Prob. 39 : An isosceles triangle *ABC* having its base *AB* = 40 mm and altitude 60 mm is resting on the H.P. on its base *AB*. Draw the projections of the plane when its surface is inclined to H.P. at an angle of 45° and the base *AB* which is on the H.P. is making an angle of 50° to the V.P.

Soln. :

Method 1 : Change of position method :

In this method plane is rotated and principal planes do not change their position.

Refer Fig. Prob. 39(a).

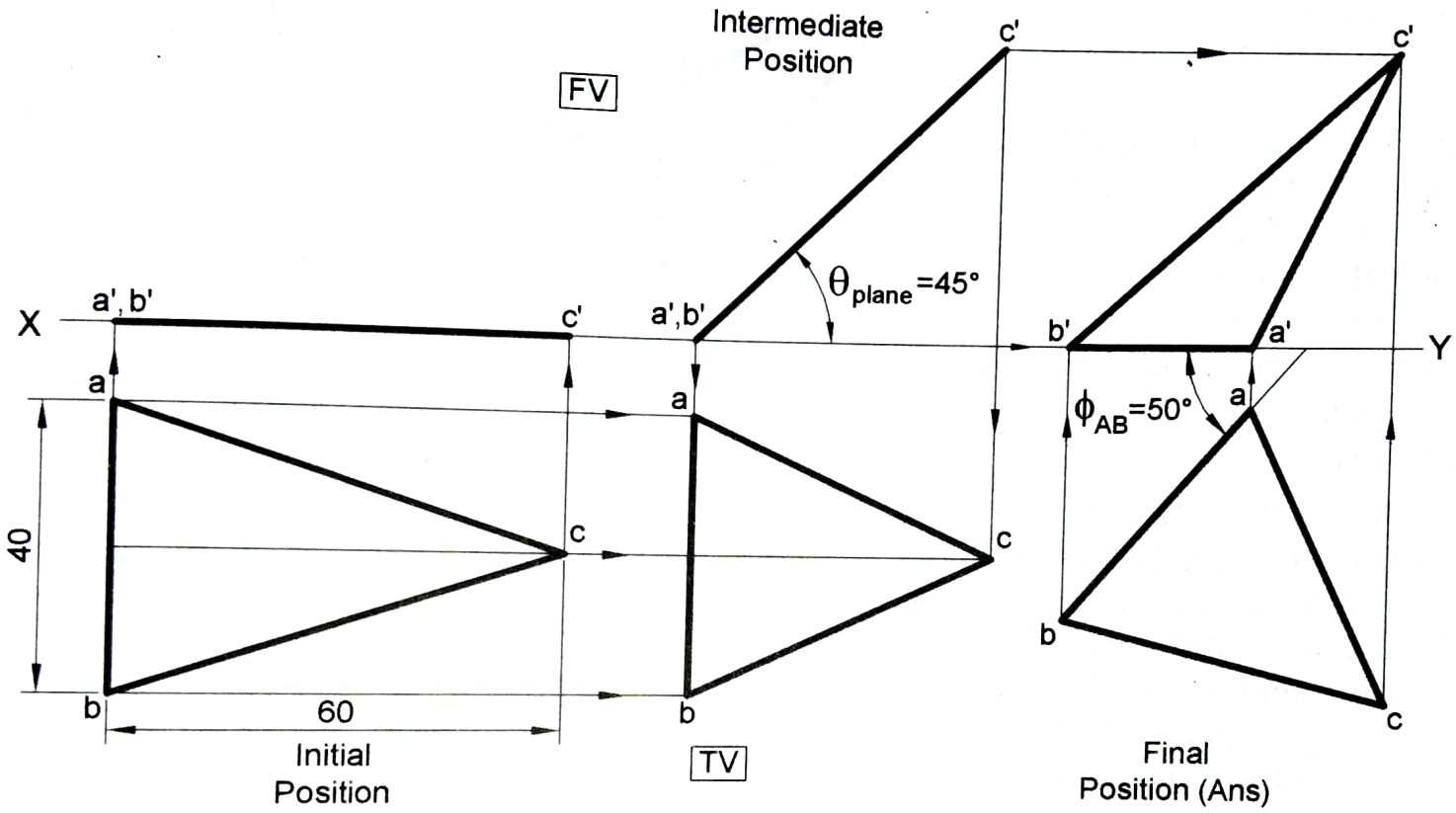


Fig. Prob. 39(a)

Prob. 40 : An isosceles triangle *ABC* having its base *AB* = 40 mm and altitude 60 mm is resting on the V.P. on its base *AB*. Draw the projections of the plane when its surface is inclined to V.P. at an angle of 45° and the base *AB* which is on the V.P. is making an angle of 50° to the H.P.

Soln. :

Method 1 : Change of position method :

In this method plane is rotated and principal planes do not change their position. Refer Fig. Prob. 40(a).

Initial position :

Step 1 : Since isosceles triangle *ABC* is inclined to V.P. with its base *AB* on the V.P., initially we will assume the plane to be kept on the V.P. with its base *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : As we have kept the plane on V.P., its F.V. will show the true shape. Hence draw the F.V. *a′b′ c′* with base *a′b′* perpendicular to the *XY* line and project the T.V. *ab - c* which will be line view coinciding with the *XY* line.

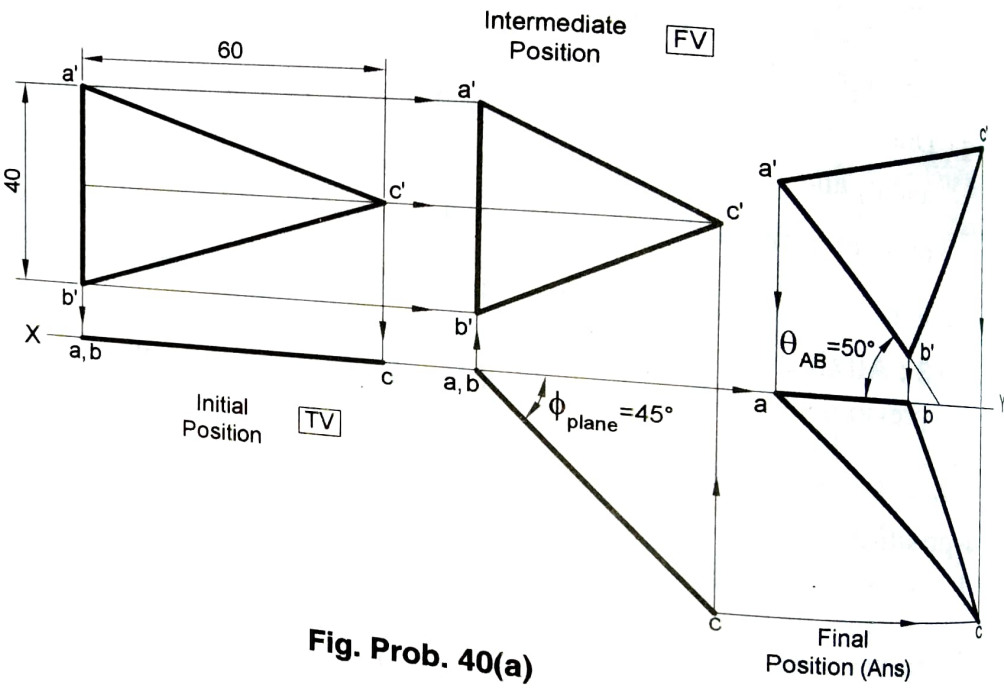


Fig. Prob. 40(a)

Intermediate position :

Step 1 : When an isosceles triangle *ABC* will be inclined to V.P. at an angle of 45°, its T.V. will appear as a line making 45° to the *XY* line. Hence redraw the T.V. of first stage at an angle of $\phi_{plane} = 45°$ with the *XY* line keeping *ab* on the *XY* line.

Step 2 : Project the points *a*, *b* and *c* from the T.V. vertically up and project the points *a′*, *b′* and *c′* from the first stage F.V. parallel to *XY* line and to the right to get the same points in the second stage F.V.

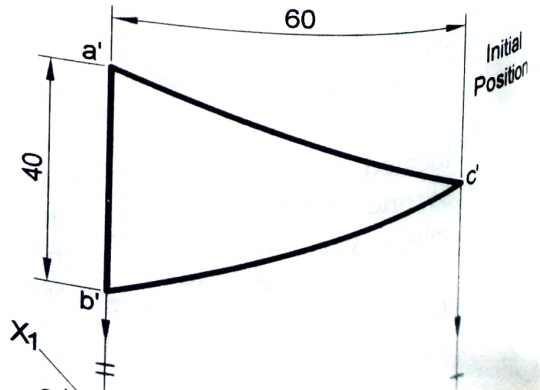
Step 3 : Join points *a′*, *b′* and *c′* in a proper sequence in the second stage F.V.

Final position :

Step 1 : Since base *AB* is making angle of 50° with the H.P. redraw the F.V. of the second stage such that side *a′b′* is making an angle of 50° with the *XY* line.

Step 2 : Project the points of the third stage F.V. (i.e. *a′*, *b′* and *c′*) vertically down. Again project the points of the second stage T.V. (i.e. *a*, *b* and *c*) parallel to the *XY* line and to the right to intersect vertical projectors from third stage F.V. and locate points *a*, *b* and *c*.

Step 3 : Join points *a* , *b* and *c* in proper sequence to get the T.V. of final position.



BC follow the steps given below :

tep 1 : We have the line view of plane *ABC* in both, the auxiliary F.V. and the auxiliary T.V. Let us take a reference line X_2Y_2 parallel to the line view of the plane in auxiliary F.V.

tep 2 : Project points a_1', b_1' and c_1' to X_2Y_2 and mark points a_2, b_2 and c_2. Distance of point a_2 from reference line X_2Y_2 will be same as the distance of point '*a*' from X_1Y_1 in the T.V. Similarly points b_2 and c_2 can be marked.

tep 3 : Join points a_2, b_2 and c_2 in proper sequence which will give us the true shape of triangular plane *ABC*.

rob. 42 : *ABC* is an equilateral triangle of side 60 mm long. Its corner *A* is on H.P. and side *BC* is 20 mm above H.P. Draw the projections of the triangle when side *BC* is inclined to V.P. at an angle of 50°. Find the inclination of plane with H.P. and V.P.

oln. : Refer Fig. Prob. 42.

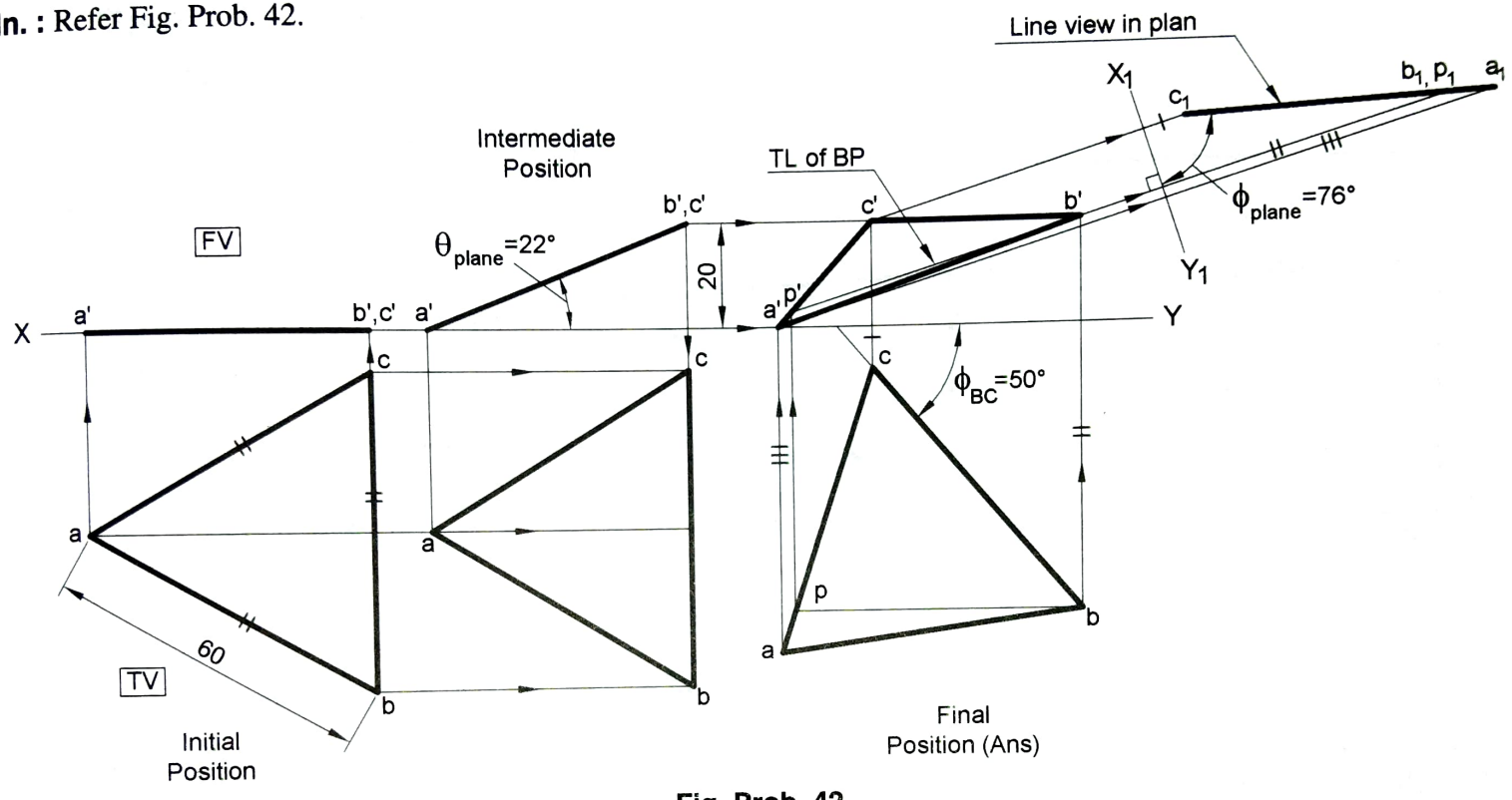


Fig. Prob. 42

Initial position :

Step 1 : Since equilateral triangle *ABC* is inclined to H.P. with its corner *A* on the H.P., initially we will assume the plane to be kept on the H.P. such that line joining corner *A* and centre of the triangle is parallel to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abc* keeping corner '*a*' in such a position that the line joining corner '*a*' and centre of the triangle is parallel to the *XY* line and project the F.V. a'- $b'c'$ which will be line view coinciding with the *XY* line.

