RGPVNOTES.IN

Program : **B.Tech**

Subject Name: **Engineering Graphics**

Subject Code: **BT-105**

Semester: **1st**

Module V

Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids

Orthographic Projections:

Introduction

Any object has three dimensions, viz., length, width and thickness. A projection is defined as a representation of an object on a two dimensional plane. The projections of an object should convey all the three dimensions, along with other details of the object on a sheet of paper. The elements to be considered while obtaining a projection are:

(i) The object

(ii) The plane of projection

(iii) The point of sight

(iv) The rays of sight

A projection may be obtained by viewing the object from the point of sight and tracing in correct sequence, the points of intersection between the rays of sight and the plane on to which the object is projected. A projection is called orthographic projection when the point of sight is imagined to be located at infinity so that the rays of sight are parallel to each other and intersect the plane of projection at right angle to it.

The principles of orthographic projection may be followed in four different angles or systems, viz., first, second, third and fourth angle projections. A projection is said to be first, second, third or fourth angle when the object is imagined to be in the first, second, third or fourth quadrant respectively. However, the Bureau of Indian Standards (SP–46:1988) prefers first angle projection and throughout this book, first angle projection is followed.

Principle of First Angle Projection

In first angle projection, the object is imagined to be positioned in the first quadrant. The view from the front of the object is obtained by looking at the object from the right side of the quadrant and tracing in correct sequence, the points of intersection between the projection plane and the rays of sight extended. The object is between the observer and the plane of projection (vertical plane). Here, the object is imagined to be transparent and the projection lines are extended from various points of the object to intersect the projection plane. Hence, in first angle projection, any view is so placed that it represents the side of the object away from it.

Methods of obtaining Orthographic Views

1. View from Front

The view from the front of an object is defined as the view that is obtained as projection on the vertical plane by looking at the object normal to its front surface. It is the usual practice to position the object such that its view from the front reveals most of the important features. Figure shows the method of obtaining the view from the front of an object.

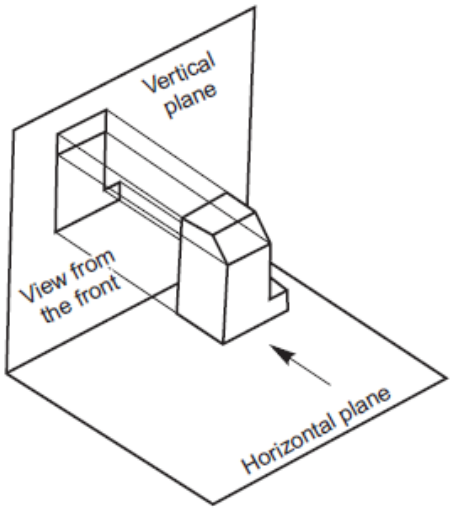


Fig. 5.1 Principle of obtaining the view from the front

2. View from above

The view from above of an object is defined as the view that is obtained as projection on the horizontal plane, by looking the object normal to its top surface. Figure shows the method of obtaining the view from above of an object.

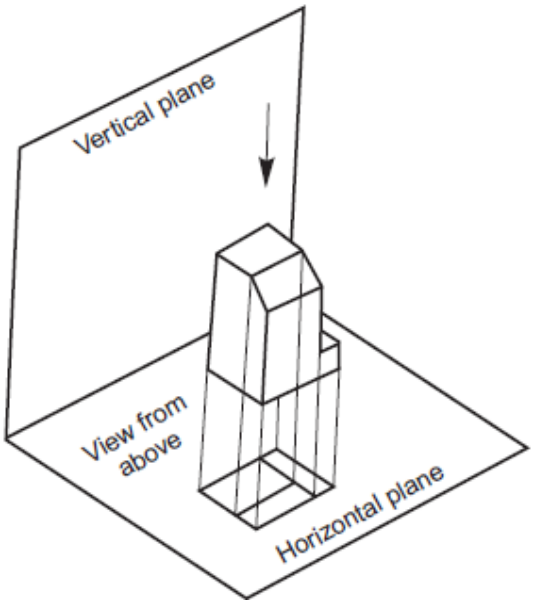


Fig. 5.2 Principle of obtaining the view from the above

3. View from the Side

The view from the side of an object is defined as the view that is obtained as projection on the profile plane by looking the object, normal to its side surface. As there are two sides for an object, viz., left side and right side, two possible views from the side, viz., view from the left and view from the right may be obtained for any object. Figure shows the method of obtaining the view from the left of an object.

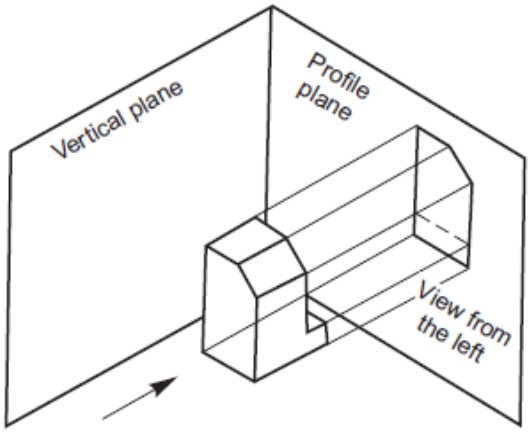


Fig. 5.3 Principle of obtaining the view from the Left

Presentation of Views

The different views of an object are placed on a drawing sheet which is a two dimensional one, to reveal all the three dimensions of the object. For this, the horizontal and profile planes are rotated till they coincide with the vertical plane. Figure shows the relative positions of the views, viz., the view from the front, above and the left of an object.

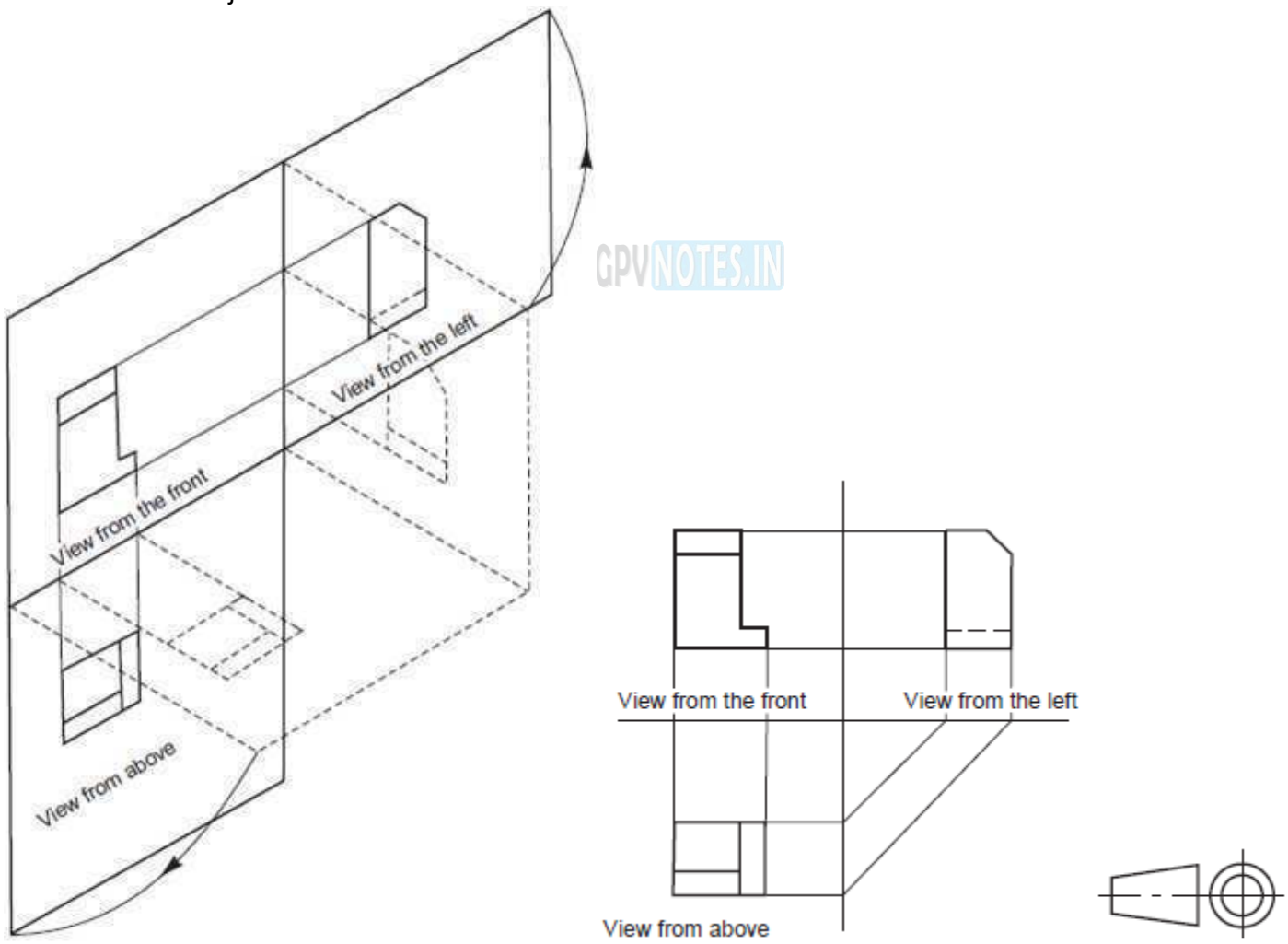


Fig. 5.5 Relative positions of the three views and the symbol

Designation and Relative Positions of Views

An object positioned in space may be imagined as surrounded by six mutually perpendicular planes. So, for any object, six different views may be obtained by viewing at it along the six directions, normal to these planes. Figure shows an object with six possible directions to obtain the different views which are designated as follows:

1. View in the direction **a** = view from the front
2. View in the direction **b** = view from above
3. View in the direction **c** = view from the left
4. View in the direction **d** = view from the right
5. View in the direction **e** = view from below
6. View in the direction **f** = view from the rear

Figure (a) shows the relative positions of the above six views in the first angle projection and Fig. (b), the distinguishing symbol of this method of projection. Figure (c) shows the relative position of the views in the third angle projection and Fig. (d), the distinguishing symbol of this method of projection.

