EXERCISES

7.1 Draw the projections of the following points, keeping the distance between the projectors as 25 on the same reference line.

A - 25 above H.P and 45 in front of V.P.

B - 35 above H.P and 50 behind V.P.

C - 40 below H.P and 30 behind V.P.

D - 30 below H.P and 40 in front of V.P.

E - 50 above H.P and on V.P.

F - 45 below H.P and on V.P.

G - on H.P and 35 in front of V.P.

H - on H.P and 25 behind V.P.

I - on both H.P and V.P.

7.2 State the quadrants in which the following points are located:

A - front and top views are above xy.

B - front view below xy and top view above xy.

C - front view above xy and top view below xy.

D - front and top views are below xy.

7.3 Mention the relative positions of the projections of the following points with respect to xy:

A - in the fourth quadant.

B - in the second quadrant.

C - in the third quadrant.

D - in the first quadrant.

7.4 Indicate the positions of the points shown in Fig. 7.16; with respect to the planes of projection.

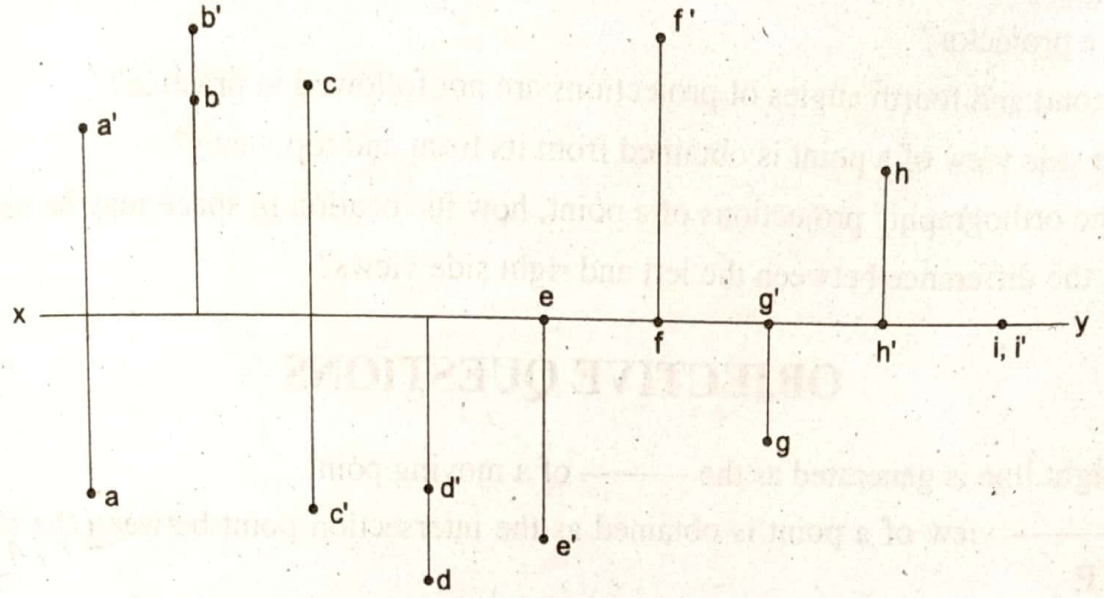

Fig. 7.16

7.5 A point at 25 above the reference line xy is the front view of two points A and B. The point A is 40 behind V.P and the point B is 50 in front of V.P. Draw the projections of the points and state their positions relative to the planes of projection and the quadrants in which they lie. (Aug/Sep 2008, June 2009, JNTU)

7.6 For the points A, B, C and D in Problem 7.1 and 7.2, add the left side views.

7.7 A point A is 40 above H.P and 25 in front of V.P. Another point B is 20 behind V.P and 30 below H.P. The horizontal distance between the points is 100. Draw the three projections of the points A and B and join their front views, top views and left side views.

7.8 Draw the projections of a point B, lying in first quadrant such that its shortest distance from the reference line XY is 50 and it is equi-distant from H.P and V.P. The point is 30 from P.P. Draw the projections of the point and determine its distances from H.P and V.P.

7.9 Two points P and Q are in the H.P. The point P is 30 in front of V.P and Q is behind the V.P. The distance between their projectors is 80 and line joining their top views makes an angle of 40° with xy. Find the distance of the point Q from the V.P. (June 2008, 2009, JNTU)

7.10 Two pegs fixed on a wall are 4.5m apart. The distance between the pegs measured parallel to the floor is 3.6m. If one peg is 1.5m above the floor, find the height of the second peg and the inclination of the line joining the two pegs, with the floor. (May/June 2008, JNTU)

7.11 A point P is 20 below the H.P and lies in the third quadrant. Its shortest distance from XY is 40. Draw its projections. (May/June 2008, JNTU)

PROJECTIONS OF STRAIGHT LINES

8.1 INTRODUCTION

In Chapter 7, it is stated that a straight line may be generated by a point moving in one direction. A straight line may also be defined as the shortest distance between two points. A straight line may be located in space either by specifying the location of the end points or by specifying the location of one end point and the direction.

8.2 TWO VIEW PROJECTIONS OF STRAIGHT LINES

The following are the possible positions of a straight line, with respect to the planes of projection:

1. Parallel to both the planes
2. Perpendicular to one plane
3. Inclined to one plane and parallel to the other
4. Inclined to both the planes
5. Contained by a plane, perpendicular to both the principal planes

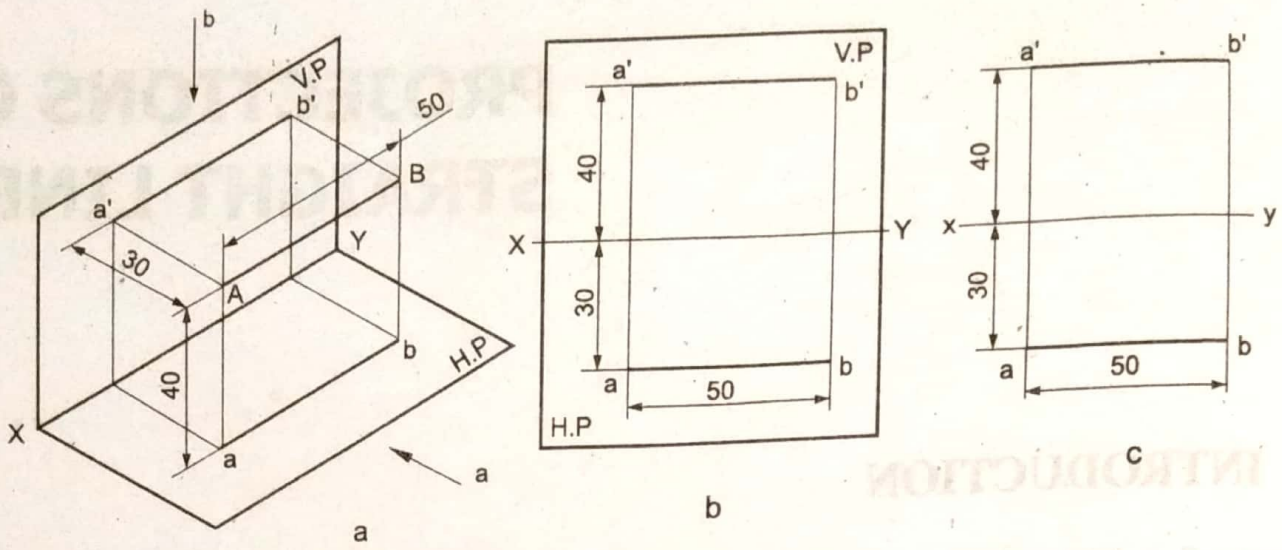

Fig. 8.1

Construction (Fig. 8.1c)