Step 3 : Join points a', b', c' ...

Determination of θ_{plane} and ϕ_{plane} :

Step 1 : Angle made by the line view of the plane in second stage F.V. with XY line will give us θ_{plane}.

Step 2 : For determination of ϕ_{plane} draw a line bp parallel to the XY line in the T.V. to intersect ac at point 'p'. point 'p' to the F.V. as p' on side $a'c'$. Join $b'p'$ and draw a new reference line X_1Y_1 perpendicular to it. points a', b' and c' to X_1Y_1 line and mark a_1, b_1 and c_1 in auxiliary T.V. by usual method. Join a_1, b_1 and c_1 will give the line view of the plane the angle of which with X_1Y_1 line will give ϕ_{plane}.

Prob. 43 : *ABC* is a triangular plate having sides *AB* = 40 mm, *BC* = 75 mm and *CA* = 60 mm. The trian resting on the H.P. on its side *AB* which is inclined to V.P. at an angle of 60°. Corner *C* of the tri is 30 mm above H.P. and corner *A* is 10 mm in front of V.P. Draw the projections of the plane.

Soln. : Refer Fig. Prob. 43.

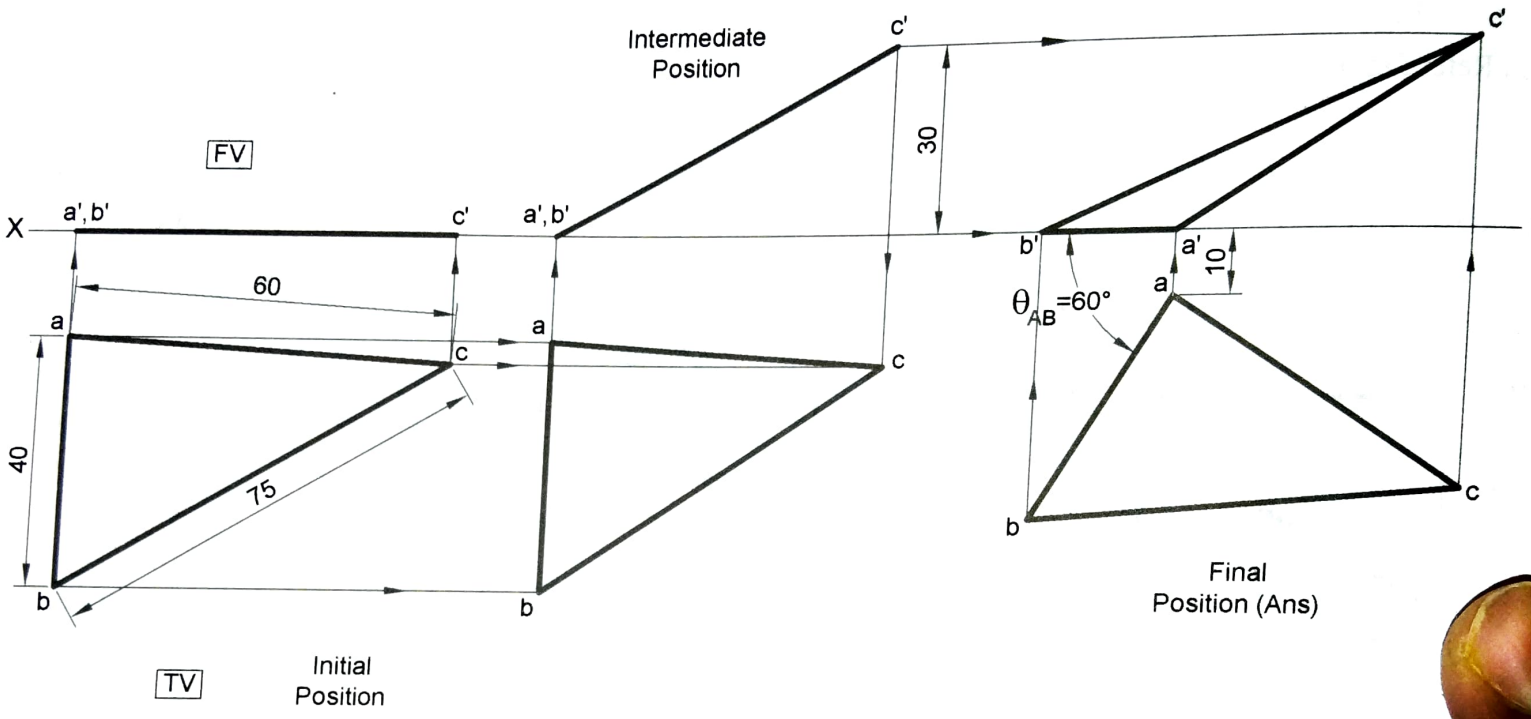


Fig. Prob. 43

Initial position :

Step 1 : Since triangle *ABC* is inclined to H.P. with its side *AB* on the H.P., initially we will assume the the H.P. with side *AB* perpendicular to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abc* of given sides keeping side *ab* perpendicular to the *XY* line and p $a'b'$-c' which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage keeping $a'b'$ on the *XY* line and c' at a distance of 30 mm above *XY*.

Step 2 : Project the points a', b' and c' from the F.V. vertically down and project the points *a*, *b* and *c* from the fi T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

Prob. 45 : Draw the projections of an isosceles triangular lamina of base 40 mm and altitude 70 mm. when it is inclined with V.P. in such a way that its elevation is an equilateral triangle, while the base is inclined at 50° with H.P. and is in V.P. Find the inclination of the lamina with reference planes. Assume the object in the first quadrant.

Soln. : Refer Fig. Prob. 45.

Initial position :

Step 1 : Since elevation of isosceles triangle *ABC* is an equilateral triangle it is inclined to V.P. with its side *AB* on the V.P. So initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. *a′ b′ c′* of given dimensions keeping side *a′ b′* perpendicular to the *XY* line and project the T.V. *a b - c* which will be line view coinciding with the *XY* line.

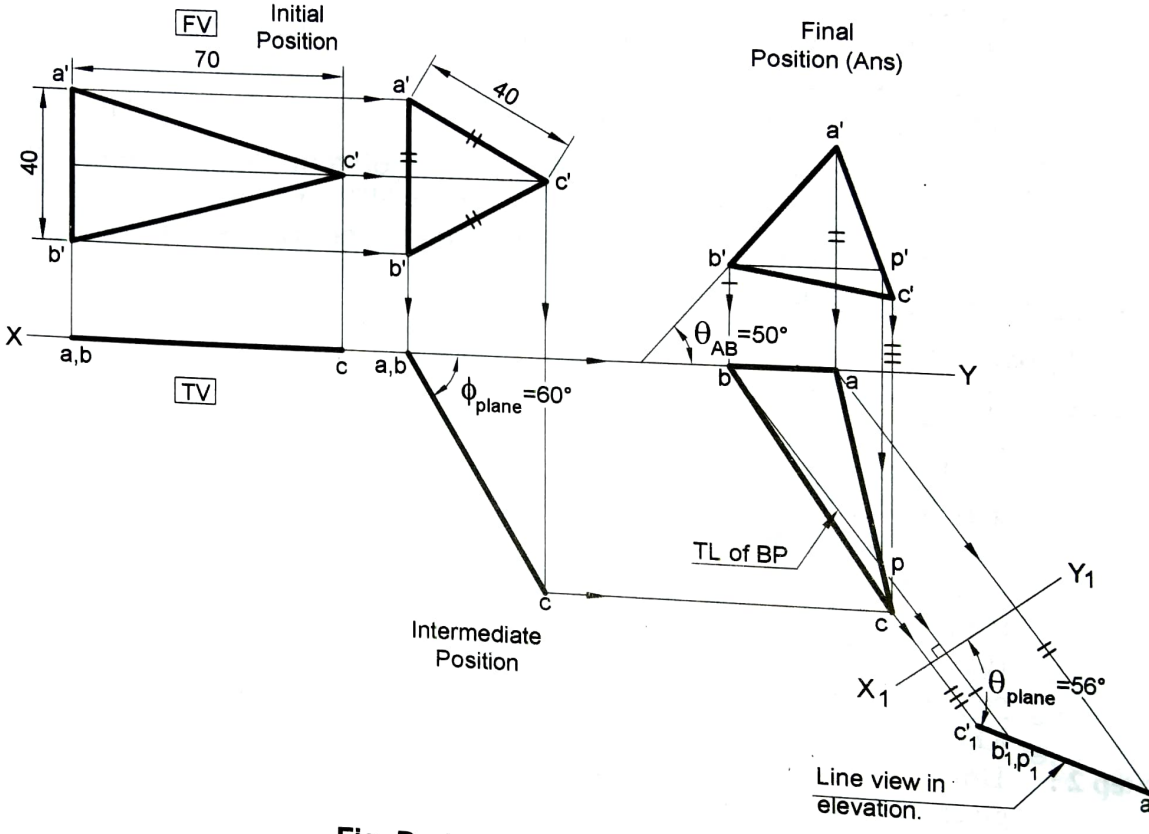


Fig. Prob. 45

ntermediate position :

tep 1 : Draw projectors parallel to the *XY* line and to the right , from corners *a′, b′* and *c′* of the first stage F.V

tep 2 : Draw line *a′ b′* perpendicular to *XY* line keeping *a′* and *b′* on their respective projectors and equilateral triangle *a′b′c′* of side equal to *a′b′* keeping point *c′* on its projector.

tep 3 : Now draw two projectors through points *a′* and *c′* in the F.V. and redraw the first stage T projector of *a′* and '*c*' on projector of *c′*.

inal position :

tep 1 : Since side *AB* is making an angle of 50° with the H.P. redraw the F.V. of the second stage su making an angle of 50° with the *XY* line.

tep 2 : Project the points of the third stage F.V. (i.e. *a′, b′* and *c′*) vertically down. Again project the poi stage T.V. (i.e. *a, b* and *c*) parallel to the *XY* line and to the right to intersect vertical projectors F.V. and locate points *a, b* and *c*.

tep 3 : Join points *a , b* and *c* in proper sequence to get the T.V. of final position.

etermination of θ_{plane} and ϕ_{plane} :

Prob. 46 : A 30° - 60° set square has its shortest edge 50 mm long and is in the H.P. The T.V. of the set square is an isosceles triangle. Draw projections with the hypotenuse of the set square inclined at 40° to the V.P.

Soln. : Refer Fig. Prob. 46.

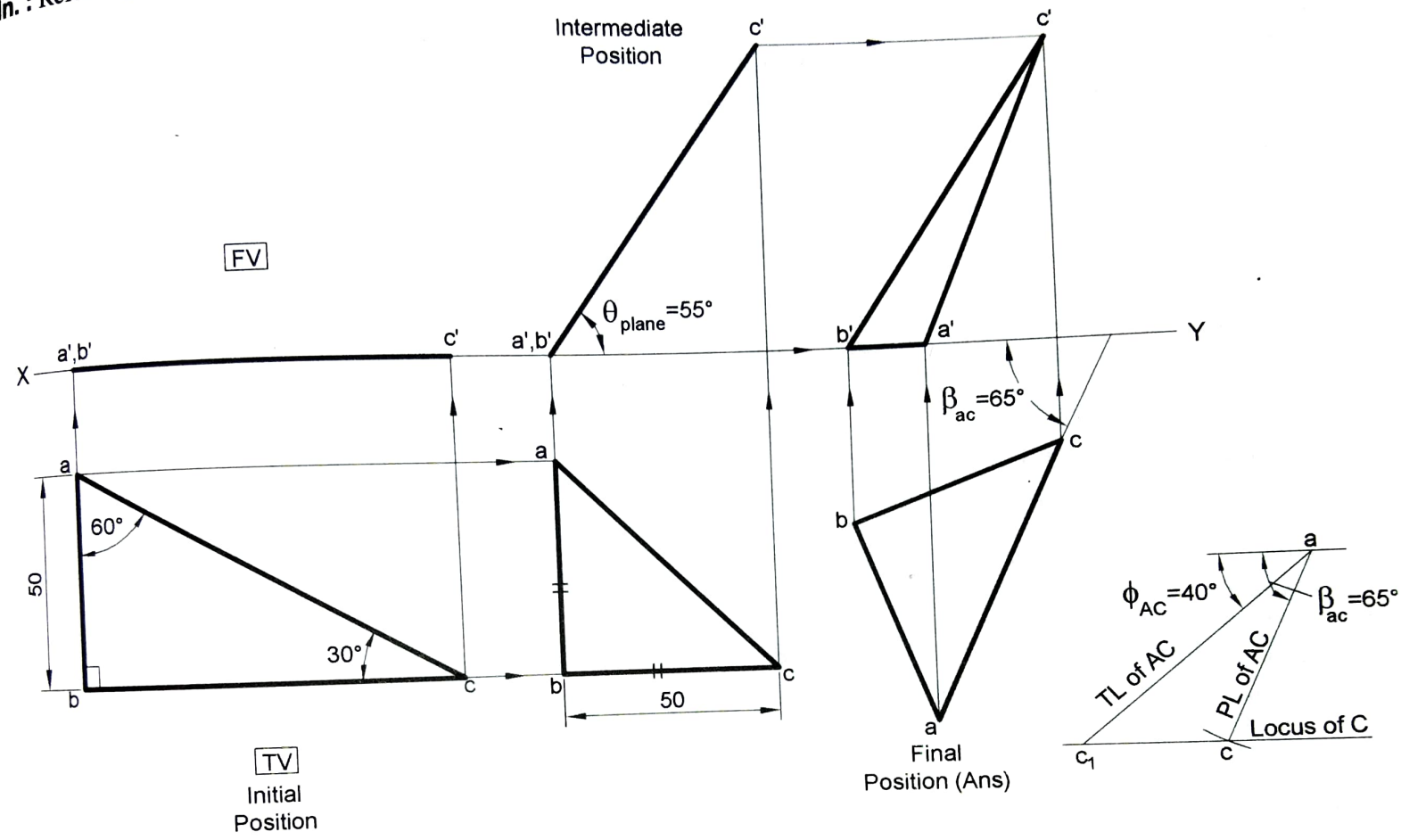


Fig. Prob. 46

Initial position :

Step 1 : Let the shortest side of the set square be *AB*. Since set square is inclined to H.P. with its shortest side *AB* on assume the set square to be kept on H.P. initially with side *AB* perpendicular to V.P. (i.e. *XY*).

