ME1480 Engineering Drawing

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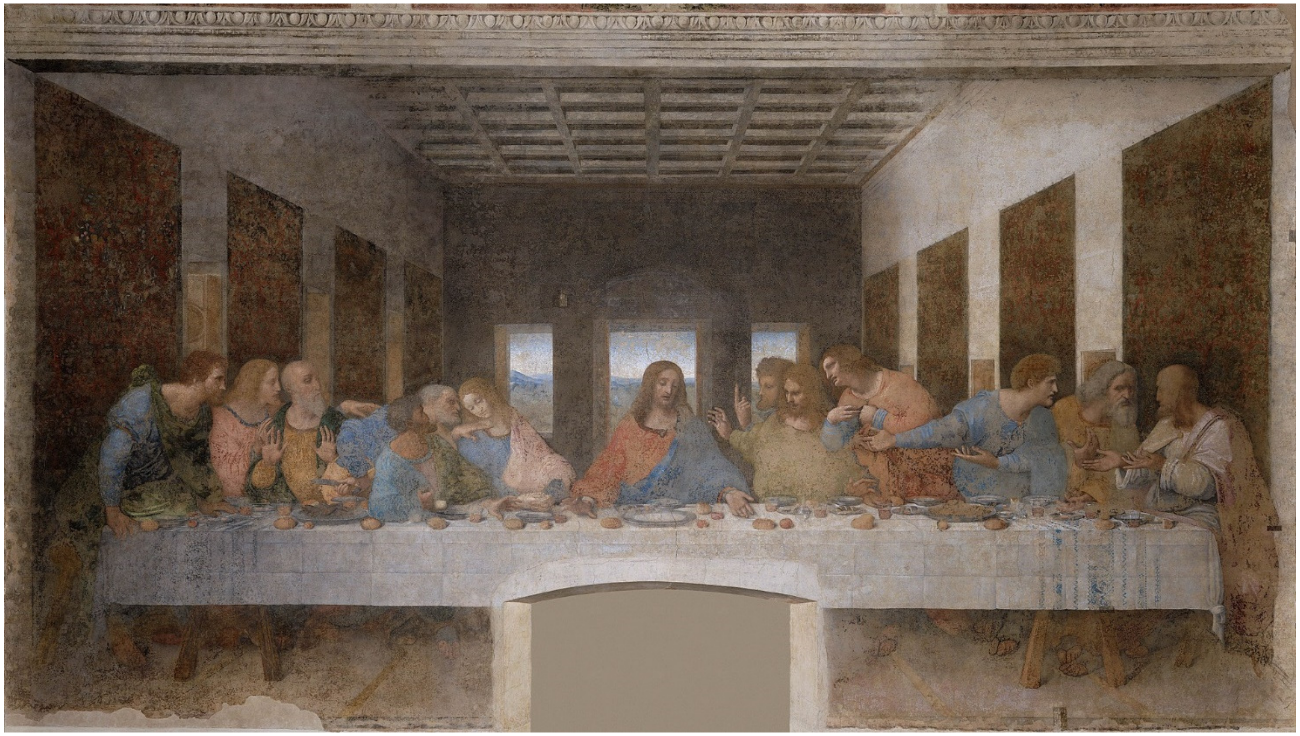
Introduction (Engineering Drawing)

Mind thinks in pictures. (Thoughts, Daydreaming, Dreams are seen)



A picture is worth thousand words.

The Last Supper

By Leonardo da Vinci, 1498

1. https://www.medicalnewstoday.com/articles/284378.php

Introduction (Engineering Drawing)

Cave Drawing
Bhimbetka (Bhopal)

Bison pursuing hunter

1. Archaeological Survey of India

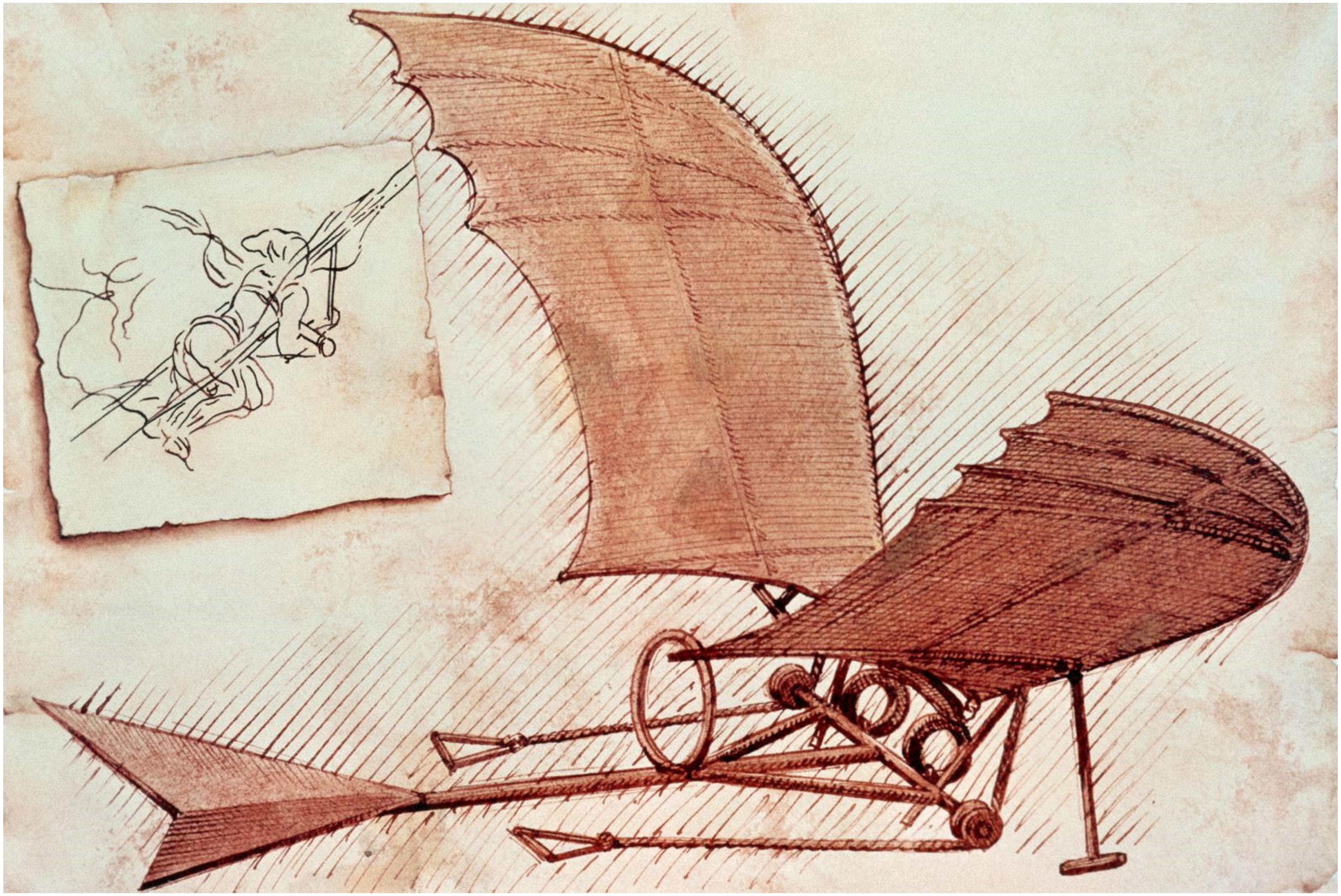
Introduction (Engineering Drawing)

Charama, Kanker District, Chhattishgarh

Depiction of UFO??

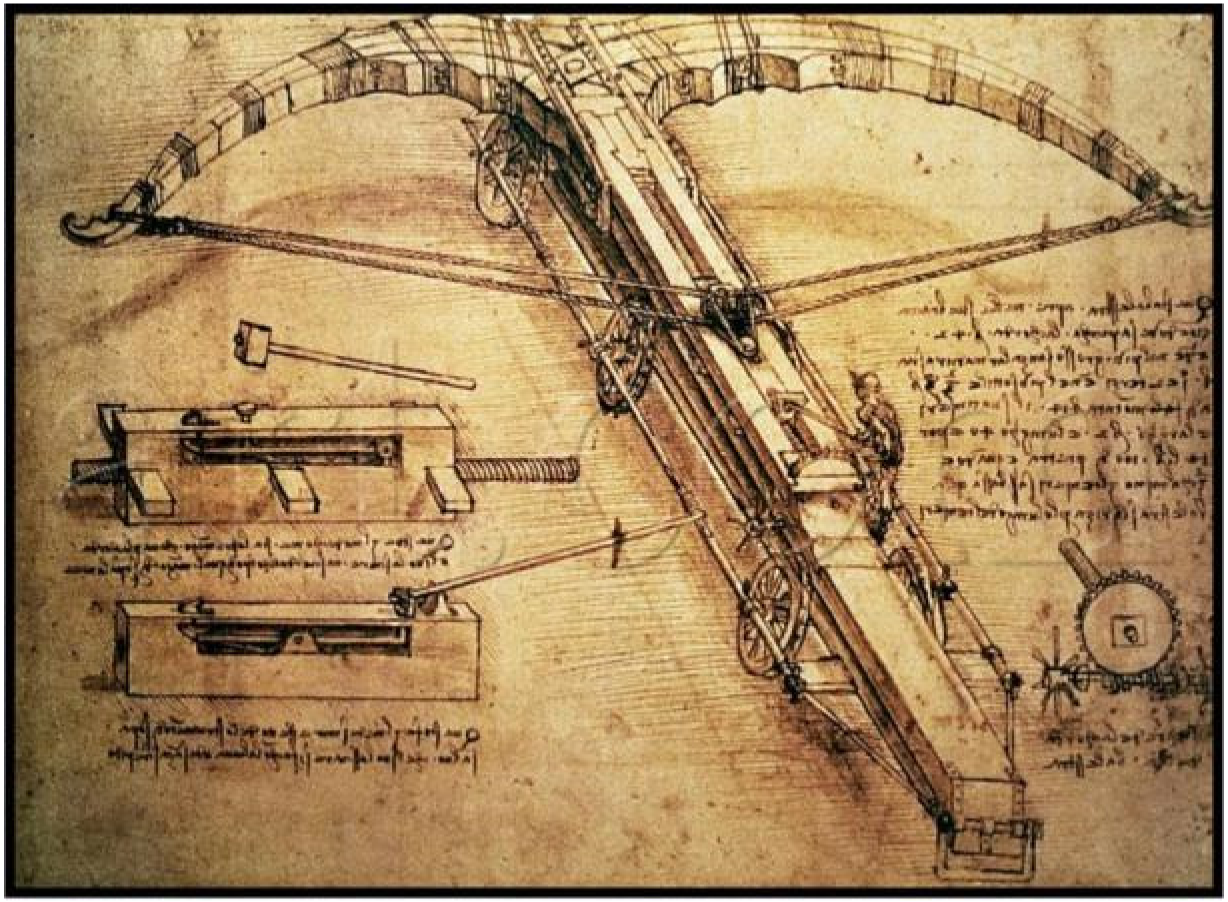
https://timesofindia.indiatimes.com/india/10000-year-old-rock-paintings-depicting-aliens-and-UFOs-found-in-Chhattisgarh/articleshow/38435091.cms

Bright Idea (Freehand Sketch)

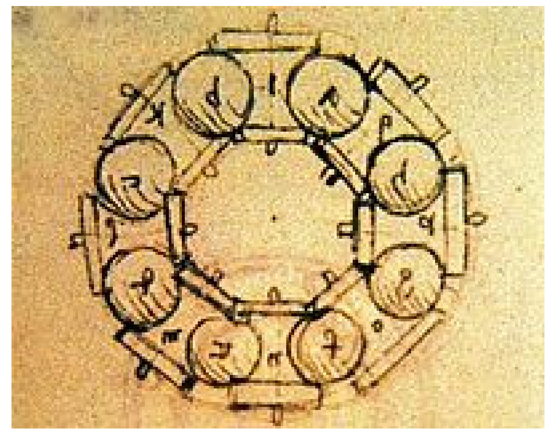


Flying Machine Leonardo Da Vinci

Bright Idea (Freehand Sketch)



Catapult Leonardo Da Vinci

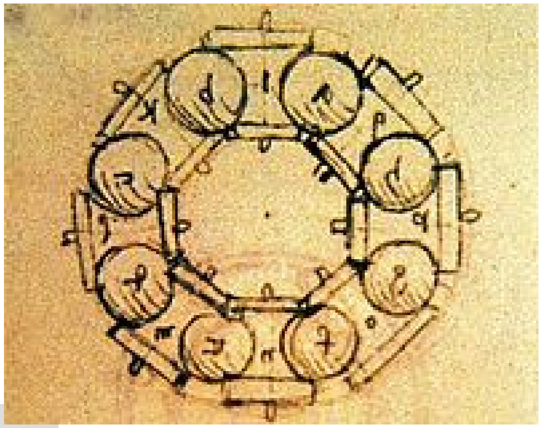


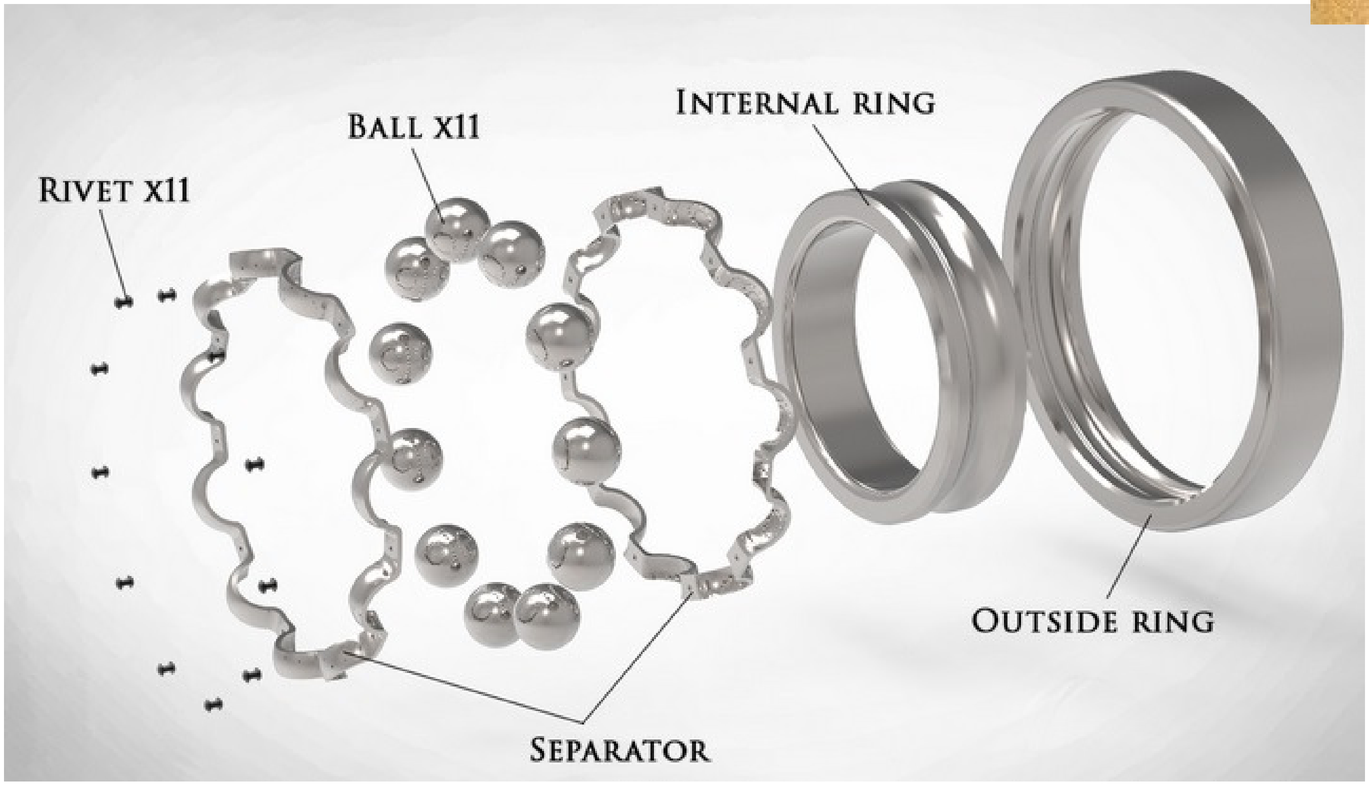
Bearing Leonardo Da Vinci

Bearing

Written text is required to describe size, location and specification of the object.

(Ensures easy reproduction with accuracy)

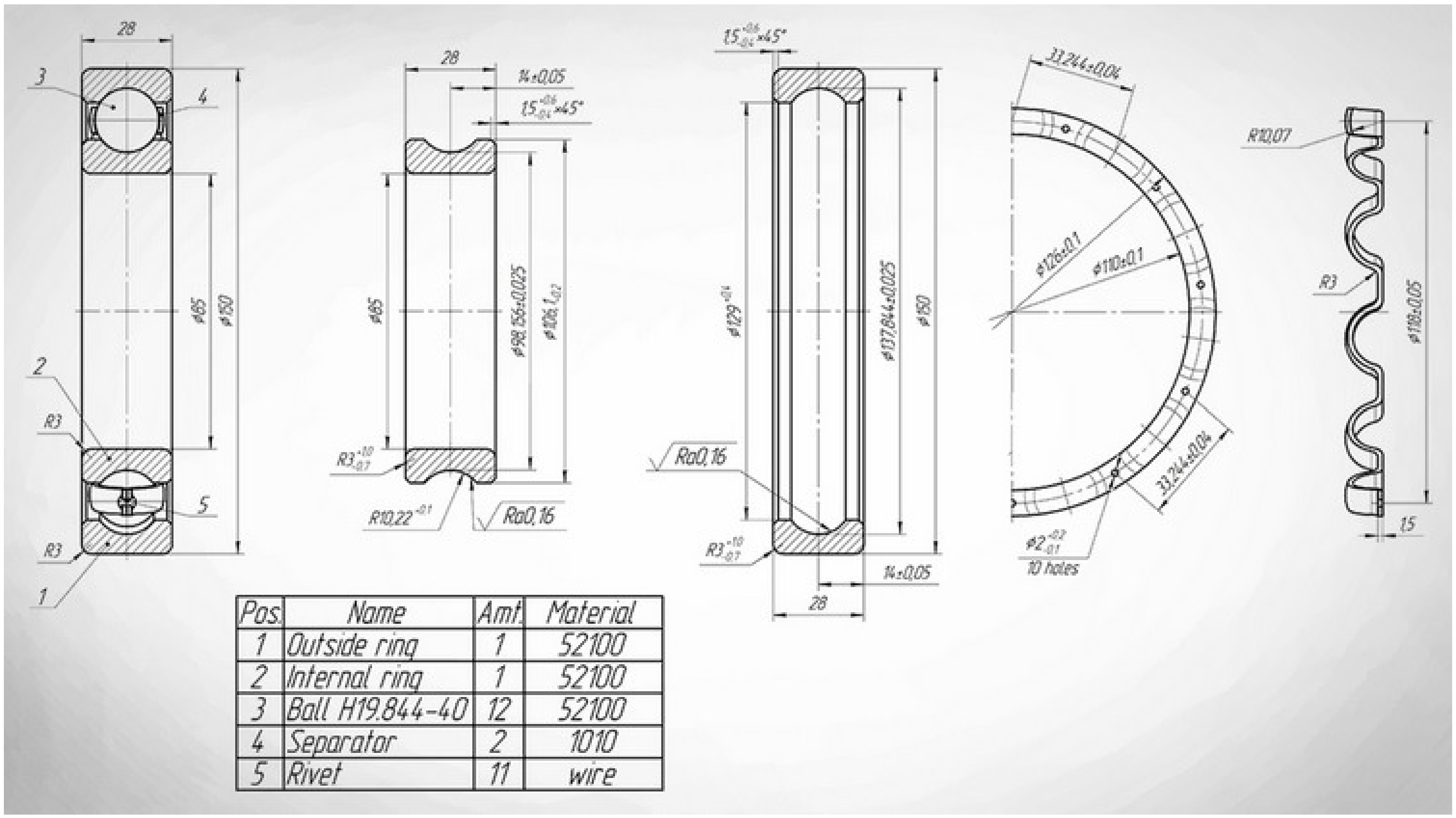




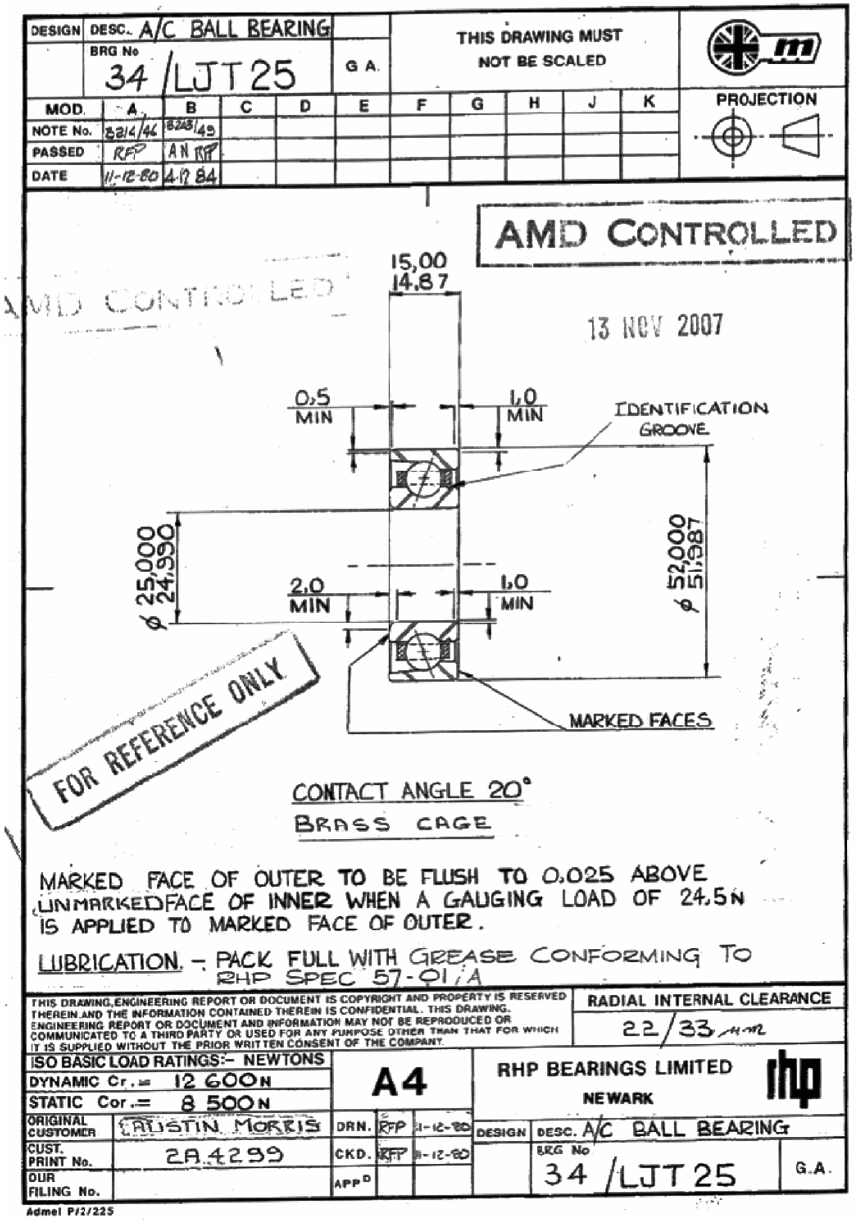
Purpose of Engineering Drawing

1. To convey the geometric content of the part
2. Dimensions
3. Geometric details (hidden lines and surfaces, shapes, section views, etc.)
4. Manufacturing details
5. Tolerances
6. Surface roughness
7. Machining instructions and materials

Bearing (Engineering Drawing)

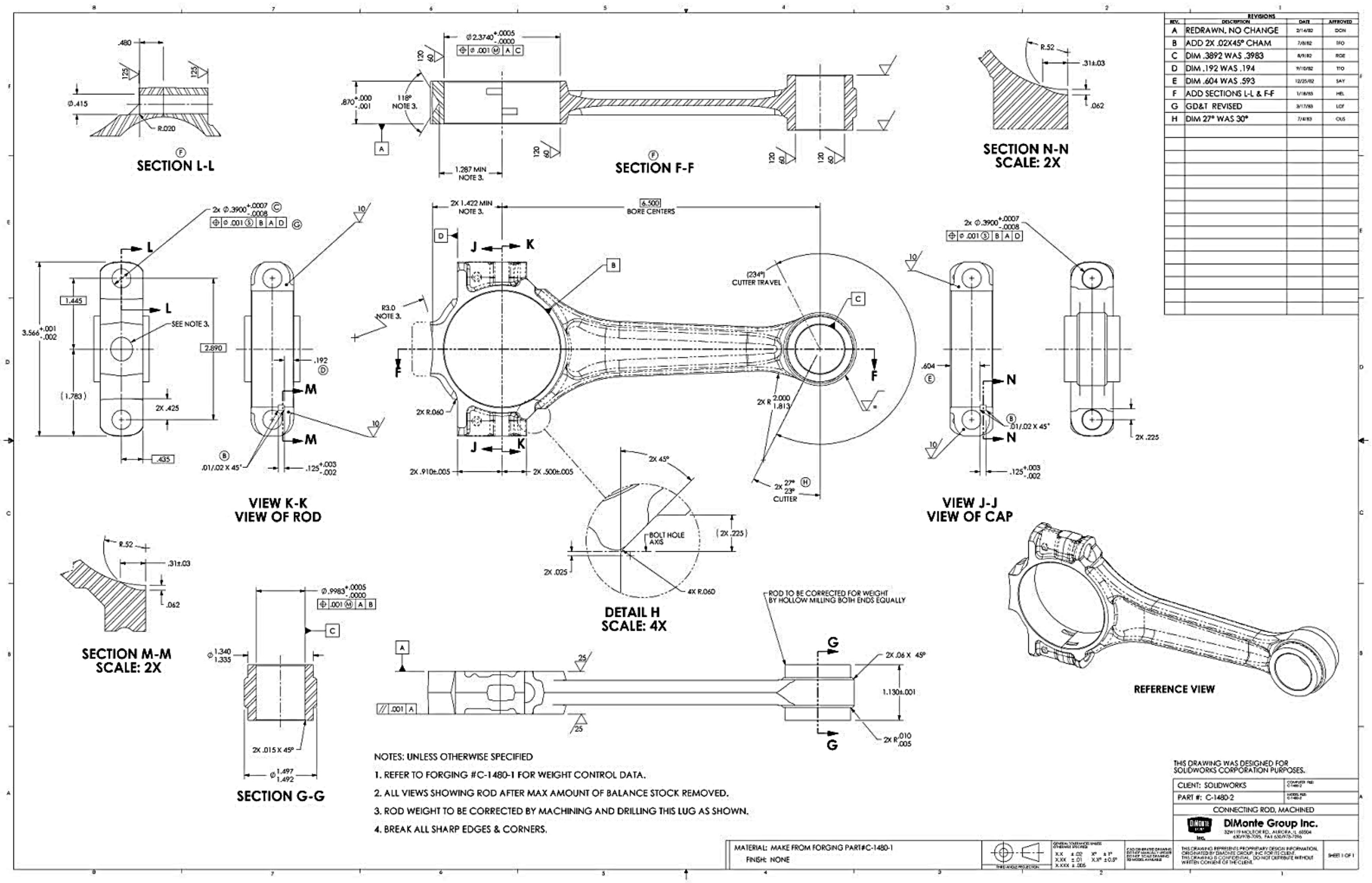


Bearing (Actual Industry Drawing)

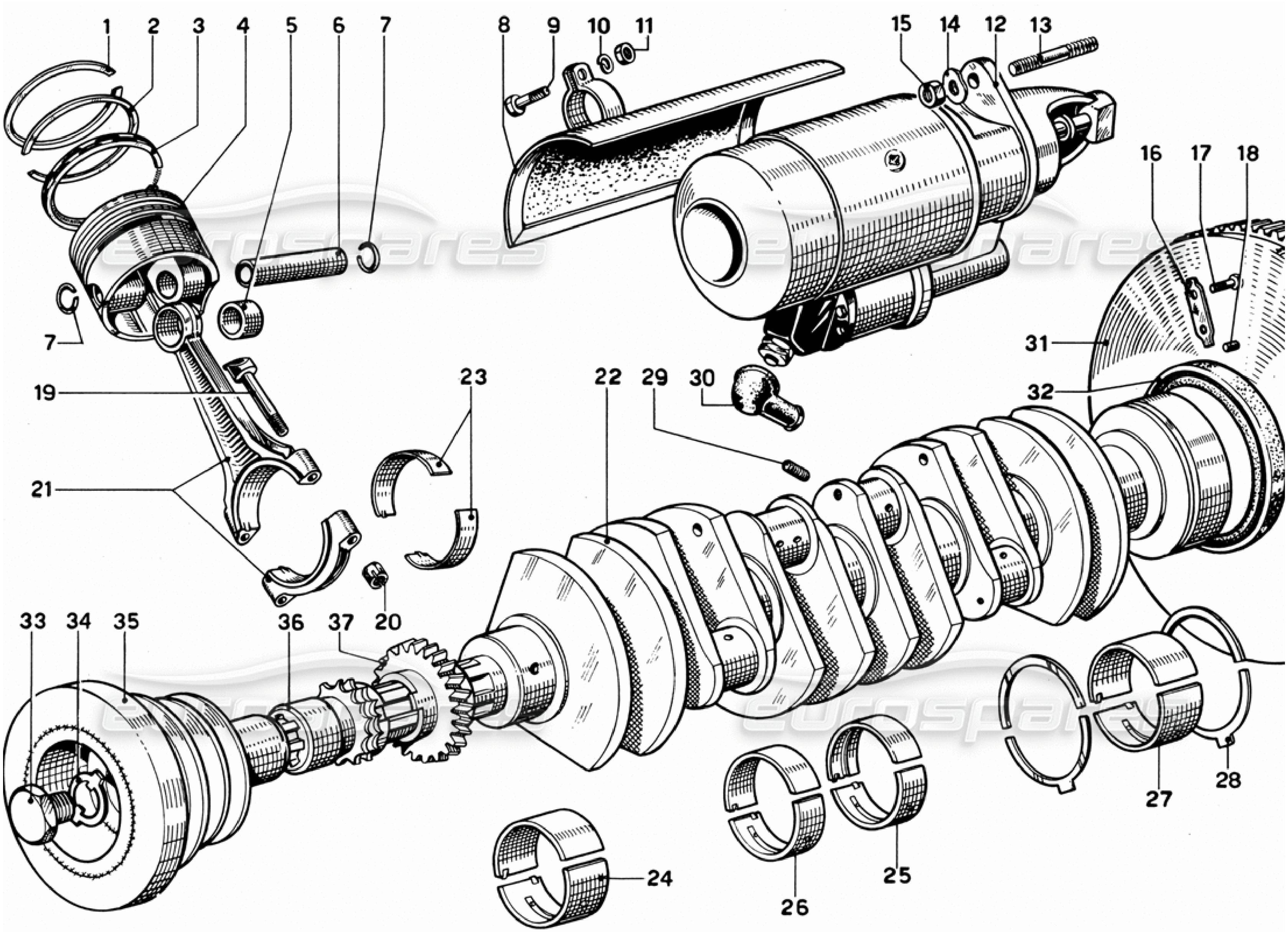


Applications (Engineering Drawing)

Mechanical Engineering

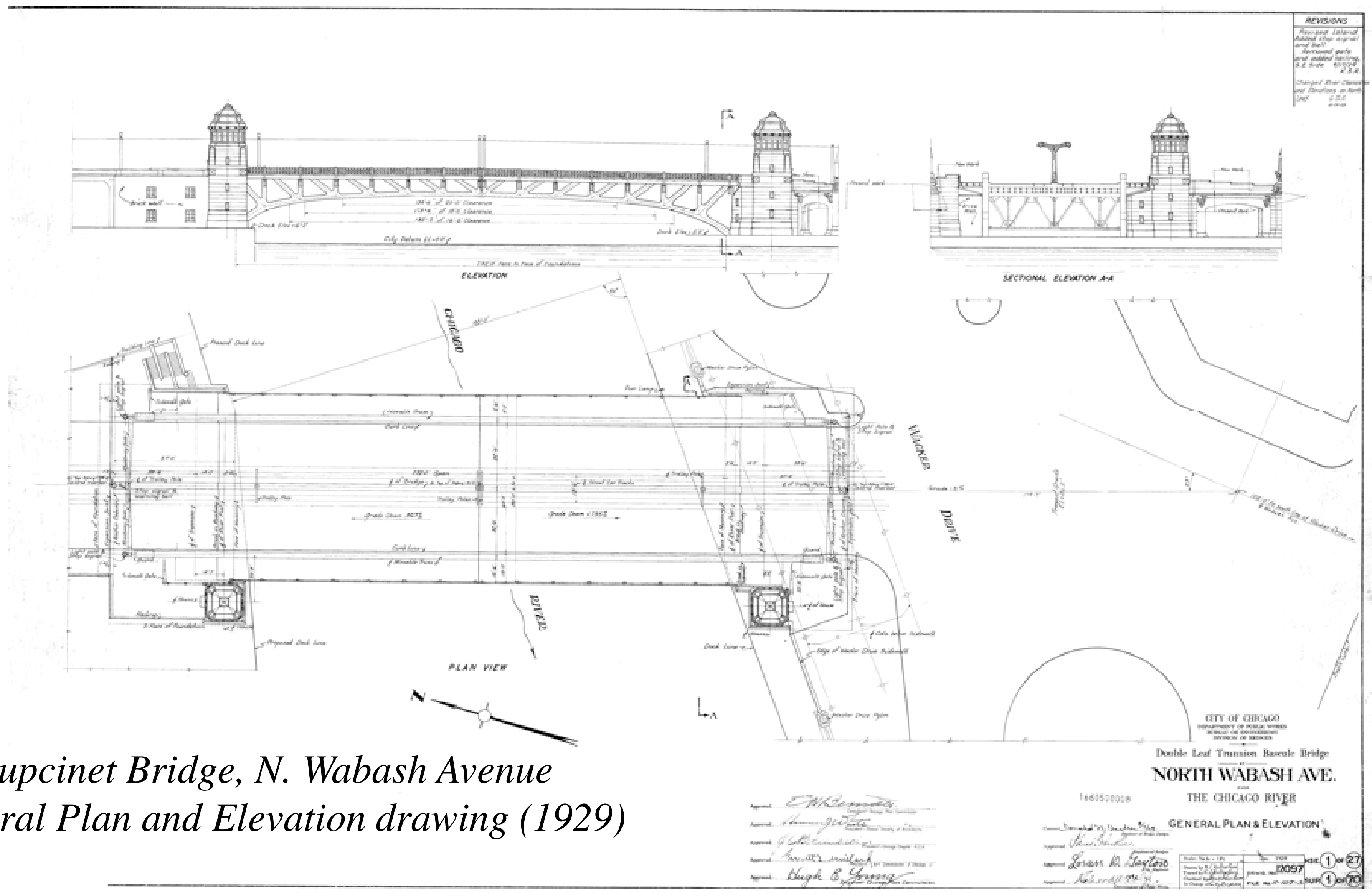


Applications (Engineering Drawing)



Applications (Engineering Drawing)

Civil Engineering (Buildings, Highways, Pipelines, Bridges, Water and Sewage systems.)



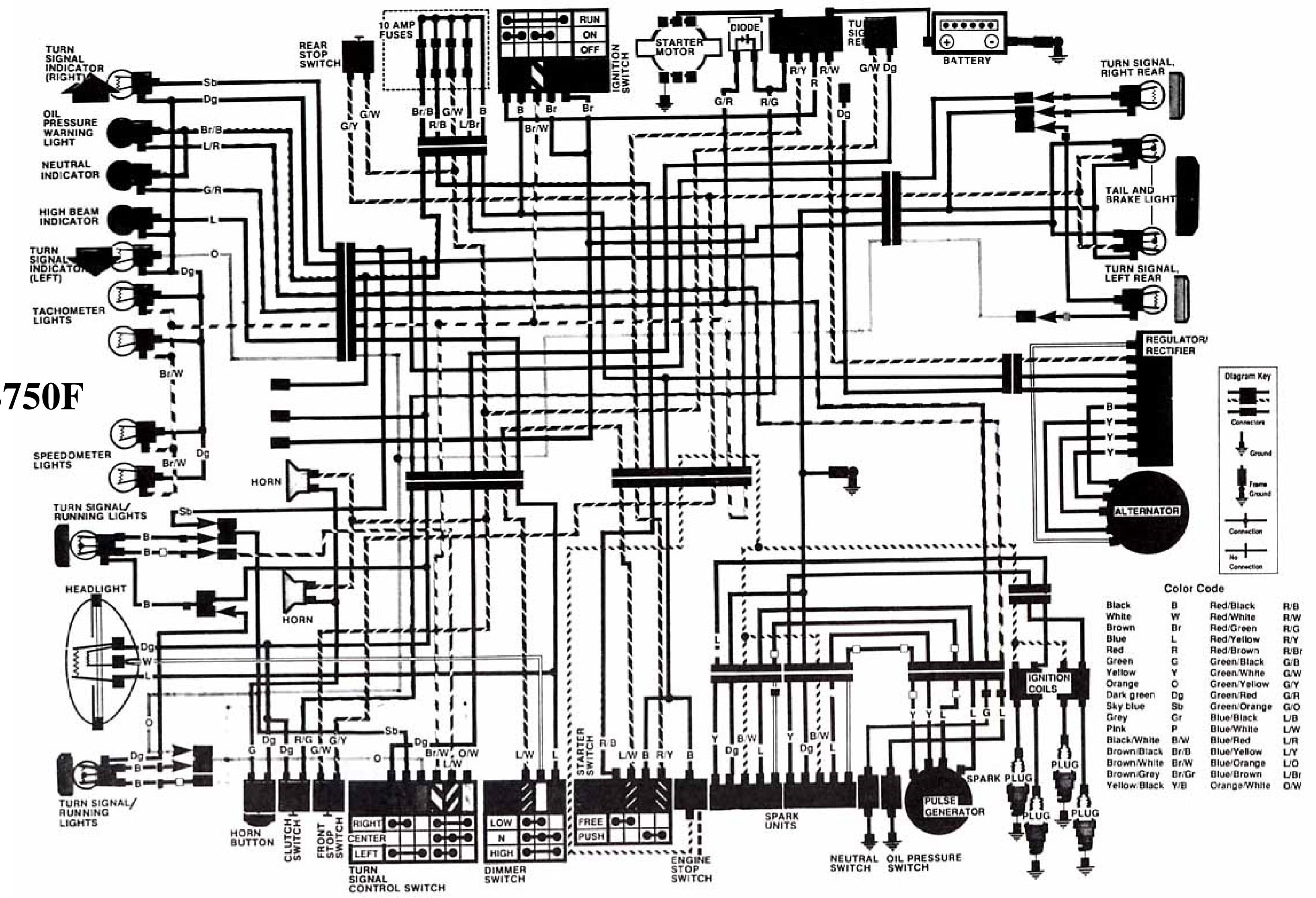
Irv Kupcinet Bridge, N. Wabash Avenue
General Plan and Elevation drawing (1929)

 1. Courtesy of the Chicago Department of Transportation - Division of Engineering

Applications (Engineering Drawing)

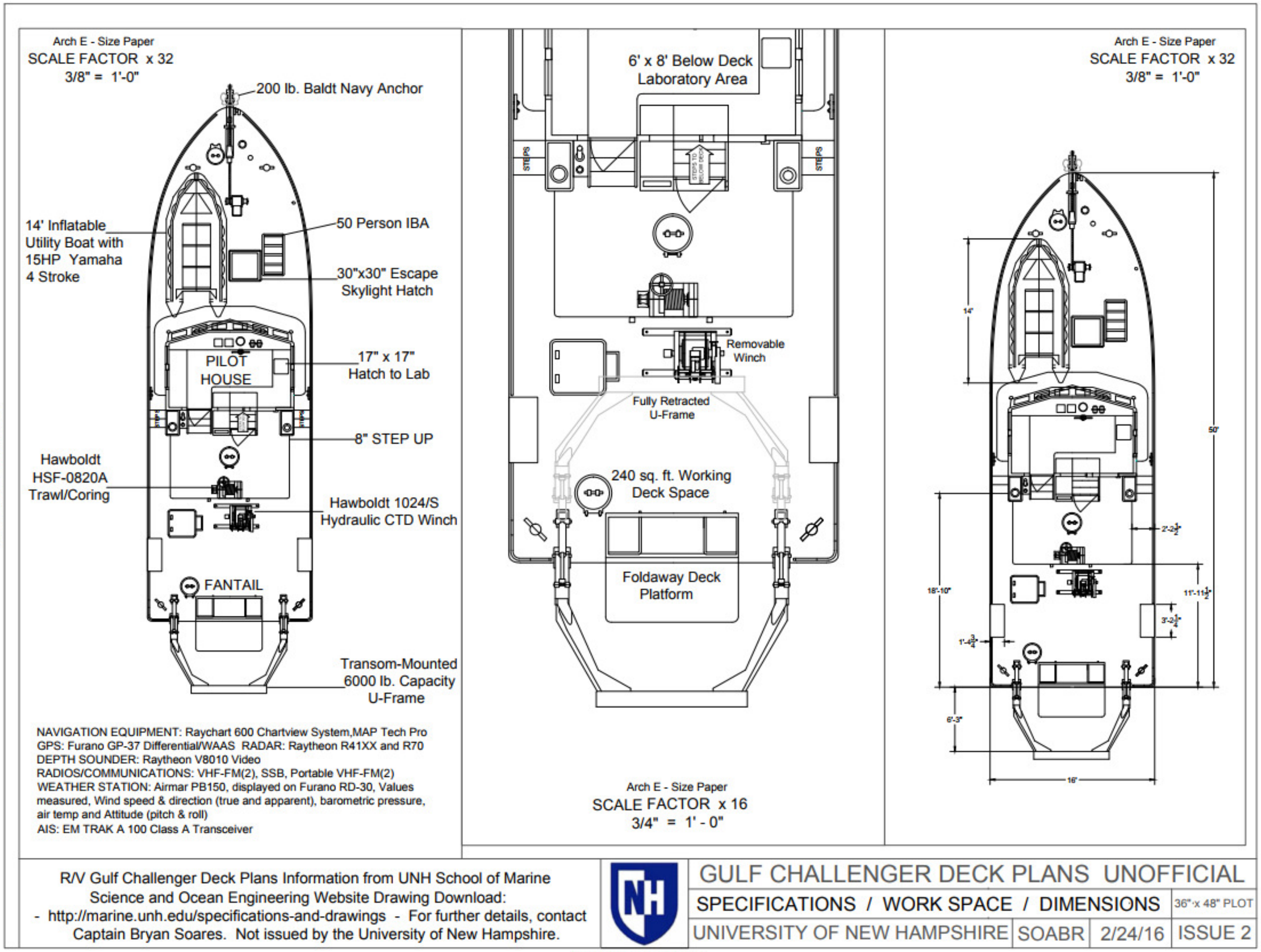
Electrical Engineering (Sensors, Wiring diagrams, Circuit diagrams.)

Honda CB750F



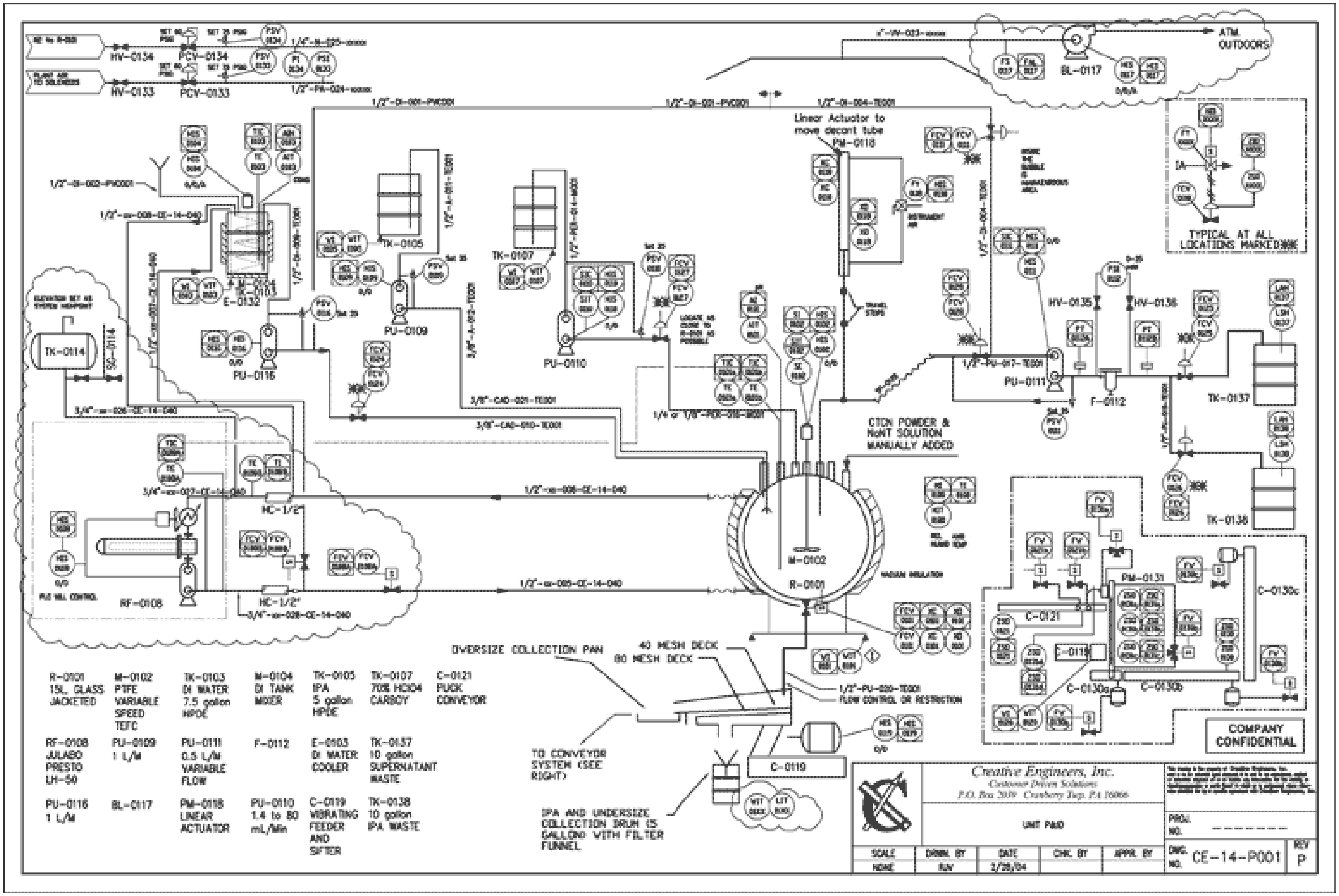
Applications (Engineering Drawing)

Ocean Engineering (Deck plans, other equipment on ship.)



Applications (Engineering Drawing)

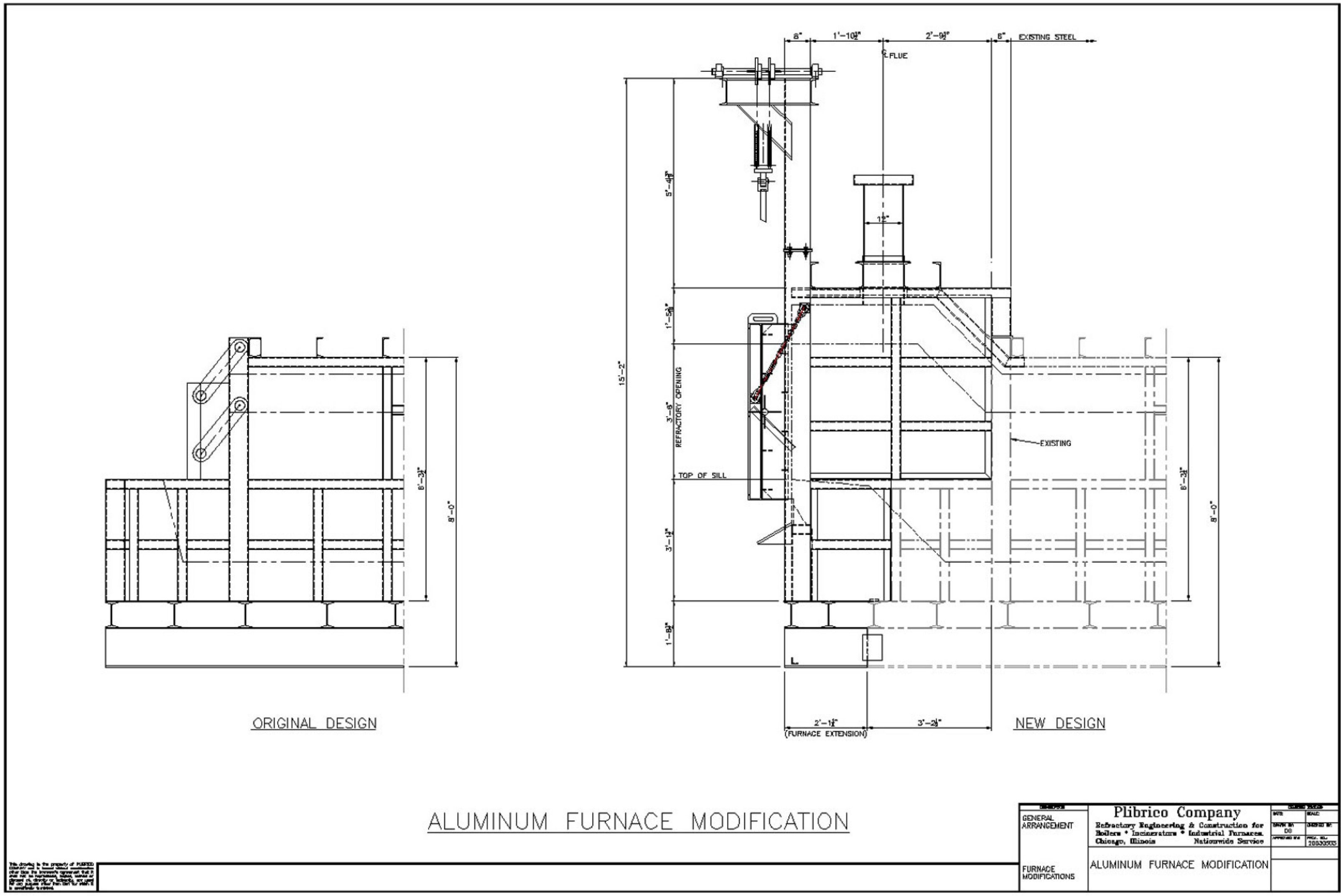
Chemical Engineering (Processing plant layout, piping)



 1. http://www.creativeengineers.com

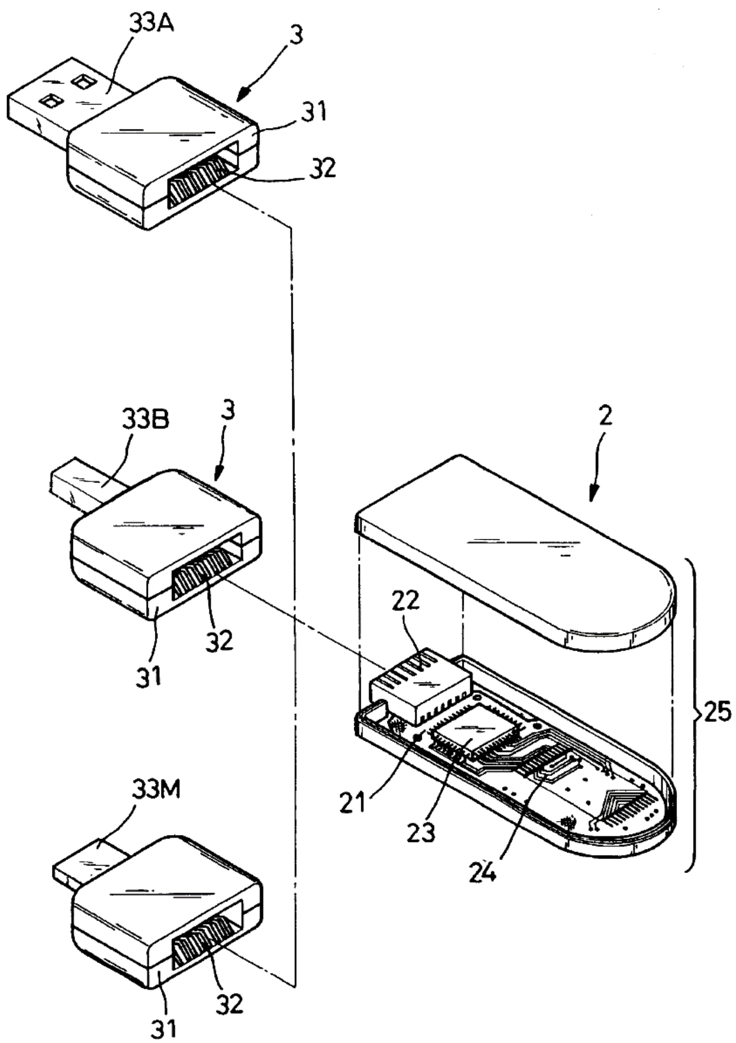
Applications (Engineering Drawing)

Metallurgical and Materials Engineering (Furnace Drawing)



Applications (Engineering Drawing)

Computer Science Engineering (Pen drive patent)



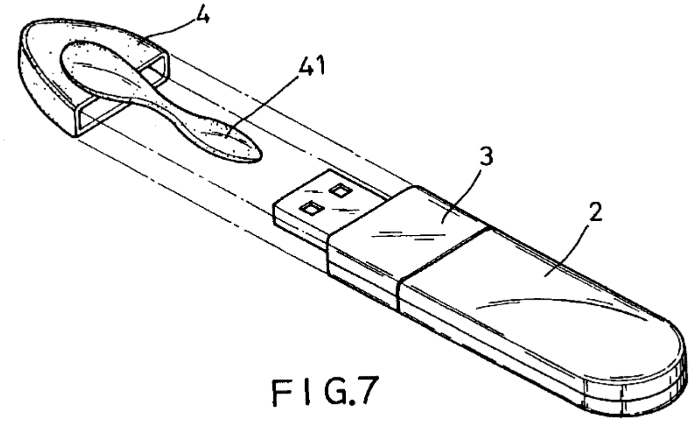


FIG.7

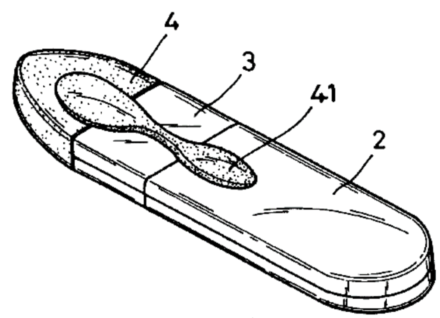


FIG.8

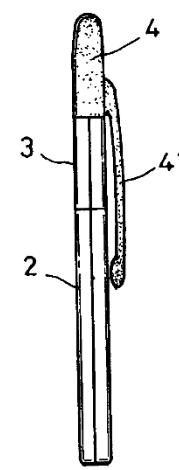


FIG.9

Paper Size (A series)

1. The size of paper in A series varies from A0 to A10.

2. For the A0 size, the area of the paper is $1m^2$, with the ratio of length to width being $\sqrt{2}: 1$.

3. Therefore, the length and the width of A0 sheets are 1189 mm and 841 mm respectively.

4. For every successive paper size A1, A2 etc., the area becomes half of the previous size maintaining the same length to width ratio.

