**Problem 2.** *A square lamina ABCD, of 25 mm side is parallel to HP and is 10 mm from it. Draw its projections and locate its trace.*

**Solution :** Fig. 11.15. As the square lamina ABCD is parallel to HP its projection on HP projects true shape and size. It has no HT, its front view will be an edge view, i.e., a line, and will be its VT also.

Therefore, draw a square of 25 mm side keeping its near side parallel to XY line in top view and name its corners. Project from top view, **abcd** , to the front view to intersect a line drawn parallel to the XY line and 10 mm below it in points **b'**,**c'**and **a'd'**.In front view point **b'** overlaps point **c'** and point **a'** overlaps **d'**.

The points **a** and **b** are nearer to the observer in top view. Therefore, **a'**, **b'** will be written before the front views **d'** and **c'**, respectively e.g., in front view we shall write **b'**, **c'** and **a'**,**d'** .

**Problem 3.** *A rectangle ABCD, 60 mm × 40 mm , is parallel to HP with one of its sides inclined at 30° to VP and the end of the side near VP is 15 mm in front of the VP and 30 mm above the HP. Draw its projections and position of traces.*

**Solution :** Refer Fig. 11.16. Angle made by a line to VP is shown by its TL projection in top view. Assume the side BA to be inclined at 30° to VP and the distance of the end B 15 mm in front of the VP and 30 mm above the HP.

Draw the rectangle **abcd** , in top view, true shape and size, keeping point **b** 15 mm below the XY line and the line **ba** inclined at 30° to XY line. Project from **b** vertically upwards and mark **b'**, on this projector, 30 mm above the XY line. Through **b'** draw a line parallel to the XY line and on this line mark the projections of the other corner points, by projecting from top view.

**Problem 4.** *A regular hexagonal lamina, of 20 mm side, rests on one of its sides on HP. It is parallel to and 11 mm away from VP and it is in first quadrant. Draw its projections.*

**Solution :** Refer Fig. 11.17.

parallel to the XY line.

**Problem 5.** *A regular pentagon ABCDE, 20 mm side, has its corner A in HP and the side CD parallel to the HP. Draw its projections when its plan is parallel to and 10 mm away from VP. Also draw its traces.*

**Solution :** Refer Fig. 11.18. Taking side **c'd'**, 20 mm long, parallel to XY, complete the pentagon **a'b'c'd'e'** in front view . Draw XY through **a'**. Project downwards from the front view, to obtain the top view **abcde** of the pentagon ABCDE, which will be a line parallel to and 10 mm below the XY line.

Top view is the HT as well and there is no VT.

## 11.5. PROJECTIONS OF PLANES INCLINED TO ONE OF THE PRINCIPAL PLANES AND PERPENDICULAR TO THE OTHER

*Projections of such planes are drawn in two stages.* In the *first or initial stage*, the plane is assumed to be parallel to that principal plane *to which it is inclined* and its projections are drawn as in problems 2 to 5. *In the second stage , the plane is tilted at the given inclination to the principal plane* and its projections are drawn , using the projections drawn in first stage. There may be two different cases of this type of planes.

**CASE I:** *When a plane is inclined to HP and perpendicular to VP, first assume it to be parallel to the HP and draw its top view as the top view is to be true shape and size in this position.* Then draw the front view, by projecting from the top view, which will be a line parallel to XY line.

*In the second stage, tilt the front view (i.e. edge view) so that it makes the given inclination to the XY line. Then project the final top view by projecting, all the points from this front view, downwards and projecting parallel to the XY line from the top view of the initial stage.* The intersections of the corresponding vertical and horizontal projectors of a point locate the point in . These points when joined,

**Problem 6.** *A square lamina ABCD, of 30 mm side, is perpendicular to VP and inclined to HP at 45°. It rests on one of its sides (say BC) in HP. Draw its projections and position of traces. The corner point C is 12 mm in front of the VP.*

**Solution :** Fig. 11.19. As the plane lamina is inclined to HP, its projections can be drawn in two stages.

1. Draw the top view **abcd** keeping the side **bc** perpendicular to XY line with corner C 12 mm away from it and the lamina on HP. Project upwards from this top view to cut the XY line at points **a'**, **b'**, **c'** and **d'**. Thus **a'b'c'd'**, is the front view for initial position of the lamina.

2. Since the plane is inclined to HP at 30° reproduce the front view (i.e. edge view) of the initial position such that it is inclined to the XY line at 45° and has point **b'c'** as $b_1'c_1'$ on XY line. The intersections of vertical projectors drawn through points $a_1'b_1'c_1'd_1'$ on second front view and horizontal projectors drawn through corresponding points **a** , **b**, **c** and **d** of the top view of first stage locate the points $a_1$, $b_1$ , $c_1$ and $d_1$ on top view of second stage. Join these points systematically.