Step 2 : Draw a right angled triangle *abc* in the T.V. with its shortest side *ab* 50 mm long and perpendicular to *XY* Take $\angle bca = 30°$ and $\angle bac = 60°$. Project the F.V. *a´b´- c´* which will be a line coinciding with the *XY* line.

Intermediate position :

Step 1 : Draw projectors parallel to the *XY* line and to the right , from corners '*a*' , '*b*' and '*c*' of the first stage T.V.

Step 2 : Draw line *ab* perpendicular to *XY* line keeping '*a*' and '*b*' on their respective projectors and construct an iso triangle *abc* of sides $ab = bc = 50$ mm keeping point '*c*' on its projector.

Step 3 : Now draw two projectors through points '*a*' and '*c*' in the T.V. and redraw the first stage F.V. keeping *a´b´* projector of '*a*' and *c´* on ector of '*c*'

Final position :

Step 1 : Hypotenuse *AC* is ma .P. but it is seen in its apparent length in the secon

4.6.2 Projections of Quadrilateral Planes :

Prob. 56 : A rectangular plane *ABCD* with side *AB* = 30 mm and *BC* = 50 mm is resting on the H.P. on its smaller side *AB*. Draw the projections of the plane when its surface makes an angle of 45° with the H.P. and the side *AB* which is on the H.P. is inclined at 45° to the V.P. Draw the projections of the plane.

Soln. : Method 1 : Change of position method : Refer Fig. Prob. 56(a)

Initial position :

Step 1 : Since surface of the plane is given to be inclined with H.P. with its side *AB* on the H.P., initially we will assume the plane to be kept on the H.P. with side *AB* perpendicular to V.P. (i.e. *XY*).

Step 2 : As we have kept the plane on H.P., its T.V. will show the true shape. Hence draw the T.V. *abcd* with side *ab* perpendicular to the *XY* line and project the F.V. *a′b′- c′d′* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : When a rectangle *ABCD* will be inclined to H.P. at an angle of 45°, its F.V. will appear as a line making 45° to the *XY* line. Hence redraw the F.V. of first stage at an angle of θ_{plane} = 45° with the *XY* line keeping *a′b′* on the *XY* line.

Step 2 : Project the points *a′, b′, c′* and *d′* from the F.V. vertically down and project the points *a, b, c* and *d* from the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

Step 3 : Join points *a, b, c* and *d* in a proper sequence in the second stage T.V.

Final position :

Step 1 : Since side *AB* is making angle of 45° with the V.P. redraw the T.V. of the second stage such that side *ab* is making an angle of 45° with the *XY* line.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c* and *d*) vertically up. Again project the points of the second stage F.V. (i.e. *a′, b′, c′* and *d′*) parallel to the *XY* line and to the right to intersect vertical projectors from third stage T.V. and locate points *a′, b′, c′* and *d′*.

Step 3 : Join points *a′, b′, c′* and *d′* in proper sequence to get the F.V. of final position.

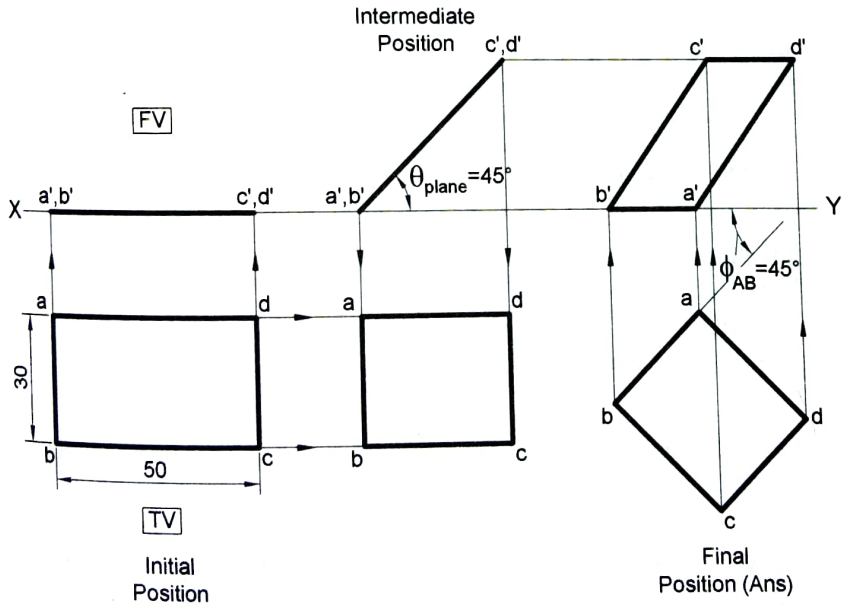


Fig. Prob. 56(a)

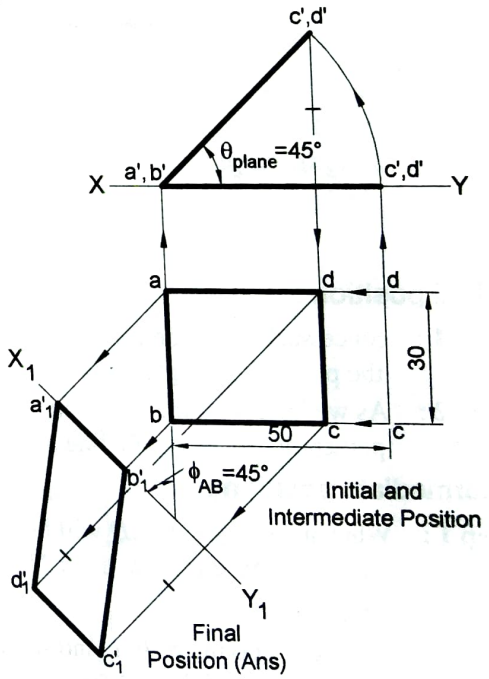


Fig. Prob. 56(b)

Method 2 : Auxiliary plane method : Refer to the Fig. Prob. 56(b)

Initial position : Same as described in Method 1.

Intermediate position :

Step 1 : Now rectangle *ABCD* has to make an angle of 45° to H.P. For th... the re... ut its side *AB* so that corners *C* and *D* will move on arcs in the F.V. and on str... he X... T.V.

second stage. Now draw a projector through new ... of the vertical projector at point ... a, b, new 'c' and of C and D in the T.V.) and to the left to intersect the vertical projector at point ... new 'c' and new 'd' in the T.V. which is the T.V. of the rectangle in intermediate position.

Final position :

Step 1 : Now the side *AB* is to be inclined to V.P. at 45° hence we will take an *AVP* in place of V.P. which will be making the required angle with *AB*. This new plane will be seen as a line in the T.V and is shown as a line X_1Y_1 in Fig. Prob. 56(b).

Step 2 : Draw new reference line X_1Y_1, making 45° to *ab* in the second stage T.V. Draw projectors through points *a, b, c* and *d* and mark points a_1', b_1', c_1' and d_1' in auxiliary F.V. with the help of second stage F.V.

Step 3 : Join points a_1', b_1', c_1' and d_1' in proper sequence which will give us the final F.V.

Prob. 57 : A rectangular plane *ABCD* with side *AB* = 30 mm and *BC* = 50 mm is resting on the V.P. on its smaller side *AB*. Draw the projections of the plane when its surface makes an angle of 45° with the V.P. and the side *AB* which is on the V.P. is inclined at 45° to the H.P. Draw the projections of the plane.

Soln. : Method 1 : Change of position method- Refer Fig. Prob. 57(a)

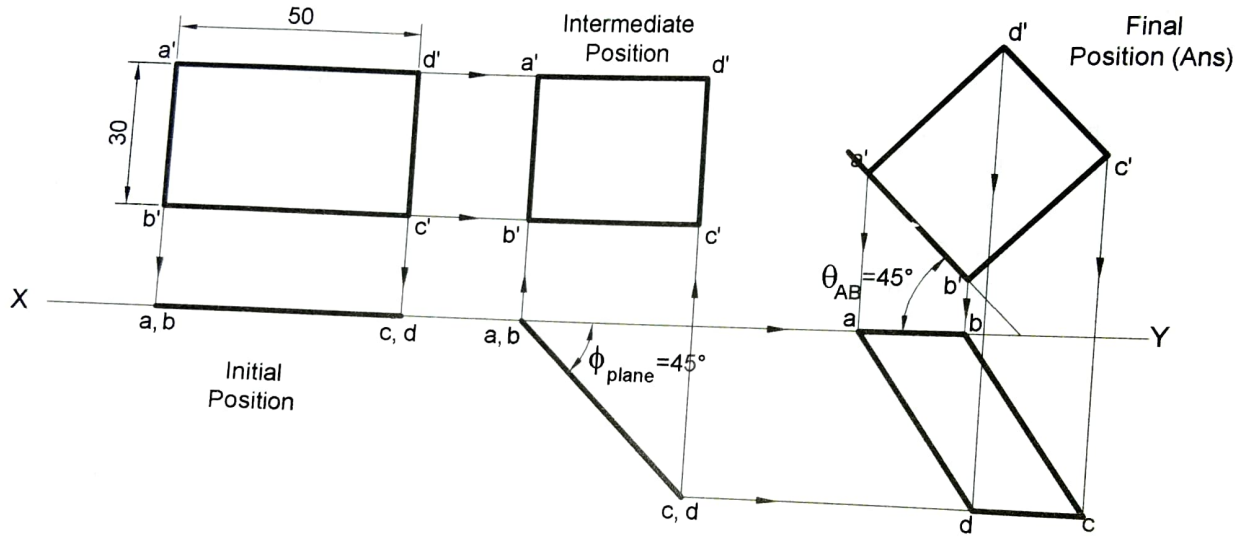


Fig. Prob. 57(a)

nitial position :

tep 1 : Since surface of the plane is given to be inclined with V.P. with its side *AB* on the V.P., initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

tep 2 : As we have kept the plane on V.P., its F.V. will show the true shape. Hence draw the F.V. *a'b'c'd'* with side *a'b'* perpendicular to the *XY* line and project the T.V. *ab - cd* which will be line view coinciding with the *XY* line.

termediate position :

ep 1 : When a rectangle *ABCD* will be inclined to V.P. at an angle of 45°, its T.V. will appear as a line maki... the *XY* line. Hence redraw the T.V. of first stage at an angle of ϕ_{plane} = 45° with the *XY* line keeping ... line.

p 2 : Project the points *a, b, c* and *d* from the T.V. vertically up and project the points *a', b', c'* and *d'* fro... stage F.V. parallel to *XY* line and to the right to get the same points in the second stage F.V.

3 : Join points *a', b', c'* and *d'* in a proper sequence in the second stage F.V.

l position :

1 : Since side *AB* is making an angle of 45° with the H.P. redraw the F.V. of the s... *a'b'* is making an angle of 45° with the *XY* line. ...ch that sid...

2 : Project the points of the third stage F.V. (i.e. *a', b', c'* and *d'*) vertically down. Again ... second stage T.V. (i.e. *a, b, c* and *d*) parallel to the *XY* line and to the right to intersect ... of the third stage F.V. and locate points *a, b, c* and *d*. ...om

: Join points *a, b, c* and *d* in proper sequence to get the T.V. of final position.

ne in the F.V and is shown as a line X_1Y_1 in Fig. Prob. 57(b).

Draw new reference line X_1Y_1, making 45° to $a'b'$ in the second stage F.V. Draw projectors through points a', b', c' and d' and mark points a_1, b_1, c_1 and d_1 in auxiliary T.V. with the help of second stage T.V.

Join points a_1, b_1, c_1 and d_1 in proper sequence which will give us the final T.V.

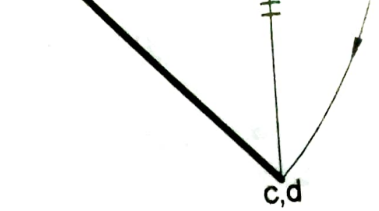


Fig. Prob. 57(b)

58 : A rhombus *ABCD* having major diagonal *AC* = 90 mm and minor diagonal *BD* = 60 mm is resting on the H.P. on its corner *A*. Draw the projections of the rhombus when its surface is inclined to H.P. at an angle of 45° and diagonal AC is contained by an auxiliary vertical plane making an angle of 30° to the V.P.