1. Draw the reference line xy and draw a projector at any convenient point on it.
2. Locate the projections of the end point A of the line a′ , at 40 above xy and a, at 30 below xy.
3. Through a′ and a, draw lines a′ b′ and ab, parallel to xy and of length 50.
4. Join the points b′ and b by a projector.

   a′ b′ and a b are the projections of the line AB.

8.2.2 Straight line perpendicular to one plane

When a line is perpendicular to one of the planes, it is evident that it is parallel to the other plane. Further, when a line is parallel to a plane, the length of the projection on that plane is equal to the true length of the line.

Problem 2 *A line AB of 25 long, is perpendicular to H.P and parallel to V.P. The end points A and B of the line are 35 and 10 above H.P respectively. The line is 20 in front of V.P. Draw the projections of the line.*

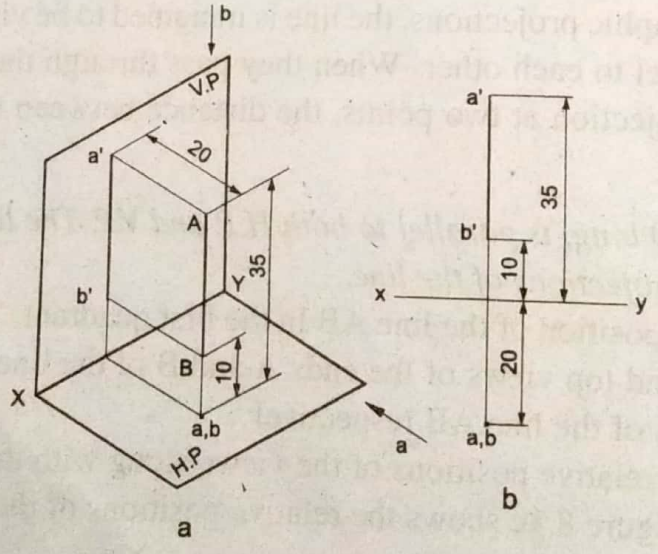

Fig. 8.2

Figure 8.2a shows the position of the line AB in the first quadrant. As the line is parallel to V.P, the length of the front view is equal to the true length of the line and the top view appears as a point.

Construction (Fig. 8.2b)

1. Draw the front view a′ b′ , a line perpendicular to xy such that, a′ and b′ are 35 and 10 above xy respectively.
2. Locate the top view of the line a, b; a point 20 below xy.

Problem 3 *A line AB of 25 long, is perpendicular to V.P and parallel to H.P. The end points A and B of the line are 10 and 35 in front of V.P respectively. The line is 20 above H.P. Draw its projections.*

Figure 8.3a shows the position of the line AB in the first quadrant. As the line is parallel to H.P, the length of the top view is equal to the true length of the line and the front view appears as a point.

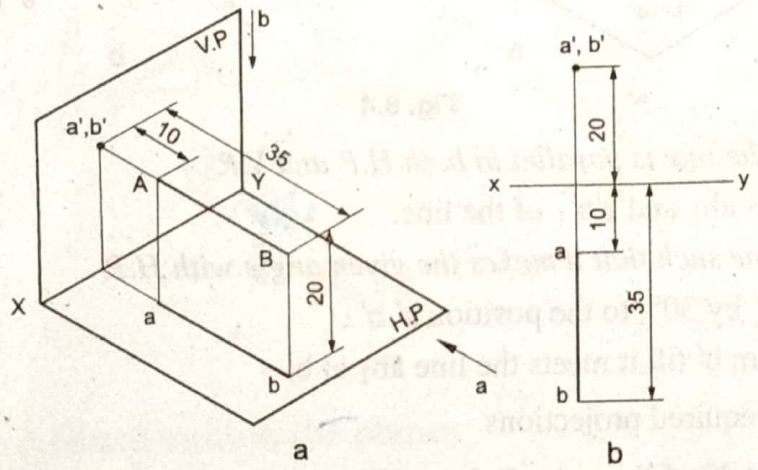

Fig. 8.3

Construction (Fig. 8.3b)

1. Draw the top view of the line ab, a line perpendicular to xy such that, a and b are 10 and 35 below xy respectively.
2. Locate the front view of the line a′, b′ ; a point 20 above xy.

NOTE In both the above cases, the projectors drawn, connecting both the views, intersect the reference line xy at right angle.

8.2.3 Straight line inclined to one plane and parallel to the other

The problems of this nature are normally solved in two stages. In the first stage, the line is assumed to be parallel to both the planes and projections are drawn. In the second stage, the line is rotated to make the required angle and the final views are obtained.

Problem 4 *A line AB is 30 long and inclined at 30° to H.P and parallel to V.P. The end A of the line is 15 above H.P and 20 in front of V.P. Draw the projections of the line.*

Figure 8.4a shows the position of the line in the first quadrant, along with the views obtained by projection on H.P and V.P.

Construction (Fig. 8.4b)