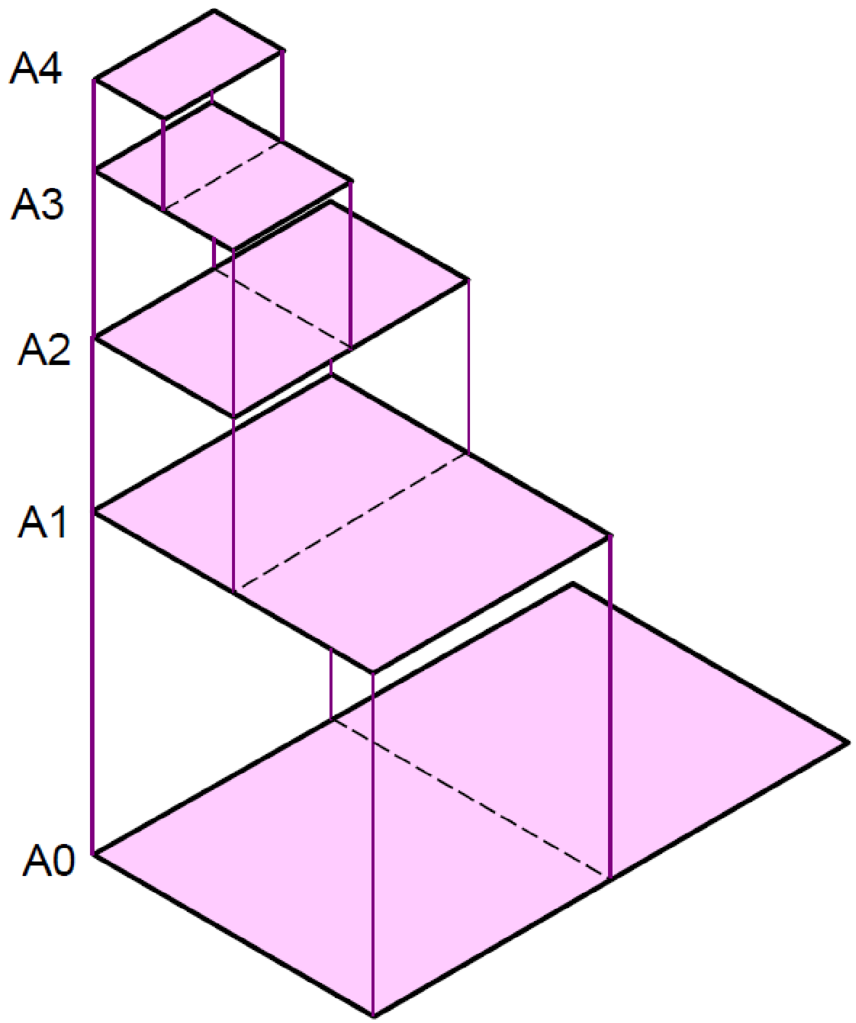
5. Therefore, the length of the succeeding size will be same as width of the preceding size (The length of A1 is same as width of A0).

6. ISO 216:2007 is a document issued by International Organization for standardization for governing various sizes of paper.

Paper Size (A series)

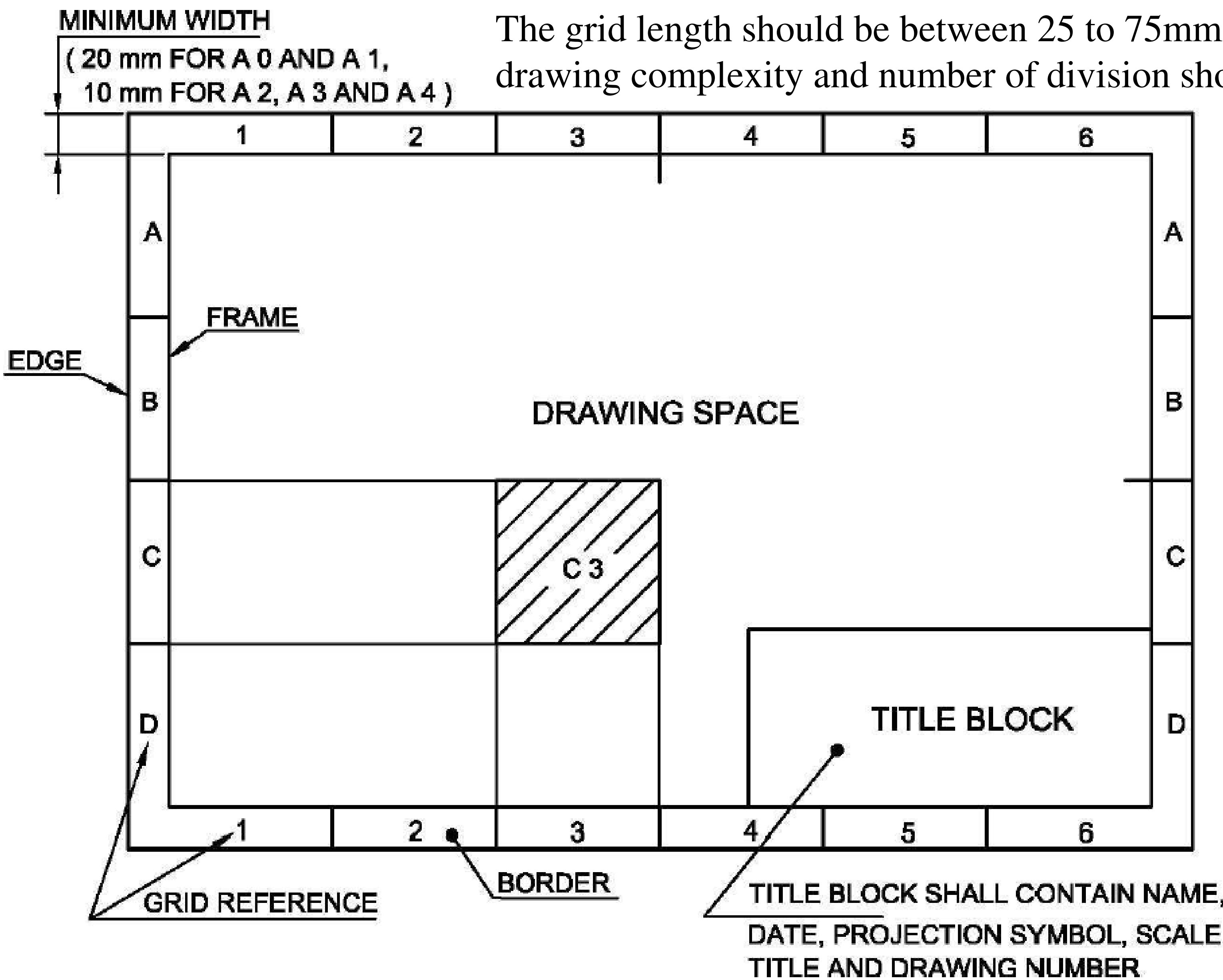
Frequently used sizes:

Paper Size	Width (mm)	Length (mm)	Area (m^2)
A0	841	1189	1
A1	594	841	0.5
A2	420	594	0.25
A3	297	420	0.125
A4	210	297	0.0625



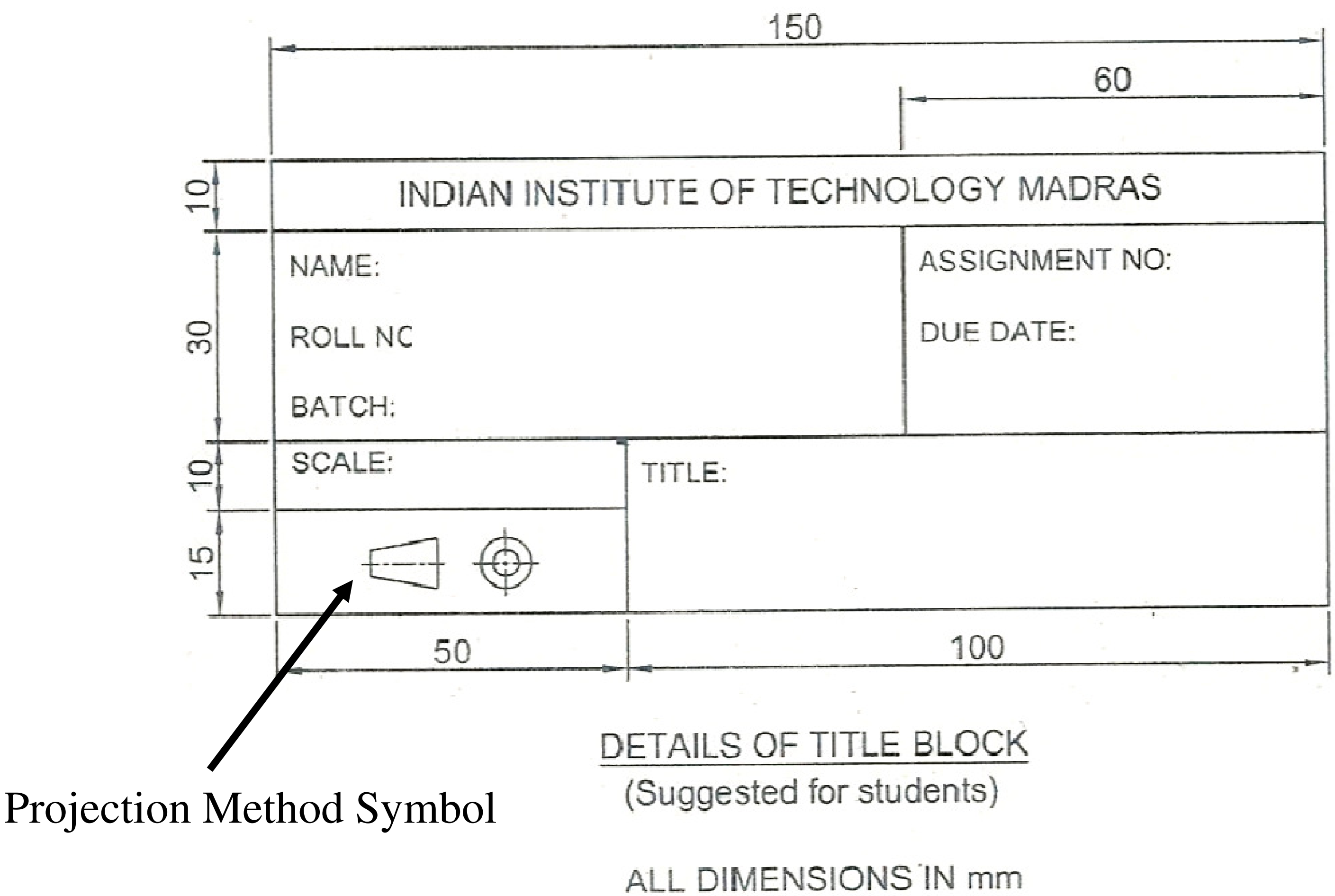
Drawing Sheet Layout

The grid length should be between 25 to 75mm based on the drawing complexity and number of division should be even.



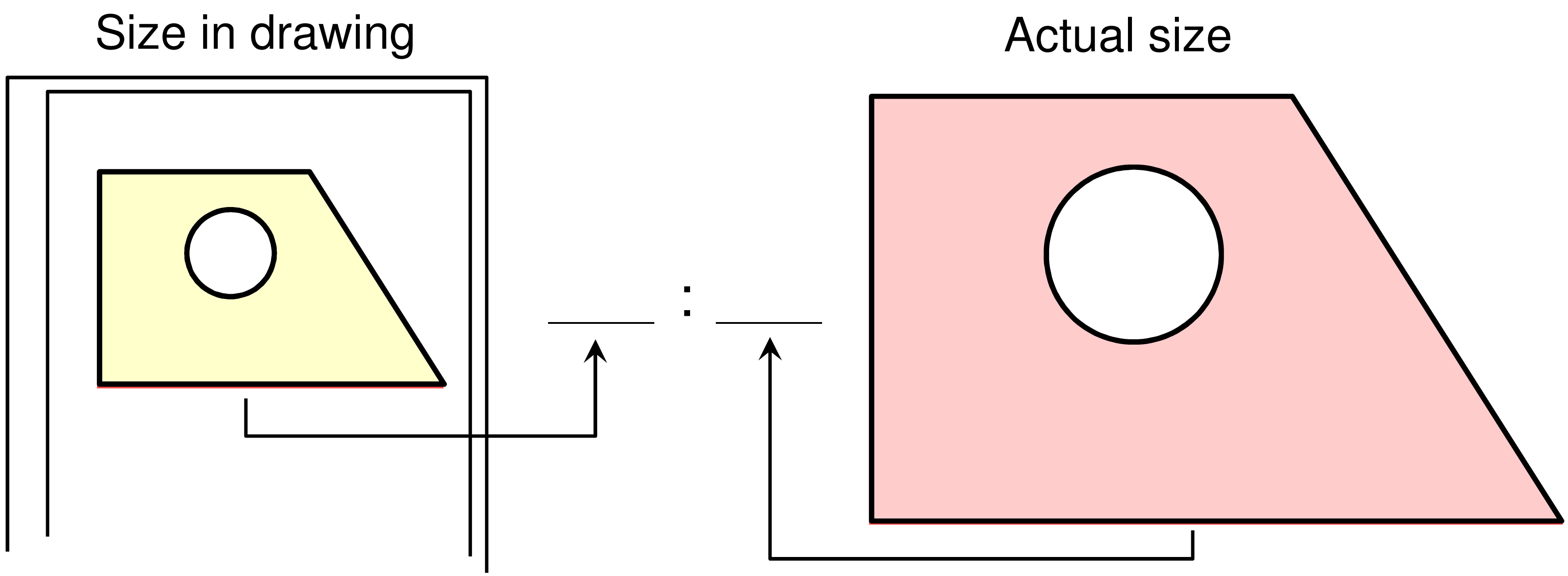
Title Block Layout

Title block shall contain the student's name, date of exercise, projection symbol, scale title, and drawing number.



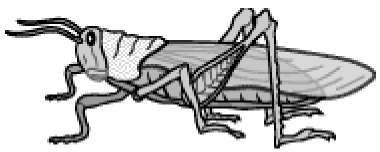
Drawing Scales

Scale is defined as the ratio of the linear dimensions of the object as represented in a drawing to the actual dimensions.

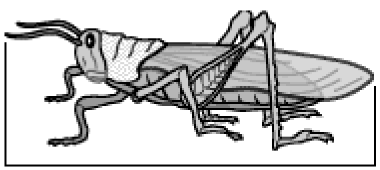


Dimension numbers shown in the drawing are correspond to "true size" of the object and they are independent of the scale used in creating that drawing.

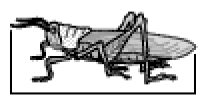
Drawing Scales



Actual	SCALE 1:1	for full size	
Size	SCALE **X**:1	for ***enlargement*** scales	(X > 1)
	SCALE 1:**X**	for ***reduction*** scales	(X > 1)

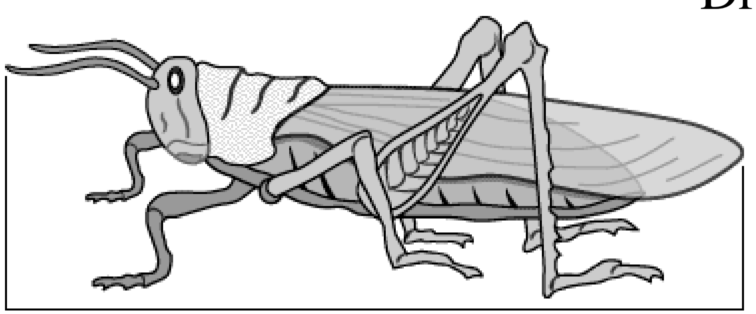


Scale of 1:1



Scale of 1:2

Drawing



Scale of 2:1

Exercise: A mural of a dog was painted on a wall. The enlarged dog was 45 ft. tall. If the average height for this breed of dog is 3 ft., what is the scale factor?

Solution: 15:1

Lettering & Dimensioning

- Text's style on the drawing must have the following 2 properties

Legibility

- Shape
- Space between letters
- Space between words

Uniformity

- Size (or text height)
- line thickness

Examples

GOOD

Not uniform in style.

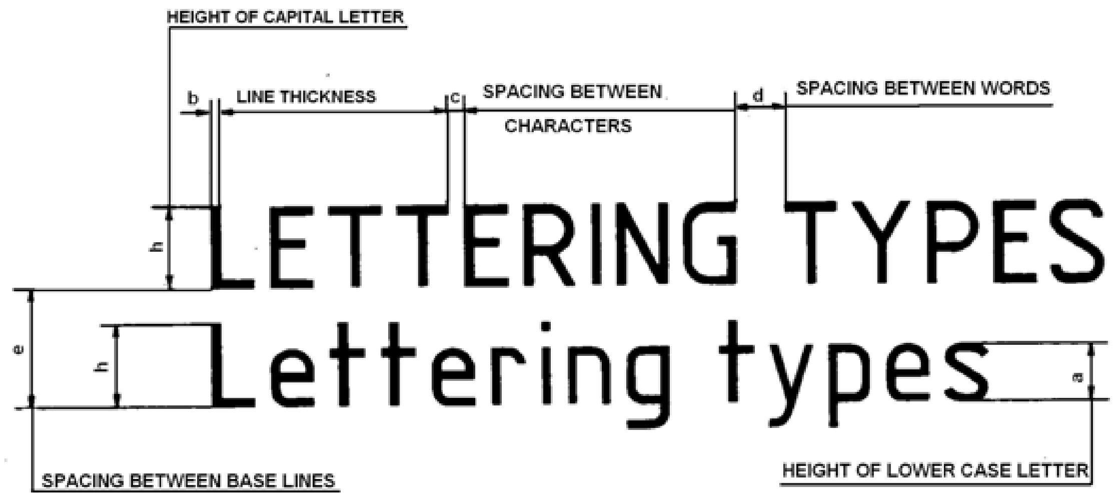
Not uniform in height.

Not uniformly vertical.

Not uniform in thickness of stroke.

Inappropriate space between letters

Lettering Height



Specifications	Value	Size (mm)					
Capital letter height	h	3.5	5	7	10	14	20
Lowercase letter height	a = (7/10)h	2.5	3.5	5	7	10	14
Thickness of lines	b = (1/10)h	0.35	0.5	0.7	1	1.4	2
Spacing between characters	c = (1/5)h	0.7	1	1.4	2	2.8	4
Min. spacing b/n words	d = (3/5)h	2.1	3	4.2	6	8.4	12
Min. spacing b/n baselines	e = (7/5)h	5	7	10	14	20	28

1. Refer to BIS SP 46(2003) for details 2. http://nptel.ac.in/courses/112103019/2

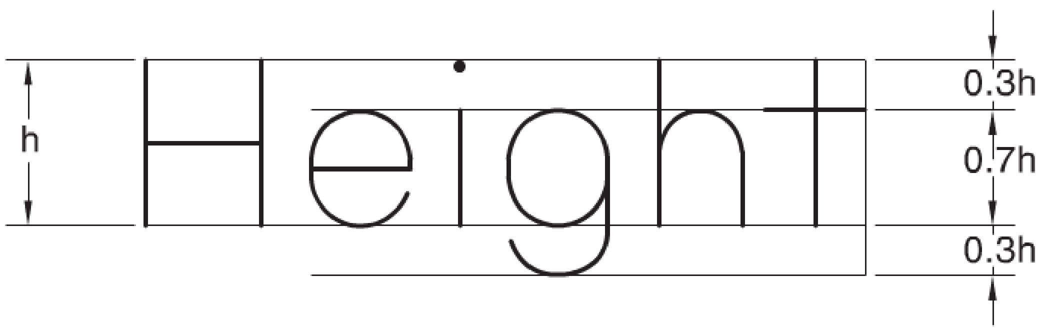
Lettering Height

Lettering type B (Refer to BIS SP46(2003) for details)

Main title: h=7 mm

Subtitles: h=5 mm

Dimensions and notes: h=3.5 mm



Basic Line Types

Types of Lines	Appearance	Name according to application
Continuous thick line		Visible line
Continuous thin line		Dimension line Extension line Leader line
Dash thick line		Hidden line
Chain thin line		Center line

<u>NOTE</u> : We will learn other types of line in practical classes.

1. Refer to BIS SP 46(2003) for details

Meaning of Lines

Visible lines represent features that can be seen in the current view

Hidden lines represent features that can not be seen in the current view

Center line represents symmetry, path of motion, centers of circles, axis of axi-symmetrical parts

Dimension and Extension lines indicate the sizes and location of features on a drawing

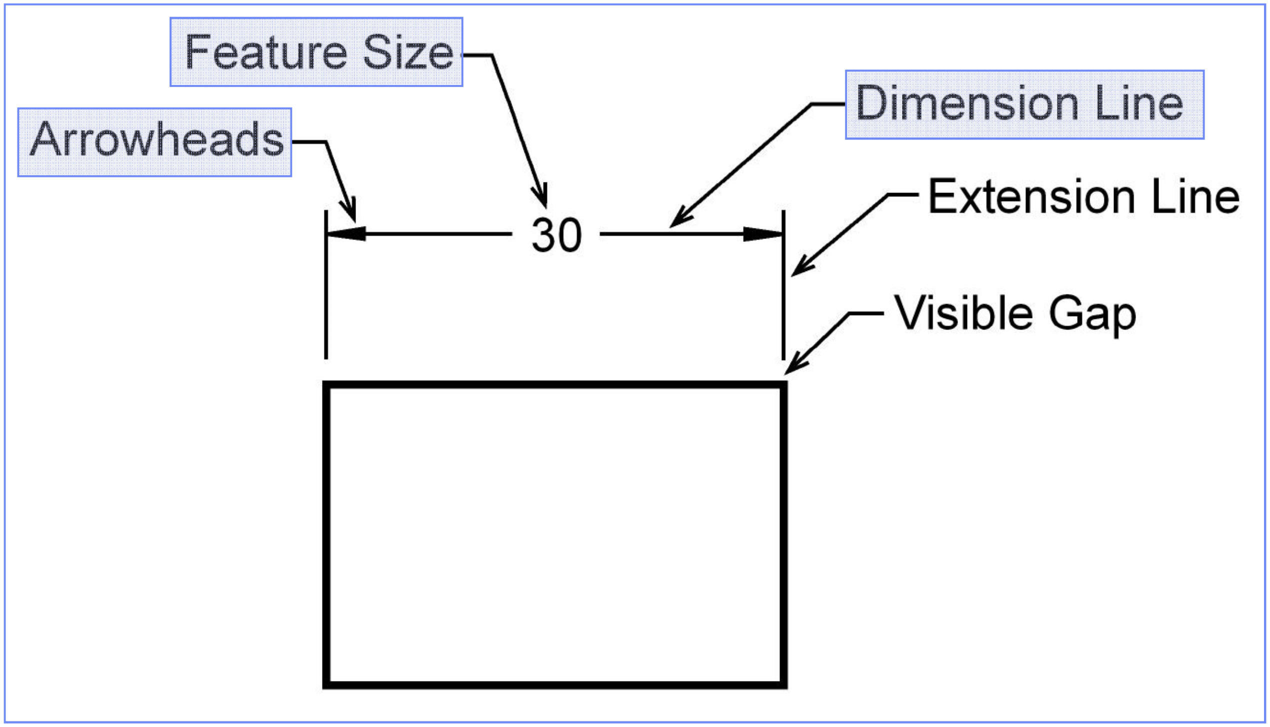
Lines used in Dimensioning

- **Dimensioning requires the use of**
  - → Dimension lines
  - → Extension lines
  - → Leader lines

- All three line types are drawn ***thin*** so that they will not be confused with visible lines.

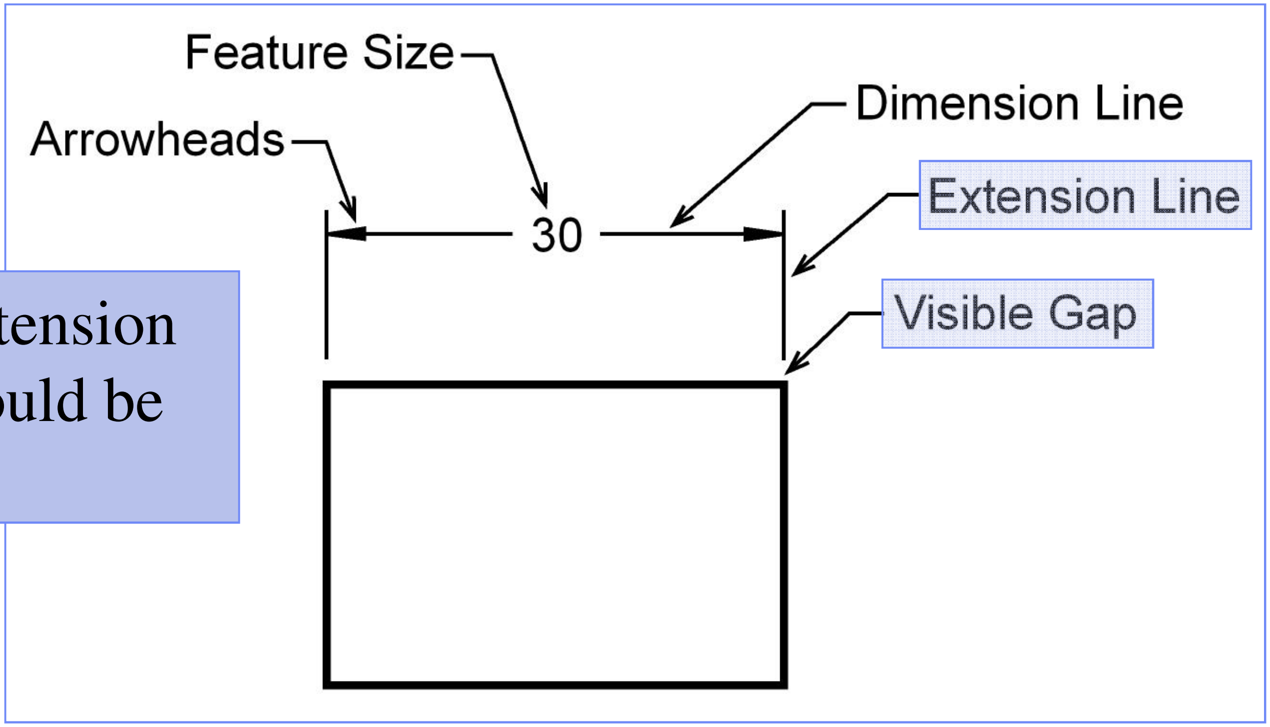
Dimension Line

- **Dimension Line:** A line terminated by arrowheads, which indicates the direction and extent of a dimension.



Extension Line

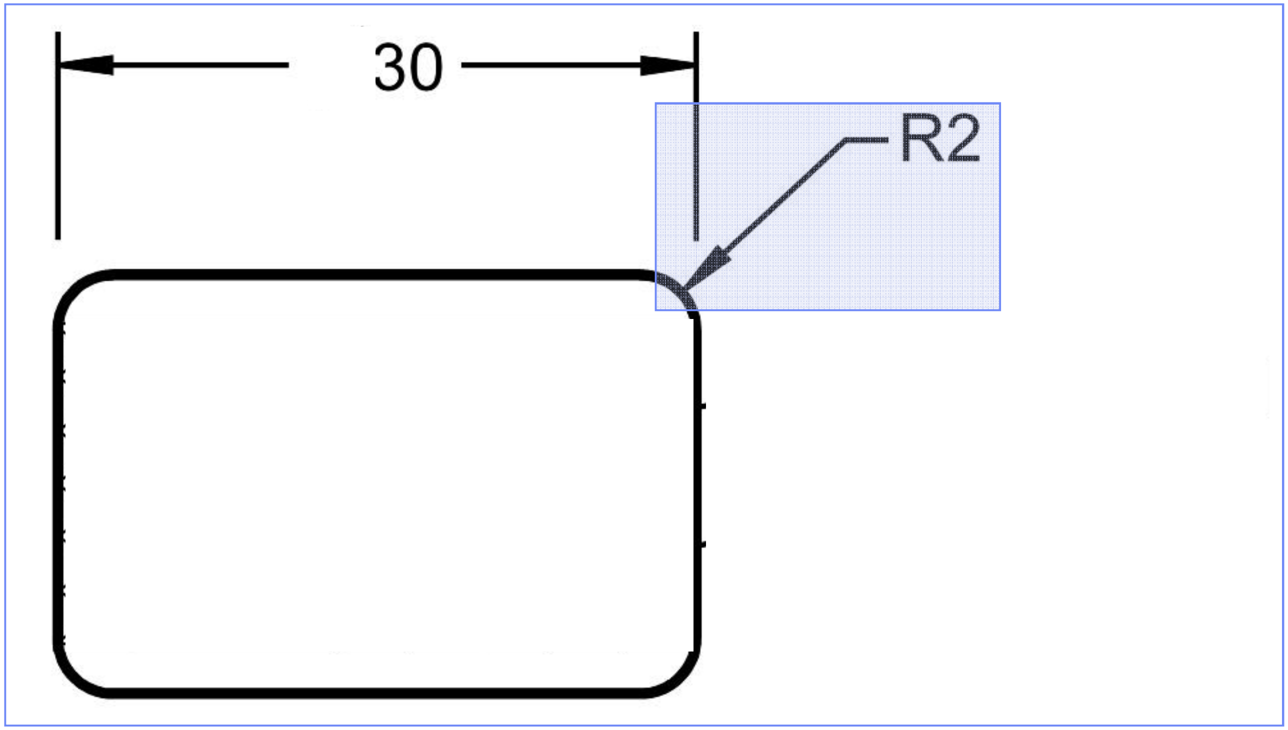
- **Extension line:** An extension line is a thin solid line that extends from a point on the drawing to which the dimension refers.



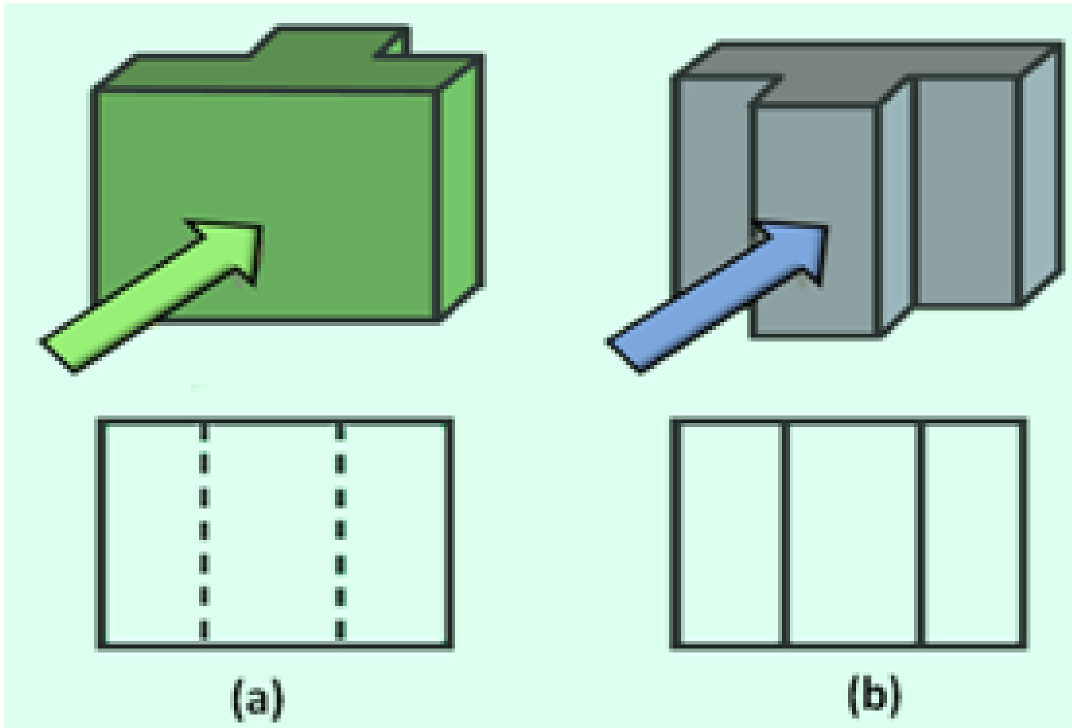
Long extension lines should be avoided.

Leader Line

- **Leader Line:** A straight inclined thin solid line that is usually terminated by an arrowhead.

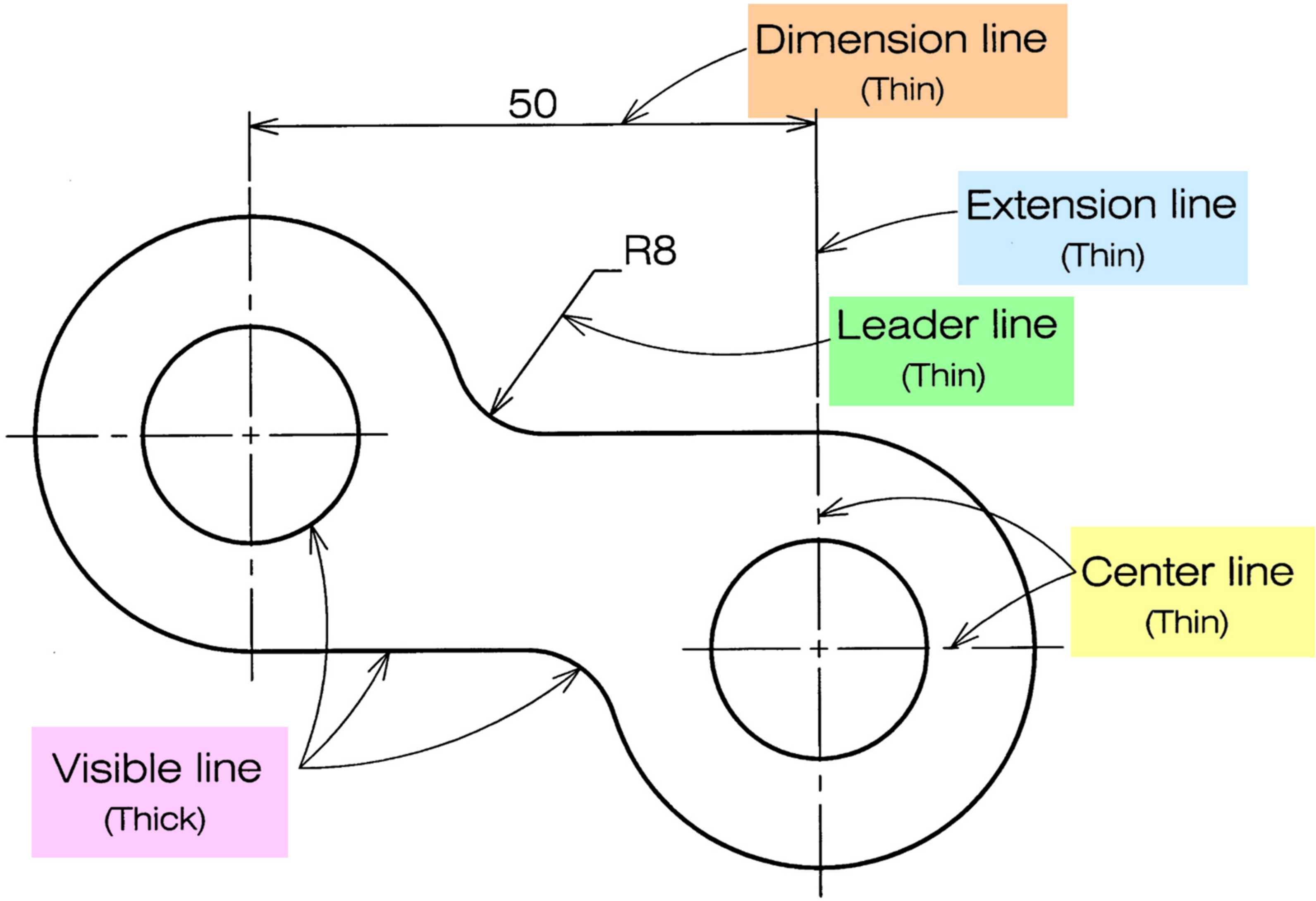


Example



Hidden line Vs Visible line

Example


Dimension line
(Thin)
50
Extension line
(Thin)
R8
Leader line
(Thin)
Center line
(Thin)
Visible line
(Thick)

Guidelines

LINES, LETTERING AND DIMENSIONING

LINE TYPES

Sl. No	LINE TYPE	APPLICATION	PENCIL TYPE
1	Continuous thick	Visible edges, Visible outlines	H (Medium grade)
2	Continuous thin	Construction lines, Guide lines, Projection lines, Dimension lines, Extension lines, Leader lines and Hatching lines	2H (Hard grade)
3	Dashed thick	Hidden outlines, Hidden edges	H
4	Chain thin	Center lines, Axes, Lines of symmetry, Trajectories and Pitch circles	2H
5	Continuous thin free hand	Limits of partial or interrupted views	2H
6		Border lines, Lettering and Free hand skecthing	HB (Soft grade)

SCALES

TYPE	RECOMMENDED		
Enlargement scale	50:1	20:1	10:1
	5:1	2:1	-
Full size	1:1		
Reduction scale	1:2	1:5	1:10
	1:20	1:50	1:100
	1:200	1:500	1:1000
	1:2000	1:5000	1:10000

$$\text{Scale of a drawing / Representative fraction} = \frac{\text{Drawing length of an element}}{\text{Actual length of that element}}$$

(PTO)

Guidelines

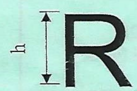
LETTERING

Recommended letter sizes

2.5 mm & 3.5 mm - For Dimensioning & Marking

5 mm - For Writing notes & Subtitles

10 mm - For Title of the Drawing



Lettering Types:

1) Vertical single stroke letters
2) Inclined single stroke letters

Shape identification symbol for dimensioning

Ø - Diameter

R - Radius

☐ - Square

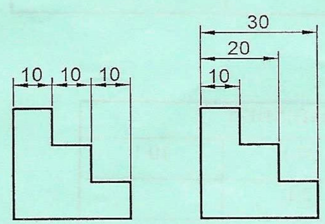
SØ - Spherical diameter

SR - Spherical radius

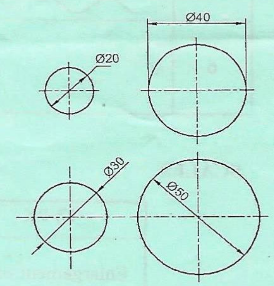
Lettering sizes ratio:

Height of the Upper case letters 'h'	(14/14) h	2.5	3.5	5	7	10	14	20
Height of the Lower case letters 'c'	(10/14) h	-	2.5	3.5	5	7	10	14

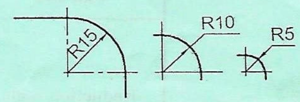
DIMENSIONING METHODS



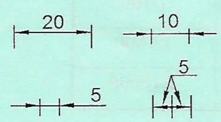
Chain dimensioning Parallel dimensioning



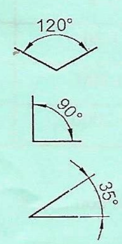
Diameter dimensioning for circles



Radius dimensioning for arcs



Linear dimensioning



Angular dimensioning

Prepared for B.Tech - CS & MM 17, by
S. RAVISUBRAMANIAN, ME
CAE Lab, Machine Design Section,
Dept. of Mechanical Engineering,
IIT Madras, Chennai - 600 036

30/01/2018

Thank you

ME1480 Engineering Drawing

Dr. Piyush Shakya
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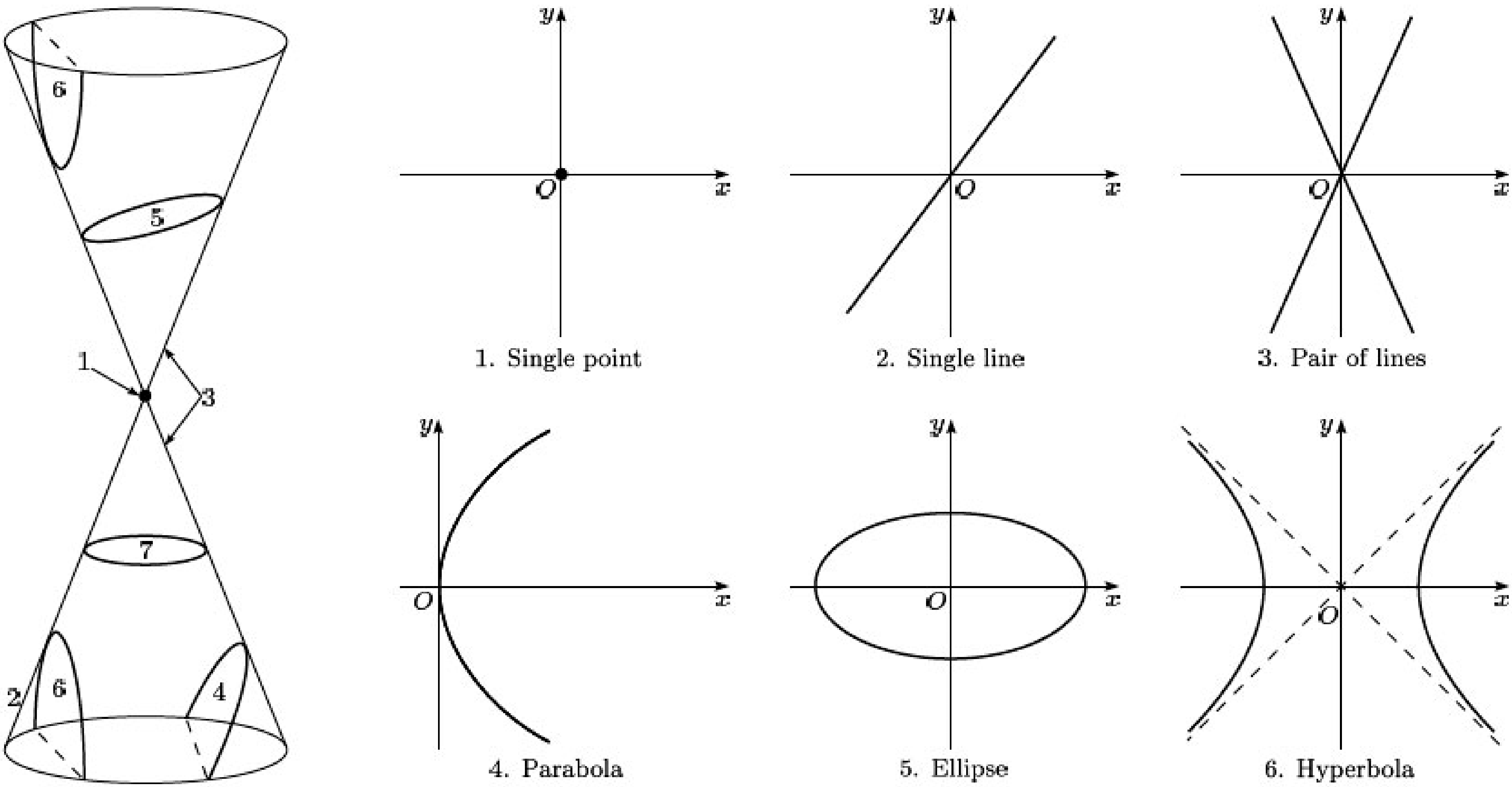
Department of Mechanical Engineering
Indian Institute of Technology Madras, Chennai

Conic Sections

Conic Sections are the curves that appear when a plane intersects a double right circular cone at different angles.



Common Definition of Conic Sections

Conic section curve is the locus of a point moving in a plane such that the ratio of its distance from a fixed point (focus) and from a fixed line (directrix) remains constant. The ratio is called eccentricity.

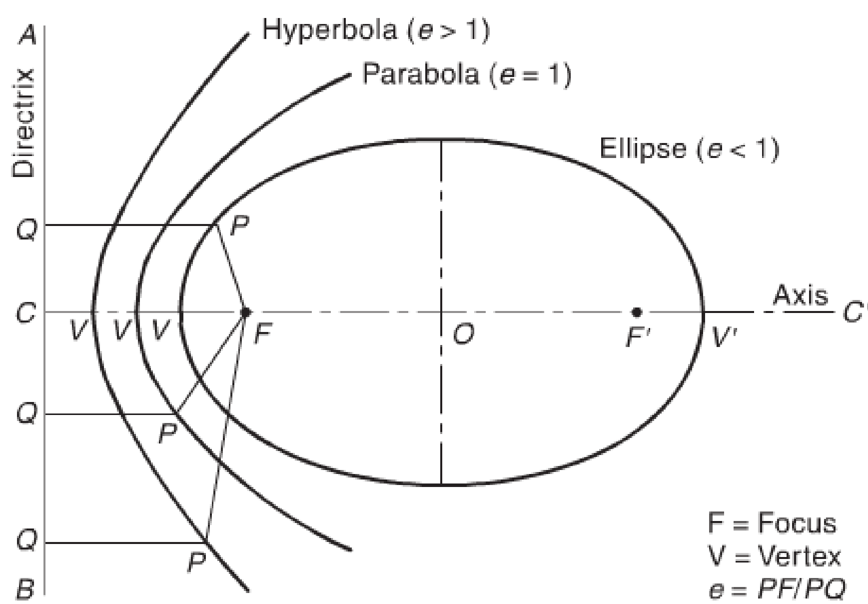
$$Eccentricity(e) = \frac{Distance\ of\ the\ point\ from\ the\ focus}{Distance\ of\ the\ point\ from\ the\ directrix}$$

The portion of a tangent to a conic section curve cut off between the directrix and the curve subtends a right angle at the focus.

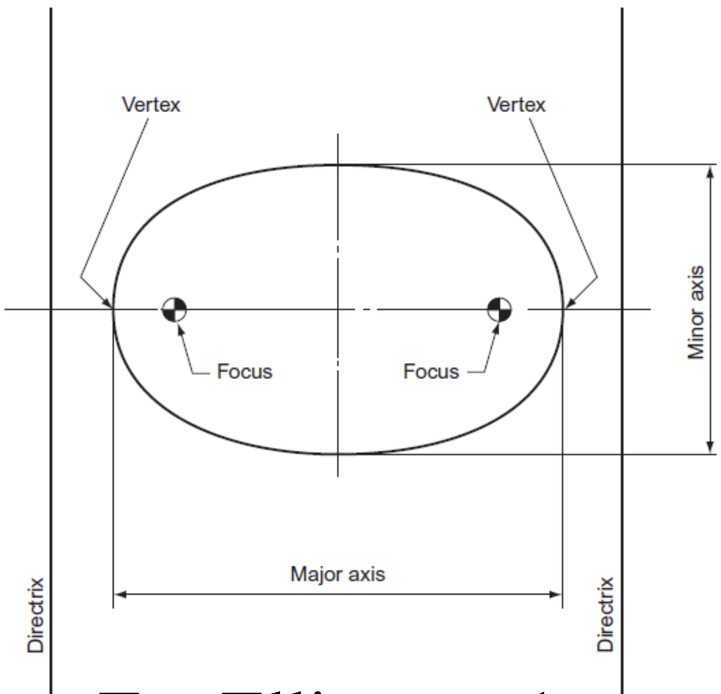
For Ellipse $e<1$

For Parabola $e=1$

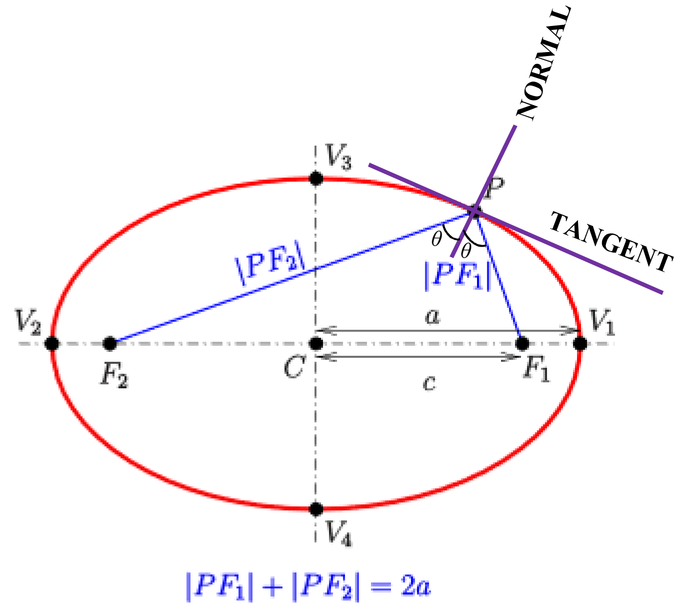
For Hyperbola $e>1$



Ellipse



For Ellipse e<1

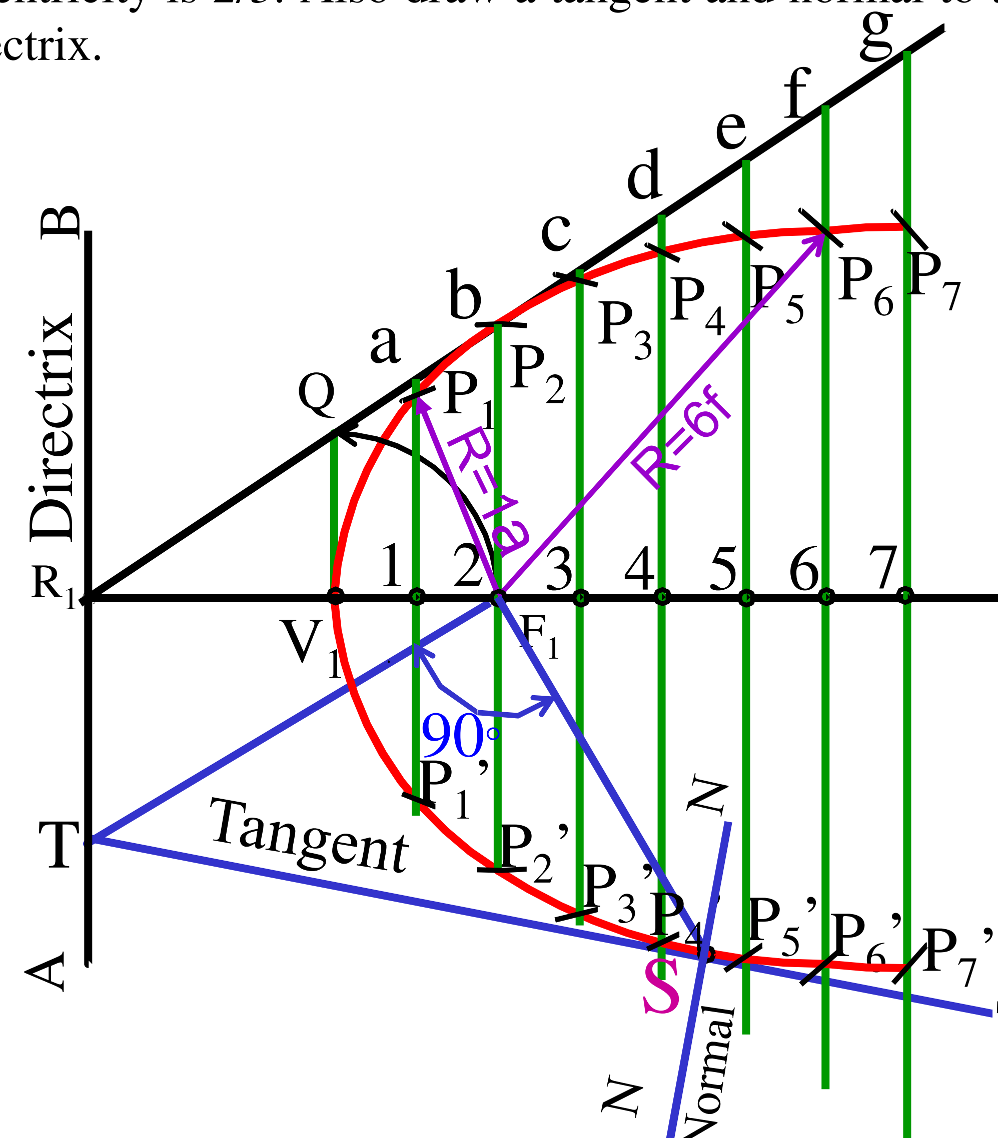


An ellipse is the locus of a point moving in a plane such that the sum of its distance from two fixed points (foci) is constant.

