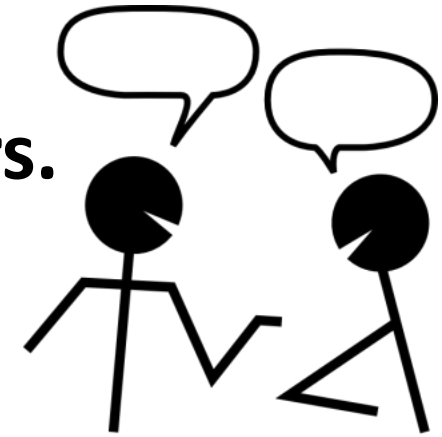
Engineering Graphics



- **Universal language for engineers.**

- **A drawing that contains all information of an object**

Drawing is important for all branches of engineering.

Roll of engineering graphics

Visualization

Ability to mentally picture things that do not exist.

Communication

The design solution should be communicated without ambiguity.

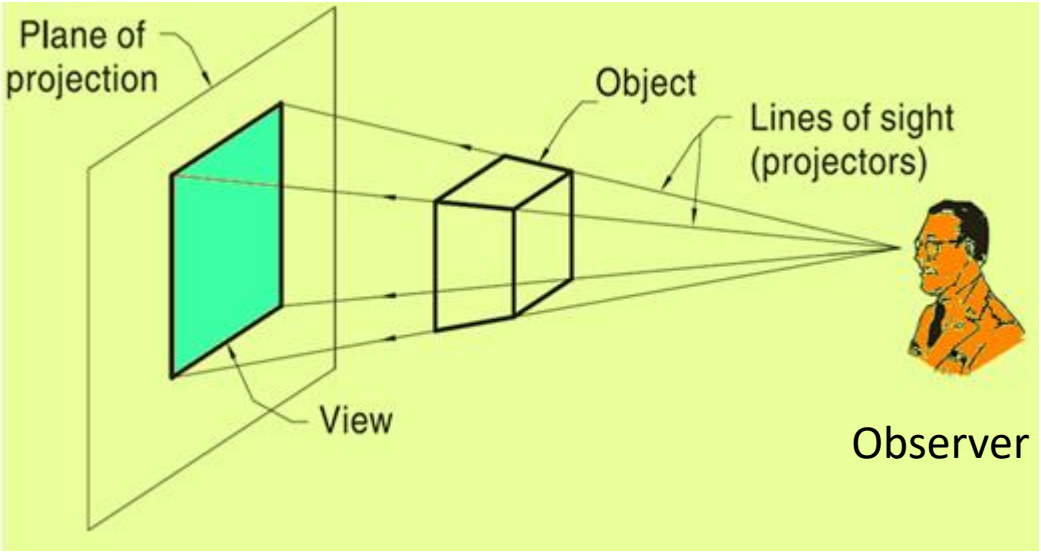
Documentation

Permanent record of the solution.

Projection theory

- 3-D objects are represented on a 2-D media.
- The act of obtaining the image of an object is termed **“projection”.**
- The image obtained by projection is known as a **“view”.**

A simple Projection system



Observer at finite distance from the object

Orthographic Projection

Lines of sight (LoS) are perpendicular to the plane of projection.

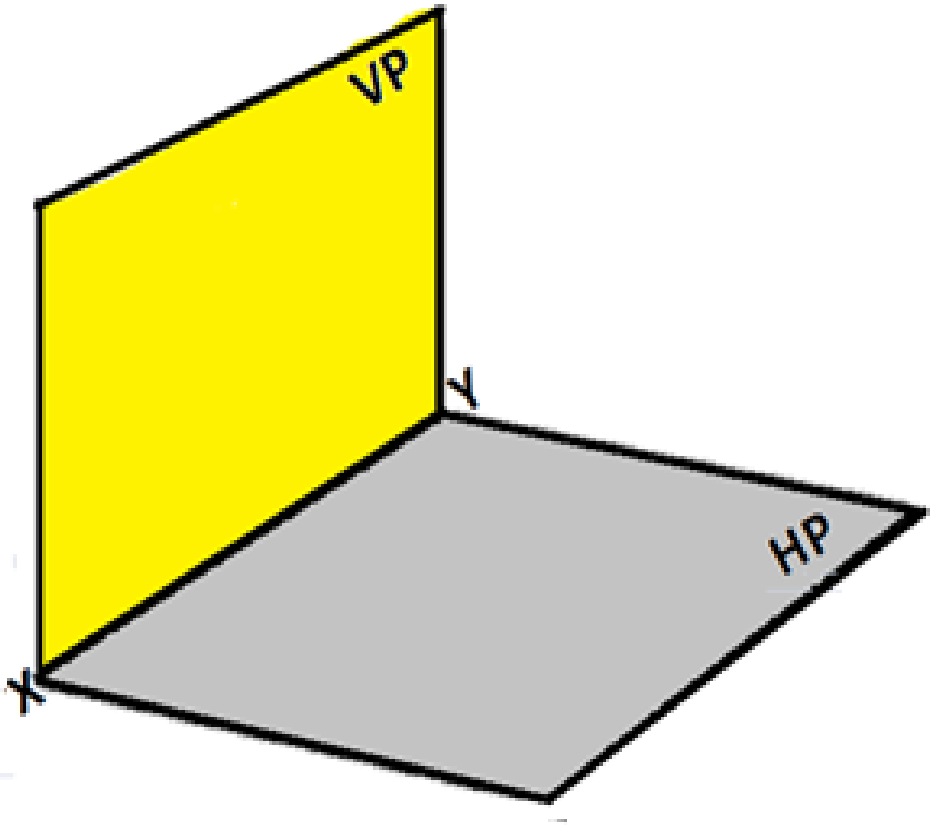
[Observer at infinite distance from the object.]

REFERENCE PLANES

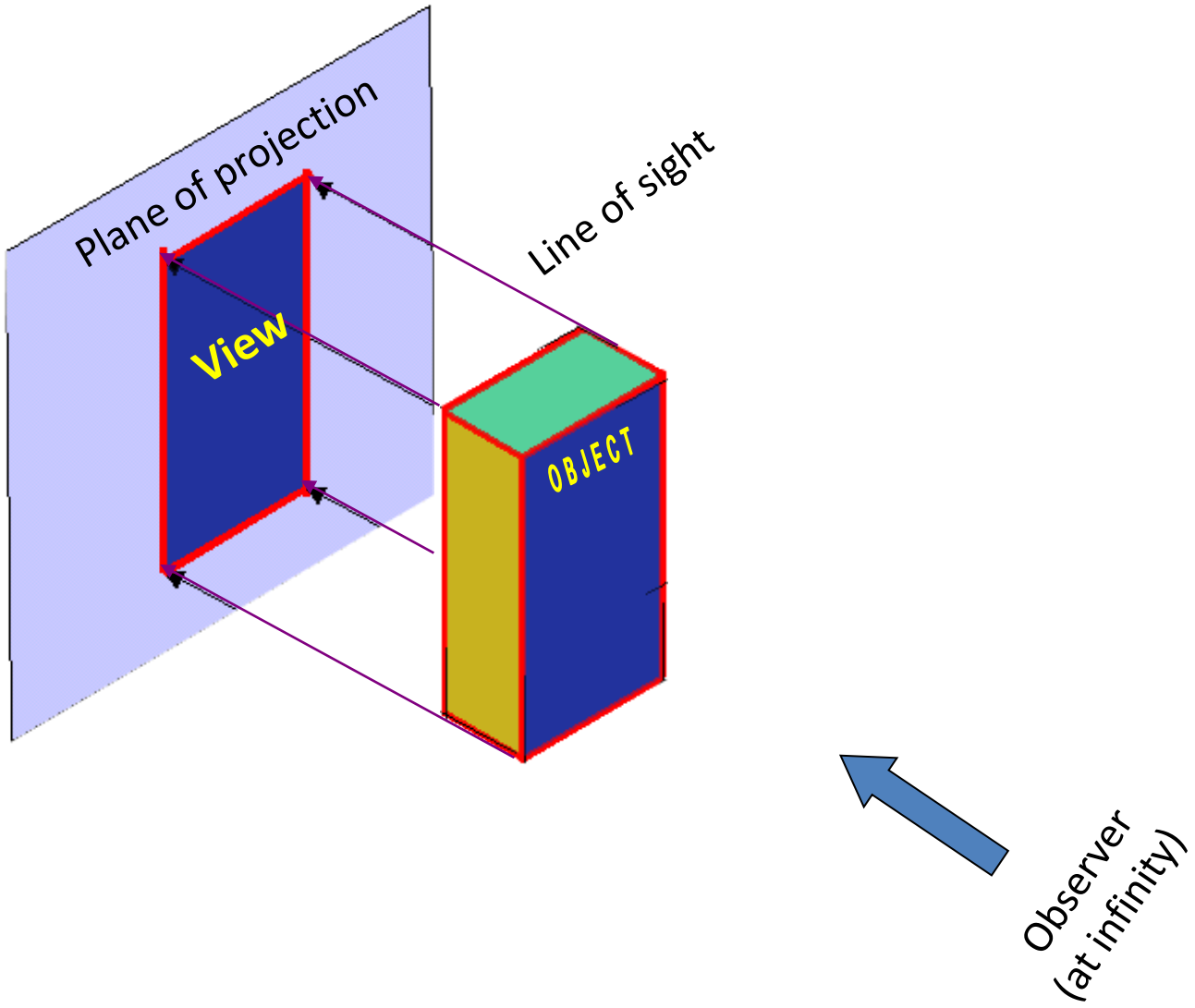
1. HORIZONTAL PLANE (HP)
2. VERTICAL PLANE (VP)

REFERENCE LINE

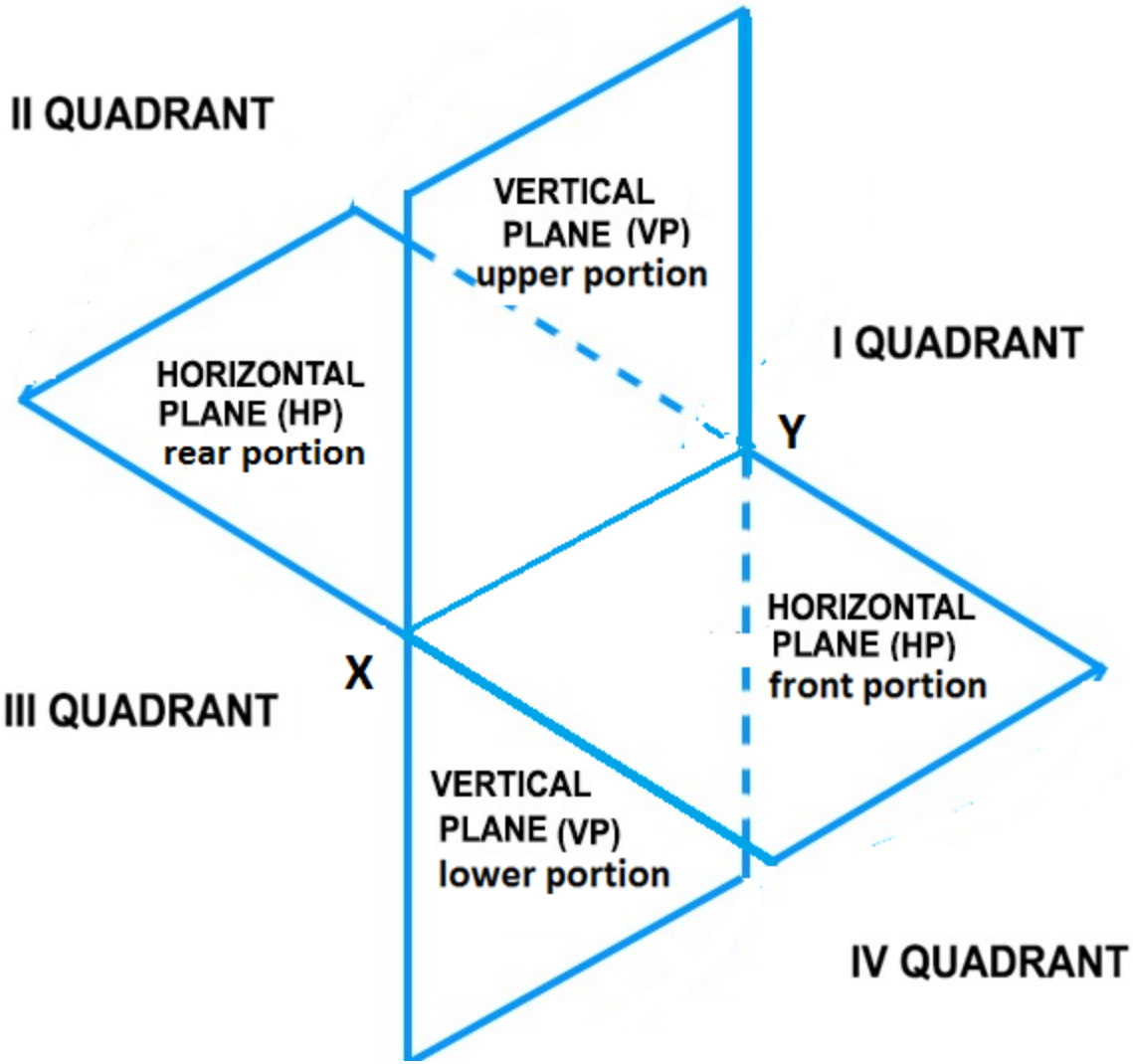
X Y LINE / GROUND LINE



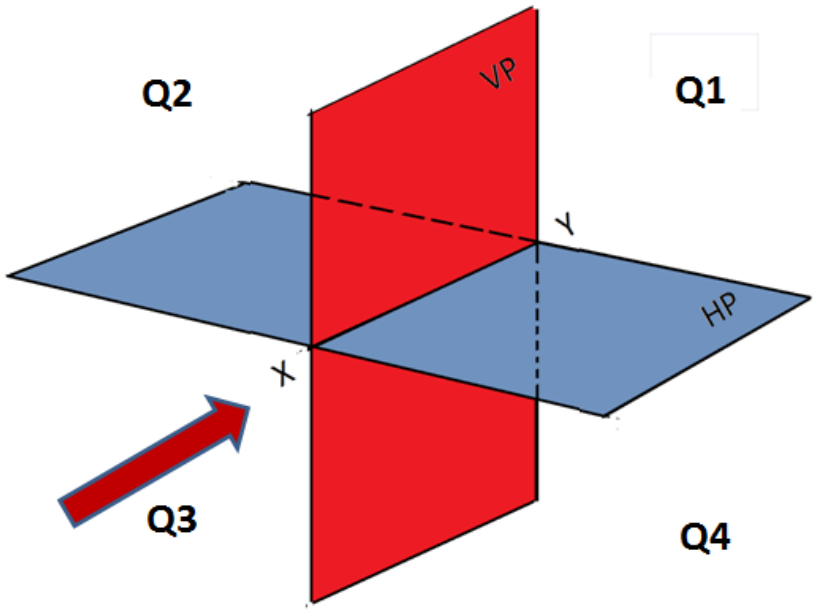
ORTHOGRAPHIC PROJECTION

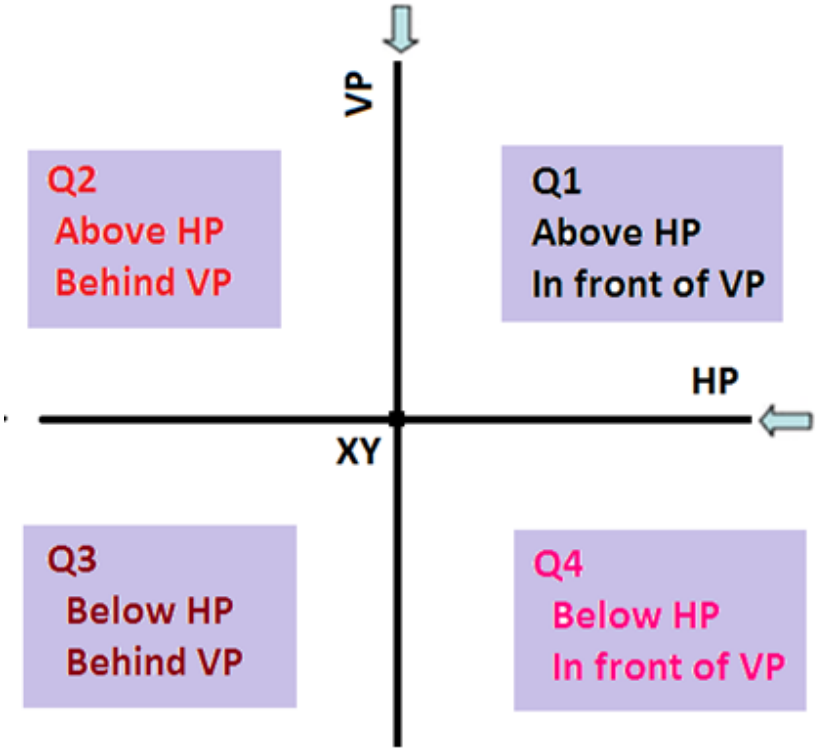


THE QUADRANTS

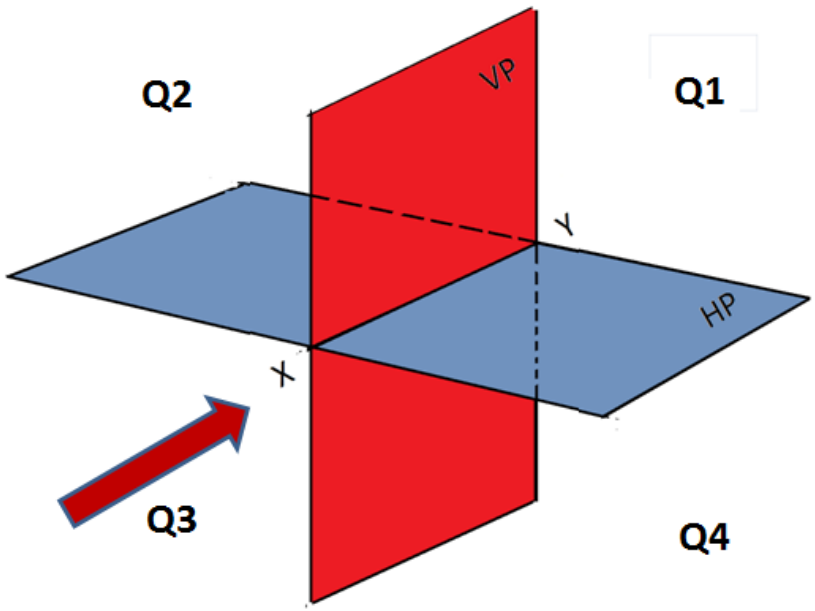


Quadrant pattern observed along XY



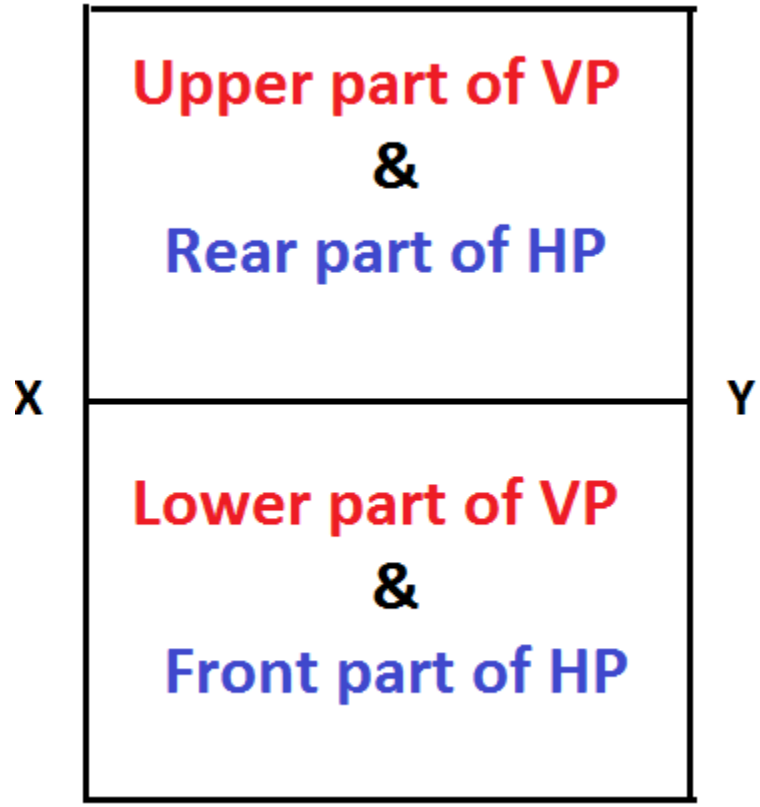


Opening the quadrants



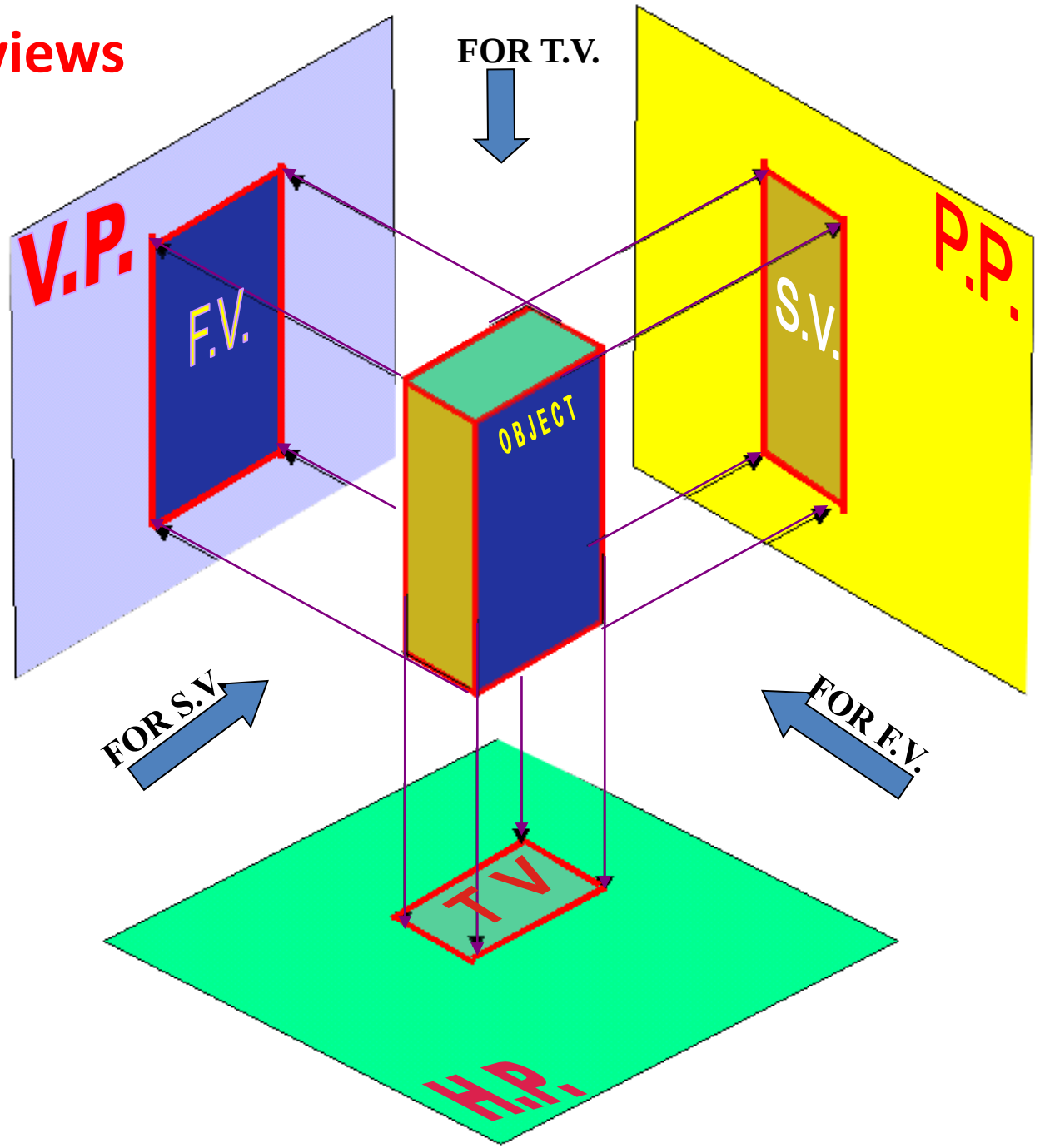
HP is rotated clockwise and brought in the plane of VP

After rotation

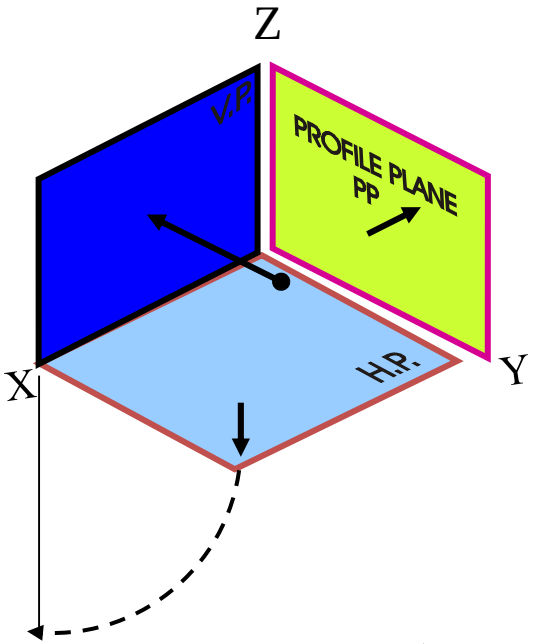


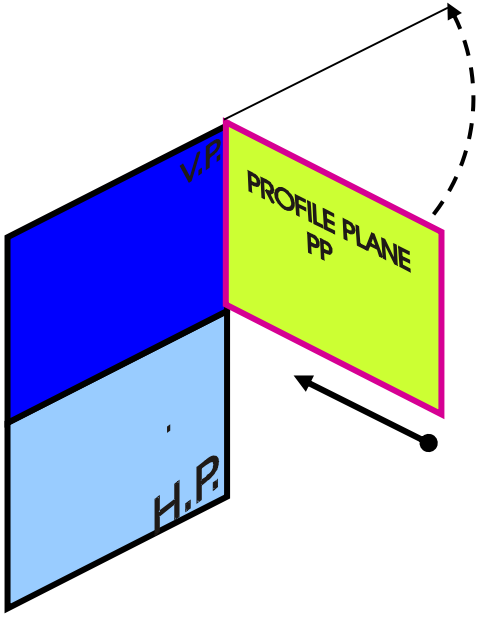
- **Q1 and Q3 open outward**
- **Q2 and Q4 open inward**

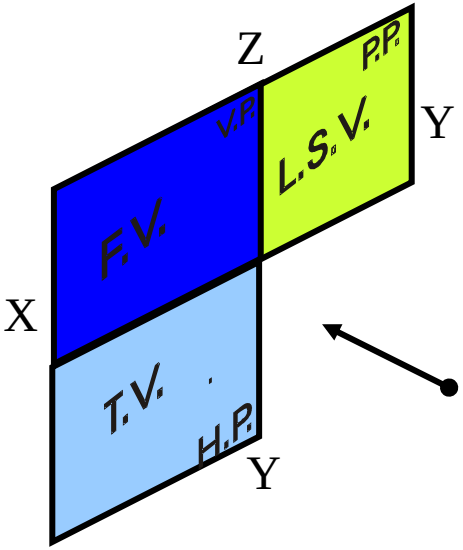
Different views

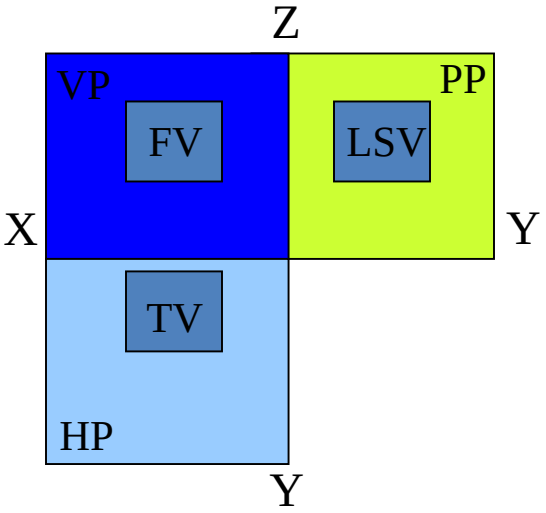


Position of views

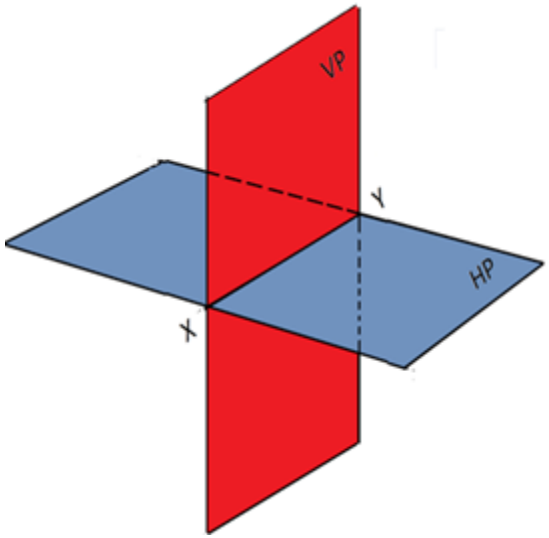








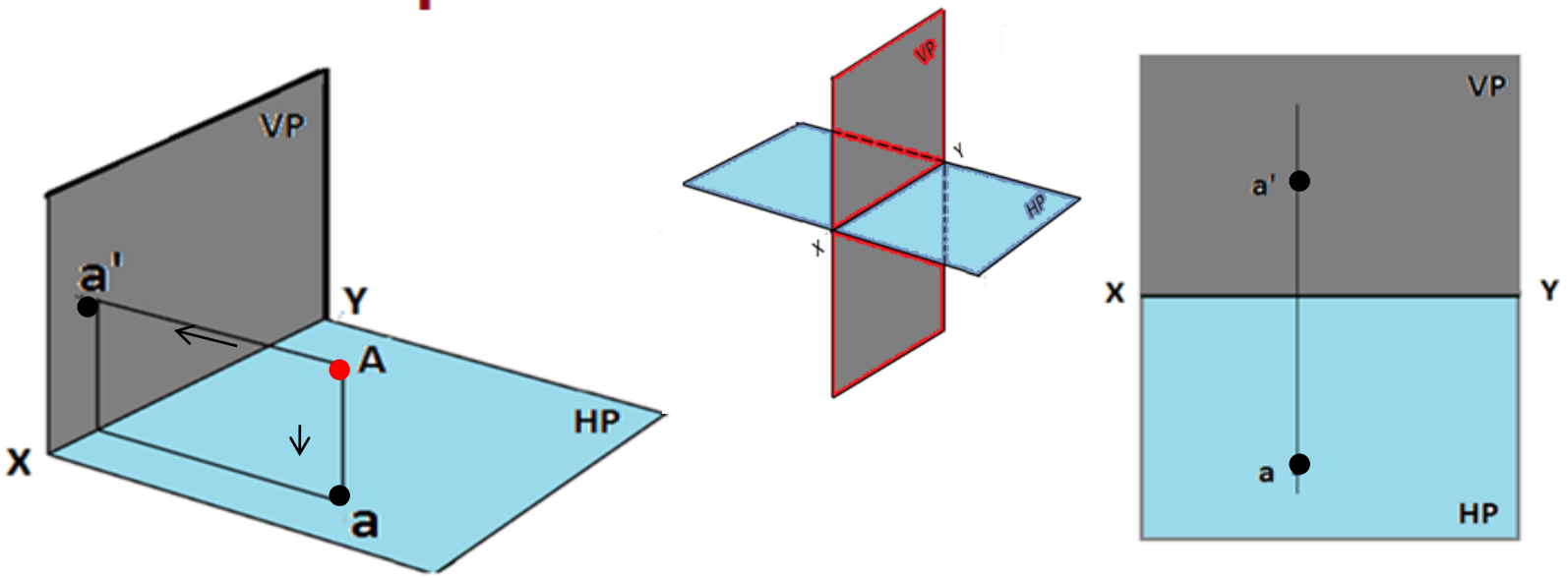
Possible positions of an object



1. In 1st quadrant: above HP & in front of VP
2. In 2nd quadrant: above HP & behind VP
3. In 3rd quadrant: below HP & behind VP
4. In 4th quadrant: below HP & in front of VP
5. In plane: on HP & in front of VP
6. In plane: on HP & behind VP
7. In plane: on VP & above HP
8. In plane: on VP & below HP
9. In planes: on HP & on VP

