# CHAPTER 12

# PROJECTIONS OF PLANES

## 12-0. Introduction:

Plane figures or surfaces have only two dimensions, viz. length and breadth. They do not have thickness. A plane figure may be assumed to be contained by a plane, and its projections can be drawn, if the position of that plane with respect to the principal planes of projection is known.

In this chapter, we shall discuss the following topics:

1. Types of planes and their projections.
2. Traces of planes.

## 12-1. Types of planes:

Planes may be divided into two main types:

I. Perpendicular planes.
II. Oblique planes.

**I. Perpendicular planes:** These planes can be divided into the following sub-types:

(i) Perpendicular to both the reference planes.
(ii) Perpendicular to one plane and parallel to the other.
(iii) Perpendicular to one plane and inclined to the other.

**(i) *Perpendicular to both the reference planes*** (fig. 12-1): A square *ABCD* is perpendicular to both the planes. Its H.T. and V.T. are in a straight line perpendicular to *xy*.

The front view *b′c′* and the top view *ab* of the square are both lines coinciding with the V.T. and the H.T. respectively.

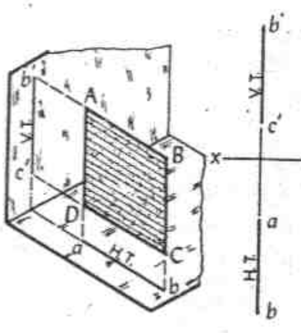


FIG. 12-1

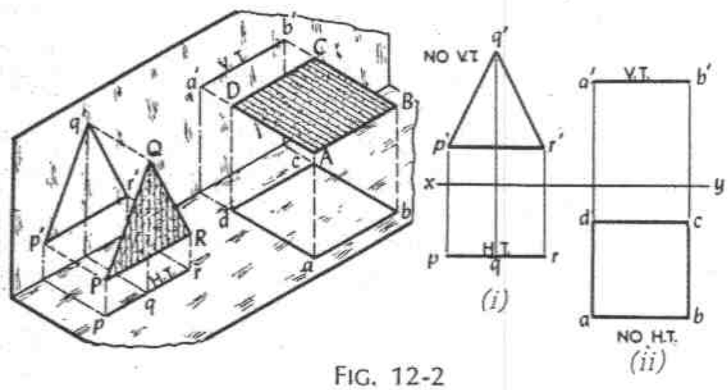


FIG. 12-2

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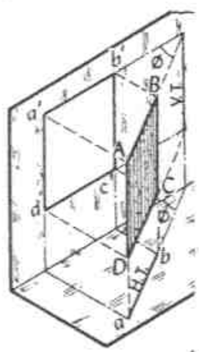

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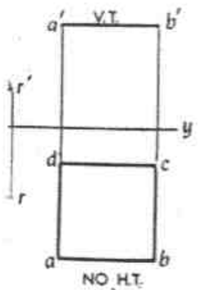


(ii)



**(ii) *Perpendicular to one plane and parallel to the other plane:***

(a) Plane, perpendicular to the H.P. and parallel to the V.P. [fig. 12-2(i)].

A triangle *PQR* is perpendicular to the H.P. and is parallel to the V.P. Its H.T. is parallel to *xy*. It has no V.T.

The front view *p′ q′ r′* shows the exact shape and size of the triangle. The top view *pqr* is a line parallel to *xy*. It coincides with the H.T.

(b) Plane, perpendicular to the V.P. and parallel to the H.P. [fig. 12-2(ii)].

A square *ABCD* is perpendicular to the V.P. and parallel to the H.P. Its V.T. is parallel to *xy*. It has no H.T.

The top view *abcd* shows the true shape and true size of the square. The front view *a′b′* is a line, parallel to *xy*. It coincides with the V.T.

**(iii) *Perpendicular to one plane and inclined to the other plane:***

(a) Plane, perpendicular to the H.P. and inclined to the V.P. (fig. 12-3).

A square *ABCD* is perpendicular to the H.P. and inclined at an angle ø to the V.P. Its V.T. is perpendicular to *xy*. Its H.T. is inclined at ø to xy.

Its top view *ab* is a line linclined at ø to *xy*. The front view *a′ b′ c′ d′* is smaller than *ABCD*.

