ORTHOGRAPHIC PROJECTIONS

OF POINTS, LINES & PLANES

To draw projections of any object, one must have following information:

A) **OBJECT**

{With its description, well defined}

B) **OBSERVER**

{Always observing perpendicular to resp. Ref. Plane}

C) **LOCATION OF OBJECT**

{Means its position with reference to H.P. & V.P.}

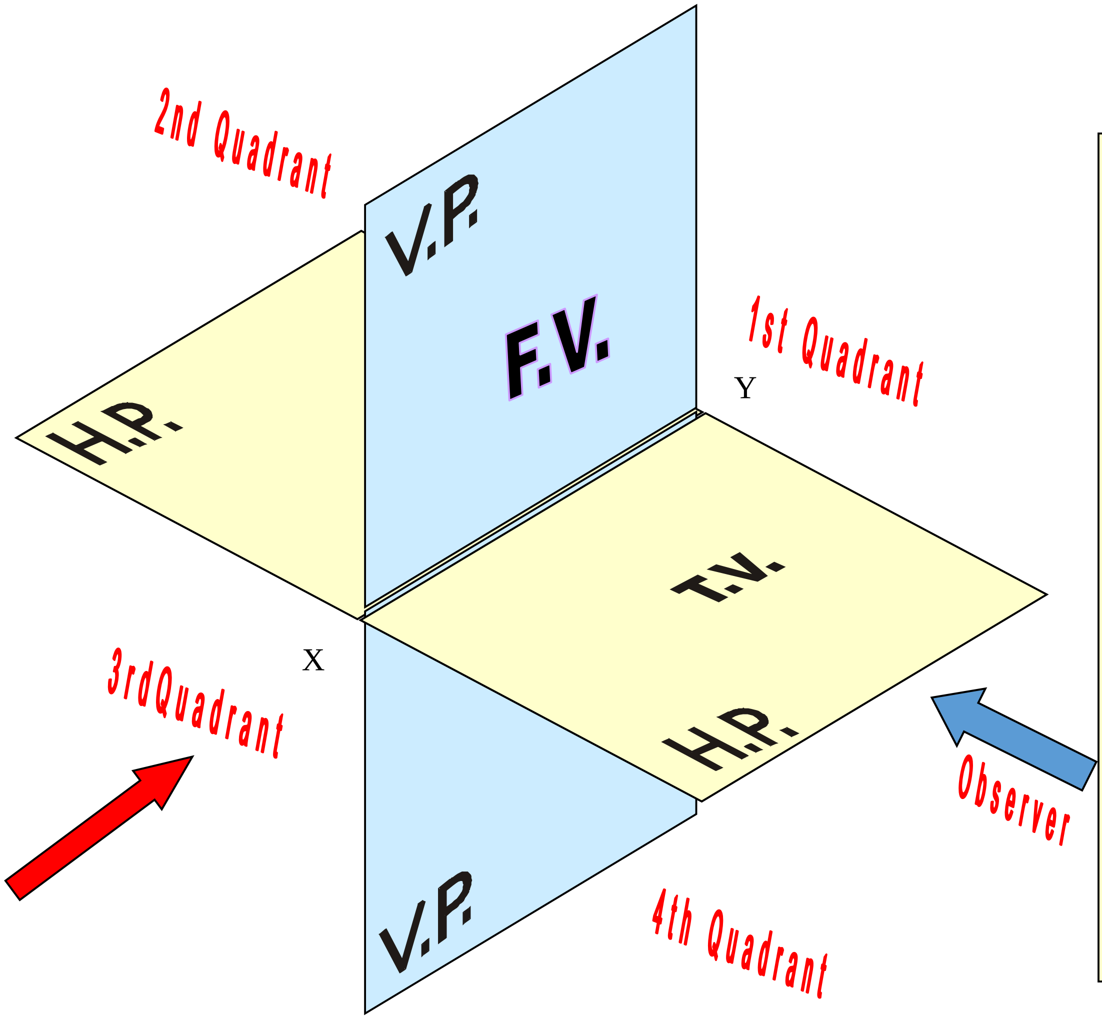
NOTATIONS

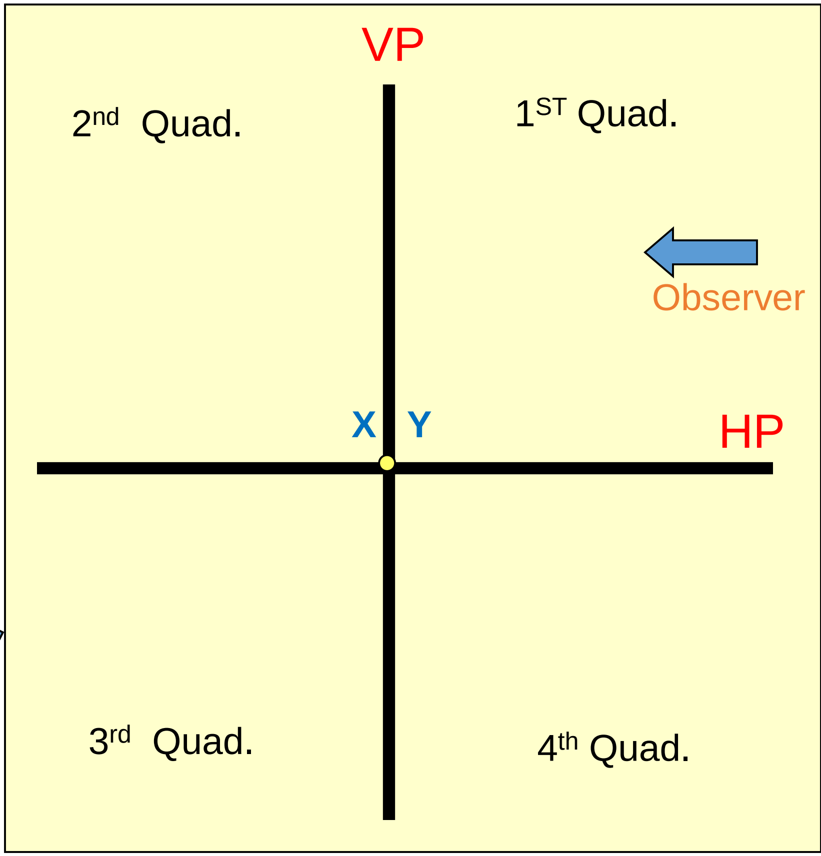
Following notations should be followed while naming Different views in orthographic projections.

OBJECT	POINT A	LINE AB
IT'S TOP VIEW	a	a b
IT'S FRONT VIEW	a´	a´ b´
IT'S SIDE VIEW	a´´	a´´ b´´

Same system of notations should be followed incase numbers, like 1, 2, 3 – are used.

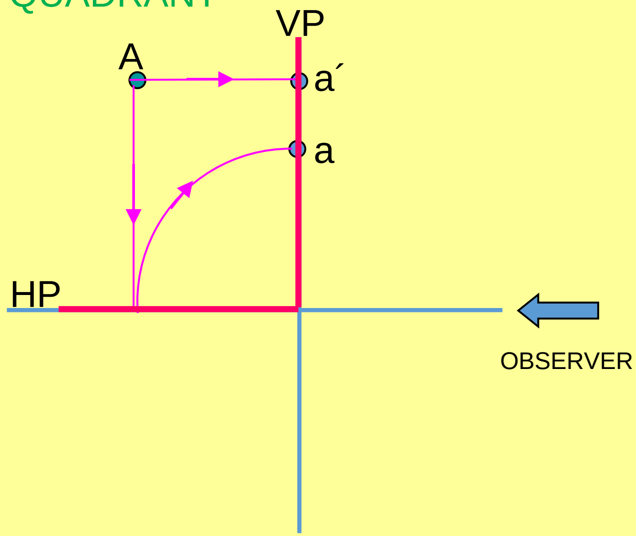
TERMS 'ABOVE' & 'BELOW' WITH RESPECT TO H.P.
AND TERMS 'INFRONT' & 'BEHIND' WITH RESPECT TO V.P.

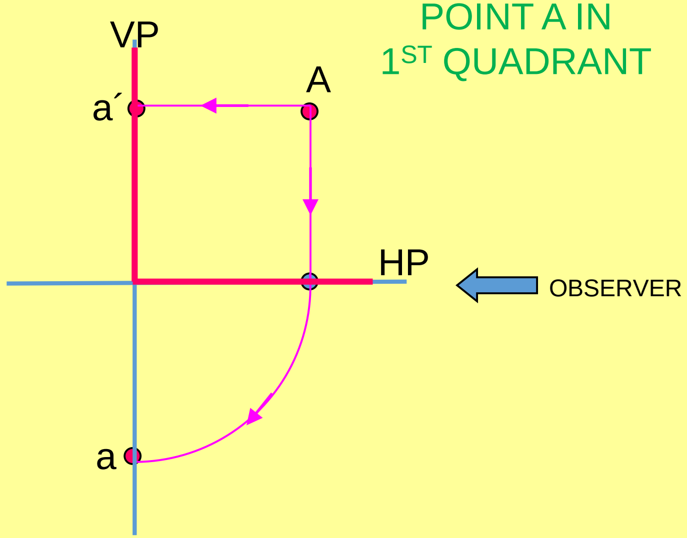


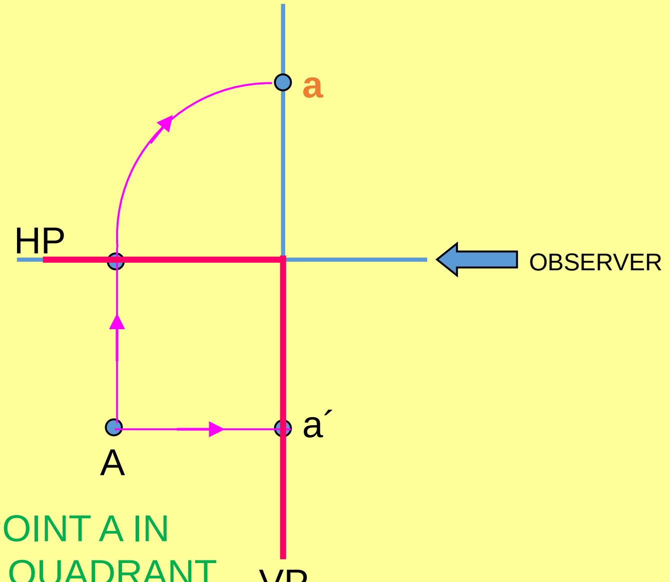


This quadrant pattern, if observed along x-y line (in red arrow direction) will exactly appear as shown on right side and hence it is further used to understand illustration properly.