NOTE: A comparison of Figs. (a), (b) and (c), (d) reveals that in both the methods of projection, the views are identical in shape and detail. Only their location with respect to the view from the front is different.

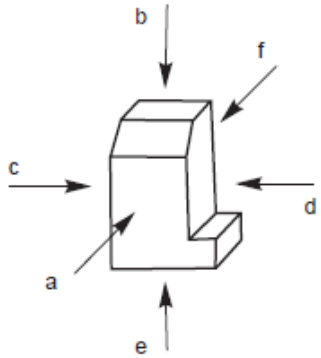
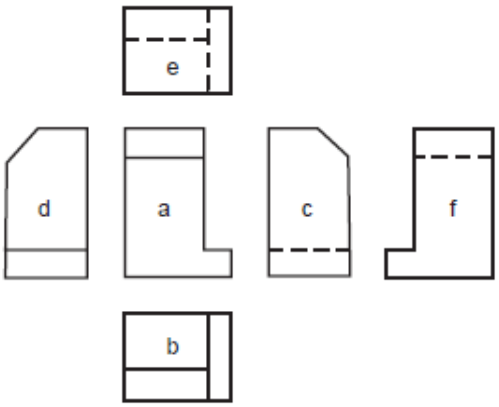
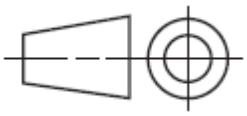


Fig. 5.6 Designation of Views

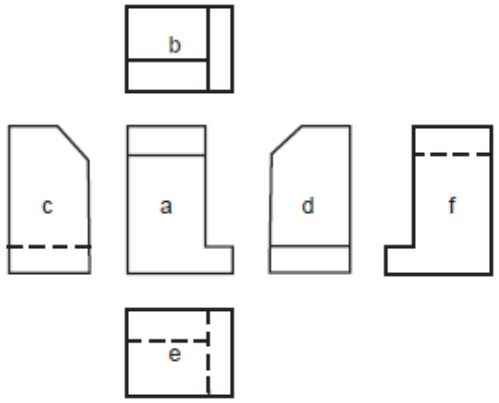


(a)

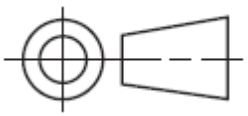


(b)

Relative positions of six views in first angle projection



(c)



(d)

Relative positions of six views in third angle projection

Fig. 5.7

Position of the Object

It is important to understand the significance of the position of the object relative to the planes of projection. To get useful information about the object in the orthographic projections, the object may be imagined to be positioned properly because of the following facts:

1. Any line on an object will show its true length, only when it is parallel to the plane of projection.
2. Any surface of an object will appear in its true shape, only when it is parallel to the plane of projection.

In the light of the above, it is necessary that the object is imagined to be positioned such that its principal surfaces are parallel to the planes of projection.

Hidden Lines

While obtaining the projection of an object on to any principal plane of projection, certain features of the object may not be visible. The invisible or hidden features are represented by short dashes of medium thickness. Figure shows the application of hidden lines in the projection of an object.

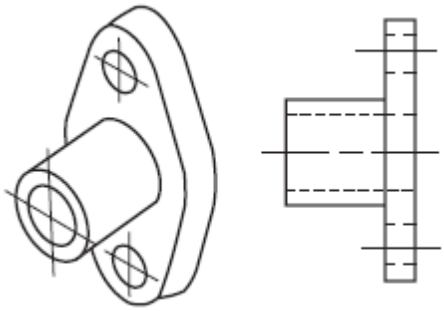


Fig. 5.8 Application of Hidden Lines

Curved Surfaces

Certain objects contain curved surfaces, tangential to other curved surfaces. The difficulty in representing the surfaces can be overcome if the following rule is observed. Wherever a tangential line drawn to the curved surface becomes a projector, a line should be drawn in the adjacent view. Figure shows the representation of certain curved surfaces, tangential to other curved surfaces.

Certain objects manufactured by casting technique, frequently contain corners filleted and the edges rounded. When the radius of a rounded corner is greater than 3 mm and the angle between the surfaces is more than 90°, no line is shown in the adjacent view. Figure shows the application of the above principle.

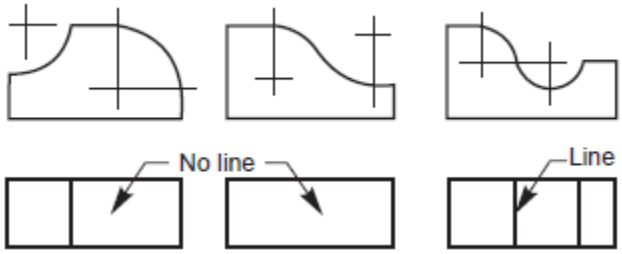
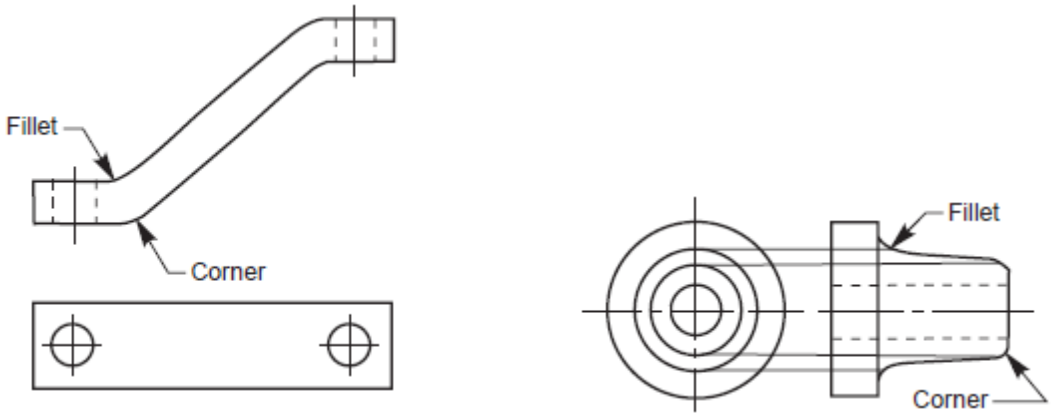


Fig. 5.9 Representation of tangential curved surfaces



(a) (b)

Fig. 5.10 Representation of corners and fillets

If true projection is followed in drawing the view of an object containing fillets and rounds; it will result in misleading impression. In conventional practice, fillets and rounds are represented by lines called run outs. The run outs are terminated at the point of tangency.

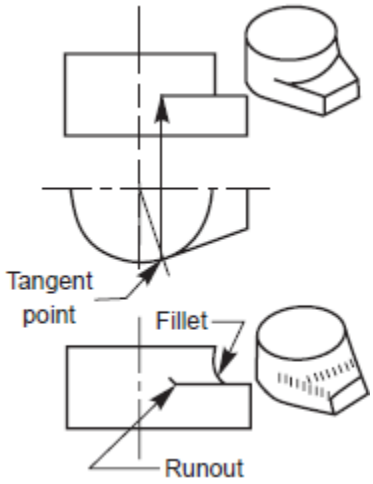


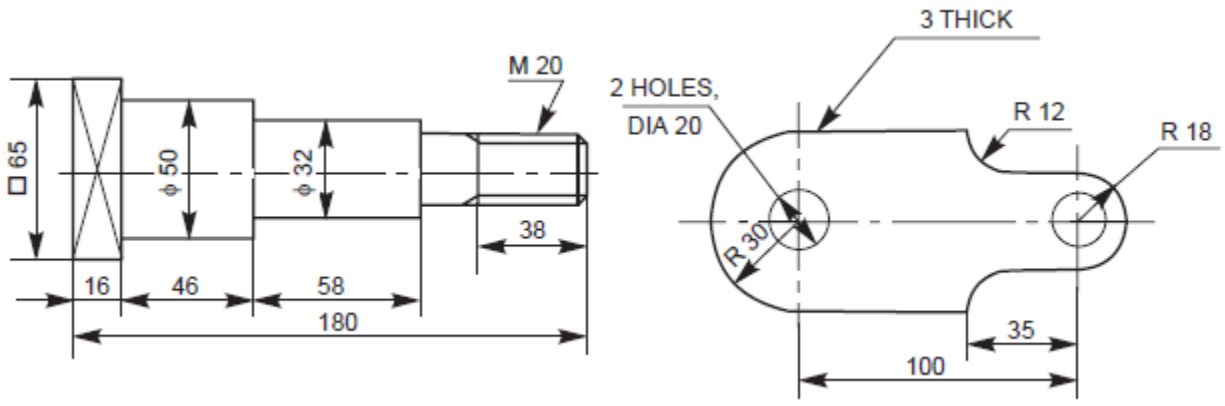
Fig. 5.11 Run outs

Selection of Views

For describing any object completely through its orthographic projections, it is important to select a number of views. The number of views required to describe any object will depend upon the extent of complexity involved in it. The higher the symmetry, the lesser the number of views required.

1. One View Drawings

Some objects with cylindrical, square or hexagonal features or, plates of any size with any number of features in it may be represented by a single view. In such cases, the diameter of the cylinder, the side of the square, the side of the hexagon or the thickness of the plate may be expressed by a note or abbreviation. Square sections are indicated by light crossed diagonal lines. Figure shows some objects which may be described by one-view drawings.



