

# PROJECTIONS LINES AND PLANES AND THEIR TRACES

## 3.1 INTRODUCTION OF PROJECTIONS LINES

A straight line is a set of collinear points having some definite length. Definite length of line is given by distance between end points. Hence if the projections of end points are known then projection of straight lines can be drawn easily by joining projection of respective end points.



Fig. 3.1

## 3.2 PROJECTIONS OF STRAIGHT LINES (FIRST QUADRANT ONLY)

### 3.2.1 Line is Parallel to Both the H.P. and the V.P.

**Problem 3.1:** A 60 mm long line  $AB_0$  is parallel to both the H.P. and the V.P. and 50 mm from H.P. and 30 mm from V.P. Draw the projections of line AB by using first angle projection method.

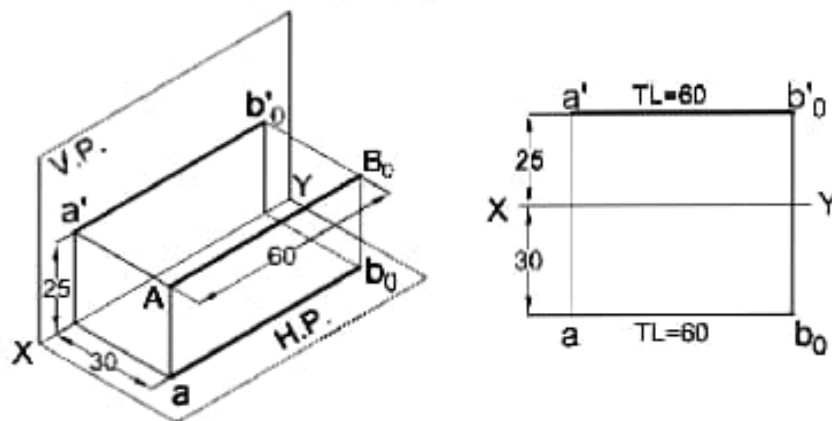


Fig. 3.2

#### Conclusions:

- If a line is parallel to the H.P., its elevation is parallel to the xy line and the projection on the H.P. (i.e. plan) will show its True Length.
- If a line is parallel to the V.P., its plan is parallel to the xy line and the projection on the V.P. (i.e. elevation) will show its True Length.

### 3.2.2 Line is Inclined to the H.P. ( $\theta$ ) and Parallel to the V.P.

**Problem 3.2:** A 76 mm long line  $AB_1$  is inclined at  $30^\circ$  to the H.P. and parallel to the V.P. Its one end is 25 mm above the H.P. and 30 mm in front of the V.P. draw its projections.

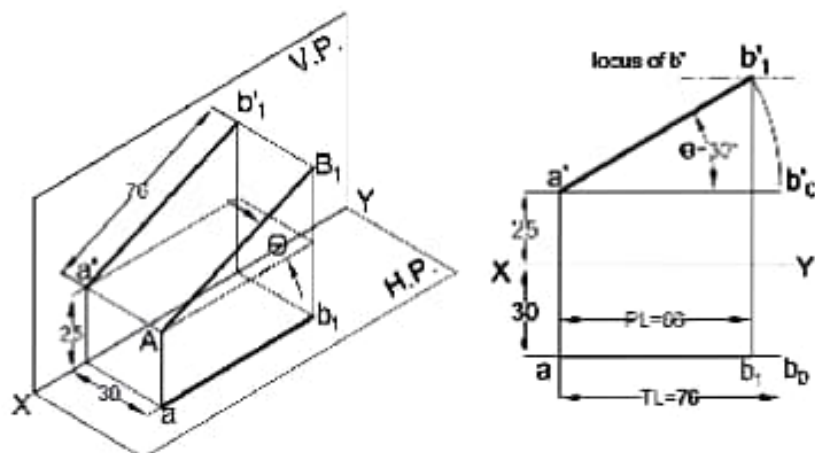


Fig. 3.3

**Conclusions:**

- If a line is inclined to the H.P. ( $\theta$ ), its T.L. in elevation will show this angle and plan will be shorter than T.L.

**3.2.3 Line is parallel to the H.P. and Inclined to the V.P.**

**Problem 3.3:** A 60 mm long line AB is inclined at  $30^\circ$  to the V.P. and parallel to the H.P. and is in the first quadrant. End A is 25 mm above the H.P. and 30 mm in front of the V.P. Draw projection.

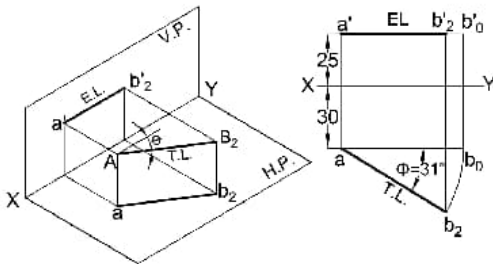


Fig. 3.4

**Conclusions:**

- If line is inclined to the VP ( $\phi$ ), in plan TL will show this angle and elevation will be shorter than TL.

**3.3 OBLIQUE LINES (FIRST QUADRANT ONLY)**

- When the line is inclined to both the reference planes (i.e.  $\theta$  and  $\phi$ ) then that line is called the Oblique Line.
- The oblique line problem is solved in three stages.

Stage 1 : Assume line parallel to both the reference planes.

Stage 2 : Line Incline with first reference plane, keeping it parallel to the second reference plane.

Stage 3 : Line inclined with second reference plane, keeping it parallel to the first reference plane.

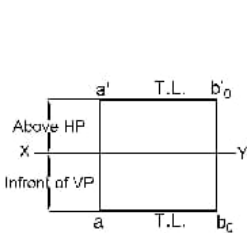
**3.3.1 Reference Diagram for Projection of Oblique Lines Procedure**

Fig. 3.5

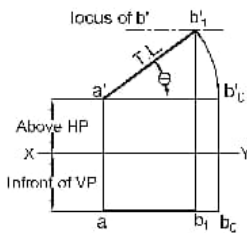


Fig. 3.6

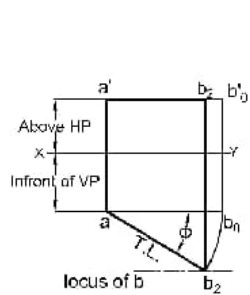


Fig. 3.7

**Stage 1 : Line  $l^{th}$  to HP & VP (Refer Fig. 3.5)**

- Draw the projections of Point A as  $a'$  at above HP and  $a$  at in front of VP distance.
- Line  $AB_0$  is same length as AB and considered parallel to both the H.P. and V.P. Projections of this line  $AB_0$  are  $a'b'_0$  and  $ab_0$ .

**Stage 2 : Line Incline with HP &  $\Pi^{st}$  to the VP. (Refer Fig. 3.6)**

3. (Repeat stage 1 and stage 2.)
4. From point  $a'$ , Draw line at an angle of ' $\theta$ ' and cut it with  $a'b_0'$ .
5. Name the intersection point i.e.  $b_1'$ . Line  $a'b_1'$  is same as TL.
6. Draw projector vertically downward from  $b_1'$  till it intersects  $ab_0$ . Name the intersection point i.e.  $b_1$ . Now  $ab_1 = PL$ .
7. Draw locus of  $b'$  through  $b_1'$  and  $\Pi^{el}$  to the XY Line.

**Stage 3 : Line inclined with VP &  $\Pi^{st}$  to HP. (Refer Fig. 3.7)**

8. Repeat stage 1 and stage 2.
9. From point  $a$ , Draw line at an angle of  $\phi$  and cut it with a TL i.e.  $ab_0$ .
10. Name the intersection point i.e.  $b_2$ . Line  $ab_2$  is same as TL.
11. Draw projector vertically up from  $b_2$  till it intersects with  $a'b_0'$ .
12. Name the intersection point i.e.  $b_2'$ . Now  $a'b_2' = EL$ .
13. Draw locus of  $b$  through  $b_2$  and  $\Pi^{el}$  to the XY Line.

**Final Stage: Reference Diagram**

14. Combine stage I, II and III. (Refer Fig. 3.7)
15. With centre  $a'$  and length  $a'b_2'$  (EL) cut the locus of  $b'$ . Name the intersection point i.e.  $b'$ .
16. Join  $a'b'$  to get the FV.
17. With centre  $a$  and length  $ab_1$  cut the locus of  $b$ . Name the intersection point i.e.  $b$ .
18. Join  $ab$  to get the TV.

Fig. 3.8 represents **Reference Diagram** for projection of Oblique Line.

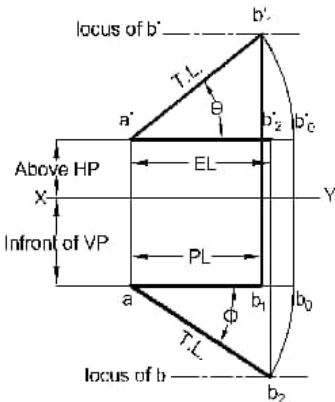


Fig. 3.8

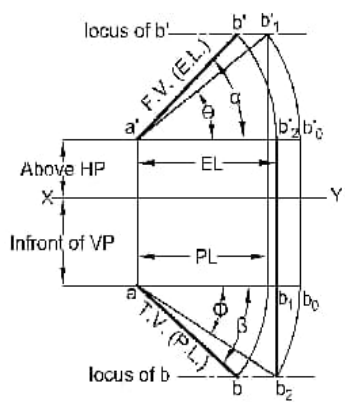


Fig. 3.9

**Stage 2 : Line Incline with HP &  $\Pi^{el}$  to the VP. (Refer Fig. 3.6)**

3. (Repeat stage 1 and stage 2.)
4. From point  $a'$ , Draw line at an angle of ' $\theta$ ' and cut it with  $a'b_0'$ .
5. Name the intersection point i.e.  $b_1'$ . Line  $a'b_1'$  is same as TL.
6. Draw projector vertically downward from  $b_1'$  till it intersects  $ab_0$ . Name the intersection point i.e.  $b_1$ . Now  $ab_1 = PL$ .
7. Draw locus of  $b'$  through  $b_1'$  and  $\Pi^{el}$  to the XY Line.

**Stage 3 : Line inclined with VP &  $\Pi^{el}$  to HP. (Refer Fig. 3.7)**

8. Repeat stage 1 and stage 2.
9. From point  $a$ , Draw line at an angle of  $\phi$  and cut it with a TL i.e.  $ab_0$ .
10. Name the intersection point i.e.  $b_2$ . Line  $ab_2$  is same as TL.
11. Draw projector vertically up from  $b_2$  till it intersects with  $a'b_0'$ .
12. Name the intersection point i.e.  $b_2'$ . Now  $a'b_2' = EL$ .
13. Draw locus of  $b$  through  $b_2$  and  $\Pi^{el}$  to the XY Line.

**Final Stage: Reference Diagram**

14. Combine stage I, II and III. (Refer Fig. 3.7)
15. With centre  $a'$  and length  $a'b_2'$  (EL) cut the locus of  $b'$ . Name the intersection point i.e.  $b'$ .
16. Join  $a'b'$  to get the FV.
17. With centre  $a$  and length  $ab_1$  cut the locus of  $b$ . Name the intersection point i.e.  $b$ .
18. Join  $ab$  to get the TV.

Fig. 3.8 represents **Reference Diagram** for projection of Oblique Line.

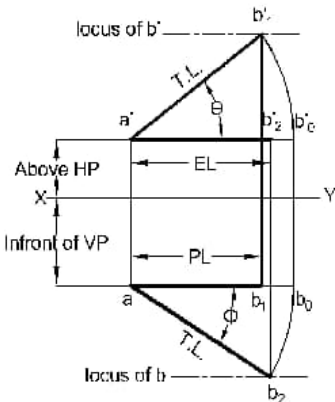


Fig. 3.8

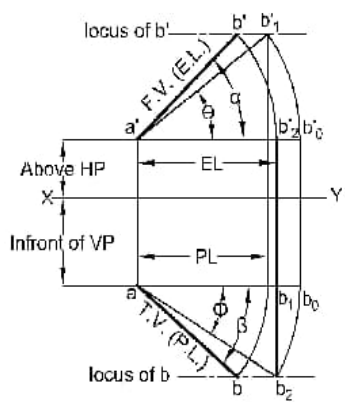


Fig. 3.9

**Problem 3.4 :** A line AB is 100 mm long. It is inclined at  $40^\circ$  to the H.P. and  $30^\circ$  to the V.P. The end A is 10 mm above H.P. and 25 mm in front of V.P. Assuming end B in the first quadrant, draw the projections of the line AB & locate Traces

Given Data	Significance
AB = 100mm	$ab_0 = a'b_0' = a'b_1' = b_2$
$\theta = 40^\circ$	$a'b_1'$ is $40^\circ$ to the XY
$\phi = 30^\circ$	$ab_2$ is $30^\circ$ to the XY
A is 10 mm above H.P.	$a'$ is 10 mm above XY
A is 25 mm in front of V.P.	$a$ is 25 mm below XY

**Solution:**

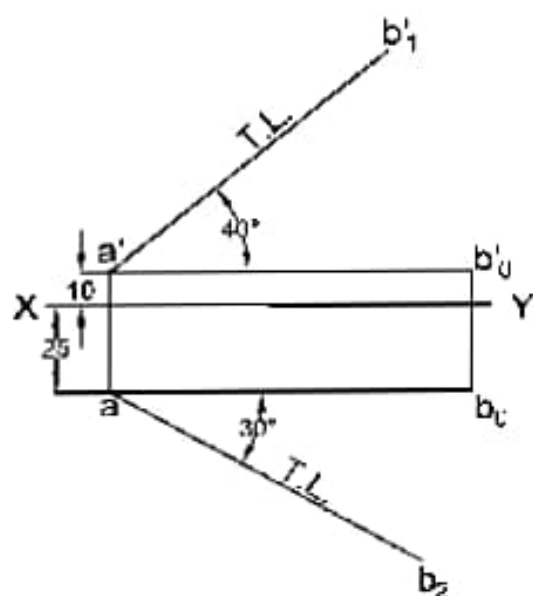


Fig. 3.10

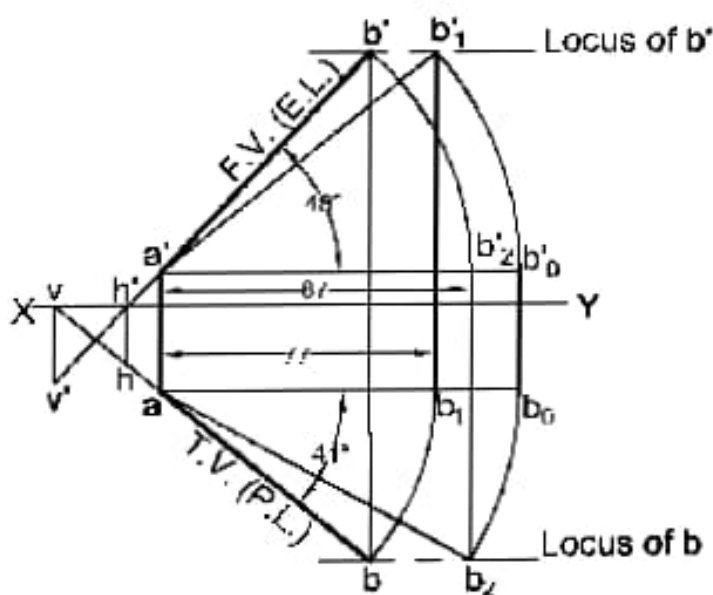


Fig. 3.11

**Step 1 : Draw given data (Fig. 3.10)**

1. Follow steps given in Stage I ( Section 3.3.1)
2. Follow step 4 & step 9 given in Stage II and Stage III ( Section 3.3.1)

**Step 2 : Draw Complete Reference diagram (Fig. 3.11)**

3. Follow step 5 to step 7 given in Stage II ( Section 3.3.1)
4. Follow step 10 to step 13 given in Stage III (Section 3.3.1)
5. Complete final stage (Section 3.3.1)

**Type II: Problems Based on EL and PL**

**Problem 3.5:** A line AB is 100 mm long. The end A is 10 mm above H.P. and 25 mm in front of V.P. Elevation length and plan length of the line are 87mm and 77mm respectively. Draw the projections of the line AB & locate Traces.