The normal at any point on the ellipse bisects the angle subtended by the foci on that point.

Ellipse (Focus-Directrix method)

Draw an ellipse when the distance of its focus from its directrix is equal to 50 mm and the eccentricity is 2/3. Also draw a tangent and normal to this ellipse at a point 75 mm from the directrix.



Eccentricity = 2/3

$$\frac{QV_1}{R_1V_1} = \frac{V_1F_1}{R_1V_1} = \frac{2}{3}$$

Dist. Between directrix & focus = 50 mm

1 part = 50/(2+3)=10 mm

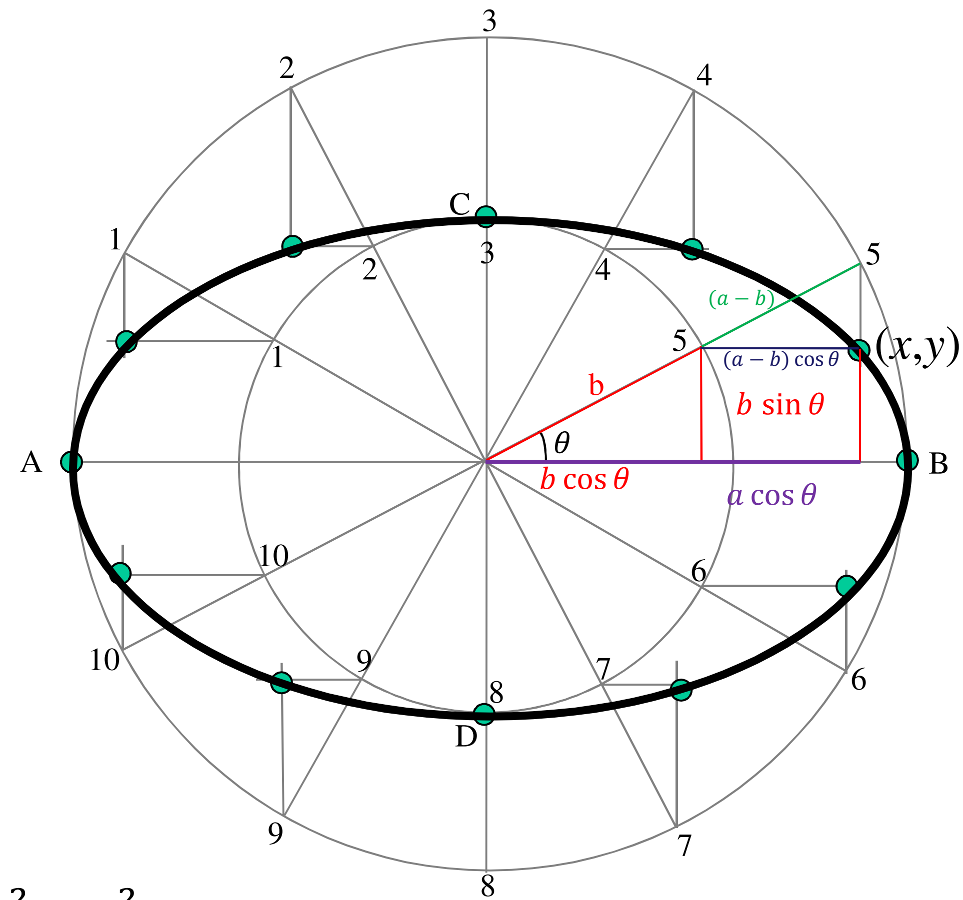
V_1F_1 = 2 parts = 20 mm

V_1R_1 = 3 parts = 30 mm

Ellipse (Concentric Circle Method)

Draw an ellipse by **concentric circle method** Take major axis 120 mm and minor axis 90 mm long.

1. Draw both axes as perpendicular bisectors of each other & name their ends as shown.
2. Taking their intersecting point as a center, draw two concentric circles considering both as respective diameters.
3. Divide both circles in 12 equal parts & name as shown.
4. From all points of outer circle draw vertical lines downwards and upwards respectively.
5. From all points of inner circle draw horizontal lines to intersect those vertical lines.
6. Mark all intersecting points properly as those are the points on ellipse.
7. Join all these points along with the ends of both axes in smooth possible curve. It is required ellipse.



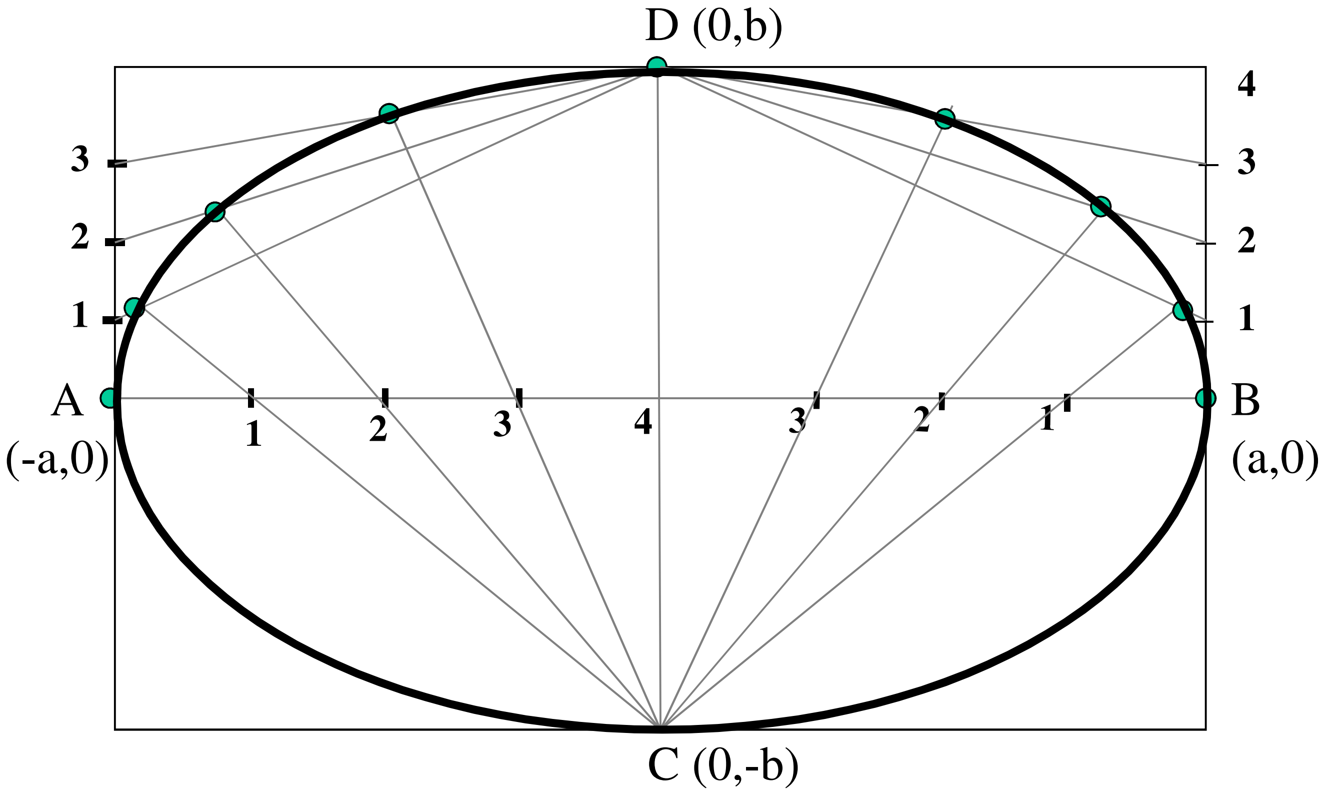
$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$$

$$x = a\cos\theta; \quad y = b\sin\theta;$$

Ellipse (Rectangle method)

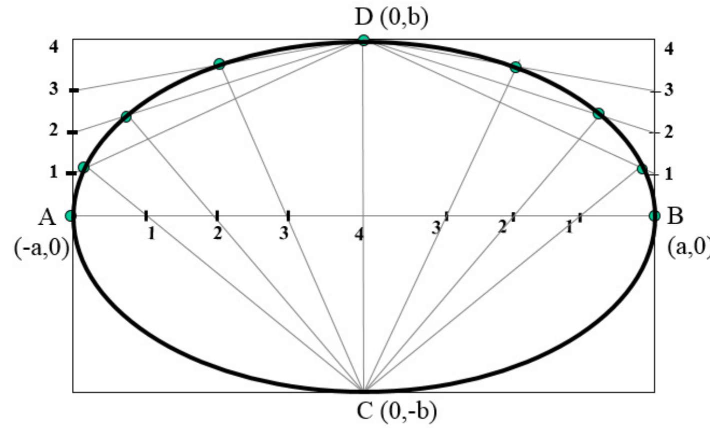
Draw an ellipse by **Rectangle method** Take major axis 120 mm and minor axis 90 mm long.

1. Draw a rectangle taking major and minor axes as sides.
2. In this rectangle draw both axes as perpendicular bisectors of each other.
3. For construction, select upper left part of rectangle. Divide vertical small side and horizontal long side into same number of equal parts. (here divided in four parts)
4. Name those as shown.



5. Now join all vertical points 1,2,3,4, to the upper end of minor axis and all horizontal points i.e.1,2,3,4 to the lower end of minor axis.
6. Then extend C-1 line up to D-1 and mark that point. Similarly, extend C-2, C-3, C-4 lines up to D-2, D-3, & D-4 lines.
7. Mark all these points properly and join all along with ends A and D in smooth possible curve. Do similar construction in right side part along with lower half of the rectangle. Join all points in smooth curve.

Reason (Ellipse Rectangle method)



Assume that the half of the major and minor axis is divided in n parts.

Coordinate of i^{th} point on the vertical line passing through B (V_i) in the first quadrant = $\left(a, \frac{ib}{n}\right)$

Coordinate of i^{th} point on the horizontal line passing through B (H_i) in the first quadrant = $\left(\frac{(n-i)a}{n}, 0\right)$

Eq. of line passing through D $(0,b)$ and V_i $\left(a, \frac{ib}{n}\right)$

$$y - Y_1 = \frac{Y_2 - Y_1}{X_2 - X_1}(x - X_1)$$

$$y - b = \frac{\frac{ib}{n} - b}{a}(x) \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Eq. of line passing through C $(0,-b)$ and H_i $\left(\frac{(n-i)a}{n}, 0\right)$

$$y - Y_1 = \frac{Y_2 - Y_1}{X_2 - X_1}(x - X_1)$$

$$y + b = \frac{b}{\frac{(n-i)\,a}{n}}(x) \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$y = \frac{\frac{ib}{n} - b}{a}(x) + b = \frac{b}{\frac{(n-i)\,a}{n}}(x) \text{ -b}$$

Reason (Ellipse Rectangle method)

$$y = \frac{\frac{ib}{n} - b}{a}(x) + b = \frac{b}{\frac{(n-i)\,a}{n}}(x) \text{ -b}$$

$$\frac{b}{a}x\left[\frac{n}{n-i} - \frac{i-n}{n}\right] = 2b$$

$$x\left[\frac{n}{n-i} + \frac{n-i}{n}\right] = 2a$$

$$x\left[\frac{n^2+(n-i)^2}{n(n-i)}\right] = 2a$$

$$x = \frac{2an(n-i)}{n^2+(n-i)^2} \qquad \left(\frac{x}{a}\right)^2 = \frac{4n^2(n-i)^2}{[n^2+(n-i)^2]^2}$$

From eq.(1), $\quad y = \frac{bn}{(n-i)a}\,x - b$

Simplifying we get, $y = \left(\frac{bn}{(n-i)}\right)\left[\frac{2n(n-i)}{n^2+(n-i)^2}\right] - b$

$$y = \frac{2bn^2}{[n^2+(n-i)^2]} - b$$

$$y = \frac{b(n^2-(n-i)^2)}{[n^2+(n-i)^2]}$$

$$\left(\frac{y}{b}\right)^2 = \frac{[n^2-(n-i)^2]^2}{[n^2+(n-i)^2]^2}$$

Let us assume $n^2 = p$ and $(n-i)^2 = q$

$$\left(\frac{x}{a}\right)^2 = \frac{4pq}{(p+q)^2} \quad \text{and} \quad \left(\frac{y}{b}\right)^2 = \frac{(p-q)^2}{(p+q)^2}$$

$$\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2 = \frac{4pq}{(p+q)^2} + \frac{(p-q)^2}{(p+q)^2} = \frac{4pq+(p-q)^2}{(p+q)^2}$$

$$\left(\frac{x}{a}\right)^2 + \left(\frac{y}{b}\right)^2 = 1$$

Ellipse (Parallelogram method)

The sides of a parallelogram are 120 mm and 80 mm. The included angle between them is 75°. Inscribe an ellipse in the given parallelogram.

CONSTRUCTION Figure 5.17

1. Draw a parallelogram *KLMN* with sides *KL* = 80 mm, *LM* = 120 mm and $\angle KLM = 75°$.
2. Mark *A*, *B*, *C*, *D* as mid-points of *KL*, *MN*, *NK*, *LM* respectively.
3. Mark *O* as the perpendicular bisectors of *AB* and *CD*.
4. Divide lines *OA* and *KA* into same number of equal parts, say 4. Mark 1, 2, 3 on *OA* and 1′, 2′, 3′ on *KA*.
5. Join point *C* with the points 1′, 2′, 3′.

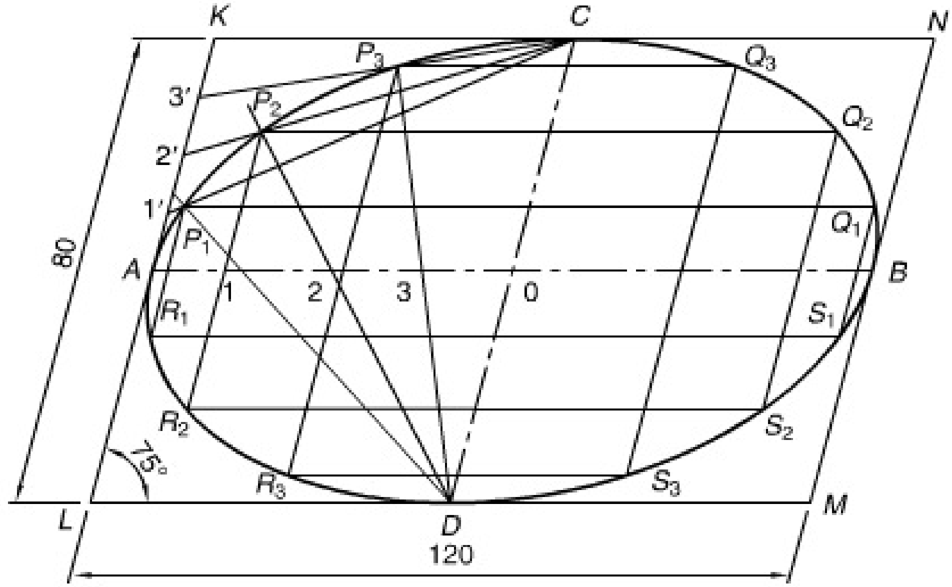


Fig. 5.17

6. Draw lines from point *D*, to join points 1, 2 and 3 and produce to intersect lines *C*1′, *C*2′ *C*3′ at points P_1, P_2, P_3 respectively.
7. Draw a smooth curve through *A*, P_1, P_2, P_3, *C*. This is one-quarter of an ellipse.
8. Draw lines parallel to *AB* through points P_1, P_2, P_3 and make each of them equal on either sides of *CD* and obtain Q_1, Q_2, Q_3.
9. Similarly, draw lines parallel to line *CD* passing through points P_1, P_2, P_3 and points Q_1, Q_2, Q_3. Make each of them equal on either sides of *AB* and obtain points R_1, R_2, R_3, S_1, S_2, S_3.
10. Join the points obtained in steps 8 and 9 with a smooth curve.

Ellipse (Arcs of circle method)

Two fixed points M and N are 100 mm apart. Trace the complete path of point P moving in such a way that the sum of its distance from M and N is always the same and equal to 130 mm. Name the traced curve.

CONSTRUCTION Figure 5.14

1. Draw a major axis AB 130 mm long and locate its mid-point O.
2. Mark foci M and N on AB with symmetry about O such that MN = 100 mm.
3. Mark points 1, 2, 3, etc., on OM at any convenient distances, which need not be equal.
4. With foci M and N as the centres and lengths equal to $A1$ and $B1$ as the radii respectively, draw arcs to intersect each other at P_1 and P_1'.
5. With foci M and N as the centres and radii $B1$ and $A1$ respectively, draw arcs to intersect each other at Q_1 and Q_1'.
6. Repeat step 4 and step 5 with the remaining points 2, 3 and 4 to obtain additional points P_2, P_2', Q_2, Q_2', P_3, … etc.
7. Draw a smooth curve passing through all these points. The curve obtained is an ellipse.

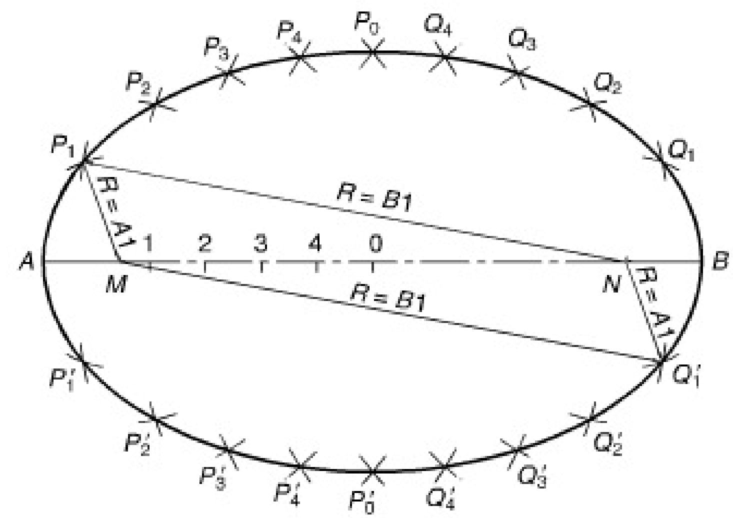


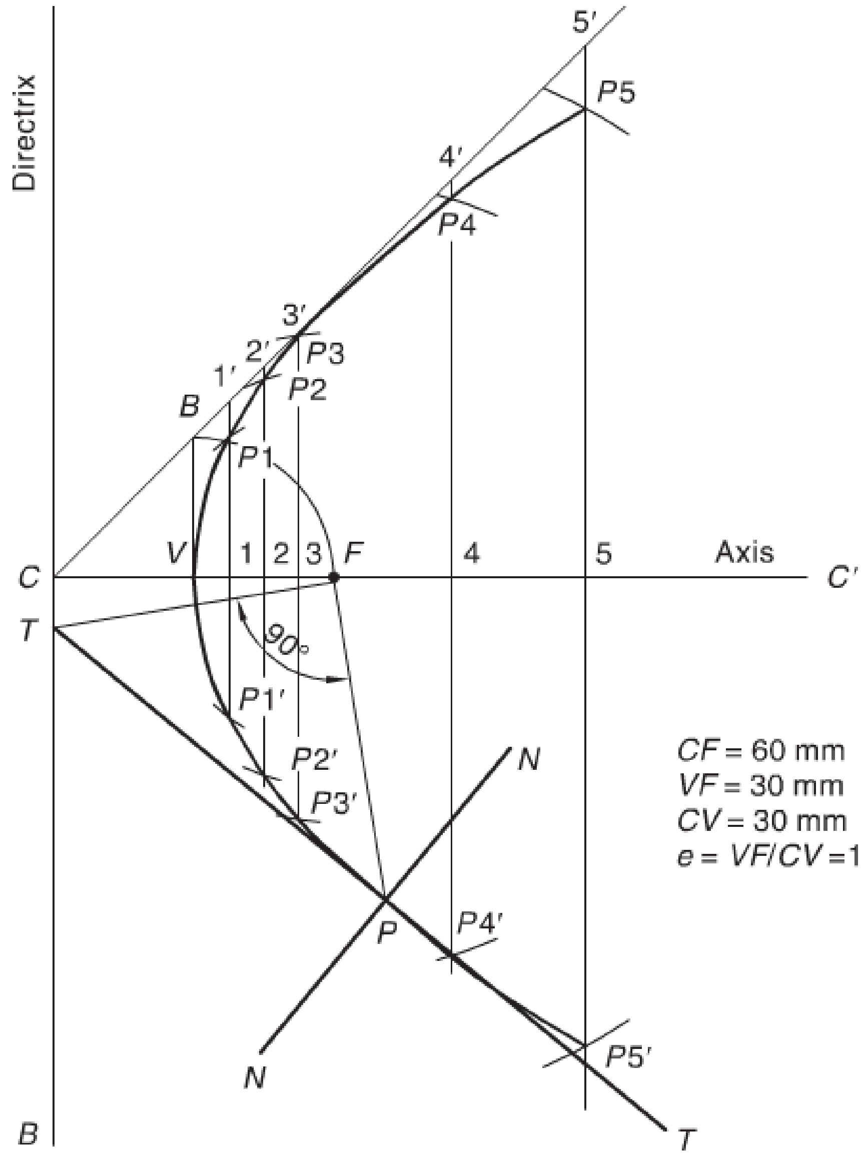
Fig. 5.14

Parabola (Focus-Directrix method)

Draw a Parabola for distance of the focus from the directrix being 60 mm

For Parabola eccentricity is 1.

1. Draw directrix *AB* and axis *CC′* as shown.
2. Mark *F* on *CC′* such that *CF* = 60 mm.
3. Mark *V* at the midpoint of *CF*. Therefore, *e* = *VF*/*VC* = 1.
4. At *V*, erect a perpendicular *VB* = *VF*. Join *CB*.
5. Mark a few points, say, 1, 2, 3, … on *VC′* and erect perpendiculars through them meeting *CB* produced at 1′, 2′, 3′, …
6. With *F* as a centre and radius = 1–1′, cut two arcs on the perpendicular through 1 to locate *P*1 and *P*1′. Similarly, with *F* as a centre and radii = 2–2′, 3–3′, etc., cut arcs on the corresponding perpendiculars to locate *P*2 and *P*2′, *P*3 and *P*3′, etc.
7. Draw a smooth curve passing through *V*, *P*1, *P*2, *P*3 … *P*3′, *P*2′, *P*1′.

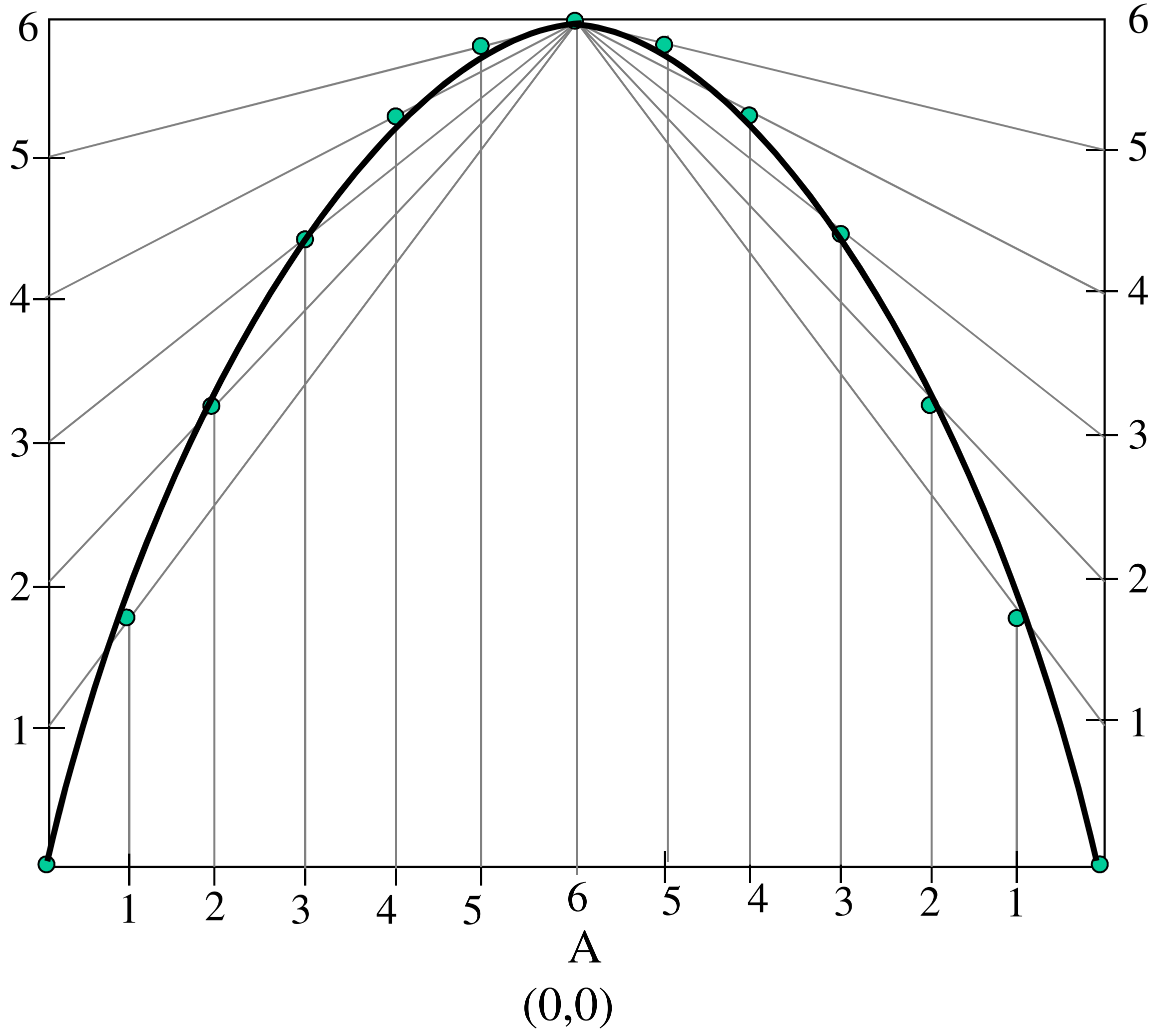


Parabola (Rectangle method)

A ball thrown in the air attains 100cm height and covers a horizontal distance of 150cm on the ground. Draw the path of the ball (projectile).

1. Draw rectangle of above size and divide it in two equal vertical parts.
2. Consider left part for construction. Divide height and length in equal number of parts and name those 1,2,3,4,5& 6.
3. Join vertical 1,2,3,4,5 & 6 to the top center of rectangle.
4. Similarly draw upward vertical lines from horizontal1,2,3,4,5 and wherever these lines intersect previously drawn inclined lines in sequence. Mark those points and further join in smooth possible curve.
5. Repeat the construction on right side rectangle also join all in sequence.

This locus is Parabola.



Reason (Parabola Rectangle method)

Consider five points $A(0,0), B(0,a), C\left(-\frac{b}{2},0\right), D\left(\frac{b}{2},0\right)$, and E $\left(\frac{b}{2},a\right)$.

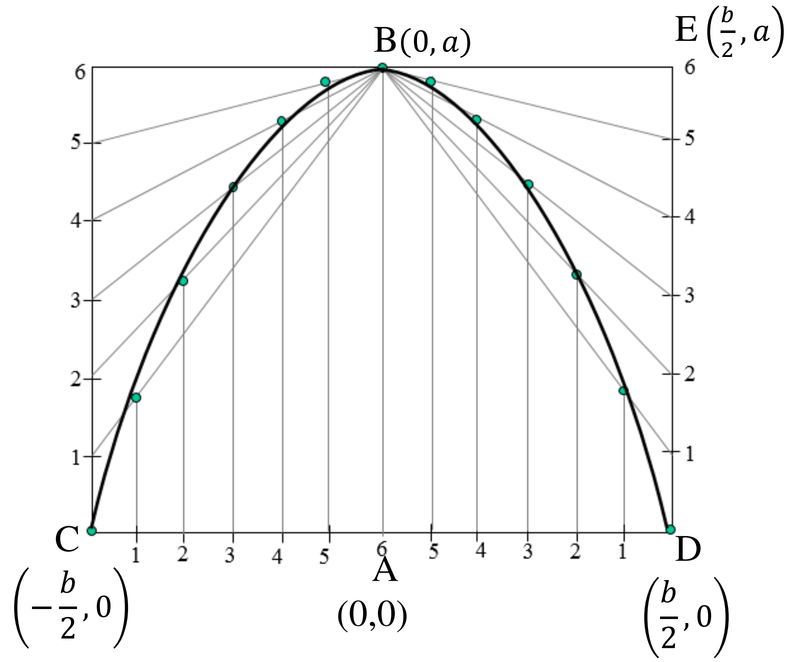
Divide the DE in n-parts and consider the i^{th} point on the vertical line passing through D, $V_i\left(\frac{b}{2},\frac{ia}{n}\right)$

Divide AD in n-parts and consider the i^{th} point on the horizontal line passing through D, $H_i\left(\left(\frac{n-i}{n}\right)\frac{b}{2},0\right)$.

Equation of the vertical line through $H_i\left(\left(\frac{n-i}{n}\right)\frac{b}{2},0\right)$,

$$x = \frac{n-i}{n}.\frac{b}{2}$$

$$\frac{2x}{b} = \frac{n-i}{n}$$



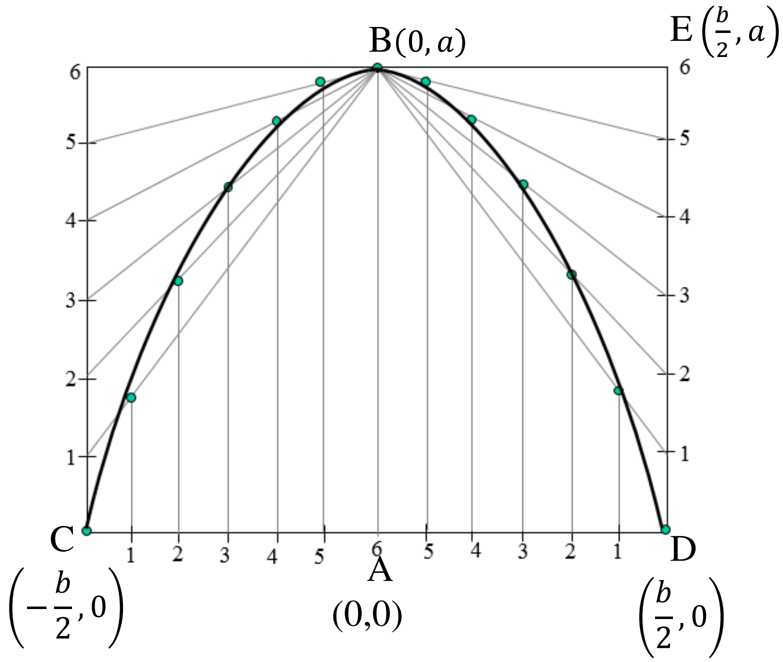
Reason (Parabola Rectangle method)

Equation of the vertical line through $H_i\left(\left(\frac{n-i}{n}\right)\frac{b}{2},0\right)$,

$$\frac{2x}{b}=\frac{n-i}{n}$$

Equation of line passing through $V_i\left(\frac{b}{2},\frac{ia}{n}\right)$ and $B(0,a)$,

$$y-Y_1=\frac{Y_2-Y_1}{X_2-X_1}(x-X_1)$$



$$y-a=\frac{\frac{ia}{n}-a}{\frac{b}{2}}(x)$$

$$y-a=a\left(\frac{i}{n}-1\right)\left(\frac{2x}{b}\right)$$

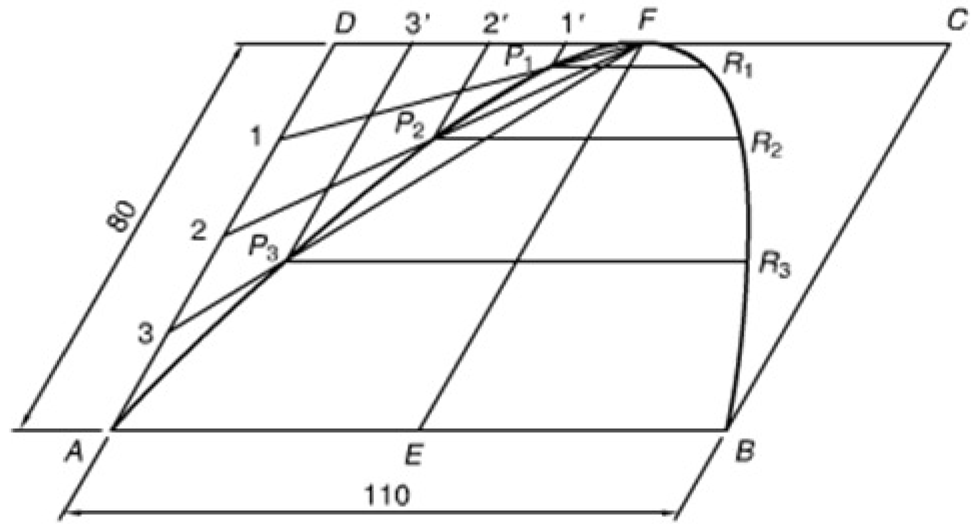
$$y-a=-a\left(\frac{n-i}{n}\right)\left(\frac{2x}{b}\right)$$

$$y-a=-a\left(\frac{2x}{b}\right)^2$$

$$y-a=-\frac{4ax^2}{b^2}$$

Parabola (Parallelogram method)

Inscribe a parabola in a parallelogram of 110 mm × 80 mm sides, the included angle being 60°. Consider the longer side of the parallelogram as the base of the parabola.

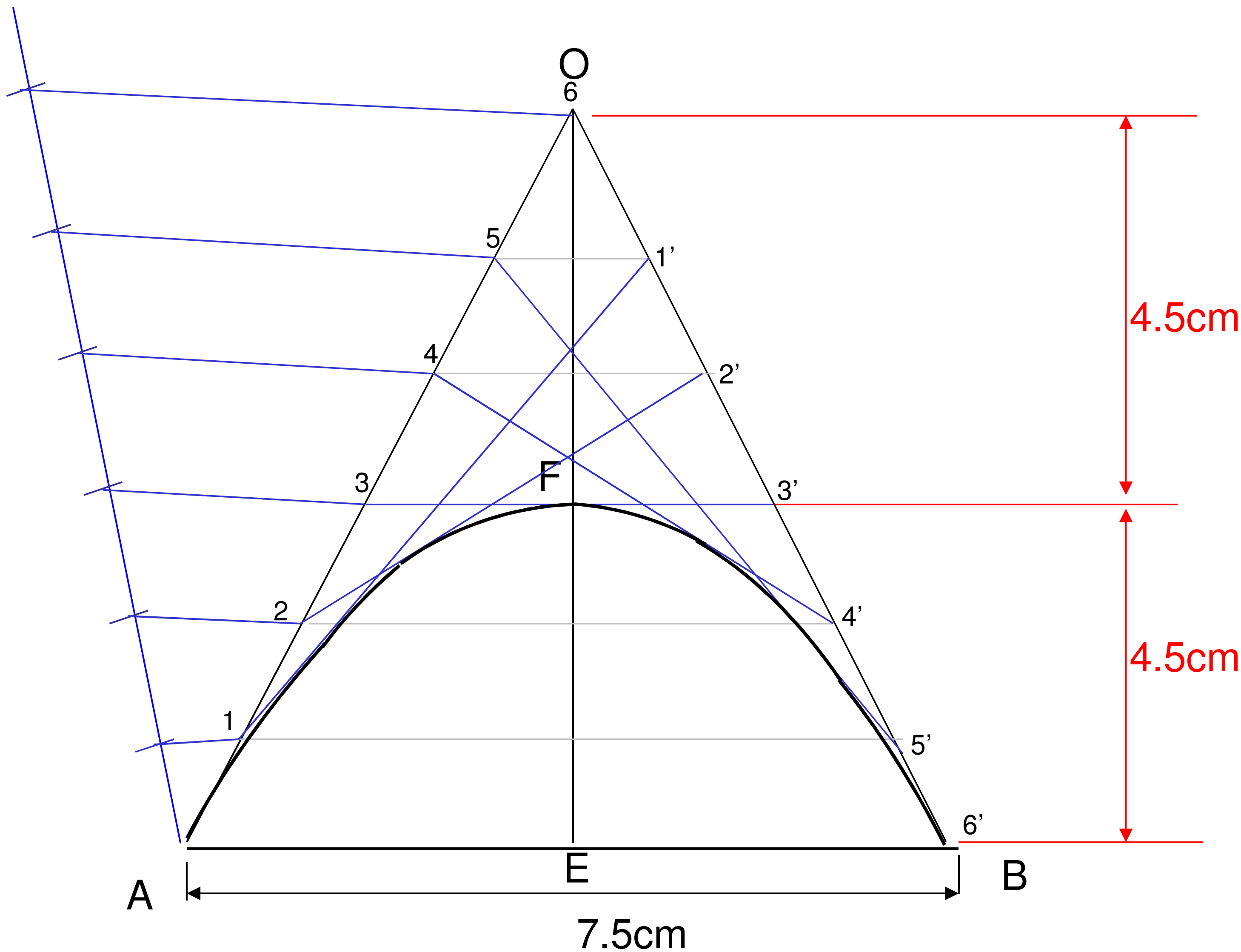


CONSTRUCTION Figure 5.32

1. Draw a parallelogram *ABCD*, *AB* = *110* mm and *AD* = 80 mm. Let ∠*DAB* = 60°.
2. Mark *E* and *F* as the mid-points of *AB* and *CD* respectively.
3. Divide lines, *FD* and *DA*, into same number of equal parts, say 4. Mark divisions of *DA* as 1, 2, 3 and divisions of *FD* as 1′, 2′, 3′.
4. Connect point *F* with points 1, 2, 3.
5. Through 1′, 2′, 3′ draw lines parallel to axis *EF* to meet lines *F*1, *F*2, *F*3 at points P_1, P_2, P_3 respectively.
6. Draw a curve through *F*, P_1, P_2, P_3, *A*. This is one-half of the parabola.
7. Draw horizontal lines through points P_1, P_2, P_3. Make their distances equal on either side of *EF* and obtain points R_1, R_2, R_3 of the curve.
8. Draw a curve to pass through points *F*, R_1, R_2, R_3, *B*. This is other half of the parabola.

Parabola (Tangent method)

Draw a parabola by tangent method given base 7.5cm and axis 4.5cm



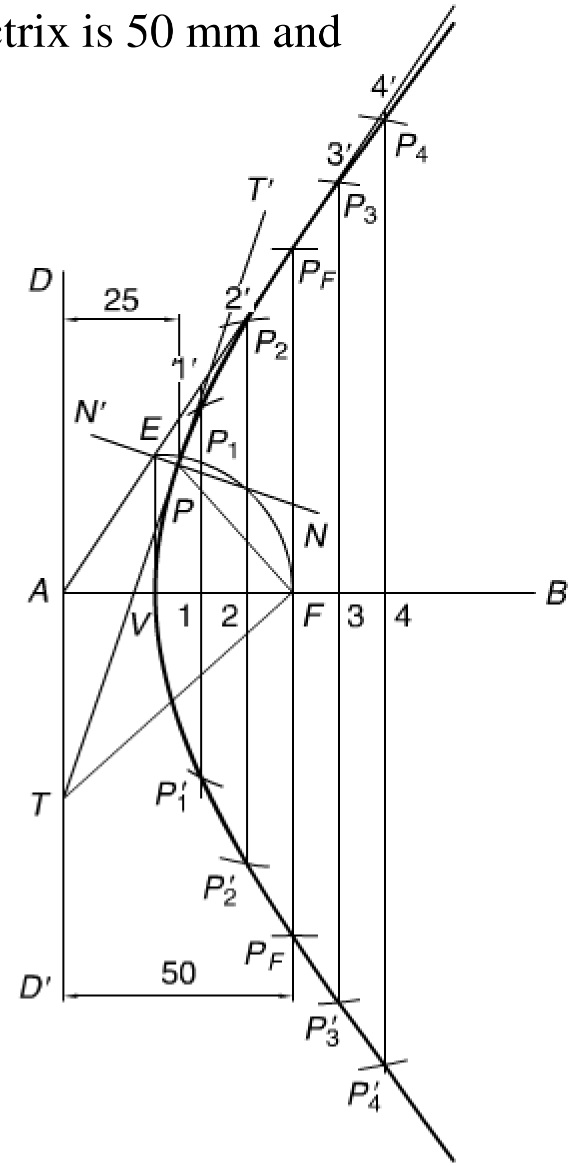
Hyperbola (Focus-Directrix method)

Draw a hyperbola when the distance between its focus and directrix is 50 mm and eccentricity is 1.5.

1. Draw directrix DD' and principal axis AB perpendicular to the DD'.
2. Mark focus F on the principal axis AB at a distance of 50 mm from the directrix DD', i.e., AF = 50 mm.
3. Divide the line AF into five equal parts (as $e = 3/2$) and mark vertex V on it such that $\frac{VF}{AV} = \frac{2}{3}$. Thus, vertex V satisfies the condition for being a point of the curve.
4. At V, draw a vertical line VE equal to VF. Join AE and extend it to some distance. Thus, in the triangle AVE, $\frac{VE}{AV} = \frac{VF}{AV} = \frac{3}{2}$.
5. Mark any point 1 on the axis and through it, draw a perpendicular line to meet AE produced at $1'$. Thus, $\frac{11'}{A1} = \frac{VE}{AV} = \frac{3}{2}$.
6. With centre F and radius equal to $11'$, draw arcs to intersect the perpendicular line $11'$ at point P_1 and P_1'. These are the points of the ellipse because ratio $\frac{11'}{AV} = \frac{3}{2}$.
7. Similarly, mark any number of points 2, 3, 4, … on VB at any convenient distances which need not be equal. Through these points, erect lines $22'$, $33'$, $44'$, …, perpendicular to principal axis AB. With F as the centre and radius equal to $22'$, $33'$, $44'$, …, draw arcs to intersect the perpendicular line $22'$, $33'$, $44'$, … at points P_2 and P_2', P_3 and P_3', … etc., respectively.
8. Join points P_2', P_1', V, P_1, P_2, etc., to form a smooth hyperbolic curve.

For Hyperbola

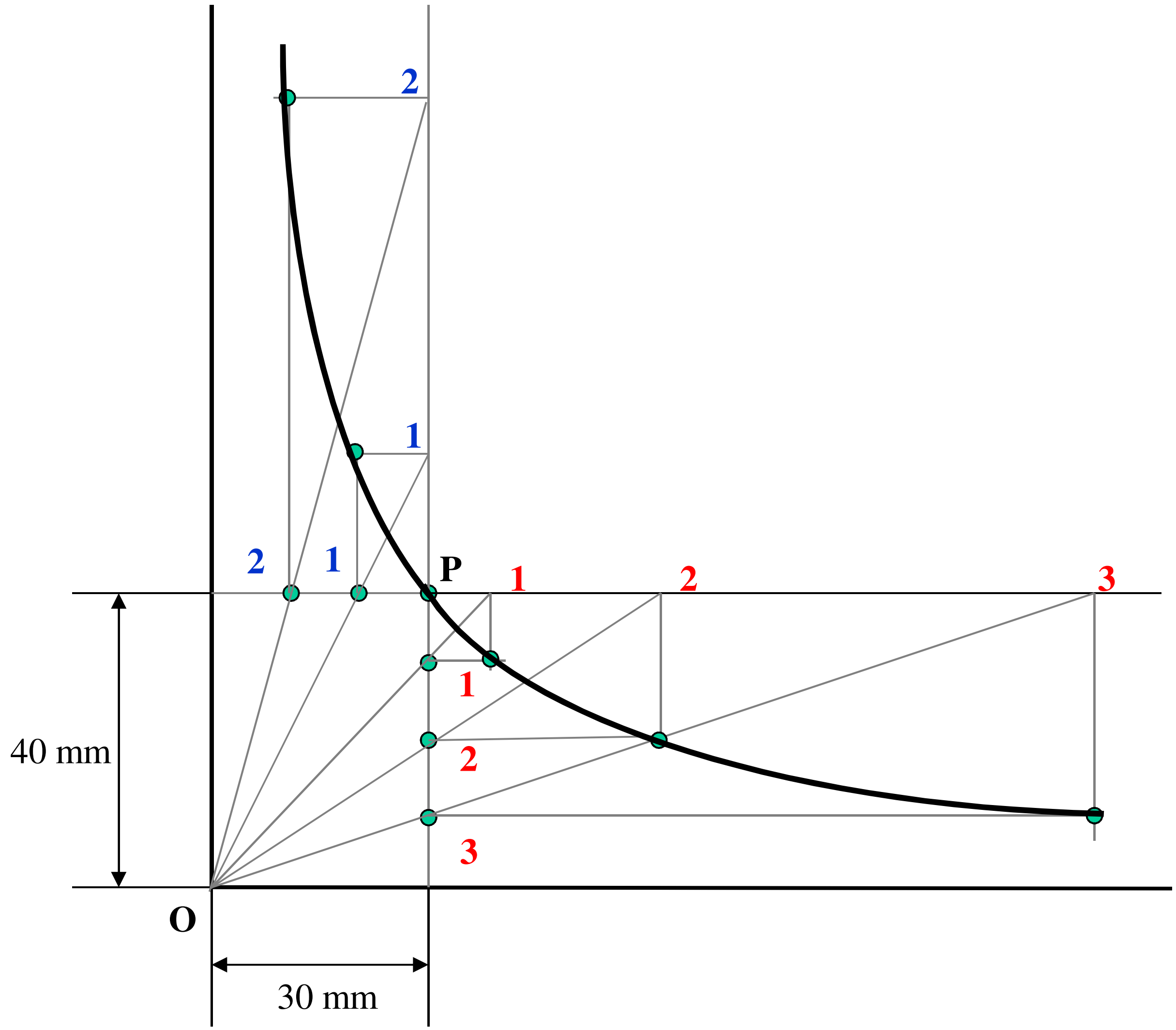
eccentricity > 1.



Hyperbola (Point method)

Point P is 40 mm and 30 mm from horizontal and vertical axes respectively. Draw Hyperbola through it.

1. Extend horizontal line from P to right side.
2. Extend vertical line from P upward.
3 On horizontal line from P, mark some points taking any distance and name them after P-1, 2,3,4 etc.
4 Join 1-2-3-4 points to pole O. Let them cut part [P-B] also at 1,2,3,4 points.
5. From horizontal 1,2,3,4 draw vertical lines downwards and
6. From vertical 1,2,3,4 points [from P-B] draw horizontal lines.
7. Line from 1 horizontal and line from 1 vertical will meet at P_1.Similarly mark P_2, P_3, P_4 points.
8. Repeat the procedure by marking four points on upward vertical line from P and joining all those to pole O. Name this points P_6, P_7, P_8 etc. and join them by smooth curve.



Reason (Hyperbola Point method)

Consider $O(0,0)$ and $P(an, bn)$.

Divide the PM in n-parts and consider the i^{th} point on the vertical line passing through P, V_i $(an, b(n-i))$

Equation of line passing through O, V_i $(an, b(n-i))$

$$y = \left(\frac{b}{a}\right)\left(\frac{n-i}{n}\right)x$$

Equation of the horizontal line through P

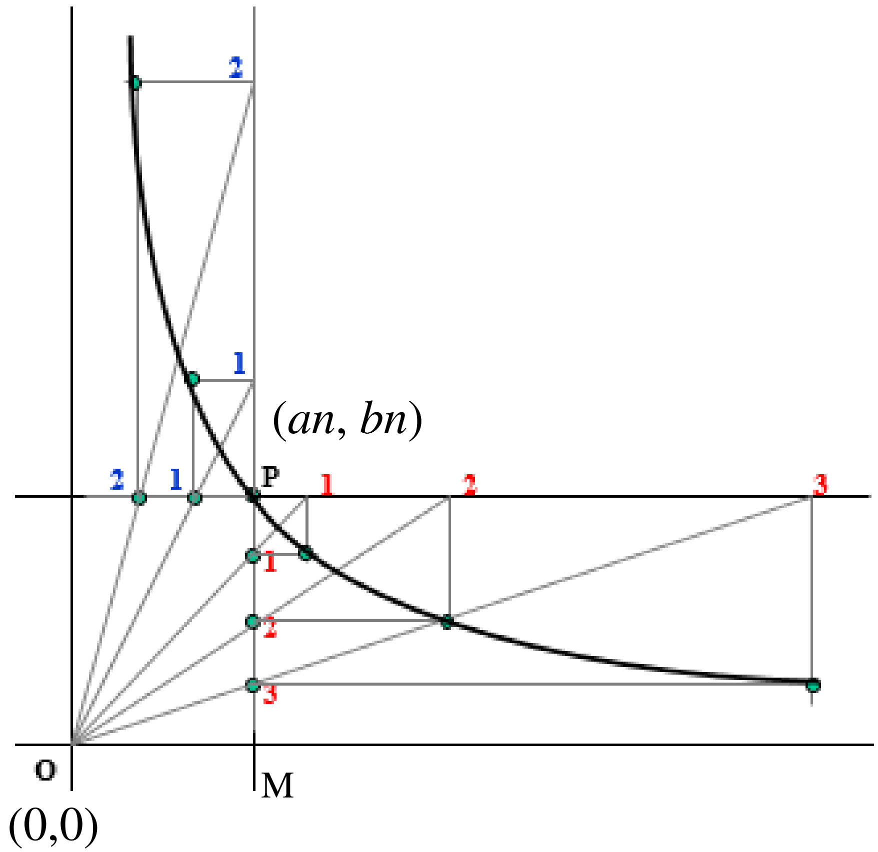
$$y = bn$$

These two lines intersect at H_i

$$bn = \left(\frac{b}{a}\right)\left(\frac{n-i}{n}\right)x$$

Therefore $H_i = \left(\frac{an^2}{n-i}, bn\right)$

and $V_i = (an, b(n-i))$



Reason (Hyperbola Point method)

$H_i = \left(\frac{an^2}{n-i}, bn\right) \qquad V_i = (an, b(n-i))$

The x coordinate of H_i and y coordinate of V_i together form the coordinates of a point on a curve.