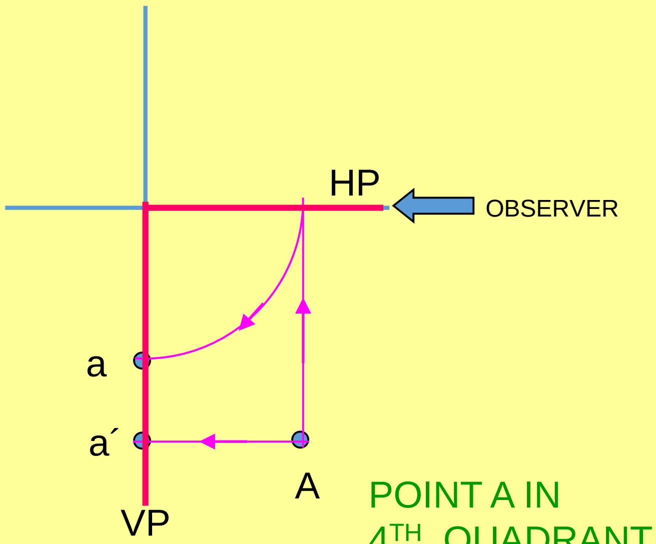
Point A is placed In different quadrants and it's FV & TV are brought in same plane for Observer to see clearly. FV is visible as it is a view on VP. But as TV is is a view on HP, it is rotated downward 90^0, in clockwise direction. The front part of HP comes below XY line and the part behind VP comes above.







POINT A IN
3RD QUADRANT



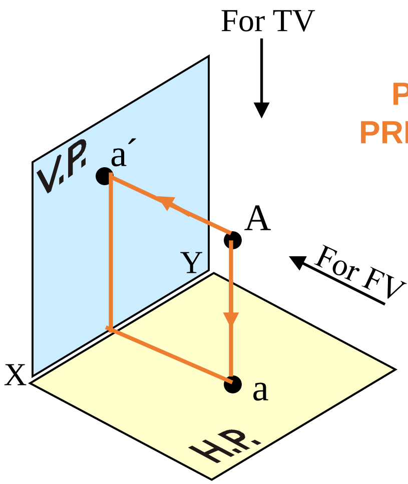
POINT A IN
4TH QUADRANT

PROJECTIONS OF A POINT IN FIRST QUADRANT

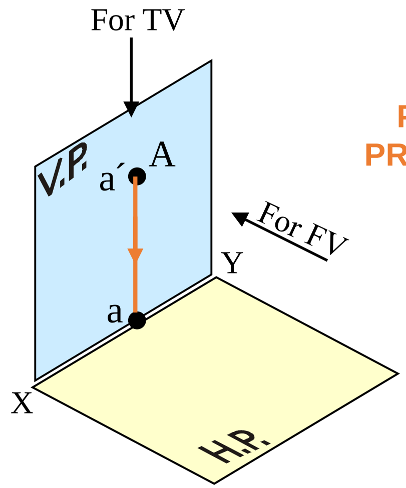
POINT A ABOVE HP
& INFRONT OF VP

POINT A ABOVE HP
& IN VP

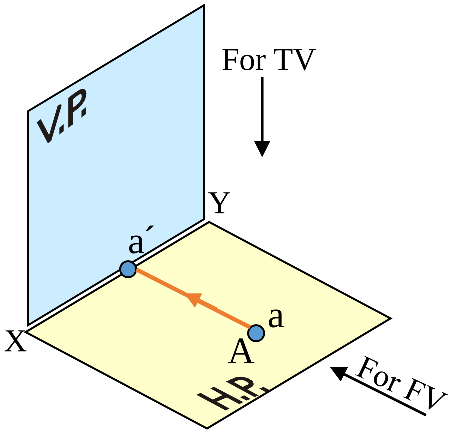
POINT A IN HP
& INFRONT OF VP



PICTORIAL
PRESENTATION

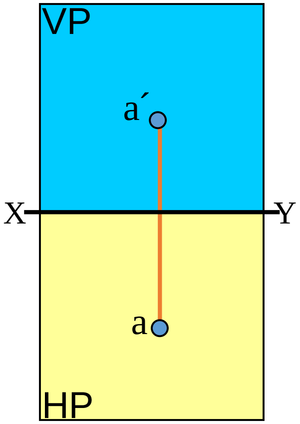


PICTORIAL
PRESENTATION

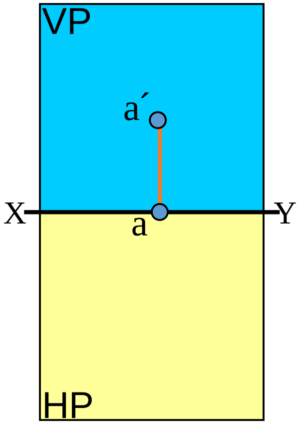


ORTHOGRAPHIC PRESENTATIONS
OF ALL ABOVE CASES.

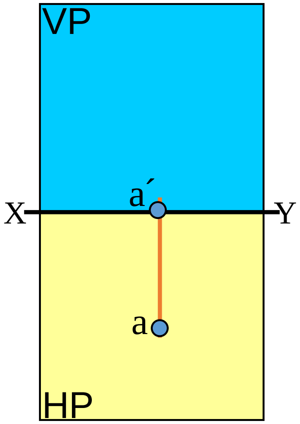
FV above XY,
TV below XY.



FV above XY,
TV on XY.



FV on XY,
TV below XY.



PROJECTIONS OF STRAIGHT LINES

INFORMATION REGARDING A LINE MEANS:

- **It's length**
- **Position of it's ends with HP & VP**
- **It's inclinations with HP & VP will be given.**

AIM:- To draw it's projections - means FV & TV.

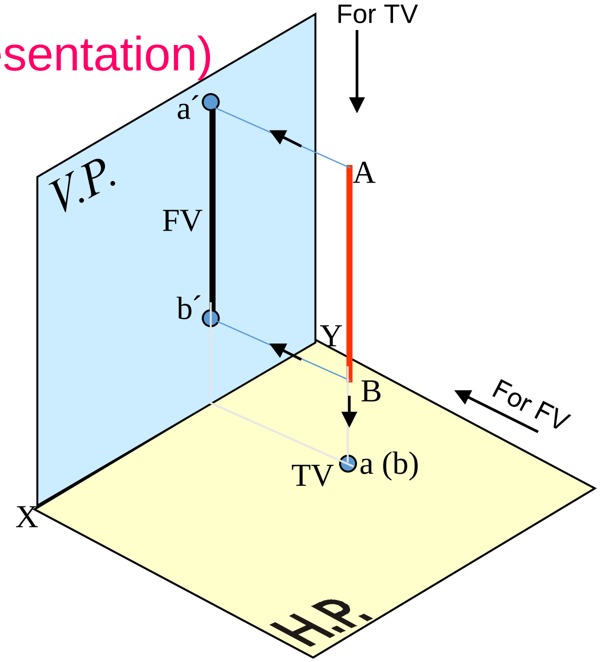
SIMPLE CASES OF THE LINE

1. A vertical line (line perpendicular to HP & parallel to VP)
2. Line parallel to both HP & VP.
3. Line inclined to HP & parallel to VP.
4. Line inclined to VP & parallel to HP.
5. Line inclined to both HP & VP.

(Pictorial Presentation)

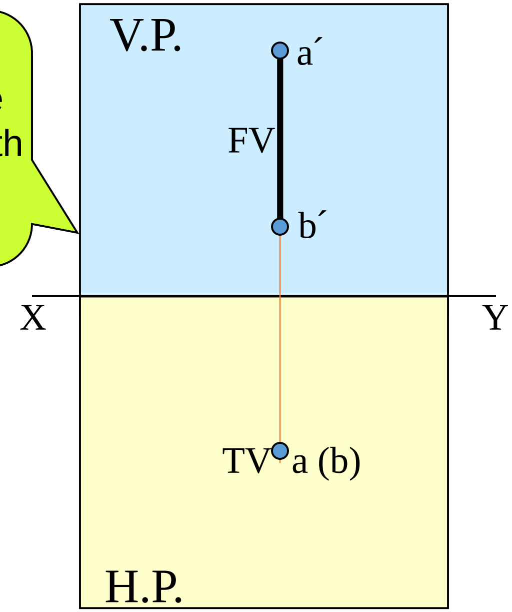
1.

A line perpendicular to HP & parallel to VP



Orthographic Pattern

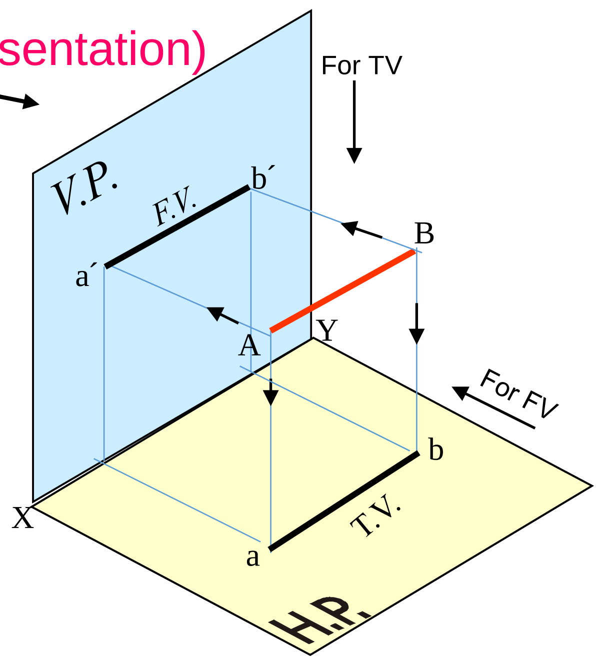
Note:
FV is a vertical line
Showing True Length
&
TV is a point.



(Pictorial Presentation)

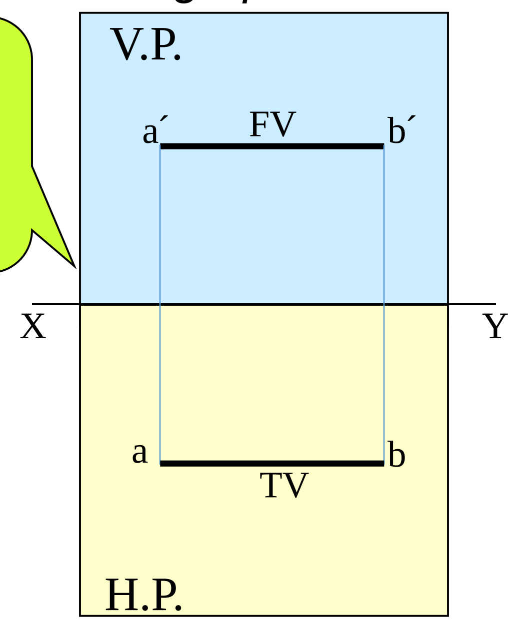
2.

A line // to HP & // to VP



Orthographic Pattern

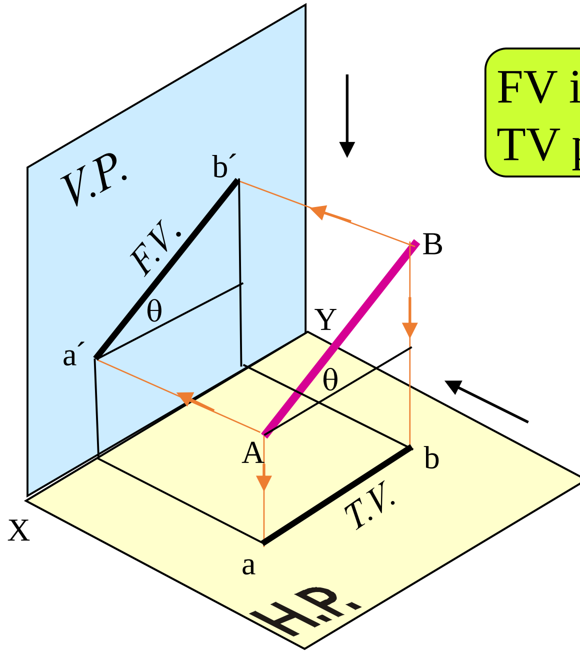
Note:
FV & TV both are
// to XY
&
both show T. L.