Given Data	Significance
AB = 100mm	$ab_0 = a'b_0' = a'b_1' = ab_2$
EL = 87	$a'b_2' = a'b' = 87$
PL = 77	$ab_1 = ab = 77$
A is 10 mm above H.P.	$a'$ is 10 mm above XY
A is 25 mm in front of V.P.	$a$ is 10 mm above XY

**Solution:**

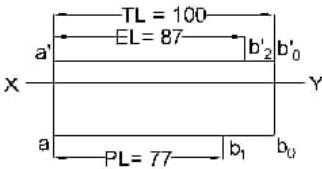


Fig. 3.12

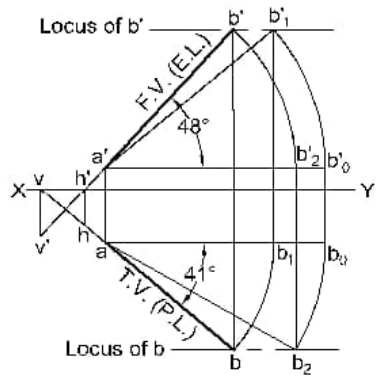


Fig. 3.13

**Step 1 : Draw given data (Refer Fig. 3.12)**

1. Follow steps given in Stage I (Section 3.3.1)
2. Draw EL = 87 measured from point  $a'$  & on  $a'b_0'$ . Plot point  $b_2'$ .
3. Draw PL = 77 measured from point  $a$  & on  $ab_0$ . Plot point  $b_1$ .

**Step 2 : Draw Complete Reference diagram (Refer Fig. 3.13)**

4. Draw Projector vertically upward from  $b_1$  & cut it by  $a'b_0'$  with centre as  $a'$ . Name the intersection point i.e.  $b_1'$ .
5. Draw Projector vertically downward from  $b_2'$  & cut it by  $ab_0$  with centre as  $a$ . Name the intersection point i.e.  $b_2$ .
6. Follow step 7 & 13 from Stage II & Stage III (Section 3.3.1)
7. Complete final stage (Section 3.3.1)

**Type III: When  $a'$ ,  $a$  & Locus of Other End Point (i.e.  $b'$  /  $b$ ) given**

**Problem 3.6:** A line AB 65 mm long has its end point A 25 mm above HP and 20 mm in front of VP. End point B is 60 mm above HP and 50 mm in front of VP. Draw the projections of the line AB assuming it to be in the first quadrant.

Given Data	Significance
AB = 65mm	$ab_0 = a'b'_0 = a'b'_1 = ab_2$
A 25 mm above HP	$a'$ is 25 mm above XY
A 20 mm in front of VP	$a$ is 20 mm above XY
B is 60 mm above HP	$b'$ is 60 mm above XY
B 50 mm in front of VP	$b$ is 50 mm above XY

**Solution:**

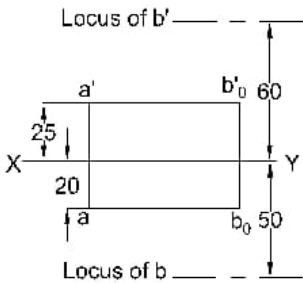


Fig. 3.14

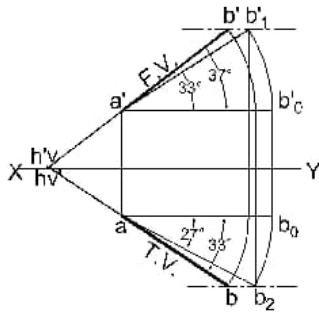


Fig. 3.15

**Step 1 : Draw given data (Fig. 3.14)**

1. Follow steps given in Stage I (Section 3.3.1)
2. Draw Locus of  $b'$  60 mm above XY.
3. Draw Locus of  $b$  50 mm above XY.

**Step 2 : Draw Complete Reference diagram (Fig. 3.15)**

4. Cut Locus of  $b'$  by  $a'b'_0$  with centre as  $a'$ . Name the intersection point i.e.  $b'_1$ . Draw Projector vertically downward from  $b'_1$  till it intersects with  $ab_0$ . Name the intersection point i.e.  $b_1$ .
5. Cut Locus of  $b$  by  $ab_0$  with centre as  $a$ . Name the intersection point i.e.  $b_2$ .
6. Draw Projector vertically upward from  $b_2$  till it intersects with  $ab_0$ . Name the intersection point i.e.  $b_1$ .
7. Complete final stage (Section 3.3.1)

**Type IV: Problems Based on  $\alpha$  (FV inclination) &  $\beta$  (TV inclination)**

**Problem 3.7 :** A line AB has its end point A on the HP and 25 mm in front of VP. The length of line AB in the plan is 50 mm and in elevation is 60 mm. The plan of the line is making an angle of  $30^\circ$  to the XY line. Draw the projections of the line And locate its traces.

Given Data	Significance
A is on HP	$a'$ is on XY
A 25 mm in front of VP	$a$ is 25 mm below XY
PL = 50	$ab = ab_1$
EL = 60	$a'b' = a'b_2'$
$\beta = 30^\circ$	$ab$ is at $30^\circ$ to XY

**Solution:**

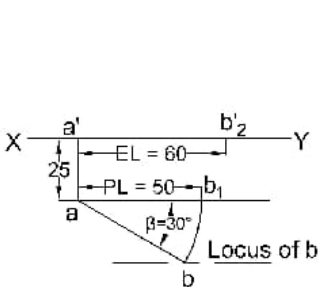


Fig. 3.16

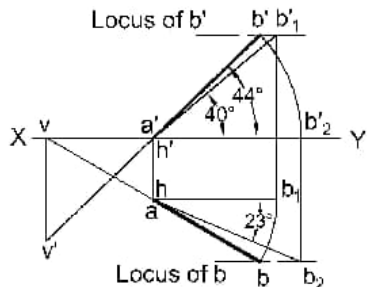


Fig. 3.17

**Step 1 : Draw given data (Fig. 3.16)**

1. Follow step1 given in Stage I ( Section 3.3.1)
2. Follow step 2 & 3 given in problem 2 (Type II)
3. Draw line at  $\beta = 30^\circ$  from point a & cut it with PL. Name the intersection point i.e. b.
4. Follow step 13 from Stage III ( Section 3.3.1)

**Step 2 : Draw Complete Reference diagram (Fig. 3.17)**

5. Draw Projector vertically downward from  $b_2'$  & cut locus of b. Name the intersection point i.e.  $b_2$ .
6. Join  $ab_2$  to get the TL as well as  $\Phi$ .
7. Follow step 4 given in problem 2 (Type II)
8. Follow step 7 from Stage II ( Section 3.3.1)
9. Follow step 15 & 16 given in Stage III (Section 3.3.1)



**Type V: Problems Based on DBEP (Distance Between End Projectors)**

**Problem 3.8 :** The point A of a line AB is 15 mm above HP and in VP. The FV and TV inclined to XY at  $40^\circ$  and  $35^\circ$  respectively. Draw the projections of a line, if the projector distance between end points of the line is 60mm. Find true length of a line and locate its traces.

Given Data	Significance
A is 15mm above the HP	$a'$ is 15 mm above XY
A is in the VP	$a$ is on XY
$\alpha = 40^\circ$	$a'b'$ $40^\circ$ to XY
$\beta = 30^\circ$	$ab$ $30^\circ$ to XY
$DBEP(a-b) = 60$	$a-b = 60$

**Solution:**

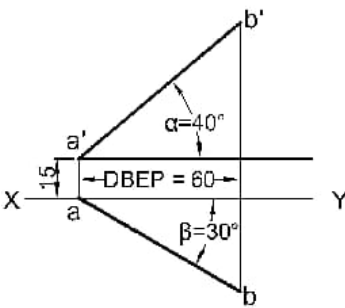


Fig. 3.18

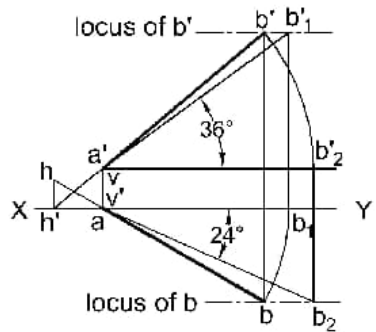


Fig. 3.19

**Step 1 : Draw given data (Fig. 3.18)**

1. Follow step1 (Section 3.3.1)
2. Draw a line  $l^{60}$  to projector of  $a'$  at 60mm.
3. This line consists of projections of end B.
4. Draw line at  $\alpha = 40^\circ$  from point  $a'$  till it cuts projector of end B to get  $b'$ .
5. Draw line at  $\beta = 30^\circ$  from point  $a$  & till it cuts projector of end B to get  $b$ .

**Step 2 : Draw Complete Reference diagram (Fig. 3.19)**

6. Follow step 7 & 13 from Stage II & Stage III (Section 3.3.1).
7. Draw an arc with center  $a$  & radius  $ab$  to intersect XY line to get  $b_1$ .
8. Draw Projector vertically upward from  $b_1$  till it intersect locus of  $b'$  to get  $b_1'$ .
9. Draw an arc with center  $a'$  & radius  $a'b'$  till it intersect horizontal line passing through  $a'$  to get  $b_2'$ .
10. Projector vertically downward from  $b_2'$  till it intersects locus of  $b$  to get  $b_2$ .

**Type VI: When Either  $a'$  or  $a$  & locus of  $b$  or  $b'$  Given**

**Problem 3.9:** A line  $AB$  is, 80mm long has its end point  $A$  15 mm above  $HP$ . The line is inclined to  $HP$  and  $VP$  at  $30^\circ$  and  $45^\circ$  respectively. End  $B$  of line is 100mm in front of the  $VP$ . Draw the projections of the line And locate its traces. Also find distance of end  $A$  from  $VP$ .

Given Data	Significance
$AB = 80$	$ab_0 = a'b_0' = a'b_1' = ab_2$
$A$ is 15 mm above $HP$	$a'$ is 15 mm above $XY$
$\theta = 30^\circ$	$a'b_1'$ is $40^\circ$ to the $XY$
$\phi = 45^\circ$	$ab_2$ is $30^\circ$ to the $XY$
$B$ is 100 mm in front of $VP$	$b$ is 100 mm below $XY$
(assume $A$ 10mm in front of $VP$ )	( $a$ is 10 mm below $XY$ )

**Solution:**

This problem can be solve by two methods

**1. By Assumption method**

Assumption method is used when position of  $a'$  /  $a$  / both  $a'$  &  $a$  not given in question. In these types of problems initially,

1. Assume Location of  $a$  (if not given) instead of given locus of  $b$  i.e.  $a$ .
2. Assume Location of  $a'$  (if not given) instead of given locus of  $b'$  i.e.  $a'$ .
3. Once location of  $a$  &  $a'$  are known, reference diagram can be completed with the remaining given data.
4. After completing reference diagram consider locus of  $b$  or  $b'$  and plot actual positions.

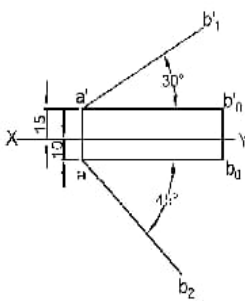


Fig. 3.20

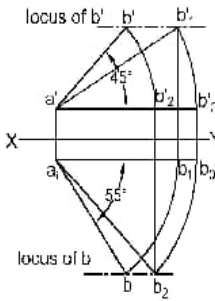


Fig. 3.21

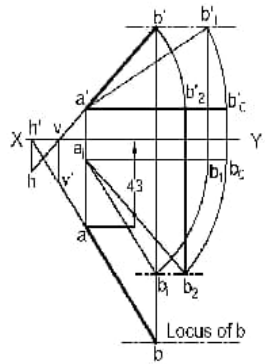


Fig. 3.22

**Step 1 : Draw given data (Fig. 3.20)**

1. Assume location of  $a$ .
2. Now given data consists of  $TL$ ,  $a'$ ,  $a$ , ' $\theta$ ' and ' $\phi$ '.
3. This is similar to Type I.
4. Draw given data

**Step 2 : Complete Reference diagram**

- Without considering actual locus of b complete the reference diagram as discussed in type I. (Fig. 3.18)
- Distance of end A from VP = 43 mm

**Step 3 : Draw Actual Positions of FV & TV. (Fig. 3.22)**

- Now draw actual locus of b 100 mm below XY
- Actual location of b must be below  $b'$ , therefore draw vertically downward line passing through  $b'$  till it intersects locus of b.
- Name the intersection point i.e. b.
- Now take  $PL = a.b$  as a radius, with the centre b and cut the extended projector of a.
- This is the actual position of a & Join ab to get TV.
- The position of  $a'$  is as per the question, hence  $a'b'$  is actual FV.

**2. Without Assumption Method**

**Note:** Given data is taken as it is. Minimum five data are required with a proper relationship.

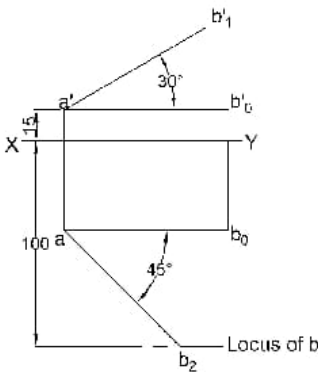


Fig. 3.23

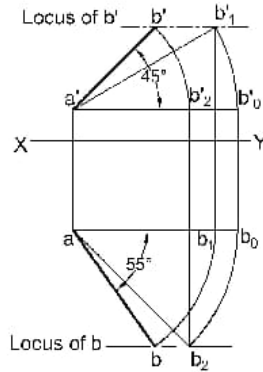


Fig. 3.24

**Step 1 : Draw given data (Fig. 3.23)**

- Draw locus of b 100 mm below XY.
- Plot  $b_2$  on locus of b at an appropriate position.
- Now draw line of 80 mm at an angle of  $\phi$  from point  $b_2$  & Name another end i.e. a.
- From a draw vertically upward projector and plot  $a'$  15 mm above XY line on the same projector.
- Draw  $30^\circ$  incline line from  $a'$  & cut it by TL to get  $b'_1$ . Also plot  $b'_0$

**Step 2 : Complete Reference diagram**

- Follow step 6 & 7 from Stage II (Section 3.3.1).
- Follow step 10 to 13 from Stage III (Section 3.3.1).
- Complete final stage (Section 3.3.1)

**Type VII: When Either  $a'$  or  $a$ , locus of  $b$  or  $b'$  & DBEP Given**

**Problem 3.10 :** The point A of a line AB is 25 mm above HP and its end point B is 20 mm in front of VP. It's Plan and Elevation makes  $40^\circ$  &  $35^\circ$  with XY. Draw the projections; if the projector distance between the end points is 60 mm. Find the inclination made by the line with HP & VP. Also locate the traces.

**Given Data**

A is 25 mm above HP

B is 20 mm in front of VP

(Assume P 20 mm in front of VP)

 $\beta = 40^\circ$  $\alpha = 35^\circ$ DBEP<sub>(a-b)</sub> = 60**Significance** $a'$  is 25 mm above XY $b$  is 20 mm below XY

(p 20 mm below XY)

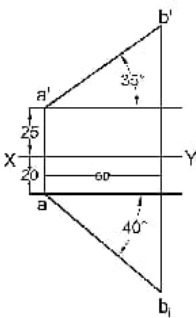
 $ab$  is  $40^\circ$  to the XY $a'b'$  is  $35^\circ$  to the XY $a \leftarrow b = 60$ **Solution:** By Assumption Method

Fig. 3.25

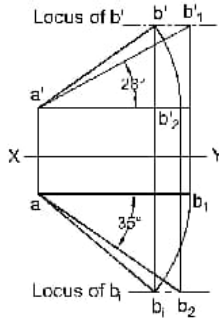


Fig. 3.26

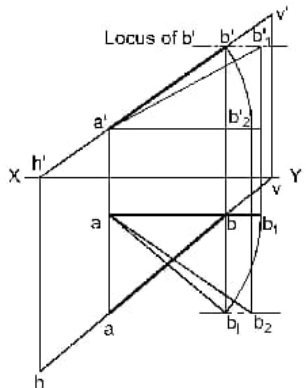


Fig. 3.27

**Step 1 : Draw given data:**

1. Assume location of  $a$  i.e.  $a$
2. Now given data consists of  $a'$ ,  $a$ ,  $\alpha$ ,  $\beta$  and DBEP. This is similar to Type V.
3. Refer Type V to draw given data.