Sol. : Refer Fig. Prob. 58

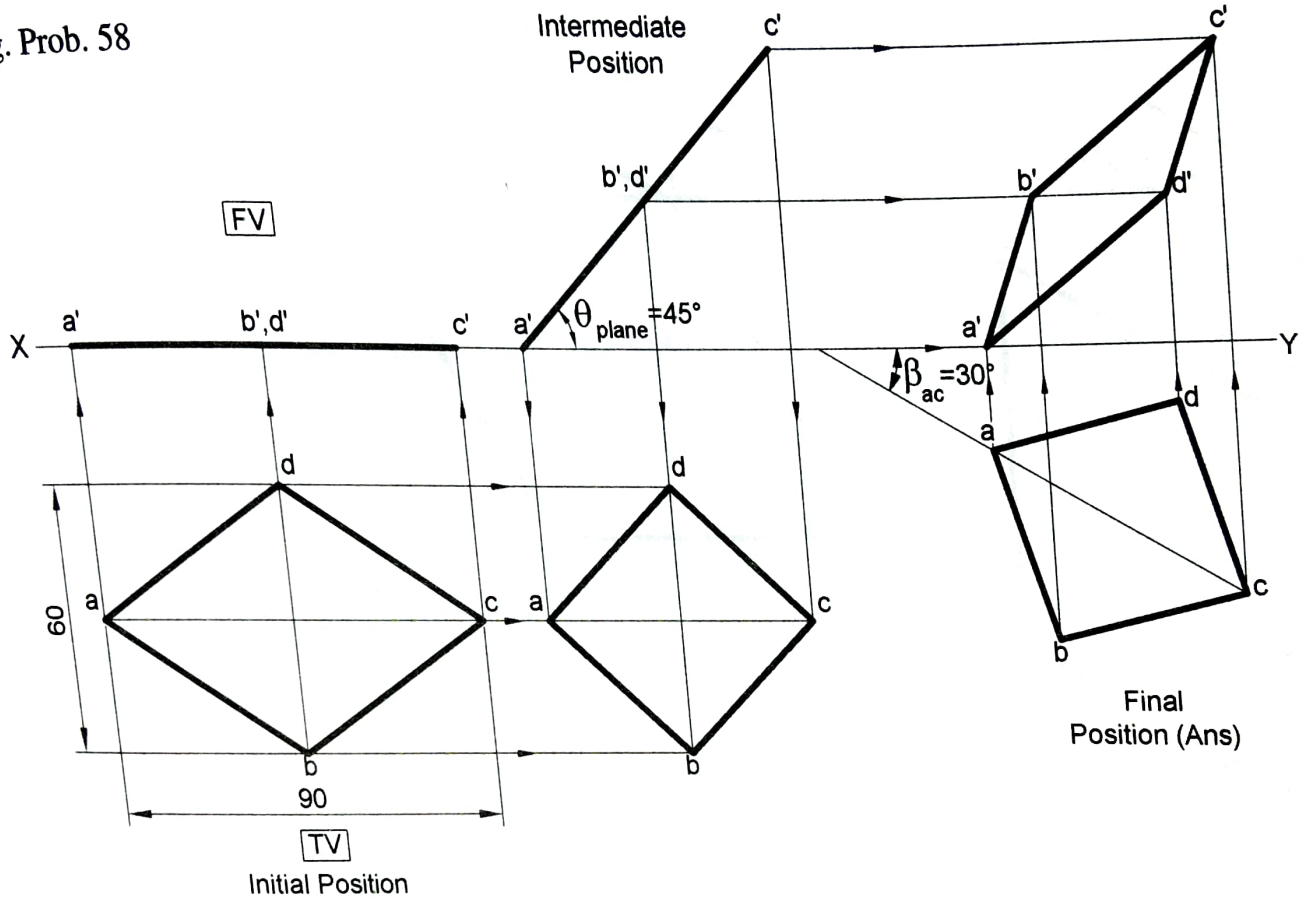


Fig. Prob. 58

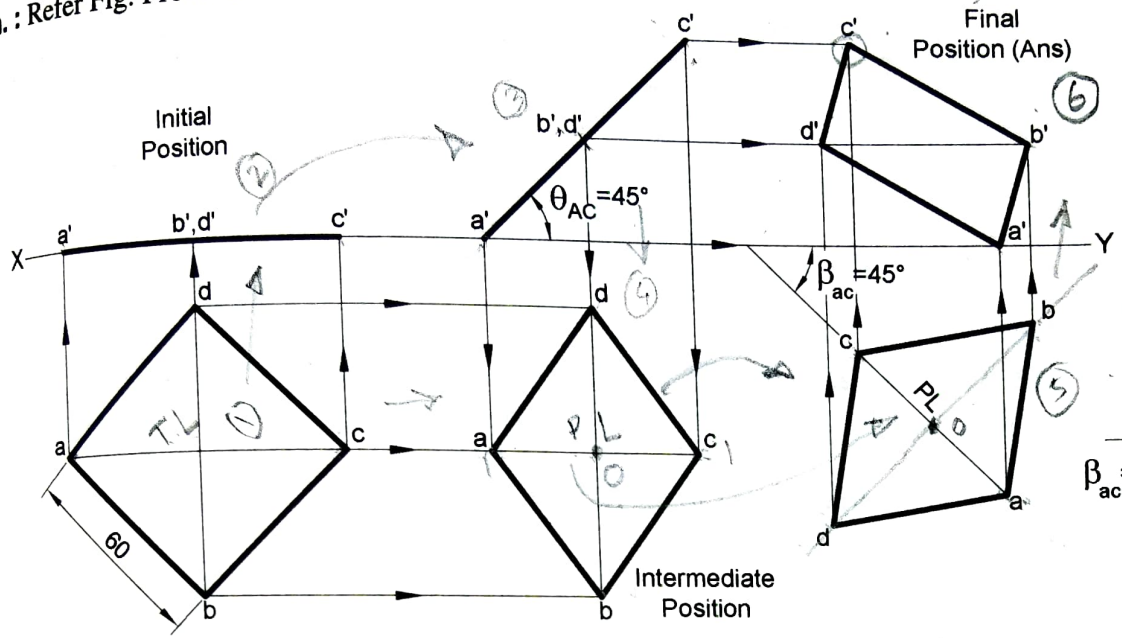
Step 3 : Join points a', b', c' and d' in proper sequence to get the F.V. of final position.

Determination of ϕ_{plane} :

Draw the line view of the rhombus on an *AIP* denoted as line X_1Y_1 perpendicular to sides $a'b'$ and $c'd'$ in the third stage F.V. The angle made by line view c_1d_1 - a_1b_1 in the auxiliary T.V. with the X_1Y_1 line is ϕ_{plane}.

Prob. 60 : A square plate of 60 mm side is resting on the H.P. on one of its corners in such a way that its surface makes an angle of 45° to the H.P. Draw the projections of the square plate when diagonal passing through the corner on the H.P. makes an angle of 30° to the V.P.

Soln. : Refer Fig. Prob. 60.



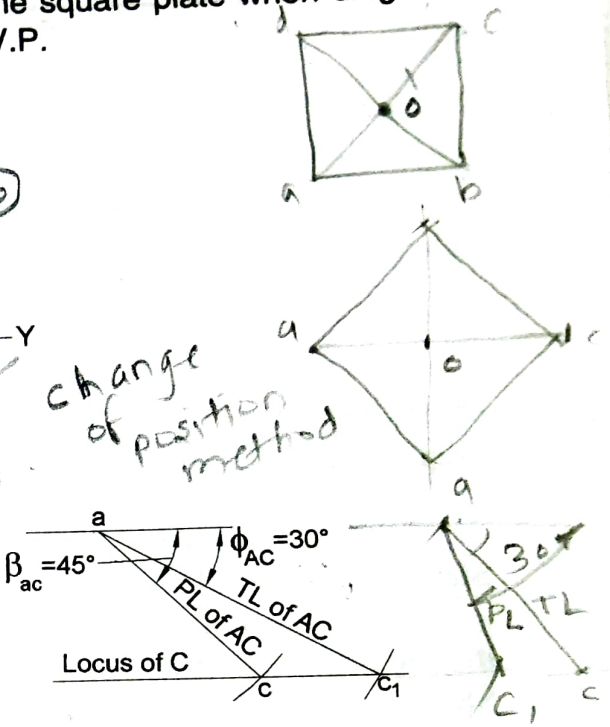


Fig. Prob. 60

Initial position :

Step 1 : Let the square plate be *ABCD*. Since square plate is inclined with H.P. with its corner *A* on the H.P., initially we will assume the square to be kept on the H.P. with diagonal *AC* parallel to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcd* with diagonal *ac* parallel to the *XY* line and project the F.V. a' - $b'd'$ - c' which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage at an angle of $\theta_{plane} = 45°$ with the *XY* line keeping a' on the *XY* line.

Step 2 : Project the points a', b', c' and d' from the F.V. vertically down and project the points *a*, *b*, *c* and *d* from the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

Step 3 : Join points *a*, *b*, *c* and *d* in a proper sequence in the second stage T.V.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c* and *d*) vertically up. Again project the points of the second stage F.V. (i.e. *a′, b′, c′* and *d′*) parallel to the *XY* line and to the right to intersect vertical projectors from third stage T.V. and locate points *a′, b′, c′* and *d′*.

Step 3 : Join points *a′, b′, c′* and *d′* in proper sequence to get the F.V. of final position.

Prob. 61 : A rectangle having sides 50 mm and 80 mm is kept in the V.P. on one of its smaller sides in such a way that its surface makes an angle of 45° with the V.P. Draw the projections of the rectangle when one of its longer sides makes an angle of 30° to H.P.

Soln. : Refer Fig. Prob. 61.

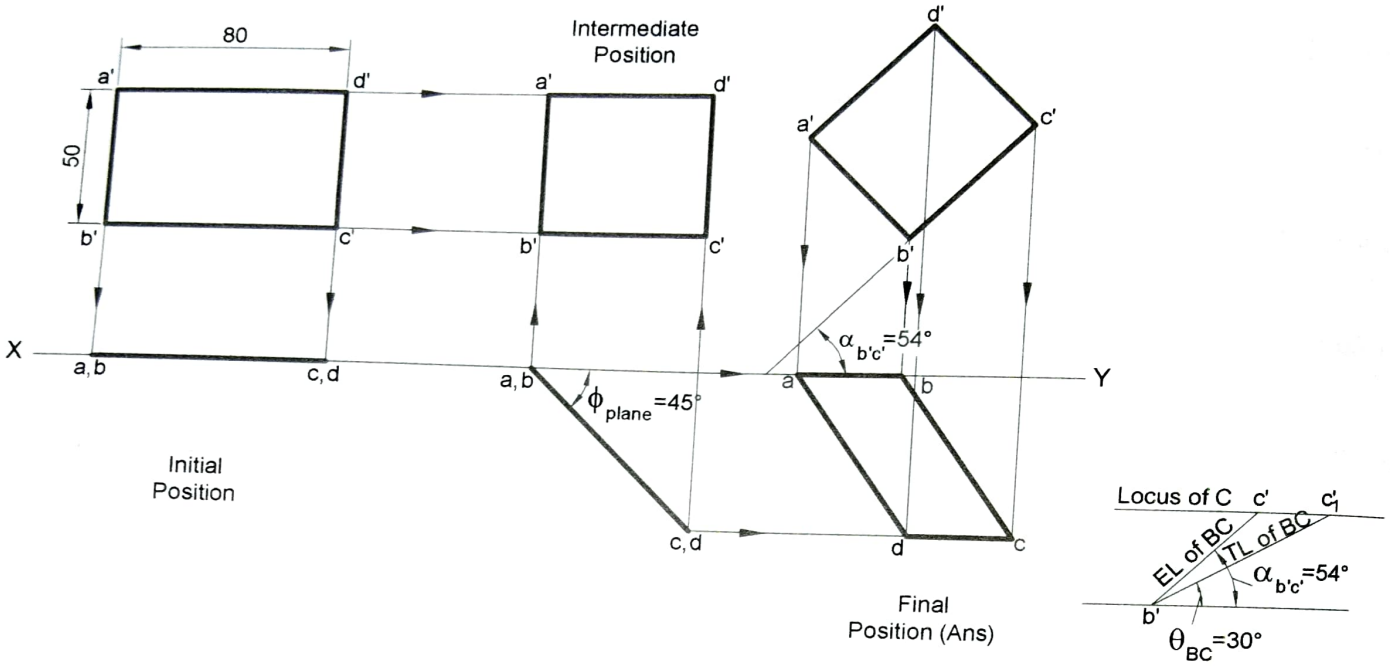


Fig. Prob. 61

Initial position :

Step 1 : Let the rectangular plate be *ABCD* with *AB* as one of its smaller sides. Since rectangle is inclined with V.P. with its smaller side *AB* on the V.P., initially we will assume the rectangle to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. *a′b′c′d′* with side *a′b′* perpendicular to the *XY* line and project the T.V. *ab - cd* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the T.V. of first stage at an angle of $\phi_{plane} = 45°$ with the *XY* line keeping *ab* on the *XY* line.

Step 2 : Project the points *a, b, c* and *d* from the T.V. vertically up and project the points *a′, b′, c′* and *d′* from stage F.V. parallel to *XY* line and to the right to get the same points in the second stage F.V.

Step 3 : Join points *a′, b′, c′* and *d′* in a proper sequence in the second stage F.V.

Final position :

Step 1 : Let longer side *BC* is making an angle of 30° with the H.P. but it is seen in its apparent len... F.V. Hence we will calculate $\alpha_{b'c'}$ as shown in Fig. Prob. 61. Redraw the F.V. of the ... elevation *b′c′* is making an angle of $\alpha_{b'c'}$ with the *XY* line.

Step 2 : Project the points of the third stage F.V. (i.e. *a′, b′, c′* and *d′*) vertically down. Again proje... second stage T.V. (i.e. *a, b, c* and *d*) parallel to the *XY* line and to the right to intersect vertic... third stage F.V. and locate points *a, b, c* and *d*.

Step 3 : Join points *a, b, c* and *d* in proper sequence to get the T.V. of final position.

Prob. 62 : A rectangular plate having sides 45 mm and 75 mm is resting on the H.P. on one of its smaller sides and is inclined to H.P. in such a way that its plan appears to be another rectangle of smaller side 45 mm and longer side 65 mm. Draw the projections of the rectangle when one of its longer sides makes an angle of 45° to V.P.

Soln. : Refer Fig. Prob. 62.

