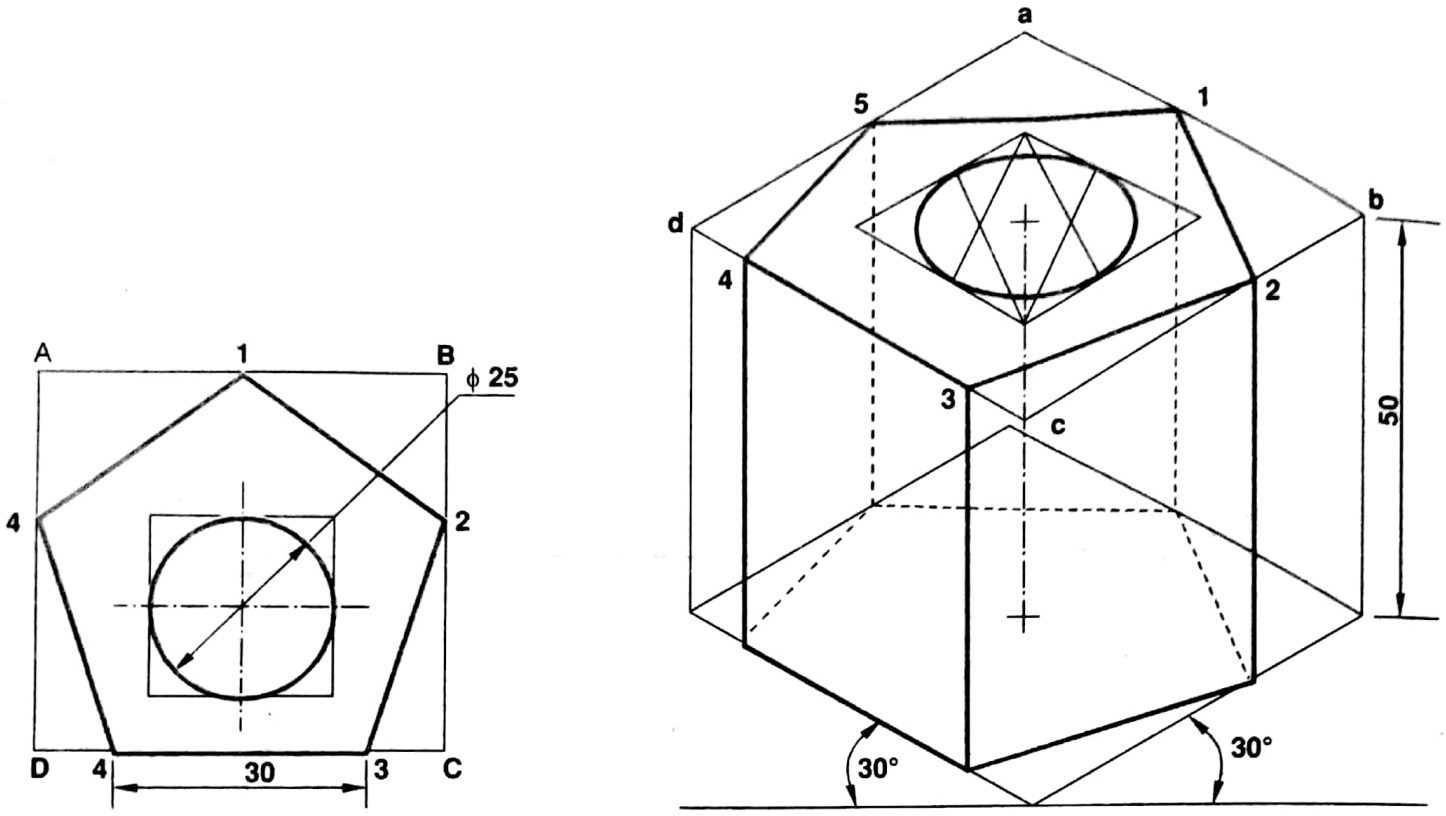


Fig. 16.45 Solution to problem 16.35

PROBLEM 16.36 *A square prism of side 40 mmm and height 65 mm is resting on ground. A vertical hole of diameter 20 mm is cut through from top face reaching bottom face of the prism. Draw the isometric projection of the prism.* *(PTU, Jalandhar December 2005, May 2015)*

SOLUTION. The interpretation of the solution is left to the reader. See Fig. 16.46.

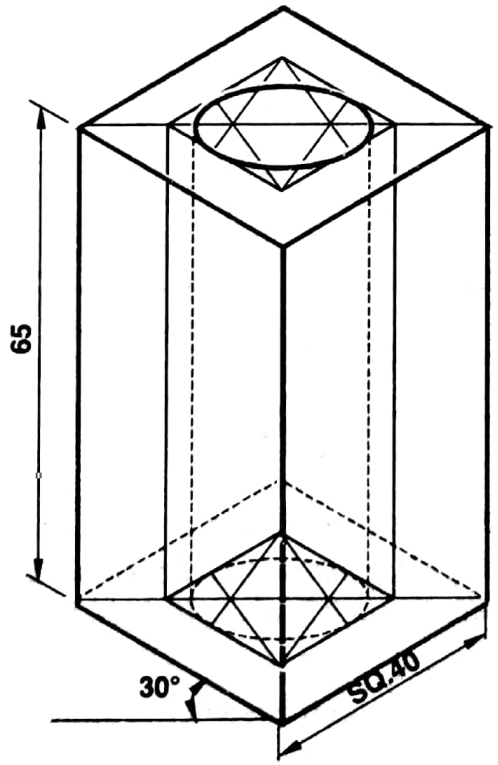


Fig. 16.46 Solution to problem 16.36

PROBLEM 16.37 *Draw the isometric projection of a sphere of radius 30 mm resting centrally on the top of the square prism of side 40 mm and height 60 mm.* *(PTU, Jalandhar May 2006)*

SOLUTION. The interpretation of the solution is left to the reader. See Fig. 16.47.