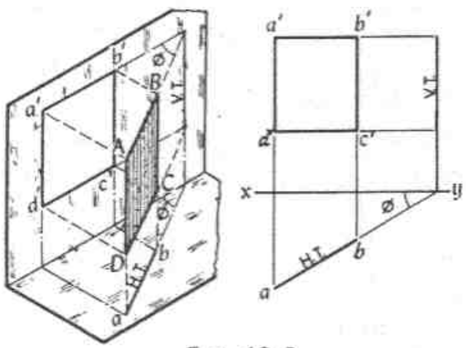



FIG. 12-3

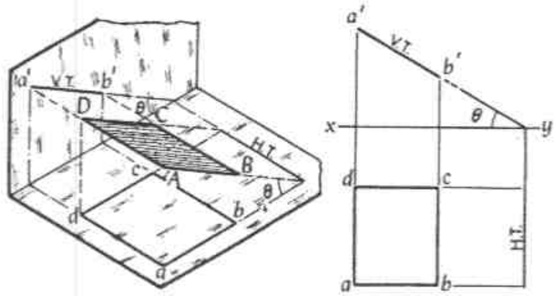



FIG. 12-4

(b) Plane, perpendicular to the V.P. and inclined to the H.P. (fig. 12-4).

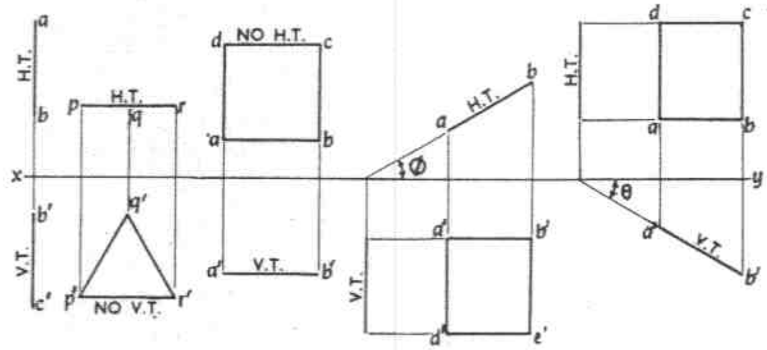



FIG. 12-5

(c) When a plane is perpendicular to one of the reference planes and inclined to the other, its inclination is shown by the angle which its projection on the plane to which it is perpendicular, makes with *xy*. Its projection on the plane to which it is inclined, is smaller than the plane itself.

**Problem 12-1.** *Show by means of traces, each of the following planes:*

(a) *Perpendicular to the H.P. and the V.P.*

(b) *Perpendicular to the H.P. and inclined at 30° to the V.P.*

(c) *Parallel to and 40 mm away from the V.P.*

(d) *Inclined at 45° to the H.P. and perpendicular to the V.P.*

(e) *Parallel to the H.P. and 25 mm away from it.*

Fig. 12-6 and fig. 12-7 show the various traces.

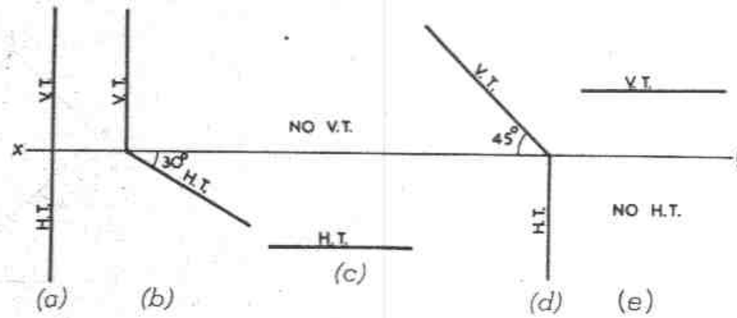
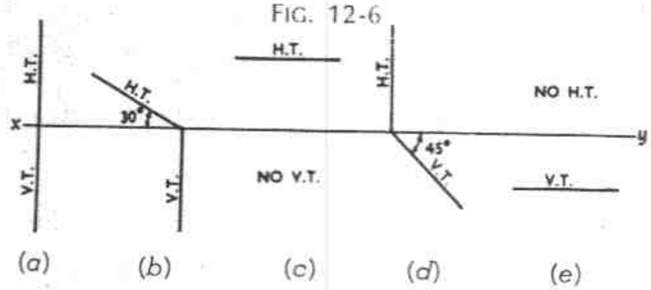



FIG. 12-6




(Third-angle projection)

FIG. 12-7

(a) The H.T. and the V.T. are in a line perpendicular to xy.

(b) The H.T. is inclined at 30° to *xy*; the V.T. is normal to *xy*; both the traces intersect in *xy*.

(c) The H.T. is parallel to and 40 mm away from *xy*. It has no V.T.