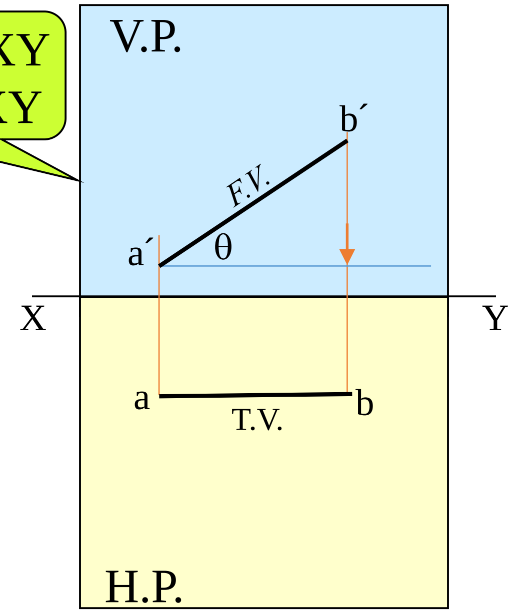
3.

A line inclined to HP and parallel to VP

(Pictorial presentation)



FV inclined to XY
TV parallel to XY

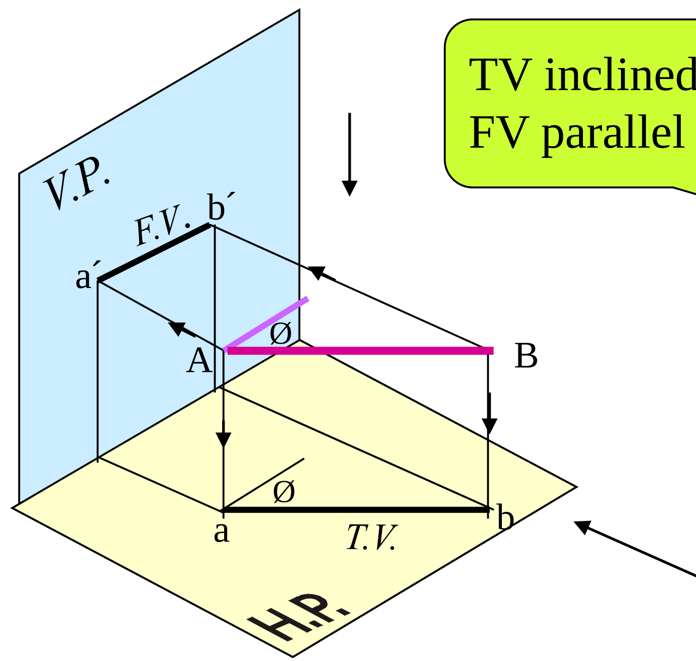


Orthographic Projections

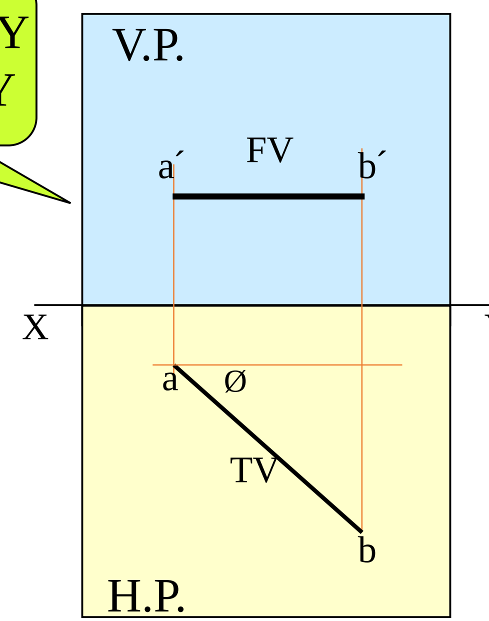
4.

A line inclined to VP and parallel to HP

(Pictorial presentation)



TV inclined to XY
FV parallel to XY



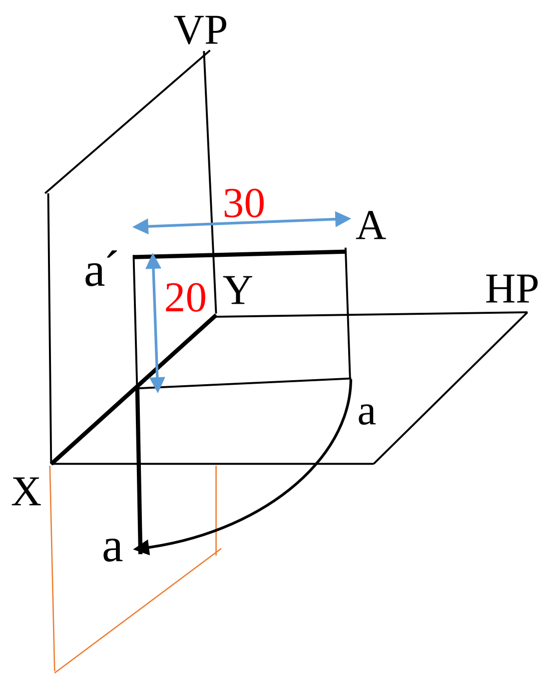
EXAMPLE PROBLEMS ON POINTS

PROBLEM 1:

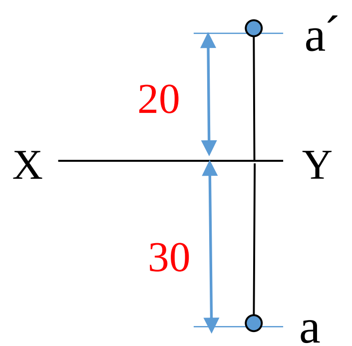
A point A is 20 mm above HP and 30 mm in front of VP. Draw its projections

Solution steps:

1) Draw reference line XY.
2) Mark a point a´ at a distance of 20 mm above XY.
3) Through this point draw a perpendicular line to XY and mark the top view a at a distance of 30 mm below XY.



Orthographic projection

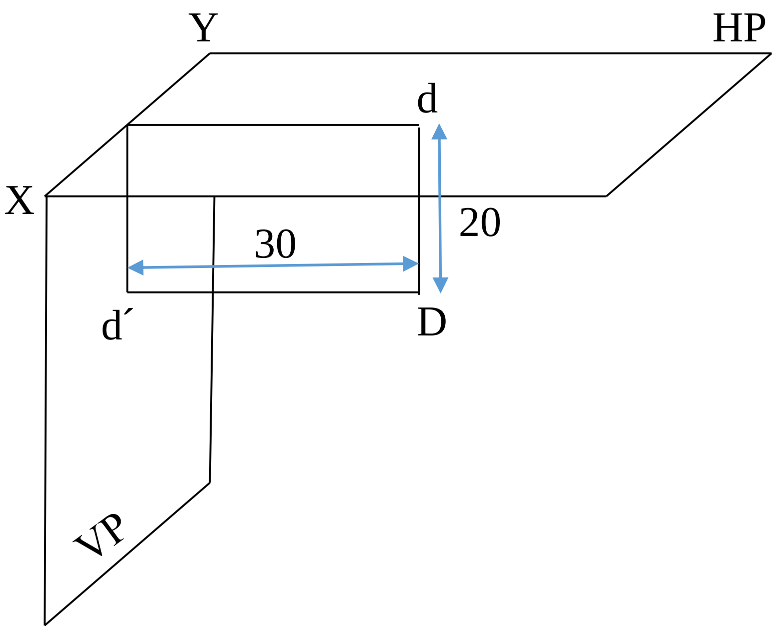


PROBLEM 2:

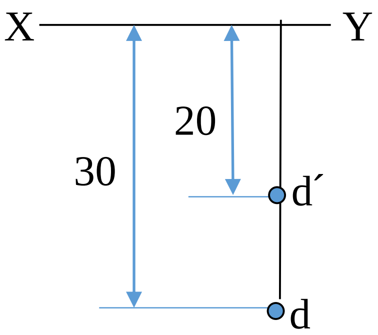
A point D is 20 mm below HP and 30 mm in front of VP. Draw its projections.

Solution steps:

1) Draw reference line XY.
2) Mark a point d´ at a distance of 20 mm below XY.
3) Through this point draw a perpendicular line to XY and mark the top view d at a distance of 30 mm above XY.



Orthographic projection

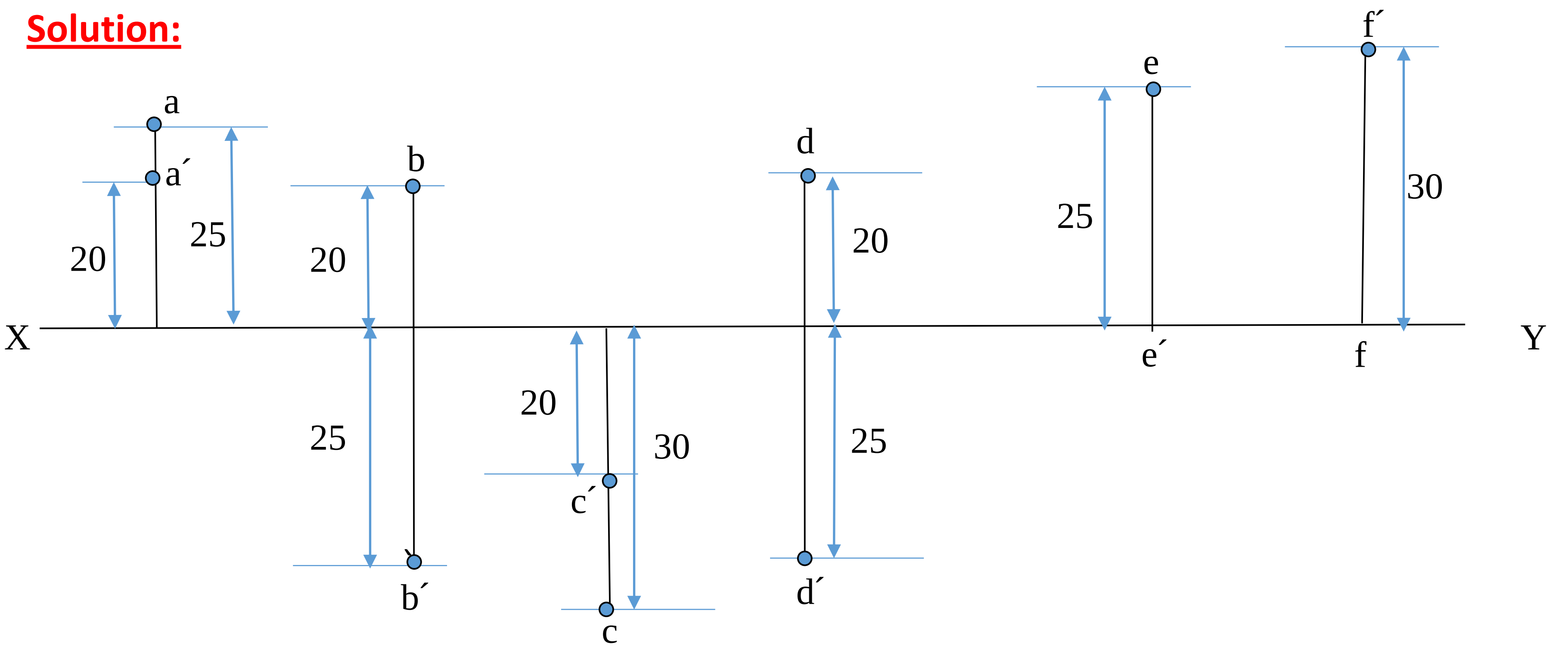


PROBLEM 3:

Draw the projections of the following points on the same ground line, keeping the distance between projectors equal to 25 mm.