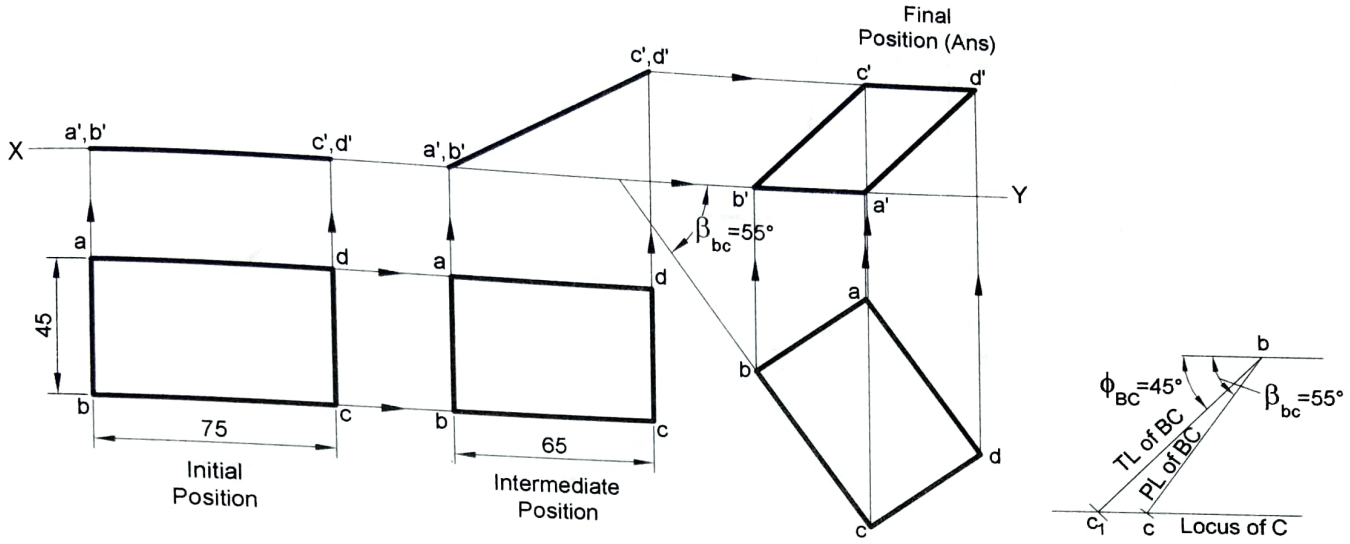


Fig. Prob. 62

Initial position :

Step 1 : Let the rectangle be *ABCD* having *AB* as one of its smaller sides and *BC* as one of its longer sides. Since plan of the rectangle is showing its apparent shape, it is inclined to H.P. with its side *AB* on the H.P. So initially we will assume the plane to be kept on the H.P. with side *AB* perpendicular to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcd* of given dimensions keeping side *ab* perpendicular to the *XY* line and project the F.V. *a′ b′-c′d′* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Draw projectors parallel to the *XY* line and to the right , from corners '*a*' , '*b*', '*c*' and '*d*' of the initial stage T.V.

Step 2 : Draw line *ab* perpendicular to *XY* line keeping '*a*' and '*b*' on their respective projectors and construct the rectangle *abcd* having side *bc* = 65 mm and keeping points '*c*' and '*d*' on their projectors.

Step 3 : Now draw two projectors through points '*a*' and '*d*' in the T.V. and redraw the first stage F.V. keeping *a′b′* on the projector of '*a*' and *c′d′* on the projector of '*d*'.

Final position :

Step 1 : Since one of the longer sides, say *BC* is making an angle of 45° with the V.P. but it is seen in its apparent length in the i ate sta Hence we will calculate β_{bc} as shown in Fig. Prob. 62. Redraw the T.V. of the inte e s of longer side *bc* is making an angle of β_{bc} with the *XY* line.

Step 2 : Proj f T.V. (i.e. *a*, *b*, *c* and *d*) vertically up. Again project the points of the rm nd *d′* rallel to the *XY* line and to the right to intersect vertical projectors fin d′.

Ste nts F.V. of final position.

Prob. 63 : A rectangular plate having sides 45 mm and 75 mm is resting on the V.P. on one of its smaller sides and is inclined to V.P. in such a way that its elevation appears to be another rectangle of smaller side 45 mm and longer side 65 mm. Draw the projections of the rectangle when the smaller side which is in V.P. makes an angle of 45° to H.P.

Soln. : Refer Fig. Prob. 63.

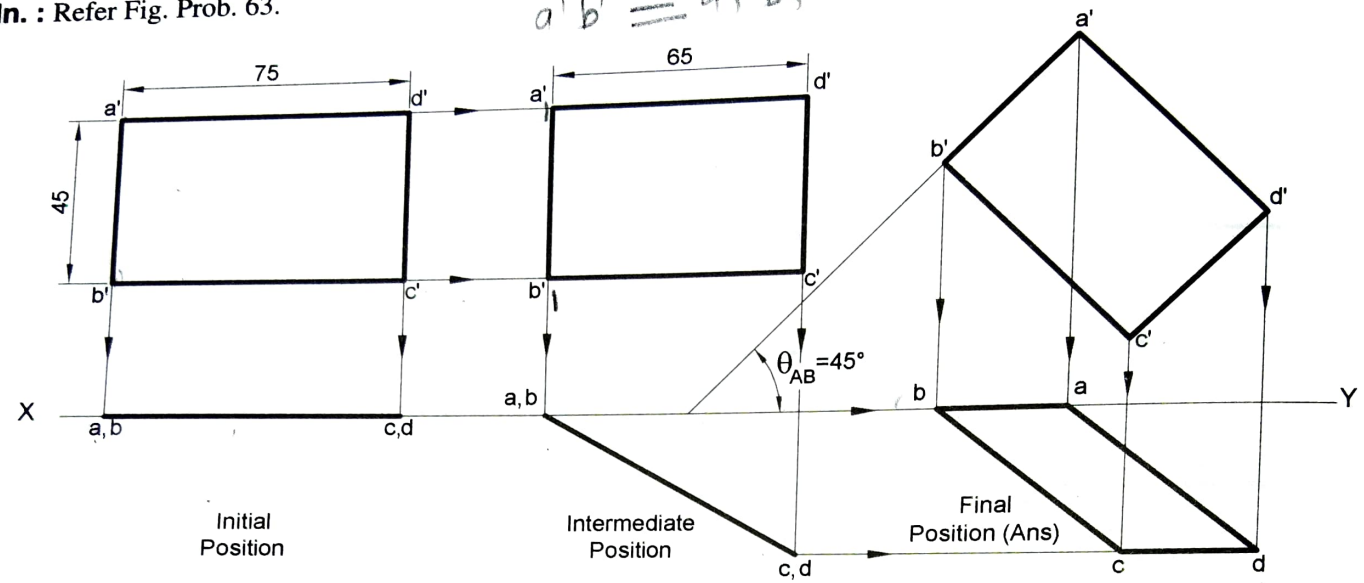


Fig. Prob. 63

Initial position :

Step 1 : Let the rectangle be *ABCD* having *AB* as one of its smaller sides and *BC* as one of its longer sides. Since elevation of the rectangle is showing its apparent shape, it is inclined to V.P. with its side *AB* on the V.P. So initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. $a'b'c'd'$ of given dimensions keeping side $a'b'$ perpendicular to the *XY* line and project the T.V. *ab - cd* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Draw projectors parallel to the *XY* line and to the right , from corners a', b', c' and d' of the initial stage F.V.

Step 2 : Draw line $a'b'$ perpendicular to *XY* line keeping a' and b' on their respective projectors and construct the rectangle $a'b'c'd'$ having side $b'c' = 65$ mm keeping points c' and d' on their projectors.

Step 3 : Now draw two projectors through points b' and c' in the F.V. and redraw the initial stage T.V. keeping *ab* on the projector of b' and *cd* on the projector of c'.

Final position :

appears as a rhombus in the plan with diagonal containing the corner *A* on the H.P. in such a way that the plane projections of the square when another diagonal is making an angle of 45° with V.P. Also measure inclination of the plane with H.P.

Soln. : Refer Fig. Prob. 64.

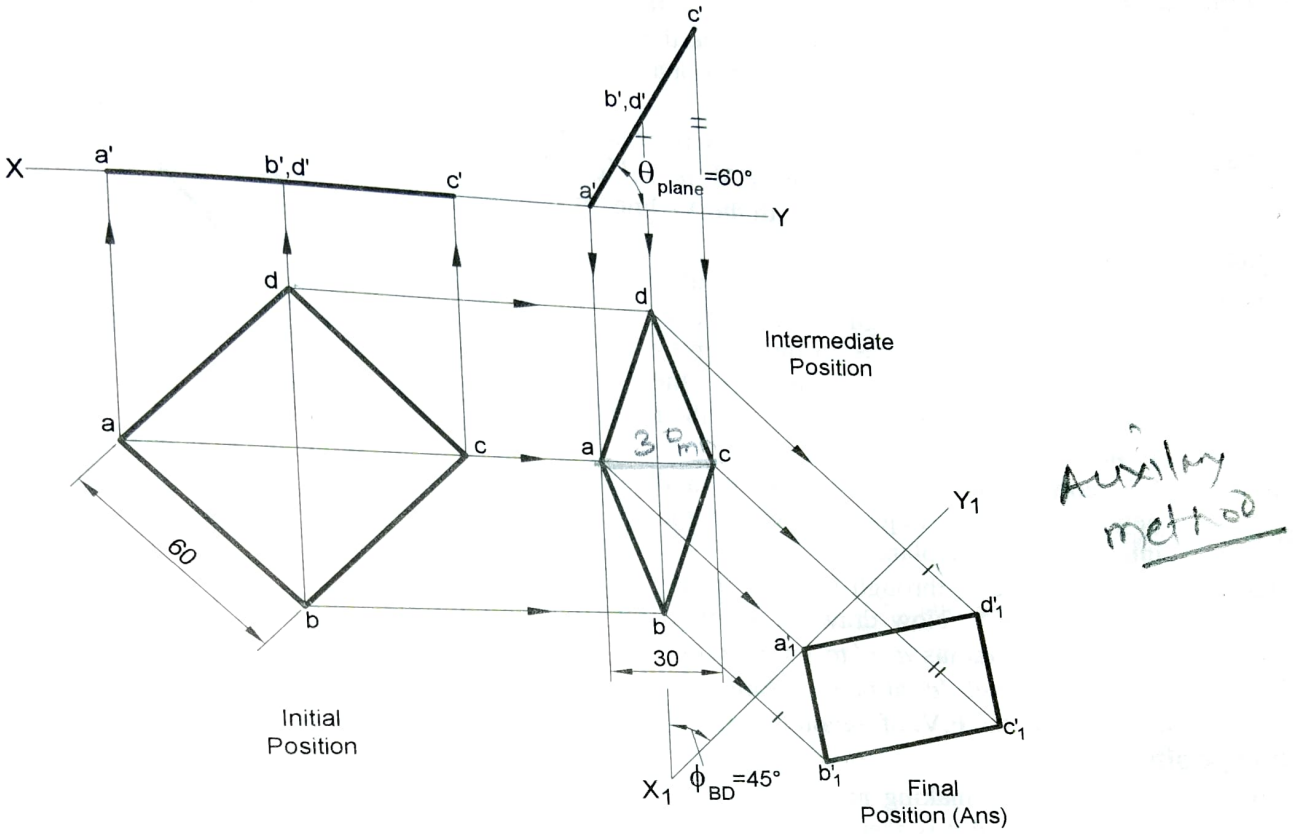


Fig. Prob. 64

Initial position :

Step 1 : Since square is inclined with H.P. with its corner *A* on the H.P., initially we will assume the square to be kept on the H.P. with diagonal *AC* parallel to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcd* with diagonal *ac* parallel to the *XY* line and project the F.V. *a′-b′d′-c′* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Draw projectors parallel to the *XY* line and to the right , from corners '*a*' , '*b*', '*c*' and '*d*' of the initial stage T.V.

Step 2 : Draw line *ac* = 30 mm parallel to *XY* line keeping '*a*' and '*c*' on their projector and construct the rhombus *abcd* keeping points '*b*' and '*d*' on their projectors.

Step 3 : Now draw two projectors through points '*a*' and '*c*' in the T.V. and redraw the first stage F.V. keeping *a′* on the projector of '*a*' and *c′* on the projector of '*c*'.

Final position :

Step 1 : Now the diagonal *BD* is to be inclined to V.P. at 45° hence we will take an *AVP* in place of V.P. which will be making the required angle with *BD*. This new plane will be seen as a line in the T.V and is shown as a line X_1Y_1 in

Prob. 64.

ew refere making 45° to *bd* in the intermediate stage T.V. Draw projectors through points *a*,

nd ma c_1' and d_1' in auxiliary F.V. Distances of points a_1', b_1', c_1' and d_1' from X_1Y_1 will

distan b', c' and d' from *XY* line.

d d_1' in which will give us the final F.V.

Prob. 66 : A rectangular plane *ABCD* with side *AB* = 40 mm and *BC* = 60 mm has its side *AB* on V.P. and side *BC* making an angle of 30° with H.P. Draw the projections of the rectangle if its F.V. appears to be square.

Soln. : Refer Fig. Prob. 66.

Initial position :

Step 1 : Since elevation of the rectangle is showing its apparent shape, it is inclined to V.P. with its side *AB* on the V.P. So initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. $a'b'c'd'$ of given dimensions keeping side $a'b'$ perpendicular to the *XY* line and project the T.V. *ab - cd* which will be line view coinciding with the *XY* line.

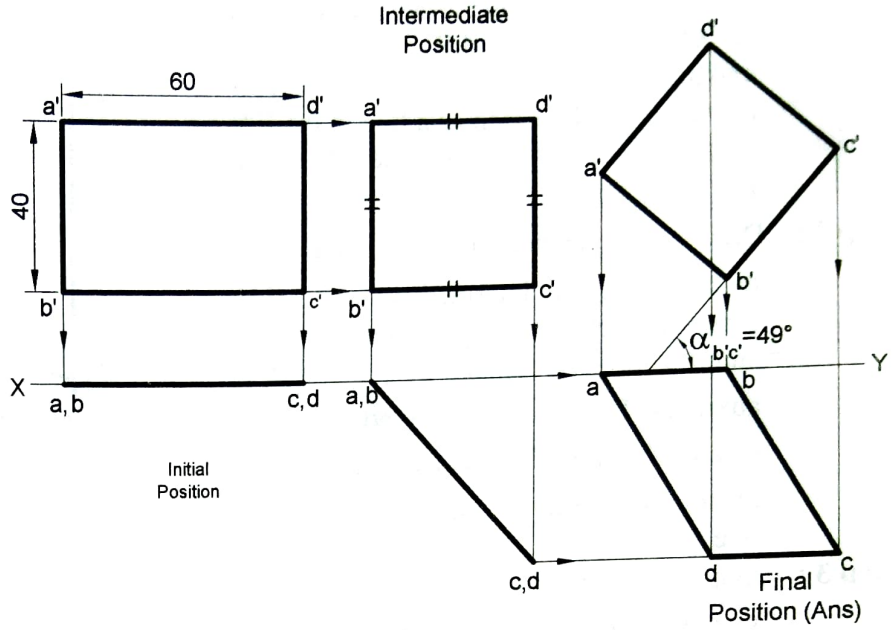


Fig. Prob. 66

Intermediate position :

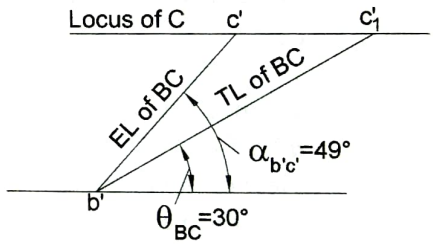
Step 1 : Draw projectors parallel to the *XY* line and to the right , from corners a', b', c' and d' of the initial stage F.V.