PROJECTION OF POINTS

A - in First quadrant



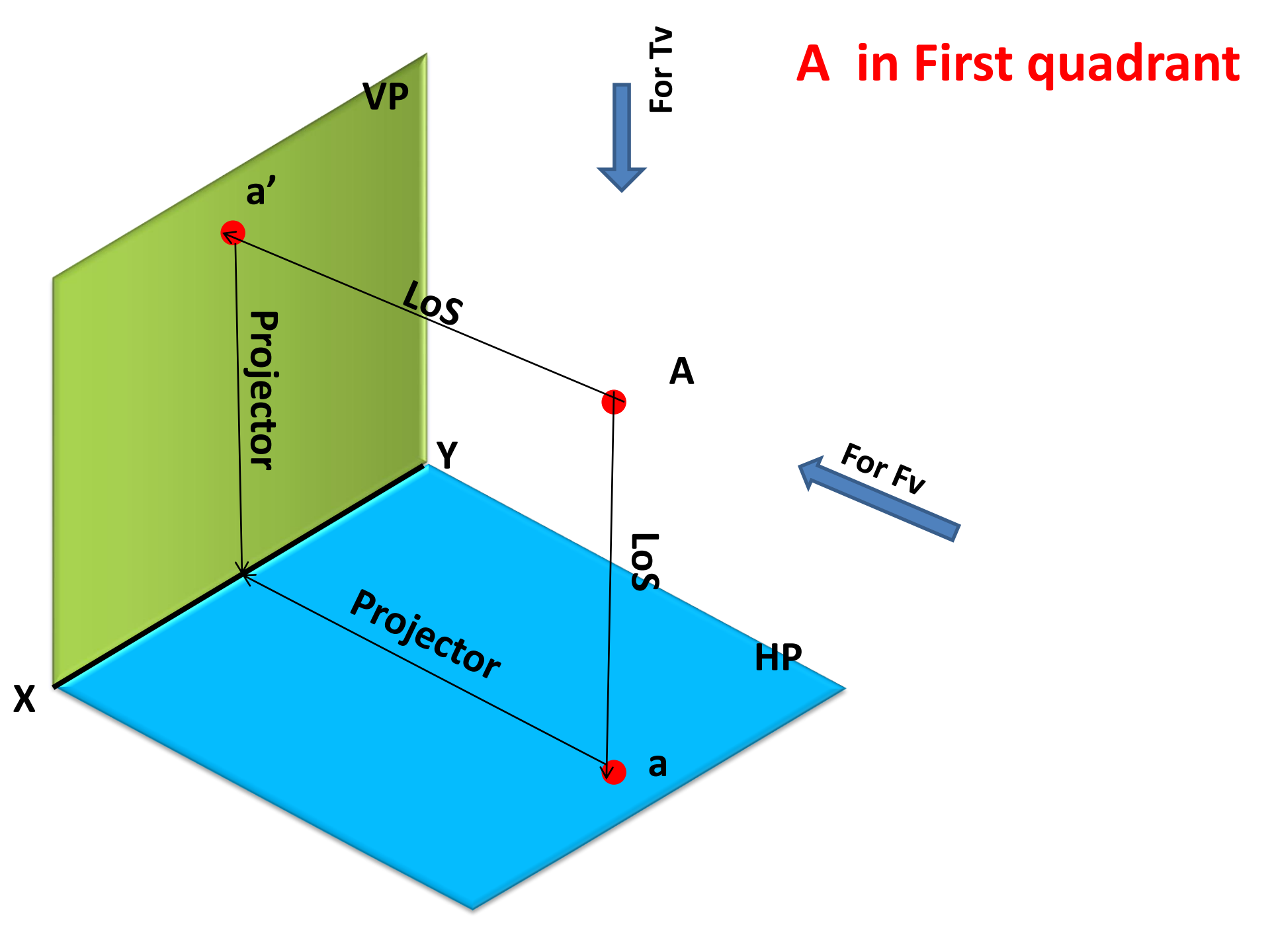
HP rotated clockwise by 90^0

A ⇒ Object (point)

a ⇒ TV (plan)

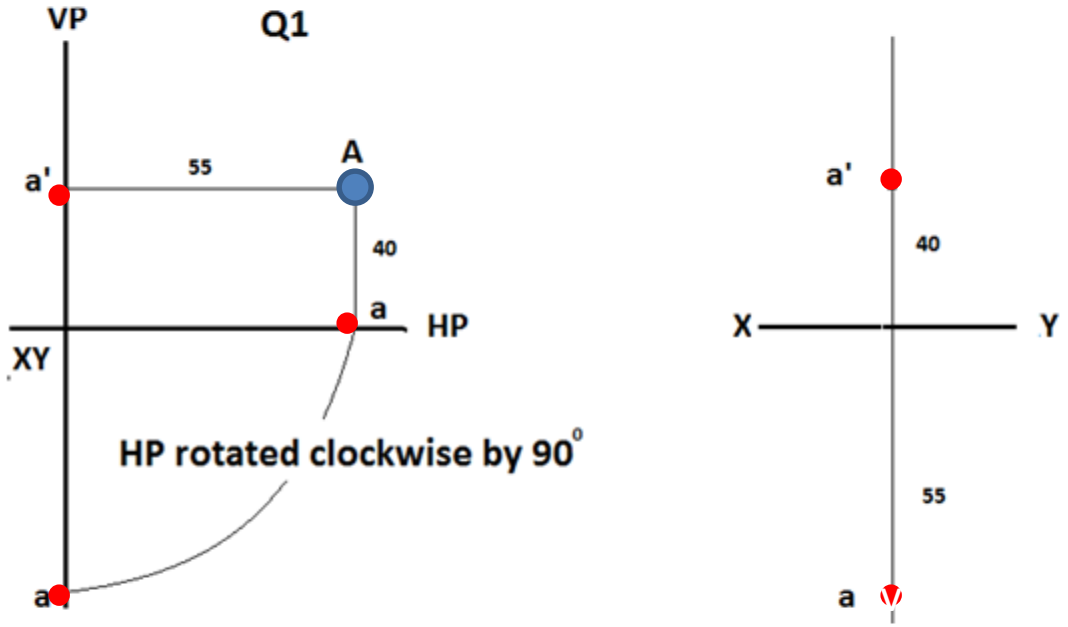
a' ⇒ FV (elevation)

A in First quadrant



PROJECTION OF POINTS

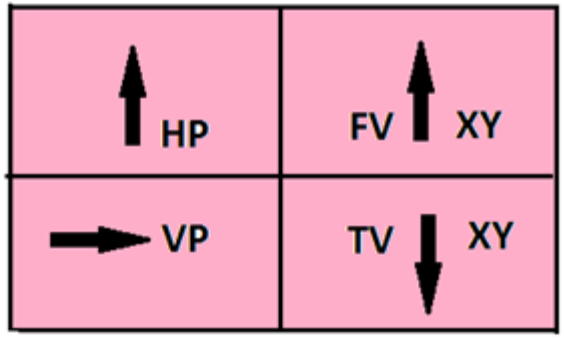
A - in first quadrant



Point A in First quadrant	
A above HP	a' - FV (Elevation) above XY
A in front of VP	a - T V (Plan) below XY

Projection of lines

Q1. Point A is 25mm above HP and 50mm in front of VP. Draw the projections of A.

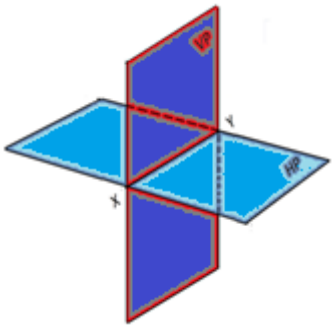


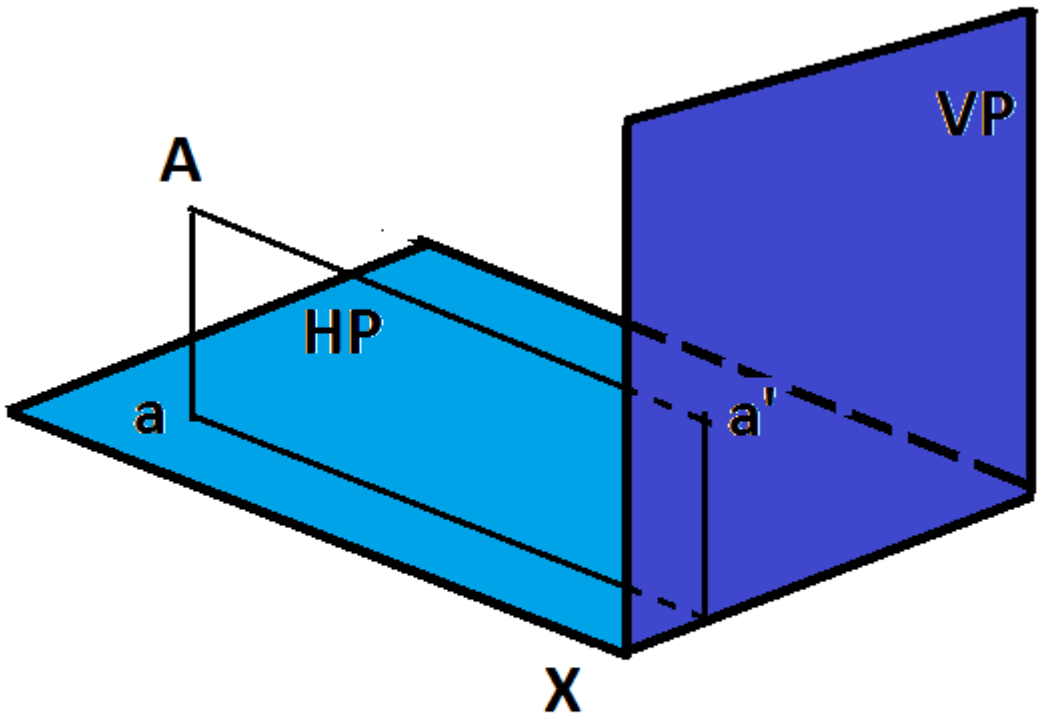
Solution steps

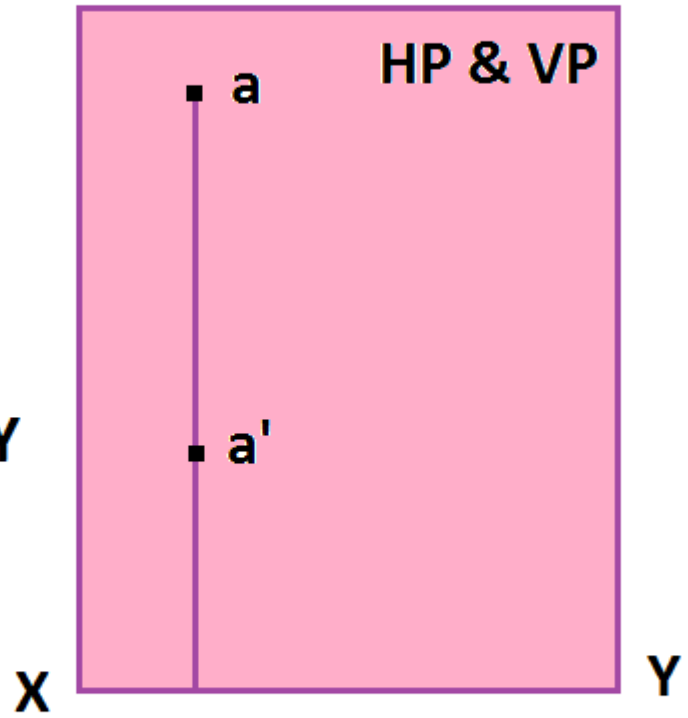
1. XY line (stronger line)
2. Projector (weaker line)
3. Read: A 25 mm above HP
4. Realize: a' 25 mm above XY
   and position a' on the projector
5. Read: A 50 mm in front of VP
6. Realize: a 50 mm below XY
   and position a on the projector

PROJECTION OF POINTS

A - in Second quadrant







A ⇨ Object (point)

a ⇨ TV (plan)

a' ⇨ FV (elevation)

HP rotated clockwise by 90^0

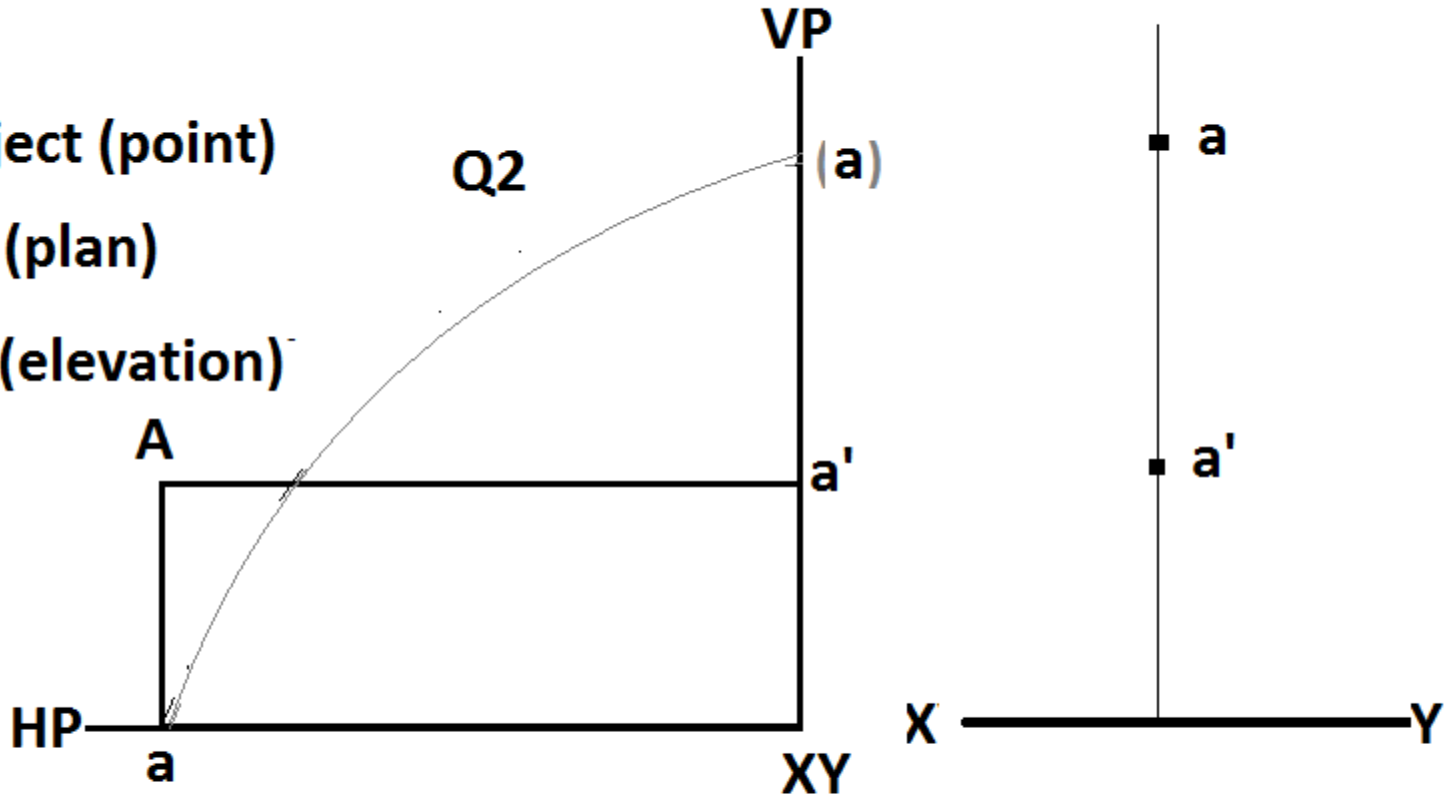
PROJECTION OF POINTS

A - in Second quadrant

A ⇨ Object (point)

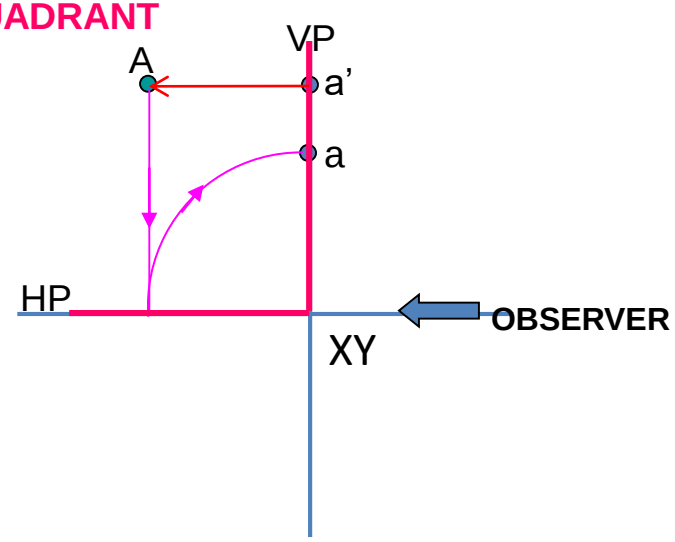
a ⇨ TV (plan)

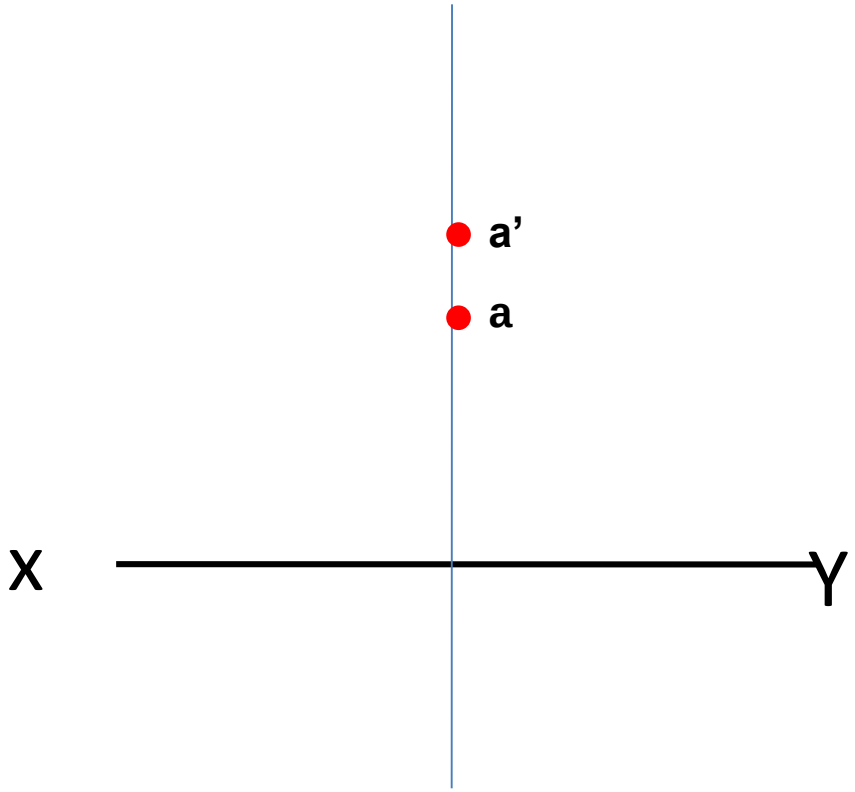
a' ⇨ FV (elevation)



Point A in Second quadrant	
A above HP	a' - FV (Elevation) above XY
A behind VP	a - T V (Plan) above XY

