Chapter 8

ORTHOGRAPHIC PROJECTION

8-0. INTRODUCTION

Practical solid geometry or *descriptive geometry* deals with the representation of points, lines, planes and solids on a flat surface (such as a sheet of paper), in such a manner that their relative positions and true forms can be accurately determined.

8-1. PRINCIPLE OF PROJECTION

If straight lines are drawn from various points on the contour of an object to meet a plane, the object is said to be projected on that plane. The figure formed by joining, in correct sequence, the points at which these lines meet the plane, is called the *projection* of the object. The lines from the object to the plane are called *projectors*.

8-2. METHODS OF PROJECTION

In engineering drawing following *four* methods of projection are commonly used, they are:

(1) Orthographic projection
(2) Isometric projection
(3) Oblique projection
(4) Perspective projection.

In the above methods (2), (3) and (4) represent the object by a pictorial view as eyes see it. In these methods of projection a three dimensional object is represented on a projection plane by one view only. While in the orthographic projection an object is represented by two or three views on the mutual perpendicular projection planes. Each projection view represents two dimensions of an object. For the complete description of the three dimensional object at least *two* or *three* views are required.

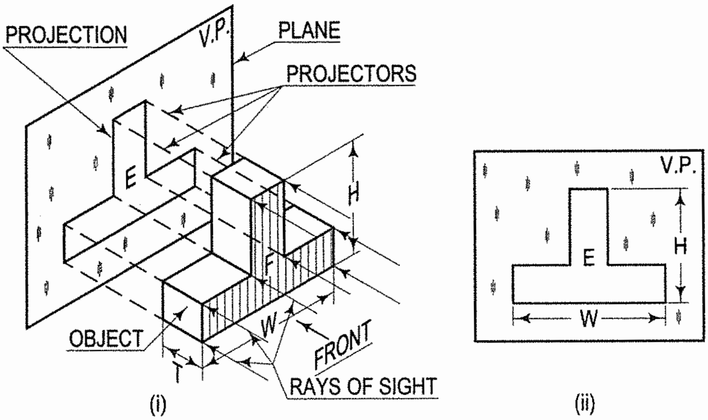
8-3. ORTHOGRAPHIC PROJECTION

When the projectors are parallel to each other and also perpendicular to the plane, the projection is called *orthographic projection*.

Step 1: Imagine that a person looks at the block [fig. 8-1(i)] from a theoretically infinite distance, so that the rays of sight from his eyes are parallel to one another and perpendicular to the front surface *F*. The view of this block will be the shaded figure, showing the front surface of the object in its true shape and proportion.

Step 2: If these rays of sight are extended further to meet perpendicularly a vertical plane (marked V.P.) set up behind the block.

Step 3: The points at which they meet the plane are joined in proper sequence, the resulting figure (marked *E*) will also be exactly similar to the front surface and this is known as *an elevation or front-view*. This figure is the projection of the block. *The lines from the block to the plane are the projectors.* As the projectors are perpendicular to the plane on which the projection is obtained, it is the orthographic projection. The projection is shown separately in fig. 8-1(ii). It shows only two dimensions of the block viz. the height *H* and the width *W*. It does not show the thickness. Thus, we find that only one projection is insufficient for complete description of the block.



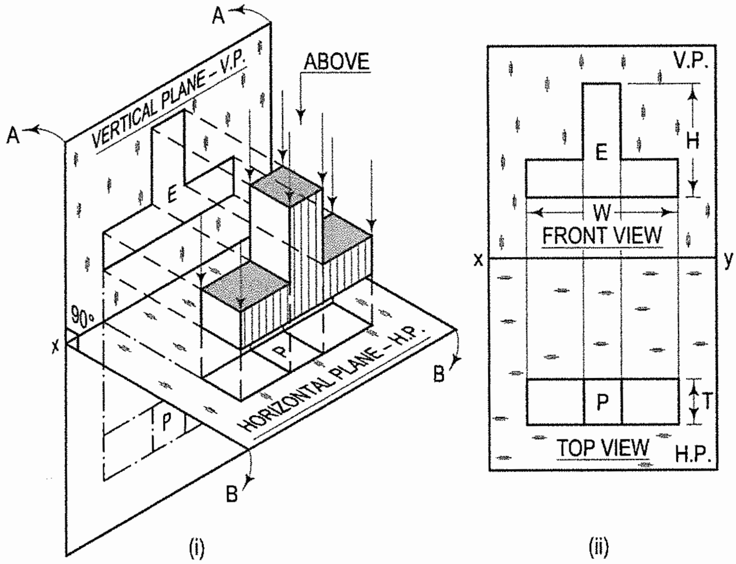


FIG. 8-2

Let us further assume that another plane marked H.P. (horizontal plane) [fig. 8-2(i)] is hinged at right angles to the first plane, so that the block is in front of the V.P. and above the H.P. The projection on the H.P. (figure *P*) shows the top surfaces of the block. If a person looks at the block from above, he will obtain the same view as the figure *P* and is known as a *plan* or *top-view*. It shows the width *W* and the thickness *T* of the block. It however does not show the height of the block.

One of the planes is now rotated or turned around on the hinges so that it lies in extension of the other plane. This can be done in *two* ways:

(i) by turning the V.P. in direction of arrows *A*

(ii) by turning the H.P. in direction of arrows *B*.

The H.P. when turned and brought in line with the V.P. is shown by dashed lines. The two projections can now be drawn on a flat sheet of paper, in correct relationship with each other, as shown in fig. 8-2(ii).

When studied together, they supply all information regarding the shape and the size of the block. Any solid may thus be represented by means of orthographic projections or orthographic views.

8-4. PLANES OF PROJECTION

The two planes employed for the purpose of orthographic projections are called *reference planes or principal planes of projection*. They intersect each other at right angles. The *vertical plane* of projection (in front of the observer) is usually denoted by the letters V.P. It is often called the *frontal plane* and denoted by the letters F.P.

The other plane is the *horizontal plane* of projection known as the H.P. The line in which they intersect is termed the *reference line* and is denoted by the letters *xy*. The projection on the V.P. is called the *front view* or the *elevation* of the object. The projection on the H.P. is called the *top view* or the *plan*.

8-5. FOUR QUADRANTS

When the planes of projection are extended beyond the line of intersection, they form four quadrants or dihedral angles which may be numbered as in fig. 8-3. The object may be situated in any one of the quadrants, its position relative to the planes being described as "*above or below the H.P.*" and "*in front of or behind the V.P.*"

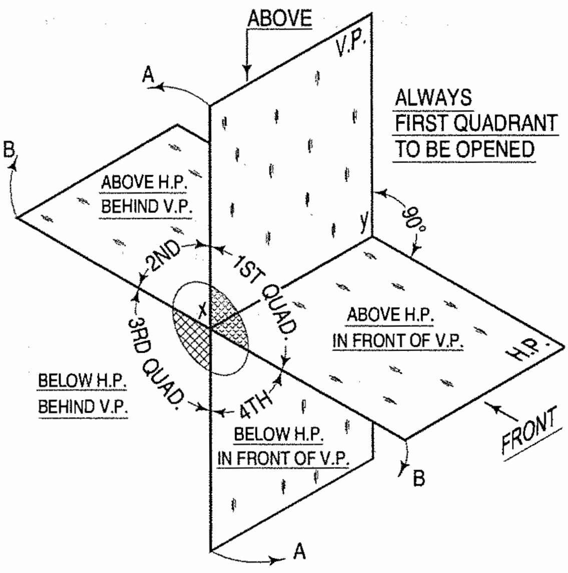


FIG. 8-3

The planes are assumed to be transparent. The projections are obtained by drawing perpendiculars from the object to the planes, i.e. by looking from the front and from above. They are then shown on a flat surface by rotating one of the planes as already explained. *It should be remembered that the first and the third quadrants are always opened out while rotating the planes.* The positions of the views with respect to the reference line will change according to the quadrant in which the object may be situated. This has been explained in detail in the next chapter.