3. The VT coincides with the front view and HT is the line $b_1$ $c_1$ itself.

**Problem 7.** *A regular hexagonal lamina, of side 20 mm, rests on one of its sides on HP such that it is perpendicular to VP and inclined to the HP at 45°. Its corner nearest to the VP is 15 mm away from the VP. Draw its projections in first angle.*

**Solution :** Refer Fig. 11.20 (a), (b).

5. Draw downward projector through point $1_1'$, in the elevation and horizontal projector through point 1 in the previous plan. The point of intersection, $1_1$ , of these projectors is a point on the required plan. Similarly, plot all the remaining points by obtaining their respective points of intersection. Join the points , systematically, to obtain the final top view.

**Problem 8.** *A regular pentagon ABCDE, of 25 mm side, has its side BC in HP. Its plane is perpendicular to the HP and inclined at 45° to the VP. Draw the projections of the pentagon and show its traces when its corner nearest to the VP is 10 mm from it.*

**Solution :** Refer Fig. 11.21.

1. Draw a pentagon **a'b'c'd'e'**, of 25 mm side , in front view, keeping the side **b'c'** on XY line.

2. Project from he elevation **a'b'c'd'e'** the plan **abcde**, which is to be a straight line 10 mm away from the XY line, as a point on it (A here) is given to be 10 mm away from the VP.

3. Next, tilt the plan about a so that it is inclined at 45° to the XY line and name the points on it by adding suffix 1 to them.

4. Project the corresponding (second stage) front view $a_1'b_1'c_1'd_1'$ by drawing vertical projectors through the points in second stage top view and horizontal projectors through the first stage front view, as shown.

**Problem 9.** *A regular hexagonal lamina, side 20 mm, rests on HP on one of its sides such that it is perpendicular to the Hp and inclined to VP at 30°. Draw its projections, in first angle, when the corner nearest to the VP is 15 mm away from it.*

**Solution :** Refer Fig. 11.22 (a), (b).

1. Draw the XY line and then draw the regular hexagon **1'2'3'4'5'6'**, in elevation, with one of its sides (**5'6'** here) on the XY line.

2. As the lamina is perpendicular to the HP, its plan will be a line. Therefore, draw the plan , **123456**, 15 m away from the XY line and parallel to it, Fig. 11.22 (a).

3. Then draw the plan in the changed position, $1_1$ $2_1$ $3_1$.$4_1$ $5_1$ $6_1$ , so that it makes 30° angle with the XY line and has the point $1_1$ , 15 mm away from the XY line.

4. Complete the corresponding new elevation, $1_1'2_1'3_1'4_1'5_1'6_1'$, by projecting upwards from this plan and projecting horizontally from the previous elevation, Fig. 11.22 (b).

**Problem 10.** *Draw the projections and traces of a thin circular sheet of ϕ 50 mm and negligible thickness, when its plane is inclined at 45° to VP and is perpendicular to HP. A point on its circumference and nearest to the VP is 40 mm away from the HP and 14 mm away from the VP. Draw its projections both in first and third quadrants.*

**Solution :** Figs. 11.23,24. First draw the projections of the sheet supposing it to be parallel to the VP and keeping one of the points (1 here) at the given distances in front and top views, and name the points as shown.

Note here that front view is a true circle and for the purpose of obtaining the points on its rim, in the final projection, the circle is divided into 12 equal parts.

Redraw the top view in the new position such that it is inclined at 45°to the XY line and point **1** remains at the same distance from the XY line and takes the position $1_1$. Project vertically from this top view and horizontally from the previous from the previous front view, to obtain the required front view as shown in Fig. 11.23 for third angle projection and Fig. 11.24 for first angle projection.

**Problem 11.** *A circulate plate, of 50 mm diameter, Is held such that its plane is perpendicular to HP and inclined at 30° to VP with its centre 30 mm above the HP and 20 mm in front of the VP. Draw its projections. Also show its traces.*

**Solution :** Refer Fig. 11.25.

1. Draw XY line. Then draw a circle of ϕ 50 mm in front view such that the centre of the circle is 30 mm above the XY line.

2. Draw the corresponding top view of the plate, which will be an edge view (i.e. a line)parallel to the XY line and 20 mm away from it.

3. Draw the top view, in the new position, so that it makes an angle of 30° to the XY line, and with the centre still 20 mm away from it.

