Principle of Orthographic Projections and Free Hand Sketching

5.1 INTRODUCTION

Pictorial view is a three dimensional representation of an object. It is easy to visualise an object with the help of pictorial view. If the pictorial view is visualsed from the front. front view of the object is obtained, if looked from side, side view is obtained and if looked from top, top view is obtained. The projections obtained in the form of front, side and top views are called *orthographic projections*.

The term *orthographic projection* is very widely used to represent the multiview projection, because of its popularity.

5.2 PRINCIPLE OF ORTHOGRAPHIC PROJECTION

Orthographic projections are preferred by engineers and drafts man to show the true shape and size of objects on a two dimensional plane. Usually, two views are sufficient to describe an object completely. Then, their views are projected one on vertical plane called *front view* and the other on the horizontal plane called *top view*. Sometimes, a third view is also required to define an object completely. Hence, a third view is projected on another vertical plane perpendicular to both H.P and V.P., called profile plane and is abbreviated as P.P. The view obtained on the profile plane is called *profile view*, *side view*, *end view* or *side elevation*. The arrangement of three planes of projections are already explained. The method of developing three views of an object and the layout of these views are explained in the following article.

5.3 FIRST ANGLE PROJECTION (ANTI-CLOCK WISE SYSTEM)

Figure 5.1 shows an object situated in the first quadrant with its main faces parallel to the three principal planes of projections. Hence, these parallel faces will have true shape and size in their views. The three views obtained on the three principal planes are explained below:

1. **Front view** is the view of the object obtained on the V.P. by drawing projectors perpendicular to V.P. from the various corners of the object. The object is viewed in the direction marked by FRONT. Note that the object is in between the eye of the observer and the plane of projection. This is indicated by terms EYE-OBJECT-PLANE.
2. **Top view** is the view of the object obtained on the H.P. by drawing projectors perpendicular to H.P. from the various corners of the object. The object is viewed in the direction marked by Top. Note that the object is in between the eye of the observer and the plane of projection. This is indicated by the term. *EYE-OBJECT-PLANE*.
3. **Left side view** is the view of the object obtained on the P.P. By drawing projectors perpendicular to P.P. from the various corners of the object. The object is viewed in the direction marked by LEFT SIDE. Note that the object is in between the eye of the observer and the plane of projection. This is indicated by the term *EYE-OBJECT-PLANE*. The layout the principal views of the object is shown in Fig. 5.2.

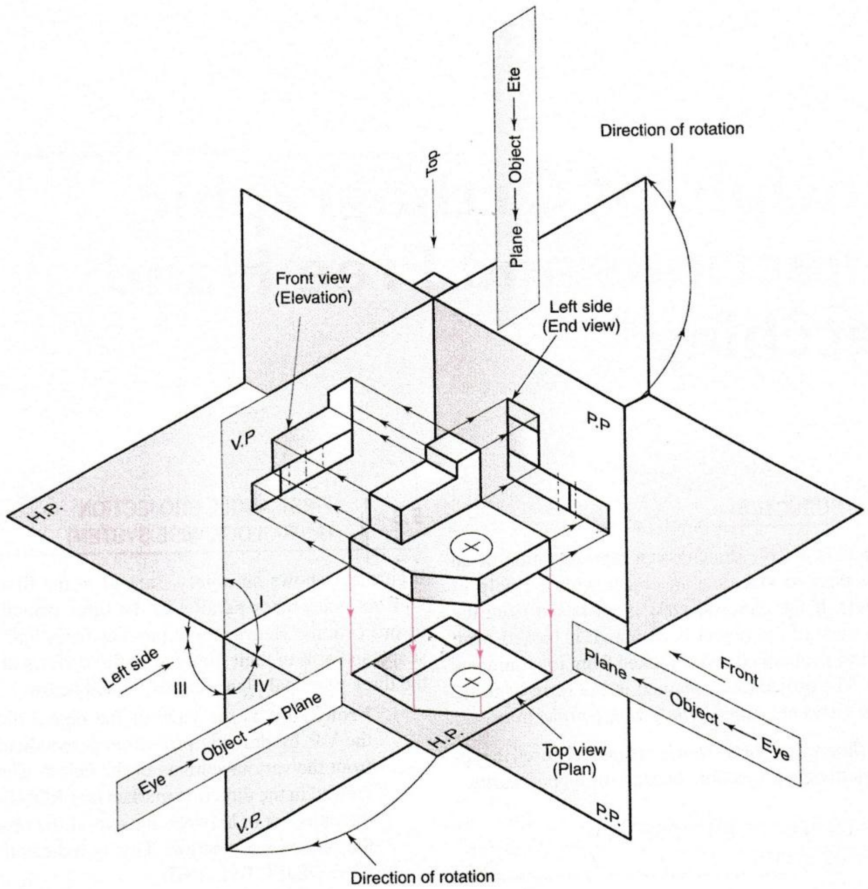


Fig. 5.1 *First angle projection of a solid (anti-clockwise system)*

Note

In first angle projection,

1. The principal planes are assumed to be transparent.
2. The object is assumed to be transparent.
3. The object is placed in between the plane of projection and the eye of the observer.
4. The view shown on the plane of projection in actually the side of the object which is away from the plane of projection.
5. The edges of the object which are not visible are shown by dashed lines.

5.4 LAYOUT OF VIEWS

If an object is very much complicated, even more than three views are required. In such cases, a different method called *transparent box method* is employed. Here, the object is placed inside a transparent box as shown in Fig. 5.3 and viewed in the directions shown. The views obtained on different planes are also marked and named. The principle of

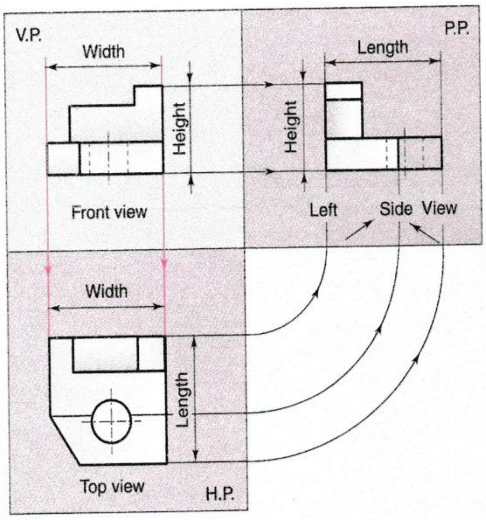


Fig. 5.2 *Lay-out of principal views of a solid (First angle projection in anti-clockwise system)*

EYE-OBJECT-PLANE is followed here also. The following are the views shown:

1. Front view
2. Top view
3. Left side view
4. Right side view
5. Bottom view
6. Rear view

The transparent box can be opened out to get the views as layed out in Fig. 5.4. The rear view may also, be placed even on the left hand side of the right side view.

5.5 ORIENTATION OF OBJECTS

In the preparation of orthographic views of an object, it should be placed in its simplest position as far as possible considering its functional aspects. The process of identifying the ideal position of the object for the preparation of the orthographic views, is called *orientation of object*. In the selection of the orientation of an object the following points may be born in mind:

1. The principal face of the object may be kept parallel to the plane of projection.
2. The most descriptive face of the object may be kept parallel to the plane of projection.
3. The object is placed in such a way that the number of hidden details to be presented, is minimum.
4. The object may be placed in its natural position as far as possible.

5.6 SELECTION OF ORTHOGRAPHIC VIEWS

The number of views required to describe an object completely through its orthographic views, depends upon the complexity of the drawing produced. The following are the important classifications of the drawings based upon the number of orthographic views:

1. One-view drawing
2. Two-view drawing
3. Three-view drawing

5.6.1 One-view Drawing

One-view drawing is a drawing of an object which can be completely described by simple orthographic view. Here, the features are represented by a note or an abbreviation. Flat objects like washers, gaskets and shims etc. are represented by making their thickness. A simple orthographic view is sufficient to describe a bolt completely as shown in Fig. 5.5. Here, diameter is represented by ϕ spherical radius is in indicated by SR and square is shown by the notation □. Fig. 5.6 shows a lock washer and all dimensions are marked.

Two-view drawing of an object which can be completely described by two orthographic views. Objects which are symmetrical about two axes can be completely represented by two orthographic views. The front and side views of the objects shown in Fig. 5.7 are sufficient to described them completely. It may be noted that the front and top views will not be sufficient to describe the objects mentioned above.

5.6.2 Two-view Drawing

The largest face containing the maximum informations may be selected as the front view. Also, proper combination of views should be selected to describe an object completely.

5.6.3 Three-view Drawing

Three-view drawing is a drawing of an object which can be represented clearly and completely by three orthographic views. The largest face containing the maximum

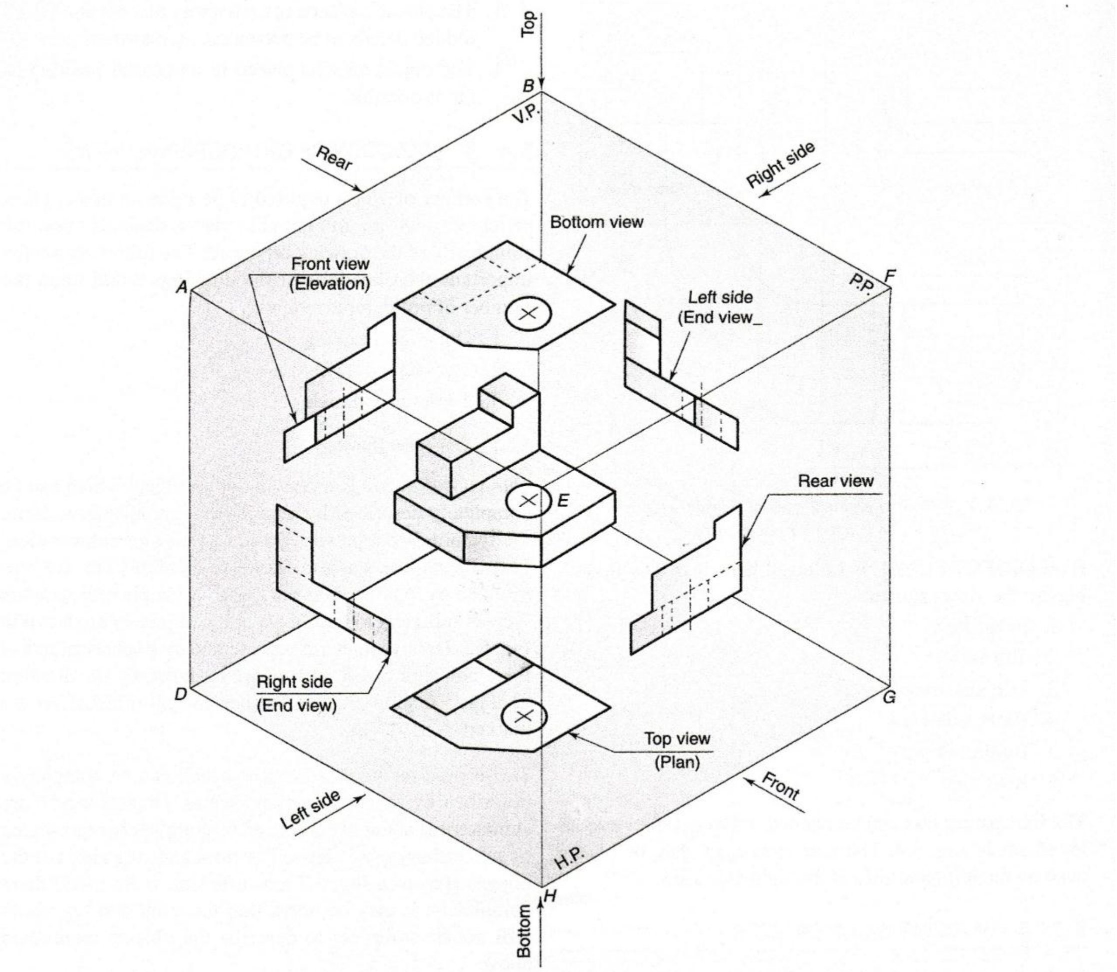


Fig. 5.3 *Transparent box containing a solid (first angle projection in anti-clockwise system)*

information should be selected as front view. Three view drawing of an object is shown in Fig. 5.8.

5.7 REPRESENTATION OF A LINE

A technical drawing consists of various lines. A line on a drawing may be used to represent the extent of the various surfaces on an object as mentioned below:

1. Edge view of a surface of an object
2. Intersection of two surfaces of an object
3. Surface limit of the surfaces of an object.

1. Edge view of a surface If a plane surface is perpendicular to one of the reference planes, is projection on that reference plane, is represented by a line. Refer Fig. 5.9 (i) If a surface *ABCD* is perpendicular to V.P. and parallel to H.P. its projection on V.P. is represented by a line *a′b′*. Here, the line *a′b′* is representing

(i) the whole plane surface *ABCD* in its front view

(ii) the edge *AB* of the surface

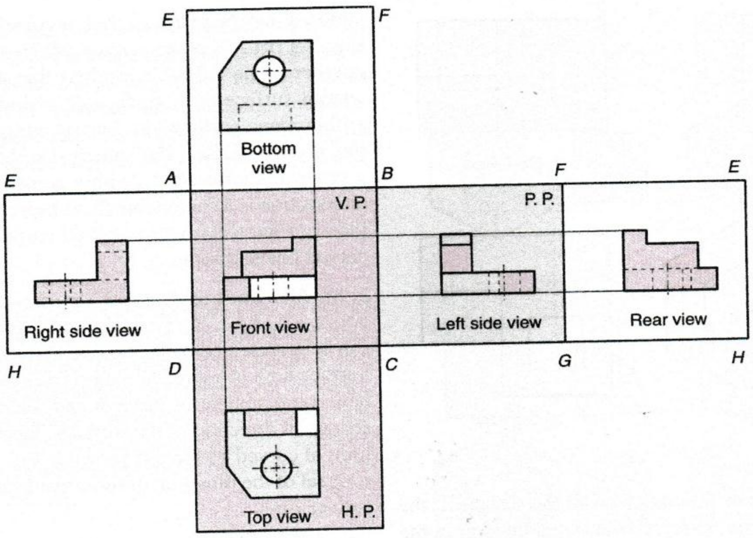
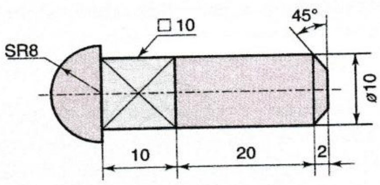


Fig. 5.4 *Layout of six views of a solid (First angle projection in anti-clockwise system)*



Fig, 5.5 *Bolt*

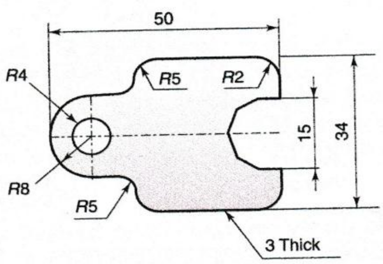


Fig. 5.6 *Lock washer*

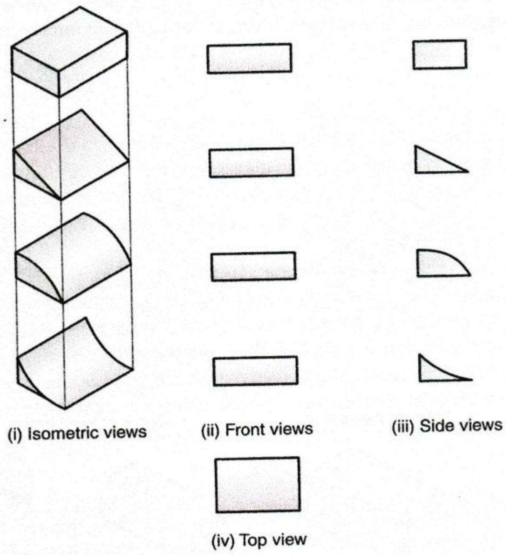


Fig. 5.7 *Two-view drawings of prisms*

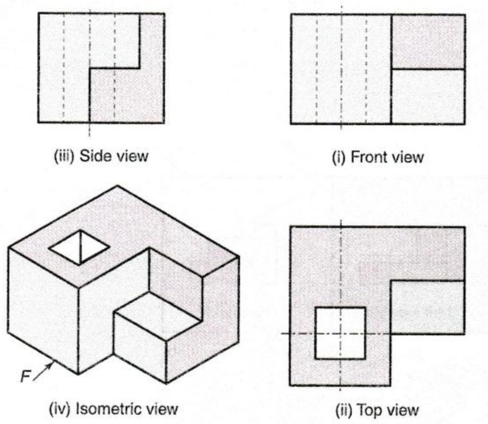


Fig. 5.8 *Three-view drawing of an object*

The line $a'b'$ represents the edge view of the surface. If the plane is vertical, it can be represented by a line, ab in the top view. Note that the edge of the surfaces need not always be straight.

2. Intersection of two surfaces If a surface is intersecting with another surface, a line is formed. The intersecting surfaces may be plane, curved or spherical in shape. Refer Fig. 5.9 (ii) If a plane surface *ABCD* is intersecting with another plane *ABEF*, a straight line *AB* is formed. If a curved surface (say, surface of cylinder) is intersecting with a plane surface, the line of intersection is a curved line (here, a circle). If a spherical surface (say, surface of a sphere) is intersecting with a plane surface, the line of intersection is a curved line (here a circle). A spherical surface can intersect with a curved surface to form another curved line and so on.

3. Surface limit of surfaces Surface limit is the boundary of a surface. Surface limits of a plane surface *ABCD* can be represented by the outer edges *AB*, *BC*, *CD* and *DA*. Surface limit of a circular plane is a circle and so on. Solids have more number of surfaces and surface limit represents change of direction of the surfaces. Identifying the surface limit of curved surfaces is shown in Fig. 5.9 (iii). Here, the reversal of the direction of the curved surface indicates the surface limit.

As the tangent drawn to the adjacent curved surfaces *AB* and *BC* at the point of tangency *B*, is coinciding with the projector $p_b'p_b'$ drawn through the same point, a line bb is drawn in the top view through the point where the projector meets the plane of projection. Here, bb represents

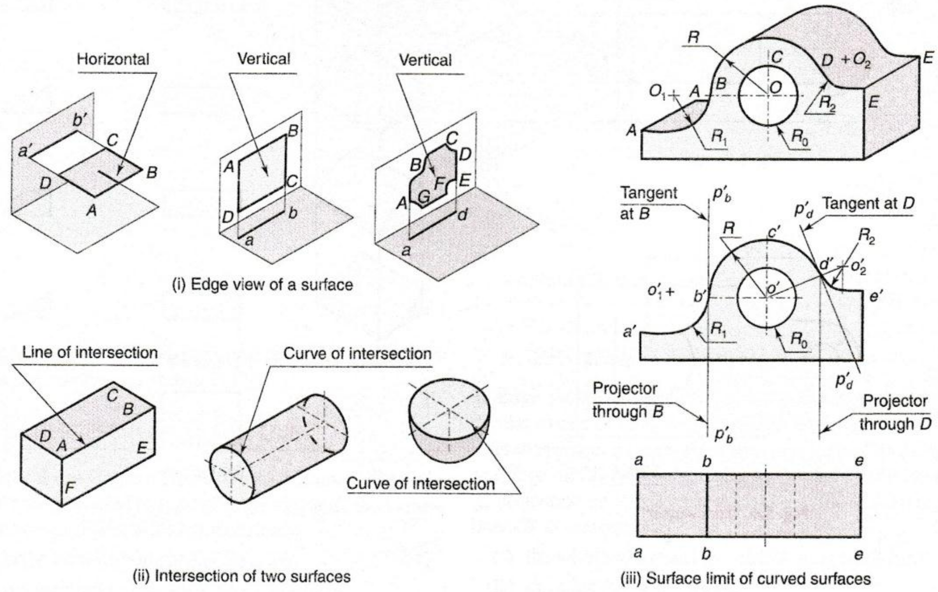


Fig. 5.9 *Representation of a line*

the surfaces limit of the two curved surfaces drawn with centres $O1$ and O. But, the tangent drawn to the adjacent curved surfaces CD and DE at the point of tangency D, is not coinciding with the projector drawn through the same point. Hence, no line is required to be drawn at this region to represent the surface limit of the curved surfaces CD and DE.

5.8 REPRESENTATION OF AN AREA

An area on an orthographics view represents the projected surface area of a part of an object. The meaning of an area in a drawing, will be understood properly only if it is clearly analysed be referring the other view or views. The surface may be inclined, horizontal or oblique and may be at a higher or lower level than the adjacent surfaces. The representation of an area in orthographic view may be grouped as shown below:

1. Area parallel or perpendicular to the planes of projections Figure 5.10 (i) shows isometric view of an object. Surface *P* is horizontal. In the top view, this surface will have true shape and size. In the front view this surface is indicated by a horizontal line *P* as it perpendicular to V.P. In the side view, this surface is indicated by a horizontal line *P* as it is perpendicular to profile plane.

2. Area inclined to one plane of projection Figure 5.10 (ii) shows isometric view of an object. Surface *Q* is inclined to H.P. In the top view this surface will not have true shape and size. In the front view this surface is indicated by an inclined line *Q* as it is inclined to H.P. In the side view, this surface will not have true shape and size and is indicated by *Q*.

3. Curved area perpendicular to one of the planes of projection Figure 5.10 (iii) shows isometric view of an object having curved surface. Surface *R* is perpendicular to V.P. The curved area will be seen as a curve in front view while in the other views of this surface will get foreshortened.

4. Area inclined to all the three planes of projection Figure 5.10 (iv) shows isometric view of an object having an oblique surface. This area is also called as *oblique area*. In all the views, the surface gets foreshortened.

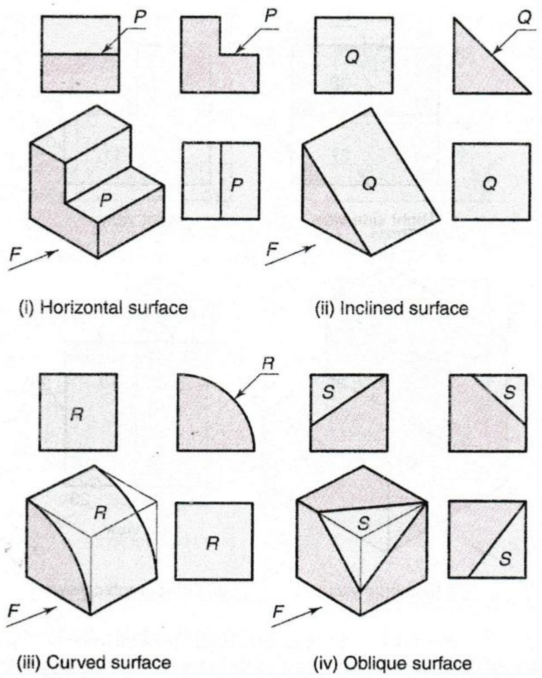


Fig. 5.10 *Representation of areas in multiview projection*

5. Area inclined to two planes of projection and perpendicular to the third plane If the surface is inclined to both H.P. and V.P, front and top views of it will get foreshortened while its side view is a straight line.

6. Hidden area Hidden area are similar to visible areas and represented as that of visible area but instead of continuous thick lines dashed lines are used. In certain drawings, there will be too many dashed lines which may impair the readability of the drawing. In such cases, if the details are clear from the other views, dashed lines may even be omitted.

Problem 5.1

Isometric view of a stepped block is shown in Fig. 5.11 (i). All the corners are named. In its orthographic views, edges are marked by 1, 2, 3 etc. Identify all the edges and present them in a tabular form.

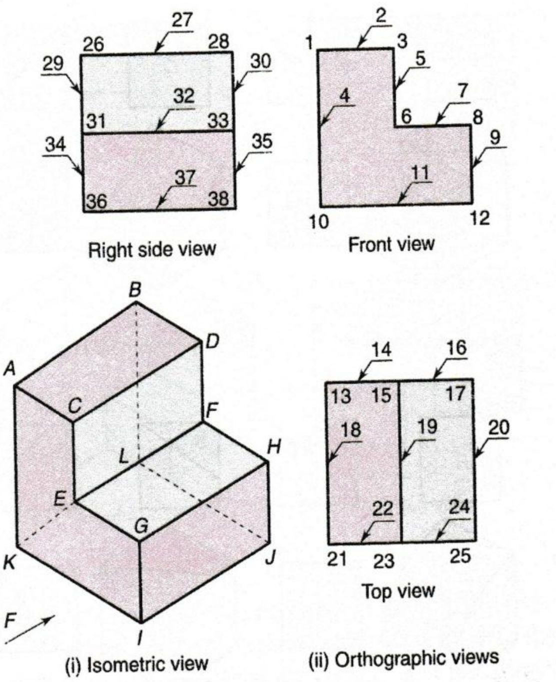


Fig. 5.11 *Identification of edges and corners*

Solution Refer Table 5.1

Table 5.1

Name of edge on isometric view	*No. on front view*	*No. of top view*	*No. on side view*
AB	1	18	27
CD	3	19	27
EF	6	19	32
GH	8	20	32
IJ	12	20	37
AC	2	22	26
CE	5	23	29
EG	7	24	31
GI	9	25	34
IK	11	23	36
KA	4	21	29 & 34
BD	2	14	28
DF	5	15	30
FH	7	16	33
HJ	9	17	36

This object has 8 surfaces and 16 edges. *ABDC* is the top horizontal surface. In the front view, the edge *BD* is falling exactly behind the edge *AC*. The corners *A* and *C* are represented by points 1 and 3 respectively while the surface *ABDC* is represented by 2. The projection of the edge *AB* is represented by the point 1 in the front view. In the top view this surface is indicated by a rectangle 13-15-23-21. Here, the edge *BD* is represented by 14, the edge *AC* is represented by 22 and so on. In the side view the surface *ABDC* is indicated by 27. Similarly, the edges of the object are identified and its shown in Table 5.1.

Problem 5.2

The various surfaces of an object are marked by alphabets and in its orthographic views the surfaces are marked by numerals as shown in Fig. 5.12. Identify the surfaces in the three views and represent them in a tabular form.

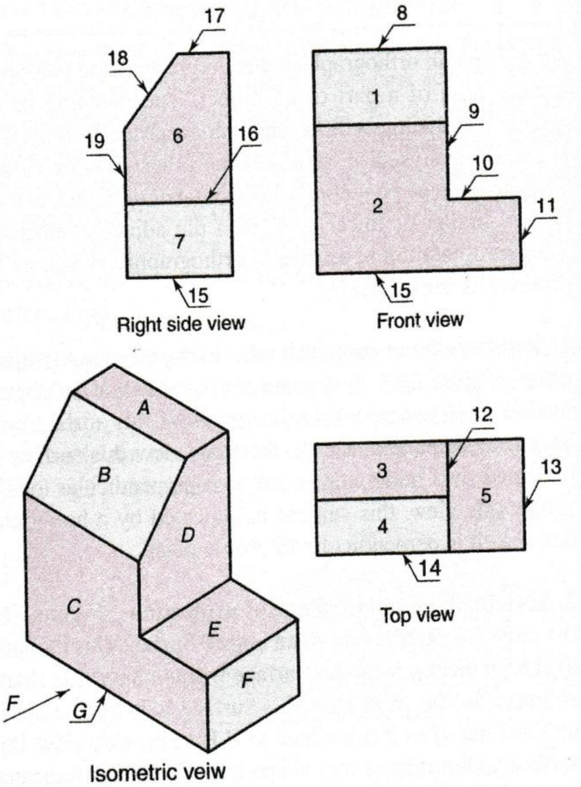


Fig. 5.12 *Identification of parallel and inclined surfaces*

Solution Refer Table 5.2

The surface *B* is inclined to both H.P. and V.P. and it will be seen as foreshortened rectangles, 1 and 4 in the front and top views respectively. Similarly, all the other surfaces can be identified as shown in Table 5.2.

Table 5.2

Name of surface on isometric view	*No. on front view*	*No. on top view*	*No. on side view*
A	8	3	17
B	1	4	18
C	2	14	19
D	9	12	6
E	10	5	16
F	11	13	7
G	15	–	15

Problem 5.3

Draw the three views of the objects shown in Fig. 5.13 (i) Also, identify the surfaces and edges marked and tabulate them.

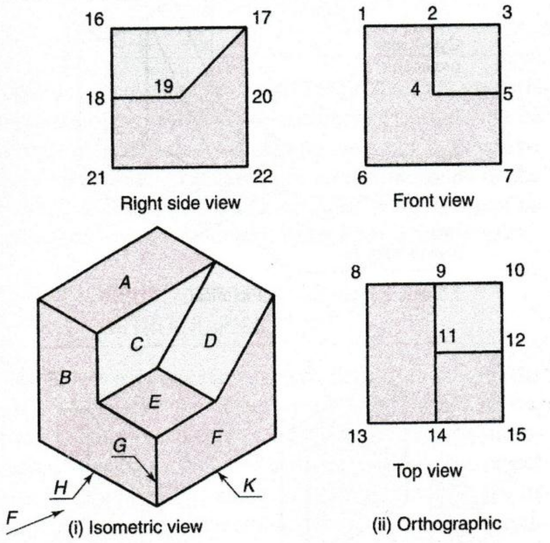


Fig. 5.13 *Identification of edges and surfaces*

Solution Refer Fig. 5.13(ii) and Table 5.3

Table 5.3 (i)

Edges	*Front view*	*Top view*	*Side view*
Edge *G*	5-7	15	18-21
Edge *H*	6-7	13-15	21
Edge *K*	7	13-15	21-22

Table 5.3 (ii)

Surfaces	*Front view*	*Top view*	*Side view*
Surface *A*	1-2	8-9-14-13	16-17
Surface *B*	1-2-4-5-7-6	13-15	16-21
Surface *C*	2-4	9-14	16-17-19-18
Surface *D*	2-3-5-4	9-10-12-11	17-19
Surface *E*	4-5	11-12-15-14	18-19
Surface *F*	3-7	10-15	18-19-17-20-22-21

Problem 5.4

An oblique angle block is shown in Fig. 5.14 and its surfaces are marked by alphabets while the orthographic views are marked by numerals. Identify all the surfaces marked by alphabets with their corresponding numerals in the orthographic views. Present them in a tabular form.

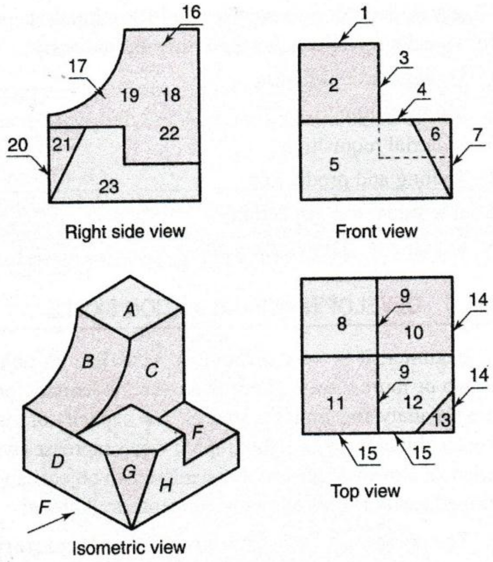


Fig. 5.14 *Identification of different types of surfaces*

Solution Refer Table 5.4

The surface *G* is triangular in shape and is oblique. Therefore, its projections will get foreshortened in all the three views. The triangles 6, 13 and 21 represent the front, top and right side views respectively.

Table 5.4

Name of the surface	*No. on front view*	*No. on top view*	*No. on side view*
A	1	8	16
B	2	11	17
C	3	9	18
D	5	15	20
E	4	12	19
F	–	10	22
G	6	13	21
H	7	14	23

5.9 PRINCIPLE OF VISUALIZATION

The process of drawing different views of an object is similar to writing a language. Reading a drawing is a process of applying the principle of projection. Note that a drawing cannot be read aloud like other languages. Visualisation is actually a mental process by which the details furnished in a pictorial or orthographic drawing, is translated to the reader.

Every student of engineering, should develop the capacity for visualising objects for the following purposes:

1. Design and estimation تصميم وتقييم
2. Modification تعديل
3. Material requisition طلب المادة
4. Tooling and production الادوات والانتاج
5. Assembly and inspection التجميع والتفتيش
6. Repair and maintenance etc. تصليح وصيانة

5.10 DEVELOPING VISUALIZATION SKILLS

For a beginner, it is very difficult to visualize an object from two or more views. There is no very systematic procedure for analysing complex shapes. The capacity of visualising an object from its orthographic views increases with experience. However, the art of visualizing an object can be developed easily if the following concepts are known:

1. The principle of orthographic and pictorial projections
2. The measuring of lines and areas

Methods of breaking down of an object, is one of the simplest method of determining the shape of it. In this method, the object is assumed to be made up of various elemental geometric forms such as prisms, pyramids cylinders, cones etc. These geometric forms may be additions in the form of projections or subtractions in the form of cavities. The entire object is obtained by adding and subtracting the above geometric forms.

1. Rectangular prism A This forms the horizontal base of the angle block. Draw its orthographic views. Identify this part in both the exploded and orthographic views.

2. Rectangular prism B This forms the vertical wall of the angle block. This is placed above the horizontal base and hence it is an addition. Draw its orthographic views in the appropriate position. Identify this part in both exploded and orthographic view. Now, try to visualize these two rectangular prisms placed in the correct position. Check whether each corner and edge can be visualised even without seeing the drawing itself. Try to visualize this compound object from different sides and prepare corresponding rough sketches.

3. Triangular prism C This forms a part connecting the horizontal and vertical prisms. This is placed in between the horizontal and vertical prisms and hence it is an addition. Draw its orthographic views in the appropriate position. Identify this part in both the exploded and orthographic views.

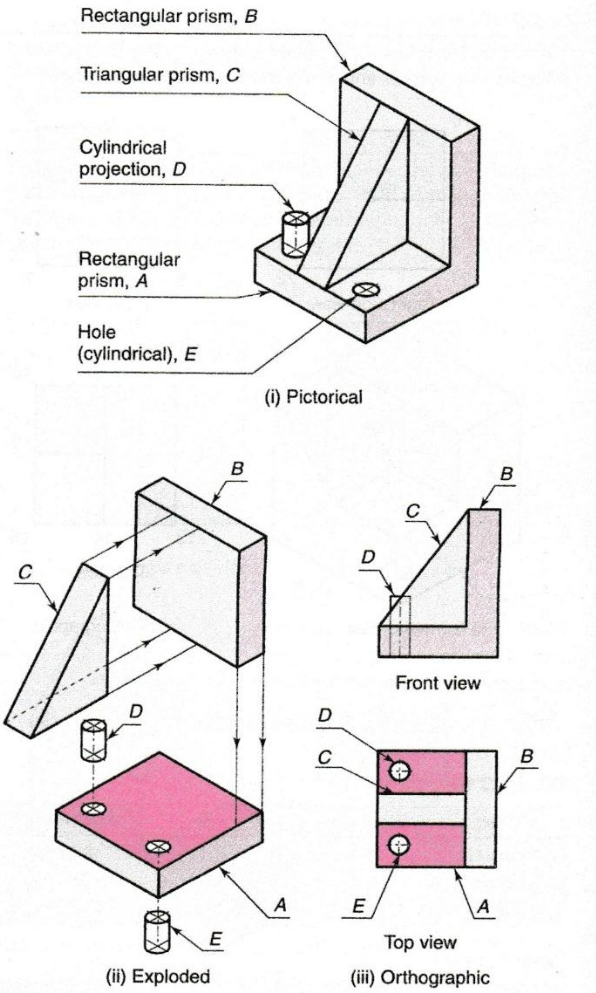


Fig. 5.15 *Visualizing an angle block*

4. Cylinders, D and E The vertical cylinder, *D* is a part placed above the horizontal prism and hence it is an addition. The vertical cylinder, *E* is the part removed from the rectangular prism *A*. Hence, this is a subtraction and forms a cavity. This is actually a hole drilled out in the horizontal base. Draw its orthographic views in the appropriate position. Identify these parts in both the exploded and orthographic views. Now, visualize the entire object.

It may be noted that the entire drawing of an object cannot be read at a glance. A drawing must be read, referring each part systematically, back and forth from one view to the other if a single orthographic view is not sufficient to identify a part completely. While visualizing an object one should think of a three dimensional object and not a two-dimensional object.

5.11 VISUALIZATION OF OBJECTS FROM PICTORIAL VIEWS

Isometric, oblique and perspective projections are the various forms of pictorial views. Reading of pictorial view of a simple object is relatively easy because the object can be easily visualized. This view give an overall shape of the object. The method of *breaking down the object* can be applied to visualize the object. Refer Prob. 5.5 for details.

5.12 VISUALIZATION OF OBJECTS FROM ORTHOGRAPHIC VIEWS

If the object is complex, it is very difficult to present the complete shape of the object by a pictorial view. Hence, in engineering practice, it is very usual to prepare orthographic views. As mentioned earlier, to visualize an object from its orthographic views, a thorough knowledge of the principles of orthographic projections is essential. Visualization from orthographic views, may be started from simple objects. Complex objects may be visualized after getting some experience.

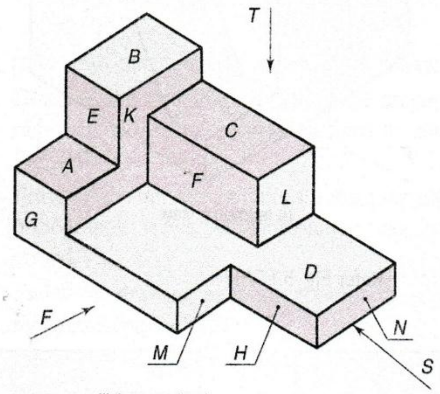
However, a general method suggested below may be followed for developing the capacity for visualization:

1. Read the given orthographic views and obtain the overall shape of the object by referring all the given views.
2. Interpret each surface of the object and identify them by marking alphabets in the orthographic views.
3. Sketch the pictorial view of the object and identify the surfaces by marking alphabets on the surfaces appropriately.
4. Read the pictorial view and confirm that it agrees fully with the orthographic views.
5. Read the orthographic views again and prepare other orthographic views which are not given.
6. Read the orthographic views, once again and draw sectional views taking sections at the different levels.
7. By doing this much, one will have a clear idea about the shape and dimensions of the object. Now, a model of the object may be made by using soft materials like soap, clay, thermocol, wood etc.
8. Before concluding, read the given drawing once again and ensure that visualization of the object is complete. Do not forget to read specification and other informations furnished on the drawing.