(a) (b)

Fig. 5.12 One View Drawings

2. Two – View Drawings

Some objects which are symmetrical about two axes may be represented completely by two views. Normally, the largest face showing most of the details of the object is selected for drawing the view from the front. The shape of the object then determines whether the second view can be a view from above or a side view. Figure shows the example of two-view drawings.

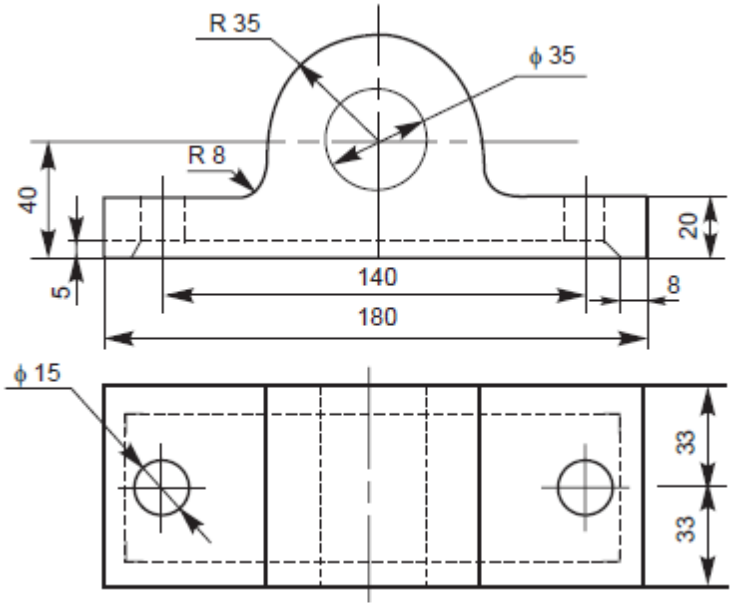
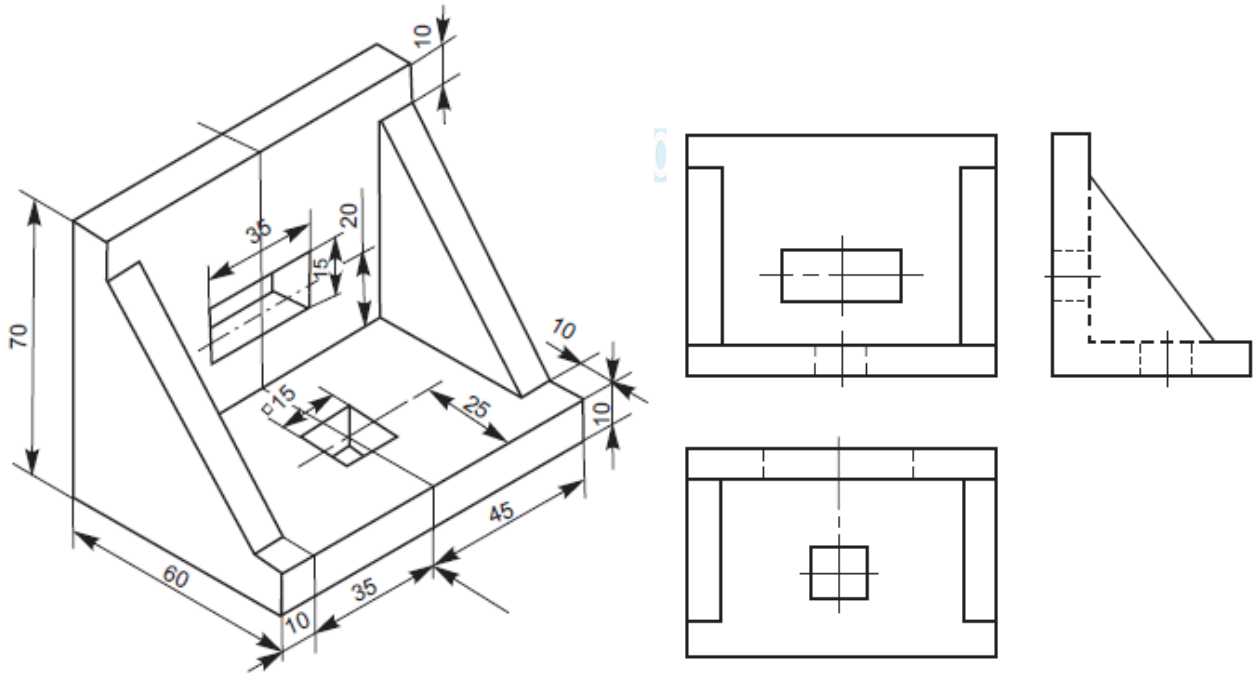


Fig. 5.13 Two – View Drawings

3. Three – View Drawings

In general, most of the objects consisting of either a single component or an assembly of a number of components are described with the help of three views. In such cases, the views normally selected are the views from the front, above and left or right side. Figure shows an object and its three necessary views.



(a) (b)

Fig. 5.14 Three – View Drawing

Examples

NOTE: - For all the examples given, the following may be noted: Arrow indicates the direction to obtain the view from the front.

1.

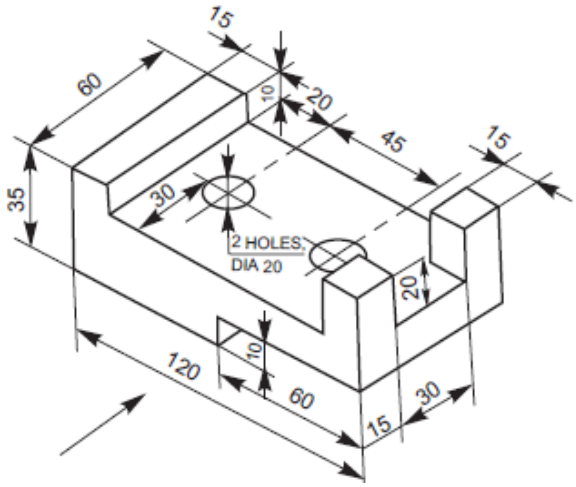


Fig. 5.15

Solution: -

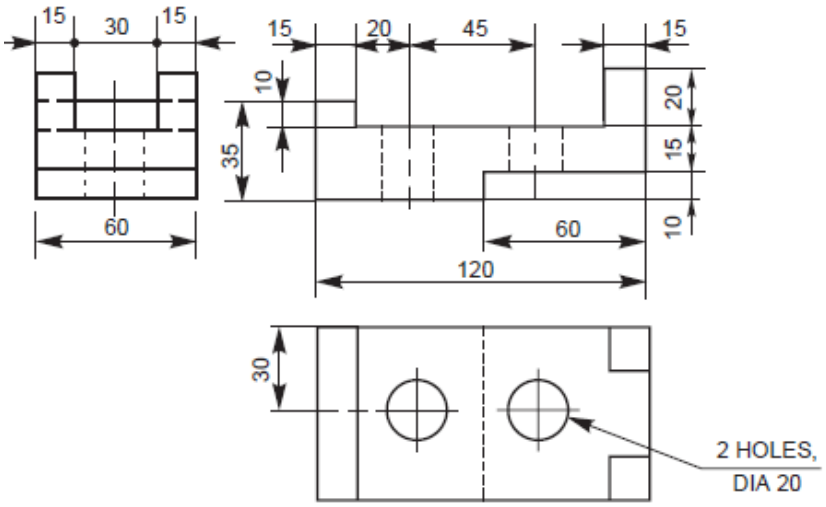


Fig. 5.16

2.

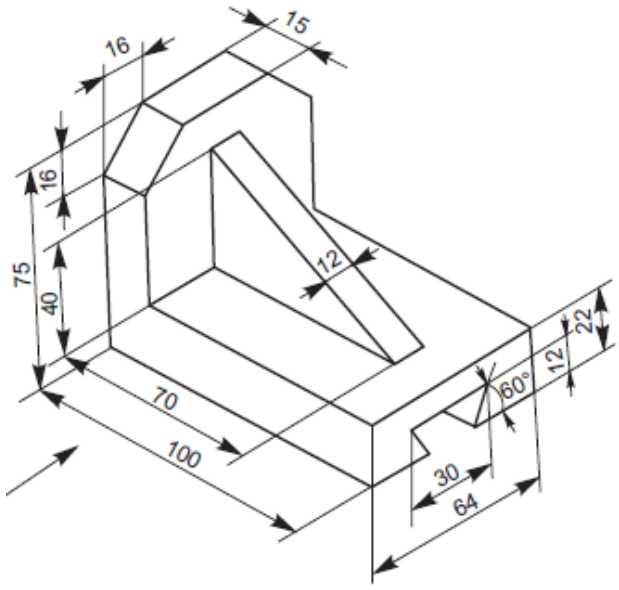


Fig. 5.17

Solution: -

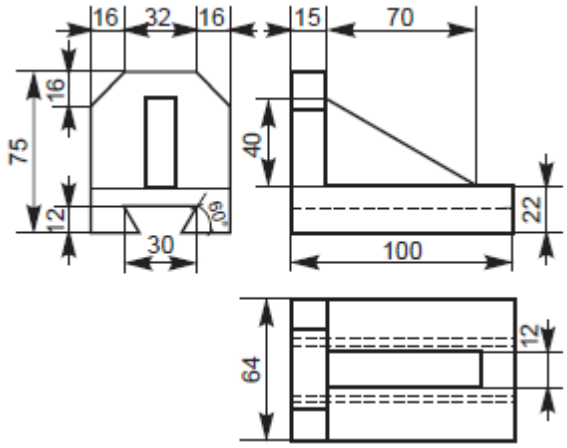


Fig. 5.18

3.

