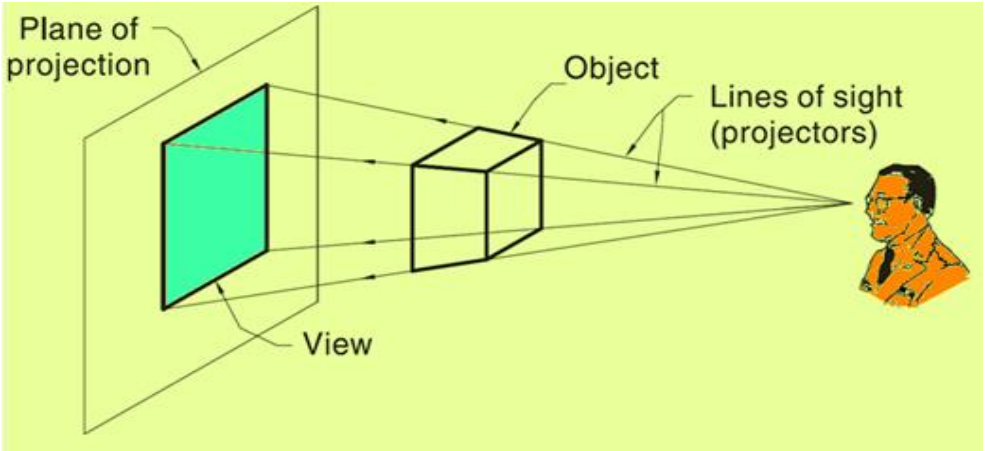
PROJECTION OF POINTS AND LINES

Theory of Projections

- In engineering, 3-dimensonal objects and structures are represented graphically on a 2-dimensional media.
- The act of obtaining the image of an object is termed “projection”. The image obtained by projection is known as a “view”.
- In effect, 3-D object is transformed into a 2-D representation, also called projections. The paper or computer screen on which a drawing is created is a plane of projection.

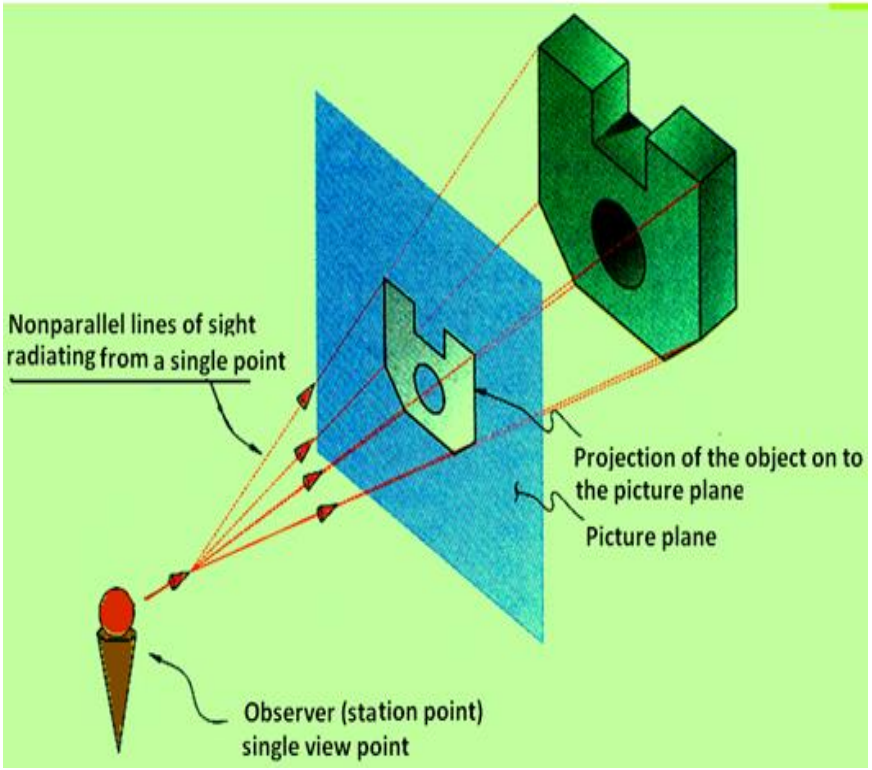


Theory of Projections (Contd…)

Plane of Projection

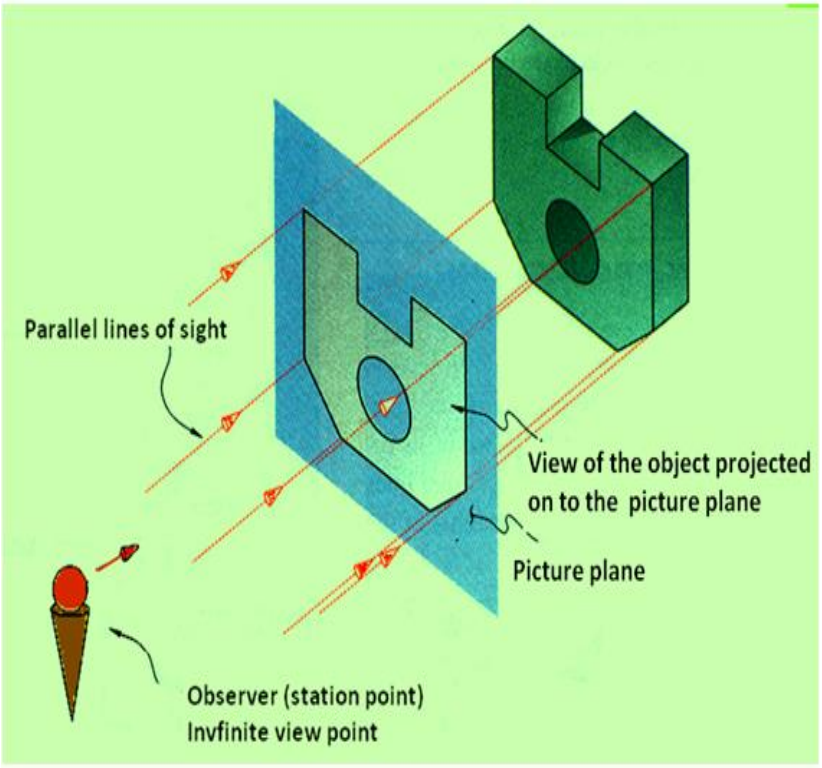
- A plane of projection (i.e, an image or picture plane) is an imaginary flat plane upon which the image created by the line of sight is projected.
- The image is produced by connecting the points where the lines of sight pierce the projection plane.
- The paper or computer screen on which a drawing is created is a plane of projection.

- Projection Methods



Perspective

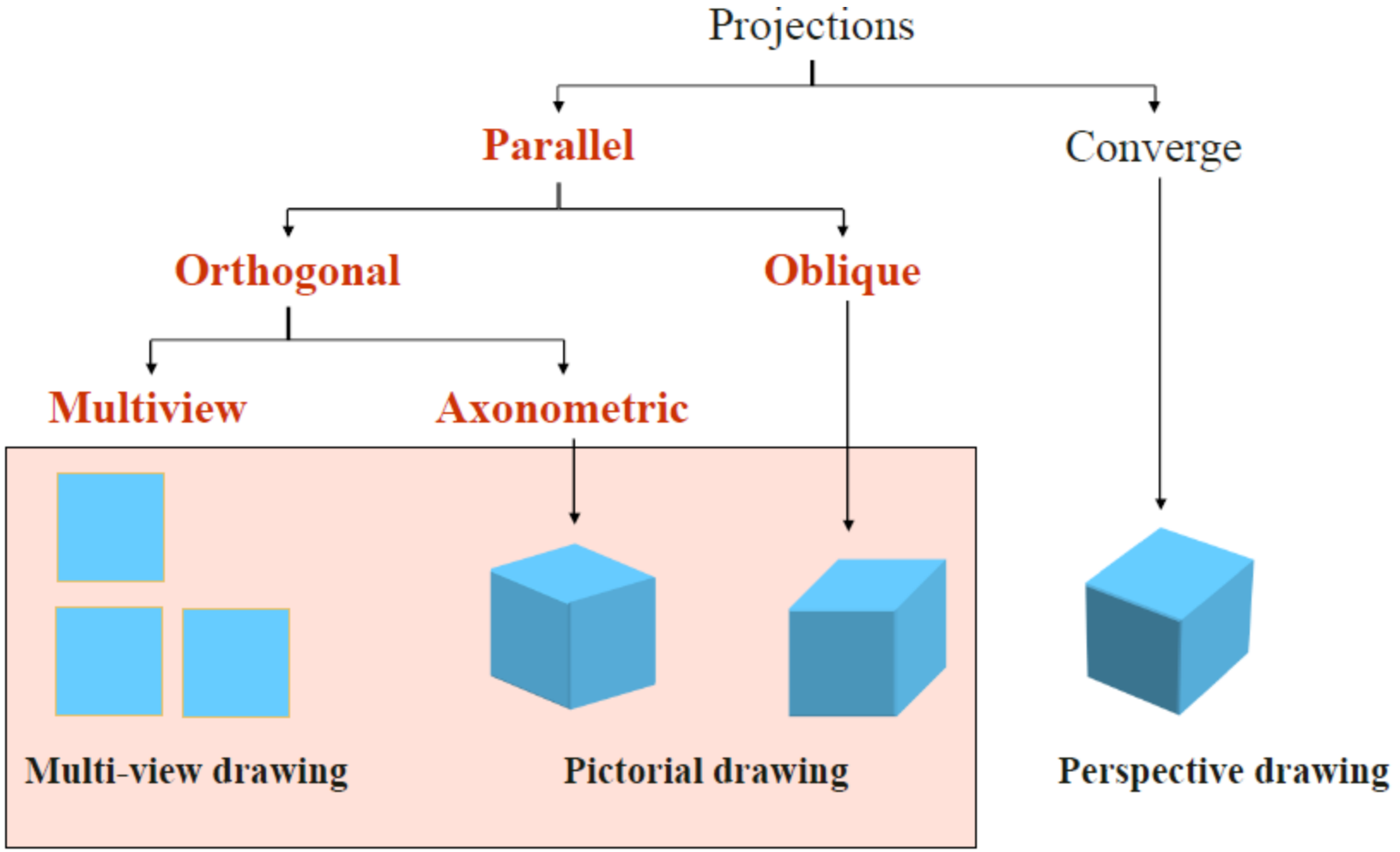
- Distance from the observer to the object is finite
- Projectors are not parallel
- Perspective projections mimic what **exactly human eyes see;** however, they are difficult to draw
- Distorted Dimensions



Parallel

- Distance from the observer to the object is infinite
- object is positioned at infinity
- Less realistic but easier to draw
- Exact Dimensions

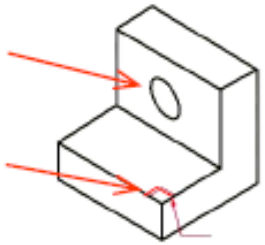
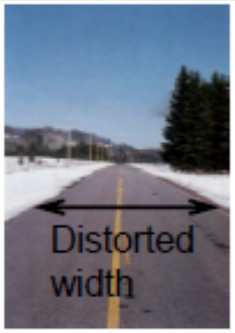
Type of Projections



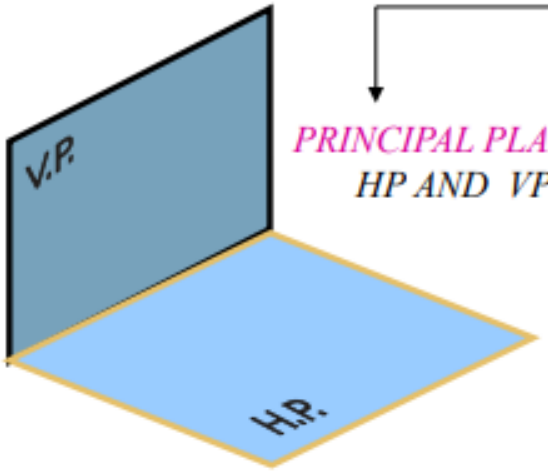
Orthographic Multi view Projections

- Orthographic multiview projections is a technical drawing in which different views of an object are projected on different reference planes observing perpendicular to respective reference plane.
- Different Reference planes are;
  - –Horizontal Plane (HP)
  - –Vertical Plane (VP)
  - –Side or Profile Plane (PP)
- Different views are;
  - *–Front View (FV) –Projected on VP*
  - *–Top View (TV) –Projected on HP*
  - *–Side View (SV) –Projected on PP*

View comparison

Type		
Multi-view drawing 	● Accurately presents object's details, i.e. size and shape.	● Require training to visualization.
Pictorial drawing 	● Easy to visualize.	● Shape and angle distortion 
Perspective drawing 	● Object looks more like what our eyes perceive.	● Difficult to create ● Size and shape distortion 

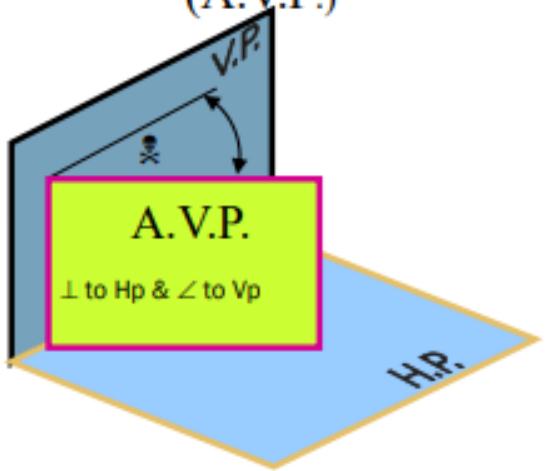
PLANES



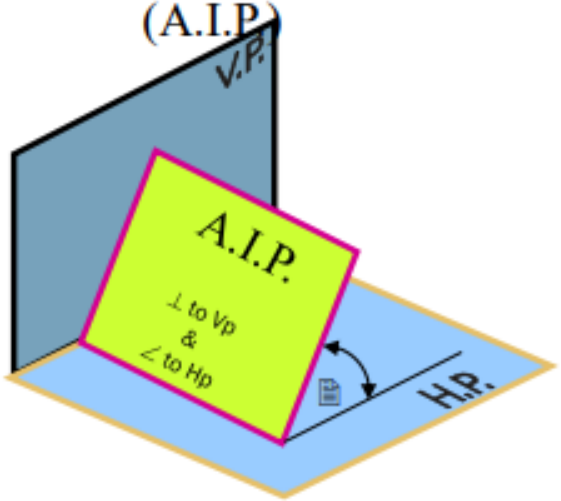
PRINCIPAL PLANES
HP AND VP

AUXILIARY PLANES

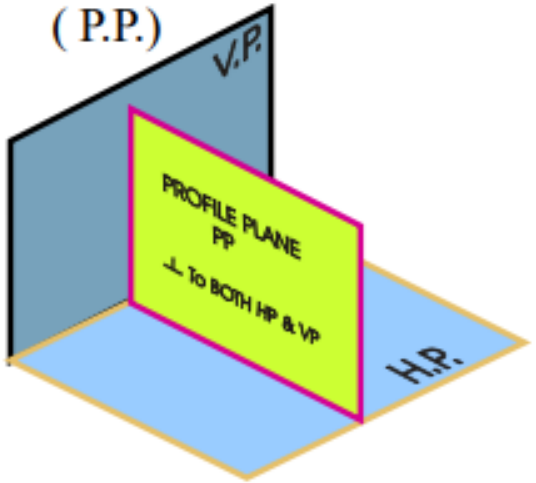
Auxiliary Vertical Plane
(A.V.P.)



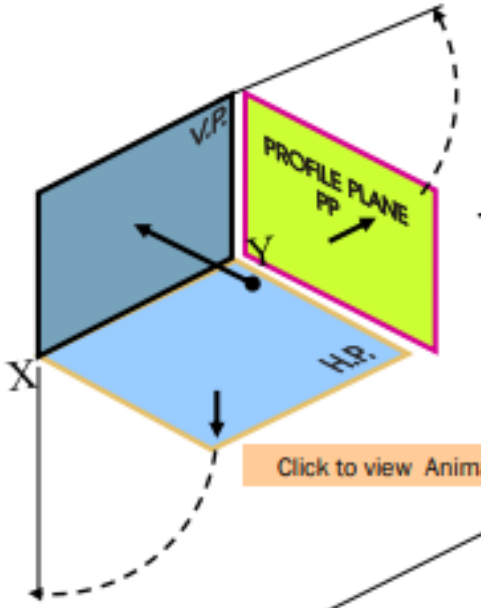
Auxiliary Inclined Plane
(A.I.P.)



Profile Plane
(P.P.)