Depending upon the experience gained, some steps mentioned above may ignored, for visualizing an object.

Problem 5.5

Figure 5.16 (i) shows isometric view of an object. Visualize the object and sketch the three orthographic views. Identify the surfaces by marking alphabets on the three views.



(i) Isometric view

Solution Refer Fig. 5.16 (ii)

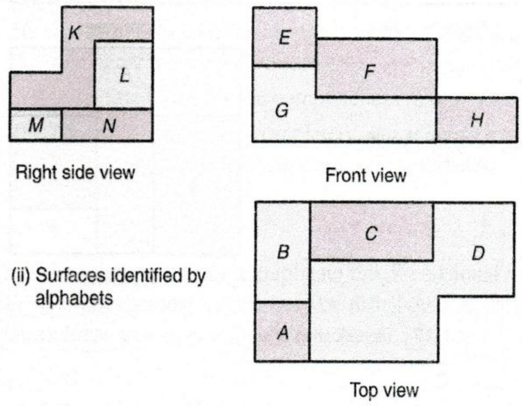
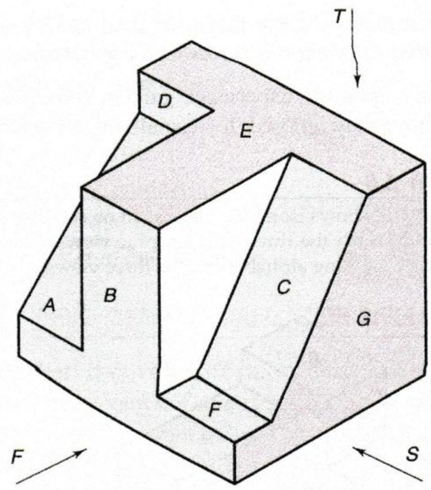


Fig. 5.16 *Identification of surfaces by marking alphabets*

All the visible surfaces are identified by marking alphabets on them.

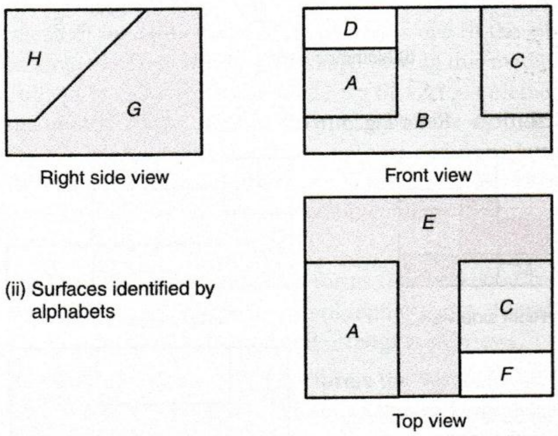
Problem 5.6

Figure 5.17 (i) shows three views of a block. Visualize the object and sketch a proportional isometric view of the block. Identify the surfaces on the isometric view.



(i) Isometric view

Solution Refer Fig. 5.17 (ii)



(ii) Surfaces identified by alphabets

Fig. 5.17 *Identification of surfaces by marking alphabets*

All the visible surfaces are identified by marking alphabets on them.

Problem 5.7

Three orthographic views of a block are shown in Figure 5.12, isometrie. Read the drawing and draw the complete views, adding missing line or lines if any.

Solution Refer Fig. 5.18 (ii)

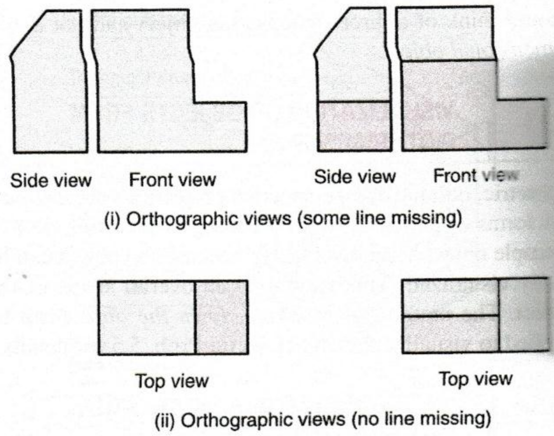


Fig. 5.18 *Identification of missing lines*

5.13 PROCEDURE TO SKETCH ORTHOGRAPHIC VIEWS

In the preparation or orthographic views of an object certain procedure is to be followed for developing speed and accuracy in drawing. To save time, as far as possible, reduce changing of instruments from one to the other. Identify the locations for placing each instrument, eraser, drawing pencils etc. so that each one of them can be picked up easily without wasting time. As a guide line, a systematic procedure for drawing orthographic views, is suggested below for the beginners.

1. Decide the direction of the front view based on the factors mentioned earlier.
2. Decide the number of views and the combination of views such as front and top views, front and left side views etc. The number of views selected should be sufficient to describe the object clearly and completely.
3. Determine the overall dimensions of the views required.
4. Select suitable scale depending upon the size of the drawing sheet to be used for the given application. The scale selected should be reasonable so that the readability of the drawing is not lost. Sometimes, larger size of the drawing sheet is to be preferred and the scale is to be selected suitably.
5. Fix the drawing sheet on the drawing board.
6. Draw the border lines and the outlines of the title block as described earlier.

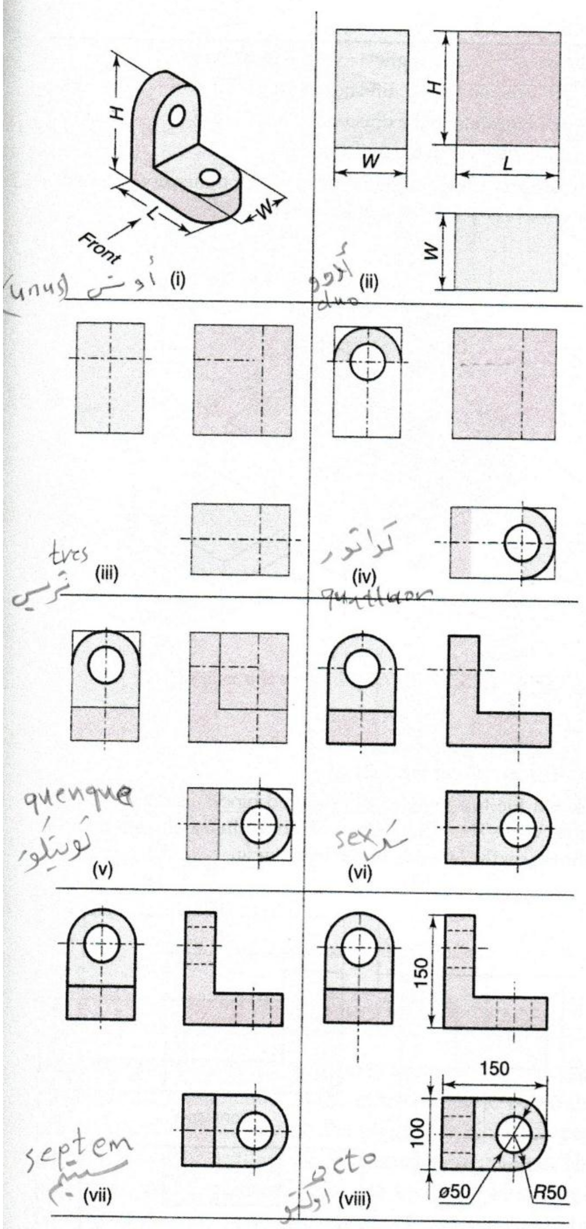


Fig. 5.19 *Drafting procedure of orthographic views*

7. The object whose orthographic views to be drawn, is shown in Fig. 5.19 (i). Locate the spaces for the different views as shown in Fig. 5.19(ii). For better appearance, equal spaces may be left between the views. However, necessary space for printing dimensions, notes etc., should be provided while leaving space between the views.
8. Based on the shape of the object locate the centre lines of the object as shown in Fig. 5.19 (iii).
9. As far as possible, each feature is to be drawn simultaneously in all the views. Here, the following order of priority may be preferred while doing so, the order of priority mentioned below may be followed.
   (i) Draw circle, semicircle, arcs first in thick line as shown in Fig. 5.19 (iv).
   (ii) Draw straight lines which constitute the overall shape of the object in thin lines as shown in Fig. 5.19 (v).
   (iii) Draw other straight edges, fillets, rounds etc.
10. Draw all the remaining details to be drawn on all other views except the hidden lines as shown in Fig. 5.19 (vi).
11. Erase all the unnecessary lines in the preparation of orthographic views. All construction lines are to be erased.
12. Finish the drawing by using appropriate line types recommended by B.I.S.
13. Draw the necessary hidden lines as shown in Fig. 5.19 (vii).
14. Mark dimensions as shown in Fig. 5.19 (viii).
15. Draw hatching lines at equal distance by using thin lines.
16. Enter notes and other necessary information if any and name the views if necessary.
17. Print title block for the completeness of drawing.
18. Check the drawings completely and identify errors in drawing, missing dimension, notes etc.

Note

Care should be taken not to duplicate the dimensional values. The dimensional values may be distributed in all the views.

5.14 OBJECTS HAVING NORMAL SURFACES

If a surface of an object is parallel to a reference plane of projection, it will be normal to the other two reference planes. The projection of the surface of the plane on a reference plane to which it is parallel will have true size and shape.

On the other hand, the projection of the surface obtained on the other reference plane will be represented by straight lines. The problem shown below illustrate this principle.

Problem 5.8

The isometric view of an object it shown in Fig. 5.20 (i) Sketch the following views to full size.

(a) Elevation
(b) Top view
(c) Left side view

Follow first angle projection method. All dimensions should be entered as per Bureau of Indian Standards.

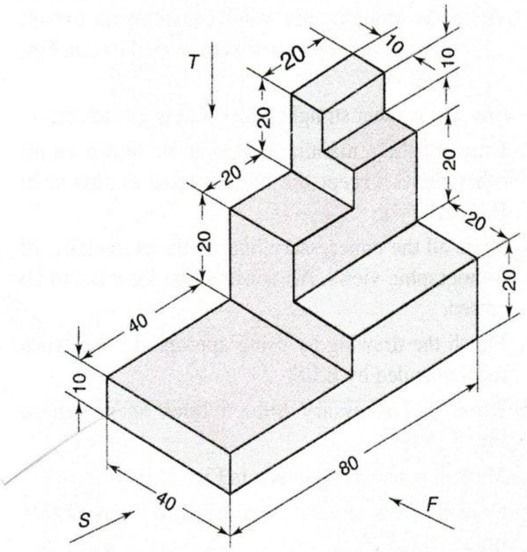


Fig. 5.20(i) *Isometric view of a stepped block*

Solution Refer Fig. 5.20 (ii)

Figure 5.20 (ii) shows front, top and left side views.

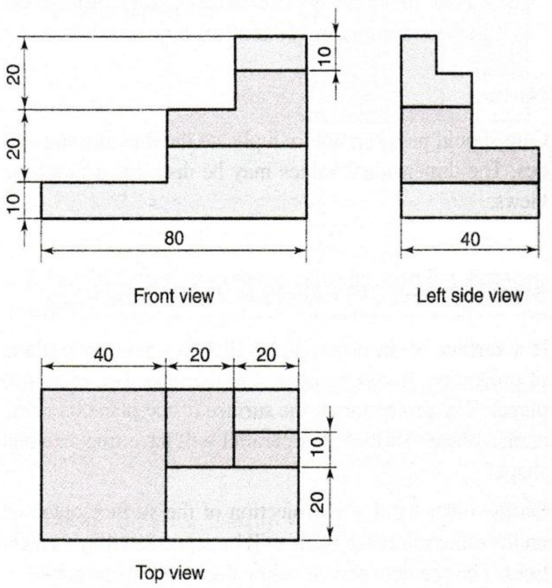


Fig. 5.20(ii) *Orthographic views of a stepped block*

Problem 5.9

The isometric view is given in Fig. 5.21 (i) Sketch:

(i) The plan in the direction of *T*.
(ii) Elevation in the direction of *F*.
(iii) Side view in the direction of *S*.

Follow first angle projection method. All dimensions should be entered as per Bureau of Indian Standards.

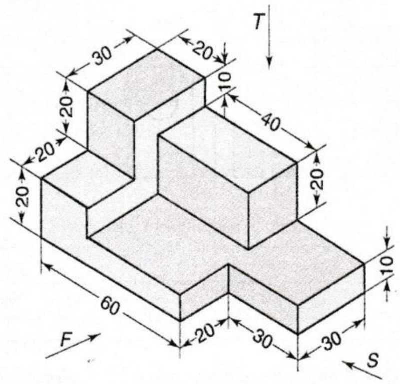


Fig. 5.21(i) *Isometric view of a stepped block*

Solution Refer Fig. 5.21 (ii)

Sketch the top view of the stepped block exactly below the front view. The right side view looked in the direction of *S* is shown on the left side of the front view.

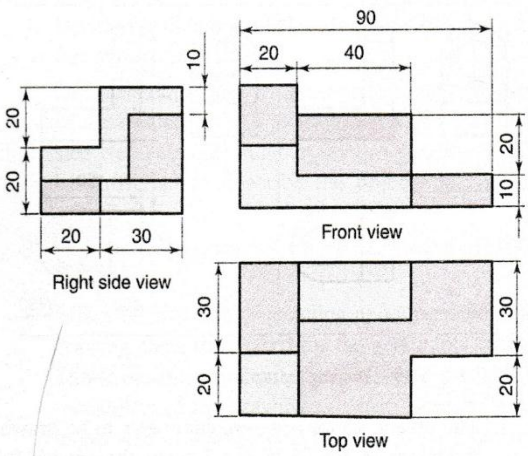


Fig. 5.21(ii) *Orthographic views of a stepped block*

Problem 5.10

Sketch the elevation, plan and end view of the block shown in Fig. 5.22.

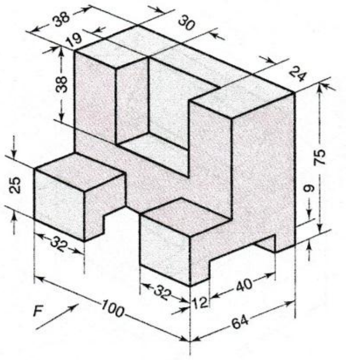


Fig. 5.22 *Isometric view of a block*

Solution Refer Fig. 5.23

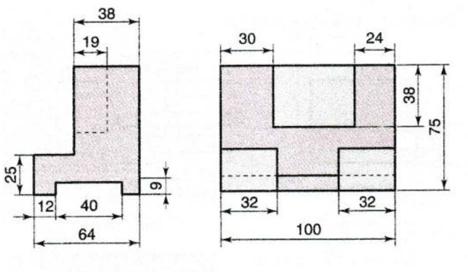
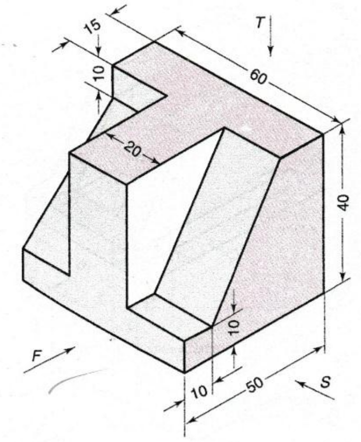
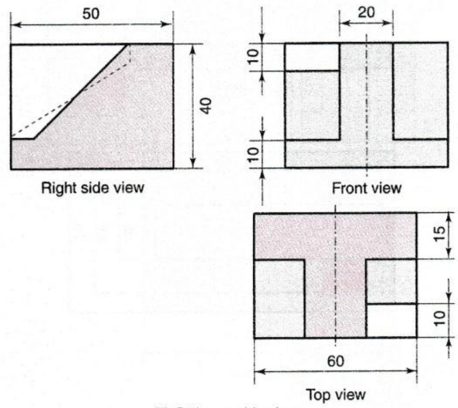


Fig. 5.23 *Orthographic views of a block*



(i) Isometric view of a block

Solution Refer Fig. 5.24 (ii)



(ii) Orthographic views

Fig. 5.24 *Views of a block*

5.15 OBJECTS HAVING INCLINED SURFACES

If any surface of an object is inclined to one of the principle planes and perpendicular to the other principle plane the projection of that surface on the plane to which it is perpendicular will be a straight line inclined to the *xy*-line. The projection of the inclined surface on the plane to which it is inclined will be foreshortened. The following examples illustrate how orthographic views of the objects having inclined surfaces are sketched from pictorial views.

Problem 5.11

The pictorial view of an object is shown in Fig. 5.24 (i). Sketch the following views and show the dimensions.

(a) Front view (b) Top view (c) Right side view

Problem 5.12

The pictorial view of the object is shown in Fig. 5.25. Sketch the orthographic views of it.

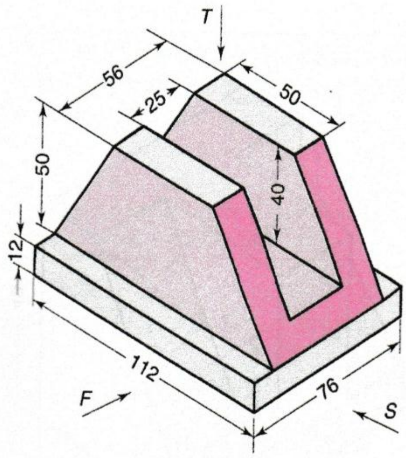


Fig. 5.25 *Isometric view of a forked end*

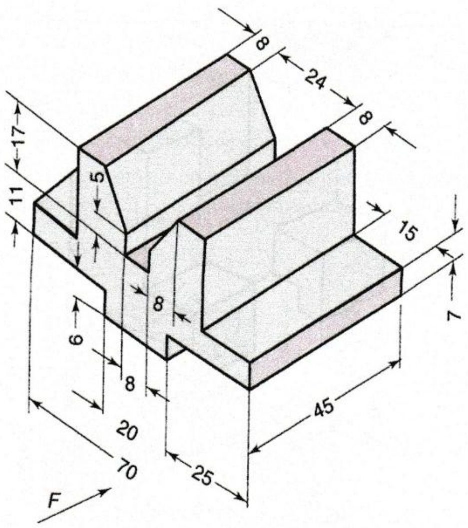


Fig. 5.27(i) *Isometric view of a cast iron block*

Solution Refer Fig. 5.26

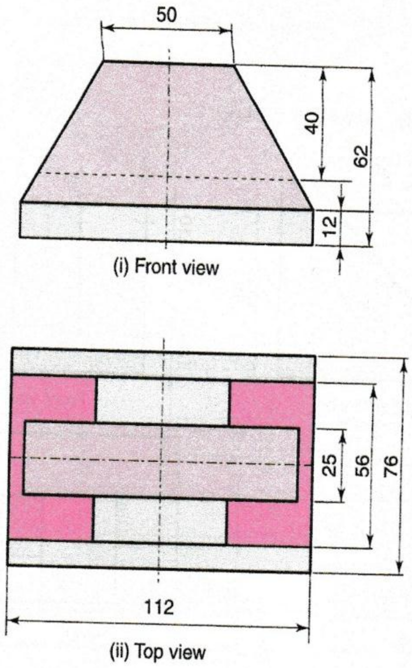


Fig. 5.26 *Orthographic views of a forked end*

Solution Refer Fig. 5.27 (ii)

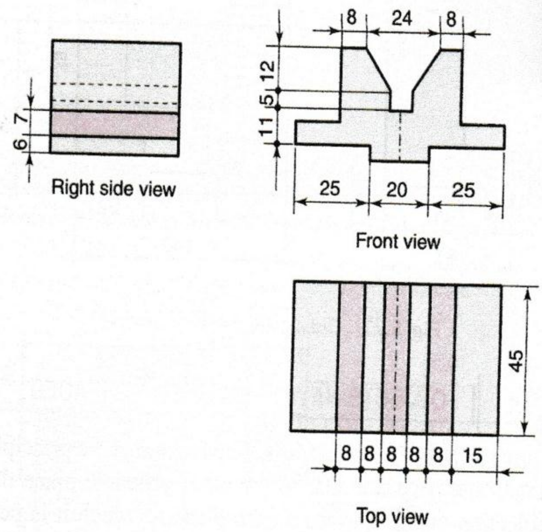


Fig. 5.27(ii) *Orthographic views of a cast iron block*

Problem 5.13

The pictorial view of an object is shown in Fig. 5.27(i) Sketch the three views and show the dimensions.

Problem 5.14

Pictorial view of a block is shown in Fig. 5.28 (i) Sketch the following views in the first angle projection:

(i) Front view in the direction of the arrow *F*,

(ii) Top view and

(iii) Left hand side view

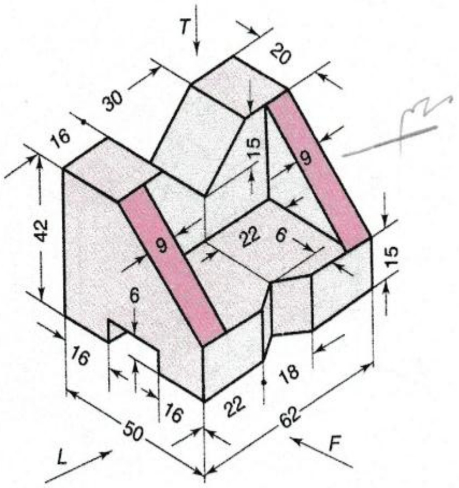


Fig. 5.28(i) *Isometric view of a M.S. block*

Solution Refer Fig. 5.28 (ii)

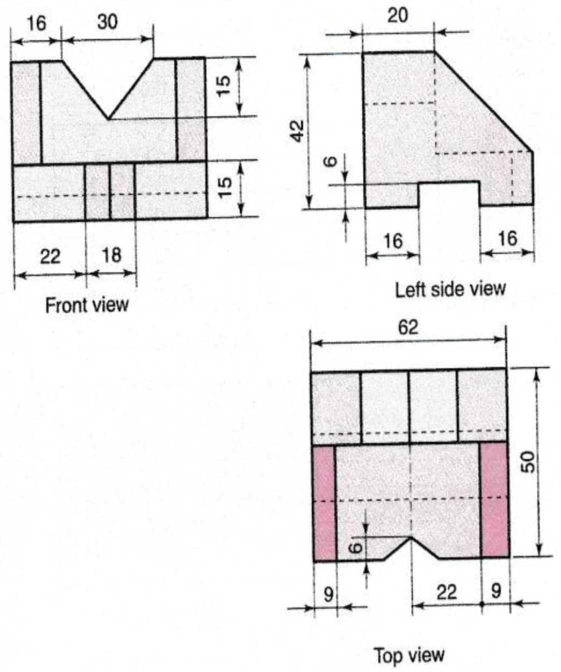


Fig. 5.28(ii) *Orthographic views of a M.S. block*

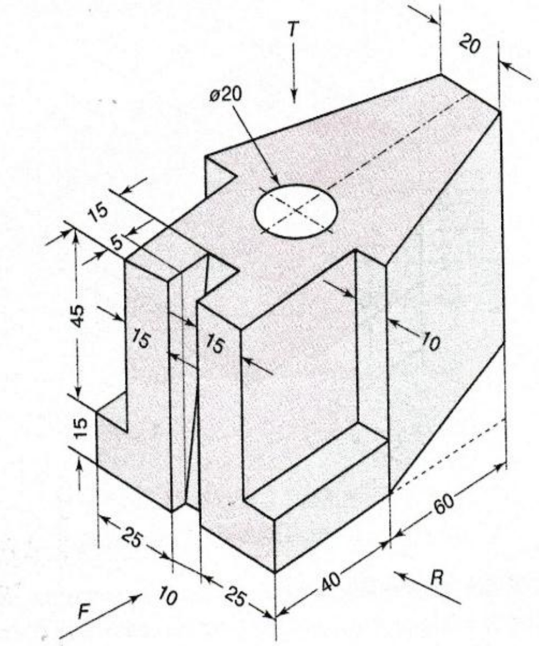


Fig. 5.29(i) *Isometric views of a steel block*

Solution Refer Fig. 5.29 (ii)

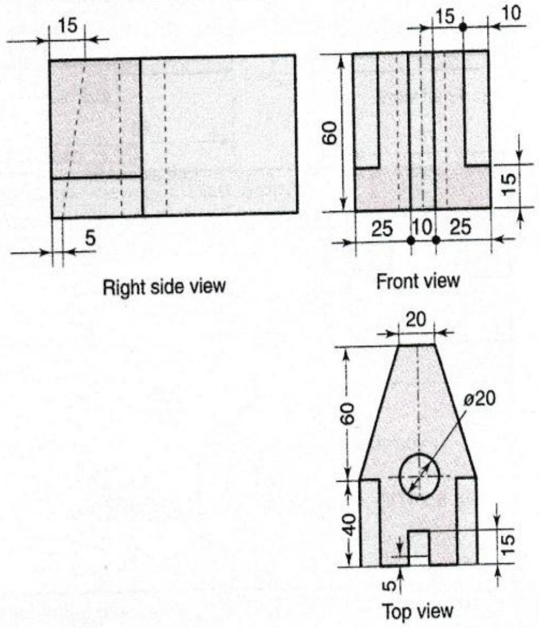


Fig. 5.29(ii) *Orthographic views of a steel block*

Problem 5.15

The isometric view of a block is shown in Fig. 5.29 (i). Sketch the views:

(i) Looking the direction of *F*
(ii) Looking the direction of *R*
(iii) Looking the direction of *T*

Problem 5.16

Pictorial view of a block is shown in Fig. 5.30 (i) Sketch:

(a) Front view in the direction of *F*
(b) Top view
(c) Left side view

Follow first angle projection. Mark on the views 10 important dimensions as per I.S. Code

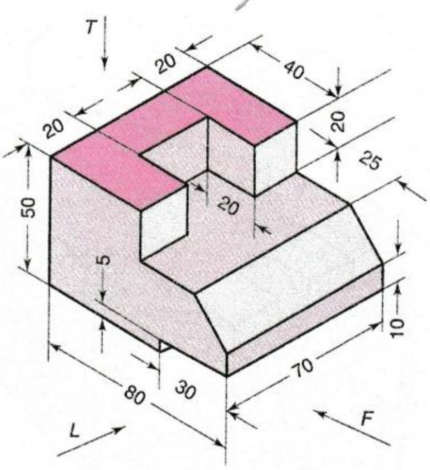


Fig. 5.30 (i) *Isometric view of a locating plug*

Solution Refer Fig. 5.30 (ii)

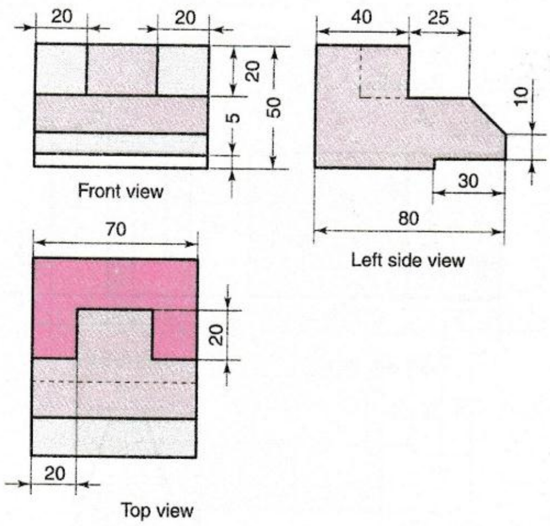


Fig. 5.30 (ii) *Orthographic views of a locating plug*

Problem 5.17

A stepped block is shown in Fig. 5.31 (i) Sketch the following orthographic views:

(i) Front elevation looking in the direction of *F*

(ii) Top view

(iii) Side view projected from view (i)

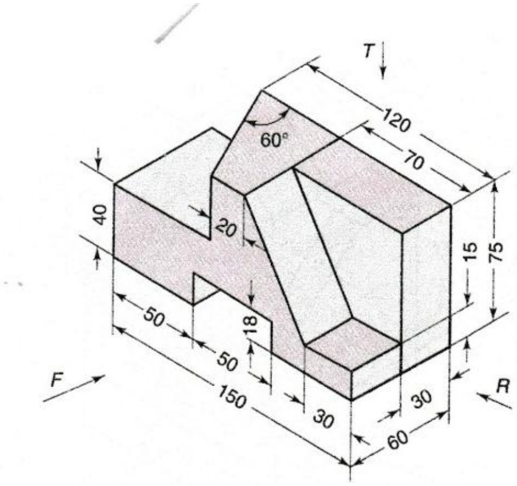


Fig. 5.31 (i) *Isometric view of a stepped block*

Take scale 1:1

Follow first angle projection method. All dimensions should be entered as per Bureau Standards. All hidden lines should be shown.

Solution Refer Fig. 5.31 (ii)

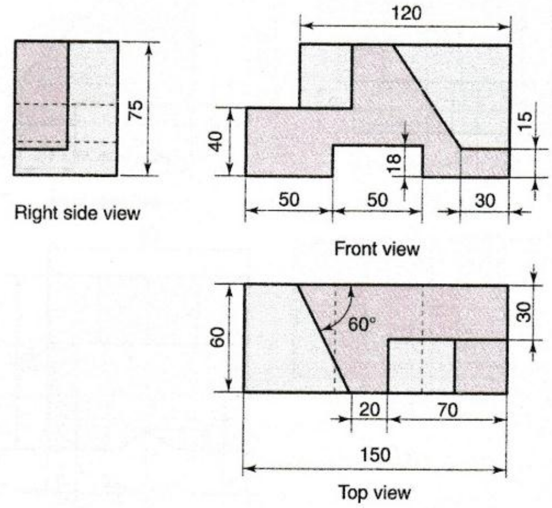


Fig. 5.31 (ii) *Orthographic views of a stepped block*

Problem 5.18

Sketch the front, top and left side views of a T-block shown in Fig. 5.32 (i) Follow the first angle projection method.

Follow first angle projection method. All dimensions should be entered as per Bureau of Indian Standards. All hidden lines should be shown.

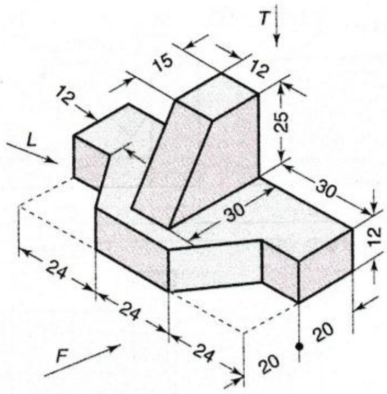


Fig. 5.32(i) *Isomtric view of a T-block*

Solution Refer Fig. 5.32 (ii)

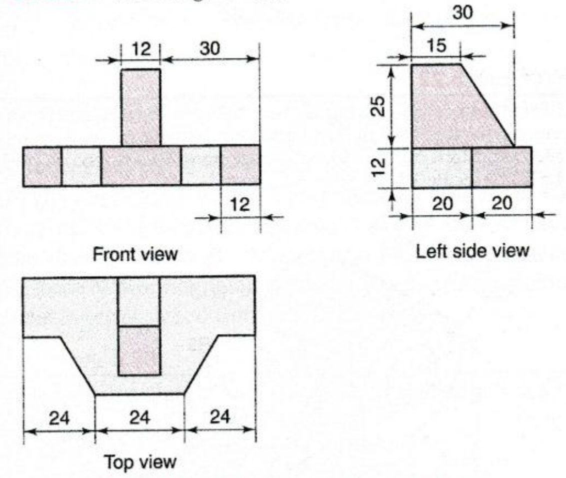


Fig. 5.32(ii) *Orthographic views of a T- block*

Problem 5.19

A M.S block is shown in Fig. 5.33 (i) Sketch its from view in the direction marked by *F* and its left side view.

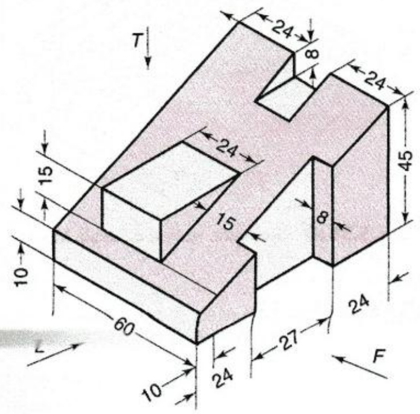


Fig. 5.33 (i) *Isometirc view of a M.S. block*

Solution Refer Fig. 5.33 (ii)

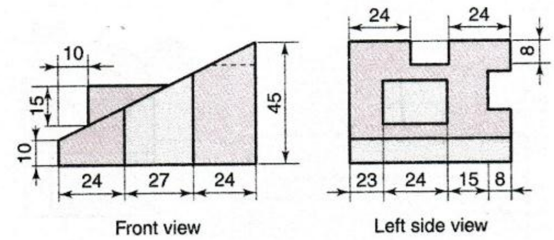


Fig. 5.33(ii) *Orthographic views of a M.S. block*

5.16 OBJECTS HAVING SIMPLE CURVED SURFACES

The projection of a curved surface of an object will be a curved line if the surface is perpendicular to plane of projection while its projection on the other plane will have a foreshortened area.

The following problems illustrate how orthographic views of objects having curved surfaces are sketched from pictorial views.

Problem 5.20

Isometric view of a shaft support is shown in Fig. 5.34 (i) Sketch front view in the direction of the arrow *F*. Add top view and left side views.

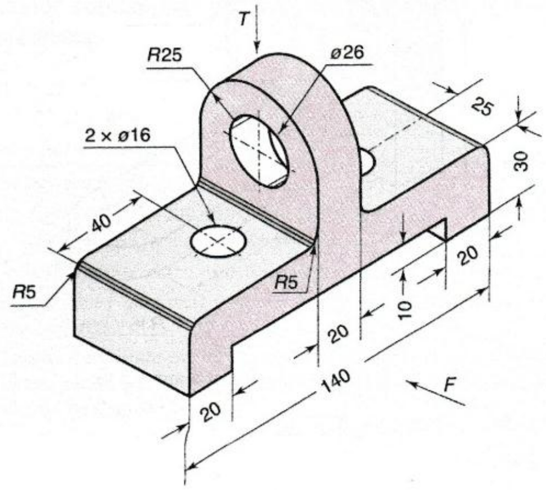


Fig. 5.34 (i) *Isometric view of a shaft support*

Solution Refer Fig. 5.34 (ii)

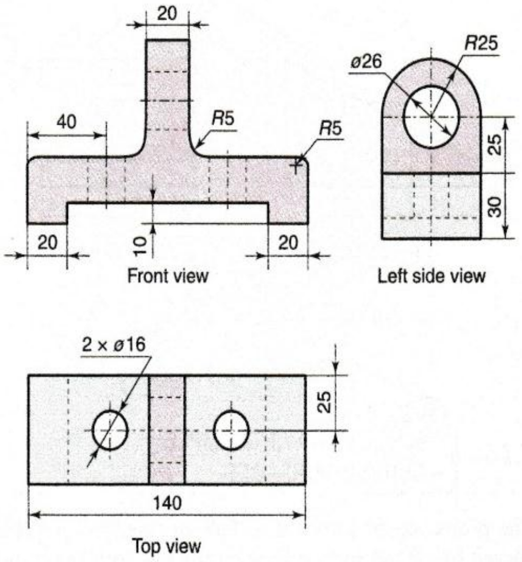


Fig. 5.34 (ii) Orthographic views of a shaft support

Problem 5.21

Isometric view of a wall bracket is shown in Fig. 5.35 (i). Sketch the front view in the direction of *F* and top and side views. Follow first angle projection.