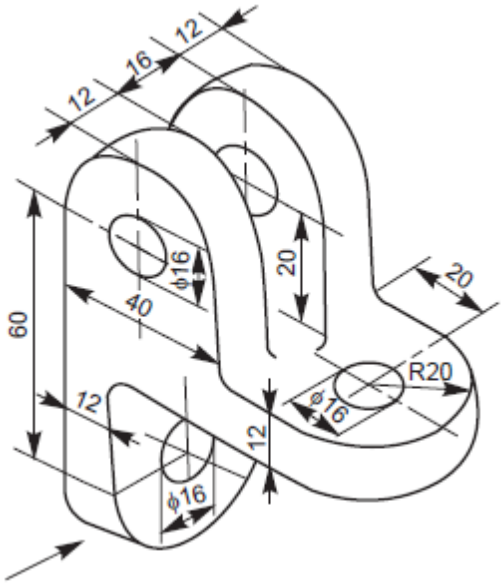


Fig. 5.19

Solution: -

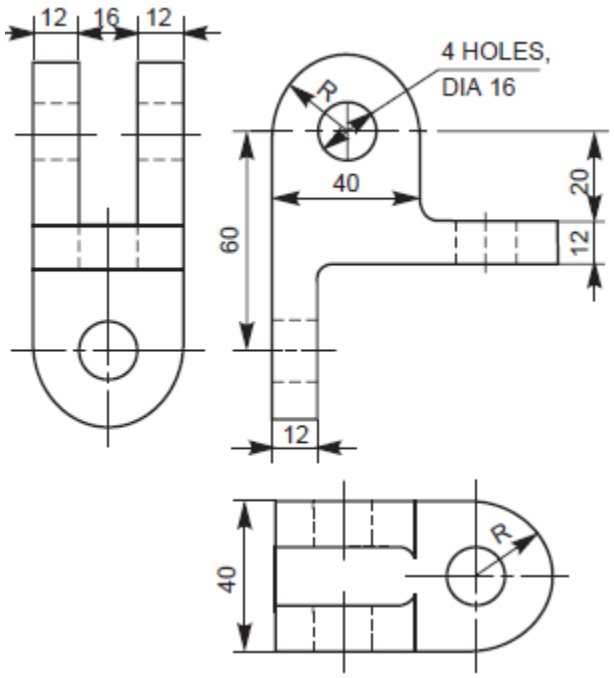


Fig. 5.20

Isometric projections: Isometric scales, isometric views of Simple objects.

Introduction

Pictorial projections are used for presenting ideas which may be easily understood by persons even without technical training and knowledge of multi-view drawing. The Pictorial drawing shows several faces of an object in one view, approximately as it appears to the eye.

Principle of Isometric Projections

It is a pictorial orthographic projection of an object in which a transparent cube containing the object is tilted until one of the solid diagonals of the cube becomes perpendicular to the vertical plane and the three axes are equally inclined to this vertical plane.

Isometric projection of a cube in steps is shown in Fig. Here ABCDEFGH is the isometric projection of the cube.

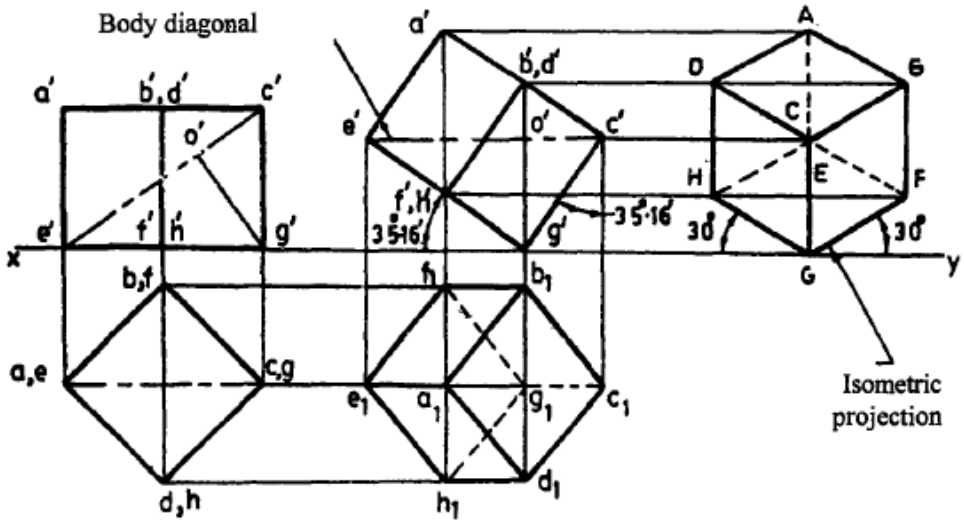


Fig. 5.21 Principle of Isometric Projection

The front view of the cube, resting on one of its corners (G) is the isometric projection of the cube.

Isometric Scale

In the isometric projection of a cube shown in Fig., the top face ABCD is sloping away from the observer and hence the edges of the top face will appear fore-shortened. The true shape of the triangle DAB is represented by the triangle DPB.

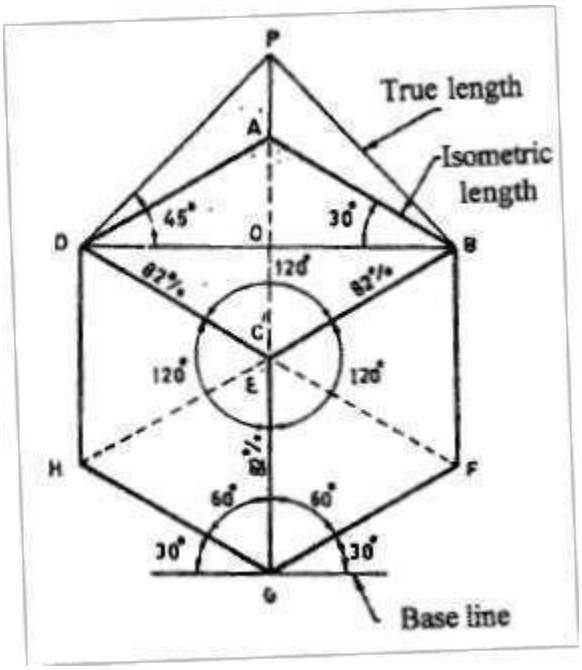


Fig. 5.22 An isometric Cube

The extent of reduction of an isometric line can be easily found by construction of a diagram called isometric scale. For this, reproduce the triangle DPA as shown in Fig. Mark the divisions of true length on DP. Through these divisions draw vertical lines to get the corresponding points on DA. The divisions of the line DA give dimensions to isometric scale.

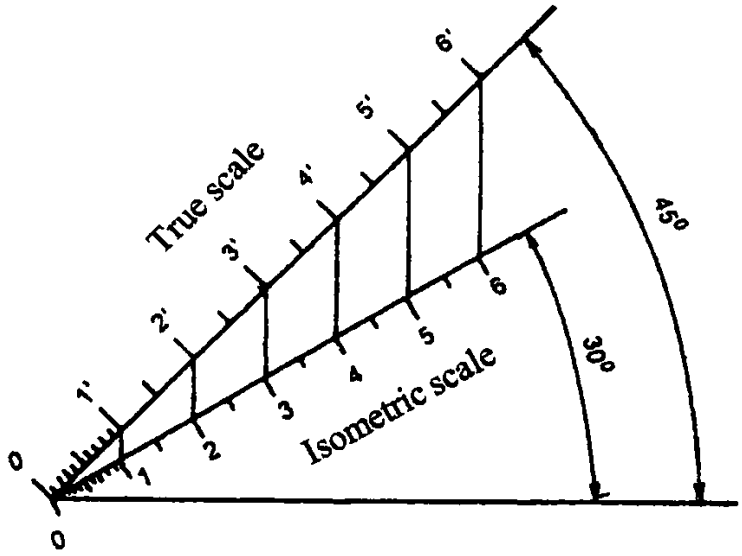


Fig. 5.23 Isometric Scale

From the triangle ADO and PDO in Fig., the ratio of the isometric length to the true length,
i.e., DA/DP = cos 45°/cos30° = 0.816
The isometric axes are reduced in the ratio 1:0.816 i.e. 82% approximately.

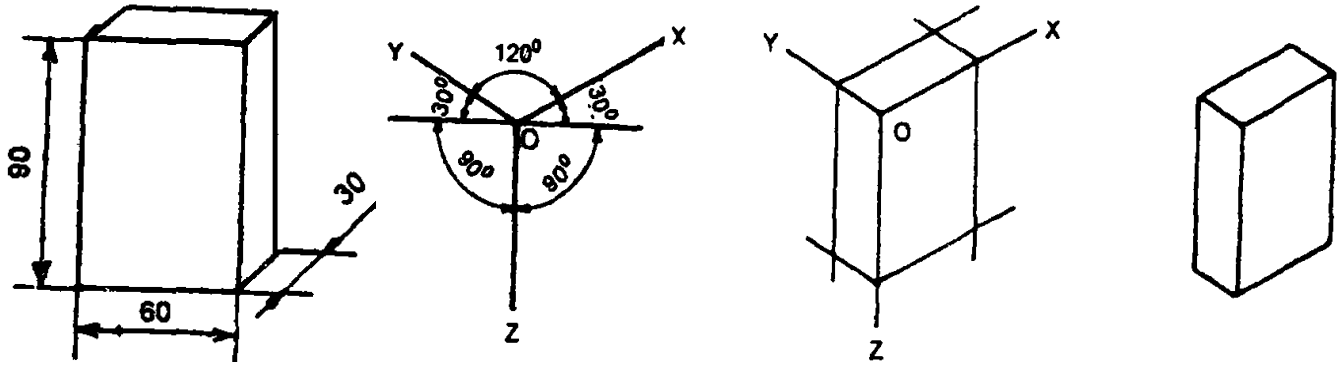
Lines in Isometric Projection

The following are the relations between the lines in isometric projection which are evident from Fig..