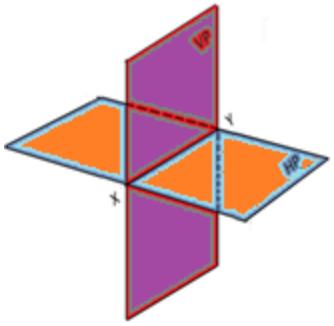
POINT A IN 2ND QUADRANT

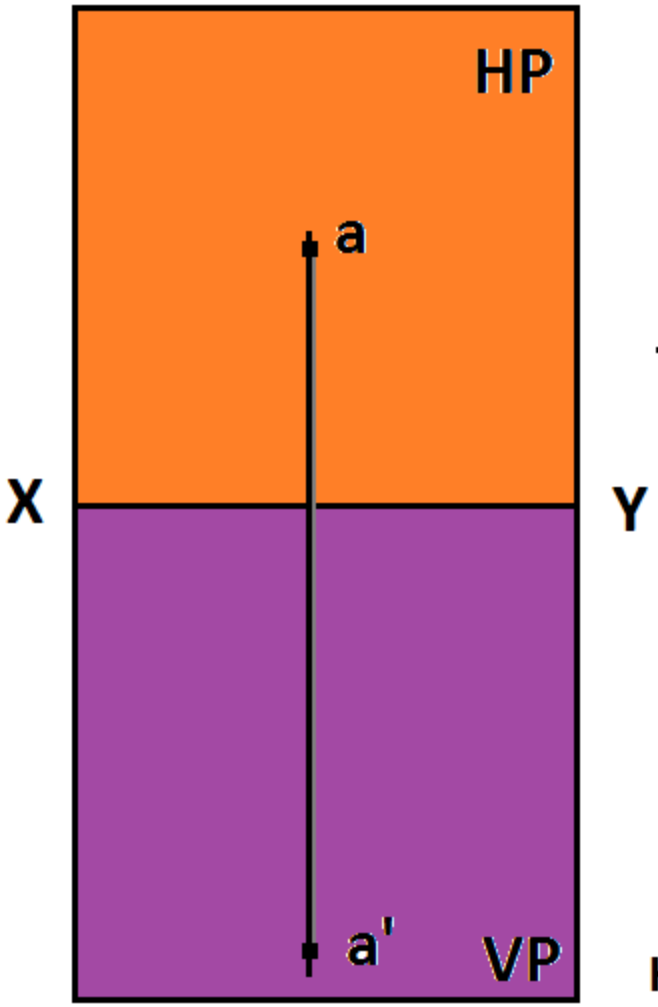


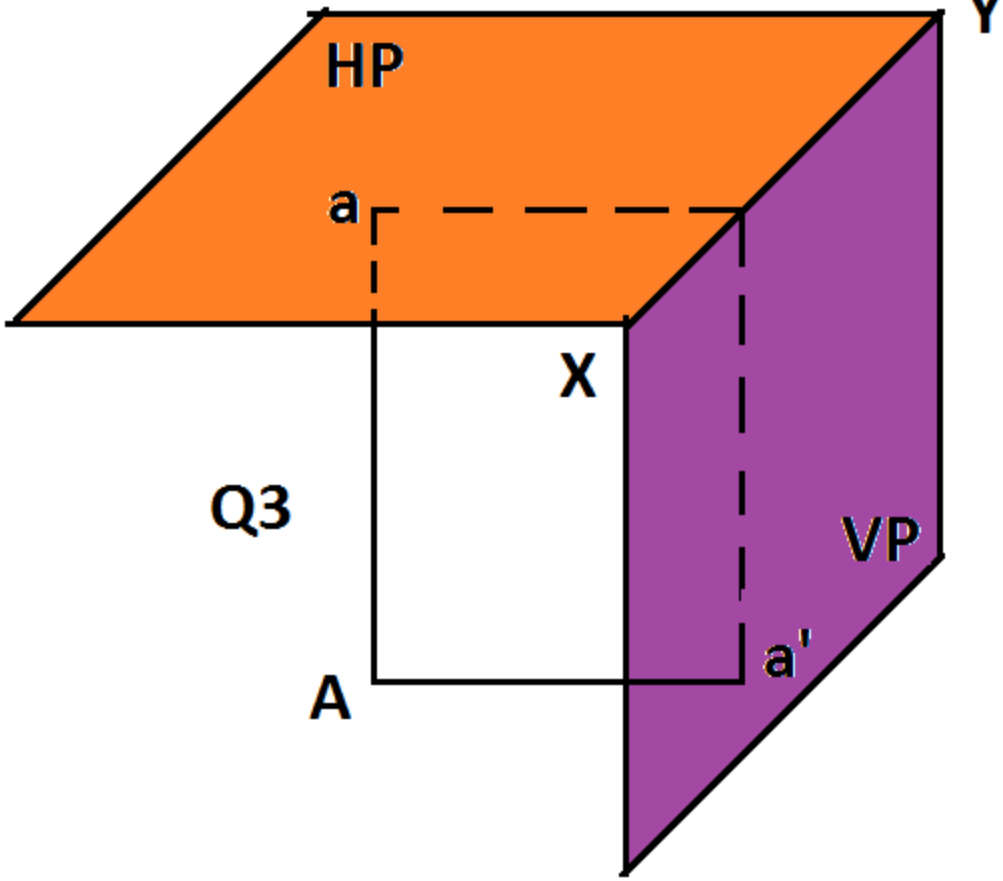


PROJECTION OF POINTS

A - in Third quadrant



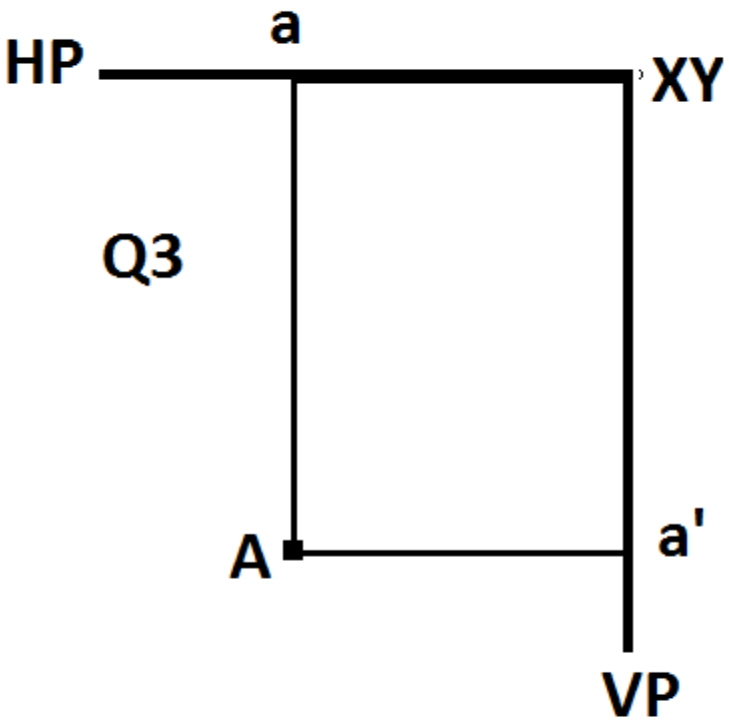


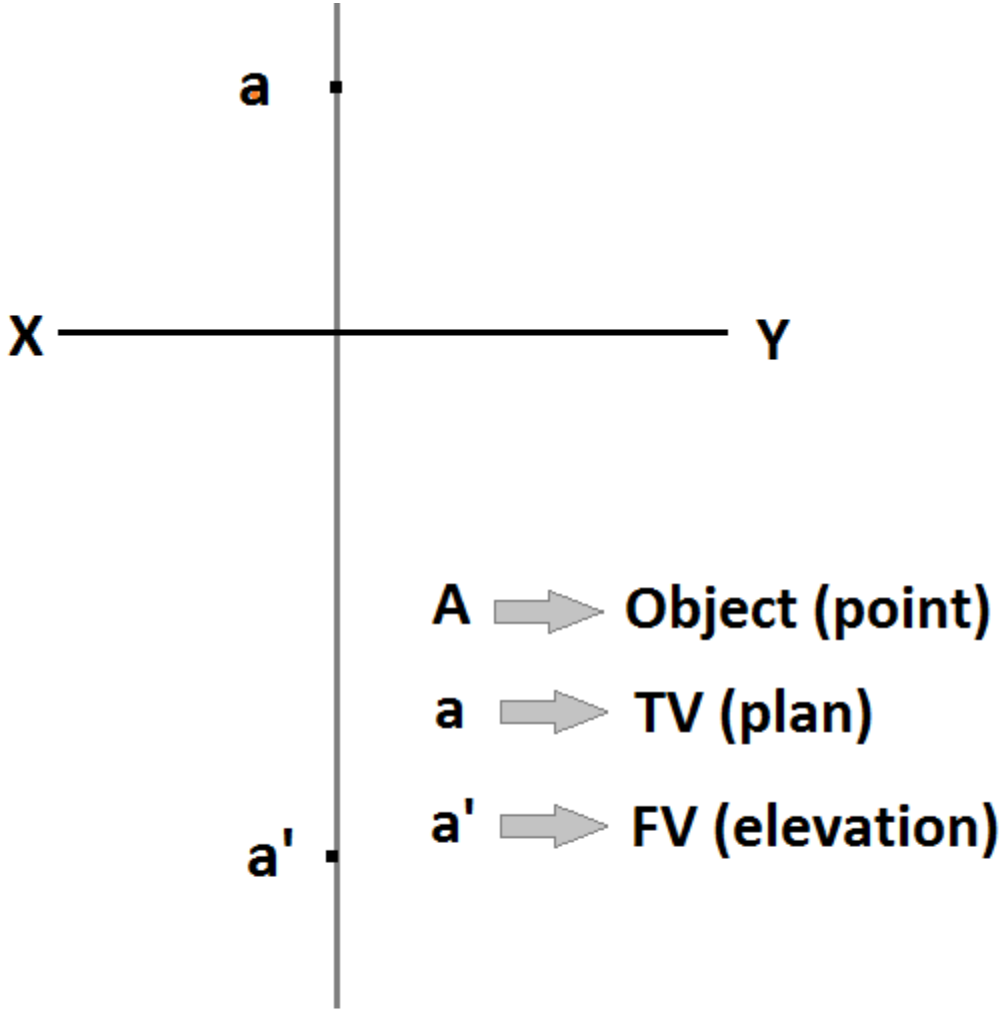


HP rotated clockwise by 90°

PROJECTION OF POINTS

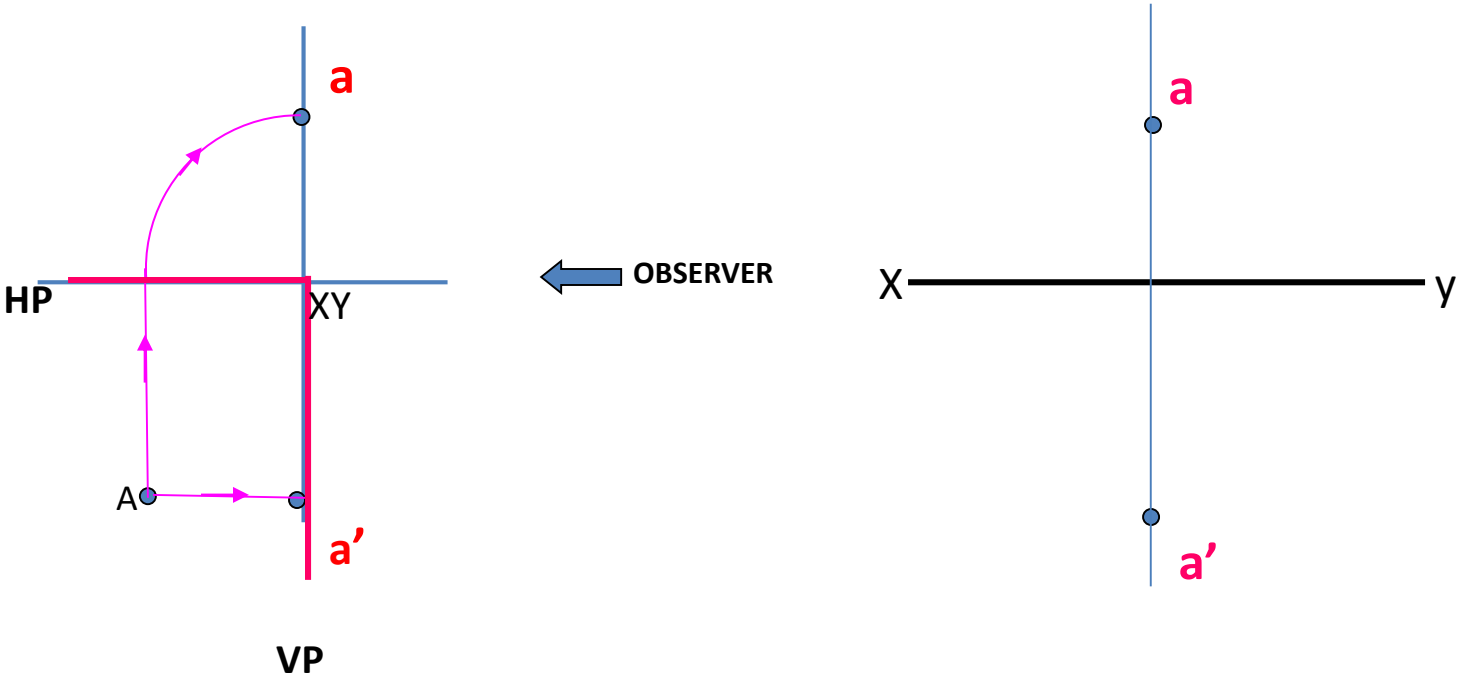
A - in Third quadrant





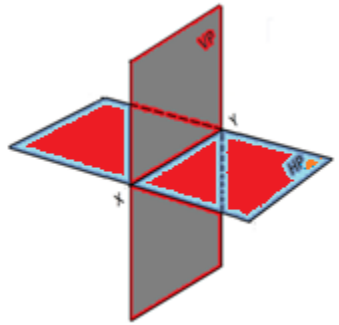
Point A in Third quadrant	
A below HP	a' - FV (Elevation) below XY
A behind VP	a - T V (Plan) above XY

POINT A IN 3RD QUADRANT

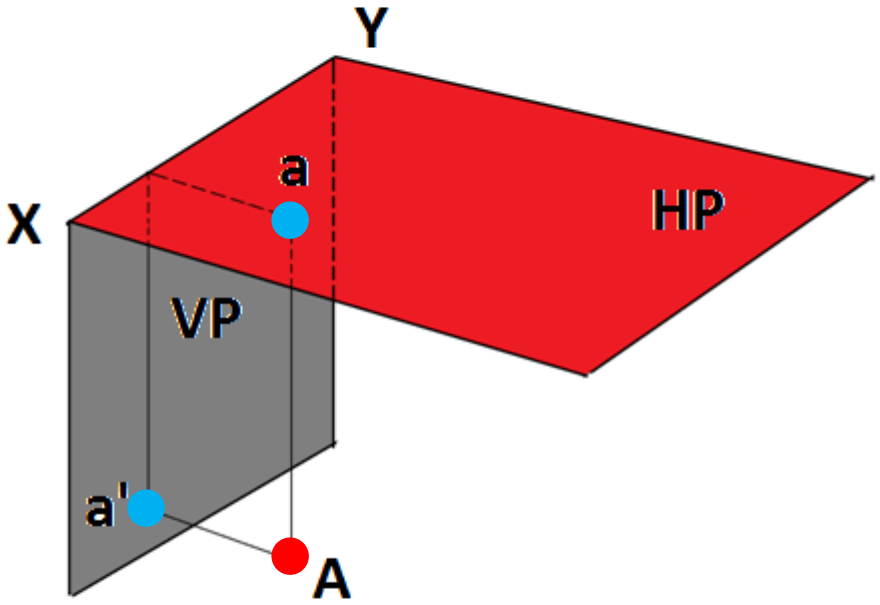


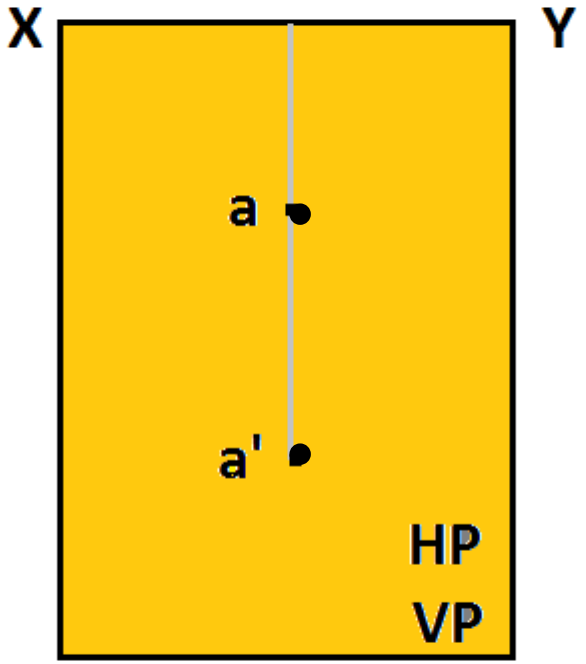
Convention: Horizontal plane is always rotated clockwise

PROJECTION OF POINTS



A - in Fourth quadrant





HP rotated clockwise by 90°

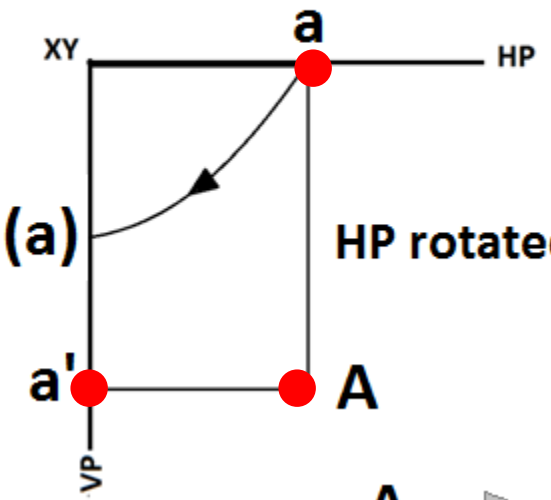
A ⇨ Object (point)

a ⇨ TV (plan)

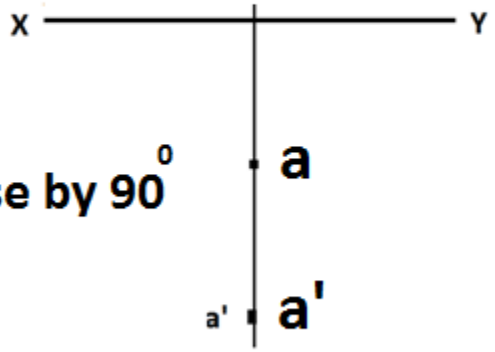
a' ⇨ FV (elevation)

PROJECTION OF POINTS

A - in Fourth quadrant



HP rotated clockwise by 90^0

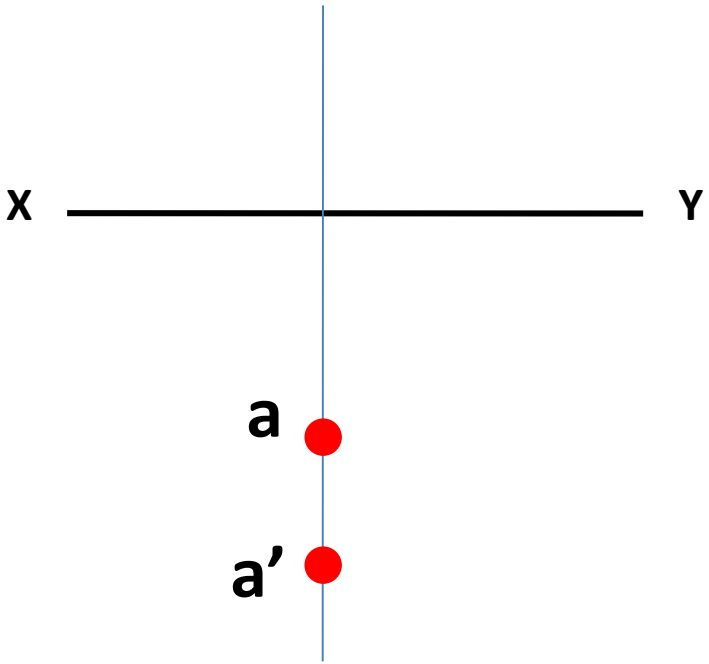


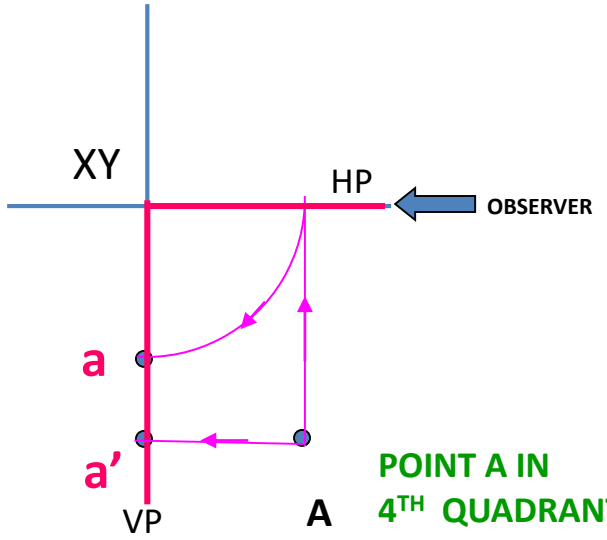
A ⇨ Object (point)

a ⇨ TV (plan)

a' ⇨ FV (elevation)

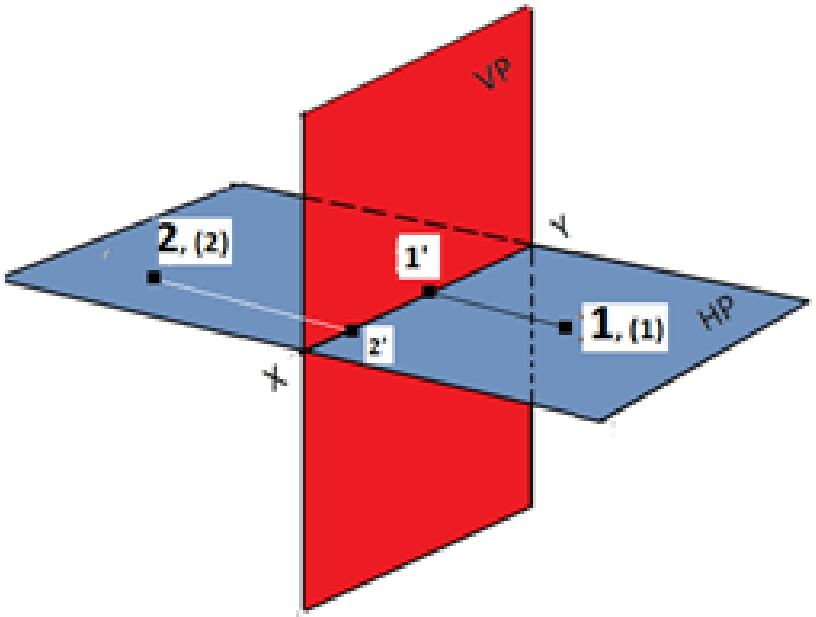
Point A in Fourth quadrant	
A below HP	a' – FV (Elevation) below XY
A in front of VP	a - TV (Plan) below XY



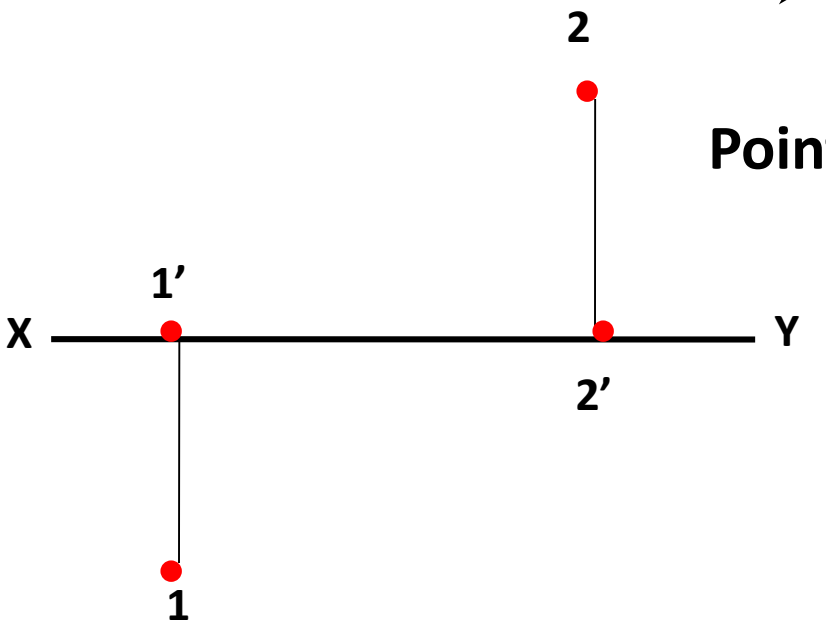


Convention: Horizontal plane is always rotated clockwise

POINT ON HP

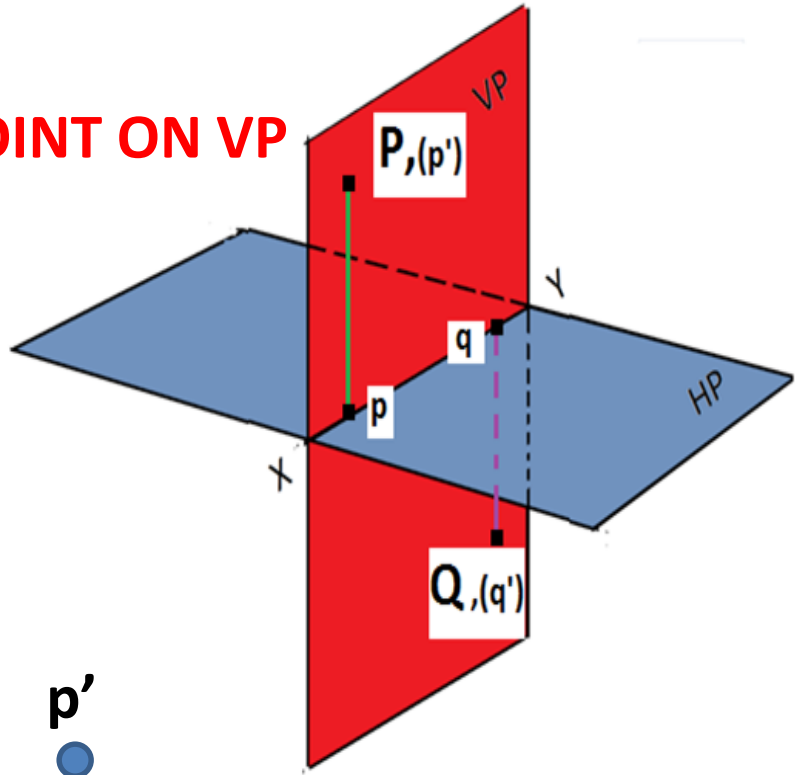


- **1 - on HP & in front of VP**
  - **1' – on XY**
  - **1 - below XY**
- **2 – on HP & behind VP**
  - **2' – on XY**
  - **2– above XY**



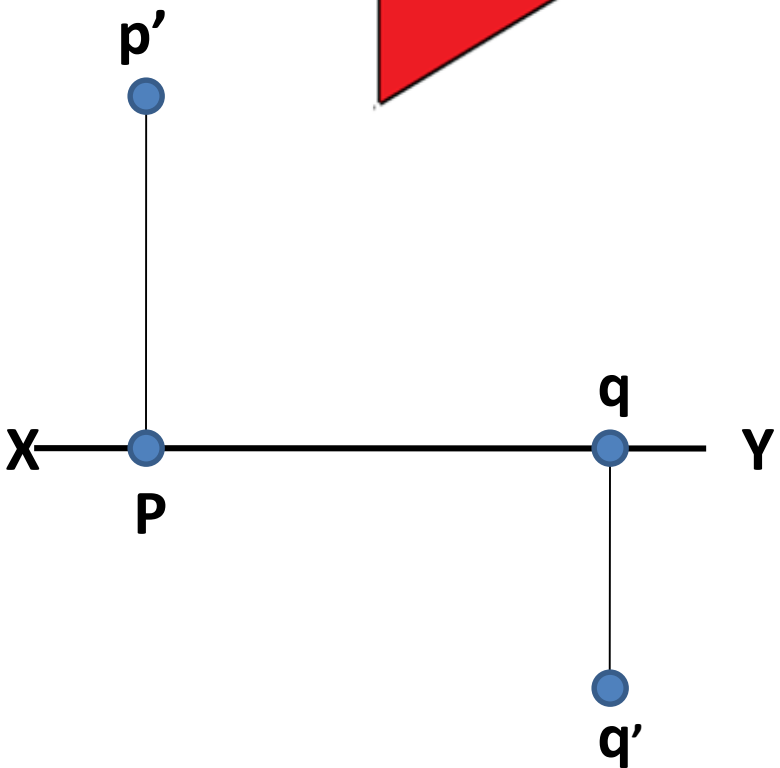
Point on HP, its FV (elevation) on XY

POINT ON VP

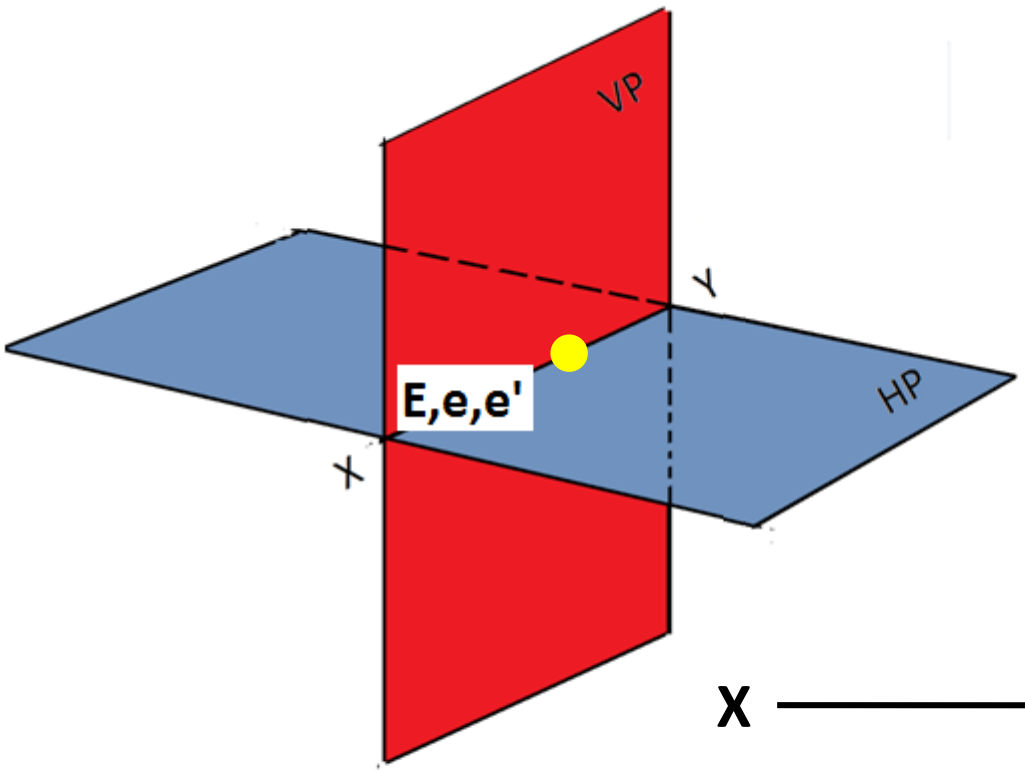


- **P - on VP & above HP**
  - **P – on XY**
  - **p' - above XY**
- **Q – on VP & below HP**
  - **q – on XY**
  - **q' – below XY**

Point on VP, its TV (plan) on XY



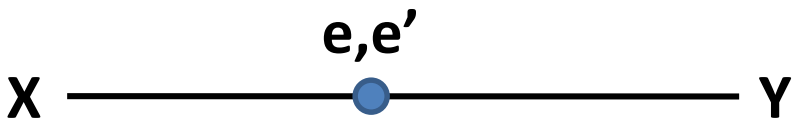
POINT ON BOTH HP & VP



E - on both HP & VP

e' - on XY

e - on XY



Point on both HP & VP, its Front and Top views on XY

PROJECTION OF POINTS

A in First quadrant

A above HP ..... a' above XY

A in front of VP .....a below XY

A in Second quadrant

A above HP .....a' above XY

A behind VP .....a above XY

A in Third quadrant

A below HP .....a' below XY

A behind VP .....a above XY

A in Fourth quadrant

A below HP .....a' below XY

A in front of VP .....a below XY

PROJECTIONS OF POINTS

A above HP	a’ above XY
A on HP	a’ on XY
A below HP	a’ below XY
A in front of VP	a below XY
A on VP	a on XY
A behind VP	a above XY

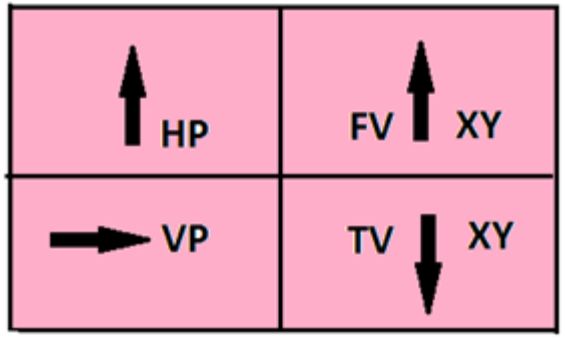
PROJECTIONS OF POINTS

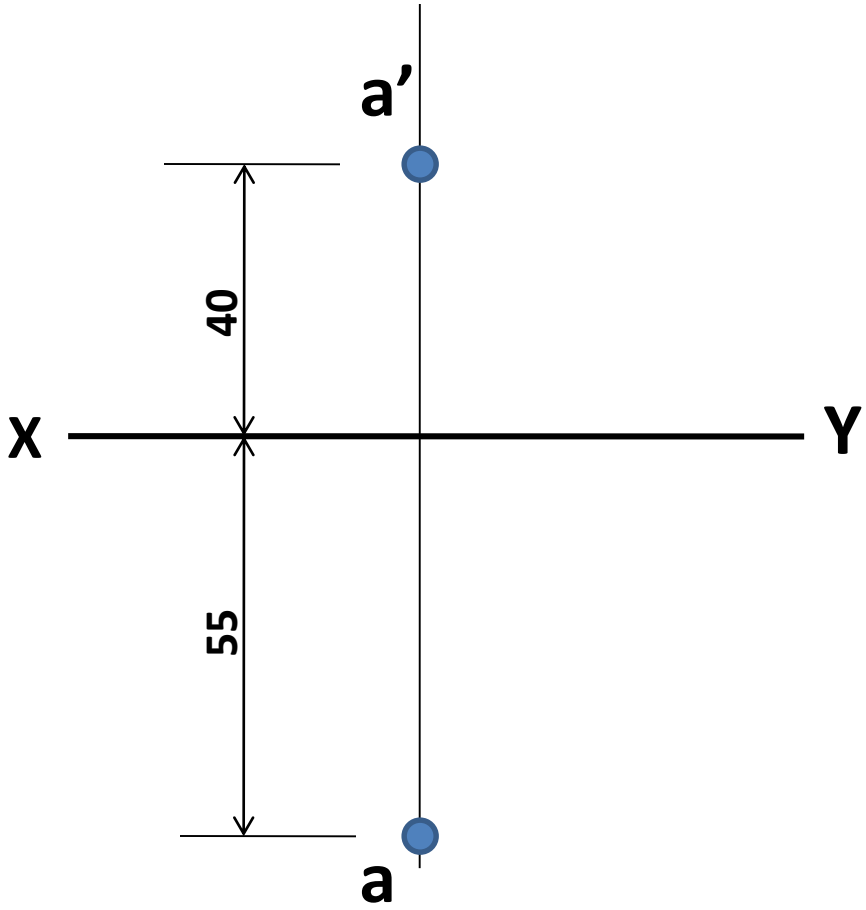
Draw the projections of the following points.

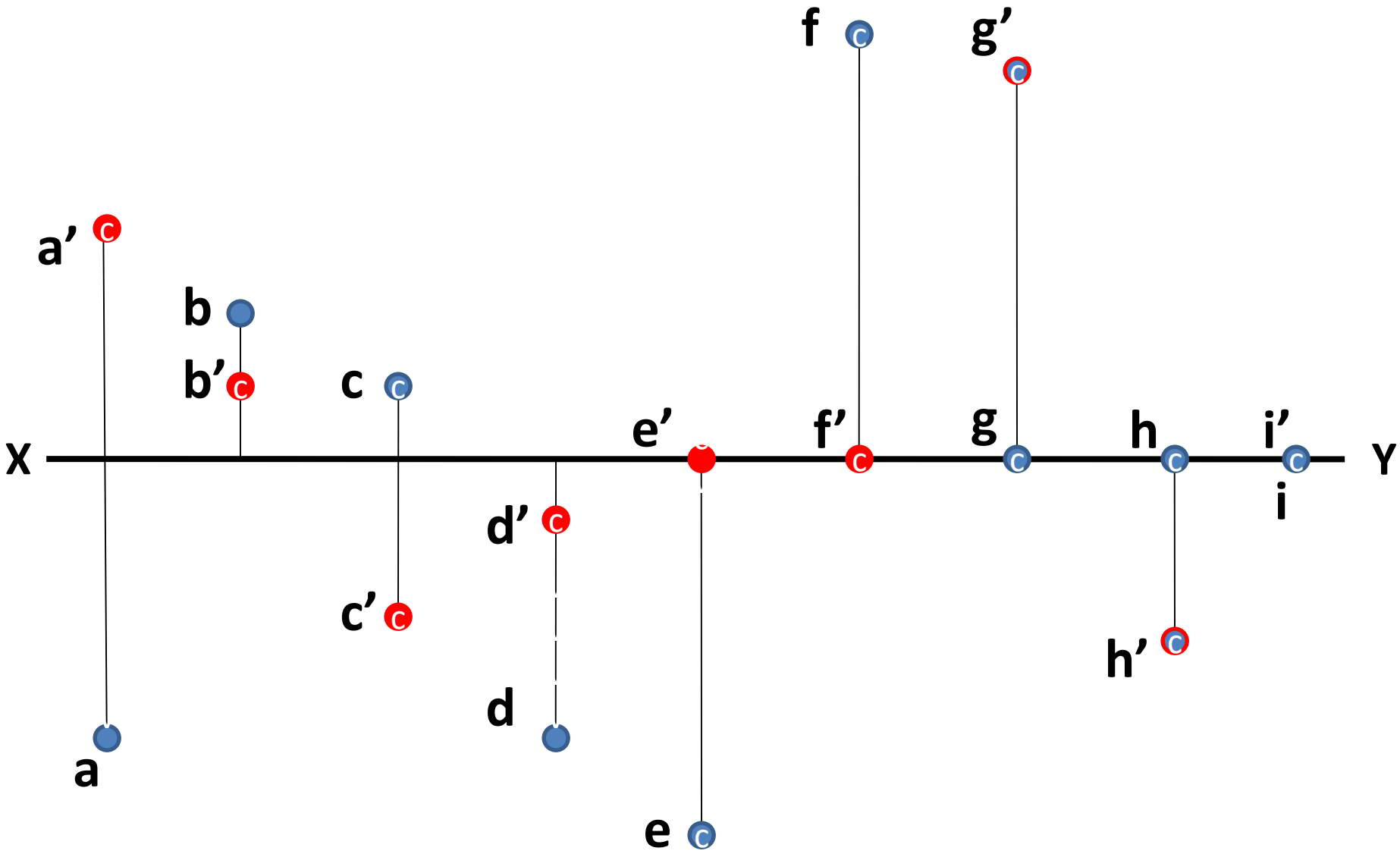
1. *A 40 mm above HP and 55 mm in front of VP.*
2. *B 10 mm above HP and 25 mm behind VP.*
3. *C 35 mm below HP and 20 mm behind VP.*
4. *D 10 mm below HP and 40 mm in front of VP.*
5. *E on HP and 50 mm in front of VP.*
6. *F on HP and 80 mm behind VP.*
7. *G on VP and 75 mm above HP.*
8. *H on VP and 30 mm below HP.*
9. *I on both HP and VP.*

Draw the projections of the following points.