PATTERN OF PLANES & VIEWS (First Angle Method)



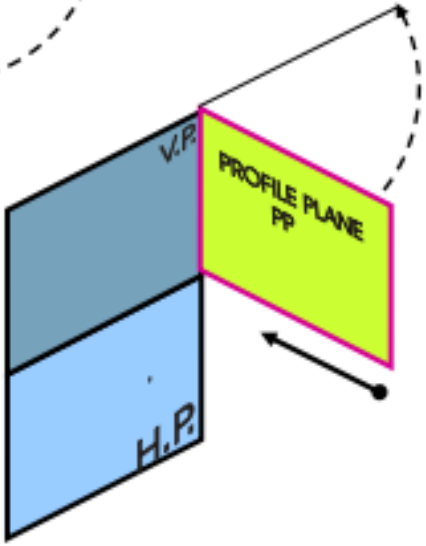
THIS IS A PICTORIAL SET-UP OF ALL THREE PLANES.
ARROW DIRECTION IS A NORMAL WAY OF OBSERVING THE OBJECT.
BUT IN THIS DIRECTION ONLY VP AND A VIEW ON IT (FV) CAN BE SEEN.
THE OTHER PLANES AND VIEWS ON THOSE CAN NOT BE SEEN.

PROCEDURE TO SOLVE ABOVE PROBLEM:-

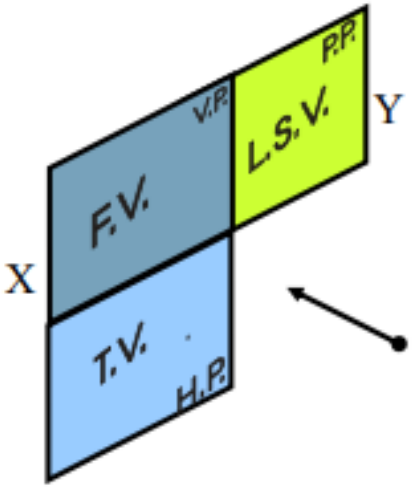
TO MAKE THOSE PLANES ALSO VISIBLE FROM THE ARROW DIRECTION,
A) HP IS ROTATED 90^0 DOUNWARD
B) PP, 90^0 IN RIGHT SIDE DIRECTION.
THIS WAY BOTH PLANES ARE BROUGHT IN THE SAME PLANE CONTAINING VP.

Click to view Animation

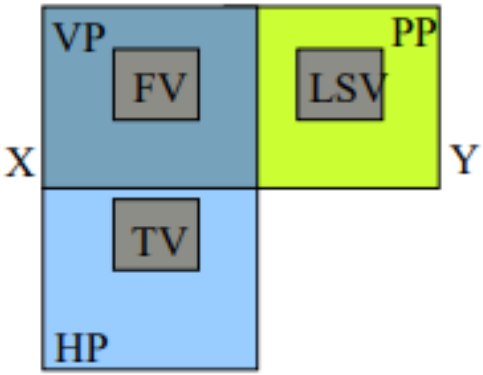
On clicking the button if a warning comes please click YES to continue, this program is safe for your pc.



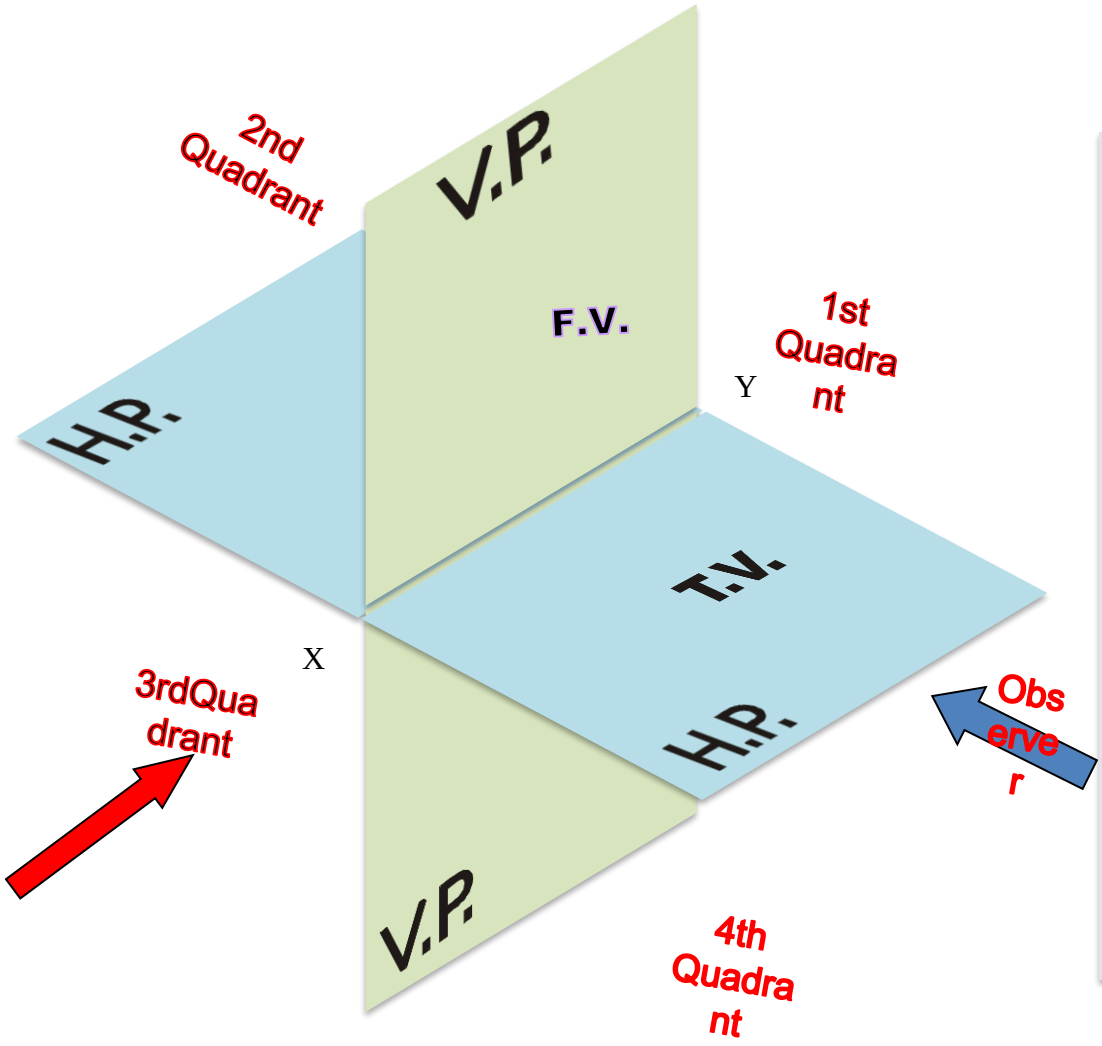
HP IS ROTATED DOWNWARD 90^0
AND
BROUGHT IN THE PLANE OF VP.

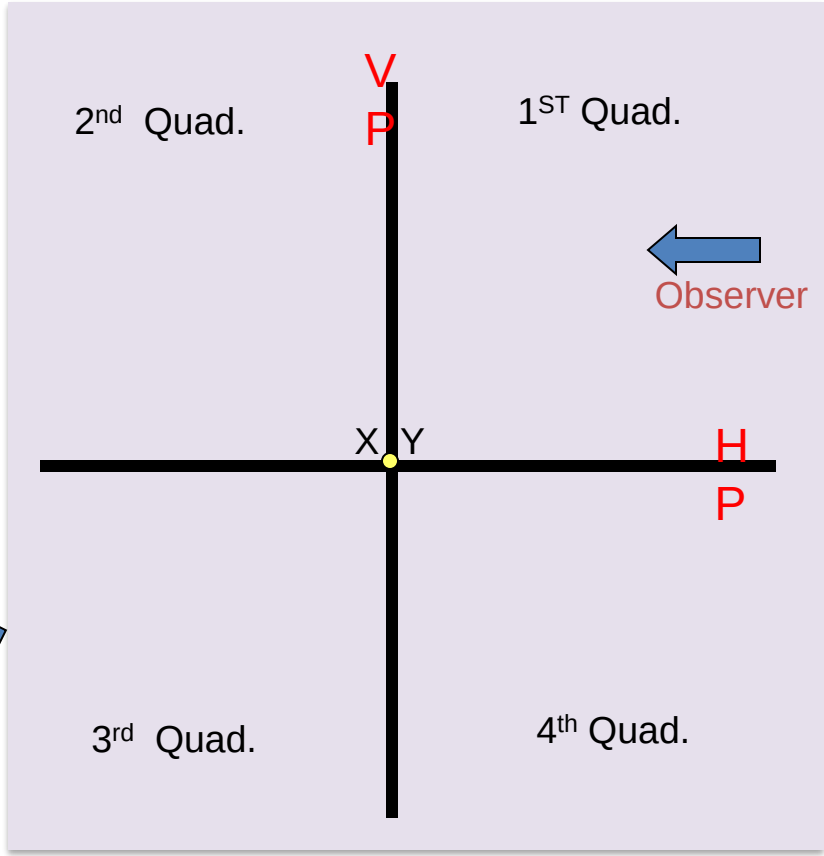


PP IS ROTATED IN RIGHT SIDE 90^0
AND
BROUGHT IN THE PLANE OF VP.



ACTUAL PATTERN OF PLANES & VIEWS
OF ORTHOGRAPHIC PROJECTIONS
DRAWN IN
FIRST ANGLE METHOD OF PROJECTIONS





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 PROPERLLY.