Step 2 : Draw line $a'b'$ perpendicular to *XY* line keeping a' and b' on their respective projectors and construct the square $a'b'c'd'$ keeping points c' and d' on their projectors.

Step 3 : Now draw two projectors vertically down through points b' and c' in the F.V. and redraw the first stage T.V. keeping *ab* on the projector of b' and *cd* on the projector of c'.

Final position :

Step 1 : Since the longer side, *BC* is making an angle of 30° with the H.P. but it is seen in its apparent length in the intermediate stage F.V. Hence we will calculate α_{bc} as shown in Fig. Prob. 66. Redraw the F.V. of the intermediate stage such that elevation of longer side *BC* is making an angle of $\alpha_{b'c'}$ with the *XY* line.



Step 2 : Project the points of the final stage F.V. (i.e. a', b', c' and d') vertically down. Again project the points of the intermediate stage T.V. (i.e. *a*, *b*, *c* and *d*) parallel to the XY line and to the right to intersect vertical projectors from final stage F.V. and locate points *a*, *b*, *c* and *d*.

Step 3 : Join points *a* , *b*, *c* and *d* in proper sequence to get the T.V. of final position.

Prob. 67 : A trapezium *ABCD* having larger parallel side *AB* = 60 mm, smaller parallel side *CD* = 30 mm and height 50 mm is kept in V.P. on its side *AB* in such a way that its elevation appears as another trapezium of same parallel sides but of height 30 mm. Draw the projections of the trapezium when the side in V.P. makes an angle of 50° with H.P.

Soln. : Refer Fig. Prob. 67.

Initial position :

Step 1 : Since elevation of the trapezium is showing its apparent shape, hence it is inclined to V.P. with its side *AB* on the V.P. So initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. $a'b'c'd'$ of given dimensions keeping side $a'b'$ perpendicular to the *XY* line and project the T.V. *ab - cd* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Draw projectors parallel to the *XY* line a[illegible]t , from corners a', b', c' and d' of the initial stage F.V.

Step 2 : Draw line $a'b'$ perpendi[illegible] b' on their respective projectors and construct the new

4.6.3 Projections of Pentagonal Planes :

Prob. 73 : A pentagonal plane *ABCDE* of side 40 mm is kept on the H.P. on its side *AB* in such a way that its surface makes an angle of 40° with H.P. Draw the projections of the pentagonal plane *ABCDE* when side *AB* which is in the H.P. is inclined at 40° with V.P. with its end *A* 20 mm infront of V.P.

Soln. : Refer Fig. Prob. 73.

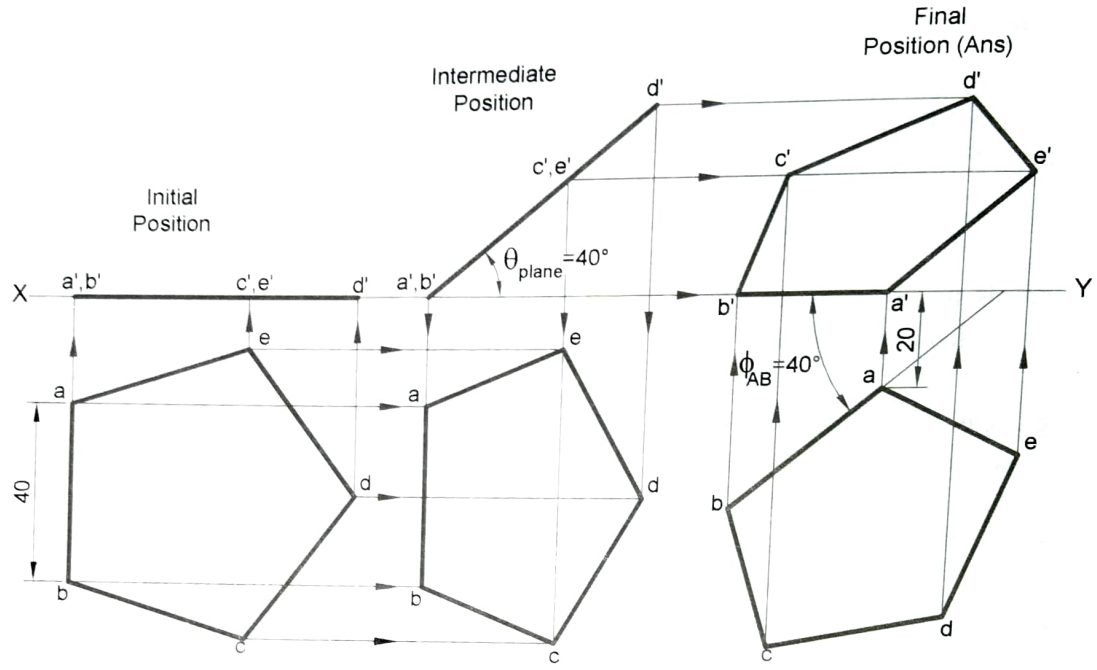


Fig. Prob. 73

Initial position :

Step 1 : Since pentagonal plane *ABCDE* is inclined to H.P. with its side *AB* on the H.P., initially we will assume the plane to be kept on the H.P. with side *AB* perpendicular to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcde* of given side keeping side *ab* perpendicular to the *XY* line and project the F.V. *a'b'- c'e'- d'* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage making 40° with the *XY* line and keeping *a' b'* on it.

Step 2 : Project the points *a', b', c', d'* and *e'* from the F.V. vertically down and project the points *a, b, c, d* and *e* fr first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V

Step 3 : Join points *a, b, c, d* and *e* in a proper sequence in the second stage T.V.

Final position :

Step 1 : Since side *AB* is making an angle of 40° with the V.P., redraw the T.V. of the second stage such making an angle of 40° with the *XY* line with corner '*a*' 20 mm below the *XY* line.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c, d* and *e*) vertically up. Again project the points of stage F.V. (i.e. *a', b', c', d'* and *e'*) parallel to the *XY* line and to the right to intersect vertical projectors fr stage T.V. and locate points *a', b', c', d'* and *e'*.

Step 3 : Join points *a', b', c', d'* and *e'* in proper sequence to get the F.V. of final position.

Prob. 74 : A pentagonal plane of side 40 mm is kept on the H.P. on one of its corners with the side opp the corner on H.P. 20 mm above H.P. and parallel to both H.P. and V.P. Draw the projection plane and find its inclinations with H.P. and V.P.

Soln. : Refer Fig. Prob. 74.

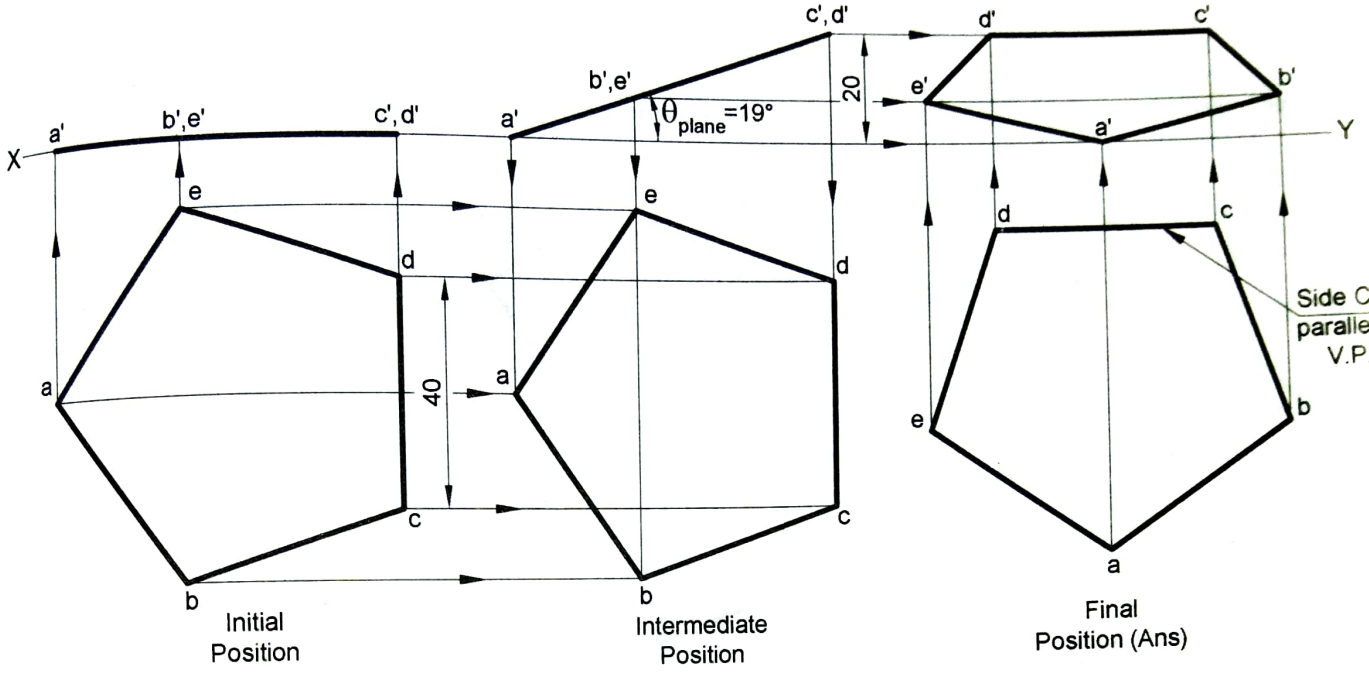


Fig. Prob. 74

Initial position :

Step 1 : Let the pentagonal plane be *ABCDE*. Since pentagon is inclined to H.P. with its corner *A* on the H.P., i will assume the plane to be kept on the H.P. such that line joining corner *A* and centre of the pentagon to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcde* keeping corner '*a*' in such a position that the line joining corner '*a*' and ce pentagon is parallel to the *XY* line and project the F.V. *a′- b′e′- c′d′* which will be line view coincidi *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage keeping *a′* on the *XY* line and *c′d′* at a distance of 20 mm above *XY*.

Step 2 : Project the points *a′, b′, c′, d′* and *e′* from the F.V. vertically down and project the points *a, b, c, d* and first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

Step 3 : Join points *a, b, c, d* and *e* in a proper sequence in the second stage T.V.

Final position :

Step 1 : At present, side *CD* is parallel to H.P. and perpendicular to V.P. Since side *CD* is to be parallel to V.P., T.V. of the second stage such that side *cd* is parallel to the *XY* line.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c, d* and *e*) vertically up. Again project the points of stage F.V. (i.e. *a′, b′, c′, d′* and *e′*) parallel to the *XY* line and to the right to intersect vertical projectors stage T.V. and locate points new *a′, b′, c′, d′* and *e′*.

Step 3 : Join points *a′, b′, c′, d′* and *e′* in proper sequence to get the F.V. of final position.

Determination of θ_{plane} and ϕ_{plane} :

Step 1 : Angle made by the line view of the plane in second stage F.V. with *XY* will give us θ_{plane}.

Step 2 : ... plane is in such a position that its $\theta_{plane} + \phi_{plane} = 90°$. Hence $\phi_{plane} = 90° - \theta$

Prob. 76 : A regular pentagon *ABCDE* of 50 mm sides has its side *AB* in the V.P. and inclined at an angle of 30° to the H.P. The corner *A* is 15 mm above the H.P. and the corner *D* is 20 mm infront of the V.P. Draw the projections of the plane and find its inclination with the V.P.

Soln. : Refer Fig. Prob. 76.

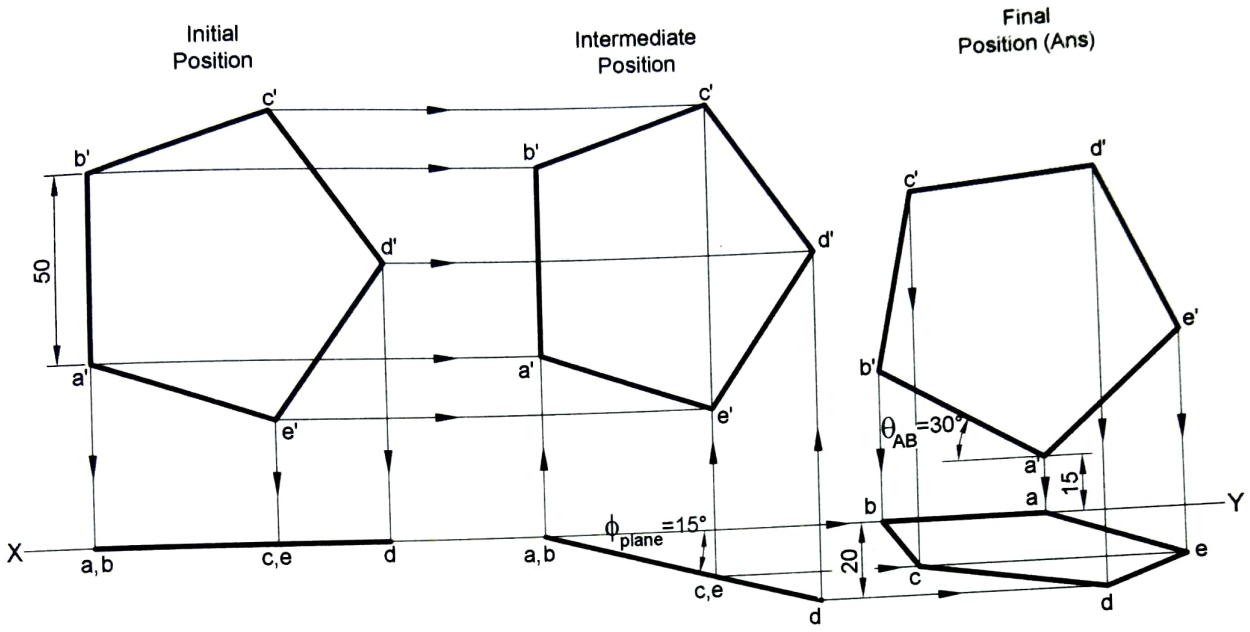


Fig. Prob. 76

Initial position :

Step 1 : Since pentagonal plane *ABCDE* is inclined to V.P. with its side *AB* on the V.P., initially we will assume the plane to be kept on the V.P. with side *AB* perpendicular to H.P. (i.e. *XY*).