(d) The H.T. is perpendicular to *xy*; the V.T. makes 45° angle with *xy*; both intersect in *xy*.

(e) The V.T. is parallel to and 25 mm away from *xy*. It has no H.T.

## 12-4. Projections of planes parallel to one of the reference planes:

The projection of a plane on the reference plane parallel to it will show its true shape. Hence, beginning should be made by drawing that view. The other view which will be a line, should then be projected from it.

will show the true shape. The front view will be a line parallel to *xy*. The plane is then tilted so that it is inclined to the H.P. The new front view will be inclined to *xy* at the true inclination. In the top view the corners will move along their respective paths (parallel to *xy*).

**Problem 12-4.** (fig. 12-10): *A regular pentagon of 25 mm side has one side on the ground. Its plane is inclined at 45° to the H.P. and perpendicular to the V.P. Draw its projections and show its traces.*

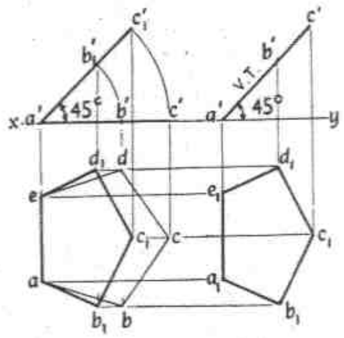
Assuming it to be parallel to the H.P.

(i) Draw the pentagon in the top view with one side perpendicular to *xy* [fig. 12-10(i)]. Project the front view. It will be the line *a'c'* contained by *xy*.

(ii) Tilt the front view about the point *a'*, so that it makes 45° angle with *xy*.

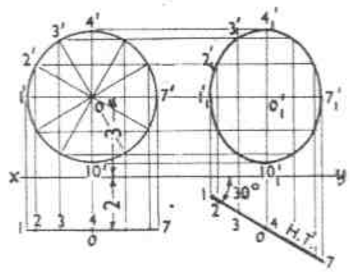
(iii) Project the new top view $ab_1c_1d_1e$ upwards from this front view and horizontally from the first top view. It will be more convenient if the front view is reproduced in the new position separately and the top view projected from it, as shown in fig. 12-10(ii). The V.T. coincides with the front view and the H.T. is perpendicular to *xy*, through the point of intersection between *xy* and the front view-produced.

(b) *Plane, inclined to the V.P. and perpendicular to the H.P.:* In the initial stage, the plane may be assumed to be parallel to the V.P. and then tilted to the required position in the next stage. The projections are drawn as illustrated in the next problem.




(i) (ii)

FIG. 12-10




(i) (ii)

FIG. 12-11

**Problem 12-5.** (fig. 12-11): *Draw the projections of a circle of 5 cm diameter, having its plane vertical and inclined at 30° to the V.P. Its centre is 3 cm above the H.P. and 2 cm in front of the V.P. Show also its traces.*

A circle has no corners to project one view from another. However, a number of points, say twelve, equal distances apart, may be marked on its circumference.

(i) Assuming the circle to be parallel to the V.P., draw its projections. The front view will be a circle [fig. 12-11(i)], having its centre 3 cm above *xy*. The top view will be a line, parallel to and 2 cm below *xy*.

If an edge is in the V.P., in the initial position, the plane is assumed to be lying in the V.P. with an edge perpendicular to the H.P. *If a corner is in the V.P., the line joining that corner with centre of the plane is kept parallel to the H.P.*

**Problem 12-6.** (fig. 12-12): *A square ABCD of 50 mm side has its corner A in the H.P., its diagonal AC inclined at 30° to the H.P. and the diagonal BD inclined at 45° to the V.P. and parallel to the H.P. Draw its projections.*

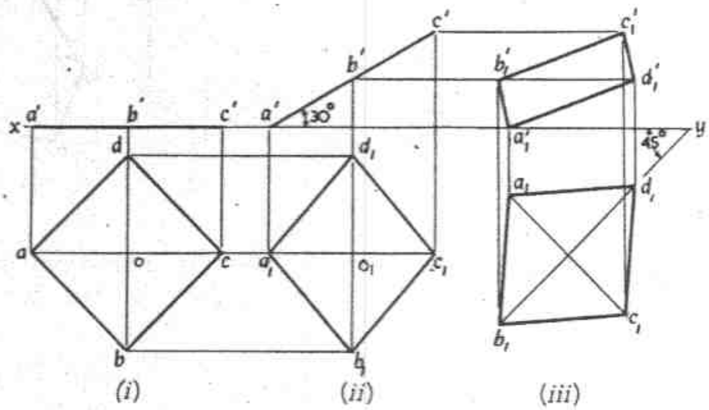



FIG. 12-12

In the initial stage, assume the square to be lying in the H.P. with *AC* parallel to the V.P.

