Engineering Graphics Study Material For Students (First Year)

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Conversion of pictorial views in to orthographic views.

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Projection of Points and Lines

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Projections of Solids:

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Section & Development

Intersection of Surfaces:

1. Essential Information:
2. Display of Engineering Applications:
3. Solution Steps to solve Problem:
4. Case 1: Cylinder to Cylinder:
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Isometric Projections

OBJECTIVE OF THIS CD

Sky is the limit for vision.
Vision and memory are close relatives.
Anything in the jurisdiction of vision can be memorized for a long period.
We may not remember what we hear for a long time,
but we can easily remember and even visualize what we have seen years ago.
So vision helps visualization and both help in memorizing an event or situation.

Video effects are far more effective, is now an established fact.
Every effort has been done in this CD, to bring various planes, objects and situations in-front of observer, so that he/she can further visualize in proper direction and reach to the correct solution, himself.

Off-course this all will assist & give good results only when one will practice all these methods and techniques by drawing on sheets with his/her own hands, other wise not!

So observe each illustration carefully
note proper notes given everywhere
Go through the Tips given & solution steps carefully
Discuss your doubts with your teacher and make practice yourself.
Then success is yours !!

Go ahead confidently! CREATIVE TECHNIQUES wishes you best luck !

SCALES

DIMENSIONS OF LARGE OBJECTS MUST BE REDUCED TO ACCOMMODATE ON STANDARD SIZE DRAWING SHEET.THIS REDUCTION CREATES A SCALE OF THAT REDUCTION RATIO, WHICH IS GENERALLY A FRACTION..

SUCH A SCALE IS CALLED REDUCING SCALE

AND

THAT RATIO IS CALLED REPRESENTATIVE FACTOR.

SIMILARLY IN CASE OF TINY OBJECTS DIMENSIONS MUST BE INCREASED FOR ABOVE PURPOSE. HENCE THIS SCALE IS CALLED ENLARGING SCALE. HERE THE RATIO CALLED REPRESENTATIVE FACTOR IS MORE THAN UNITY.

FOR FULL SIZE SCALE
R.F.=1 OR (1:1)
MEANS DRAWING & OBJECT ARE OF SAME SIZE.
Other RFs are described as
1:10, 1:100,
1:1000, 1:1,00,000

USE FOLLOWING FORMULAS FOR THE CALCULATIONS IN THIS TOPIC.

A REPRESENTATIVE FACTOR (R.F.) $= \dfrac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

$$= \frac{\text{LENGTH OF DRAWING}}{\text{ACTUAL LENGTH}}$$

$$= \sqrt{\frac{\text{AREA OF DRAWING}}{\text{ACTUAL AREA}}}$$

$$= \sqrt[3]{\frac{\text{VOLUME AS PER DRWG.}}{\text{ACTUAL VOLUME}}}$$

B LENGTH OF SCALE = R.F. X MAX. LENGTH TO BE MEASURED.

BE FRIENDLY WITH THESE UNITS.

1 KILOMETRE	= 10 HECTOMETRES
1 HECTOMETRE	= 10 DECAMETRES
1 DECAMETRE	= 10 METRES
1 METRE	= 10 DECIMETRES
1 DECIMETRE	= 10 CENTIMETRES
1 CENTIMETRE	= 10 MILIMETRES

TYPES OF SCALES:

1. PLAIN SCALES (FOR DIMENSIONS UP TO SINGLE DECIMAL)
2. DIAGONAL SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
3. VERNIER SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
4. COMPARATIVE SCALES (FOR COMPARING TWO DIFFERENT UNITS)
5. SCALE OF CORDS (FOR MEASURING/CONSTRUCTING ANGLES)

PLAIN SCALE:-This type of scale represents two units or a unit and it's sub-division.

PROBLEM NO.1:- Draw a scale 1 cm = 1m to read decimeters, to measure maximum distance of 6 m. Show on it a distance of 4 m and 6 dm.

PLAIN SCALE

CONSTRUCTION:-

a) Calculate R.F.= $\frac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

R.F.= 1cm/ 1m = 1/100

Length of scale = R.F. X max. distance

= 1/100 X 600 cm

= 6 cms

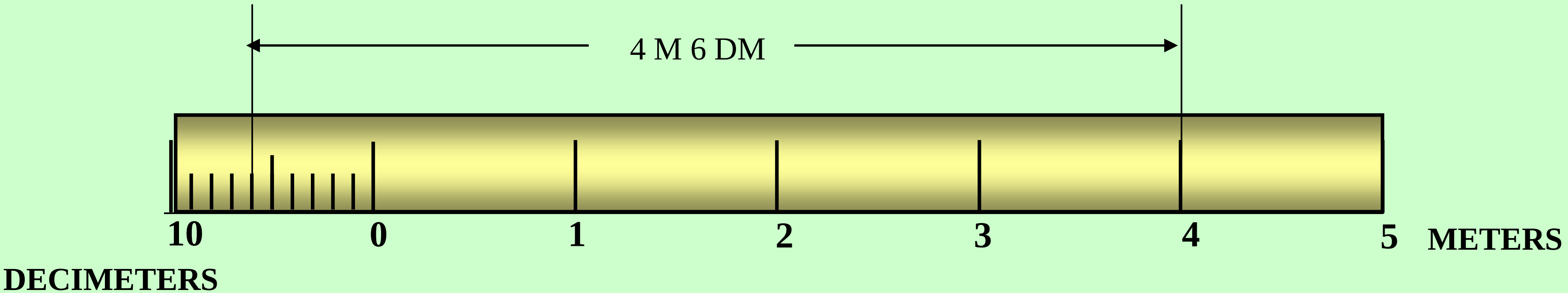
b) Draw a line 6 cm long and divide it in 6 equal parts. Each part will represent larger division unit.

c) Sub divide the first part which will represent second unit or fraction of first unit.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a look of scale.

e) After construction of scale mention it's RF and name of scale as shown.

f) Show the distance 4 m 6 dm on it as shown.



R.F. = 1/100

PLANE SCALE SHOWING METERS AND DECIMETERS.

PROBLEM NO.2:- In a map a 36 km distance is shown by a line 45 cms long. Calculate the R.F. and construct a plain scale to read kilometers and hectometers, for max. 12 km. Show a distance of 8.3 km on it.

PLAIN SCALE

CONSTRUCTION:-

a) Calculate R.F.

R.F.= 45 cm/ 36 km = 45/ 36 . 1000 . 100 = 1/ 80,000

Length of scale = R.F. $\times$ max. distance

= 1/ 80000 $\times$ 12 km

= 15 cm

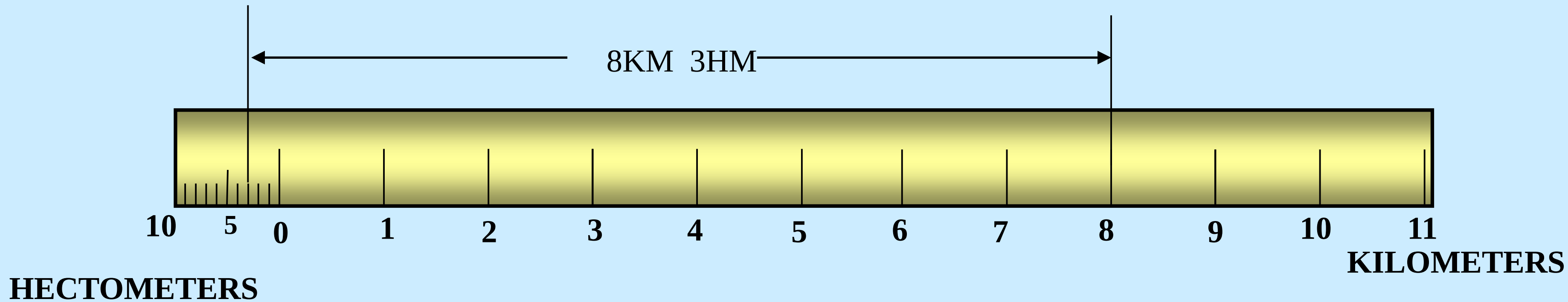
b) Draw a line 15 cm long and divide it in 12 equal parts. Each part will represent larger division unit.

c) Sub divide the first part which will represent second unit or fraction of first unit.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a look of scale.

e) After construction of scale mention it's RF and name of scale as shown.

f) Show the distance 8.3 km on it as shown.



R.F. = 1/80,000

PLANE SCALE SHOWING KILOMETERS AND HECTOMETERS

PROBLEM NO.3:- The distance between two stations is 210 km. A passenger train covers this distance in 7 hours. Construct a plain scale to measure time up to a single minute. RF is 1/200,000 Indicate the distance traveled by train in 29 minutes.

PLAIN SCALE

CONSTRUCTION:-

a) 210 km in 7 hours. Means speed of the train is 30 km per hour (60 minutes)

Length of scale = R.F. $\times$ max. distance per hour
= 1/ 2,00,000 $\times$ 30km
= 15 cm

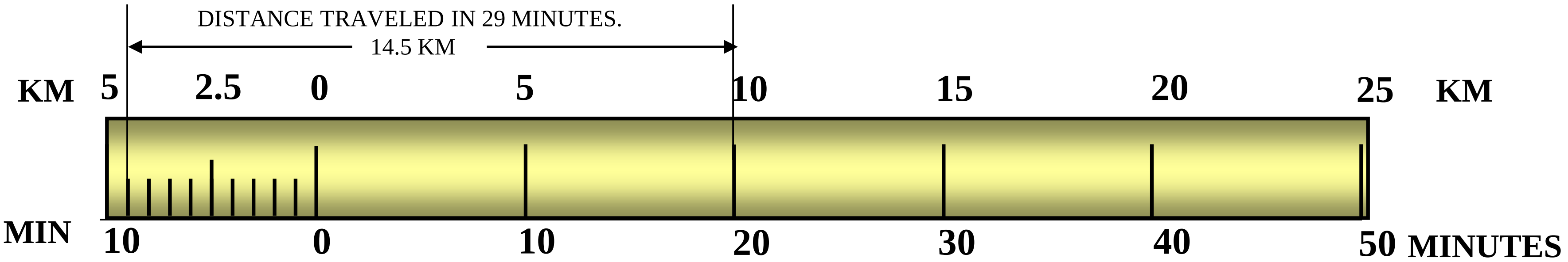
b) 15 cm length will represent 30 km and 1 hour i.e. 60 minutes.
Draw a line 15 cm long and divide it in 6 equal parts. Each part will represent 5 km and 10 minutes.

c) Sub divide the first part in 10 equal parts,which will represent second unit or fraction of first unit.
Each smaller part will represent distance traveled in one minute.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a proper look of scale.

e) Show km on upper side and time in minutes on lower side of the scale as shown.
After construction of scale mention it's RF and name of scale as shown.

f) Show the distance traveled in 29 minutes, which is 14.5 km, on it as shown.