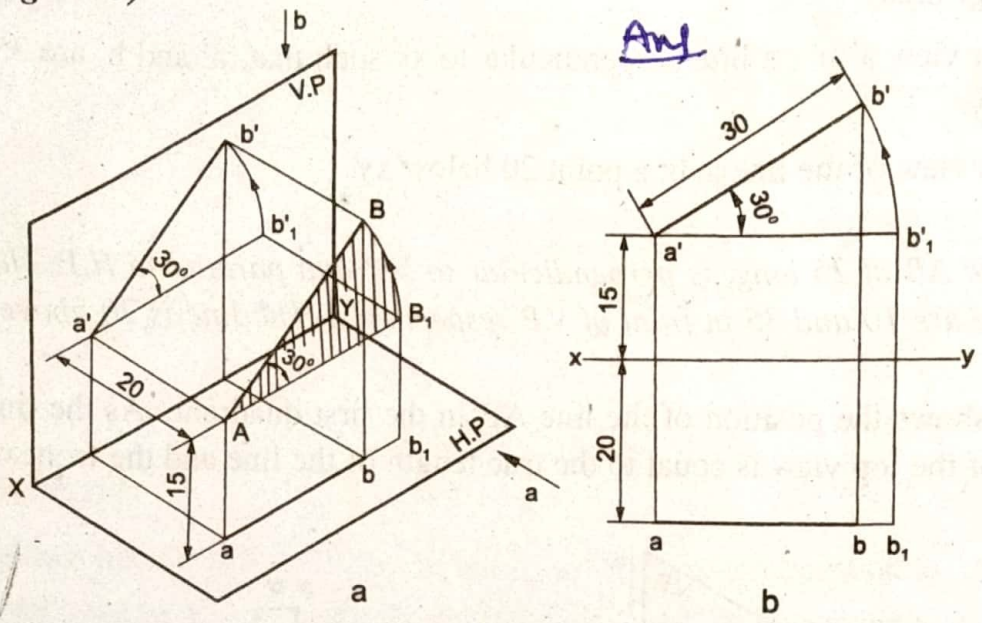

Fig. 8.4

Stage I *Assume that the line is parallel to both H.P and V.P.*

1. Draw the projections ab_1 and $a'b'_1$ of the line.

Stage II *Rotate the line such that it makes the given angle with H.P.*

2. Rotate the line $a'\ b_1'$ by 30°, to the position $a'\ b'$.
3. Drop a projector from b' till it meets the line ab_1 at b.

   $a'\ b'$ and ab are the required projections.

NOTE (i) The distance 20 of the point B from V.P remains unchanged, irrespective of the angle of inclination of the line with H.P. The actual position of b on ab_1 depends upon the angle θ . In other words, the line ab_1 may be termed as the locus of the top view of the end point B.

(ii) It may be noted that the length $a'\ b'$ is the true length of the given line AB and the inclination of the front view with xy is the true inclination of the line with H.P.

Problem 5 *A line AB is 30 long and inclined at 30° to V.P and parallel to H.P. The end A of the line is 15 above H.P and 20 in front of V.P. Draw its projections.*

Figure 8.5a shows the position of the line in the first quadrant, along with the views obtained by projection.

Construction (Fig. 8.5b)

1. Draw the projections $a'\ b_1'$ and ab_1 for the line, assuming that it is parallel to both H.P and V.P.
2. Rotate the line ab_1 by 30°, to the position ab.
3. Drop a projector from b till it meets the line $a'b_1'$ at b' .

   $a'b'$ and ab are the required projections.

NOTE

1. The line $a'\ b_1'$ is the locus of the front view of the end point B.
2. The length ab is the true length of the given line and the inclination of the top view with xy is the true inclination of the line with V.P.

Any !

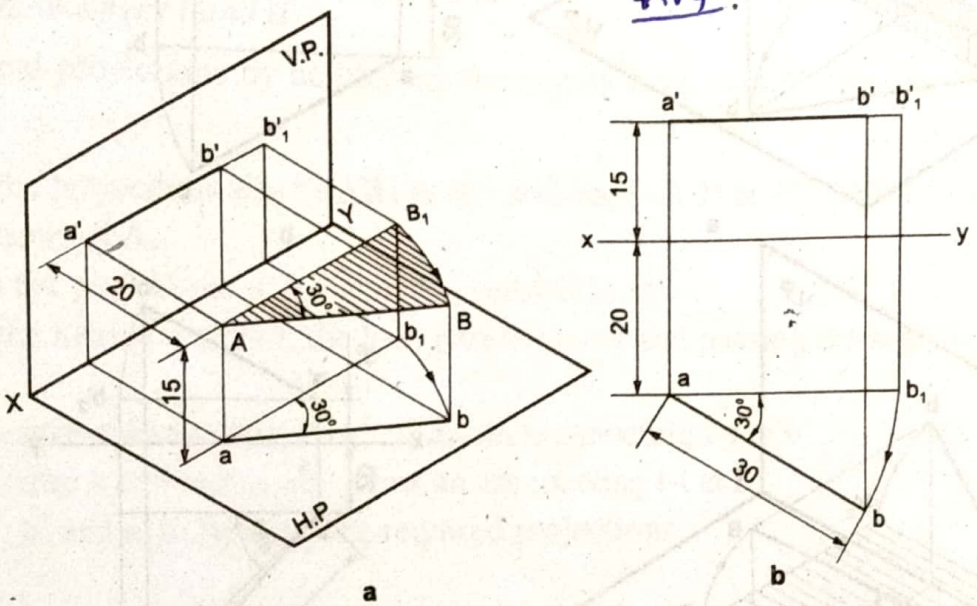

Fig. 8.5

8.2.4 Straight line inclined to both the planes

A line inclined to both H.P and V.P is called an oblique line. The methods discussed in the above two problems may be combined to draw the projections of oblique lines.

Problem 6 *A line AB of 100 length, is inclined at an angle of* 30° *to H.P and* 45° *to V.P. The point A is 15 above H.P and 20 in front of V.P. Draw the projections of the line.*

(May/June 2008, JNTU)

Construction (Fig. 8.6)

Stage I *Assume that the line is inclined at 30° to H.P and parallel to V.P*

1. Draw the projections $a'b_1'$ and ab_1 of the line $AB_1 = AB$ (Figs. 8.6a,b).

   Keeping the inclination 30° constant, rotate the line AB_1 to AB, till it is inclined at 45° to V.P. This process of rotation does not change the length of the top view ab_1 and the distance of the point B_1 (=B) from H.P. Hence, (i) the length of ab_1 is the final length of the top view and (ii) the line f-f, parallel to xy and passing through b_1' is the locus of the front view of the end point B.