1. The lines that are parallel on the object are parallel in the isometric projection.
2. Vertical lines on the object appear vertical in the isometric projection.
3. Horizontal lines on the object are drawn at an angle of 30° with the horizontal in the isometric projection.
4. A line parallel to an isometric axis is called an isometric line and it is fore shortened to 82%.
5. A line which is not parallel to any isometric axis is called non-isometric line and the extents of fore-shortening of non-isometric lines are different if their inclinations with the vertical planes are different.

Isometric Projection

Figure (a) shows a rectangular block in pictorial form and Fig. (b), the steps for drawing an isometric projection using the isometric scale.



(a) (b)

Fig. 5.24 Developing Isometric Projection

Isometric Drawing

Drawings of objects are seldom drawn in true isometric projections, as the use of an isometric scale is inconvenient. Instead, a convenient method in which the foreshortening of lengths is ignored and actual or true lengths are used to obtain the projections, called isometric drawing or isometric view is normally used. This is advantageous because the measurement may be made directly from a drawing.

The isometric drawing of figure is slightly larger (approximately 22%) than the isometric projection. As the proportions are the same, the increased size does not affect the pictorial value of the representation and at the same time, it may be done quickly. Figure shows the difference between the isometric drawing and isometric projection.

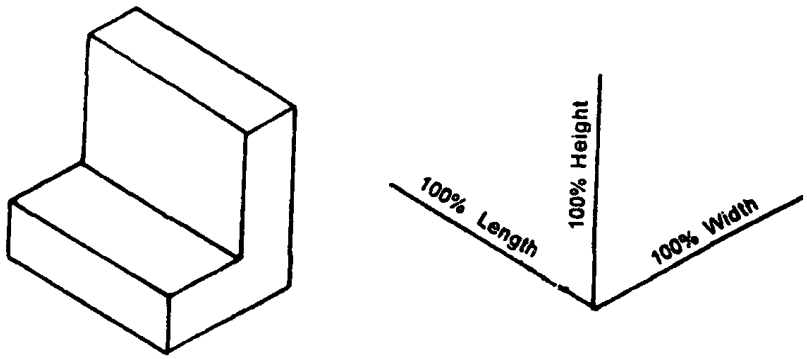


Fig. 5.25 (a) Isometric Drawing

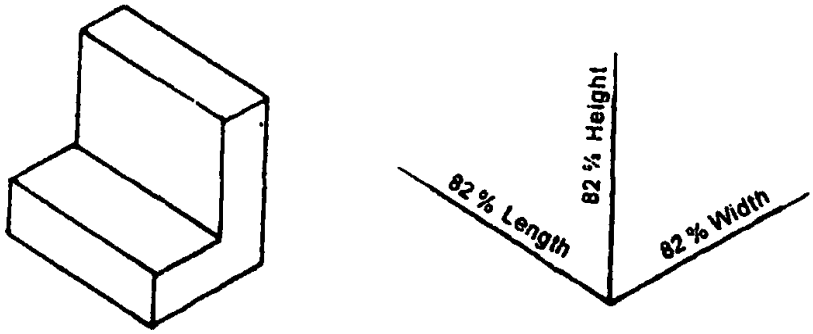


Fig. 5.26 (b) Isometric Projection

Steps to be followed to make isometric drawing from orthographic views are given below (Fig.).

1. Study the given views and note the principal dimensions and other features of the object.
2. Draw the isometric axes (a).
3. Mark the principal dimensions to-their true values along the isometric axes (b).
4. Complete the housing block by drawing lines parallel to the isometric axes and passing through the above markings (e).
5. Locate the principal corners of all the features of the object on the three faces of the housing block (d).
6. Draw lines parallel to the axes and passing through the above points and obtain the isometric drawing of the object by darkening the visible edges (e).

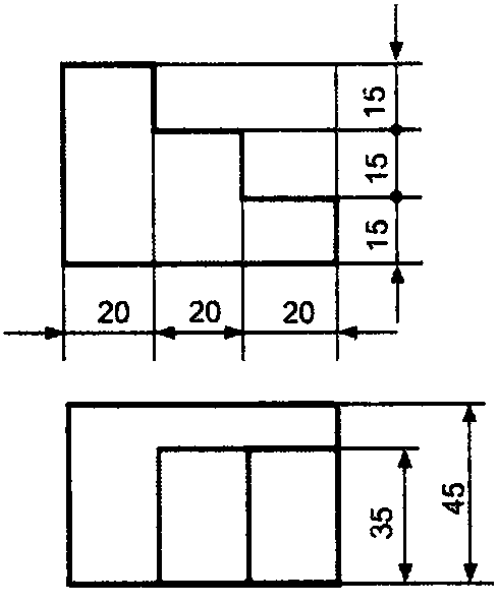
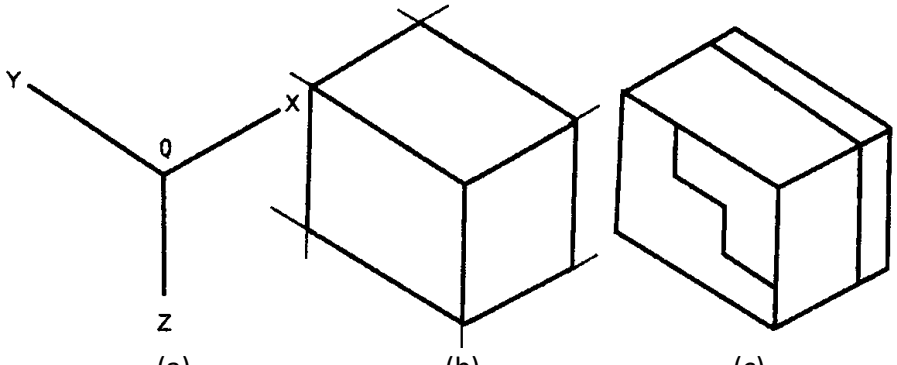
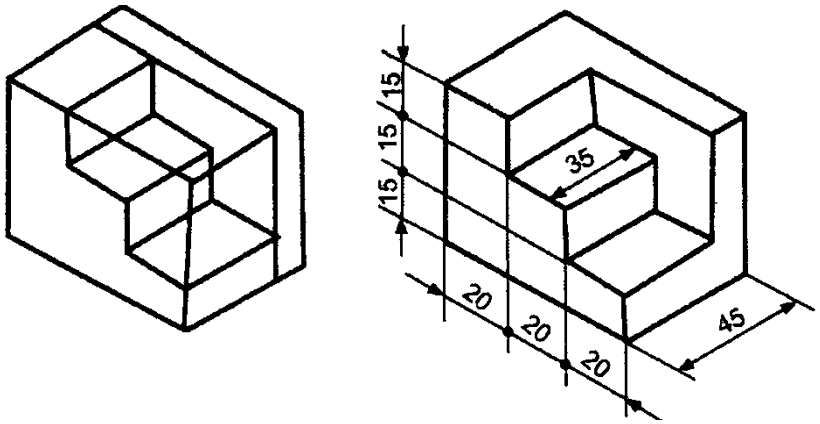


Fig. 5.27 (A) Orthographic View



(a) (b) (c)



(d) (e)

Fig. 5.28 (B) Isometric View

Non-Isometric Lines

In an isometric projection or drawing, the lines that are not parallel to the isometric axes are called non-isometric lines. These lines obviously do not appear in their true length on the drawing and cannot be measured directly. These lines are drawn in an isometric projection or drawing by locating their end points.

Figure shows the isometric drawing of an object containing non isometric lines from the given orthographic views.