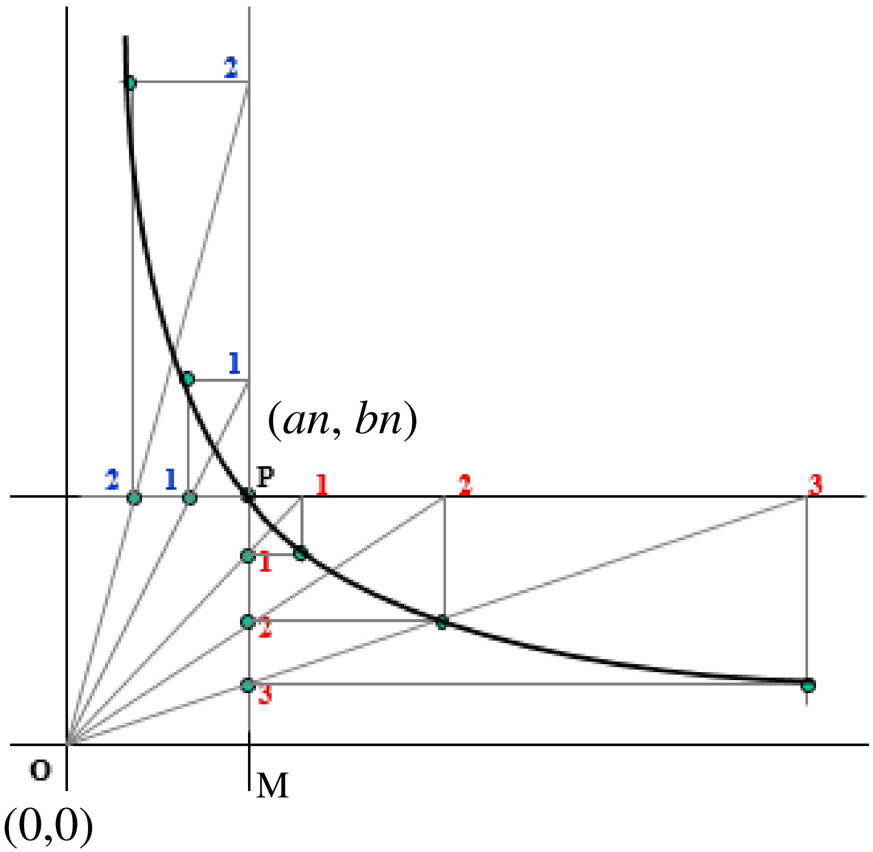
Therefore, the coordinates of a point on the curve $(x, y) = \left(\frac{an^2}{n-i}, b(n-i)\right)$

$$\frac{x}{a} = \frac{an^2}{a(n-i)} = \frac{n^2}{n-i}$$

$$\frac{y}{b} = (n-i)$$

$$\frac{x}{a} = \frac{n^2}{\frac{y}{b}}$$

$$xy = abn^2$$

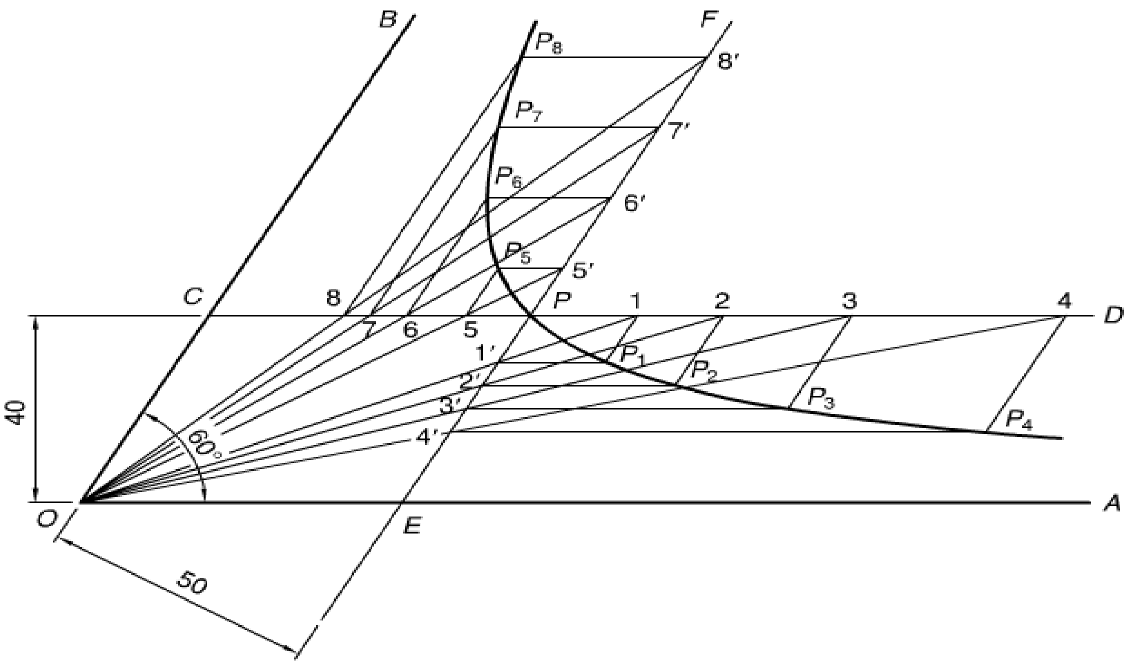


Hyperbola (Oblique Asymptotes Method)

Draw a hyperbola when the asymptotes are inclined at 60° to each other and it passes through a point P at a distance of 40 mm and 50 mm from the asymptotes.

CONSTRUCTION Figure 5.45

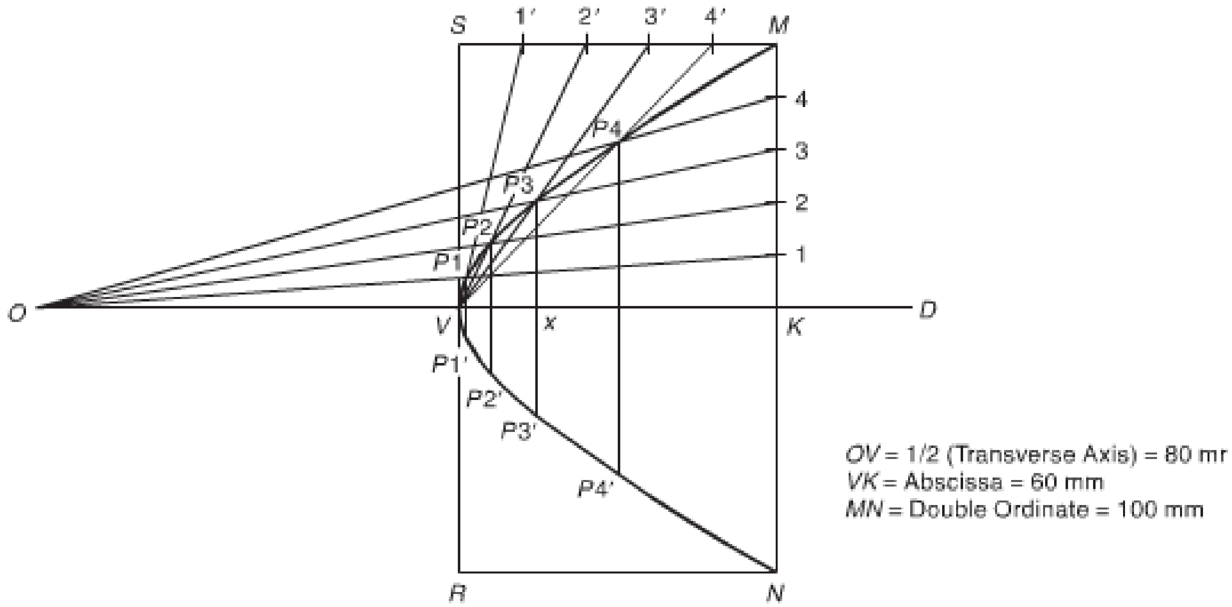
1. Draw asymptotes *OA* and *OB* with an included angle of 60°.
2. Mark a point *P* such that its distance from *OA* is 40 mm and from *OB* is 50 mm.
3. Through point *P*, draw lines *CD* and *EF* parallel to asymptotes *OA* and *OB* respectively.
4. Mark points 1, 2, 3, …etc. along *CD* which need not be equidistant and lying on both sides of point *P*. It is advisable to mark points 1, 2, 3, at distances in increasing order.



5. Join *O*1, *O*2, *O*3, …etc. and extend them, if necessary, until they meet the line *EF* at points 1′, 2′, 3′, …etc.
6. Through 1, 2, 3, …etc., draw lines parallel to *OB* and through 1′, 2′, 3′, … etc., draw lines parallel to *OA*. Let them intersect at points P_1, P_2, P_3, …etc. respectively.
7. Draw a smooth curve passing through points P_1, P_2, P_3, …etc. The obtained curve is the required hyperbola.

Hyperbola (Rectangle method)

Draw a hyperbola having the double ordinate of 100 mm, the abscissa of 60 mm and the transverse axis of 160 mm.



1. Draw axis *OD* and mark *V* and *K* on it such that *OV* = 1/2(Transverse Axis) = 80 mm and *VK* = Abscissa = 60 mm.
2. Through *K*, draw double ordinate *MN* = 100 mm.
3. Construct rectangle *MNRS* such that *NR* = *VK*.
4. Divide *MK* and *MS* into the same number of equal parts, say 5. Number the divisions as shown.
5. Join *O*–1, *O*–2, *O*–3, etc. Also join *V*–1′, *V*–2′, *V*–3′, etc. Mark *P*1, *P*2, *P*3, etc., at the intersections of *O*–1 and *V*–1′, *O*–2 and *V*–2′, *O*–3 and *V*–3′, etc., respectively.
6. Obtain *P*1′, *P*2′, *P*3′, etc., in other half in a similar way. *Alternatively*, draw *P*1–*P*1′, *P*2–*P*2′, *P*3–*P*3′, etc., such that *P*3–*x* = *x*–*P*3′ and likewise.

Thank you

Projection of points and lines

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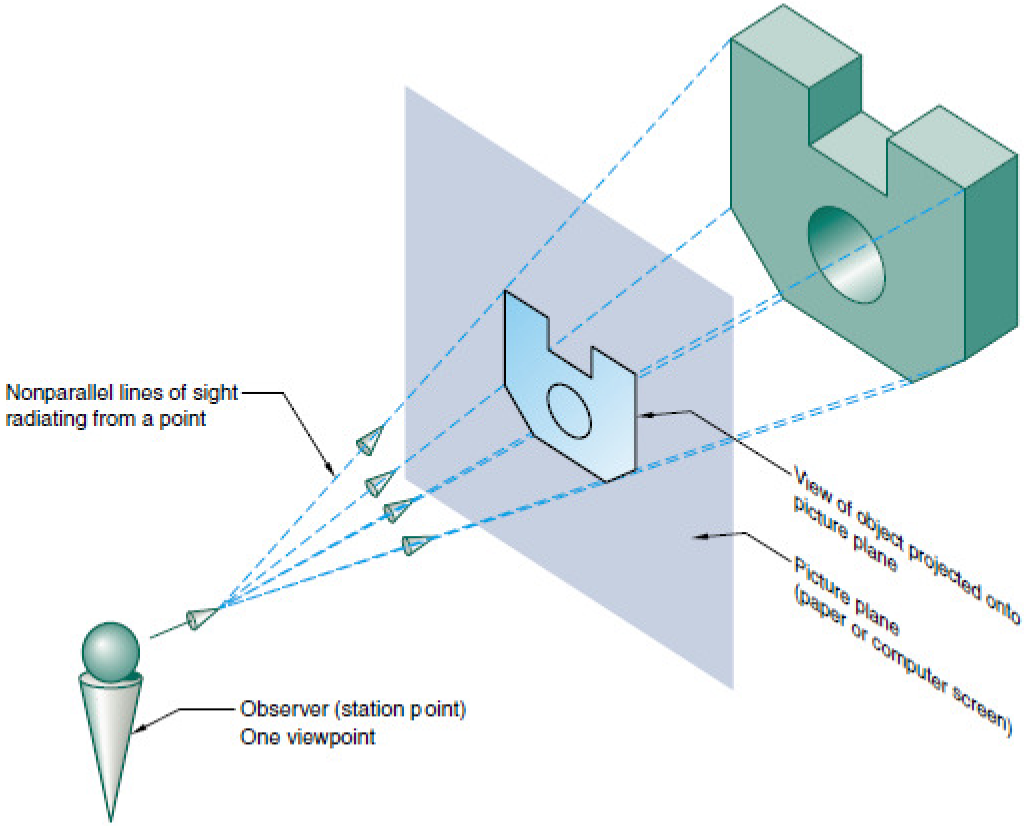
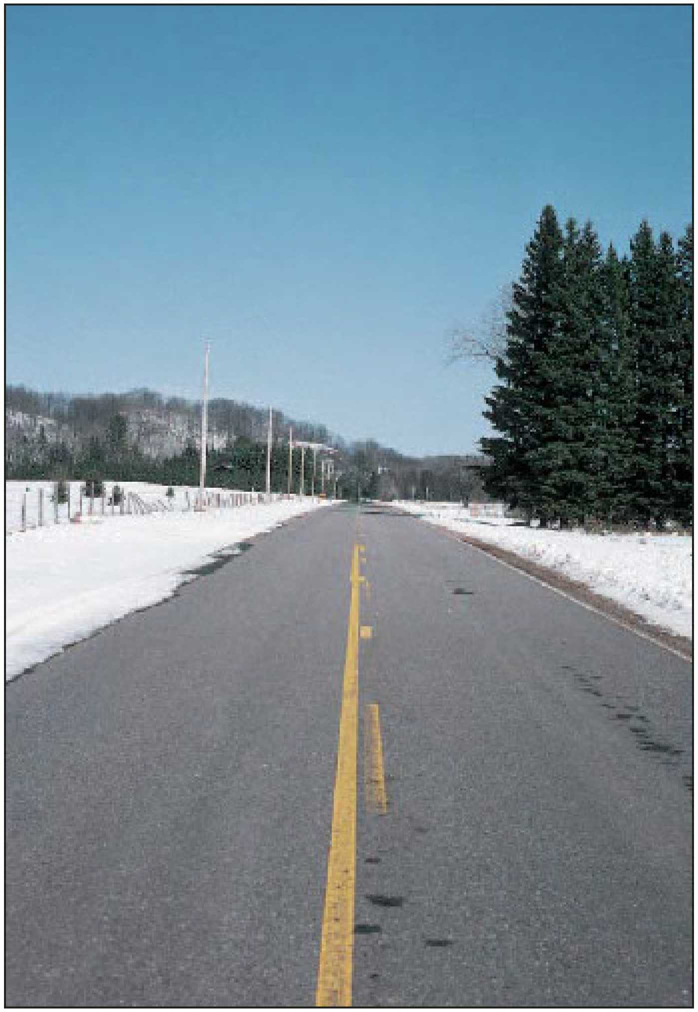
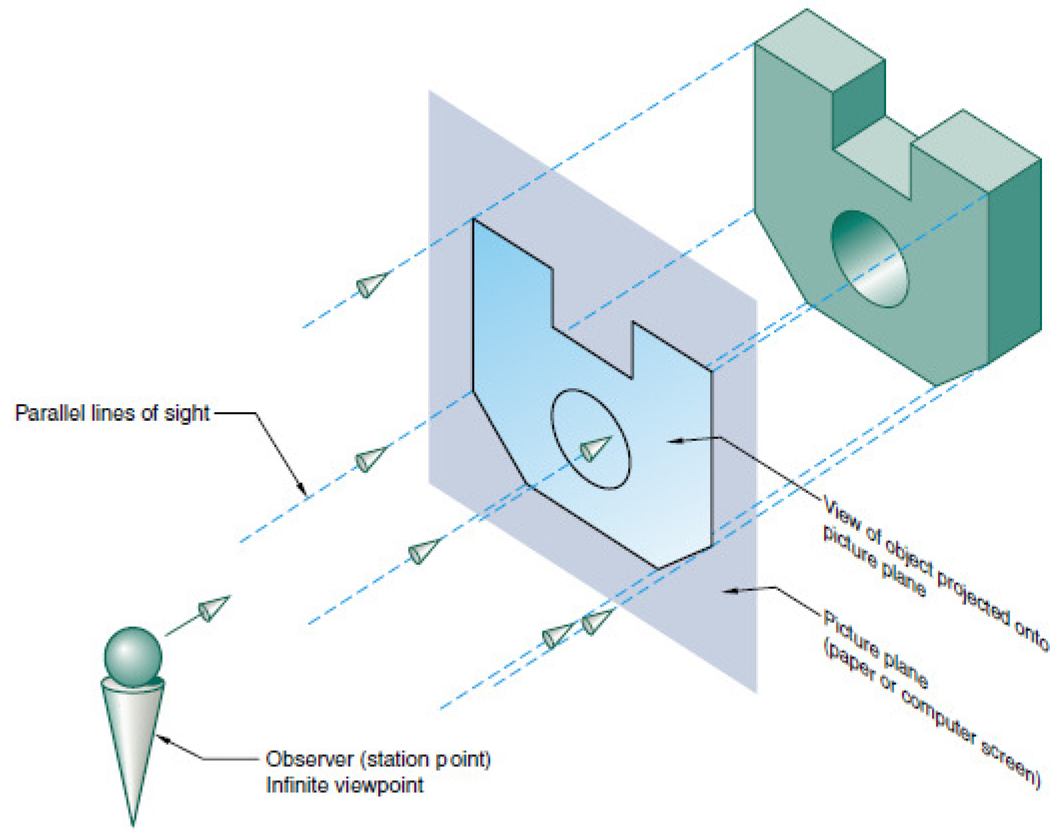
Perspective Projection



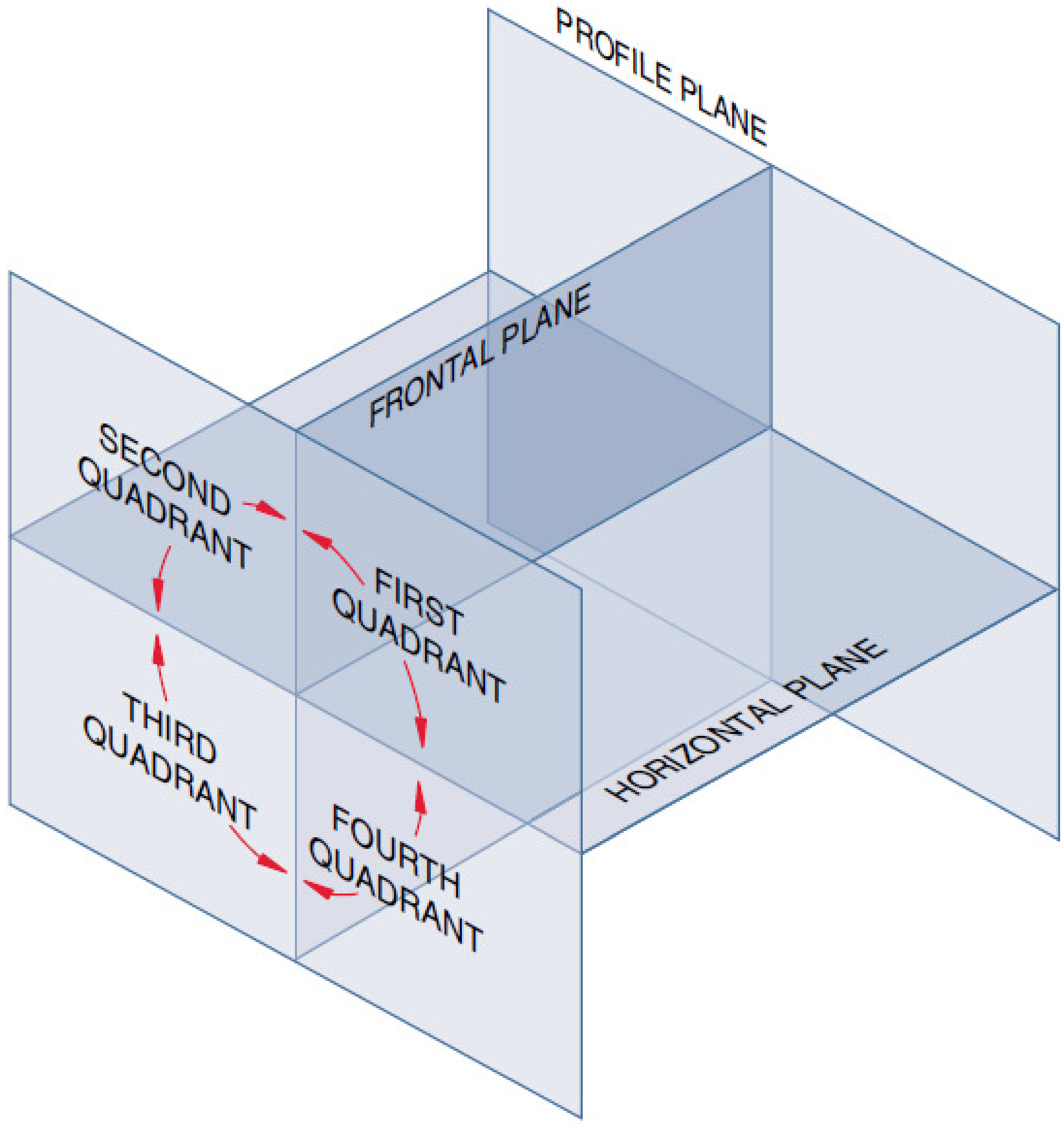


A camera captures views in perspective projection

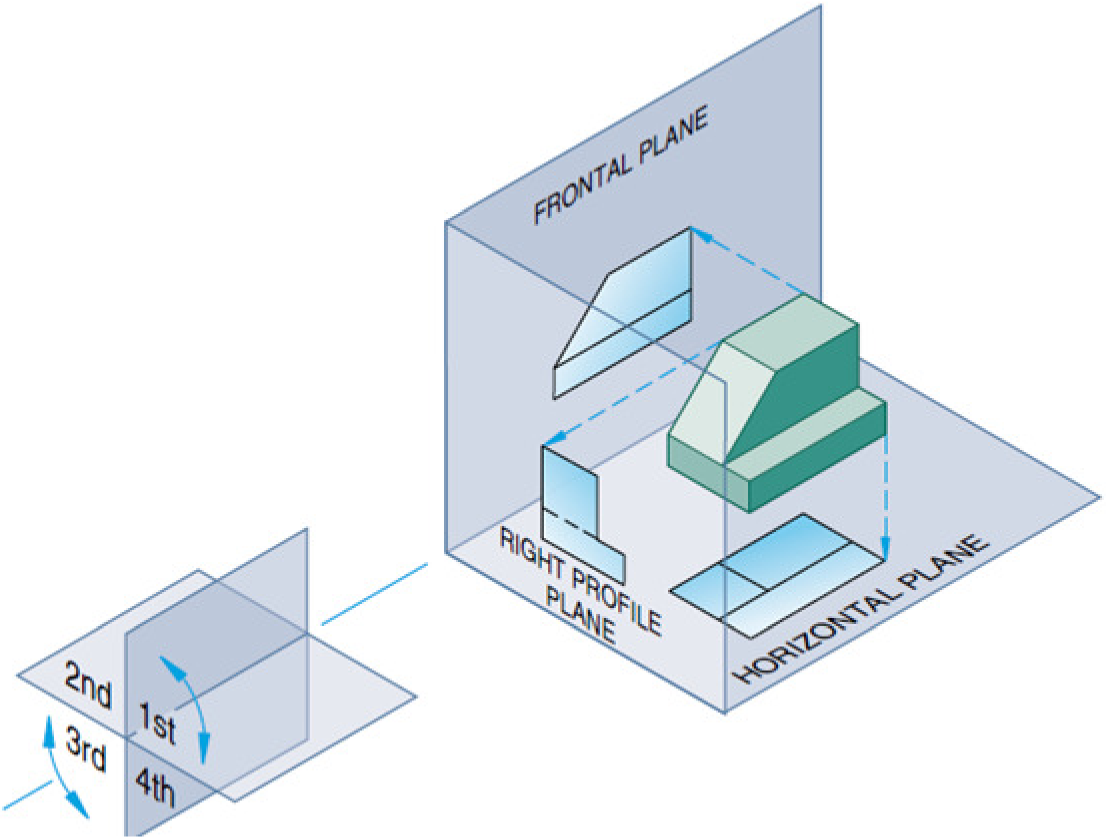
Parallel Projection

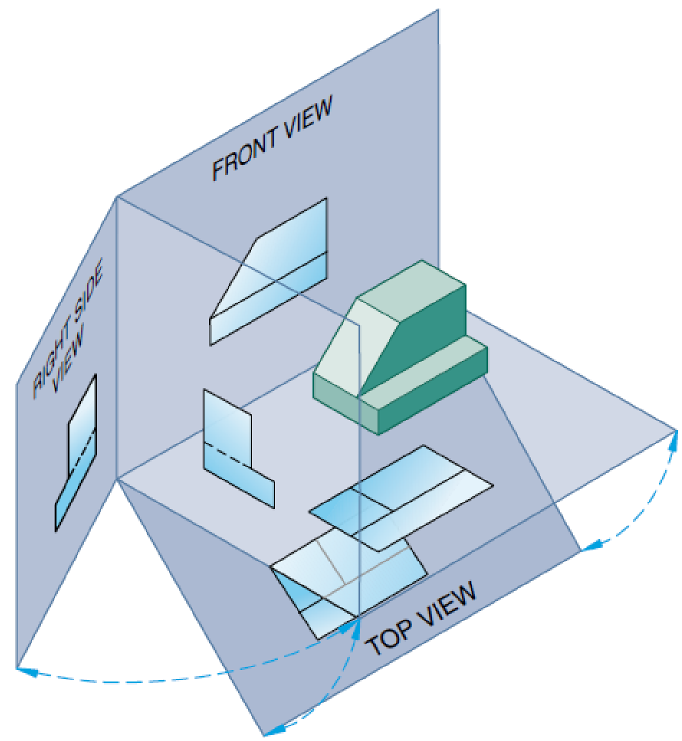


Principal projection planes

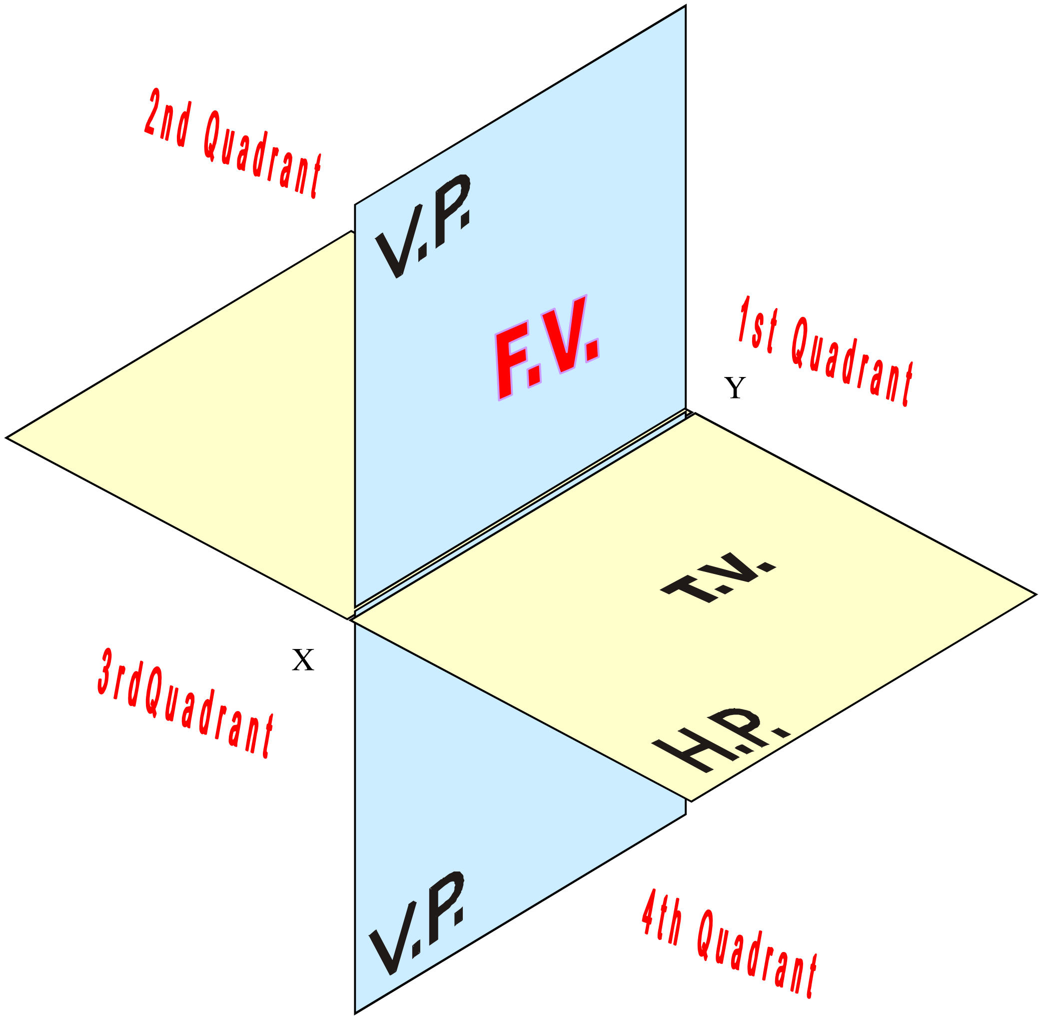


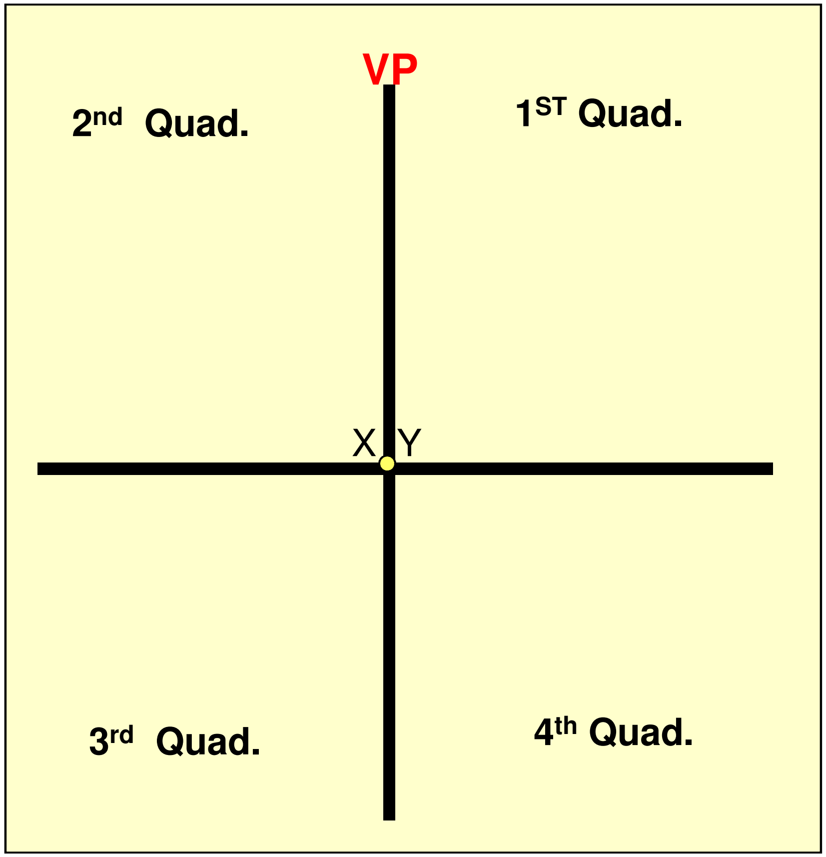
Orthogonal projection





Orthogonal projection





Observed along X-Y line

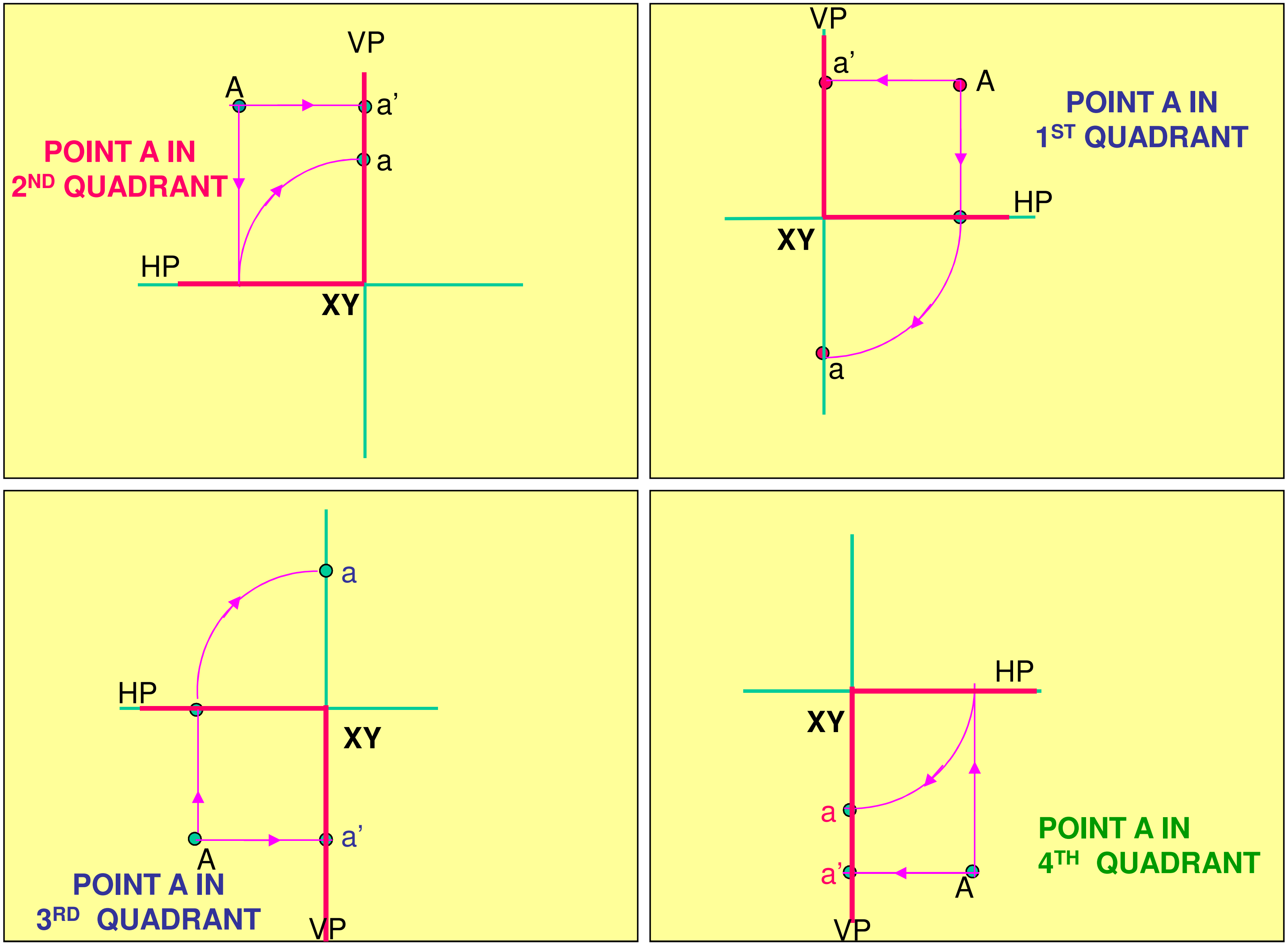
Projection of Points (Notation)

Following notation should be followed for naming different views in orthographic projections.

View (Object)	Point A	Line AB
Top	a	a b
Front	a’	a’ b’
Side	a’’	a’’ b’’

The same notation system should be used for numbers (1,2,3…) as well.

Projection of Points



Projection of Points

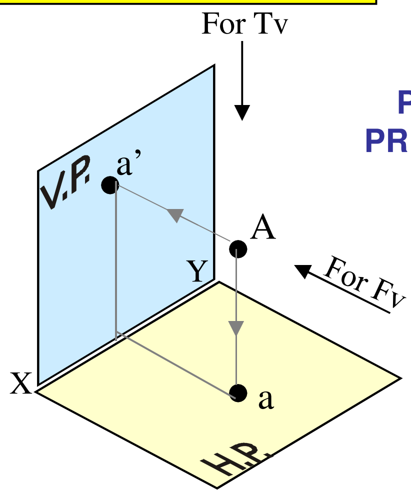
FV & TV of a point always lie in the same vertical line.

1. FV of a point ‘A’ is represented by a’. It shows position of the point with respect to HP.
   I. If the point lies above HP, a’ lies above the XY line.
   II. If the point lies in the HP, a’ lies on the XY line.
   III. If the point lies below the HP, a’ lies below the XY line.

2. TV of a point ‘A’ is represented by a. It shows position of the point with respect to VP.
   I. If the point lies in front of VP, a lies below the XY line.
   II. If the point lies in the VP, a lies on the XY line.
   III. If the point behind the VP, a lies above the XY line.

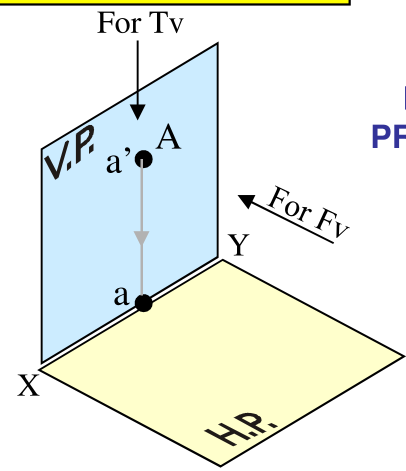
Example (A point in the 1st Quadrant)

POINT A ABOVE HP & IN FRONT OF VP



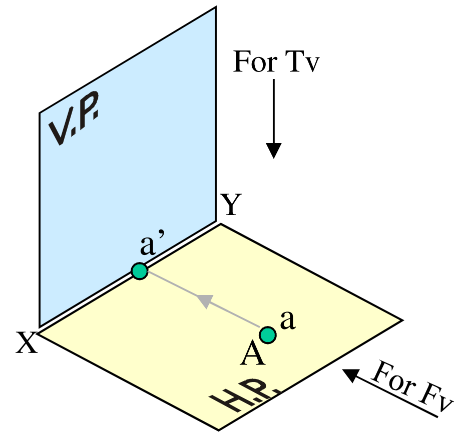
PICTORIAL PRESENTATION

POINT A ABOVE HP & IN VP



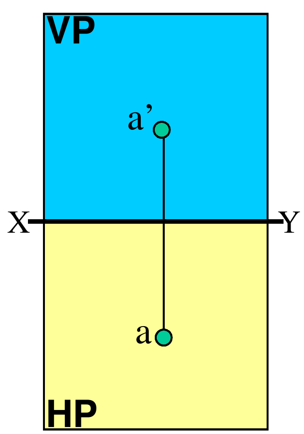
PICTORIAL PRESENTATION

POINT A IN HP & IN FRONT OF VP

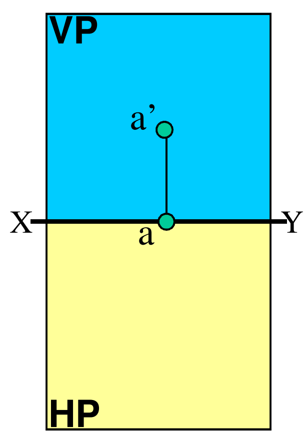


ORTHOGRAPHIC PRESENTATIONS OF ALL ABOVE CASES.

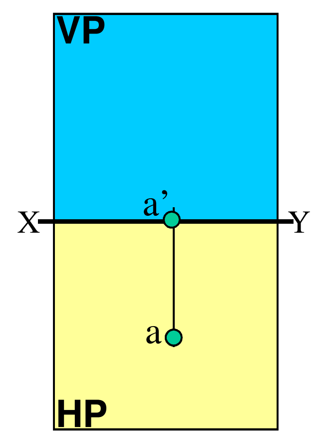
Fv above xy, Tv below xy.



Fv above xy, Tv on xy.



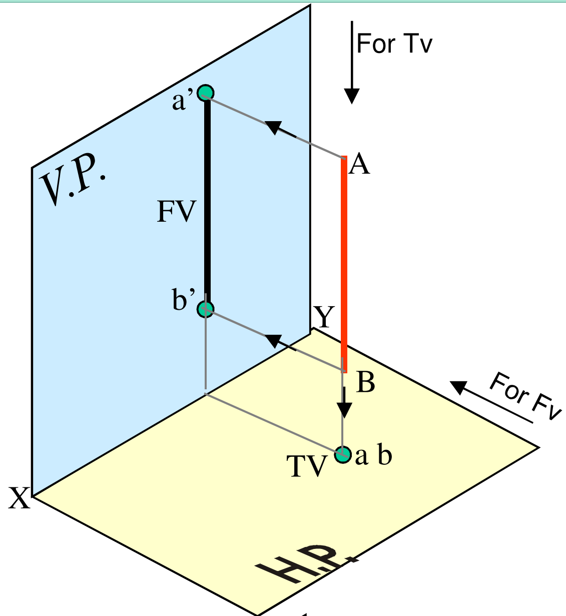
Fv on xy, Tv below xy.



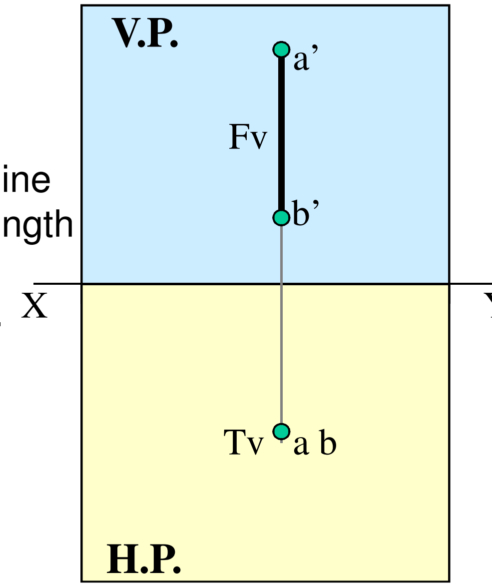
Projection of Lines

1.

A Line perpendicular to Hp & // to Vp



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

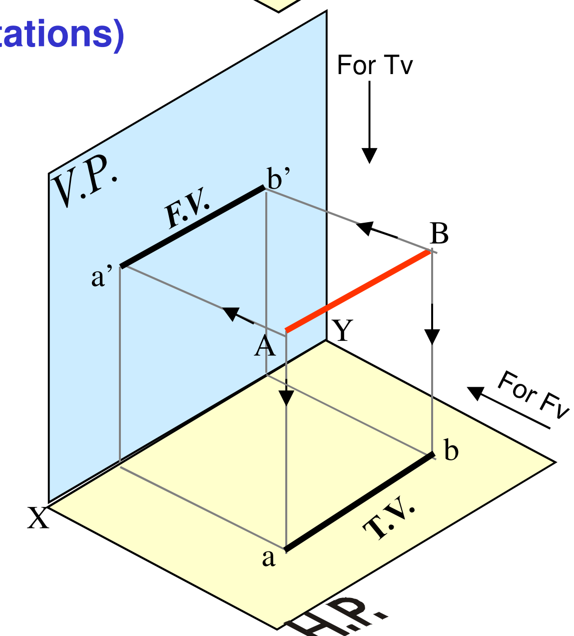


(Pictorial presentations)

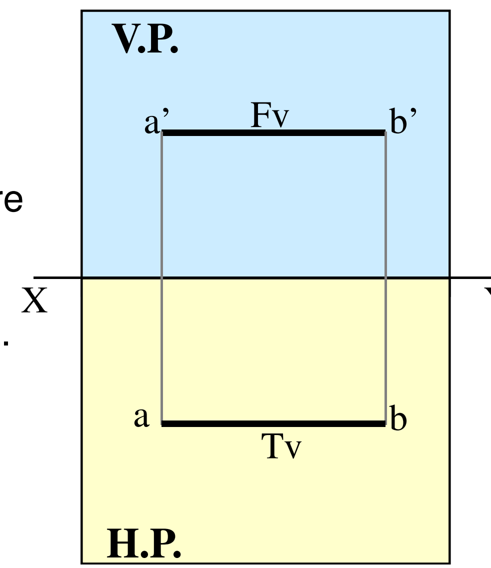
Orthographic Projections

2.

A Line
// to Hp
&
// to Vp



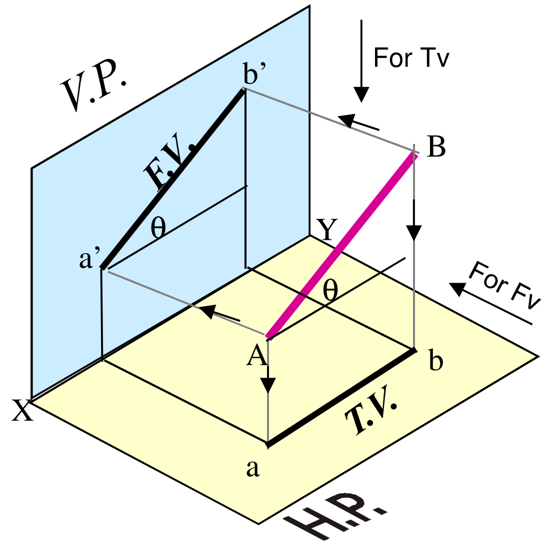
Note:
Fv & Tv both are
// to xy
&
both show T. L.



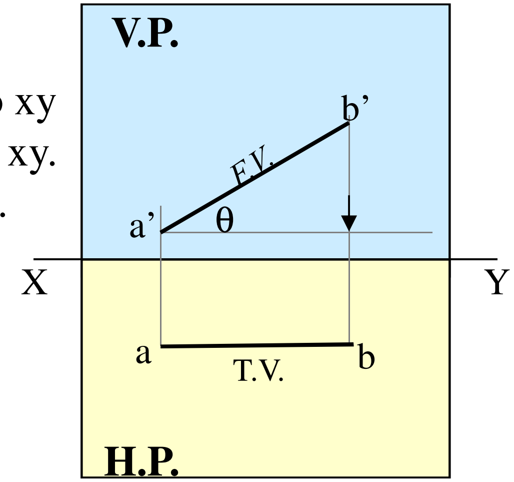
Projection of Lines

3.

A Line inclined to Hp
and
parallel to Vp



Note:
Fv inclined to xy
Tv parallel to xy.
Fv shows T.L.

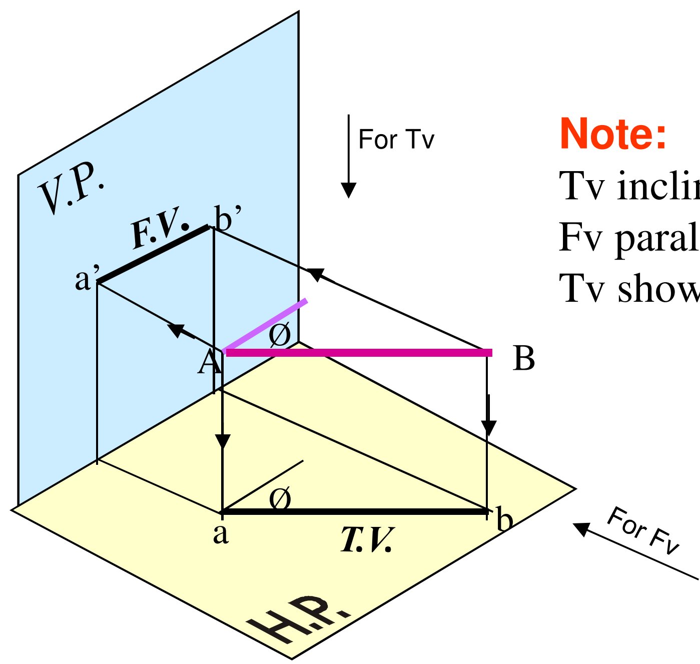


(Pictorial presentations)

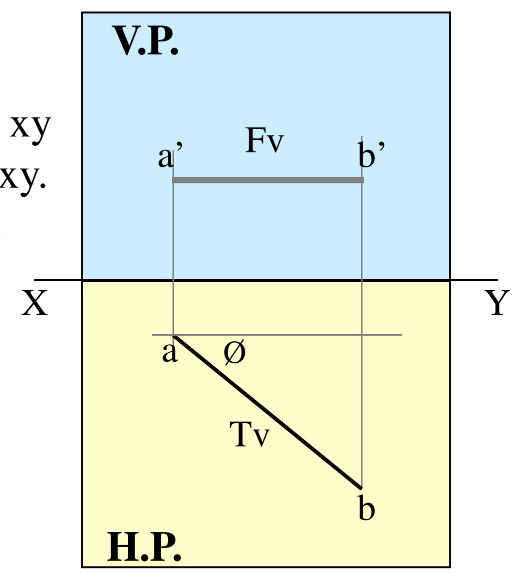
Orthographic Projections

4.

A Line inclined to Vp
and
parallel to Hp

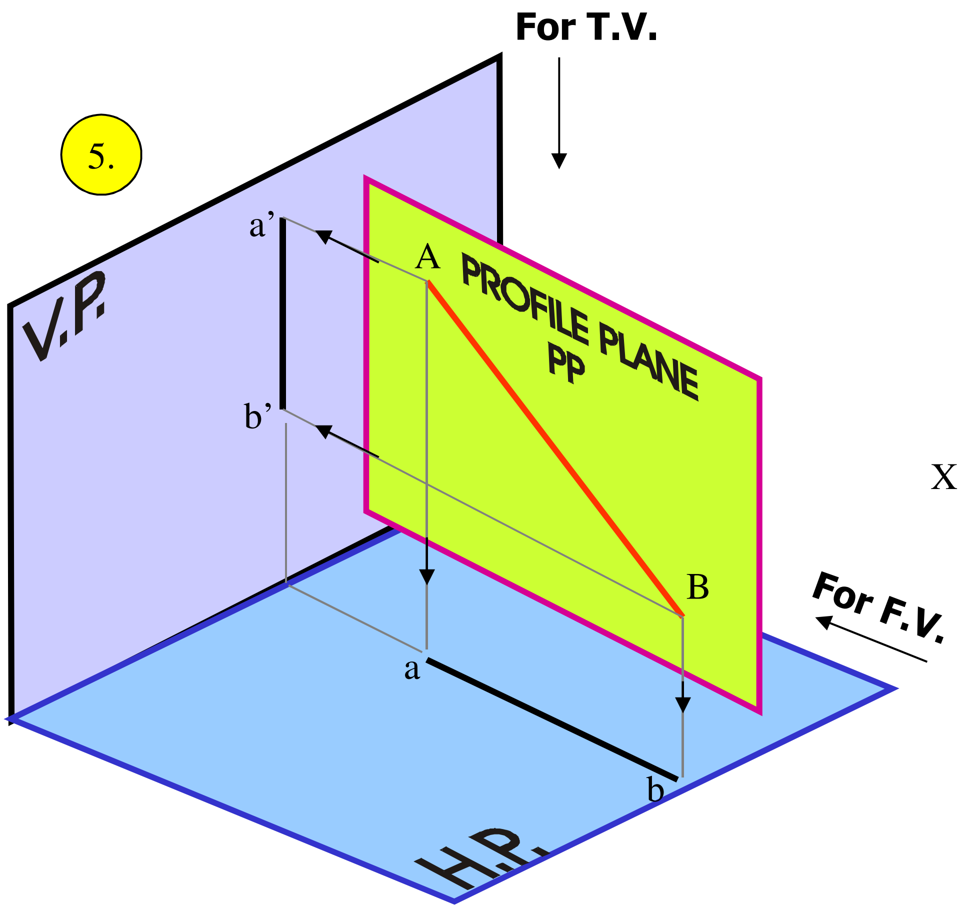


Note:
Tv inclined to xy
Fv parallel to xy.
Tv shows T.L.