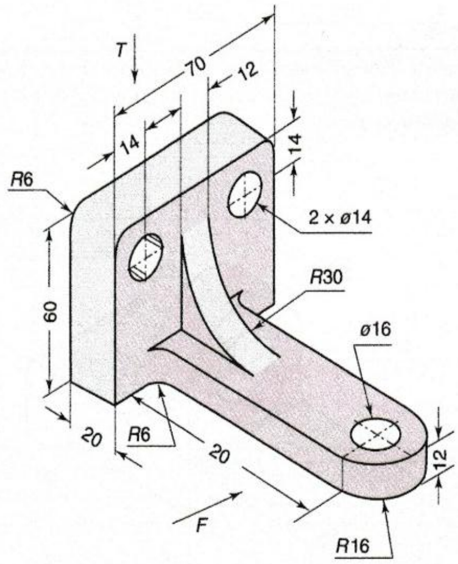


Fig. 5.35 (i) Isometic view of a wall bracket

Solution Refer Fig. 5.35 (ii)

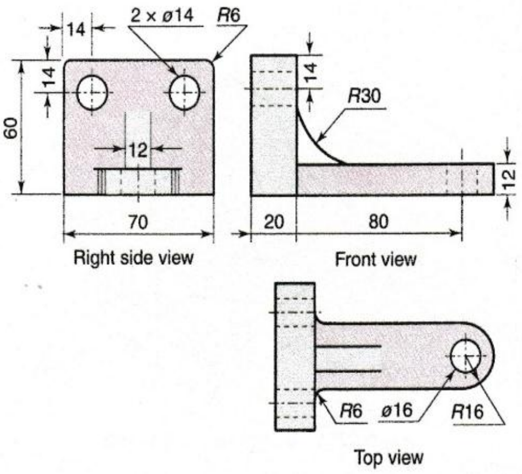


Fig. 5.35 (ii) Orthigraphic views of a wall bracket

Problem 5.22

Pictorial view of a bearing is given in Fig. 5.36 (i) Sketch front view in the direction of *F* and top view in first angle projection method. Mark on the views 10 important dimensions as per I.S. Code. Scale 1:1

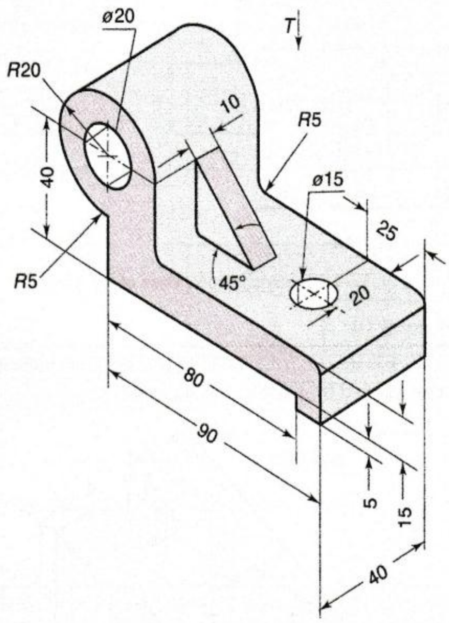


Fig. 5.36 (i) Isometric view of a simple bearing

Solution Refer Fig. 5.36 (ii)

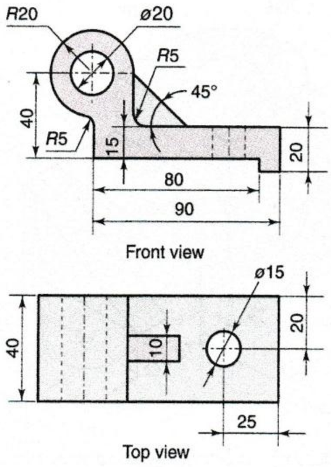


Fig. 5.36 (ii) *Orthographic views of a simple bearing*

5.17 OBJECT HAVING OBLIQUE SURFACES

A surfaces is called on oblique surface if it is inclined to the three reference planes. The projection of oblique surfaces will have foreshortened areas and they will not show true size and shape of surfaces. The following problems illustrate how orthographic views of objects having oblique surfaces are sketched from pictorial views.

Problem 5.23

The isometric view of an C.I. object is given in Fig. 5.37 (i). Sketch:

(a) Front view looking the direction *F*

(b) Top view and side view

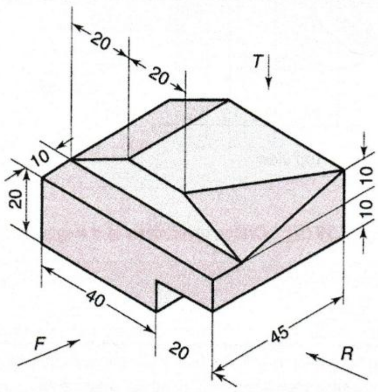


Fig. 5.37 (i) *Isometric view of a C.I. block having an oblique surface*

Solution Refer Fig. 5.37 (ii)

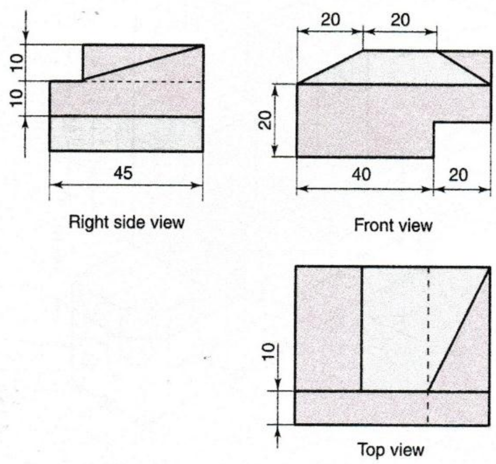


Fig. 5.37 (ii) *Orthographic views of a C.I. block having an oblique surface*

5.18 OBJECTS HAVING CURVED SURFACES

Objects having more complicated curved surfaces are discussed in the article. Objects may have fillets and rounds. A fillet is filled-in interior corner on a casting. It is difficult to cast sharp interior corners. The radius of the fillet will be given in the Sketch.

Rounds are rounded external corners on a casting. Rounded interior corners can be cast easily and gives a better appearance.

Problem 5.24

Sketch the three views:

(i) Looking in the directions of arrow *F*

(ii) Looking in the direction of arrow *T*

(iii) Looking in the directions of arrow *L*

of the given pictorial view of a support as shown in the Fig. 5.38 (i).

Follow first angle projection method. All dimensions should be entered as per Bureau of Indian Standards. All hidden lines should be shown.

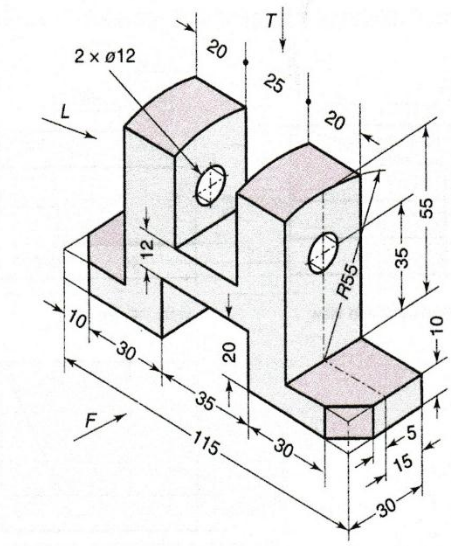


Fig. 5.38 (i) *Isometric view of a support*

Solution Refer Fig. 5.38 (ii)

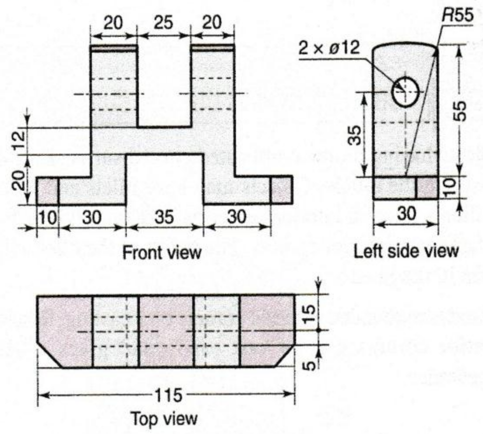


Fig. 5.38 (ii) *Orthographic views of a support*

Problem 5.25

The pictorial view of an object is given in Fig. 5.39 (i). Sketch

(i) Front view in the direction of the arrow *F*

(ii) Top view

(iii) Left side in the first angle projection method

Mark 10 important dimensions on the views as per the I.S. code.

Show all the hidden details. Scale 1:1

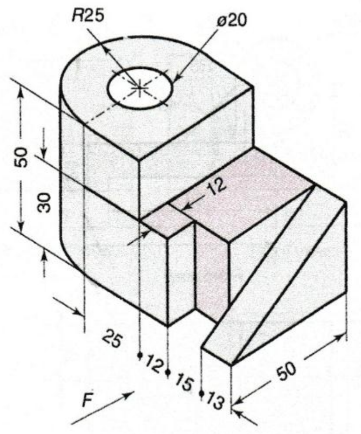


Fig. 5.39 (i) *Isometric view of a stepped block*

Solution Refer Fig. 5.39 (ii)

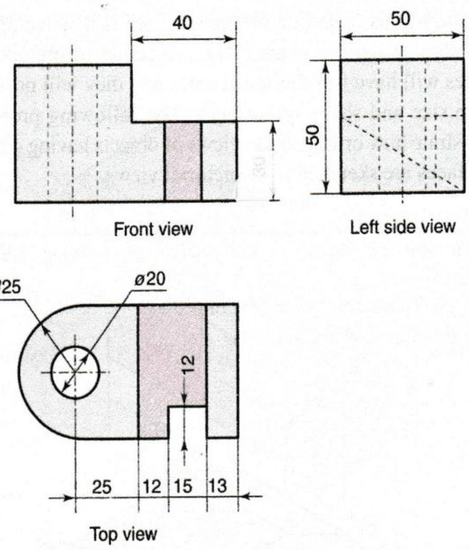


Fig. 5.39 (ii) *Orthographic views of a stepped block*

Problem 5.26

Pictorial view of a guide block is shown in Fig. 5.40 (i) Draw the three views in the first angle projection.

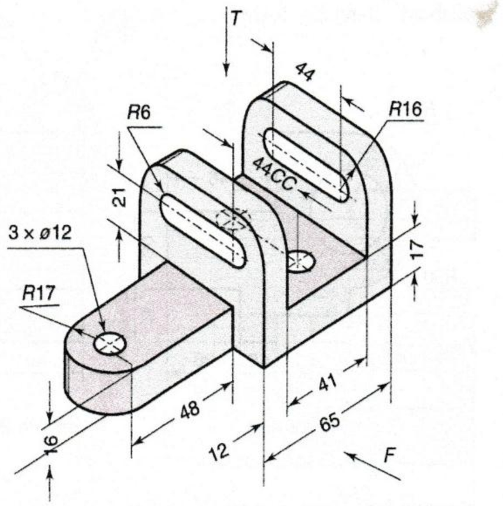


Fig. 5.40 (i) *Isometric view of a guide block*

Solution Refer Fig. 5.40 (ii)

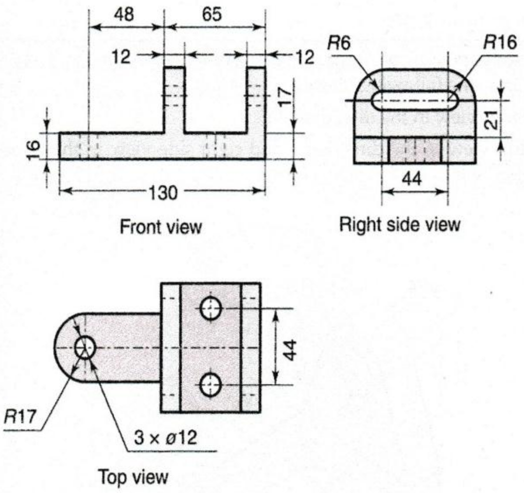


Fig. 5.40 (ii) *Orthographic view of a guide block*

Problem 5.27

Figure 5.41(i) shows pictorial view of a vice jaw. Sketch to full size

(i) front view in the direction *F*

(ii) plan

(iii) an end view showing the principal dimensions

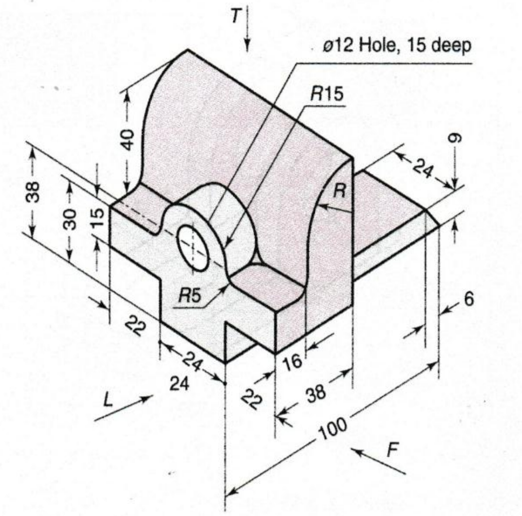


Fig. 5.41 (i) *Isometric views of a vice jaw*

Solution Refer Fig. 5.41 (ii)

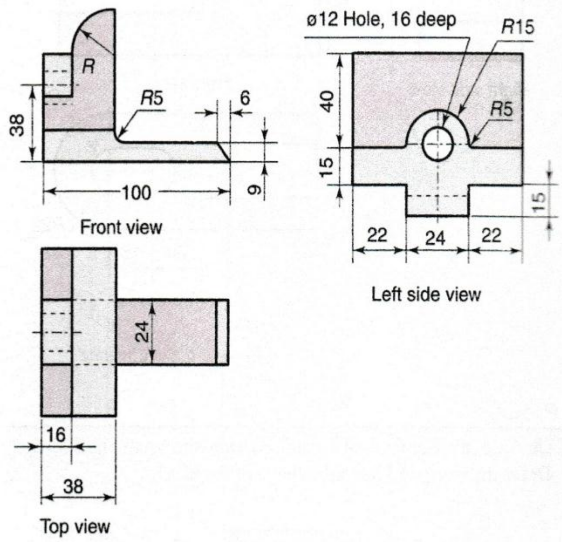


Fig. 5.41 (ii) *Orthographic views of a vice jaw*

Problem 5.28

Isometric view of a shaft bearing is shown in Fig. 5.42 (i). Draw the following views: front view in the direction of F, top view and right side view.

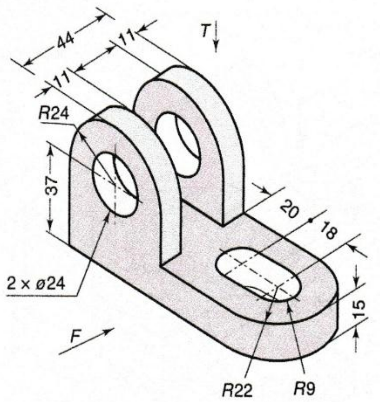


Fig. 5.42(i) *Isometric view of a shaft bearing*

Solution Refer Fig. 5.42 (ii)

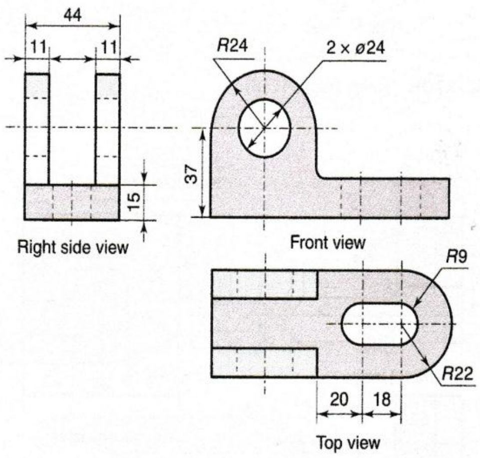


Fig. 5.42(ii) *Orthographic views of a shaft bearing*

Problem 5.29

Oblique cavalier view of a guide block is shown in Fig. 5.43 (i). Draw the front and left side views of the block.

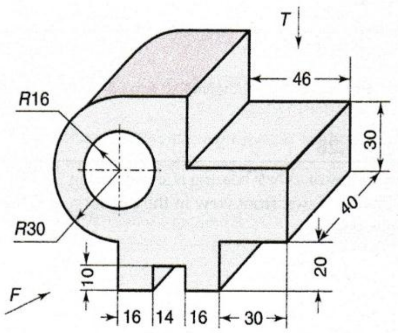


Fig. 5.43(i) *Oblique (cavalier) view of guide block*

Solution Refer Fig. 5.43 (ii)

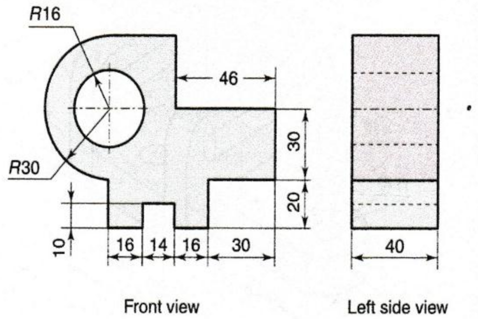


Fig. 5.43(ii) *Orthographic views of a guide block*

Problem 5.30

Isometric view of an adjustable support is shown in Fig. 5.44 (i). Draw the following views.

Front view in the direction of *F*.

Top view in the direction *T* and right side view in the direction of *R*.

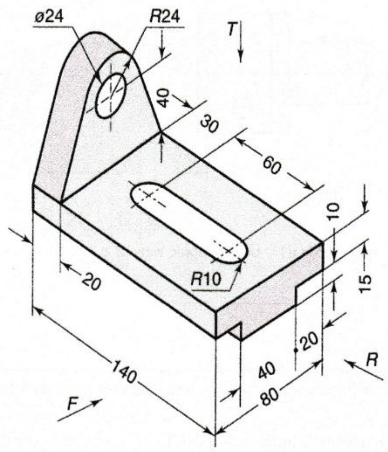


Fig. 5.44(i) *Isometric view of an ajustable support*

Solution Refer Fig. 5.44 (ii)

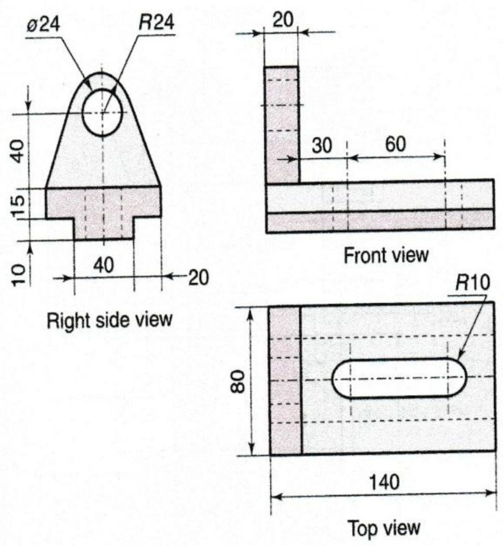


Fig. 5.44(ii) *Orthographic views of a adjustable support*

Problem 5.31

Isometric view of a shaft end support is shown in Fig. 5.45 (i). Draw the three views of the support.

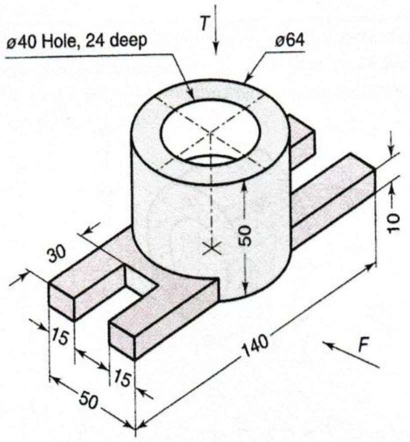


Fig. 5.45(i) *Isometric view of a shaft end support*

Solution Refer Fig. 5.45 (ii)

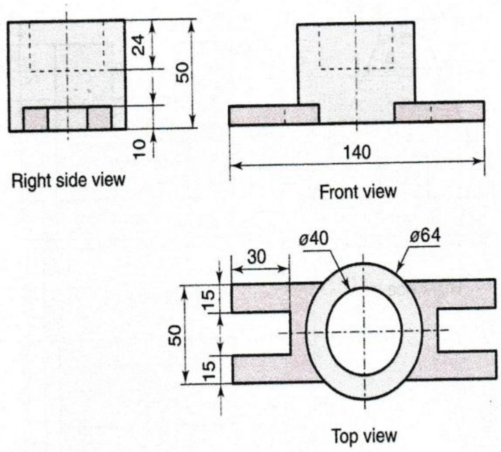


Fig. 5.45(ii) *Orthographic views of a shaft end support*

Problem 5.32

Isometric view of a typical block is shown in Fig. 5.46 (i). Draw the front view in the direction of *F*. Also add top view and a view from the right side.

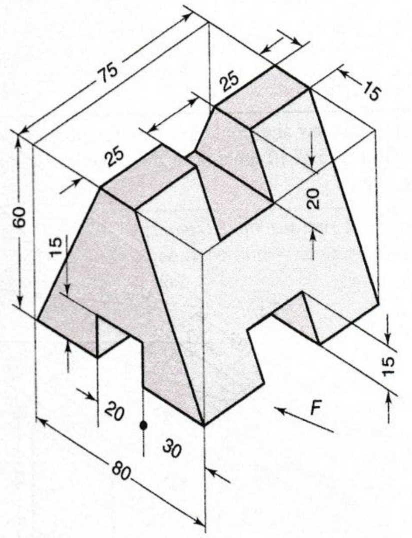


Fig. 5.46(i) *Isometric view of a typical block*

Solution Refer Fig. 5.46 (ii)

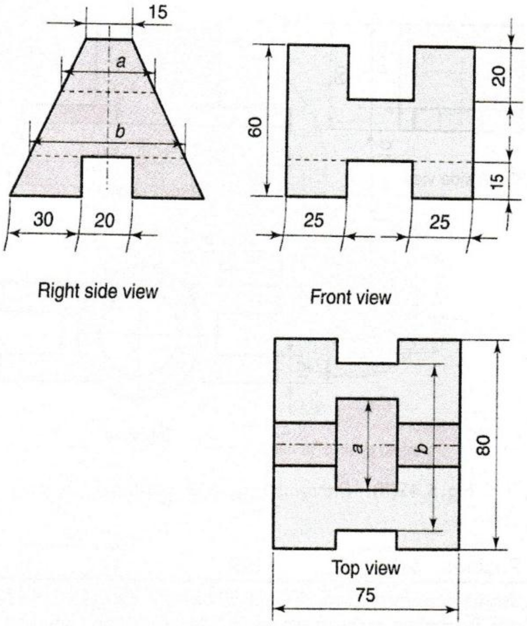


Fig. 5.46 (ii) *Orthographic views of a typical block*

Problem 5.33

Draw the top view and front view of a typical machine base shown in Fig. 5.47 (i) looking in the direction of *T* and *F* respectively.

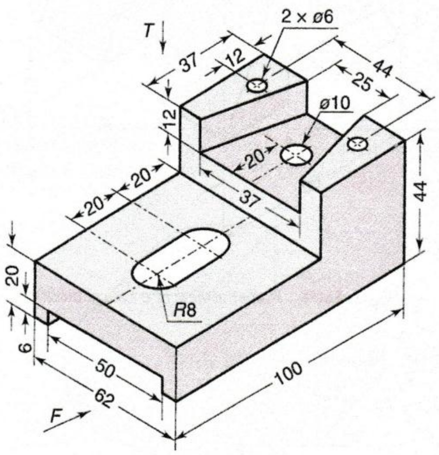


Fig. 5.47 (i) *Isometric view of a typical machine base*

Solution Refer Fig. 5.47 (ii)

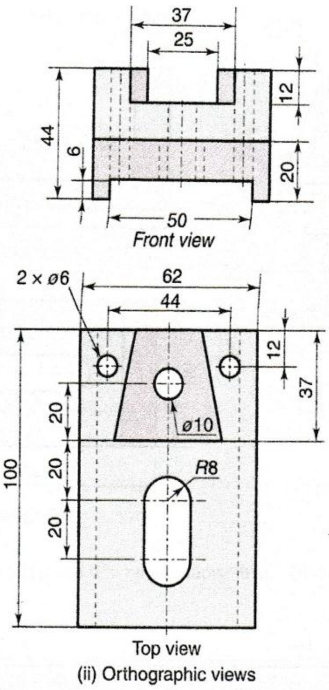


Fig. 5.47 (ii) *Orthographic views of a typical machine base*

Problem 5.34

Pictorial view of shaft end bearing and showing in Fig. 5.48 (i). Draw the views in the first angle projection method. Mark the important dimension as per code.

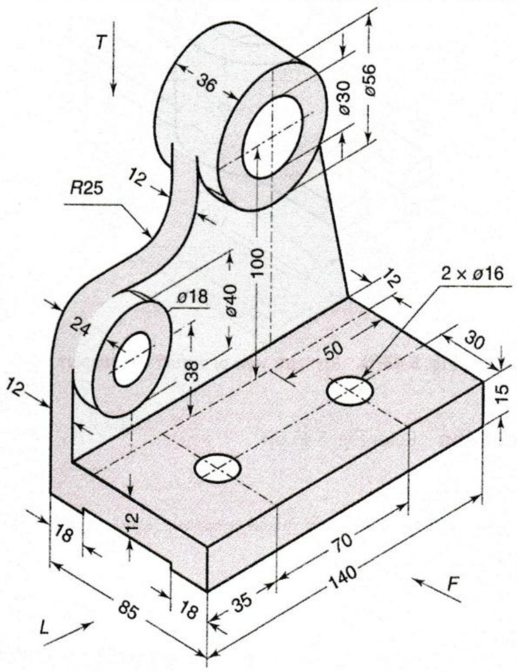


Fig. 5.48 (i) *Isometric view of a shaft end bearing*

Solution Refer Fig. 5.48 (ii)

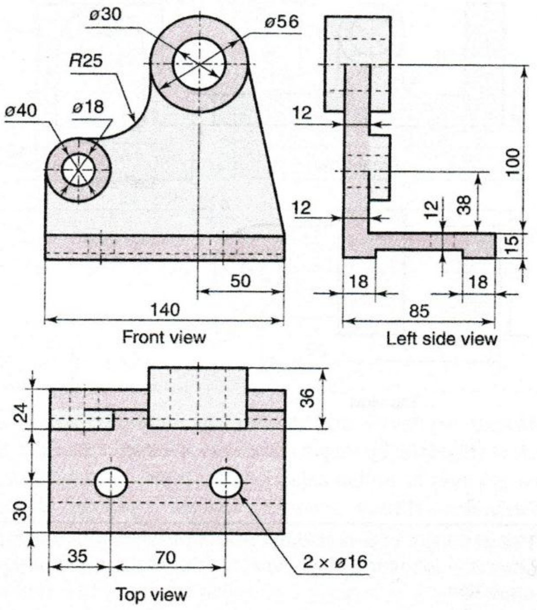


Fig. 5.48 (ii) *Orthographic views of a shaft end bearing*

Problem 5.35

Isometric view of a Bearing support is shown in Fig. 5.49 (i). Draw the following views: The view looking in the direction of *F*, the view looking in the direction of *T* and the view looking in the direction of *L*.

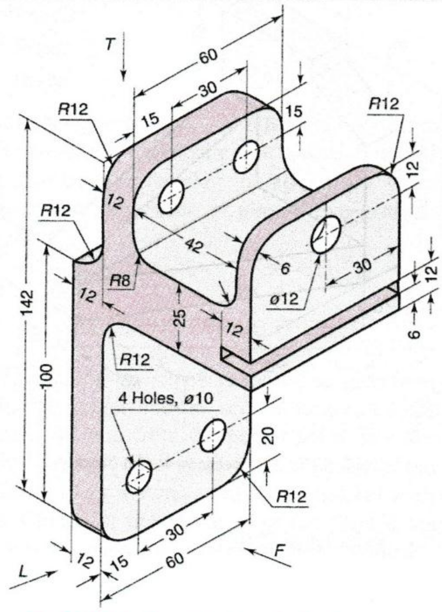


Fig. 5.49 (i) *Isometric view of a bearing support*

Solution Refer Fig. 5.49 (ii)

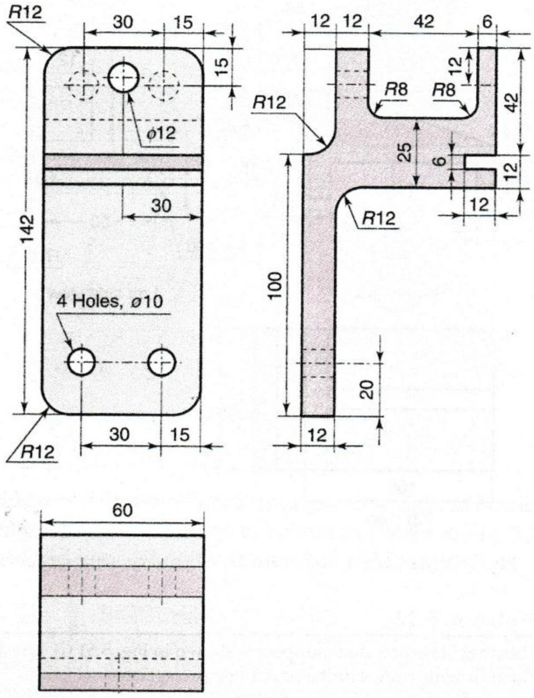


Fig. 5.49 (ii) *Orthographic views of bearing support*

Problem 5.36

Pictorial view of a horizontal shaft support is shown in Fig. 5.50 (i). Draw the three views of the full size scale in the first angle projection method.

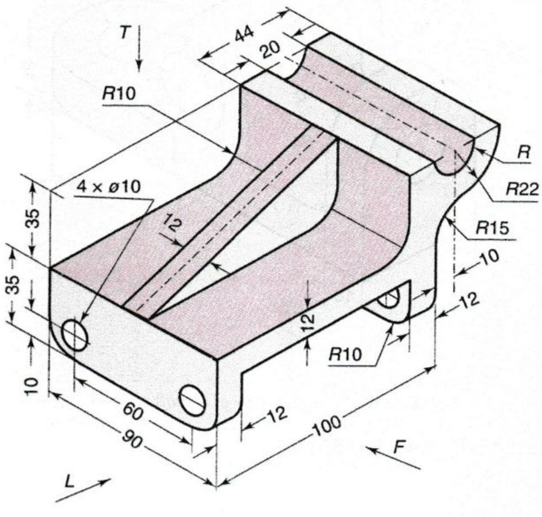


Fig. 5.50(i) *Isometric view of a horizontal shaft support*

Solution Refer Fig. 5.50 (ii)

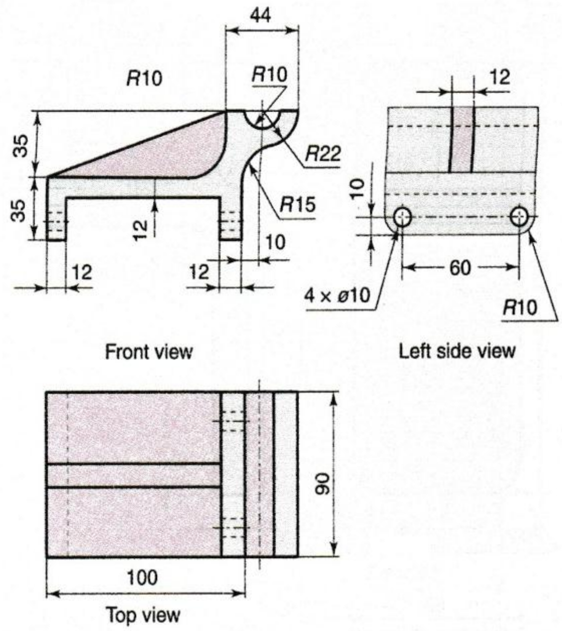


Fig. 5.50(ii) *Orthographic views of a horizontal shaft support*

Problem 5.37

Pictorial view of a shaft support is shown in Fig. 5.51 (i). Draw the following views in the first angle projection.

(a) Front view in the direction *F*

(b) Top view in the direction *T*

(c) Side view of the direction *L*

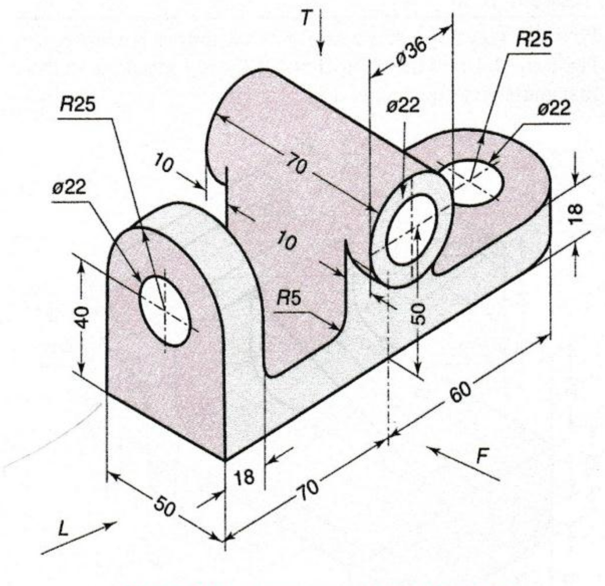


Fig. 5.51(i) *Isomeric view of a shaft support*

Solution Refer Fig. 5.51 (ii)

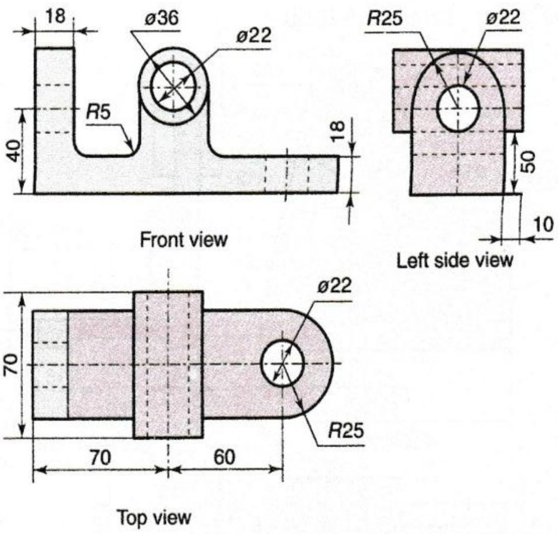


Fig. 5.51(ii) *Orthographic views of a shaft support*

Problem 5.38

Pictorial view of a horizontal bearing is shown in 5.52 (i). Draw the following views to a suitable scale in first angle projection:

(a) Front view in the direction of arrow *F*

(b) Top view

(c) Left side view

(d) Mark on the view the dimensions as per I.S code

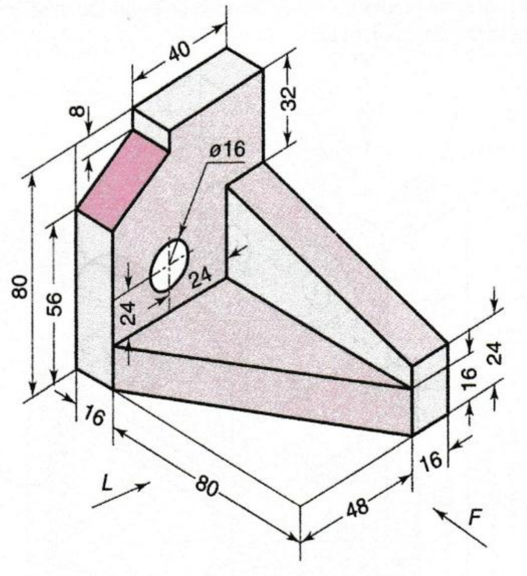


Fig. 5.52(i) *Isometric view of a bracket*

Solution Refer Fig. 5.52 (ii)

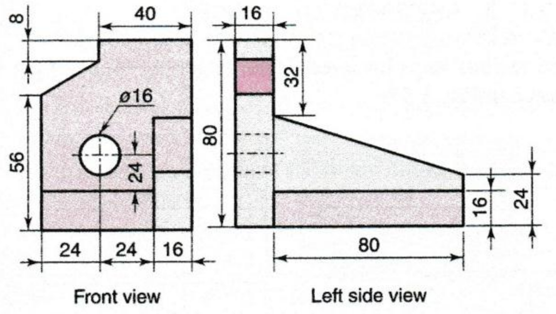


Fig. 5.52(ii) *Orthographic view of a bracket*

5.19 FREE HAND SKETCHING

A sketch communicates information. *Freehand sketching* is one of the effective methods employed to convey technical ideas very rapidly. This is also called as *thinking with pencil*. Freehand sketches are drawn without drafting aids. A freehand sketch may be defined as a drawing prepared by a pencil without using drawing instruments. A freehand sketch will never be perfectly uniform. If it is developed systematically as per the standard drafting practice, the sketches will be more proportional and uniform.

5.20 MATERIALS USED FOR SKETCHING

The following are the materials used for sketching:

1. Pencil
2. Paper
3. Eraser

For sketching, soft pencil of HB grade is preferred. The pencil should have conical point. A sketch pad of unruled paper may be used for sketching purposes. Graph papers having square, isometric or perspective grids are sometimes used.

5.21 SKETCHING STRAIGHT LINES

While sketching lines, pencil should be held freely by the thumb, first finger and the second finger at a distance of 30 mm to 40 mm from the pencil point. For sketching a straight line, first of all mark the end points of the straight line. Then, mark a series of short dashes between the end points. Check for the waviness of the short dashes. After correcting the waviness, sketch the line completely.

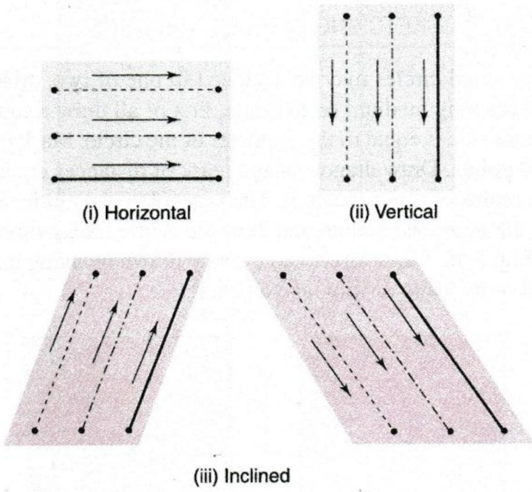


Fig. 5.53 *Sketching straight lines*

Horizontal lines are drawn from the left to right and vertical lines are drawn from top to bottom as shown in Fig. 5.53. Inclined lines are drawn from left to right as shown.

5.22 SKETCHING SQUARES

First of all, draw a horizontal line and a vertical line crossing each other. Then, mark equal distances on both lines and then draw horizontals and verticals through these end points to obtain the required square. This is shown in Fig. 5.54.

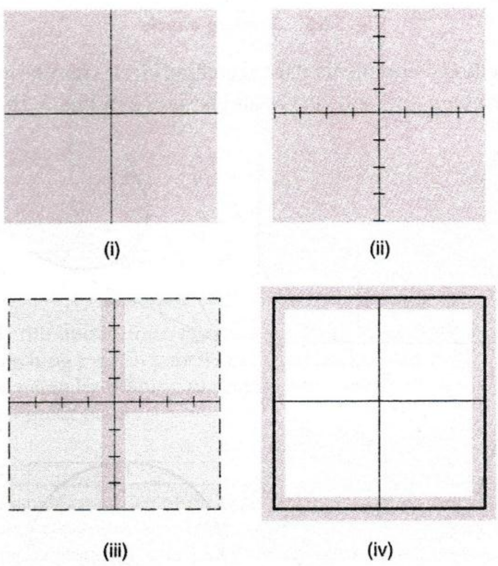


Fig. 5.54 *Sketching a square*

5.23 SKETCHING CIRCLES AND ARCS

Very small circles may be sketched in one of two strokes. For drawing medium sized circle, first of all draw a square whose side is equal to the diameter of the circle. Mark their mid points. Draw diagonals and mark of distances equal to the radius of the circle on it. Then complete the circle. Rub off all unnecessary lines and draw the centre lines as shown in Fig. 5.55. Large circle can even be drawn by using trammel or by using a string and a pencil.