(i) Point A, 20 mm above HP, 25 mm behind VP;
(ii) Point B, 25 mm below HP, 20 mm behind VP;
(iii) Point C, 20 mm below HP, 30 mm in front of VP;
(iv) Point D, 20 mm above HP, 25 mm in front of VP;
(v) Point E, on HP, 25 mm behind VP;
(vi) Point F, on VP, 30 mm above HP;

Solution:



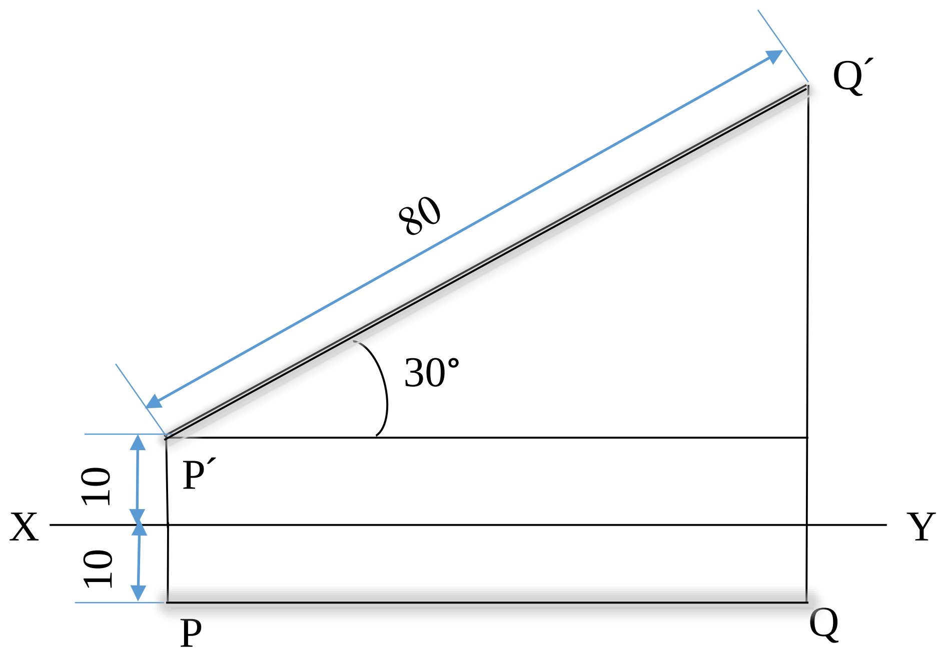
Parallel to VP and inclined to HP

PROBLEM 4:

Draw projections of a 80 mm long line PQ. Its end P is 10 mm above HP and 10 mm in front of VP. The line is parallel to VP and inclined to HP at 30°.

Solution steps:

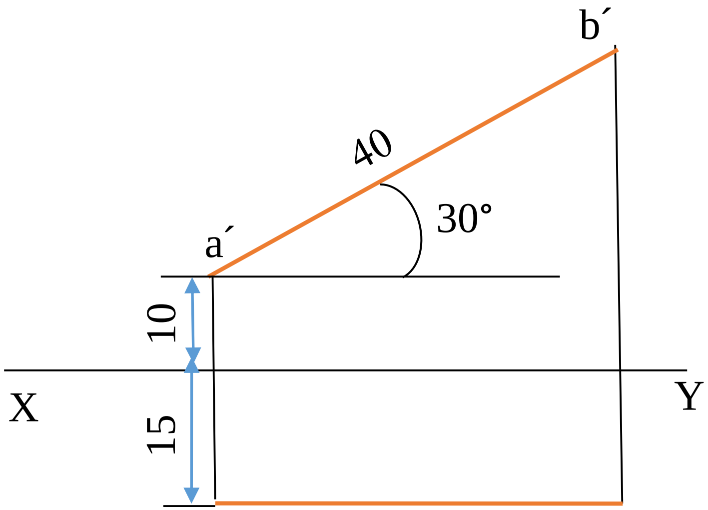
1) Draw the plan and elevations of the end point P.
2) Draw plan PQ of the line at an angle of 30° to XY.
3) Draw the projector of Q.
4) From the elevation of end point P draw a line parallel to XY meeting projector of Q at Q´.
5) P´Q´ is the elevation and PQ is the plan of the line.



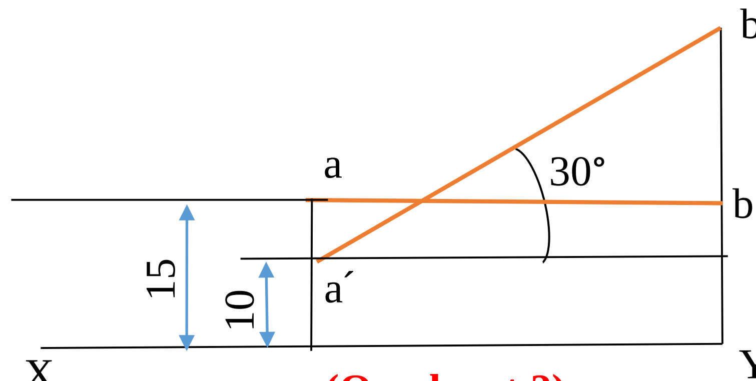
Parallel to VP and inclined to HP

PROBLEM 5:

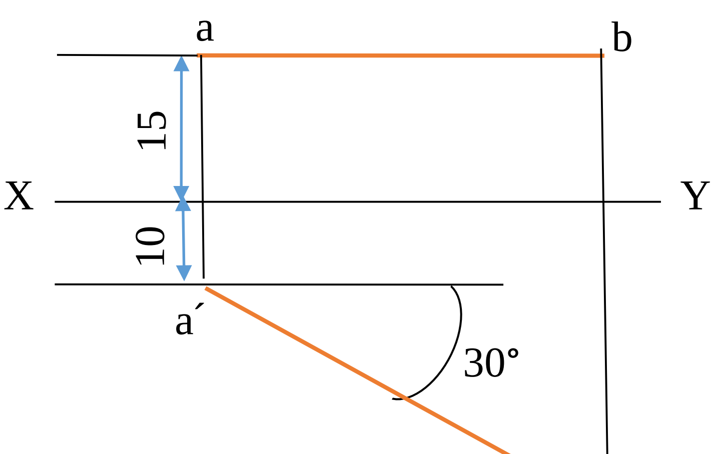
A straight line AB of 40 mm length has one of its ends A, at 10 mm from the HP and 15 mm from the VP. Draw the projections of the line if it is parallel to the VP and inclined at 30° to the HP. Assume the line to be located in each of the four quadrants by turns. (EXAMPLE)



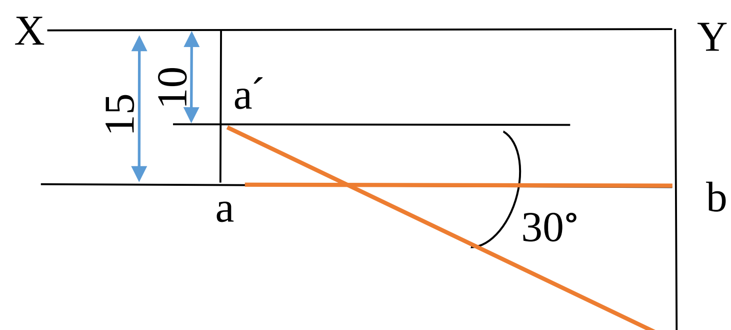
(Quadrant 1)



(Quadrant 2)



(Quadrant 3)

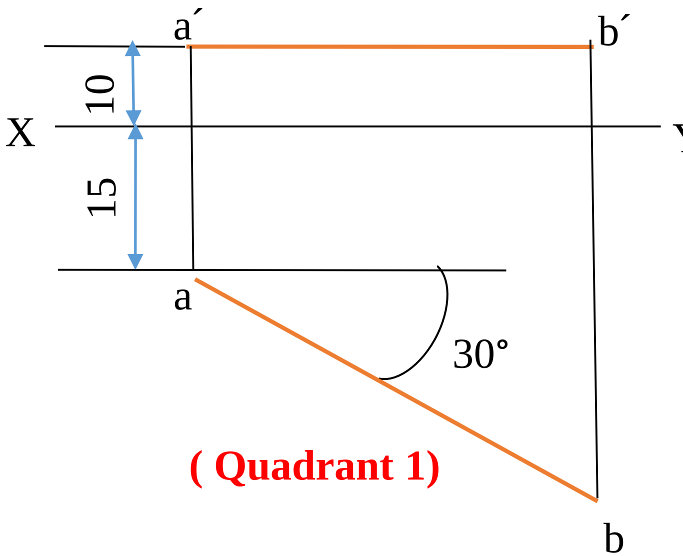


(Quadrant 4)

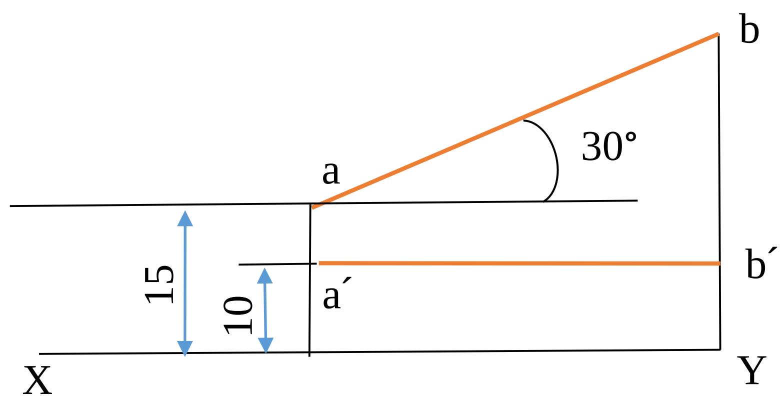
Parallel to HP and inclined to VP

PROBLEM 6:

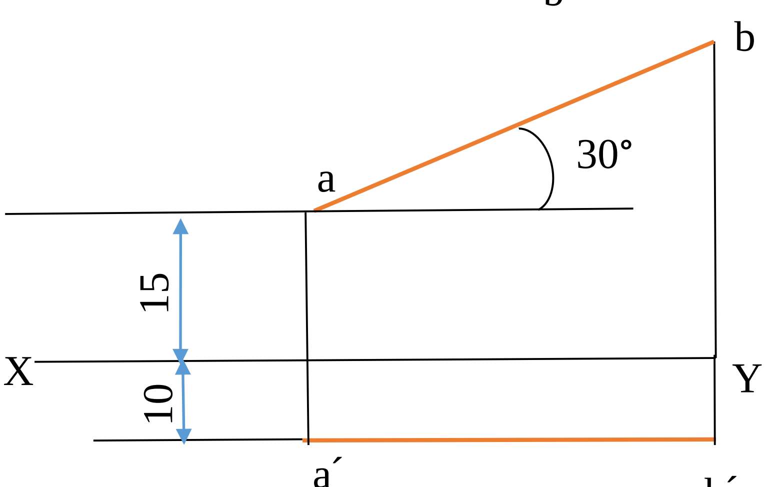
A straight line AB of 40 mm length is parallel to the HP and inclined at 30° to the VP. Its end point A is 10 mm from the HP and 15 mm from the VP. Draw the projections of the line AB, assuming it to be located in all the four quadrants by turns.