R.F. = 1/100

PLANE SCALE SHOWING METERS AND DECIMETERS.

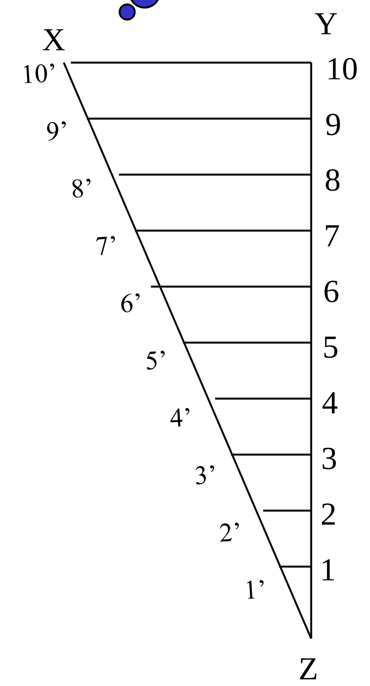
We have seen that the plain scales give only two dimensions, such as a unit and it’s subunit or it’s fraction.

DIAGONAL SCALE

The diagonal scales give us three successive dimensions that is a unit, a subunit and a subdivision of a subunit.

The principle of construction of a diagonal scale is as follows.
Let the XY in figure be a subunit.
From Y draw a perpendicular YZ to a suitable height.
Join XZ. Divide YZ in to 10 equal parts.
Draw parallel lines to XY from all these divisions
and number them as shown.
From geometry we know that similar triangles have
their like sides proportional.

Consider two similar triangles XYZ and 7’ 7Z,
we have 7Z / YZ = 7’7 / XY (each part being one unit)
Means 7’ 7 = 7 / 10. x X Y = 0.7 XY
:.
Similarly
1’ – 1 = 0.1 XY
2’ – 2 = 0.2 XY
Thus, it is very clear that, the sides of small triangles,
which are parallel to divided lines, become progressively
shorter in length by 0.1 XY.



The solved examples ON NEXT PAGES will make the principles of diagonal scales clear.

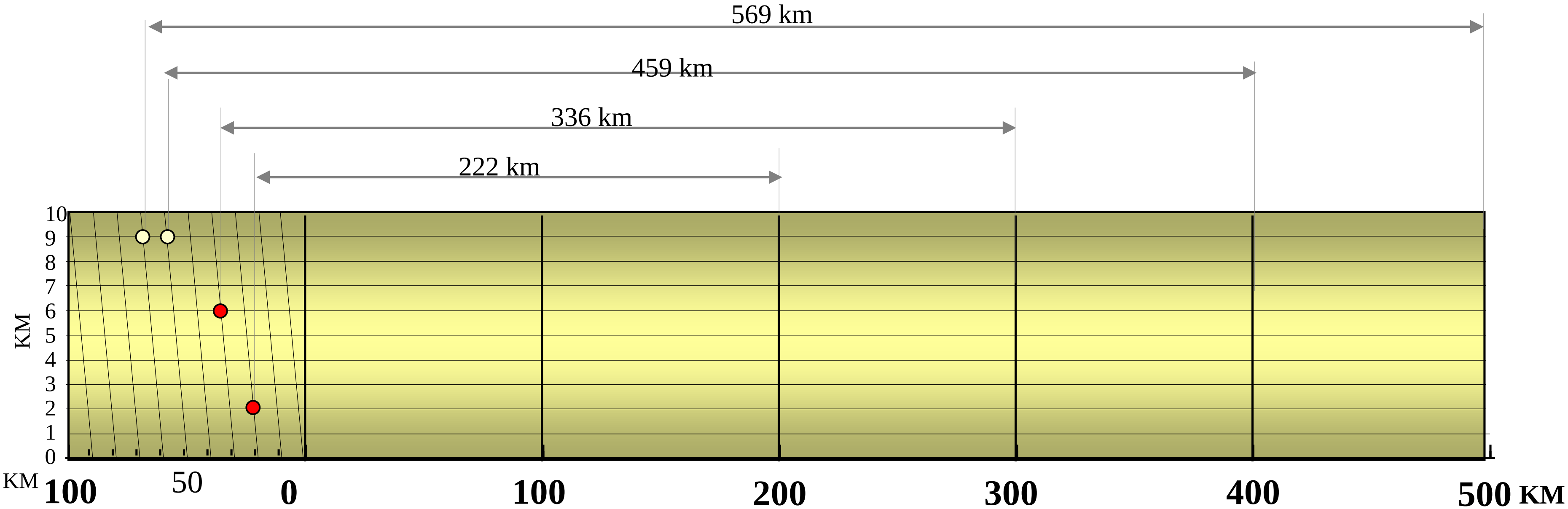
PROBLEM NO. 4 : The distance between Delhi and Agra is 200 km.
In a railway map it is represented by a line 5 cm long. Find it's R.F.
Draw a diagonal scale to show single km. And maximum 600 km.
Indicate on it following distances. 1) 222 km 2) 336 km 3) 459 km 4) 569 km

DIAGONAL SCALE

SOLUTION STEPS: RF = 5 cm / 200 km = 1 / 40, 00, 000

Length of scale = 1 / 40, 00, 000 X 600 X 10^5 = 15 cm

Draw a line 15 cm long. It will represent 600 km.Divide it in six equal parts.(each will represent 100 km.) **Divide** first division in ten equal parts.Each will represent 10 km.**Draw** a line upward from left end and mark 10 parts on it of any distance. **Name** those parts 0 to 10 as shown.Join 9th sub-division of horizontal scale with 10th division of the vertical divisions. **Then** draw parallel lines to this line from remaining sub divisions and complete diagonal scale.



R.F. = 1 / 40,00,000

DIAGONAL SCALE SHOWING KILOMETERS.

PROBLEM NO.5: A rectangular plot of land measuring 1.28 hectors is represented on a map by a similar rectangle of 8 sq. cm. Calculate RF of the scale. Draw a diagonal scale to read single meter. Show a distance of 438 m on it.

DIAGONAL SCALE

SOLUTION :

1 hector = 10, 000 sq. meters

1.28 hectors = 1.28 X 10, 000 sq. meters

$= 1.28 \times 10^4 \times 10^4$ sq. cm

8 sq. cm area on map represents

$= 1.28 \times 10^4 \times 10^4$ sq. cm on land

1 cm sq. on map represents

$= 1.28 \times 10^4 \times 10^4 / 8$ sq cm on land

1 cm on map represent

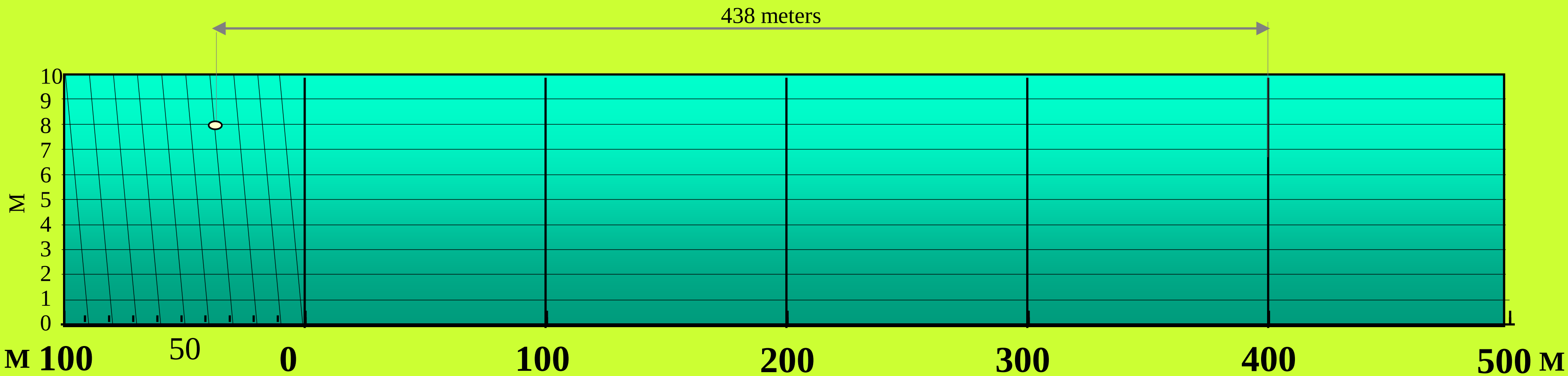
$$= \sqrt{1.28 \times 10^4 \times 10^4 / 8} \text{ cm}$$

= 4, 000 cm

1 cm on drawing represent 4, 000 cm, Means RF = 1 / 4000

Assuming length of scale 15 cm, it will represent 600 m.

Draw a line 15 cm long.
It will represent 600 m.Divide it in six equal parts.
(each will represent 100 m.)
Divide first division in ten equal parts.Each will represent 10 m.
Draw a line upward from left end and mark 10 parts on it of any distance.
Name those parts 0 to 10 as shown.Join 9th sub-division of horizontal scale with 10th division of the vertical divisions.
Then draw parallel lines to this line from remaining sub divisions and complete diagonal scale.



R.F. = 1 / 4000

DIAGONAL SCALE SHOWING METERS.

PROBLEM NO.6:. Draw a diagonal scale of R.F. 1: 2.5, showing centimeters and millimeters and long enough to measure up to 20 centimeters.