8-6. FIRST-ANGLE PROJECTION

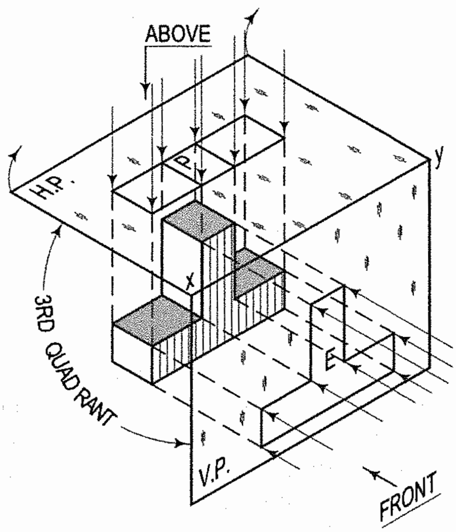
We have assumed the object to be situated in front of the V.P. and above the H.P. i.e. in the first quadrant and then projected it on these planes. This method of projection is known as *first-angle projection method*. The object lies between the observer and the plane of projection. In this method, when the views are drawn in their relative positions, the top view comes below the front view. In other words, the view seen from above is placed on the other side of (i.e. below) the front view. Each projection shows the view of that surface (of the object) which is remote from the plane on which it is projected and which is nearest to the observer.

TABLE 8-1
DIFFERENCE BETWEEN FIRST-ANGLE PROJECTION METHOD AND THIRD-ANGLE PROJECTION METHOD

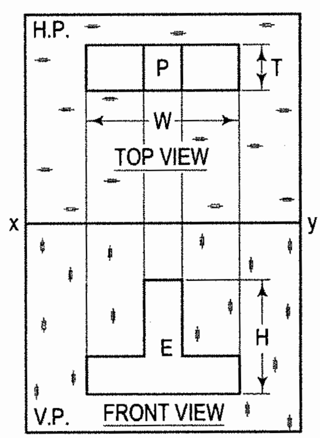
No.	First-angle projection method	Third-angle projection method
1.	The object is kept in the *first quadrant*.	The object is assumed to be kept in the *third quadrant*.
2.	The object lies between the observer and the plane of projection.	The plane of projection lies between the observer and the object.
3.	The plane of projection is assumed to be non-transparent.	The plane of projection is assumed to be *transparent*.
4.	In this method, when the views are drawn in their relative positions, the *plan* comes *below* the *elevation*, the view of the object as observed from the *left-side* is drawn to the *right of elevation*.	In this method, when the views are drawn in their relative positions, the *plan*, comes *above* the elevation, *left hand side view* is drawn to the *left hand side of the elevation*.
5.	This method of projection is now recommended by the "Bureau of Indian Standards' from 1991.	This method of projection is used in U.S.A. and also in other countries.

8-7. THIRD-ANGLE PROJECTION

In this method of projection, the object is assumed to be situated in the third quadrant [fig. 8-4(i)]. The planes of projection are assumed to be transparent. They lie between the object and the observer. When the observer views the object from the front, the rays of sight intersect the V.P. The figure formed by joining the points of intersection in correct sequence is the front view of the object. The top view is obtained in a similar manner by looking from above. When the two planes are brought in line with each other, the views will be seen as shown in fig. 8-4(ii). The top view in this case comes above the front view.



(i)



(ii)

FIG. 8-4

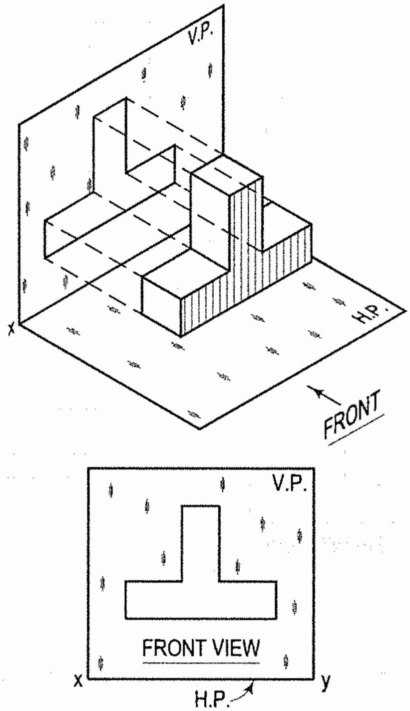
In other words, the view seen from above the object is placed on the same side of (i.e. above) the front view.

Each projection shows the view of that surface (of the object) which is nearest to the plane on which it is projected.

On comparison, it is quite evident that the views obtained by the two methods of projection are completely identical in shape, size and all other details. The difference lies in their relative positions only.

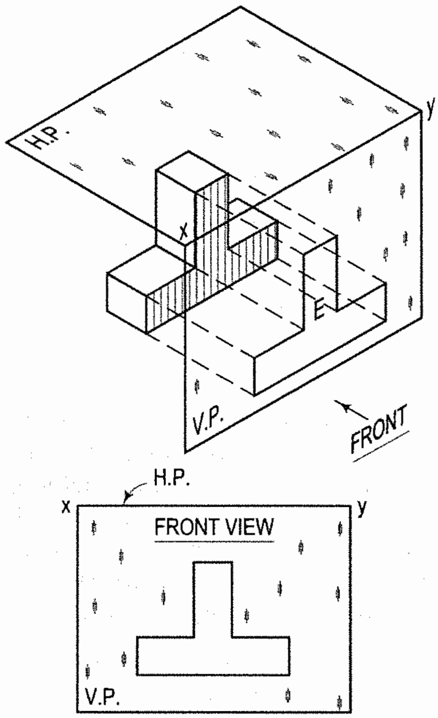
8-8. REFERENCE LINE

Studying the projections independently, it can be seen that while considering the front view (fig. 8-5 and fig. 8-6), which is the view as seen from the front, the H.P. coincides with the line *xy*. In other words, *xy* represents the H.P.



FIRST-ANGLE PROJECTION

FIG. 8-5

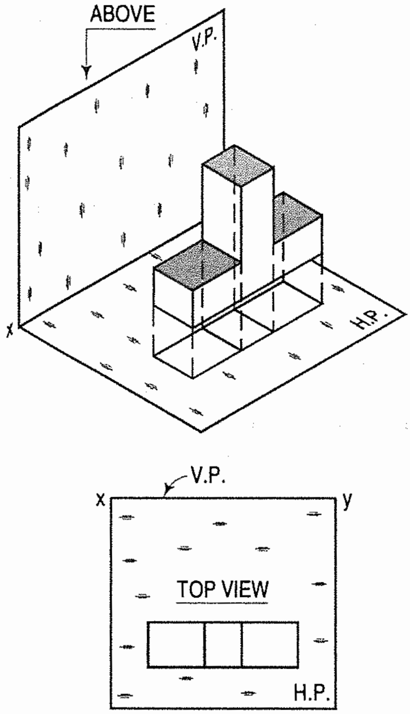


THIRD-ANGLE PROJECTION

FIG. 8-6

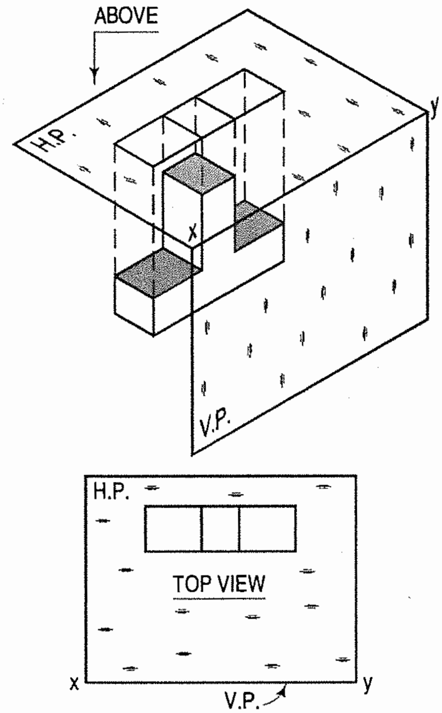
Similarly, while considering the top view (fig. 8-7 and fig 8-8), which is the view obtained by looking from above, the same line *xy* represents the V.P. Hence, when the two projections are drawn in correct relationship with each other (fig. 8-9), *xy* represents both the H.P. and the V.P. This line *xy* is called the *reference line*. The squares or rectangles for individual planes are thus unnecessary and are therefore discarded.