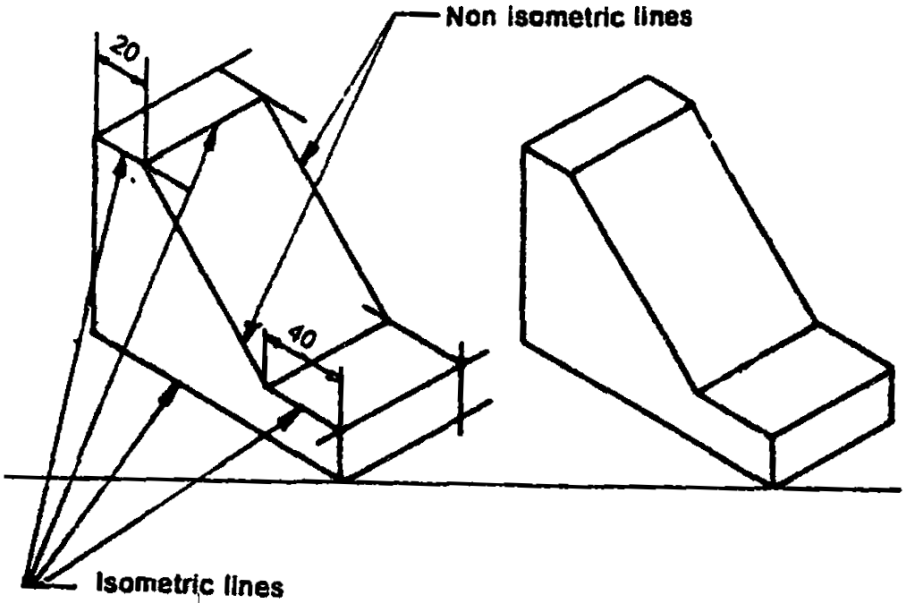


Fig. 5.29

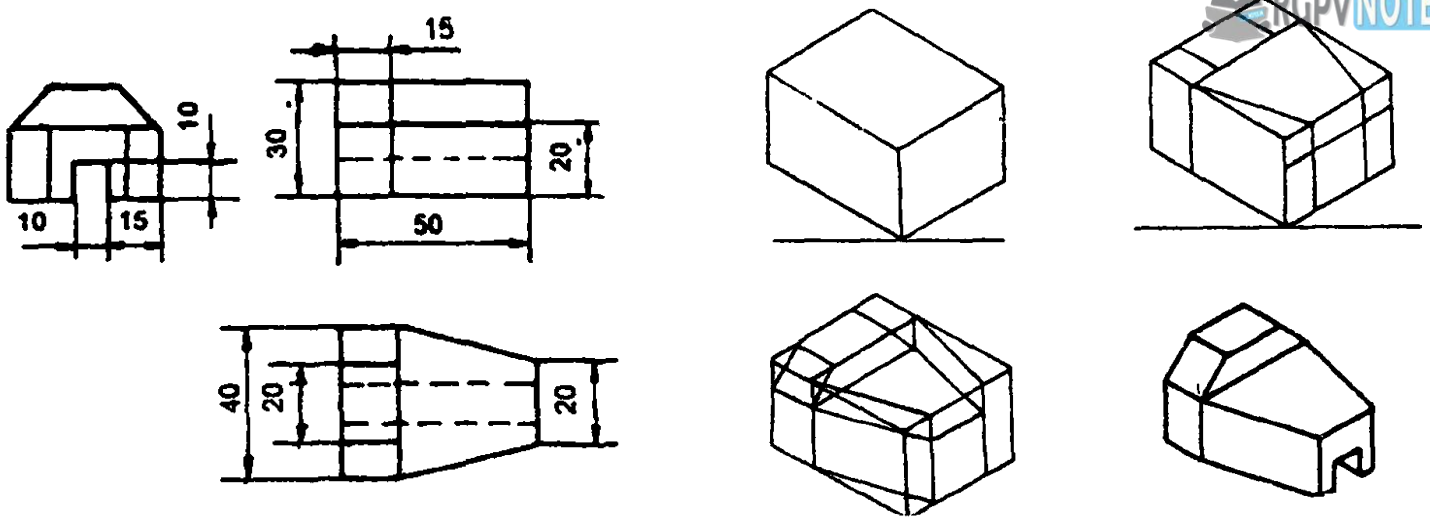
Methods of Constructing Isometric Drawing

The methods used are:

1. Box method.
2. Off-set method.

Box Method

When an object contains a number of non-isometric lines, the isometric drawing may be conveniently constructed by using the box method. In this method, the object is imagined to be enclosed in a rectangular box and both isometric and non-isometric lines are located by their respective points of contact with the surfaces and edges of the box.

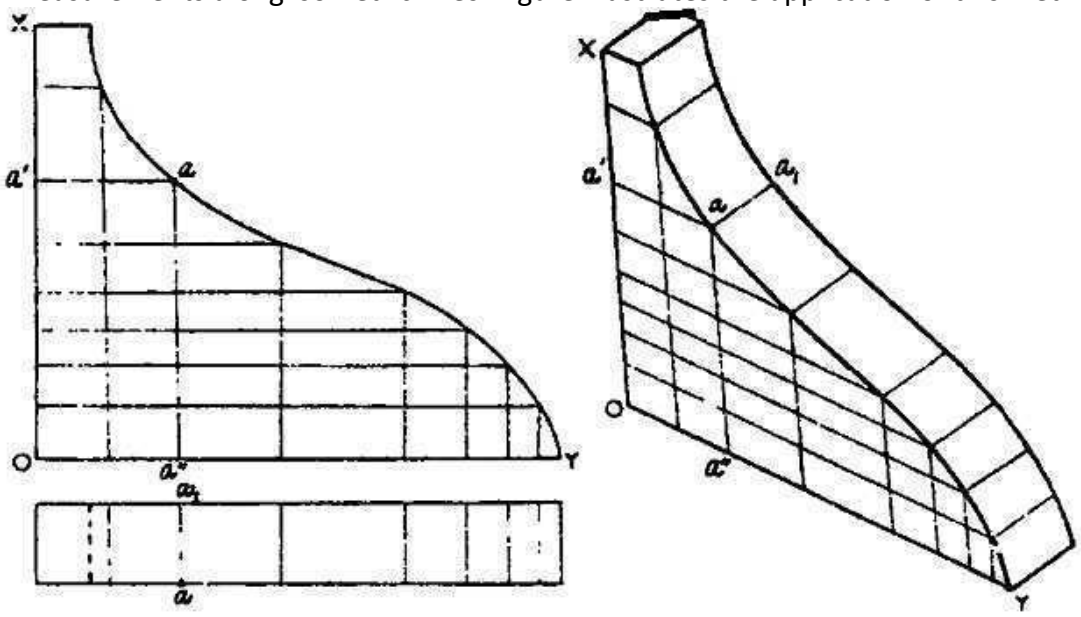


(a) (b)

Fig. 5.30

Off-set Method

Off-set method of making an isometric drawing is preferred when the object contains irregular curved surfaces. In the off-set method, the curved feature may be obtained by plotting the points on the curve, located by the measurements along isometric lines. Figure illustrates the application of this method.



(a) (b)

Fig. 5.31

Isometric Projection of Planes

Problem: Draw the isometric projection of a rectangle of 100mm and 70mm sides if its plane is (a) Vertical and (b) Horizontal.

Construction:-

1. Draw the given rectangle ABCD as shown in Fig. (a).

Note:

(i) In the isometric projection, vertical lines are drawn vertical and the horizontal lines are drawn inclined 30° to the base line.

(it) As the sides of the rectangle are parallel to the isometric axes they are fore-shortened to approximately 82% in the isometric projections.

Hence AB = CD = 1000 x 0.82mm = 82mm. Similarly, BC = AD = 57.4 mm.

(a) When the plane is vertical:

2. Draw the side AD inclined at 30° to the base line as shown in Fig. b and mark AD = 57.4mm.
3. Draw the verticals at A and D and mark off AB = DC = 82mm on these verticals.
4. Join BC which is parallel to AD.

ABCD is the required isometric projection. This can also be drawn as shown in Fig. c. Arrows show the direction of viewing.

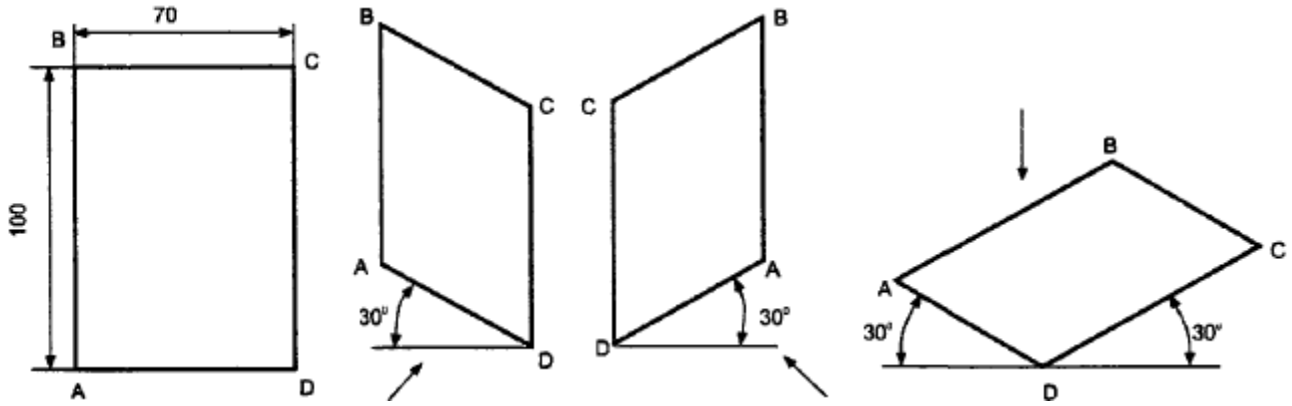


Fig. 5..32

(b) When the plane is horizontal.

5. Draw the sides AD and DC inclined at 30° to be base line and complete the isometric projection ABCD as shown in Fig. d. Arrow at the top shows the direction of viewing.

Problem: Figure shows the projection of a pentagonal plane. Draw the isometric drawing of the plane (i) when the surface is parallel to V.P. and (ii) parallel to H.P.

Construction: -

1. Enclose the given pentagon in a rectangle 1234.
2. Make the isometric drawing of the rectangle 1234 by using true lengths.
3. Locate the points A and B such that Ia = lA and 1 b = IB.
4. Similarly locate point C, D and E such that 2c = 2C, 3d = 3D and e4 = E4.
5. ABCDE is the isometric drawing of the pentagon.
6. Following the above principle of construction fig. c can be