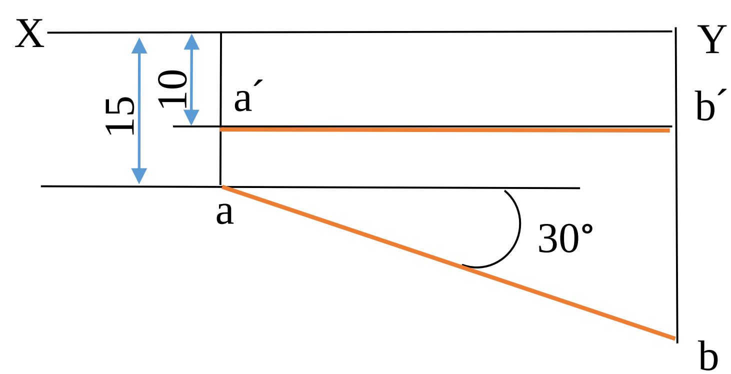
(Quadrant 1)



(Quadrant 2)



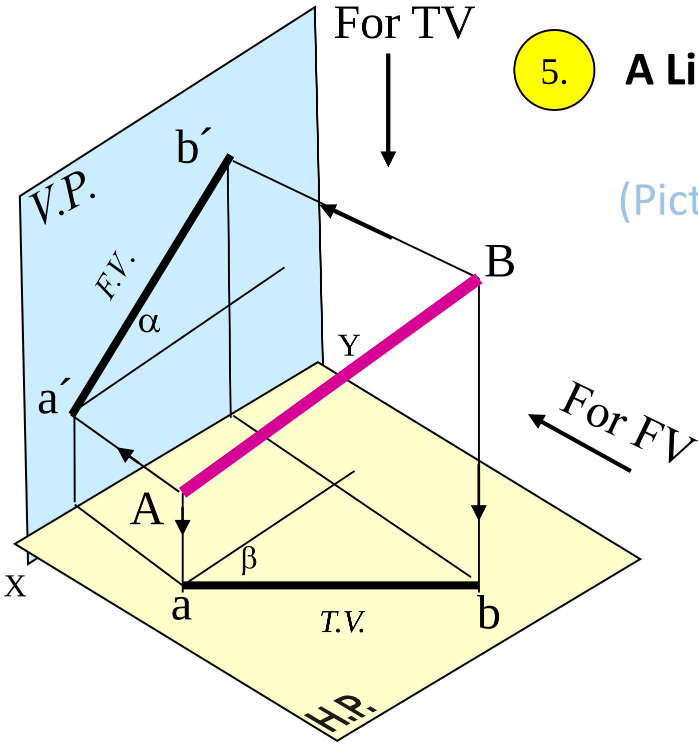
(Quadrant 3)



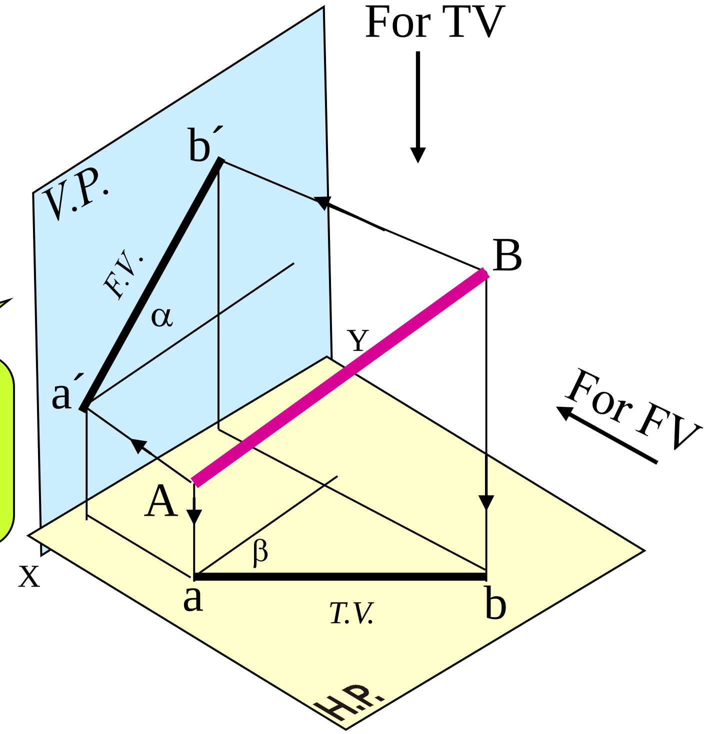
(Quadrant 4)

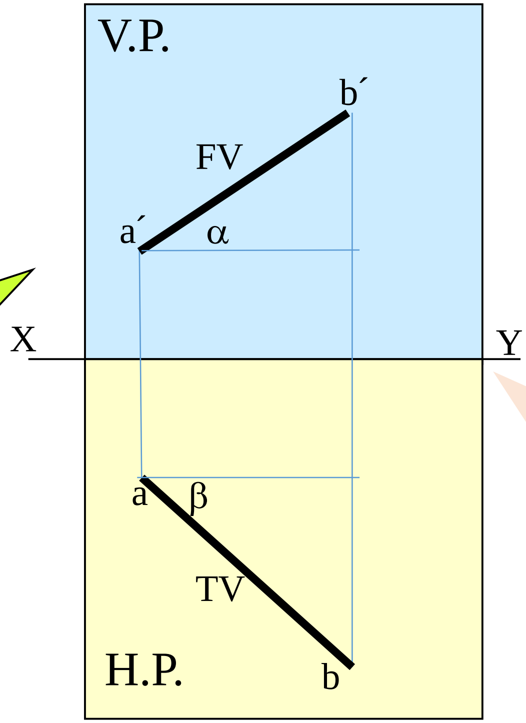
5. **A Line inclined to both HP and VP**

(Pictorial presentation)



On removal of object i.e. Line AB
FV as a image on VP.
TV as a image on HP,



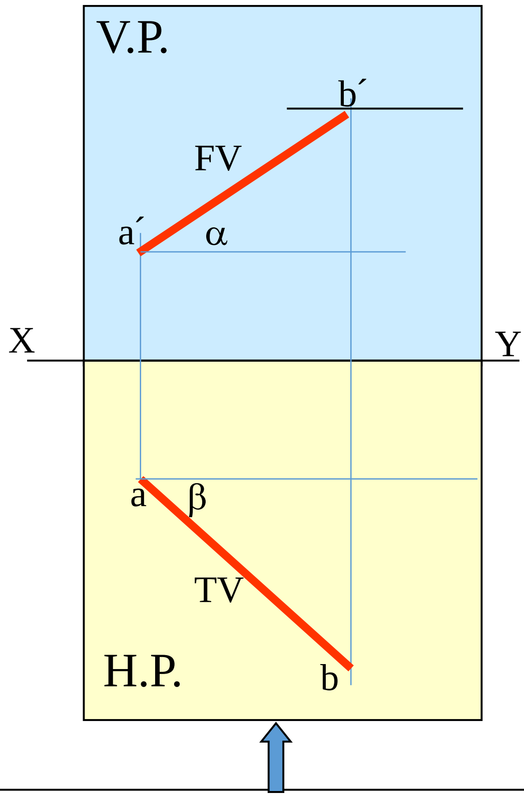


Orthographic Projections
FV is seen on VP clearly.
To see TV clearly, HP is rotated 90^0 downwards,
Hence it comes below XY.

Note:-
Both FV & TV are inclined to XY.
(No view is parallel to XY)
Both FV & TV are reduced lengths
(No view shows True Length)

Orthographic Projections

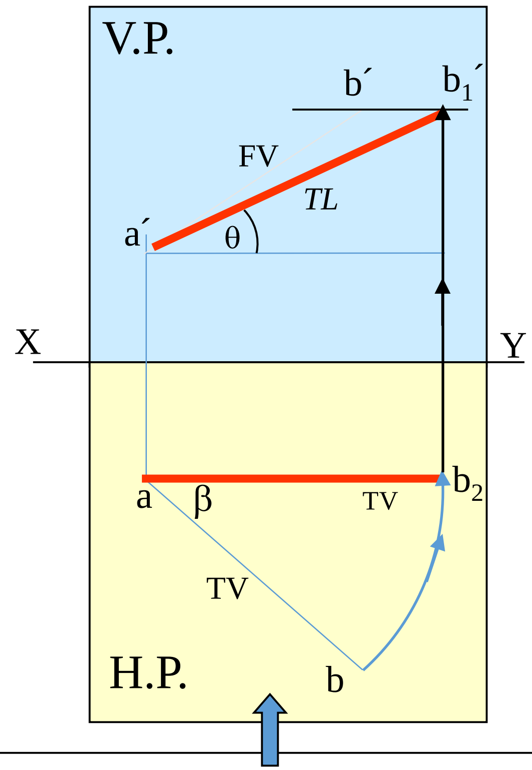
Means FV & TV of Line AB are shown below, with their apparent inclinations α & β



Here TV (ab) is not // to XY line
Hence it's corresponding FV a' b' is not showing
True Length &
True Inclination with HP.

Note the procedure

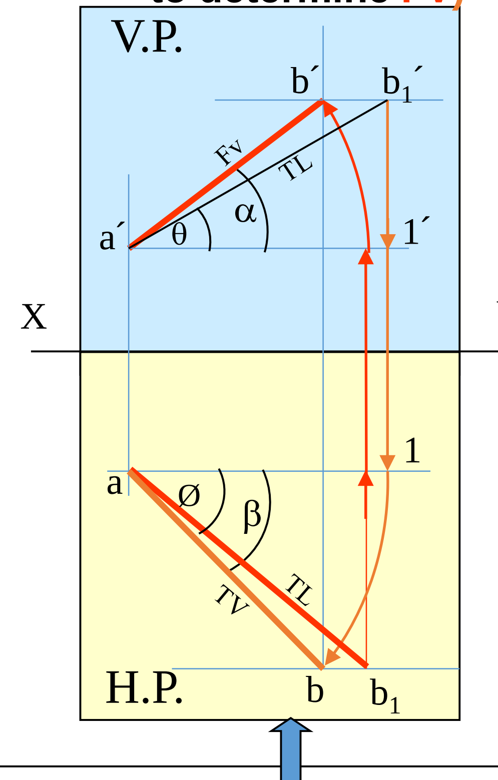
When FV & TV known,
How to find True Length.
(Views are rotated to determine True Length & it's inclinations with HP & VP).