Further, in first-angle projection method, the H.P. is always assumed to be so placed as to coincide with the ground on or above which the object is situated. Hence, in this method, the line *xy* is also the line for the ground.



FIRST-ANGLE PROJECTION

FIG. 8-7

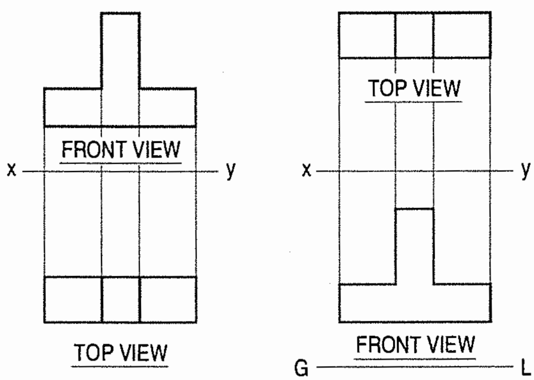


THIRD-ANGLE PROJECTION

FIG. 8-8

In third-angle projection method, the H.P. is assumed to be placed above the object. The object may be situated on or above the ground. Hence, in this method, the line *xy* does not represent the ground. The line for the ground, denoted by letters GL, may be drawn parallel to *xy* and below the front view [fig. 8-9(ii)].

In brief, when an object is situated on the ground, in first-angle projection method, the bottom of its front view will coincide with xy; in third-angle projection method, it will coincide with GL, while xy will be above the front view and parallel to Ground line.



(i) (ii)

FIG. 8-9

Symbols for methods of projection: For every drawing it is absolutely essential to indicate the method of projection adopted. This is done by means of a symbolic figure drawn within the title block on the drawing sheet.

The symbolic figure for the first-angle projection method is shown in fig. 8-10, while that for the third-angle projection method is shown in fig. 8-11 which are self expanatory. These symbolic figures are actually the projections of a frustum of cone of convenient dimensions according to the size of drawing.

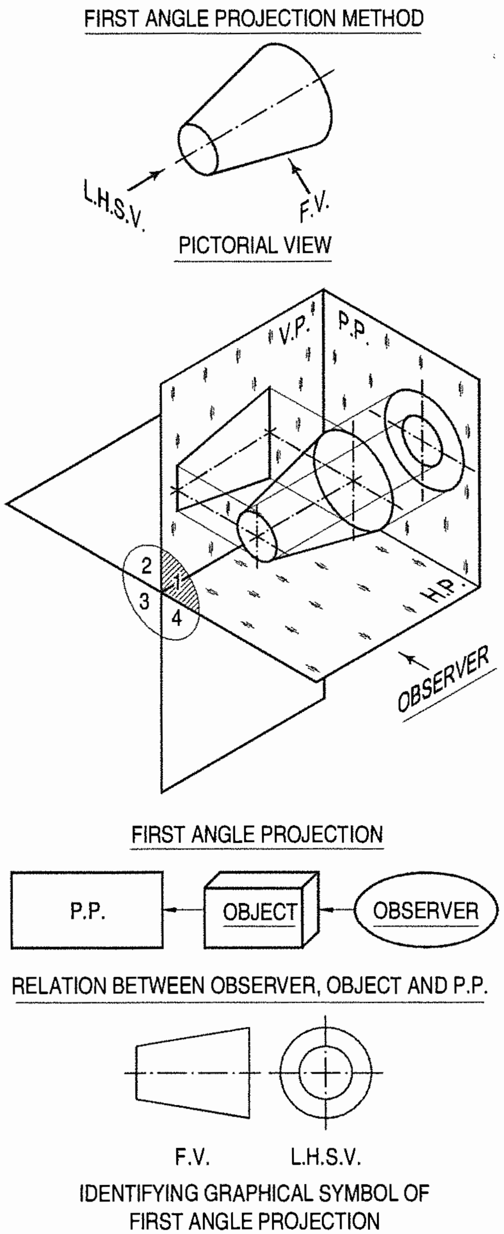


FIG. 8-10

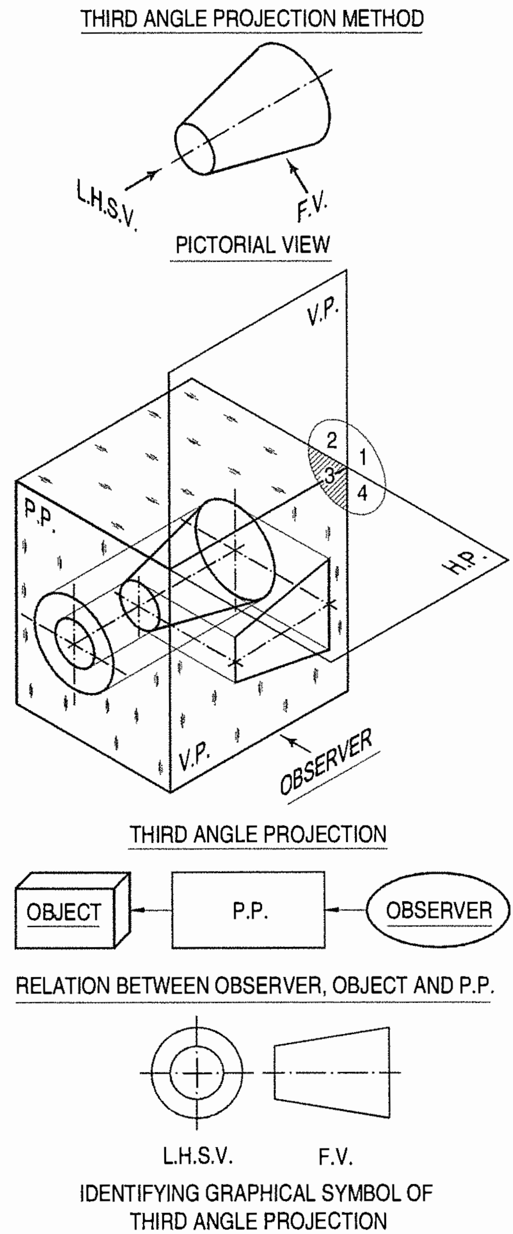


FIG. 8-11

Six views of an Object: There are *three* important elements of this projection system, namely