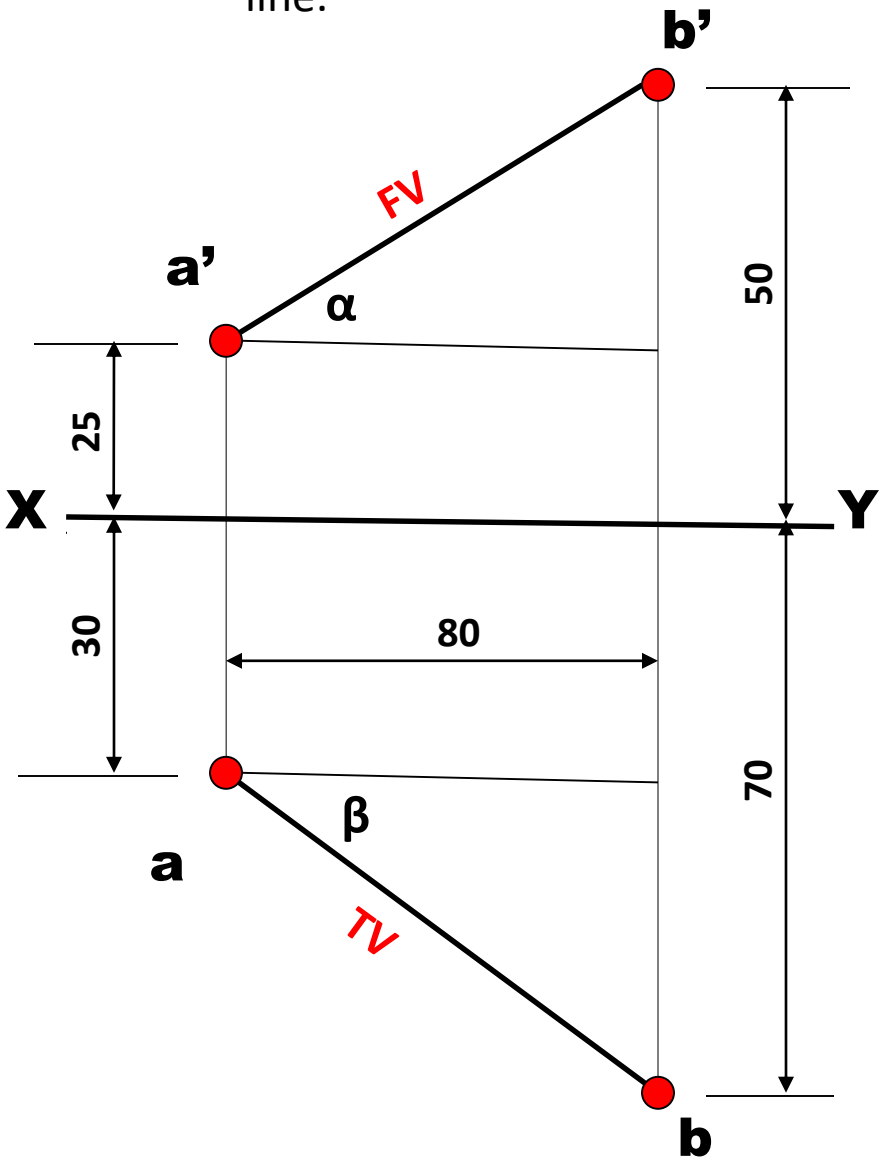
1. A 40 mm above HP and 55 mm in front of VP.






f
g’
a’
b
b’
c
e’
f’
g
h
i’
X
Y
i
d’
c’
h’
d
a
e

(1). Line AB has its end A 25 mm above HP and 30 mm in front of VP. End B is 50 mm above HP and 70 mm in front of VP. Distance between the end projectors is 80 mm. Draw the projections of the line.



Positions of A

Positions of B

Length of FV

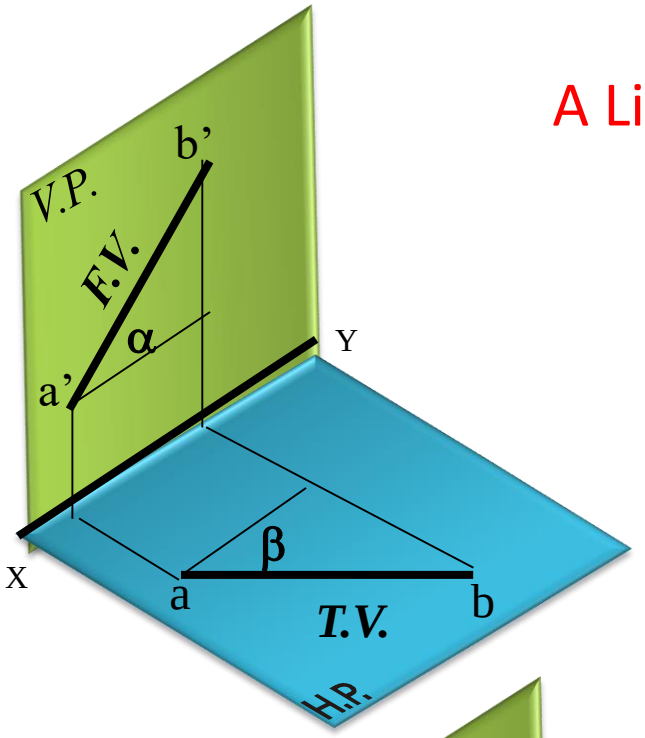
Length of TV

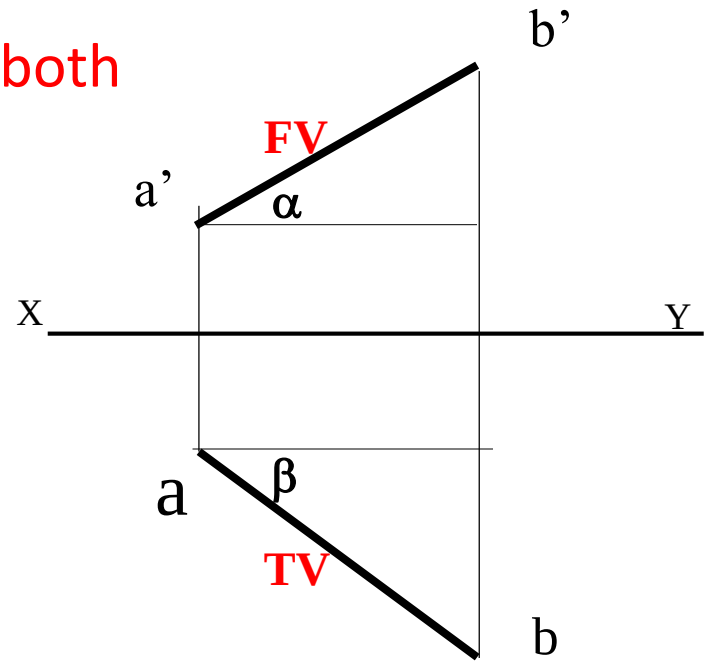
Inclination of FV to XY ……(α)

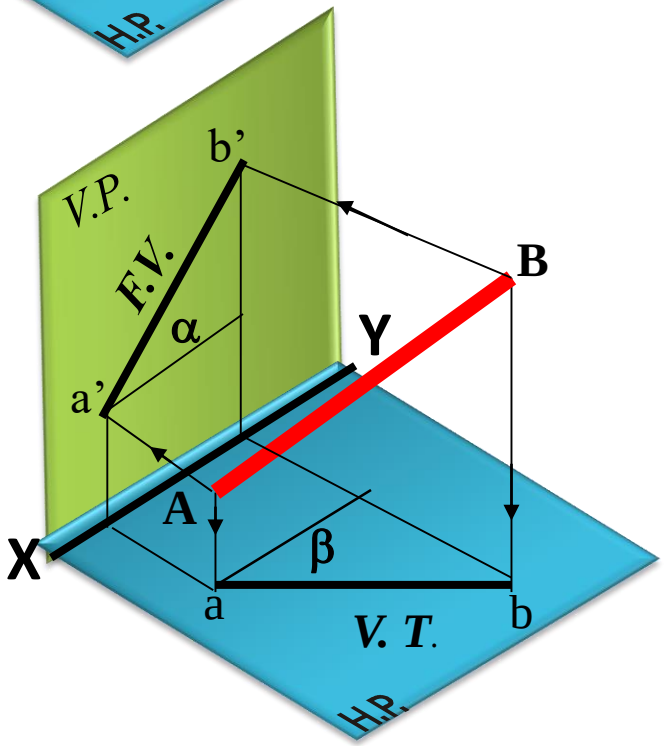
Inclination of TV to XY ……(β)

Distance b/w projectors… (Δ proj)

A Line inclined to both HP and VP







Positions of A

Positions of B

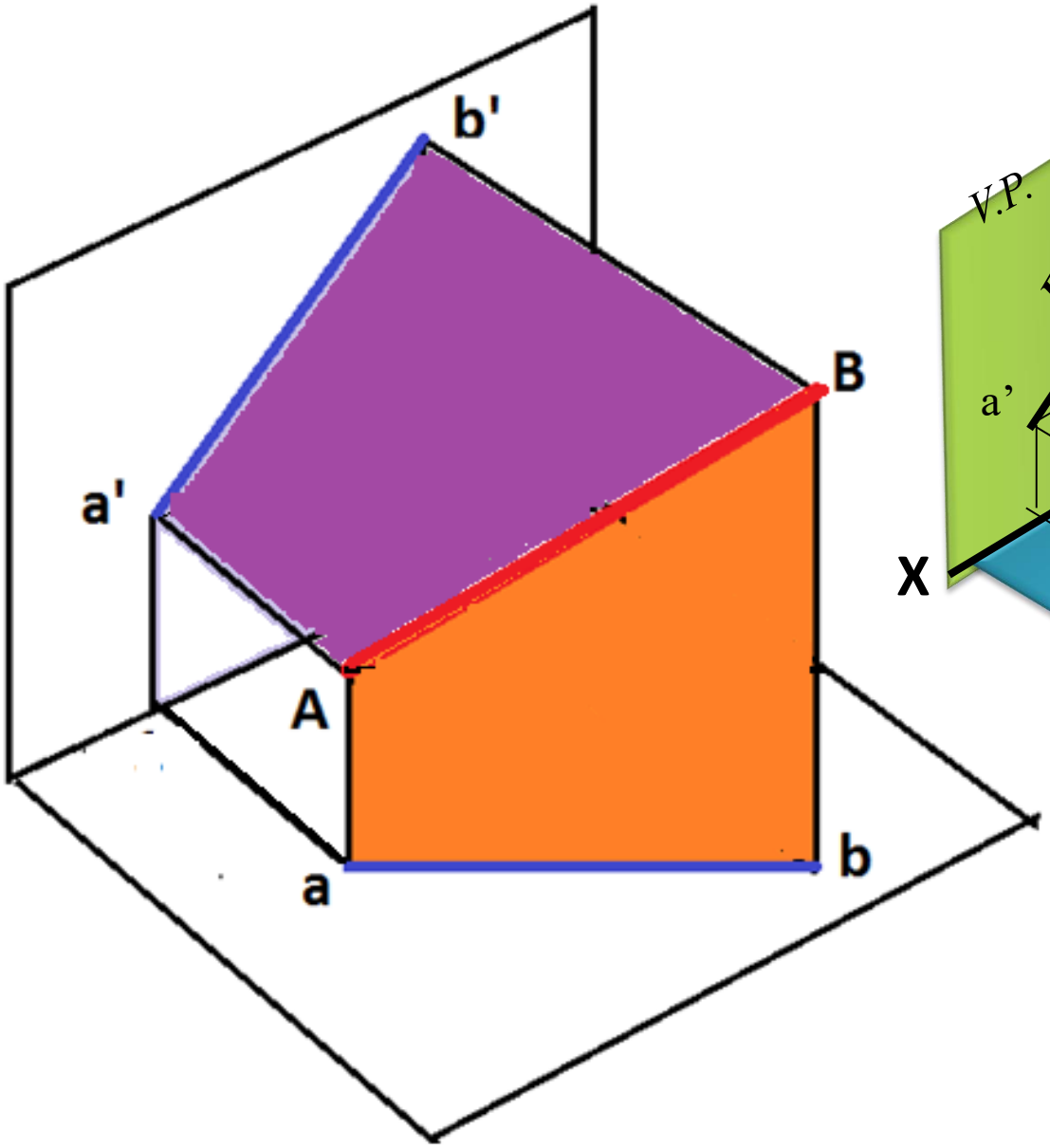
Length of FV

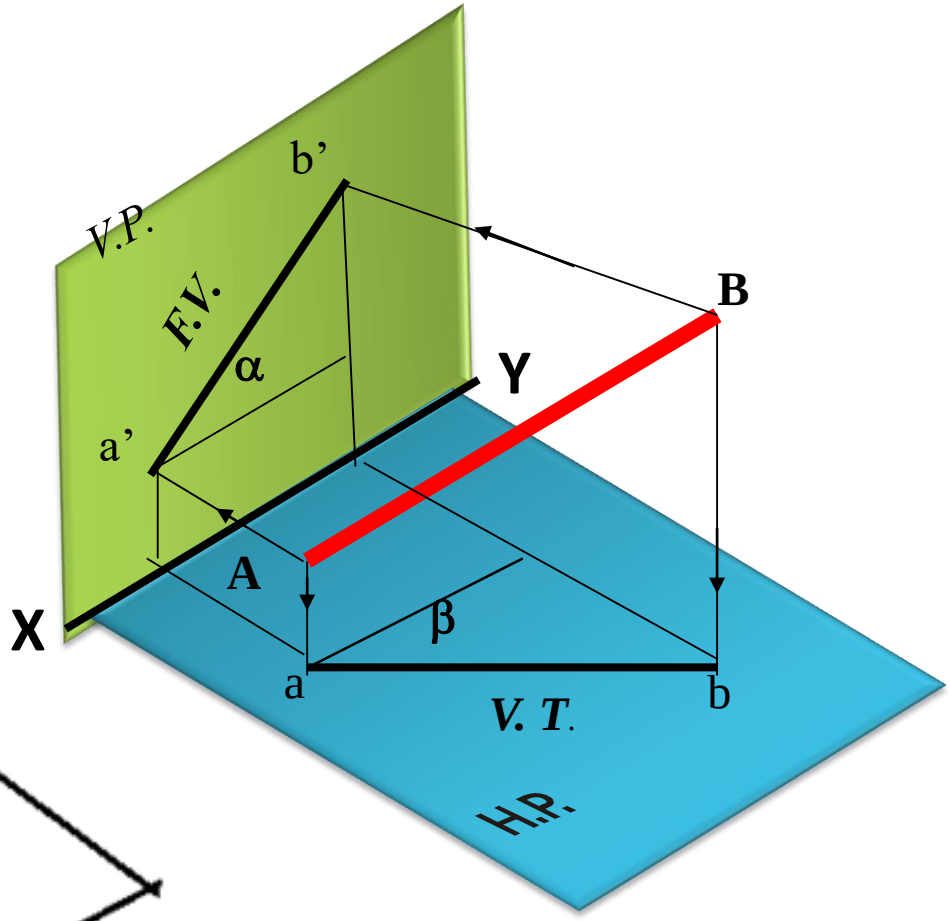
Length of TV

Inclination of FV to XY.....(α)

Inclination of TV to XY ...(β)

Distance b/w projectors... (Δ proj)

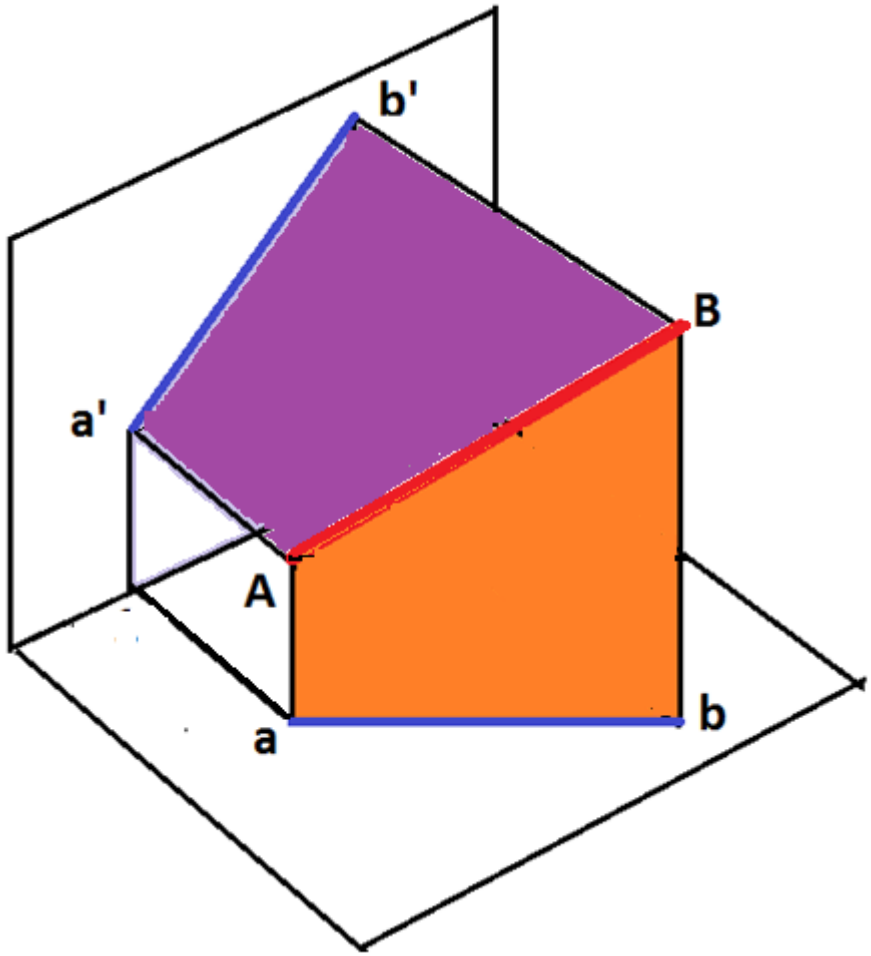

b'
B
a'
A
a
b


V.P.
b'
F.V.
α
B
Y
a'
A
X
β
a
b
V. T.
H.P.

Two trapeziums through the line AB

(1). **ABba**

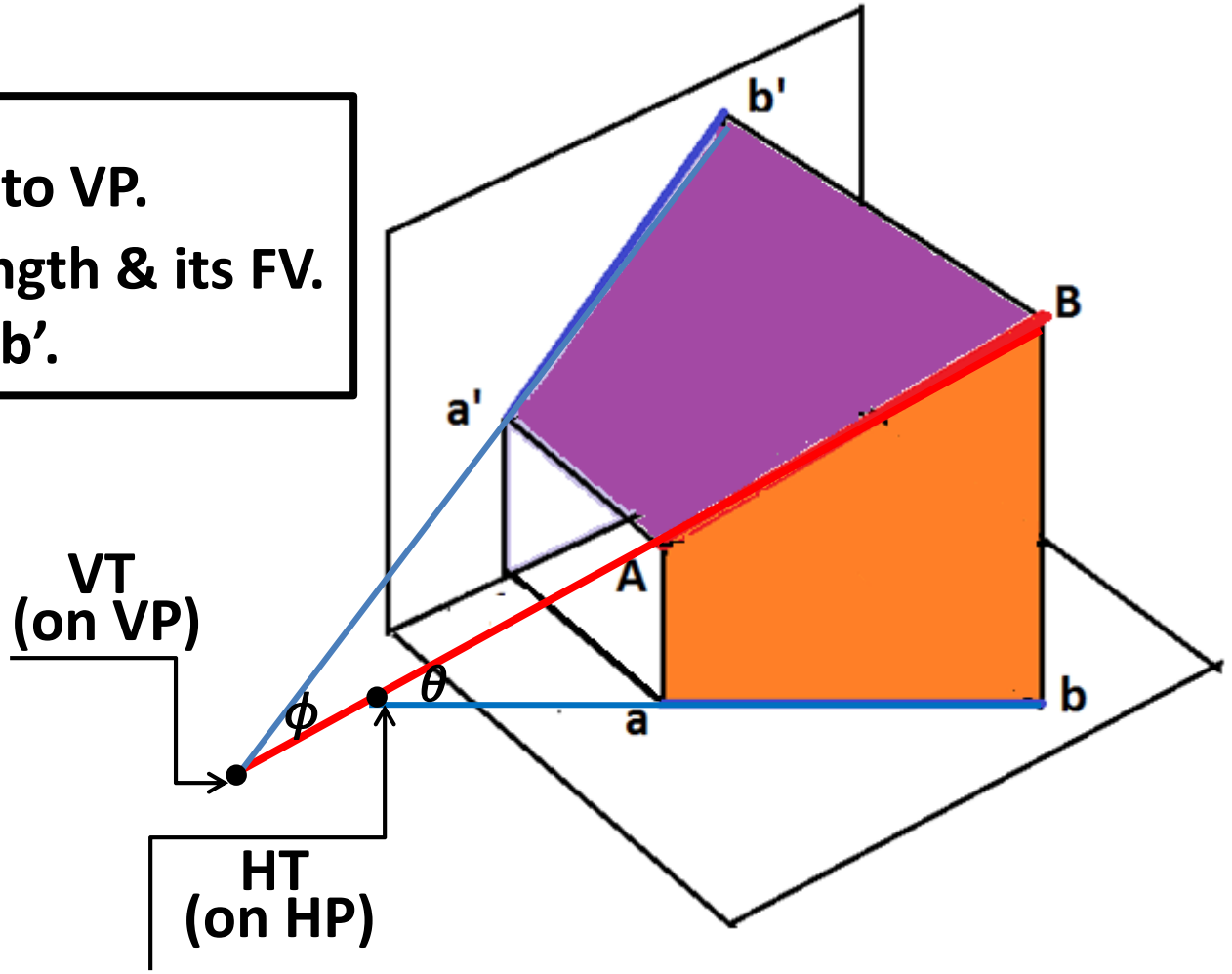
Surface perpendicular to HP.
Surface inclined to VP.
Base on HP.
Base **ab** represents **TV of AB**



(2). **ABb'a'**

Surface perpendicular to VP.
Surface inclined to HP.
Base on VP.
Base **a'b'** represents **FV of AB**

ϕ --inclination of AB to VP.
--angle b/w True length & its FV.
--angle b/w AB & a'b'.

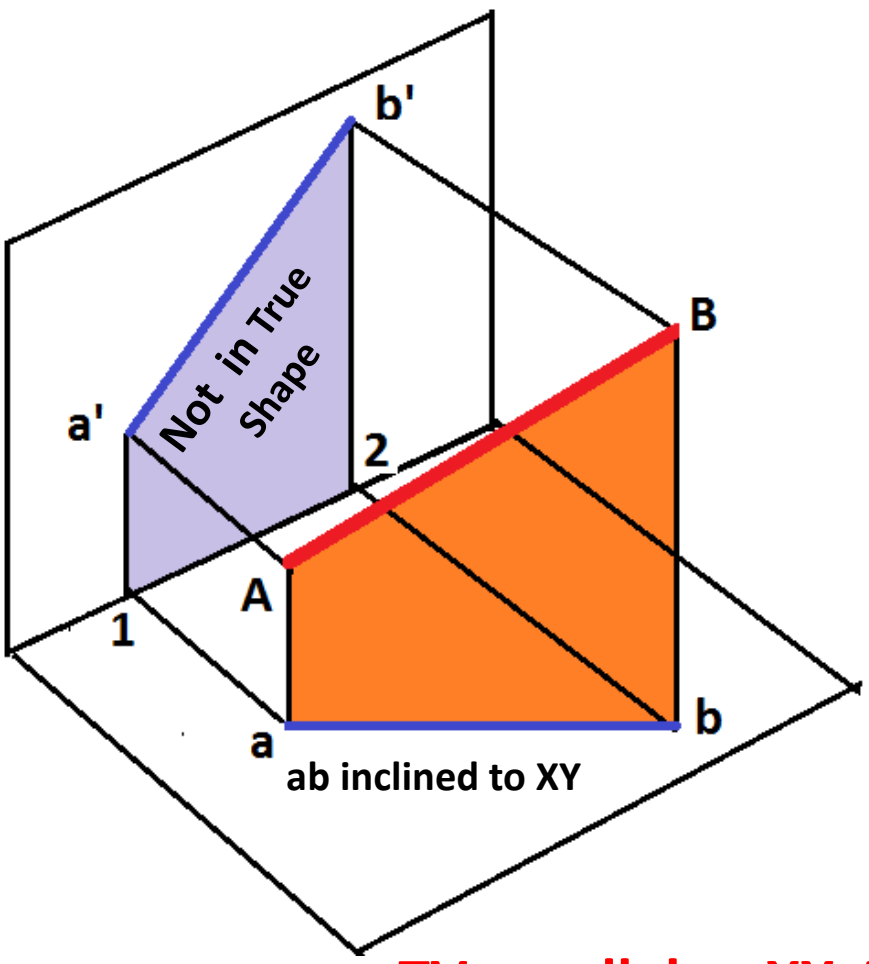


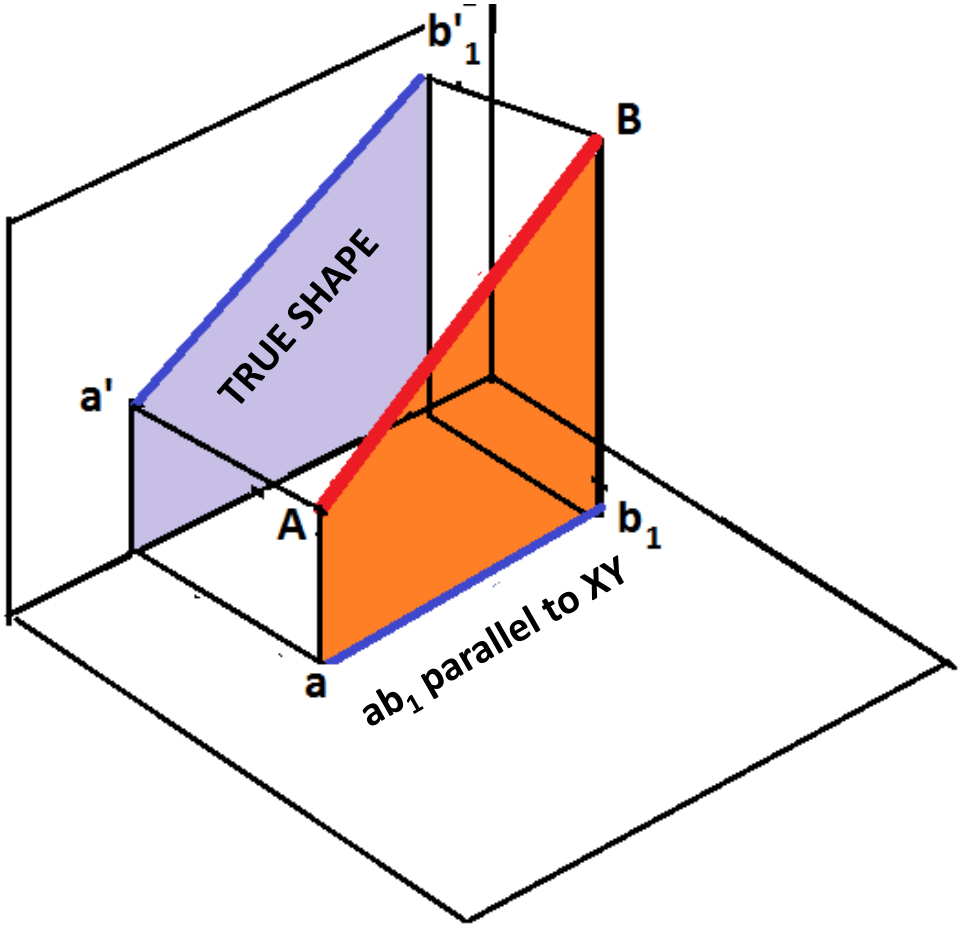
Line AB in space.
TV (ab) on HP.
FV (a'b') on VP.

θ –inclination of AB to HP.
--angle b/w True length & its TV.
--angle b/w AB & ab.