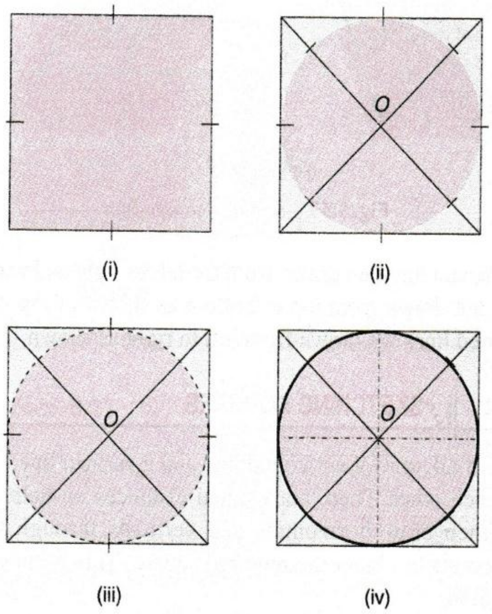


Fig. 5.55 *Sketching a circle*

The method recommended for sketching circles may be used for sketching arcs and curves and is shown in Fig. 5.56.

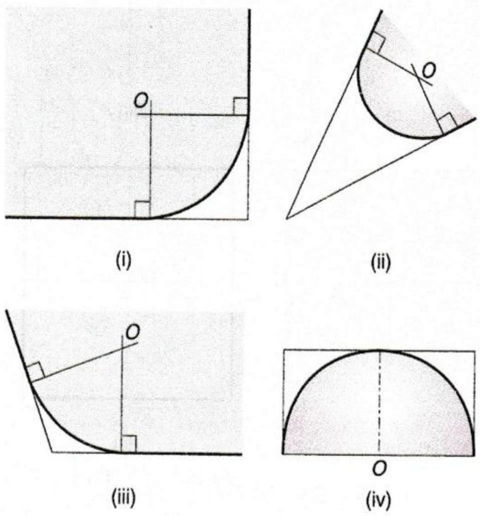


Fig. 5.56 *Sketching of arcs*

5.24 SKETCHING AN ELLIPSE

The various steps involved in the sketching of an ellipse is shown in Fig. 5.57.

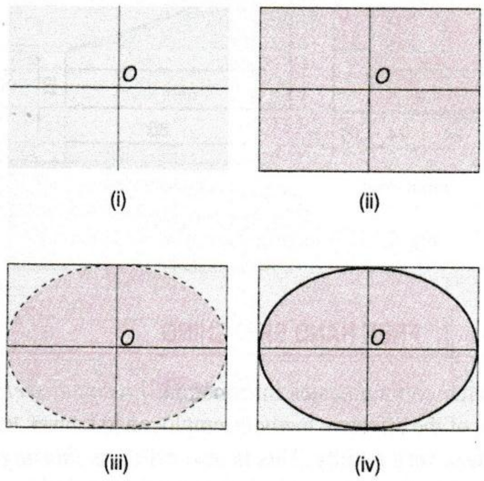


Fig. 5.57 *Sketching an ellipse*

5.25 SKETCHING AN ISOMETRIC VIEW

Isometric sketches may be drawn in plain paper or isometric graph paper. A through knowledge of the object is required for preparing isometric sketches. However, the following procedure may be generally applied in the preparation of isometric sketches.

1. Study the different views of the object.
2. Enclose the views of the object in an isometric box in such a way that it will give the length, the breadth and height of the object.
3. On the surfaces of the box, draw the orthographic views.
4. The required isometric sketches is shown in Fig. 5.58.

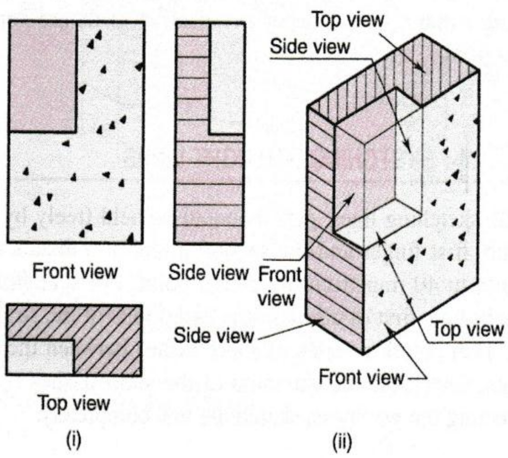


Fig. 5.58 *Sketching an isometric view*

Note

1. The length of the isometric box should have very reasonable proportion.
2. All vertical edges of the box will be parallel to the vertical axis.
3. All horizontal edges of the box will be parallel to the horizontal axis.

Problem 5.39

Draw different steps invovled in the sketching of an orthographic view of a flange shown in Fig. 5.59.

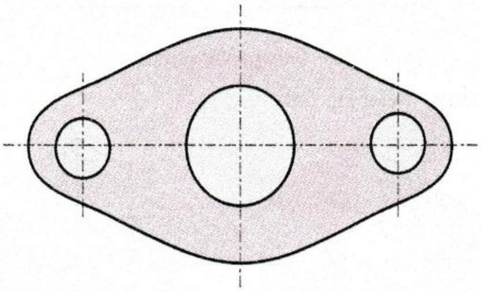


Fig. 5.59 *Flange*

Solution Refer Fig. 5.60

The different steps involved in the sketching of a flange is shown below.

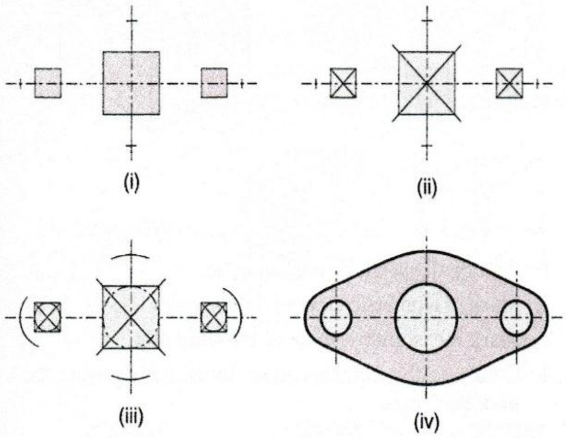


Fig. 5.60 *Steps in sketching of a flange*

Problem 5.40

Show different steps involved in the freehand isometric sketching of a block shown in Fig. 5.61.

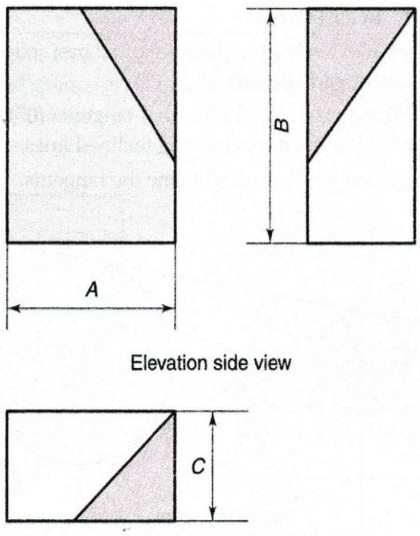


Fig. 5.61 *Orthographic views of a block*

Solution Refer Fig. 5.62

The different steps involved in the sketching of a plate is shown in Fig. 5.62.

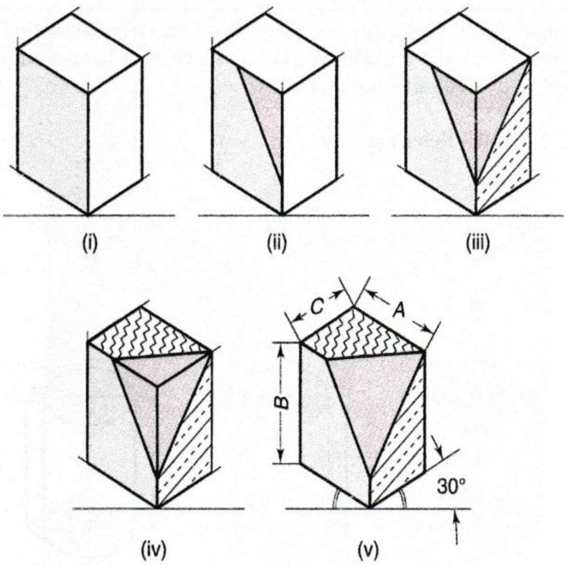


Fig. 5.62 *Steps in isometric sketching*

All the above four drawings may be prepared by simply sketching by thin pencil lines. The final i.e. the (v)th drawing are made by rubbing of unnecessary lines within the oblique triangular plane.

Problem 5.41

Sketch two circles of diameters 20 mm and 40 mm. The distance between the centres may be taken as 60 mm. Also, sketch one external and one internal tangents. Dimension the figure as per B.I.S.

Solution Refer Fig. 5.63

1. Sketch two circles at a distance of 60 mm following the method already described.
2. Sketch the external and internal tangents following the method described for drawing inclined lines.
3. Dimension the figure and name the tangents.

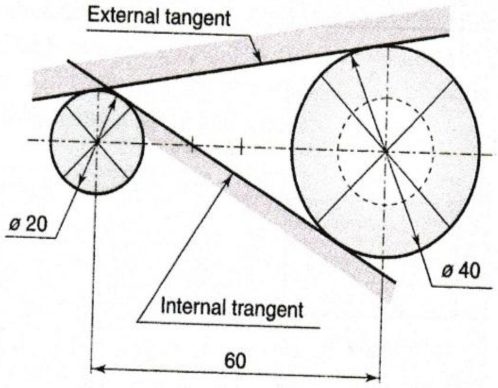


Fig. 5.63 *Sketching external and internal tangents to two given circles*

Problem 5.42

Show the different steps involved in the free hand sketching (isomertic) of a cylinder resting on its circular base on the ground. Take suitable dimensions.

Solution Refer Fig. 5.64

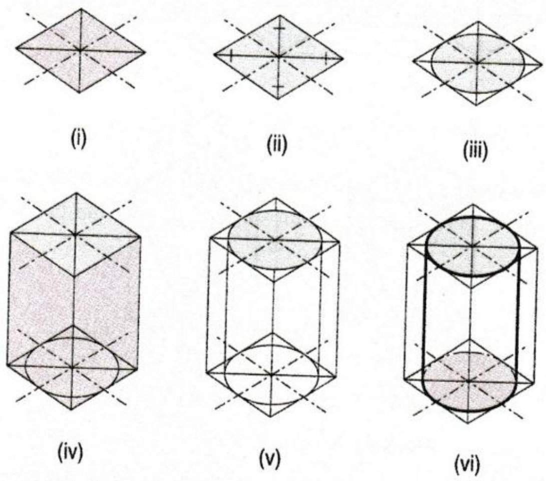


Fig. 5.64 *Steps in isomertic sketching of a cylinder*

1. Sketch the isometric view of the circle to represent the base of the cylinder as shown in Fig. 5.64 (i) to (iii).
2. Draw perpendiculars through the four corners of the rhombus and complete the box as shown in Fig. 5.64 (iv).
3. Draw the ellipse at the top of the box also. Draw vertical lines through the extreme left and right points of the ellipse as shown in Fig. 5.64 (v).
4. Complete the isometric view of the cylinder as shown in Fig. 5.64 (vi). Note that a portion of the ellipse at the bottom side and behind, will be represented in dashed lines as it is not visible.

Problem 5.43

Show different steps involved in the free hand isometric sketching of a block shown in Fig. 5.65.

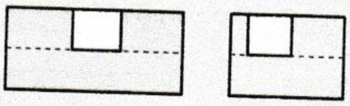


Fig. 5.65 *Orthographic views of a block*

Solution Refer Fig. 5.66

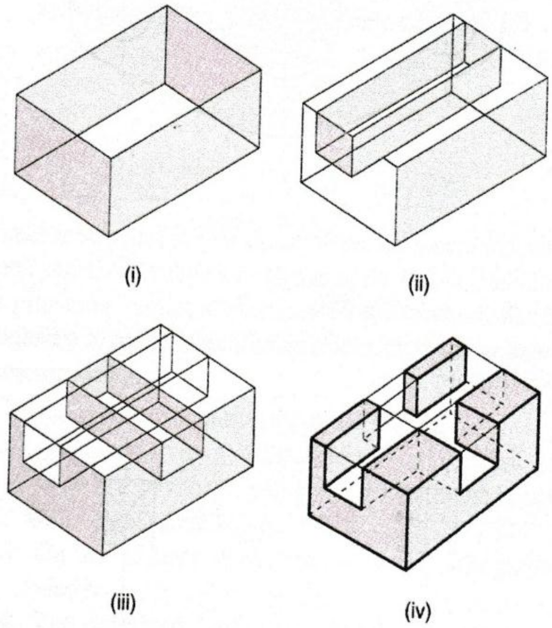


Fig. 5.66 *Steps in isometric sketching of a block*

1. First of all sketch an enclosing box.
2. Mark of isometric view of the long slot.
3. Mark the isometric view of the short slot.
4. Complete the isometric view. Invisible edges are shown in dotted lines.

Problem 5.44

Orthographic views of a support block are shown Fig. 5.67. Show the different steps involved in the free hand oblique sketching of the support block. Need not dimension.

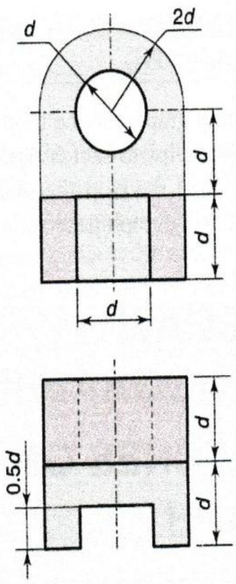


Fig. 5.67 *Support block*

Solution Refer Fig. 5.68

Enclose the given block one in a bottom box and other in an upper box.

1. Sketch the front view of the bottom box and draw receding lines at an angle of 30° and of lengthe 2*d* to get oblique view of the bottom box.
2. Sketch the upper box above the first box as shown.
3. Mark the rectangular slot provided in the front portion of the bottom box.
4. Mark the curved surfaces in the front rear side of the upper box.
5. Mark the cylindrical hole as explained before.
6. After rubbing off the unnecessary lines, obtain the required drawing, Invisible lines are shown in dotted line

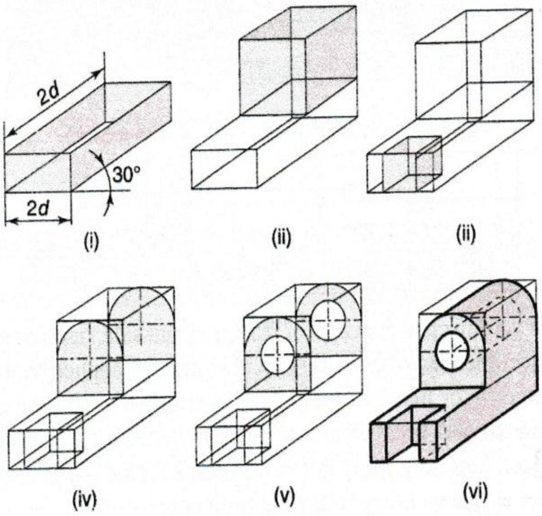


Fig. 5.68 *Steps in oblique sketching of a support block*

Problem 5.45

Orthographic views of a bracket are shown in Fig. 5.69. Prepare a free hand oblique drawing of it. Retain all construction lines. Need no dimension.

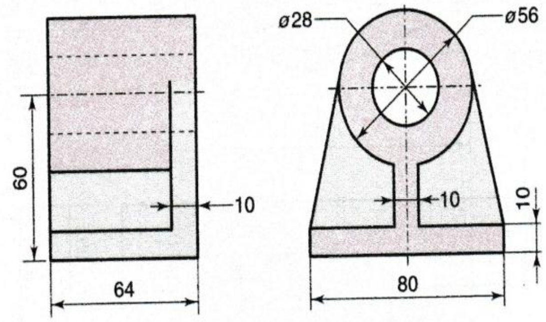


Fig. 5.69 *Orthographic views of a bracket*

Solution Refer Fig. 5.70

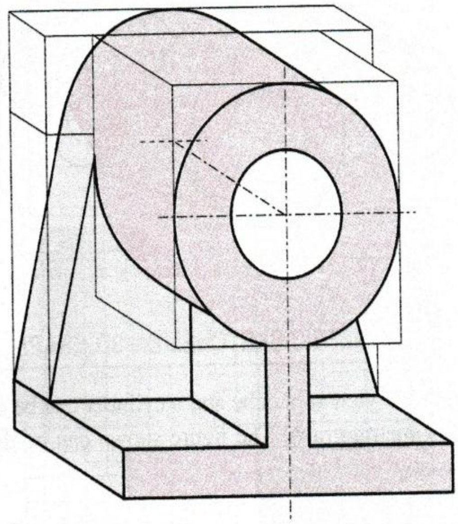


Fig. 5.70 *Sketch (oblique) of a bracket*

1. First of all sketch four rectangular boxes.
2. Sketch the views within these boxes and obtain the required oblique drawing.

Problem 5.46

The front and top views of a gland are shown in Fig. 5.71. Prepare an oblique drawing by free hand. Do not rub off construction lines. Need no dimension.

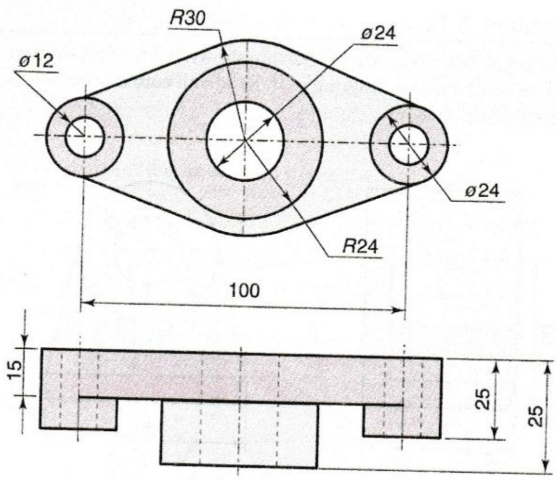


Fig. 5.71 *Orthographic views of a gland*

Solution Refer Fig. 5.72

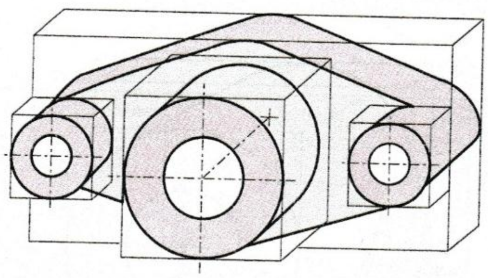


Fig. 5.72 *Free hand oblique sketching of a gland*

5.26 ISOMETRIC SKETCHES ON 3D GRAPH

The isometric view of a cube and a cylinder can be drawn on this isometric graph. The figure shown can be dimensioned easily. See Fig. 5.73.

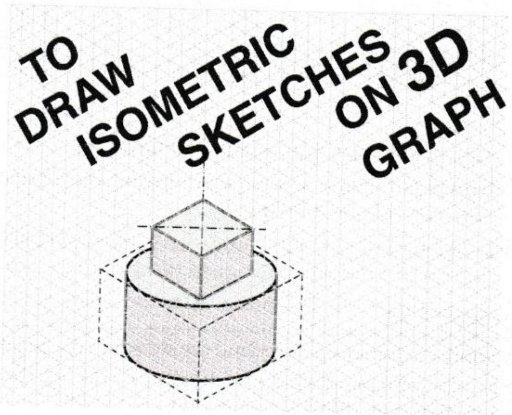


Fig. 5.73 *Isometirc view of a cube on a cylinder*

5.27 ORTHOGRAPHIC SKETCHES ON 2 D GRAPH

This simple ordinary graph may be used to prepare orthographic views. This helps to sketch figures proportionely. Later the student will develop the skill for developing sketching without using graph papers. See Fig. 5.74.

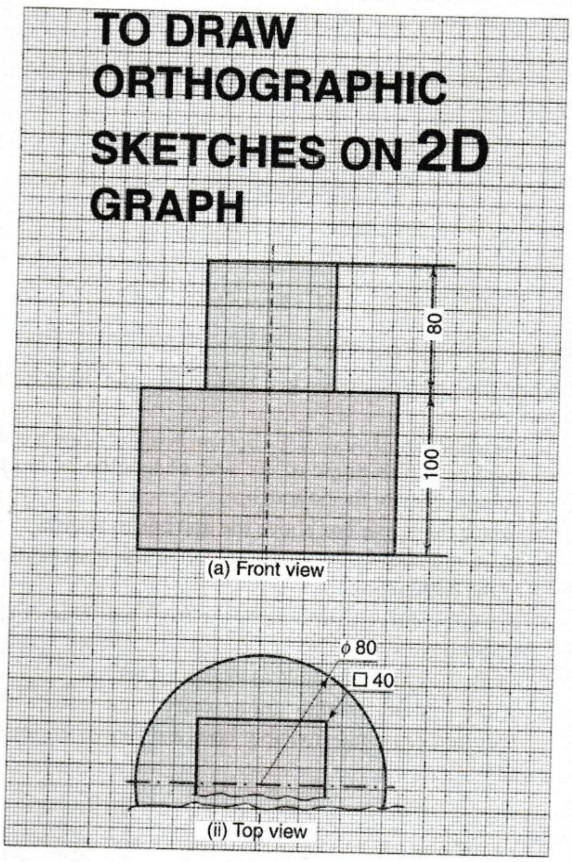


Fig. 5.74 *Orthographic views of a cube on a cylinder*

5.28 COLOURING TECHNICS FOR STUDYING SKETCHING OF ORTHOGRAPHIC VIEWS

For getting clear concepts of front, top and side views of an object the idea of colouring technic may be applied to the isometric or pictorial views. In general, we apply one or more colours for the portions seen in the front view of the object. Similarly apply different colours for the other views also, as shown in the following problems.

First of all, sketch the front view of this object and then colour it, as applied in the pictorial view appropriately.

Similarly, apply the same colouring technic to fill in the sketches of top and side views. All the views are then dimensioned.

It may be noted that the pictorial drawing are prepared on 3 D graph called isometric graph while the orthographic views are made as 2 D graph called *x-y* graph. Students are directed to use these graphs at the time of practiceing these drawings. Later they will be competent to sketch these drawing even without using these graphs.

5.29 MORE SOLVED PROBLEMS

Problem 5.47

Pictorial view of a stepped block is given Fig. 5.75. Sketch free hand drawing of the following:

1. Front view
2. Top view
3. Side view from right

Draw all the dotted lines and enter the dimensions

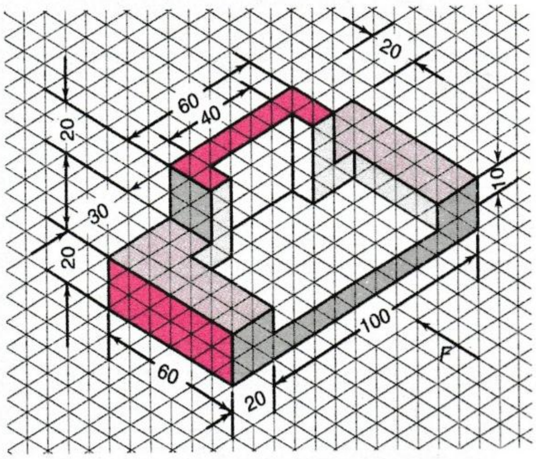


Fig. 5.75 *Pictorial view of a stepped block*

Solution Refer Fig. 5.76

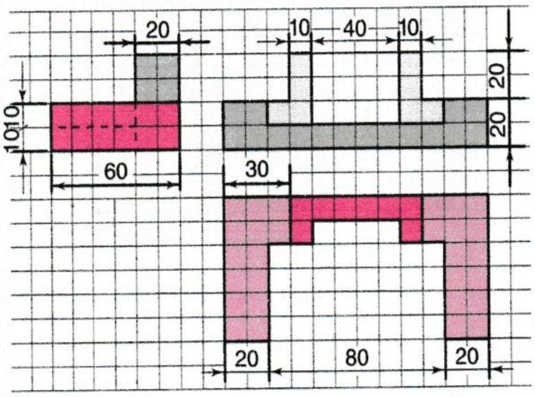


Fig. 5.76 *Orthographic views of the block*

The required 3 views are shown in Fig. 5.76. The side view from right is shown on the left side.

Problem 5.48

Make free hand sketches of the front, top and right side views of a 3 D object shown isometrically in Fig. 5.77. Dimensions are not shown. But the drawing sketched is proportionate. Assume diameter of the small hole is 10 mm. Show the dimension in the three views.

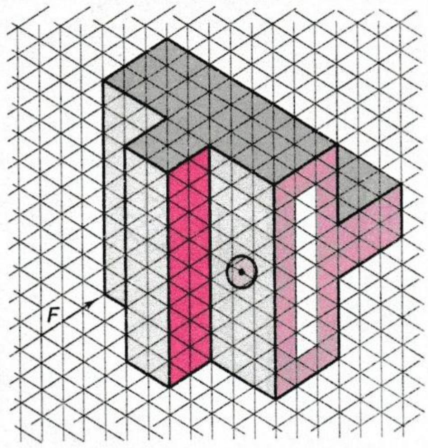


Fig. 5.77 *Isometrically sketched 3D object*

Solution Refer Fig. 5.78

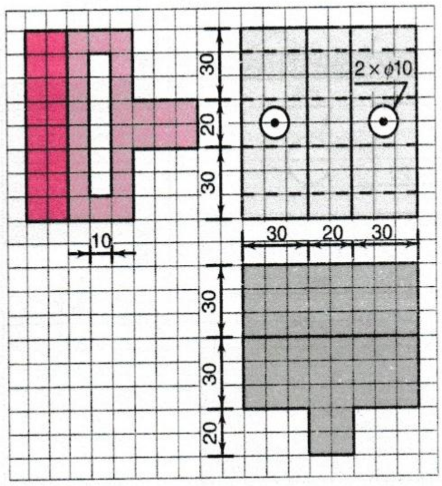


Fig. 5.78 *Orthographic views of a 3D Object*

The required views are shown dimensioned. Take 1 division = 1 mm.

Note

Make sure that you are able to sketch the dimensioned isometric view of the 3D block from the orthographic views drawn.

Problem 5.49

Isometric sketch of a guide block is shown in Fig. 5.79. Sketch the front view in the direction of *F*, the side view from left and the top view. Measure and mark the proportionate dimensions in mm in the drawing taking $\phi 20$ for the hole shown.

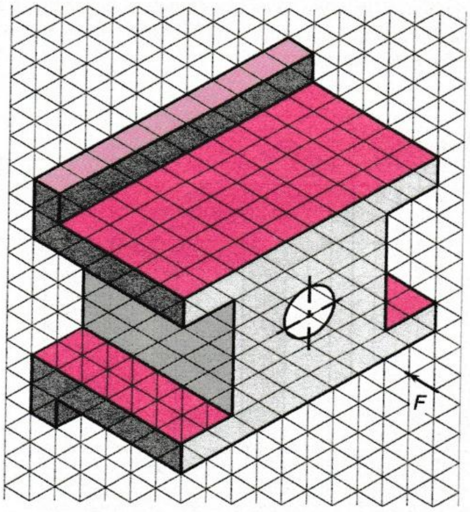


Fig. 5.79 *Isometric sketch of a guide block*

Solution Refer Fig. 5.80

The required three views are shown below.

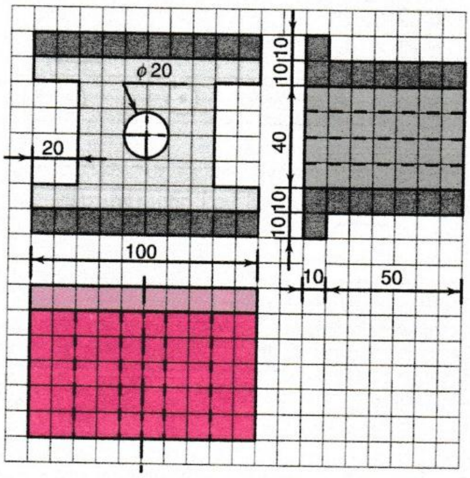


Fig. 5.80 *Front, top and side views of a guide block*

Note

Try whether you are able to make isometric (dimensioned) sketch of the guide block from the orthographic views.

Problem 5.50

An isometric sketch of a M.S. Angle block is shown in Fig. 5.81. Make free hand sketches of the following views.

1. Front view
2. Top view
3. Right side view and the left side

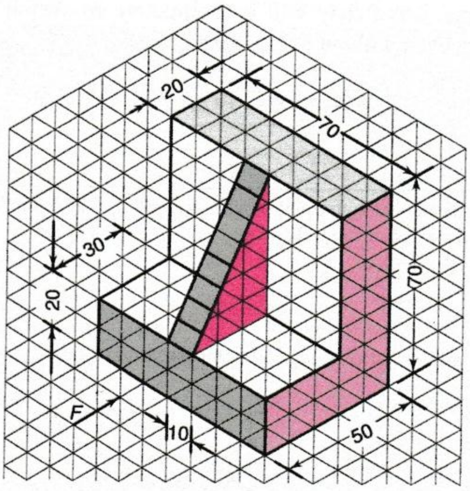


Fig. 5.81 *Mild steel angle block*

Solution Refer Fig. 5.82

The required solution in shown in Fig. 5.82.

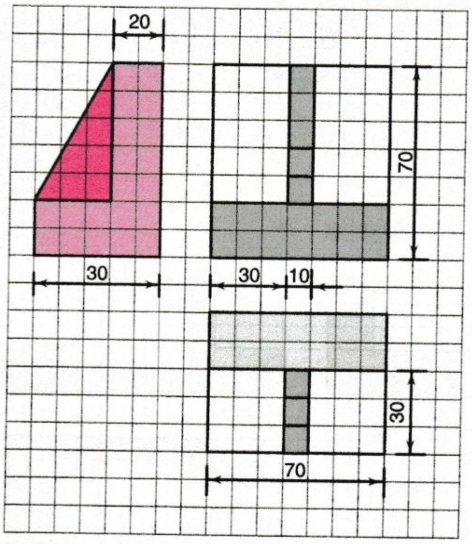


Fig. 5.82 *Orthographic views of the M.S. block*

Note

Try to sketch an isometric view of the sliding block and enter all dimensions without missing.

Problem 5.53

Make Free hand sketch of the front, top and right side of the adjustable support shown in Fig. 5.87.

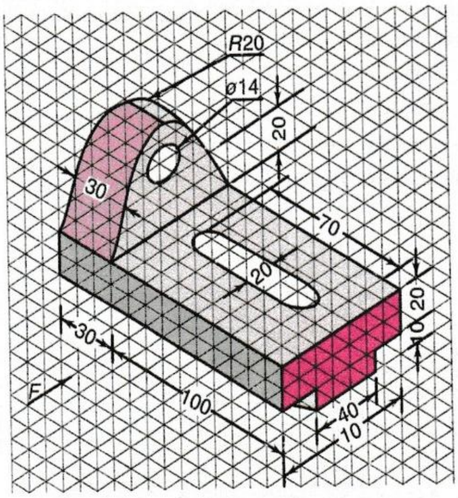


Fig. 5.87 *Isometric projection of adjustable support*

Solution Refer Fig. 5.88

The required three views are shown in Fig. 5.88.

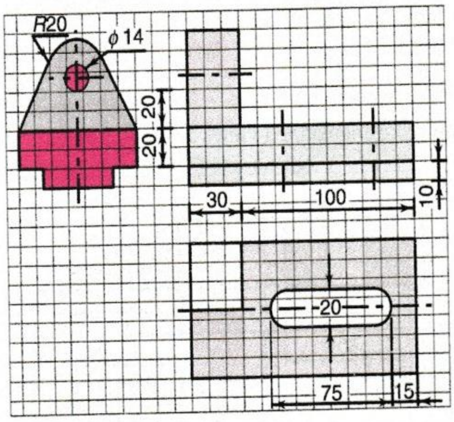


Fig. 5.88 *Orthographic views of a adjustable support*

Note

From the orthographic views sketch the isometric view by using isometric graph.

Problem 5.54

Sketch by free hand the following views of a shaft support

1. Front view in the direction of arrow *F*
2. Top view
3. Right side view on the left side

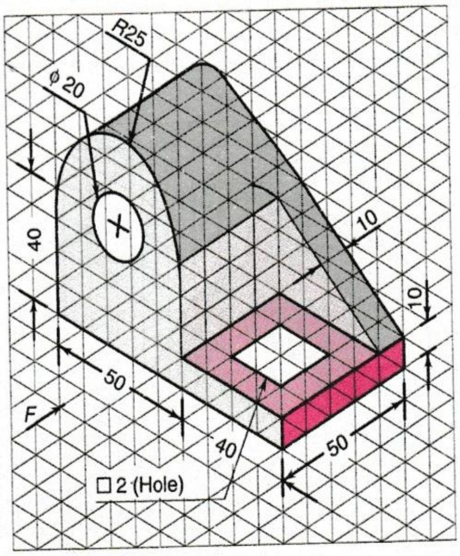


Fig. 5.89 *Shaft support*

Solution Refer Fig. 5.90

The required views are shown in Fig. 5.90.

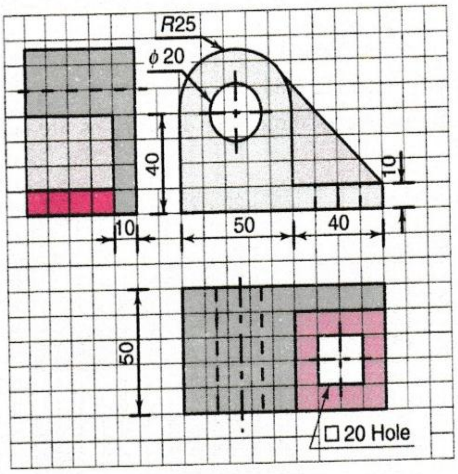


Fig. 5.90 *3 views of a shaft support*

Note

Try to add a view of the shaft from the right side. Dotted lines need not be drawn.

Isometric Projection

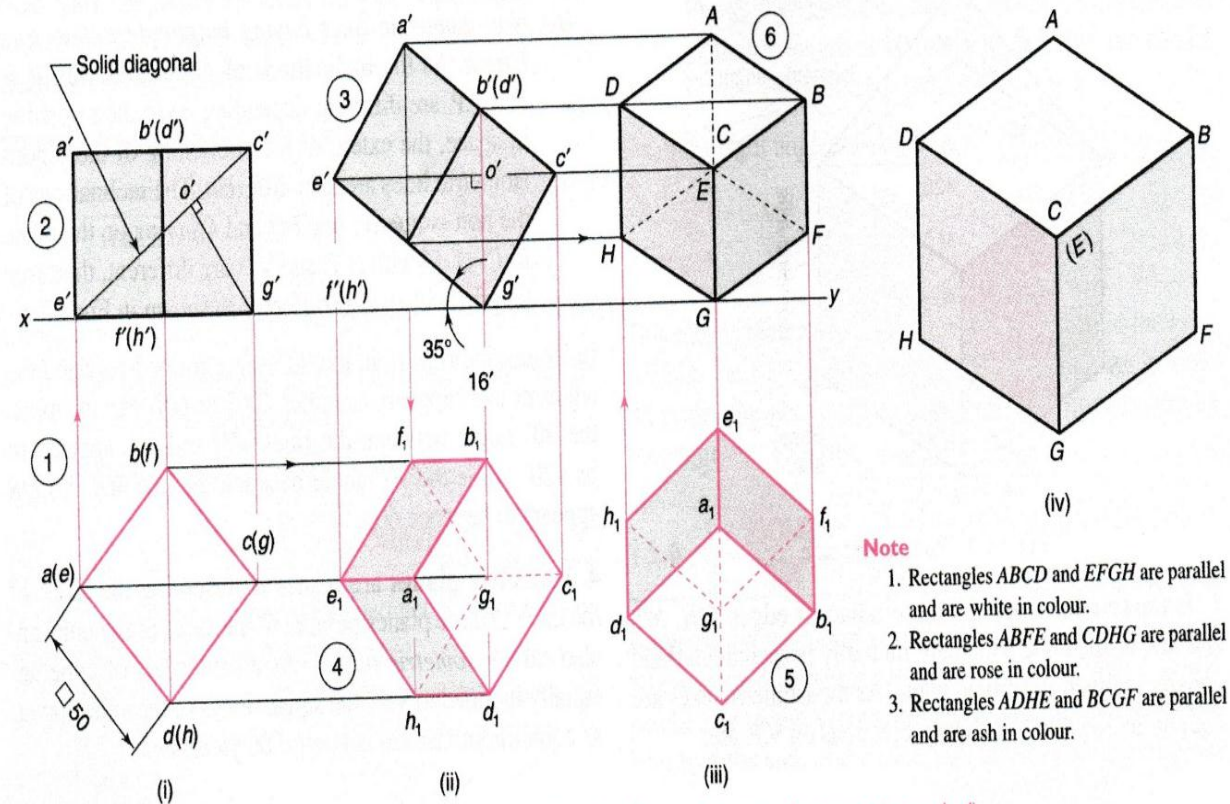
13.1 INTRODUCTION

Isometric projection is a pictorial orthographic projection of an object on the vertical plane of projection in which the transparent cube containing the object is tilted in such a way that its three mutually perpendicular edges (say, axes) make equal angles with the plane of projection. Hence, the angles between the edge in the isometric position will be equal to 360°/3 = 120°. As the inclinations of these three edges with the V.P. are the same, each edge (axis) of the cube will be foreshortened in the same proportion. It can be found that the extent of foreshortening of each axis is 82% of its true lengths. In this position of the cube, one of its *body diagonal* otherwise called *solid diagonal*, will be perpendicular to the vertical plane of projection and it can be seen that the cube is resting on one of its corners on H.P. Solid diagonal is an imaginary line joining one of its corners on top with the diametrically opposite corner at its bottom.