(a) an object

(b) plane of projection

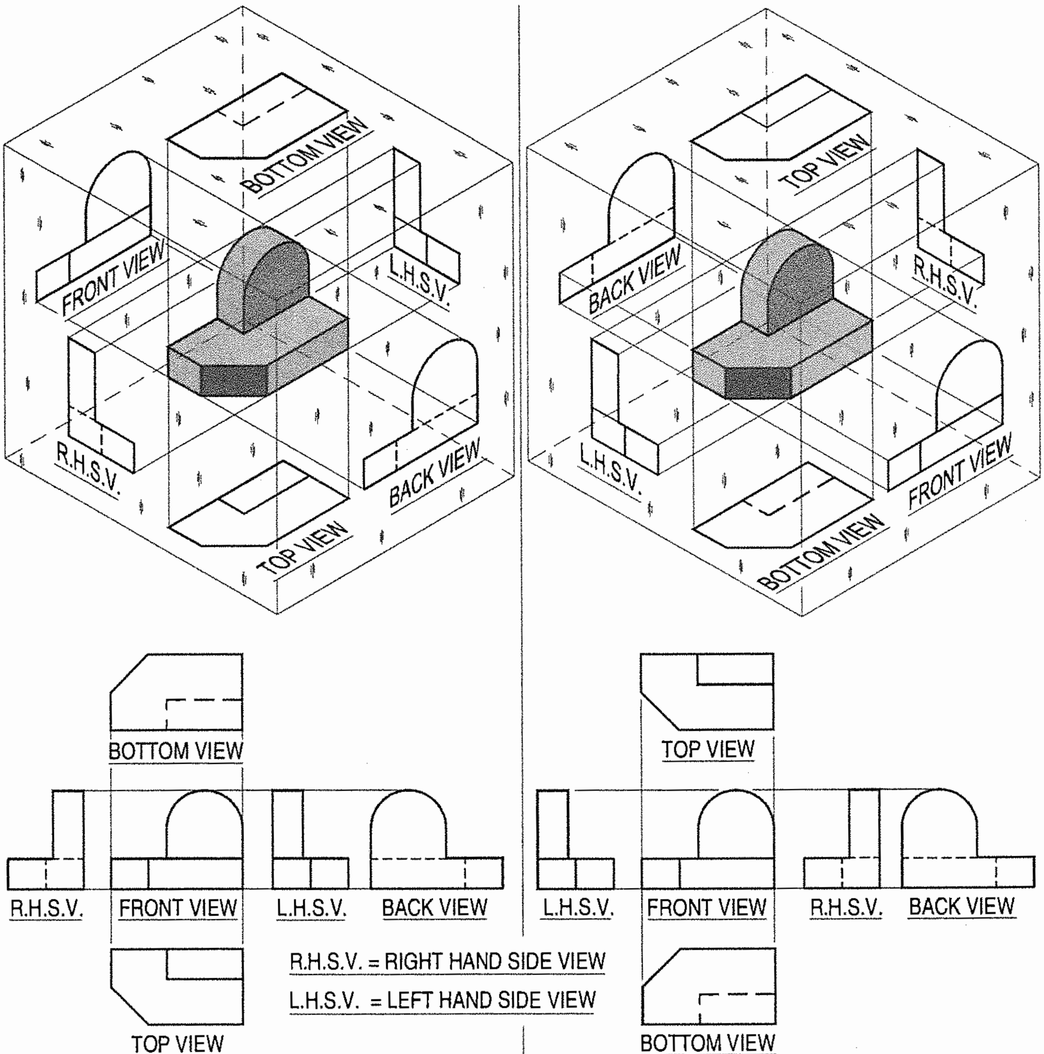
(c) an observer.

Very often, two views are not sufficient to describe an object completely. The planes of projection being imaginary, following six views are obtained:

(1) Front view
(2) Top view
(3) Left hand side view
(4) Right hand side view
(5) Back view
(6) Bottom view

These projections are shown projected on the respective planes, placed by the methods of first-angle projection and third-angle projection as shown in fig. 8-12 and fig. 8-13 respectively.

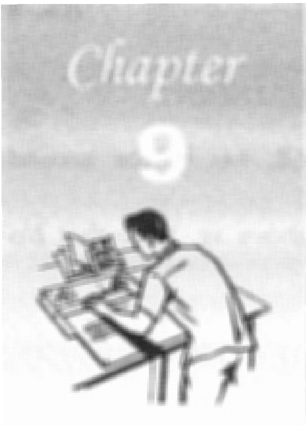
Ordinarily, two views — the front view and top view are shown. Two other views i.e. L.H.S.V. or R.H.S.V. may be required to describe an object completely. Only in exceptional cases, when an object is of a very complex nature, five or six views may be found necessary.



FIRST ANGLE PROJECTION
FIG. 8-12

THIRD ANGLE PROJECTION
FIG. 8-13

Chapter 9



PROJECTIONS OF POINTS

9-0. INTRODUCTION

A point may be situated, in space, in any one of the four quadrants formed by the two principal planes of projection or may lie in any one or both of them. Its projections are obtained by extending projectors perpendicular to the planes.

One of the planes is then rotated so that the first and third quadrants are opened out. The projections are shown on a flat surface in their respective positions either above or below or in *xy*.

CHAROTAR COGNIFRONT

This book is accompanied by a computer CD, which contains an audiovisual animation presented for better visualization and understanding of the subject. Readers are requested to refer Presentation module 21 for the projections of points.

9-1. A POINT IS SITUATED IN THE FIRST QUADRANT

The pictorial view [fig. 9-1(i)] shows a point *A* situated above the H.P. and in front of the V.P., i.e. in the first quadrant. *a*' is its front view and *a* the top view. After rotation of the plane, these projections will be seen as shown in fig. 9-1(ii).

The front view *a*' is above *xy* and the top view *a* below it. The line joining *a*' and *a* (which also is called a projector), intersects *xy* at right angles at a point *o*. It is quite evident from the pictorial view that *a'o* = *Aa*, i.e. the distance of the front view from *xy* = the distance of *A* from the H.P. viz. *h*. Similarly, *ao* = *Aa*', i.e. the distance of the top view from *xy* = the distance of *A* from the V.P. viz. *d*.

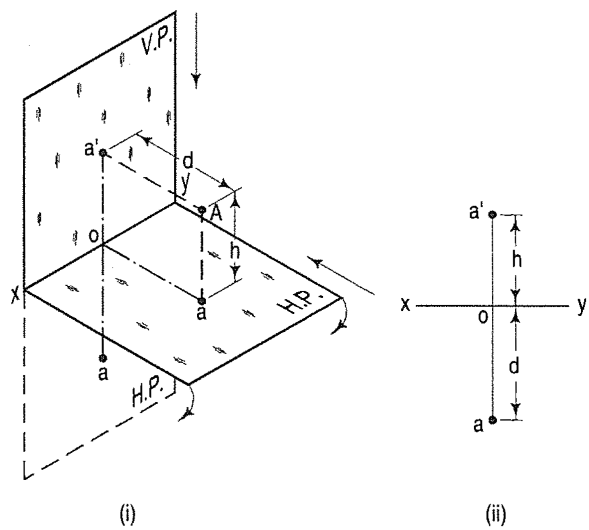


FIG. 9-1

9-2. A POINT IS SITUATED IN THE SECOND QUADRANT

A point *B* (fig. 9-2) is above the H.P. and behind the V.P., i.e. in the second quadrant. *b*' is the front view and *b* the top view.

When the planes are rotated, both the views are seen above *xy*. Note that *b'o* = *Bb* and *bo* = *Bb*'.

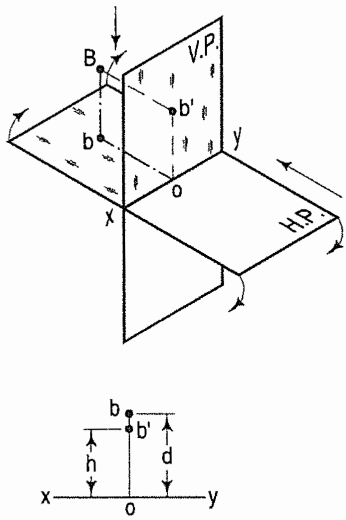


FIG. 9-2

9-3. A POINT IS SITUATED IN THE THIRD QUADRANT

A point *C* (fig. 9-3) is below the H.P. and behind the V.P., i.e. in the third quadrant. Its front view *c*' is below *xy* and the top view *c* above *xy*. Also *c'o* = *Cc* and *co* = *Cc*'.

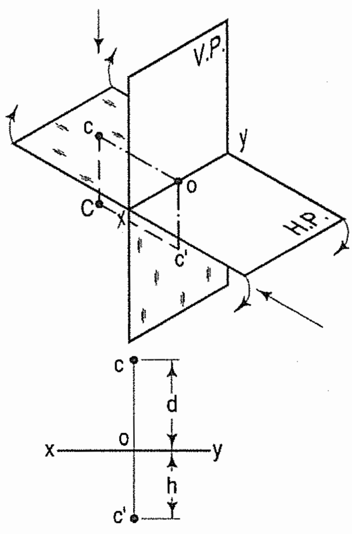


FIG. 9-3

9-4. A POINT IS SITUATED IN THE FOURTH QUADRANT

A point *E* (fig. 9-4) is below the H.P. and in front of the V.P., i.e. in the fourth quadrant. Both its projections are below *xy*, and *e'o* = *Ee* and *eo* = *Ee'*.