Length of ab_1 = length of ab

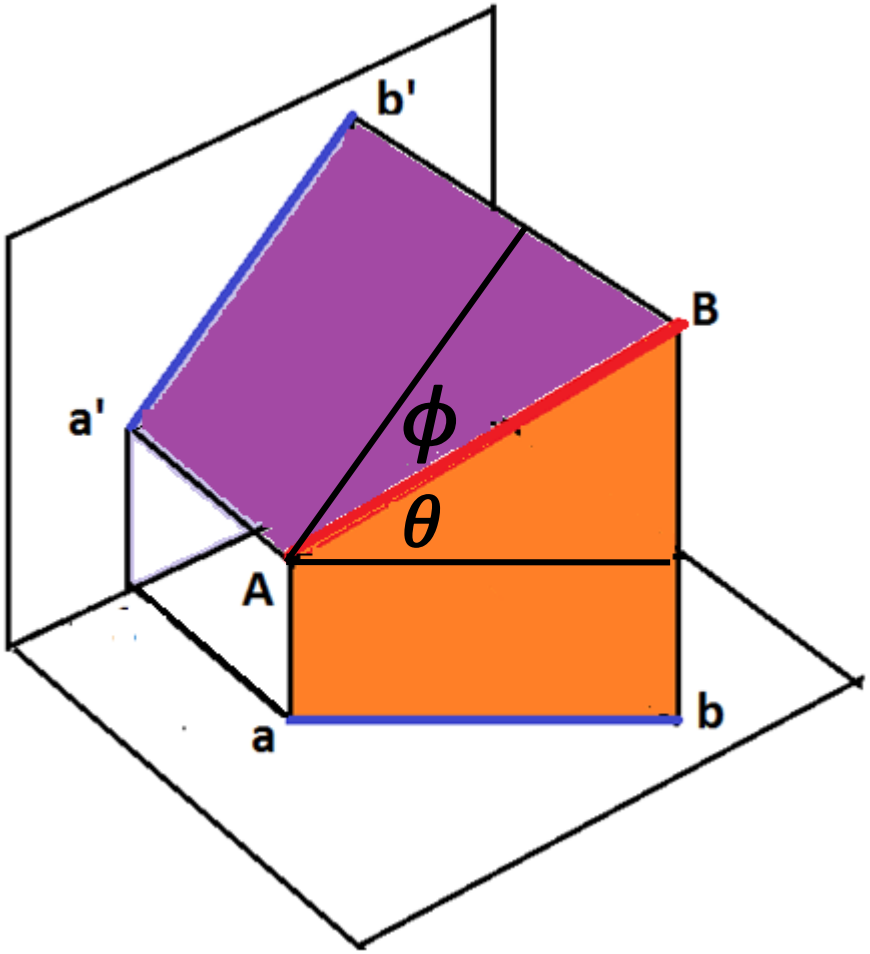
Height of b'_1 = Height of b'

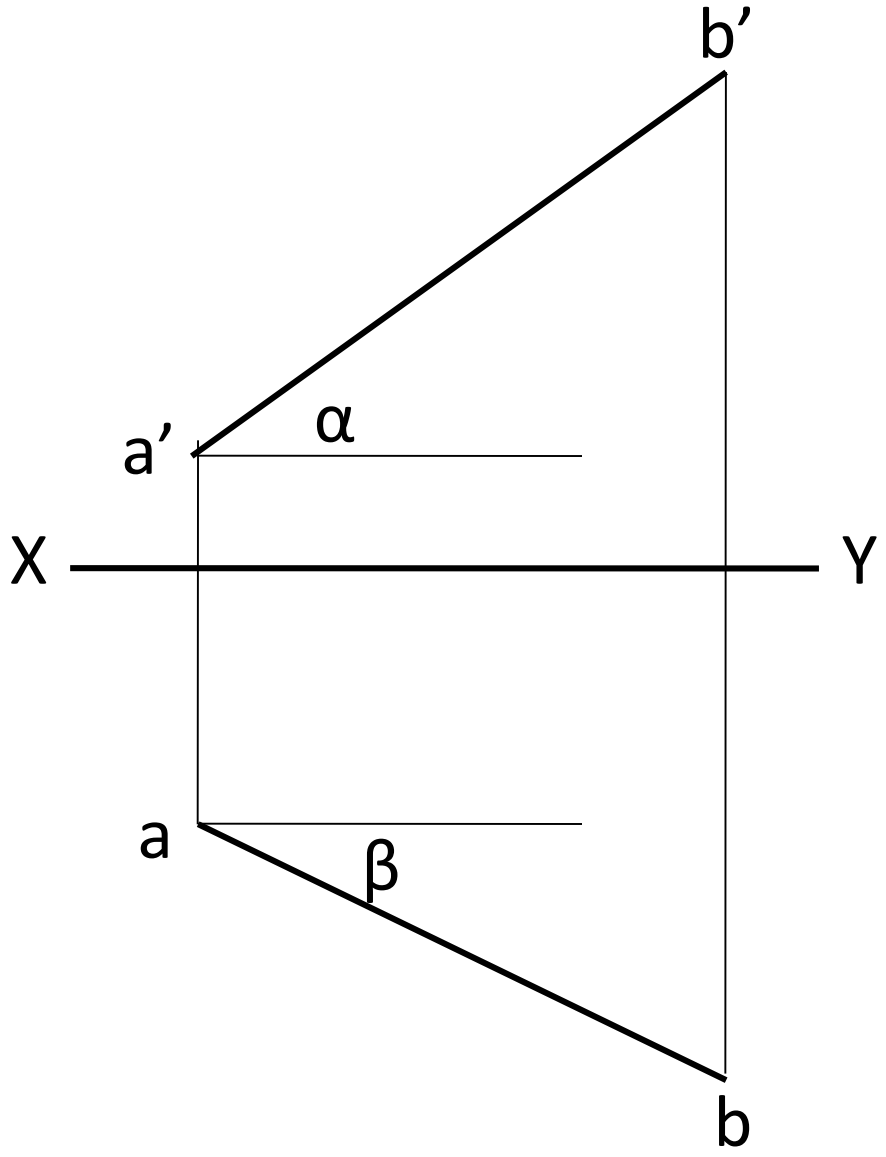




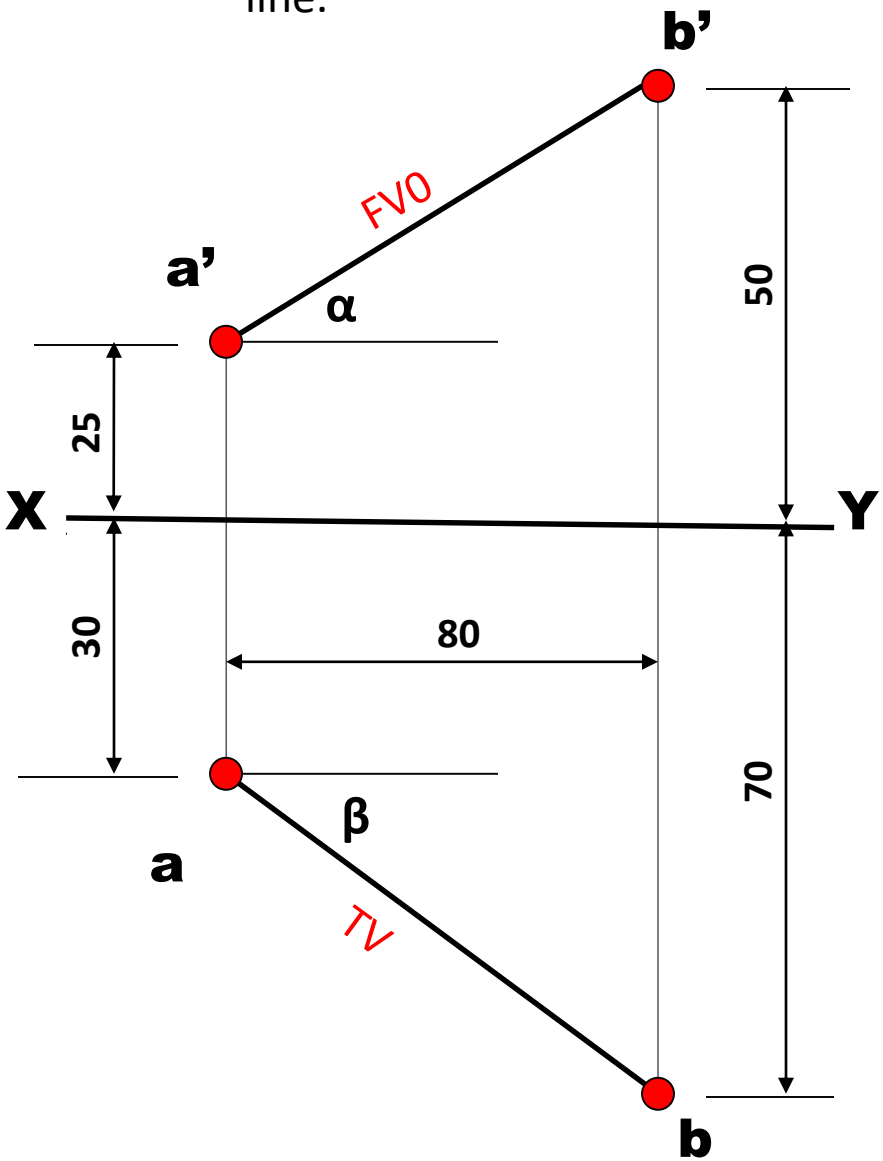
TV parallel to XY; FV represents the True length

LINE AB INCLINED TO HP & VP





(1). Line AB has its end A 25 mm above HP and 30 mm in front of VP. End B is 50 mm above HP and 70 mm in front of VP. Distance between the end projectors is 80 mm. Draw the projections of the line.



Positions of A

Positions of B

Length of FV

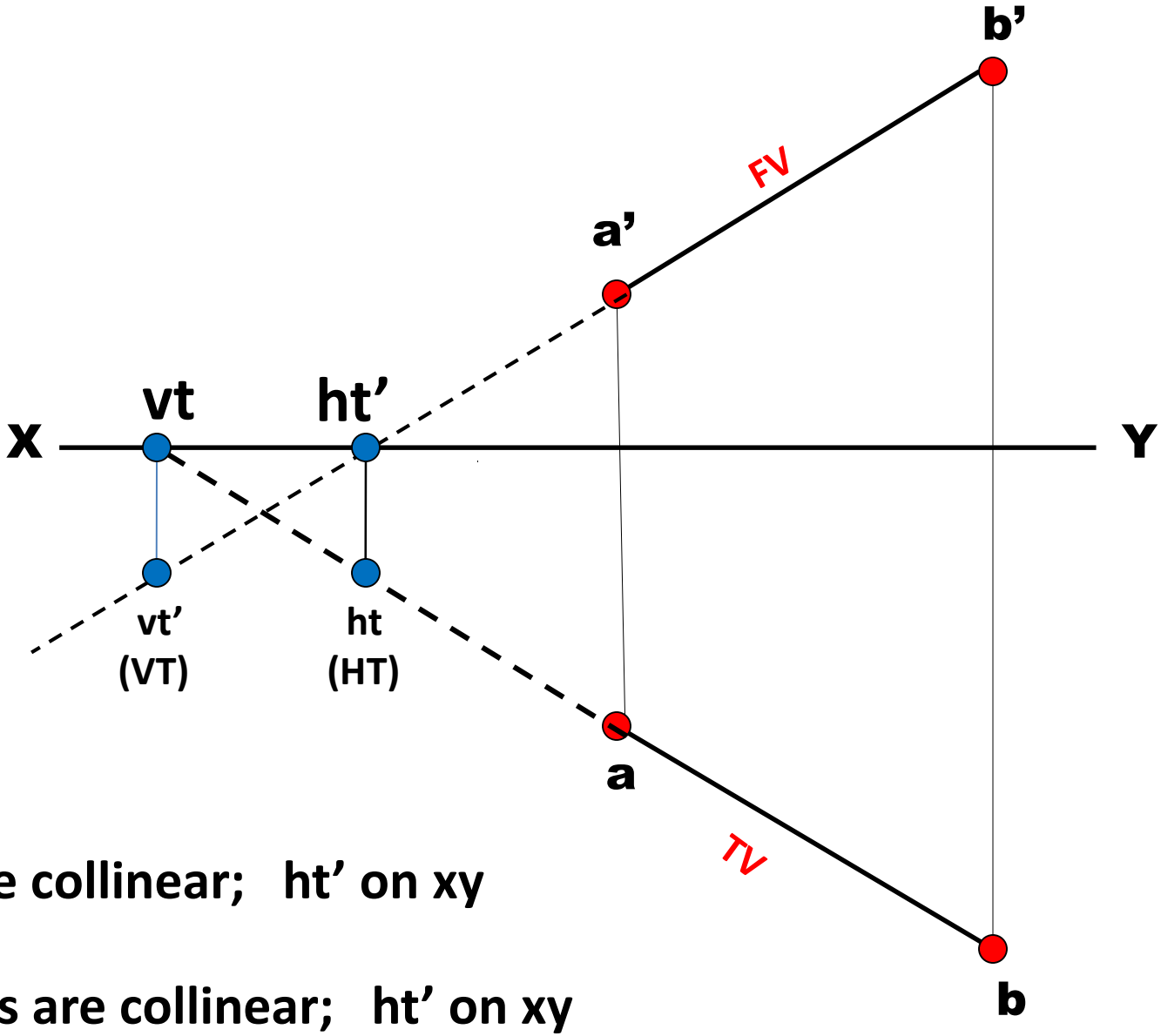
Length of TV

Inclination of FV to XY .....(α)

Inclination of TV to XY .....(β)

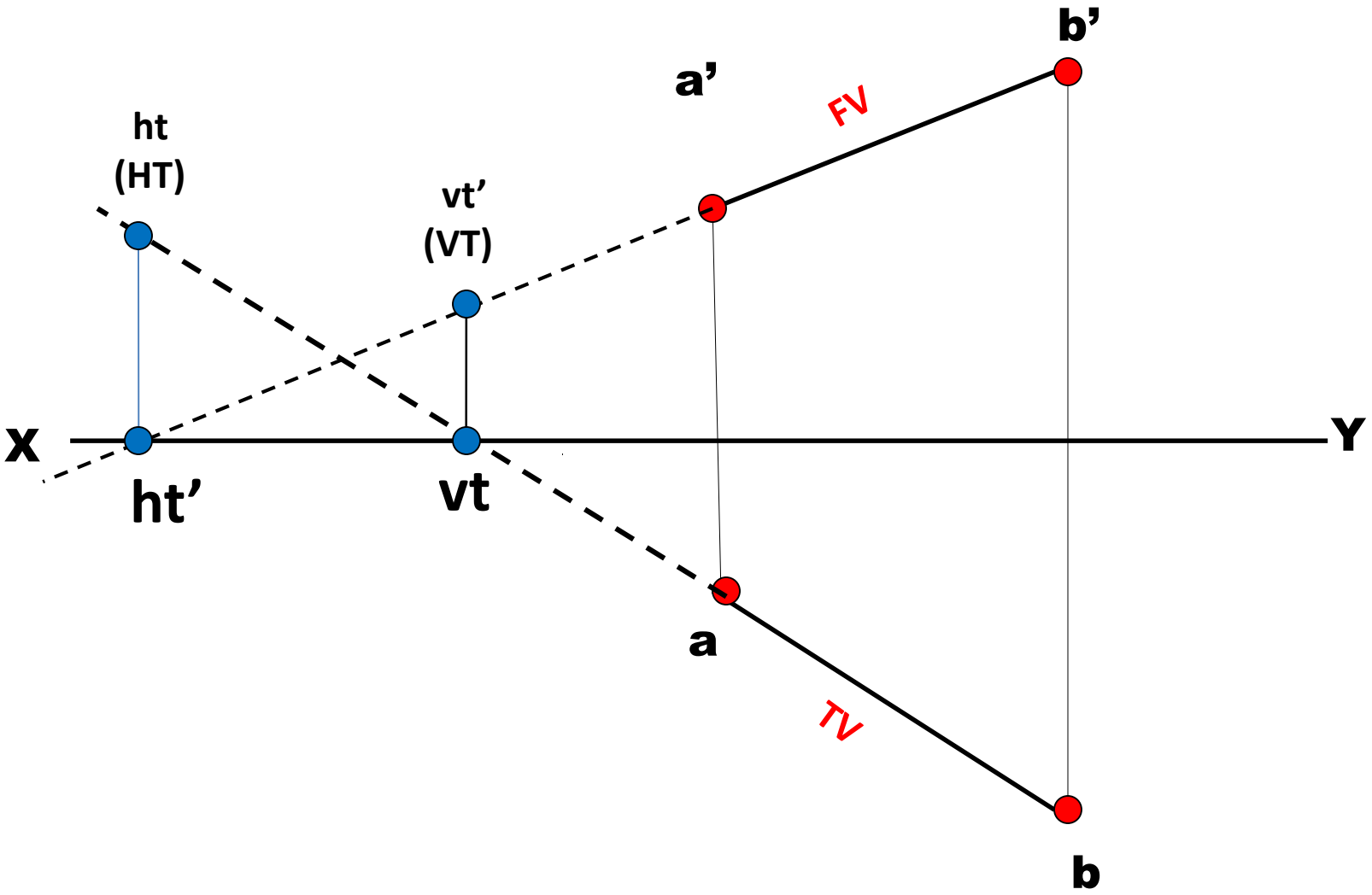
Distance b/w projectors..(Δ proj)

TRACES OF A LINE

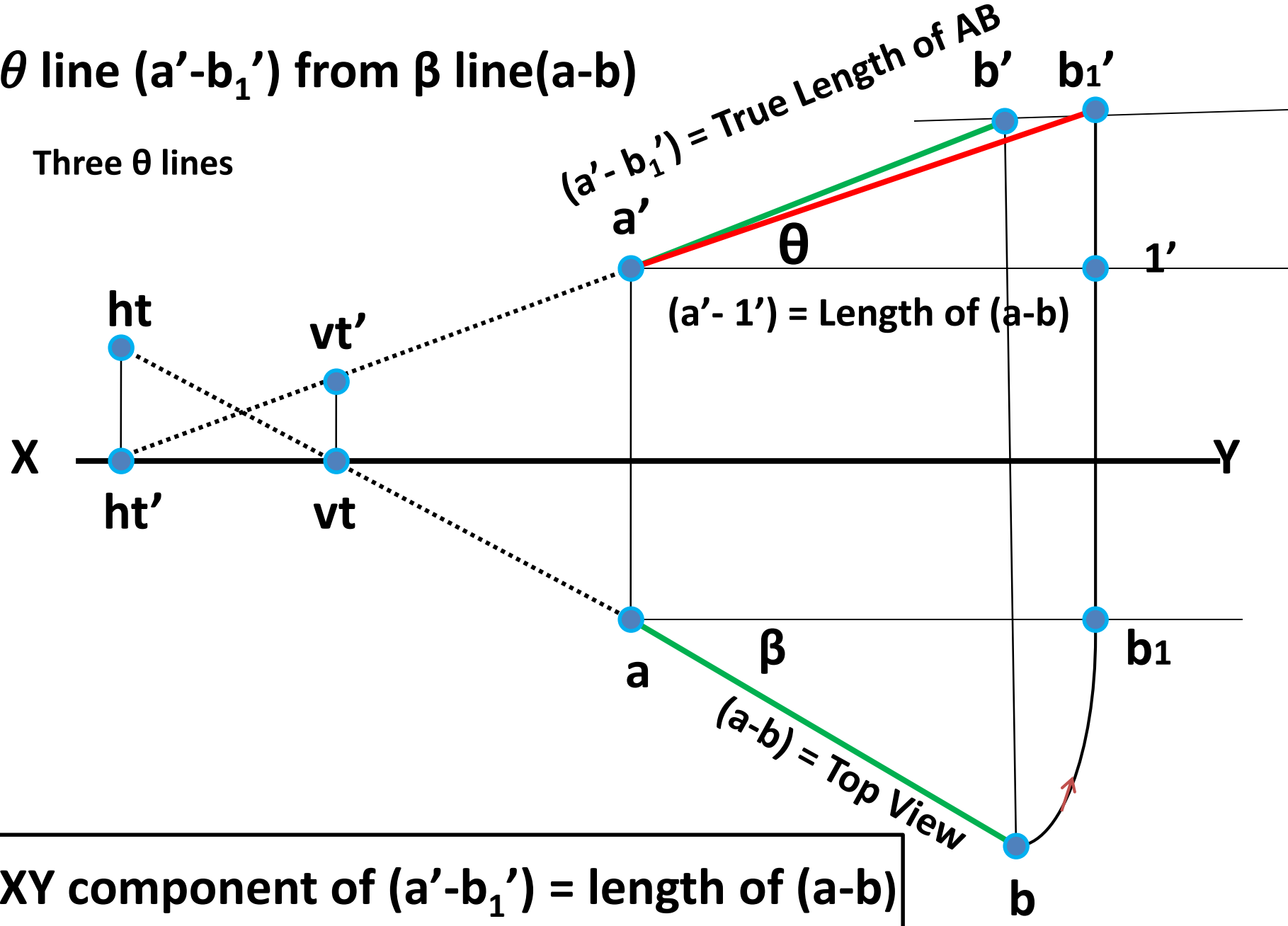


All Plan points are collinear; ht’ on xy

All Elevation points are collinear; ht’ on xy

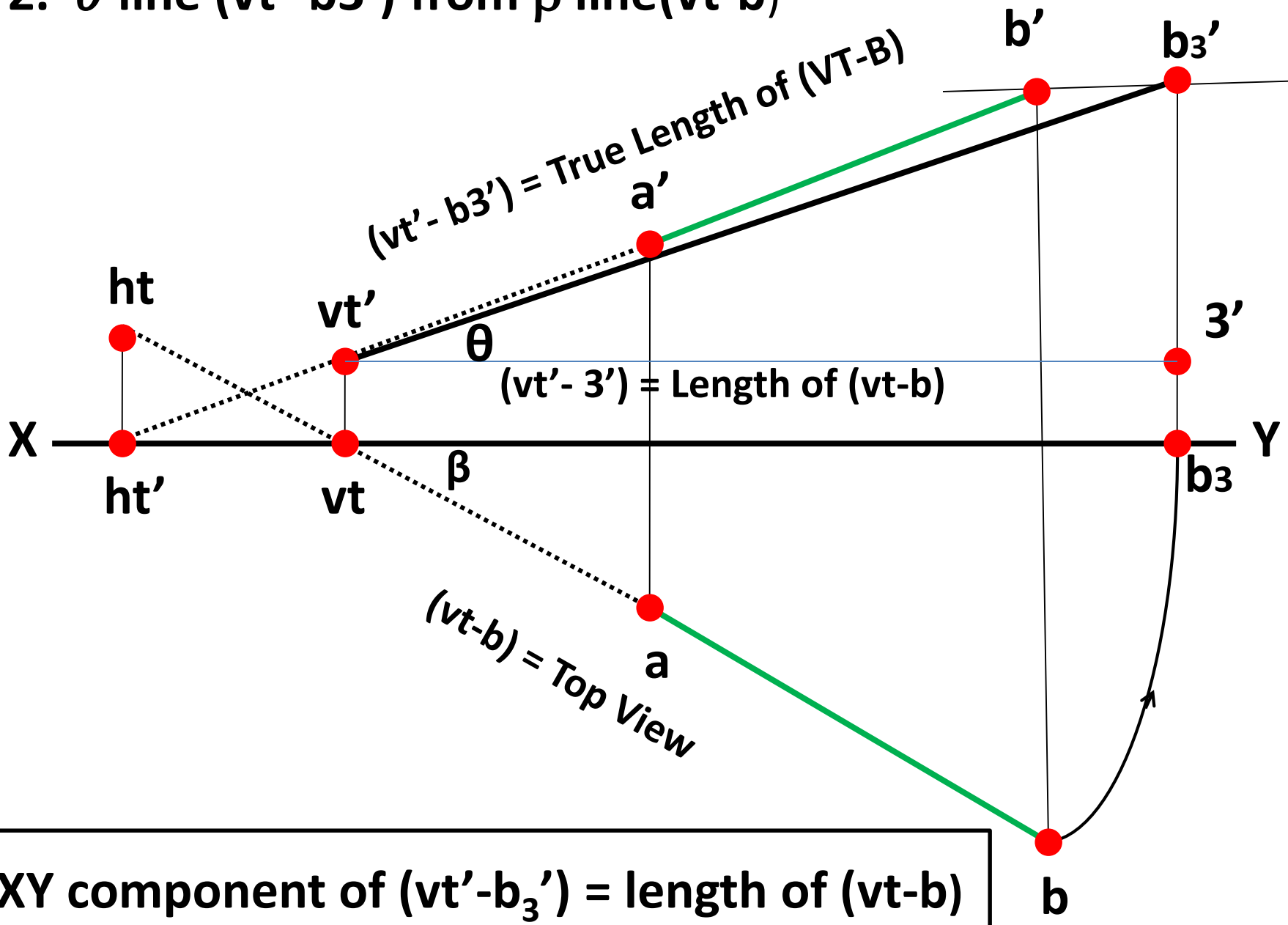

b’
a’
FV
ht
(HT)
vt’
(VT)
X
Y
ht’
vt
a
TV
b

θ line (a'-b_1') from β line(a-b)



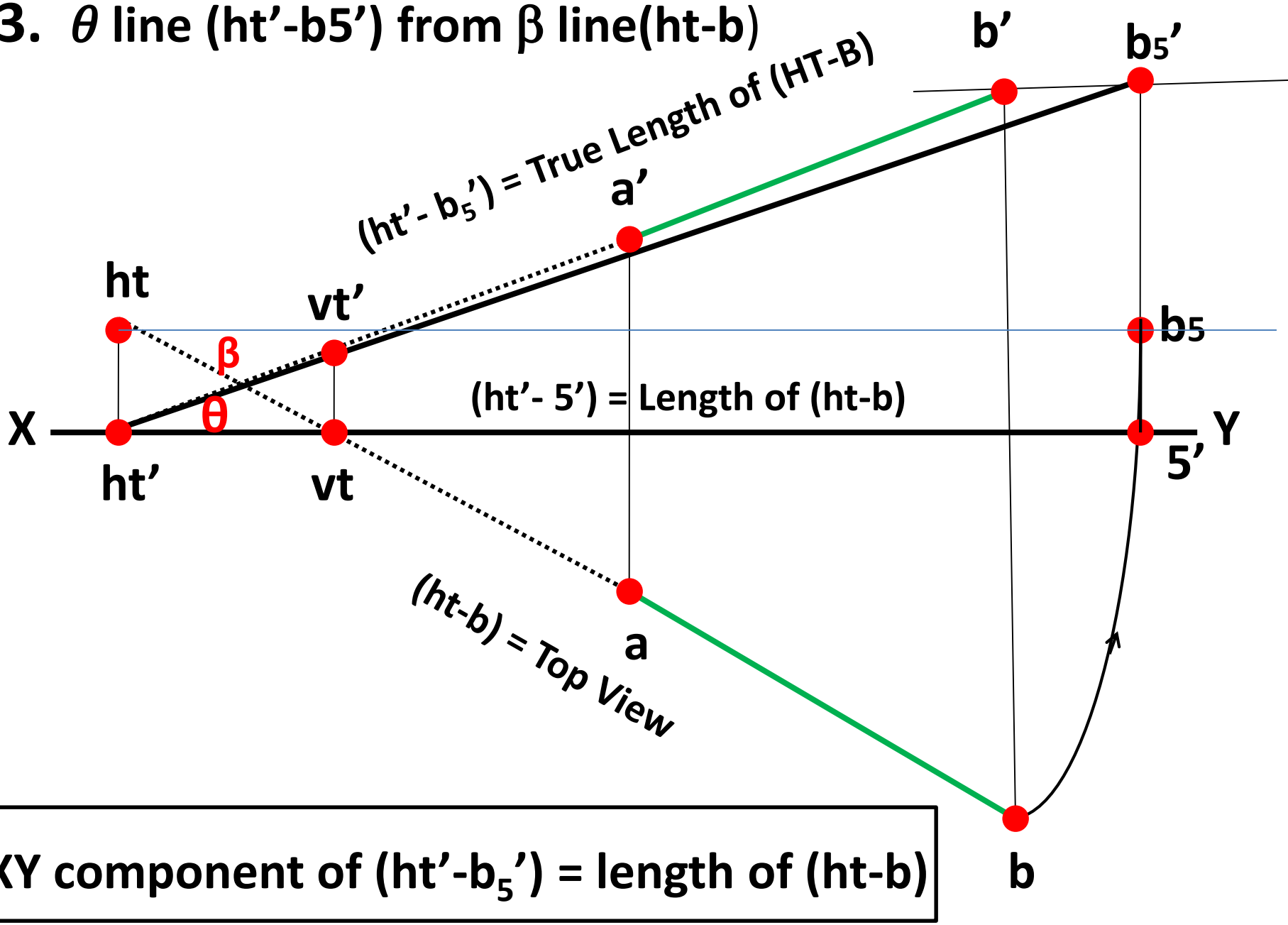
XY component of (a'-b_1') = length of (a-b)

2. θ line (vt'-b3') from β line(vt-b)



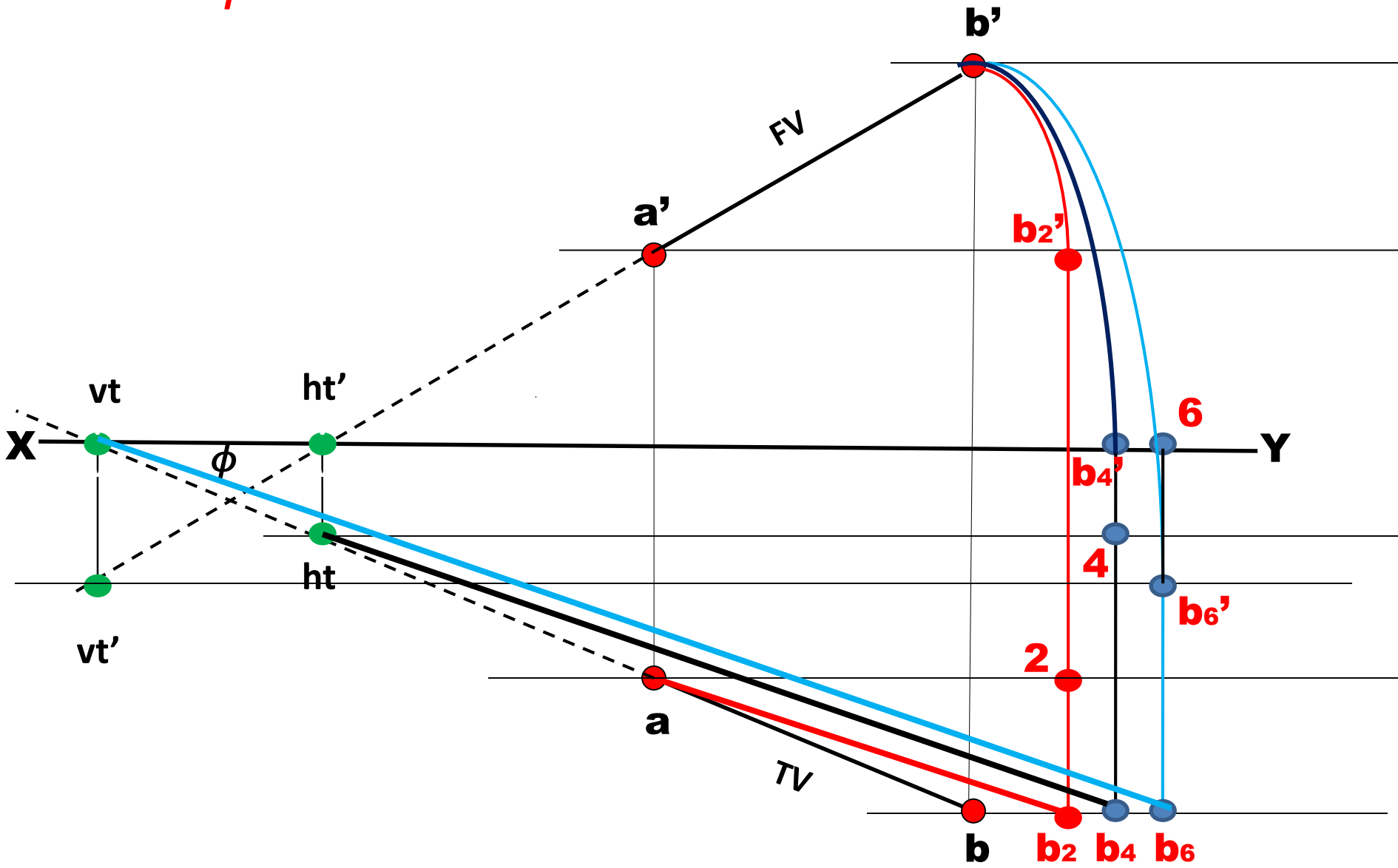
XY component of (vt'-b_3') = length of (vt-b)