13.2 PRINCIPLES OF ISOMETRIC PROJECTION

The following two methods can be used to describe the principle of isometric projection:

1. Change of position of view (Rotation) method
2. Auxiliary projection method



Note

1. Rectangles *ABCD* and *EFGH* are parallel and are white in colour.
2. Rectangles *ABFE* and *CDHG* are parallel and are rose in colour.
3. Rectangles *ADHE* and *BCGF* are parallel and are ash in colour.

Fig. 13.1 *Isometric projection of a cube (change of position of view rotation method)*

Change of position of view method for obtaining the isometric projection of a cube is described below:

Figure 13.1 (i) shows the front and top views of a cube when placed on one of its faces on H.P. with its sides equally inclined to V.P. Here, the solid diagonal *EC* is parallel to V.P. and inclined to H.P. Its top view *ec* is parallel to *xy*-line while its front view *e′ c′* is inclined to *xy*-line.

The front view is titled about the corner *g′* until the body diagonal *e′c′* becomes parallel to H.P. The new position of the front view and its corresponding top view, are shown in Fig. 13.1 (ii). Note that the solid diagonal *EC* is now parallel to both H.P. and V.P.

Change the position of the view by rotating it about the point g_1 through 90°. Now, the solid diagonal *EC* becomes perpendicular to V.P. and its top view e_1c_1 is perpendicular to *xy*-line. In the front view the point e_1' is just behind c_1'. These points are represented by *E* and *C*. This front view represents the isometric projection of the cube and is shown in Fig. 13.1 (iii) at the top. Figure 13.1 (iv) shows an enlarged and shaded isometric projection of the enbo *ABCDEFGH*.

13.3 TERMINOLOGY

In isometric projection it is usual to use capital letters in place of lower care letters. The isometric projection of the cube shown in Fig. 13.1, is reproduced in Fig. 13.2.

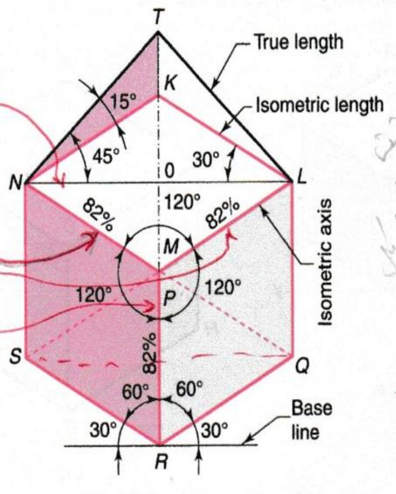


Fig. 13.2 *An isometric cube*

1. Isometric axes are the three adjacent edges *MN*, *ML* and *MR* of the cube which are mutually perpendicular and equally inclined to vertical plane. As the isometric axes are equally inclined to V.P. their projections on V.P. are:

(i) *Equally foreshortened* i.e. the lengths *MN*, *ML* and *MR* will have shorter length than the actual length of sides the cube

(ii) *Making equal angles with each other* i.e. angle *LMR* = angle *NMR* = angle *LMN* =120°. The actual inclination of the isometric axes with the vertical plane is 35° 16′. Isometric axes coincide with the edges *ML*, *MN* and *MR* of the cube. Foreshortening of isometric axes is approximately 82%.

2. Isometric lines are lines parallel to isometric axes. All lines parallel to *LM*. *MN* and *MR* are isometric lines. All isometric lines are equally foreshortened. In isometric projection, all isometric lines lying in a plane perpendicular to both H.P. and V.P., are drawn perpendicular to the *xy*-line or the base line. For example *MR*, *NS* etc. are always perpendicular to the base line. In isometric projection, all isometric lines lying in a plane perpendicular to the above said line *MR*, *NS* etc., are drawn inclined 30° to the *xy*-line or base line. For example *QR*, *RS* etc. are lying in a plane *PQRS* perpendicular to the line *MR*.

3. Non-isometric lines are lines which are not parallel to isometric axes. Any line other than isometric lines, is non-isometric line. *LN*, *QS*, *KM*, *LR* etc. are non-isometric lines. There are two types of non-isometric lines.

(i) *Non-isometric lines having length equal to true length of the side of the cube.* Lines *LN* and *QS* are the only two lines parallel to both H.P. and V.P. and hence, they have true lengths.

(ii) *Non-isometric lines having lengths less than true length.* As the inclinations of these lines with H.P. and V.P. are different depending upon their position in space, the extent of foreshortening of these non-isometric lines are also different. The inclinations of the non-isometric line *PQ* and *RS* lying on the plane *B′ C′ G′ F′* with H.P. and V.P. are different, their true lengths will also be different as shown in Fig. 13.3.

In isometric projection, the 90° angle formed between the adjacent axes appears as either 120° or 60°. For example, the 90° angle between the lines *MN* and *ML* appears to be 120° while the 90° angle between the line *MR* and *QR* appears to between 60°.

4. Isometric planes are planes representing the faces of the cube. All the planes parallel to the faces of the cube are also called *isometric planes*. As all the sides of cube are equally inclined to V.P., the square faces of the cube appear as equal rhombuses in isometric projection.

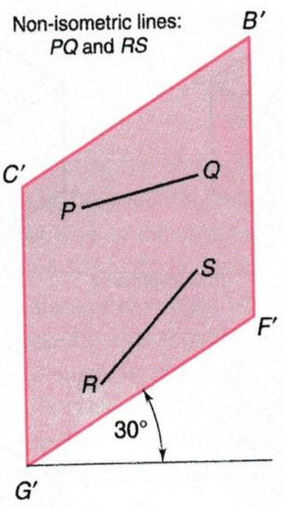


Fig. 13.3 *Isometric and non-isometric lines*

13.4 ISOMETRIC SCALE

In the isometric projection of the cube shown in Fig. 13.2, the square top face *KLMN* will appear as a rhombus. Here, all the edges parallel to the isometric axes are foreshortened to 0.82 times the true length. Note that the lengths *KL*, *LM*, *MN* and *NK* are all parallel to the isometric axes and are foreshortened. The diagonal *NL* is parallel to both H.P. and V.P. and hence, it is not foreshortened. Point *O* is the point of intersection of the two diagonals *NL* and *KM*.

Now mark the point *T* such that *NT* = *LT*, true length of the side of the cube. Here, angle *NTL* is 90°. Now, *NK* represents the isometric scale.

Form the triangles KNO and TNO,

$$\frac{\text{Isometric length, } KN}{\text{True length, } TN} = \frac{\cos 45^\circ}{\cos 30^\circ}$$

$$= 0.816$$

Note

1. The foreshortening of the isometric axes can be taken as 82% approximately.
2. Isometric length = 0.82 × true length

13.5 CONSTRUCTION OF ISOMETRIC SCALE

For drawing isometric projections isometric scale is to be constructed as described below:

1. Draw a horizontal line *NL* and then draw lines *NK* and *NT* at angle 30° and 45° with *NL* as shown in Fig. 13.4 (i).
2. Mark the required length (Say, 50 mm) on *NT* to represent the true length. Name the divisions as 0, 1, 2, and 3.

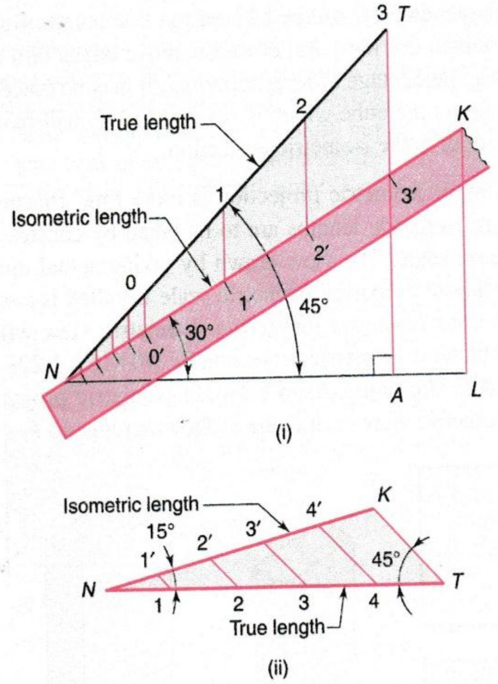


Fig. 13.4 *Construction of isometric scale*

3. Draw perpendiculars through these points to meet the line *NK* and the corresponding points are named as 0′, 1′, 2′ and 3′ respectively. The division on the line *NK* gives the isometric length 0′1′ represents isometric length of 10 mm. The first division can be further subdivided as required.

From the right angled triangles *NA*3′ and *NA*3,

$$\frac{N3'}{N3} = \frac{\cos 45^\circ}{\cos 30^\circ}$$

This means that the isometric axes are reduced in the ratio 1:0.816. i.e. 82% approximately. For obtaining the isometric scale, the above triangle may also be constructed as shown in Fig. 13.4 (ii)

13.6 ISOMETRIC PROJECTION AND ISOMETRIC VIEW OR DRAWING

Isometric projection of cube is the front view of the cube whose body diagonal is placed in such a way that it is perpendicular to the vertical plane. As discussed earlier the length of the side of the cube will be less then the original length of the side of the cube. This foreshortened length can be taken directly from the isometric scale.

The extend the foreshortening of the edges which are mutually perpendicular, will be 82% of the true length. But the lines which are not parallel to the above edges will have different percentage of foreshortening. It may be noted that any line on the cube which is parallel to V.P. will have its true length in the isometric projection.

Drawing of isometric projection is more time consuming because isometric lengths are to be taken by constructing isometric scale. The view drawn by taking actual dimension without preparing isometric scale is called is *isometric view or isometric projection*. Isometric view will be larger than the isometric projection by 1/0.816 = 1.228 (i.e. 122.5%). The comparison between isometric projection and isometric view or drawing is shown in Fig. 13.5.

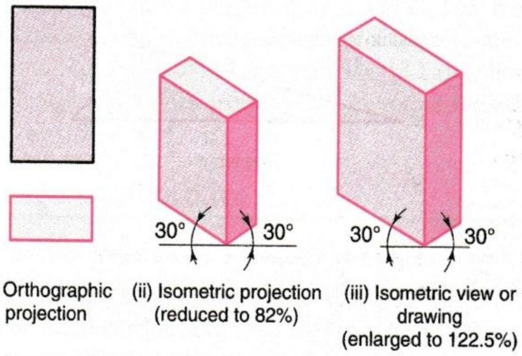


Fig. 13.5 *Comparison between isometric projection and isometric view or drawing*

13.7 VARIOUS POSITIONS OF THE ISOMETRIC AXES

For the purpose of showing different sides of an object, object can be revolved about the three isometric axis; but the angle between the isometric axes should be 120°. Different positions of the isometric axes are shown in Fig. 13.6.

Figure 13.6 (i) shows top surface of the cube, with the axis *OC* vertical. In the figure on the left side the three isometric axes *OA*, *OB* and *OC* make an angle of 120° between them. But figure on the right side shows different angles between the isometric axes.

Figure 13.6 (ii) shows bottom surface of the cube with the axis *OC* vertical. In the figure on the left side the three isometric axes *OA*, *OB OC* makes an angle of 120° between them. But the figure on the right side shows different angles between the isometric axes.

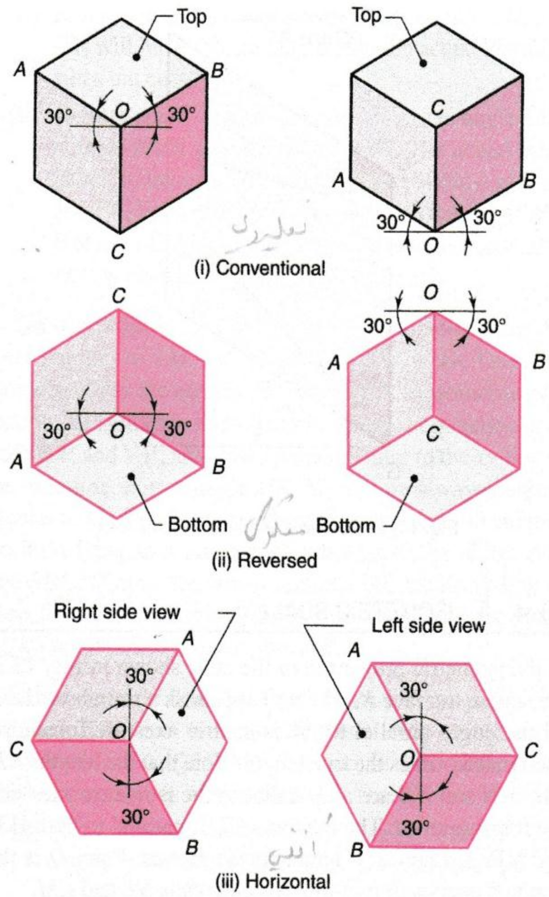


Fig. 13.6 *Different positions of the isometric axes*

Figure 13.6 (iii) shows the left and right side view of the cube when the axis *OC* is horizontal.

Note

1. As it is easy to draw an isometric projection from the lower most corner, the arrangement shown in Fig. 13.6 (i) is generally preferred.
2. Isometric graph shown in appendix can be used to develop the skill of sketching the drawings isometrically. Use this graph.

Rules

Isometric Projection

1. In isometric projection, the three mutually perpendicular axes (isometric axes) of the cube containing the object are equally inclined to V.P.
2. All the isometric axes are equally foreshortened to the tune of 81.6%.

3. All the isometric lines are equally foreshortened to the tune of 81.6%.
4. All isometric axes make an angle of 120 between them.
5. All vertical lines of the object are represented by vertical lines in the isometric projection.
6. All horizontal lines of the object are represented by a lines inclined 30° to the horizontal.
7. All inclined lines of the object which are not parallel to the isometric axes should not be drawn at the inclination given on the object. Here, end points are to be located first and them to be joined.
8. In isometric projections all the three mutually perpendicular planes which enclose the object will be visible.
9. In isometric projection, a square is represented by a rhombus.
10. In isometric projection, a sphere is represented by a circle whose diameter is equal to the diameter of the sphere itself.
11. In isometric projection, the distance between the centre of the sphere and the point of contact of the sphere with the plane is equal to 0.82 times the radius of the sphere.
12. In isometric projection, dimensions are to be taken from the isometric scale.
13. In isometric view, the fore shortening of the isometric axes is neglected and actual dimensions are taken.
14. In isometric view will be 122.5% larger than the isometric projection.
15. In the isometric view of the circle, the major axis of the ellipse formed will be 122.5% large than the diameter of the circle.
16. Isometric projection of a sphere is a circle whose diameter is equal to the diameter of the sphere itself.

13.8 ISOMETRIC VIEW OF PLANES

Problem 13.1

Draw the isometric views of a square lamina of 50 mm side when it is placed with its surface:

(a) Vertical

(b) Horizontal

Solution Refer Fig. 13.7 and 13.8

Let, *ABCD* be the square lamina of side 50 mm.

(a) When vertical

If the surface of the square *ABCD* is vertical and parallel to V.P. its front view can be represented by *a'b'c'd'*. The step by step procedure for drawing isometric view of the vertical face of the square lamina is described below:

1. Draw the square *a'b'c'd'* of side 50 mm to represent the front view of the square lamina *ABCD*.
2. Draw a base line and mark point D_1 on it as shown.

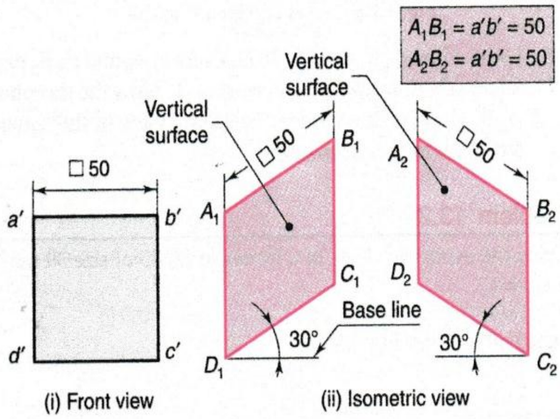


Fig. 13.7 *Views of a square lamina*

3. Draw a vertical line D_1A_1 equal to 50 mm through D_1 to represent the vertical edge *d'a'* in the front view.
4. Draw D_1, C_1, of length 50 mm inclined 30° to the base line to represent the horizontal edge *d'c'*.
5. Draw a line A_1, B_1 parallel to D_1 C_1 from A_1 and a vertical line from C_1 to intersect at B_1.

Now the rhombus $A_1B_1C_1D_1$ is the required isometric view of the square surface which is vertical. If the surface of the square *ABCD* is vertical and parallel to profile plane, its side view can be represented by $A_2B_2C_2D_2$. The procedure mentioned above can be followed to obtain the isometric view of the surface.

(b) When horizontal

If the surface of the square *ABCD* is horizontal, its top view can be represented by *abcd*. The step by step procedure for drawing isometric view of horizontal face of the square lamina is described delow:

1. Draw the square *abcd* of side 50 mm to represent the top view of the square lamina *ABCD*.
2. Draw a base line and mark point D_3 on it.
3. Draw line D_3 A_3 equal to 50 mm and inclined 30° to the base line to represent horizontal line *da*.
4. Draw line D_3 C_3 equal to 50 mm and inclined 30° to the base line to represent horizontal line *dc*. Note that the line D_3 A_3 and D_3 C_3 are perpendicular to each other, but in isometric view their inclination is 120° as explained earlier.

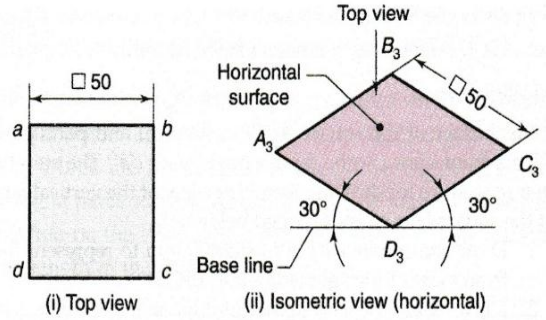


Fig. 13.8 *Views of a square lamina*

5. Draw a line $A_3 B_3$ parallel to $D_3 C_3$ form A_3 and $C_3 B_3$ parallel to $D_3 A_3$ from C_3 to intersect at B_3. Now the rhombus $A_3 B_3 C_3 D_3$ is the required isometric view of the square surface which is horizontal.

Problem 13.2

Draw the isometric views of a rectangle *PQRS* of size 30 mm × 60 mm.

Solution Refer Fig. 13.9

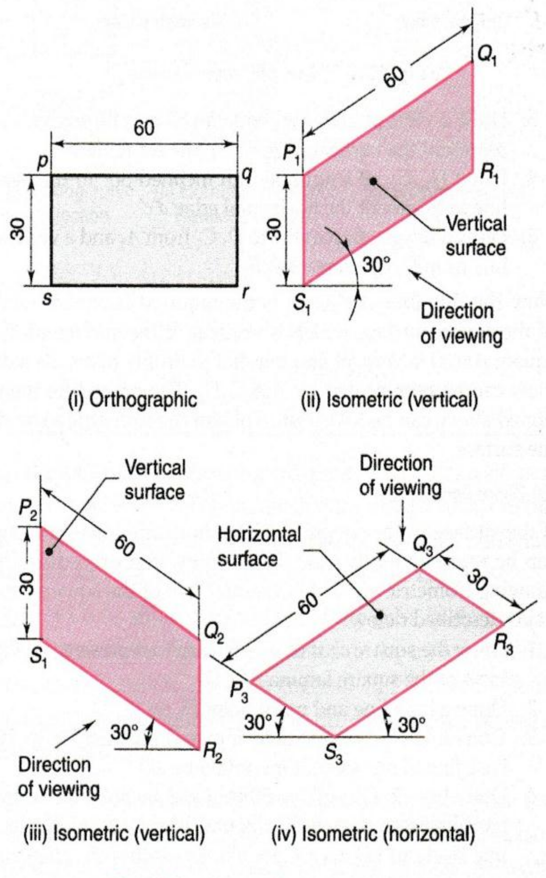


Fig. 13.9 *Views of a rectangular lamina*

The procedure described in the Prob. 13.1 can be followed to obtain the results shown in Fig. 13.9.

Problem 13.3

Draw the an isometric views of 30°-60° set square whose length of longer edge is 250 mm when the set square is placed (a) vertical with its longer side touching the horizontal plane and (b) horizontal neglect the thickness of the set-squares.

Solution Refer Fig. 13.10

Let, *ABC* be the set square with angle *B* 90° and *AC* be the longer edge of length 250 mm. Draw the front view *a′b′c′* of the set square. Enclose the front view within a rectangle *a′c′d′e′*.

(a) When surface of the set square is vertical

1. Draw the isometric view $A_1C_1D_1E$ of the rectangle *a′, c′, d′, e′* keeping the edge A_1C_1 horizontal as described in Prob. 13.1.
2. Locate the position B_1 taking $e'b' = E_1B_1$.
3. Join the points $A_1B_1C_1$ to obtain the required isometric view of the triangle *ABC* with *AC* touching the horizontal plane.

(b) When surface of the set square is horizontal

1. Draw the isometric view $A_2C_2D_2E_2$ of the rectangle *a′c′d′e′* keeping its surface horizontal as described Prob. 13.1.
2. Locate the position B_2 taking $e'b' = E_2B_2$.
3. Join the points $A_2B_2C_2$ to obtain the required isometric view of the triangle *ABC* which is horizontal.

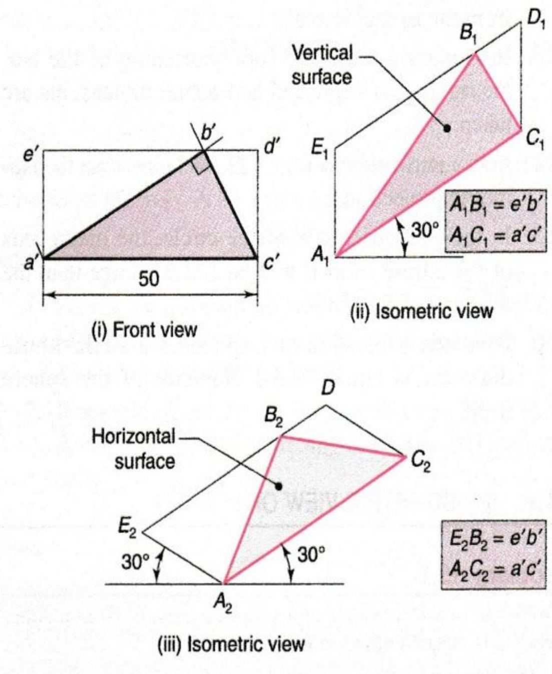


Fig. 13.10 *Views of a 30°-60° set-square*

Problem 13.4

Hexagonal lamina of side 25 mm is resting vertically on one if its corners on H.P. with its adjacent sides inclined equally to the H.P. If the plane of lamina is parallel to V.P., draw its isometric view.

Solution Refer Fig. 13.11

Draw the hexagonal lamina as per the given data and enclose it with in a rectangle. The required view can be drawn as described in Prob. 13.3.

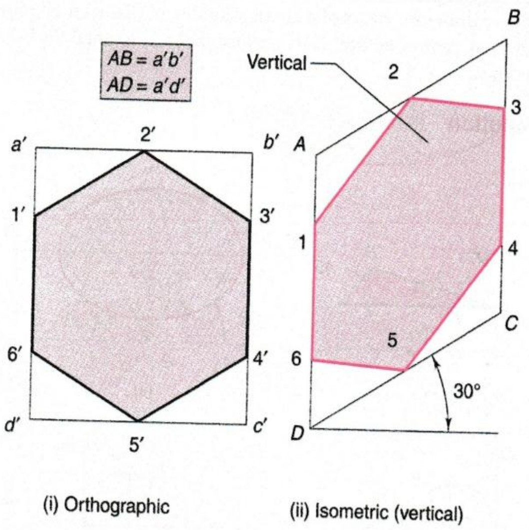


Fig. 13.11 *Views of a hexagonal lamina*

Problem 13.5

The front view of a quadrilateral *ABCD* whose surface is parallel to V.P. is shown in Fig. 13.12. One of the included angles is 60°. Draw the isometric view.

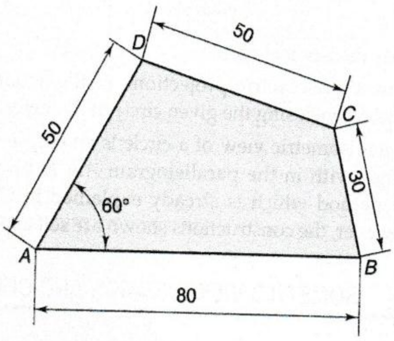


Fig. 13.12 *A quadrilateral lamina*

Solution Refer Fig. 13.13

Draw front view of the given figure to scale and enclose it within a rectangle $a'b'e'f'$. The surface may be vertical or horizontal.

1. If the surface is vertical, its isometric view can be represented by $A_1B_1E_1F_1$. Locate the points C_1 and D_1. $A_1B_1C_1D_1$ is the required isometric view.
2. Similarly, obtain $A_2B_2C_2D_2$ which is required isometric view when the plane is horizontal.

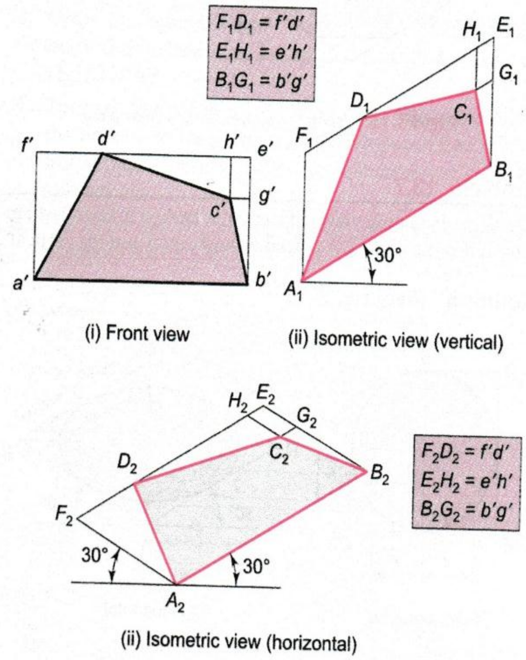


Fig. 13.13 *Views of a quadrilateral lamina*

Problem 13.6

Draw the isometric view of an irregular plane shown in Fig. 13.14. Isometric view need not be dimensioned. Assume that the plane is parallel to H.P. Consider that the edge *ML* is parallel to the reference plane.

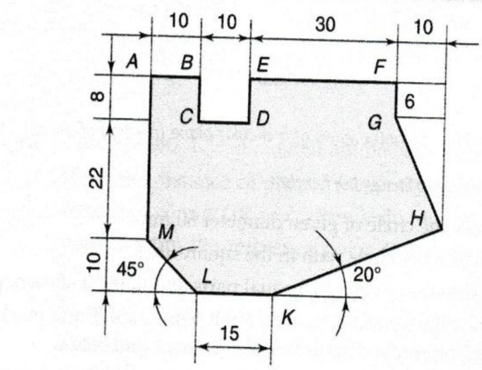


Fig. 13.14 *Irregular plane*

Solution Refer Fig. 13.15

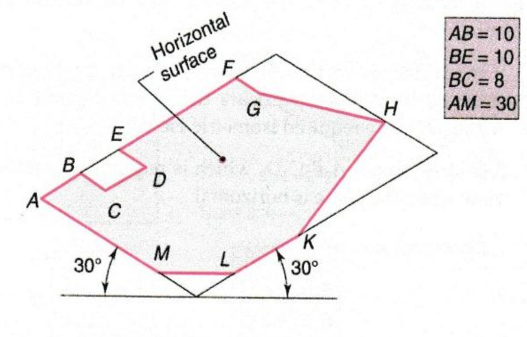


Fig. 13.15 *Isometric view of an irregular plane*

Problem 13.7

Draw the isometric views of a circular lamina of 60 mm diameter when the surface is placed (i) horizontal and (ii) vertical.

Solution Refer Fig. 17.16

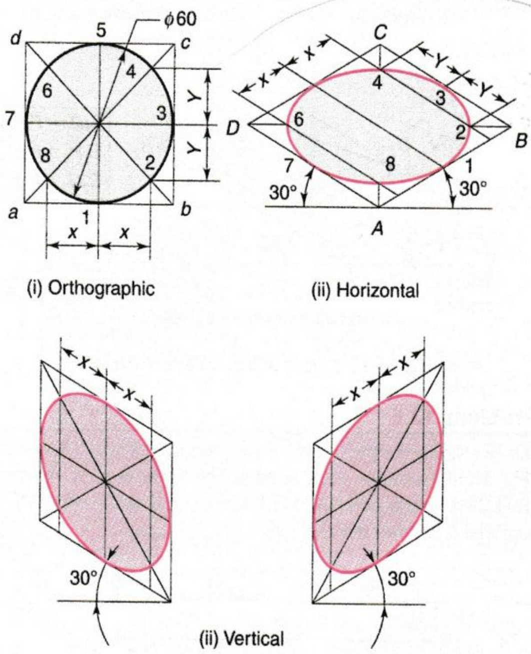


Fig. 13.16 *Isometric views of a circular plane (method of points)*

(a) When the surface is horizontal

1. Draw the circle of given diameter 60 mm.
2. Enclose the circle with in the square *abcd*.
3. Divide the circle into 8 equal parts and name it shown.
4. Draw lines parallel to *ad* through point 2 and 8 and mark the horizontal distances of the points 2 and 8 as *x*.
5. Draw the isometric view of the square, *ABCD* as shown in Fig. 13.16 (ii).
6. Join the diagonals *AC* and *BD*.
7. Draw lines at distance *x* on either sides of the centre to cut the diagonals at points 2, 4, 6 and 8.
8. Join the point 1, 2, 3, 4 etc. to obtain the required ellipse which is horizontal.

(b) When the surface is vertical

Procedure explained above can be followed to obtain the required isometric of the circular lamina which is vertical.

Problem 13.8

Draw isometric views of a circular lamina of diameter 80 mm by four centre method if its surface is (1) horizontal and (2) vertical.

Solution Refer Fig. 13.17

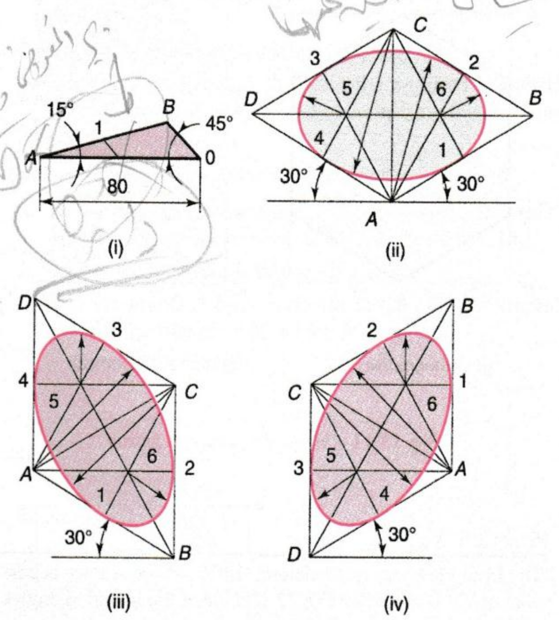


Fig. 13.17 *Isometric projections of a circular plane (four centre method)*

1. Draw the isometric scale.
2. Draw the isometric projections of the square *ABCD* which is enclosing the given circle of diameter 80 mm.
3. As the isometric view of a circle is an ellipse draw the ellipse with in the parallelogram *ABCD* by four centre method which is already explained in Chapter 6. However, the constructions shown are self explanatory.

13.9 ISOMETRIC VIEW OF ARCS AND CURVES

Problem 13.9

Draw the isometric view of a 90° arc of circle of radius 40 mm in horizontal and vertical position.

Solution Refer Fig. 13.18

The arc is tangential to the isometric lines at *a* and *b*. If the arc is horizontal it can be drawn as shown in Fig. 13.18 (ii) and if vertical they can be drawn as shown in Fig. 13.18 (iii) and (iv).

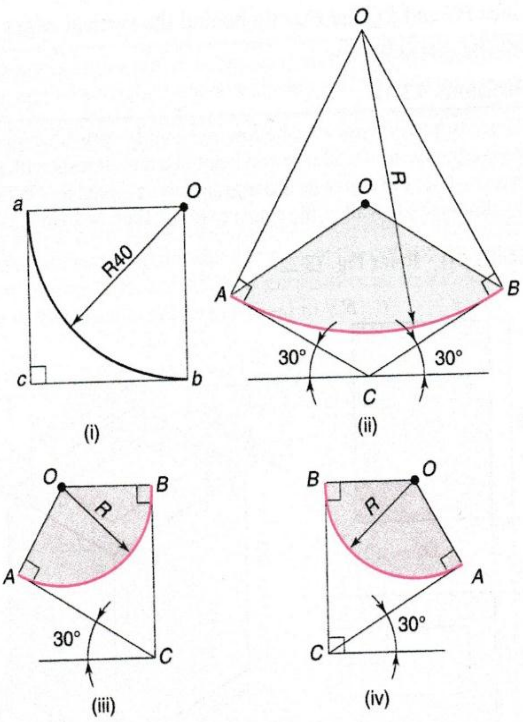


Fig. 13.18 *Isometric views of arcs*

Problem 13.10

Draw the isometric drawing of a curve *ABC* shown in Fig. 13.19.

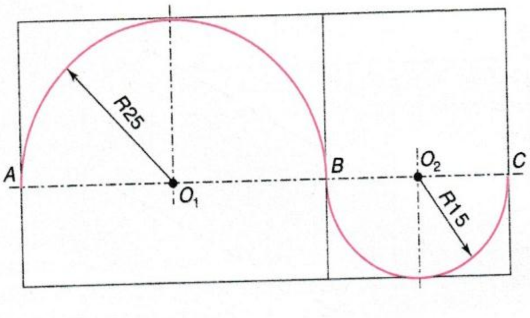


Fig. 13.19 *Curve ABC*

Solution Refer Fig. 13.20

A general method of drawing isometric view of any irregular curve is described as follows:

1. Enclose the given curve within a rectangle *PQRO*. See Fig. 13.20(i).
2. Mark a number of points 1, 2, 3 etc. on the curve.
3. Draw verticals and horizontals through these points and their co-ordinates are marked as x_1, y_1; x_2, y_2; x_3, y_3 etc. These distances are marked by using superimposed running dimensioning in two directions. Here, the distance of point 2 from *OP* measured along $OR = x_2$ and the distance of this point from *OR* measured along $OP = y_2$ and so on.
4. Draw the isometric view of the rectangle *PQRO* and mark the distance, x_1, y_1; x_2, y_2 etc. on it as shown in Fig. 13.20 (ii).
5. Through the points x_1, x_2, x_3 etc. draw lines parallel to the line *OP* to meet the lines drawn parallel to the line *RO* through points y_1, y_2, y_3 etc. to intersect at 1, 2, 3 etc. respectively.
6. The curve passing through these points is the required isometric curve *ABC*.

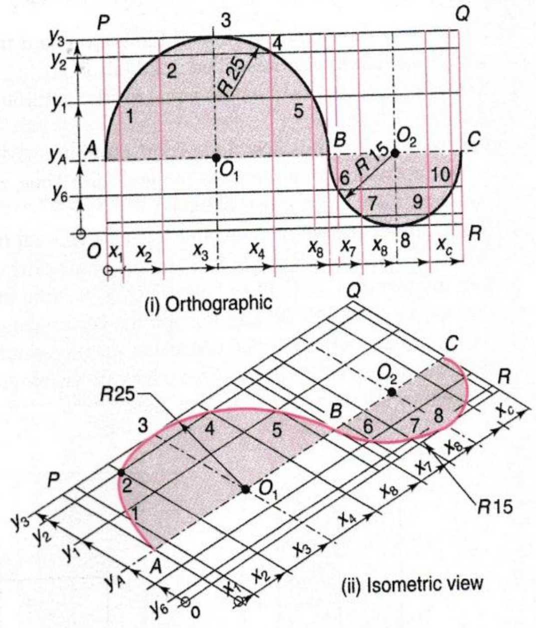


Fig. 13.20 *Views of the curve ABC*

Note

1. Three points 1, 2, 3 ... need not be equidistant.
2. Here, the distance of point 2 from reference point *O*, measured along *OR* is x_2. Similarly, the distance of point 2 from the reference point *O* measured along *OP*, is y_2.
3. In other words, point 2 is a point of intersection of lines drawn parallel to *OP* and *OR* through the points x_2 and y_2 respectively. Similarly, obtain the points 1, 3, 4 etc.

13.10 ISOMETRICS OF PRISMS

Isometric projection or view of simple prisms can by drawn either by following box method or co-ordinate method.

Problem 13.11

Draw isometric view of a square prism, side of base 35 mm and 70 mm long when the axis of the prism is:
- (a) vertical
- (b) horizontal

Assume that the adjacent sides of base are equally inclined to V.P.

Solution Refer Fig. 13.21

First of all draw the top and front views of the square prism satisfying the given condition and name the corners as shown in figure. Enclose the top view within a square 1-2-3-4. Now, the whole prism can be assumed to be enclosed within another square prism of side length x mm and height 70 mm.

(a) When the axis is vertical, the end faces 1-2-3-4 will be horizontal.