**Step 2 : Complete Reference diagram:**

4. (Refer Type V)

**Step 3 : Draw Actual Positions of FV & TV:**

5. Location of  $b$  must be below  $b'$ , therefore plot  $b$  20mm below XY and on the vertical projector passing through  $b'$ .
6. Now take  $PL = ab$  as a radius, with the centre  $b$  and cut the extended projector of  $a$ .
7. This is the actual position of  $a$  & Join  $ab$  to get TV.
8. The position of  $a'$  is as per the question, hence  $a'b'$  is actual FV.

**Type VIII: Problems Based on Midpoint or Any Point Situated on Line**

**Problem 3.11:** A line AB, 80 mm long is inclined at an angle of  $30^\circ$  with the HP and  $45^\circ$  with the VP. Point 'P' of the line is 45 mm above the HP and 55 mm in front of the VP. Draw the projections of the line when 'P' is a point situated on AB and is 30 mm away from 'A'. Locate traces of the line.

**Given Data**

AB = 80mm

 $\theta = 30^\circ$  $\phi = 45^\circ$ 

P is 45 mm above H.P.

P is 55 mm in front of V.P.

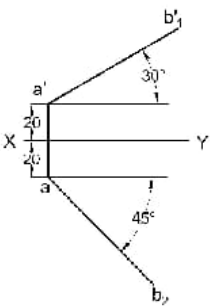
**Significance** $ab_0 = a'b'_0 = a'b'_1 = ab_2$  $a'b'_1$  is  $30^\circ$  to the XY $ab_2$  is  $45^\circ$  to the XY $p'$  is 10 mm above XY $p$  is 10 mm above XY**Solution:** By Assumption Method

Fig. 3.28

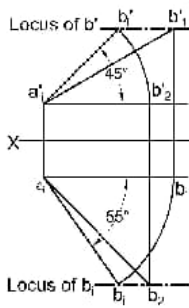


Fig. 3.29

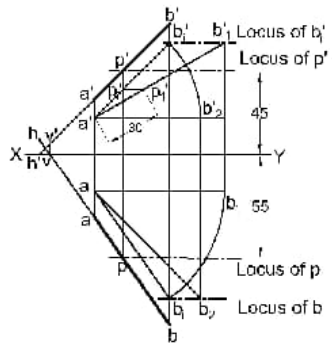


Fig. 3.30

**Step 1 : Draw given data:**

1. Assume location of a & a' i.e.  $a$  &  $a'$ .
2. Now given data consists of TL,  $a'$ ,  $a$ ,  $\theta$ , &  $\phi$ . This is similar to Type I.
3. Refer Type I to draw given data.

**Step 2 : Complete Reference diagram:-**

4. (Refer Type I)

**Step 3 : Draw Actual Positions of FV & TV:**

4. Plot  $p_2'$  at 30mm from  $a'$  and project it horizontally on  $a'b'$ . Name the intersection point as  $p'$ .
6. Now plot actual position of  $p'$  and  $p$  on the vertical projector passing through  $p'$  at 45mm above XY line & 55mm below XY line respectively.
7. Draw parallel line to  $a'b'$  &  $ab$  through  $p'$  &  $p$  respectively. These are the actual positions of FV & TV.

Type IX: Problems Based on  $\theta + \phi = 90^\circ$ :

**Problem 3.12:** The elevation length of line AB measuring 125 mm long, is 75 mm and its plan length is 100 mm. Its end A is 10 mm above HP and 30 mm in front of the VP. Draw the projections and find its inclinations with the reference planes. Locate the traces.

Given Data	Significance
$AB = 125\text{mm}$	$ab_0 = a'b'_0 = a'b'_1 = ab_2$
$EL = 75$	$a'b' = a'b'_2 = 75$
$PL = 100$	$ab = ab_1 = 100$
A is 10 mm above H.P.	$a'$ is 10 mm above XY
A is 30 mm in front of V.P.	$a$ is 30 mm below XY

**Solution:** Refer Type II for Drawing Steps

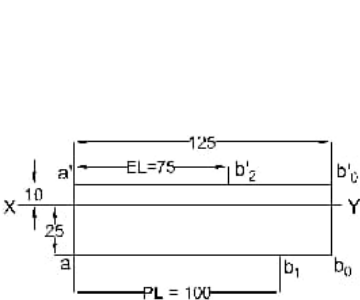


Fig. 3.31

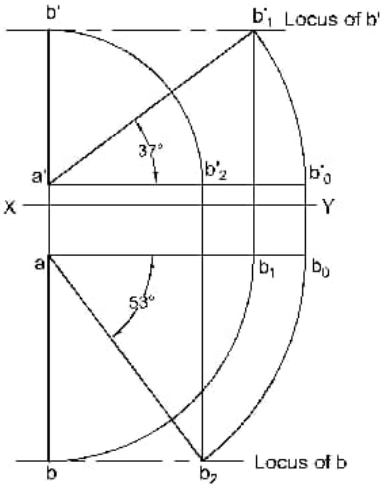


Fig. 3.32

**Type X: Miscellaneous Problems**

**Problem 3.13:** A line AB has its end A 30mm above the HP and 25 mm in front of the VP line makes  $30^\circ$  to the HP and  $45^\circ$  to the VP distance between the projectors of ends A & B is 47mm. Draw the projections and Locate the traces.

**Given Data**

A is 30 mm above H.P.

A is 25 mm in front of V.P.

$\theta = 30^\circ$

$\phi = 45^\circ$

DBEP<sub>(a-b)</sub> = 47

**Significance**

a' is 30 mm above XY

a is 25 mm below XY

a'b<sub>1</sub>' is  $30^\circ$  to the XY

ab<sub>2</sub> is  $45^\circ$  to the XY

$a \leftrightarrow b = 47$

**Solution:** Refer **Type II** for Drawing Steps:

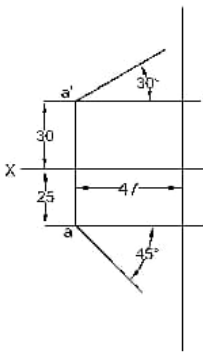


Fig. 3.33

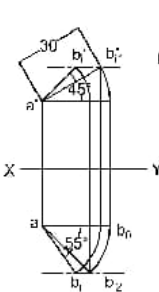


Fig. 3.34

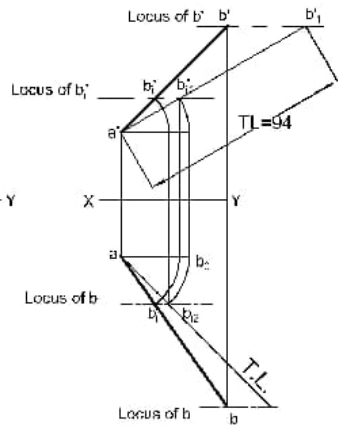


Fig. 3.35

**Step 1: Draw given data:**

1. Follow step1, 4 & 9 (Section 3.3.1)
2. Follow step 2 & 3 From Type V

**Step 2: Complete Reference diagram:**

3. Assume any TL
4. Complete reference diagram without considering DBEP distance.
5. Follow step given in Section 3.3.1

**Step 3: Draw Final Projections:**

6. Now extend ab<sub>1</sub>' and cut the projector of b'b. Name the intersection point b<sub>1</sub>'.
7. Now extend ab<sub>2</sub> and cut the projector of b'b. Name the intersection point b.
8. Now extend ab<sub>1</sub>' and cut the locus of b'. Name the intersection point b<sub>1</sub>'.
9. Now extend ab<sub>2</sub> and cut the locus of b. Name the intersection point b<sub>2</sub>

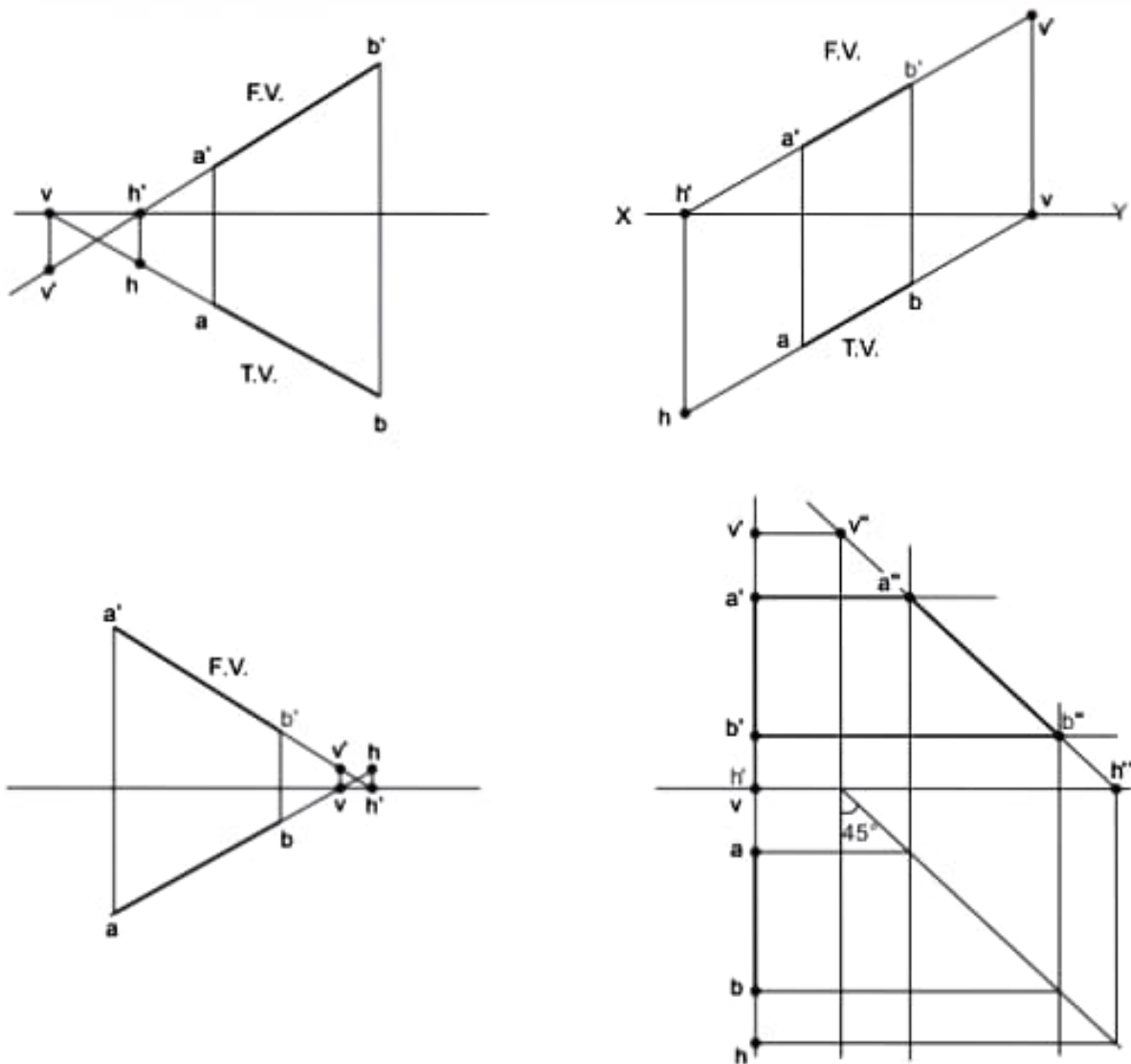


Fig. 3.36

## PROBLEMS FOR PRACTICE

### Type I

1. A line AB 70 mm long is inclined at an angle  $30^\circ$  to the HP and  $45^\circ$  to the VP. Its end point A is 10 mm above the HP and 20mm in front of the VP. Draw the projection of lines AB & locate Traces.
2. The point A of 65 mm long line AB is in HP and 15 mm in front of VP. The line is inclined to HP and VP at  $40^\circ$  &  $35^\circ$  respectively. Draw the projection of lines AB & locate Traces.
3. A line BC 80 mm long is inclined at  $45^\circ$  to the HP and  $30^\circ$  to VP. Its end B is in the HP and 40 mm in front of VP. Draw its projections and determine its traces.
4. A straight line AB, 80 mm long is inclined at an angle  $30^\circ$  to the HP and  $45^\circ$  to the VP. Its end point A is 15 mm above the HP and 12mm in front of the VP. Draw the projection of lines & locate Traces. ( $\alpha=450$ ,  $\beta=550$ )
5. A line AB 80 mm long is inclined at an angle  $40^\circ$  to the HP and  $35^\circ$  to the VP. Its end point A is in the HP and in the VP. Draw the projection of lines AB & locate Traces.



**Type II**

6. The point A of a line AB is 15 mm above HP and in VP. The line is inclined to HP and VP at  $40^\circ$  and  $35^\circ$  respectively. Draw the projections of the line, if its plan (TV) measures 65 mm. Find the true length of the line and locate its traces.

**(TL = 85mm )**

7. A line AB 75 mm long is inclined at an angle of  $35^\circ$  degrees to the VP. Its end A is 20 mm above the HP and 15 mm in front of VP. Plan length (TV) of the line is 50 mm. Draw the projections of the line & Also locate traces. **( $\alpha = 66^\circ$   $\beta = 59^\circ$ )**
8. A line AB 70 mm long is inclined at an angle of  $30^\circ$  degree to the HP. Its end point A is 10 mm above the HP and 15 mm in front of VP. Elevation length (FV) of the line is 45 mm. Draw the projection of the line & locate the traces. **( $\Phi = 49^\circ$ ,  $\alpha = 52^\circ$ ,  $\beta = 61^\circ$ )**
9. A line AB, 65 mm long has its end point A is 20 mm above the HP and 10 mm in front of VP. Elevation length and plan length of the line are same and is of 50 mm. Draw the projections of the line AB and locate its traces. **( $\Theta = 40^\circ$ ,  $\Phi = 40^\circ$ ,  $\alpha = 56^\circ$ ,  $\beta = 56^\circ$ )**.
10. The elevation length of line AB measuring 125 mm long is 90 mm and its plan length is 105 mm. Its end B is 30 mm from both the reference planes. Draw the projections and locate the traces. **( $\Theta = 37^\circ$ ,  $\Phi = 44^\circ$ )**

**Type III**

11. The point A of 80 mm long line AB is 20 mm above HP and 60 mm in front of VP. The end point B is 15 mm in front of VP, while its plan measures 65mm. Draw the projections of the line and find the inclinations made by the line with HP and VP. Also, locate the traces of line. **( $\alpha = 45^\circ$ ,  $\beta = 44^\circ$ ,  $\Theta = 36^\circ$ ,  $\Phi = 34^\circ$ )**
12. The end point C of the line CD is 15 mm in front of the vertical plane and 25 mm above the horizontal plane. The end D of the line is equidistance from both the principal reference planes. The line is 110 mm long and is inclined at an angle of  $30^\circ$  with the horizontal plane. Draw the projections of the line and find its indination with vertical plane. Locate the traces of the line.
13. A line AB has its end point A 10 mm above HP and 20 mm in front of VP. The length of the line in elevation is 65 mm. End B of the line is 60 mm above the HP. Line is inclined to VP at an angle of  $40^\circ$  degrees. Draw projections. Find TL, Angle with HP and Angle with VP of the line. Also locate its traces.