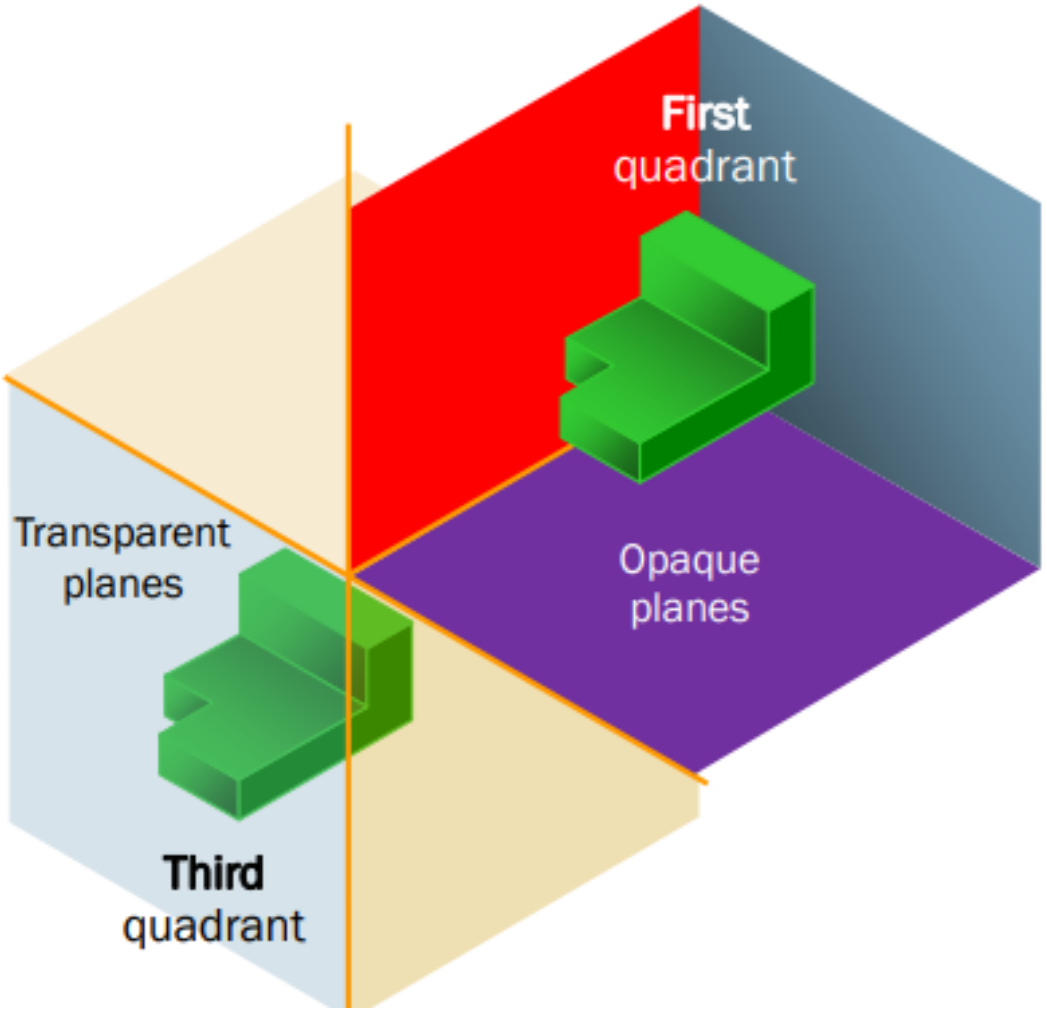
Projection systems

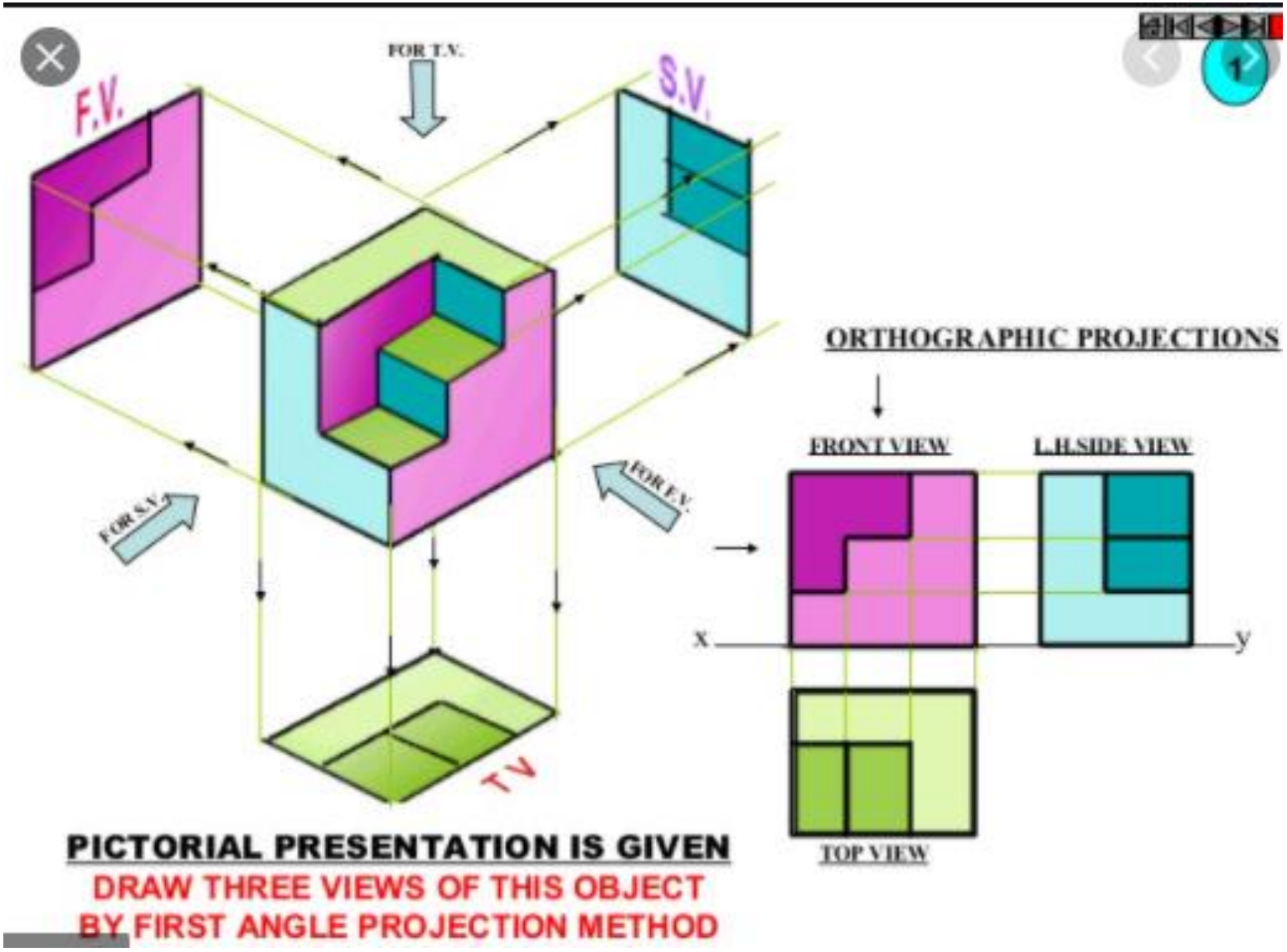
1. First angle system

- European countries
- ISO standard

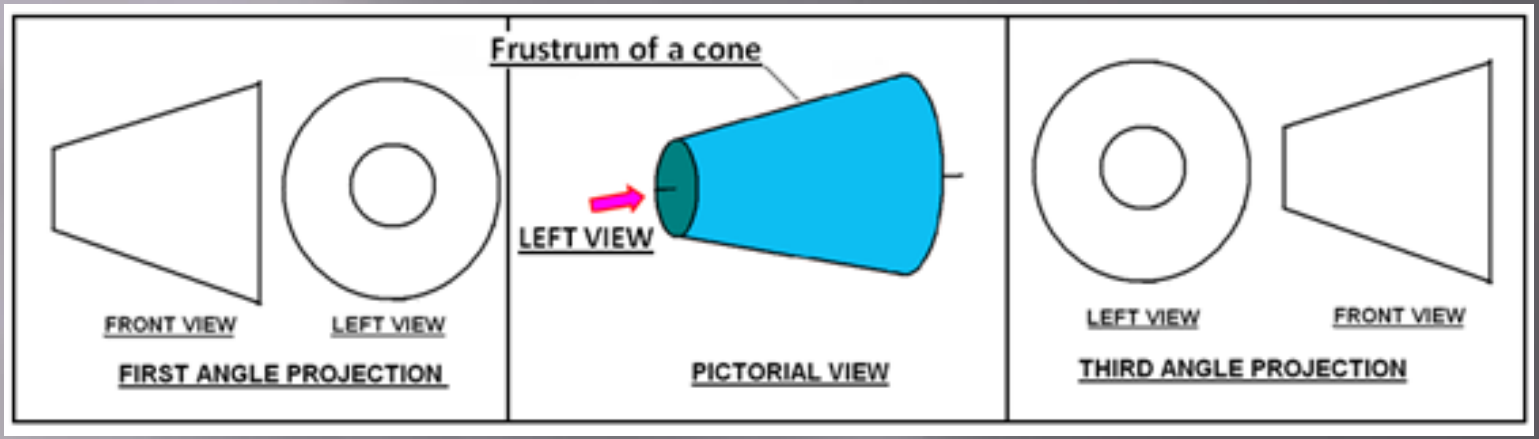
2. Third angle system

- Canada, USA, Japan, Thailand




F.V.
FOR T.V.
S.V.
FOR S.V.
FOR F.V.
T.V.
ORTHOGRAPHIC PROJECTIONS
FRONT VIEW
L.H.SIDE VIEW
x
y
TOP VIEW
PICTORIAL PRESENTATION IS GIVEN
DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

Symbol of projection



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.

Orientation of Point in Space

(1)In quadrant *I (Above H.P & In Front of V.P.)*

(2) In quadrant *II (Above H.P & Behind V.P.)*

(3) In quadrant *III (Below H.P & Behind V.P.)*

(4) In quadrant *IV (Below H.P & In Front of V.P.)*

Orientation of Point in Space

(5) In Plane (*Above H.P. & In V.P.*)

(6) In Plane (*Below H.P. & In V.P.*)

(7) In Plane (*In H.P. & In front of V.P.*)

(8) In Plane (*In H.P. & Behind V.P.*)

(9) In Plane (*In H.P. & V.P.*)

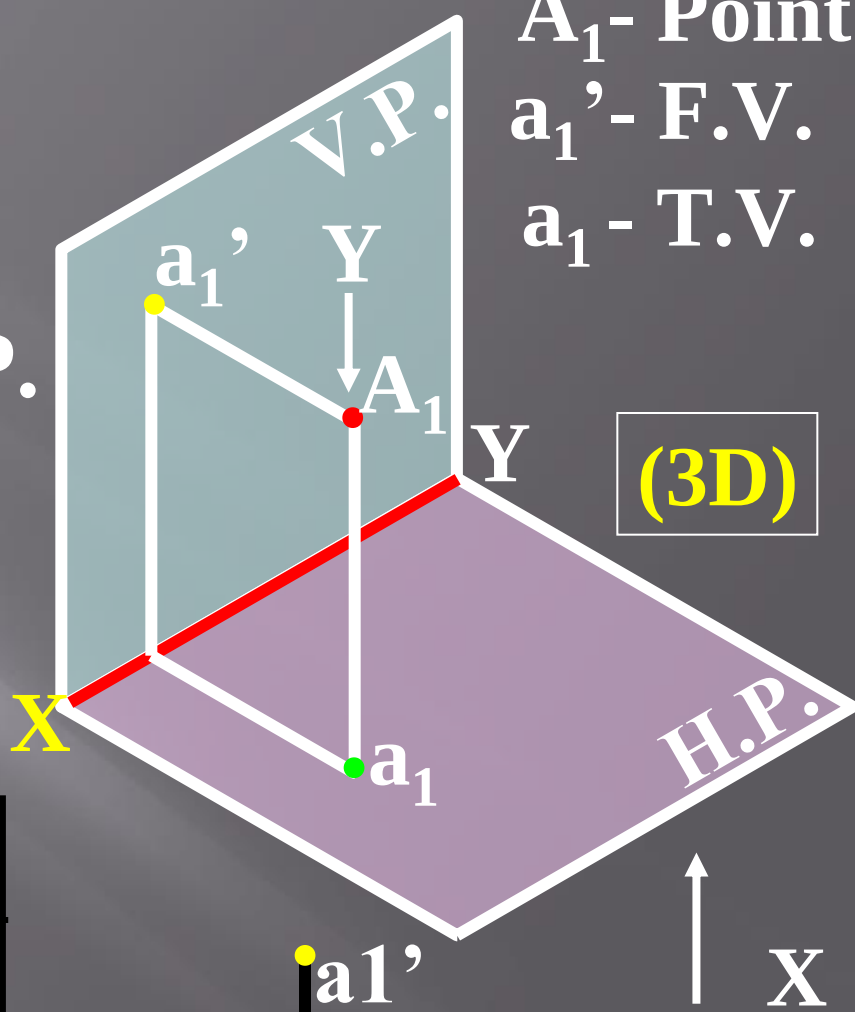
(6) In Plane (*Below H.P. & In V.P.*)

Position: 1 (I Qua.)

Point A_1

- Above H.P.
- In Front Of V.P.

A_1- Point
a_1'- F.V.
a_1 - T.V.



(3D)

CONCLUSIONS:

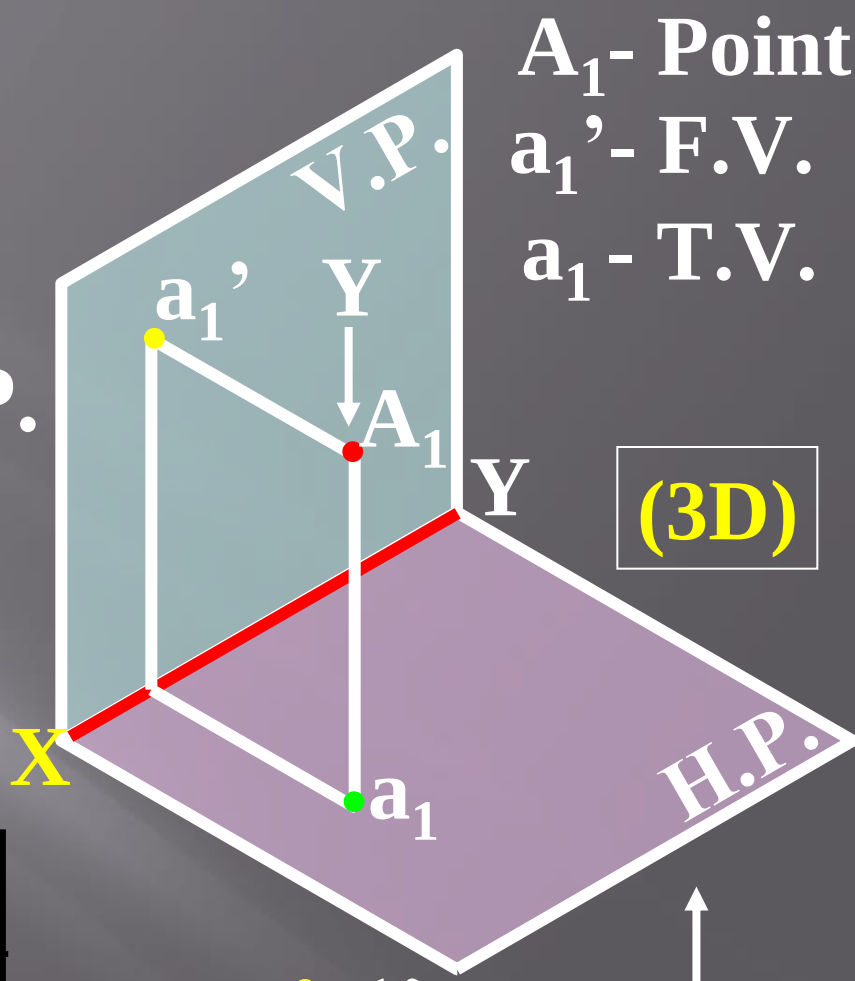
In 3D	In 2D
Point, Above H.P.	F.V. Above XY
Point, In-Front Of V.P.	T.V. Below XY

(2D)

POSITION: 1 (I Qua.)

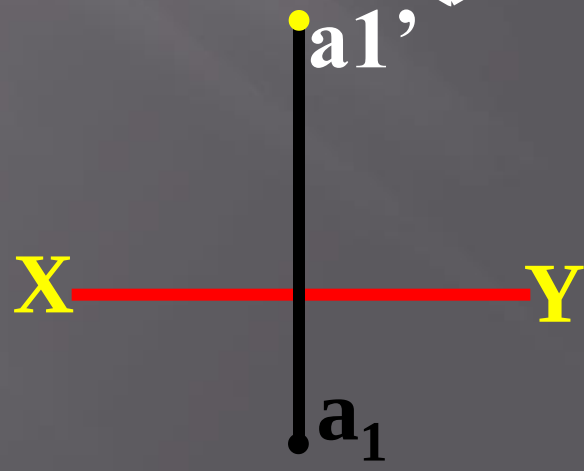
POINT A_1

- Above H.P.
- In Front Of V.P.



CONCLUSIONS:

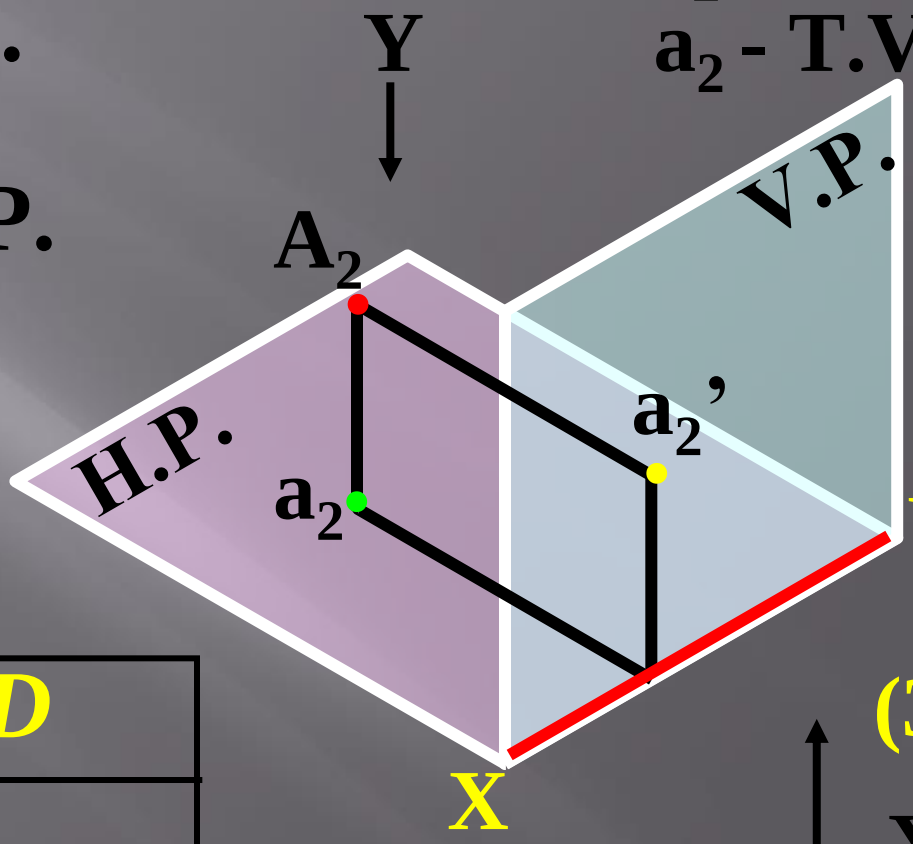
In 3D	*In 2D*
Point, Above H.P.	F.V. Above XY
Point, In-Front Of V.P.	T.V. Below XY



POSITION:2 (II Qua.)

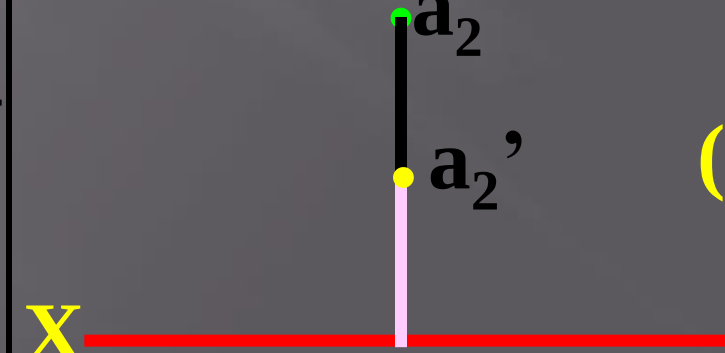
POINT A_2
- Above H.P.
- Behind V.P.

A_2- Point
a_2'- F.V.
a_2 - T.V.



(3D)

X



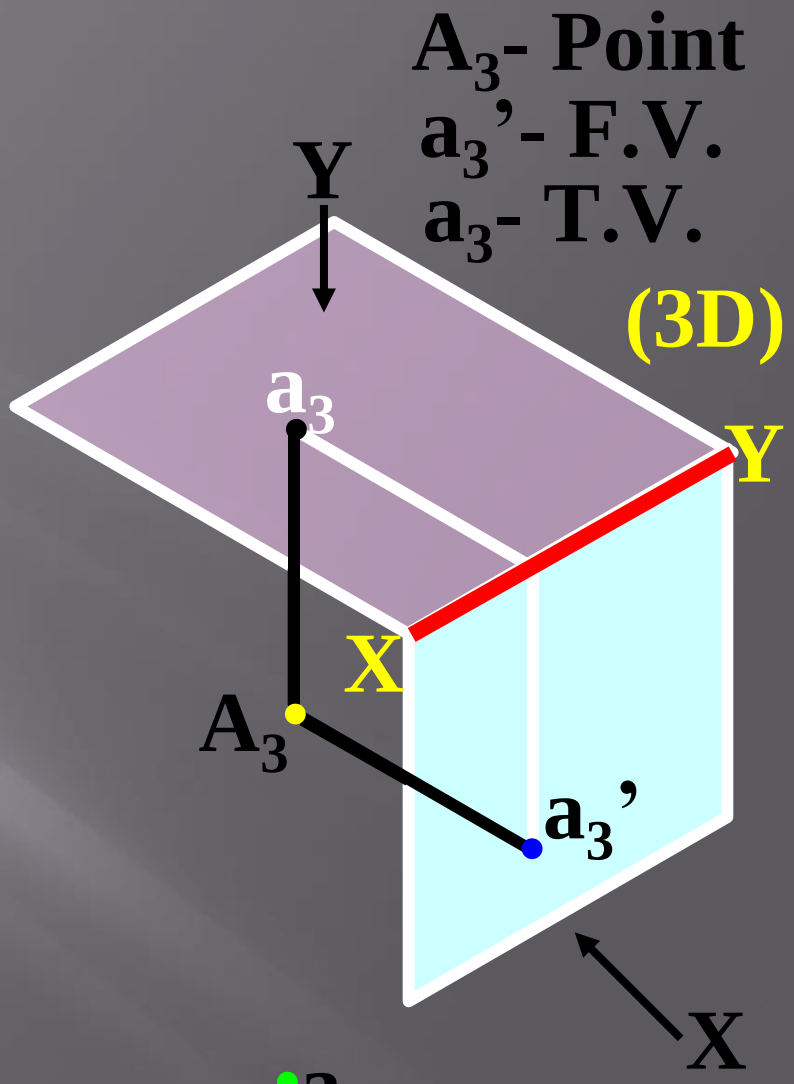
(2D)

CONCLUSIONS:

In 3D	In 2D
Point, Above H.P.	F.V. Above XY
Point, Behind V.P.	T.V. Above XY

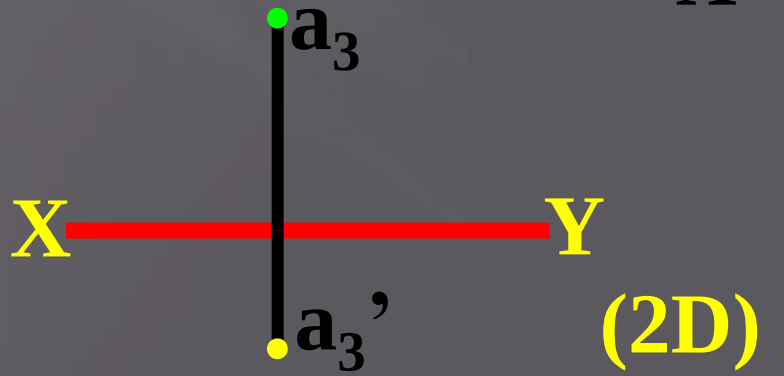
POSITION: 3 (III Qua.)