1. Now, draw the isometric view of the bottom end face which is a rhombus as described in Prob. 13.1.
2. Draw perpendiculars of length equal to 70 mm through points 1, 2, 3 and 4.
3. Join these end points and the second rhombus 1-2-3-4 at the top which represents the top end face. Thus, the isometric view of the box is obtained.
4. Now, obtain the point A on the top end face taking $A_1 = a_1$. Similarly, obtain all other corners of the prism.
5. Join the corner A, B, C, D and also P, Q, R, S. Note that the bottom edges PS, SR and RQ and the vertical edges CS and CR are not visible and hence they are represented by dashed lines while all the other edges are visible and hence they are represented by firm lines.

(b) When the axis is horizontal, the end face 1-2-3-4 will be vertical.

The procedure explained above may be followed to obtain isometric view of the prism shown in Fig. 13.21 (iii).

Note

Lines PS and RQ are exactly behind the vertical edges AP and BQ respectively.

Problem 13.12

Draw isometric view of a hollow rectangular prism of outer base edges 50 mm × 40 mm and height 60 mm. It rests with its base on H.P. and one of its rectangular faces parallel to V.P. The thickness of the wall of the prism may be taken as 10 mm.

Solution Refer Fig. 13.22

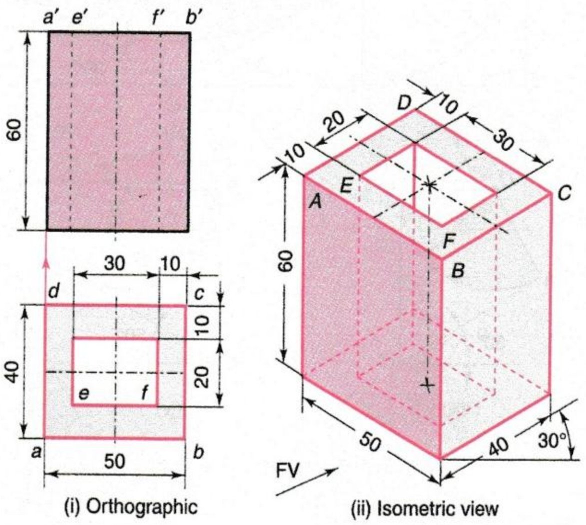


Fig. 13.22 *Hollow rectangular prism with the axis vertical*

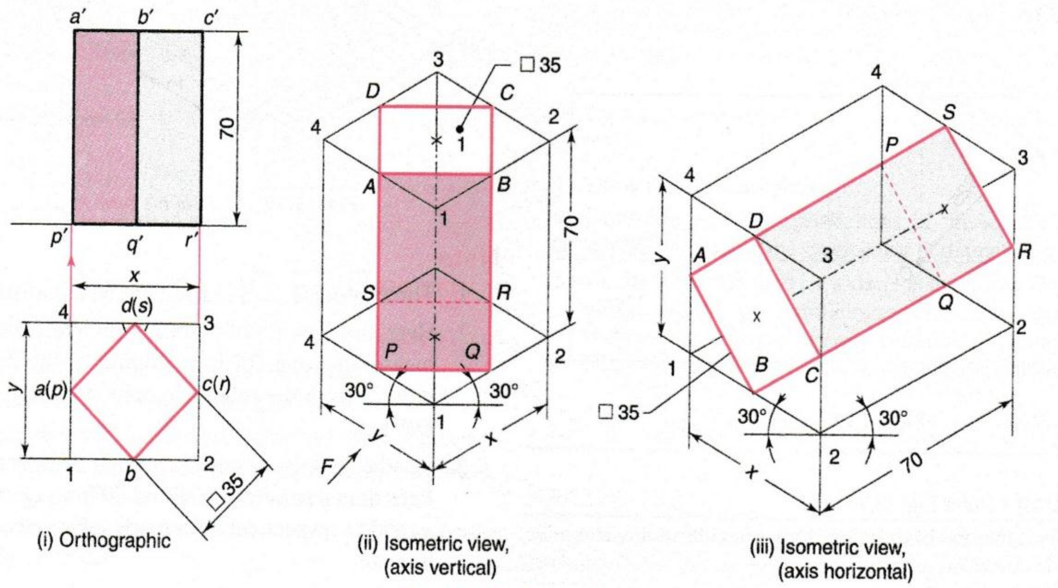


Fig. 13.21 *Square prism*

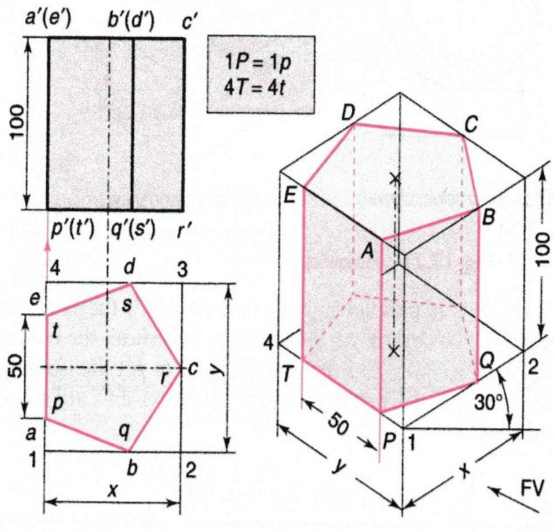
The procedure explained in the above problem may be followed here also, to obtain the required isometric view of the hollow rectangular prism. The edges of the prism which are not visible are shown in dashed lines while firm lines are used to shown the edges which are visible.

Problem 13.13

Draw the orthographic projections and isometric view of a pentagonal prism of base 50 mm side and axis 100 mm long which is resting on its base with a vertical face perpendicular to V.P.

Solution Refer Fig. 13.23

The procedure explained in Prob. 13.11 can be followed here to obtain the required isometric view of the pentagonal prism. Here, the vertical face *APTE* is perpendicular to V.P. Identify the vertical face which are inclined to V.P.



(i) Orthographic views (ii) Isometric view

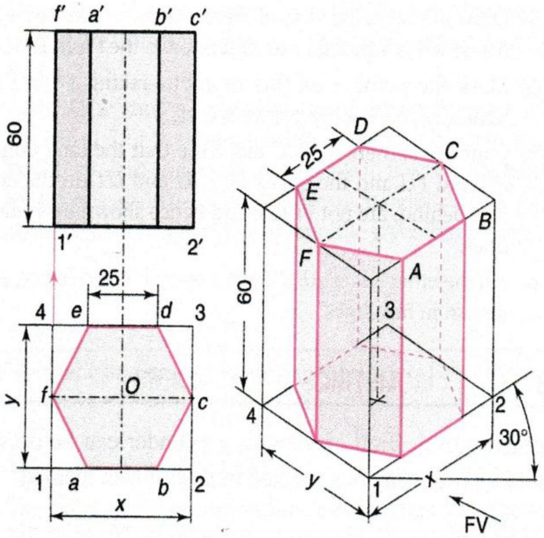
Fig. 13.23 *Pentagonal prism with the axis vertical*

Problem 13.14

Draw the isometric view of a hexagonal prism of 25 mm side and height 60 mm. resting with its base edge on the ground and parallel to V.P.

Solution Refer Fig. 13.24

The procedure explained in Prob. 13.11 may be followed here also, to obtain the required isometric view of the hexagonal prism. The top view is enclosed within a square 1-2-3-4 whose side lengths are *x* and *y*.



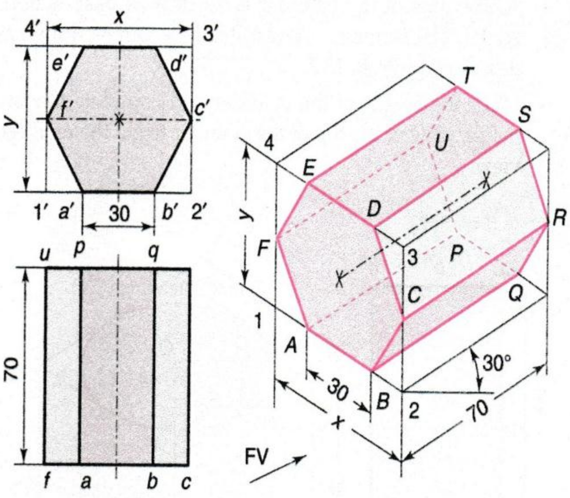
(i) Orthographic views (ii) Isometric view

Fig. 13.24 *Hexagonal prism with the axis vertical*

Problem 13.15

Draw the isometric view of a hexagonal prism side of base 30 mm and height 70 mm when it lies on the ground with one of its rectangular faces touching the ground.

Solution Refer Fig. 13.25



(i) Orthographic views (ii) Isometric view

Fig. 13.25 *Hexagonal prism with the axis horizontal*

1. Draw the front and then the top view of the prism.
2. Enclose the front view in a rectangle 1′-2′-3′-4′. Note that the rectangle is vertical.

3. Draw the isometric view of this rectangle marked by 1-2-3-4 which is a rhombus as described in the Prob. 13.1.
4. Mark the point *A* on this rhombus taking 1*A* = 1′*a*′. Similarly, mark other points *B*, *C* etc.
5. Joint the corners *A*, *B*, *C* etc. Note that the long edges *AP* and *FU* and the edges *PQ*, *PU* and *UT* on the end face behind, are not visible and hence shown in dashed lines.
6. All the other edges *AB*, *BC* etc. are visible and hence, are shown in firm lines.

13.11 ISOMETRICS OF CYLINDERS

Isometric projection of view of a cylinder can be drawn either by following box method or co-ordinate method.

Problem 13.16

Draw isometric view of a cylinder of diameter 40 mm and length 60 mm, if it is resting on one of its circular bases.

Solution Refer Fig. 13.26

1. Draw the top and front views of the cylinder.
2. Enclose the top view within a square 1-2-3-4. Now, the whole cylinder can be assumed to be enclosed within a square prism of side 40 mm and height 60 mm.
3. Draw the isometric view of the prism.
4. As the axis of the cylinder is vertical its base is horizontal. The isometric view of the base can be drawn as described in Prob. 13.7.
5. Mark the height of the cylinder and complete the isometric view of the top of the cylinder to get the required view.

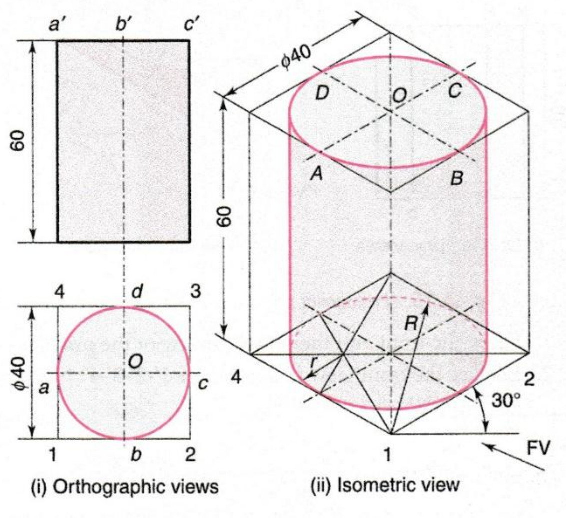


Fig. 13.26 *Cylinder with its axis vertical*

Problem 13.17

A hollow cylinder of inside diameter 40 mm, outside diameter 60 mm and 80 mm long, is resting on its generator on the ground with its axis parallel to V.P. Draw the isometric view of it.

Solution Refer Fig. 13.27

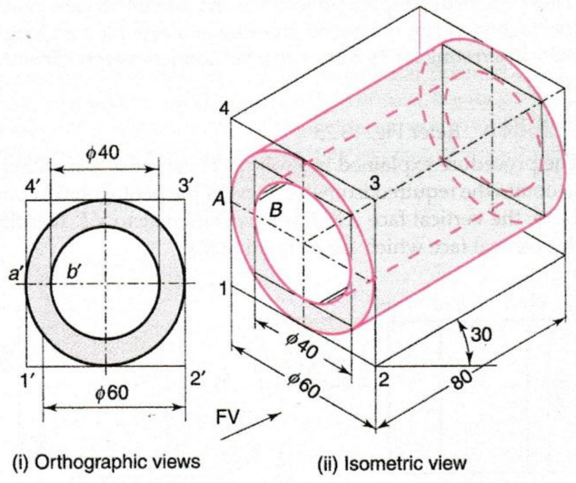


Fig. 13.27 *Hollow cylinder with the axis horizontal*

As the axis is parallel to both H.P. and V.P., the end view need only be drawn. As the end face is vertical, the method explained in Prob. 13.7 may be followed to get the isometric view of the end. The edges which are not visible, are shown in dashed lines.

13.12 ISOMETRICS OF PYRAMIDS

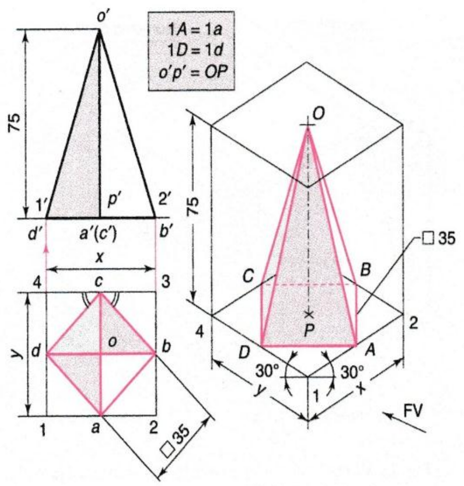
Isometric projection or view of simple pyramids can be drawn either by following box method or co-ordinate method.

Problem 13.18

A square pyramid of side of base 35 mm and height 75 mm is resting on the H.P. with the sides of base equally inclined to V.P. Draw its isometric view.

Solution Refer Fig. 13.28

1. Draw the top and front views of the square pyramid.
2. Enclose the top view within a square 1-2-3-4.
3. Draw the isometric view of the enclosing square and. locate the points *A*, *B*, *C* and *D*.
4. Locate the centre *P* of the base by drawing diagonals.
5. Mark the height *PO* = 75 mm by drawing a perpendicular through the point *P*.
6. Join the corners. The edge *CB* is not visible and hence, is shown in dotted lines.



(i) Orthographic views (ii) Isometric view

Fig. 13.28 *Square pyramid with the axis vertical*

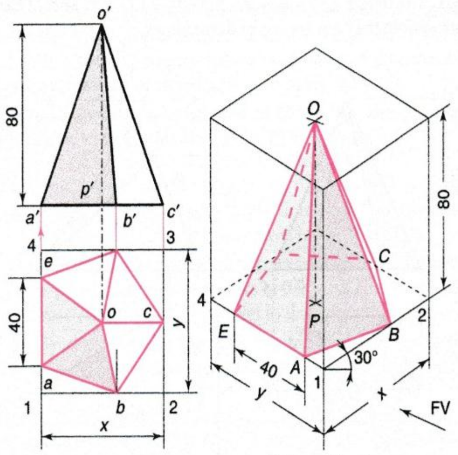
Note

The point O in the top can also be obtained by construction the box and then locating the geometrical centre of the top face of the square.

Problem 13.19

A pentagonal pyramid of side 40 mm and height 80 mm is resting on H.P. with the one side of the base perpendicular to V.P. Draw its isometric view.

Solution Refer Fig. 13.29



(i) Orthographic views (ii) Isometric view

Fig. 13.29 *Pentagonal pyramid with the axis vertical*

Here, edge AE is perpendicular to V.P. The height of the pyramid in the isometric view can be located as described in the Prob. 13.18.

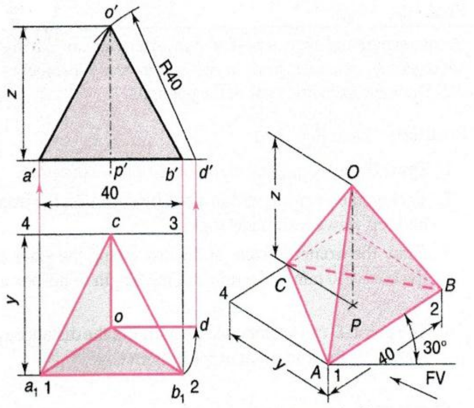
Also, draw another isometric view keeping the edge AE on the side 1-2 of the isometric box. Compare the two figures. Which all slant edges will be invisible in the new figure? Note that in this isometric view, the direction of looking FV should be shown on the left side to obtain the given front view.

Problem 13.20

A tetrahedron of side 40 mm is resting on H.P. Draw its isometric view if one of its edges on H.P. is parallel to V.P.

Solution Refer Fig. 13.30

The height of the tetrahedron can be found as shown in Fig. 13.30 (i) and the required isometric view is shown in Fig. 13.30 (ii).



(i) Orthographic views (ii) Isometric view

Fig. 13.30 *Tetrahedron with an edge of base parallel to V.P.*

Problem 13.21

Draw the isometric view of a tetrahedron resting on H.P. One edge on H.P., is perpendicular to V.P. The length of side of tetrahedron is 50 mm.

Solution Refer Fig. 13.31

Note

The edge OC is almost behind the edge OB and hence, the isometric view of the tetrahedron appears as a triangle.

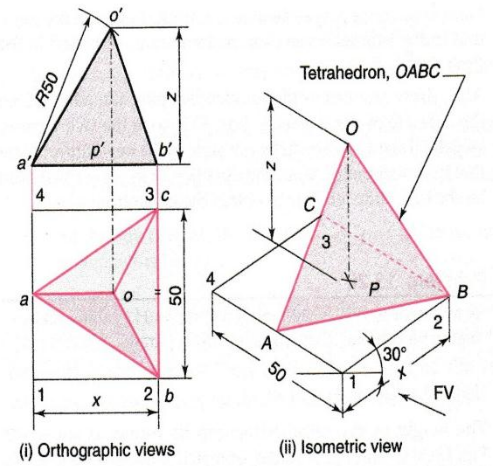


Fig. 13.31 *Tetrahedron with the edge BC perpendicular to V.P.*

Problem 13.22

A square pyramid edge of base 40 mm an axis 60 mm is lying on one of its triangular faces in H.P. and its axis is parallel to V.P. Draw the isometric view of the pyramid.

Solution Refer Fig. 13.32

1. Draw the orthographic views of the square pyramid.
2. Enclose the pyramid within a box by enclosing the front and top views within rectangles.
3. Draw the isometric view of the box taking the sides of the box as 40 mm and y mm and the length of the box as $x_1 + x_2$.
4. The point, D can be obtained by marking the distance x_1. Here, O is the mid point of the bottom edge.

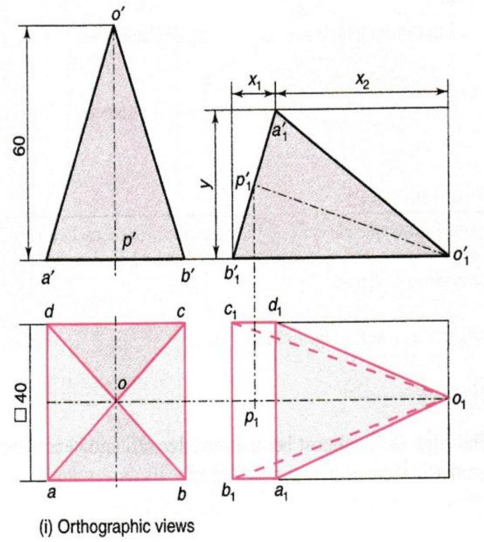


Fig. 13.32 (i)

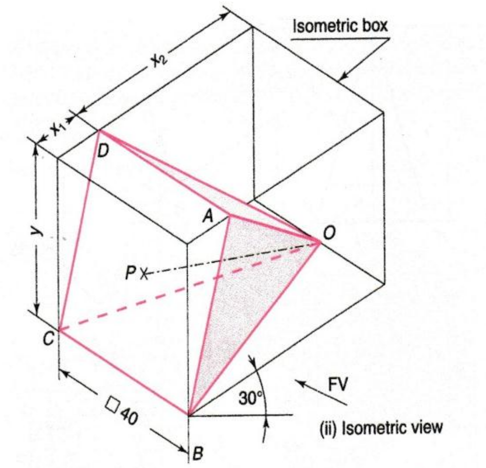


Fig. 13.32 (ii) *Square pyramid lying on a triangular face*

5. Join all edges to obtain the required isometric view. Here, the edge CO is invisible and hence, is shown in dotted lines.

Also, draw an isometric view, keeping the apex on the left side. Compare these two figures. Which all slant edges will be invisible in the new figure?

Problem 13.23

A hexagonal pyramid base 50 mm side and axis 100 mm long, is resting on H.P. on one of its slant edges with its adjacent base edges equally inclined to H.P. Draw its isometric view.

Solution Refer Fig. 13.33

The point O is the mid point of the bottom short edge of the box. The length $QO = q_1 o_1$. As the edges CO, DO and EO are not visible they are shown in dotted lines.

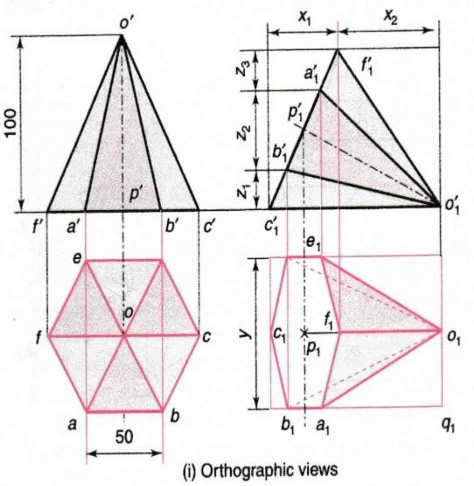


Fig. 13.33 (i)

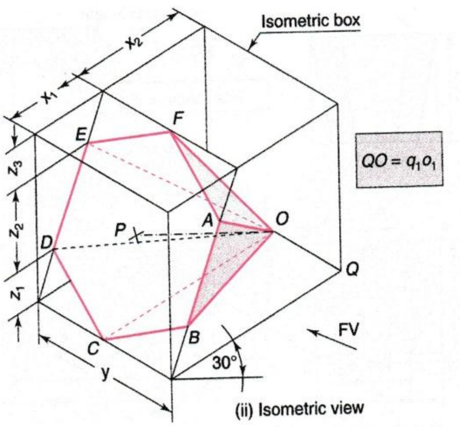


Fig. 13.33 (ii) *Hexagonal pyramid lying on a corner edge, CO*

Note

P is a point on the base *ABCDEF* and it will be the mid point of the line *CF* joining *C* and *F*.

Problem 13.24

Draw the projection of a frustum of a square pyramid with sides of two faces 6 cm and 4 cm and height 6 cm. The solid is standing on H.P. in the upright position and the base edge nearer to V.P. is 2 cm from it. Draw the isometric projection of the solid mentioned above if a base edge is parallel to V.P.

Solution Refer Fig. 13.34

As the isometric projection is required, an isometric scale is constructed and the lengths are taken from the isometric scale for drawing the required view. (i) If the base edge *cd* is parallel to the V.P. the top and front views with be as shown in Fig. 13.34(i). Applying the principles already studied the isometric projection law be obtained as shown in Fig. 13.34(ii).

If an edge of base is inclined at 45° to V.P., the isometric projection will be as shown in Fig. 13.34 (iii) and (iv).

Notes

1. Also draw the isometric projection if the base edges are equally inclined to V.P. as shown in Fig. 13.34 (iv).
2. For obtaining this isometric projection, first draw the top and then the front views of the frustum, keeping the base edges *ab* and *cd* parallel to the *xy*-line.
3. By drawing the top and the front views, draw the required isometric projection as shown in figure.

Problem 13.25

A pentagonal pyramid of base 25 mm and axis 70 mm long rests on its base on H.P. in such a way that one of its base edges is parallel to V.P. and nearer to it. Horizontal section plane bisects the axis. Draw the isometric view of the frustum of the pyramid.

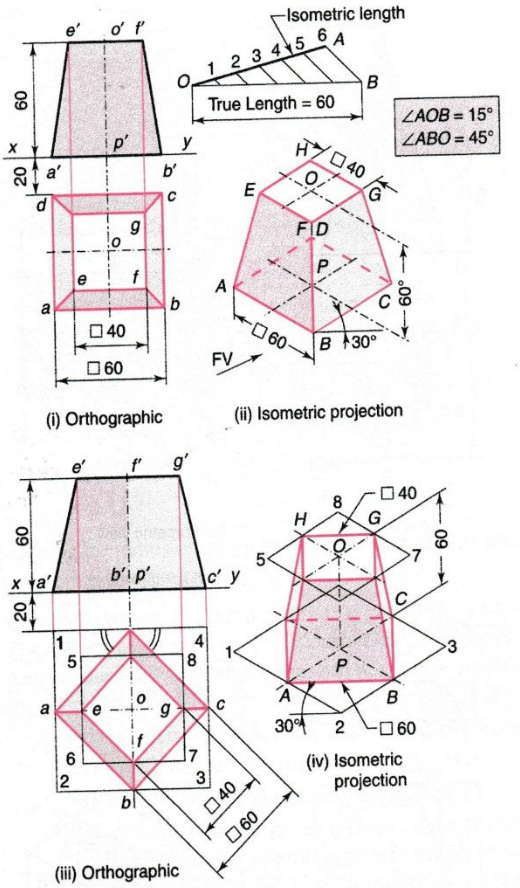


Fig. 13.34 *Frustum of a square pyramid*

Solution Refer Fig. 13.35

1. After drawing the top and front views of the frustum of the pentagonal pyramid, enclose the top view within a rectangle.
2. Draw the isometric view of the base and mark the height of the frustum such that *PQ* = 35 mm.
3. Then, draw the isometric view of the top rectangle taking half the length on either sides of centre line.
4. Join the points *B* and *G*, *C* and *H* etc. to get the required isometric view.

Problem 13.26

Draw the isometric view of a frustum of a hexagonal pyramid base 60 mm side, top 40 mm and height 30 mm. Keep one base edge parallel to V.P.

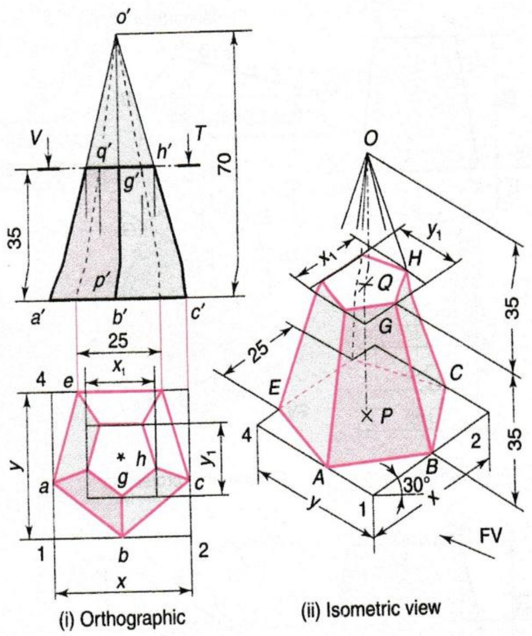


Fig. 13.35 *Frustum of a pentagonal pyramid*

Solution Refer Fig. 13.36

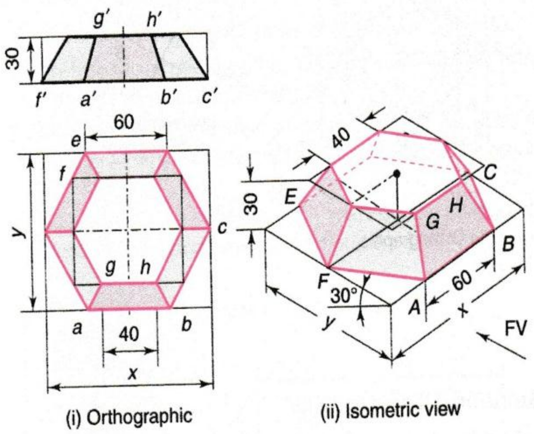


Fig. 13.36 *Frustum of a hexagonal pyramid, axis vertical*

Draw the top and front views and proceed as before for getting the required isometric view.

Problem 13.27

A waste paper basket is in the form of a frustum of hexagonal pyramid with base 80 mm hexagon and top 120 mm. Draw the isometric projection if its height is 200 mm.

Solution Refer Fig. 13.37

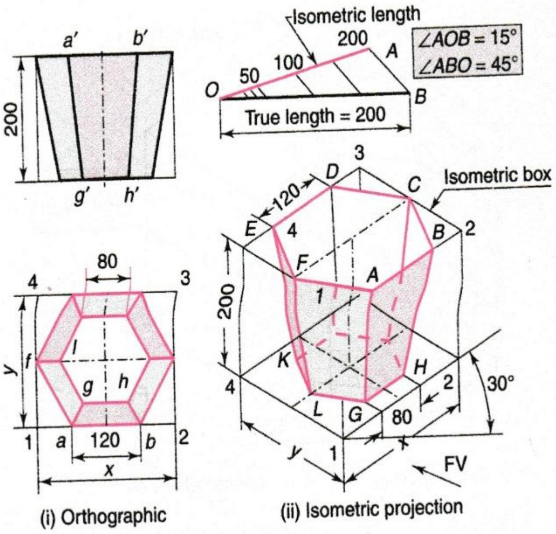


Fig. 13.37 *Frustum of a hexagonal pyramid*

1. Draw the top view of the basket which consists of two hexagons and name them.
2. Enclose these views within a rectangle 1-2-3-4 and height 200 mm.
3. Construct an isometric scale and complete the isometric box.
4. Draw the small hexagon *L*, *G*, *H*... on the base of the box.
5. Similarly, draw the large hexagon *ABCD*... on the top of the box as shown.
6. Join *A* and *G* and obtain the slanting edge *AG*.
7. Similarly draw all the visible edges *AG*, *BH*, ...
8. The invisible edges are shown by dotted lines.

13.13 ISOMETRICS OF CONES

Isometric projections or view of a cone can be drawn even without constructing the box. They are explained in the following problems.

Problem 13.28

A cone of diameter 50 mm and height 60 mm is placed on the horizontal plane with its axis vertical. Draw its isometric view.

Solution Refer Fig. 13.38

1. Draw the top and front views of the cone.
2. Inscribe the top view in a square and divide it as shown.

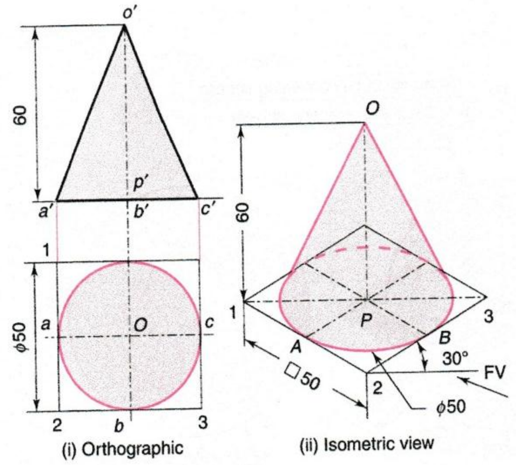


Fig. 13.38 *Cone on its base on H.P.*

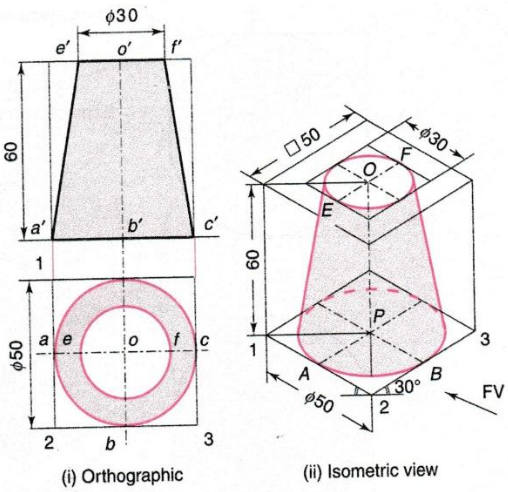


Fig. 13.39 *Frustum of a cone with the axis vertical*

3. Draw the isometric view of the square and mark its centre *P* and then draw an ellipse within the rhombus, 1-2-3-4.
4. Locate the apex *O* by drawing a perpendicular through the point *P* of length *OP* = 60 mm.
5. From the apex draw two tangents to the ellipse, to get the required isometric view of the cone.

Note

If only an approximate ellipse is to be formed follow the four centre method.

Problem 13.29

Draw isometric view of a frustum of a cone base diameter 50 mm, top face diameter 30 mm and length of axis 60 mm, resting on horizontal plane.

Solution Refer Fig. 13.39

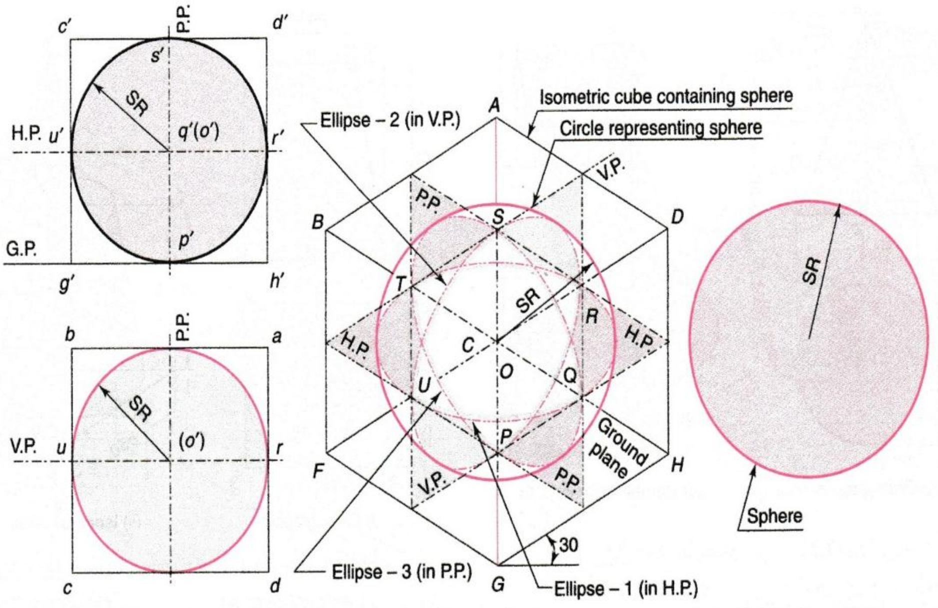
1. Obtain the isometric view of the square prism.
2. Then, cut down 10 mm on all sides at corners to get square (rhombus in isometric) of 30 mm at the top.
3. Draw an ellipse within the rhombus of side 30 mm each. Similarly obtain bottom ellipse.
4. Draw two tangents to the two ellipses to get the required view.

13.14 ISOMETRICS OF SPHERES

We know that orthographic projections such as front view, top view, side view, auxiliary front view, auxiliary top view etc. of a sphere are circles of radius equal to the radius of the sphere. Similarly, isometric projection, diametric projection and trimetric projection are also circle of radius equal to the radius of the sphere. Also, we know that section of a sphere is a circle.

Consider a sphere encased in a cube as shown in Fig. 13.40. The sphere touches the cube at six different points. In the construction of the isometric projection of a sphere, the following points may be noted:

1. First of all, cut the sphere by three section planes:
   (a) Horizontal section plane indicated by H.P.
   (b) Vertical section plane indicated by V.P.
   (c) Another vertical section plane called profile plane, perpendicular to both H.P. and V.P., and is indicated by P.P. Note that all these section planes pass through the centre of the sphere *O*.
2. The section of the sphere cut by H.P. is a circle and its isometric projection can be represented by the ellipse – 1 on H.P.
3. The section of the sphere cut by V.P. is a circle and its isometric projection can be represented by the ellipse – 2 on V.P.
4. The section of the sphere cut by P.P. is a circle and its isometric view can be represented by the ellipse – 3 on P.P.
5. The centres of all the ellipses, will coincide with the centre of the sphere *O*. But, in isometric projection this centre will coincide with the corner *C* of the isometric cube.
6. Now, draw a circle with centre *C* and radius equal to the true radius, *SR* of the sphere to get isometric projection of it.



(i) Orthographic views (ii) Isometric view (iii) Photographic

Fig. 13.40 *Views of a sphere*

7. The point of intersection P of the two vertical ellipses which is at the bottom most side, in actually the point of touching of the sphere with the bottom surface of the cube. The other points of intersection of the sphere with the surfaces of the cube, are indicated by points Q, R, S, T and U.
8. Line OP is the line joining the centre O of the sphere with the point of intersection of the sphere with the bottom of the cube. Its front view is shown by $o'p'$ in front view. But, when the cube is tilted to the isometric position, the line OP becomes inclined and gets foreshortened to 82% approximately.
9. Isometric projection of the sphere with centre O and radius SR, and resting on a plane $EFGH$ is shown.
10. In the isometric view, foreshortening of the isometric axes neglected and true lengths are taken along the axes. Therefore, the length OP in isometric view will be same as that of the radius of the sphere, SR. The isometric view of the sphere obtained will be 22.5% large than the sphere of true radius SR.

Note

1. The major diameter of each ellipse is equal to the true diameter of the sphere.
2. The ends of the major axes of the three ellipses are actually on the surface of the sphere itself.
3. In the isometric projection of a compound object consisting of a sphere or a portion of a sphere, all dimensions are taken after reducing it to isometric scale except the radius of the sphere or the portion of the sphere. This radius should be equal to the radius of the sphere itself.
4. In the isometric view of a compound object consisting of a sphere or a portion of a sphere, all dimensions taken are true dimensions except the radius of the sphere or the portion of the sphere. The radius should $\sqrt{3} \div \sqrt{2} = 1.225$ i.e. 22.5 % longer than the radius of a sphere itself.

Problem 13.30

A sphere of radius 30 mm is resting centrally on the top surface of a square plate of side 75 mm and of negligible thickness. Draw the isometric projection and isometric view.

Solution Refer Fig. 13.41

For obtaining the required figures, the procedure explained below may be followed:

1. Draw the orthographic projections of the sphere and the plate.
2. Construct an isometric scale.
3. Draw the isometric projection of the square plate taking all dimensions from the isometric scale (i.e. reduced length). Also, mark its centre P, the centre of square plate.
4. For locating the centre of the sphere O, draw a vertical line through P and mark the point O on it such that OP is 30 mm from the isometric scale. Note that this is the reduced length and is equal to 30 × 0.82 mm. This reduced length is indicated by R_r.