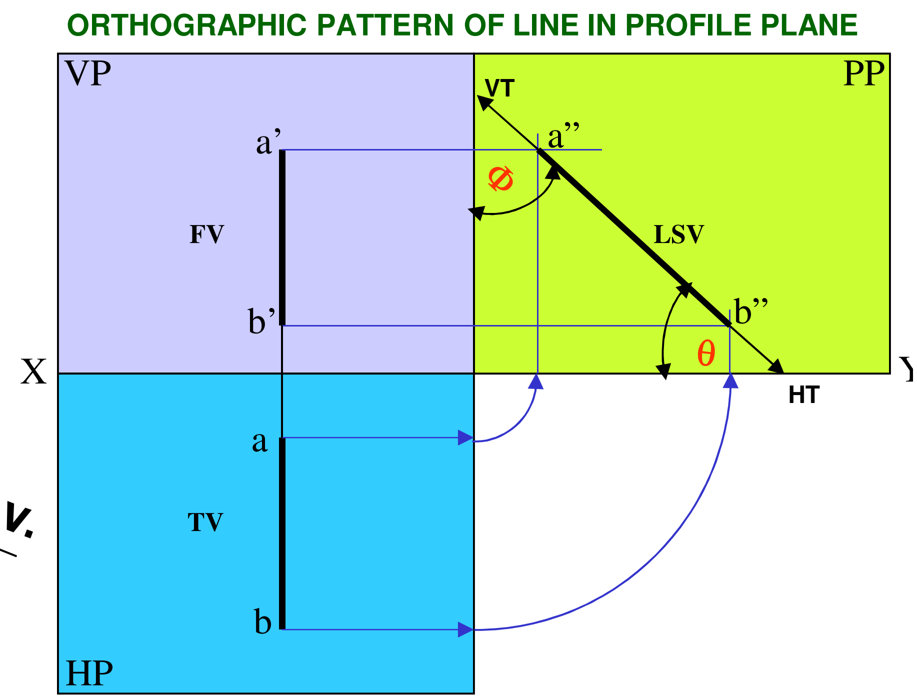


Projection of Lines

LINE IN A PROFILE PLANE **(MEANS IN A PLANE PERPENDICULAR TO BOTH HP & VP)**

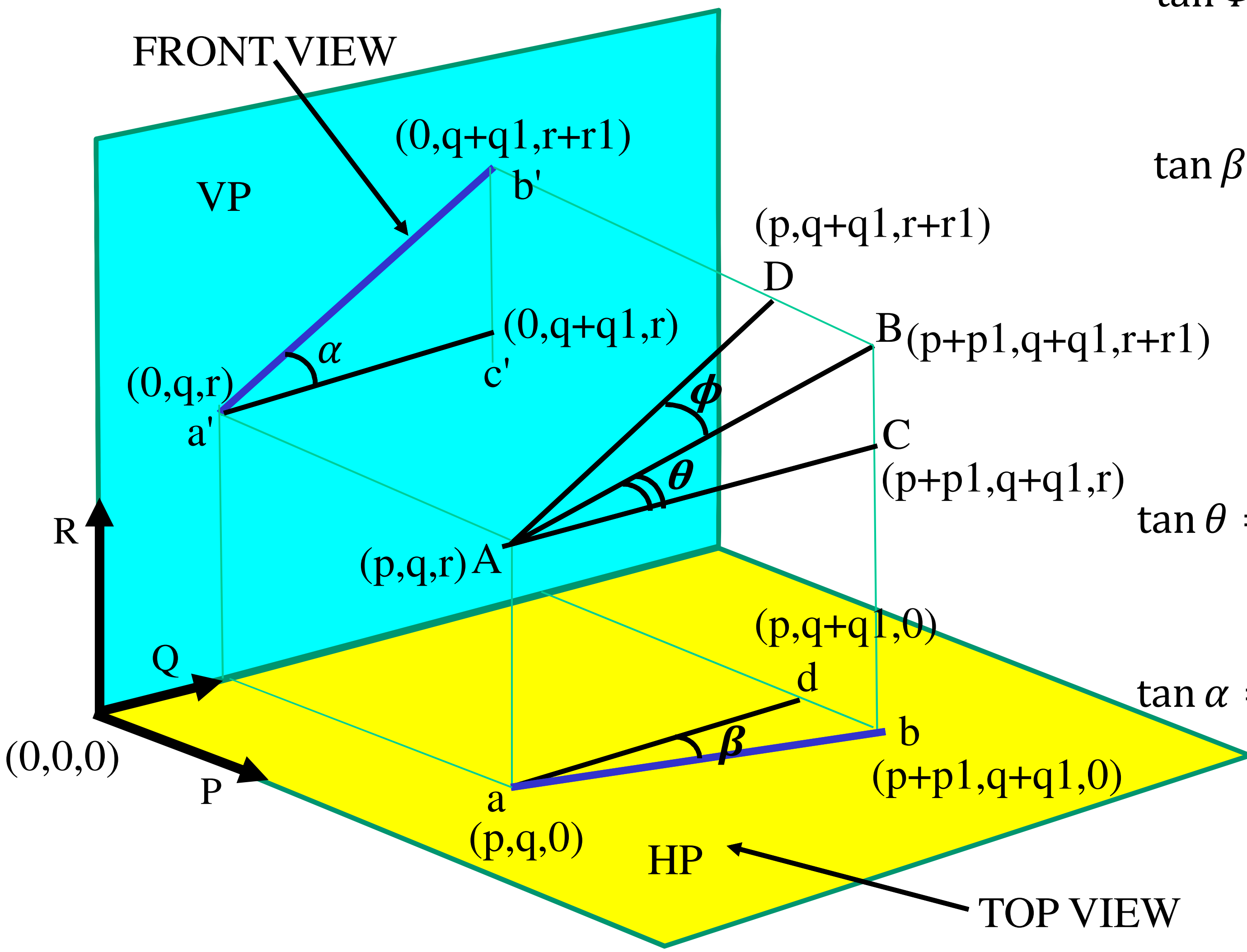


(Pictorial presentation)



Orthographic Projection

Projection of Lines



$$\tan \Phi = \frac{BD}{AD} = \frac{p1}{\sqrt{(q1)^2+(r1)^2}}$$

$$\tan \beta = \frac{bd}{ad} = \frac{p1}{q1}$$

$$\beta > \Phi$$

$$\tan \theta = \frac{BC}{AC} = \frac{r1}{\sqrt{(p1)^2+(q1)^2}}$$

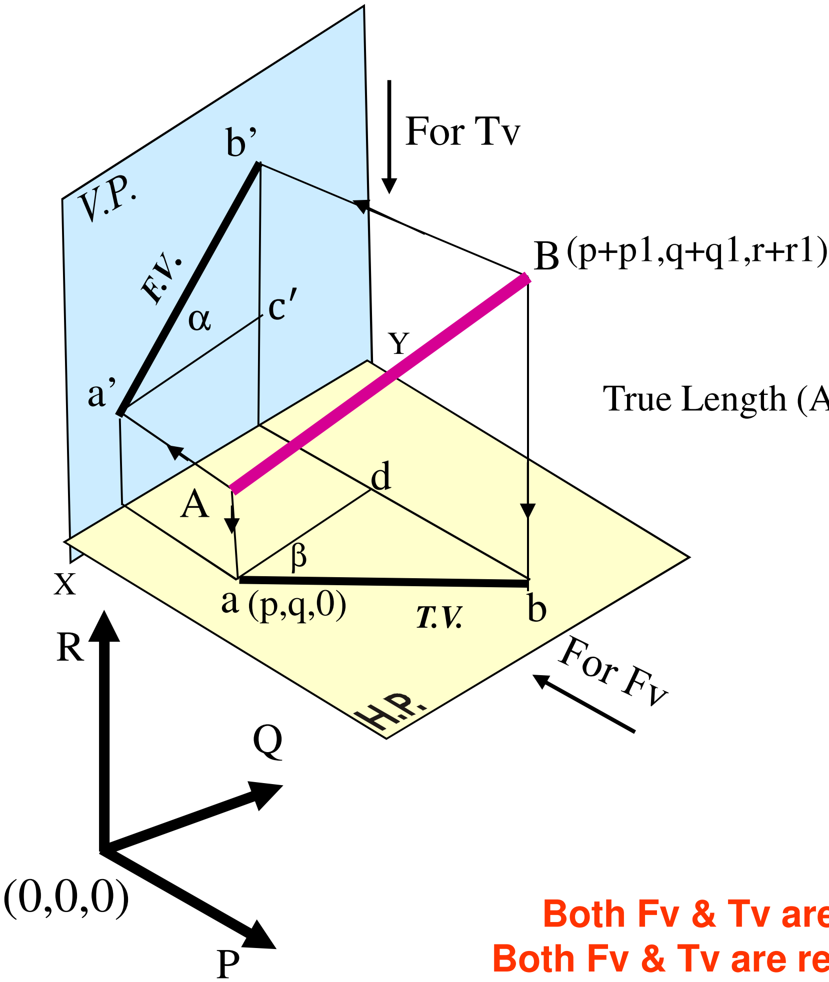
$$\tan \alpha = \frac{b'c'}{a'c'} = \frac{r1}{q1}$$

$$\alpha > \theta$$

Projection of Lines

6. A Line inclined to both Hp and Vp

(Pictorial presentations)



$$b'c' = r1$$

$$a'c' = ad = q1$$

$$a'b' = \sqrt{(r1)^2+(q1)^2}$$

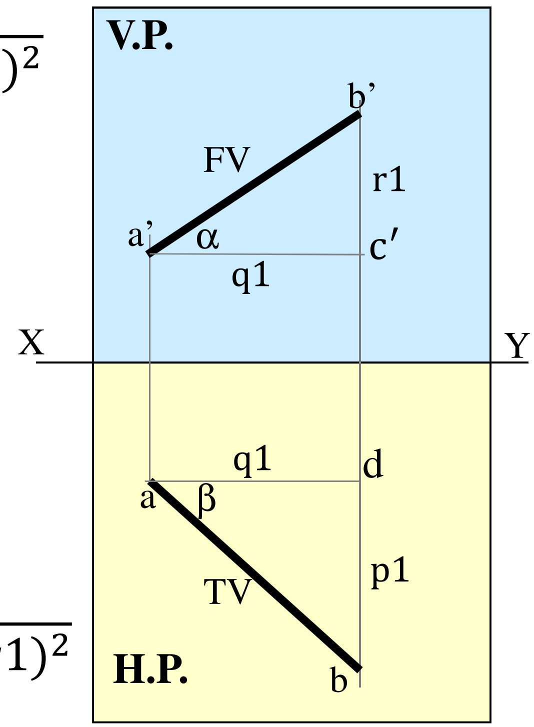
True Length (AB)= $\sqrt{(p1)^2+(q1)^2+(r1)^2}$

$$bd = p1$$

$$ad = q1$$

$$ab = \sqrt{(p1)^2+(q1)^2}$$

Orthographic Projections



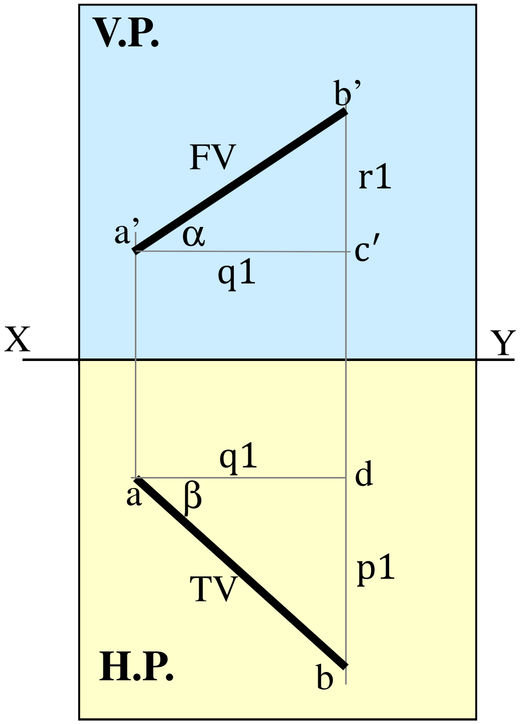
Note:

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

Both Fv & Tv are reduced lengths. (No view shows True Length)

Projection of Lines

Find the True Length and its inclinations with HP and VP when FV and TV are given?



$$a'b' = \sqrt{(r1)^2+(q1)^2}$$

$$ab = \sqrt{(p1)^2+(q1)^2}$$

True Length (AB)= $\sqrt{(p1)^2+(q1)^2+(r1)^2}$

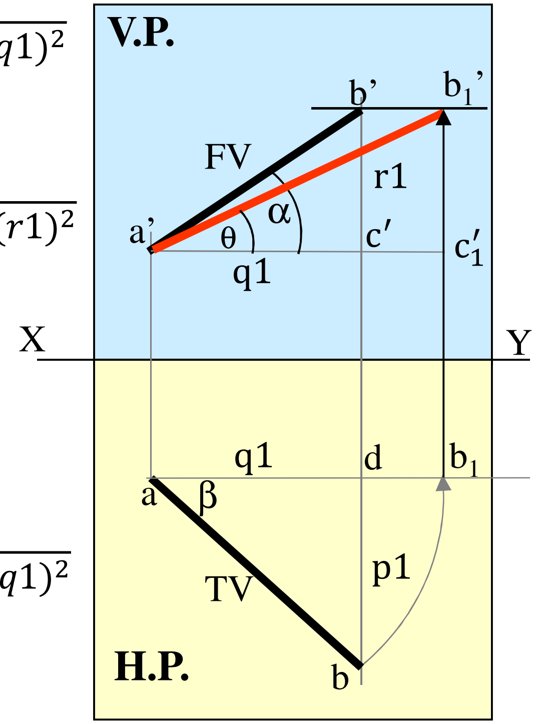
$$ab_1 = a'c_1' = \sqrt{(p1)^2+(q1)^2}$$

$$b'c' = b_1'c_1' = r1$$

$$TL = a'\,b_1' = \sqrt{(p1)^2+(q1)^2+(r1)^2}$$

$$\tan\theta = \frac{r1}{\sqrt{(p1)^2+(q1)^2}}$$

$$ab_1 = ab = \sqrt{(p1)^2+(q1)^2}$$



In this sketch, TV is rotated and made // to XY line. Hence its corresponding FV a’ b$_1$’ is showing

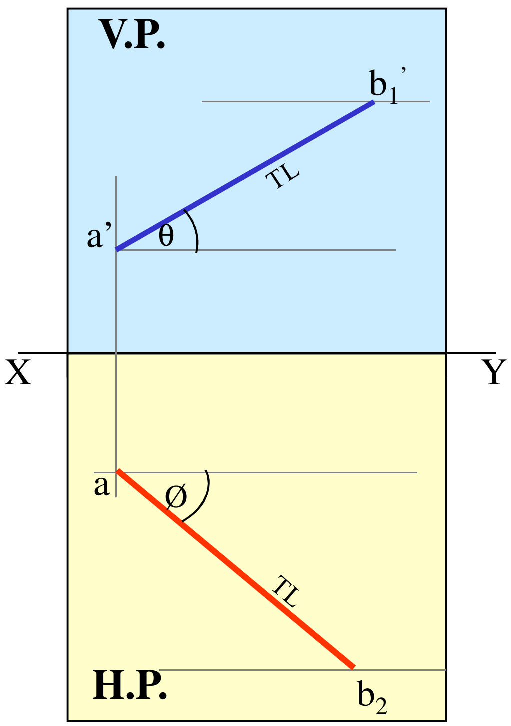
True Length

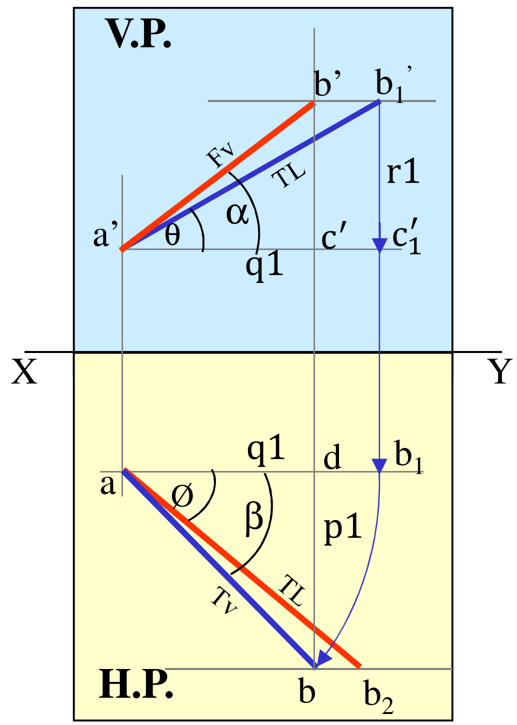
&

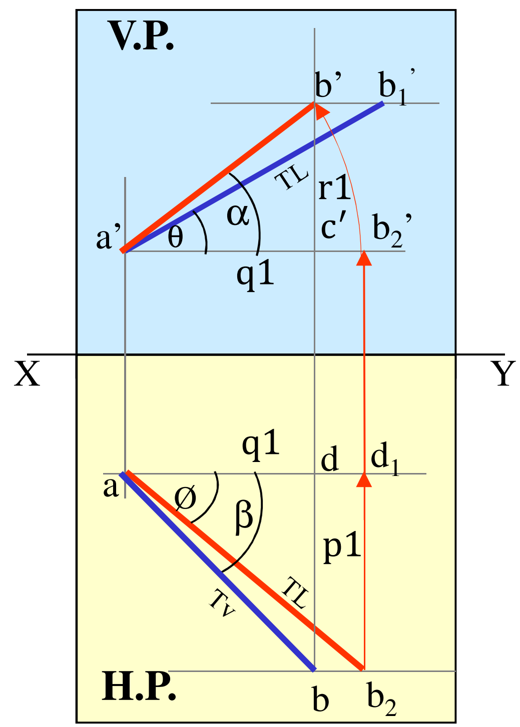
True Inclination with HP.

Projection of Lines

Find the FV and TV when the True length and its actual inclinations are known?







$$\tan\theta = \frac{r1}{\sqrt{(p1)^2+(q1)^2}}$$

$$\tan\Phi = \frac{p1}{\sqrt{(q1)^2+(r1)^2}}$$

$$TL = a'\,b_1' = \sqrt{(p1)^2+(q1)^2+(r1)^2}$$

$$a'c_1' = ab_1 = \sqrt{(p1)^2+(q1)^2}$$

$$ab = ab_1 = \sqrt{(p1)^2+(q1)^2}$$

$$TL = ab_2 = \sqrt{(p1)^2+(q1)^2+(r1)^2}$$

$$ad_1 = a'b_2' = \sqrt{(q1)^2+(r1)^2}$$

$$a'b' = a'b_2' = \sqrt{(q1)^2+(r1)^2}$$

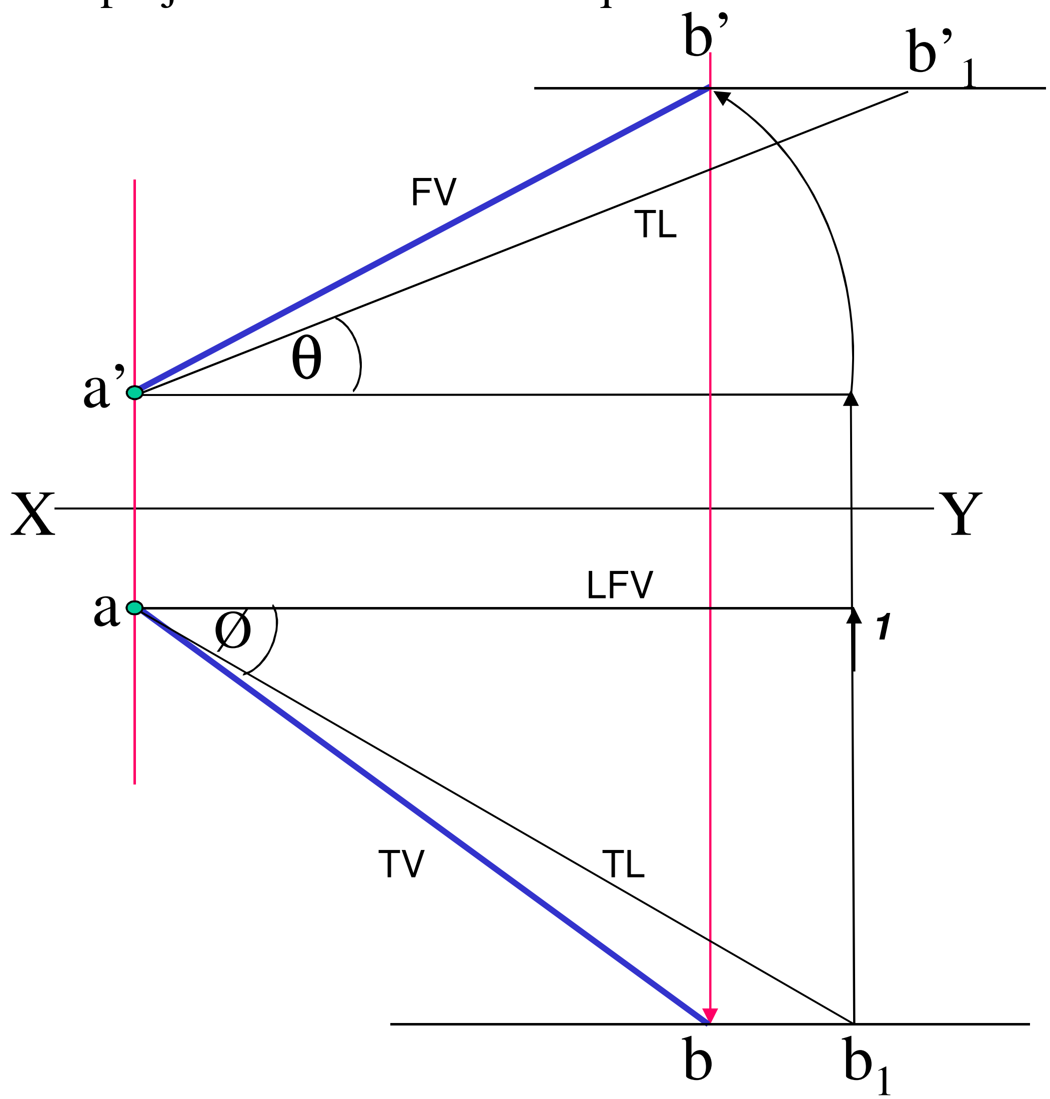
True Length is never rotated. Its horizontal component is drawn & it is further rotated to locate view.

Projection of Lines (Example 1)

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

SOLUTION STEPS:

1) Draw XY line.
2) Locate *a'* 12 mm above XY line & *a* 10 mm below XY line.
3) Take 30^0 angle from *a'* & 40^0 from *a* and mark TL (i.e. 75 mm) 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 *a1* 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 downward & get point *b*. Join *a* & *b* I.e. Tv.



Projection of Lines (Example 2)

A line AB 75mm long makes 45^0 inclination with Vp while its Fv makes 55^0 with XY. End A is 10 mm above Hp and 15 mm in front of Vp. If the line is in 1st quadrant draw its projections and find its inclination with Hp.

SOLUTION STEPS:

1.Draw XY line.

2.Locate *a'* 10 mm above XY & *a* 15 mm below XY.

3.Draw a line 45^0 inclined to XY from point *a* and cut TL 75 mm on it and name that point *b1*. Draw locus from point *b1*

4.Take 55^0 angle from *a'* for Fv above XY line.

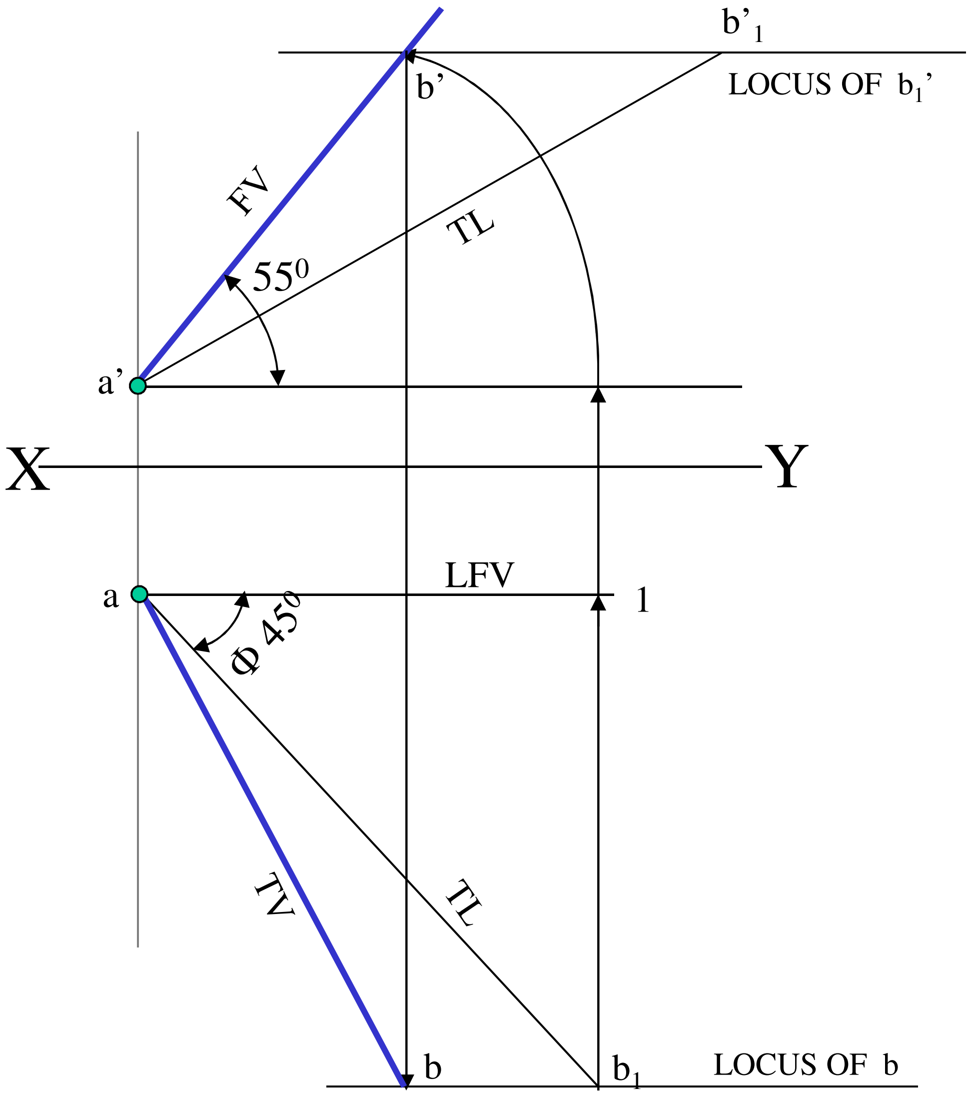
5.Draw a vertical line from *b1* up to locus of *a* and name it *1*. It is horizontal component of TL & is LFV.

6.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.

7. Drop a projector from *b'* on locus from point *b1* and name intersecting point *b*. Line *ab* is Tv of line AB.

8.Draw locus from *b'* and from *a'* with TL distance cut point *b1'*

9.Join *a' b1'* as TL and measure its angle at *a'*. It will be true angle of line with HP.



Projection of Lines (Example 3)

Fv of a line AB is 50^0 inclined to XY and measures 55 mm long while its Tv is 60^0 inclined to XY line. If end A is 10 mm above Hp and 15 mm in front of Vp, draw its projections, find TL, inclinations of line with Hp & Vp.

SOLUTION STEPS:

1.Draw XY line

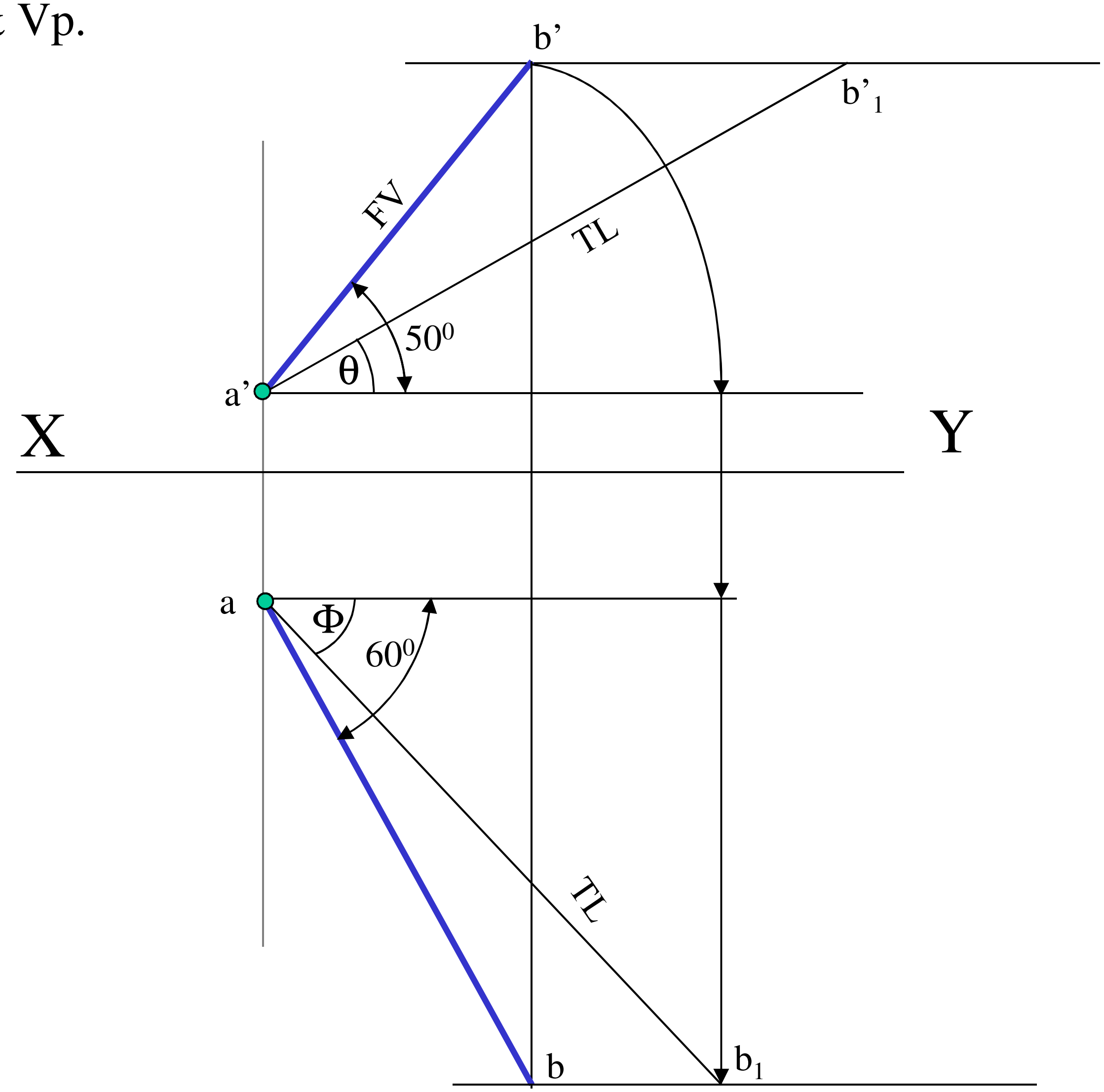
2.Locate *a'* 10 mm above XY and a 15 mm below XY line.

3.Draw locus from these points.

4.Draw Fv 50^0 to XY from *a'* and mark *b'* Cutting 55 mm on it.

5.Similarly draw Tv 60^0 to XY from *a* & drawing projector from *b'* Locate point b and join *ab*.

6.Then rotating views as shown, locate True Lengths ab_1 & $a'b_1'$ and their angles with Hp and Vp.



Projection of Lines (Example 4)

Line AB is 75 mm long. Its 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 its angle with Hp and Vp.

SOLUTION STEPS:

1.Draw XY line.

2.Locate *a'* 10 mm above XY and *a* 15 mm below XY line.

3.Draw locus from these points.

4.Cut 60 mm distance on locus of *a'* & mark 1' on it as it is LTV.

5.Similarly Similarly cut 50 mm on locus of *a* and mark point 1 as it is LFV.

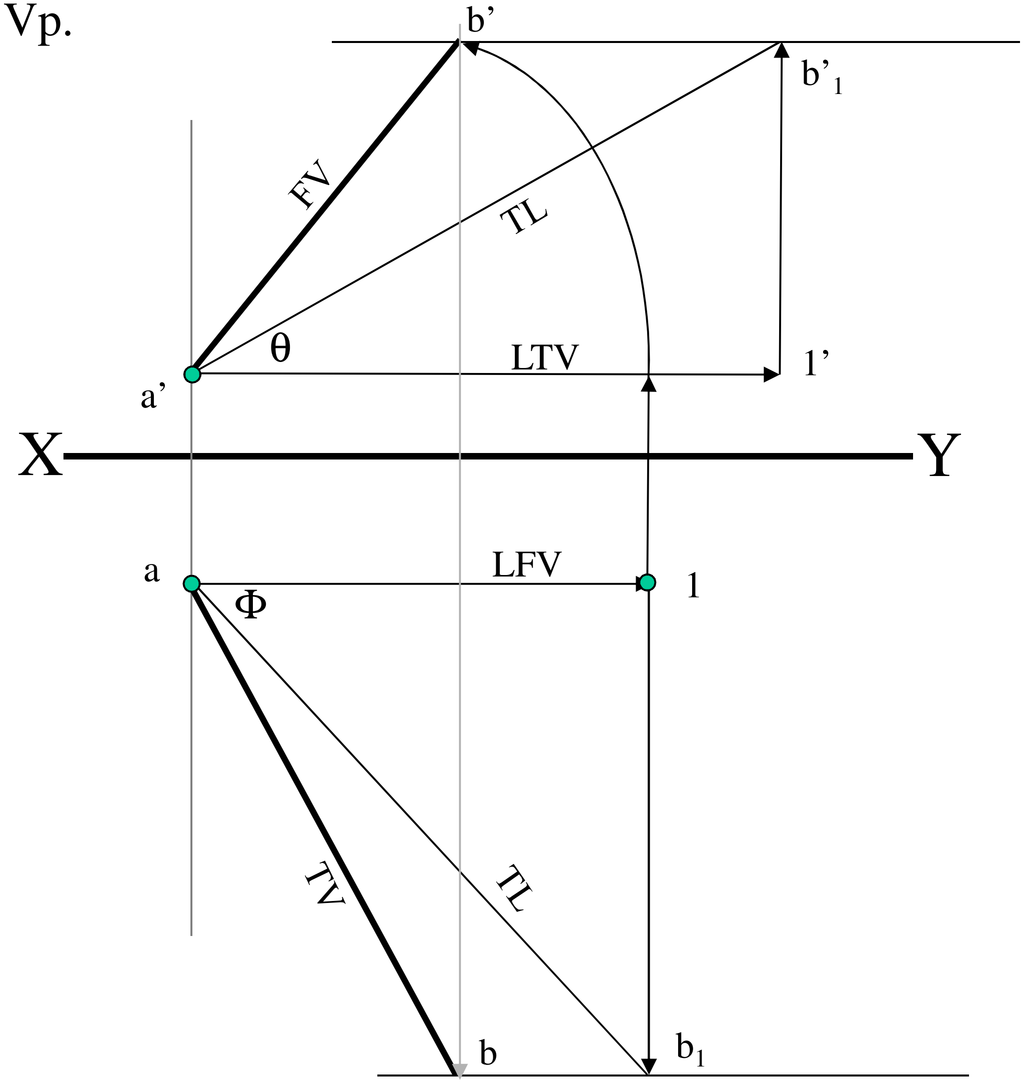
6.From *1'* draw a vertical line upward and from *a'* taking TL (75 mm) in compass, mark b'_1 point on it. Join $a'b'_1$ points.

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. *a1* locate *b'* and join a' with it to get Fv.

10. Locate tv similarly and measure Angles θ & Φ

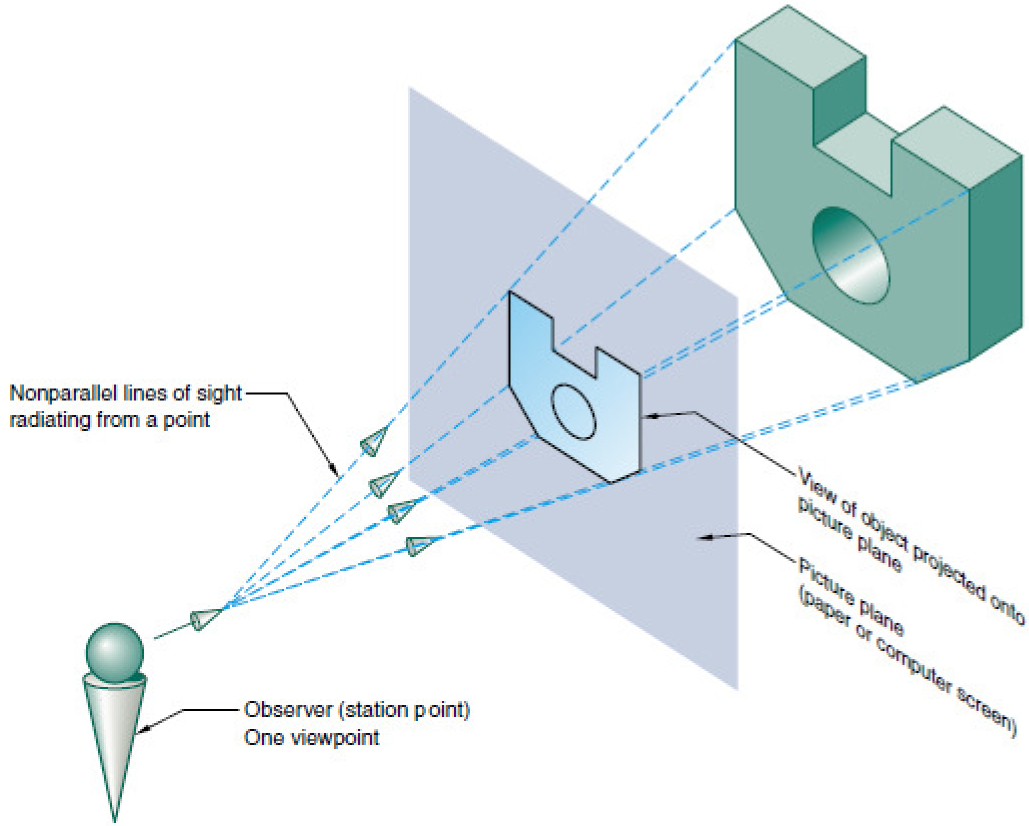


Thank you

Orthographic Projections

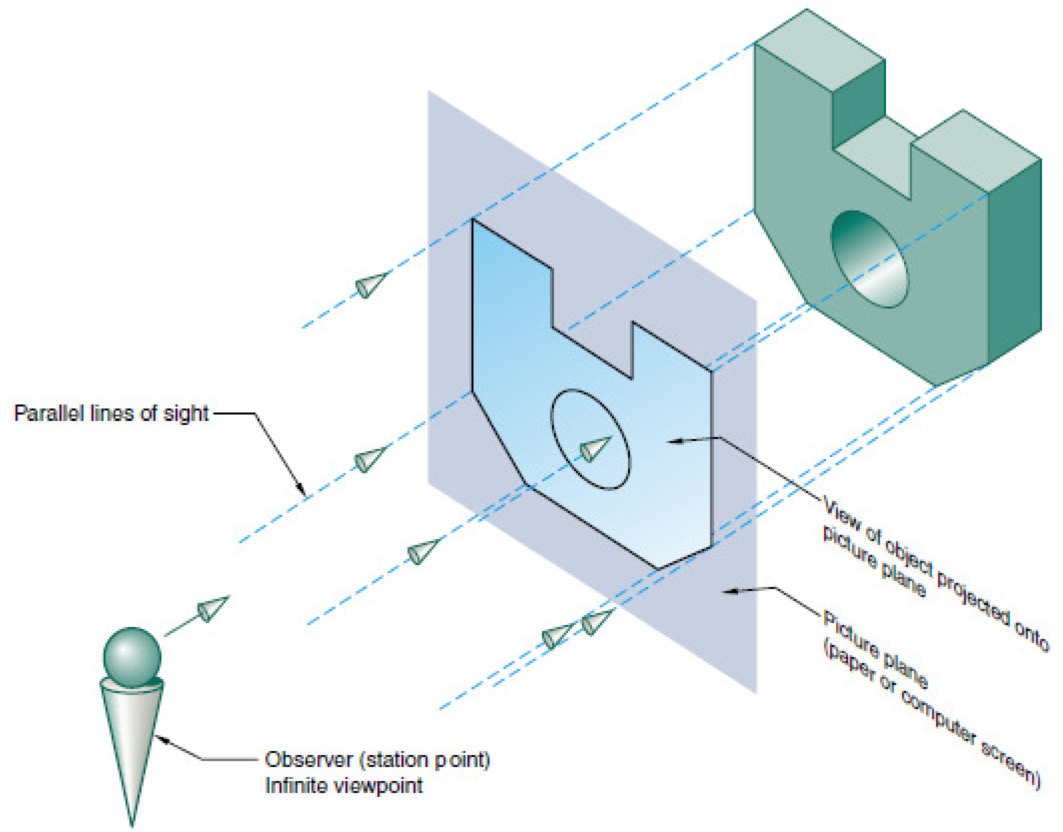
Dr. Piyush Shakya
Associate Professor
Department of Mechanical Engineering
Indian Institute of Technology Madras, Chennai