4. Draw its second corresponding front view and traces as shown.

**Problem 12.** *A regular hexagonal thin plate of 45 mm side has a circular hole of 45 mm diameter in its centre. It is resting on one of its corners in HP. Draw its projections when the plate surface is vertical and inclined at 30° to the VP.*

**Solution :** Refer Fig. 11.26.

1. Draw elevation **a'b'c'd'e'f'** keeping one corner (E here) in HP, i.e., **e'** on the XY line.

2. Draw a hole of ϕ 45 mm, in the centre of the hexagon in elevation Divide the circle into 12 equal parts and number the division points as shown.

3. Draw the corresponding plan for the plate along with the hole and name all the corner points on the hexagon and the circle.

4. Then draw the plan in the new position so that it is inclined at 30° to the XY line.

5. Then draw vertical projectors through points on the plan and horizontal projectors through the points on the previous elevation, as shown in figure. The points of intersection of the corresponding vertical and horizontal projectors locate points on the final elevation..

**Problem 13.** *The elevation* **a'b'c'd'** *of a rectangular lamina ABCD of 30×60 mm sides is a square of 30 mm side when its side AB is in the VP and the side AD is making an angle of 20° to the HP. Draw its projections fulfilling the given conditions.*

**Solution :** Refer Fig. 11.27.

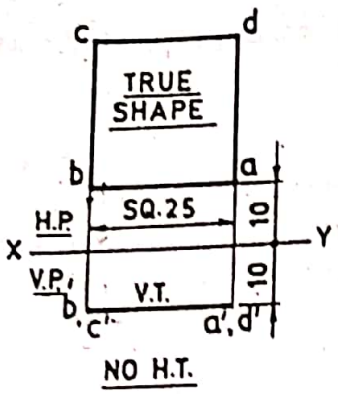