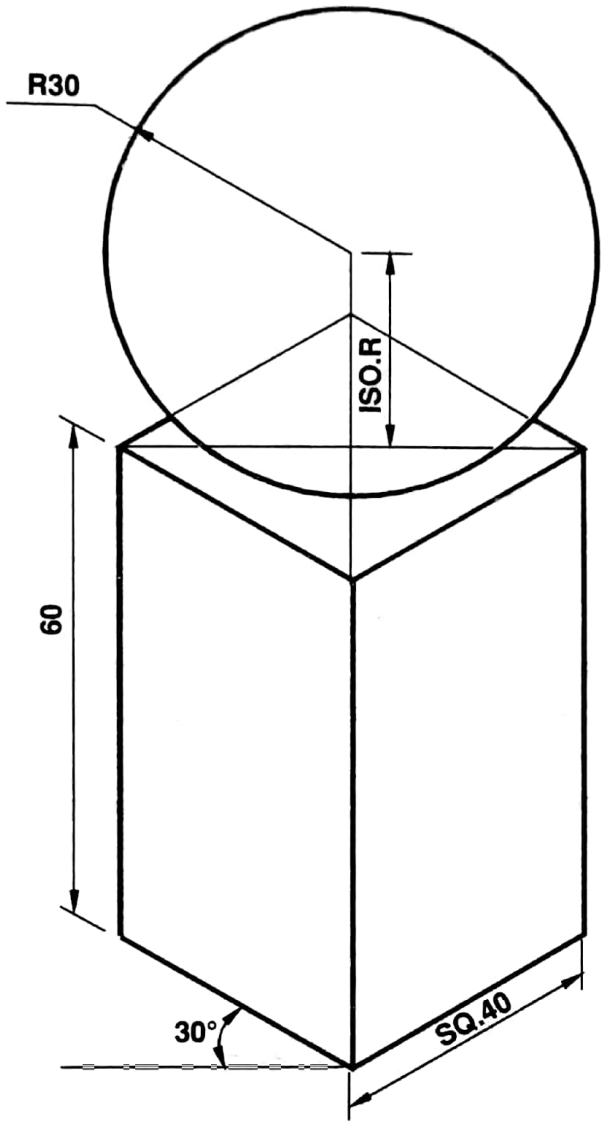


Fig. 16.47 Solution to problem 16.37

PROBLEM 16.38 *A pentagonal prism is placed on the square slab 60 mm and 20 mm height. The side of prism is 25 mm and height 50 mm. Draw its isometric projections.*

SOLUTION. All the construction lines are retained to make the understanding of the solution easily. See Fig. 16.48.