**( $\alpha = 50^\circ$ ,  $\beta = 53^\circ$ ,  $\Theta = 36^\circ$ ,  $\Phi = 40^\circ$ , TL = 85mm)****Type IV**

14. The elevation length of a straight line CD is  $60^\circ$  mm long and is inclined at 60 degrees to the XY. The end C is 15 mm above the HP and 20 mm in front of VP. Draw the projections of the line if it is inclined at  $30^\circ$  degree to the HP and is completely in the first quadrant. Find the TL of the line, its inclination with VP and locate its traces. **(TL = 104 mm)**
15. The point P of line PQ is in HP & 15mm in front of VP. The TV of line PQ makes  $40^\circ$  with XY while its plan measures 80mm. Draw the projections if the true length of line is 100mm. Find the true inclination made by the line & locate the traces.
16. The FV of line AB measures 50mm and makes an angle  $45^\circ$  with XY line. The point A is 10 mm above the HP and 20 mm in front of the VP. Draw the projections of line AB if it is inclined with the VP at  $45^\circ$ .
17. Line AB makes an angle of  $30^\circ$  with VP. Its plan measures 70mm and is inclined at an angle of  $45^\circ$  with XY. Draw projections if point A is 20 mm away from both the planes. Locate the traces. **( $\Theta = 45^\circ$ )**
18. A line AB is 110 mm long and inclined at  $30^\circ$  with HP. Its elevation makes  $45^\circ$  with XY. Draw its projections if its end A is 20 mm above the HP and 15 mm in front of VP. Find its inclination with VP. Also locate the traces. **( $\Phi = 39^\circ$ )**

**Type II**

6. The point A of a line AB is 15 mm above HP and in VP. The line is inclined to HP and VP at  $40^\circ$  and  $35^\circ$  respectively. Draw the projections of the line, if its plan (TV) measures 65 mm. Find the true length of the line and locate its traces.

**(TL = 85mm )**

7. A line AB 75 mm long is inclined at an angle of  $35^\circ$  degrees to the VP. Its end A is 20 mm above the HP and 15 mm in front of VP. Plan length (TV) of the line is 50 mm. Draw the projections of the line & Also locate traces. **( $\alpha = 66^\circ$   $\beta = 59^\circ$ )**
8. A line AB 70 mm long is inclined at an angle of  $30^\circ$  degree to the HP. Its end point A is 10 mm above the HP and 15 mm in front of VP. Elevation length (FV) of the line is 45 mm. Draw the projection of the line & locate the traces. **( $\Phi = 49^\circ$ ,  $\alpha = 52^\circ$ ,  $\beta = 61^\circ$ )**
9. A line AB, 65 mm long has its end point A is 20 mm above the HP and 10 mm in front of VP. Elevation length and plan length of the line are same and is of 50 mm. Draw the projections of the line AB and locate its traces. **( $\theta = 40^\circ$ ,  $\Phi = 40^\circ$ ,  $\alpha = 56^\circ$ ,  $\beta = 56^\circ$ )**.
10. The elevation length of line AB measuring 125 mm long is 90 mm and its plan length is 105 mm. Its end B is 30 mm from both the reference planes. Draw the projections and locate the traces. **( $\theta = 37^\circ$ ,  $\Phi = 44^\circ$ )**

**Type III**

11. The point A of 80 mm long line AB is 20 mm above HP and 60 mm in front of VP. The end point B is 15 mm in front of VP, while its plan measures 65mm. Draw the projections of the line and find the inclinations made by the line with HP and VP. Also, locate the traces of line. **( $\alpha = 45^\circ$ ,  $\beta = 44^\circ$ ,  $\theta = 36^\circ$ ,  $\Phi = 34^\circ$ )**
12. The end point C of the line CD is 15 mm in front of the vertical plane and 25 mm above the horizontal plane. The end D of the line is equidistance from both the principal reference planes. The line is 110 mm long and is inclined at an angle of  $30^\circ$  with the horizontal plane. Draw the projections of the line and find its indination with vertical plane. Locate the traces of the line.
13. A line AB has its end point A 10 mm above HP and 20 mm in front of VP. The length of the line in elevation is 65 mm. End B of the line is 60 mm above the HP. Line is inclined to VP at an angle of  $40^\circ$  degrees. Draw projections. Find TL, Angle with HP and Angle with VP of the line. Also locate its traces.

**( $\alpha = 50^\circ$ ,  $\beta = 53^\circ$ ,  $\theta = 36^\circ$ ,  $\Phi = 40^\circ$ , TL = 85mm)****Type IV**

14. The elevation length of a straight line CD is  $60^\circ$  mm long and is inclined at 60 degrees to the XY. The end C is 15 mm above the HP and 20 mm in front of VP. Draw the projections of the line if it is inclined at  $30^\circ$  degree to the HP and is completely in the first quadrant. Find the TL of the line, its inclination with VP and locate its traces. **(TL = 104 mm)**
15. The point P of line PQ is in HP & 15mm in front of VP. The TV of line PQ makes  $40^\circ$  with XY while its plan measures 80mm. Draw the projections if the true length of line is 100mm. Find the true inclination made by the line & locate the traces.
16. The FV of line AB measures 50mm and makes an angle  $45^\circ$  with XY line. The point A is 10 mm above the HP and 20 mm in front of the VP. Draw the projections of line AB if it is inclined with the VP at  $45^\circ$ .
17. Line AB makes an angle of  $30^\circ$  with VP. Its plan measures 70mm and is inclined at an angle of  $45^\circ$  with XY. Draw projections if point A is 20 mm away from both the planes. Locate the traces. **( $\theta = 45^\circ$ )**
18. A line AB is 110 mm long and inclined at  $30^\circ$  with HP. Its elevation makes  $45^\circ$  with XY. Draw its projections if its end A is 20 mm above the HP and 15 mm in front of VP. Find its inclination with VP. Also locate the traces. **( $\Phi = 39^\circ$ )**

**Type V**

19. A line AB has its end point A 16 mm above the HP and 25 mm in front of VP. The length of the line in the plan is 60 mm and length of the elevation 65 mm. The distance between the projectors of end points A and B is 45 mm. draw the projections & locate its traces.  
( $\alpha=46^\circ$ ,  $\beta=41^\circ$ ,  $\theta=38^\circ$ ,  $\Phi=31^\circ$ , TL = 76mm)
20. Draw the projections of the AB when its end A is 20 mm above HP and 10 mm in front of VP, its end B is 55 mm above the HP and 60 mm in front of VP and distance between projectors A and B (measured parallel to the XY line) is 45 mm. draw the projections & Locate its traces.  
( $\alpha=38^\circ$ ,  $\beta=48^\circ$ , TL=76mm)
21. The point P of a line PQ is in VP and 20 mm above HP. The top view of a line PQ makes  $40^\circ$  with XY, while its elevation makes  $35^\circ$  with XY. Draw the projections if the projector distance between end points of line is 80 mm. find true inclinations made by line and locate the traces.

(TL=119 mm,  $\theta=28^\circ$ ,  $\Phi=35^\circ$ , HT=24 mm above XY, VT=20 mm above XY)

**Type VI**

22. Point P of a line PQ is 25 mm above HP and point Q is 65 mm in front of VP. The line is inclined to HP at  $30^\circ$  while its plan makes  $45^\circ$  with XY. Draw the projections; if plan length is 70 mm. Find True Length and inclination made by the line with VP. Locate the trace.  
(TL= 81mm,  $\Phi = 37.7$ )
23. A line AB, 80 mm long, has its end point A on the HP. Line makes an angle of  $30^\circ$  with HP and  $45^\circ$  with VP. End 'B' of the line is on the VP. Draw the projections of line and locate traces of the line.
24. A line AB, 80 mm long, has its end point A 15mm above the HP. Line makes an angle of  $30^\circ$  with HP and  $45^\circ$  with VP. End B of the line is 10 mm in front of the VP. Draw the projections of line and locate traces of the line.
25. A line CD, 80 mm long, has its end point C 15mm above the HP. Line makes an angle of  $30^\circ$  with HP and  $38^\circ$  with VP. End D of the line is 80 mm in front of the VP. Draw the projections of line and locate traces of the line. (A is 40mm above the HP)

**Type VII**

26. The point P of 90 mm long line PQ is 20 mm above HP and its point Q is 25 mm in front of VP. Its plan makes  $40^\circ$  with VP while, the projector distance between the end points of line PQ is 60 mm. Draw the projections of the line and find the inclinations made by it with HP and VP. Also, locate the traces of line.  
( $\theta=30$ ,  $\Phi = 34$ )
27. The point of a line PQ is 25mm above HP and its end point Q is 20mm in front of VP. The line is inclined to VP at  $40^\circ$  while its elevation makes  $40^\circ$  with HP. Draw the projections if the projector Distance between the end points of line PQ is 60mm. Find the inclination made by the line with HP. Also locate the traces.
28. The point P of 75 mm long line PQ is in HP while its other end Q is in VP. The Projector distance between the end points of the line PQ is 80 mm. Draw the projections if its plan measures 60 mm. Find inclinations made by the line with HP and VP. Also locate the traces.

**Type VIII**

29. Draw the projections of line AB, 90 mm long, its midpoint M, being 50 mm above the HP and 40 mm in front of VP. The end A is 20 mm above the HP and 10 mm in front of VP. Show the traces and the inclinations of the line with the HP and the VP.  
( $\alpha= \beta=63^\circ$ ,  $\theta= \Phi=42^\circ$  HT=VT= 10 mm above XY).
30. Draw the projections of a line AB, 90 mm long, its mid- point 'M' being 50 mm above the HP and 35mm in front of the VP. The end 'A' is 20mm above the HP and 10 mm in front of VP. Show traces and inclinations of the line with HP and VP.
31. A line AB, 80 mm long is inclined at an angle of  $30^\circ$  with the HP and  $45^\circ$  with the VP. Point P of the line is 45 mm above the HP and 55 mm in front of the VP. Draw the projections of the line when 'P' is a point situated on AB and is 30 mm away from 'A'. Locate traces of the line.

**Type IX**

32. A line AB is contained by a plane perpendicular to both HP & VP. End point A is 20mm in front of the VP and end B is 25mm above the HP. Elevation length of the line is 55mm and Plan length of the line is 75mm. Draw the projections of the line and locate its traces. ( $\theta=36.3^\circ$ ,  $\phi=53.7^\circ$ ).
33. A line AB of 75mm has its end B 15mm above the HP and 50mm in front of the VP. End A of the line is on the VP. Sum of inclinations of the line with HP & VP is  $90^\circ$ . Draw the projections of the line and locate traces. ( $\theta=48.2^\circ$ ,  $\phi=41.8^\circ$ )
34. The point A of 80mm long line AB is 10mm in front of the VP. Line makes  $55^\circ$  with HP and  $35^\circ$  with VP. Draw projections and locate traces.
35. A line AB, 75 mm long, has its end A in the H.P. and 15 mm in front of the V.P. The end B is in the first quadrant. The line is inclined at  $35^\circ$  to the H.P. and  $55^\circ$  to the V.P. Draw its projections and find out its traces.

**3.5 INTRODUCTION OF PROJECTIONS OF PLANES**

A plane surface has only length and breadth. The plane surface is having negligible thickness and considered as zero.

**3.6 TYPES OF PLANES****Triangle (3 Sides)**

1. Equilateral
2. Isosceles
3. Right angled triangle

**Quadrilateral (4 sides)**

1. Square
2. Rectangle
3. Rhombus

**Polygons (More than 4 Sides)**

1. Pentagon
2. Hexagon

**Circular**

1. Circle
2. semicircle

Following Fig. 3.37 Shows True Shape of All Planes

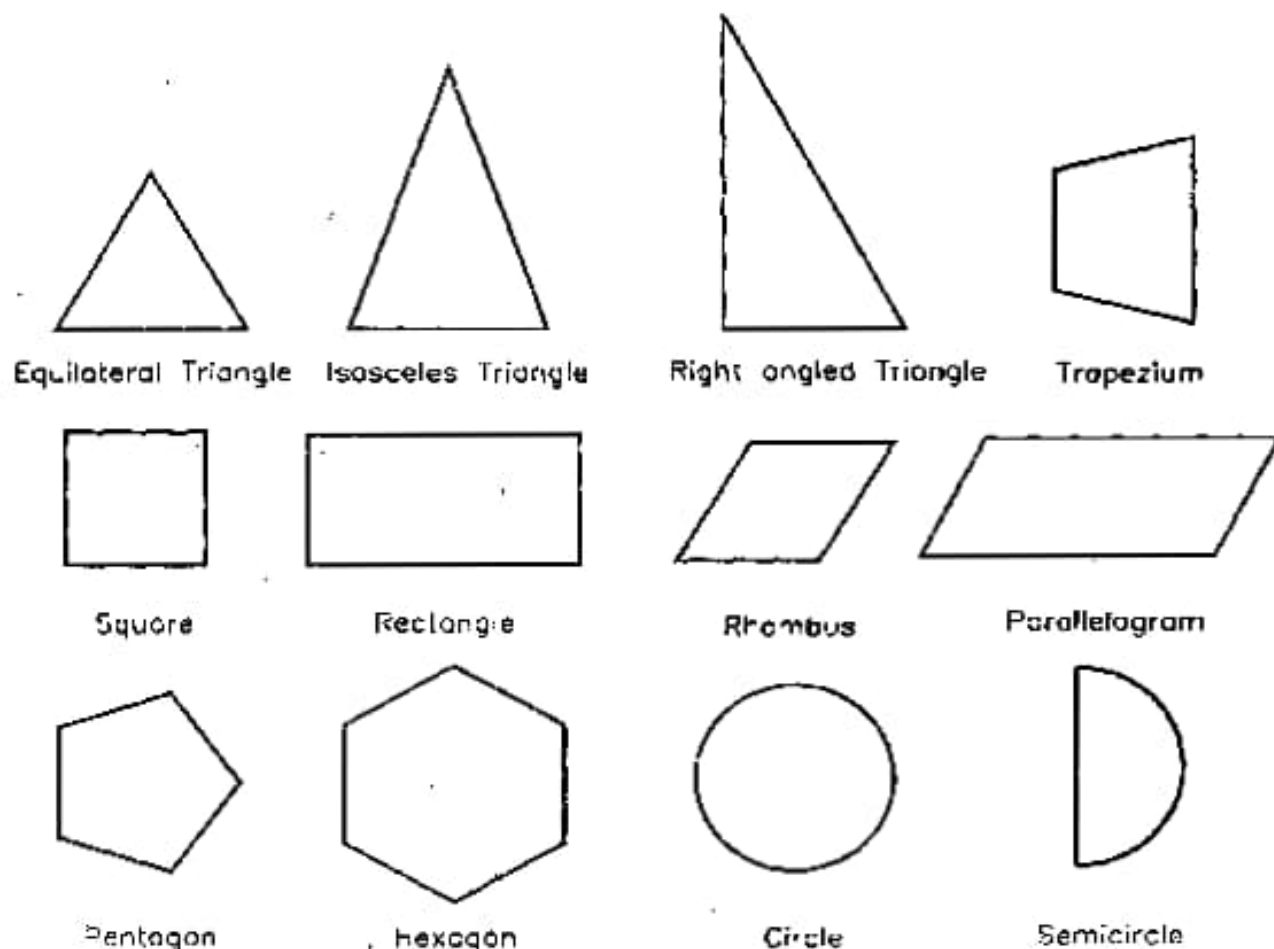


Fig. 3.37

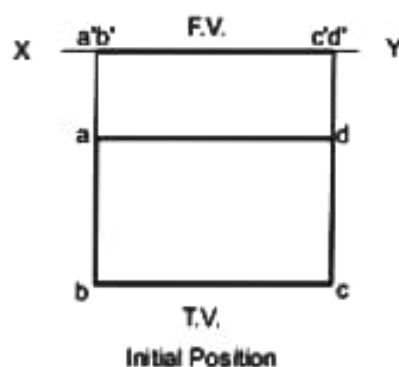
### 3.7.1 When Plane is Resting On Hp

View	Significance	Position
Top View	Draw True shape of the polygon	Below XY Line
Front View	Draw Line View	On XY line

**Step 1:** Drawing True shape and Line View:

#### 1. Resting On Side

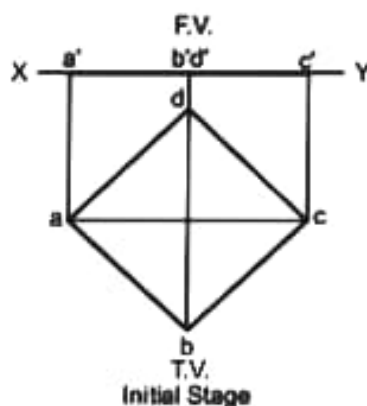
- The True shape of the plane has to be drawn below XY line.
- Given side should be perpendicular to XY.
- Draw true shape keeping given side on left.