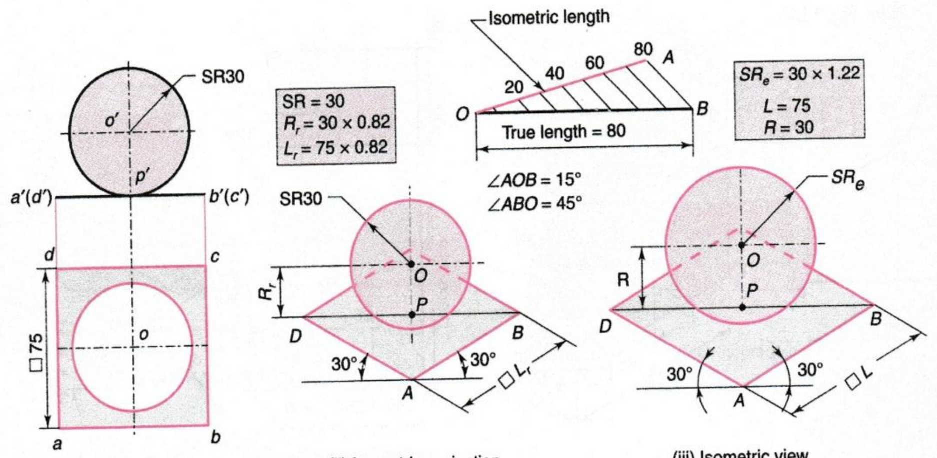


Fig. 13.41 *Projections of sphere resting on a plate*

5. With centre *O* and spherical radius *SR* = 30 mm (true radius) draw a get the required isometric projection of the sphere.

For constructing isometric view:

6. Draw the isometric view of the square plate taking the length of side as 75 mm itself (i.e. the true length). Locate the centre *P*.
7. For locating the centre of the sphere *O*, draw a vertical line through *P* and mark the point *O* on it such that *OP* = 30 mm. This is the true length of the radius of the sphere and is indicated by *R*.
8. With centre *O* and spherical radius SR_e = 30 × 1.225 (enlarged radius) draw a circle to get the required isometric view of the sphere.

Note

1. Isometric projection is smaller than the isometric view.
2. In both isometric projection and isometric view, the circle is not passing through the point of contact *P* at the bottom and actually it is inside the circle and hence will not be seen in isometrics.

13.15 ISOMETRIC FROM ORTHOGRAPHIC PROJECTIONS

So far we have studied how isometrics of simple geometrical solids are prepared. In engineering practice sometimes simple engineering objects are to be prepared in isometrics. If isometrics are to be prepared from orthographic views, one should have a thorough knowledge in reading such drawings and should be capable of visulising the object. If the three dimensional picture is clear in mind, it is quite easy to prepare the isometrics. First of all, identify location of the origin of the isometric axes in such a way that it produces a drawing which furnishes maximum information. The construction lines may even be retained. Make a free hand sketch before starting the actual drawing.

Note

1. If isometric projection is to be drawn all dimensions are to be taken form isometric scale (reduced length) except the radius for a sphere (true length).
2. If isometric view is to be drawn all dimensions taken should be true lengths except the radius for a sphere (enlarged length).

Problem 13.31

Construct an isometric drawing of a curved block shown in Fig. 13.42.

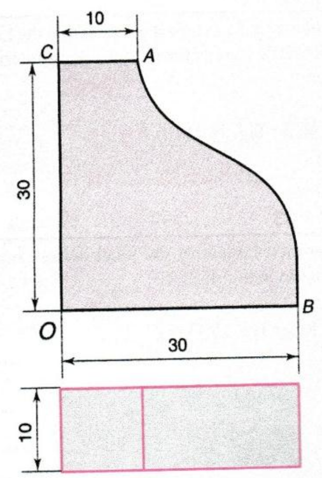
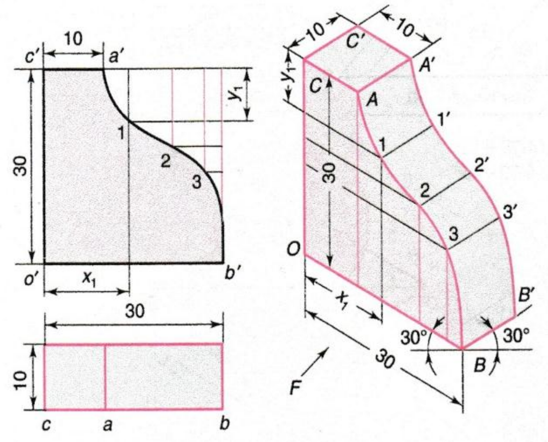


Fig. 13.42 *An irregular curve*

Solution Refer Fig. 13.43



(i) Orthographic views (ii) Isometric view

Fig. 13.43 *Isometric view of an irregular curve*

1. Mark a number of parts, 1, 2, 3 etc. on front view of the curve.
2. Locate their x and y co-ordinates. Let x and y, be the co-ordinate of the point 1.
3. The intersection of the co-ordinates of the point will be the point on the isometric drawing.
4. Draw a smooth curve passing through the points A, 1, 2, 3 and B.
5. Draw a line B-B' of length 10 mm at an angle of 30°. Now draw another curve through B' and parallel to AB as shown to get the required isometric view of the curved portion.

Problem 13.32

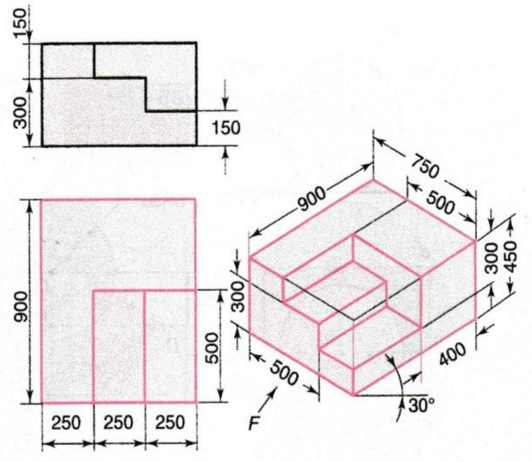
Two views of a model of steps is an shown in the Fig. 13.44 (i). Draw the isometric view of the model. Use isometric scale 1:10 (1 cm = 10 cm).

Solution Refer Fig. 13.44 (ii)

Problem 13.33

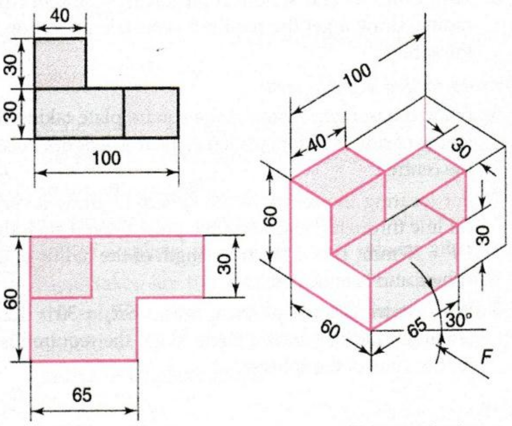
Draw the isometric view of the block whose orthographic views are shown in Fig. 13.45 (i).

Solution Refer Fig. 13.45 (ii)



(i) Orthographic views (ii) Isometric view

Fig. 13.44 *Orthographic views of steps*



(i) Orthographic views (ii) Isometric view

Fig. 13.45 *Stepped block*

Problem 13.34

Draw the isometric projection of the block shown in Fig. 13.46 (i).

Solution Refer Fig. 13.46 (ii)

1. First draw the isometric view of the bottom rectangular block if size 120 mm × 80 mm × 20 mm.
2. Enclose the front view of the forked portion of the block within another rectangular block of size 2120 mm × 60 mm × 60 mm isometric view over the first block.

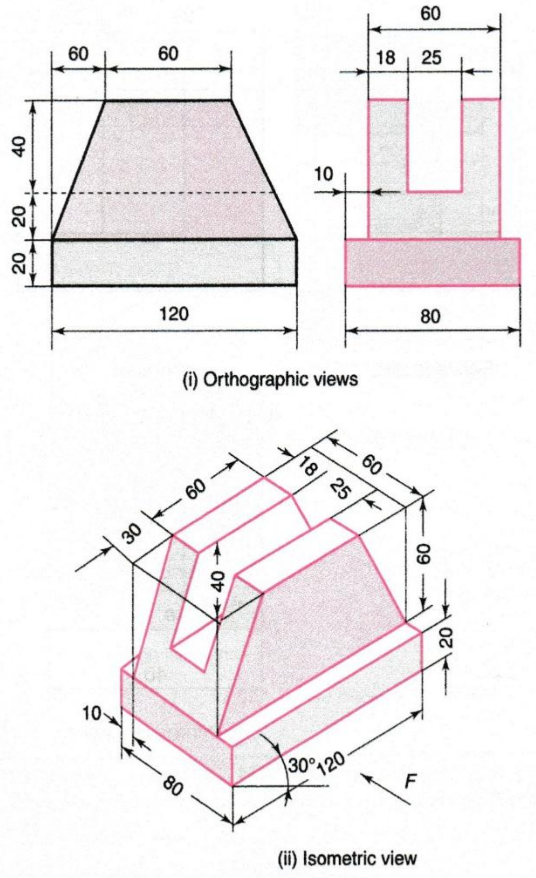


Fig. 13.46 *Block*

3. Mark the side view of the forked potion of the block on the left side of the appropriate isometric view.
4. Similarly mark the front view of the top portion of the block on the front side of the isometric view.
5. Obtain the required isometric view of the block as shown.

Problem 13.35

The Fig. 13.47(i) shows the orthographic projection of an object. Draw the isometric view to the full scale.

Solution Refer Fig. 13.47 (ii)

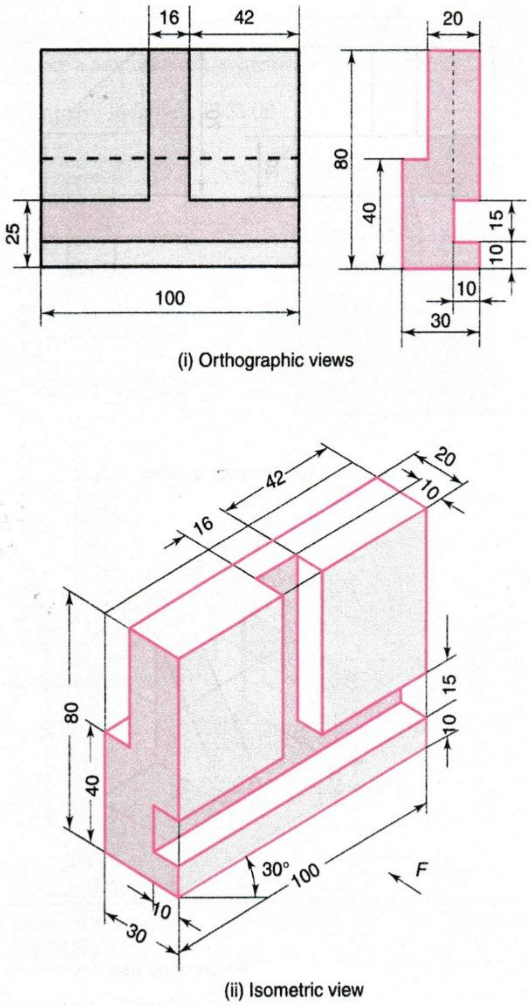


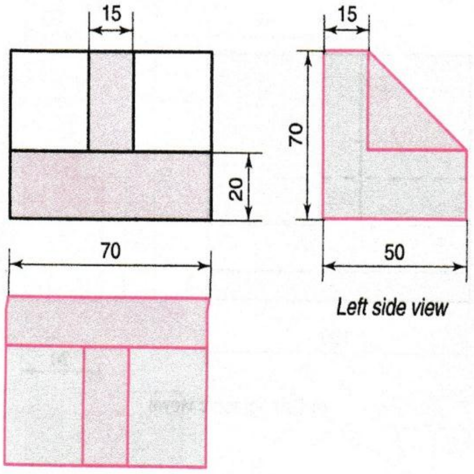
Fig. 13.47 *Slotted block*

Problem 13.36

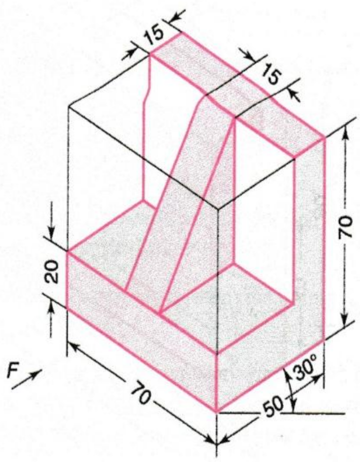
Orthographic views of an object are shown in Fig. 13.48(i). Draw the isometric view of the same.

Solution Refer Fig. 13.48 (ii)

For the purpose of comparison, draw another isometric view where *F* is to be marked on the right side instead of on left side.



(i) Orthographic views



(ii) Isometric view

Fig. 13.48 *Angle block*

Problem 13.37

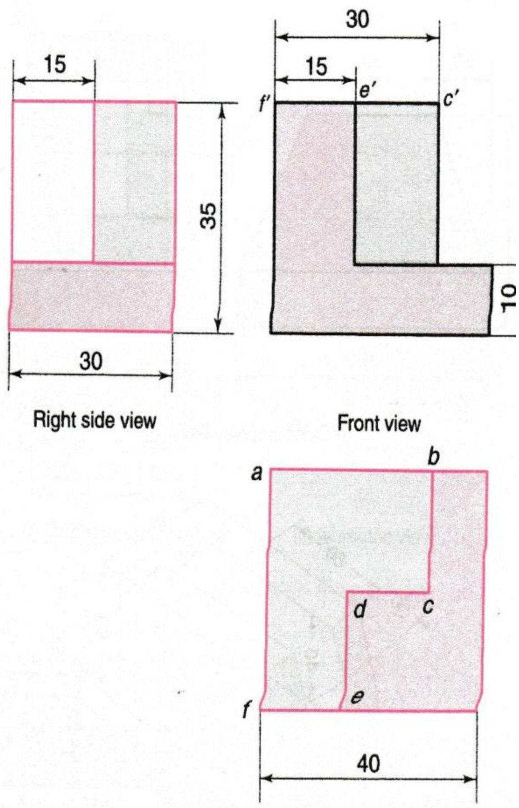
The orthographic views of a block are shown in Fig. 13.49(i). Prepare a proportional isometric drawing by free hand, do not dimension.

Solution Refer Fig. 13.49 (ii)

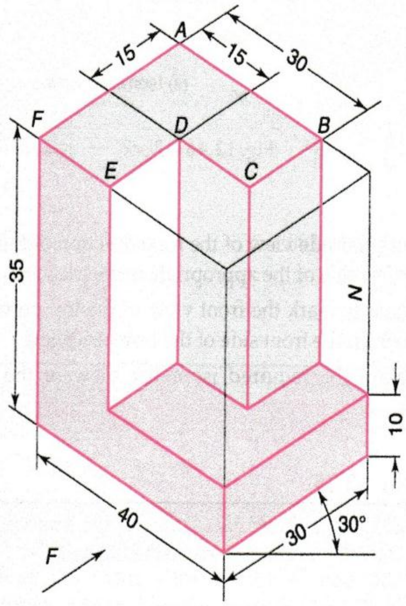
Problem 13.38

Draw the isometric view of the object, whose orthographic projections are given in Fig. 13.50(i).

Solution Refer Fig. 13.50 (ii)



(i) Orthographic views



(ii) Isometric view

Fig. 13.49 *C.I. block*

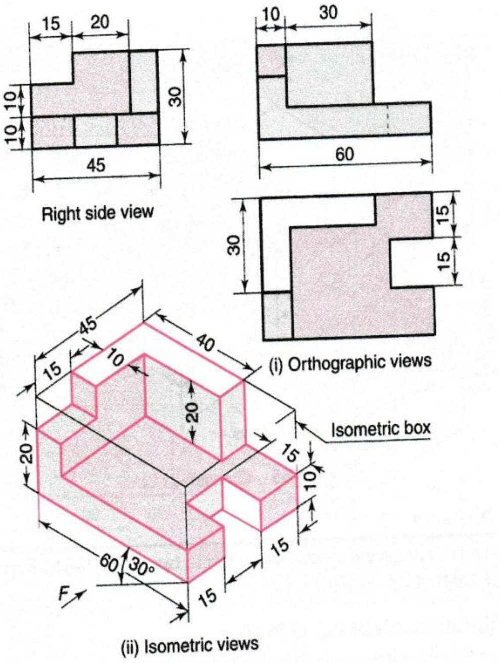


Fig. 13.50 *Slotted block*

Problem 13.39

Orthographic views of a block are shown in Fig. 13.51 (i). Prepare a proportionate isometric drawing by free hand. Need not dimension.

Solution Refer Fig. 13.51 (ii)

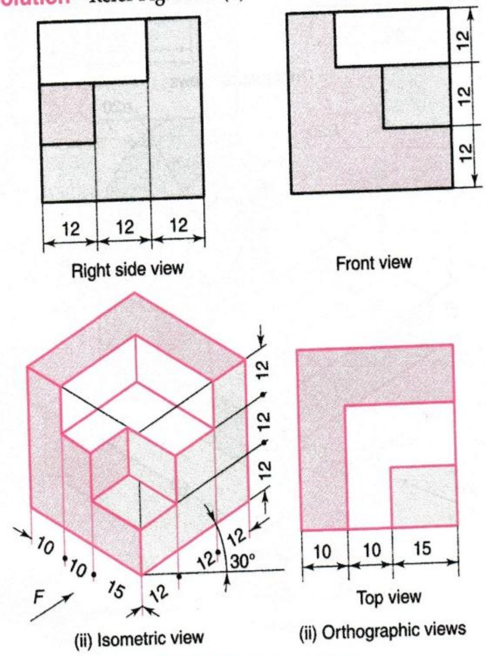


Fig. 13.51 *Stepped block*

Problem 13.40

The orthographic views of a support are shown in Fig. 13.52 (i). Prepare a proportionate isometric drawing by free hand.

Solution Refer Fig. 13.52 (ii)

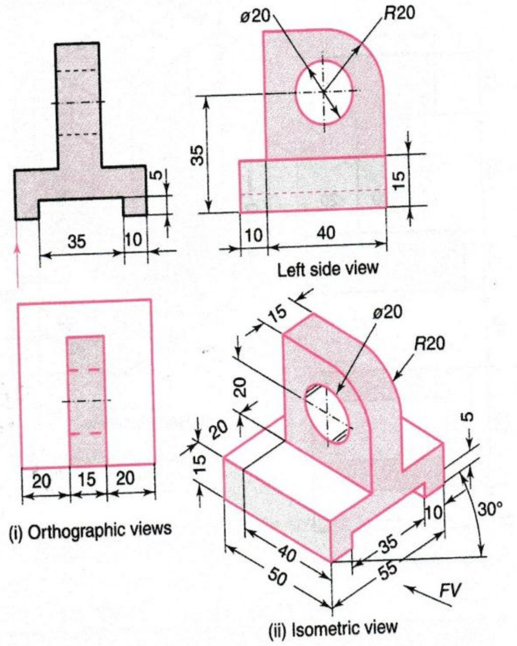


Fig. 17.52 *Support*

Problem 13.41

Draw the isometric projection of the solid shown in Fig. 13.53 (i).

Solution Refer Fig. 13.53 (ii)

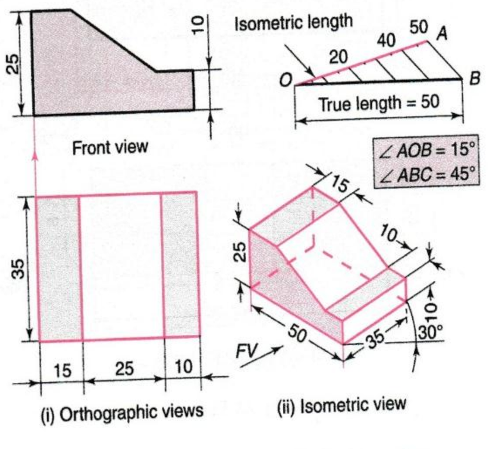
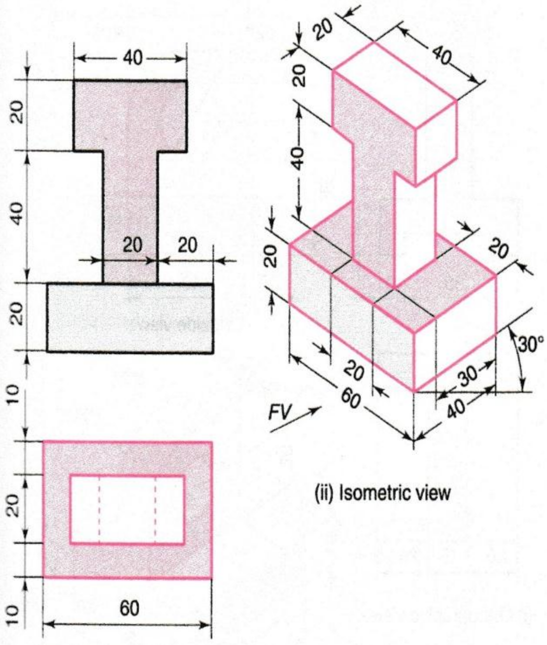


Fig. 13.53 *Stepped block with slopping surface*

Problem 13.42

Draw the isometric view of an I-block shown in Fig. 13.54 (i).

Solution Refer Fig. 13.54 (ii)



(i) Orthographic views

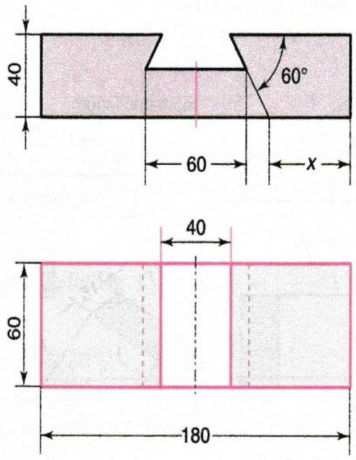
(ii) Isometric view

Fig. 13.54 *I-block*

Problem 13.43

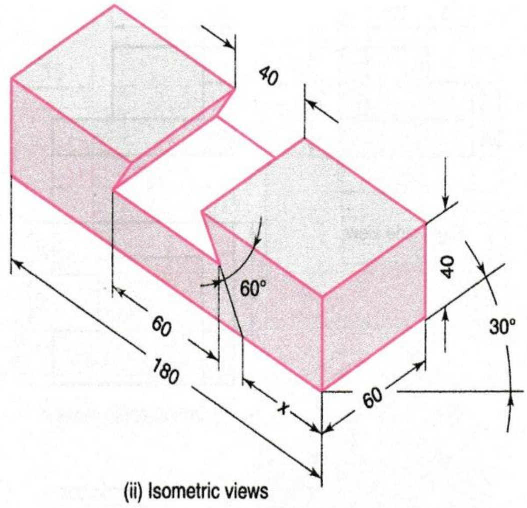
Draw the isometric view of the channel block whose orthographic views are given in Fig. 13.55 (i).

Solution Refer Fig. 13.55 (ii)



(i) Orthographic views

Fig. 13.55



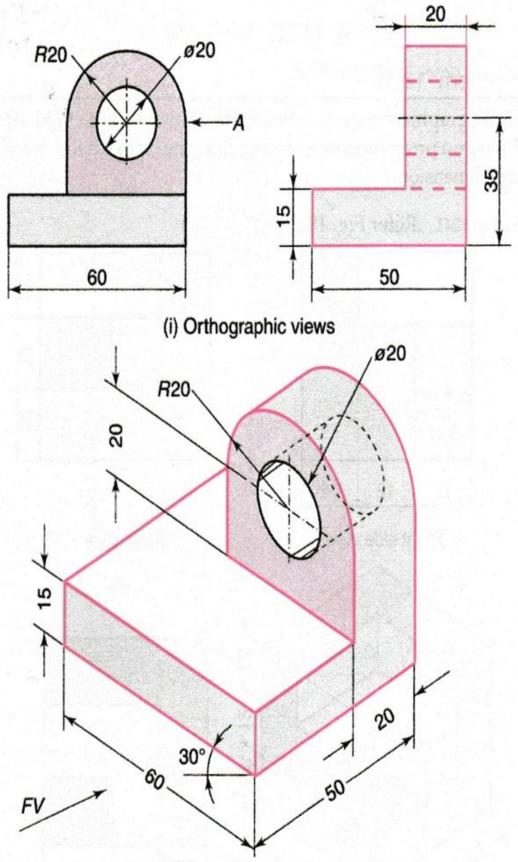
(ii) Isometric views

Fig. 13.55 *Channelled block*

Problem 13.44

Draw the isometric view of the objects, two views of which are shown in Fig. 13.56 (i).

Solution Refer Fig. 13.56 (ii)



(i) Orthographic views

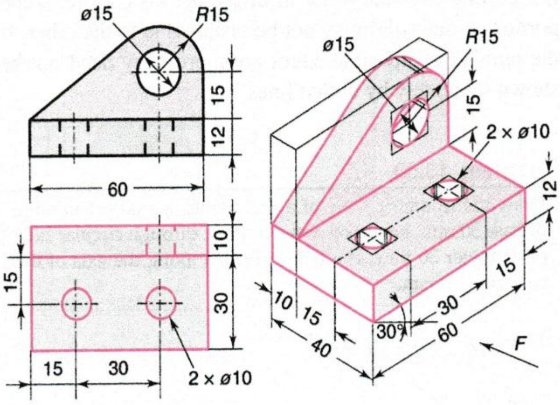
(ii) Isometric view

Fig. 13.56 *Shaft support*

Problem 13.45

Draw the isometric view of a bracket from its orthographic views shown in Fig. 13.57 (i).

Solution Refer Fig. 13.57 (ii)



(i) Orthographic views (ii) Isometric view

Fig. 13.57 *Angle bracket*

Problem 13.46

Orthographic views of a cast iron support is shown in Fig. 13.58 (i). Draw the isometric view.

Solution Refer Fig. 13.58 (ii)

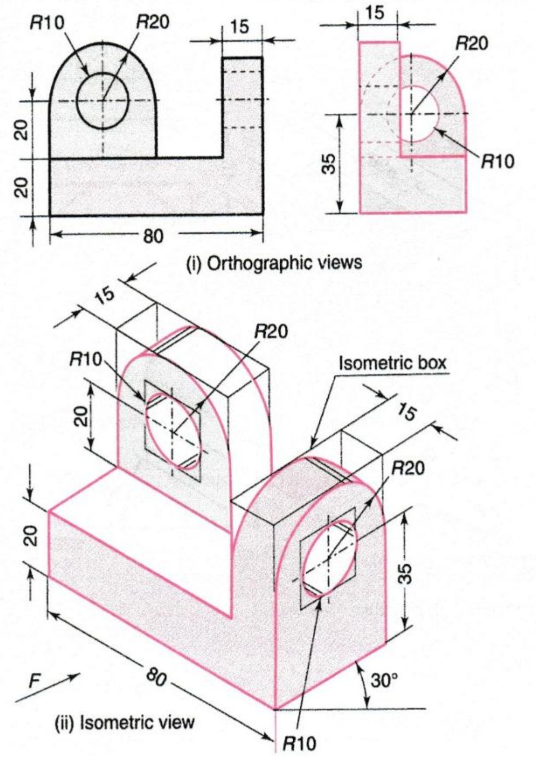
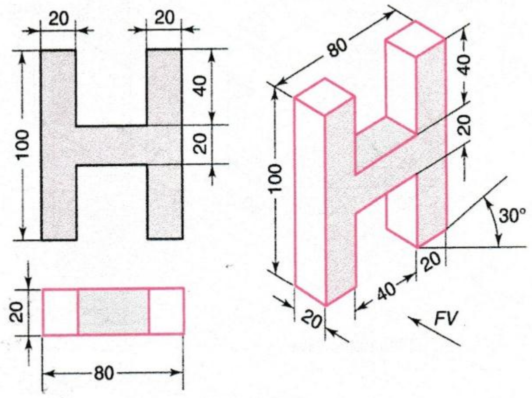


Fig. 13.58 *Cast iron support*

Problem 13.47

Orthographic views of the letter *H* is shown in Fig. 13.59 (i). Draw its isometric projection.

Solution Refer Fig. 13.59 (ii)



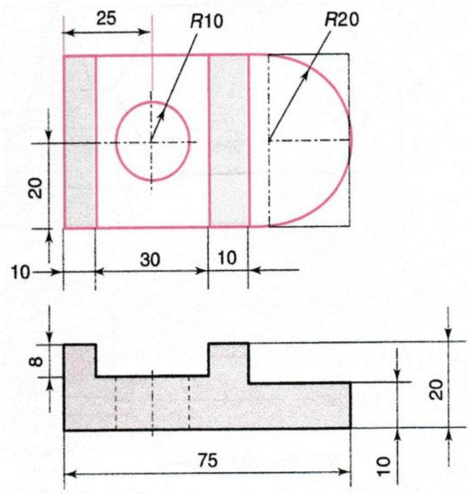
(i) Orthographic views (ii) Isometric view

Fig. 13.59 *An alphabet*

Problem 13.48

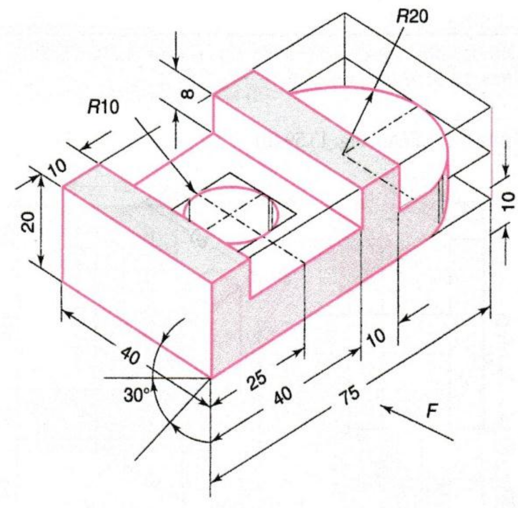
Front and top views of a bracket is shown in Fig. 13.60 (i). Draw its isometric view. Dimension the view as per BIS.

Solution Refer Fig. 13.60 (ii)



(i) Orthographic views

Fig. 13.60



(ii) Isometric view

Fig. 13.60 *Bracket*

Problem 13.49

Front and top views of the ink point are shown in Fig. 13.61 (i). Draw its isometric view.

Solution Refer Fig. 13.61 (ii)

13.16 ISOMETRICS OF COMBINATION OF SOLIDS

In this article we will deal with projections of simple solids placed one over the other in different ways. Here, some portion of one solid may not be visible due to the other. If the number of invisible edges are more, they need not be shown separately by dotted lines.

Problem 13.50

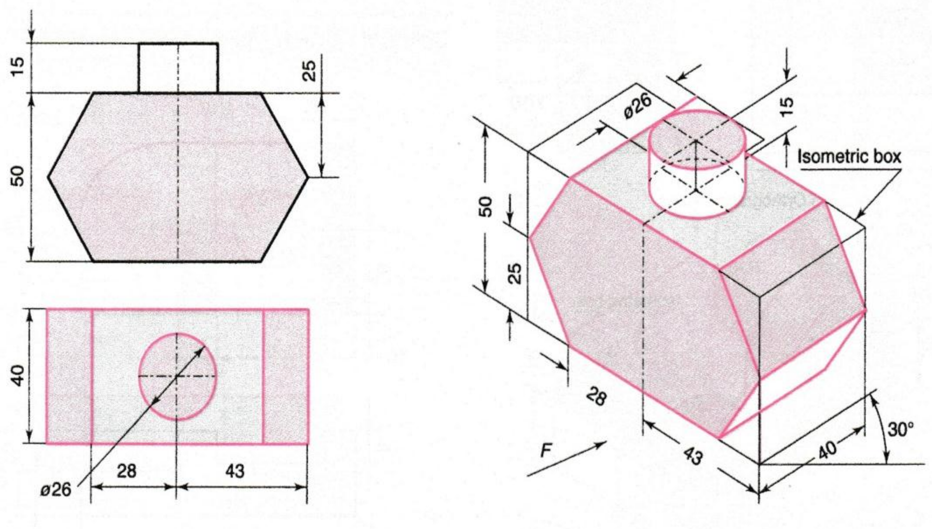
Draw the isometric view of a hollow hexagonal prism edge of base 30 mm. height 60 mm, having a through circular hole of diameter 30 mm. The hole is drilled along the axis of the hexagonal prism.

Solution Refer Fig. 13.62

Problem 13.51

A cylindrical slab 7.5 cm in diameter and 2 cm thick is surmounted by cube of 3.7 cm side. On the top of the cube, rests a square pyramid of altitude 3.7 cm and side of base 2.5 cm. The axis of solids are in same of line. Draw the isometric view of the combinations.

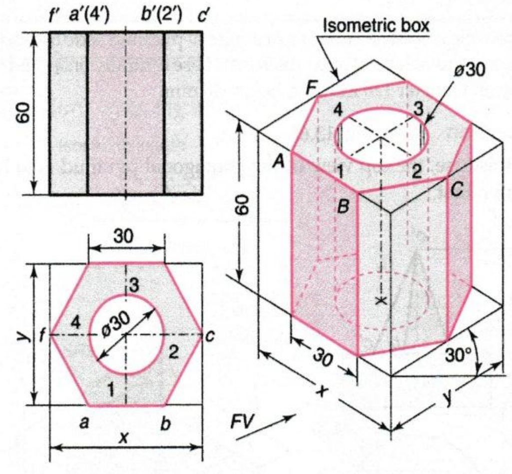
Solution Refer Fig. 13.63



(i) Orthographic views

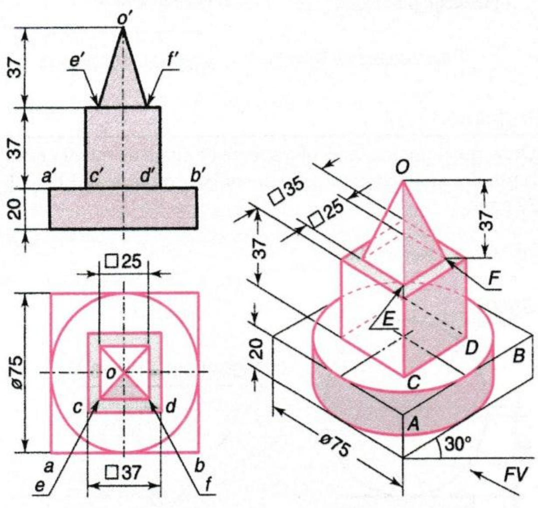
(ii) Isometric view

Fig. 13.61 *Ink Pot*



(i) Orthographic views (ii) Isometric view

Fig. 13.62 *Hollow hexagonal prism with the axis vertical*



(i) Orthographic views (ii) Isometric view

Fig. 13.63 *Combination of cylinder, cube and pyramid*

Problem 13.52

A right circular cone base 5 cm diameter and height 6 cm rests symmetrically over a rectangular block 5 cm × 4 cm base and 3 cm height. Draw the isometric view.

Solution Refer Fig. 13.64

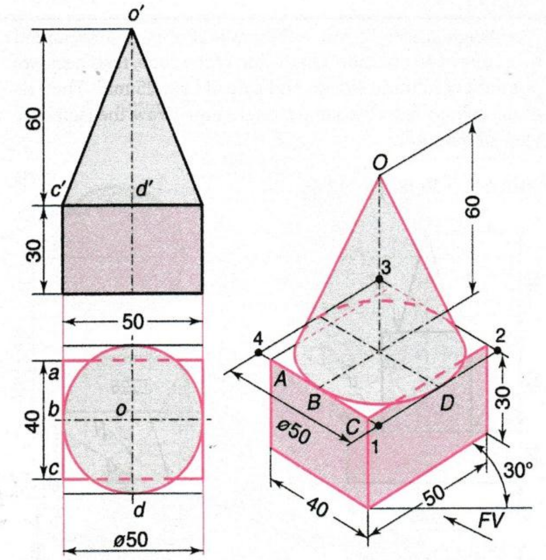
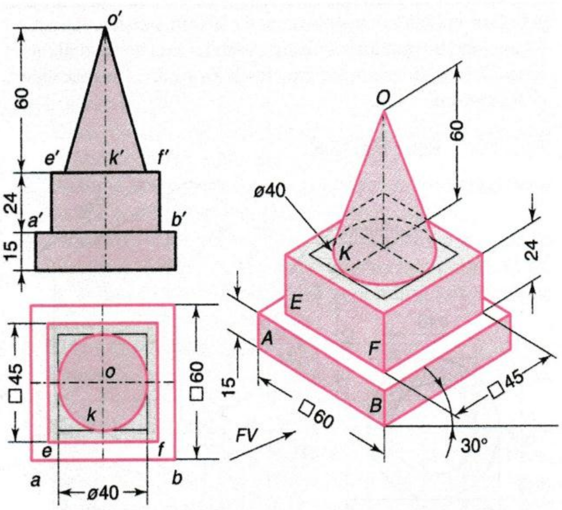


Fig. 13.64 *Combination of prism and cone*

Problem 13.53

A square slab of 60 mm side and 15 mm height is surmounted by another square slab of 45 mm side and 24 mm height. On its top, a right circular cone of diameter 40 mm and height 60 mm is placed. The axis of the solids are in a same vertical line. Draw the isometric view of solids.

Solution Refer 13.65



(i) Orthographic views (ii) Isometric view

Fig. 13.65 *Combination of square prisms and a cone*

Problem 13.54

A rectangular slab 75 mm × 50 mm × 20 mm is surmounted by a cube of 40 mm side. On the top of the cube, rests a square pyramid of altitude 40 mm and side of base 25 mm. The axis of the solids are in the same straight line. Draw the isometric view of the solid.