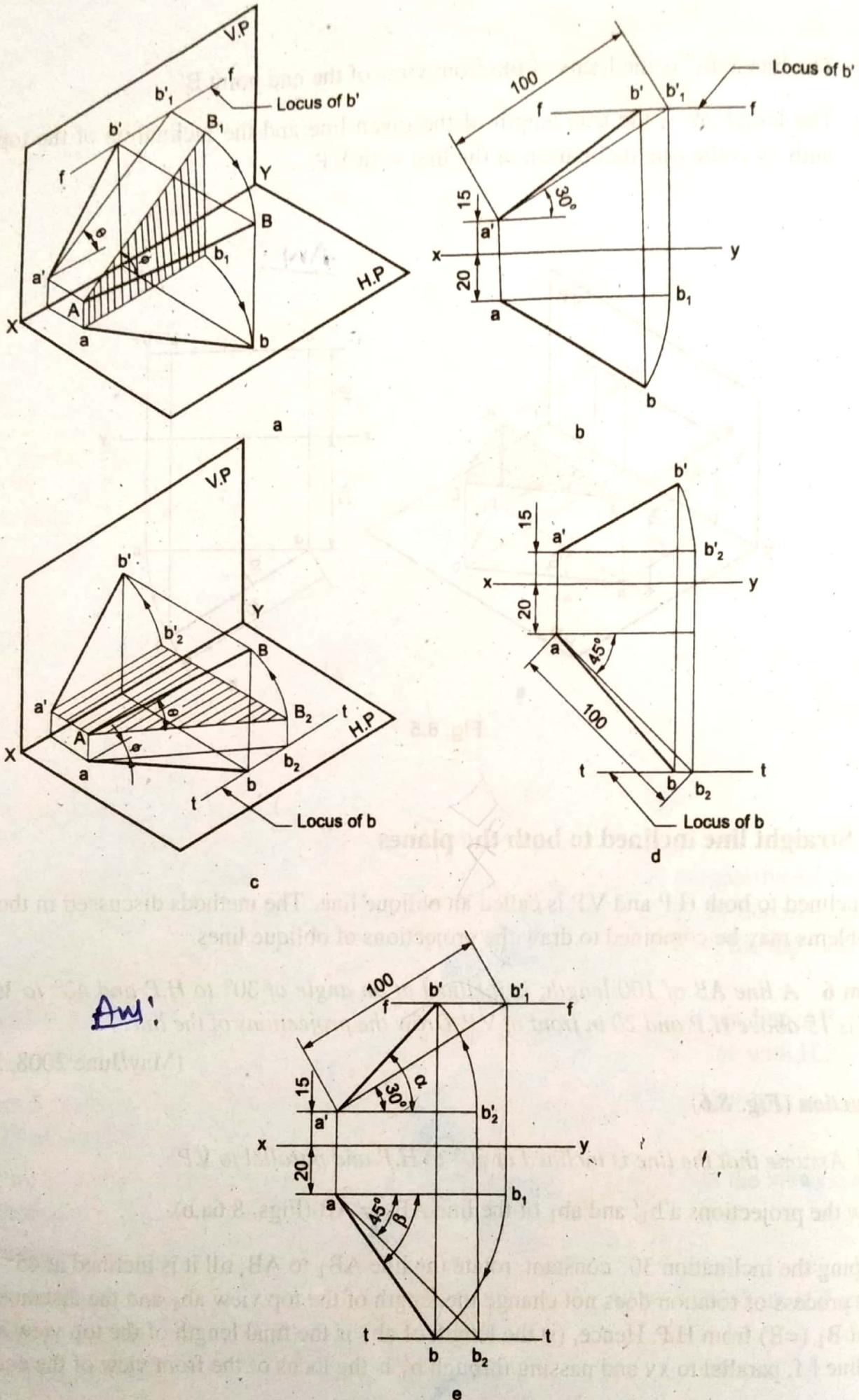
V.P
H.P
X
Y
f
b'1
b'
B1
B
b1
a'
A
a
b
Locus of b'
θ
a
100
15
20
30°
x
y
b1
b'2
B2
b2
t
45°
β
Locus of b
Aw!

Fig. 8.6

Problem 20 *A line AB of 80 long, has its end A, 15 from both H.P and V.P. The other end B is 40 above H.P and 50 in front of V.P. Draw the projections of the line and determine the inclinations of the line with H.P and V.P.*

Construction (Fig. 8.30)

(i) Locate the projections a' and a of the end A of the line AB.

(ii) Draw the loci f-f and t-t of the front and top views of the end B respectively.

(iii) With centre a' and radius 80, draw an arc intersecting f-f at b_1'.

(iv) Join a', b_1' and measure its inclination θ with xy.

(v) With centre a and radius 80, draw an arc intersecting t-t at b_2.

(vi) Join a, b_2 and measure its inclination ϕ with xy.

(vii) Obtain the projections a' b' and ab of the line AB, following the principle of Construction:

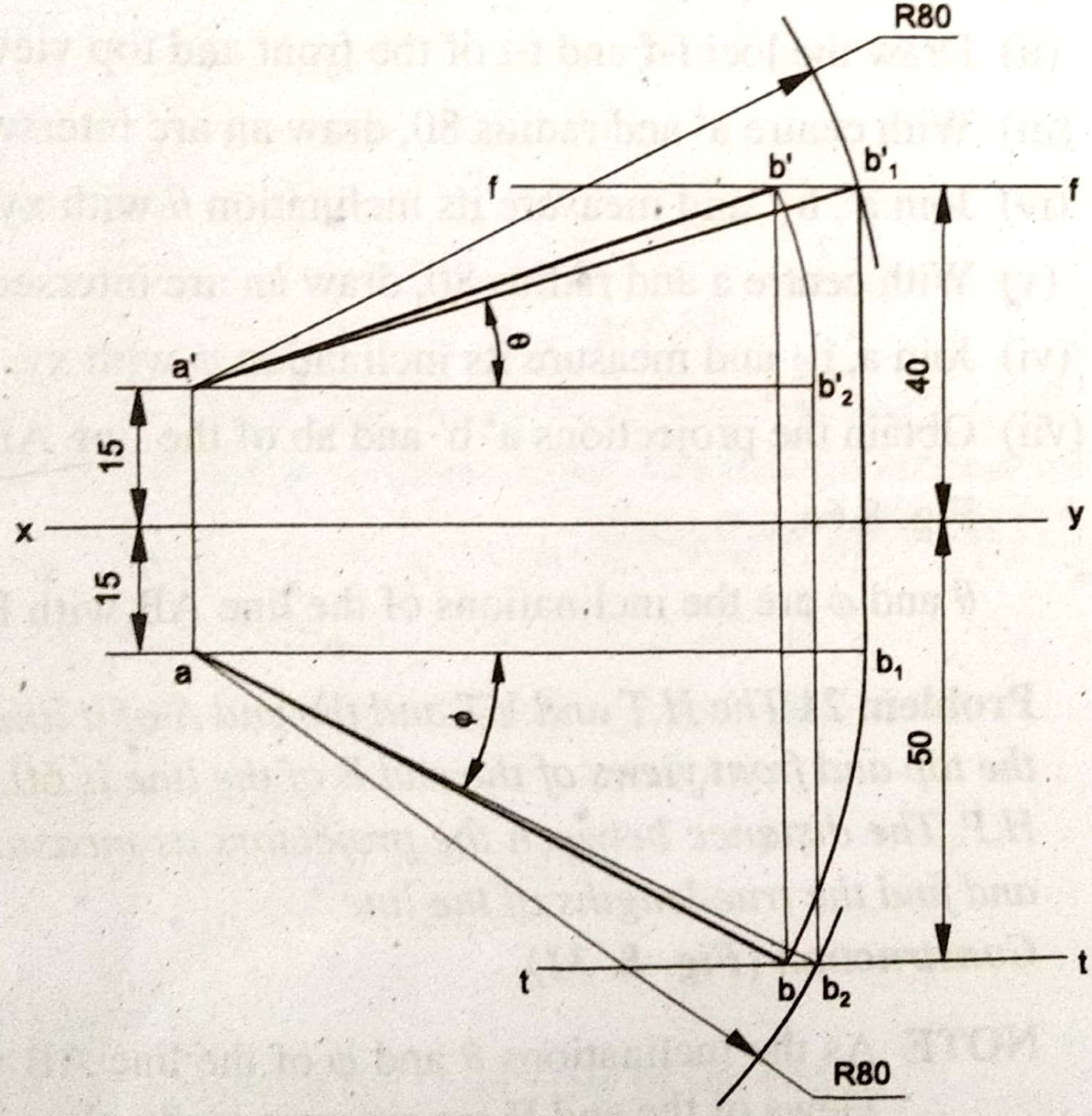

Fig. 8.30

(iii) Locate a′ on the line h-V.T and at 10 above xy.