3. θ line (ht'-b5') from β line(ht-b)

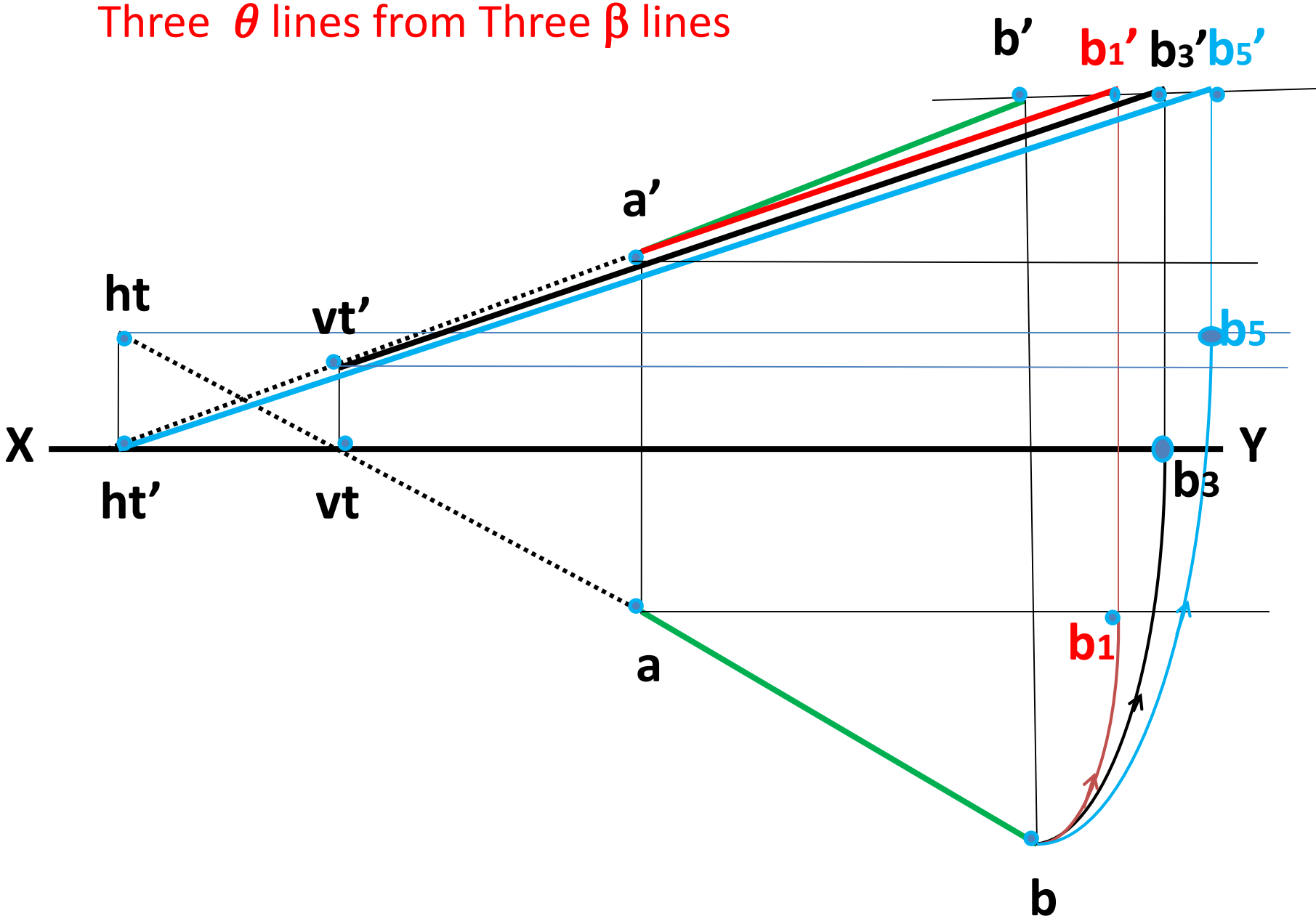


XY component of (ht'-b_5') = length of (ht-b)

Three ϕ lines from Three α lines

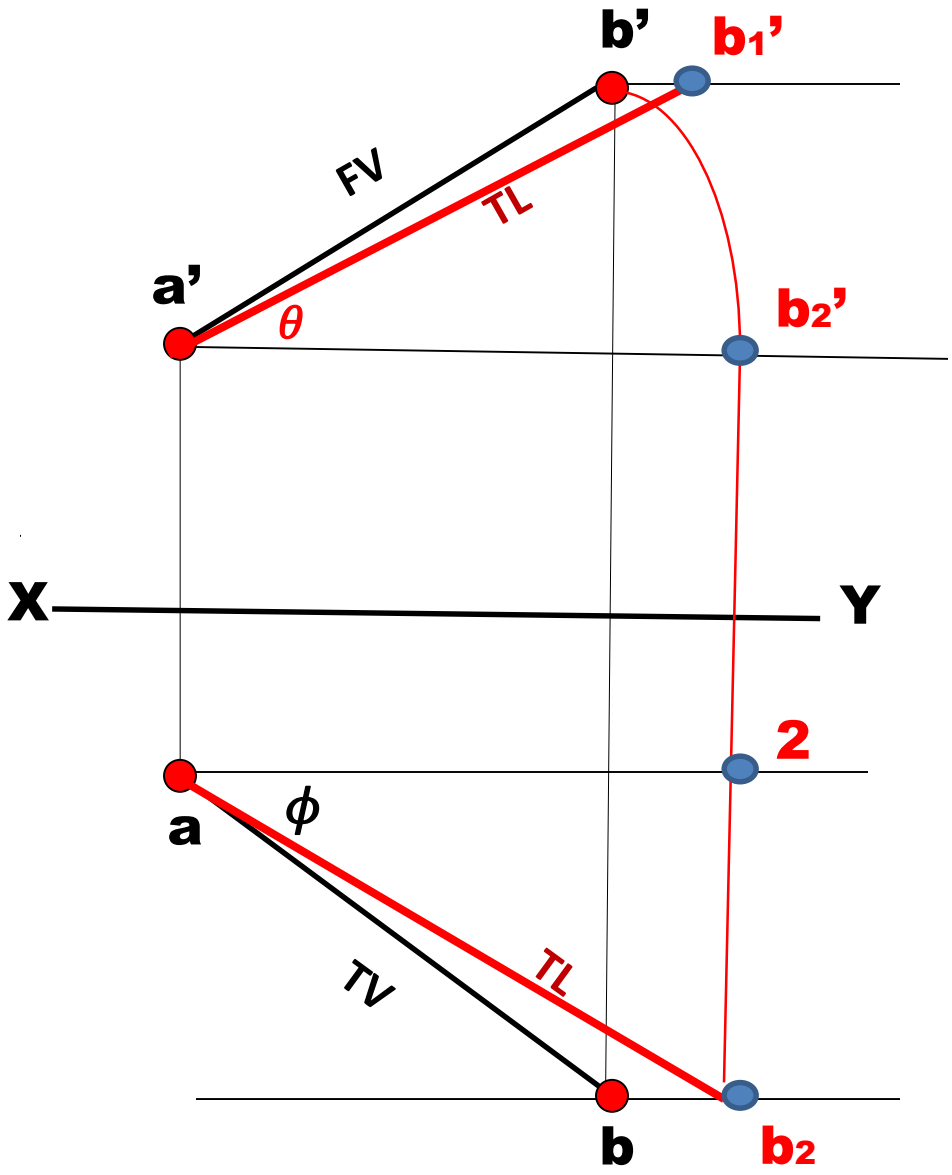


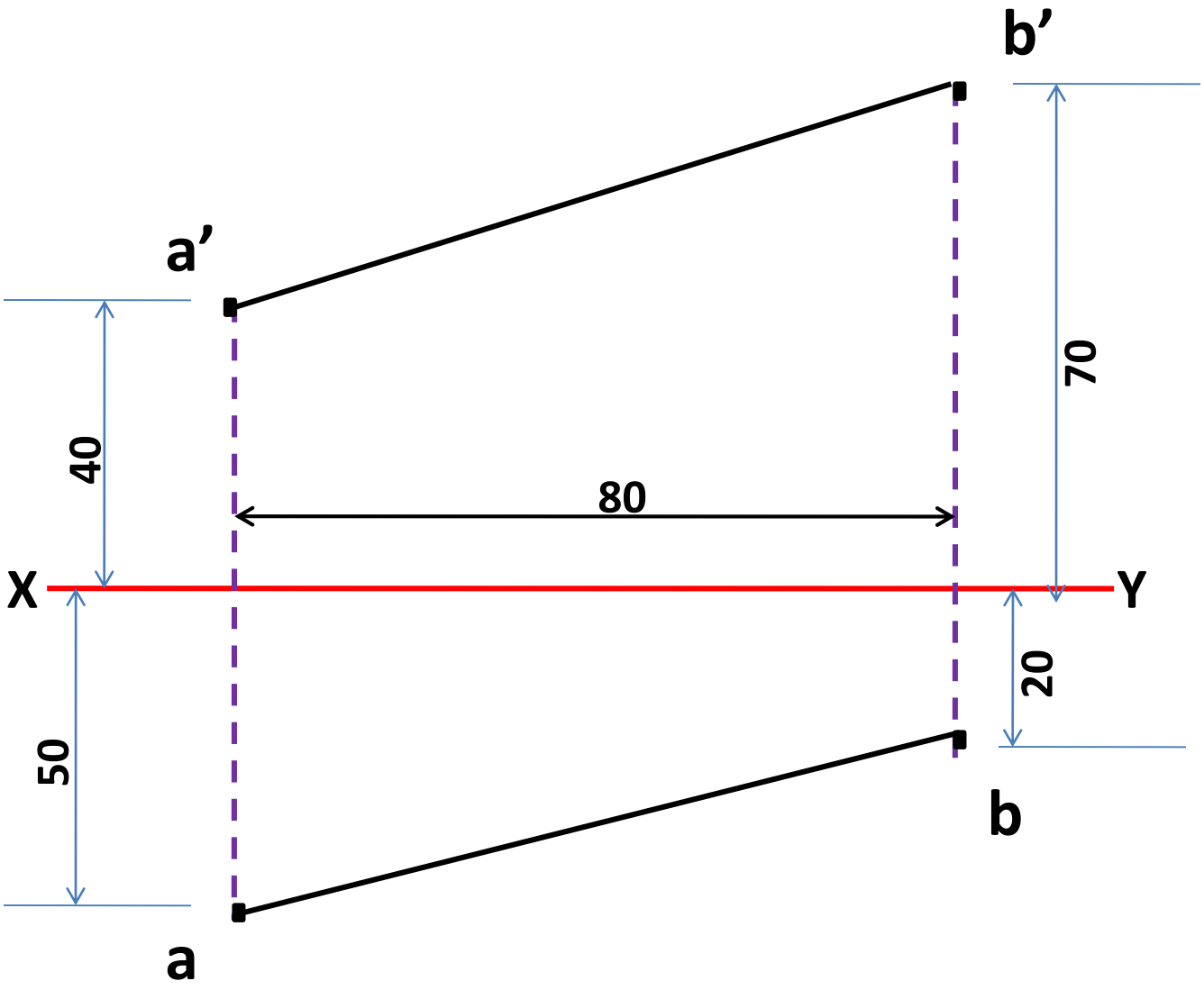
Three θ lines from Three β lines

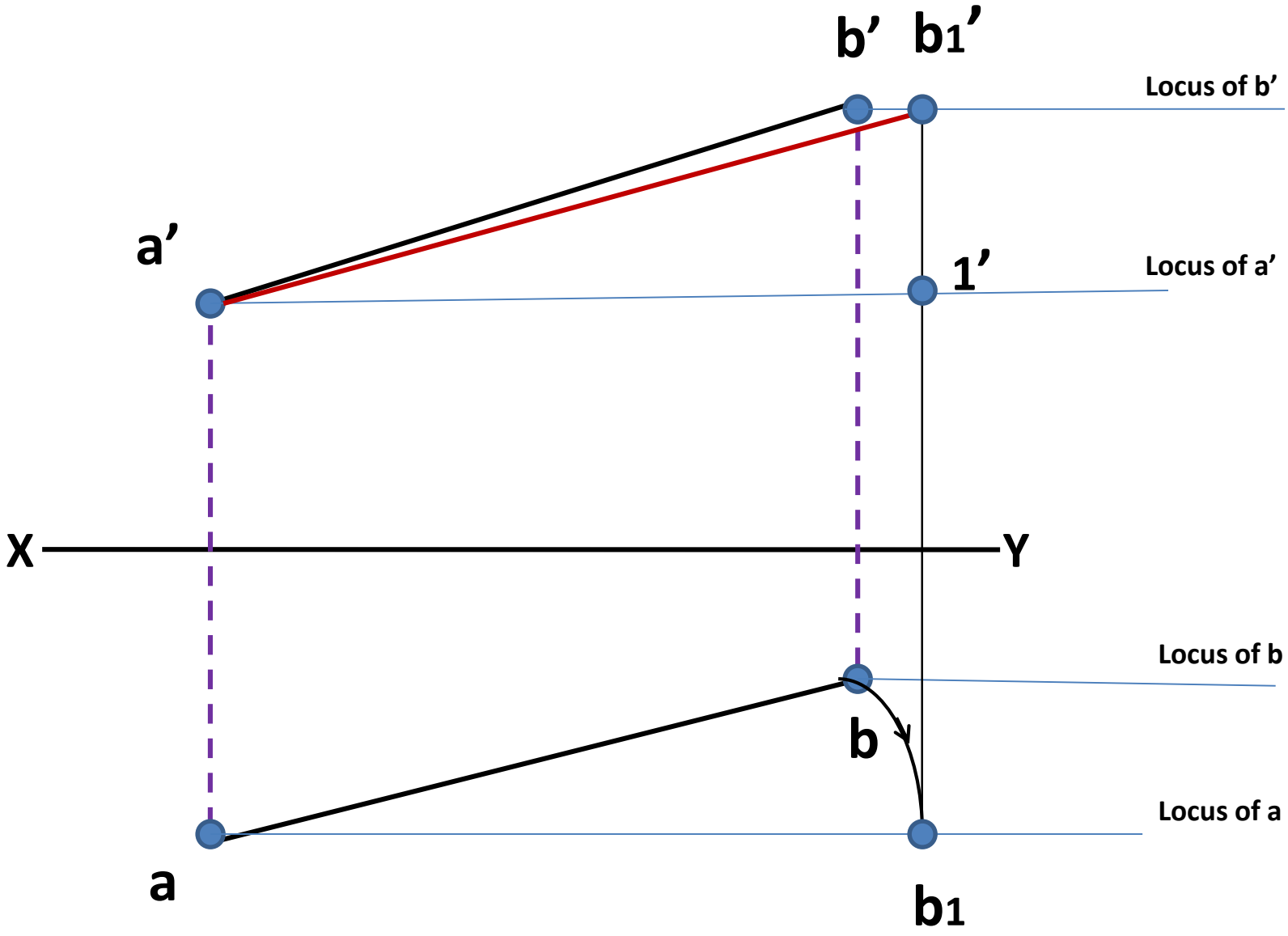


True length from α line

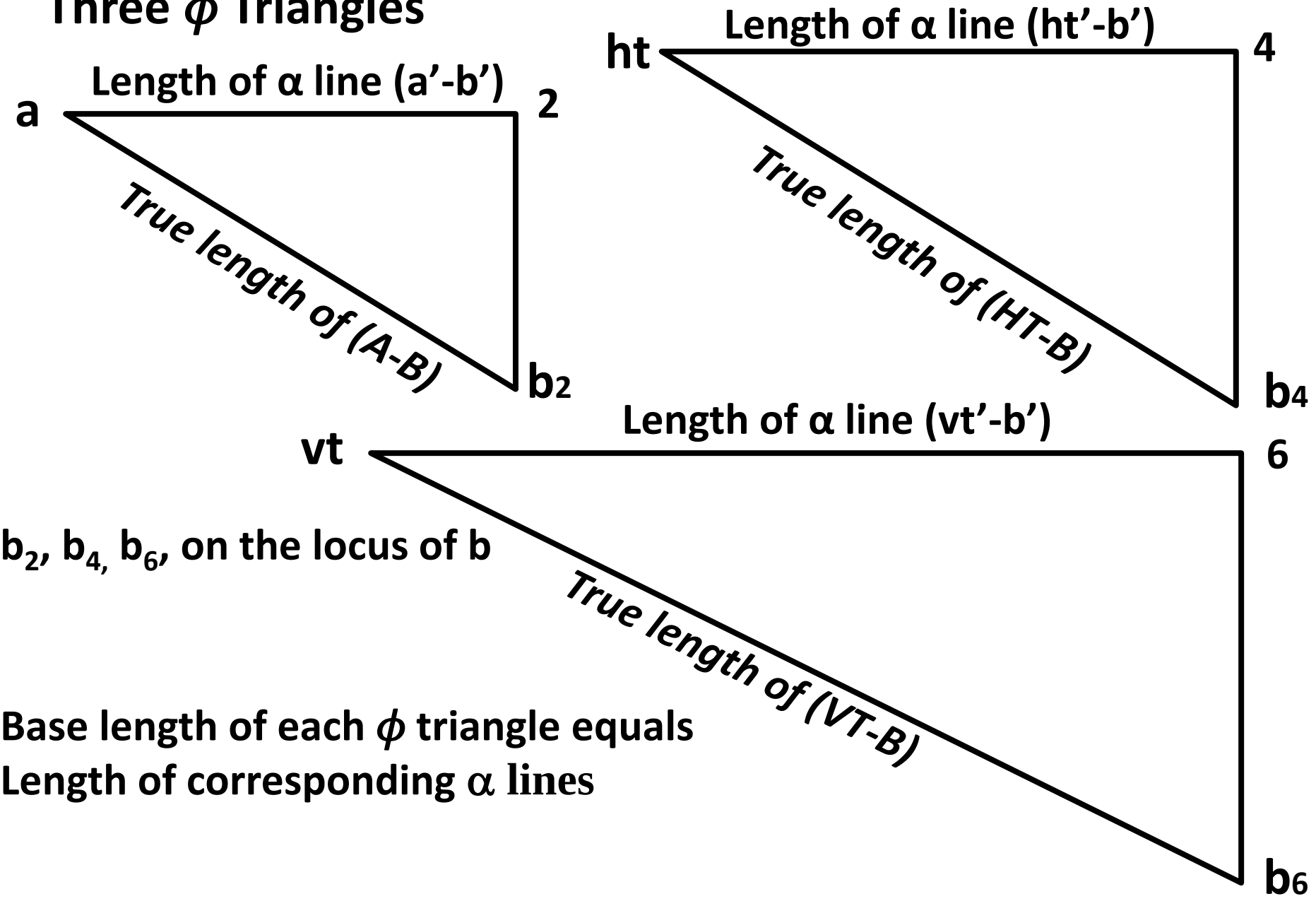
Triangle formed




b’
a’
70
40
80
X
Y
20
50
b
a

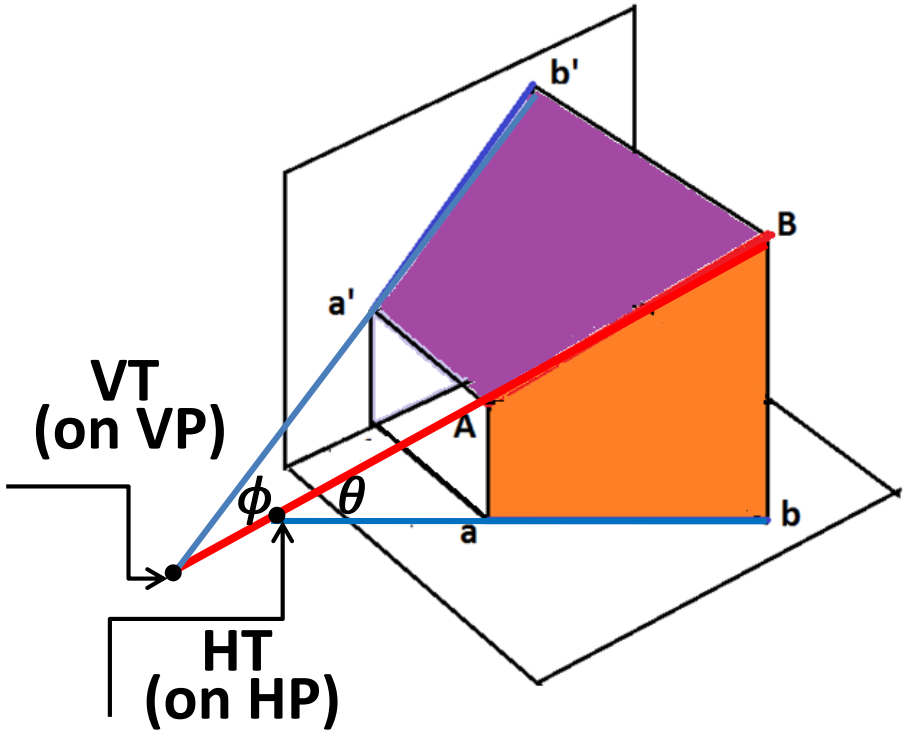

b’
b1’
Locus of b’
a’
1’
Locus of a’
X
Y
Locus of b
b
Locus of a
a
b1

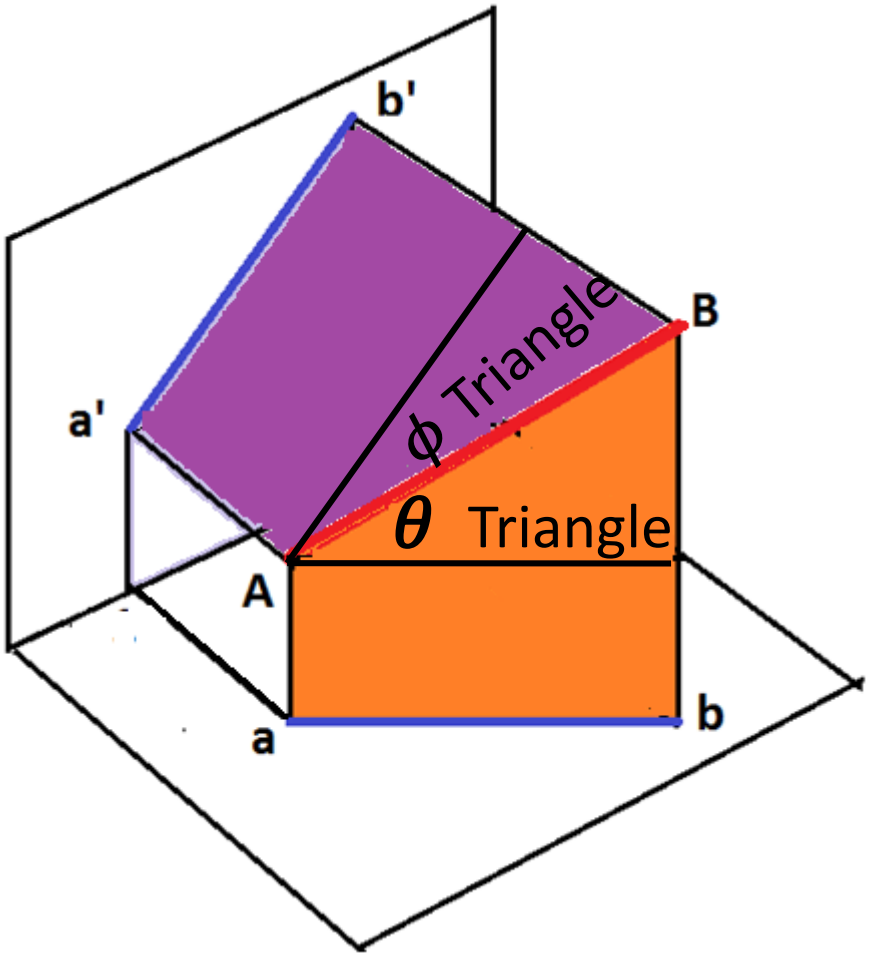
Three ϕ Triangles

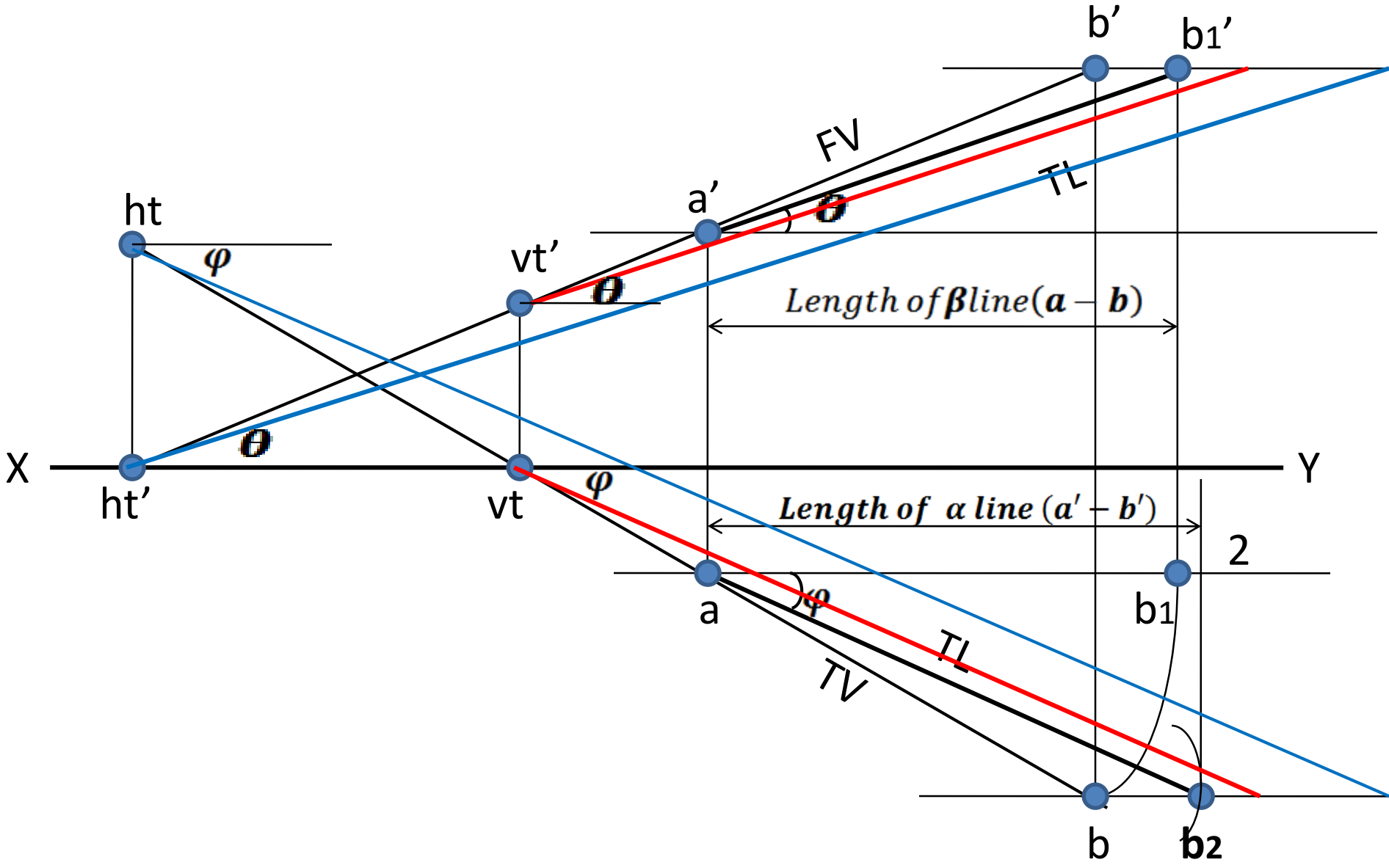


b_2, b_4, b_6, on the locus of b

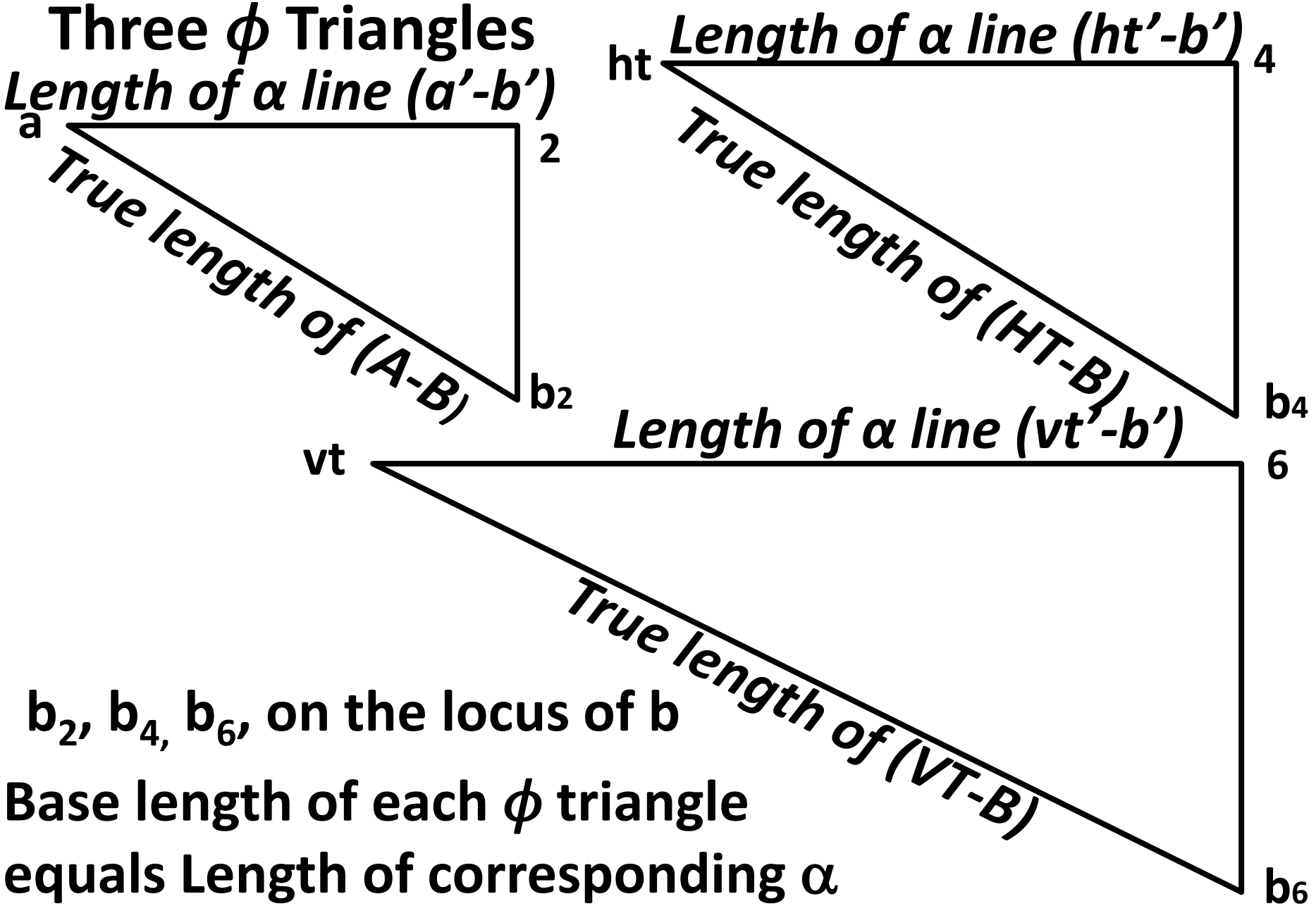
Base length of each ϕ triangle equals
Length of corresponding α lines


b'
B
a'
A
VT
(on VP)
ϕ
θ
a
b
HT
(on HP)


b'
B
a'
ϕ Triangle
θ Triangle
A
a
b


b’
b1’
FV
TL
a’
ht
φ
θ
vt’
θ
Length of β line (a – b)
X
Y
θ
ht’
vt
φ
Length of α line (a′ – b′)
2
a
φ
b1
TL
TV
b
b2