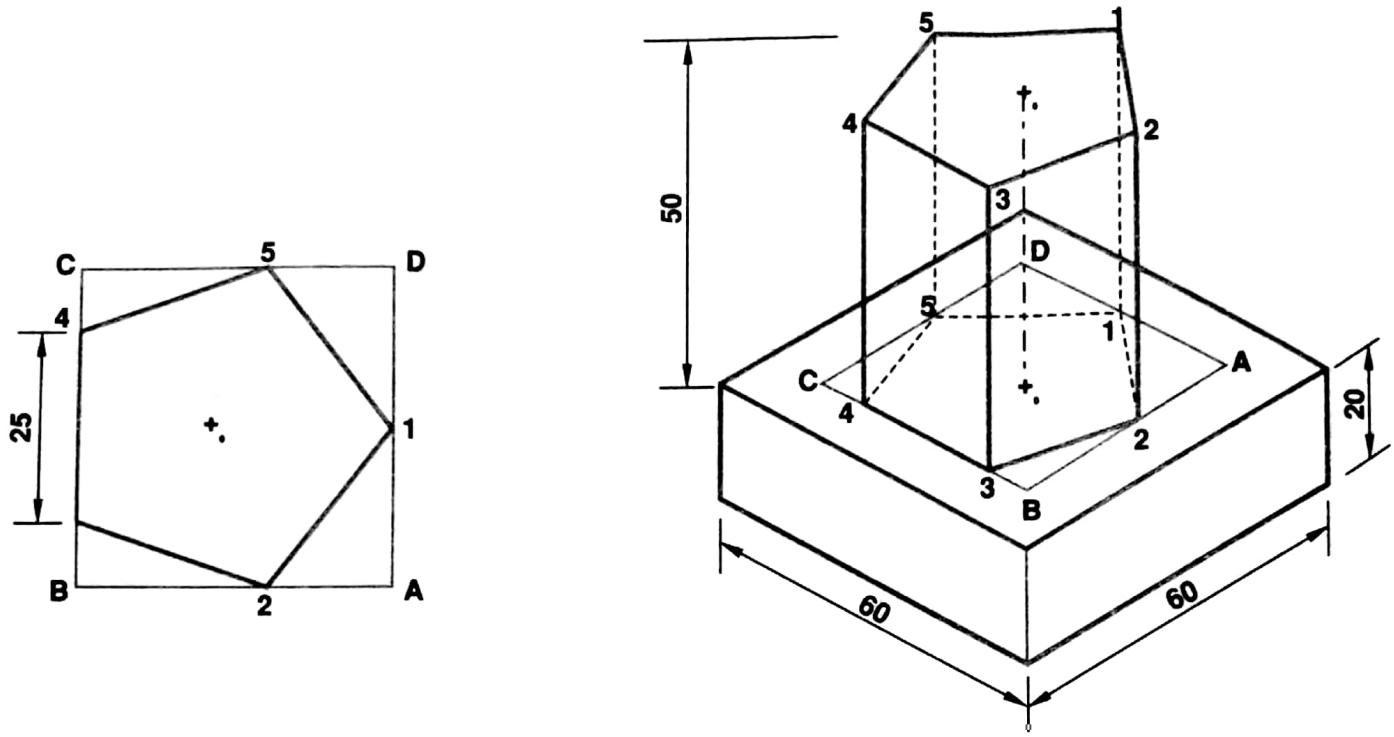


Fig. 16.48 Solution to problem 16.38

PROBLEM 16.39 *Draw isometric projections of a cylindrical block of 50 mm diameter and 20 mm thicknesses having a cube of 25 mm side resting centrally on top of it, which in turn is having a sphere of 25 mm diameter resting centrally on top of it.* (*PTU, Jalandhar December 2007*)

SOLUTION. All construction lines are retained to make the solution self-explanatory. See Fig. 16.49.

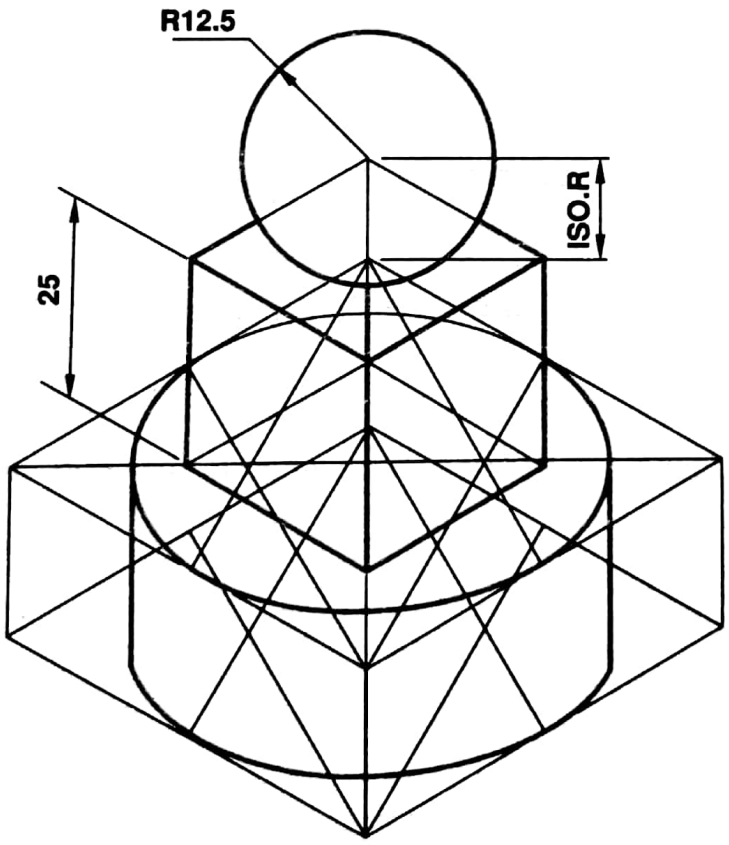


Fig. 16.49 Solution to problem 16.39

PROBLEM 16.40 *Draw the isometric projection from the orthographic projection of the block as shown in Fig. 16.2 (a).*

SOLUTION. The interpretation of the solution is left to the reader. See Fig. 16.50.