Perspective Projection

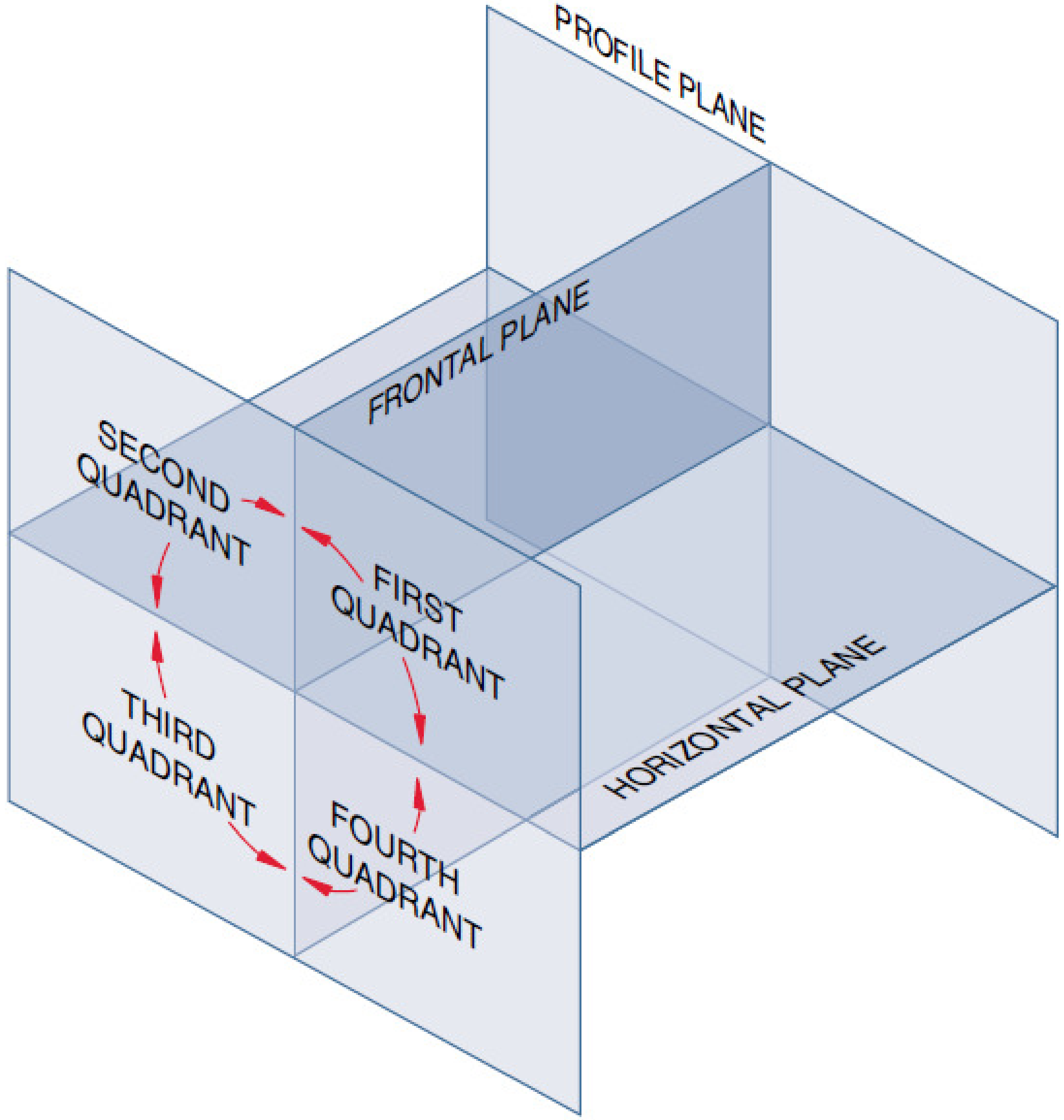


A camera captures views in perspective projection

Parallel Projection



Principal Projection Planes



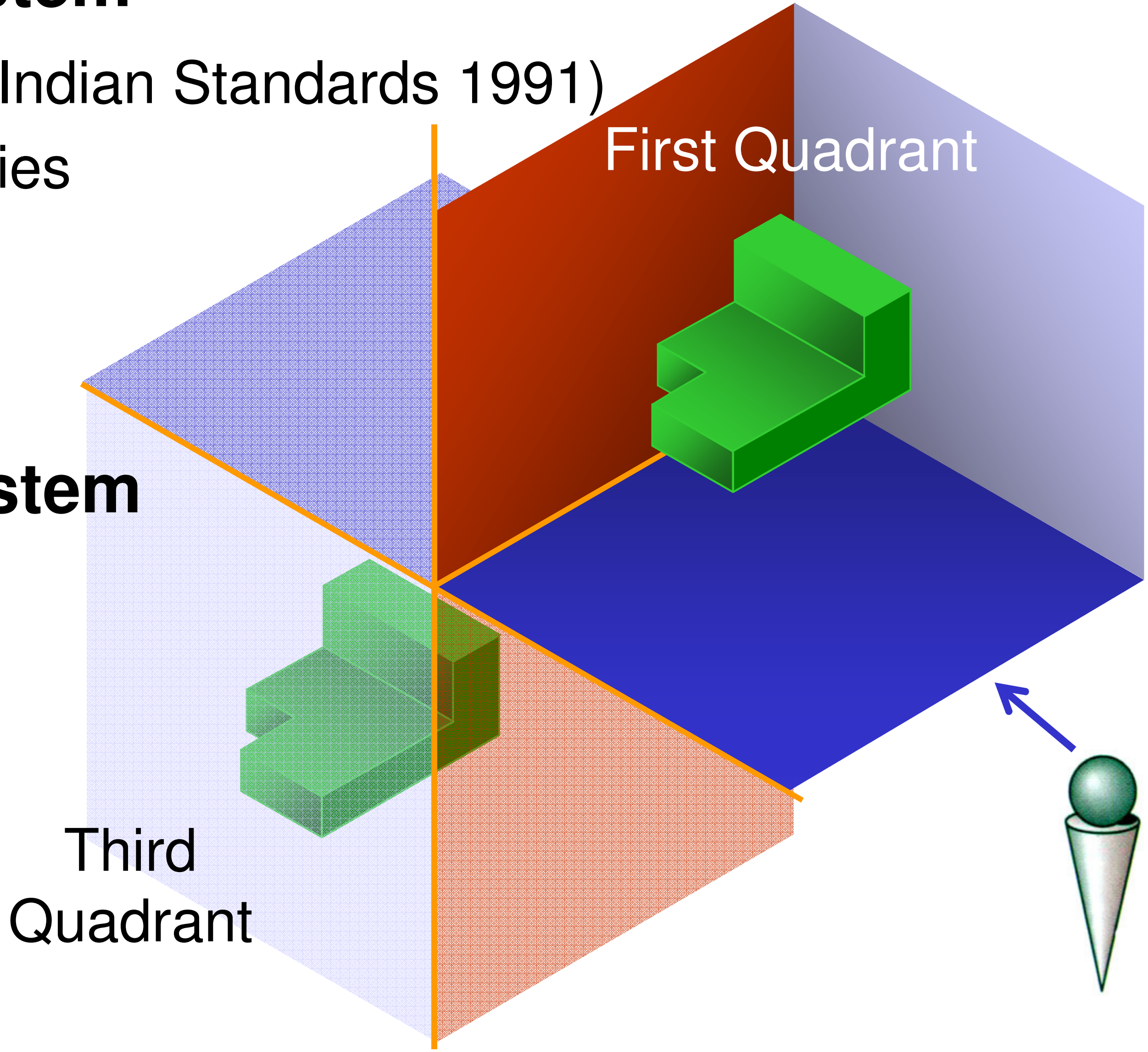
Projection System

1. First angle system

- India (Bureau of Indian Standards 1991)
- European countries
- ISO standard

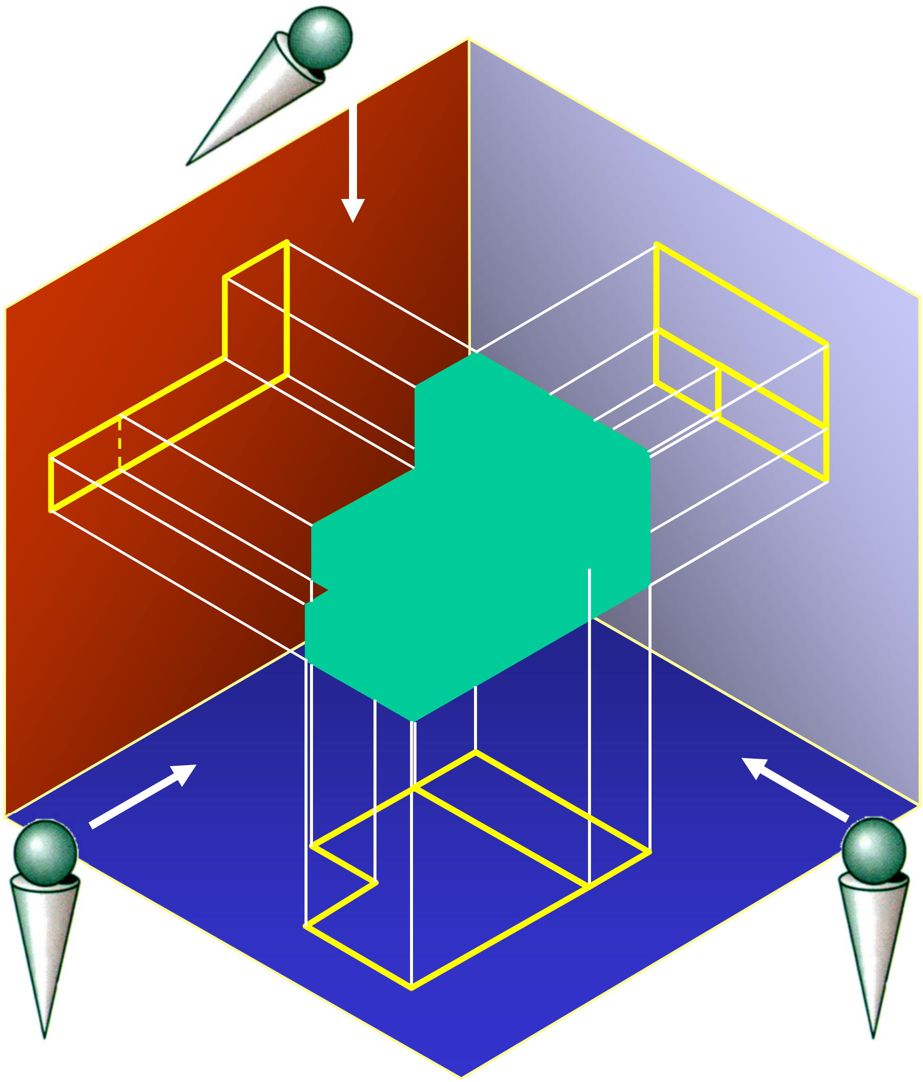
2. Third angle system

- Canada
- USA
- Japan, Thailand

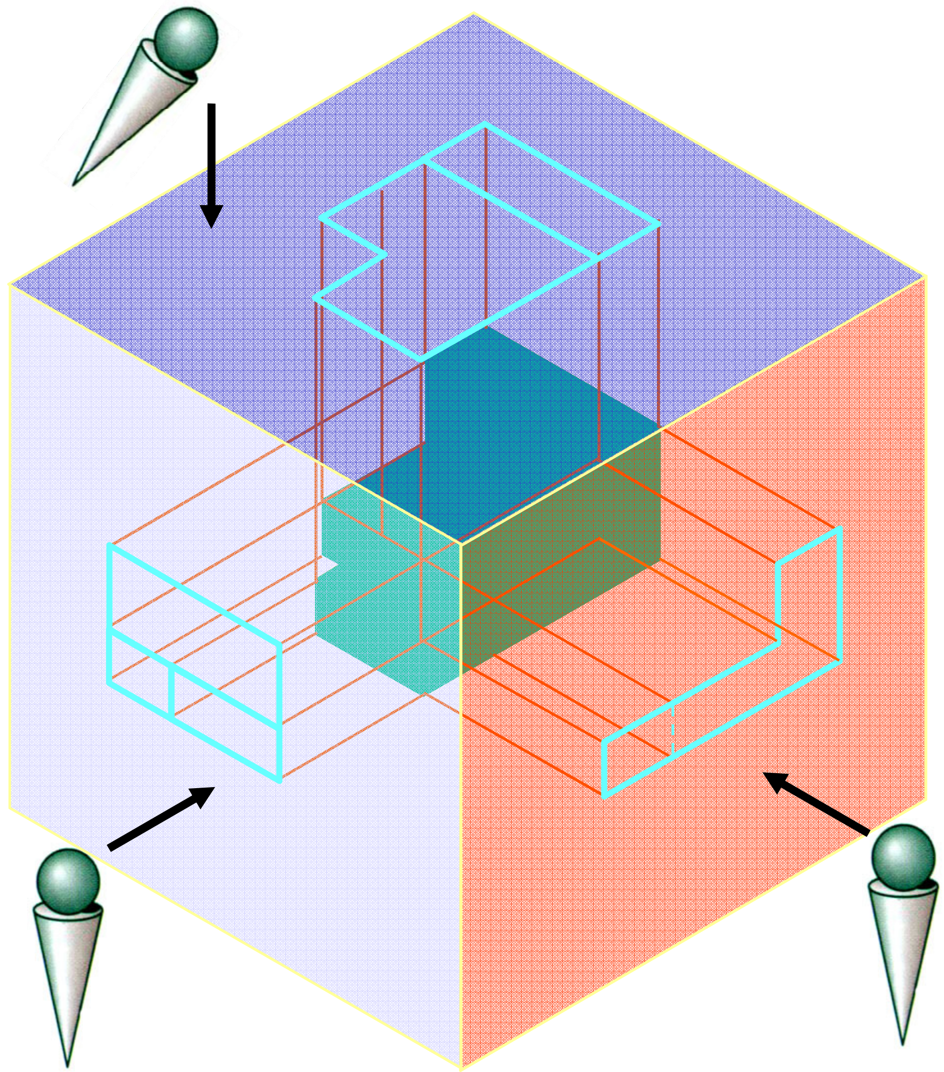


Orthographic projection

1st angle system

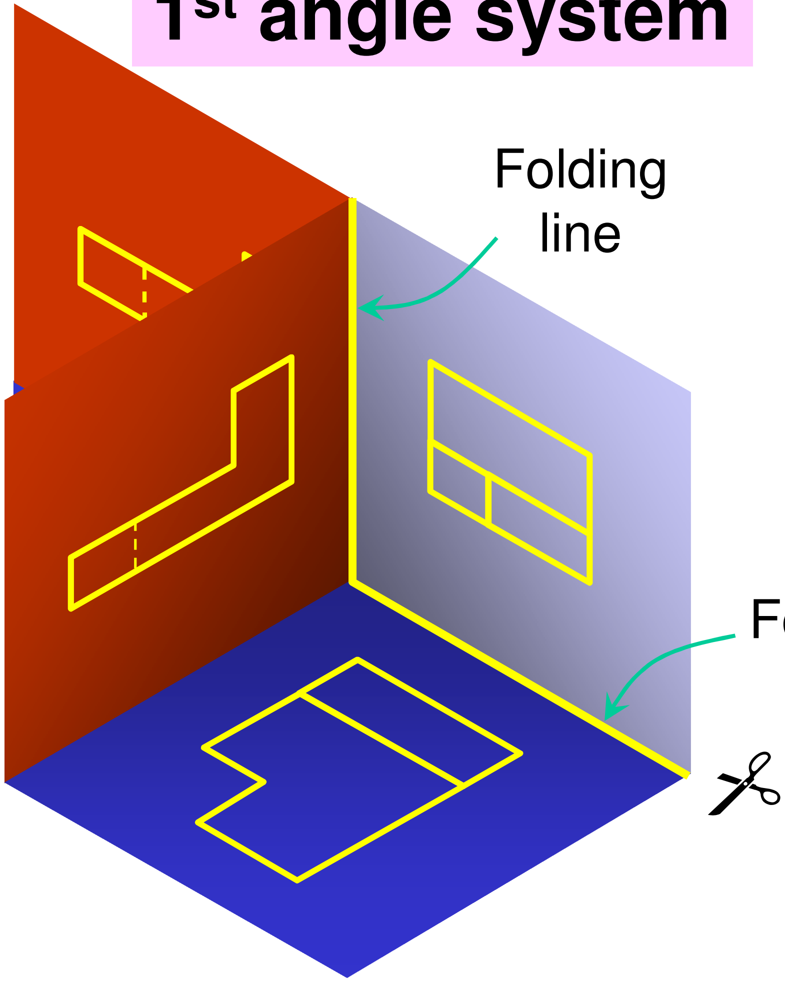


3rd angle system

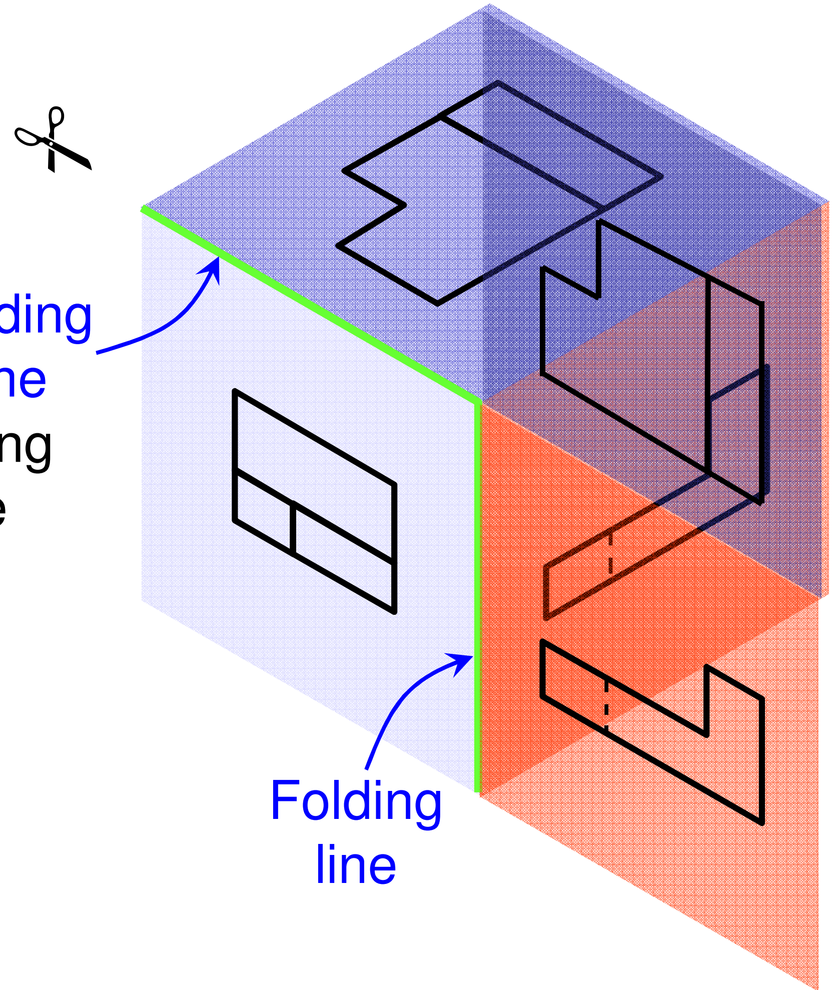


Orthographic Views

1st angle system

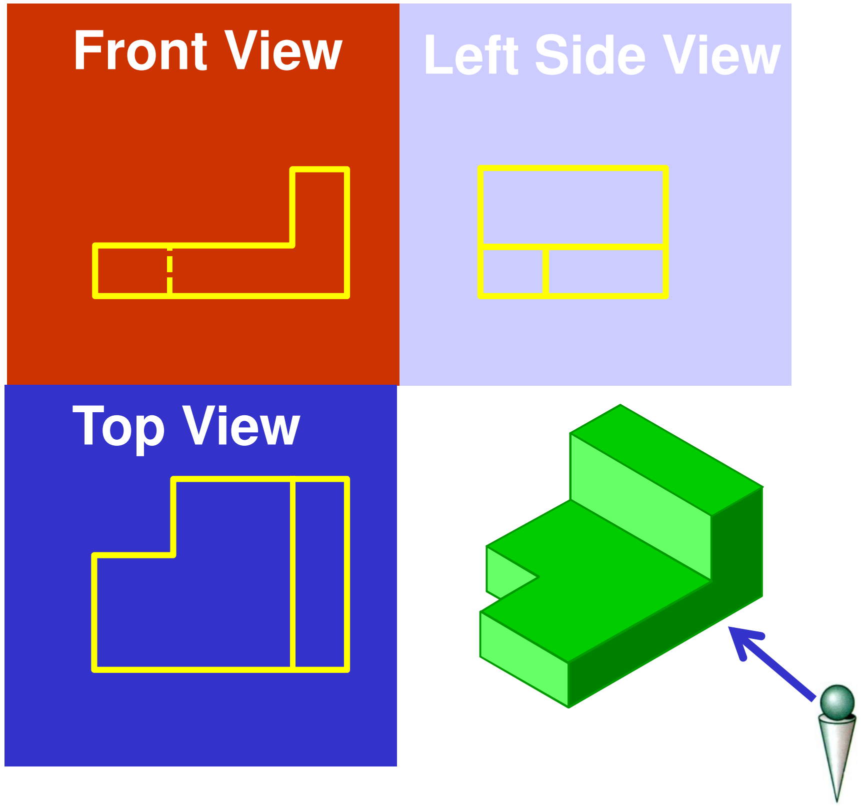


3rd angle system

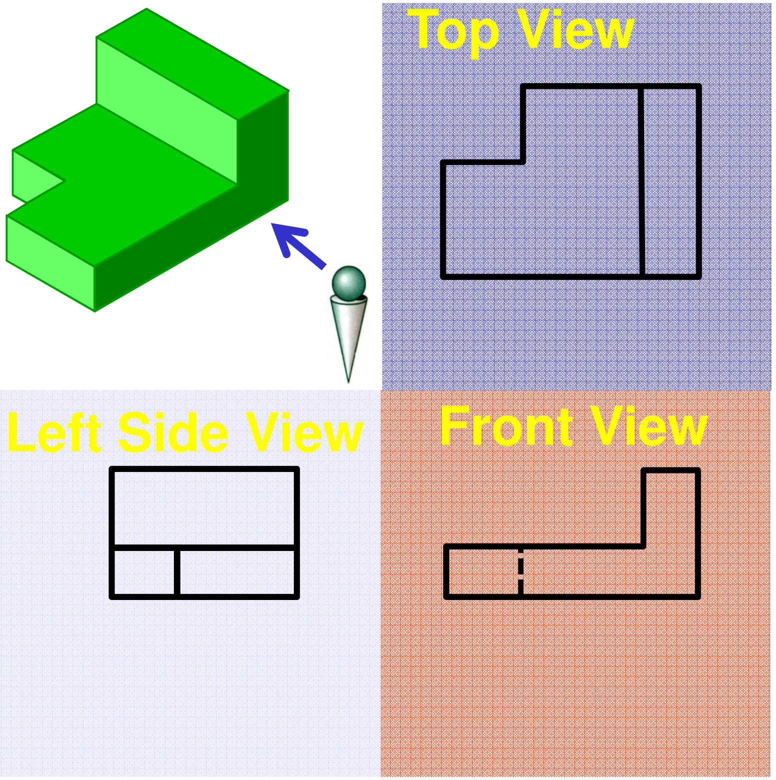


Orthographic Views

1^{st} angle system

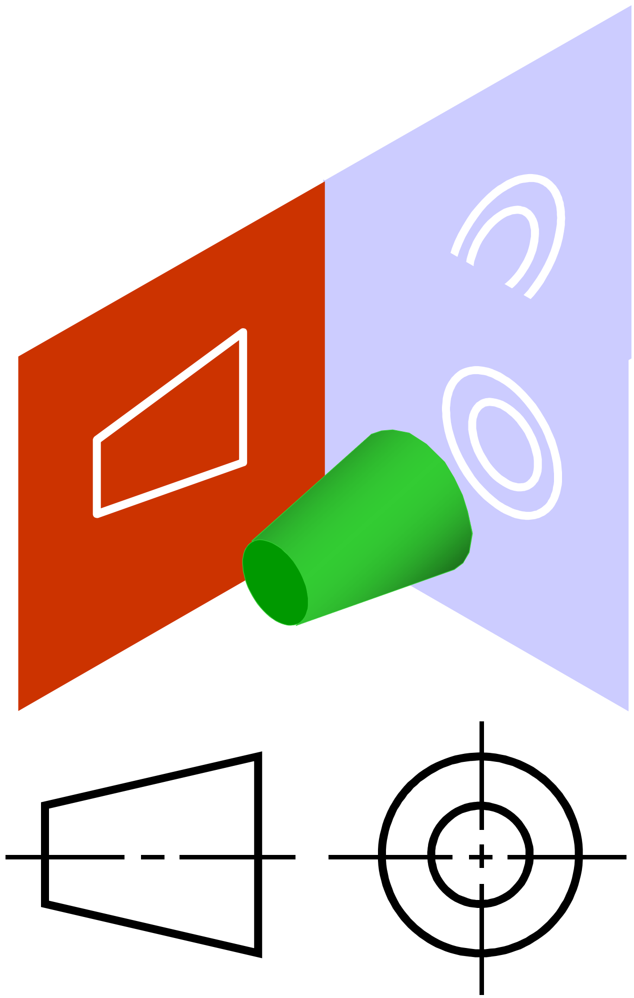


3^{rd} angle system



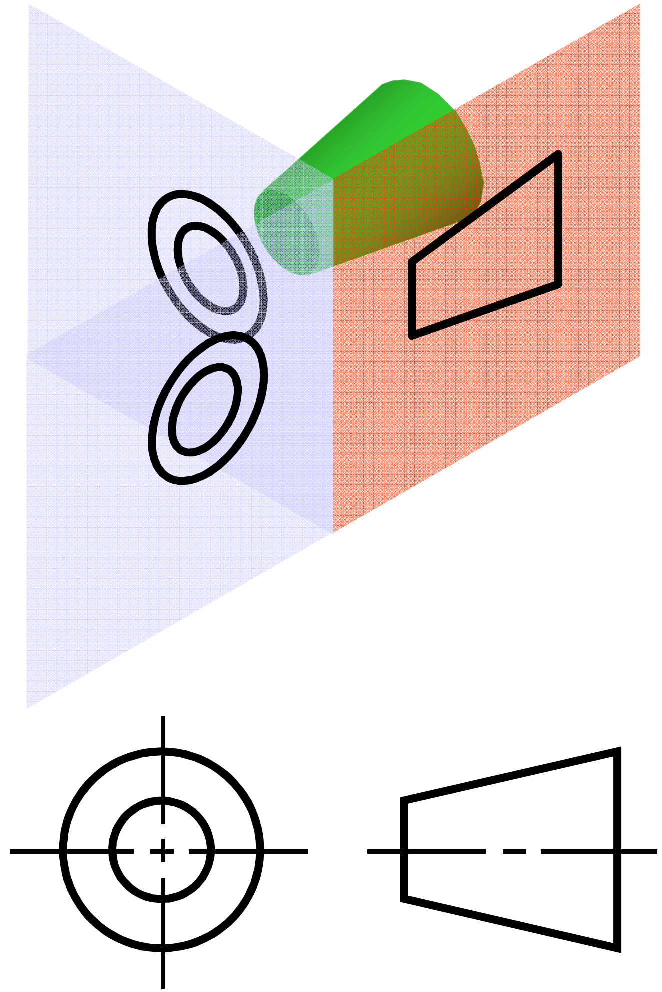
Projection Symbols

First angle system



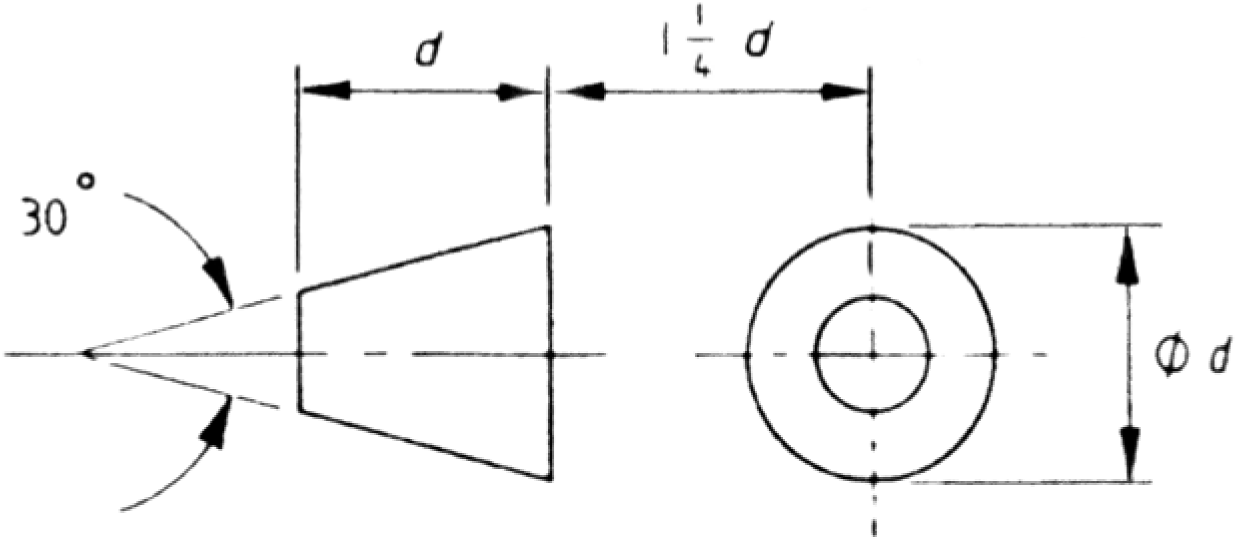
Front View Left Side View

Third angle system



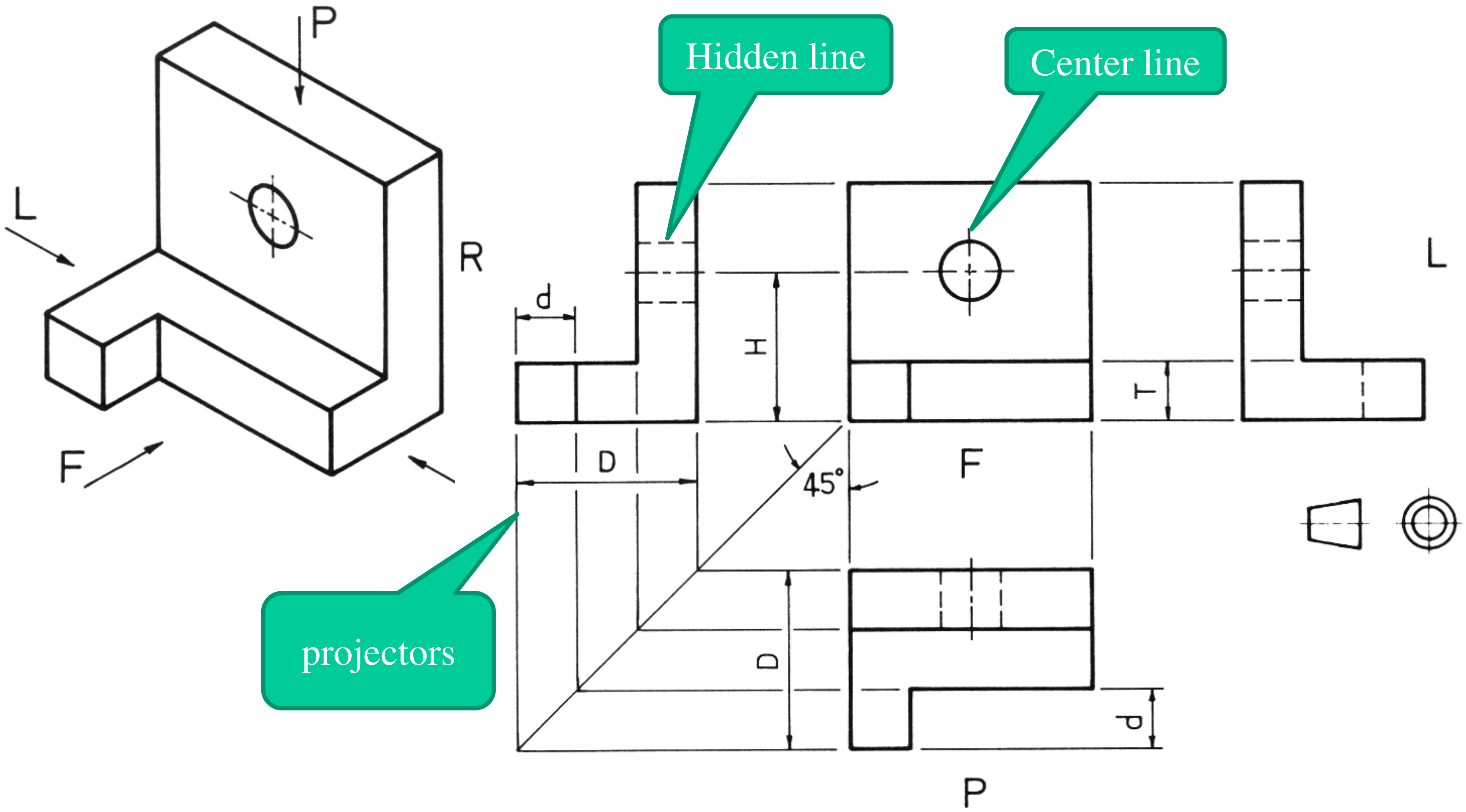
Left Side View Front View

First Angle Projection Symbol Proportions

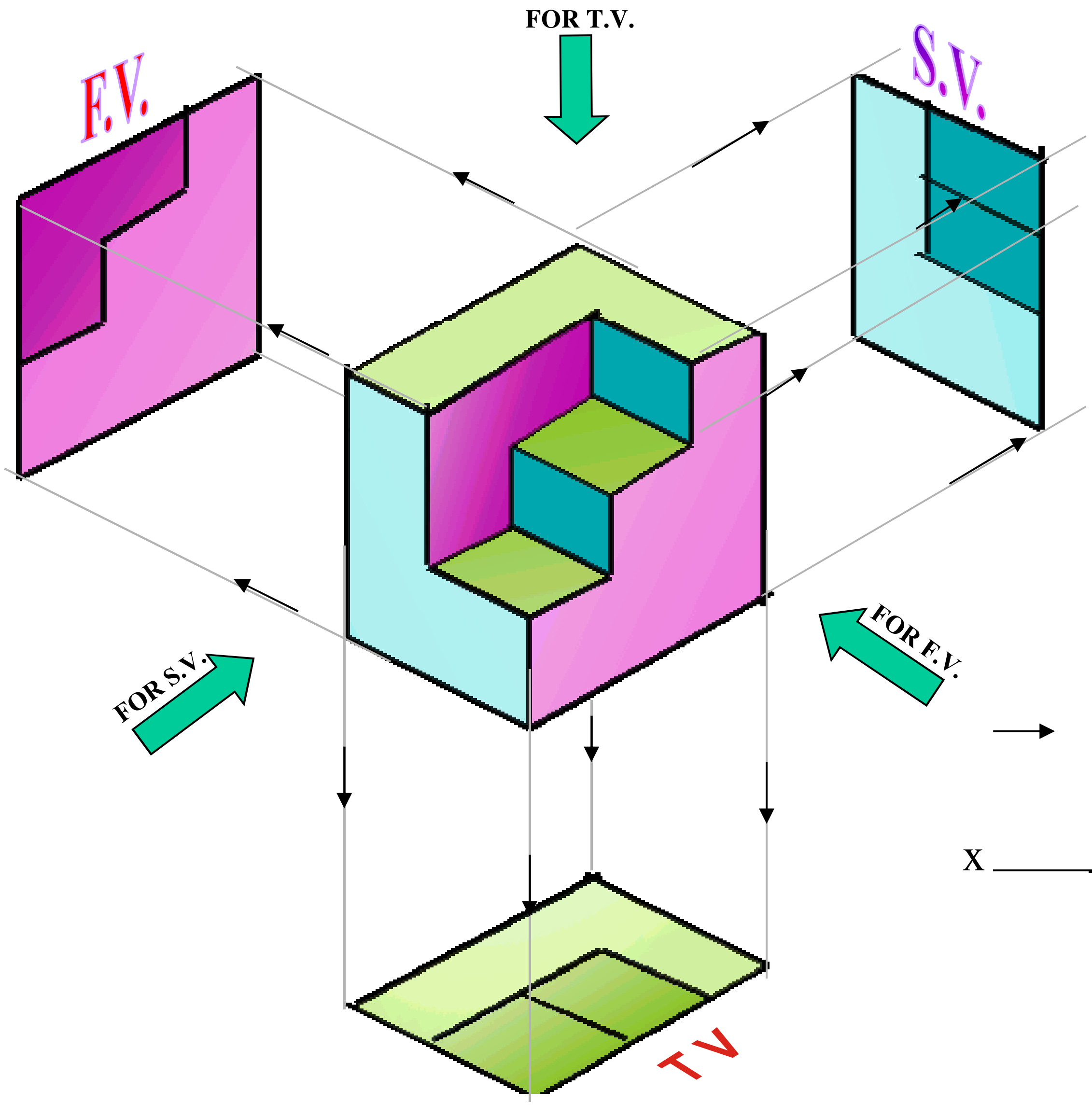


Hidden Lines

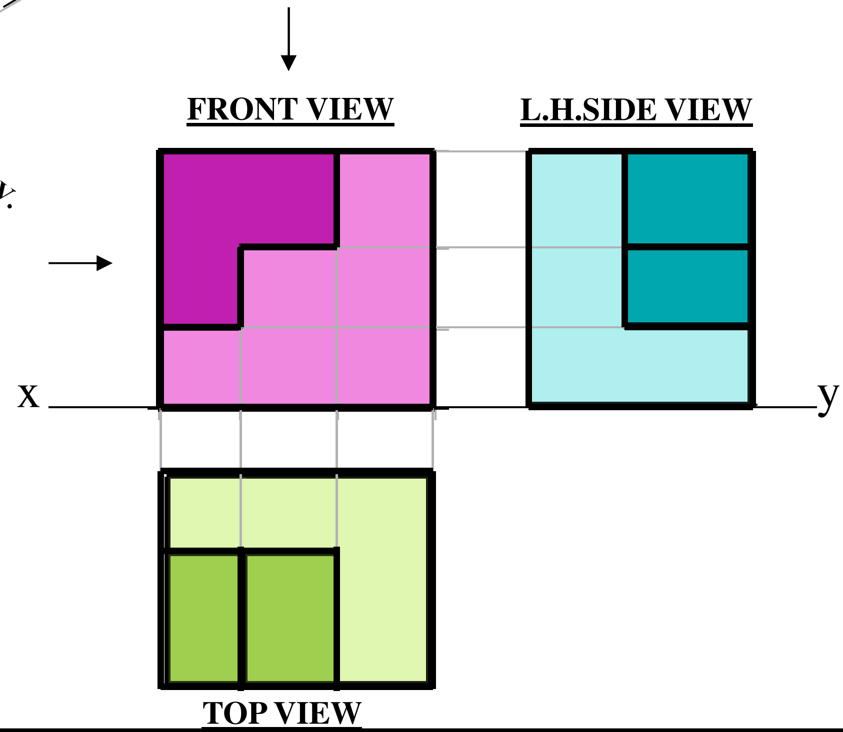
Some parts of the object cannot be seen from the position of the observer, as they will be covered by portions of the object closer to the observer's eyes. The edges of such hidden parts are shown by dashed lines.



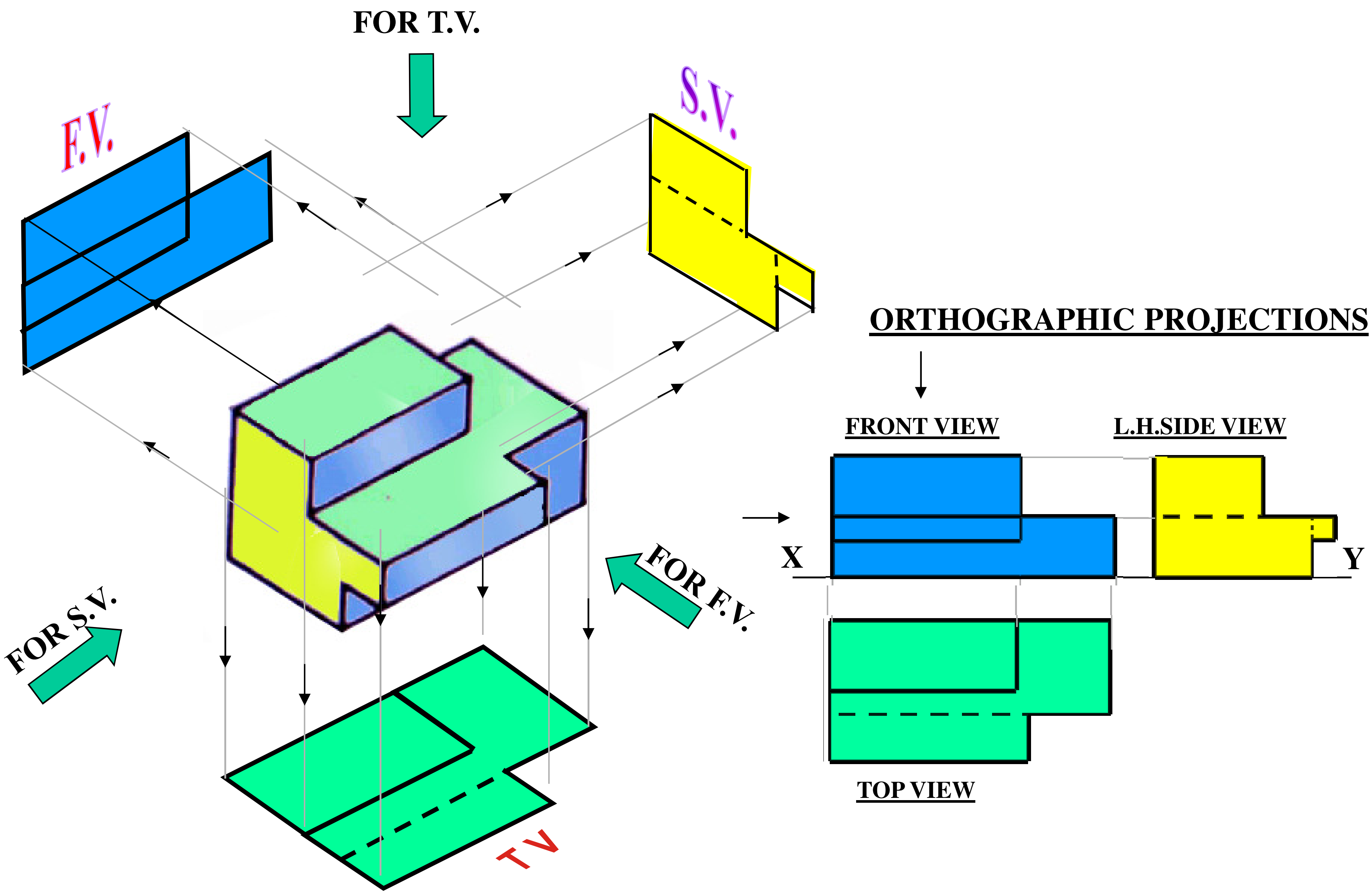
First Angle Projection (Example)



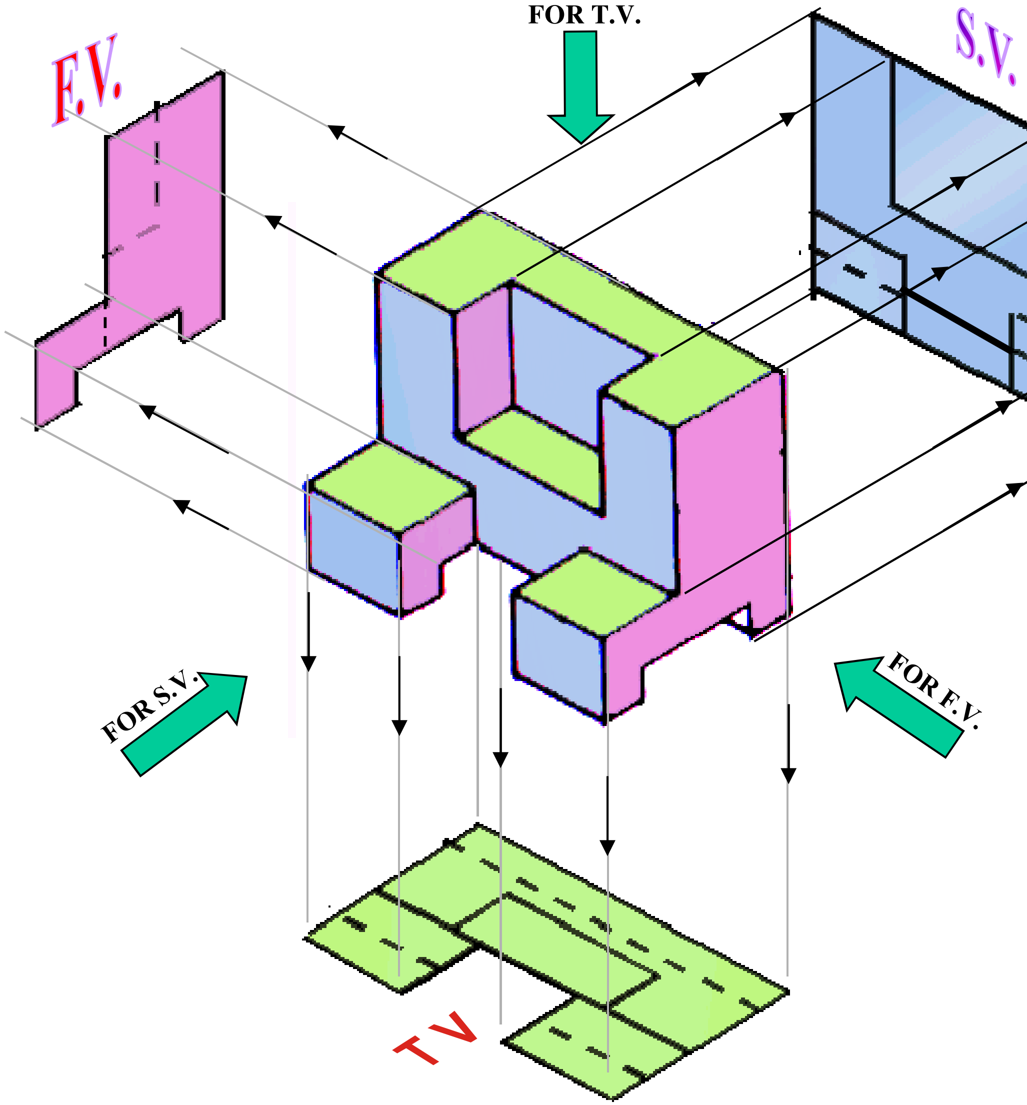
ORTHOGRAPHIC PROJECTIONS

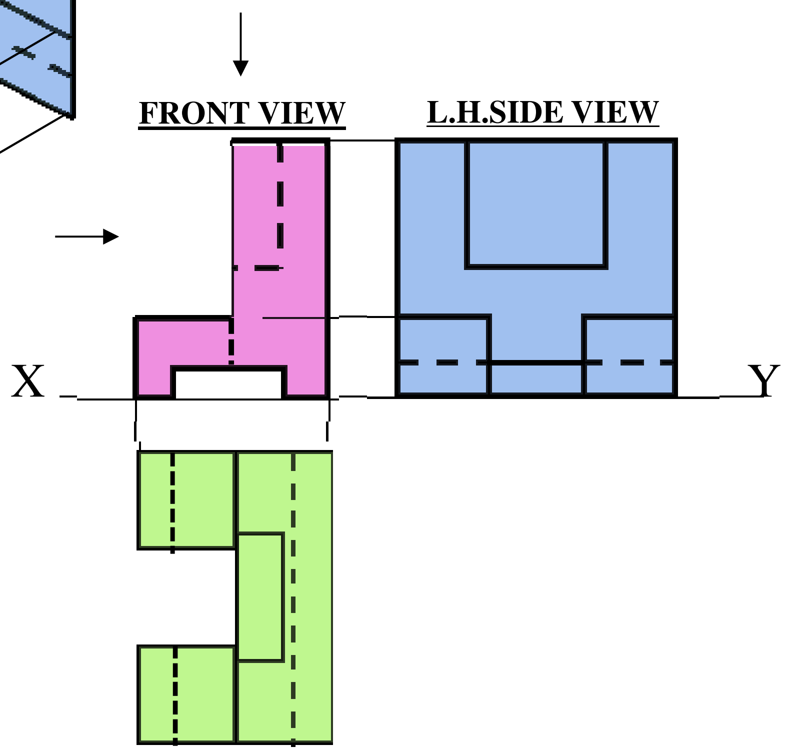


First Angle Projection (Example)

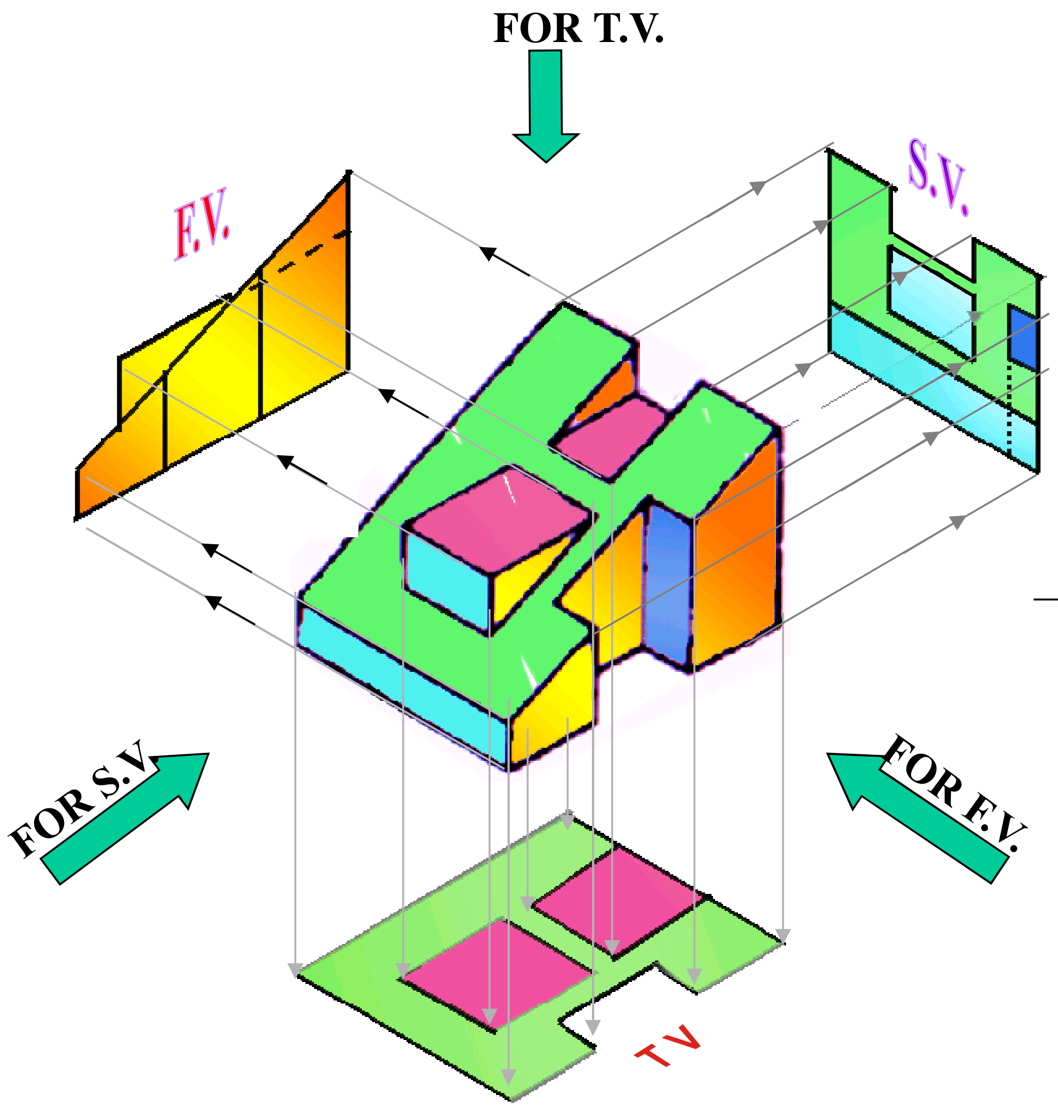


First Angle Projection (Example)

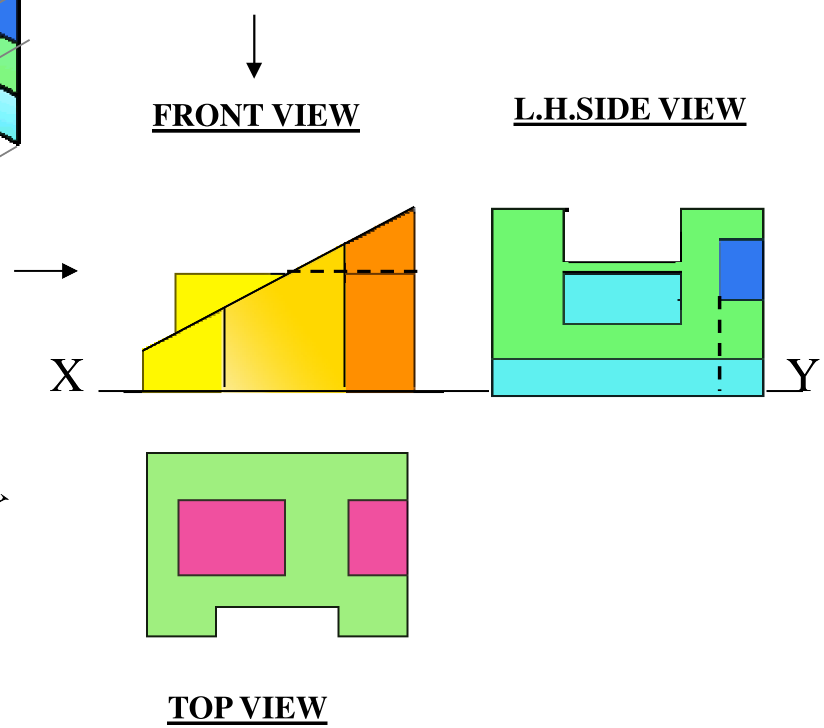




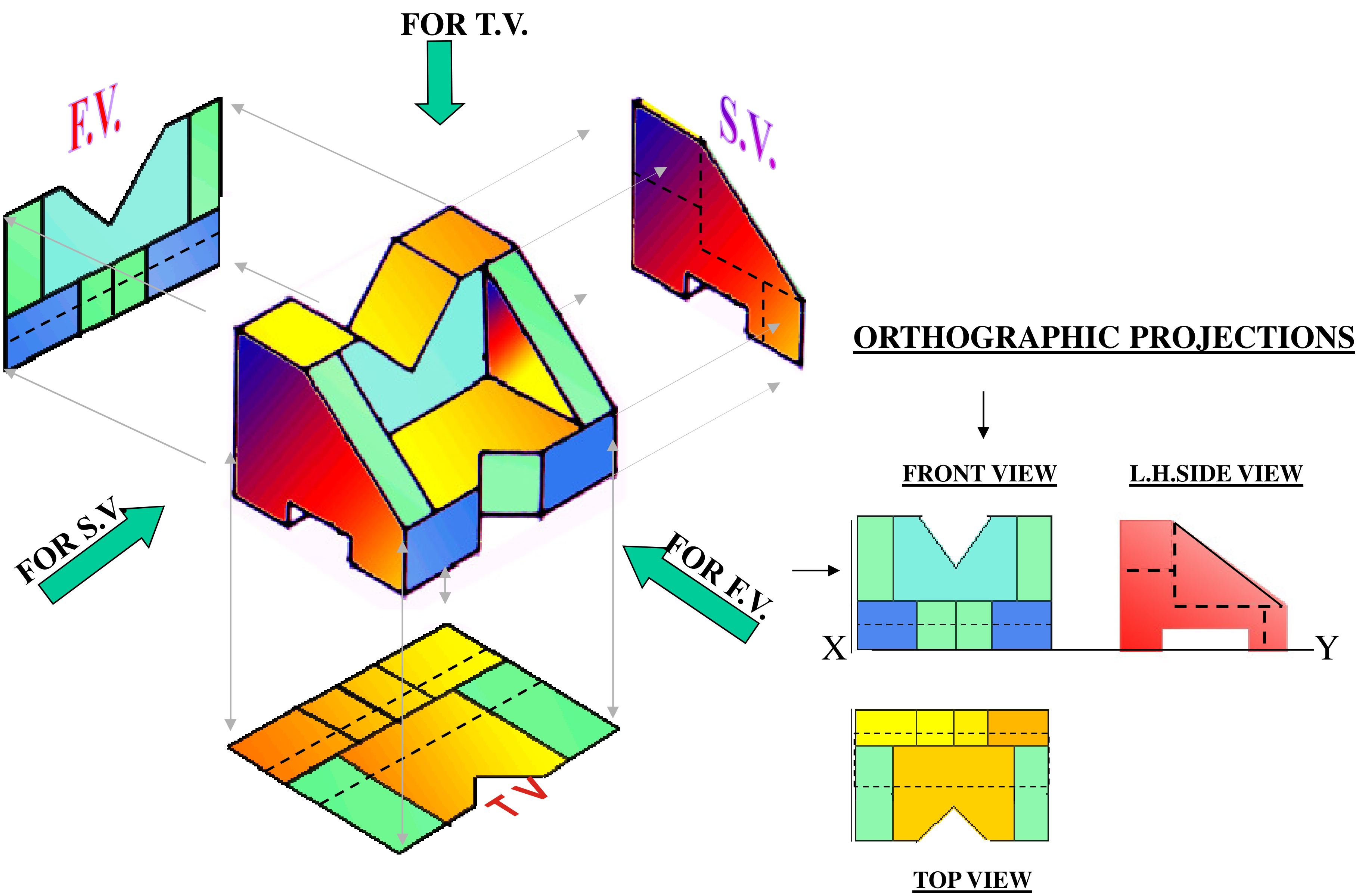
First Angle Projection (Example)



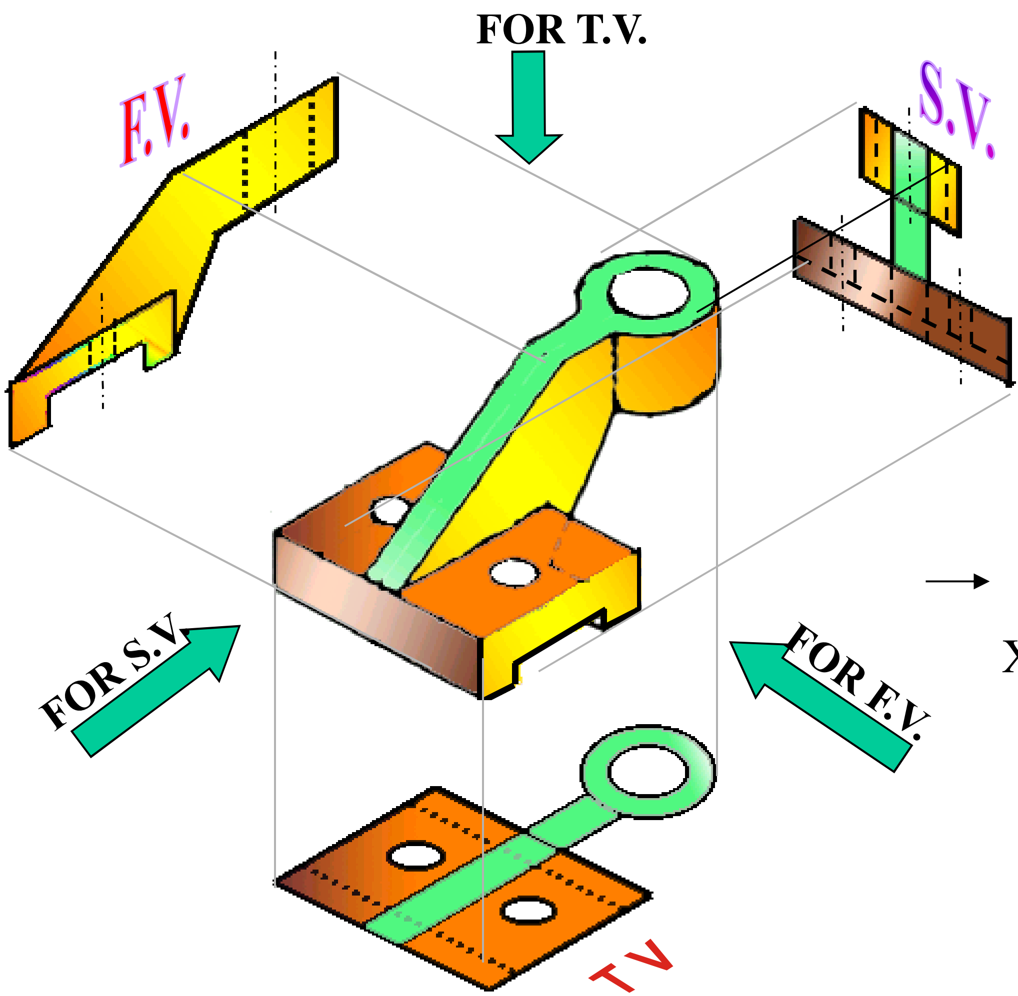
ORTHOGRAPHIC PROJECTIONS



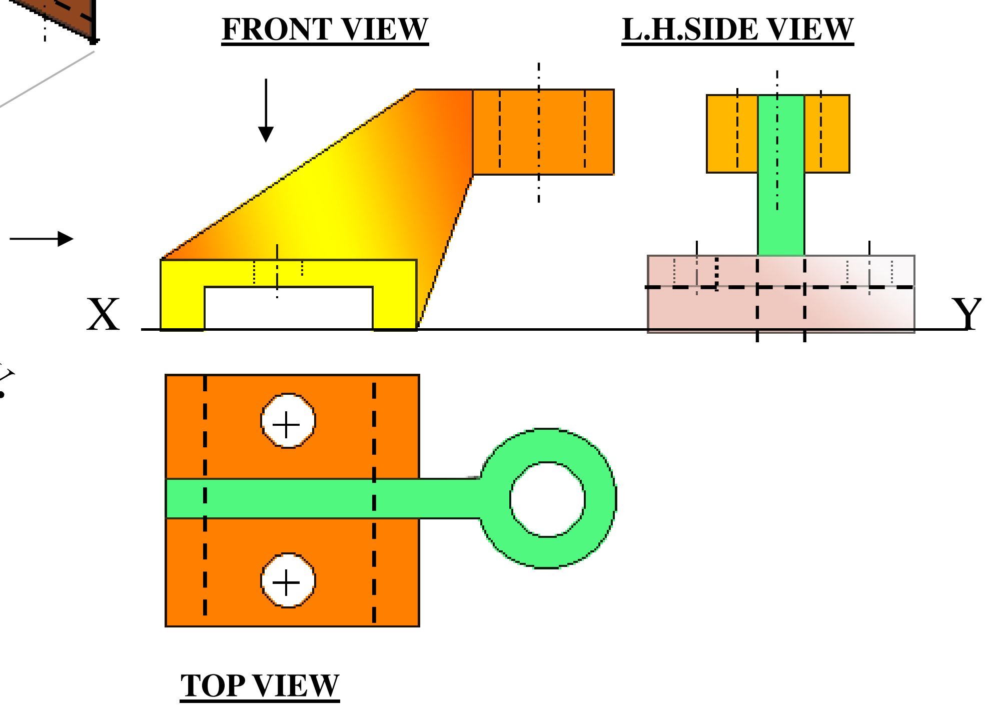
First Angle Projection (Example)



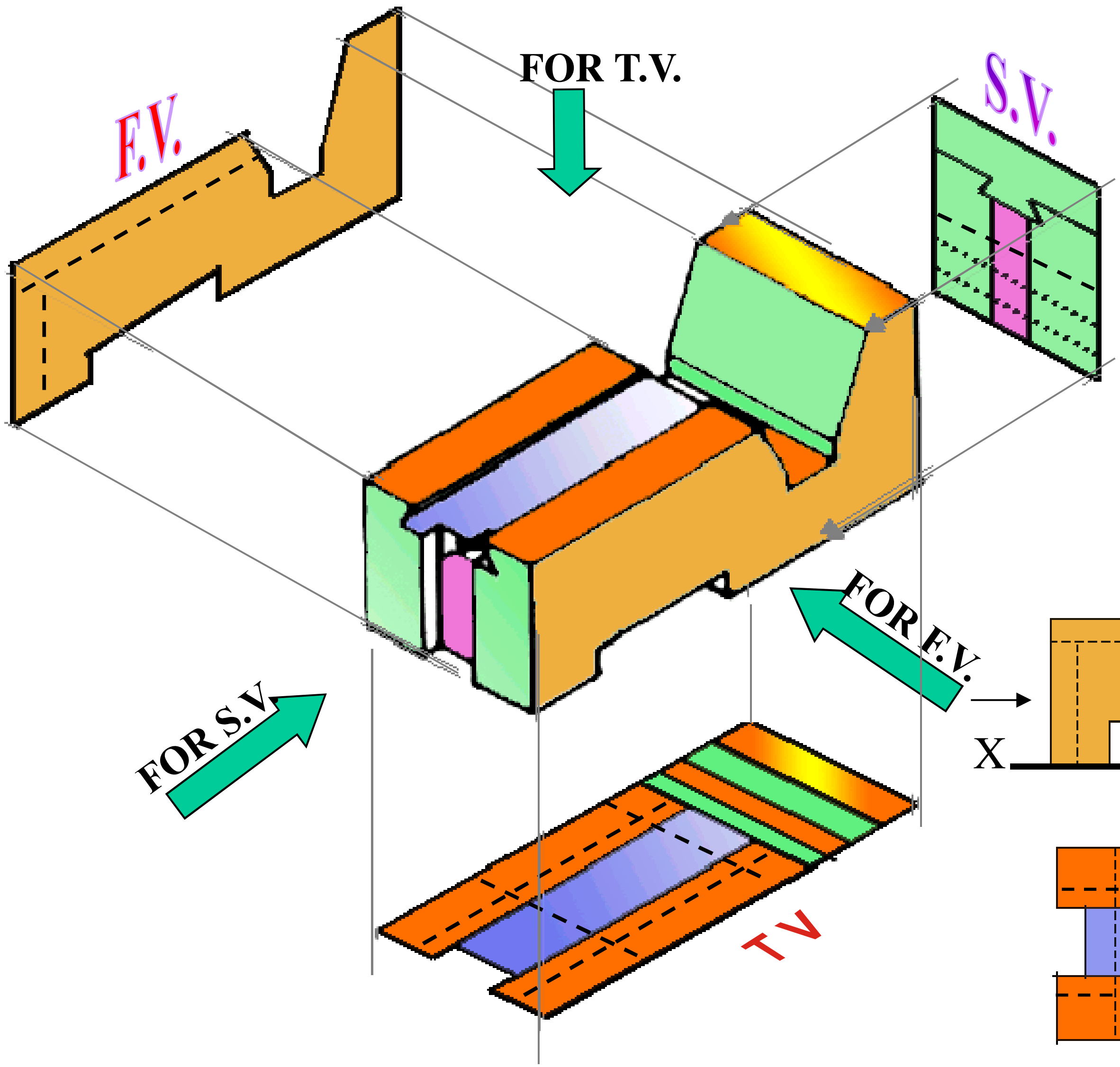
First Angle Projection (Example)



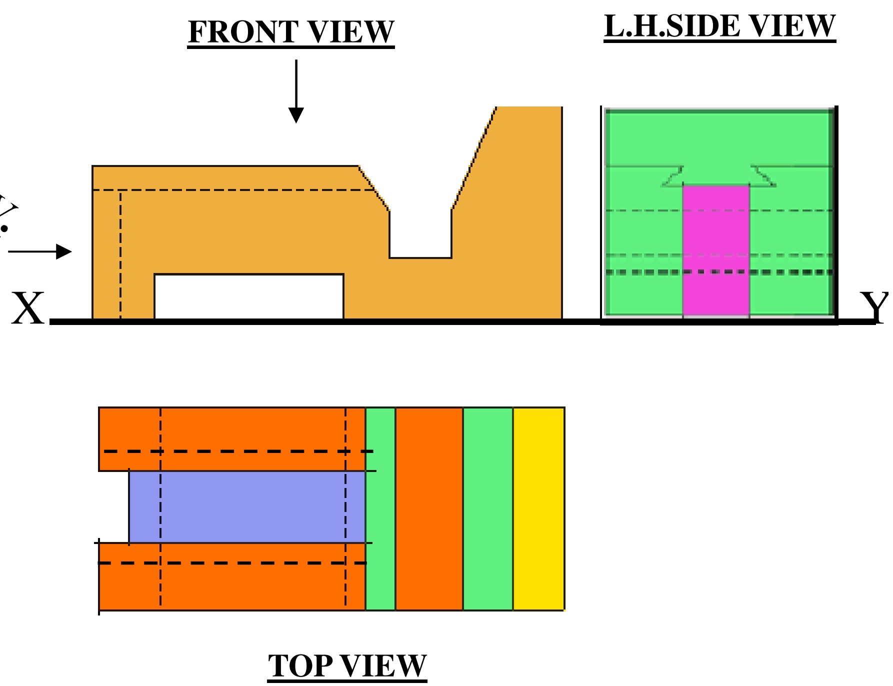
ORTHOGRAPHIC PROJECTIONS



First Angle Projection (Example)