Fig 11.15 Third angle projection

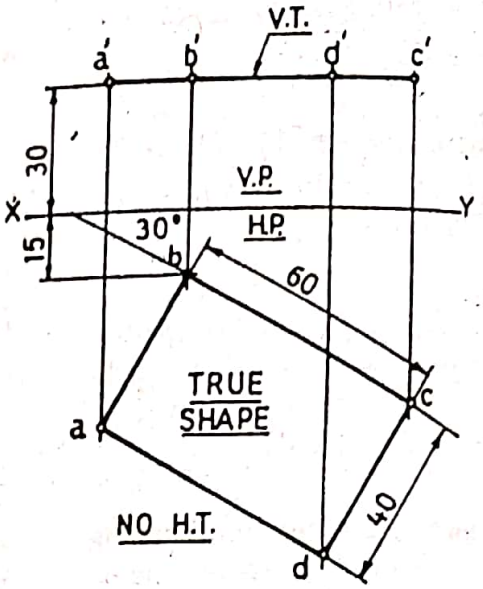


Fig 11.16

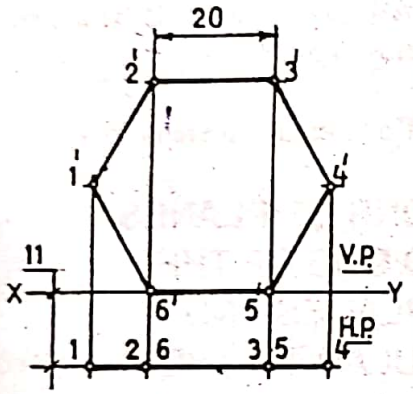


Fig 11.17

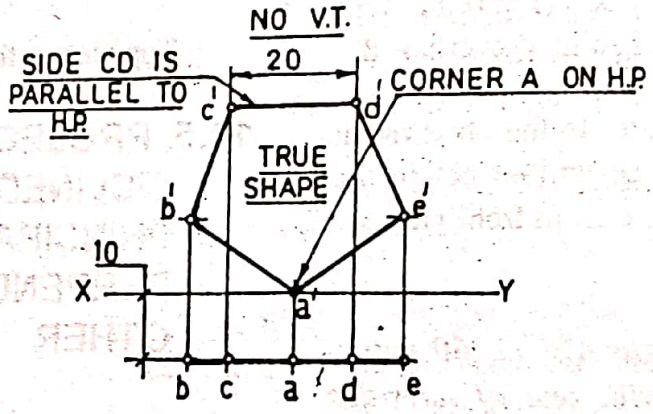


Fig 11.18

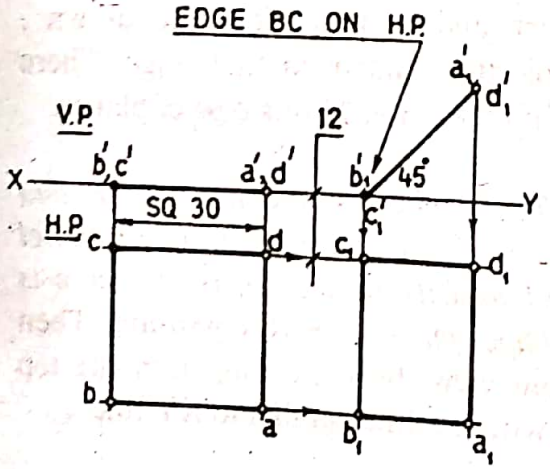


Fig 11.19

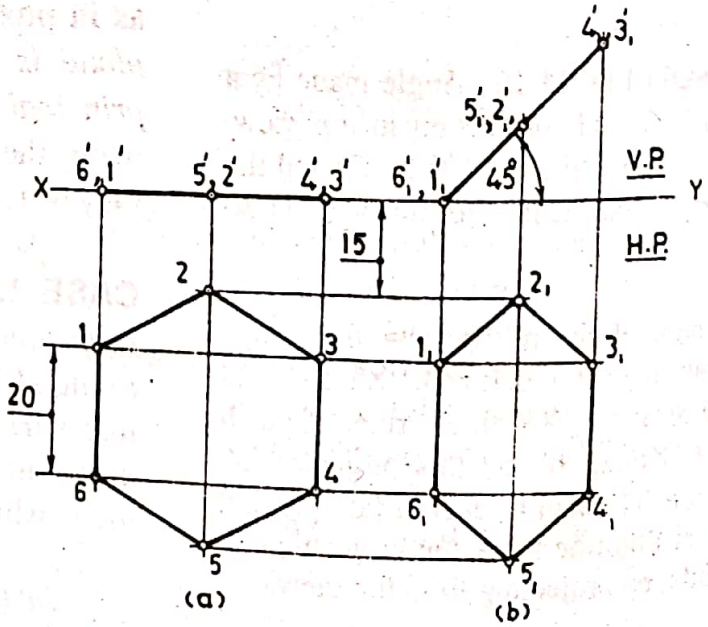


Fig 11.20

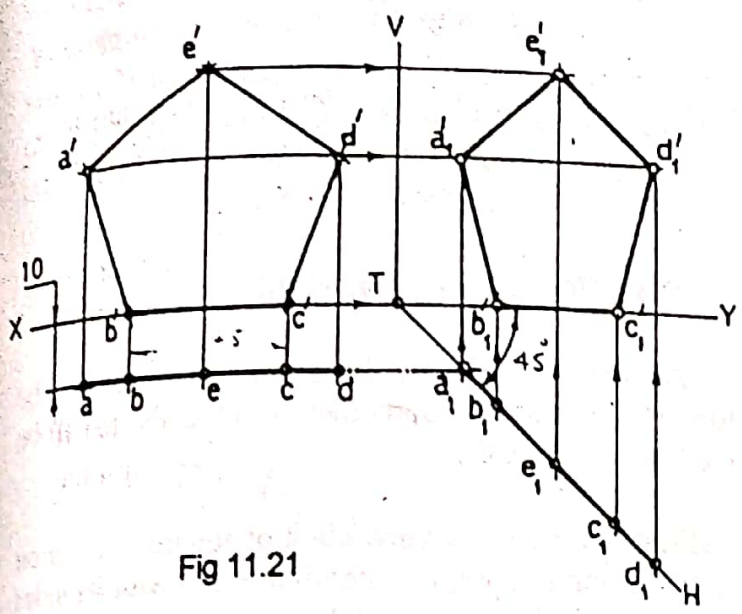


Fig 11.21

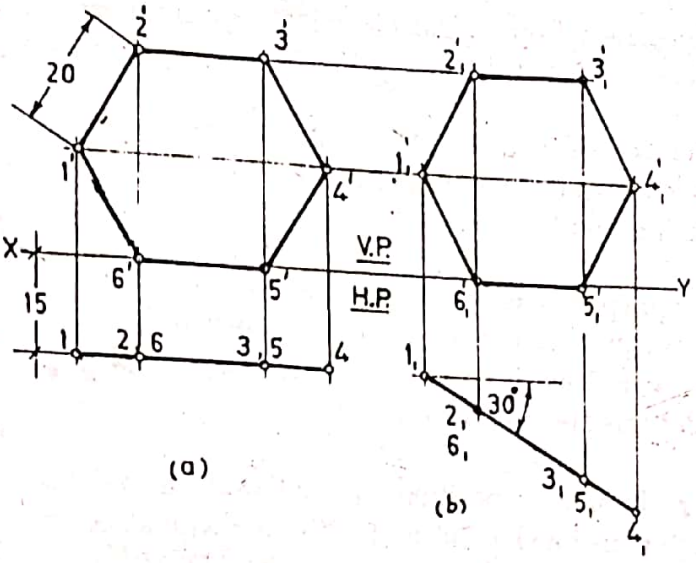


Fig 11.22

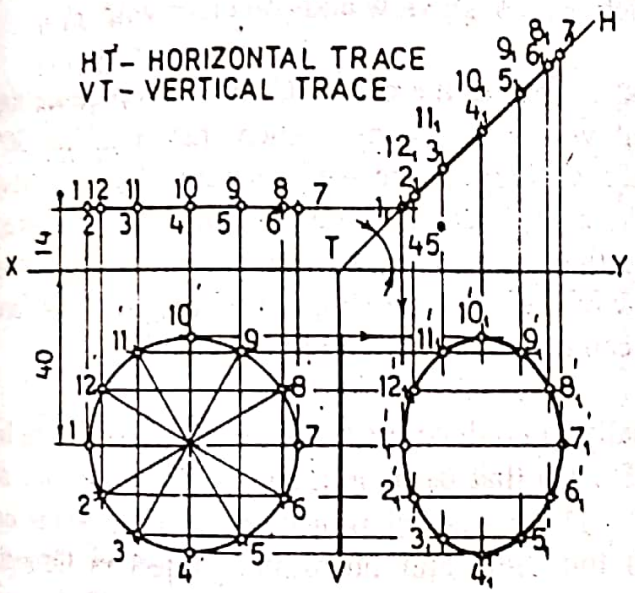


Fig 11.23 Third angle projection

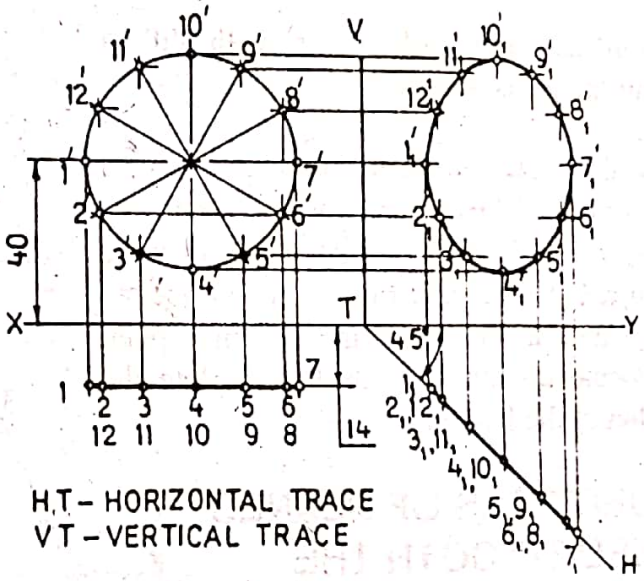


Fig 11.24 First angle projection

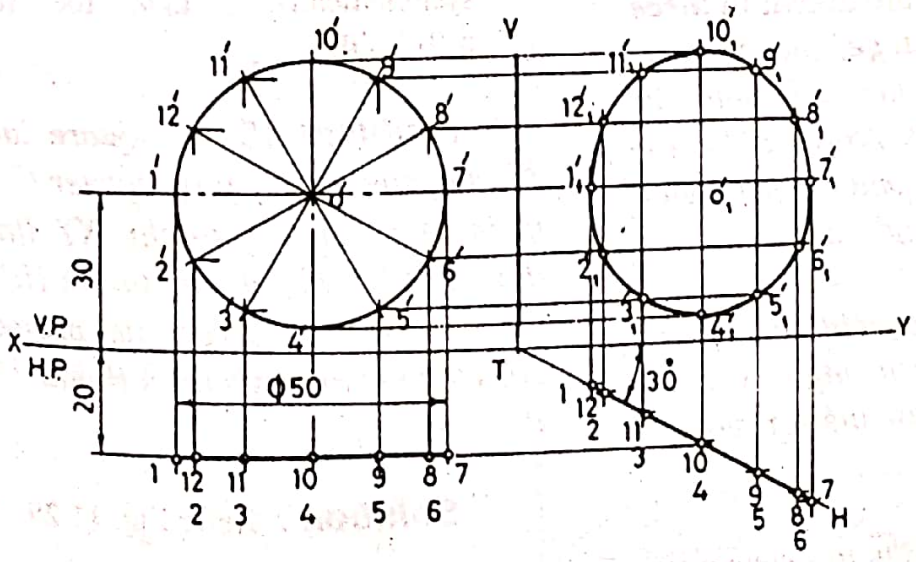


Fig 11.25