Step 2 : Draw the F.V. $a'b'c'd'e'$ of given side keeping side $a'b'$ perpendicular to the *XY* line and project the F.V. *ab - ce - d* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the T.V. of first stage keeping *ab* on the *XY* line and *'d'* at a distance of 20 mm below *XY*.

Step 2 : Project the points *a, b, c, d* and *e* from the T.V. vertically up and project the points a', b', c', d' and e' from the first stage F.V. parallel to *XY* line and to the right to get the same points in the second stage F.V.

Step 3 : Join points a', b', c', d' and e' in a proper sequence in the second stage F.V.

Final position :

Step 1 : Now side *AB* which is on V.P. is to make an angle of 30° to H.P. in such a way that corner *'A'* of the pentagon should be 15 mm above H.P. Hence redraw the F.V. of the intermediate stage keeping side $a'b'$ inclined at 30° to the *XY* line and corner a' 15 mm above the *XY* line. This will give us the final F.V. of the pentagon.

Step 2 : Project the points of the final stage F.V. (i.e. a', b', c', d' and e') vertically down. Again project the points of the second stage T.V. (i.e. *a, b, c, d* and *e*) parallel to the *XY* line and to the right to intersect vertical projectors from third stage F.V. and locate points new *a, b, c, d* and *e*.

Step 3 : Join points *a, b, c, d* and *e* in proper sequence to get the T.V. in final position.

Determination of ϕ_{plane} :

Angle made by the line view of the plane in in

Soln. : Refer Fig. Prob. 81.

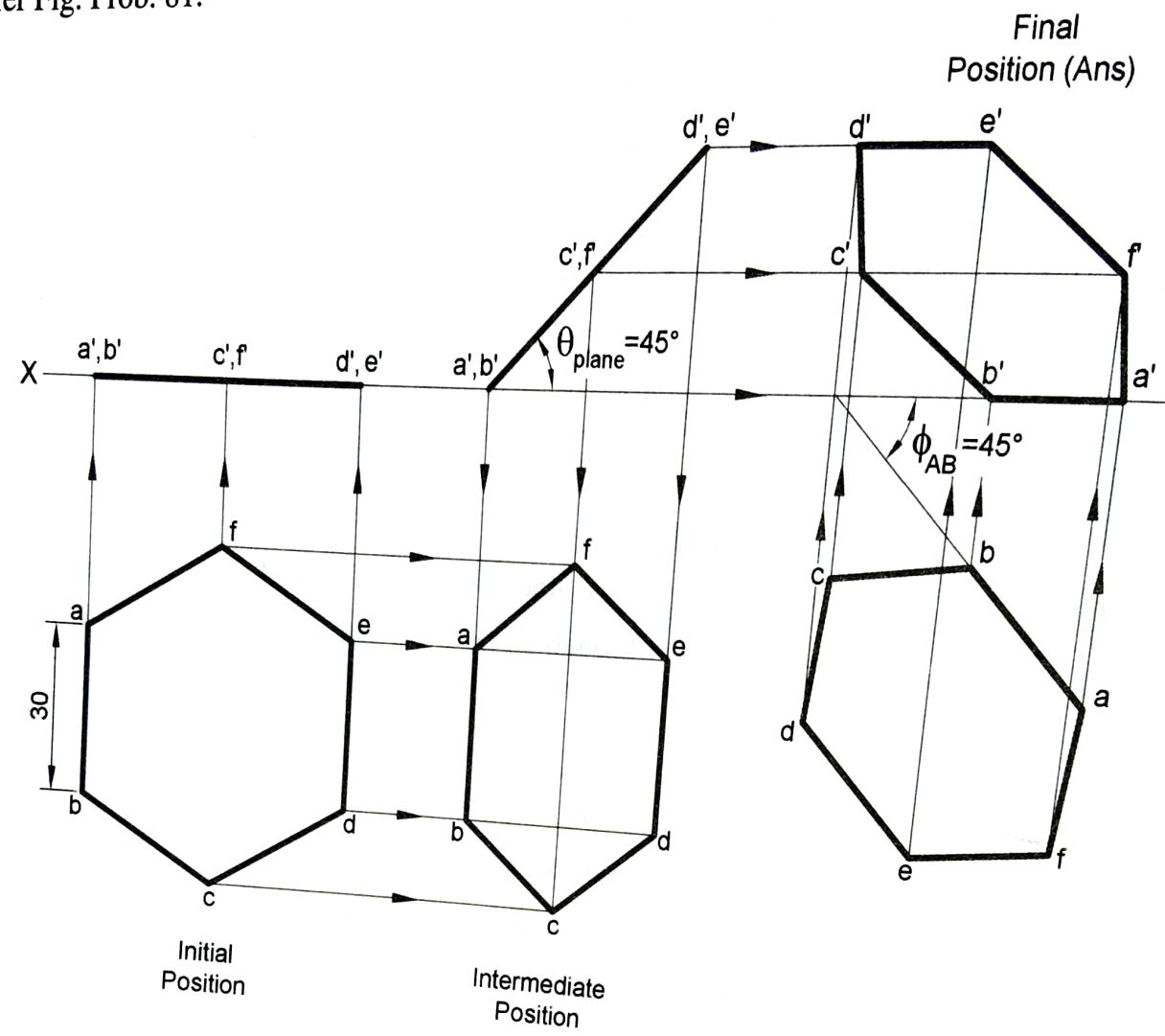


Fig. Prob. 81

Initial position :

Step 1 : Let the hexagon be *ABCDEF*. Since hexagonal plane *ABCDEF* is inclined to H.P. with its side initially we will assume the plane to be kept on the H.P. with side *AB* perpendicular to V.P. (i.e. *X*

Step 2 : Draw the T.V. *abcdef* of given side keeping side *ab* perpendicular to the *XY* line and p *a′b′- c′f′- d′e′* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage making 45° with the *XY* line and keeping *a′b′* on it.

Step 2 : Project the points *a′, b′, c′, d′, e′* and *f′* from the F.V. vertically down and project the points *a, b,* from the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage

Step 3 : Join points *a, b, c, d , e* and *f* in a proper sequence in the second stage T.V.

Final position :

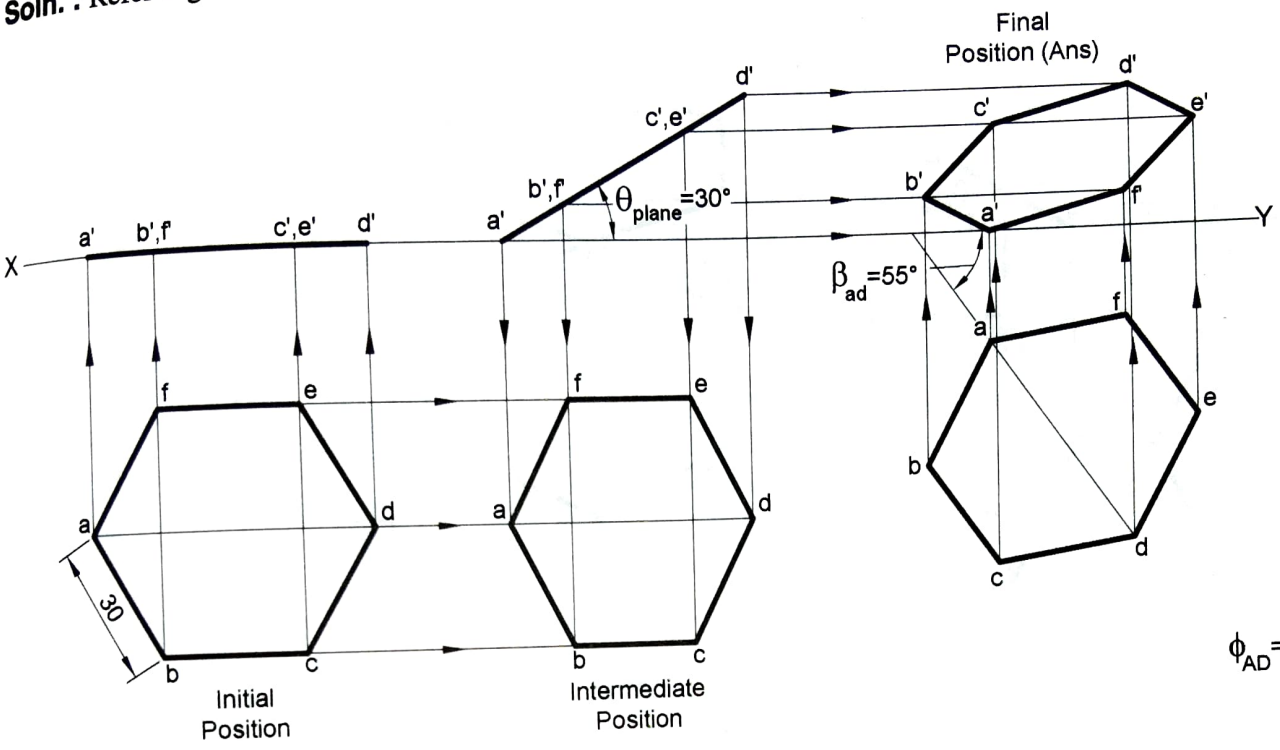
Step 1 : Since side *AB* is making an angle of 45° with the V.P. redraw the T.V. of the second stage such that making an angle of 45° with the *XY* line.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c, d , e* and *f*) vertically up. Again project the poi second stage F.V. (i.e. *a′, b′, c′, d′, e′* and *f′*) parallel to the *XY* line and to the right to intersect vertical p from third stage T.V. and locate points *a′, b′, c′, d′, e′* and *f′*.

Step 3 : Join points *a′, b′, c′, d′, e′* and *f′* in proper sequence to get the F.V.

Prob. 82 : 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° to H.P. Draw the projection of the plane when diagonal passing through the corner on H.P. makes on angle of 45° to the V.P.

Soln. : Refer Fig. Prob. 82.



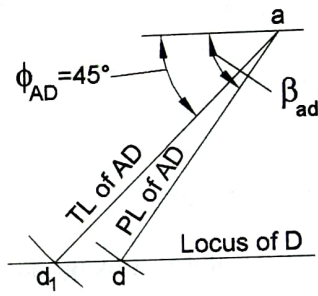


Fig. Prob. 82

Initial position :

Step 1 : Let the hexagonal plane be *ABCDEF*. Since hexagonal plane is inclined with H.P. with its corner *A* on the H.P initially we will assume the hexagonal to be kept on the H.P. with diagonal *AD* parallel to V.P. (i.e. *XY*).

Step 2 : Draw the T.V. *abcdef* with diagonal *ad* parallel to the *XY* line and project the F.V. *a′- bf ′- c′e′- d′* which will b line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage at an angle of θ_{plane} = 30° with the *XY* line keeping *a′* on the *XY* line.

Step 2 : Project the points *a′, b′, c′, d′, e′* and *f′* from the F.V. vertically down and project the points *a, b, c, d, e* and *f* fro the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

Step 3 : Join points *a, b, c , d, e* and *f* in a proper sequence in the second stage T.V.

Final position :

Step 1 : Since diagonal *AD* is making an angle of 45° with the V.P. but it is seen in its apparent length in the second sta T.V. Hence we will calculate β_{ad} as shown in Fig. Prob. 82. Redraw the T.V. of the second stage such that plan diagonal *ad* is making an angle of β_{ad} with the *XY* line.

Step 2 : Project the points of the third stage T.V. (i.e. *a, b, c , d, e* and *f*) vertically up. Again project the points of t second stage F.V. (i.e. *a′, b′, c′, d′, e′* and *f′*) parallel to the *XY* line and to the right to intersect vertical projecto from third stage T.V. and locate points *a′, b′, c′, d′, e′* and *f′*.

Prob. 83 : A hexagonal plane of side 40 mm is resting on one of its corners on H.P. while corner opposite to it is on V.P. Draw three views of the plane if it is inclined at 30° to H.P. and 60° to V.P.

Soln. : Refer Fig. Prob. 83.

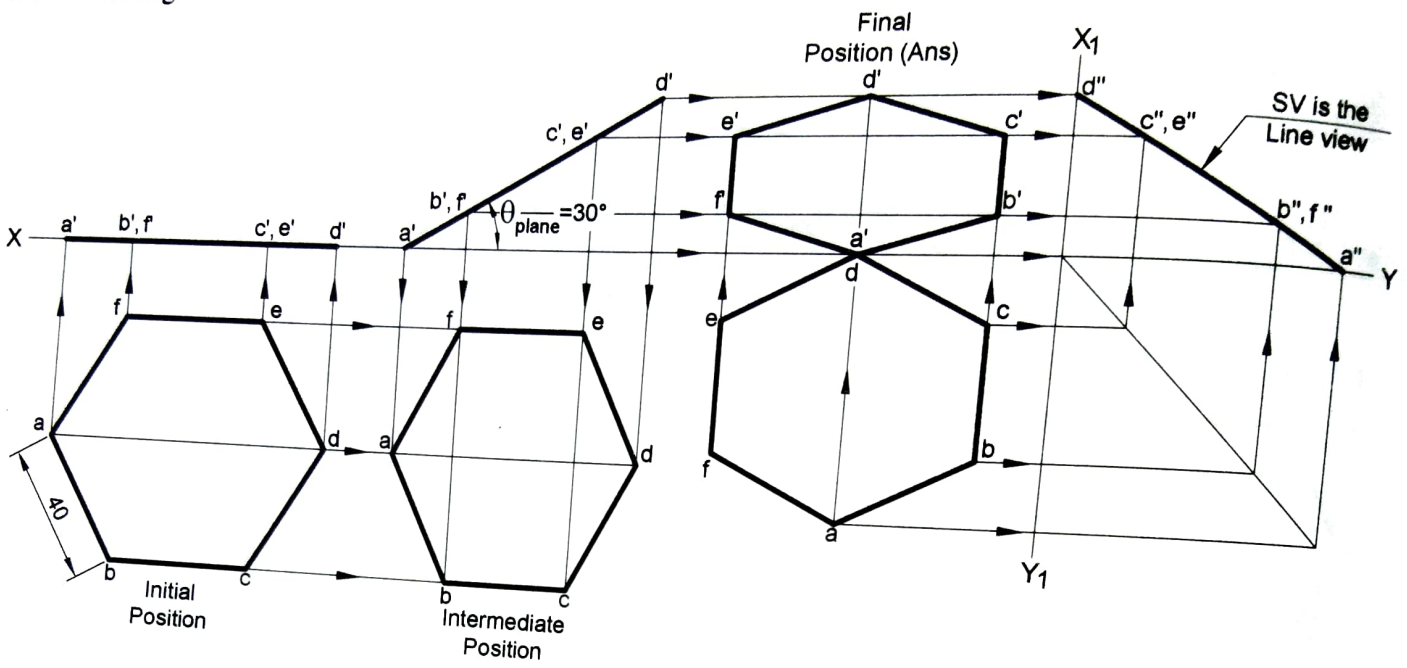
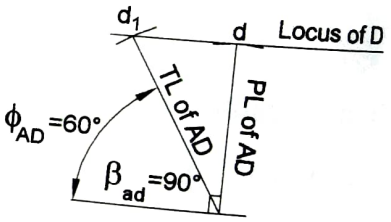


Fig. Prob. 83

Initial position :

Step 1 : Let the hexagonal plane be *ABCDEF*. Since hexagonal plane is inclined with H.P. with its corner *A* on the H.P., initially we will assume the hexagonal to be kept on the H.P. with diagonal *AD* parallel to V.P. (i.e. *XY*).