**Fig. 3.38**

#### 2. Resting On Corner

- The True shape of the plane has to be drawn below XY line.
- The line passing through given corner and center of plane must be parallel to XY.
- Draw true shape keeping corner on left side.



**Fig. 3.39**

**Step 2 :** Drawing Inclination with HP i.e.  $\theta$  and Reduced Size of TV i.e. Plan

**1. When ' $\theta$ ' i.e. inclination with HP is given-**

Rotate line view i.e. FV of step I by given angle keeping left end on XY.

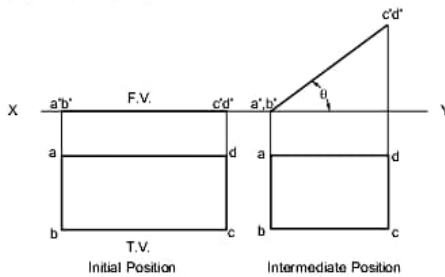


Fig. 3.40

**2. When 'Above HP' distance of one of the corner or edge is given-**

- First draw line parallel to XY at a given distance and above XY line.
- Plot given corner or edge points on parallel line.
- Join points with left end which is on XY.

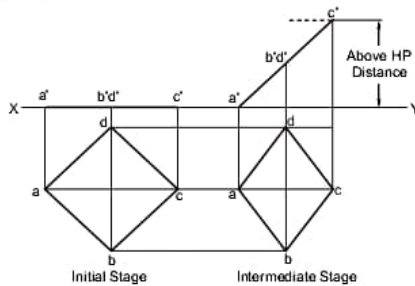


Fig. 3.41

**3. When information about Top View/Plan is given.**

- First project all the points from step I Top View horizontally.
- First plot resting side/ corner points on this horizontal projector.
- Complete given information of Top View of Step II.
- Project all the points above XY line from Top View of Step II
- Complete FV of step II

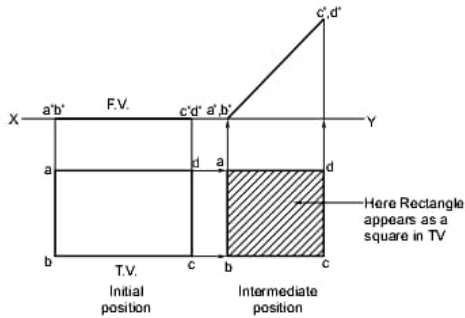


Fig. 3.42

**Step 3 : Drawing side/diagonal/diameter at an angle made by plane with VP i.e.  $\phi$**

**When True length of given side/diagonal/diameter is making an angle " $\phi$ " & true length is unchanged from Step I to Step II**

- First Draw a line at given angle from XY line instep III.
- On these inclined line, Plot points of given side.
- With the help of these complete TV of Step III
- TV of Step II and Step III should be same in size and shape, only orientation will change.
- Project all the points above XY line from Top View of Step III
- Complete FV by using horizontal projector from FV of Step II

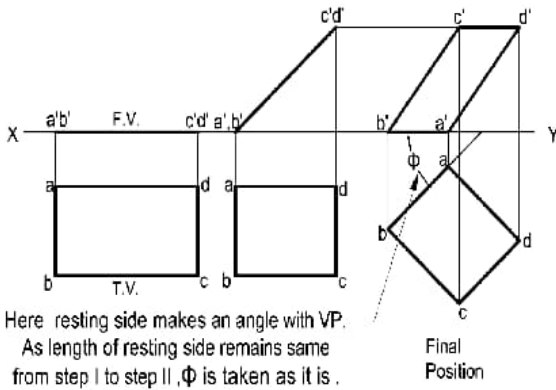


Fig. 3.43

**When True length of given side/diagonal/diameter is making an angle " $\phi$ " & True Length is changed from Step I to Step II:**

- First complete  $\beta$  construction.
- Draw a line at calculated  $\beta$  angle from XY line instep III.
- On these inclined line, Plot points of given side.
- With the help of these complete TV of Step III
- TV of Step II and Step III should be same in size and shape, only orientation will change.
- Project all the points above XY line from Top View of Step III
- Complete FV by using horizontal projector from FV of Step II

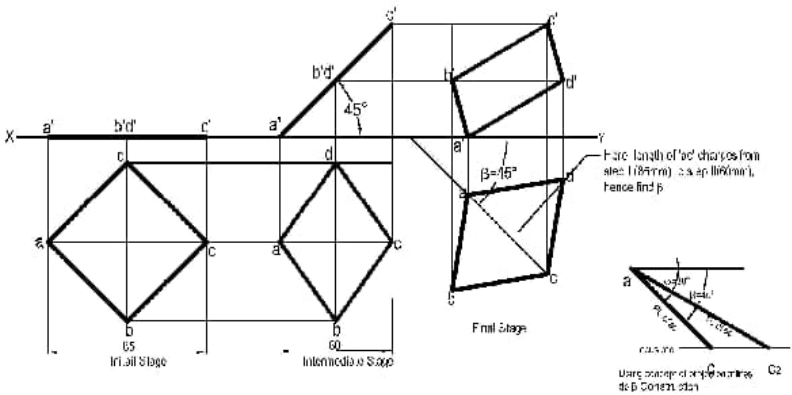


Fig. 3.44

**When Plan / TV of given side / diagonal / diameter is making an angle with VP i.e. ' $\beta$ ':**

- Draw a line at given angle ' $\beta$ ' from XY line in downward direction.
- On these inclined line, Plot points of given side.
- With the help of these complete TV of Step III
- TV of Step II and Step III should be same in size and shape, only orientation will change.
- Project all the points above XY line from Top View of Step III
- Complete FV by using horizontal projector from FV of Step II

**Example 1 :** Draw the projections of a circular plate of negligible thickness of 50 mm diameter resting on HP on a point A on the circumference, with its plane inclined at 45 deg. to HP and the top view of the diameter passing through the resting point makes 60 deg. with VP.

it means ' $\beta = 60^\circ$ ' and with diameter passing through the resting point

**Example 2 :** A hexagonal plate of side 50mm is resting in HP on one of its corner. Then, Its surface is inclined to HP at an angle of  $37^\circ$ . Draw the projections, if the top view of a diagonal line passing through the resting corner and its opposite corner is inclined to VP at an angle of  $40^\circ$ . Find the inclination made by the plane with VP.

it means ' $\beta = 40^\circ$ ' and with diagonal passing through resting corner.



Type I: On H.P., on side:

Case (i) when ' $\theta$ ' is given

**Problem 3.14 :** A pentagonal plate of side 50 mm is resting on one of its edges in the H.P. with that edge making  $50^\circ$  with V.P. The plane is inclined at  $30^\circ$  to the H.P.

**Solution :**

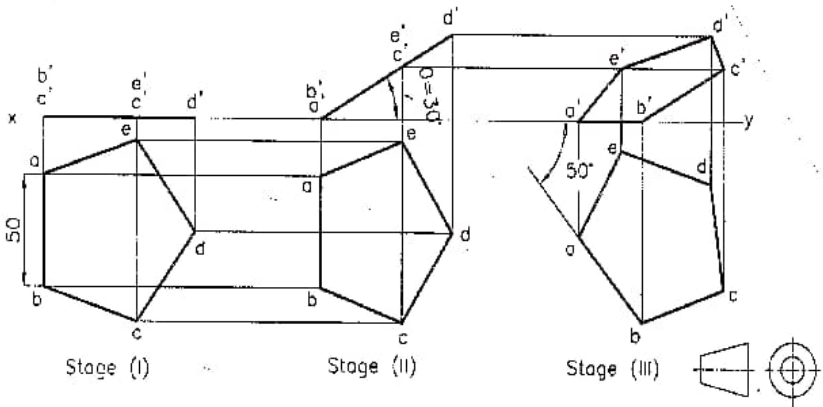


Fig. 3.45

**Problem 3.15 :** A rhombus ABCD has its diagonal AC = 50 mm and BD = 80 mm. The side AB of the plane is in H.P. The side BC is in V.P. and the plane makes an angle of  $30^\circ$  with the H.P. Obtain the projections of the plane and find its inclination with the V.P.

**Solution :**

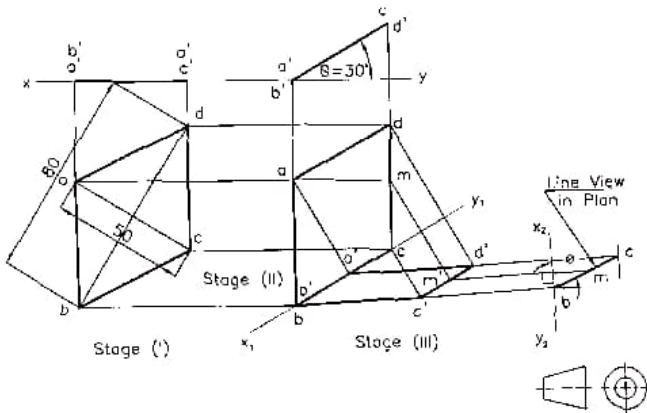


Fig. 3.46

Case (ii): When 'Above HP' Distance is given,

Problem 3.16 : A pentagonal plate ABCDE of 40 mm length of sides has side AB on H.P. inclined at  $20^\circ$  to V.P. Corner D of the plate is in the V.P. and 45 mm above H.P. Refer Fig. 3.47.

Solution :

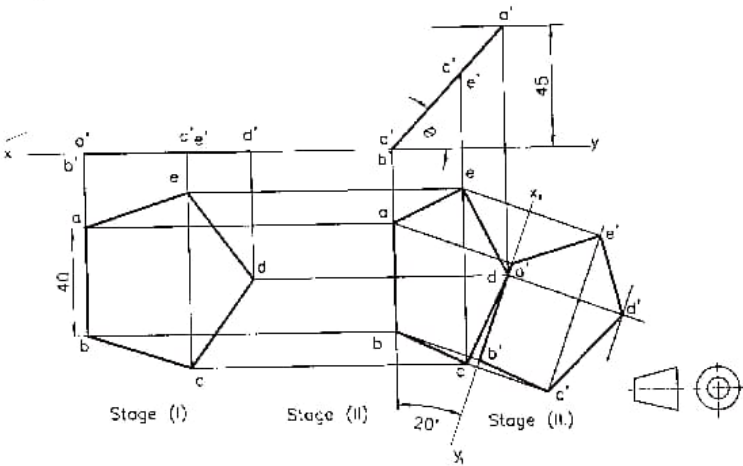


Fig. 3.47

Problem 3.17 : A triangle ABC,  $AB=40\text{mm}$ ,  $BC=60\text{mm}$  and angle  $ABC=90^\circ$  is resting in HP on its side AB. Its surface is inclined to HP so that the point C is 39mm above HP. Draw the projections if the resting side makes an angle of  $20^\circ$  with VP. Find the inclination made by the plane with VP.

Solution :

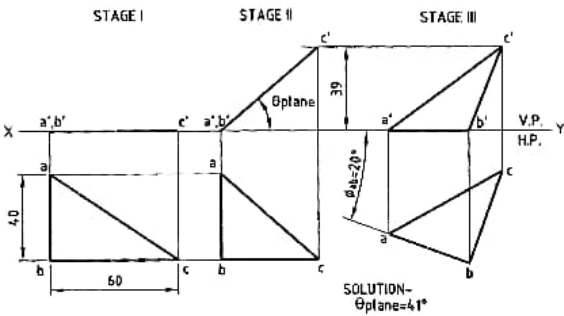


Fig. 3.48

Case (ii): When information about Top View / Plan is given.

**Problem 3.18 :** A circular plate of 60 mm diameter is held on a point on its circumference on the H.P. The diameter through this point has its top view length of 45 mm and the same diameter is inclined to the V.P. at  $45^\circ$ .

**Solution :**

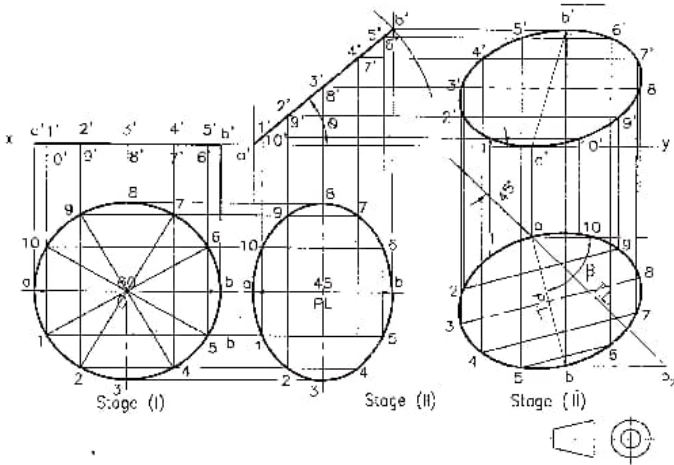


Fig. 3.49

**Problem 3.19 :** A 30-60 degree sets square has its shortest side 50 mm long and is in the H.P. The top view of the sets square is an isosceles triangle and hypotenuse of the sets square inclined at an angle of  $40^\circ$  with the V.P. Draw the projections of the sets square and find its inclination with the H.P.

**Solution :**

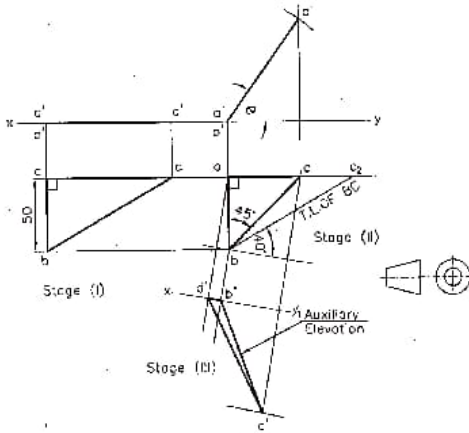


Fig. 3.50

**Problem 3.20 :** Draw the projections of a circle of 70 mm diameter resting on the H.P. on a point A on the circumference, its plane inclined to the H.P. such that the plan is an ellipse of minor axis 45 mm. The plan of the diameter through the point A is making an angle of  $45^\circ$  with the V.P. Measure the angle of the plane with the H.P.

**Solution :**

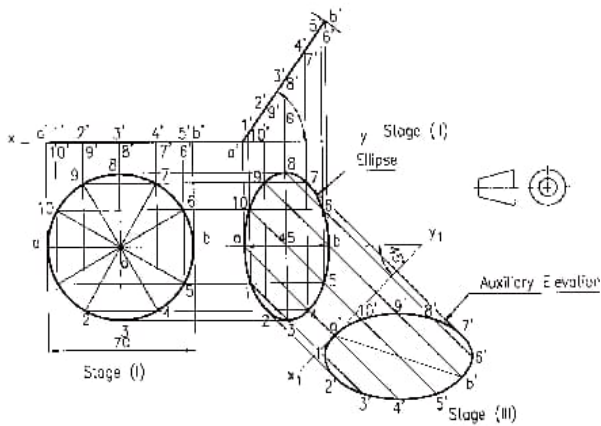


Fig. 3.51

**Problem 3.21 :** A rectangle ABCD with AB 60 mm long and BC 80 mm long is having AB on ground and BC inclined at  $20^\circ$  with V.P. Draw the projections if plan of the rectangle is a square. Find the inclinations, of the plane with the H.P. and the V.P.