(iv) Draw a projector through a′ and locate a on v-H.T.

(v) Draw another projector at 70 from a′ a, intersecting h-V.T at b′ and v-H.T at b.

a′ b′ and ab are the projections of the line.

(vi) Determine the true length and true inclinations of the line, following the method of Construction: Fig.8.9c.

Problem 40 *A line AB of 70 long, has its end A at 10 above H.P and 15 in front of V.P. Its front view and top view measure 50 and 60 respectively. Draw the projections of the line and determine its inclinations with H.P and V.P.* (May/June 2008, 2012, JNTU)

Construction (Fig. 8.50)

(i) Draw the reference line xy and locate the projections a,′ a of the end A.

(ii) Draw a′ b_2′ (=50), parallel to xy, representing the length of the front view.

(iii) With centre a and radius 70 (true length), draw an arc intersecting the projector through b_2′ at b_2.

(iv) Join a, b_2.

Inclination ϕ of the line ab_2 with xy, represents the true inclination of the line with V.P.

(v) Draw ab_1 (=60), parallel to xy, representing the length of the top view.

(vi) With centre a′ and radius 70 (true length), draw an arc intersecting the projector through b_1 at b_1′.

The inclination θ of the line a′ b_1′ with xy represents the true inclination of the line with H.P.

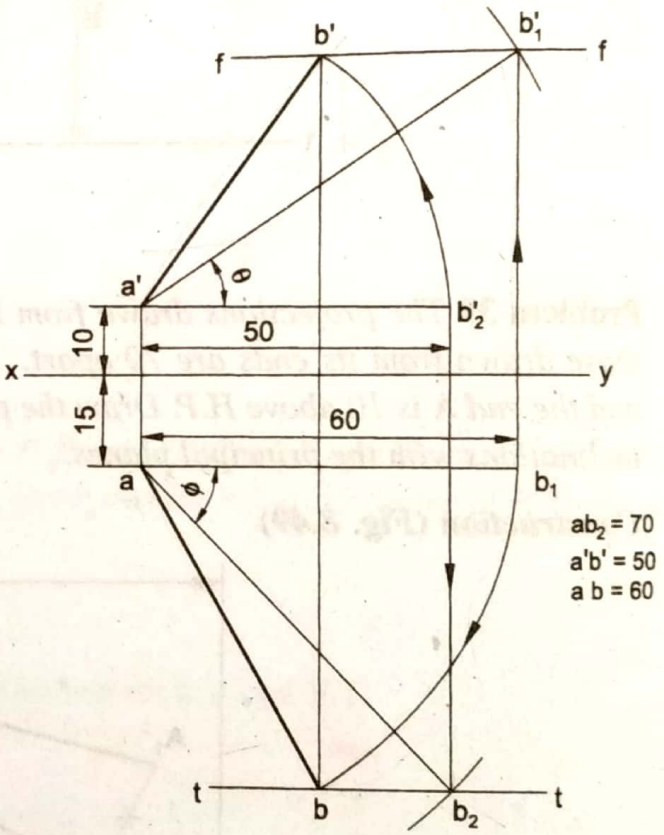

Fig. 8.50

(vii) Through b_1′, draw the line f-f; representing the locus of front view of B.

(viii) Through b_2, draw the line t-t representing the locus of top view of B.

(ix) With centre a′ and radius a′b_2′ , draw an arc intersecting f-f at b′.

(x) Join a′, b′; representing the front view of the line.

(xi) With centre a and radius ab_1, draw an arc intersecting t-t at b.

(xii) Join a, b; representing the top view of the line.

PROJECTIONS OF PLANES

9.1 INTRODUCTION

In structural design, it is necessary to know the representation of plane surfaces of different shapes in all the possible orientations. The treatment presented here is based on the principles dealt with, in the preceding two chapters.

Plane surfaces have two dimensions, viz., length and breadth; the third dimension, the thickness being zero. Plane surfaces may be considered of infinite sizes. However, for convenience, segments of planes only are considered in the treatment presented here. Planes are represented in space by the following:

a - three points, not on a straight line

b - two intersecting lines

c - a line and a point

d - two parallel lines

The front and top views for the above cases are shown in Fig. 9.1.

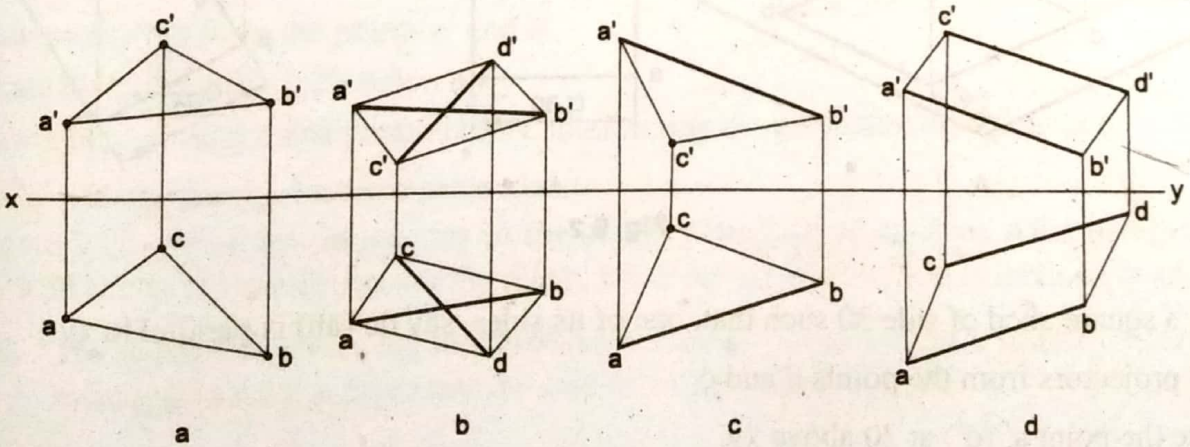

Fig. 9.1

1. Plane parallel to one of the principal planes and perpendicular to the other
2. Plane inclined to one of the principal planes and perpendicular to the other
3. Plane perpendicular to both the principal planes
4. Plane inclined to both the principal planes

9.2.1 Plane parallel to one of the principal planes and perpendicular to the other

9. 2. 1. 1 *Plane parallel to H.P and perpendicular to V.P*

Problem 1 *A square plane ABCD of side 30, is parallel to H.P and 20 away from it. Draw the projections of the plane, when two of its sides are (i) parallel to V.P and (ii) inclined at* 30° *to V.P.*

Figure 9.2a shows the first quadrant with the plane ABCD, such that two of its sides are parallel to V.P. As the plane is parallel to H.P, its projection on H.P, viz., the top view reveals the true shape of the plane. The front view appears as a straight line, parallel to xy.