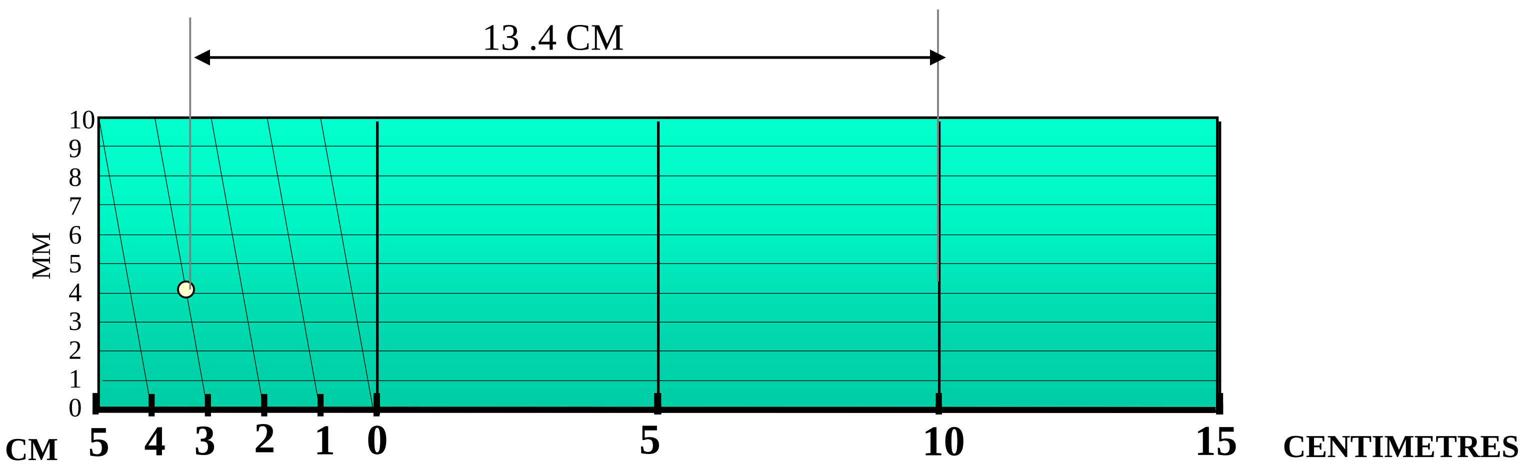
SOLUTION STEPS:

R.F. = 1 / 2.5

Length of scale = 1 / 2.5 X 20 cm.

= 8 cm.

1. Draw a line 8 cm long and divide it in to 4 equal parts.
   (Each part will represent a length of 5 cm.)
2. Divide the first part into 5 equal divisions.
   (Each will show 1 cm.)
3. At the left hand end of the line, draw a vertical line and on it step-off 10 equal divisions of any length.
4. Complete the scale as explained in previous problems.
   Show the distance 13.4 cm on it.



R.F. = 1 / 2.5

DIAGONAL SCALE SHOWING CENTIMETERS.

COMPARATIVE SCALES:

These are the Scales having same R.F. but graduated to read different units.

These scales may be Plain scales or Diagonal scales and may be constructed separately or one above the other.

EXAMPLE NO. 7 :

A distance of 40 miles is represented by a line 8 cm long. Construct a plain scale to read 80 miles. Also construct a comparative scale to read kilometers upto 120 km (1 m = 1.609 km)

SOLUTION STEPS:

***Scale of Miles*:**

40 miles are represented = 8 cm

: 80 miles = 16 cm

R.F. = 8 / 40 X 1609 X 1000 X 100

= 1 / 8, 04, 500

CONSTRUCTION:

Take a line 16 cm long and divide it into 8 parts. Each will represent 10 miles. Subdivide the first part and each sub-division will measure single mile.

***Scale of Km*:**

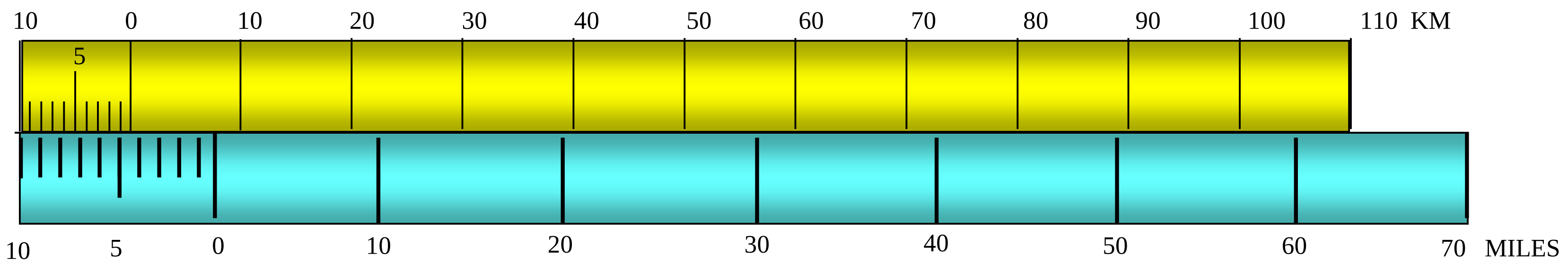
Length of scale

= 1 / 8,04,500 X 120 X 1000 X 100

= 14. 90 cm

***CONSTRUCTION*:**

On the top line of the scale of miles cut off a distance of 14.90 cm and divide it into 12 equal parts. Each part will represent 10 km. Subdivide the first part into 10 equal parts. Each subdivision will show single km.



R.F. = 1 / 804500

COMPARATIVE SCALE SHOWING MILES AND KILOMETERS

COMPARATIVE SCALE:

EXAMPLE NO. 8 :

A motor car is running at a speed of 60 kph.
On a scale of RF = 1 / 4,00,000 show the distance traveled by car in 47 minutes.

SOLUTION STEPS:

Scale of km.

length of scale = RF X 60 km

= 1 / 4,00,000 X 60 X 10^5

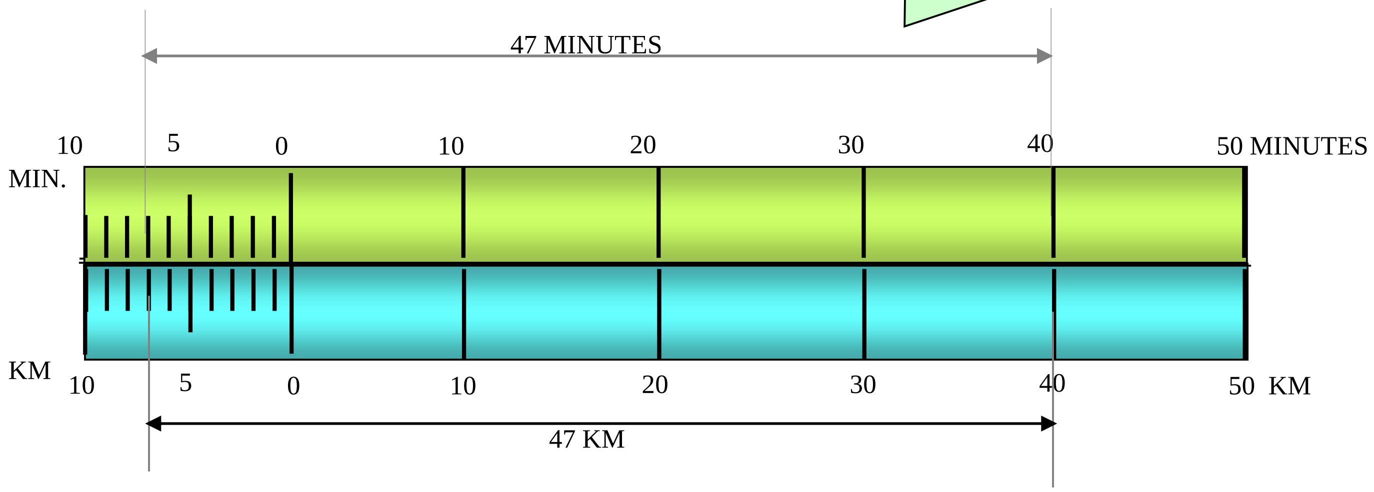
= 15 cm.

CONSTRUCTION:

Draw a line 15 cm long and divide it in 6 equal parts.
(each part will represent 10 km.)
Subdivide 1^{st} part in `0 equal subdivisions.
(each will represent 1 km.)

Time Scale:

Same 15 cm line will represent 60 minutes.
Construct the scale similar to distance scale.
It will show minimum 1 minute & max. 60min.



R.F. = 1 / 4,00,000

COMPARATIVE SCALE SHOWING MINUTES AND KILOMETERS

EXAMPLE NO. 9 :

A car is traveling at a speed of 60 km per hour. A 4 cm long line represents the distance traveled by the car in two hours. Construct a suitable comparative scale up to 10 hours. The scale should be able to read the distance traveled in one minute. Show the time required to cover 476 km and also distance in 4 hours and 24 minutes.

COMPARATIVE SCALE:

SOLUTION:

4 cm line represents distance in two hours , means for 10 hours scale, 20 cm long line is required, as length of scale.This length of scale will also represent 600 kms. (as it is a distance traveled in 10 hours)

CONSTRUCTION:

Distance Scale (km)

Draw a line 20 cm long. Divide it in TEN equal parts.(Each will show 60 km)

Sub-divide 1st part in SIX subdivisions.(Each will represent 10 km)

At the left hand end of the line, draw a vertical line and on it step-off 10 equal divisions of any length.