Step 2 : Draw the T.V. *abcdef* with diagonal *ad* parallel to the *XY* line and project the F.V. *a'- b'f'- c'e'- d'* which will be line view coinciding with the *XY* line.

Intermediate position :

Step 1 : Redraw the F.V. of first stage at an angle of $\theta_{plane} = 30°$ with the *XY* line keeping *a'* on the *XY* line.

Step 2 : Project the points *a', b', c', d', e'* and *f'* from the F.V. vertically down and project the points *a, b, c, d, e* and *f* from the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

tep 3 : Join points *a, b, c , d, e* and *f* in a proper sequence in the second stage T.V.

inal position :

ep 1 : This is the case of $\theta_{plane} + \phi_{plane} = 90°$. If plane makes an angle of 60° to V.P. , diagonal AD will also to V.P. Since diagonal *AD* is making an angle of 60° with the V.P. but it is seen in its apparent le second stage T.V. Hence we will calculate β_{ad} as shown in Fig. Prob. 83. Redraw the T.V. of such that plan of diagonal *ad* is making an angle of $\beta_{ad} = 90$ with the *XY* line and corner *'d'* is

p 2 : Project the points of the third stage T.V. (i.e. *a, b, c , d, e* and *f*) vertically up. Again projec second stage F.V. (i.e. *a', b', c', d', e'* and *f'*) parallel to the *XY* line and to the right to intersect from third stage T.V. and locate points *a', b', c', d', e'* and *f'*.

3 : Join points *a', b', c', d', e'* and *f'* in proper sequence to get the F.V. of final position.

4 : Draw the side view of the final position of the plane by usual method which will

4.6.5 Projections of Circular and Semicircular Planes :

Prob. 87 : A circular plate of diameter 60 mm is kept on the H.P. on a point of its circumference. The surface of the circular plate makes an angle of 40° to the H.P. Draw the projections of the circle when diameter passing through the point on H.P. makes an angle of 30° to V.P.

Soln. : Refer Fig. Prob. 87.

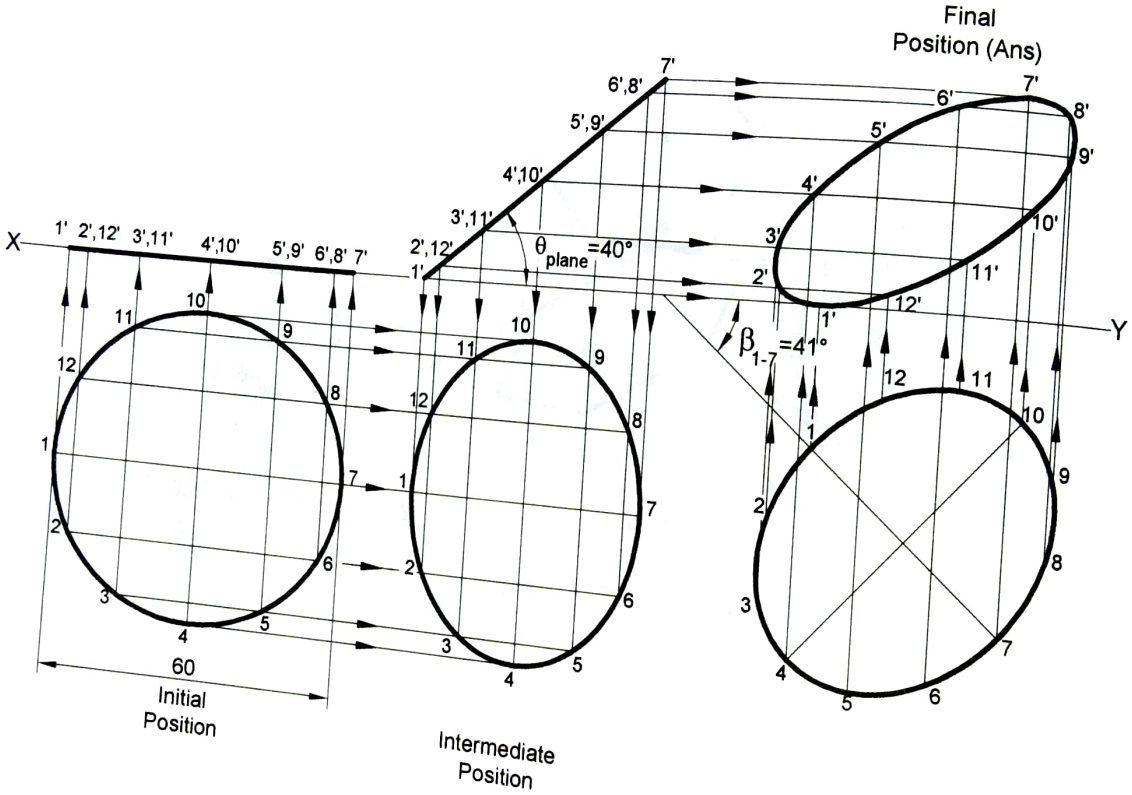
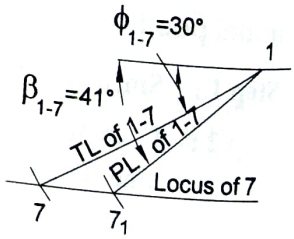


Fig. Prob. 87

Initial position :

Step 1 : Since circular plate is inclined to H.P. we will assume it to be kept on H.P. initially.

Step 2 : Draw a circle of diameter 60 mm in the T.V. Divide this circle into *12* equal parts and name it as *1, 2, 3, ... 12*. Project points *1, 2, 3, ... 12* to the F.V. as *1′, 2′, 3′, ...* *12′*. Keep diameter *1-7* parallel to the *XY* line in the T.V.



Intermediate position :

Step 1 : Redraw the F.V. of first stage at an angle of $\theta_{plane} = 40°$ with the *XY* line keeping *1′* on the *XY* line.

Step 2 : Project the points *1′, 2′, 3′, ... 12′* from the F.V. vertically down and project the points *1, 2, 3, ... 12* from the first stage T.V. parallel to *XY* line and to the right to get the same points in the second stage T.V.

tep 3 : Join points *1, 2, 3, ... 12* in a proper sequence by smooth curve in the second stage T.V.

inal position :

ep 1 : Diameter *1-7* is making an angle of 30° with the V.P. but it is seen in its apparent length in the second stage T. Hence we will calculate β_{1-7} as shown in Fig. Prob. 87. Redraw the T.V. of the second stage such th diameter *1-7* is making an angle of β_{1-7} with the *XY* line.

p 2 : Project the points of the third stage T.V. (i.e. *1, 2, 3, ... 12*) vertically up. Again project the points of stage F.V. (i.e. *1′, 2′, 3′, ... 12′*) parallel to the *XY* line and to the right to intersect stage T.V. and locate points *1′, 2′, 3′, ... 12′*.

3 : Join points *1′, 2′, 3′, ... 12′* in proper sequence by

Prob. 88 : A circular plate of diameter 60 mm is kept on the V.P. on a point of its circumference. The surface of the circular plate makes an angle of 30° to the V.P. Draw the projections of the circle when diameter passing through the point on V.P. makes an angle of 30° to H.P.

Soln. : Refer Fig. Prob. 88.

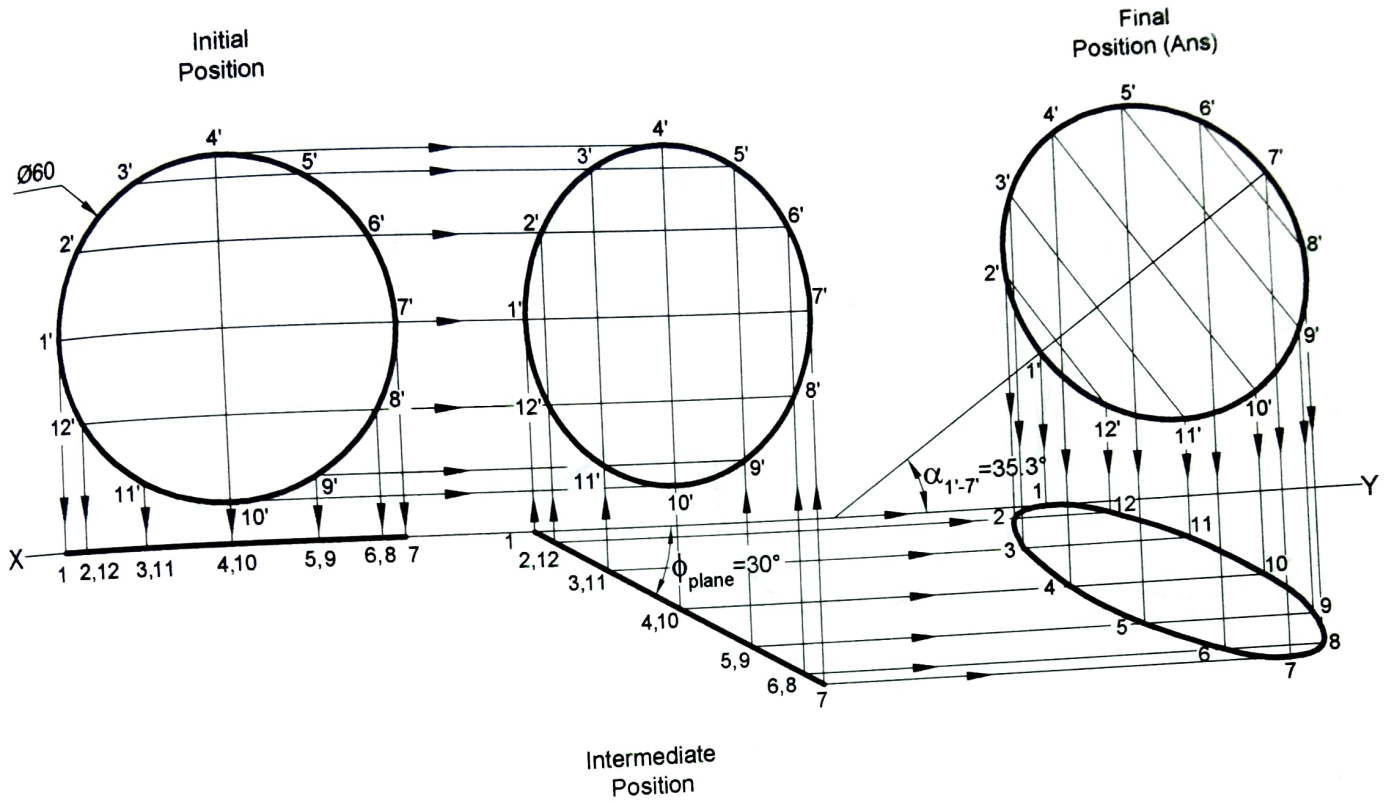
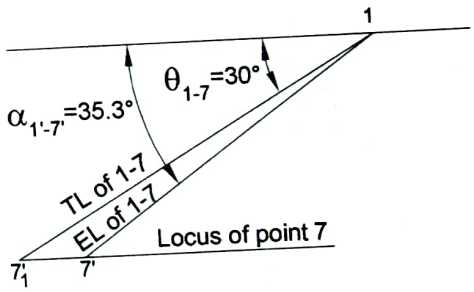


Fig. Prob. 88

Initial position :

Step 1 : Since circular plate is inclined to V.P., we will assume it to be kept on V.P. initially.

Step 2 : Draw a circle of diameter 60 mm in the F.V. Divide this circle into *12* equal parts and name it as *1′, 2′, 3′, ... 12′*. Project points *1′, 2′, 3′, ... 12′* to the T.V. as *1, 2, 3, ... 12*. Keep diameter *1′-7′* parallel to the *XY* line in the F.V.



Intermediate position :

Step 1 : Redraw the T.V. of first stage at an angle of ϕ_{plane} = 30° with the *XY* line keeping point *'1'* on the *XY* line.

Step 2 : Project the points *1 , 2 , 3 , ... 12* from the T.V. vertically up and project the points *1′, 2′, 3′, ... 12′* from the firs stage F.V. parallel to *XY* line and to the right to get the same points in the second stage F.V.

Step 3 : Join points *1′, 2′, 3′, ... 12′* in a proper sequence by smooth curve in the second stage F.V.

Final position :

Step 1 : Diameter *1-7* is making an angle of 30° with the H.P. but it is seen in its apparent length in the second stage F.V Hence we will calculate $\alpha_{1'-7'}$ as shown in Fig. Prob. 88. Redraw the F.V. of the second stage such that elevati of diameter *1′-7′* is making an angle of $\alpha_{1'-7'}$ with the *XY* line.

Step 2 : Project the points of the third stage F.V. (i.e. *1′, 2′, 3′, ... 12′*) vertically down. Again project the points of t second stage T.V. (i.e. *1, 2, 3, ... 12*) parallel to the *XY* line and to the right to intersect vertical projectors fr third stage F.V. and locate points *1, 2, 3, ... 12*.

12 in pr... equence by a smoo... to get the T.V. of final position.