Construction (Fig. 9.2b)

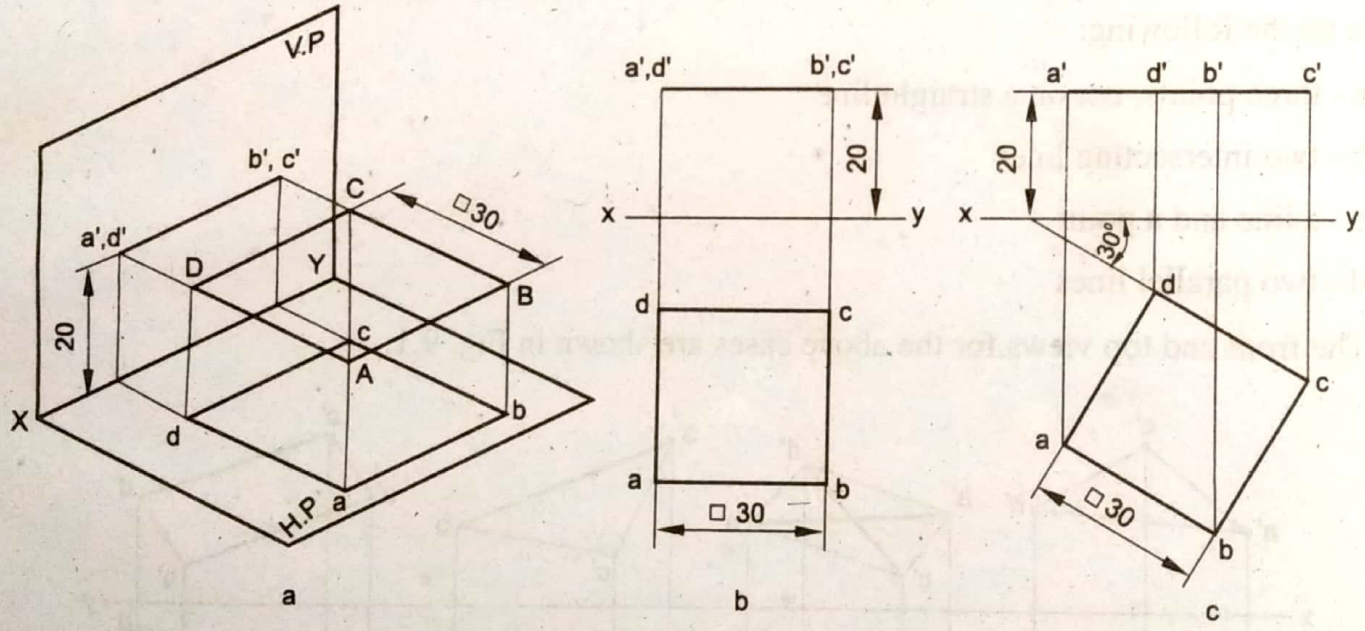

Fig. 9.2

1. Draw a square abcd of side 30 such that, one of its sides, say dc (ab) is parallel to xy.
2. Draw projectors from the points d and c.
3. Locate the point a′ (d′) at 20 above xy.
4. Draw a line through a′ and parallel to xy, intersecting the projector through c at b′ (c′).

   a′ b′ c′ d′ and abcd are the required projections.

Figure 9.2c shows the projections of the plane, when two of its sides are inclined at 30° to V.P.

NOTE When the inclination ϕ of the side dc with xy is 45°, then all the sides of the plane are said to be equally inclined to V.P.

9. 2. 1. 2 *Plane parallel to V.P and perpendicular to H.P*

Problem 2 *An equilateral triangular plane ABC of side 40, has its plane parallel to V.P and 20 away from it. Draw the projections of the plane when one of its sides is (i) perpendicular to H.P, (ii) parallel to H.P and (iii) inclined to H.P at an angle of 45°.* (Aug/Sep 2008, 2010, JNTU)

Figure 9.3a shows the first quadrant with the plane ABC such that, one of its sides is perpendicular to H.P. As the plane is parallel to V.P, its projection on V.P, i.e., the front view appears in its true shape. The top view appears as a straight line, parallel to xy.

Construction (Fig. 9.3b)

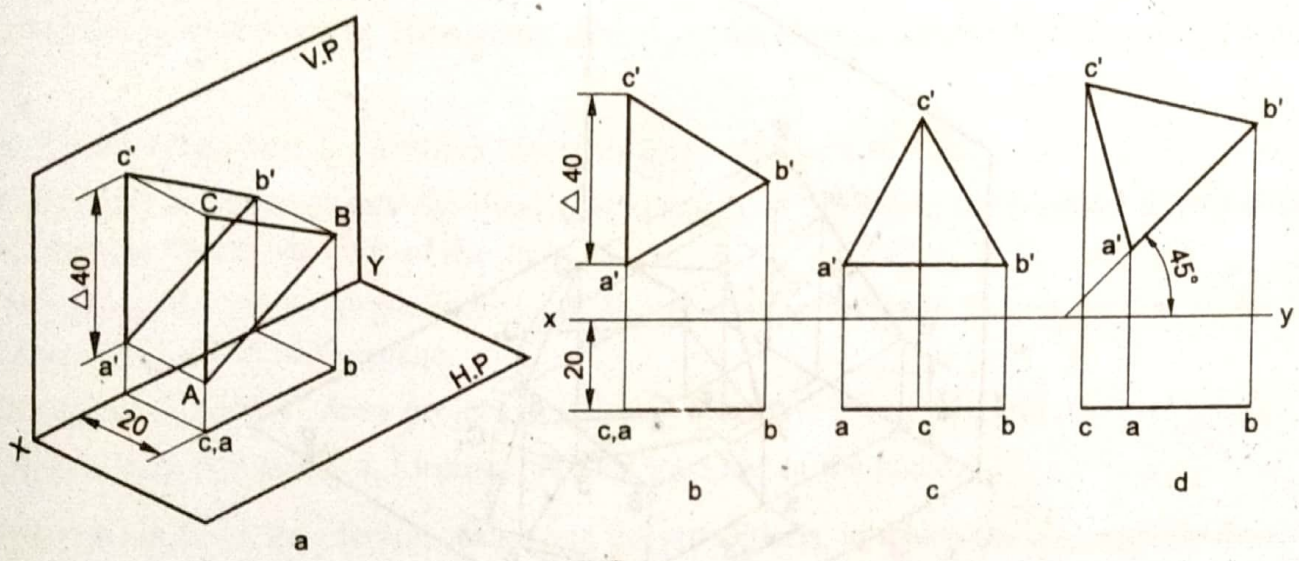

Fig. 9.3

1. Draw an equilateral triangle a′ b′ c′ of side 40 such that, one side, say a′ c′ is perpendicular to xy.
2. Draw projectors from the points a′ and b′.
3. Locate the point c (a) at 20 below xy.
4. Draw a line through c and parallel to xy, intersecting the projector through b′ at b.

a′ b′ c′ and abc are the required projections.