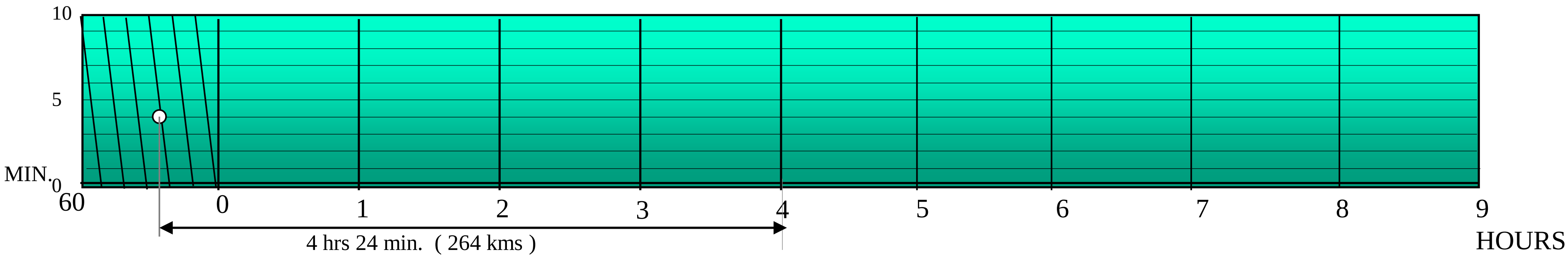
And complete the diagonal scale to read minimum ONE km.

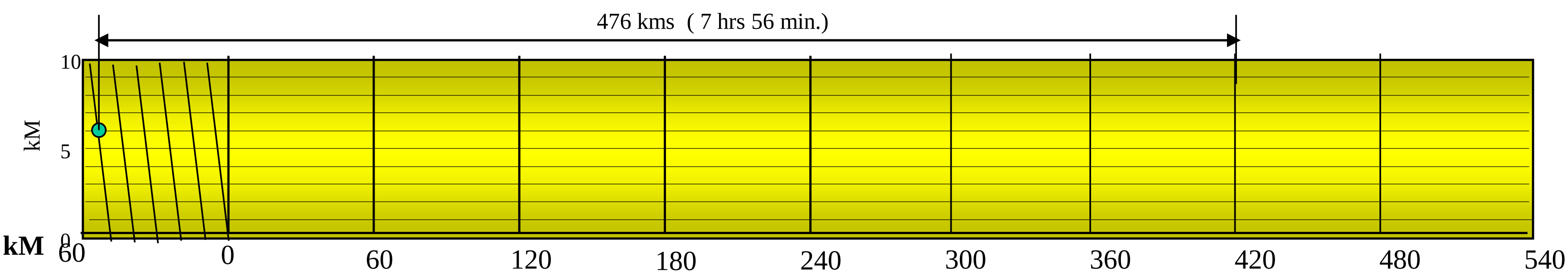
Time scale:

Draw a line 20 cm long. Divide it in TEN equal parts.(Each will show 1 hour) Sub-divide 1st part in SIX subdivisions.(Each will represent 10 minutes) At the left hand end of the line, draw a vertical line and on it step-off 10 equal divisions of any length.

And complete the diagonal scale to read minimum ONE minute.

TIME SCALE TO MEASURE MIN 1 MINUTE.





DISTANCE SCALE TO MEASURE MIN 1 KM

KILOMETERS

Vernier Scales:

These scales, like diagonal scales , are used to read to a very small unit with great accuracy.
It consists of two parts – a primary scale and a vernier. The primary scale is a plain scale fully divided into minor divisions.
As it would be difficult to sub-divide the minor divisions in ordinary way, it is done with the help of the vernier.
The graduations on vernier are derived from those on the primary scale.

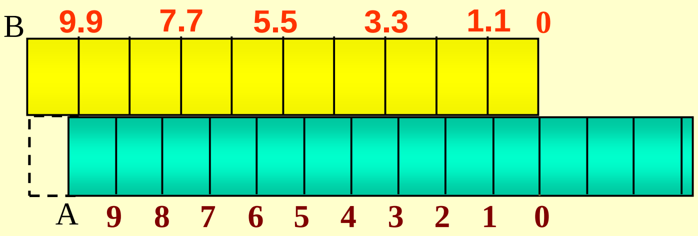


Figure to the right shows a part of a plain scale in which length A-O represents 10 cm. If we divide A-O into ten equal parts, each will be of 1 cm. Now it would not be easy to divide each of these parts into ten equal divisions to get measurements in millimeters.

Now if we take a length BO equal to 10 + 1 = 11 such equal parts, thus representing 11 cm, and divide it into ten equal divisions, each of these divisions will represent 11 / 10 – 1.1 cm.

The difference between one part of AO and one division of BO will be equal 1.1 – 1.0 = 0.1 cm or 1 mm.
This difference is called Least Count of the scale.
Minimum this distance can be measured by this scale.
The upper scale BO is the vernier.The combination of plain scale and the vernier is vernier scale.

Example 10:

Draw a vernier scale of RF = 1 / 25 to read centimeters upto 4 meters and on it, show lengths 2.39 m and 0.91 m

Vernier Scale

SOLUTION:

Length of scale = RF X max. Distance

= 1 / 25 X 4 X 100

= 16 cm

CONSTRUCTION: ***(Main scale)***

Draw a line 16 cm long.

Divide it in 4 equal parts.

(each will represent meter)

Sub-divide each part in 10 equal parts.

(each will represent decimeter)

Name those properly.

CONSTRUCTION: ***(vernier)***

Take 11 parts of Dm length and divide it in 10 equal parts.

Each will show 0.11 m or 1.1 dm or 11 cm and construct a rectangle

Covering these parts of vernier.

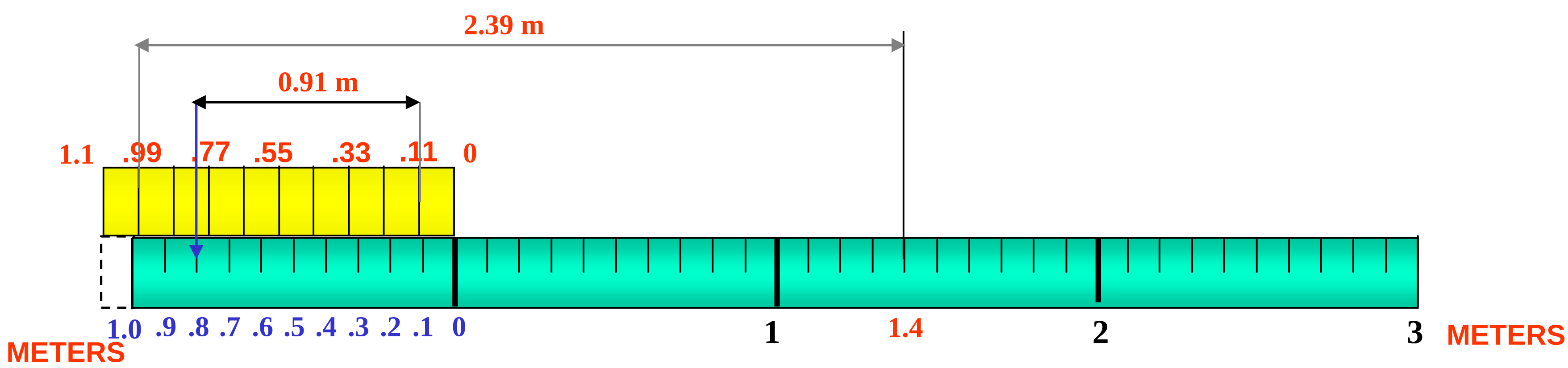
TO MEASURE GIVEN LENGTHS:

(1) For 2.39 m : Subtract 0.99 from 2.39 i.e. 2.39 - .99 = 1.4 m

The distance between 0.99 (left of Zero) and 1.4 (right of Zero) is 2.39 m

(2) For 0.91 m : Subtract 0.11 from 0.91 i.e. 0.91 – 0.11 =0.80 m

The distance between 0.11 and 0.80 (both left side of Zero) is 0.91 m



Example 11: A map of size 500cm X 50cm wide represents an area of 6250 sq.Kms. Construct a vernier scaleto measure kilometers, hectometers and decameters and long enough to measure upto 7 km. Indicate on it a) 5.33 km b) 59 decameters.

Vernier Scale

SOLUTION:

$$RF = \sqrt{\frac{\textbf{AREA OF DRAWING}}{\textbf{ACTUAL AREA}}}$$

$$= \sqrt{\frac{\textbf{500 X 50 cm sq.}}{\textbf{6250 km sq.}}}$$

$$= 2 / 10^5$$

Length of scale = RF X max. Distance

$= 2 / 10^5$ X 7 kms

= 14 cm

CONSTRUCTION: ***(Main scale)***

Draw a line 14 cm long.
Divide it in 7 equal parts.
(each will represent km)
Sub-divide each part in 10 equal parts.
(each will represent hectometer)
Name those properly.