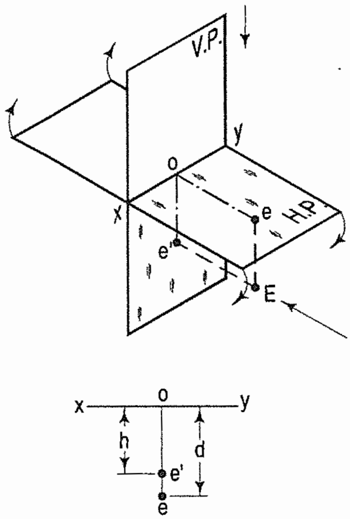


FIG. 9-4

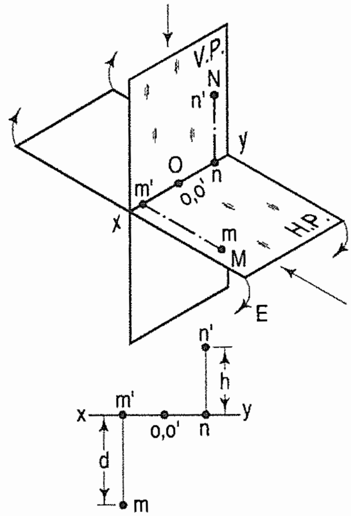


FIG. 9-5

Referring to fig. 9-5, we see that,

(i) A point *M* is in the H.P. and in front of the V.P. Its front view *m'* is in *xy* and the top view *m* below it.

(ii) A point *N* is in the V.P. and above the H.P. Its top view *n* is in *xy* and the front view *n'* above it.

(iii) A point *O* is in both the H.P. and the V.P. Its projection *o* and *o'* coincide with each other in *xy*.

9-5. GENERAL CONCLUSIONS

(i) The line joining the top view and the front view of a point is always perpendicular to *xy*. It is called a *projector*.

(ii) When a point is above the H.P., its front view is above *xy*; when it is below the H.P., the front view is below *xy*. The distance of a point from the H.P. is shown by the length of the projector from its front view to *xy*, e.g. *a'o*, *b'o* etc.

(iii) When a point is in front of the V.P., its top view is below *xy*; when it is behind the V.P., the top view is above *xy*. The distance of a point from the V.P. is shown by the length of the projector from its top view to *xy*, e.g. *ao*, *bo* etc.

(iv) When a point is in a reference plane, its projection on the other reference plane is in *xy*.

Problem 9-1. (fig. 9-1): *A point A is 25 mm above the H.P. and 30 mm in front of the V.P. Draw its projections.*

(i) Draw the reference line *xy* [fig. 9-1(ii)].

(ii) Through any point o in it, draw a perpendicular.

As the point is above the H.P. and in front of the V.P. its front view will be above xy and the top view below xy.

(iii) On the perpendicular, mark a point a' above xy, such that $a'o$ = 25 mm. Similarly, mark a point a below xy, so that ao = 30 mm. a' and a are the required projections.

Problem 9-2. (fig. 9-6): *A point A is 20 mm below the H.P. and 30 mm behind the V.P. Draw its projections.*

As the point is below the H.P. and behind the V.P., its front view will be below xy and the top view above xy.

Draw the projections as explained in problem 9-1 and as shown in fig. 9-6.

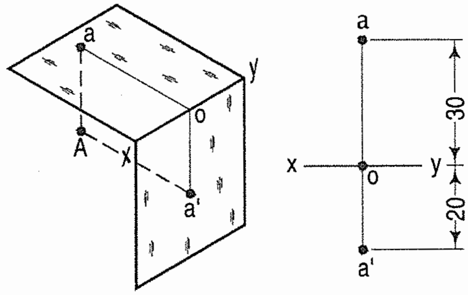


FIG. 9-6

Problem 9-3. (fig. 9-7): *A point P is in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and Auxiliary vertical plane, perpendicular to the H.P. and V.P. is 70 mm and it is equidistant from principal planes (H.P. and V.P.). Draw the projections of the point and determine its distance from the H.P. and V.P.*

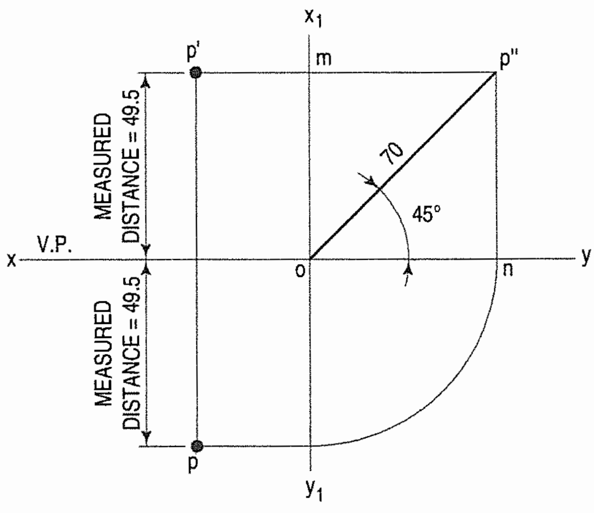


FIG. 9-7

Note: O represents intersection of H.P., V.P. and A.V.P.

(i) Draw xy and $x_1\ y_1$ perpendicular reference lines.

(ii) O represents intersection of H.P., V.P. and A.V.P.

(iii) Draw from O a line inclined at 45° of 70 mm length.

(iv) Project from P'' on xy line and $x_1\ y_1$. The projections are n and m respectively as shown in figure. From O draw arc intersecting $x_1\ y_1$.

(v) Draw a parallel line at convinent distance from $x_1\ y_1$. Extend $P''m$ to intersect a parallel line at p' and p as shown.

(vi) Measure distance from xy line, which is nearly 49.4974 mm say 49.5 mm.

Projections on auxiliary plane: Sometime projections of object on the principal (H.P. and V.P.) are insufficient. In such situation, another projection plane perpendicular to the principal planes is taken. This plane is known as auxiliary plane. The projection on the auxiliary plane is known as side view or side elevation. Refer fig. 9-8.

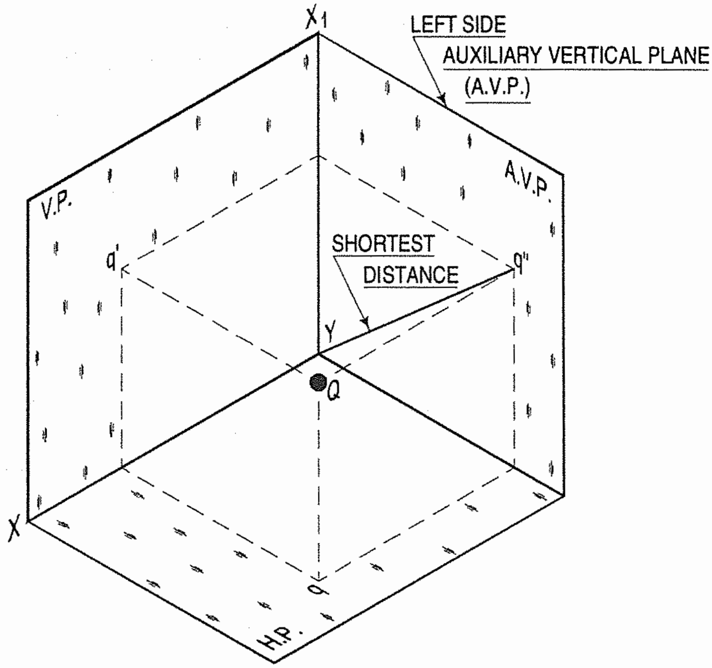


FIG. 9-8

The A.V.P. can be also taken right side also. For more details on projection on auxiliary plane, refer chapter 11.

EXERCISES 9

1. Draw the projections of the following points on the same ground line, keeping the projectors 25 mm apart.

   A, in the H.P. and 20 mm behind the V.P.

   B, 40 mm above the H.P. and 25 mm in front of the V.P.

   C, in the V.P. and 40 mm above the H.P.

   D, 25 mm below the H.P. and 25 mm behind the V.P.