Figure 9.3c shows the projections of the plane, when one of its sides ABis parallel to H.P. Figure 9.3d shows the projections of the plane, when one of its sides AB is inclined at 45° to H.P.

NOTE The symbol □ preceding the dimension, represents the side of a square. Similarly, the symbol△ is used to represent the side of an equilateral triangle

9.2.2 Plane inclined to one of the principal planes and perpendicular to the other

9.2.2.1 *Plane inclined to H.P and perpendicular to V.P* The problems of this nature, as explained in the preceding chapter; are normally solved in two stages. In the first stage, the plane is assumed to be parallel to that plane to which it is actually inclined and projections are drawn. In the second stage, the plane is rotated till it makes the required angle with the plane and then the final views are obtained.

Problem 3 *Draw the projections of a regular pentagon of 25 side with its surface making an angle of 45° with H.P. One of the sides of the pentagon is parallel to H.P and 15 away from it.*

(Aug/Sep 2008, 2010, JNTU)

Figure 9.4a shows the first quadrant with the plane in it, depicting the two stages of obtaining the projections.

Construction (Fig. 9.4b)

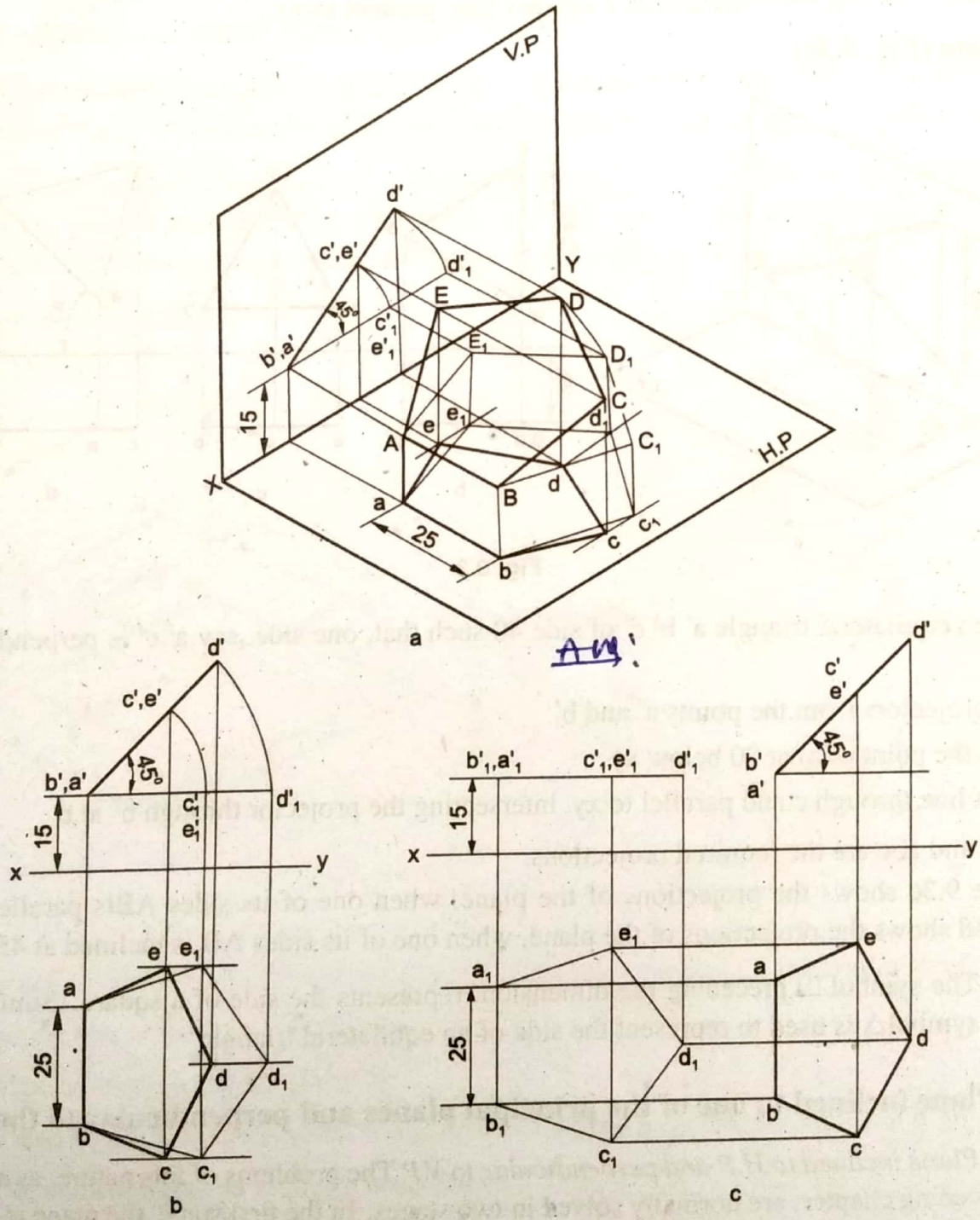

Fig. 9.4

Problem 11 *Draw the projections of a circle of 60 diameter, resting on V.P on a point on the circumference. The plane is inclined at 45° to V.P and perpendicular to H.P. The centre of the plane is 40 above H.P. Also locate its traces.* (May/June 2008, JNTU)

Construction (Fig. 9.14)

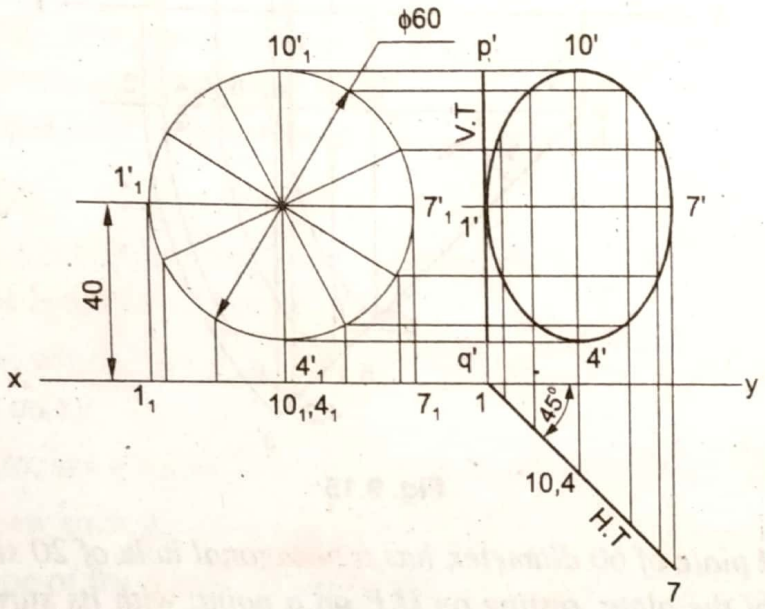

Fig. 9.14

1. Draw the projections of the circle, assuming it to be lying on V.P and with its centre at 40 above H.P.
2. Divide the circumference of the circle (front view) into some equal parts, say 12.
3. Transfer the division points on to the top view.
4. Redraw the top view such that, it makes an angle of 45° with xy and one end of it lies on xy. This forms the final top view.
5. Obtain the final front view, by projection.