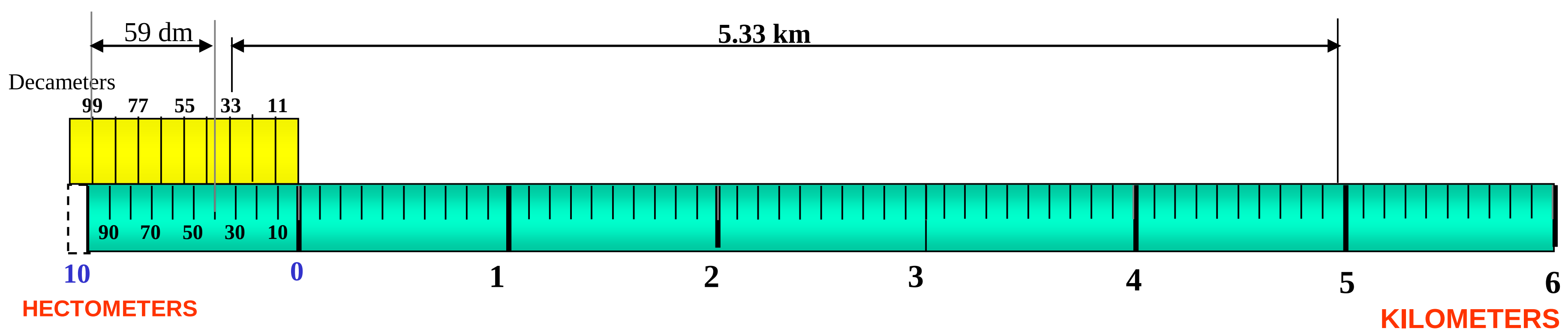
CONSTRUCTION: ***(vernier)***

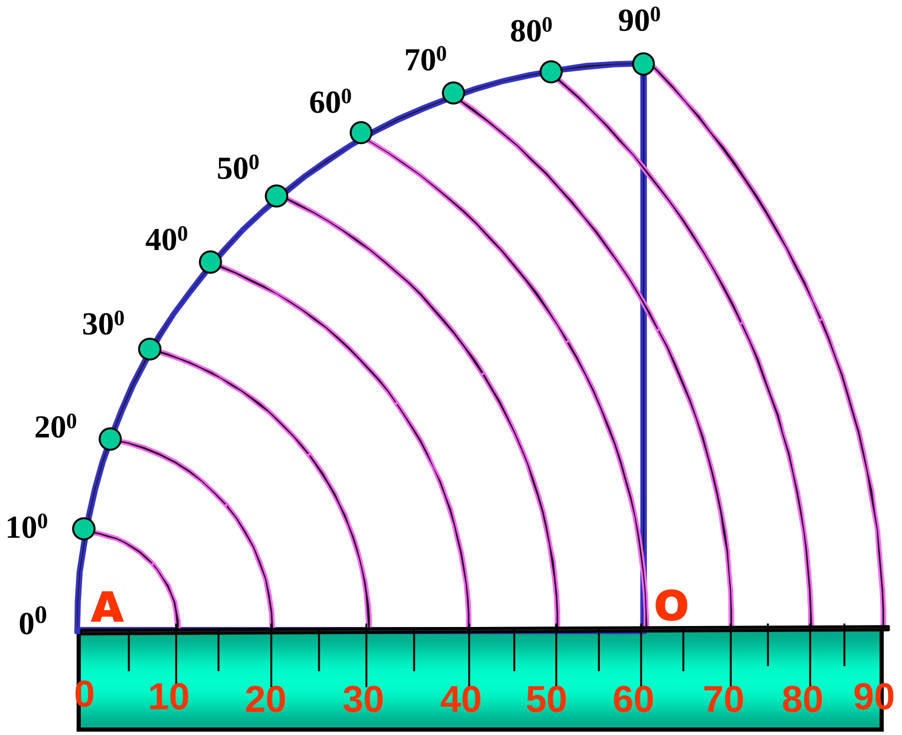
Take 11 parts of hectometer part length and divide it in 10 equal parts.
Each will show 1.1 hm m or 11 dm and
Covering in a rectangle complete scale.

TO MEASURE GIVEN LENGTHS:

a) For 5.33 km :
Subtract 0.33 from 5.33
i.e. 5.33 - 0.33 = 5.00
The distance between 33 dm
(left of Zero) and
5.00 (right of Zero) is 5.33 k m

(b) For 59 dm :
Subtract 0.99 from 0.59
i.e. 0.59 – 0.99 = - 0.4 km
(- ve sign means left of Zero)
The distance between 99 dm and
- .4 km is 59 dm
(both left side of Zero)





SCALE OF CORDS

CONSTRUCTION:

1. DRAW SECTOR OF A CIRCLE OF 90^0 WITH 'OA' RADIUS.
   ('OA' ANY CONVINIENT DISTANCE)
2. DIVIDE THIS ANGLE IN NINE EQUAL PARTS OF 10^0 EACH.
3. NAME AS SHOWN FROM END 'A' UPWARDS.
4. FROM 'A' AS CENTER, WITH CORDS OF EACH ANGLE AS RADIUS DRAW ARCS DOWNWARDS UP TO 'AO' LINE OR IT'S EXTENSION AND FORM A SCALE WITH PROPER LABELING AS SHOWN.

AS CORD LENGTHS ARE USED TO MEASURE & CONSTRUCT DIFERENT ANGLES IT IS CALLED SCALE OF CORDS.

PROBLEM 12: Construct any triangle and measure it’s angles by using scale of cords.

CONSTRUCTION:

First prepare Scale of Cords for the problem.

Then construct a triangle of given sides. (You are supposed to measure angles x, y and z)

To measure angle at x:

Take O-A distance in compass from cords scale and mark it on lower side of triangle as shown from corner **x. Name** O & A as shown. **Then** O as center, O-A radius draw an arc upto upper adjacent side.**Name** the point B.

Take A-B cord in compass and place on scale of cords from Zero. It will give value of angle at x

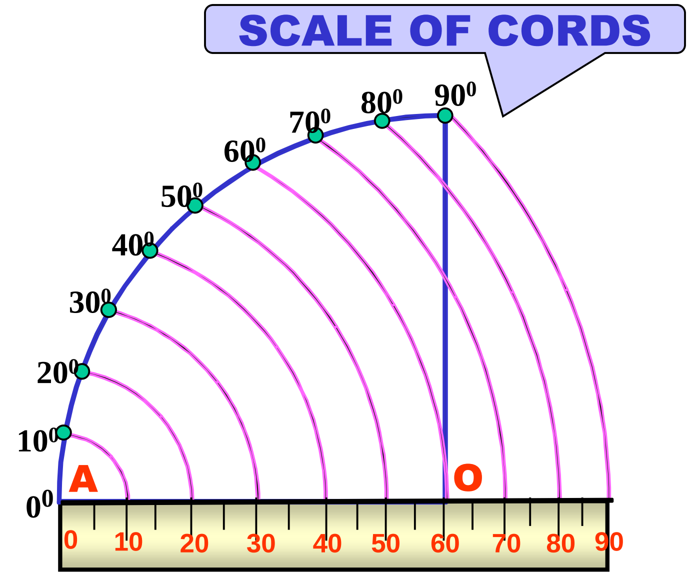
To measure angle at y:

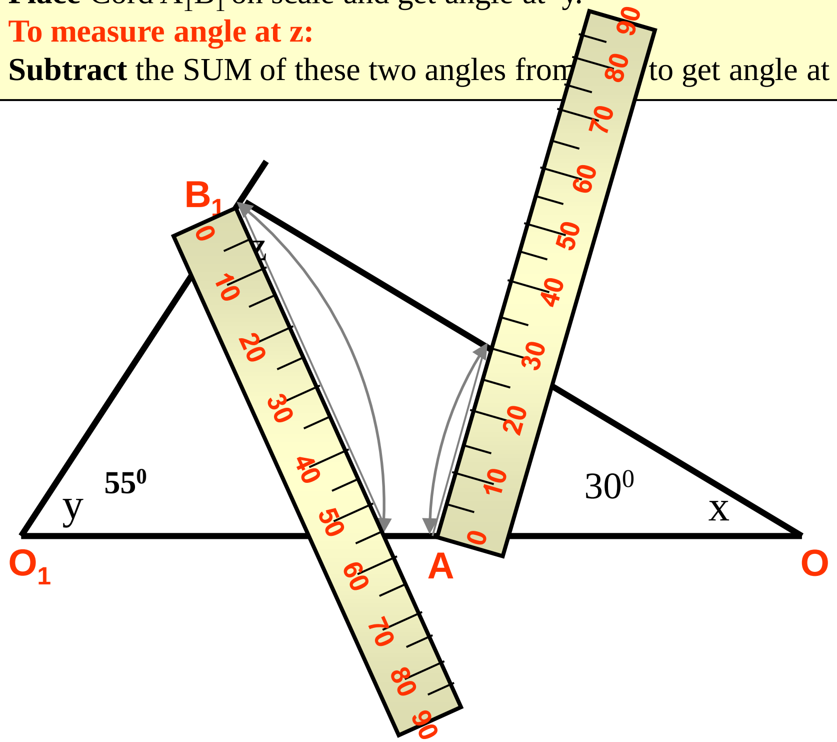
Repeat same process from O_1. Draw arc with radius O_1A_1.

Place Cord A_1B_1 on scale and get angle at y.

To measure angle at z:

Subtract the SUM of these two angles from 180 to get angle at z.





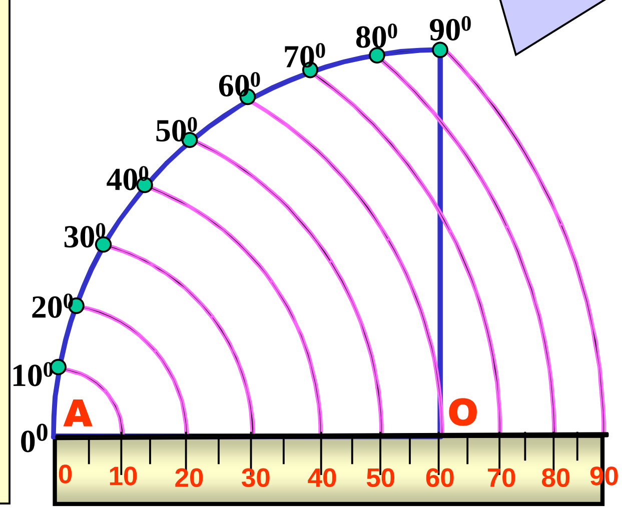
Angle at z = 180 – (55 + 30) = 95^0

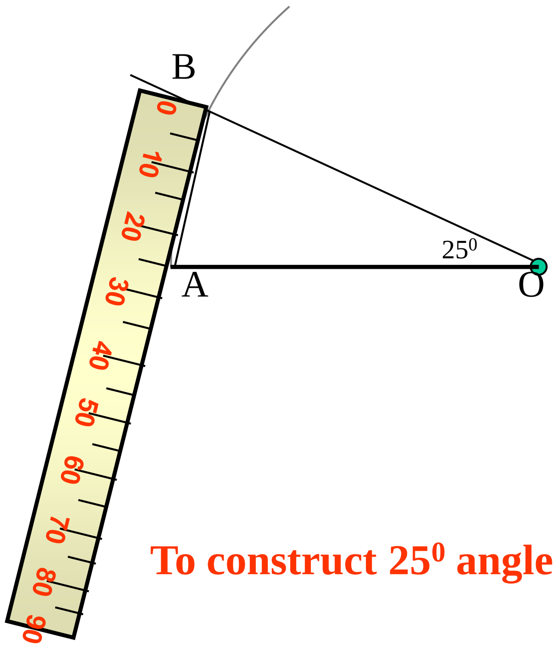
PROBLEM 12: Construct 25^0 and 115^0 angles with a horizontal line , by using scale of cords.