POINT A_3
- Below H.P.
- Behind V.P.



CONCLUSIONS:

In 3D	In 2D
Point, Below H.P.	F.V. Below XY
Point Behind V.P.	T.V. Above XY

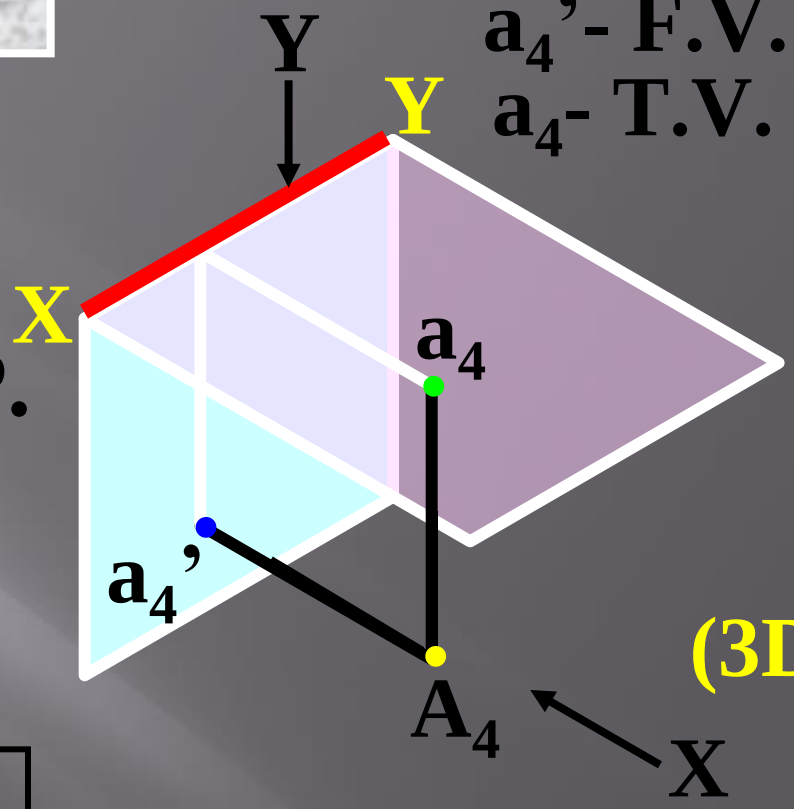


POSITION: 4 (IV Qua.)

POINT A_4

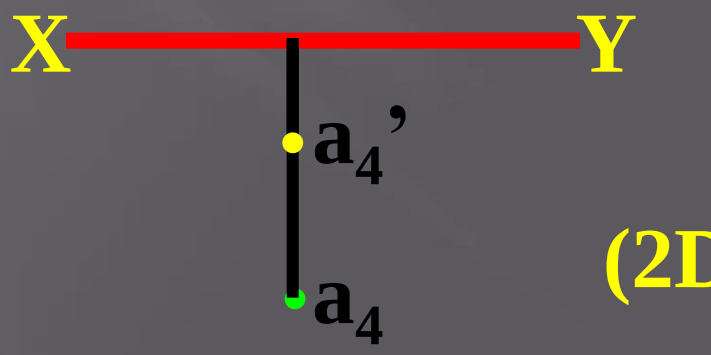
- Below H.P.
- In Front of V.P.

A_4- Point
a_4'- F.V.
a_4- T.V.



CONCLUSIONS:

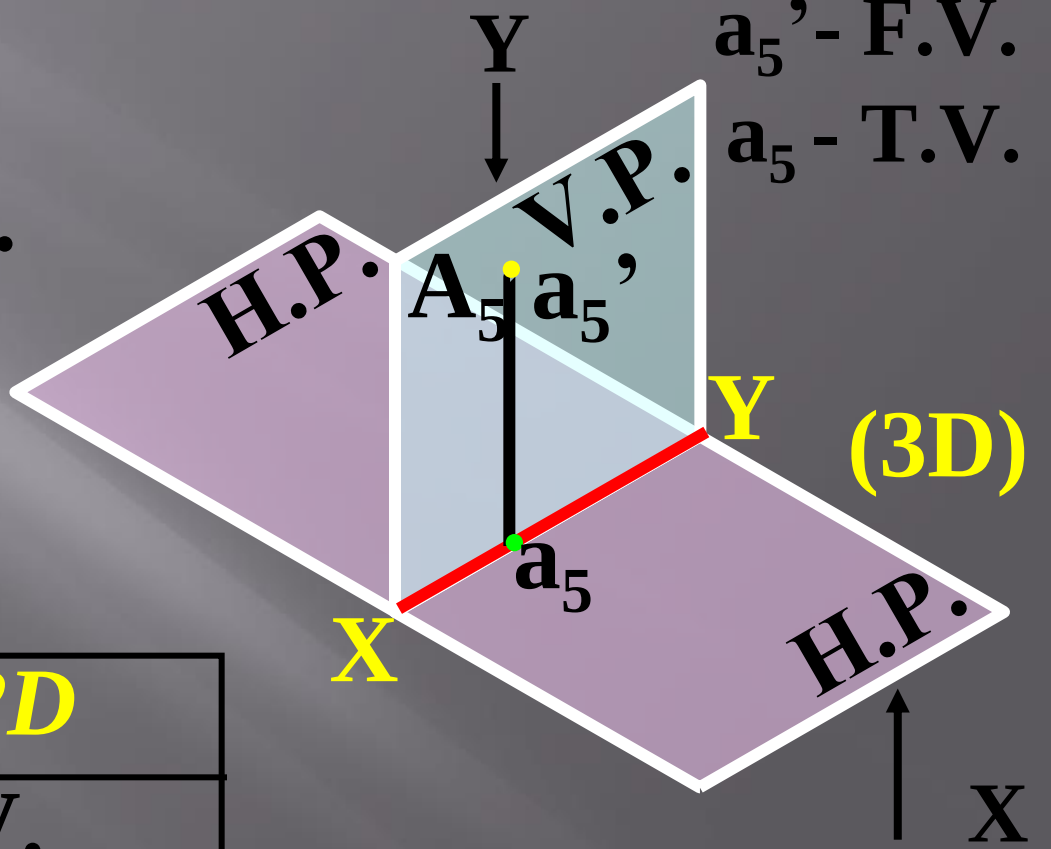
In 3D	In 2D
Point, Below H.P.	F.V. Below XY
Point, In Front Of V.P.	T.V. Below XY



POSITION: 5

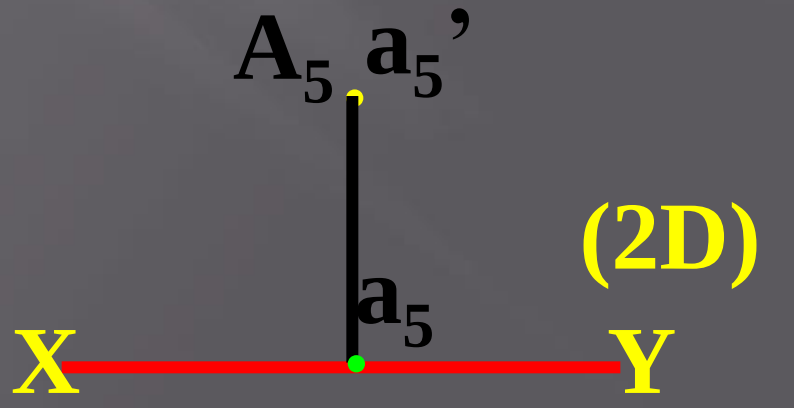
POINT A_5
- Above H.P.
- In V.P.

A_5- Point
a_5'- F.V.
a_5 - T.V.



CONCLUSIONS:

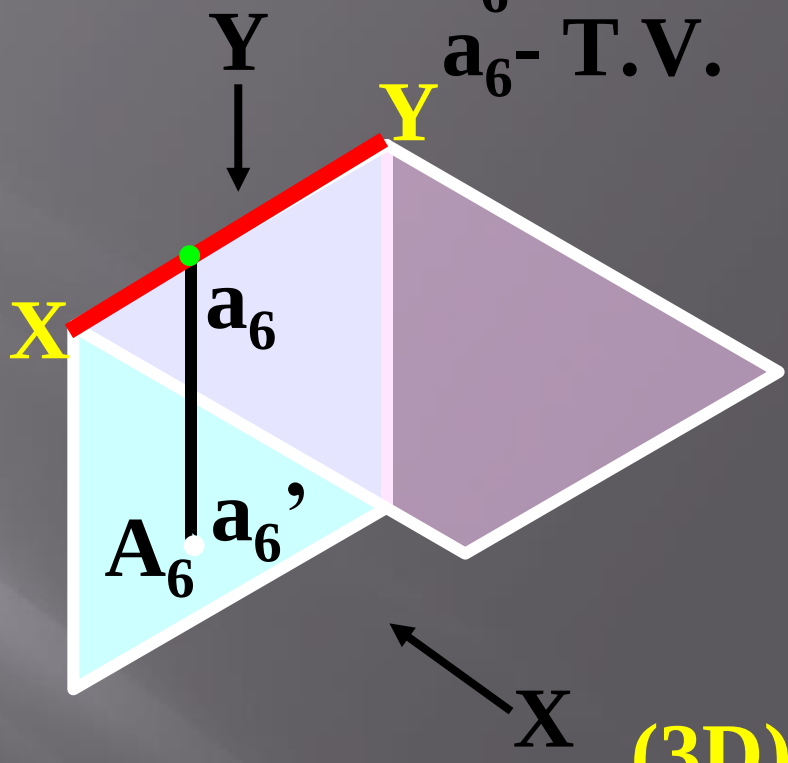
In 3D	In 2D
Point, Above H.P.	F.V. Above XY
Point, In V.P.	T.V. On XY



POSITION: 6

A_6- Point
a_6'- F.V.
a_6- T.V.

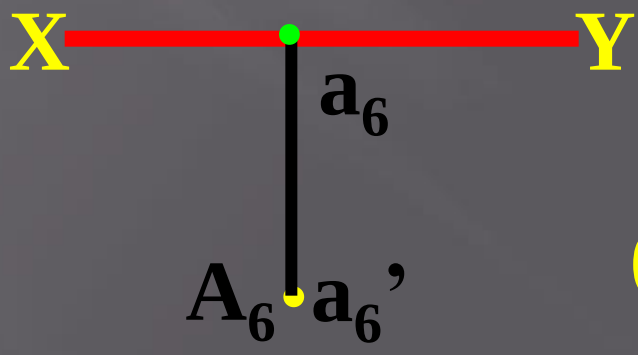
POINT A_6
- Below H.P.
- In V.P.



(3D)

CONCLUSIONS:

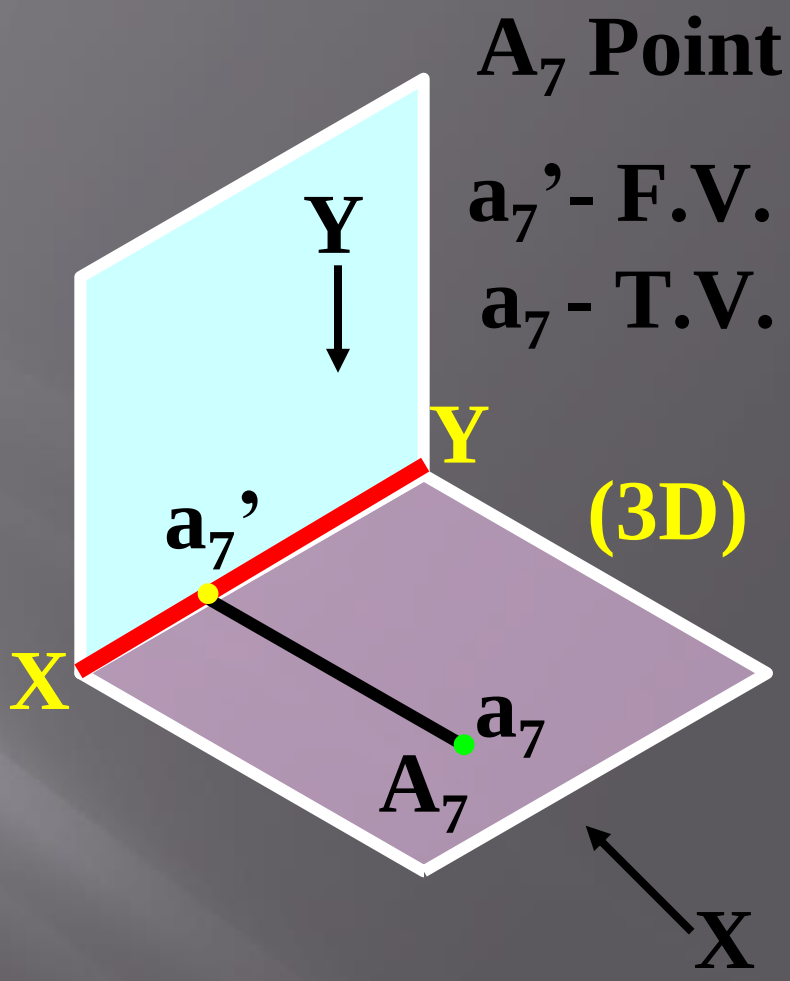
In 3D	In 2D
Point, Below H.P.	F.V. Below XY
Point In V.P.	T.V. On XY



(2D)

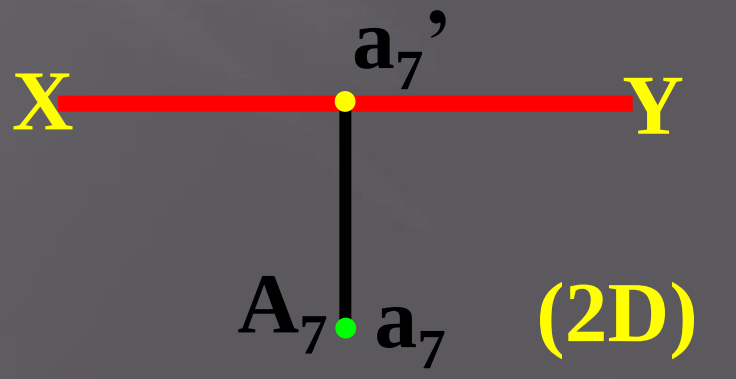
POSITION: 7

POINT A_7
- In H.P.
- In Front of V.P.