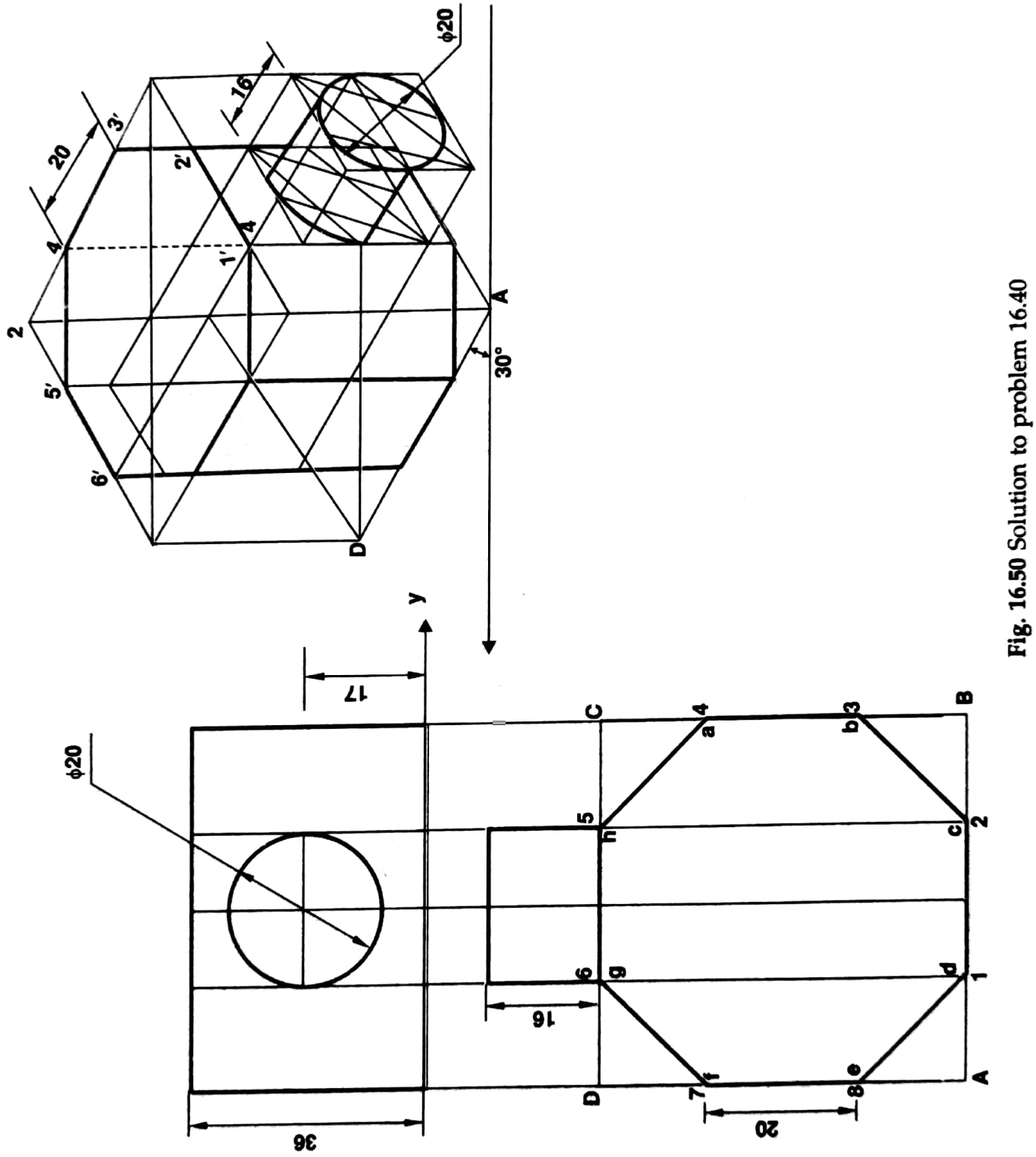


Fig. 16.50 Solution to problem 16.40

PROBLEM 16.41 *Draw isometric drawing of a hexagonal prism of base side 25 mm and axis 50 mm long (a) rests on HP on one of its rectangular faces with its axis perpendicular to the VP, (b) when its axis is kept perpendicular to HP.*

SOLUTION. All the construction lines are retained to make the solution self-explanatory. See Fig. 16.51.