The H.T coincides with the top view and the line p′ q′ represents the V.T of the plane.

Problem 33 *A circle of 40 diameter, is resting on H.P on a point, with its surface inclined at 30° to H.P. Draw the projections of the circle, when (i) the top view of the diameter, through the resting point, makes an angle of 45° with xy and (ii) the diameter passing through the resting point makes an angle of 45° with V.P.* (Aug/Sep 2008, JNTU)

Construction (Fig. 9.36)

1. Draw the projections of the circle, assuming it to be lying on H.P.
2. Redraw the front view, making 30° with xy and one end of it is lying on xy.
3. Obtain the second top view, by projection (Fig. 9.36a).

Case I

4. Redraw the second top view such that, the top view of the diameter a_1g_1 (=ag) makes 45° with xy. This is the final top view.
5. Obtain the final front view, by projection (Fig. 9.36b).

Case II

6. Determine the apparent angle of inclination β, which the diameter AB makes with V.P.
7. Redraw the second top view such that, the top view of the diameter, i.e., a_1 g_1 (=ag) makes β with xy. This is the final top view.
8. Obtain the final front view, by projection (Fig. 9.36c).

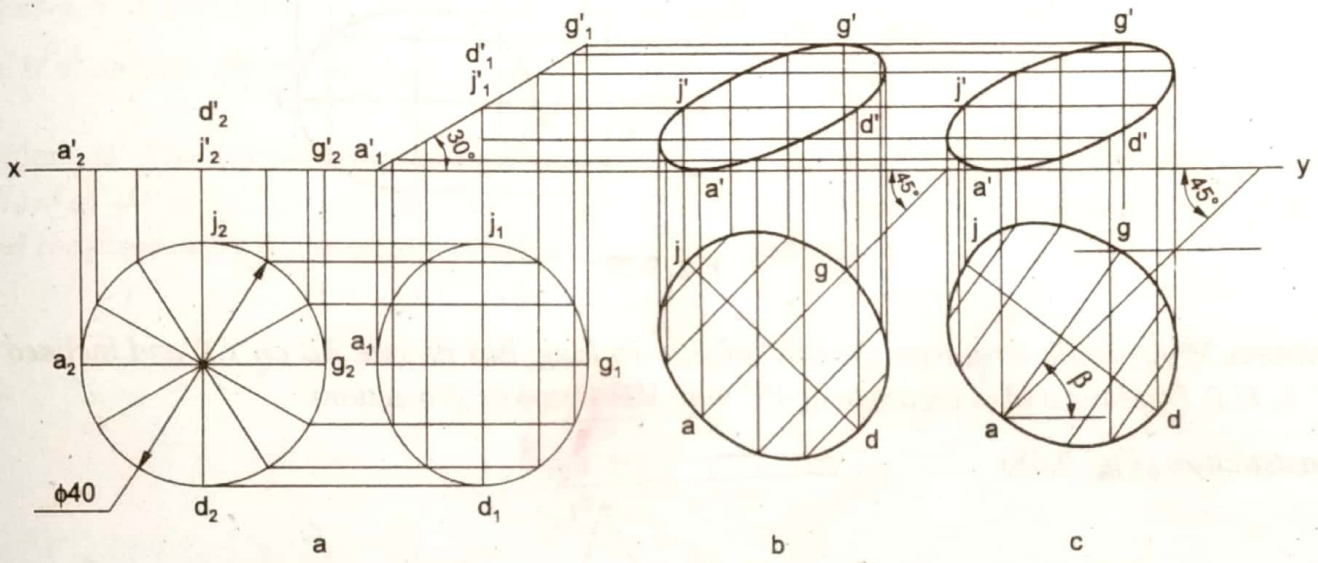

Fig. 9.36

Problem 34 *A circular plate of 50 diameter, appears as an ellipse in the front view, having its major axis 50 long and minor axis 30 long. Draw the top view, when the major axis of the ellipse is horizontal.* (May/June 2008, JNTU)

Construction (Fig. 9.37)

1. Draw the projections of the plate, assuming it to be parallel to V.P.
2. Locate $1_1'$ and $5_1'$ on the horizontal line through $1_2'$ ($5_2'$) such that, $1_1'\,5_1' = 30$, the minor axis of the ellipse.
3. Draw a projector through $5_1'$.
4. Locate the top view 1_1, by projection.
5. With 1_1 as centre and radius 1_25_2, draw an arc; intersecting the projector through $5_1'$ at 5_1.
6. Join 1_1, 5_1 forming the second top view. Locate the points 2_1,3_1, etc., on this view.
7. Obtain the second front view, by projection. Obviously, the shape of this view is an ellipse with major axis equal to 50.
8. Redraw the final front view such that, the major axis 3′-7′ is horizontal (parallel to xy).

9. Obtain the final top view, by projection.

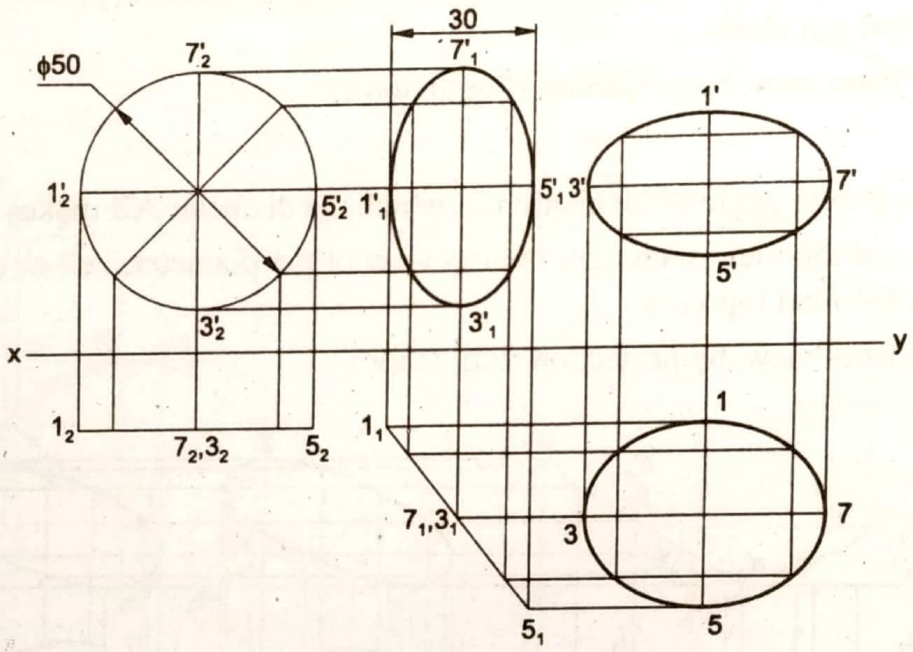

Fig. 9.37