CONCLUSIONS:

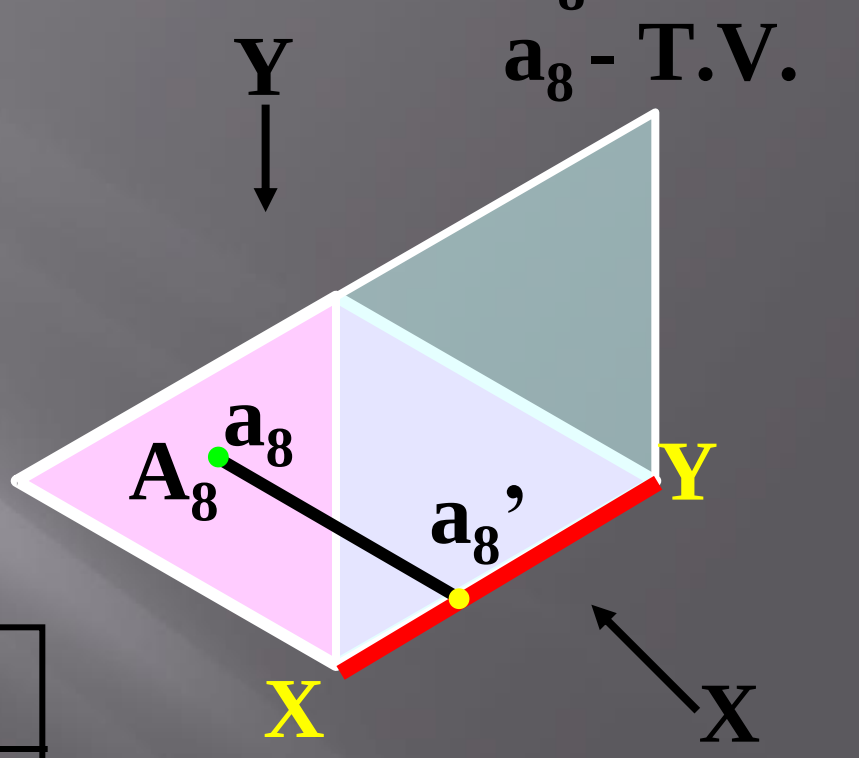
In 3D	*In 2D*
Point, In-Front Of V.P.	T.V. Below XY
Point In H.P.	F.V. On XY



POSITION: 8

A_8- Point
a_8'- F.V.
a_8 - T.V.

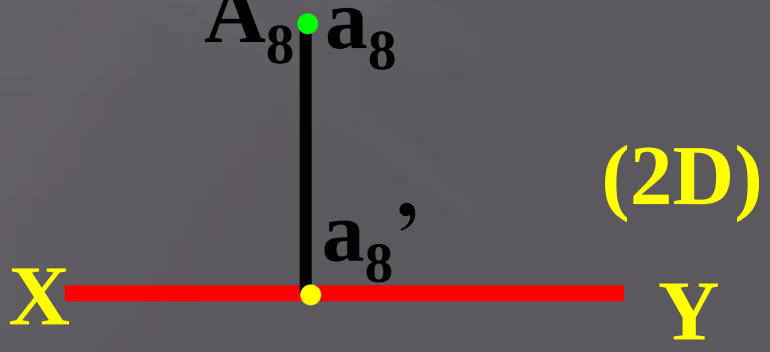
POINT A_8
- In H.P.
- Behind V.P.



(3D)

CONCLUSIONS:

In 3D	In 2D
Point, Behind V.P.	T.V. Above XY
Point, In H.P.	F.V. On XY



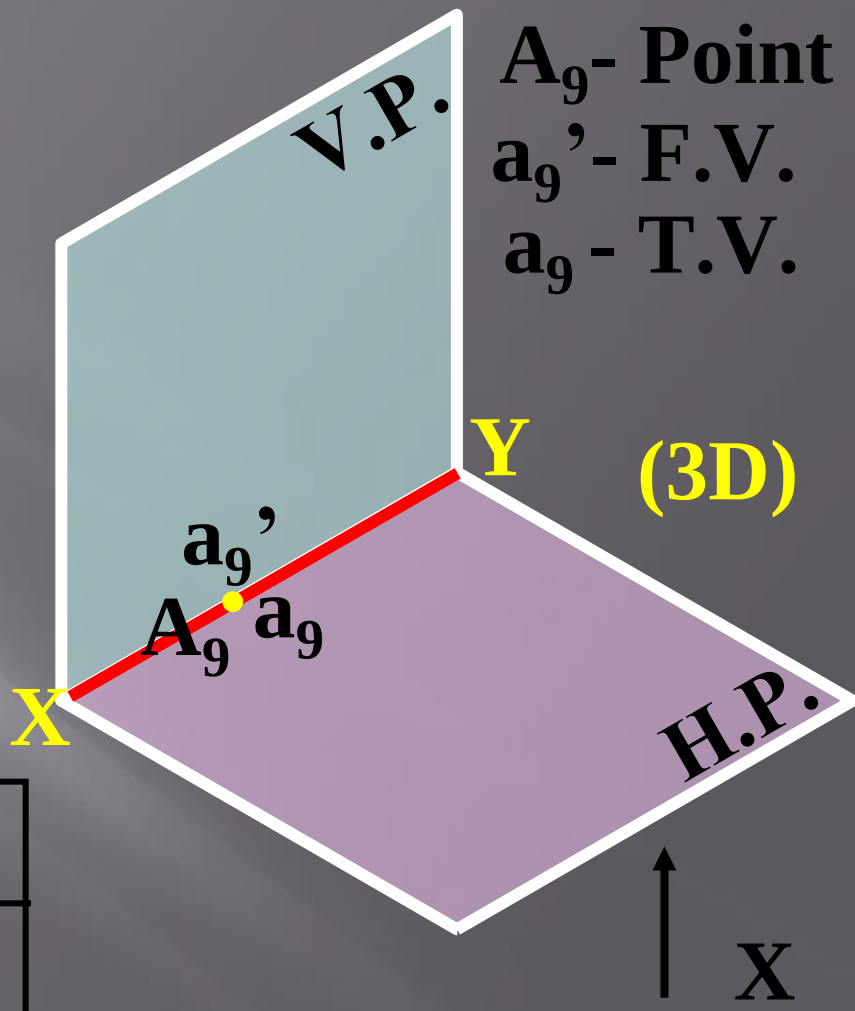
(2D)

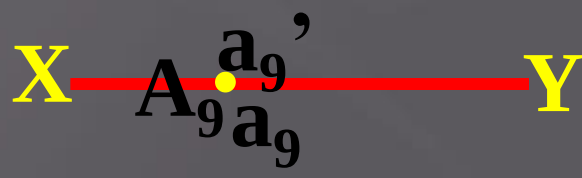
POSITION: 9

POINT A_9
- In H.P
- In V.P.

CONCLUSIONS:

In 3D	In 2D
Point, In H.P.	F.V. On XY
Point, In V.P.	T.V. On XY





(2D)

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 & // TO VP)**

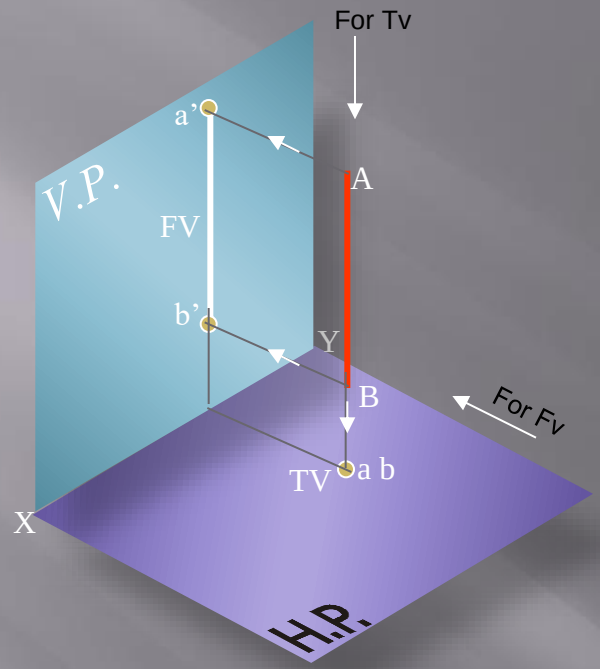
1. **LINE PARALLEL TO BOTH HP & VP.**

1. **LINE INCLINED TO HP & PARALLEL TO VP.**

1. **LINE INCLINED TO VP & PARALLEL TO HP.**

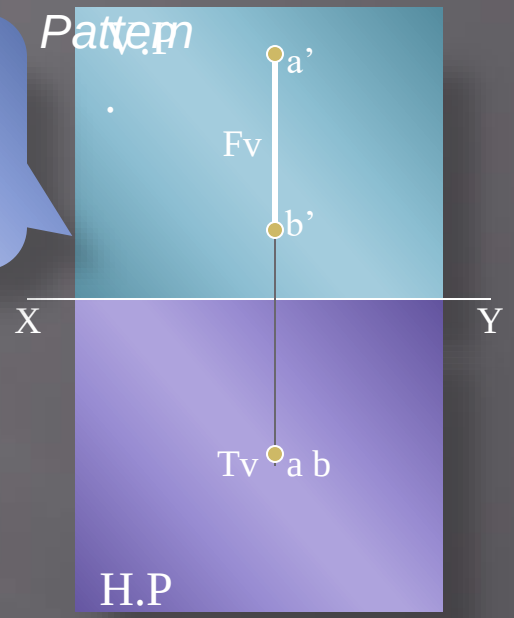
1

A Line perpendicular to Hp & // to Vp



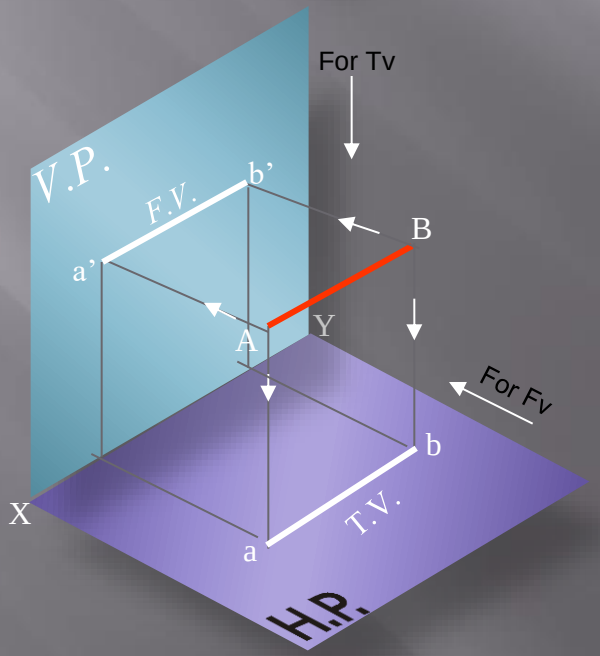
Fv is a vertical line Showing True Length & Tv is a point.

Orthographic Pattern



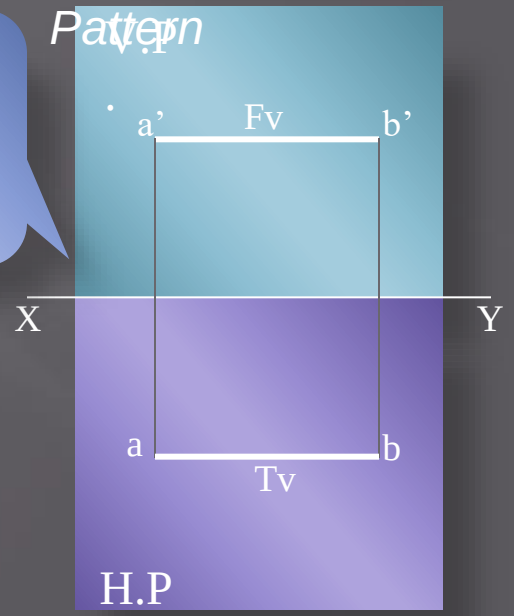
2

A Line // to Hp & // to Vp



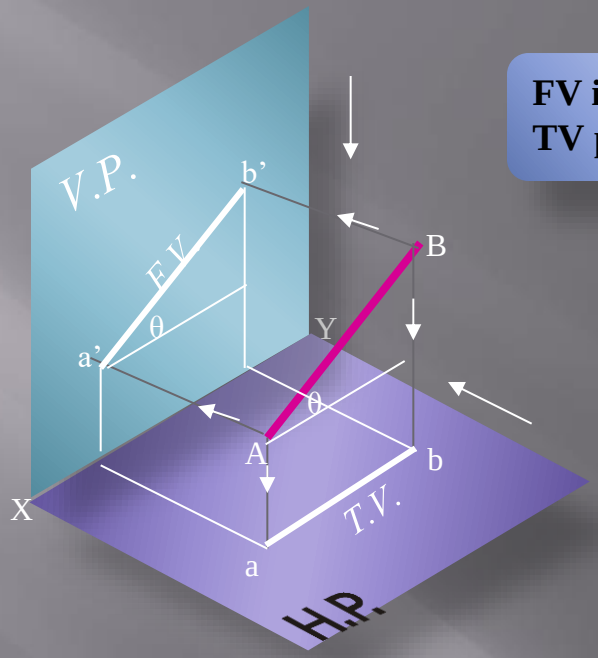
Fv & Tv both are // to xy & both show T. L.

Orthographic Pattern

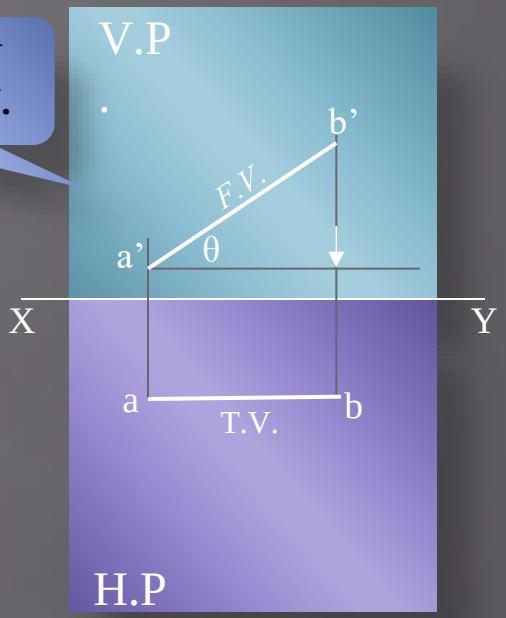


3

A Line inclined to Hp and parallel to Vp



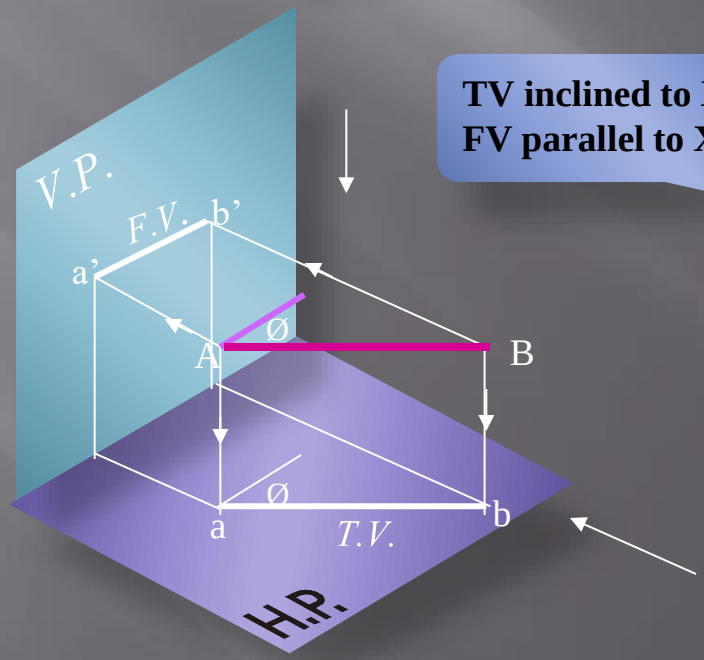
FV inclined to XY
TV parallel to XY.



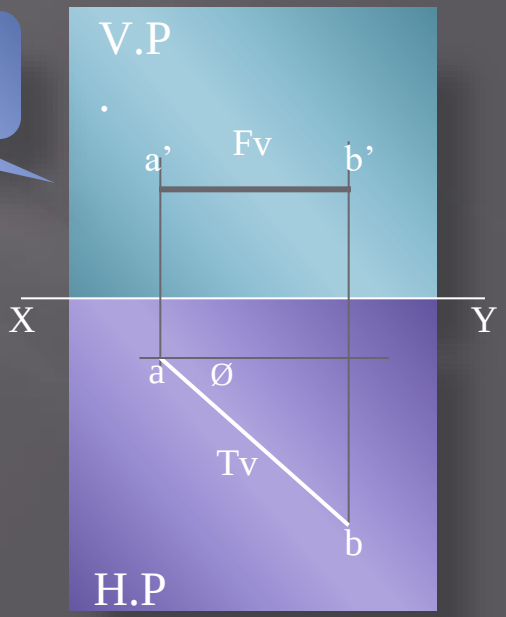
Orthographic Projections

4

A Line inclined to Vp and parallel to Hp



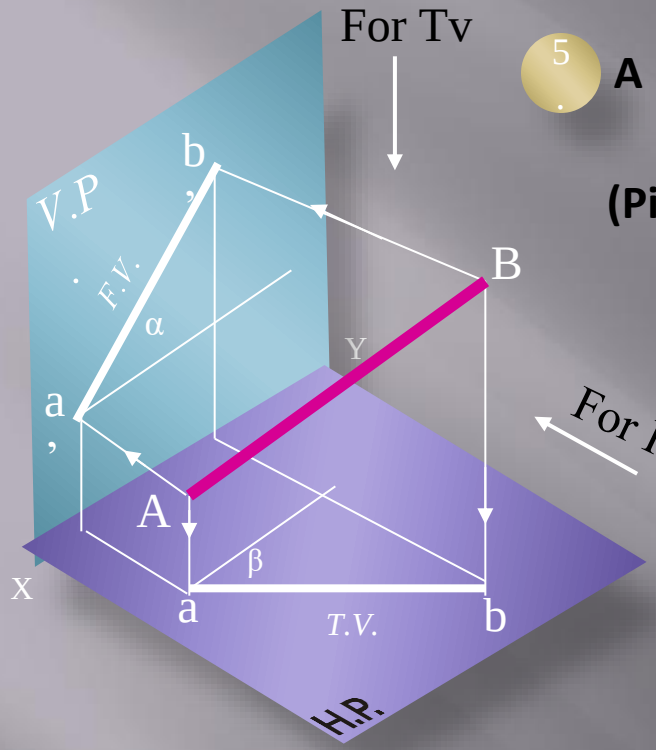
TV inclined to XY
FV parallel to XY.