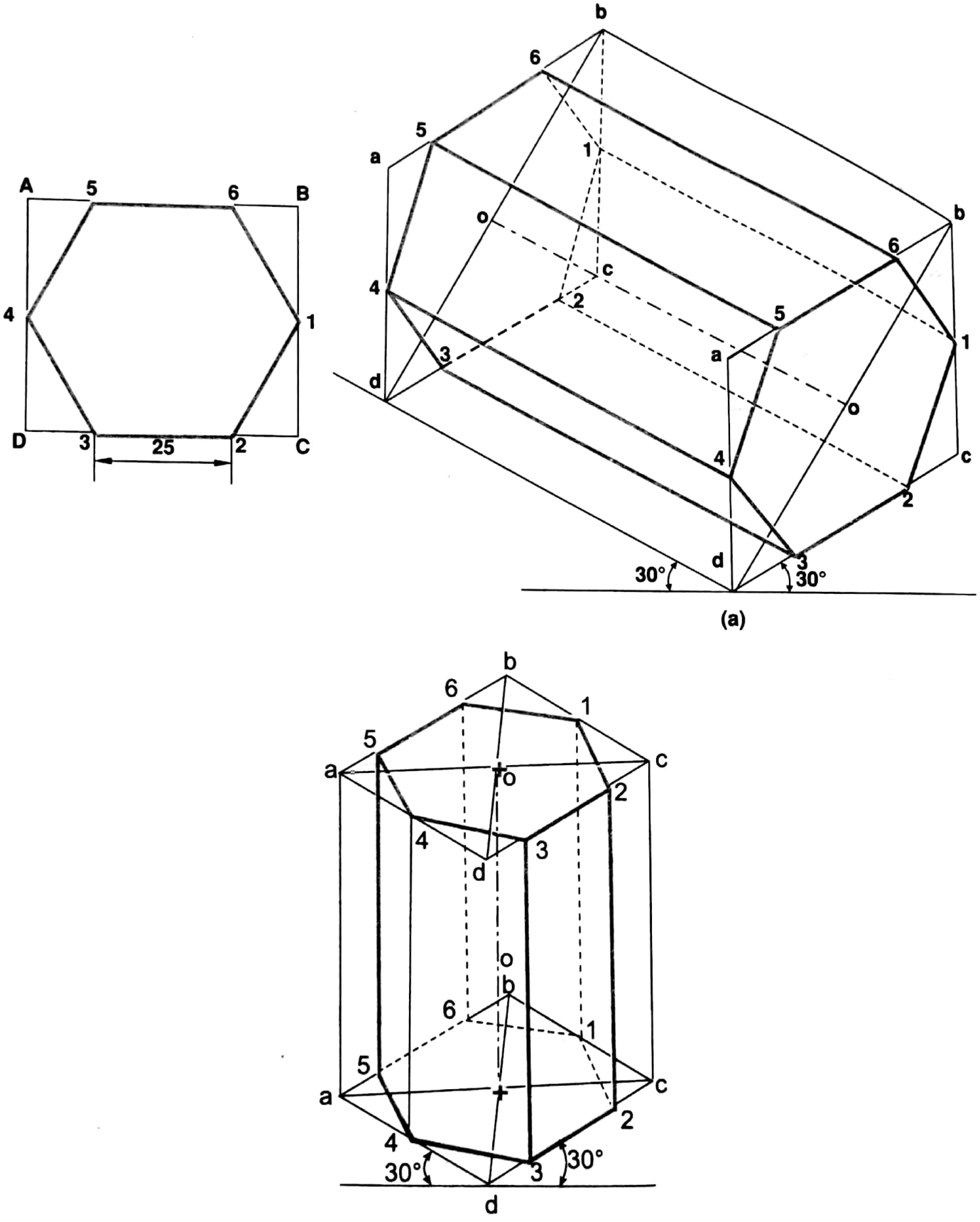


Fig. 16.51 Solution to problem 16.41

PROBLEM 16.42 *Draw isometric drawing of a hexagonal pyramid of base side 30 mm and axis 60 mm long with its axis kept perpendicular to HP.*

SOLUTION. The interpretation of the solution is left to the reader. See Fig. 16.52.

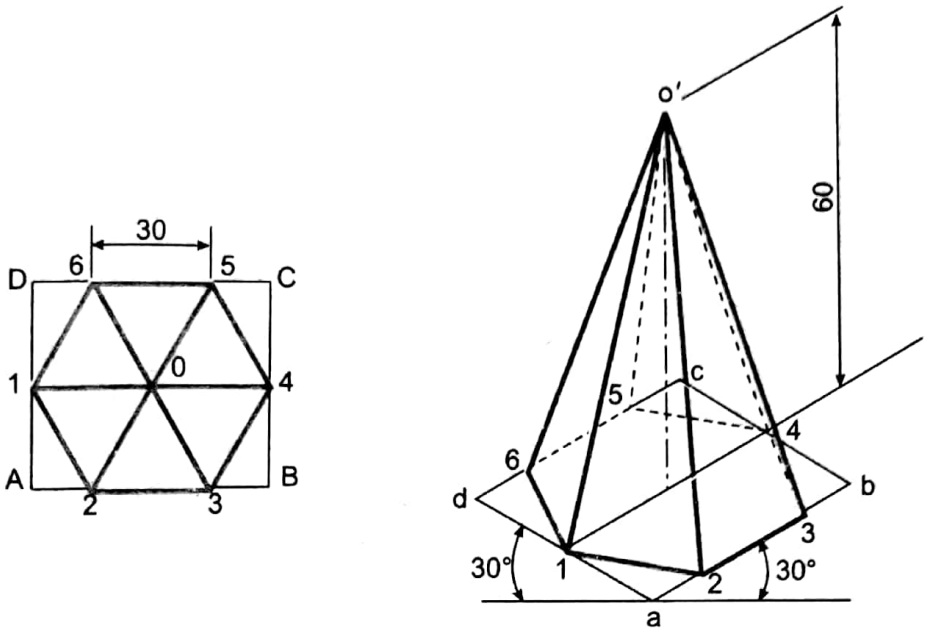


Fig. 16.52 Solution to problem 16.42

PROBLEM 16.43 *Draw isometric drawing of a frustum of a square pyramid, side of lower base is 40 mm, side of upper base is 20 mm and height of the frustum is 40 mm.*

SOLUTION. All the construction lines are retained to make the solution self-explanatory. See Fig. 16.53.