(i) Draw the top view and the front view. When the square is tilted about the corner *A* so that *AC* makes 30° angle with the H.P., *BD* remains perpendicular to the V.P. and parallel to the H.P.

(ii) Draw the second front view with a′c′ inclined at 30° to *xy*, keeping a′ or c′ in *xy*. Project the second top view. The square may now be turned so that *BD* makes 45° angle with the V.P. and remains parallel to the H.P. Only the position of the top view will change. Its shape and size will remain the same.

(iii) Reproduce the top view so that $b_1d_1$ is inclined at 45° to *xy*. Project the final front view upwards from this top view and horizontally from the second front view.

**Problem 12-7.** (fig. 12-13): *Draw the projections of a regular hexagon of 25 mm side, having one of its sides in the H.P. and inclined at 60° to the V.P., and its surface making an angle of 45° with the H.P.*

(i) Draw the hexagon in the top view with one side perpendicular to *xy*. Project the front view *a′c′* in *xy*.

(ii) Draw *a′c′* inclined at 45° to *xy* keeping a′ or c′ in *xy* and project the second top view.

(iii) Reproduce this top view making $a_1f_1$ inclined at 60° to *xy* and project the final front view.

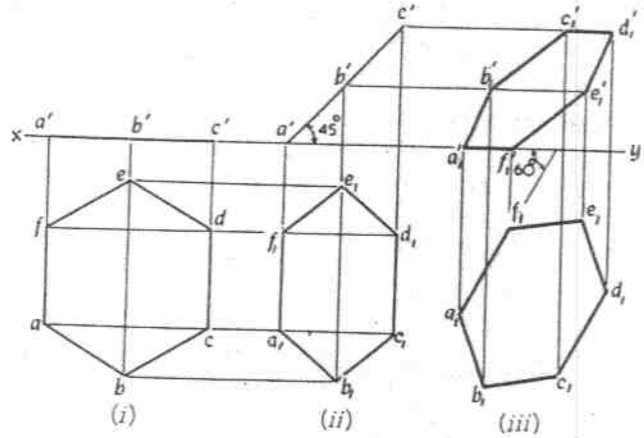



FIG. 12-13

**Problem 12-8.** (fig. 12-14): *Draw the projections of a circle of 50 mm diameter resting in the H.P. on a point A on the circumference, its plane inclined at 45° to the H.P. and*

(a) *the top view of the diameter AB making 30° angle with the V.P.;*

(b) *the diameter AB making 30° angle with the V.P.*

Draw the projections of the circle with A in the H.P. and its plane inclined at 45° to the H.P. and perpendicular to the V.P. [fig. 12-14(i) and fig. 12-14(ii)].

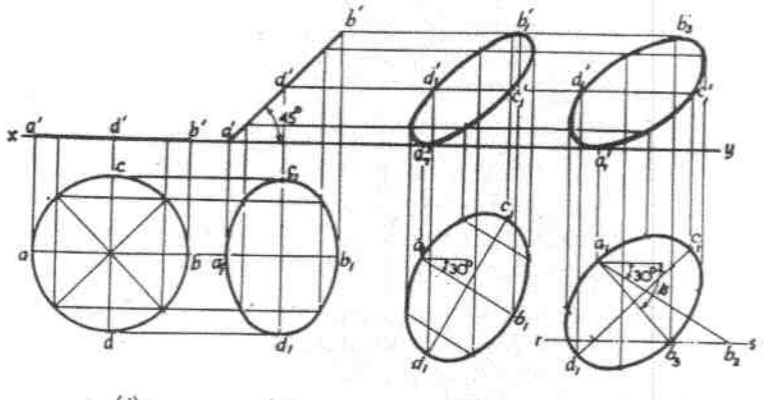



FIG. 12-14

(a) In the second top view, the line $a_1b_1$ is the top view of the diameter *AB*. Reproduce this top view so that $a_1b_1$ makes 30° angle with *xy* [fig. 12-14(iii)]. Project the required front view.

(b) If the diameter *AB*, which makes 45° angle with the H.P., is inclined at 30° to the V.P. also, its top view $a_1b_1$ will make an angle greater than 30° with *xy*. This apparent angle of inclination is determined as described below.