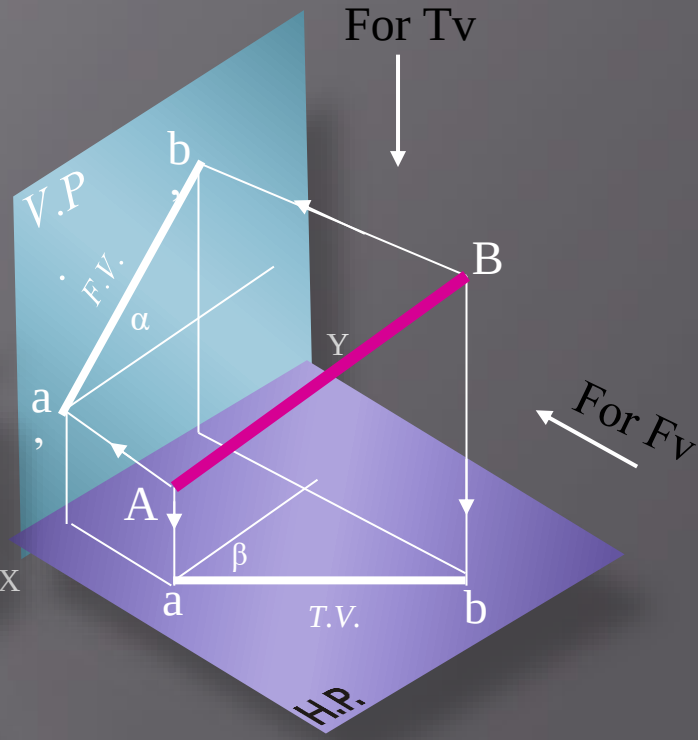
5.

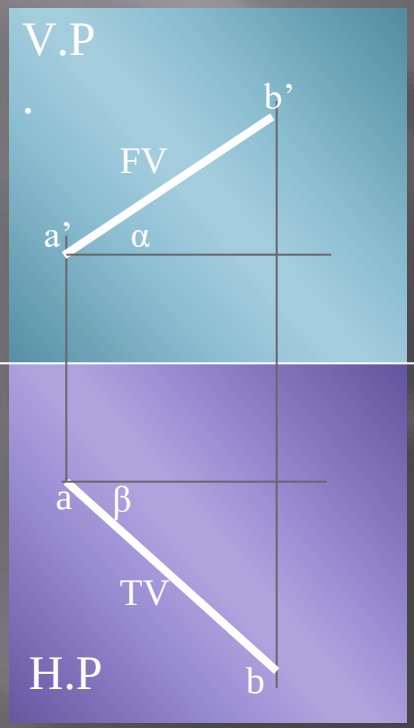
A Line inclined to both Hp and Vp

(Pictorial presentation)



On removal of object
i.e. Line AB
Fv as a image on Vp.
Tv as a image on Hp,





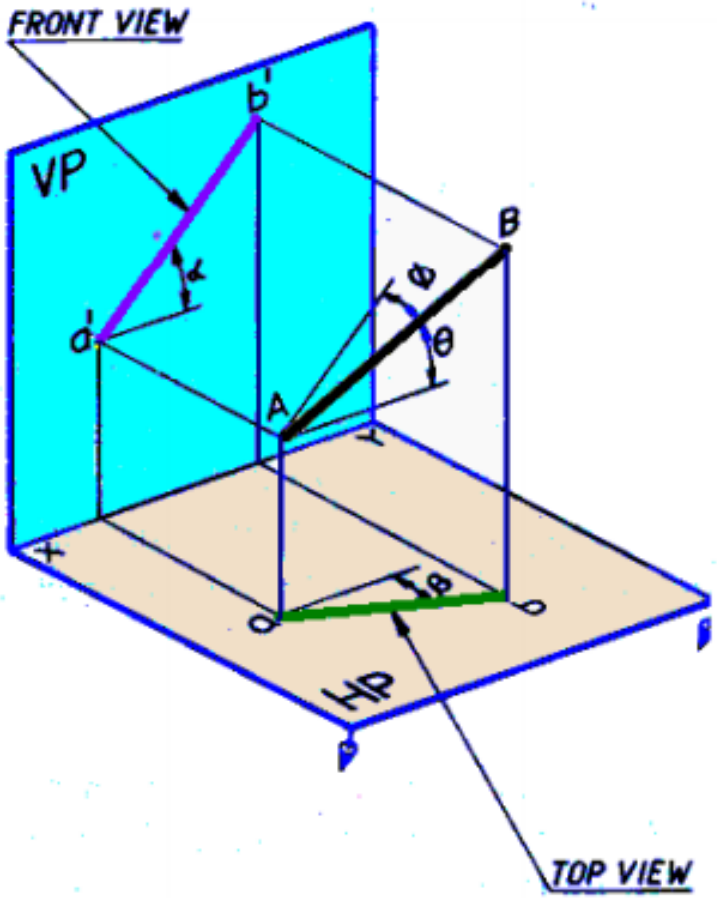
Both Fv & Tv are reduced (apparent) lengths.
α and β areApparent inclinations

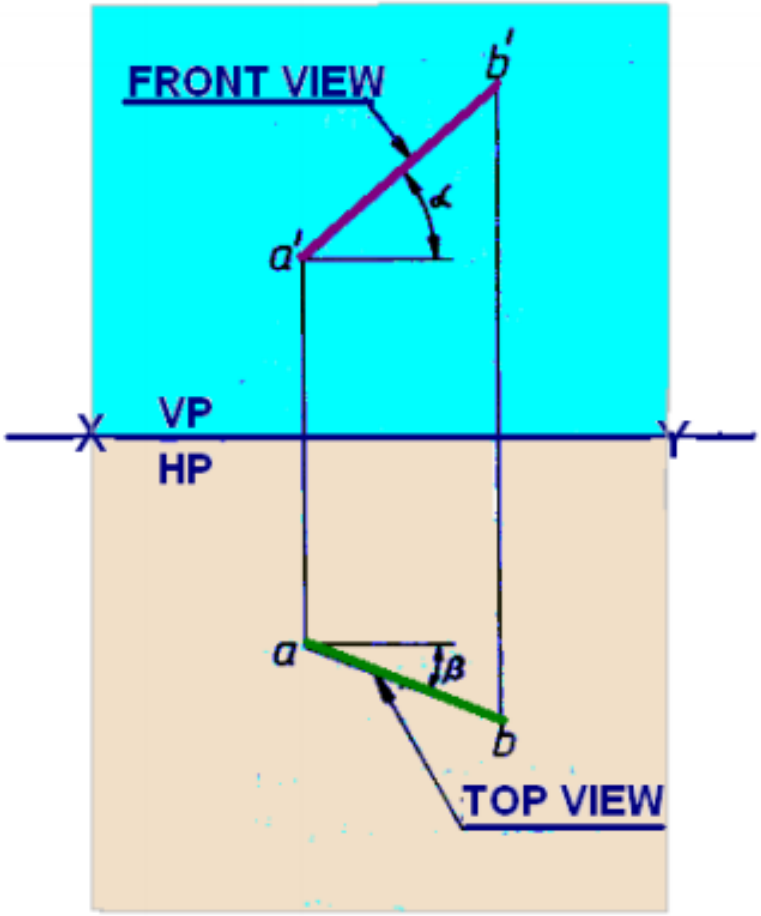
Both Fv & Tv are inclined to xy.
(No view is parallel to xy)

Line inclined to HP and VP

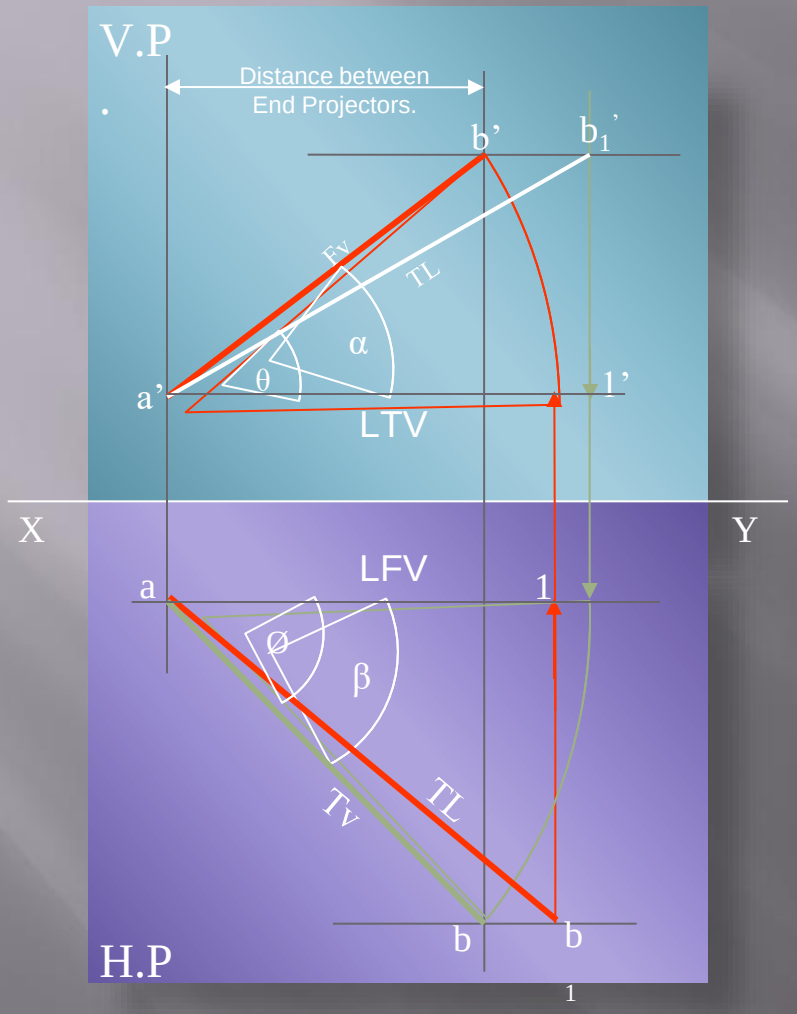
Apparent Inclinations: α and β

Apparent Lengths: ab, a´b´





The most important diagram showing graphical relations among all important parameters of this topic. Study and memorize it as a *CIRCUIT DIAGRAM* And use in solving various problems.



1) True Length (TL) – a' b_1' & a b
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 TV) – Component
7) LFV (length of FV) – Component
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

Important TEN parameters to be remembered with Notations used here onward

NOTE this

θ & α Construct with *a'*

Ø & β Construct with *a*

b' & b_1' on same locus.

b & b_1 on same locus.

Also Remember

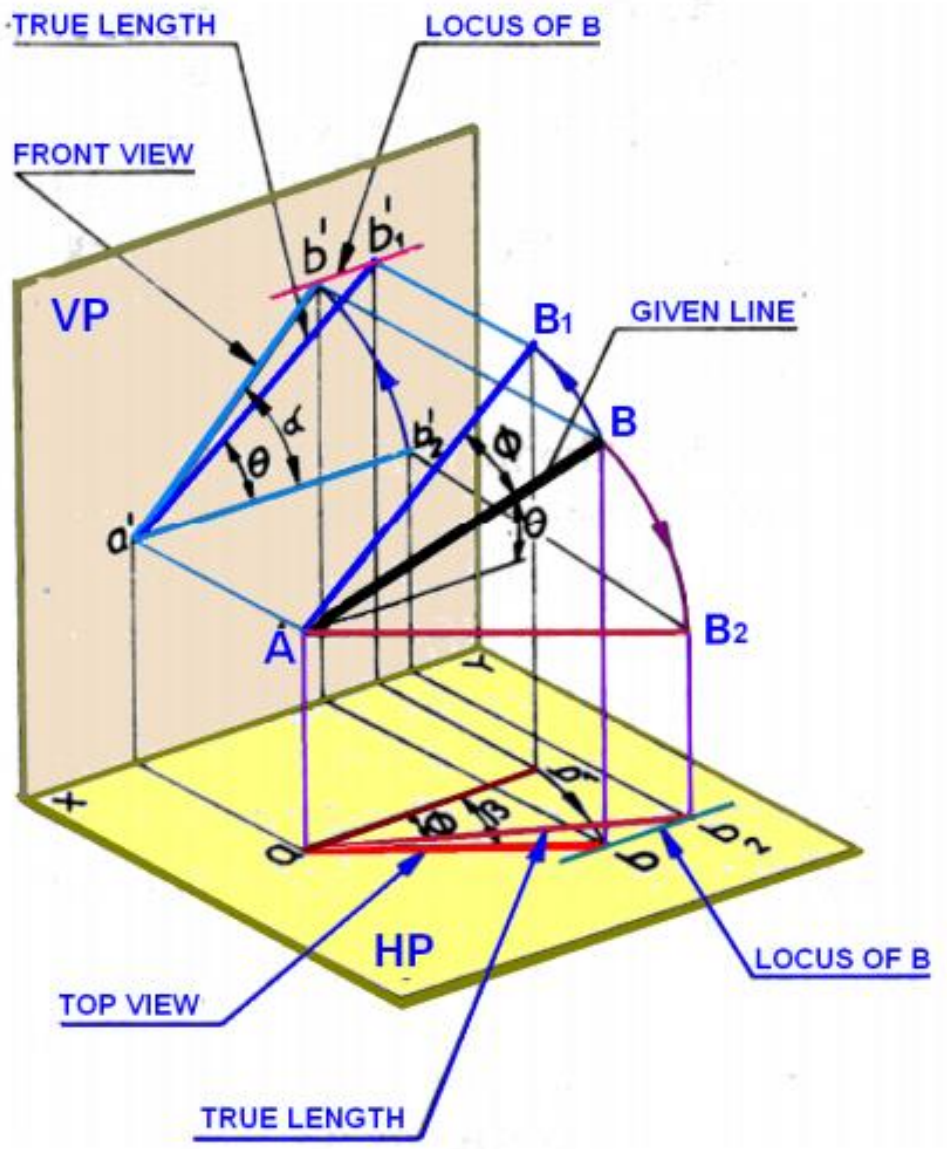
True Length is never rotated. It's horizontal component is drawn & it is further rotated to locate view.

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

Line inclined to HP and VP…….

Draw the projections of a line AB inclined to both HP and VP, whose true length and true inclinations and locations of one of the end points, say A are given.

Since the line AB is inclined at θ to HP and ϕ to VP – its top view ab and the front view a´b´ are not in true lengths and they are also not inclined at angles θ to HP and ϕ to VP.