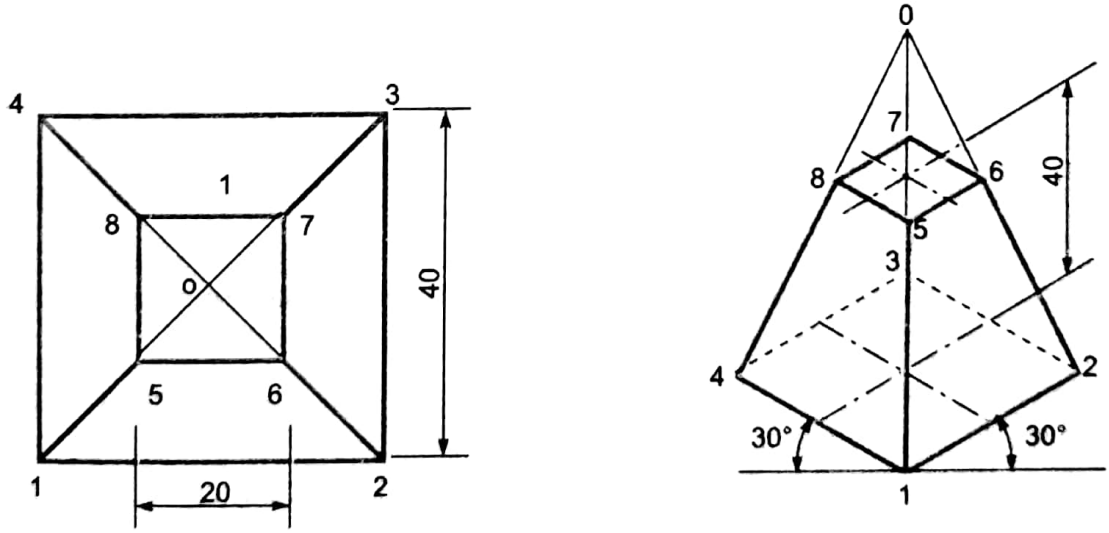


Fig. 16.53 Solution to problem 16.43

PROBLEM 16.44 *Draw the isometric drawing of a given frustum of a pentagonal pyramid as shown in Fig. 16.54 (a)*

SOLUTION. The solution to this problem is self-explanatory. See Fig. 16.54 (*b*)

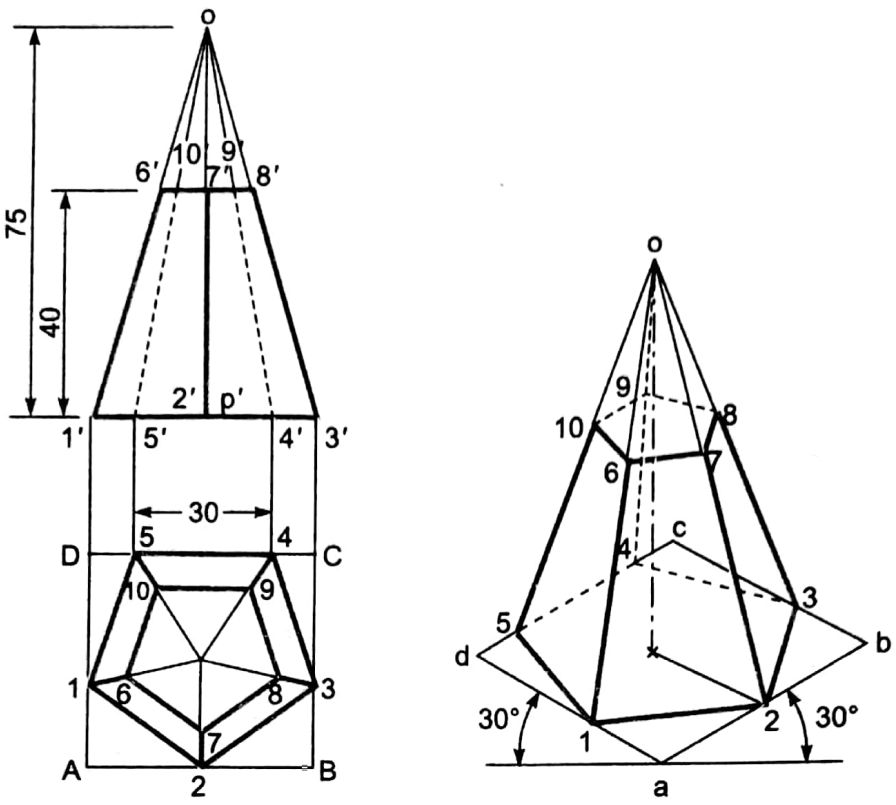


Fig. 16.54 Solution to problem 16.44

EXERCISES

ISOMETRIC PROJECTIONS OF PLANE FIGURES

16.1 Draw the isometric projection of a regular pentagon of 25 mm side.

16.2 Draw the isometric projection of a circle of 60 mm diameter by both the methods.

16.3 Draw the isometric projection of a regular hexagonal of 25 mm side.

ISOMETRIC PROJECTIONS OF PRISM, PYRAMID, CYLINDER AND CONE

16.4 Draw an isometric drawing of the frustum of a right regular pentagonal pyramid, side of base hexagon is 25 mm, side of top hexagon is 15 mm and height of the frustum is 50 mm.

16.5 Draw the isometric drawing of a cylinder, base diameter 50 mm and height 50 mm long when its axis is (*a*) horizontal and (*b*) vertical.

16.6 Draw an isometric projection of the frustum of a right circular cone, base diameter 50 mm, top diameter 25 mm and height of the frustum is 40 mm.

16.7 A cube of 30 mm edge is placed centrally on the top of a square block of 50 mm edge and 15 mm thick. Draw the isometric projections of the two solids.

16.8 A right circular cone, diameter of base 40 mm and height 50 mm rests centrally on the top of a cube of 50 mm. Draw the isometric projections of the solids.

16.9 A square prism of side 40 mm and 50 mm high is resting on HP. A vertical circular hole of

20 mm diameter is cut through its base reaching other side of the prism. Draw the isometric drawing of the solids.