In this sketch, TV is rotated and made // to XY line.
Hence it's corresponding FV, $a' b_1'$ is showing
True Length
&
True Inclination with HP.

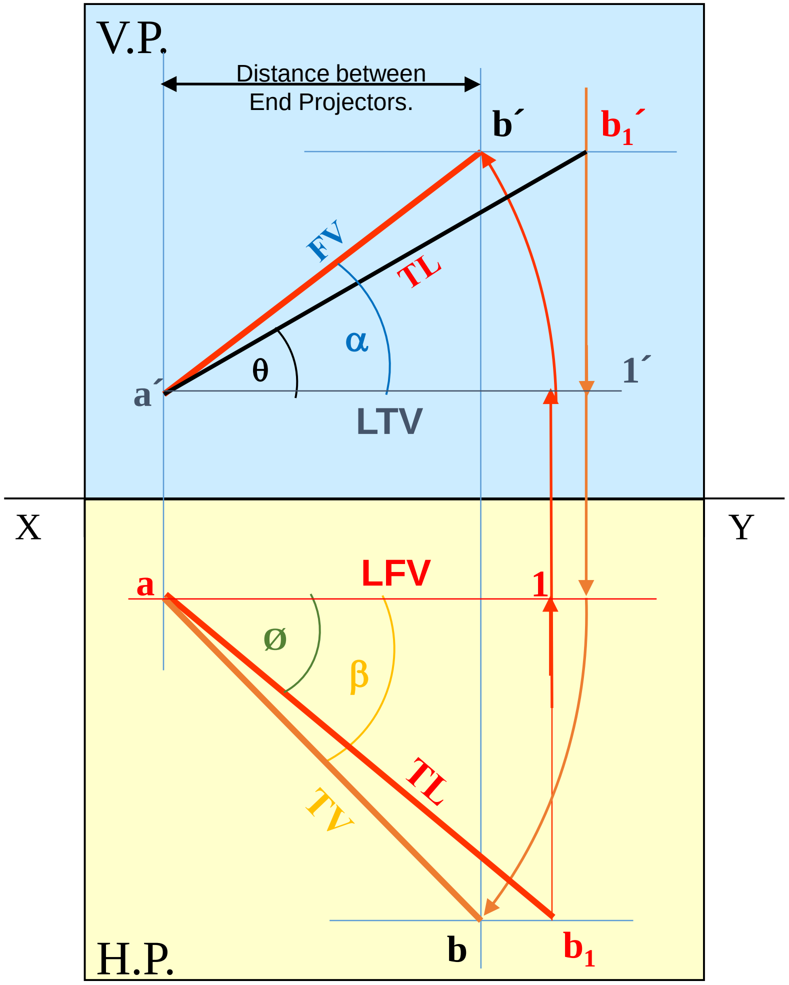
Note the procedure

When True Length is known,
How to locate FV & TV.
(Component a-1 of TL is drawn which is further rotated to determine FV)



Here a -1 is component of TL ab_1 gives length of FV.
Hence it is brought upto Locus of a' and further rotated to get point b'. a' b' will be FV.
Similarly drawing component of other TL (a' b_1') TV can be drawn.

Diagram showing graphical relations among all important parameters of this topic.



1) **True Length (TL) – a’ b_1’ & a b_1**
2) **Angle of TL with HP - θ**
3) **Angle of TL with VP – Ø**
4) **Angle of FV with XY – α**
5) **Angle of TV with XY – β**
6) **LTV (length of FV) – Component (a-1)**
7) **LFV (length of TV) – Component (a’-1’)**
8) **Position of A- Distances of a & a’ from XY**
9) **Position of B- Distances of b & b’ from XY**
10) **Distance between End Projectors**

TEN important parameters to be remembered with notations used here onward

NOTE

θ & α Construct with *a’*

Ø & β Construct with *a*

b’ & b_1’ on same locus.

b & b_1 on same locus.

Also remember

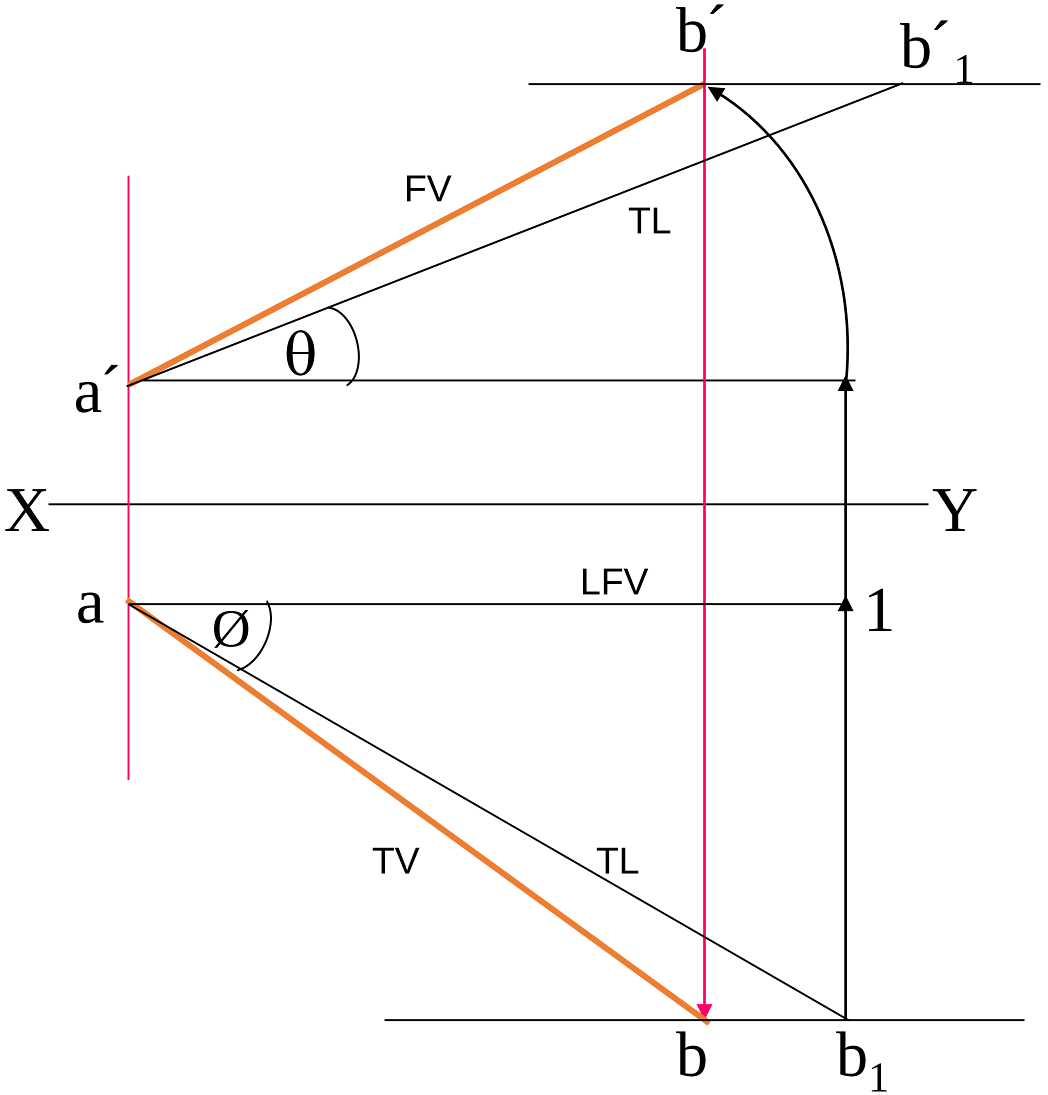
True Length is never rotated. It’s horizontal component is drawn & it is further rotated to locate view.

Views are always rotated, made horizontal & further extended to locate TL, θ & Ø

INCLINED TO HP & VP

PROBLEM 7:

Line AB is 75 mm long and it is 30^0 & 40^0 inclined to HP & VP respectively. End A is 12mm above HP and 10 mm in front of VP. Draw projections. Line is in 1st quadrant.



Solution steps:

1) Draw XY line and one projector.
2) Locate a´ 12mm above XY line & a 10mm below XY line.
3) Take 30^0 angle from a´ & 40^0 from a and mark TL, i.e., 75mm on both lines. Name those points b_1´ and b respectively.
4) Draw horizontal component of TL a b_1 from point b_1 and name it 1. (the length a-1 gives length of FV as we have seen already)
5) Extend it up to locus of a and rotating a' as center locate b´ as shown. Join a´ b´ as FV.
6) From b´ drop a projector downward & get point b. Join a & b, i.e., TV.

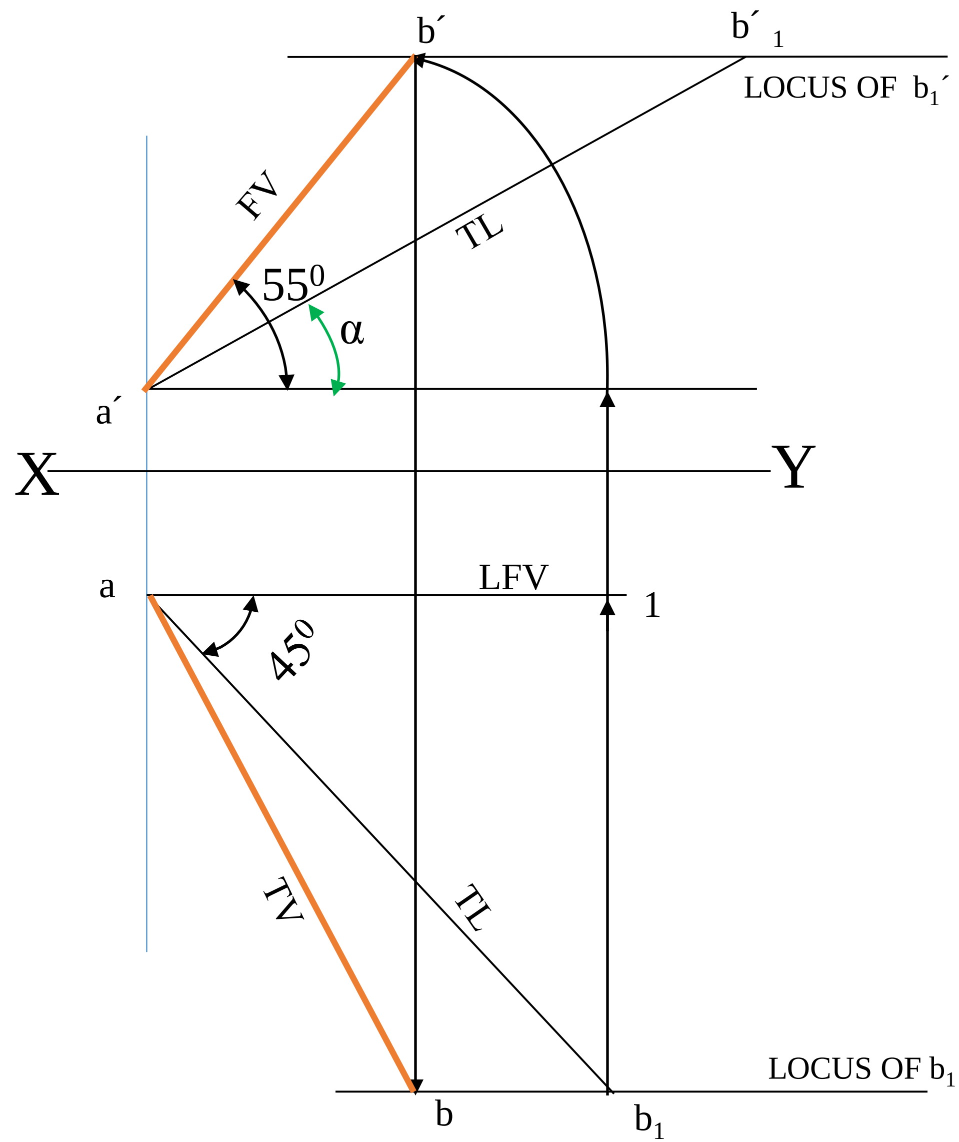
FINDING INCLINATION WITH HP

PROBLEM 8:

Line AB 75mm long makes 45^0 inclination with VP while it's FV makes 55^0. End A is 10 mm above HP and 15 mm in front of VP. If line is in 1st quadrant draw it's projections and find it's inclination with HP.

Solution Steps:-

1.Draw xy line.
2.Draw one projector for a' & a
3.Locate *a´* 10mm above XY & *a* 15 mm below XY.
4.Draw a line 45^0 inclined to XY from point *a* and cut TL 75 mm on it and name that point b_1.
5.Draw locus from point b_1.
6.Take 55^0 angle from *a´* for FV above XY line.
7.Draw a vertical line from b_1 up to locus of a and name it *1*. It is horizontal component of TL & is LFV.
8.Continue it to locus of *a´* and rotate upward up to the line of FV and name it *b´*. This *a´ b´* line is FV.
9. Drop a projector from b´ on locus from point b_1 and name intersecting point *b*. Line *ab* is TV of line ab.
10.Draw locus from *b´* and with TL distance cut point $b_1´$
11.Join *a´* $b_1´$ as TL and measure it's angle α at *a´*. It will be true angle of line with HP.

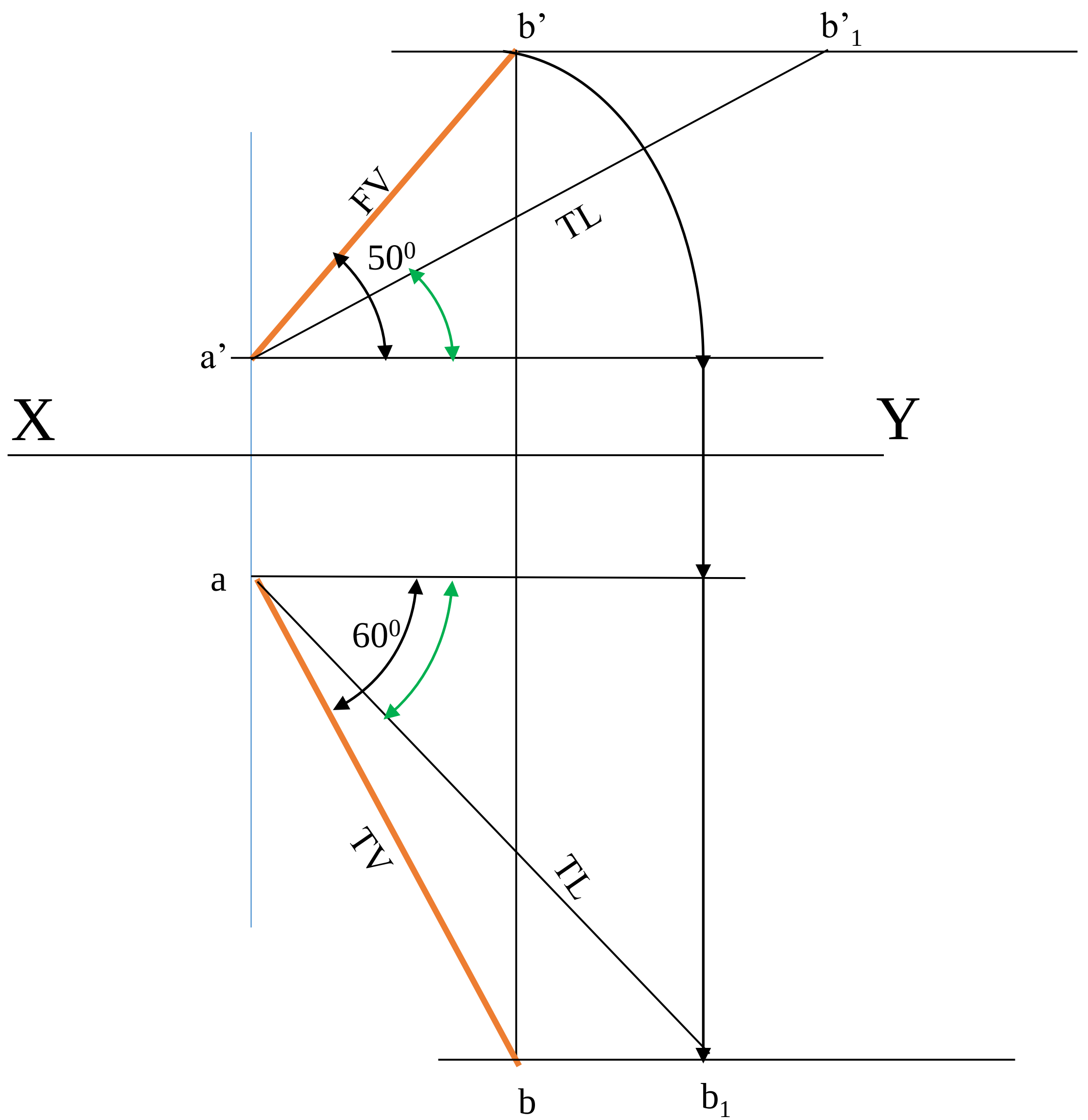


FINDING TL AND INCLINATIONS

PROBLEM 9: **FV of line AB is 50^0 inclined to XY and measures 55 mm long while it's TV is 60^0 inclined to XY line. If end A is 10 mm above HP and 15 mm in front of VP, draw it's projections, find TL, inclinations of line with HP & VP.**

Solution steps:

1.Draw XY line and one projector.
2.Locate a' 10 mm above XY and a 15 mm below XY line.
3.Draw locus from these points.
4.Draw FV 50^0 from a' and mark b' cutting 55mm on it.
5.Similarly draw TV 60^0 from a & drawing projector from b' locate point b and join a b.
6.Then rotating views as shown, locate True Lengths ab_1 & $a'b_1'$ and their angles with HP and VP.



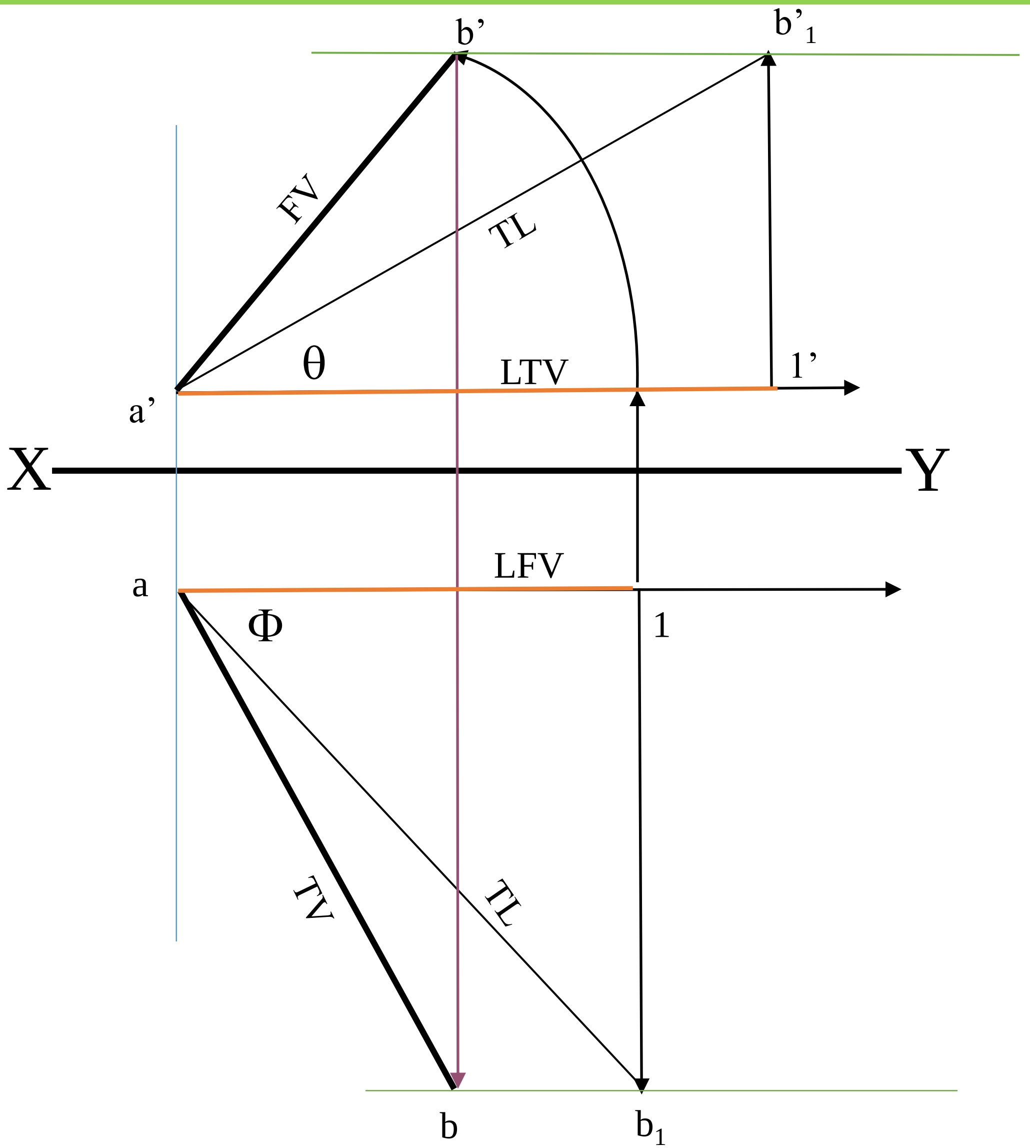
FINDING ANGLE WITH HP & VP

PROBLEM 10:-

Line AB is 75 mm long. It's FV and TV measure 50 mm & 60 mm long respectively. An end is 10 mm above HP and 15 mm in front of VP. Draw projections of line AB if end B is in first quadrant. Find angle with HP and VP.