Solution Refer Fig. 13.66

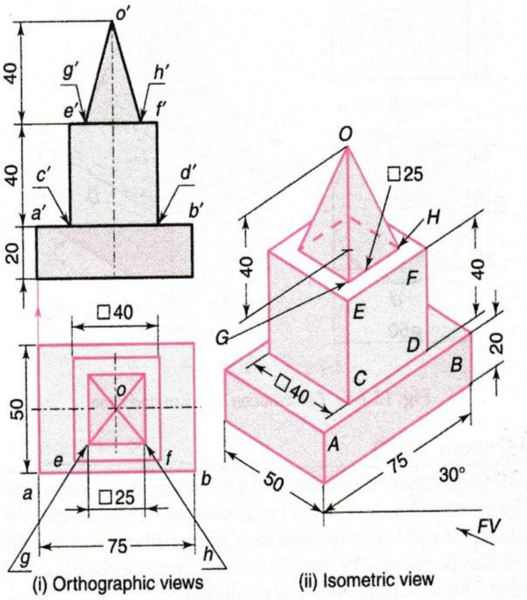


Fig. 13.66 *Combination of prisms and a pyramid*

Problem 13.55

A hollow cylinder of inside diameter 40 mm. outside diameter 60 mm and 80 mm long is resting with its axis horizontal on a block 70 mm square and 25 mm thick. Draw an isometric view of this set-up.

Solution Refer Fig. 13.67

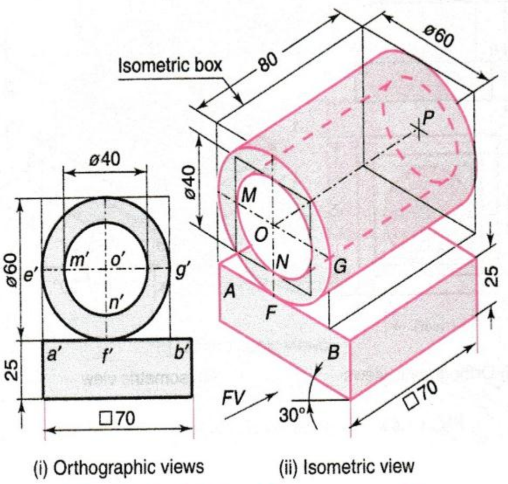


Fig. 13.67 *A hollow cylinder on a square prism*

Problem 13.56

Draw the isometric view of a pentagonal pyramid, side of base 40 mm and height 80 mm which rests base centrally on a cylinder of diameter 120 mm and height 40 mm.

Solution Refer Fig. 13.68

In this case, the top view of the pentagonal pyramid is to be drawn first.

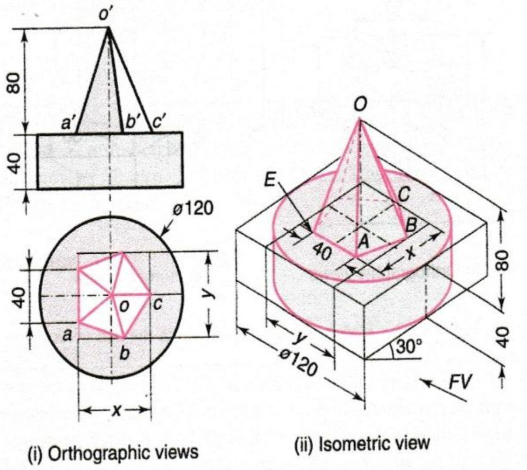


Fig. 13.68 *Combination of cylinder and pyramid*

Problem 13.57

Draw the isometric view of a sphere of diameter 60 mm kept centrally on a square prism side of base 50 mm and height 30 mm.

Solution Refer 13.69

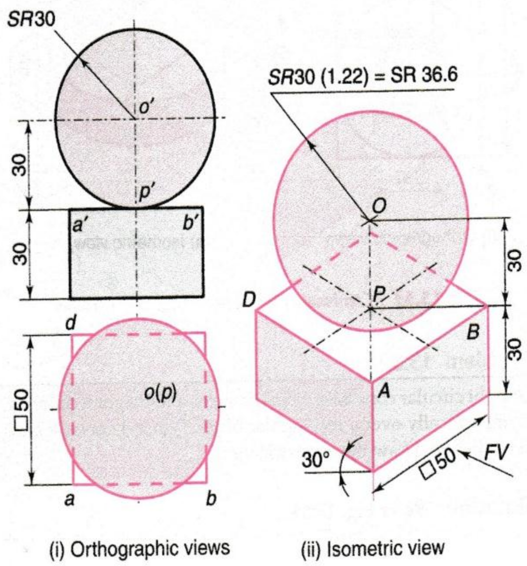


Fig. 13.69 *Sphere on square prism*

blem 13.58

w isometric projection of a sphere 50 mm diameter resting trally on a cube of side 80 mm.

ution Refer Fig. 13.70

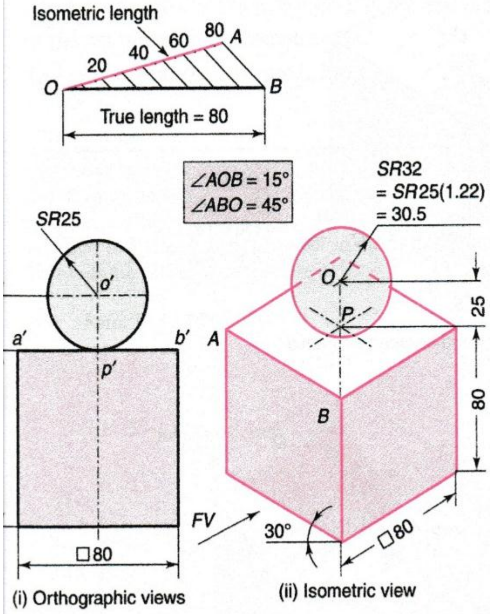


Fig. 13.70 *Sphere on cube*

blem 13.59

ylinder 80 mm base diameter and 120 mm high, is resting its base on H.P. It is surmounted centrally by a sphere of mm diameter. Draw the isometric view of the solids.

lution Refer Fig. 13.71

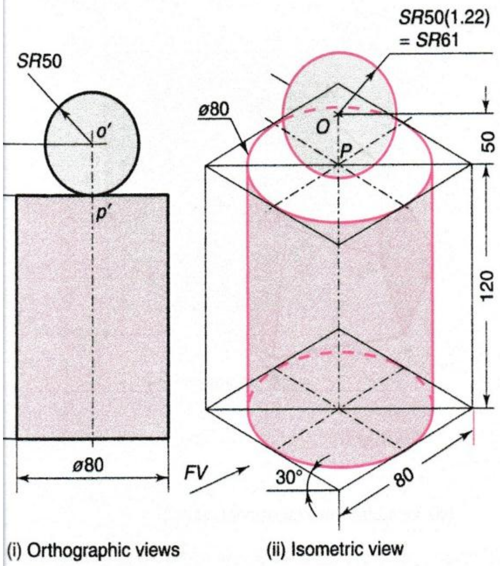


Fig. 13.71 *Sphere on cylinder*

Problem 13.60

Draw the isometric view of the paper weight shown in Fig. 13.72 (i).

Solution Refer Fig. 13.72

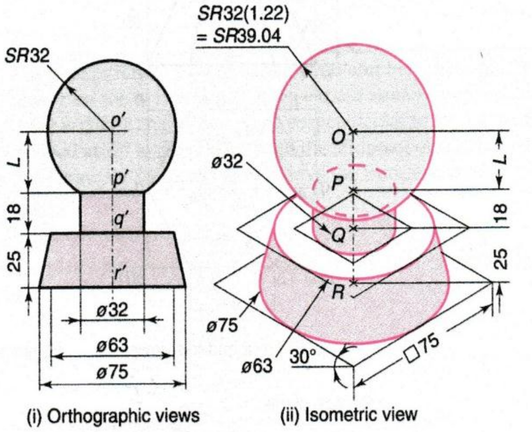


Fig. 13.72 *Paper weight*

13.17 ISOMETRICS OF TRUNCATED SOLIDS

Problem 13.61

Draw the isometric view of a hexagonal pyramid of 35 mm edge of base and height 70 mm resting with its base on H.P. It is truncated by a surface which is inclined at 30° to H.P. and perpendicular to V.P. This plane passes through the mid point of the axis of the pyramid.

Solution Refer Fig. 13.73. Drawing of truncated isometric view of an object is slightly complicated. However, the procedure followed is basically one and the same. A brief explanation is given below:

1. Draw the top and front views of the truncated pyramid as shown in Fig. 13.73 (i).
2. Assume that the pyramid is contained in a box and draw its top and front views and mark the points.
3. Draw the front view of the section plane *p′-p′* and its top view as *p-p-p-p*. Mark the intersection points a_1', a_2', a_3' and a_4' in elevation and corresponding points in the plan.
4. Draw the isometric view of the box together with the isometric view of the base and section plane. Here, *PS* = *p′s′* and *PR* = *p′r′*. Also, mark *Q-Q*.
5. Draw lines 1-1, 2-2, 3-3 and 4-4 passing through the points a_1, a_2, a_3 and a_4 in the top view. Transfer these points 1, 2, 3 and 4 to the line SR in the isometric view. Now, draw perpendiculars through these points and obtain the horizontal lines 1-1, 2-2 etc. on the cutting plane.
6. Locate the points A_1, A_2 etc. taking 1-A_1 = 1-a_1, 2-A_2 = 2-a_2 etc. respectively. Join this points to get truncated surface.

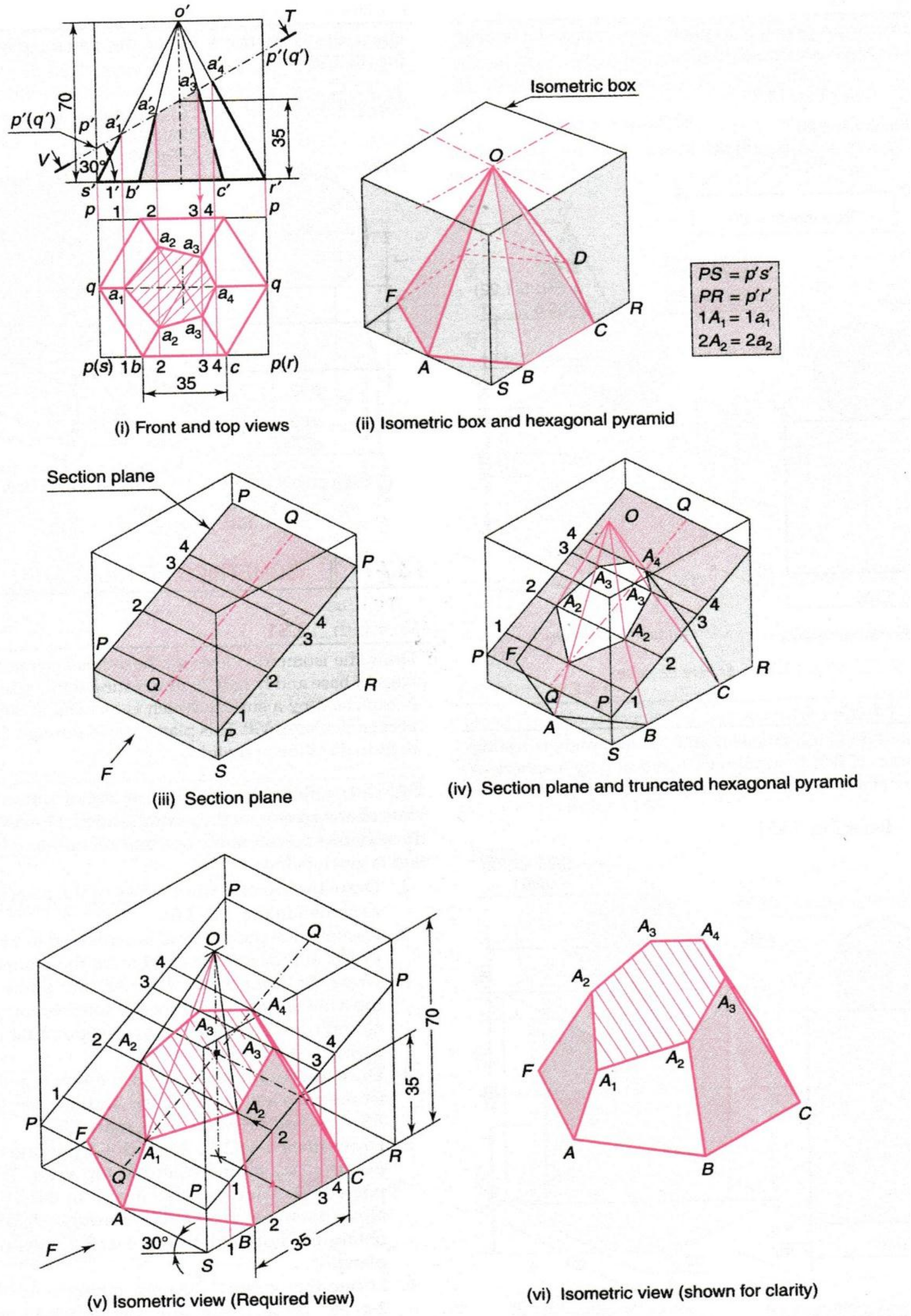


Fig. 13.73 *Isometric view of a truncated hexagonal pyramid (step-by-step drawing procedure)*

7. Join the slant edges as shown to obtain the required view of the truncated prism.

Note

1. If the slant edges are extended it will meet at point O which is the apex of the pyramid. It is the mid point of the top plane of the isometric box.
2. The truncated surface is shown hatched.

Problem 13.62

Draw the isometric view of bottom portion of cone of base diameter 50 mm and height 80 mm resting on its base in the H.P. and axis parallel to V.P. when it is cut by a cutting plane perpendicular to V.P. and inclined at 30° to the H.P. The cutting plane cuts the axis at 40 mm above its base.

Solution Refer Fig. 13.74

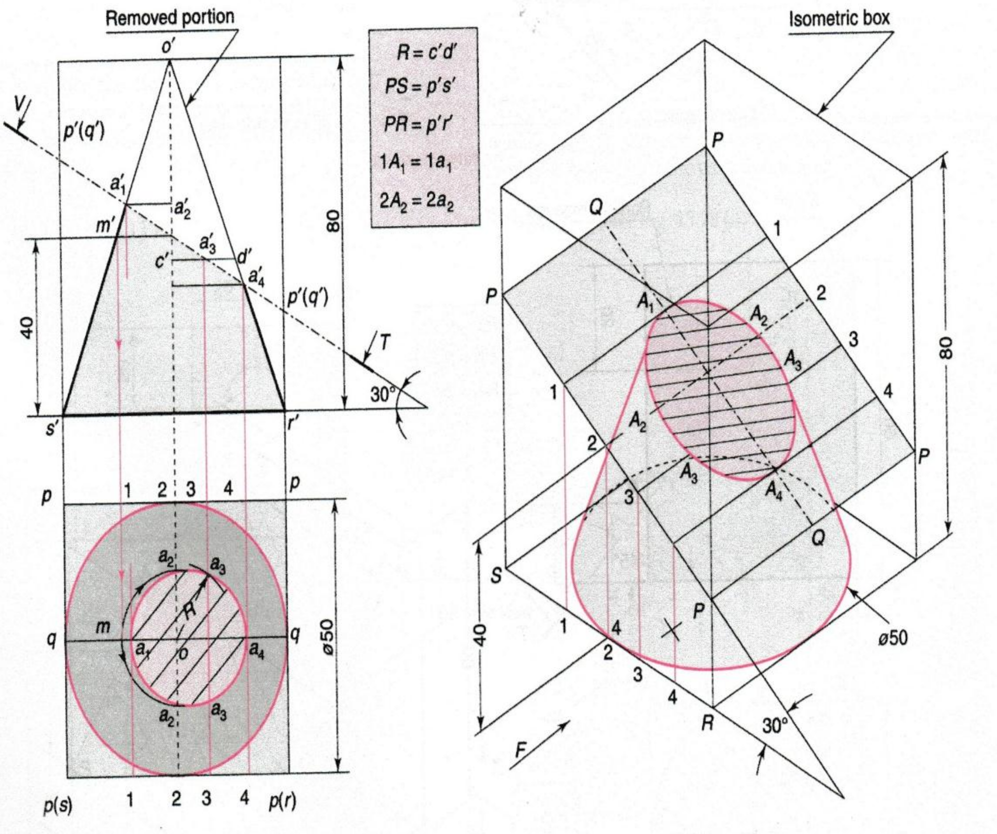
Points a_2' and a_3' can be located any where on the line $a_1'\,a_4'$. Note, how the points a_2 and a_3 are located in the top view. The line mm' is drawn vertically downwards and a semicircle $a_2\,m\,a_2$ is drawn with centre o to locate a_2 and a_2 one above and the other below.

Problem 13.63

A square pyramid, side of base 35 mm and height 70 mm, is resting on the H.P. with the sides of base equally inclined to V.P. It is cut by an inclined plane perpendicular to the V.P. and inclined at 30° to the H.P. through the midpoint of the vertical axis. Draw the isometric projection of the truncated pyramid.

Solution Refer Fig. 13.75

The procedure explained in Prob. 13.61 may be followed here.



(i) Orthographic views

(ii) Isometric view

Fig. 13.74 *Truncated cone with the axis vertical*

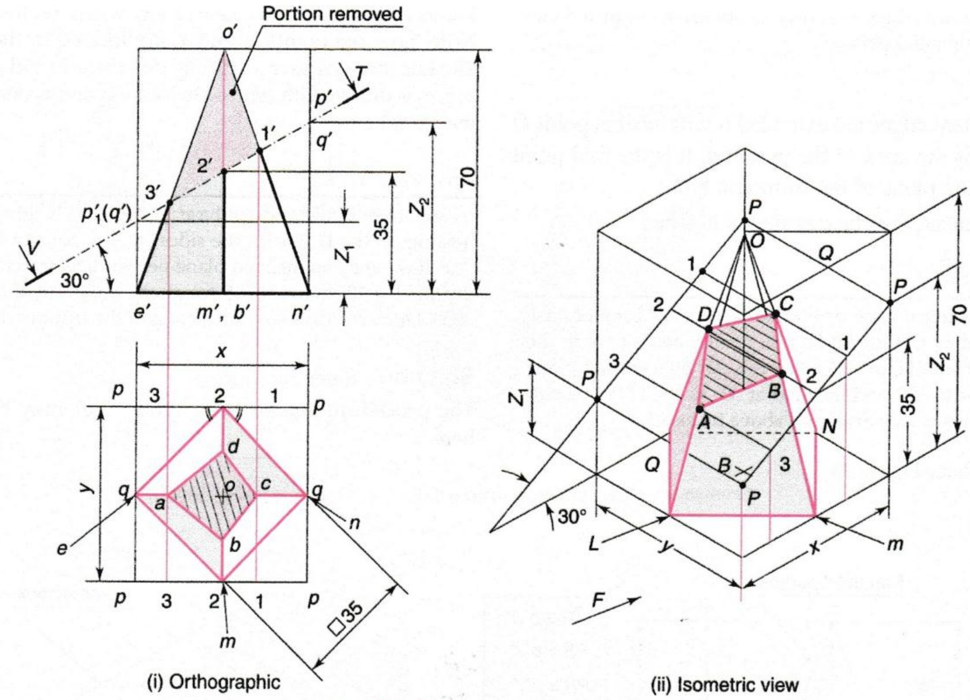


Fig. 13.75 *Truncated square pyramid*

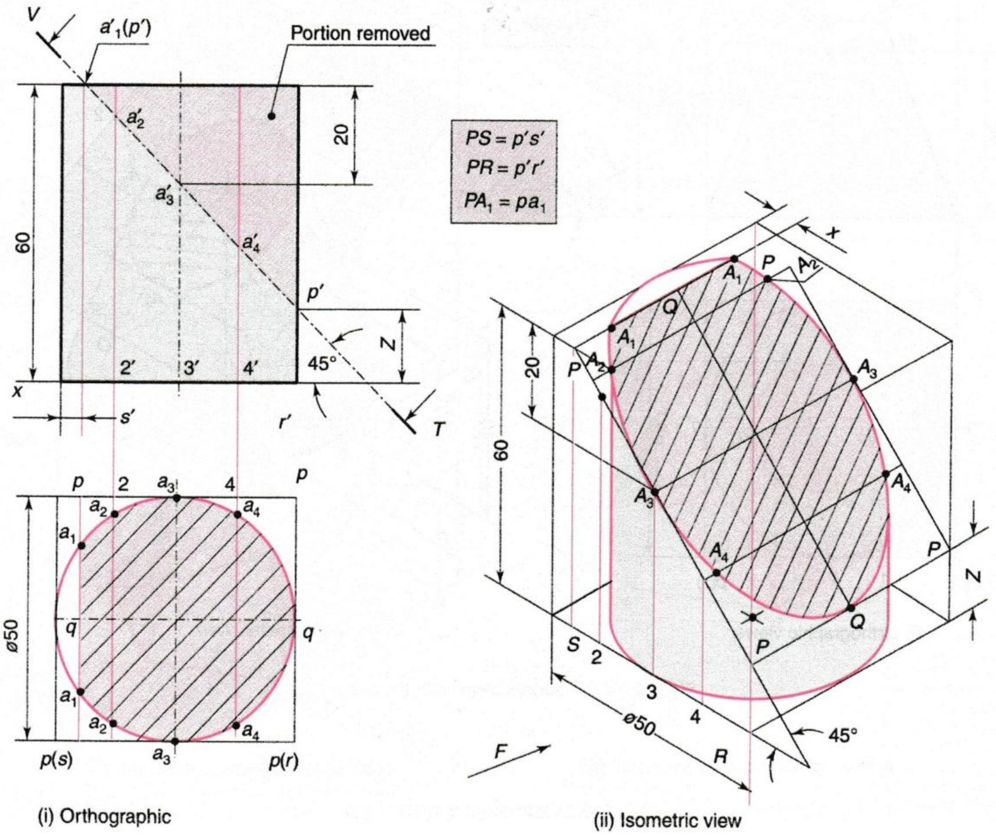


Fig. 13.76 *Truncated cylinder*

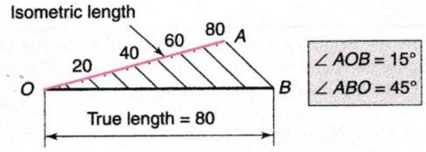
Problem 13.64

A cylinder of height 60 mm and diameter 50 mm is resting on one of its ends on the H.P. It is cut by a plane perpendicular to the V.P. and inclined at 45° to the H.P. The plane passes through a point on the axis located at 20 mm from the top. Draw the isometric view of the cut cylinder.

Solution Refer Fig. 13.76. (See page 13.34)

The procedure explained in Prob. 13.61 may be followed with suitable modifications. In this case the section plane is not cutting the cylinder fully.

It may be noted that the portion to the left of *AA* is not cut and hence this portion is not shown hatched while the cut portion which is on the right hand side of the *AA* is shown hatched. In the isometric view the direction of viewing should be clearly indicated.



13.18 MORE SOLVED PROBLEMS

Problem 13.65

A rivet head has the shape of a hemisphere of diameter 64 mm and it is placed centrally over a cylindrical shank of diameter 40 mm and height 80 mm. Draw the isometric projection of the rivet.

Solution Refer Fig. 13.77

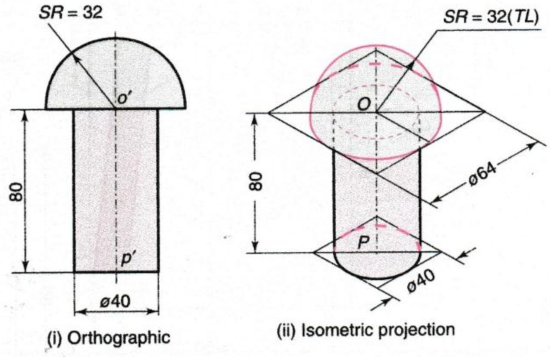


Fig. 13.77 *Rivet*

Problem 13.66

Figure 13.78 (i) shows the orthographic projections of a cast iron box. Draw isometric view to full scale.

Solution Refer Fig. 13.78 (ii)

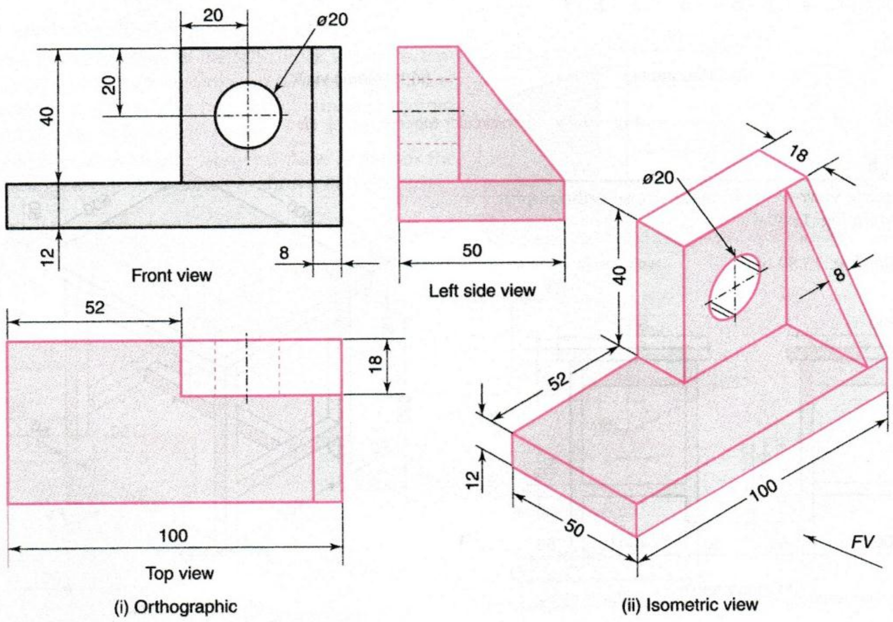
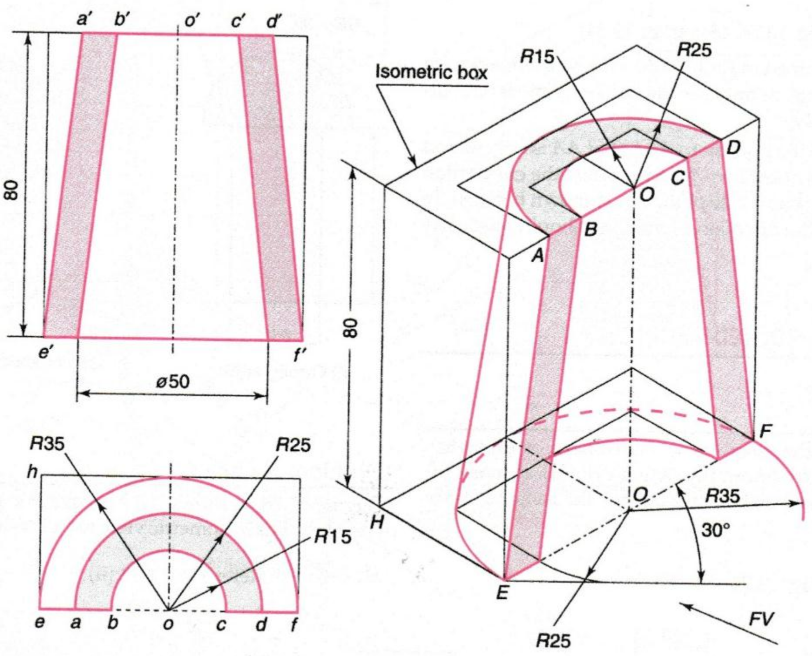


Fig. 13.78 *Cast iron block*

Problem 13.67

Draw the isometric view of a semicircular roofing tile 80 mm long inside diameter 50 mm at one end and 30 mm at the other end. Thickness of the tile is 10 mm.

Solution Refer Fig. 13.79



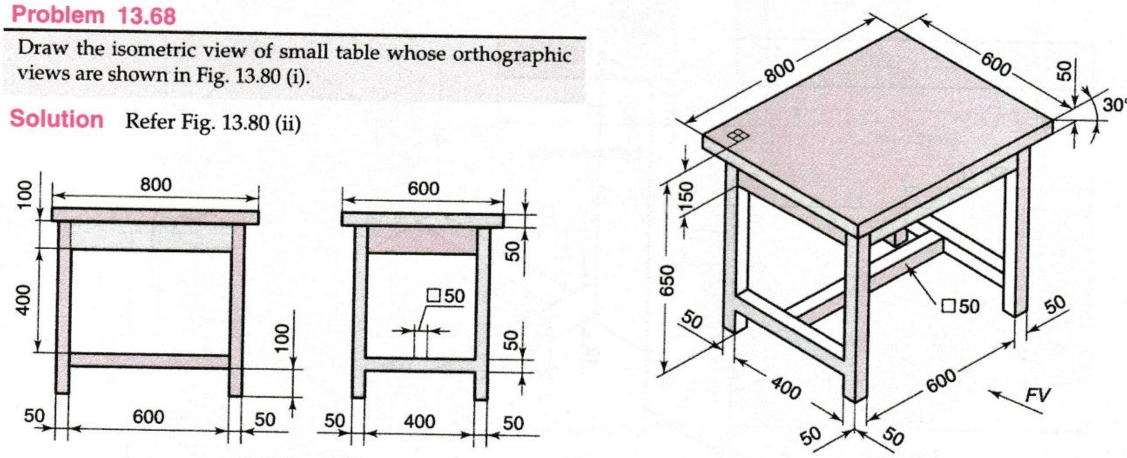
(i) Orthographic (ii) Isometric view

Fig. 13.79 *Semicircular tapered roofing tile*

Problem 13.68

Draw the isometric view of small table whose orthographic views are shown in Fig. 13.80 (i).

Solution Refer Fig. 13.80 (ii)



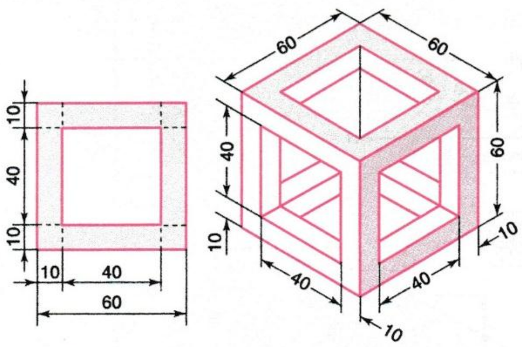
(i) Orthographic (ii) Isometric view

Fig. 13.80 *Table*

Problem 13.69

The Fig. 13.81 (i) represents a typical frame having the same view in X, Y, and Z directions. Visualize the objects and draw the isometric view of it.

Solution Refer Fig. 13.81 (ii)



(i) Orthographic (ii) Isometric view

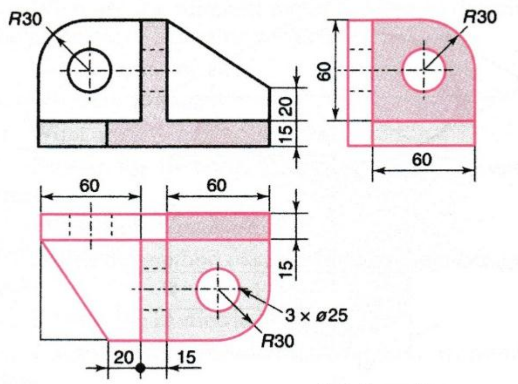
Fig. 13.81 *Typical frame having the same view in X, Y and Z directions*

Problem 13.70

Three views of a M.S. block is shown in Fig. 13.82 (i). Draw its isometric view.

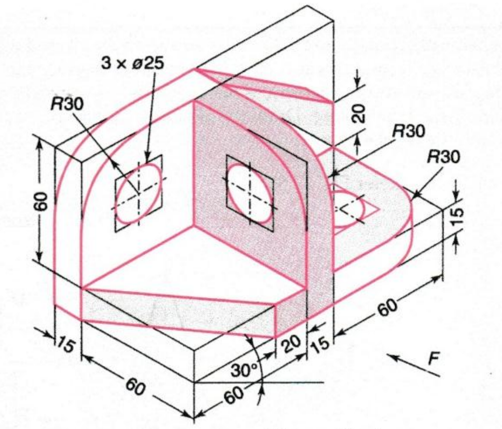
Solution Refer Fig. 13.83

1. Enclose the three views of the M.S. block within rectangles to represent the three adjacent faces of a box. Draw the isometric view of this box and obtain the required isometric view as described earlier.
2. Even without drawing the isometric view of the box the required view can be obtained as shown in the figure.



(i) Orthographic

Fig. 13.82 *M.S. block*



(ii) Isometric view

Fig. 13.83 *M.S. block*

Problem 13.71

Orthographic views of a machine element is shown in Fig. 13.84 (i). Draw the isometric projection. Dimension should be marked on the isometric projection as per Indian Standard Codes. Indicate clearly the direction of the viewing of the machine element.

Solution Refer Fig. 13.84 (ii)

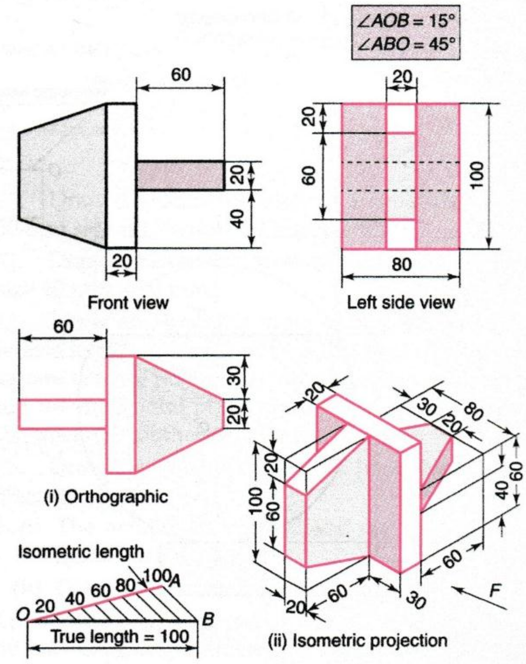


Fig. 13.84 (ii) *Machine element*

Problem 13.72

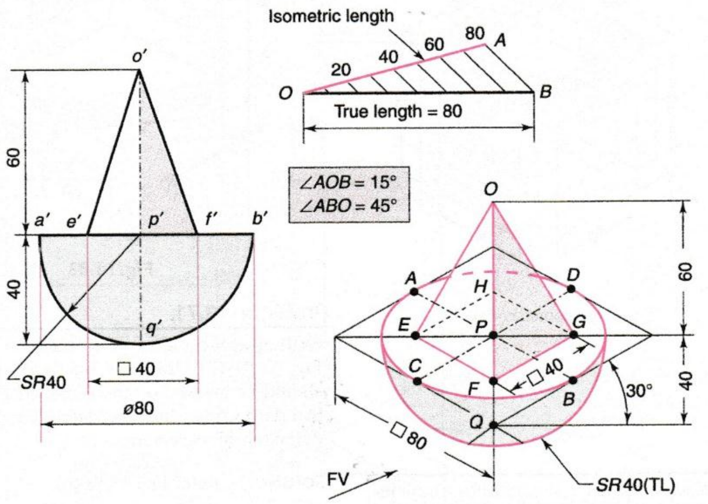
A hemisphere of diameter 80 mm is resting on the ground with its surface facing upwards. A square pyramid having side of base 40 mm and axis 60 mm, is resting on its base centrally on top of the hemisphere. Draw the isometric projection of the combination of solids.

Solution Refer Fig. 13.85

Problem 13.73

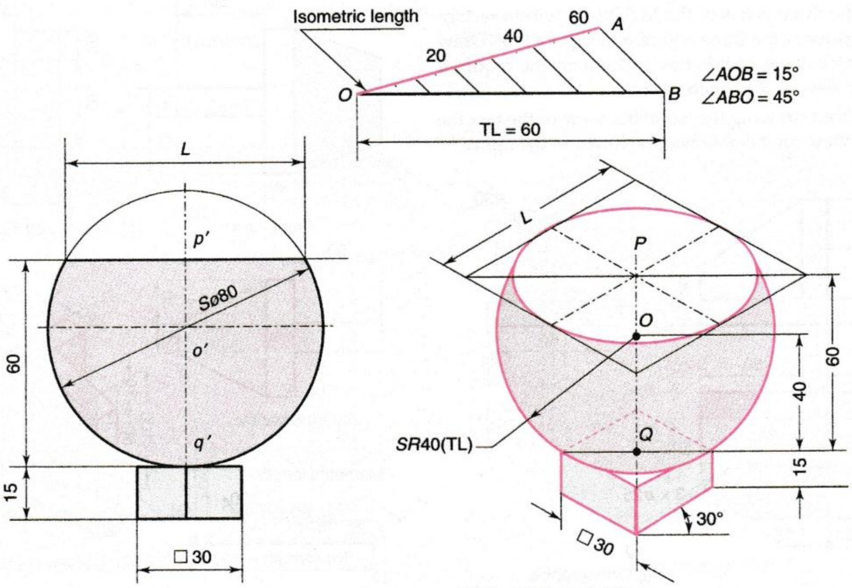
A sphere 80 mm diameter is cut horizontally by plane such that 20 mm of its diameter is cut and removed. The remaining part stands centrally on a square plate 30 mm × 30 mm and thickness 15 mm. Draw the isometric projection of combination, if the sphere remains with its flat surface up.

Solution Refer Fig. 13.86



(i) Orthographic (ii) Isometric projection

Fig. 13.85 *A square pyramid on a hemisphere*



(i) Orthographic (ii) Isometric projection

Fig. 13.86 *Portion of a sphere on square prism*