CONSTRUCTION:

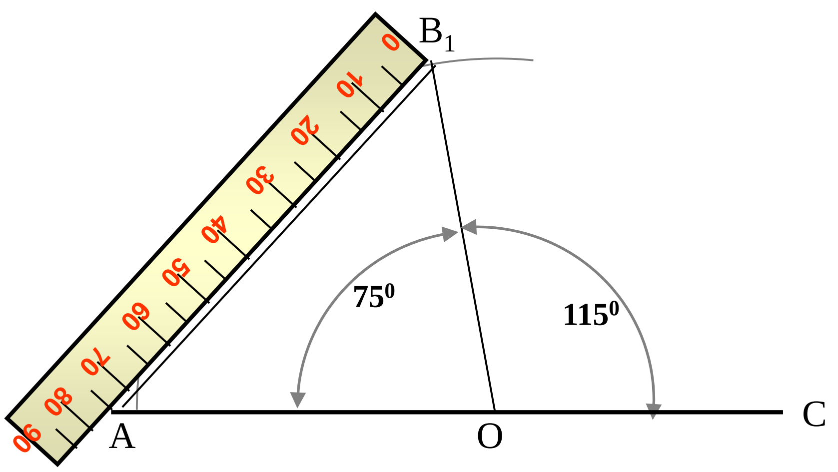
First prepare Scale of Cords for the problem.
Then Draw a horizontal line. Mark point O on it.
To construct 25^0 angle at O.
Take O-A distance in compass from cords scale and mark it on on the line drawn, from O
Name O & A as shown. **Then** O as center, O-A radius draw an arc upward..
Take cord length of 25^0 angle from scale of cords in compass and
from A cut the arc at point B.Join B with O. The angle AOB is thus 25^0
To construct 115^0 angle at O.
This scale can measure or construct angles upto 90^0 only directly.
Hence Subtract 115^0 from 180^0. We get 75^0 angle ,
which can be constructed with this scale.
Extend previous arc of OA radius and taking cord length of 75^0 in compass cut this arc at B_1 with A as center. Join B_1 with O. Now angle AOB_1 is 75^0 and angle COB_1 is 115^0.

SCALE OF CORDS





To construct 25^0 angle at O.



To construct 115^0 angle at O.

ENGINEERING CURVES

Part- I {Conic Sections}

ELLIPSE

1.Concentric Circle Method

2.Rectangle Method

3.Oblong Method

4.Arcs of Circle Method

5.Rhombus Metho

6.Basic Locus Method
(Directrix – focus)

PARABOLA

1.Rectangle Method

2 Method of Tangents
(Triangle Method)

3.Basic Locus Method
(Directrix – focus)

HYPERBOLA

1.Rectangular Hyperbola
(coordinates given)

2 Rectangular Hyperbola
(P-V diagram - Equation given)

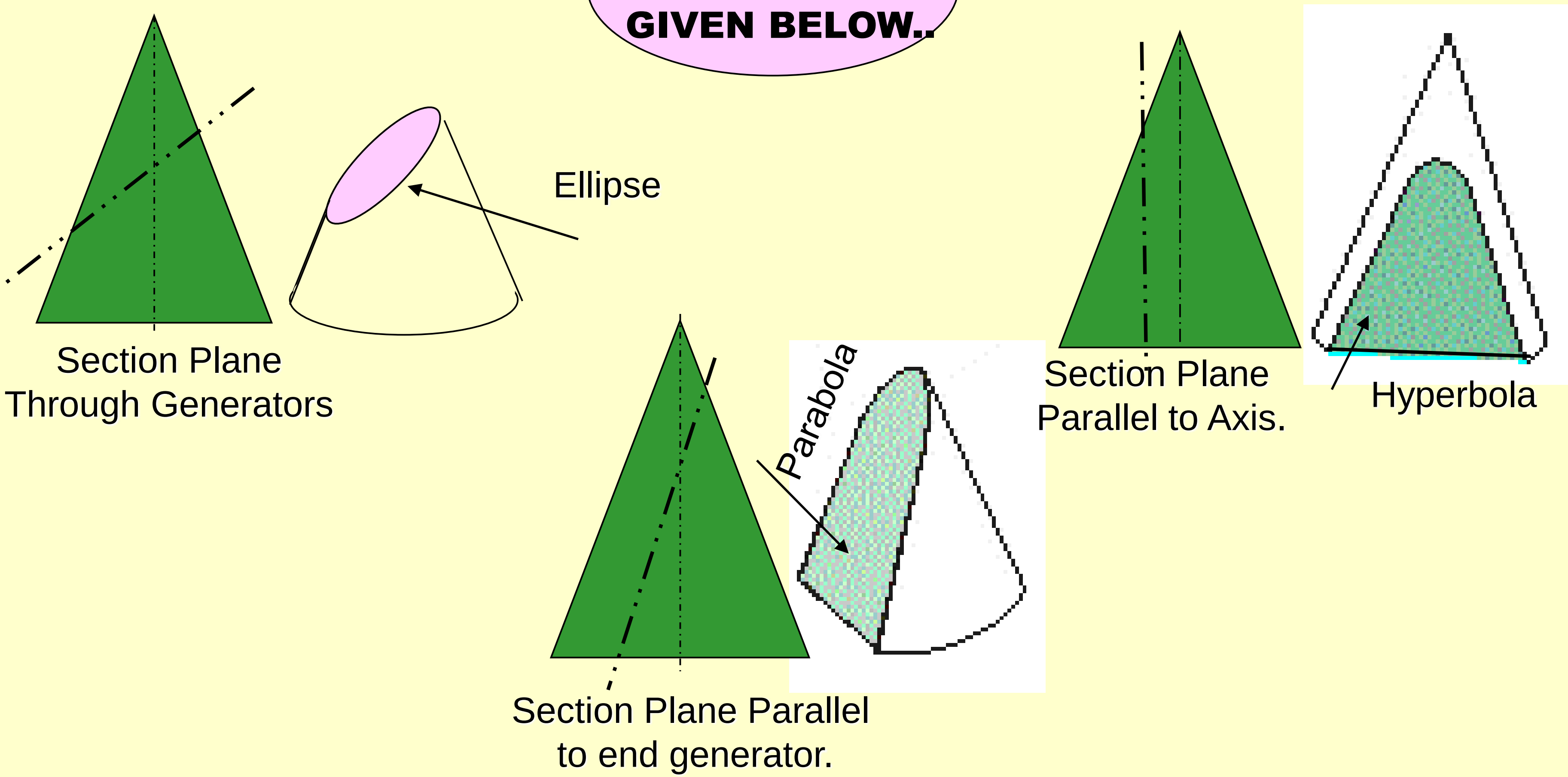
3.Basic Locus Method
(Directrix – focus)

Methods of Drawing
Tangents & Normals
To These Curves.

CONIC SECTIONS

ELLIPSE, PARABOLA AND HYPERBOLA ARE CALLED CONIC SECTIONS BECAUSE
THESE CURVES APPEAR ON THE SURFACE OF A CONE
WHEN IT IS CUT BY SOME TYPICAL CUTTING PLANES.

OBSERVE ILLUSTRATIONS GIVEN BELOW..



COMMON DEFINATION OF ELLIPSE, PARABOLA & HYPERBOLA:

These are the loci of points moving in a plane such that the ratio of it's distances from a ***fixed point*** And a ***fixed line*** always remains constant.

The Ratio is called **ECCENTRICITY. (E)**

A) For Ellipse E<1

B) For Parabola E=1

C) For Hyperbola E>1

Refer Problem nos. 6. 9 & 12

SECOND DEFINATION OF AN ELLIPSE:-

It is a locus of a point moving in a plane such that the SUM of it's distances from TWO fixed points always remains constant.

{And this ***sum equals*** to the length of ***major axis***.}

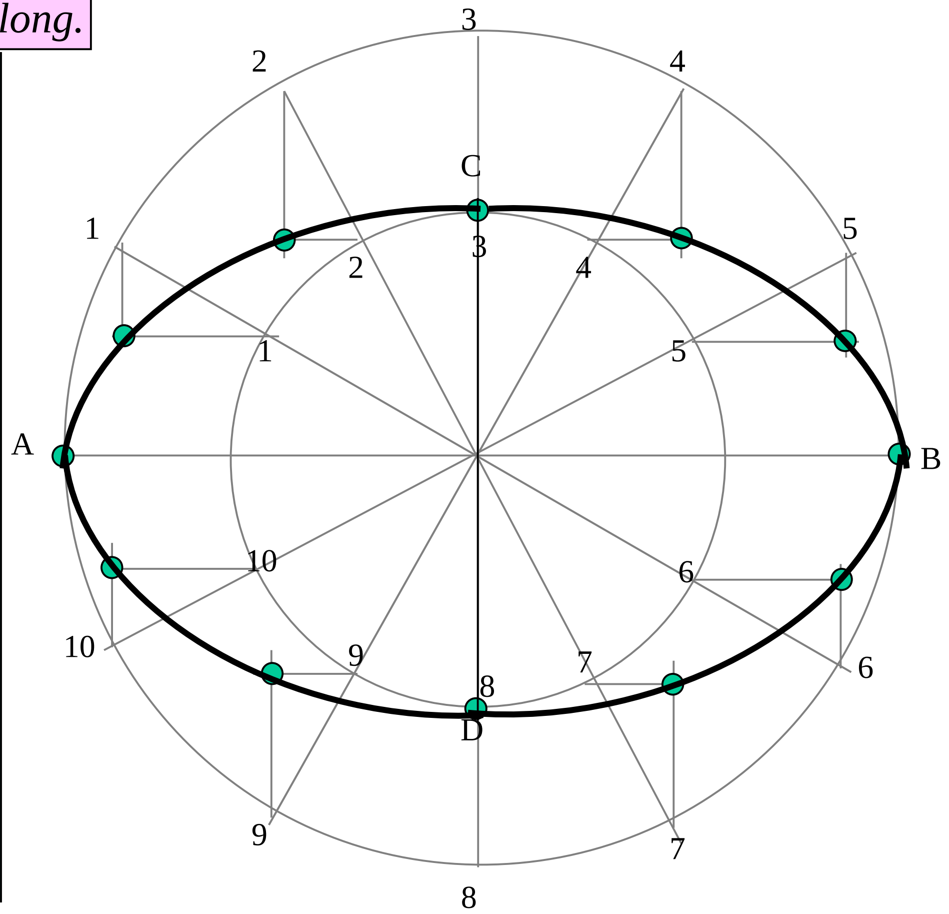
These TWO fixed points are FOCUS 1 & FOCUS 2

Refer Problem no.4

Ellipse by Arcs of Circles Method.