   E, 15 mm above the H.P. and 50 mm behind the V.P.

   F, 40 mm below the H.P. and 25 mm in front of the V.P.

   G, in both the H.P. and the V.P.

2. A point *P* is 50 mm from both the reference planes. Draw its projections in all possible positions.

3. State the quadrants in which the following points are situated:

   (a) A point *P*; its top view is 40 mm above *xy*; the front view, 20 mm below the top view.

   (b) A point *Q*, its projections coincide with each other 40 mm below *xy*.

4. A point *P* is 15 mm above the H.P. and 20 mm in front of the V.P. Another point *Q* is 25 mm behind the V.P. and 40 mm below the H.P. Draw projections of *P* and *Q* keeping the distance between their projectors equal to 90 mm. Draw straight lines joining (i) their top views and (ii) their front views.
5. Projections of various points are given in fig. 9-9. State the position of each point with respect to the planes of projection, giving the distances in centimetres.

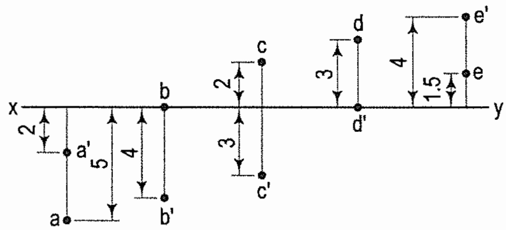


FIG. 9-9

6. Two points *A* and *B* are in the H.P. The point *A* is 30 mm in front of the V.P., while *B* is behind the V.P. The distance between their projectors is 75 mm and the line joining their top views makes an angle of 45° with *xy*. Find the distance of the point *B* from the V.P.
7. A point *P* is 20 mm below H.P. and lies in the third quadrant. Its shortest distance from *xy* is 40 mm. Draw its projections.
8. A point *A* is situated in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and auxiliary plane is 60 mm and it is equidistant from the principal planes. Draw the projections of the point and determine its distance from the principal planes.
9. A point 30 mm above *xy* line is the plan-view of two points *P* and *Q*. The elevation of *P* is 45 mm above the H.P. while that of the point *Q* is 35 mm below the H.P. Draw the projections of the points and state their position with reference to the principal planes and the quadrant in which they lie.
10. A point *Q* is situated in first quadrant. It is 40 mm above H.P. and 30 mm in front of V.P. Draw its projections and find its shortest distance from the intersection of H.P., V.P. and auxiliary plane.

Chapter 10

PROJECTIONS OF STRAIGHT LINES

10-0. INTRODUCTION

A straight line is the shortest distance between two points. Hence, the projections of a straight line may be drawn by joining the respective projections of its ends which are points.

The position of a straight line may also be described with respect to the two reference planes. It may be:

1. Parallel to one or both the planes.
2. Contained by one or both the planes.
3. Perpendicular to one of the planes.
4. Inclined to one plane and parallel to the other.
5. Inclined to both the planes.
6. Projections of lines inclined to both the planes.
7. Line contained by a plane perpendicular to both the reference planes.
8. True length of a straight line and its inclinations with the reference planes.
9. Traces of a line.
10. Methods of determining traces of a line.
11. Traces of a line, the projections of which are perpendicular to xy.
12. Positions of traces of a line.

10-1. LINE PARALLEL TO ONE OR BOTH THE PLANES (FIG. 10-1)

(a) Line *AB* is parallel to the H.P.

a and *b* are the top views of the ends *A* and *B* respectively. It can be clearly seen that the figure *ABba* is a rectangle. Hence, the top view *ab* is equal to *AB*.

a'b' is the front view of *AB* and is parallel to *xy*.

(b) Line *CD* is parallel to the V.P.

The line *c'd'* is the front view and is equal to *CD*; the top view *cd* is parallel to *xy*.

(c) Line *EF* is parallel to the H.P. and the V.P.

ef is the top view and *e'f'* is the front view; both are equal to *EF* and parallel to *xy*.

Hence, when a line is parallel to a plane, its projection on that plane is equal to its true length; while its projection on the other plane is parallel to the reference line.

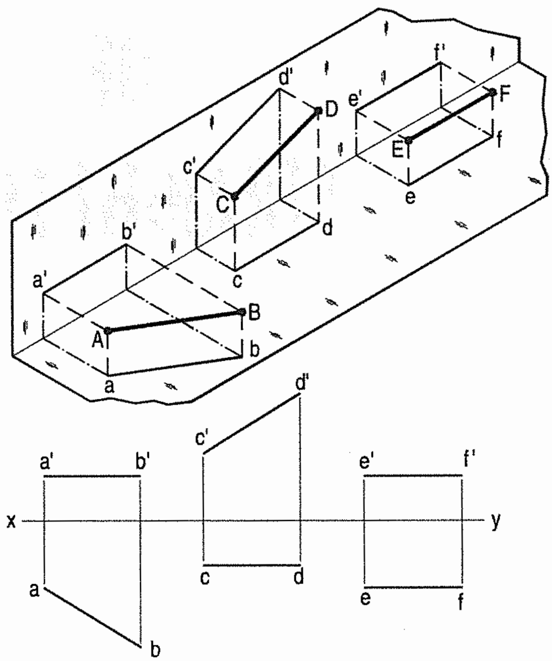


FIG. 10-1

10-2. LINE CONTAINED BY ONE OR BOTH THE PLANES (FIG. 10-2)

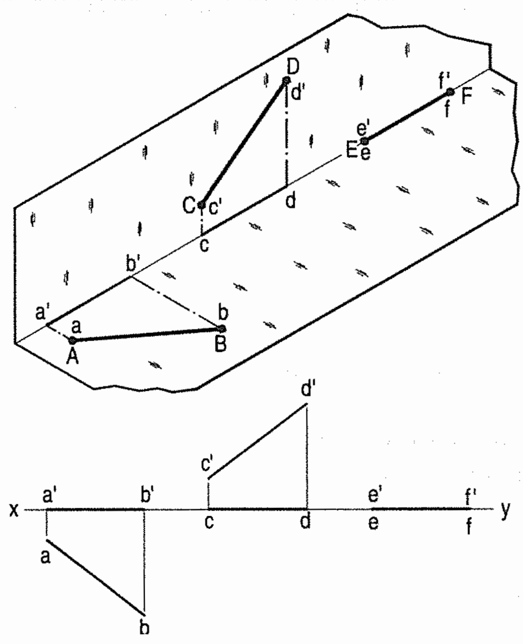


FIG. 10-2

Line *AB* is in the H.P. Its top view *ab* is equal to *AB*; its front view *a' b'* is in *xy*.

Line *CD* is in the V.P. Its front view *c'd'* is equal to *CD*; its top view *cd* is in *xy*.

Line *EF* is in both the planes. Its front view *e' f'* and the top view *ef* coincide with each other in *xy*.

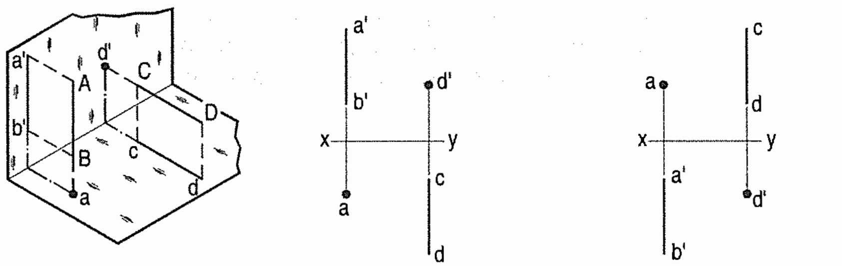
Hence, when a line is contained by a plane, its projection on that plane is equal to its true length; while its projection on the other plane is in the reference line.

10-3. LINE PERPENDICULAR TO ONE OF THE PLANES

(FIG. 10-3)

This book is accompanied by a computer CD, which contains an audiovisual animation presented for better visualization and understanding of the subject. Readers are requested to refer Presentation module 22 for the line perpendicular to one of the planes.

When a line is perpendicular to one reference plane, it will be parallel to the other.