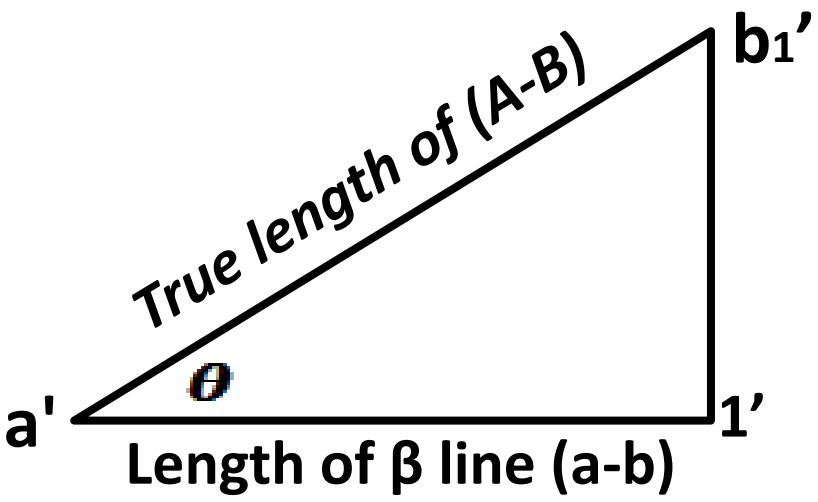
Three ϕ Triangles

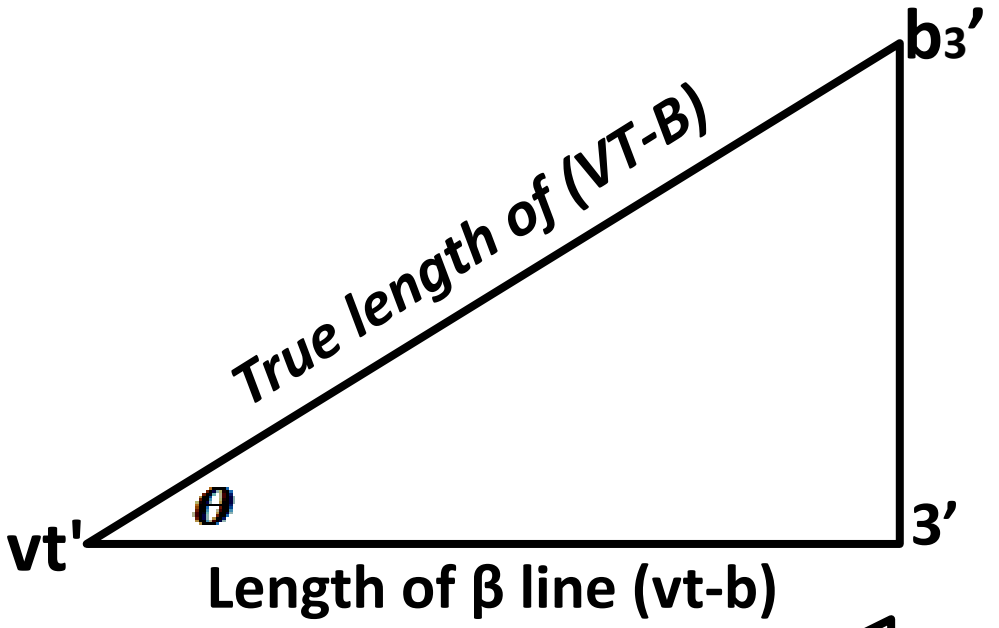


b_2, b_4, b_6, on the locus of b

Base length of each ϕ triangle equals Length of corresponding α lines

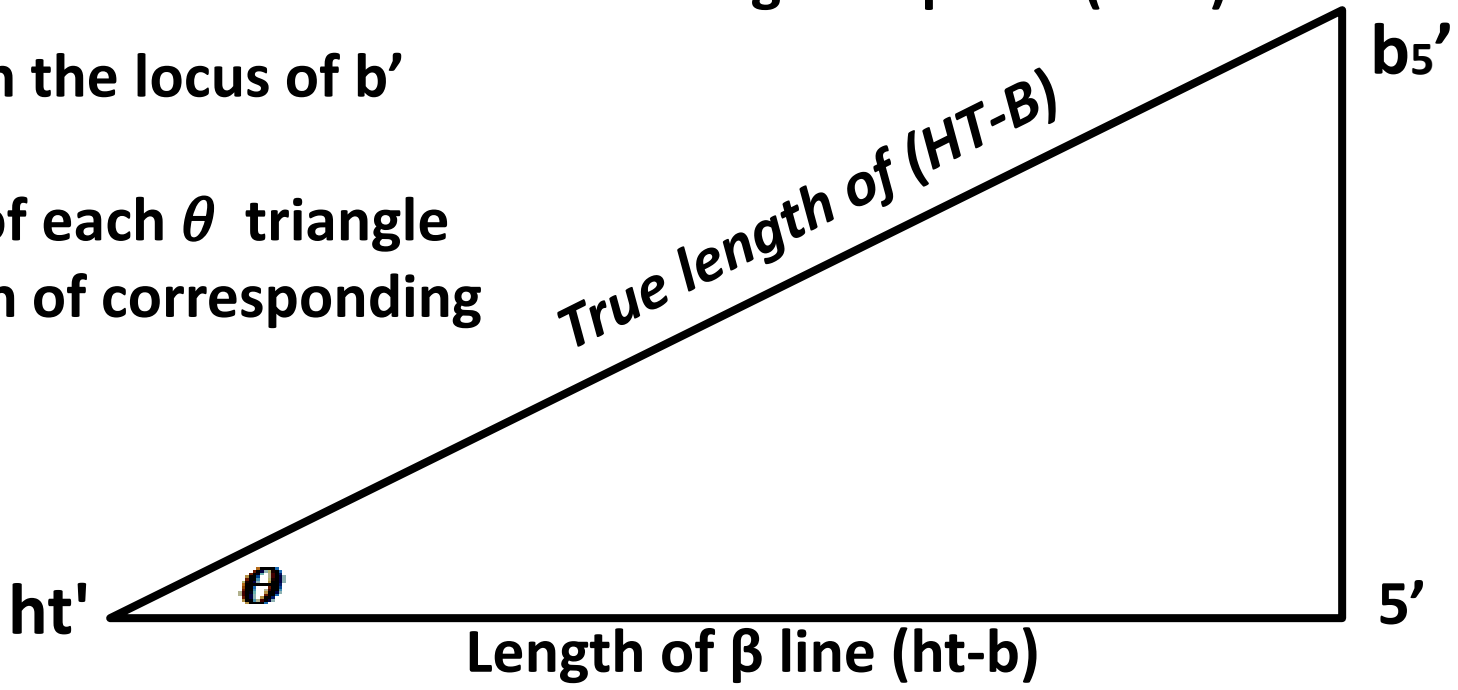
Three θ Triangles



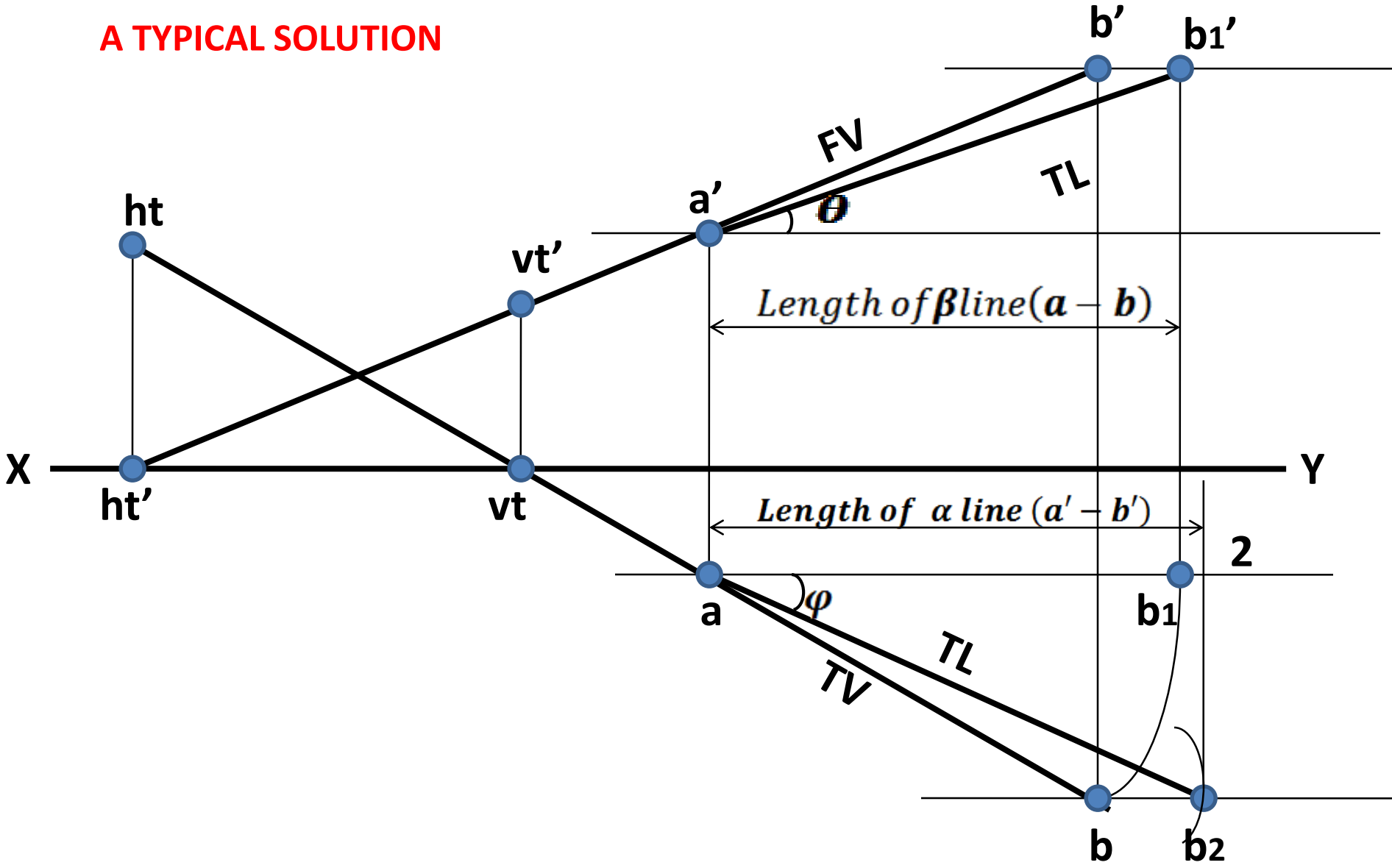


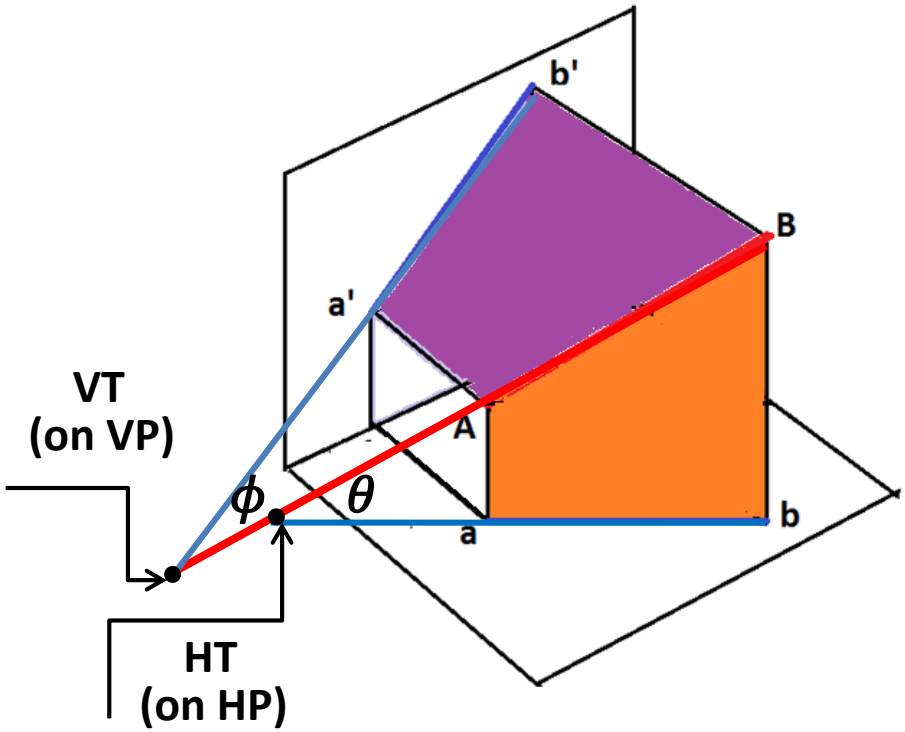
b_1', b_3' b_5', on the locus of b’

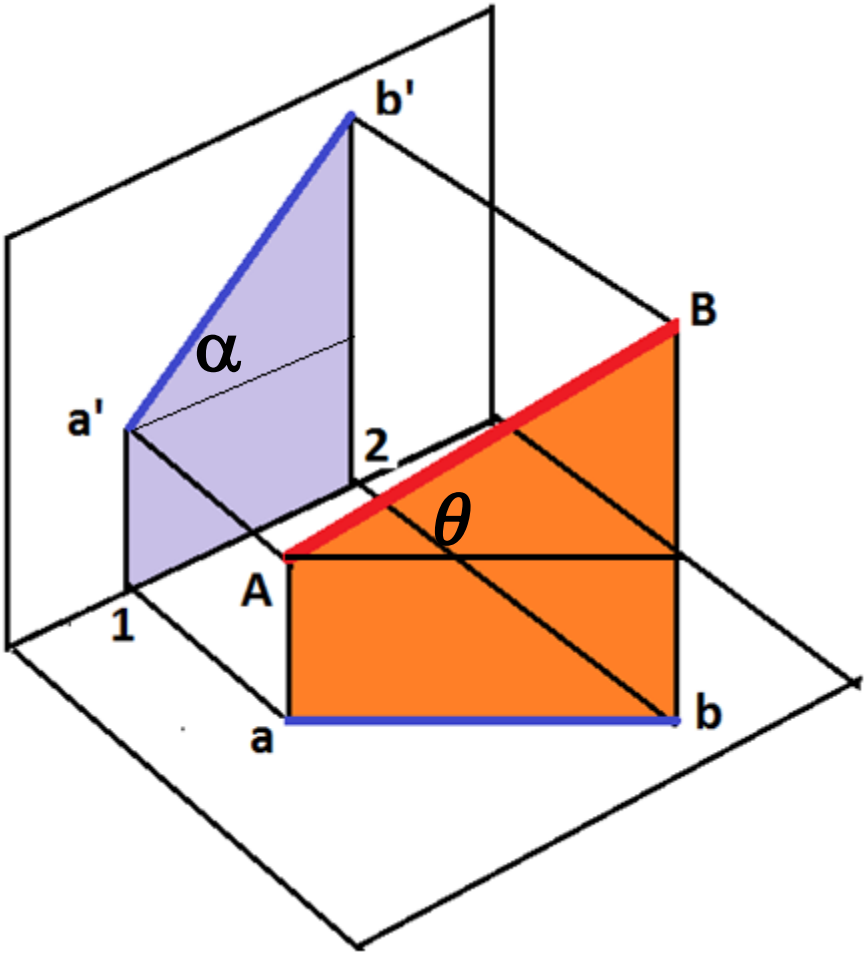
Base length of each θ triangle equals Length of corresponding β lines

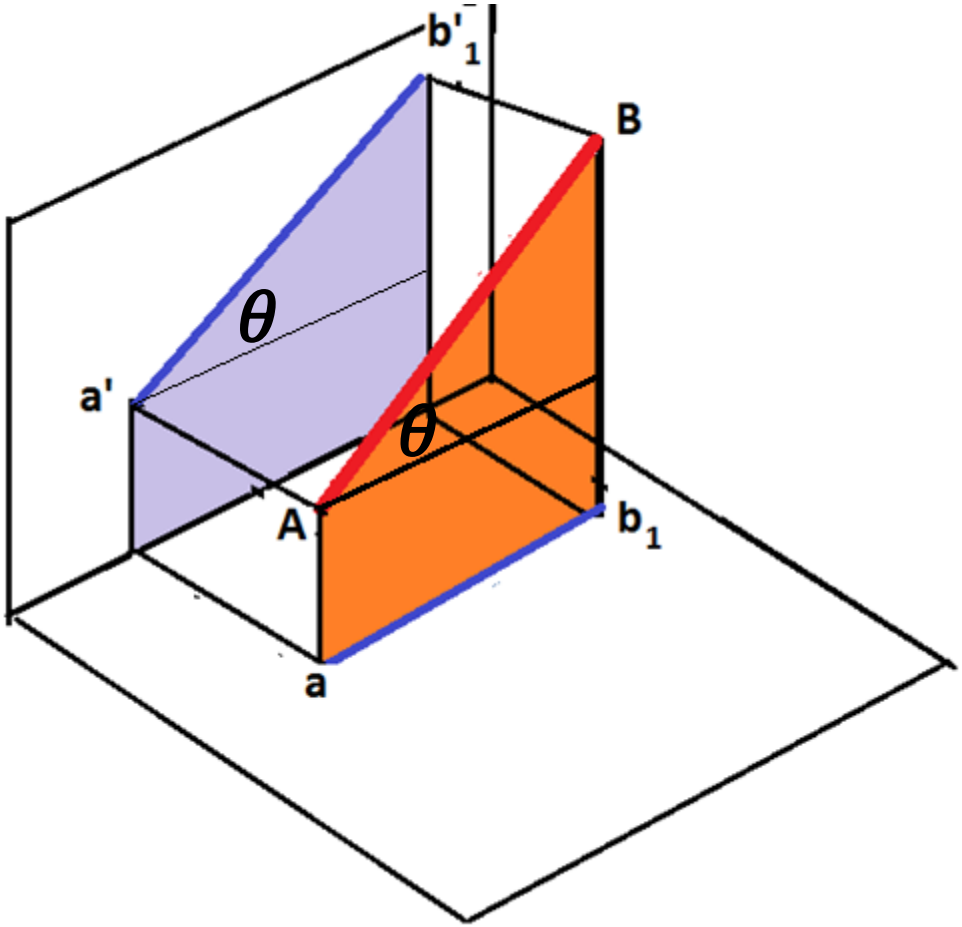


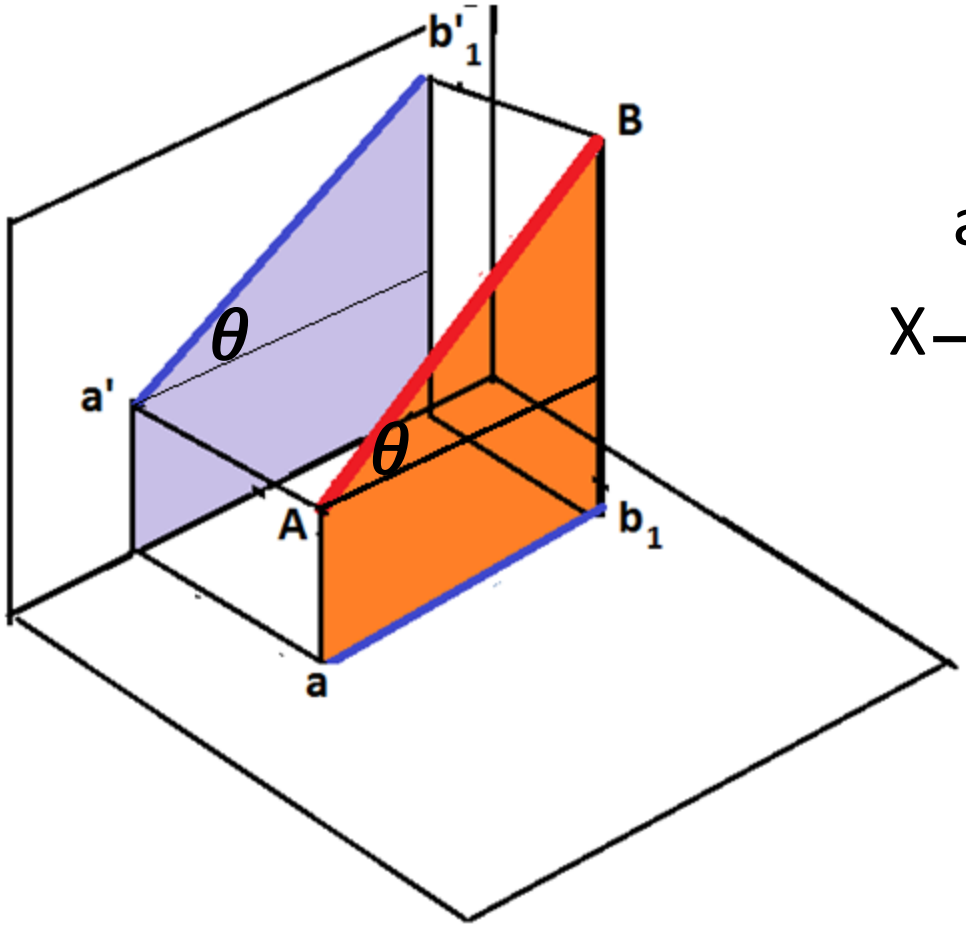
A TYPICAL SOLUTION

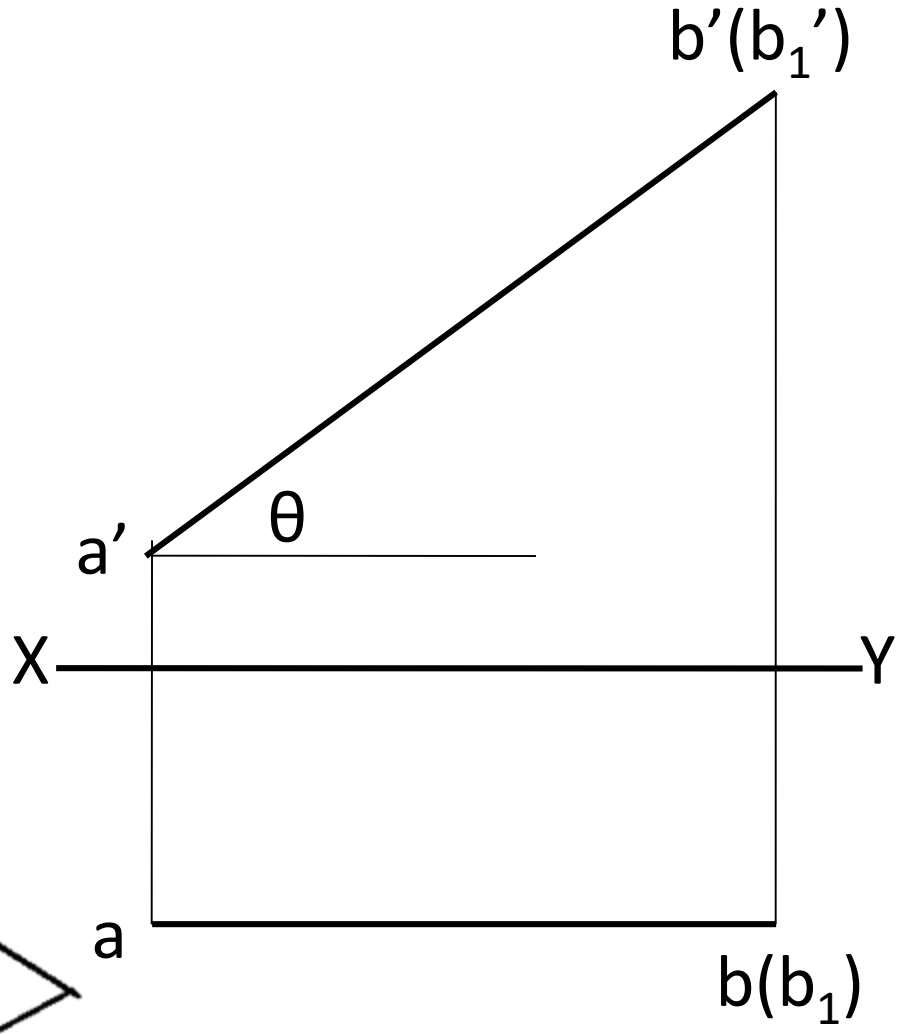



b'
B
a'
A
VT
(on VP)
ϕ
θ
a
b
HT
(on HP)

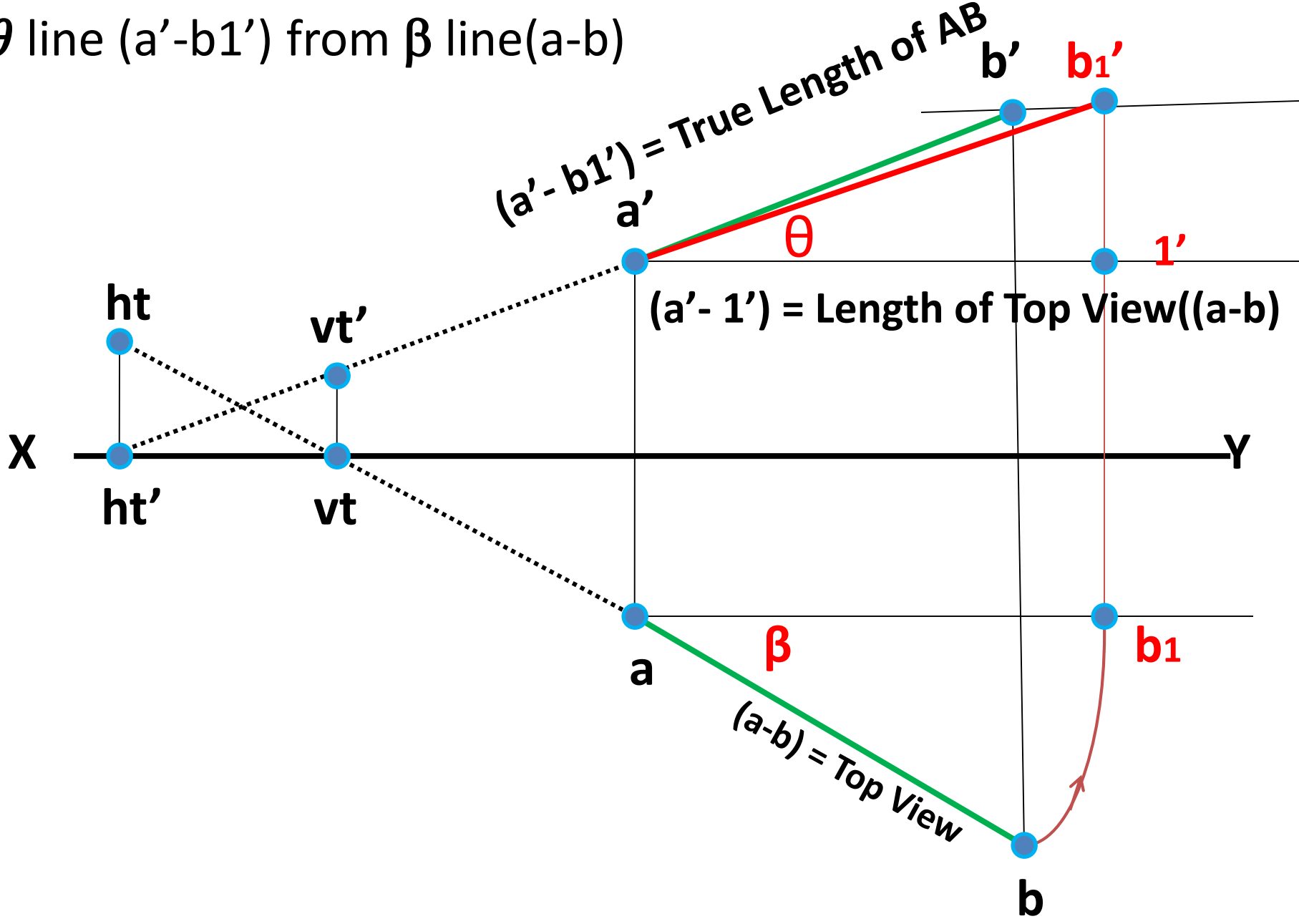

b'
α
B
a'
2
θ
A
1
a
b

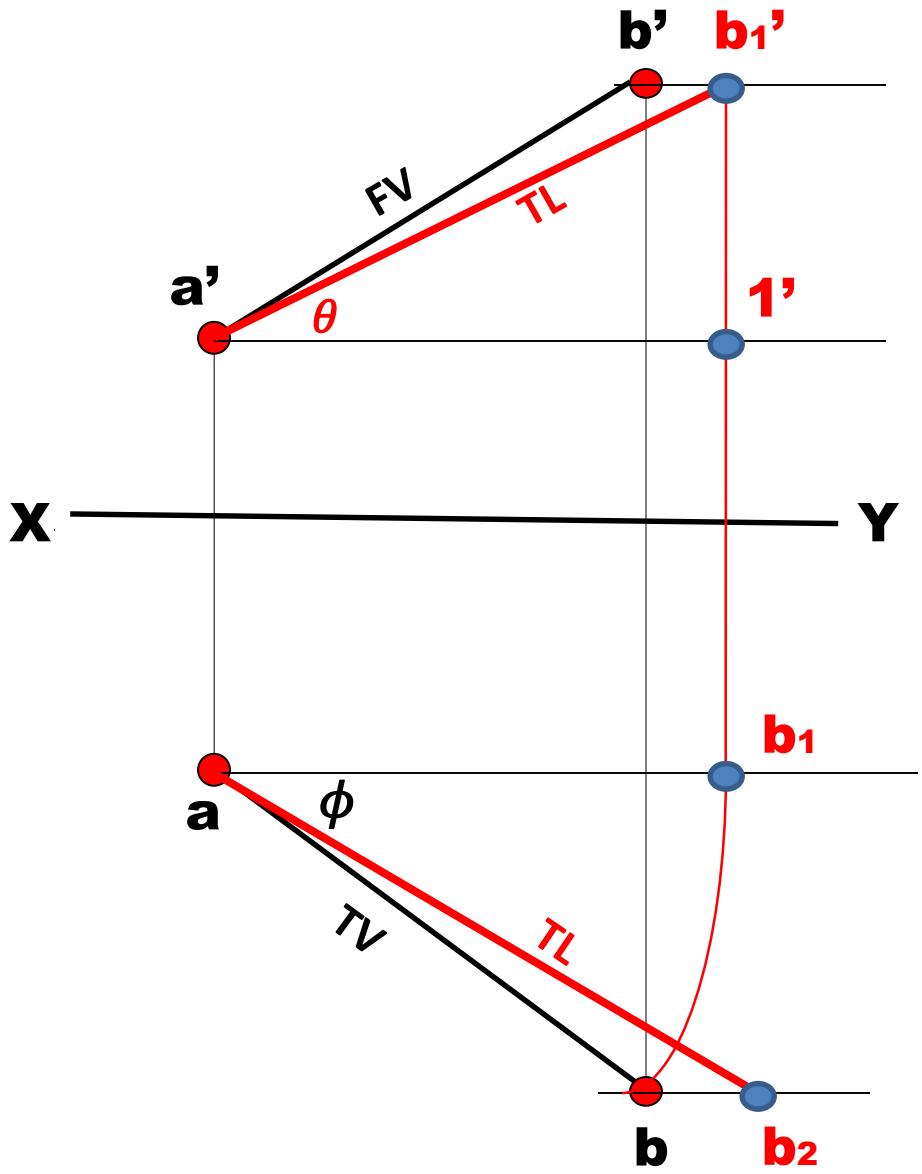

b'1
B
θ
a'
θ
A
b1
a


b'1
B
θ
a'
θ
A
b1
a


b'(b1')
θ
a'
X
Y
a
b(b1)