**Solution :**

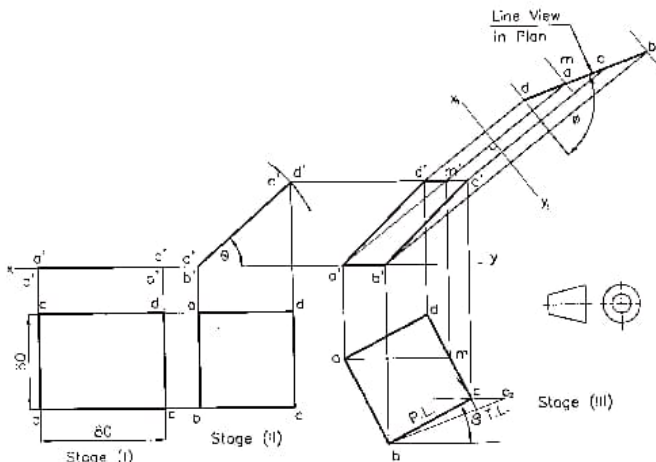


Fig. 3.52

**Problem 3.22 :** A thin rectangular plate of size 70 mm x 40 mm appears as a square of 40 mm sides in top view with one of its sides inclined at 30° to V.P. and parallel to H.P. Draw the projections of the plate and determine its inclination with the H.P.  
**Solution :**

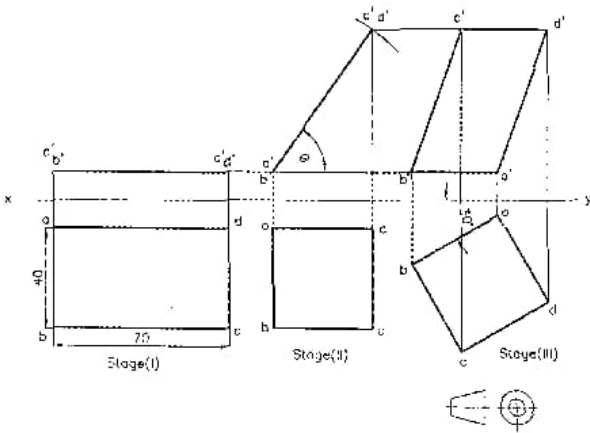


Fig. 3.53

**Problem 3.23 :** An isosceles triangular plate with base 60mm and altitude 80mm has its base in HP and inclined at 45° to VP. Its surface is inclined to HP so that its top view is an equilateral triangle. Draw its projections. Find the inclination made by the plate with HP and VP.  
**Solution :**

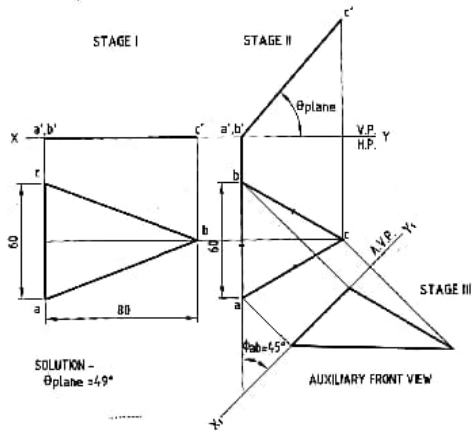


Fig. 3.54

Type II : On HP, on Corner

Case (i) When 'θ' is given

Problem 3.24 : A regular hexagon of 30 mm side has a corner in the H.P. Its surface is inclined at 40° to the H.P. and the top view of the diagonal through the corner which is in the H.P. makes an angle of 60° with the V.P. Draw its projections by using First Angle projection method.

Solution :

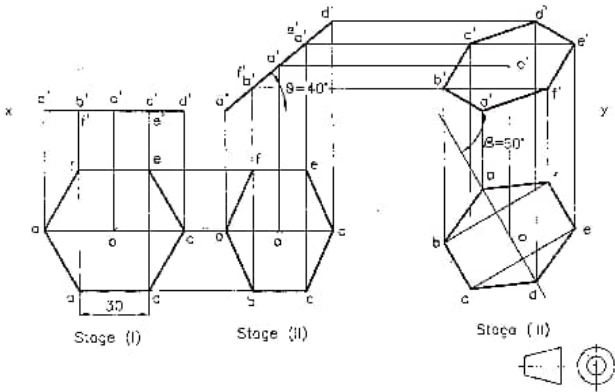


Fig. 3.55

Problem 3.25 : Draw the projections of a rhombus having diagonals 125 mm and 50 mm long, the smaller diagonal of which is parallel to both the reference planes, while the other is inclined at 30° to the H.P.

Solution :

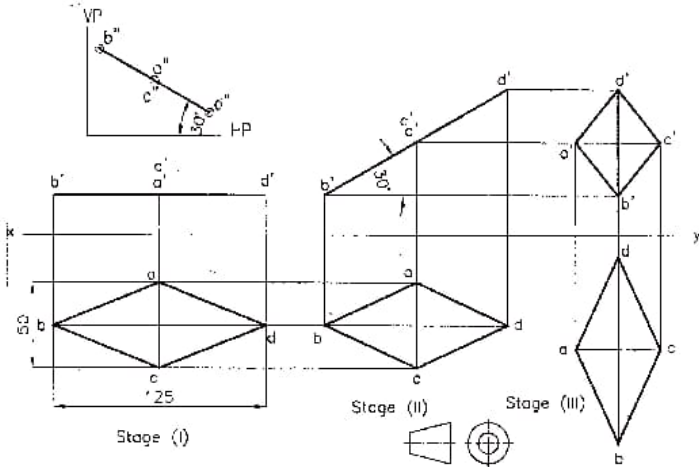


Fig. 3.56

**Problem 3.26 :** A hexagonal plate, base side 50mm, is resting in HP on one of its corner with its side parallel to VP. Then, its surface is inclined to HP so that the corner opposite to resting corner is 51mm above HP. Draw the projections, if its top view line passing through resting corner and its opposite corner, is inclined to VP at an angle of 35°. Also, find the inclination made by the plate with VP.

**Solution :**

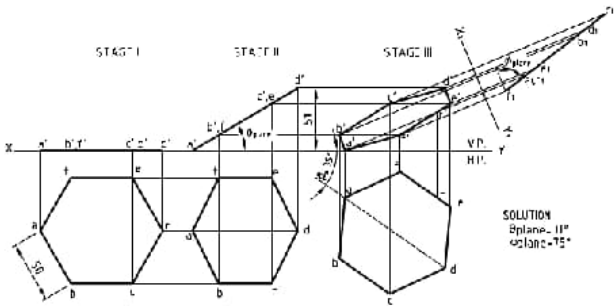


Fig. 3.57

**Case (ii) When 'Plane' is given**

**Problem 3.27 :** A square lamina ABCD, 40mm side, best on corner 'A' in the HP such that plane is seen as a rhombus in the top view with diagonal contained by corner 'A' measuring 20 mm. Another diagonal is inclined at 45° to the VP and parallel to HP. Draw its projections and determine surface inclination of plane with HP.

**Solution :**

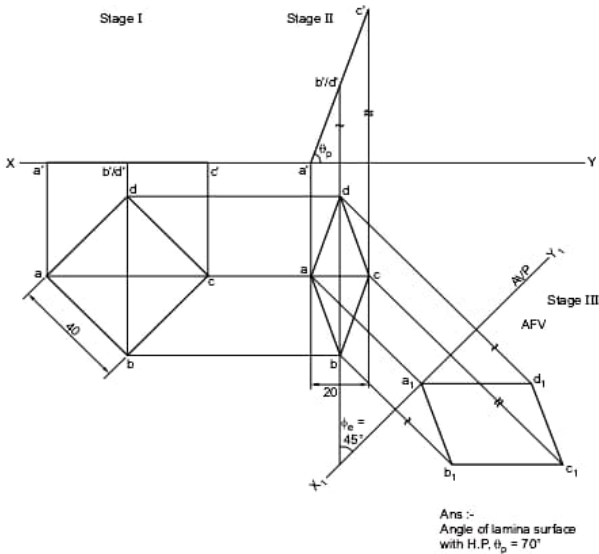


Fig. 3.58

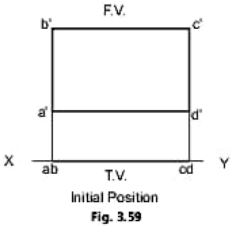
3.7.2 When Plane is Resting On V.P.

View	Significance	Position
Front View	Draw True shape of the plane	Above XY Line
Top View	Draw Line View	On XY line

Step I: Drawing True shape and Line View:

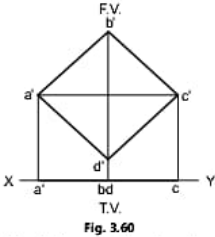
1. Resting on side

- The true shape of the plane has to be drawn above XY line.
- Given side should be perpendicular to XY.
- Draw true shape keeping given side on left.



2. Resting on corner

- The true shape of the plane has to be drawn above XY line.
- The line passing through given corner and center of plane must be parallel to XY.
- Draw true shape keeping corner on left side.



Step II: Drawing Inclination with VP i.e.  $\phi$  and Reduced Size of FV i.e. Elevation

1. When ' $\phi$ ' i.e. inclination with VP is given-

- Rotate line view i.e. TV of step I by given angle keeping left end on XY.

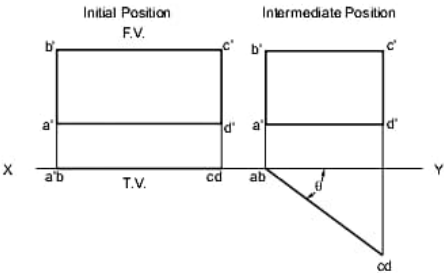


Fig. 3.61



**2. When 'In-front of VP ' distance of one of the corner or edge is given-**

- First draw line parallel to XY at a given distance.
- It should be below XY line.
- Plot given corner or edge points on parallel line.
- Join points with left end which is on XY

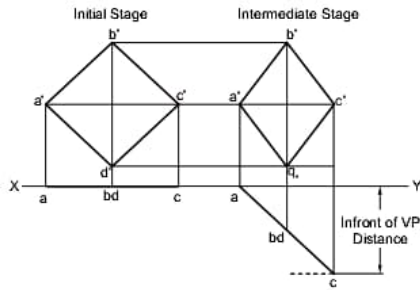


Fig. 3.62

**3. When information about front View/Elevation is given.**

- First project all the points from step I Front View
- With the help of these projectors draw given information in Front View of Step II.
- Project all the points below XY line from front View of Step II
- Complete TV and get the inclination with VP.

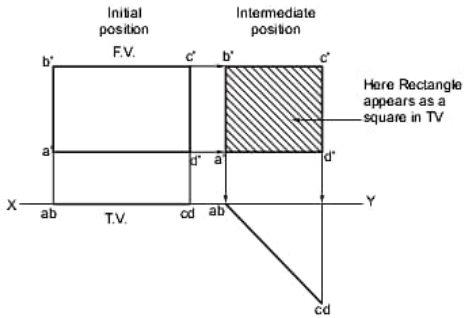


Fig. 3.63

**Step II:** Drawing 'Side/Diagonal/Diameter' at an angle made with HP i.e. ' $\theta$ '

**1. When True length of given side / diagonal / diameter is making an angle ' $\theta$ ' &**

**True length is unchanged from Step I to Step II**

- First Draw a line at given angle from XY line instep III.
- On these inclined line, Plot points of given side.
- With the help of these complete FV of Step III
- FV of Step II and Step III should be same in size and shape, only orientation will change.
- Project all the points below XY line from Front View of Step III
- Complete TV of step III by using horizontal projector from TV of Step II

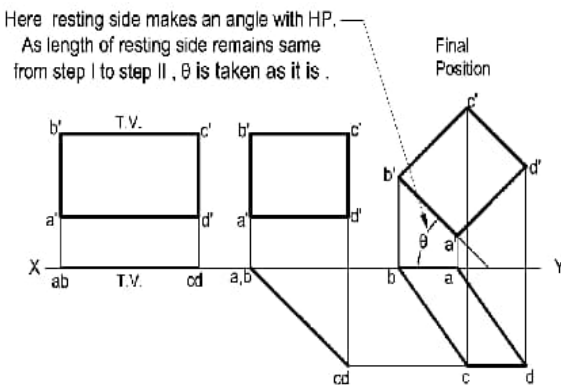


Fig. 3.64

**2. When True length of given side / diagonal / diameter is making an angle ' $\theta$ ' &**

**True Length is changed from Step I to Step II:**

- First complete ' $\alpha$ ' construction.
- Draw a line at calculated ' $\alpha$ ' angle from XY line instep III.
- On these inclined line, Plot points of given side.
- With the help of these complete FV of Step III
- FV of Step II and Step III should be same in size and shape, only orientation will change.
- Project all the points below XY line from Front View of Step III
- Complete TV of Step III by using horizontal projector from TV of Step II



Type III : On VP, on Side  
Case (i) when ' $\phi$ ' is given

Problem 3.28 : Draw the projections of a regular hexagon of 25 mm side having one of its edges in the V.P. and inclined at  $60^\circ$  to the H.P. and the surface making an angle of  $40^\circ$  with the V.P.

Solution:

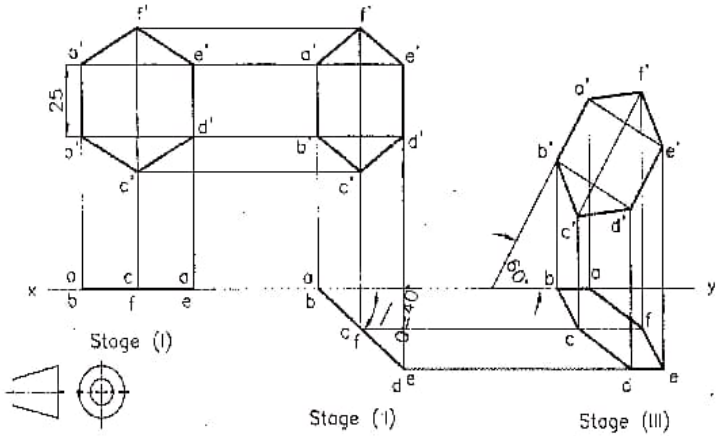


Fig. 3.66

Problem 3.29 : A semi-circular plate of 100 mm diameter has its straight edge in the V.P. and inclined at  $30^\circ$  to the H.P. The surface of the plate makes an angle of  $40^\circ$  to the V.P. Draw its projections.

Solution:

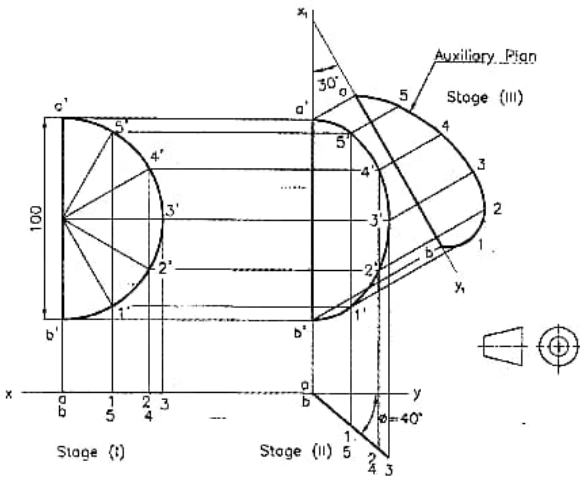


Fig. 3.67

**Problem 3.30 :** A circular disc of valve is of 70 mm diameter. It is pivoted at the ends of diameter AB which is parallel to the V.P. and inclined to the H.P. at 30°. Obtain the projections of the disc on the principal planes when the disc is inclined to V.P. at 30°. Mark the angle the disc makes with HP.