(FIRST-ANGLE PROJECTION) (THIRD-ANGLE PROJECTION)

FIG. 10-3

(a) Line *AB* is perpendicular to the H.P. The top views of its ends coincide in the point *a*. Hence, the top view of the line *AB* is the point *a*. Its front view *a' b'* is equal to *AB* and perpendicular to *xy*.

(b) Line *CD* is perpendicular to the V.P. The point *d'* is its front view and the line *cd* is the top view. *cd* is equal to *CD* and perpendicular to *xy*.

Hence, when a line is perpendicular to a plane its projection on that plane is a point; while its projection on the other plane is a line equal to its true length and perpendicular to the reference line.

In *first-angle projection method*, when top views of two or more points coincide, the point which is comparatively *farther* away from *xy* in the front view will be visible; and when their front views coincide, that which is *farther* away from *xy* in the top view will be visible.

In *third-angle projection method*, it is just the reverse. When top views of two or more points coincide the point which is comparatively *nearer xy* in the front view will be visible; and when their front views coincide, the point which is *nearer xy* in the top view will be visible.

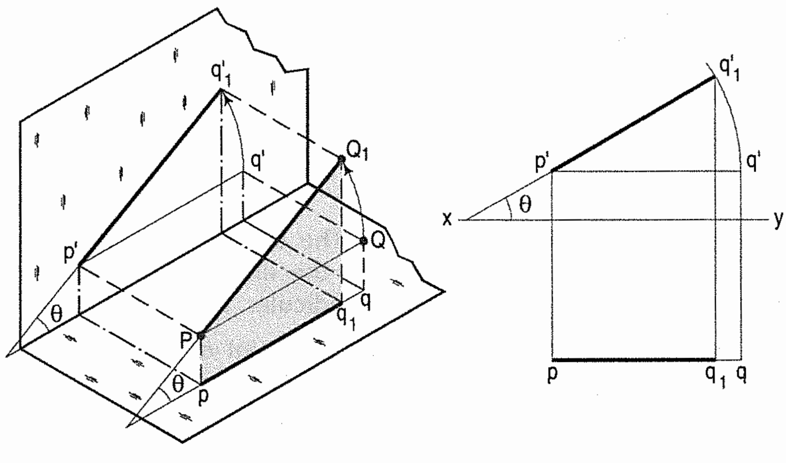
10-4. LINE INCLINED TO ONE PLANE AND PARALLEL TO THE OTHER

This book is accompanied by a computer CD, which contains an audiovisual animation presented for better visualization and understanding of the subject. Readers are requested to refer Presentation module 23 for the line inclined to one plane and parallel to the other.

The inclination of a line to a plane is the angle which the line makes with its projection on that plane.

(a) Line PQ_1 [fig. 10-4(i)] is inclined at an angle θ to the H.P. and is parallel to the V.P. The inclination is shown by the angle θ which PQ_1 makes with its own projection on the H.P., viz. the top view pq_1.

The projections [fig. 10-4(ii)] may be drawn by first assuming the line to be parallel to both the H.P. and the V.P. Its front view $p'q'$ and the top view pq will both be parallel to xy and equal to the true length. When the line is turned about the end P to the position PQ_1 so that it makes the angle θ with the H.P. while remaining parallel to the V.P., in the front view the point q' will move along an arc drawn with p' as centre and $p'q'$ as radius to a point q'_1 so that $p'q'_1$ makes the angle θ with xy. In the top view, q will move towards p along pq to a point q_1 on the projector through q'_1. $p'q'_1$ and pq_1 are the front view and the top view respectively of the line PQ_1.



(i) (ii)

FIG. 10-4

(b) Line RS_1 [fig. 10-5(i)] is inclined at an angle ø to the V.P. and is parallel to the H.P. The inclination is shown by the angle ø which RS_1 makes with its projection on the V.P., viz. the front view $r's'_1$. Assuming the line to be parallel to both the H.P. and the V.P., its projections $r's'$ and rs are drawn parallel to xy and equal to its true length [fig. 10-5(ii)].

When the line is turned about its end R to the position RS_1 so that it makes the angle ø with the V.P. while remaining parallel to the H.P., in the top view the point s will move along an arc drawn with r as centre and rs as radius to a point s_1 so that rs_1 makes the angle ϕ with xy. In the front view, the point s' will move towards r' along the line $r's'$ to a point s'_1 on the projector through s_1. rs_1 and $r's'_1$ are the projections of the line RS_1.

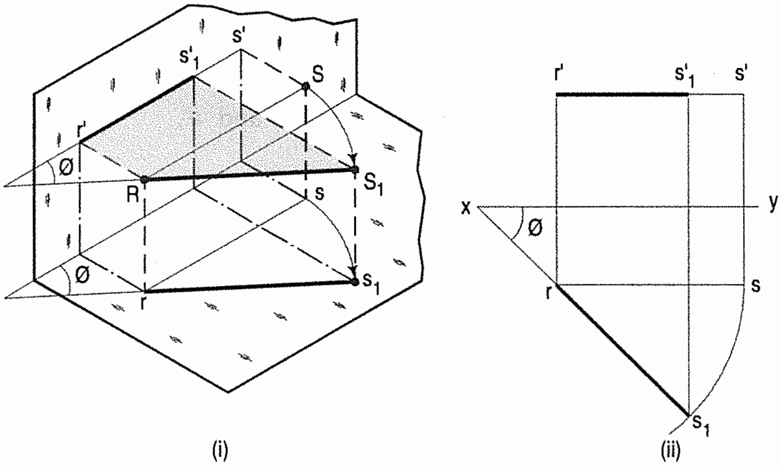


FIG. 10-5

Therefore, when the line is inclined to the H.P. and parallel to the V.P., its top view is shorter than its true length, but parallel to xy; its front view is equal to its true length and is inclined to xy at its true inclination with the H.P. And when the line is inclined to the V.P. and parallel to the H.P., its front view is shorter than its true length but parallel to xy; its top view is equal to its true length and is inclined to xy at its true inclination with the V.P.

Hence, when a line is inclined to one plane and parallel to the other, its projection on the plane to which it is inclined, is a line shorter than its true length but parallel to the reference line. Its projection on the plane to which it is parallel, is a line equal to its true length and inclined to the reference line at its true inclination.

In other words, the inclination of a line with the H.P. is seen in the front view and that with the V.P. is seen in the top view.

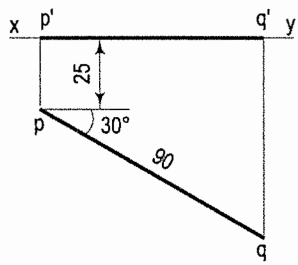


FIG. 10-6

Problem 10-1. (fig. 10-6): *A line PQ, 90 mm long, is in the H.P. and makes an angle of 30° with the V.P. Its end P is 25 mm in front of the V.P. Draw its projections.*

As the line is in the H.P., its top view will show the true length and the true inclination with the V.P. Its front view will be in xy.

(i) Mark a point p, the top view 25 mm below xy. Draw a line pq equal to 90 mm and inclined at 30° to xy.

(ii) Project p to p' and q to q' on xy.

pq and $p'q'$ are the required top view and front view respectively.

Problem 10-2. (fig. 10-7): *The length of the top view of a line parallel to the V.P. and inclined at 45° to the H.P. is 50 mm. One end of the line is 12 mm above the H.P. and 25 mm in front of the V.P. Draw the projections of the line and determine its true length.*

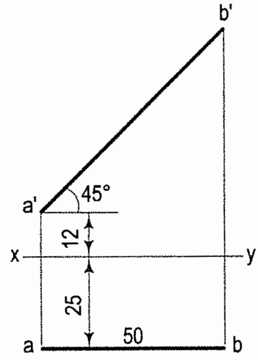


FIG. 10-7

As the line is parallel to the V.P., its top view will be parallel to *xy* and the front view will show its true length and the true inclination with the H.P.

(i) Mark *a*, the top view, 25 mm below *xy* and *a'*, the front view, 12 mm above *xy*.