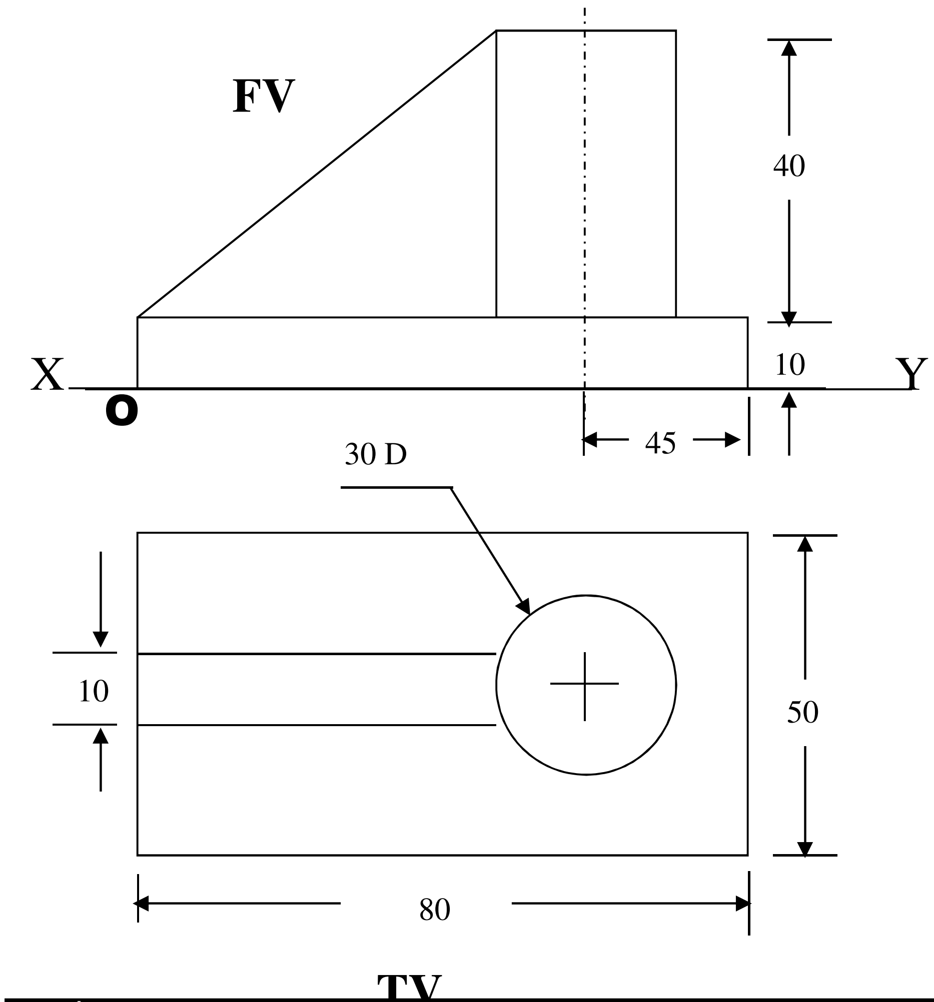


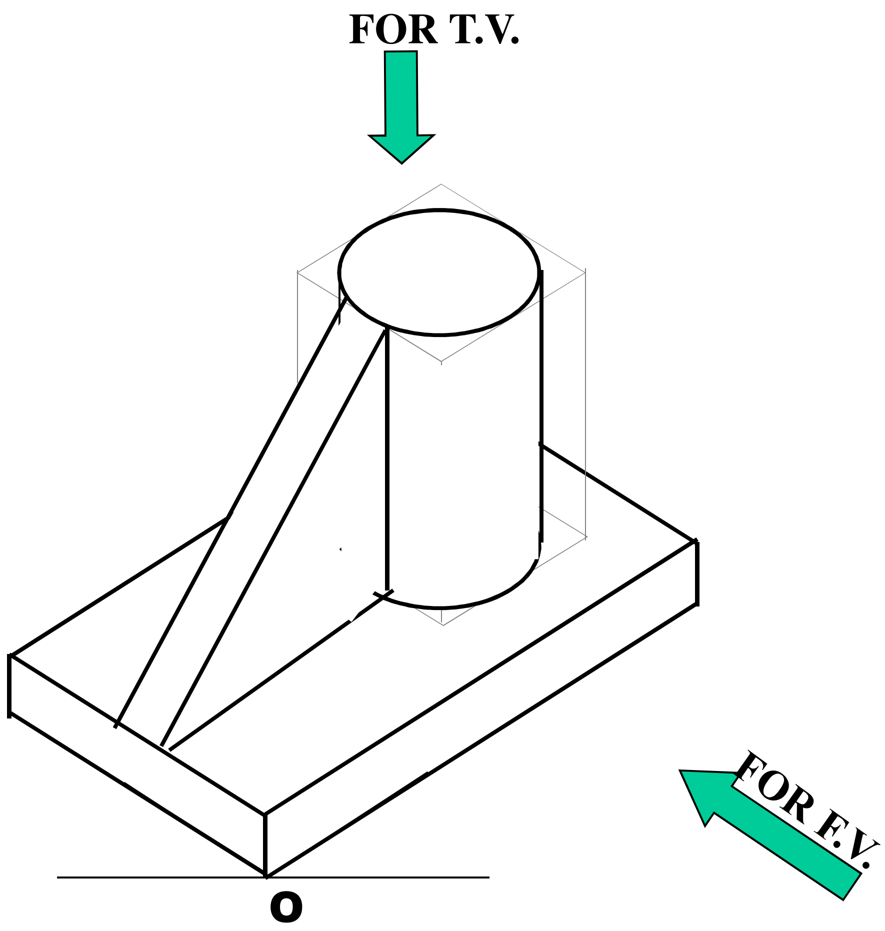
ORTHOGRAPHIC PROJECTIONS



First Angle Projection (Example)

ORTHOGRAPHIC PROJECTIONS





Thank you

Projection of Lines with Traces

Dr. Piyush Shakya
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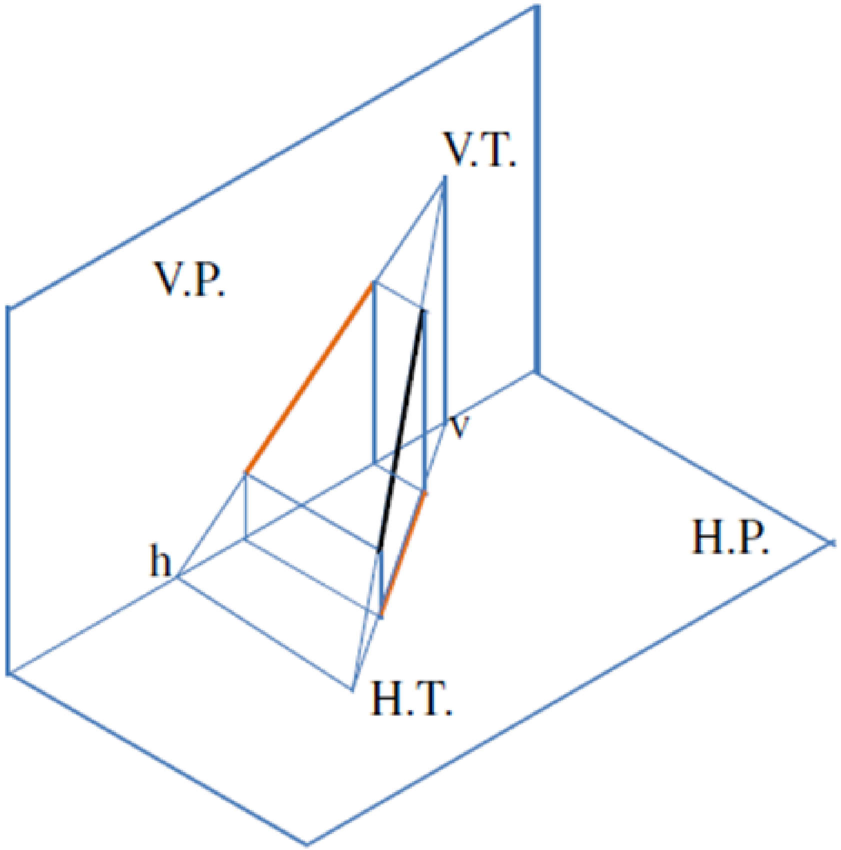
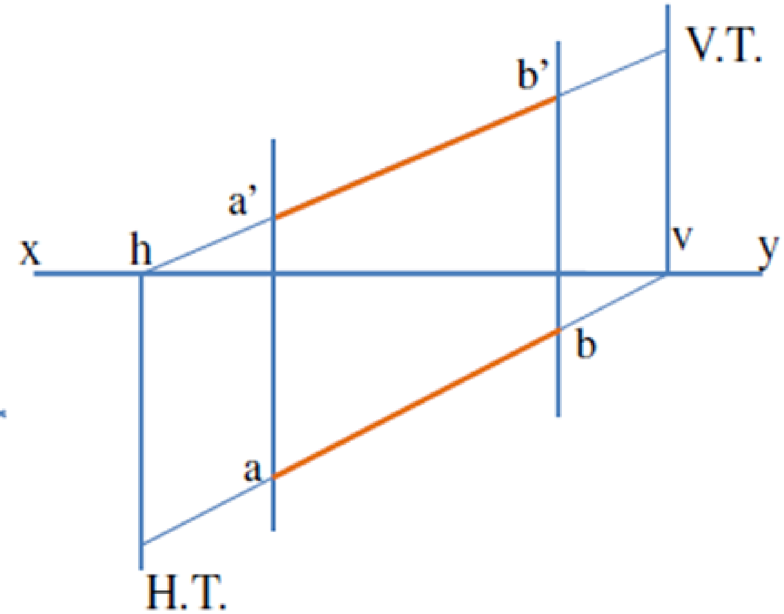
Traces of a line



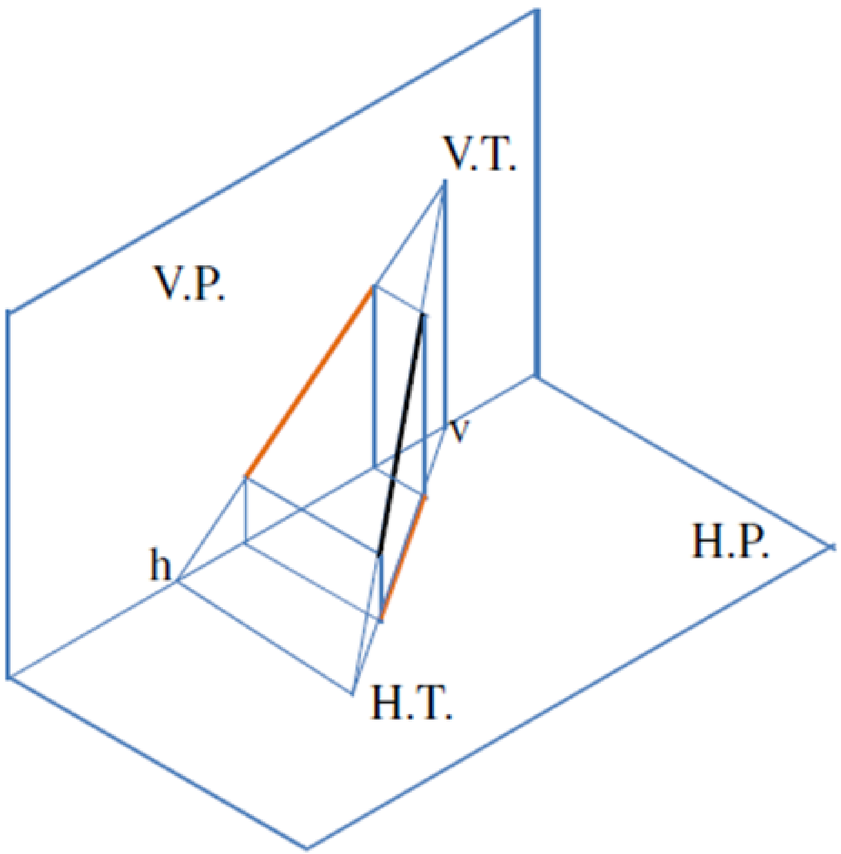


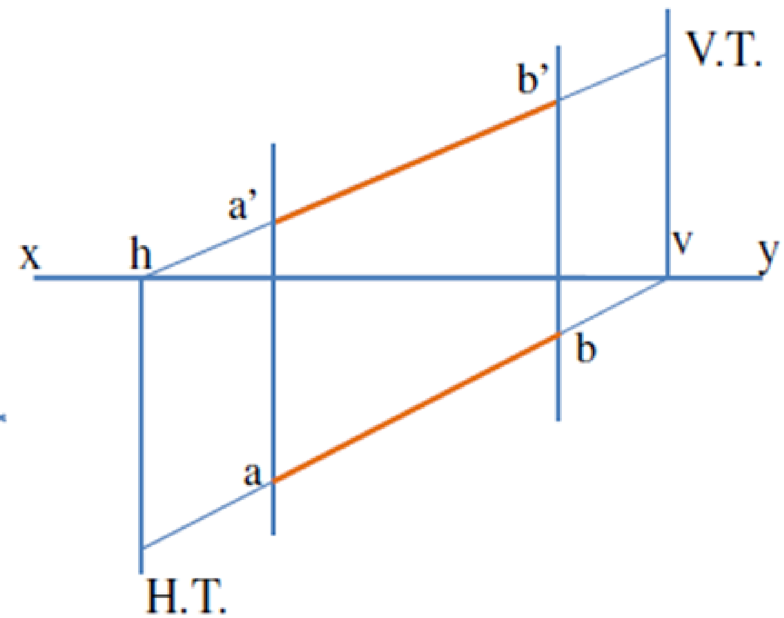
The points of intersection of a line (or its extension) with the respective reference planes are called Traces.

A Line or its extension intersects the *H. P.* at the trace of the line on *H.P.* (called *H. T.*)

A Line or its extension intersects the *V. P.* at the trace of the line on *V.P.* (called *V. T.*)

Traces of a line

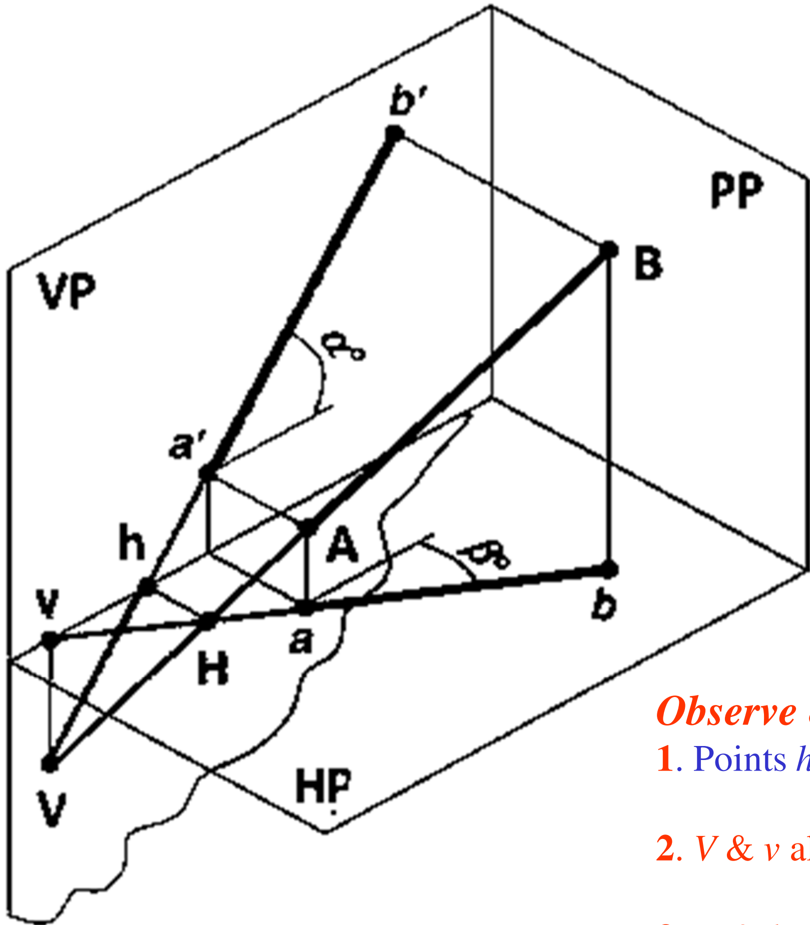




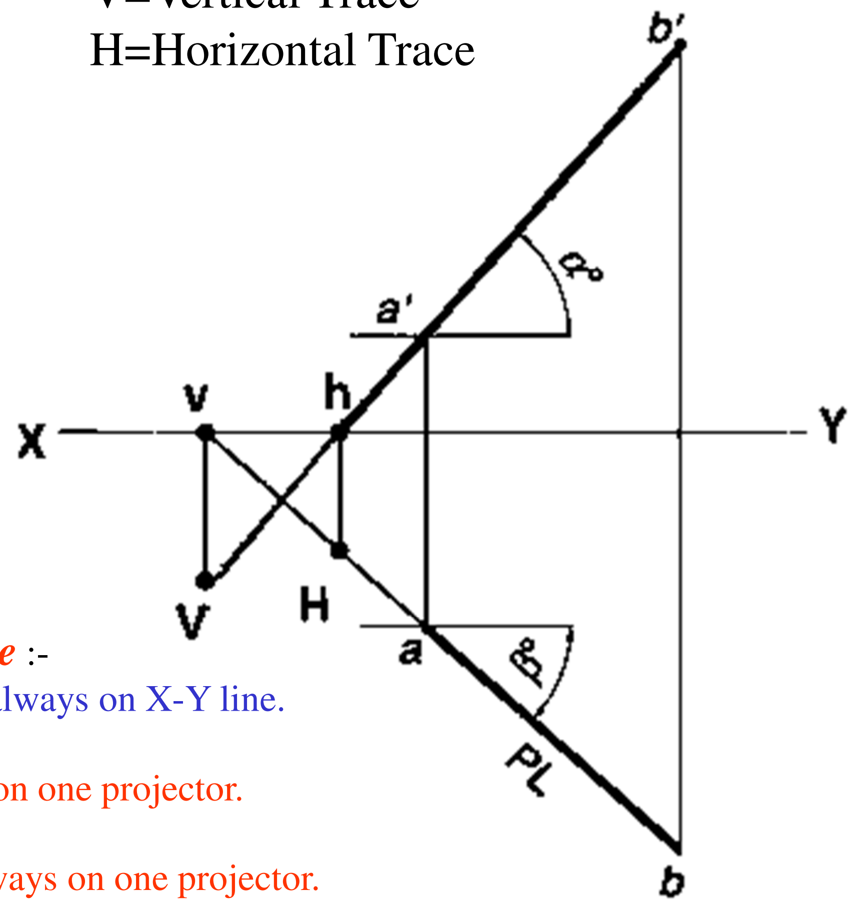
H.T.:-
It is a point on **H.P.**
Hence, its ***Fv*** comes on **XY line**.(named ***h***)

V.T.:-
It is a point on **V.P.**
Hence, its ***Tv*** comes on XY line. (named ***v***)

Traces of a line



V=Vertical Trace
H=Horizontal Trace



Observe & note :-

1. Points *h* & *v* always on X-Y line.

2. *V* & *v* always on one projector.

3. *H* & *h' (h)* always on one projector.

4. FV - *h*- *V* (VT) always co-linear.

5. TV - *v* – *H (HT)* always co-linear.

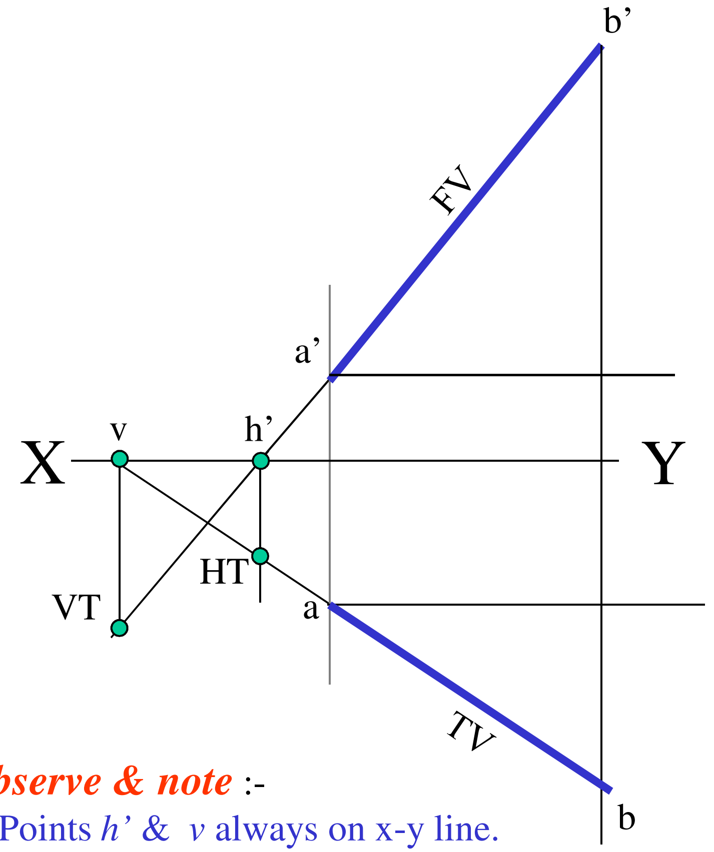
Traces of a line (Steps)

STEPS TO LOCATE HT.
(WHEN PROJECTIONS ARE GIVEN.)

1. **Begin with FV. Extend FV up to XY line.**
2. **Name this point *h'***
   (as it is a Fv of a point in Hp)
3. **Draw one projector from *h'*.**
4. **Now extend Tv to meet this projector.**
   This point is HT

STEPS TO LOCATE VT.
(WHEN PROJECTIONS ARE GIVEN.)

1. **Begin with TV. Extend TV up to XY line.**
2. **Name this point *v***
   (as it is a Tv of a point in Vp)
3. **Draw one projector from *v*.**
4. **Now extend Fv to meet this projector.**
   This point is VT



Observe & note :-

1. Points *h'* & *v* always on x-y line.
2. *VT'* & *v* always on one projector.
3. *HT* & *h'* always on one projector.
4. FV - *h'*- *VT'* always co-linear.
5. TV - *v* - *HT* always co-linear.

Traces of a line (Example 1)

The *Fv* of line *AB* makes 45^0 angle with *XY* line and measures 60 mm. Line's *Tv* makes 30^0 with *XY* line. End *A* is 15 mm above *Hp* and its *VT* is 10 mm below *Hp*. Draw projections of line *AB*, Determine inclinations with *Hp* & *Vp* and locate *HT, VT*.

SOLUTION STEPS:-

Draw xy line, one projector and locate fv *a'* 15 mm above xy.

Take 45^0 angle from *a'* and marking 60 mm on it locate point *b'*.

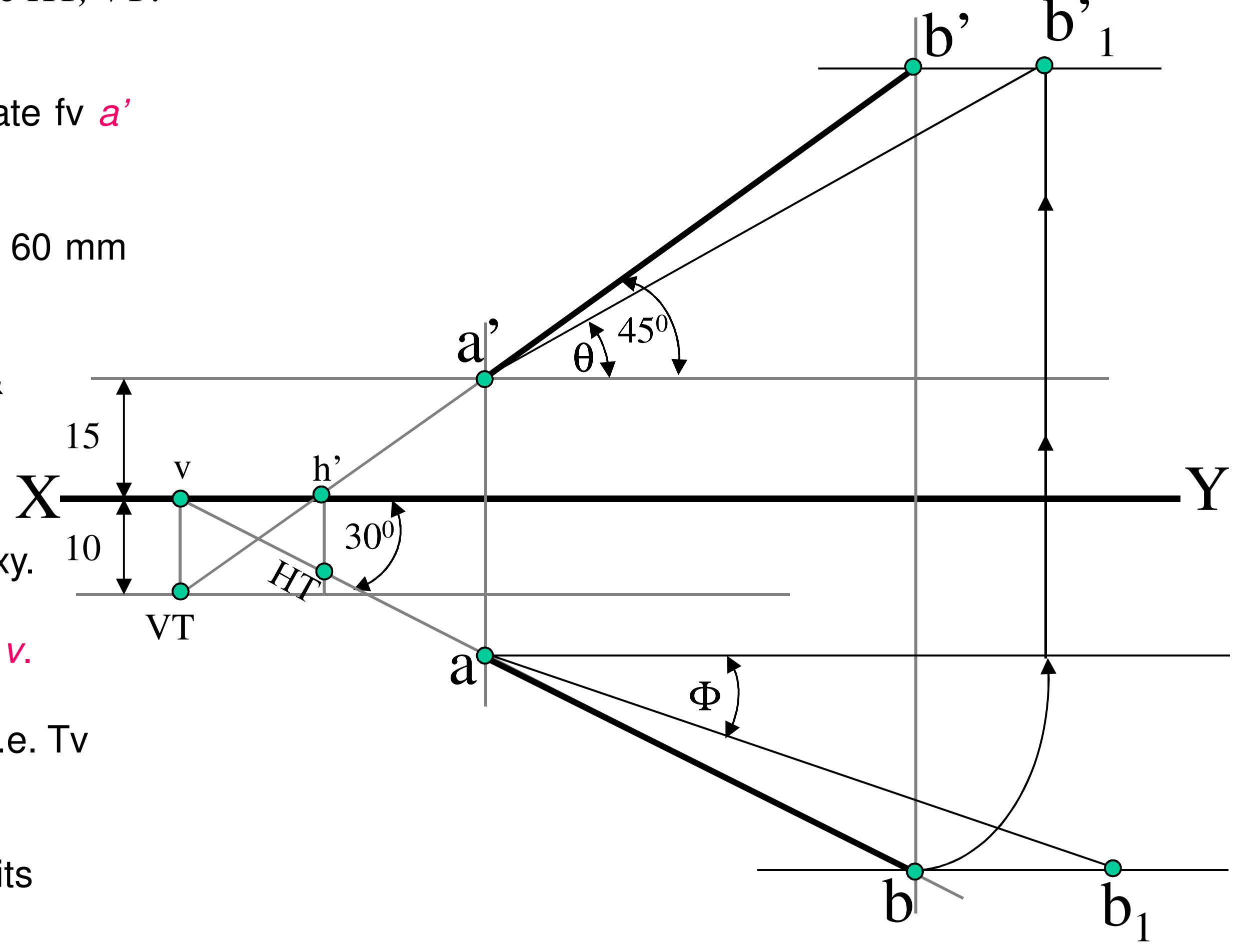
Draw locus of VT, 10 mm below xy & extending Fv to this locus locate VT. as Fv-h'-VT lie on one st. line.

Draw projector from VT, locate v on xy. From *v* take 30^0 angle downward as Tv and it's inclination can begin with *v*.

Draw projector from b' and locate *b* i.e. Tv point.

Now rotating views as usual TL and its inclinations can be found.

Name extension of Fv, touching xy as *h'* and below it, on extension of Tv, locate HT.



Traces of a line (Example 2)

One end of line *AB* is 10mm above *Hp* and other end is 100 mm in-front of *Vp*. Its *Fv* is 45^0 inclined to xy while its *HT* & *VT* are 45mm and 30 mm below *xy* respectively. Draw projections and find *TL* with its inclinations with *Hp* & *VP*.

SOLUTION STEPS:-

Draw XY line, one projector and locate *a'* 10 mm above XY.

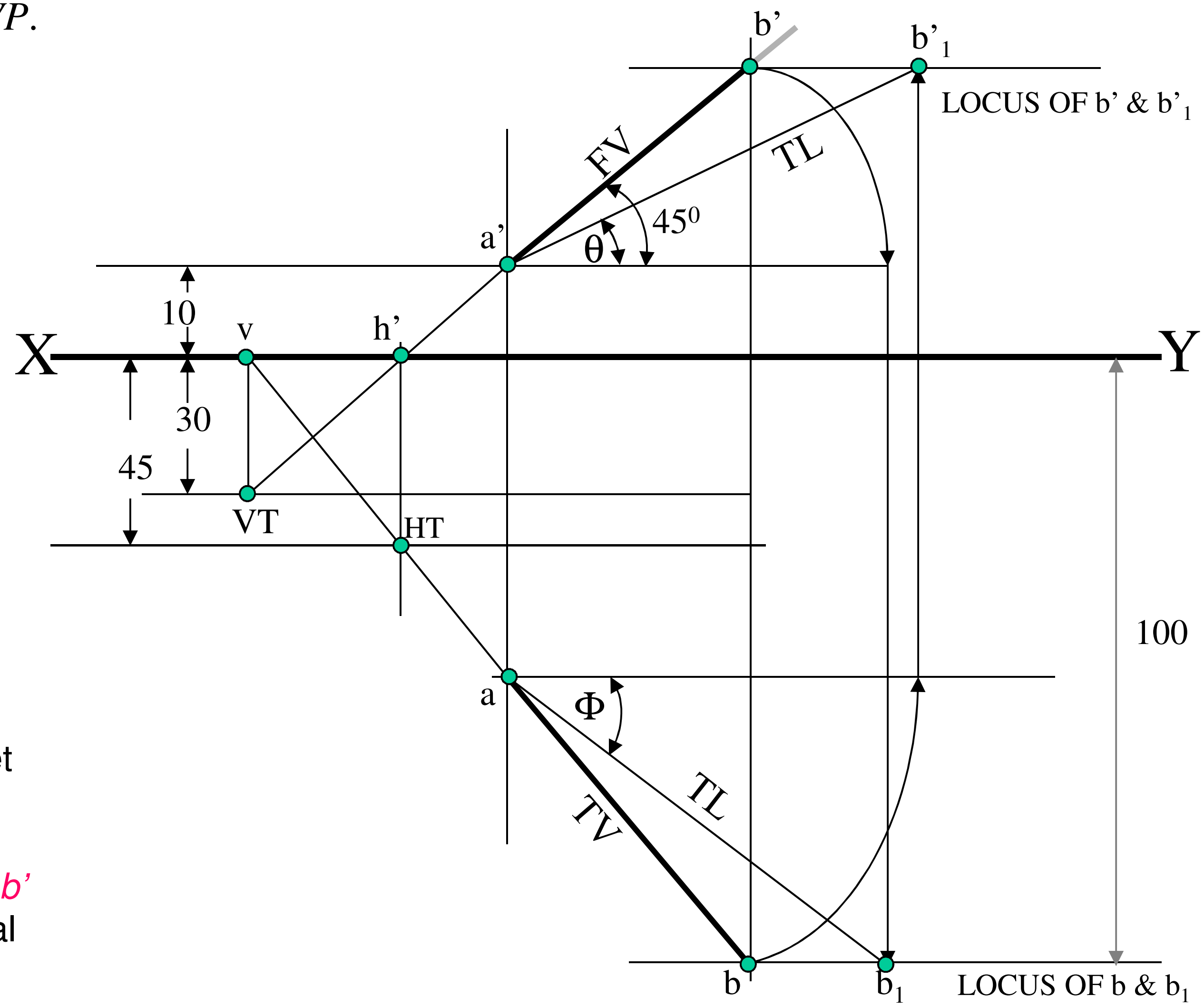
Draw locus 100 mm below XY for points *b* & b_1

Draw loci for VT and HT, 30 mm & 45 mm below xy respectively.

Take 45^0 angle from *a'* and extend that line backward to locate *h'* and VT, & Locate *v* on xy above VT.

Locate HT below *h'* as shown. Then join *v* – HT and extend to get top view end *b*.

Draw projector upward and locate *b'* Make *a b* & *a'b'* dark. Now as usual rotating views find TL and its inclinations.



Traces of a line (Example 3)

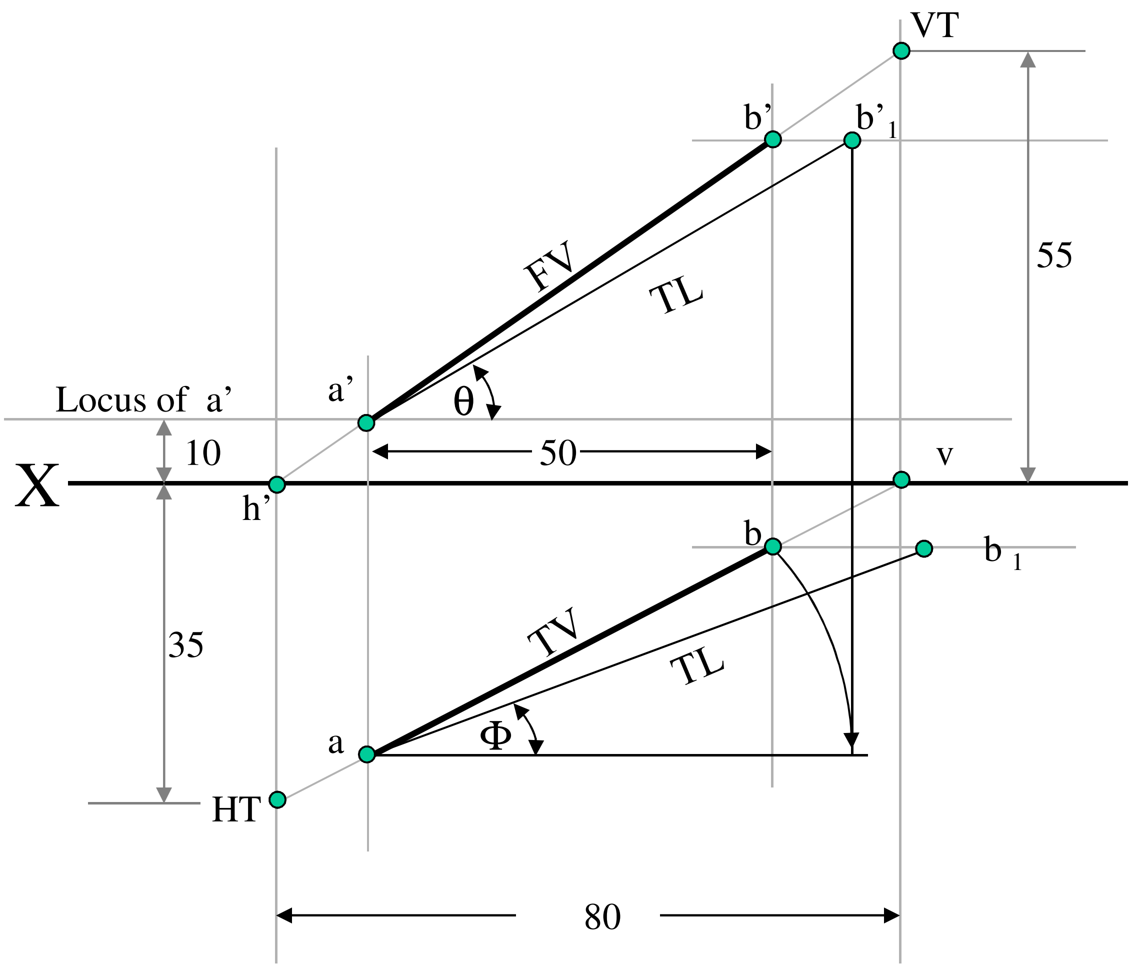
Projectors drawn from *HT* and *VT* of a line *AB* are 80 mm apart and those drawn from its ends are 50 mm apart. End *A* is 10 mm above *Hp*, *HT* is 35 mm below *XY* while its *VT* is 55 mm above *XY*. Draw projections, locate traces and find *TL* of line & inclinations with *Hp* and *Vp*.

SOLUTION STEPS:-

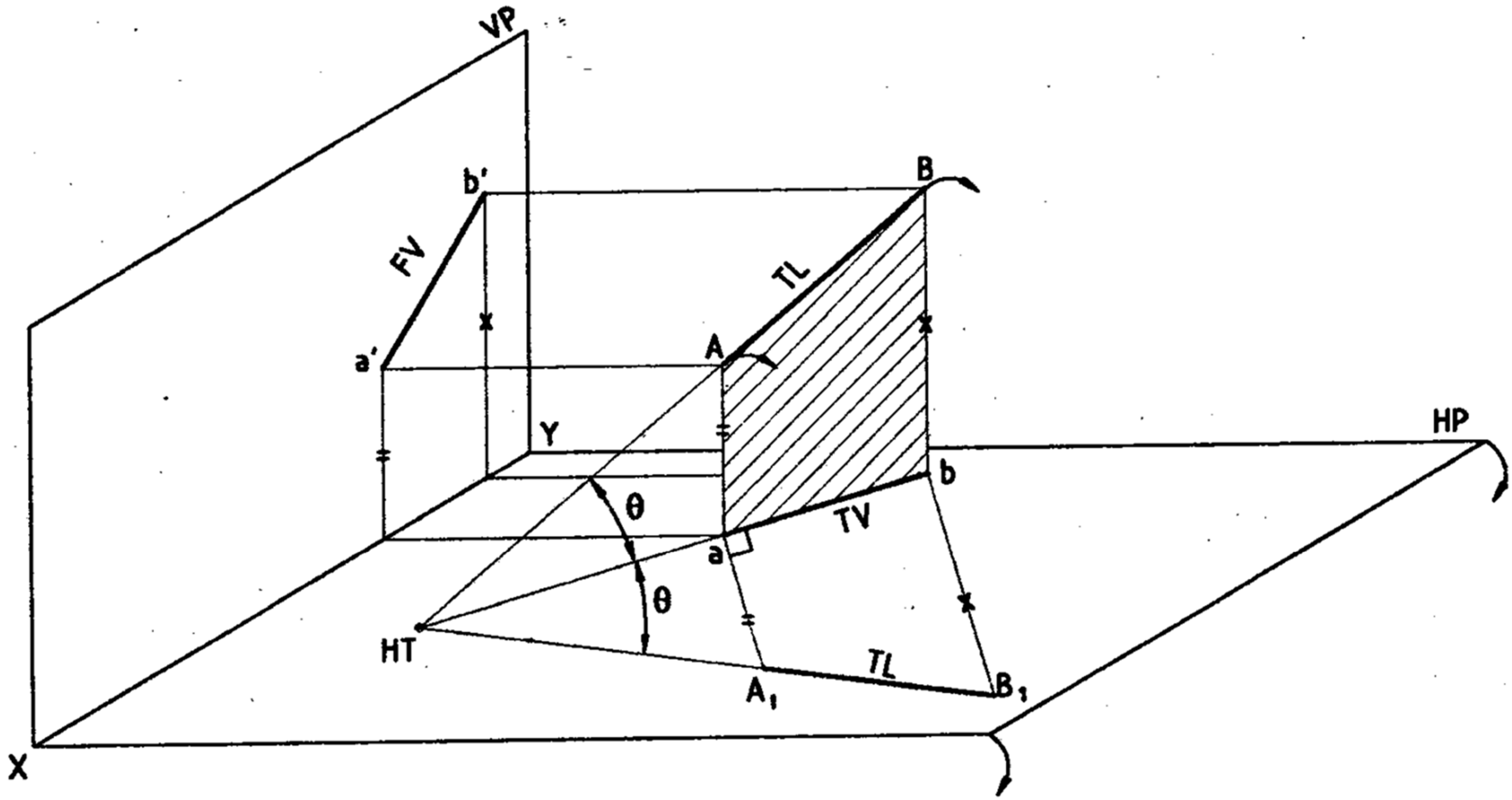
1.Draw XY line and two projectors, 80 mm apart and locate HT & VT , 35 mm below XY and 55 mm above XY respectively on these projectors.

2.Locate *h'* and *v* on xy as usual.

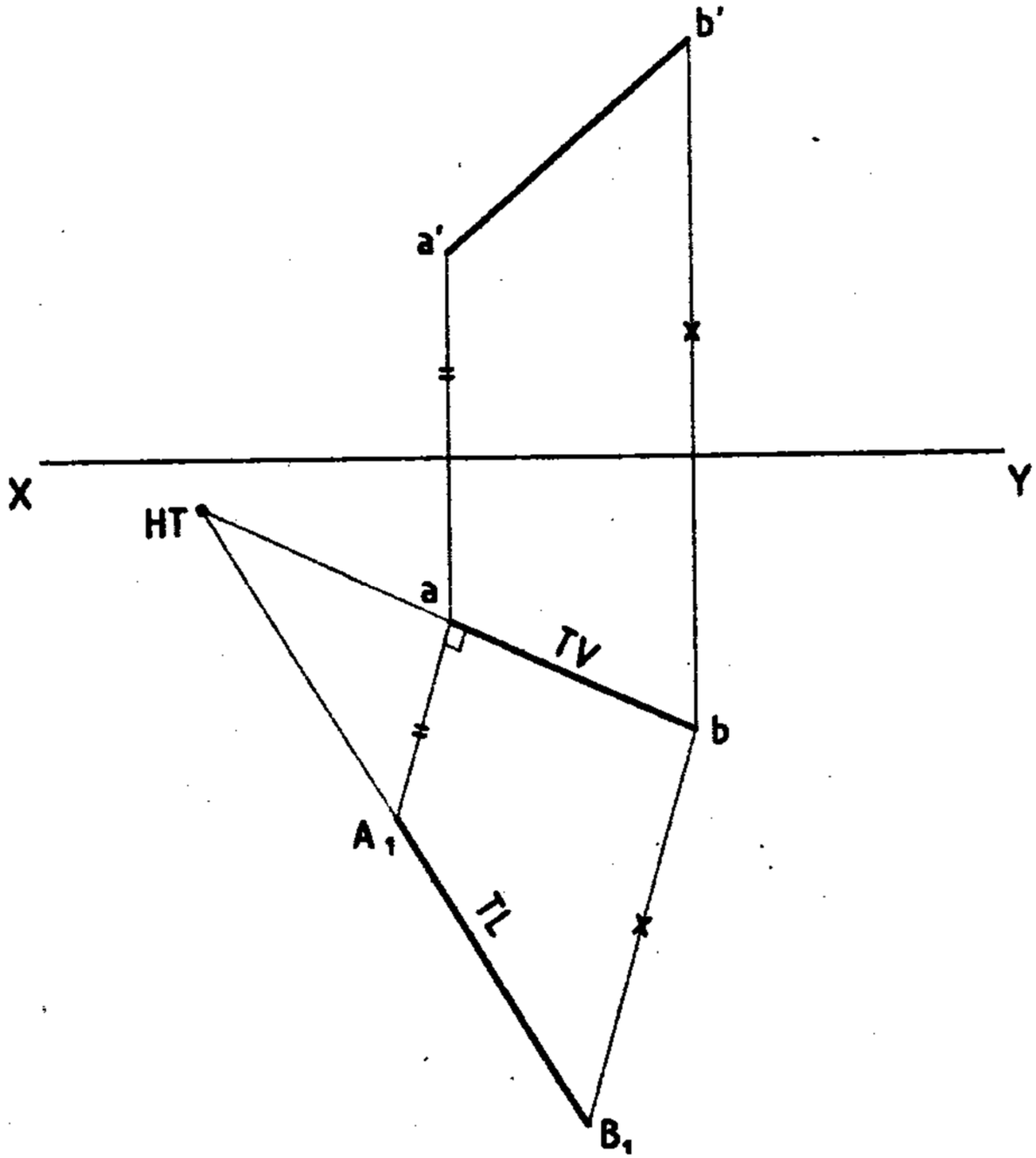
3.Now just like previous two problems, Extending certain lines complete Fv & Tv and as usual find TL and its inclinations.



Trapezoid Method

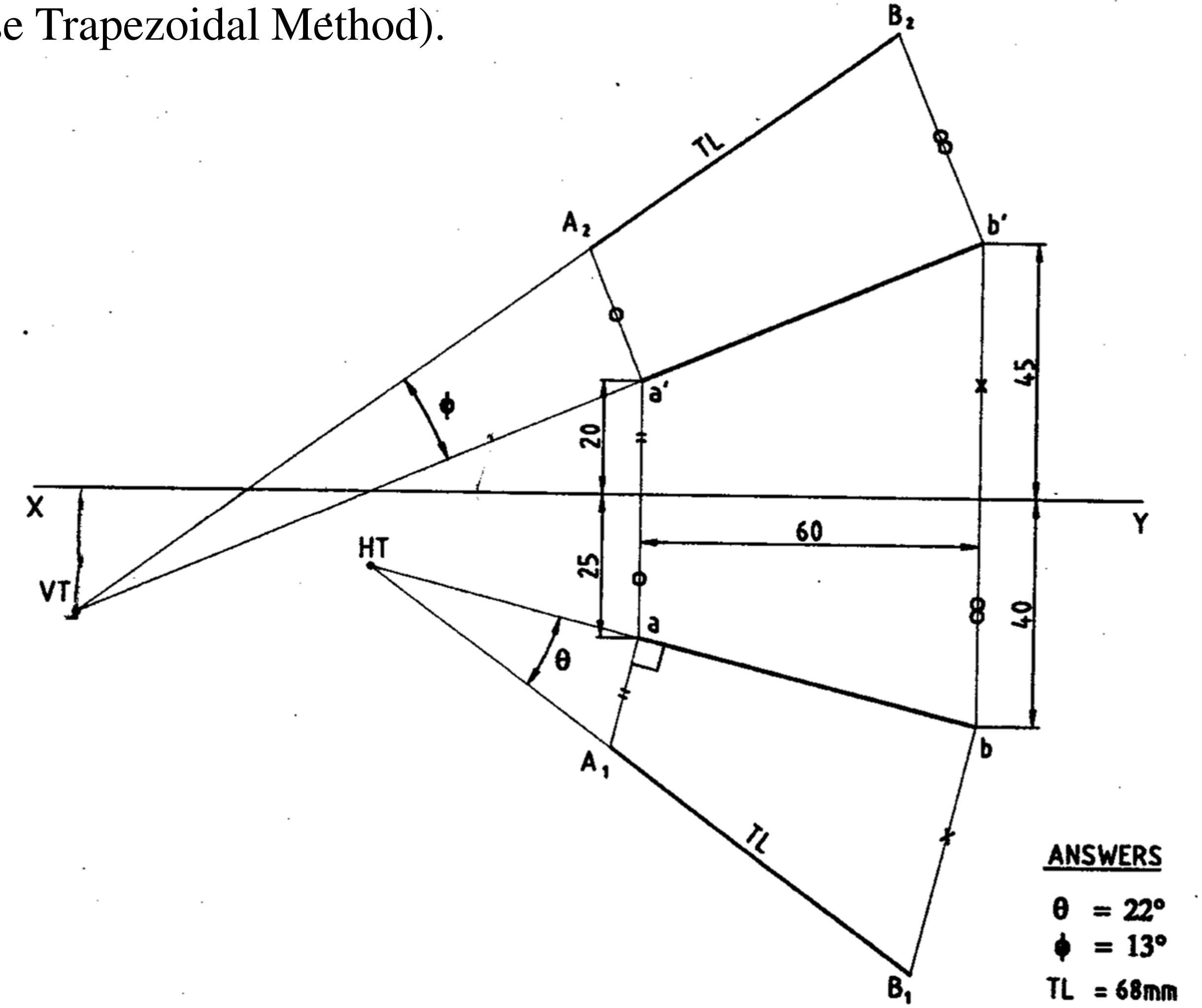


Trapezoid Method



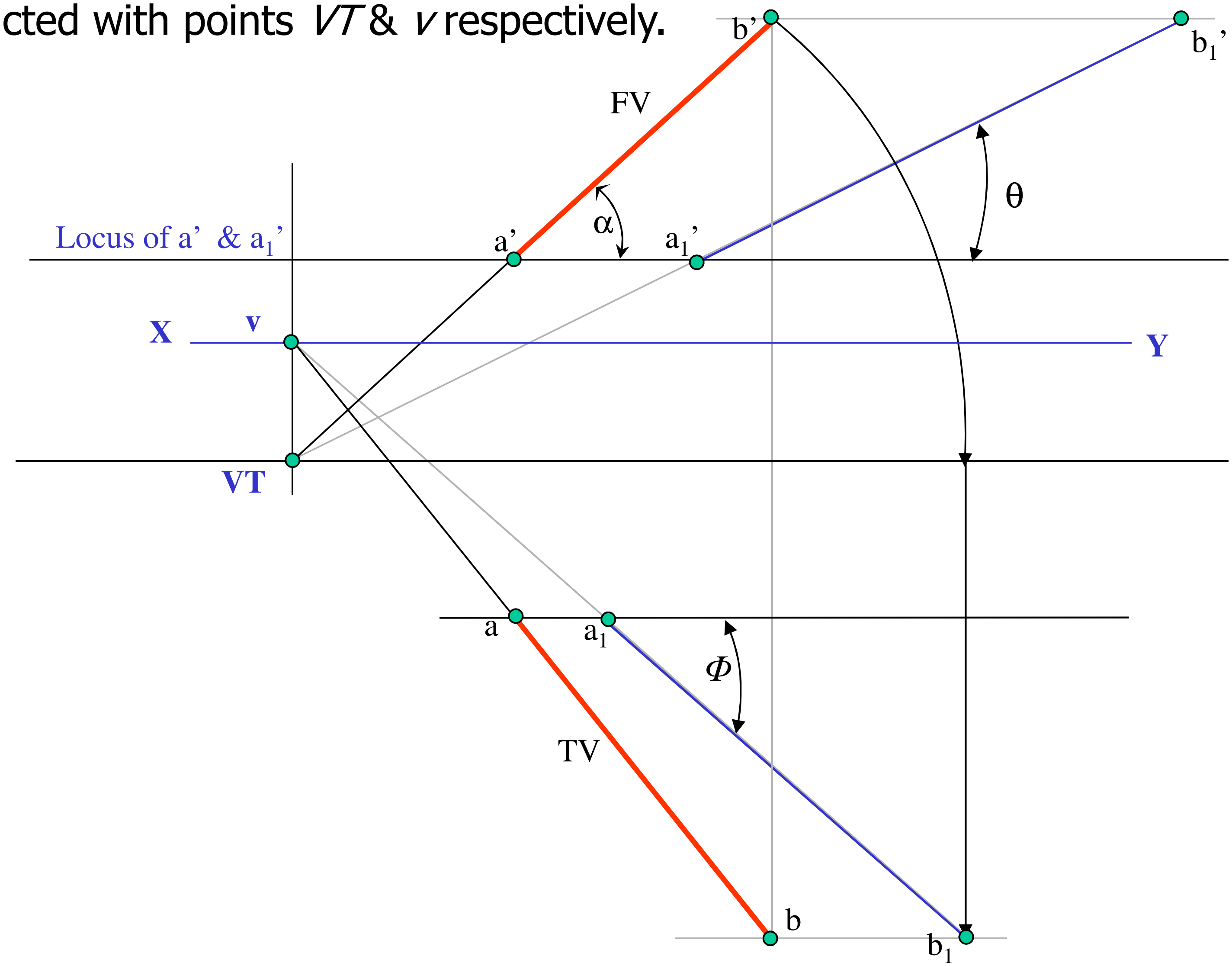
Trapezoid Method (Example 4)

A line *AB* has its end *A* 20 mm above *HP* and 25 mm in front of *VP*. The other end *B* is 45 mm above *HP* and 40 mm in front of *VP.* The distance between the end projectors is 60 mm. Draw its projections, also find the true length and true inclinations of the line with *HP* and *VP* and mark the traces (Use Trapezoidal Method).



Traces of a line (Another Method)

Instead of considering *a* & *a′* as projections of the first point, if *v* & *VT* are considered as the first point, then true inclinations of line with *Hp* & *Vp* i.e. angles θ & Φ can be constructed with points *VT* & *v* respectively.