**Solution:**

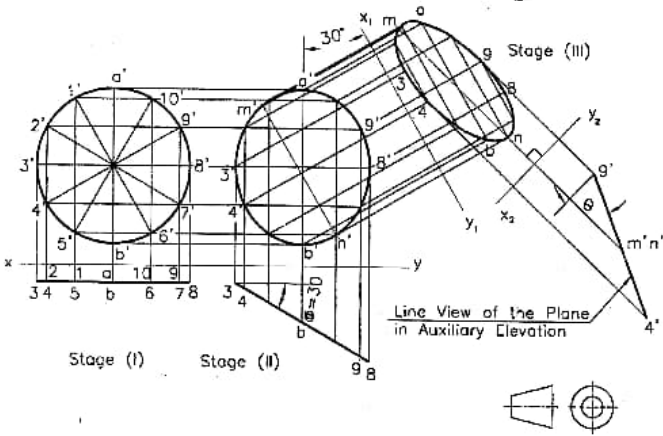


Fig. 3.68

**Case (ii) When 'Infront of VP' is given**

**Problem 3.31 :** An isosceles triangle base 50mm and altitude 80mm is resting in VP on its base. Its surface is inclined to VP so that the corner opposite to resting side is 50mm in front of VP. Draw the projections if its resting side is inclined to HP at an angle of 45°. Find inclinations made by the plane with HP and VP.

**Solution :**

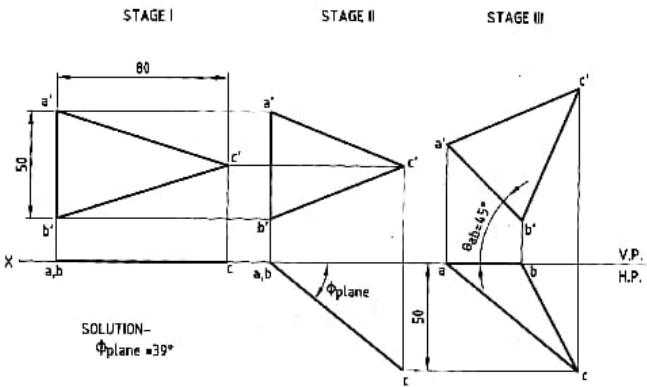


Fig. 3.69

**Case (iii) When 'Elevation' is given**

**Problem 3.32 :** A plate having shape of an isosceles triangle has base 60 mm long and altitude 80 mm. It is so placed that in the front view it is seen as an equilateral triangle of 60 mm sides and one side inclined at  $45^\circ$  to  $xy$ . Draw its projections.

**Solution:**

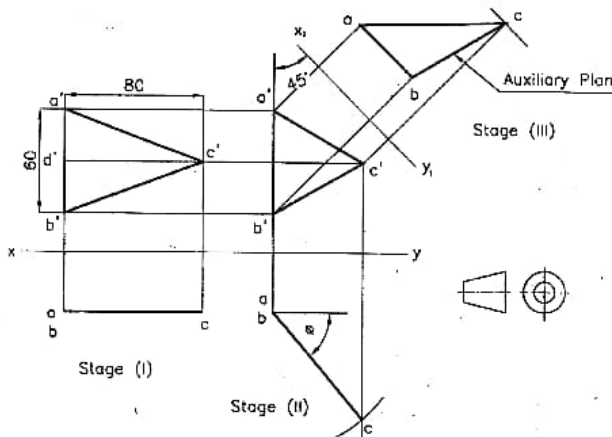


Fig. 3.70

**Problem 3.33 :** mm in the elevation. Draw projections of the rectangle, when one of its diagonals is parallel to the H.P. Find the inclination of the rectangle with the H.P. and V.P.

**Solution:**

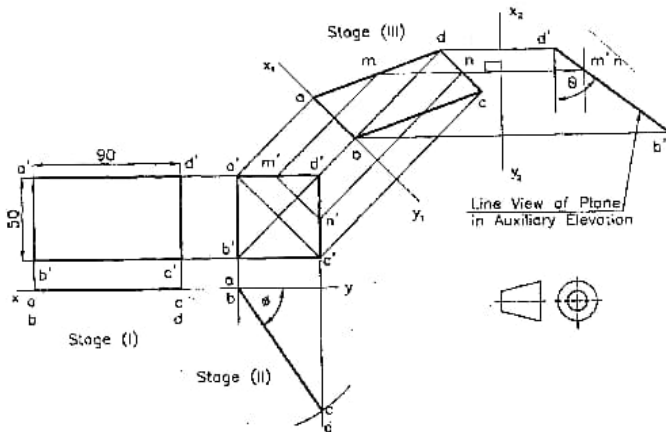


Fig. 3.71

Type IV : On VP, on Corner :

Case (i) When ' $\phi$ ' is given

Problem 3.34 : A pentagonal plate of side 40mm is held on VP on one of its corner and the edge opposite to that corner makes an angle of  $25^\circ$  with the HP. The surface of pentagonal plate is inclined at  $40^\circ$  to VP. Draw the projections and find the inclination made by the plate with HP.

Solution :

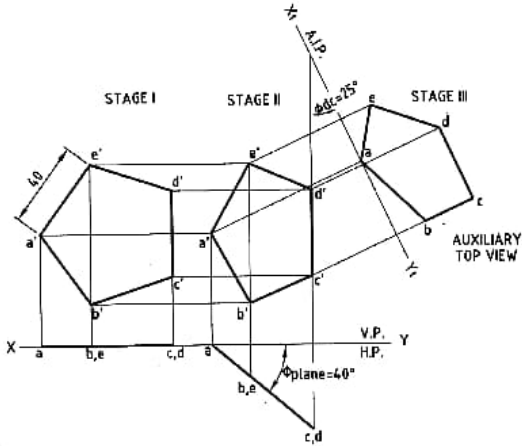


Fig. 3.72

Problem 3.35 : A rhombus of a longer diagonal 80mm and smaller diagonal 50mm is resting in VP on its corner, with its longer diagonal parallel to XY. Its surface is inclined to VP so that the corner opposite to resting corner is 50mm in front of VP. Draw the projections, if the diagonal line passing through the resting corner is inclined to HP at an angle of  $25^\circ$ . Find the inclinations made by the plane with HP and VP.

Solution :

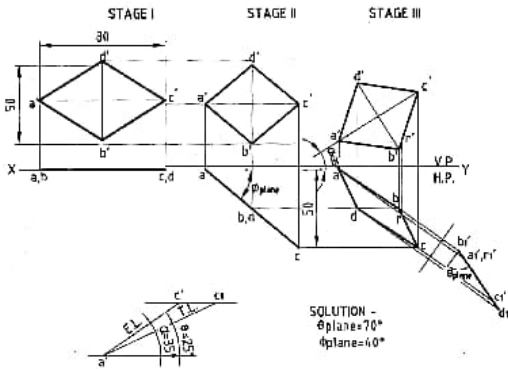


Fig. 3.73

**Case (ii) When 'Elevation' is given**

**Problem 3.36 :** A square plane of side 50mm is resting in VP on its corner in such a way that its adjacent sides are equally inclined to HP. Its surface is inclined to VP so that its FV appears as a rhombus of 40mm minor axis. Draw the projections & find the inclinations made by the plane with HP & VP, if the diagonal line passing through the resting corner is inclined to HP at an angle of  $25^\circ$ .

**Solution :**

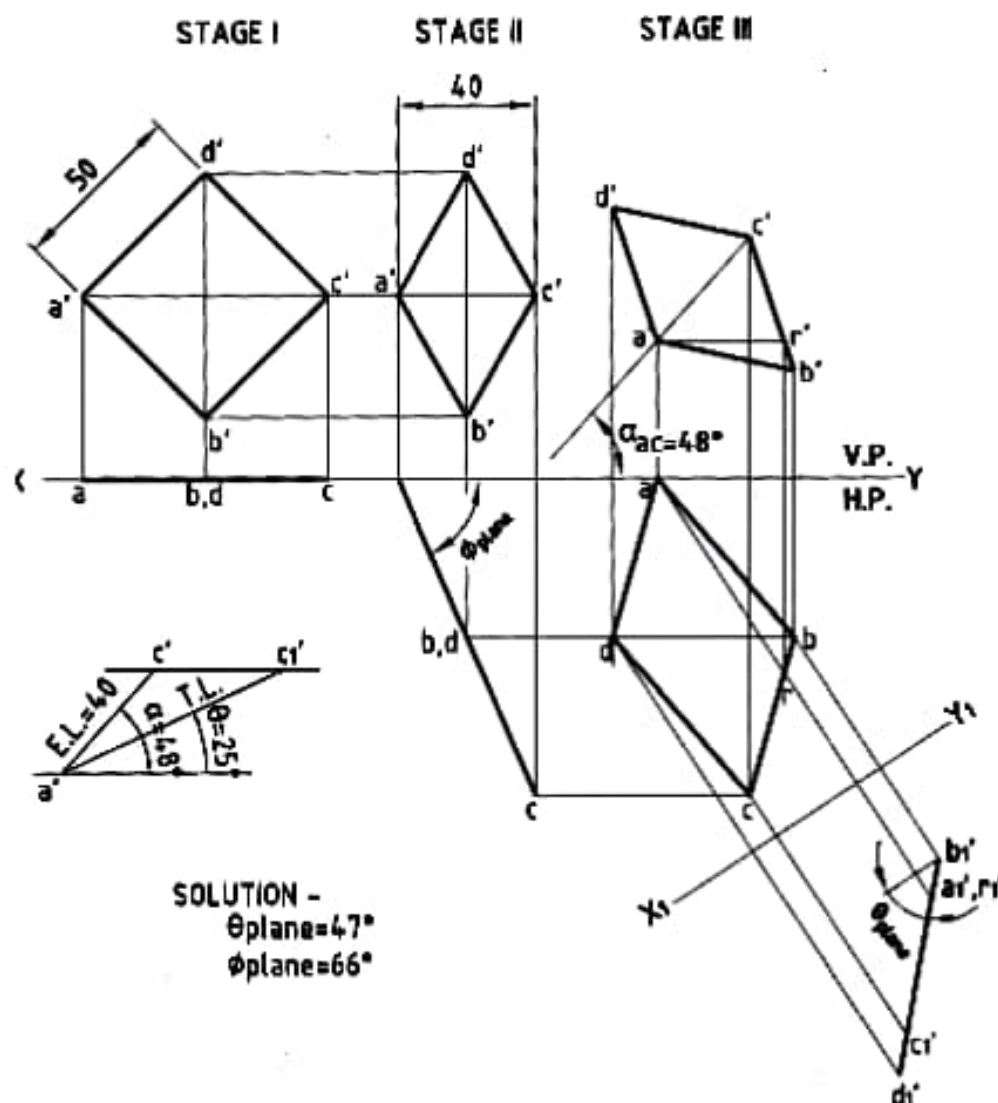


Fig. 3.74



Solution :

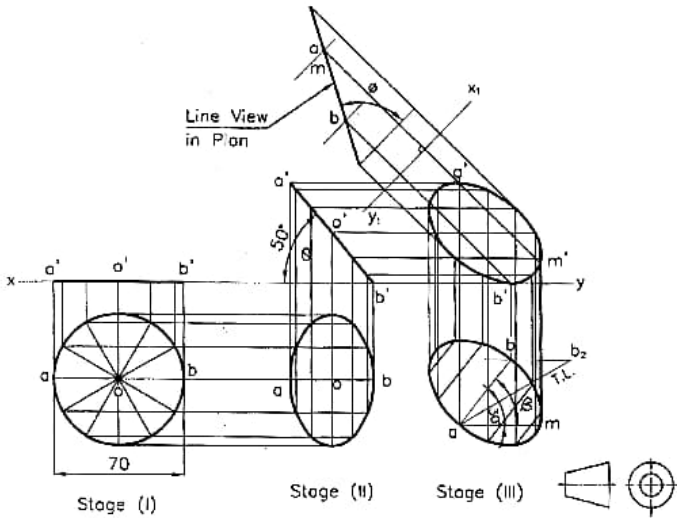


Fig. 3.75

**Problem 3.38 :** Draw the projections of a circular lamina of 60 mm diameter having end A of its diameter  $Ab$  in the H.P. and the end B in the V.P. and the surface inclined at  $30^\circ$  to the H.P. and  $60^\circ$  to the V.P.

Solution :

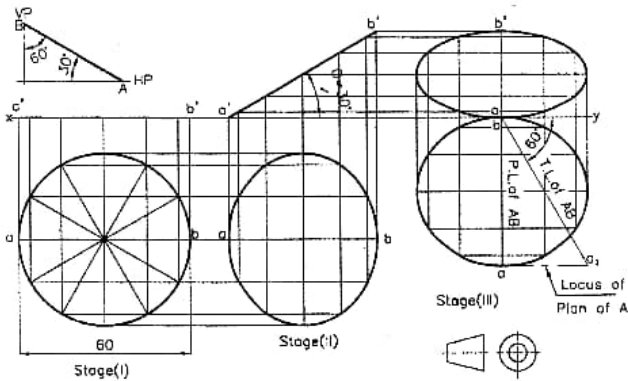


Fig. 3.76

Problem 3.39 : A hexagonal plate of side 50mm is resting in HP on one of its corner. Then, its surface is inclined to HP at an angle of 37°. Draw the projections, if the top view of a diagonal line passing through the resting corner and its opposite corner is inclined to VP at an angle of 40°. Find the inclination made by the plane with VP.

Solution:

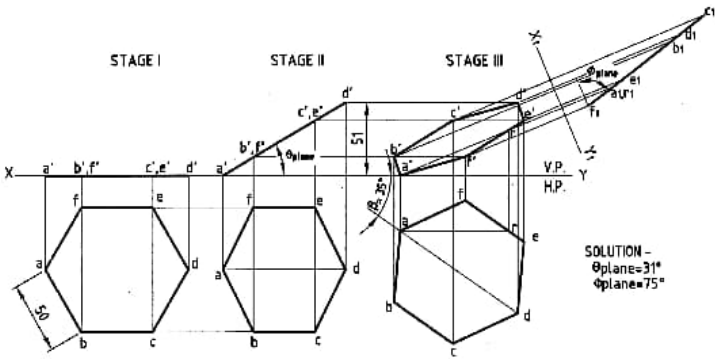


Fig. 3.77

Type VI: 'α' Calculations

Problem 3.40 : A circular lamina of diameter 60mm is resting in VP on one of its circumferential point. Then its surface is inclined to VP at an angle of 45°. Draw the projections of lamina, if the front view of a diameter line passing through the resting point makes 35° with HP. Find the true inclination made by the lamina with HP.