Problem 1 :-
Draw ellipse by **concentric circle method**.
Take major axis 100 mm and minor axis 70 mm long.

Steps:
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.



Steps:

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 upto D-1 and mark that point. Similarly extend C-2, C-3, C-4 lines up to D-2, D-3, & D-4 lines.

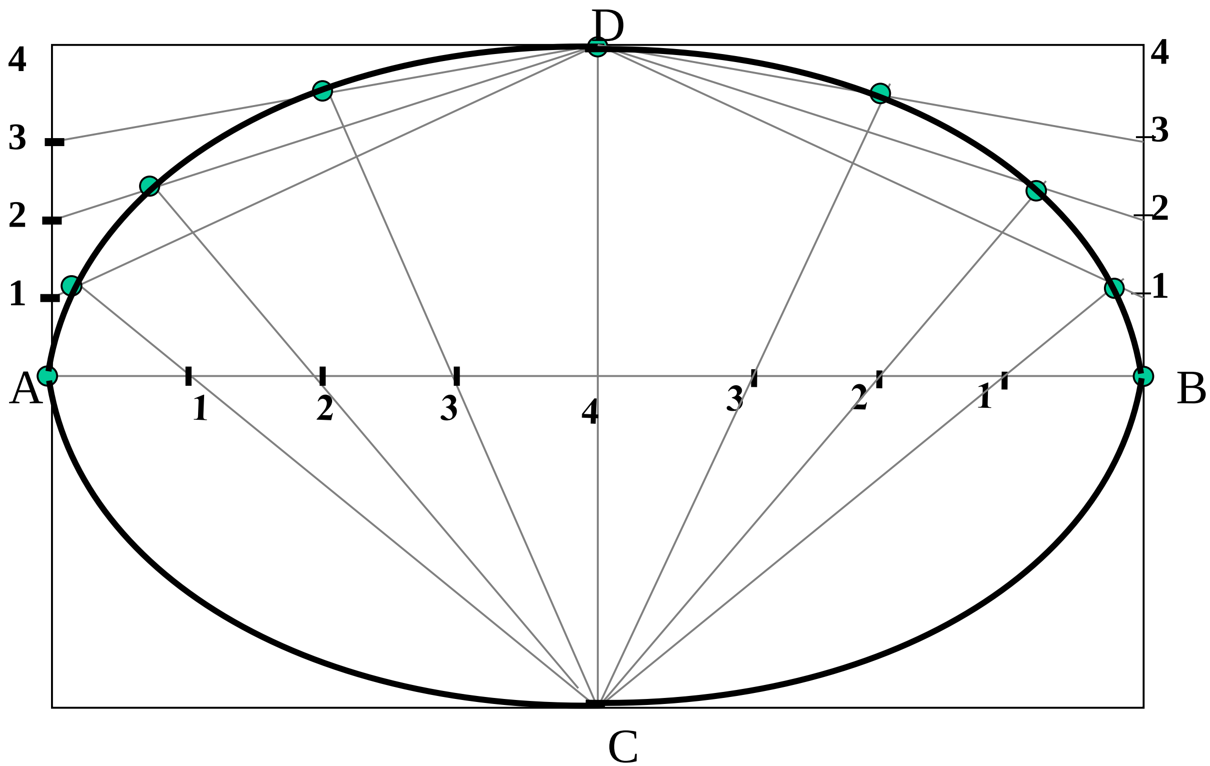
7. Mark all these points properly and join all along with ends A and D in smooth possible curve. Do similar construction in right side part.along with lower half of the rectangle.Join all points in smooth curve.

It is required ellipse.

Problem 2

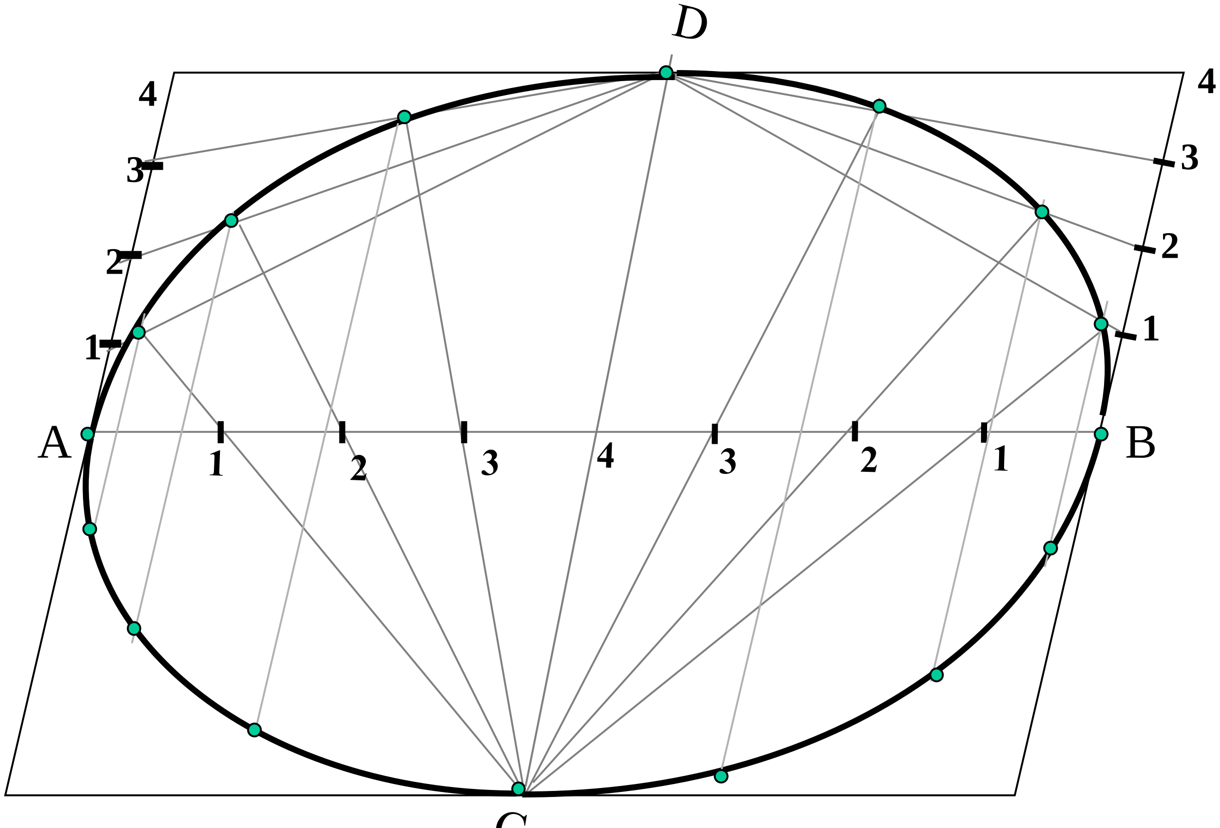
Draw ellipse by **Rectangle** *method.*

Take major axis 100 mm and minor axis 70 mm long.



Problem 3:-
Draw ellipse by **Oblong method.**
Draw a parallelogram of 100 mm and 70 mm long sides with included angle of 75^0. Inscribe Ellipse in it.

STEPS ARE SIMILAR TO THE PREVIOUS CASE (RECTANGLE METHOD) ONLY IN PLACE OF RECTANGLE, HERE IS A PARALLELOGRAM.



PROBLEM 4.
MAJOR AXIS AB & MINOR AXIS CD ARE 100 AMD 70MM LONG RESPECTIVELY .DRAW ELLIPSE BY ARCS OF CIRLES METHOD.

ELLIPSE

BY ARCS OF CIRCLE METHOD

As per the definition Ellipse is locus of point P moving in a plane such that the **SUM** of it's distances from two fixed points (F_1 & F_2) remains constant and equals to the length of major axis AB.(Note A .1+ B .1=A . 2 + B. 2 = AB)

STEPS:

1.Draw both axes as usual.Name the ends & intersecting point

2.Taking AO distance I.e.half major axis, from C, mark F_1 & F_2 On AB . (focus 1 and 2.)