16.10 A right regular hexagonal prism, side of base 20 mm and 50 mm long, lies on its rectangular face on HP. A right circular cylinder, diameter of base 30 mm and 45 mm long, rests centrally on the top rectangular surface of the prism. Draw the isometric projections of the solids.

16.11 A right regular hexagonal prism, side of base 20 mm and height 50 mm long, lies on one of its rectangular faces. A right circular cone, diameter of base 30 mm and height 40 mm rests centrally on the top rectangular surface of the prism. Draw the isometric drawing of the solids.

ISOMETRIC PROJECTION OF A SPHERE

16.12 A sphere of ϕ 40 mm rests centrally on the top of a square block of 50 mm side and 15 mm thick. Draw the isometric projections of the solids.

16.13 A hemi-sphere of 30 mm diameter rests on its circular base on the top of a square block of 30 mm side and 15 mm thick. Draw the isometric projections of the solids.

16.14 A sphere of 50 mm diameter is placed centrally on the top of a cylinder of 60 mm base diameter and 50 mm high. Draw the isometric projection of the solids.

ADDITIONAL PROBLEMS

16.15 Figs 16.53 to 16.61 show the orthographic projections of centain objects. Draw the isometric drawing of each.

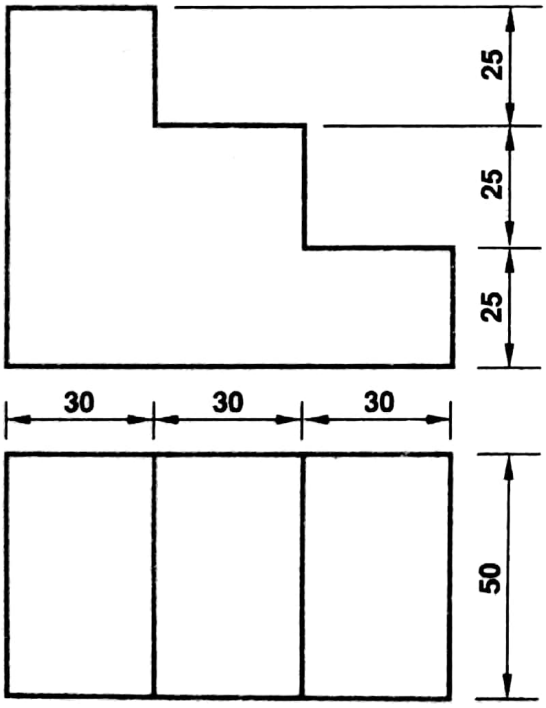


Fig. 16.55

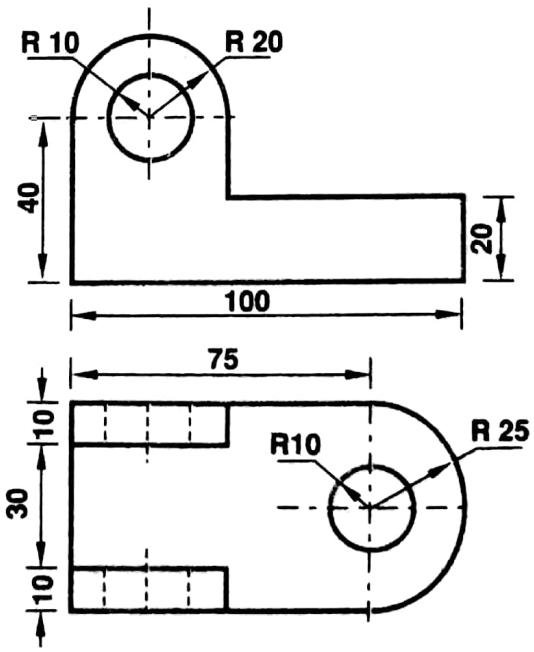


Fig. 16.56

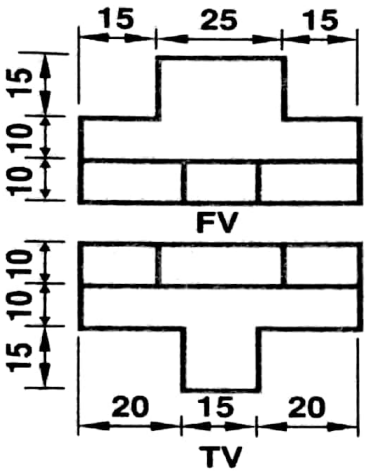


Fig. 16.57

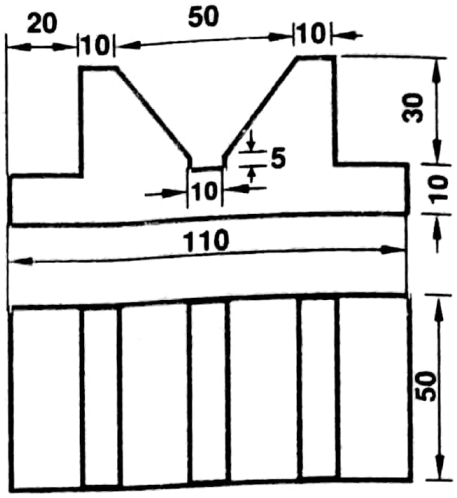


Fig. 16.58