(ii) Draw the top view *ab* 50 mm long and parallel to *xy* and draw a projector through *b*.

(iii) From *a'* draw a line making 45° angle with *xy* and cutting the projector through *b* at *b'*. Then *a'b'* is the front view and also the true length of the line.

Problem 10-3. (fig. 10-8): *The front view of a 75 mm long line measures 55 mm. The line is parallel to the H.P. and one of its ends is in the V.P. and 25 mm above the H.P. Draw the projections of the line and determine its inclination with the V.P.*

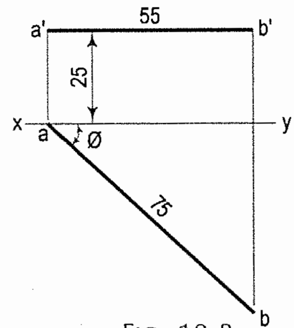


FIG. 10-8

As the line is parallel to the H.P., its front view will be parallel to *xy*.

(i) Mark *a*, the top view of one end in *xy*, and *a'*, its front view, 25 mm above *xy*.

(ii) Draw the front view *a'b'*, 55 mm long and parallel to *xy*. With *a* as centre and radius equal to 75 mm, draw an arc cutting the projector through *b'* at *b*.

Join *a* with *b*. *ab* is the top view of the line. Its inclination with *xy*, viz. ø is the inclination of the line with the V.P.

EXERCISES 10(a)

1. Draw the projections of a 75 mm long straight line, in the following positions:

(a) (i) Parallel to both the H.P. and the V.P. and 25 mm from each.

(ii) Parallel to and 30 mm above the H.P. and in the V.P.

(iii) Parallel to and 40 mm in front of the V.P. and in the H.P.

(b) (i) Perpendicular to the H.P., 20 mm in front of the V.P. and its one end 15 mm above the H.P.

(ii) Perpendicular to the V.P., 25 mm above the H.P. and its one end in the V.P.

(iii) Perpendicular to the H.P., in the V.P. and its one end in the H.P.

(c) (i) Inclined at 45° to the V.P., in the H.P. and its one end in the V.P.

(ii) Inclined at 30° to the H.P. and its one end 20 mm above it; parallel to and 30 mm in front of the V.P.

(iii) Inclined at 60° to the V.P. and its one end 15 mm in front of it; parallel to and 25 mm above the H.P.

2. A 100 mm long line is parallel to and 40 mm above the H.P. Its two ends are 25 mm and 50 mm in front of the V.P. respectively. Draw its projections and find its inclination with the V.P.
3. A 90 mm long line is parallel to and 25 mm in front of the V.P. Its one end is in the H.P. while the other is 50 mm above the H.P. Draw its projections and find its inclination with the H.P.
4. The top view of a 75 mm long line measures 55 mm. The line is in the V.P., its one end being 25 mm above the H.P. Draw its projections.
5. The front view of a line, inclined at 30° to the V.P is 65 mm long. Draw the projections of the line, when it is parallel to and 40 mm above the H.P., its one end being 30 mm in front of the V.P.
6. A vertical line *AB*, 75 mm long, has its end *A* in the H.P. and 25 mm in front of the V.P. A line *AC*, 100 mm long, is in the H.P. and parallel to the V.P. Draw the projections of the line joining *B* and *C*, and determine its inclination with the H.P.
7. Two pegs fixed on a wall are 4.5 metres apart. The distance between the pegs measured parallel to the floor is 3.6 metres. If one peg is 1.5 metres above the floor, find the height of the second peg and the inclination of the line joining the two pegs, with the floor.
8. Draw the projections of the lines in Exercises 1 to 6, assuming them to be in the third quadrant, taking the given positions to be below the H.P. instead of above the H.P., and behind the V.P., instead of in front of the V.P.

10-5. LINE INCLINED TO BOTH THE PLANES

CHAROTAR COGNIFRONT

This book is accompanied by a computer CD, which contains an audiovisual animation presented for better visualization and understanding of the subject. Readers are requested to refer Presentation module 24 for the line inclined to both the planes.

(a) A line *AB* (fig. 10-9) is inclined at θ to the H.P. and is parallel to the V.P. The end *A* is in the H.P. *AB* is shown as the hypotenuse of a right-angled triangle, making the angle θ with the base.

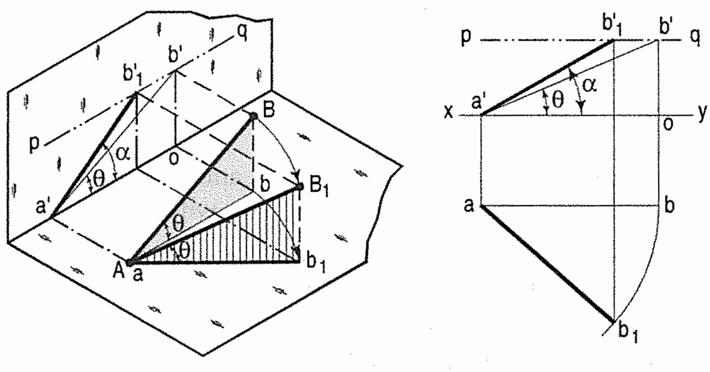


FIG. 10-9

The top view ab is shorter than AB and parallel to xy. The front view $a'b'$ is equal to AB and makes the angle θ with xy.

Keeping the end A fixed and the angle θ with the H.P. constant, if the end B is moved to any position, say B_1, the line becomes inclined to the V.P. also.

In the top view, b will move along an arc, drawn with a as centre and ab as radius, to a position b_1. The new top view ab_1 is equal to ab but shorter than AB.

In the front view, b' will move to a point b'_1 keeping its distance from xy constant and equal to $b'o$; i.e. it will move along the line pq, drawn through b' and parallel to xy. This line pq is the locus or path of the end B in the front view. b'_1 will lie on the projector through b_1. The new front view $a'b'_1$ is shorter than $a'b'$ (i.e. AB) and makes an angle α with xy. α is greater than θ.

Thus, it can be seen that as long as the inclination θ of AB with the H.P. is constant, even when it is inclined to the V.P.

(i) its length in the top view, viz. ab remains constant; and

(ii) the distance between the paths of its ends in the front view, viz. $b'o$ remains constant.

(b) The same line AB (fig. 10-10) is inclined at ø to the V.P. and is parallel to the H.P. Its end A is in the V.P. AB is shown as the hypotenuse of a right-angled triangle making the angle ø with the base.

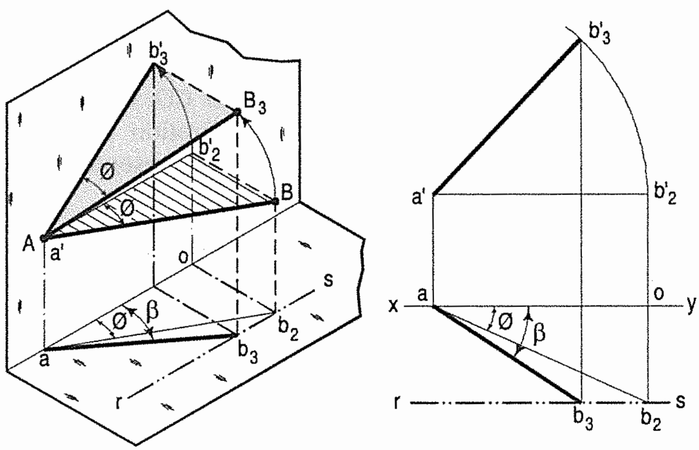


FIG. 10-10

The front view $a'b'_2$ is shorter than AB and parallel to xy. The top view ab_2 is equal to AB and makes an angle ø with xy.

Keeping the end A fixed and the angle ø with the V.P. constant, if B is moved to any position, say B_3, the line will become inclined to the H.P. also.

In the front view, b'_2, will move along the arc, drawn with a' as centre and $a'b'_2$ as radius, to a position b'_3. The new front view $a'b'_3$ is equal to $a'b'_2$ but is shorter than AB.