SOLUTION STEPS:

1.Draw XY line and one projector.
2.Locate a' 10 mm above XY and a 15 mm below XY line.
3.Draw locus from these points.
4.Cut 60mm distance on locus of a' & mark 1' on it as it is LTV.
5.Similarly cut 50mm on locus of a and mark point 1 as it is LFV.
6.From 1' draw a vertical line upward and from a' taking TL (75mm) in compass, mark b'_1 point on it. Join a' b'_1 points.
7. Draw locus from b'_1
8. With same steps below get b_1 point and draw also locus from it.
9. Now rotating one of the components i.e., a-1 locate b' and join a' with it to get FV.
10. Locate TV similarly and measure angles θ and Φ

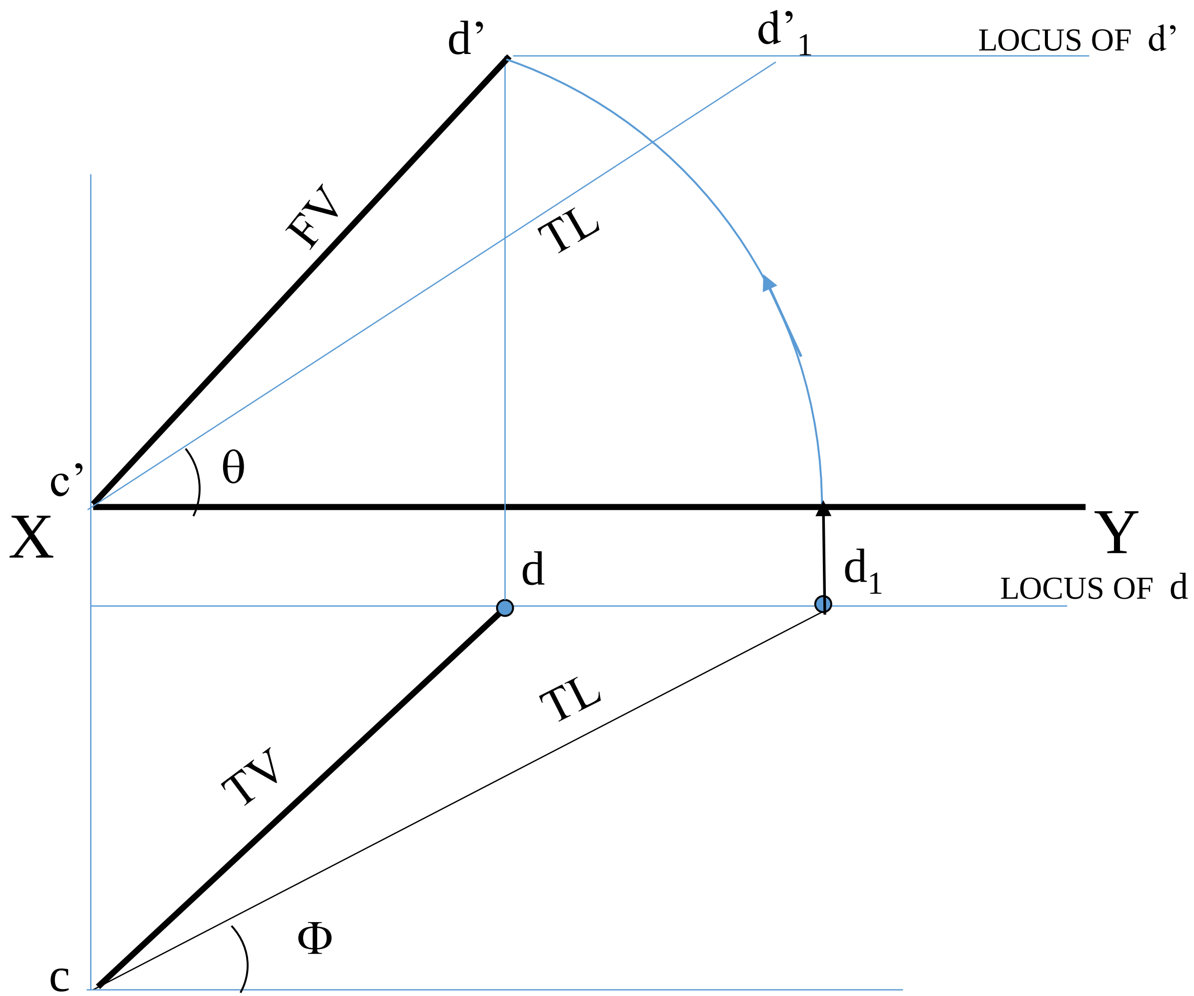


FINDING ANGLE WITH HP & VP

PROBLEM 11:- **TV of a 75 mm long line CD, measures 50 mm. End C is in HP and 50 mm in front of VP. End D is 15 mm in front of VP and it is above HP. Draw projections of CD and find angles with HP and VP.**

SOLUTION STEPS:

1.Draw XY line and one projector.
2.Locate c' on XY and c 50mm below XY line.
3.Draw locus from these points.
4.Draw locus of d 15 mm below XY.
5.Cut 50mm & 75 mm distances on locus of d from c and mark points d & d_1 as these are TV and TL. Join both with c.
6.From d_1 draw a vertical line upward up to XY i.e., up to locus of c' and draw an arc as shown.
7 Then draw one projector from d to meet this arc in d' point & join c' d'
8. Draw locus of d' and cut 75 mm on it from c' as TL
9.Measure angles θ and Φ



FINDING TRUE ANGLE

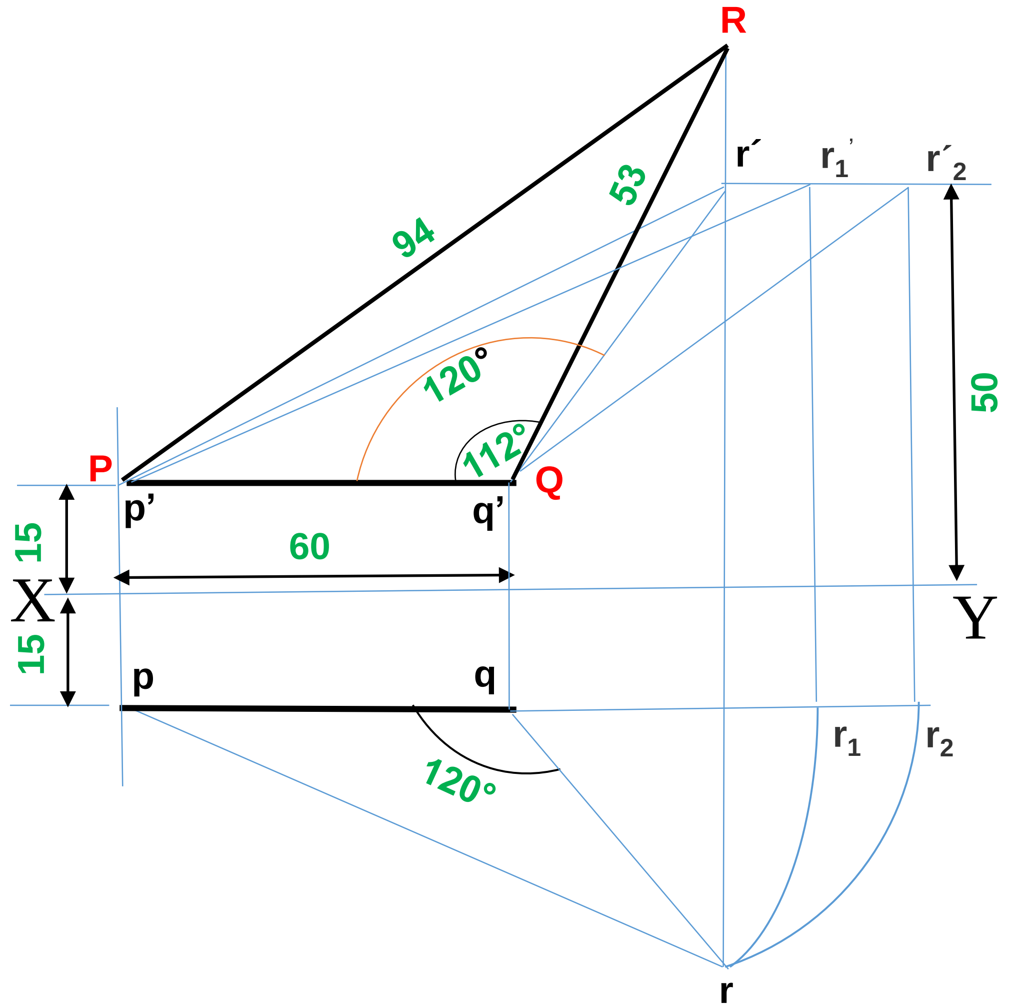
PROBLEM 9:- Two straight lines PQ and QR make an angle of 120° between them in front and top views. PQ is 60 mm long and is parallel to and 15 mm from both H.P. and V.P. Determine the true angle between PQ and QR, if point R is 50 mm above H.P. (EXAMPLE)

SOLUTION STEPS:

1. Draw a reference line xy. Mark point p´ at 15 mm above xy and point p at 15 mm below xy.
2. Draw 60 mm long lines p´q´ and pq, parallel to xy.
3. Draw a line from point q´, inclined at 120° to xy such that it meets the horizontal line at 50 mm above xy at point r´. Join q´r´ and p´r´.
4. Draw a line from point q, inclined at 120° to xy such that it meets the projector from r´ at a point r. Join qr and pr.
5. As lines pq and p´q´ are parallel to xy, they represent the true length of side PQ. Here PQ = 60 mm.
6. Draw an arc with centre p and radius pr to meet the horizontal line from p at point r_1. Project point r_1 to meet horizontal lines from point r´ at point r_1'. Join $p'r_1'$ to represent the TL of the line PR. Here, PR = p´ r_1'= 94 mm.

7. Draw an arc with centre q and radius qr, to meet the horizontal line at r_2. Project point r_2 to meet horizontal lines form point r´ at point r'_2. Join q´ r_2' to represent the TL of line QR. Here, QR = q´ r_2' = 53mm.

8. Draw actual triangle PQR taking true lengths, i.e., 60 mm, 94 mm and 53 mm. Measure the inclined angle PQR as the actual angle between sides PQ and QR. Here, it is 112°.



PROBLEMS INVOLVING TRACES OF THE LINE

TRACES OF THE LINE:-

These are the points of intersections of a line (or it's extension) with respect to reference planes.

A line itself or its extension, where ever touches H.P., that point is called **TRACE OF THE LINE ON H.P.** *(It is called H.T.)*

Similarly, a line itself or it's extension, where ever touches V.P., that point is called **TRACE OF THE LINE ON V.P.** (it is called V.T.)

V.T.:- It is a point on VP.
Hence it is called *FV* of a point in VP.
Hence it's *TV* comes on XY line.(Here onward denoted as 'v')

H.T.:- It is a point on HP.
Hence it is called *TV* of a point in HP.
Hence it's *FV* comes on XY line.(Here onward denoted as 'h')