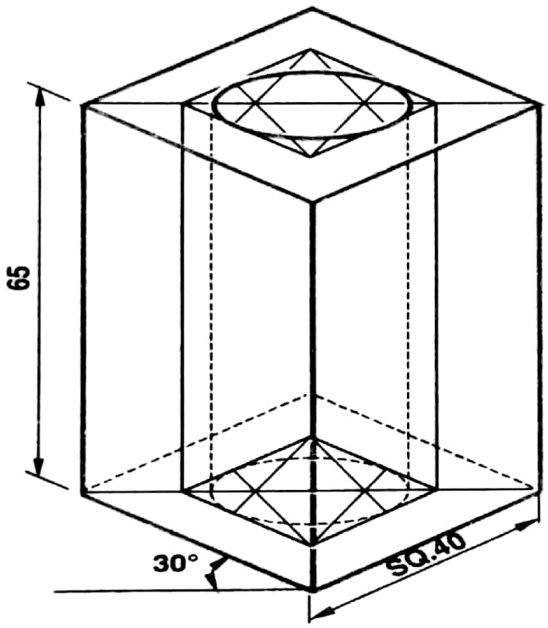


Fig. 16.59

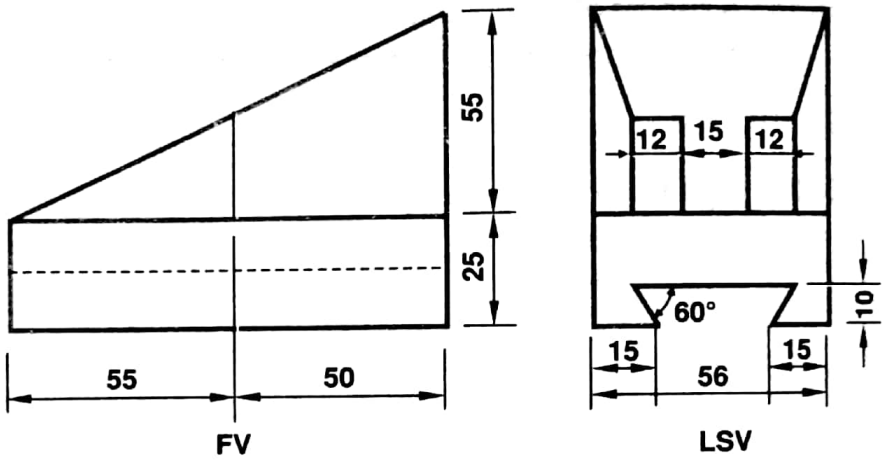


Fig. 16.60

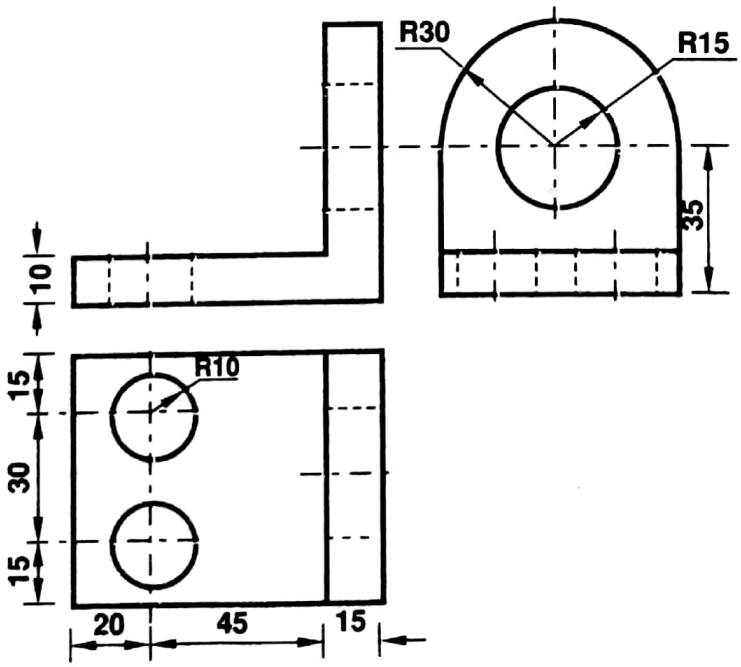


Fig. 16.61

OBJECTIVE QUESTIONS

16.1 The isometric length is in the ratio of ..... of the true length.

16.2 In isometric projections, dimensions lines are drawn parallel to ..... .

16.3 A circle in isometric projection appears as ..... .

16.4 Isometric projection of a sphere is a circle having a diameter ..... of sphere.

16.5 The three forms of axonometric projection are dimetic, trimetric and ..... projections.

16.6 What is the difference between isometric projection and isometric drawing ?

16.7 Describe the four centre method of drawing isometric projection of a circle ?

16.8 Define isometric axes, isometric lines and isometric planes ?

16.9 Define isometric scale and how is it constructed ?

16.10 What is the purpose of pictorial drawings ?

16.11 Draw the isometric projections of (*i*) a circle and (*ii*) a square.

16.12 Give the various position of isometric axes.

16.13 How isometric projection of an object is obtained ?

16.14 Draw a triangle of sides 40, 50 and 60 mm and draw its isometric projection considering it as top view.

16.15 Draw the isometric projection of a square considering it as (*i*) front view and (*ii*) top view.

ANSWERS

16.1 $\sqrt{2} : \sqrt{3}$ **16.2** Isometric axes **16.3** An ellipse **16.4** Equal to that

16.5 Isometric