Solution :

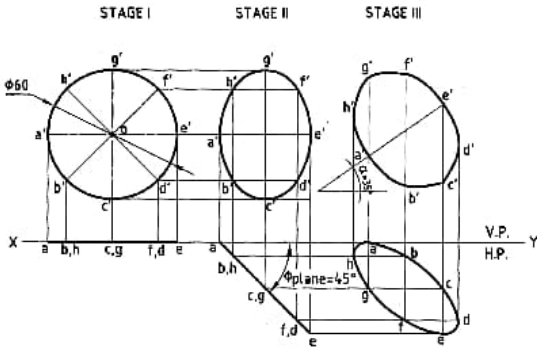
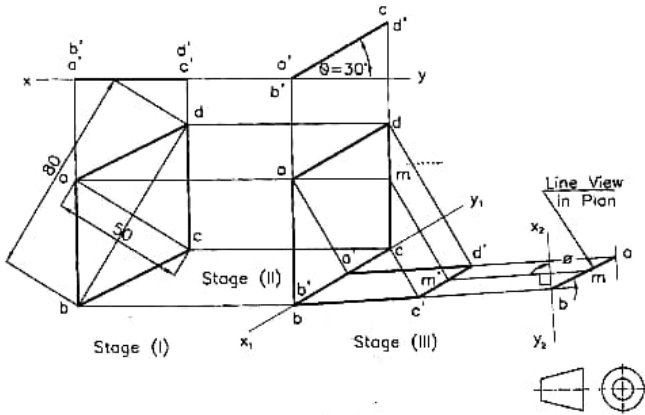


Fig. 3.78

Type VII: Line View

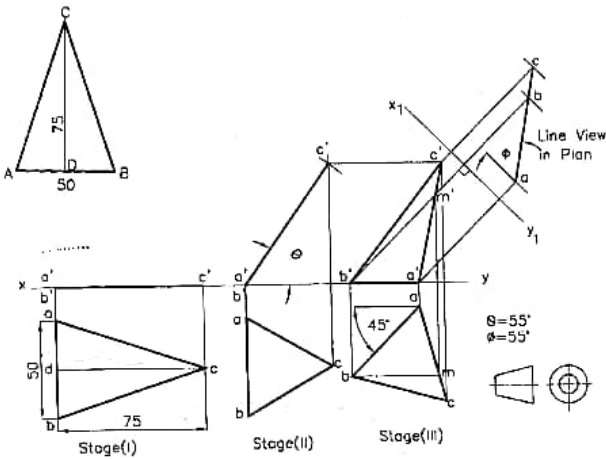
Problem 3.41 : A rhombus ABCD has its diagonal AC = 50 mm and BD = 80 mm. The side AB of the plane is in H.P. The side BC is in V.P. and the plane makes an angle of 30° with the H.P. Obtain the projections of the plane and find its inclination with the V.P.

Solution:



Problem 3.42 : An isosceles triangular plate of 50 mm base and 75 mm altitude appears as an equilateral triangle of 50 mm sides in top view. Draw the projections of the plate if its 50 mm long edge is on the H.P. and inclined at 45° to the V.P. What are inclinations of the plate with the H.P. and the V.P. Refer Fig. 3.80.

Solution:



Problem 3.43 : A rectangular plate, 50mm x 80mm, is resting in HP on its smaller side, its surface is inclined to HP at an angle of 40° . Draw the projections, if its resting side is inclined to VP at an angle of 25° . Find the inclination made by the plane with VP.

Solution :

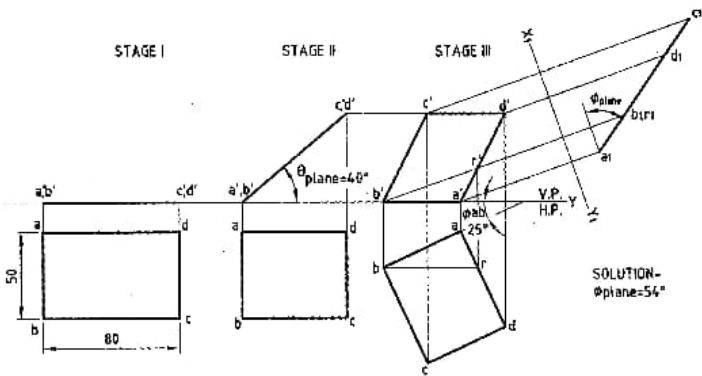


Fig. 3.81

Problem 3.44 : An equilateral triangle of 60mm side is resting in VP on one of its side. Then its surface is inclined to VP at an angle of 40°. Draw the projections of plane, if the resting side is inclined to HP at an angle of 30°. Find the inclination made by plane with HP.

Solution:

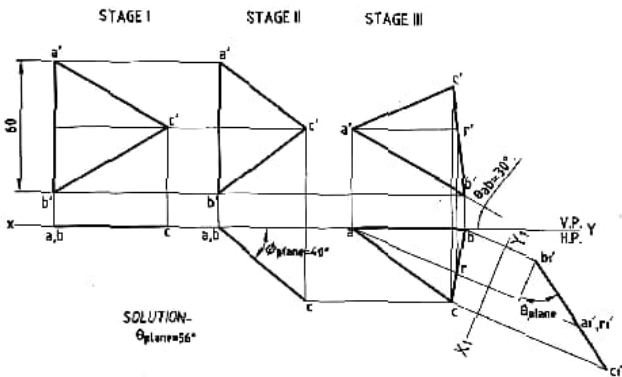


Fig. 3.82

## On HP & Resting On Side

### Case I : When 'θ' is given

1. A rectangular plate, 50 mm x 80 mm, is resting in HP on its smaller side. Its surface is inclined to HP at an angle of  $40^\circ$ . Draw the projections, if its resting side is inclined to VP at an angle of  $25^\circ$ . Find the inclination made by the plane with VP.
2. A pentagonal lamina with 30 mm sides rests on one of its edges in the HP. The plane of the lamina makes  $30^\circ$  with the HP and the edge lying in the HP, makes  $50^\circ$  with VP. Draw projections of the lamina and find the inclination of the plane with VP.
3. A regular pentagonal plane ABCDE of side 40 mm has side AB in HP making an angle of  $20^\circ$  with the VP. The Plane makes an angle of  $45^\circ$  with the HP. Draw the projections of the plane and find the angle made by the plane with the VP.
4. A circle of 50 mm diameter is resting on HP on end A of its diameter AC which is  $30^\circ$  inclined to HP while it makes  $45^\circ$  inclined to VP. Draw its projections.

### Case II : When 'above HP distance' is given

5. An isosceles triangle, base 50 mm and altitude 80 mm is resting in HP on its base. Its surface is inclined to HP so that the corner opposite to resting side is 50 mm above HP. Draw projections, if its resting side is inclined to VP at an angle of  $45^\circ$ . Find the inclinations made by the plane with HP and VP.
6. A regular pentagon of 30 mm sides has an edge on the HP making an angle of  $20^\circ$  with the VP. The corner opposite to the edge on the HP is 30 mm above HP. Obtain the projection of the plane and find inclination with the VP.

### Case III : When 'information about top view' is given

7. An isosceles triangular plate of base 50 mm and 75 mm altitude appears as an equilateral triangle of side 50 mm in top view. Draw the projections of the plate if its 50 mm long edge is on the HP and inclined at  $45^\circ$  to the VP what are the inclinations of the plate with HP & VP.
8. A  $30^\circ - 60^\circ$  set square has its shortest edge 50 mm long and is in HP the top view of the set square is an isosceles triangle. Draw the projections with the hypotenuse of the set square inclined at  $40^\circ$  to the VP.
9. A triangle PQR (PQ = 80 mm, QR = 75 mm and RP = 65 mm) has its side PQ on the HP with the sides QR and RP equally inclined to VP. Top view of the triangle is a right angled triangle. Draw the projections and find inclination of the plate with HP.
10. A triangle ABC (AB = 80 mm, BC = 75 mm and CA = 65 mm) has its side AB on the ground making an angle of  $60^\circ$  with the VP. The plane is inclined to the HP to such an extent that the top view is a right angled triangle. Obtain the projections of the plane and find its inclinations with HP and VP.
11. An isosceles triangular plate with base 60 mm and altitude 80 mm has its base in HP and inclined at  $45^\circ$  to VP. Its surface is inclined to HP so that its top view is an equilateral triangle. Draw its projections. Find the inclination made by the plate with HP and VP.
12. A regular pentagon ABCDE of side 40 mm has its corner A in HP and opposite side CD parallel to both HP and VP. Draw its projections when plans of AB and AE measure 35 mm. Measure inclination of the plane with HP.
13. A thin rectangular plate of size 70 mm x 40 mm appears as a square of side 40 mm in TV with one of its side inclined at  $30^\circ$  to VP and parallel to HP. Draw the projection of the plate and determine its inclination with HP.

**On HP & Resting On Corner****Case I : When 'θ' is given:**

14. An equilateral triangular plate of 80 mm sides has its one of the corners on HP and its surface makes  $45^\circ$  with HP. The side of the plate opposite to the corner on HP is at  $30^\circ$  to the VP. Draw the projections of the plate and find its inclination with VP.
15. A regular hexagonal plane of 30 mm side has one of its corners on the H.P. The surface of the plane is inclined at  $30^\circ$  to H.P. Draw the projection of the plane when diagonal passing through the corner on H.P makes an angle of  $45^\circ$  to the VP.
16. Draw the projection of rhombus having diagonals 96 mm and 48 mm long. The smaller diagonal is parallel to both reference plane, while the other diagonal is inclined at  $30^\circ$  to the HP and has one of its end point in HP keep the centre of rhombus 56 mm in front of VP.
17. A circular lamina of diameter 60mm is resting in HP on one of its circumferential point. Then its surface is inclined to HP at an angle of  $45^\circ$ . Draw the projections of lamina, if the top view of diameter line passing through the resting point makes  $45^\circ$  with VP. Find the true inclination made by the lamina with VP.

**Case II : When 'above HP distance' is given**

18. A hexagonal plate, base side 50 mm, is resting in HP on one of its corner with its side parallel to VP. Then its surface is inclined to HP so that the corner opposite to resting corner is 51 mm above HP. Draw the projections, if its top view line passing through resting corner and its opposite corner, is inclined to VP at an angle of  $35^\circ$ . Also find the inclination made by the plate with VP.
19. An isosceles triangle, base 50 mm and altitude 80 mm, is resting in HP on its base. Its surface is inclined to HP so that the corner opposite to resting side is 50 mm above HP. Draw the projections, if its resting side is inclined to VP at an angle of  $45^\circ$ . Find the inclinations made by the plane with HP and VP.
20. A triangle ABC [AB=40 mm, BC=60 mm, and angle ABC =  $90^\circ$ ] is resting in HP on its side AB. Then its surface is inclined to HP in such a way that the point C is 39 mm above the HP. draw the projections if the resting side is inclined at an angle of  $20^\circ$  with VP. Find the inclination made by the plane with VP.

**Case III : When 'information about top view' is given**

21. A rectangular plate ABCD having side AB =80 mm and side BC=40 mm is resting on its corner 'A' in horizontal plane. The diagonal AC measures 70 mm in plan and corner C is 20 mm in front of vertical plane. Draw projections of the plate if the plan of the diagonal AC is inclined at an angle of  $40^\circ$  with the vertical plane. Find its inclinations with the reference planes.
22. ABCD is a rhombus with diagonals AC = 43 mm and BD = 28 mm. The corner is in the HP and the rhombus is made inclined to HP such that the plan appears as a square. If the diagonal AC makes an angle of  $20^\circ$  with VP. Draw the projection of the plane and find its inclinations with HP and VP.
23. A square plate with 50 mm long diagonals is seen as a quadrilateral with lengths of diagonals as 50 mm and 30 mm in top view. One corner of the square plate is resting on HP. Draw the projections of this plate when the projected shorter diagonal makes  $30^\circ$  with VP. and Find the angle made by the plate with HP and VP.
24. A regular pentagonal plate, ABCDE, of 40 mm side is resting in HP on its corner. Its surface is inclined to HP such that top view lengths of sides AB and AE are 35 mm each. Draw the projections of plate, if side CD is made parallel to both the reference planes. Measure its inclination with HP.
25. Draw the projections of circular plate of 60 mm diameter resting on HP on a point of the circumference and its plane surface is inclined to HP in such a way that the plan is an ellipse of 40 mm minor axis. Draw the projections of the plane lamina, if the diameter through the point on HP makes an angle of  $30^\circ$  with VP.

**On VP Resting On Side****Case I : When ' $\phi$ ' is given**

26. A regular pentagon ABCDE of side 40mm has one of its edges in the VP and inclined at  $30^\circ$  to the HP. The pentagon is inclined at  $45^\circ$  to the VP. Draw the projections.
27. A pentagonal lamina of sides 40 mm is resting with one of its corners on the VP and an edge opposite to this corner making an angle of  $30^\circ$  to the HP. The surface of the lamina itself is inclined at  $45^\circ$  to the VP. Draw the projections.
28. A circular plane of 40 mm diameter is resting in VP on its point of circumference. Its surface is inclined to VP at an angle of  $40^\circ$ . Draw the projections of the plane. Find the inclination of plane to HP, if its diameter passing through the resting point is inclined to HP at an angle of  $30^\circ$ .
29. A thin semicircular plate of diameter 70 mm has its straight edge in vertical plane and inclined at  $45^\circ$  to horizontal plane. The surface of a plate makes an angle of  $30^\circ$  with VP. Draw its projections when the end point on straight edge, which is towards HP, is 18 mm above HP. Find inclination made by plate with HP.
30. A regular hexagonal lamina, of side 30 mm, has a side both HP and VP while lamina, makes an angle of  $60^\circ$  with VP. Find angle made by a lamina with HP.

**Case II : When 'infront of VP distance' is given**

31. An isosceles triangle, base 50 mm and altitude 80 mm, is resting in VP on its base. Its surface is inclined to VP so that the corner opposite to resting side is 50 mm in front of VP. Draw the projections, if its resting side is inclined to HP at an angle of  $45^\circ$ . Find the inclinations made by the plane with HP and VP.
32. A pentagonal plate of 40 mm side is resting on VP on one of its sides such that the corner opposite to it is 25 mm infront of VP. The side in VP makes an angle of  $20^\circ$  with HP. Draw its projections and find its inclination with HP & VP.
33. A regular hexagon plate ABCDEF 30 mm side is resting in VP on its side AB. Then, its surface is inclined to VP so that the side ED is 30mm in front of VP. Draw the projections if the side FA is parallel to HP. Find the inclinations made by the plate with HP and VP.

**Case III : When 'information about front view' is given**

34. An isosceles triangle, base 40 mm and height 60 mm, is resting in VP on its base in such a way that its elevation appears an equilateral triangle. Draw the projection, if its resting side is inclined to HP at An angle of  $25^\circ$ . Determine the inclinations of plane with HP and VP.
35. ABCDEF is a thin regular hexagonal plate in VP with 30 mm side. Keeping corner A in VP, corner D is brought 30 mm in front of VP. Draw the projections of the plate when edge CD is parallel to HP. And Find inclinations of the plate with HP and VP.
36. A circular lamina of diameter 60 mm is resting in VP on one its circumferential point. Then, its surface is inclined to VP at an angle of  $45^\circ$ . Draw the projections of lamina, if front view of a diameter line passing through resting point makes  $35^\circ$  with HP. Find the true inclination made by lamina with HP.

**On VP Resting On Corner****Case I : When ' $\phi$ ' is given**

37. A pentagonal plate of side 40 mm is held on the VP on one of its corners and the edge opposite to that corner makes an angle of  $25^\circ$  with the HP. The surface of pentagonal plate is inclined at  $40^\circ$  to the VP. Draw the projections and find the inclination made by the plate with HP.

**Case II : When 'infront of VP distance' is given**

38. A rhombus of a longer diagonal 80 mm and smaller diagonal 50 mm is resting in VP on its corner, with its longer diagonal parallel to XY. Its surface is inclined to VP so that the corner opposite to resting corner is 50 mm in front of VP. Draw the projections, if the diagonal line passing through the resting corner is inclined to HP at an angle of  $25^\circ$ . Find the inclinations made by the plane with HP and VP.
39. A rhombus ABCD with the diagonal AC=100 mm and BD=60 mm is resting on corner 'A' in the vertical. Its corner B is 25 mm in front of the vertical plane. Draw the projections of the plane when diagonal AC is inclined at an angle of  $30^\circ$  with the horizontal plane. Find its inclination with the reference planes.

**Case III : When 'information about front view' is given**

40. A square plane of side 50 mm is resting in VP on its corner in such a way that its adjacent sides are equally inclined to HP. Its surface is inclined to VP so that its FV appears as a rhombus of 40 mm minor axis. Draw the projections and find the inclinations made by the plane with HP and VP, if the diagonal line passing through the resting corner is inclined to HP at an angle of  $25^\circ$ .
41. A hexagonal plane figure of sides 30 mm is resting on a corner in the VP, with its surface making an angle of  $30^\circ$  with the VP. The view from the front of the diagonal passing through that corner is inclined at  $35^\circ$  to the ground line. Draw the projections.