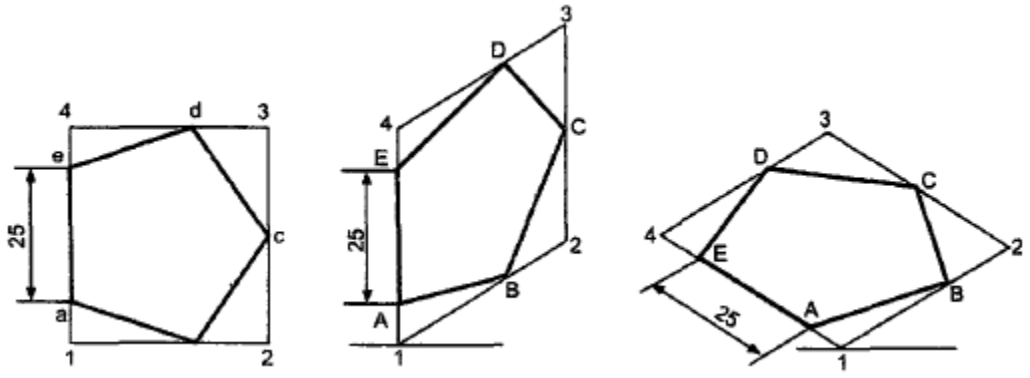
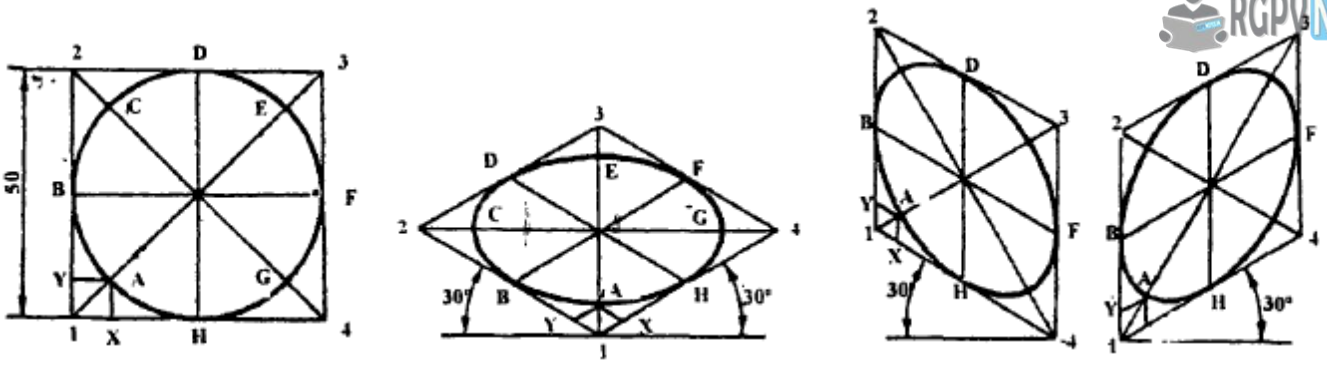


Fig. 5.33

Problem: Draw the isometric view of a circular plane of diameter 60mm whose surface is (a) Horizontal, (b) Vertical.

Construction: - Using the method of points



(a) (b) (c) (d)

Fig. 5.34

1. Enclose the circle in a square 1-2-3-4 and draw diagonals, as shown in Fig. 5.34 a. Also draw lines YA horizontally and XA vertically.

To draw the isometric view of the square 1-2-3-4 as shown in Fig. 5.34 b.

2. Mark the mid points of the sides of the square as B, D, F and H.

3. Locate the points X and Y on lines 1-4 and 1-2 respectively.

4. Through the point X, draw AX parallel to line 1-2 to get point A on the diagonal 1-3. The point A can be obtained also by drawing Y A through the point Y and parallel to the line 1-4. S. Similarly obtain other points C, E and G

6. Draw a smooth curve passing through all the points to obtain the required isometric view of the horizontal circular plane.

7. Similarly obtain isometric view of the vertical circular plane as shown in Fig. 5.34 c and d.

Problem: Draw the isometric projection of a circular plane of diameter 60mm whose surface is (a) Horizontal and (b) Vertical-use Four-centre method

Construction: - Using Four – Centre Method

1. Draw the isometric projection of the square 1-2-3-4 (rhombus) whose length of side is equal to the isometric length of the diameter of the circle = 0.82 x 60.

2. Mark the mid points A, B, C and D of the four sides of the rhombus. Join the points 3 and A. This line intersects the line 2-4 joining the point 2 and 4 at M. Similarly obtain the intersecting point N.

3. With centre M and radius = MA draw an arc A B. Also draw an arc C D with centre N.

4. With centre 1 and radius = 1C, draw an ace B C. Also draw the arc A D.

5. The ellipse ABCD is the required isometric projection of the horizontal circular plane (Fig. 5.35 a).

6. Similarly obtain the isometric projection in the vertical plane as shown in Fig. 5.35 b & c.

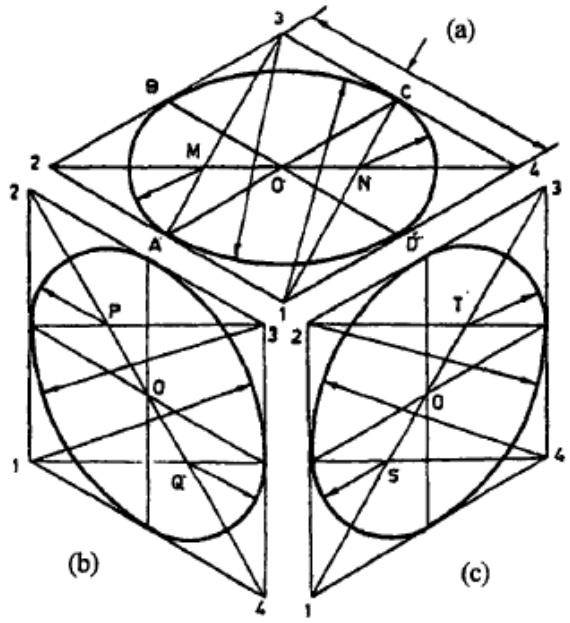


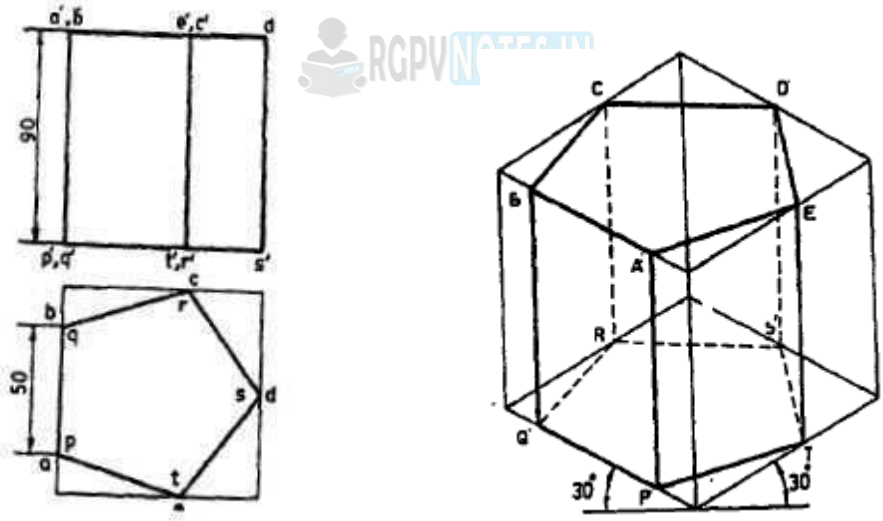
Fig. 5.35

Isometric Projection of Prisms

Problem: Draw the isometric view of a pentagonal prism of base 60 mm side, axis 100 mm long and resting on its base with a vertical face perpendicular to V.P.

Construction: -

1. The front and top views of the prism are shown in Fig. a.
2. Enclose the prism in a rectangular box and draw the isometric view as shown in Fig. b using the box method.



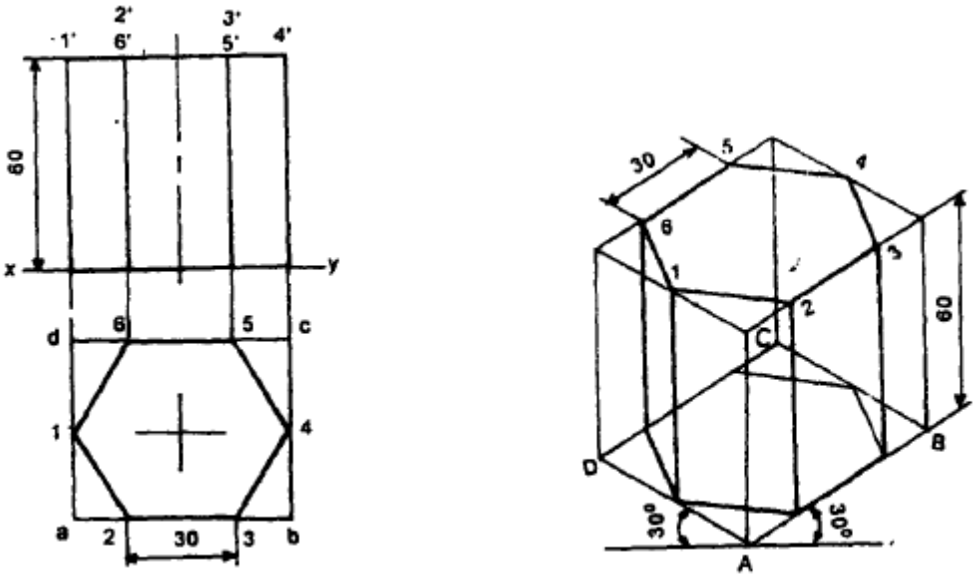
(a) (b)

Fig. 5.36 Isometric Drawing of a Pentagonal Prism

Problem: A hexagonal prism of base of side 30 mm and height 60 mm is resting on its base on H.P. Draw the isometric drawing of the prism.

Construction: -

1. Draw the orthographic views of the prism as shown in Fig. a.
2. Enclose the views in a rectangle (i.e. the top view –base and front views).
3. Determine the distances (off-sets) of the corners of the base from the edges of the box.
4. Join the points and darken the visible edges to get the isometric view.