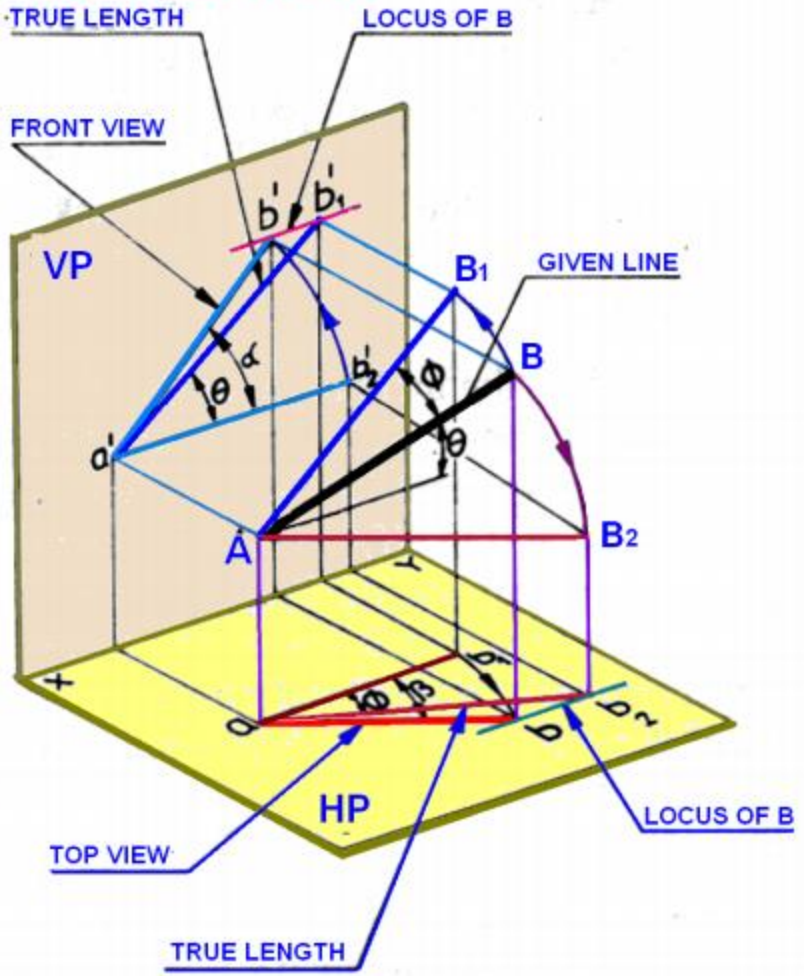
Line inclined to HP and VP…….

Step 1: Rotate the line AB to make it parallel to VP.

Rotate the line AB about the end A, keeping θ, the inclination of AB with HP constant till it becomes parallel to VP. This rotation of the line will bring the end B to the new position B1.

AB_1 is the new position of the line AB when it is inclined at θ to HP and parallel to VP.

Project AB_1 on VP and HP. Since AB_1 is parallel to VP, $a'b_1'$, the projection of AB_1 on VP is in true length inclined at θ to the XY line, and ab_1, the projection of AB_1 on HP is parallel to the XY line. Now the line is rotated back to its original position AB.



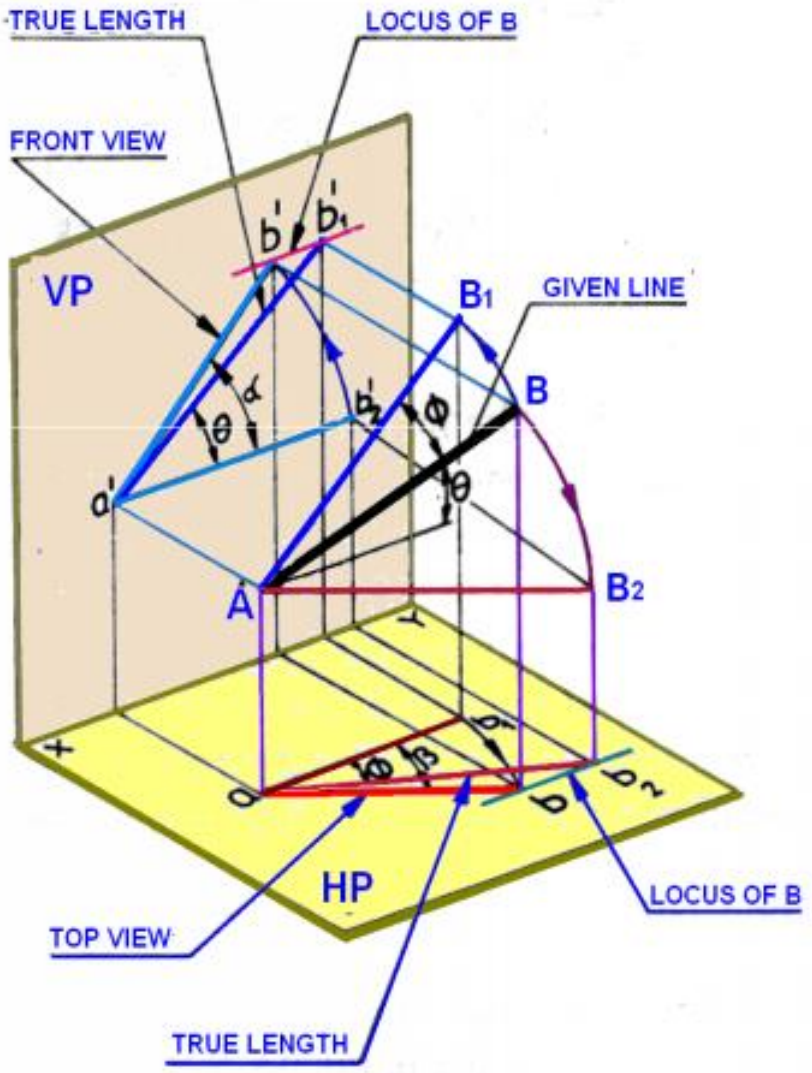
Line inclined to HP and VP…….

Step 2: Rotate the line AB to make it parallel to HP.

Rotate the line AB about the end A keeping ϕ the inclination of AB with VP constant, till it becomes parallel to HP. This rotation of the line will bring the end B to the second new Position B2.

AB_2 is the new position of the line AB, when it is inclined at ϕ to VP and parallel to HP.

Project AB2 on HP and VP. Since AB2 is parallel to HP, ab2, the projection of AB2 on HP is in true length inclined at ϕ to XY line, and $a'b_2'$ the projection of AB_2 on VP is parallel to XY line. Now the line is rotated back to its original position AB.



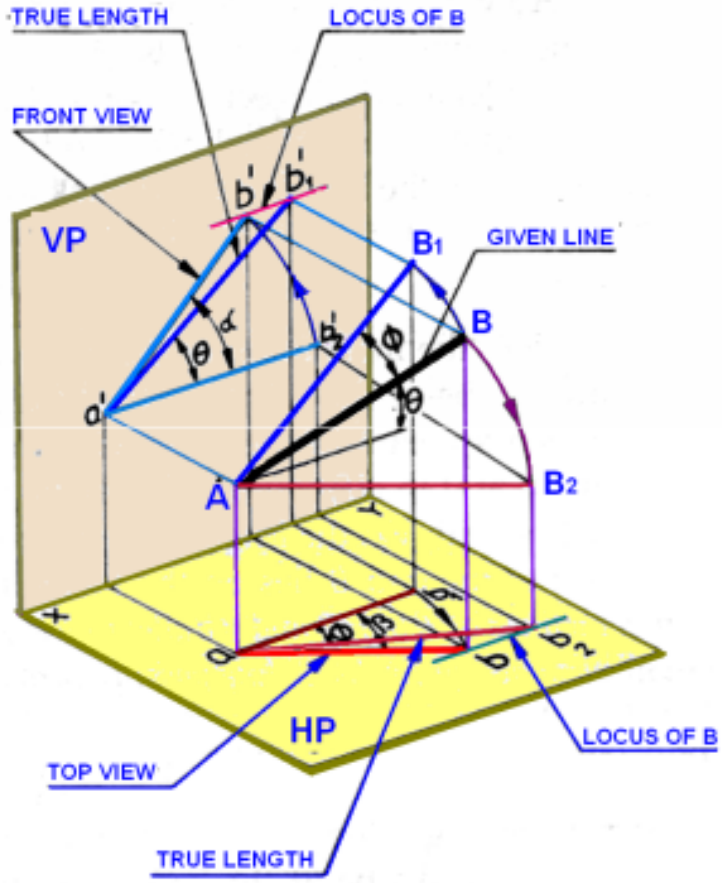
Line inclined to HP and VP…….

Step 3: Locus of end B in the front view

When the line AB is swept around about the end A keeping θ, the inclination of the line with the HP constant, by one complete rotation, the end B will always be at the same vertical height above HP, and the locus of the end B will be a circle which appears in the front view as a horizontal line passing through b'.

As long as the line is inclined at θ to HP, whatever may be the position of the line (i.e., whatever may be the inclination of the line with VP) the length of the top view will always be equal to ab1 and in the front view the projection of the end B lies on the locus line passing through b1'.

Thus ab_1, the top view of the line when it is inclined at θ to HP and parallel to VP will be equal to ab and b′, the projection of the end B in the front view will lie on the locus line



GROUP (A)

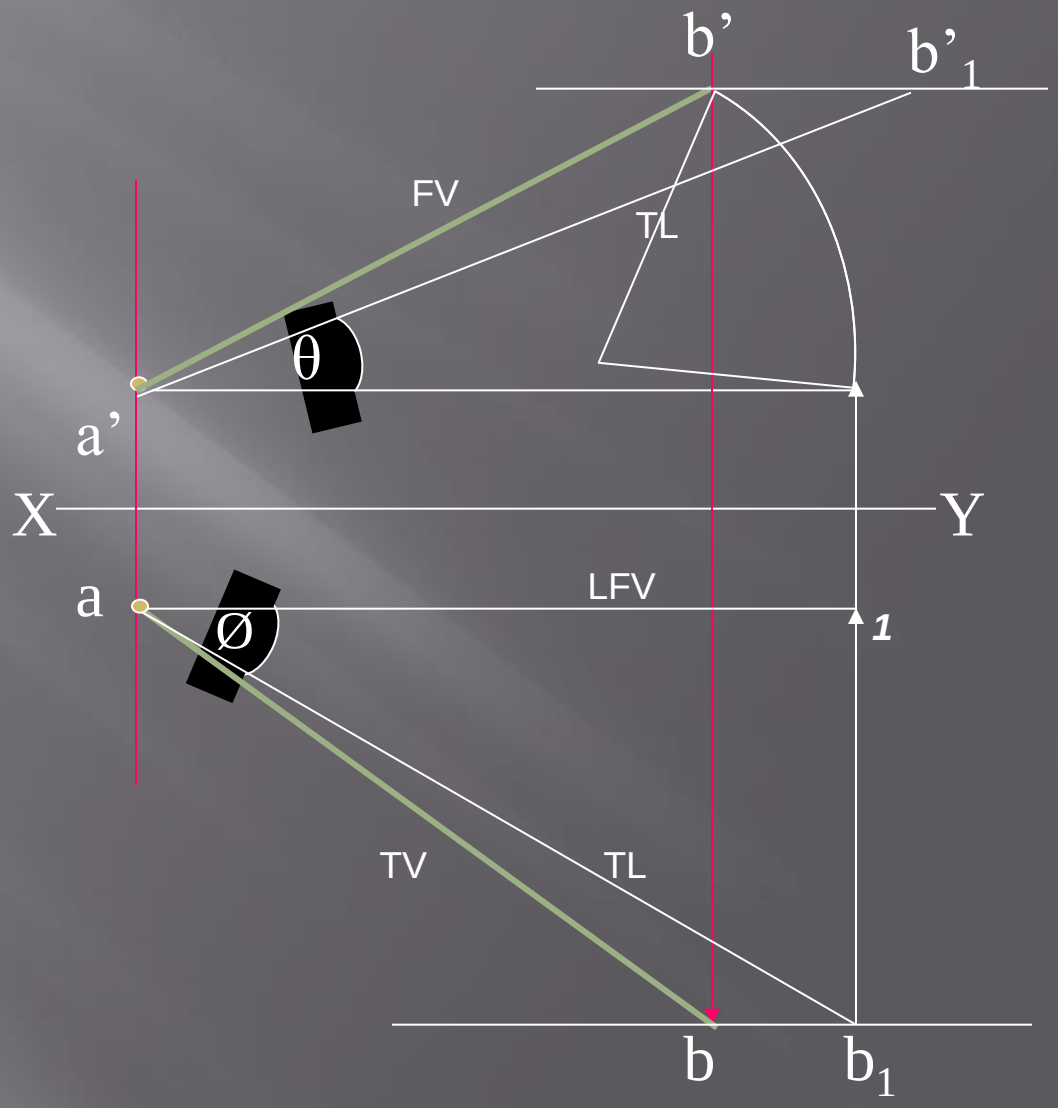
GENERAL CASES OF THE LINE INCLINED TO BOTH HP & VP (based on 10 parameters).

PROBLEM 1)

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_1 respectively.
4) Join both points with a' and a resp.
5) Draw horizontal lines (Locus) from both points.
6) 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.)
7) Extend it up to locus of a' and rotating a' as center locate b' as shown. Join a' b' as Fv.
8) From b' drop a projector down ward & get point b. Join a & b I.e. Tv.



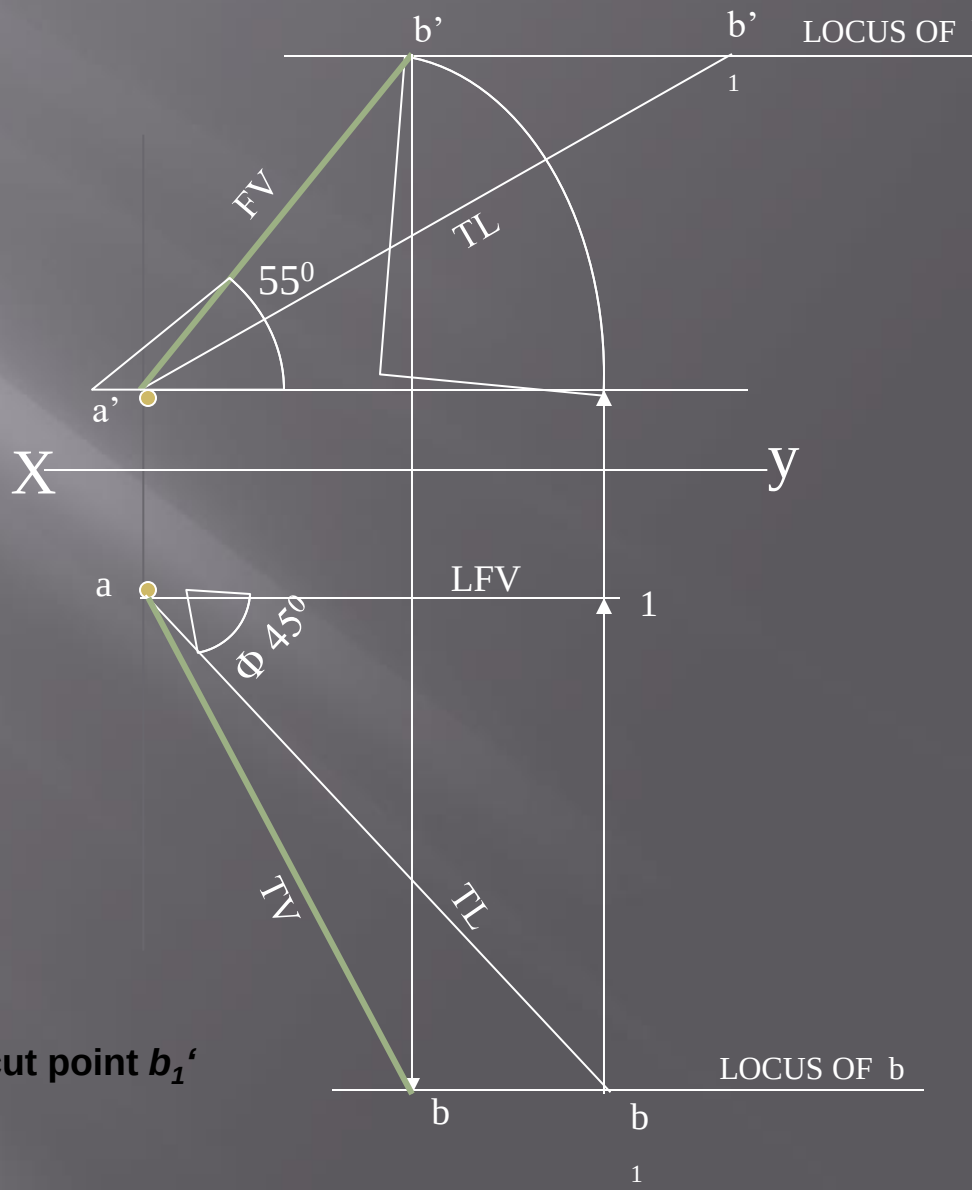
PROBLEM 2:

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 x-y line.
2. Draw one projector for a' & a
3. Locate *a'* 10mm above x-y & Tv *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 Draw locus from point b_1
5. Take 55^0 angle from *a'* for Fv above xy line.
6. Draw a vertical line from b_1 up to locus of a and name it *1*. It is horizontal component of TL & is LFV.
7. 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.
8. Drop a projector from b' on locus from point b_1 and name intersecting point *b*. Line *a b* is Tv of line AB.
9. Draw locus from *b'* and from *a'* with TL distance cut point b_1'
10. Join *a' b_1'* as TL and measure it's angle at *a'*.