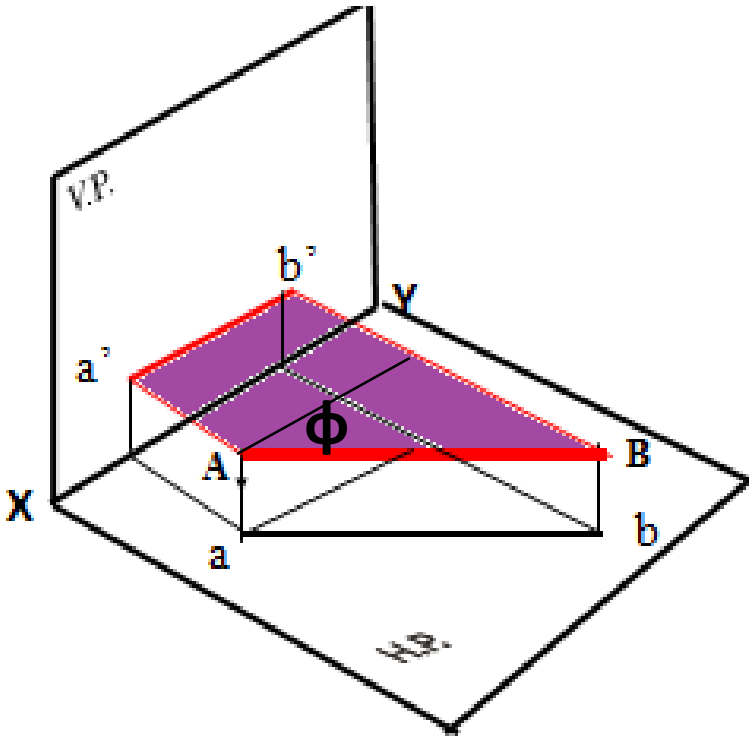
θ line (a'-b1') from β line(a-b)

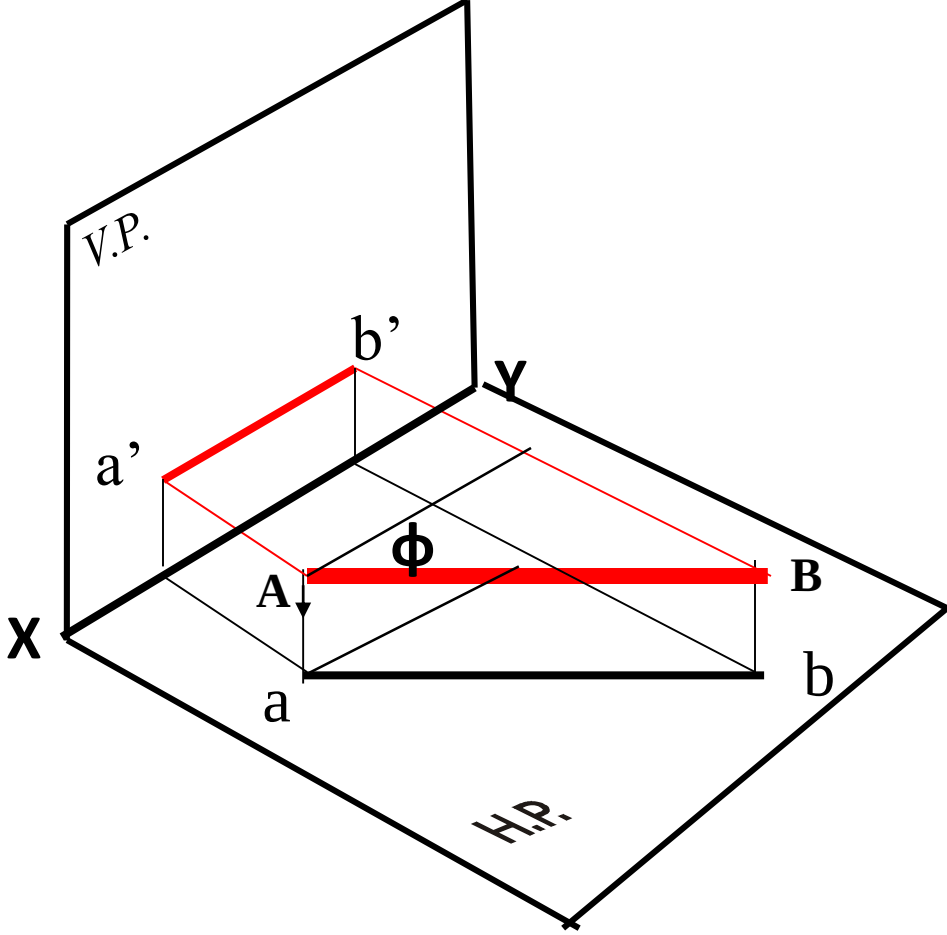


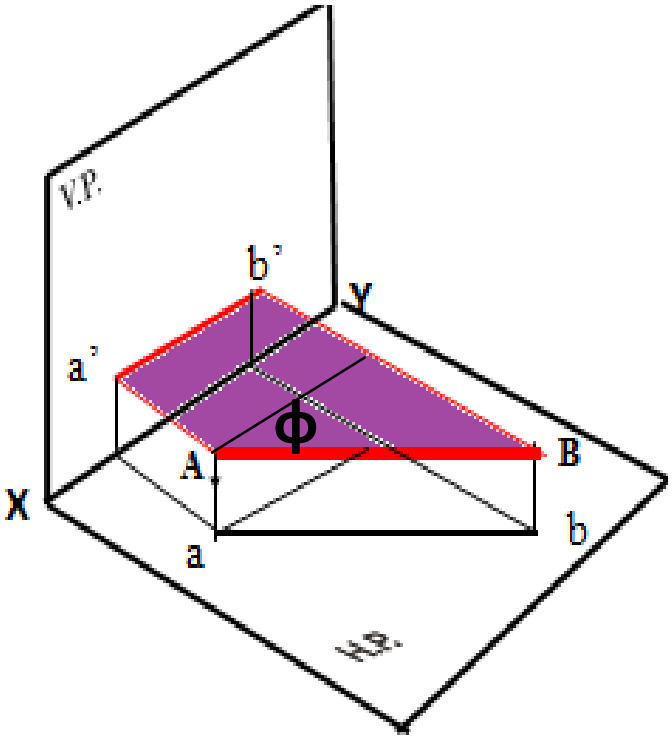


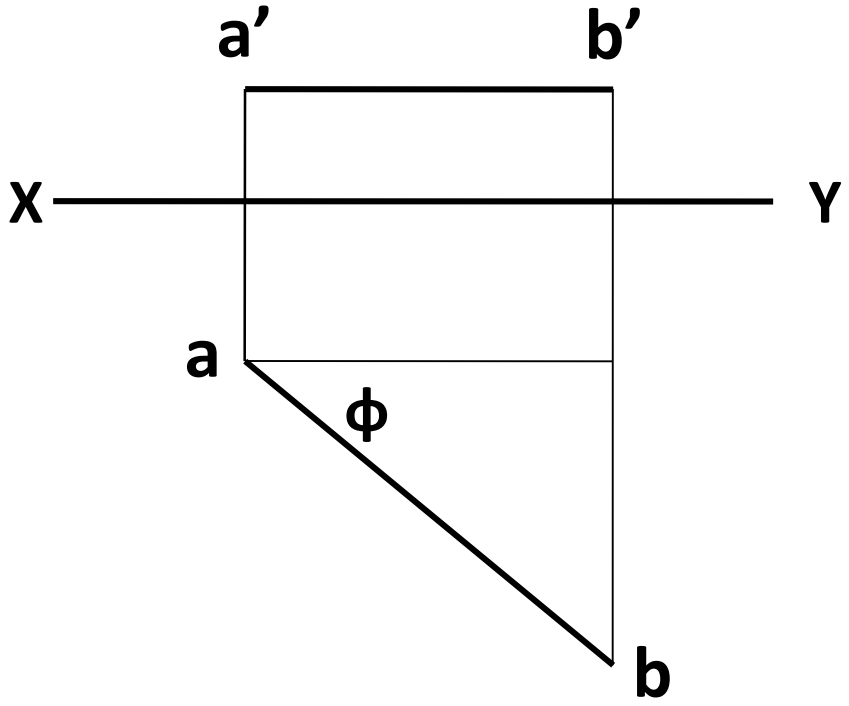
True length from β line

θ Triangle formed

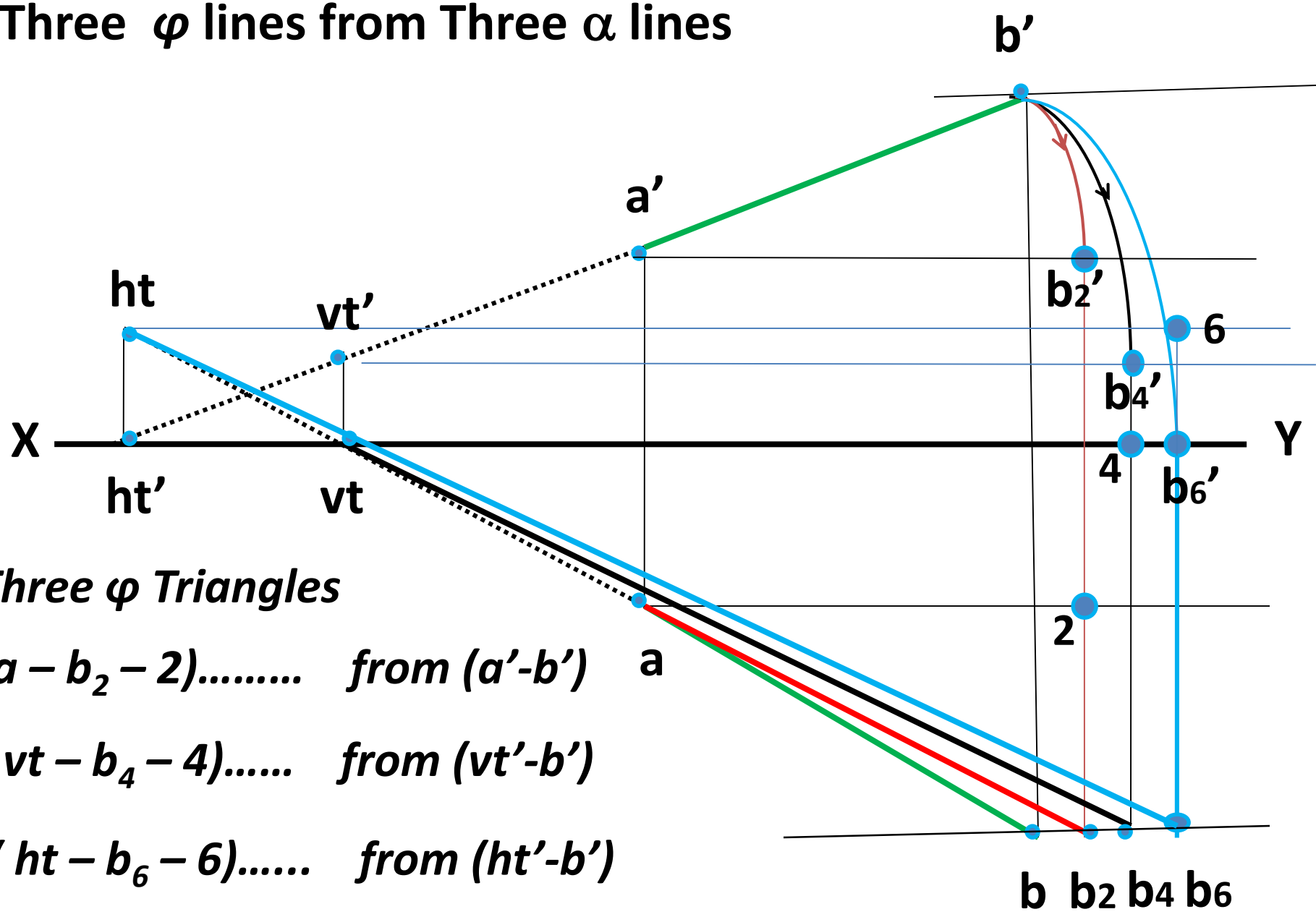

V.P.
b'
Y
a'
ϕ
A
B
X
a
b
H.P.


V.P.
b'
Y
a'
ϕ
A
B
X
a
b
H.P.


V.P.
b'
Y
a'
Φ
A
B
X
a
b
H.P.


a'
b'
X
Y
a
Φ
b

Three φ lines from Three α lines



Three φ Triangles

(a – b_2 – 2)…….. from (a’-b’)

(vt – b_4 – 4)…… from (vt’-b’)

(ht – b_6 – 6)…… from (ht’-b’)

LINES.

Projection of lines.

Locate Traces of the line.

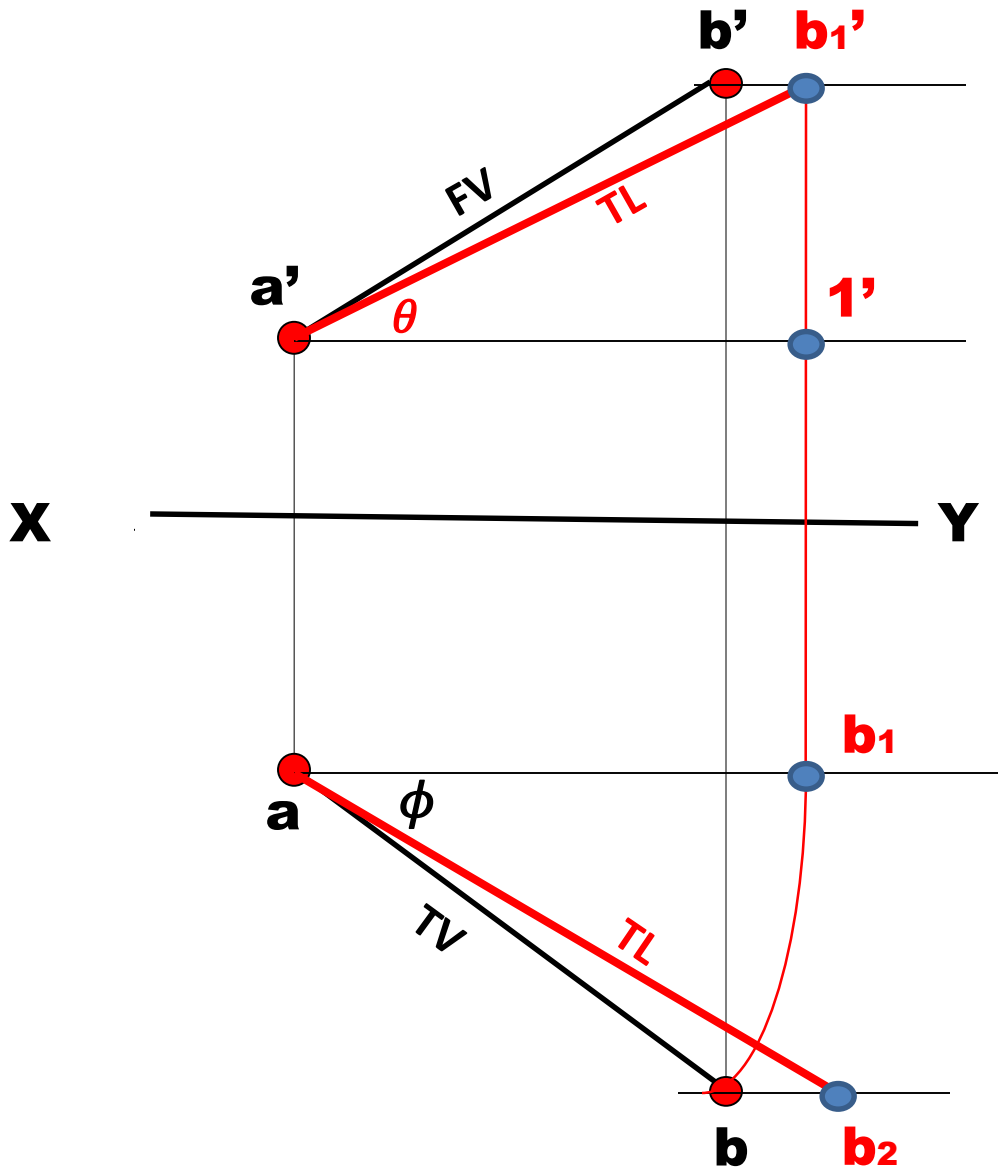
Find True length of the line.

True length from Plan.

True length from Elevation.

Obtain inclinations of the line.

Master solution.



True length from β line

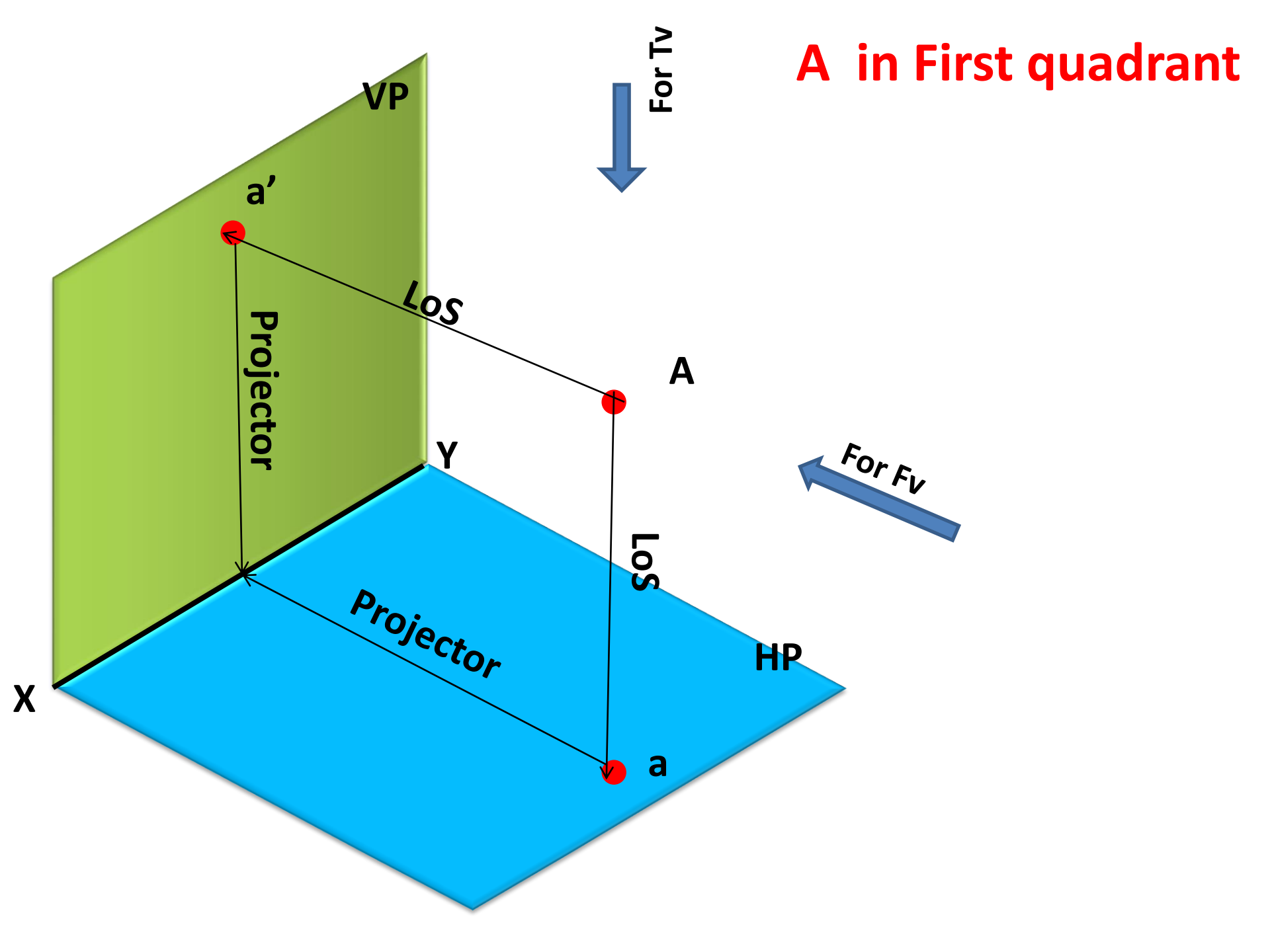
θ Triangle formed

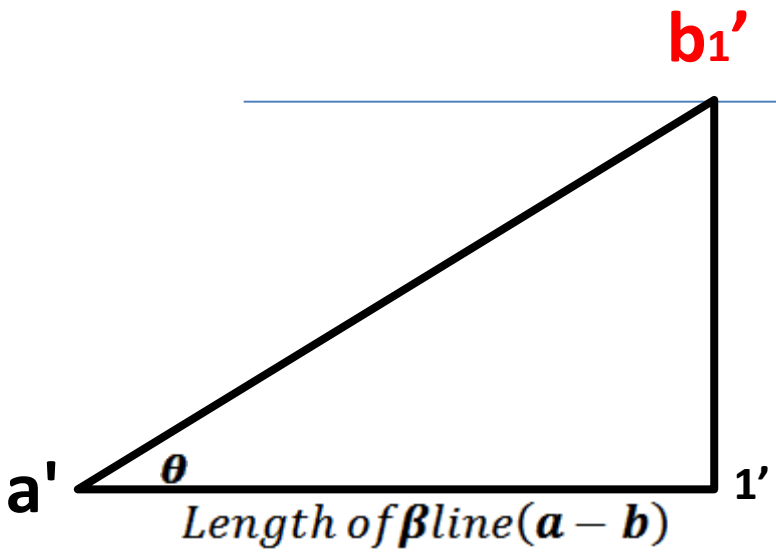
Inclinations of AB to HP and VP

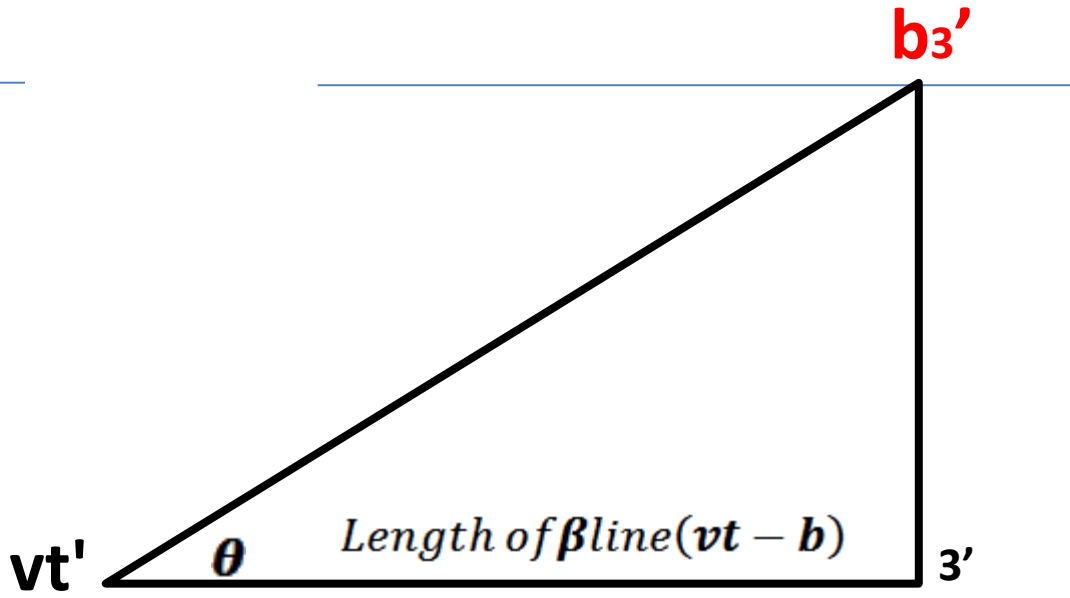
(1).To HP = angle between AB and ab
(Trapezium on HP provides θ)

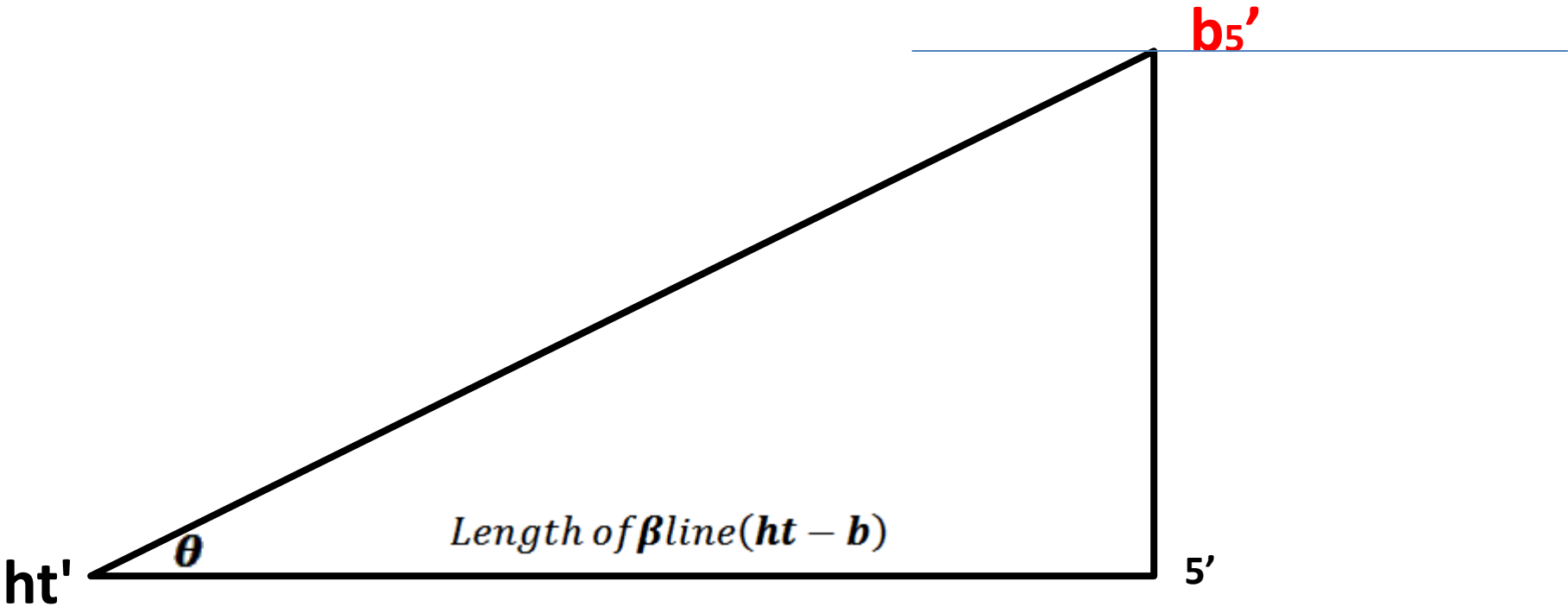
(2).To VP = angle between AB and a’b’
(Trapezium on VP provides ϕ)

A in First quadrant




b1’
a'
θ
1’
Length of β line (a − b)


b3’
vt'
θ
Length of β line (vt − b)
3’


b5’
ht'
θ
Length of β line (ht − b)
5’