(a) (b)

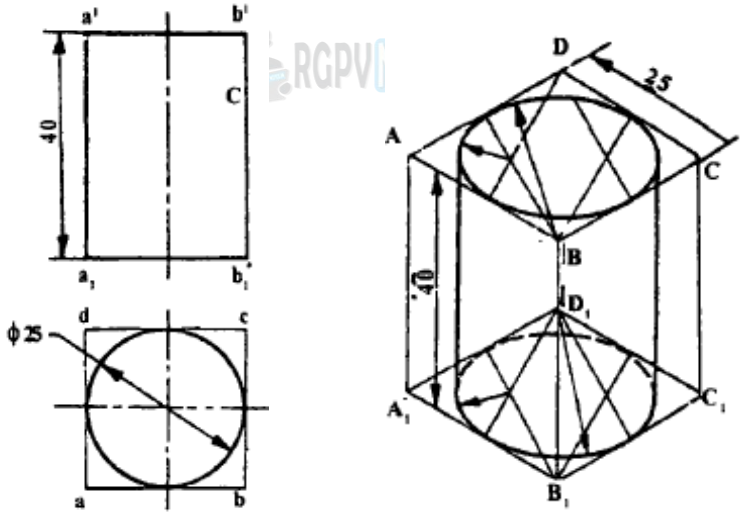
Fig. 5.37 Isometric Drawing of a Hexagonal Prism

Isometric Projection of Cylinder

Problem: Make the isometric drawing of a cylinder of base diameter 20 mm and axis 35 mm long.

Construction: -

1. Enclose the cylinder in a box and draw its isometric drawing.
2. Draw ellipses corresponding to the bottom and top bases by four centre method.
3. Join the bases by two common tangents.



(a) (b)

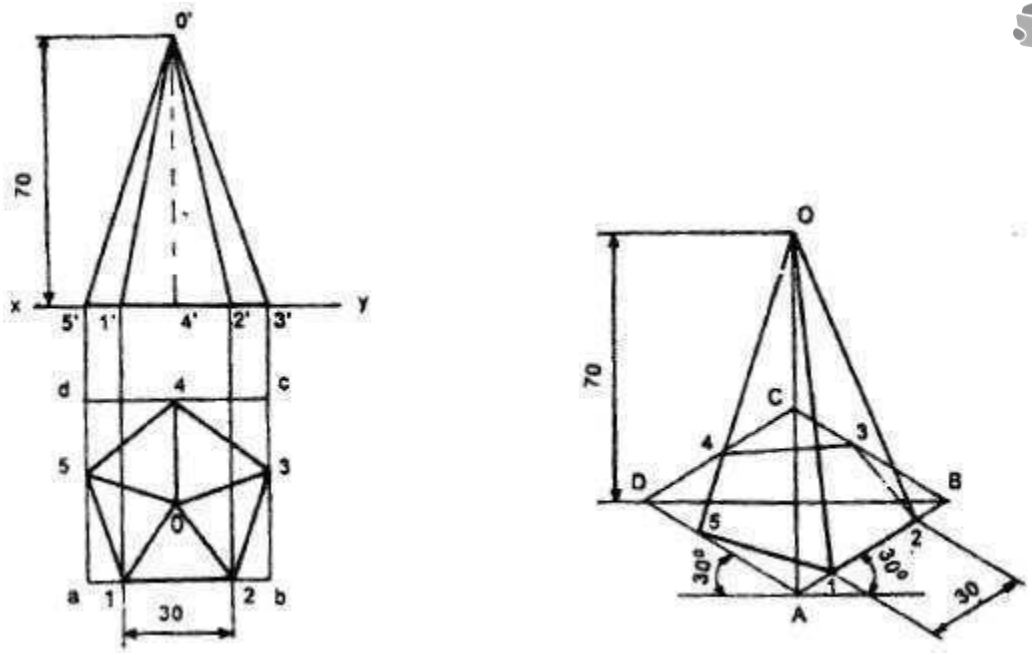
Fig. 5.38 Isometric Drawing of Cylinder

Isometric Projection of Pyramid

Problem: A pentagonal pyramid of side of base 30 mm and height 70 mm is resting with its base on H.P. Draw the isometric drawing of the pyramid.

Construction: -

1. Draw the projections of the pyramid (Fig. a).
2. Enclose the top view in a rectangle abcde and measure the off-sets of all the corners of the base and the vertex.
3. Draw the isometric view of the rectangle ABCD.
4. Using the off-sets locate the corners of the base 1, 2, etc. and the vertex o.
5. Join 0-1, 0-2, 0-3, etc. and darken the visible edges and obtain the required view.



(a) (b)

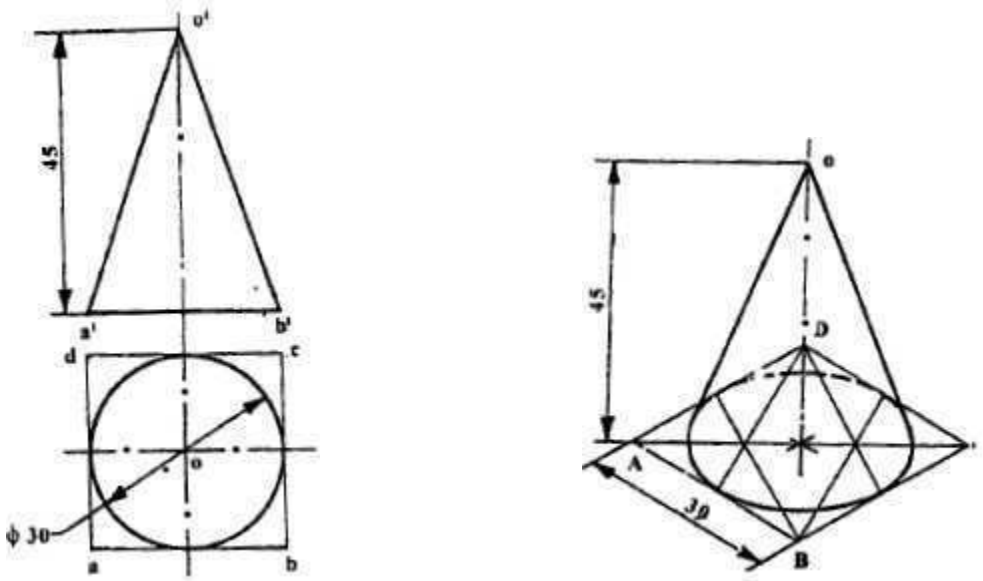
Fig. 5.39 Isometric Drawing of Pentagonal Pyramid

Isometric Projection of Cone

Problem: Draw the isometric drawing of a cone of base diameter 30 mm and axis 50 mm long.

Construction: - Using offset method

1. Enclose the base of the cone in a square (Fig. a).
2. Draw the ellipse corresponding to the circular base of the cone.
3. From the centre of the ellipse draw a vertical centre line and locate the apex at a height of 50 mm.
4. Draw the two outer most generators from the apex to the ellipse and complete the drawing.



(a) (b)

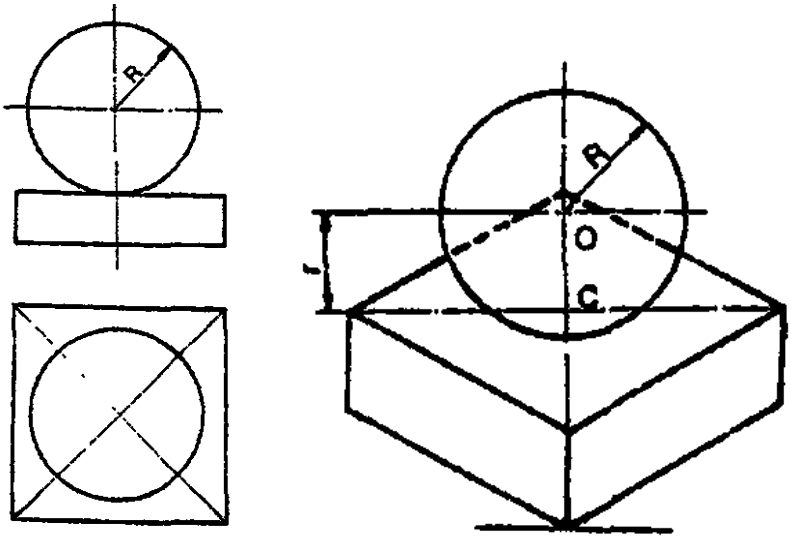
Fig. 5.40

Examples: -

The orthographic projections and the isometric projections of some solids and machine components: -

Note here (a) will be question and (b) will be answer.

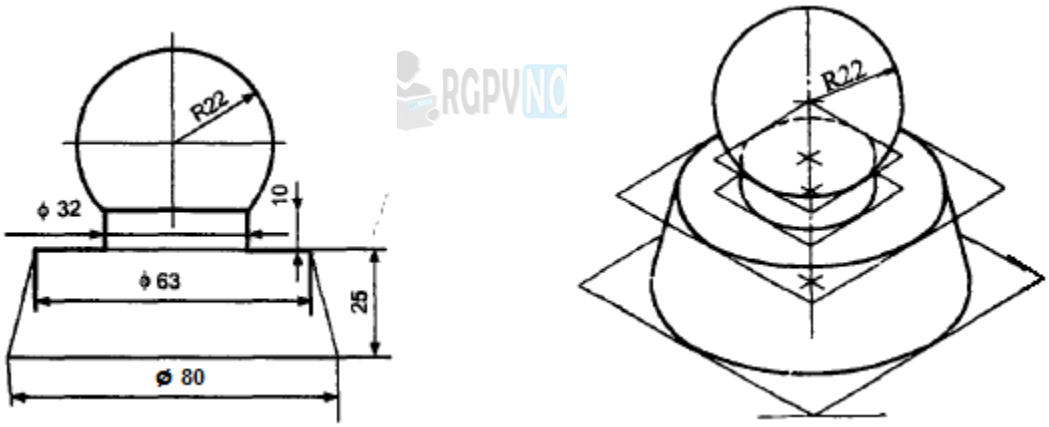
1.



(a) (b)

Fig. 5.41

2.



(a) (b)

Fig. 5.42

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