It will be true angle of line with HP.

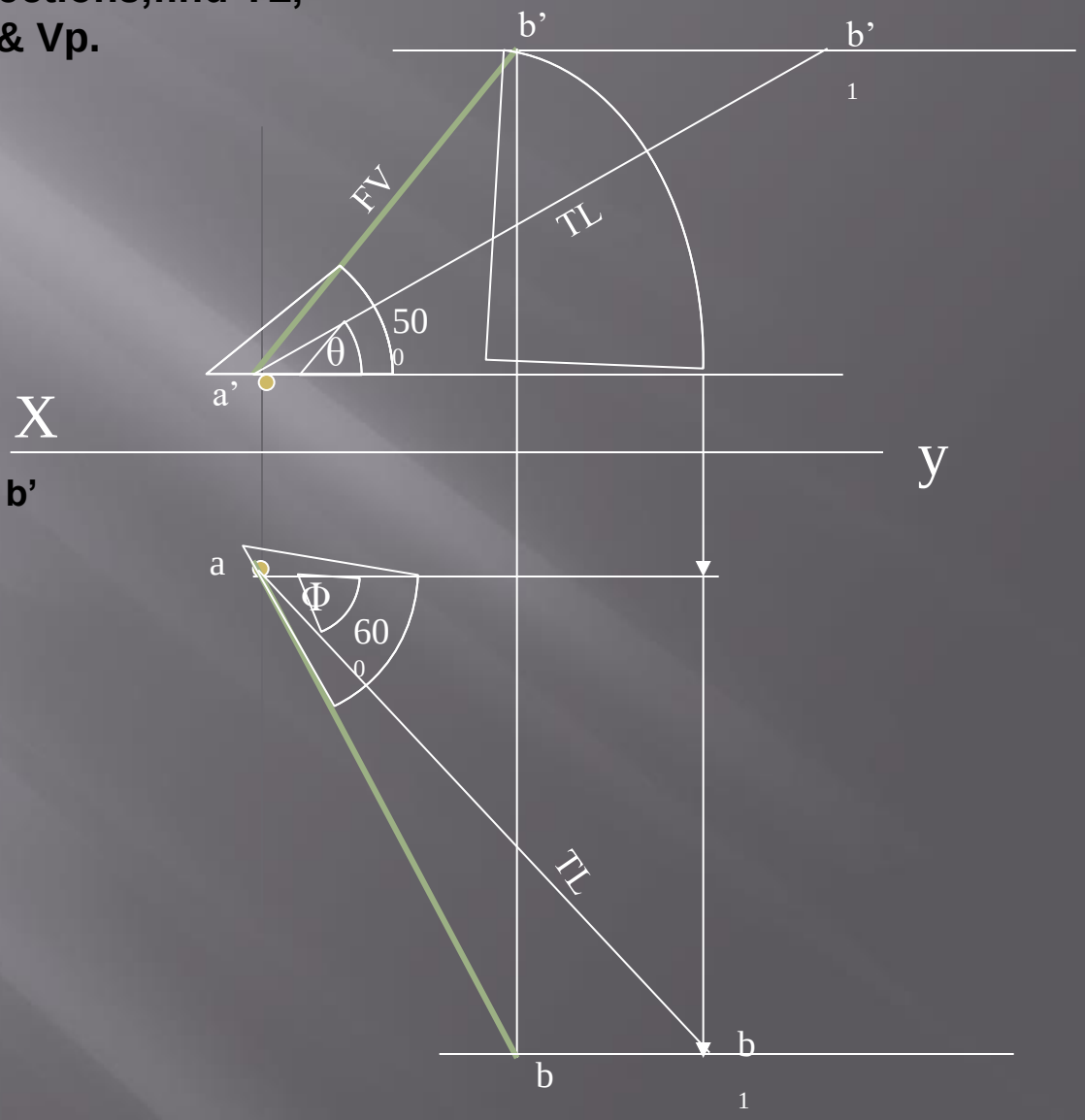


PROBLEM 3:

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 to xy from a' and mark b' Cutting 55mm on it.
5. Similarly draw Tv 60^0 to xy 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.

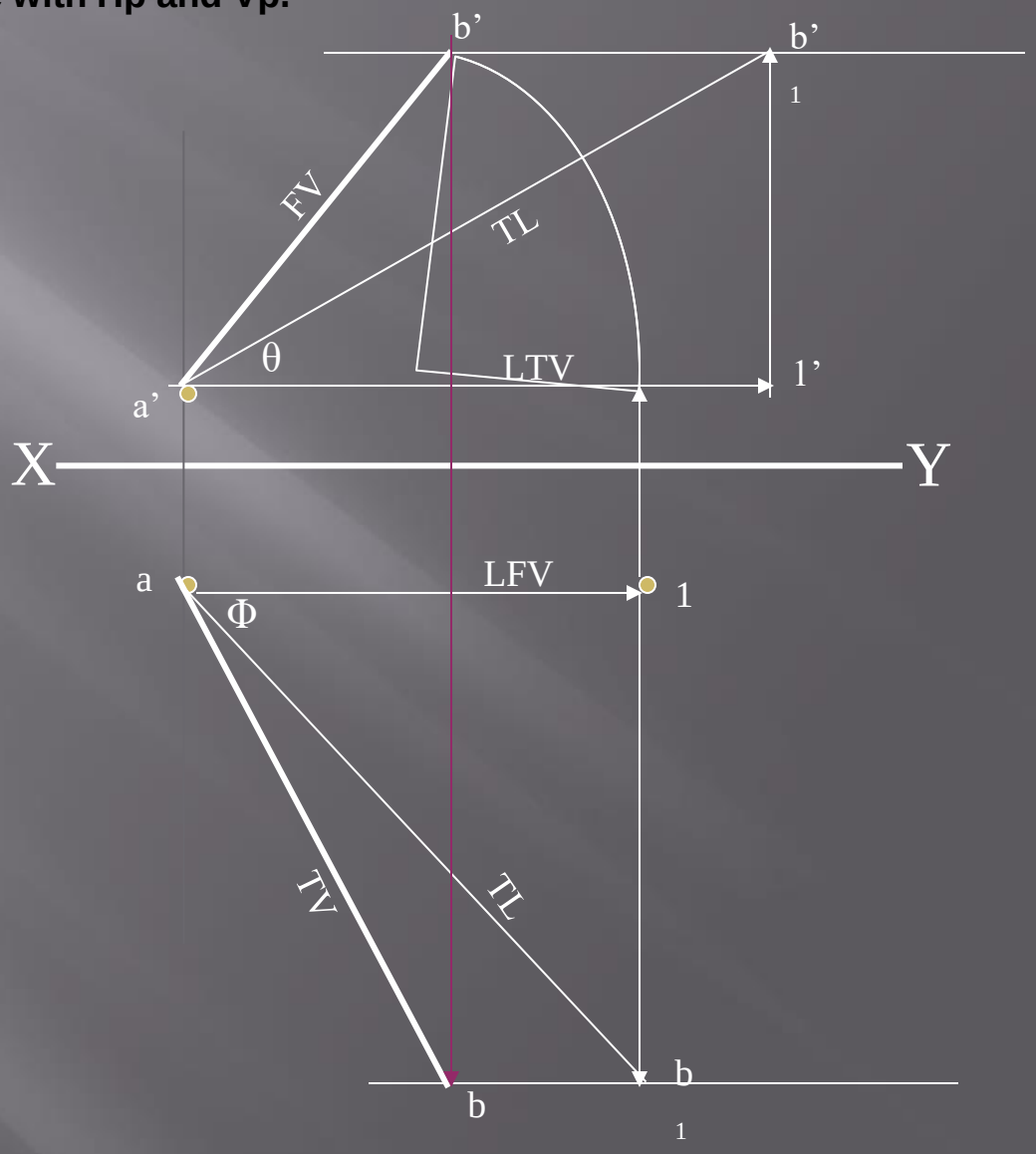


PROBLEM 4 :-

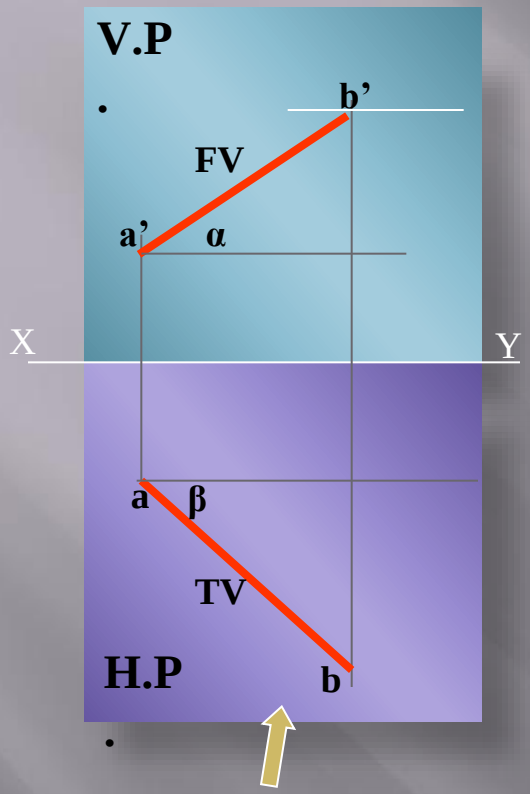
Line AB is 75 mm long .It's Fv and Tv measure 50 mm & 60 mm long respectively. End A is 10 mm above Hp and 15 mm in front of Vp. Draw projections of line AB if end B is in first quadrant.Find angle with Hp and Vp.

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 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 & Φ

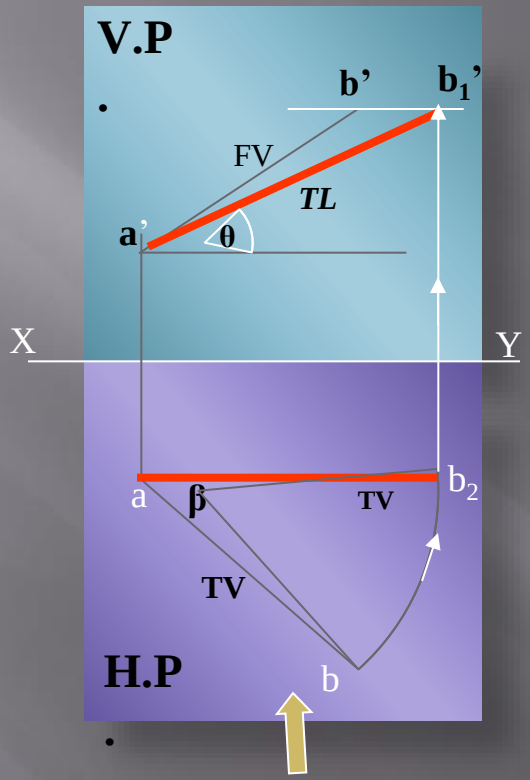


Orthographic Projections Means Fv & Tv of Line AB are shown below, with their apparent Inclinations α & β



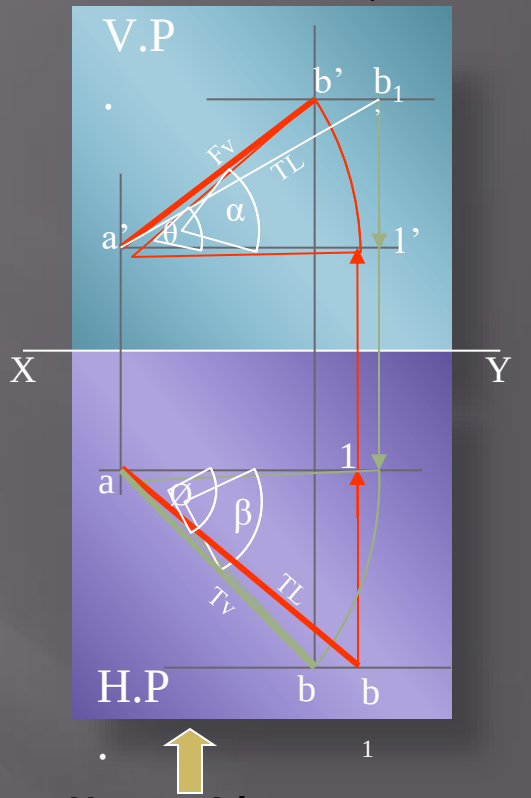
Here TV (ab) is not // to XY line Hence it's corresponding FV a' b' is not showing
True Length &
True Inclination with Hp.

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' b1' 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 ab1 gives length of Fv. Hence it is brought Up to Locus of a' and further rotated to get point b'. a' b' will be Fv.
Similarly drawing component of other TL(a' b1') Tv can be drawn.

GENERAL CASES OF THE LINE INCLINED TO BOTH HP & VP
(based on 10 parameters).

PROBLEM

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(the length a-1 gives length of Fv as we have seen already.)
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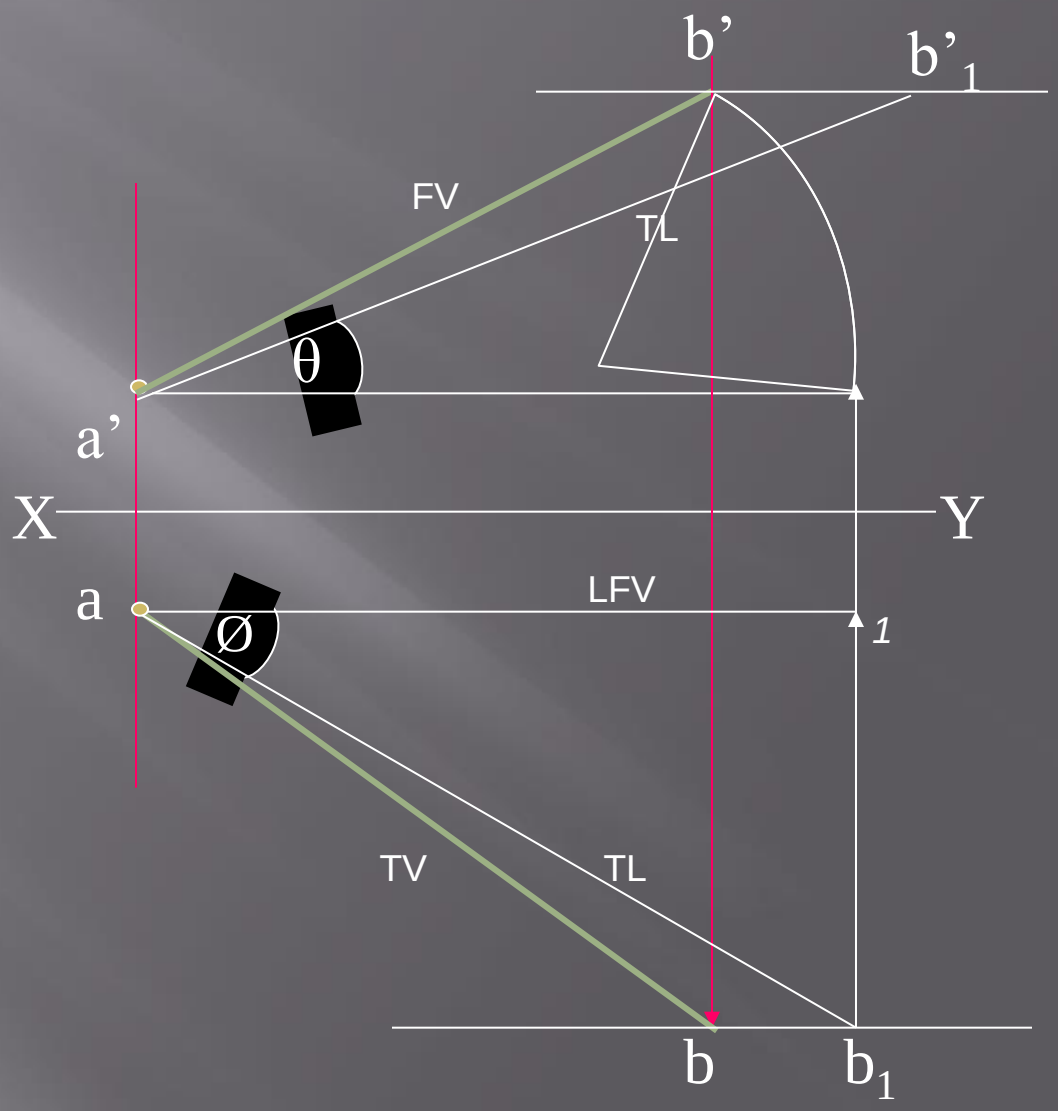

Useful Videos

- Line inclined to both HP and VP - YouTube