Traces of a line (Another Method)

$$VTb' = VTa' + a'b' = VTa' + \sqrt{q1^2 + r1^2}$$

$$VTe = VTa' + \sqrt{q1^2 + r1^2}$$

$$ve1 = VTa' + \sqrt{q1^2 + r1^2}$$

$$ve1 = vo1 + a1e2 = VTa' + \sqrt{q1^2 + r1^2}$$

So if I can prove $\dfrac{vo_1}{a_1e2} = \dfrac{VTa'}{\sqrt{q1^2 + r1^2}}$

then $a1e2 = \sqrt{q1^2 + r1^2}$

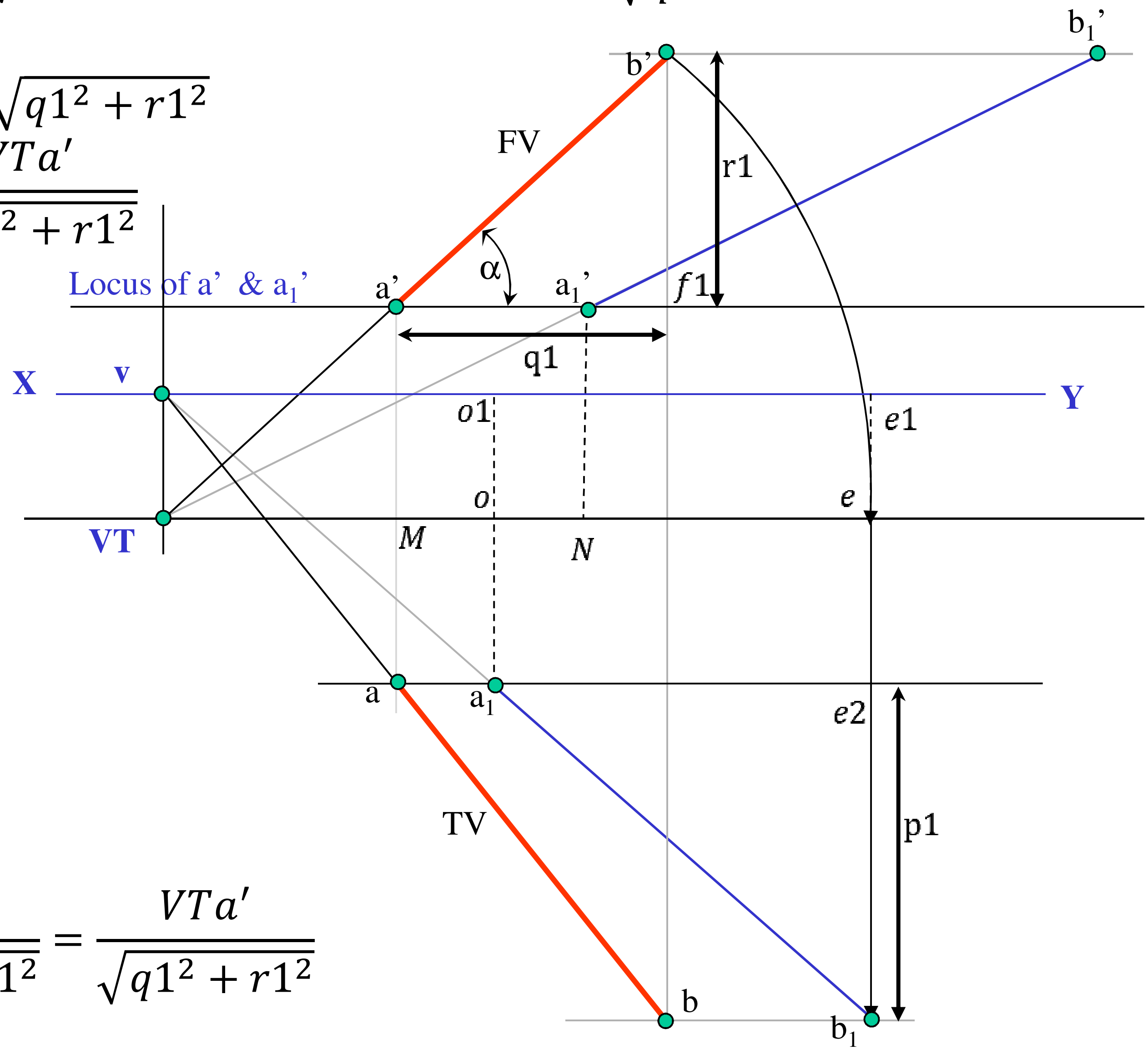
So $a1b1$ will be TL

$$\sin\alpha = \frac{a'M}{VTa'} = \frac{r1}{\sqrt{q1^2 + r1^2}}$$

$$a'M = \frac{(r1)VTa'}{\sqrt{q1^2 + r1^2}}$$

$$a_1'N = a'M = \frac{(r1)VTa'}{\sqrt{q1^2 + r1^2}}$$

$$\frac{VTa_1'}{a_1'b_1'} = \frac{a_1'N}{b'f1} = \frac{(r1)VTa'}{r1\sqrt{q1^2 + r1^2}} = \frac{VTa'}{\sqrt{q1^2 + r1^2}}$$



Traces of a line (Another Method)

$$\frac{VTa_1'}{a_1'b_1'} = \frac{VTa'}{\sqrt{q1^2 + r1^2}}$$

As per the method, $vb_1 = VT\ b_1'$ and $a_1b_1 = a_1'b_1'$

Therefore, $va_1 = VT\ a_1'$

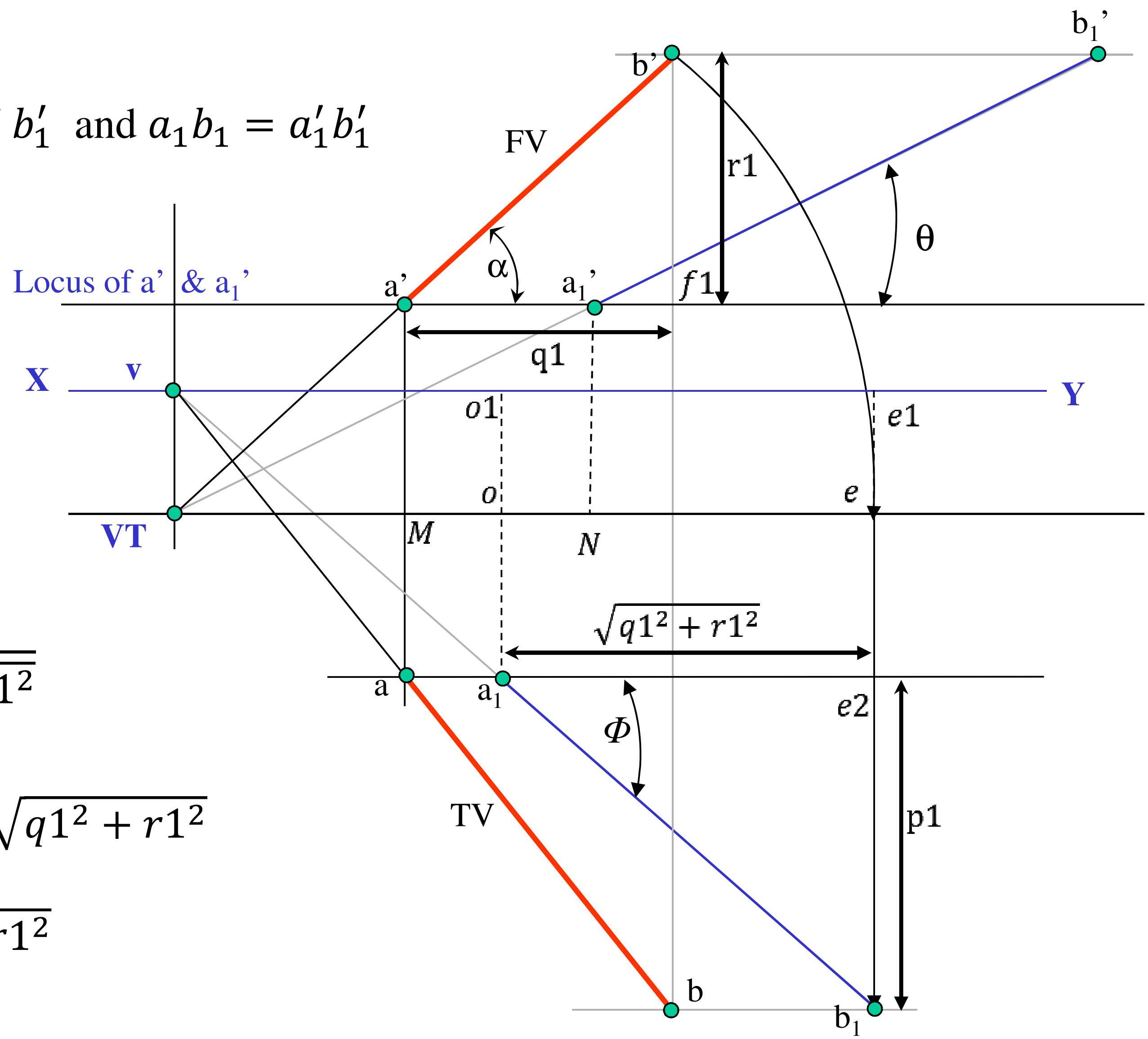
$$\frac{va_1}{a_1b_1} = \frac{VTa_1'}{a_1'b_1'}$$

$$\frac{va_1}{a_1b_1} = \frac{VTa'}{\sqrt{q1^2 + r1^2}}$$

$$\frac{vo_1}{a_1e2} = \frac{va_1}{a_1b_1} = \frac{VTa'}{\sqrt{q1^2 + r1^2}}$$

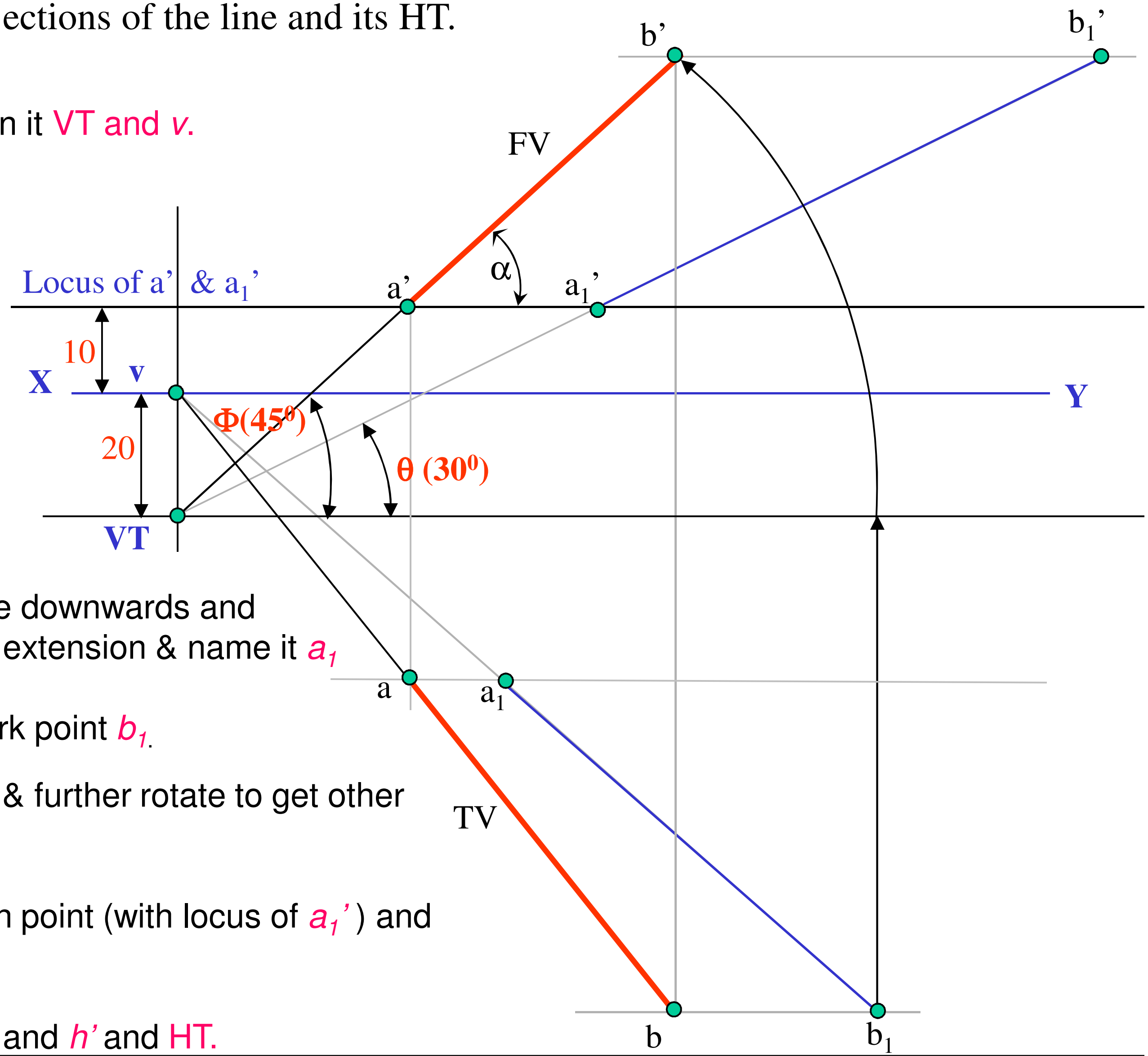
$$ve1 = vo1 + a_1e2 = VTa' + \sqrt{q1^2 + r1^2}$$

Therefore, $a_1e2 = \sqrt{q1^2 + r1^2}$



Traces of a line (Another Method, Example 5)

Line *AB* 100 mm long is 30^0 and 45^0 inclined to *Hp* & *Vp* respectively. End *A* is 10 mm above *Hp* and its VT is 20 mm below Hp. Draw projections of the line and its HT.



SOLUTION STEPS:-

Draw xy, one projector and locate on it VT and *v*.

Draw locus of *a'* 10 mm above xy.

Take 30^0 from VT and draw a line. Where it intersects with locus of *a'* name it a_1'
as it is TL of that part.

From a_1' cut 100 mm (TL) on it and locate point b_1'.

Now from *v* take 45^0 and draw a line downwards and mark on it distance VT- a_1' i.e.TL of extension & name it a_1

Extend this line by 100 mm and mark point b_1.

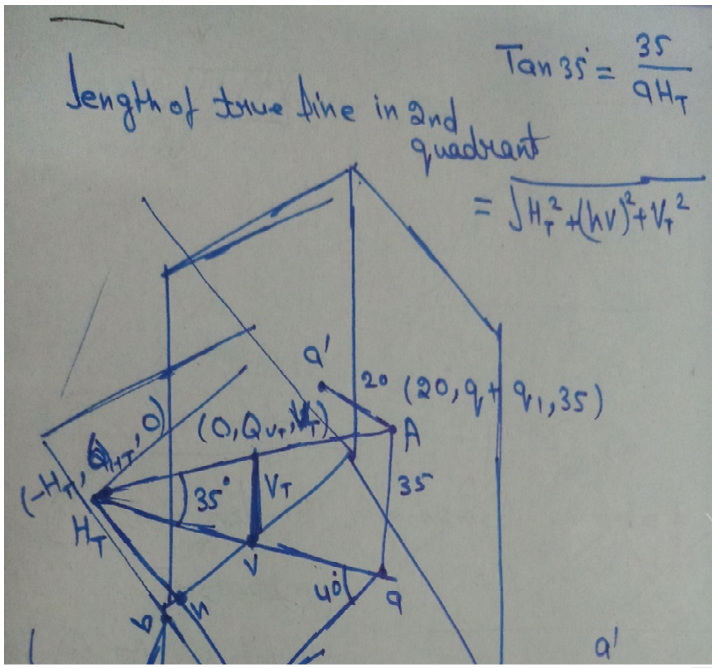
Draw its component on locus of VT & further rotate to get other end of Fv i.e. *b'*.

Join it with VT and mark intersection point (with locus of a_1') and name it *a'*

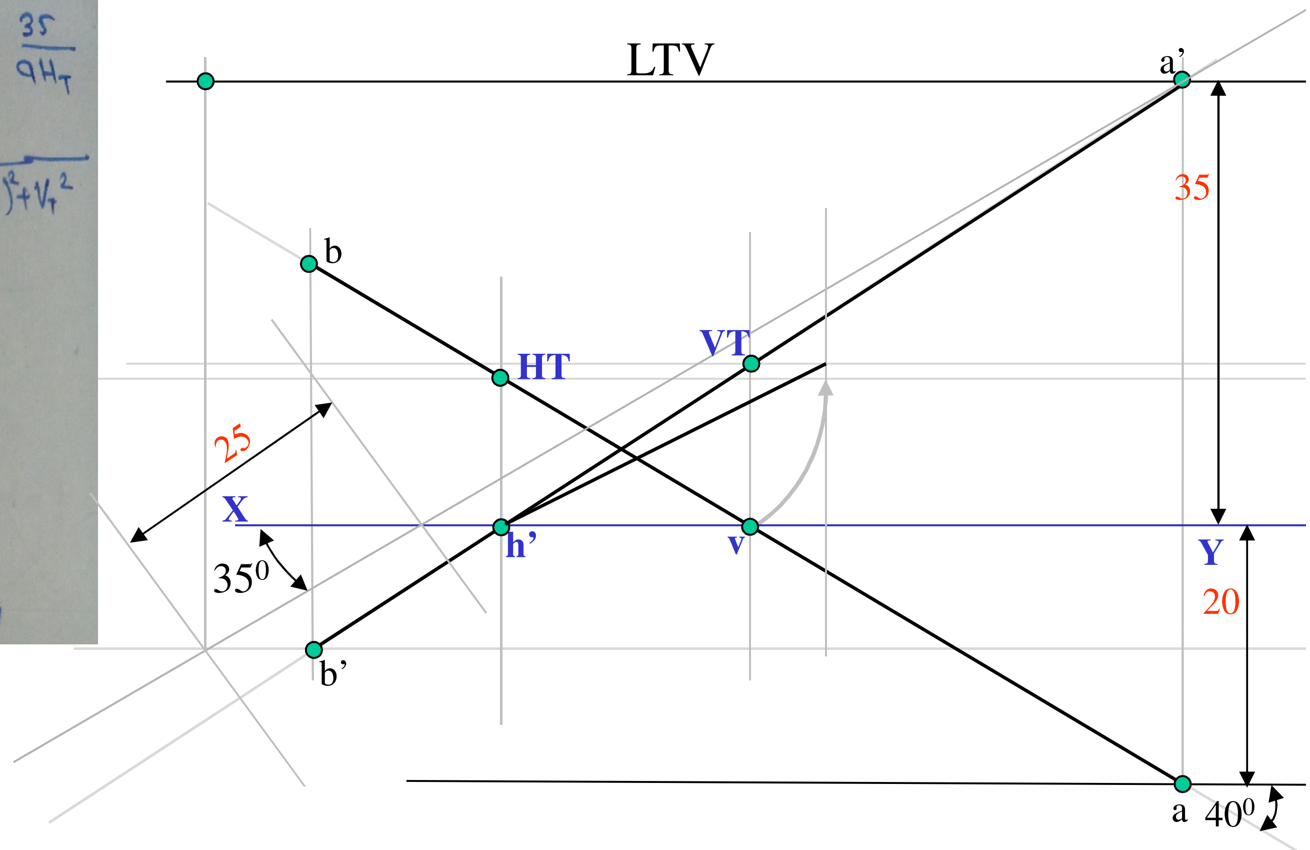
Now as usual locate points *a* and *b* and *h'* and HT.

Exam Question (Earlier Year)

End ‘A’ of a line AB is 35 mm above HP and 20 mm in front of VP. The line makes an angle of 35° with HP. End ‘B’ is in 3rd quadrant. The portion of true length in 3rd quadrant is 25 mm. The top view makes an angle of 40°. Draw the projection of the line, find its true length, angle with VP and locate the traces. Also find the length of the true line in 2nd quadrant.



rough notes



2 ways; find HT first and h’ then b’
Or find b’ first and then HT and h’

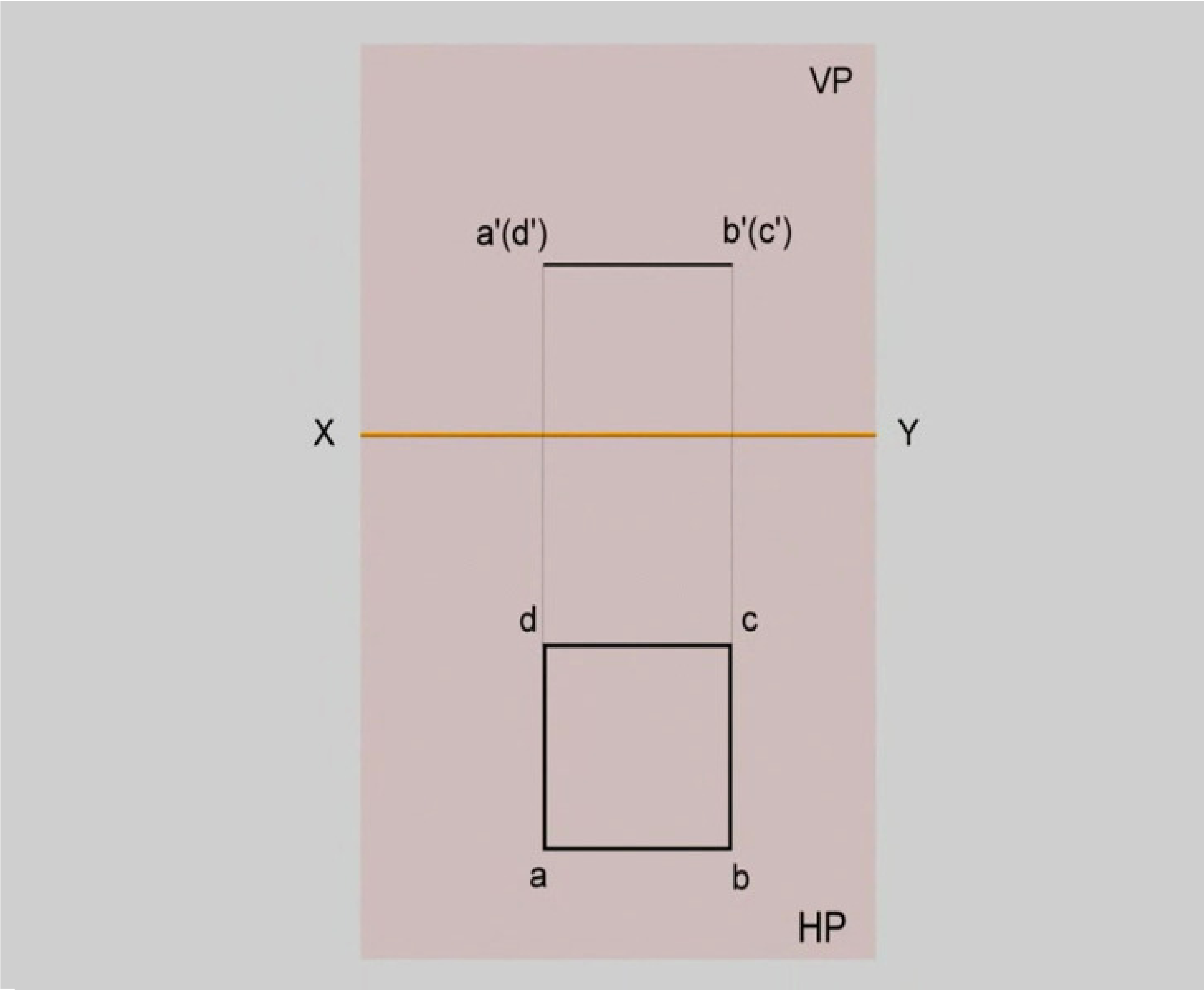
Thank you

Projection of Planes

Dr. Piyush Shakya
Associate Professor
Department of Mechanical Engineering
Indian Institute of Technology Madras, Chennai

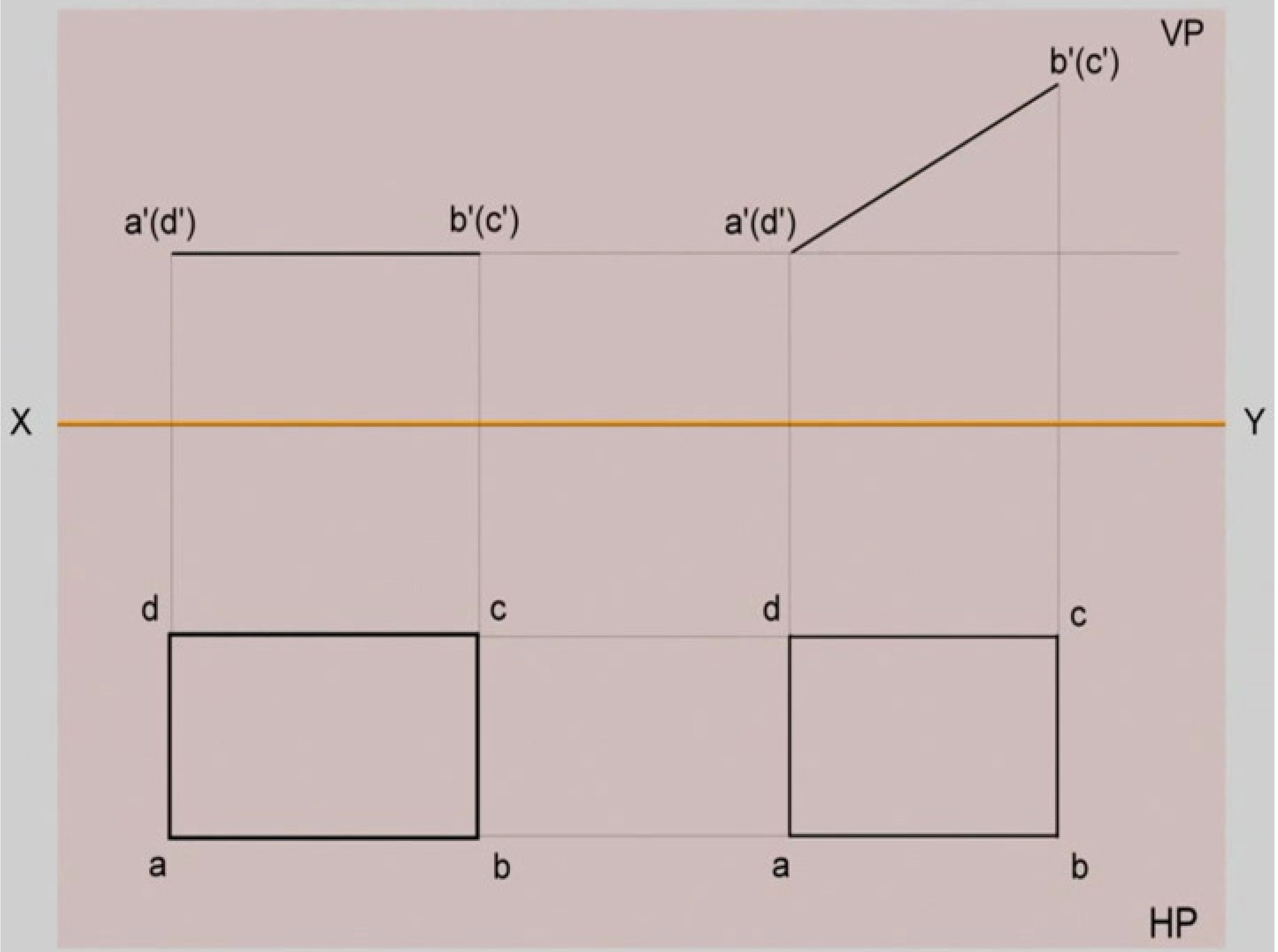
Plane figure ∥ to HP and ⊥ to VP

Demonstrated for Square



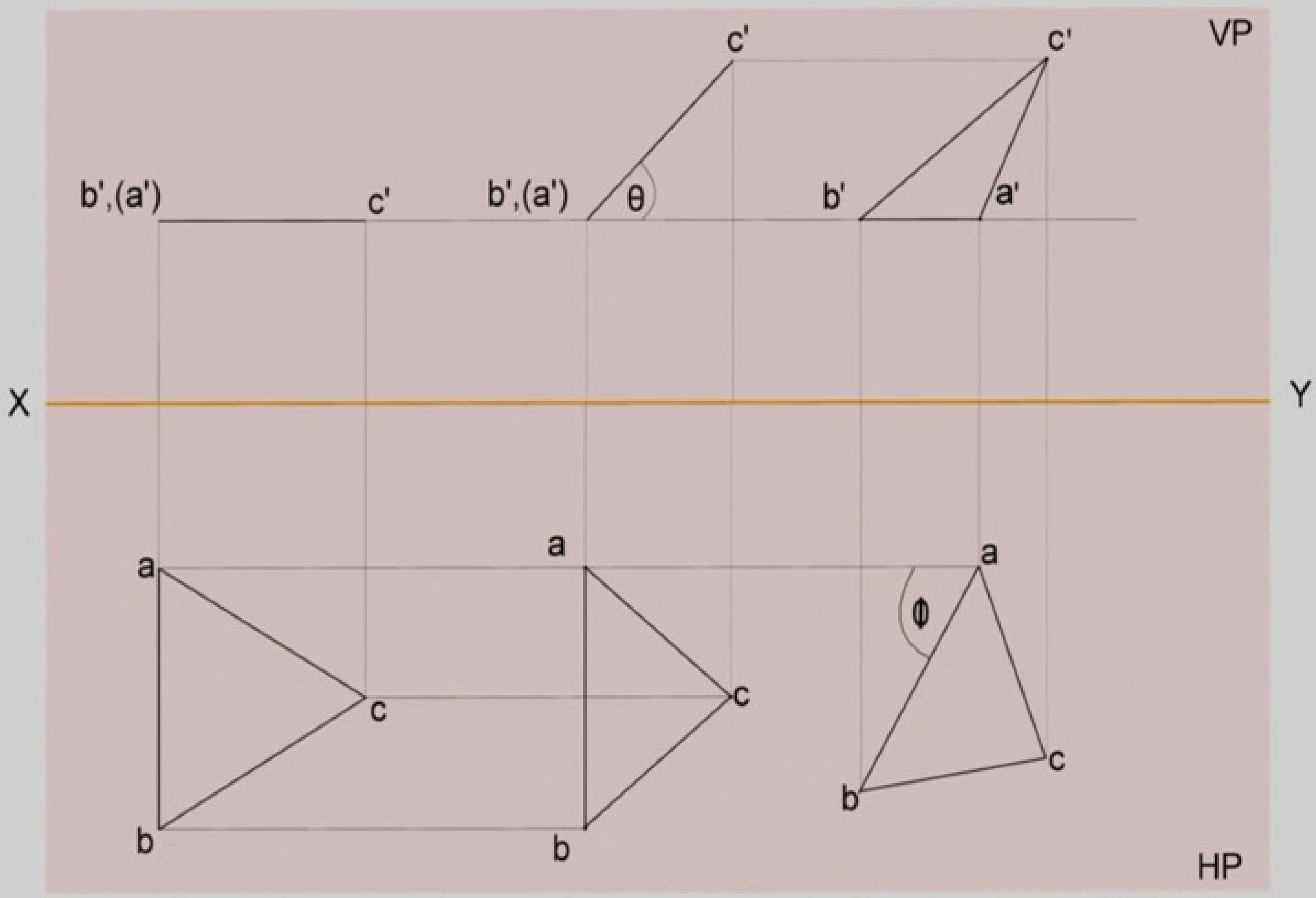
Plane figure at an angle to HP and ⊥ to VP

Demonstrated for Rectangle



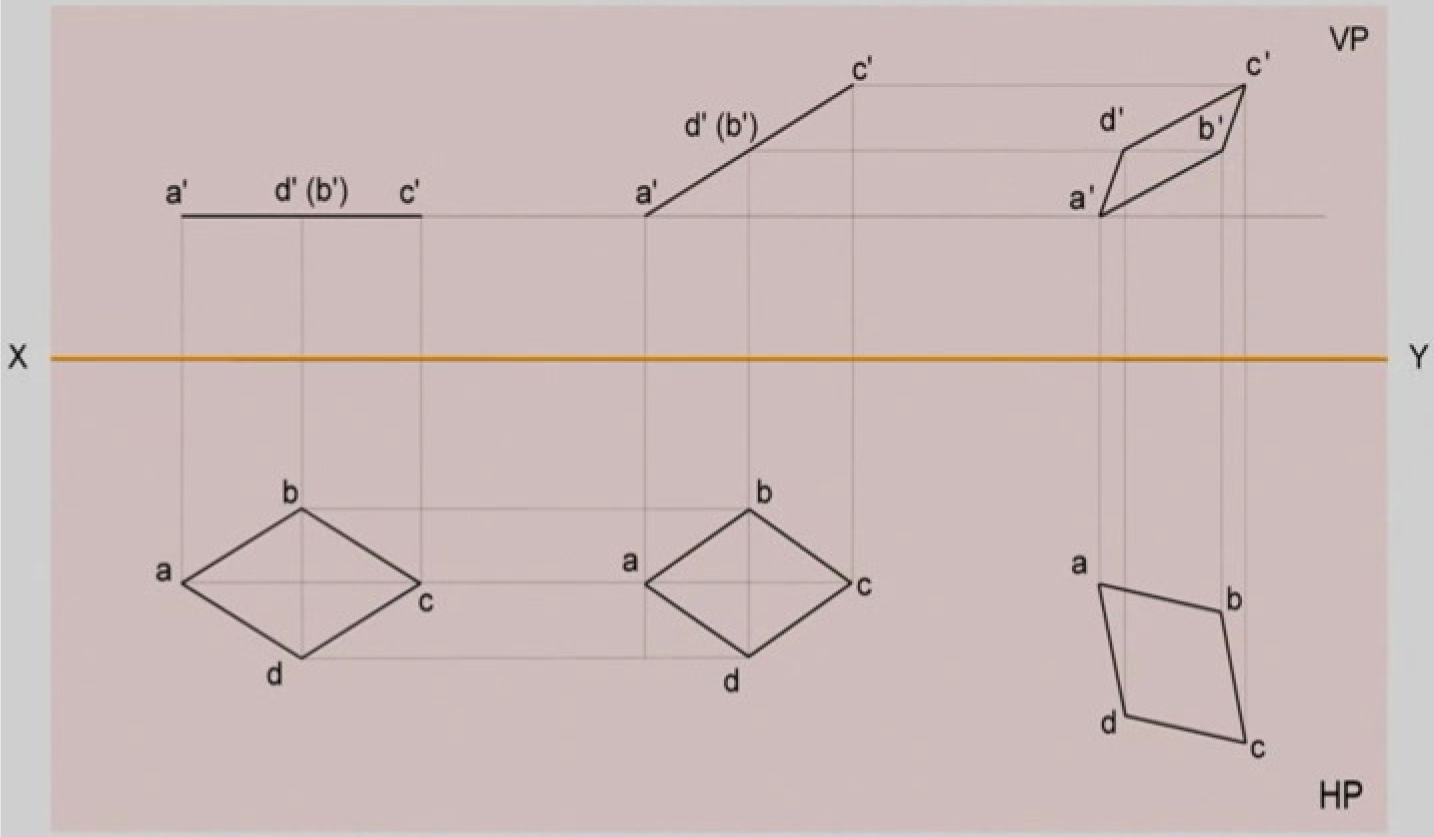
Plane figure at angles to both HP and VP

Demonstrated for Triangle



Plane figure at angles to both HP and VP

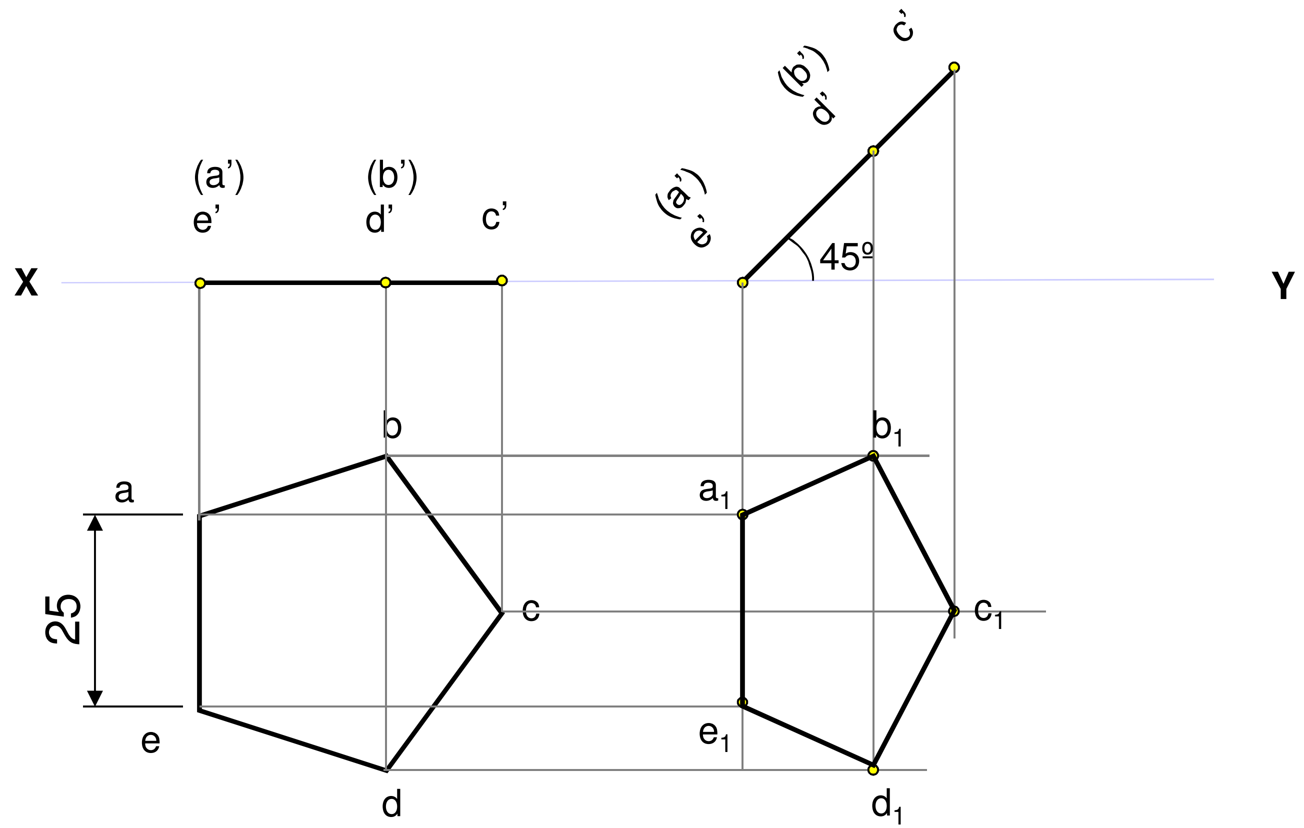
Demonstrated for Rhombus



Example 1

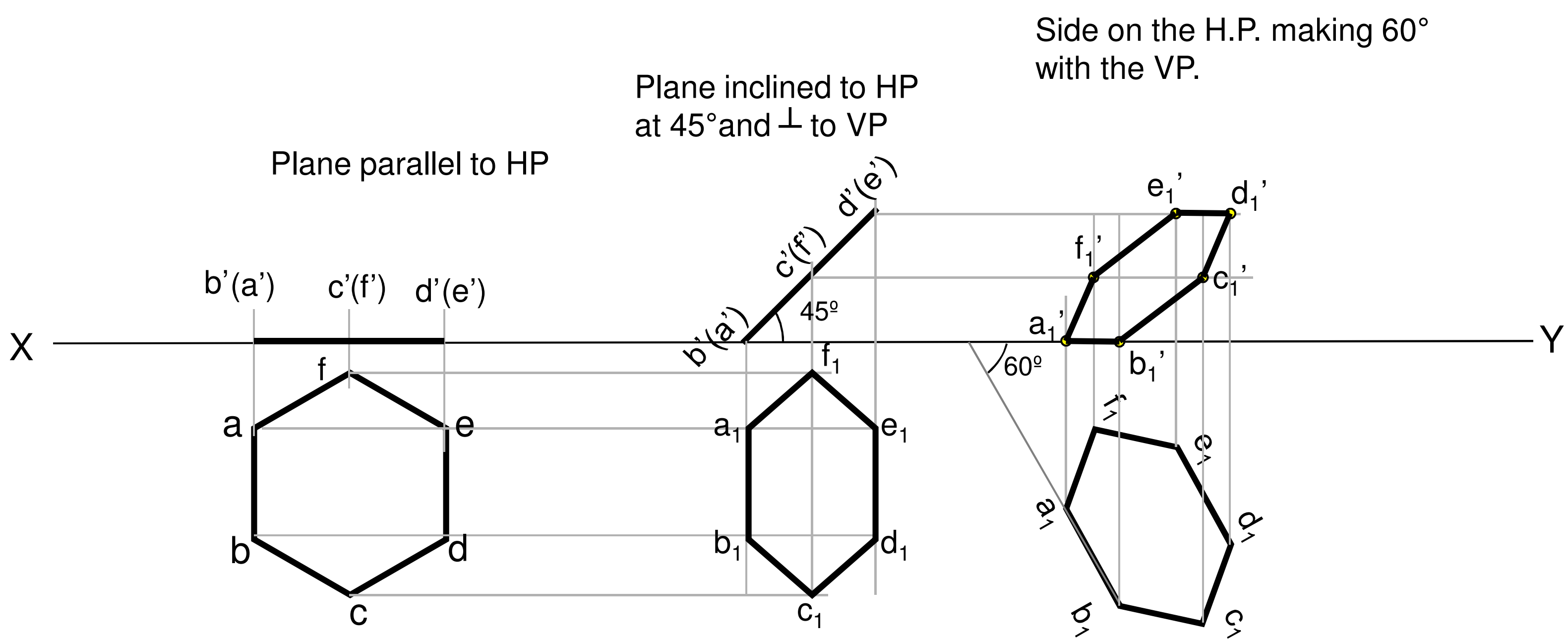
Problem: A *regular* pentagon of 25mm side has one side on the ground. Its plane is inclined at 45º to the HP and perpendicular to the VP. Draw its projections.

Hint: As the plane is inclined to HP, it should be kept parallel to HP with one edge ⊥ to VP



Example 2

Problem: Draw the projections of a regular hexagon of 25mm sides, having one of its side in the H.P. and inclined at 60º to the V.P. and its surface making an angle of 45º with the H.P.



Example 3

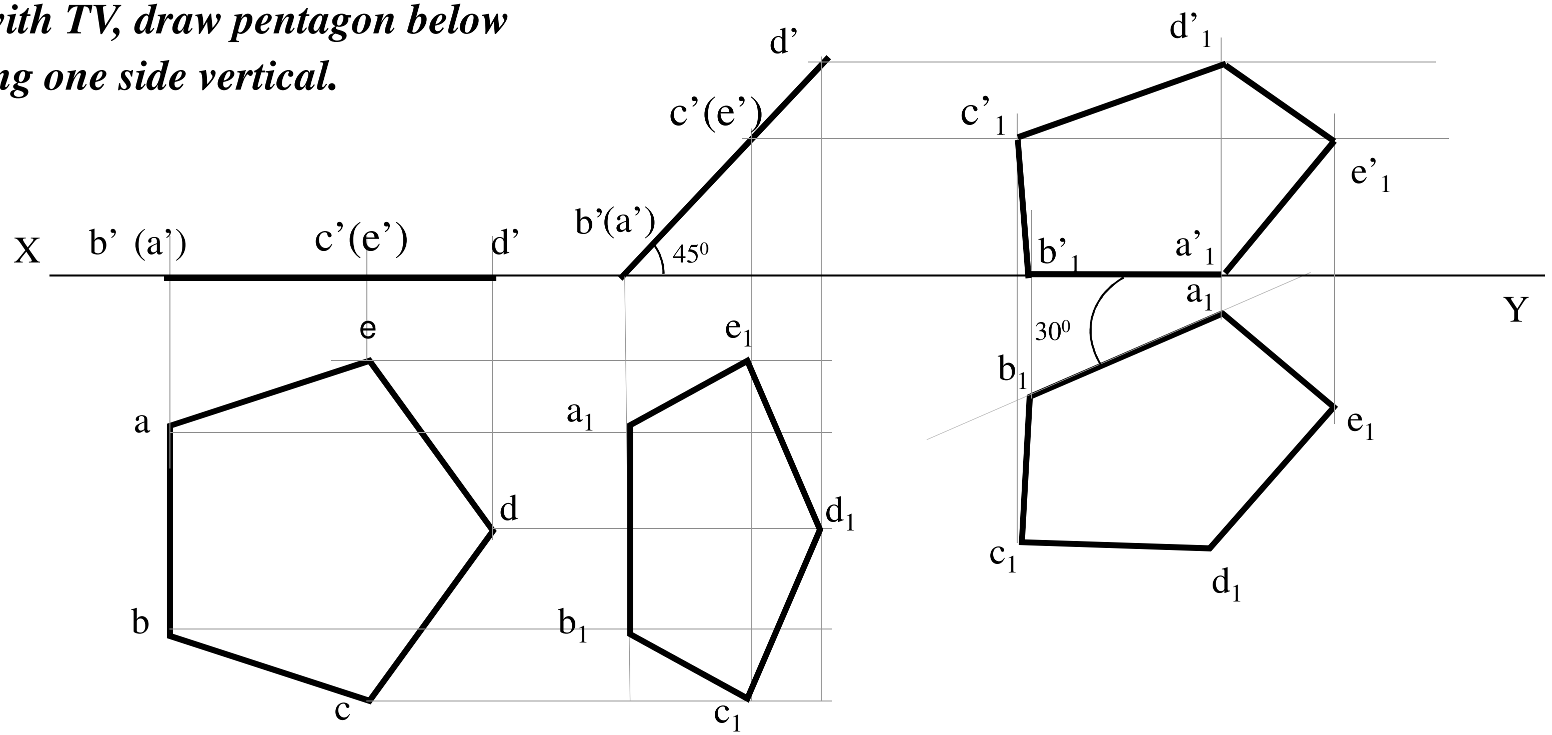
Problem: **A pentagonal plane with a 30 mm side rests on HP on an edge such that the surface is inclined at 45^0 to the HP and the edge on which it rests is inclined at 30^0 to the VP. Draw its projections**

Hint: SURFACE AND SIDE INCLINATIONS ARE DIRECTLY GIVEN.

Read problem and answer following questions

1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which side will be vertical? -------- ***any side.***

Hence begin with TV, draw pentagon below X-Y line, taking one side vertical.

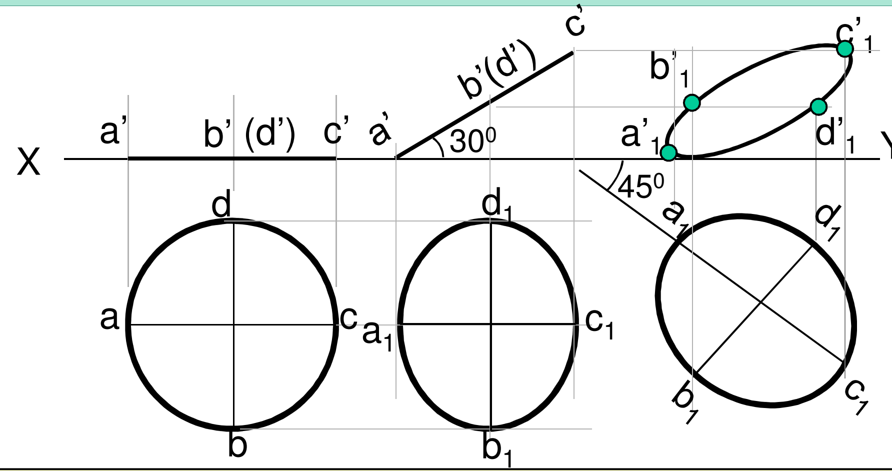


Example 4

Problem: A circle of 50 mm diameter is resting on Hp on end A of its diameter AC which is 30^0 inclined to Hp while its Tv is 45^0 inclined to Vp. Draw its projections.

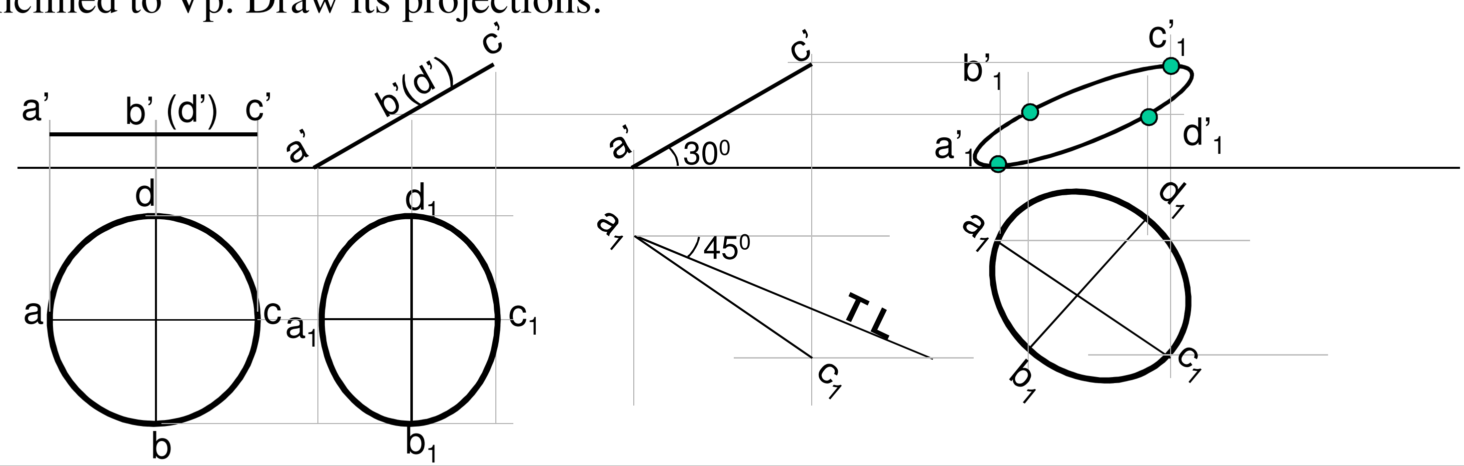
Read problem and answer following questions

1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AC***



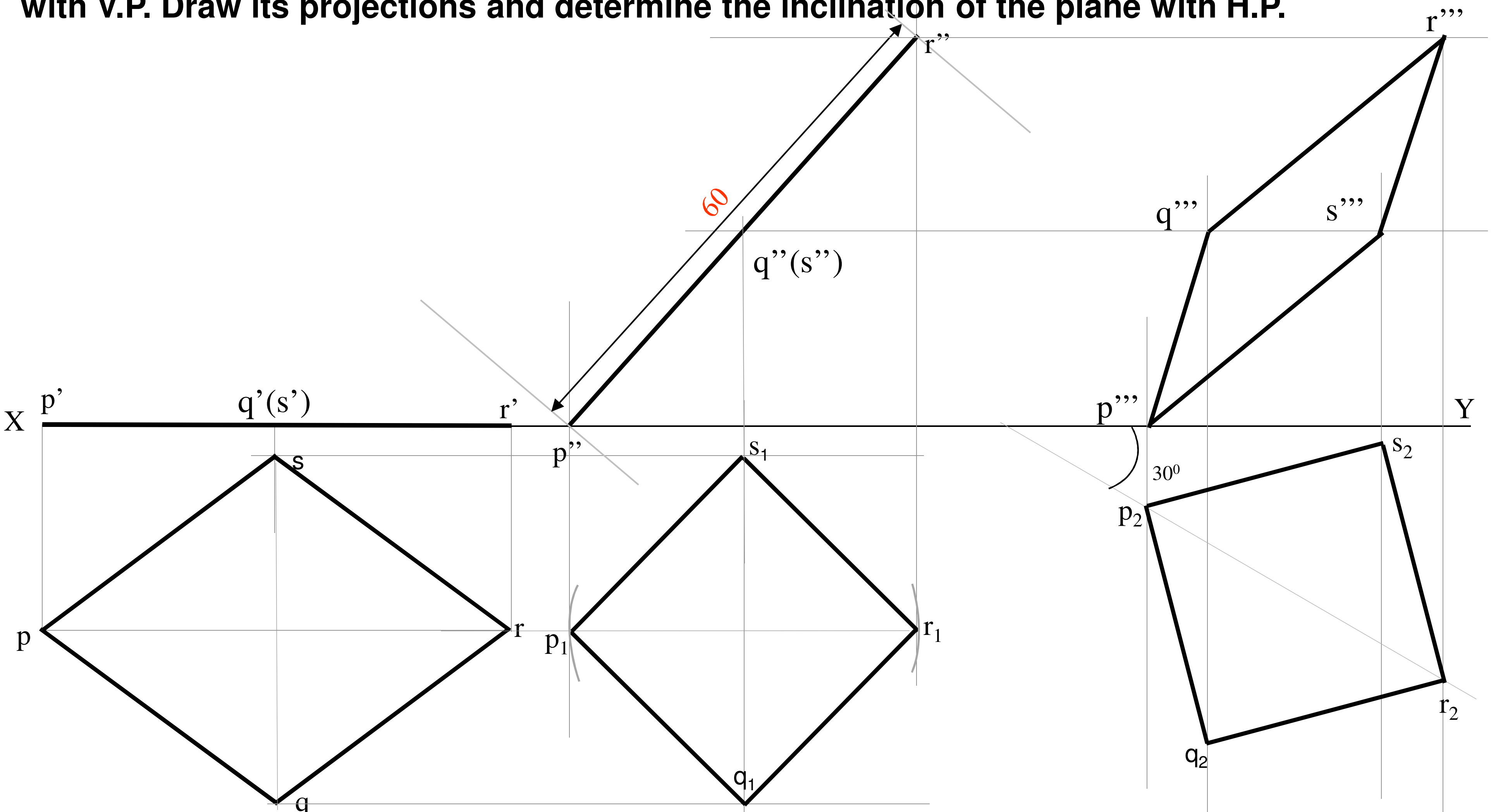
The difference in these two problems is in step 3 only. In the first problem inclination of Tv of that AC is given, It could be drawn directly as shown in 3rd step. ***While in the second problem angle of AC itself (i.e. its TL) is given. Hence here angle of TL is taken, locus of c_1 is drawn and then LTV i.e. a_1 c_1 is marked and final TV was completed. Study illustration carefully.***

Problem: A circle of 50 mm diameter is resting on Hp on end A of its diameter AC which is 30^0 inclined to Hp while it makes 45^0 inclined to Vp. Draw its projections.



Example 5

Problem: ***PQRS*** **is a rhombus having diagonal *PR*=60 mm and *QS* =40 mm and these diagonals are perpendicular to each other. The plane of the rhombus is inclined with H.P. such that its top view appears to be square. The top view of *PR* makes 30° with V.P. Draw its projections and determine the inclination of the plane with H.P.**



Thank you