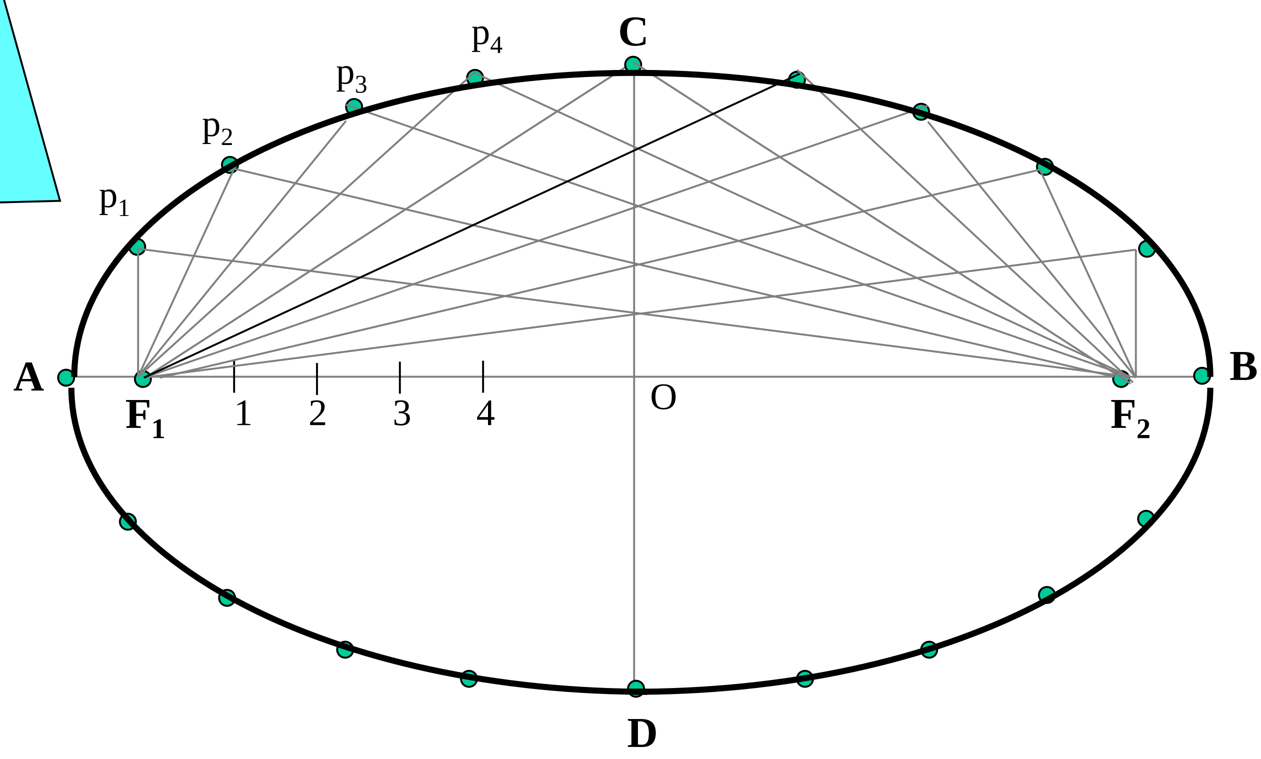
3.On line F_1- O taking any distance, mark points 1,2,3, & 4

4.Taking F_1 center, with distance A-1 draw an arc above AB and taking F_2 center, with B-1 distance cut this arc. Name the point p_1

5.Repeat this step with same centers but taking now A-2 & B-2 distances for drawing arcs. Name the point p_2

6.Similarly get all other P points. With same steps positions of P can be located below AB.

7.Join all points by smooth curve to get an ellipse/

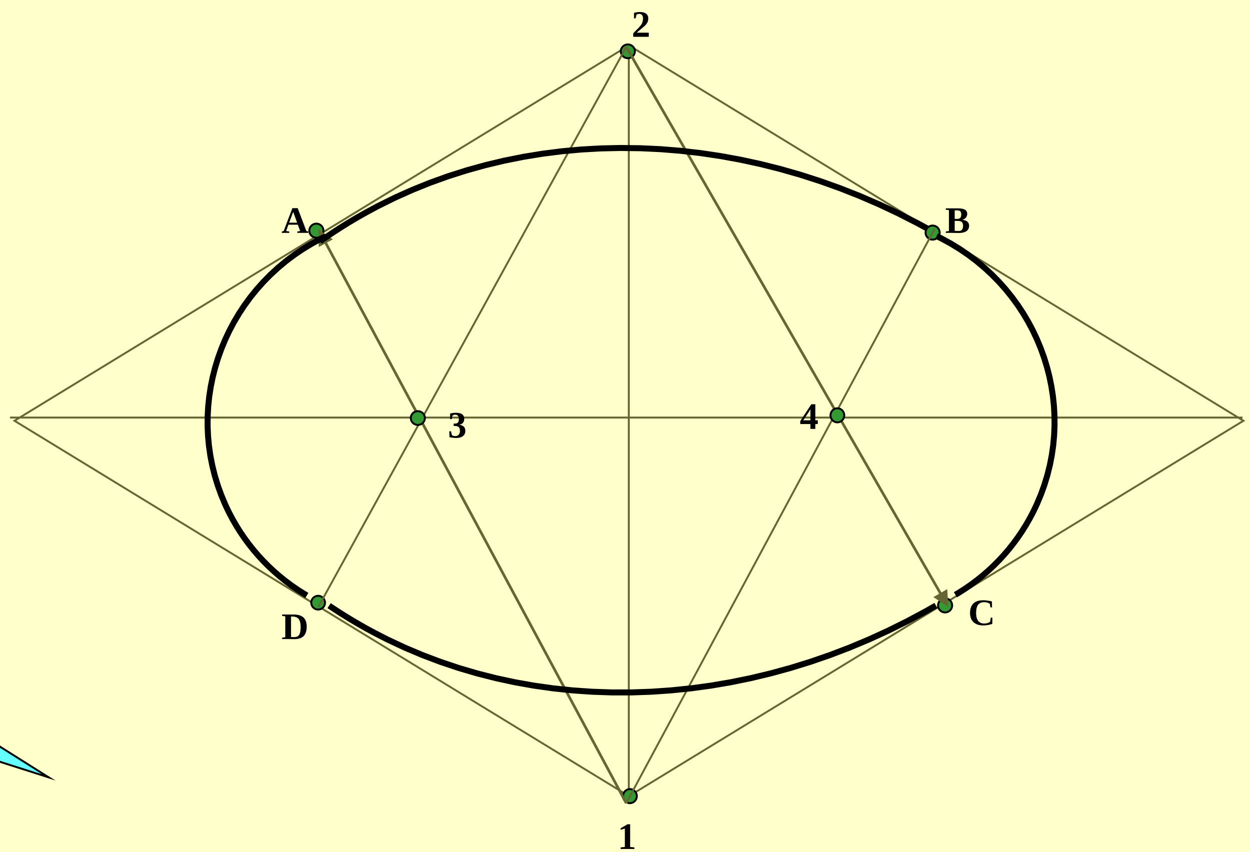


PROBLEM 5.
DRAW RHOMBUS OF 100 MM & 70 MM LONG DIAGONALS AND INSCRIBE AN ELLIPSE IN IT.

ELLIPSE
BY RHOMBUS METHOD

STEPS:

1. Draw rhombus of given dimensions.
2. Mark mid points of all sides & name Those A,B,C,& D
3. Join these points to the ends of smaller diagonals.
4. Mark points 1,2,3,4 as four centers.
5. Taking 1 as center and 1-A radius draw an arc AB.
6. Take 2 as center draw an arc CD.
7. Similarly taking 3 & 4 as centers and 3-D radius draw arcs DA & BC.



PROBLEM 6:- POINT **F** IS 50 MM FROM A LINE **AB.**A POINT **P** IS MOVING IN A PLANE SUCH THAT THE ***RATIO*** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P. { ECCENTRICITY = 2/3 }**

ELLIPSE

DIRECTRIX-FOCUS METHOD

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 2nd part from F as V. It is 20mm and 30mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 2/3 i.e 20/30

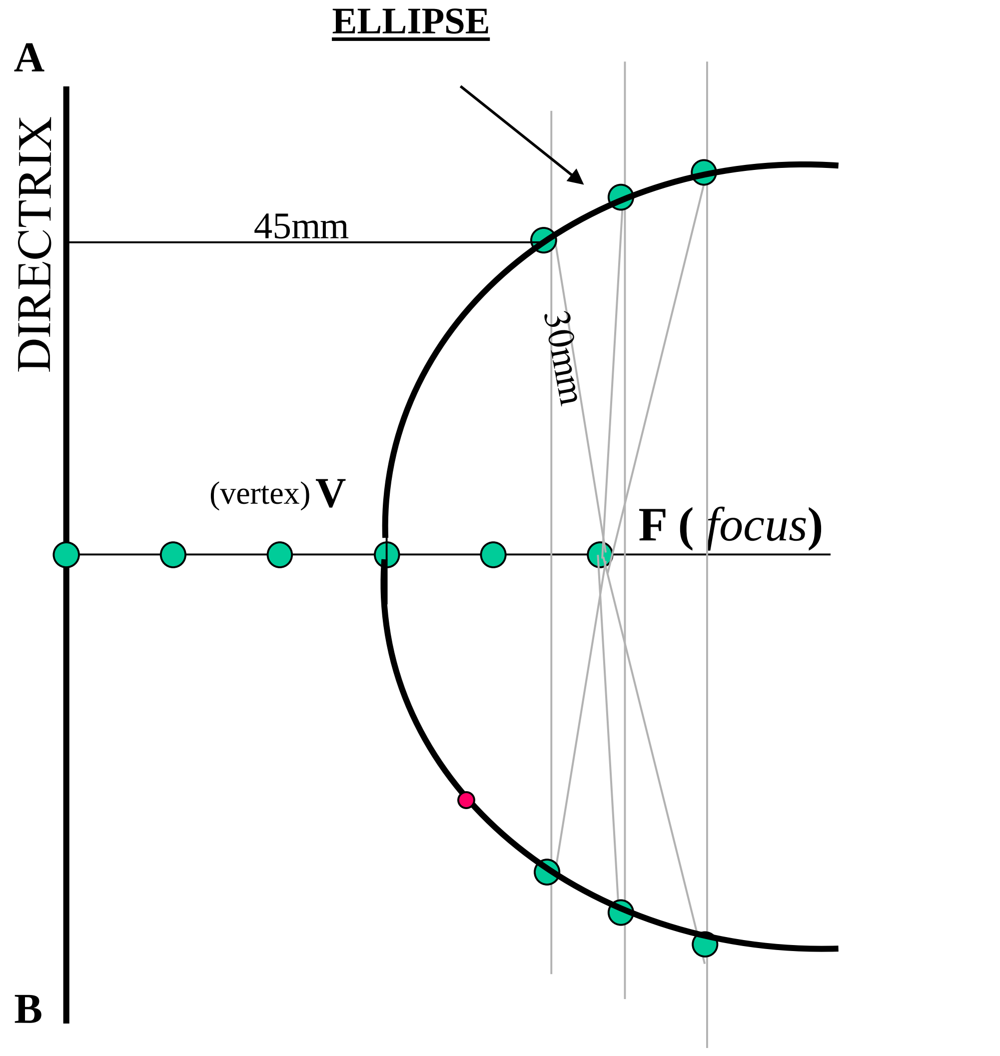
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

5.Taking 45,60 and 75mm distances from line AB, draw three vertical lines to the right side of it.

6. Now with 30, 40 and 50mm distances in compass cut these lines above and below, with F as center.

7. Join these points through V in smooth curve.

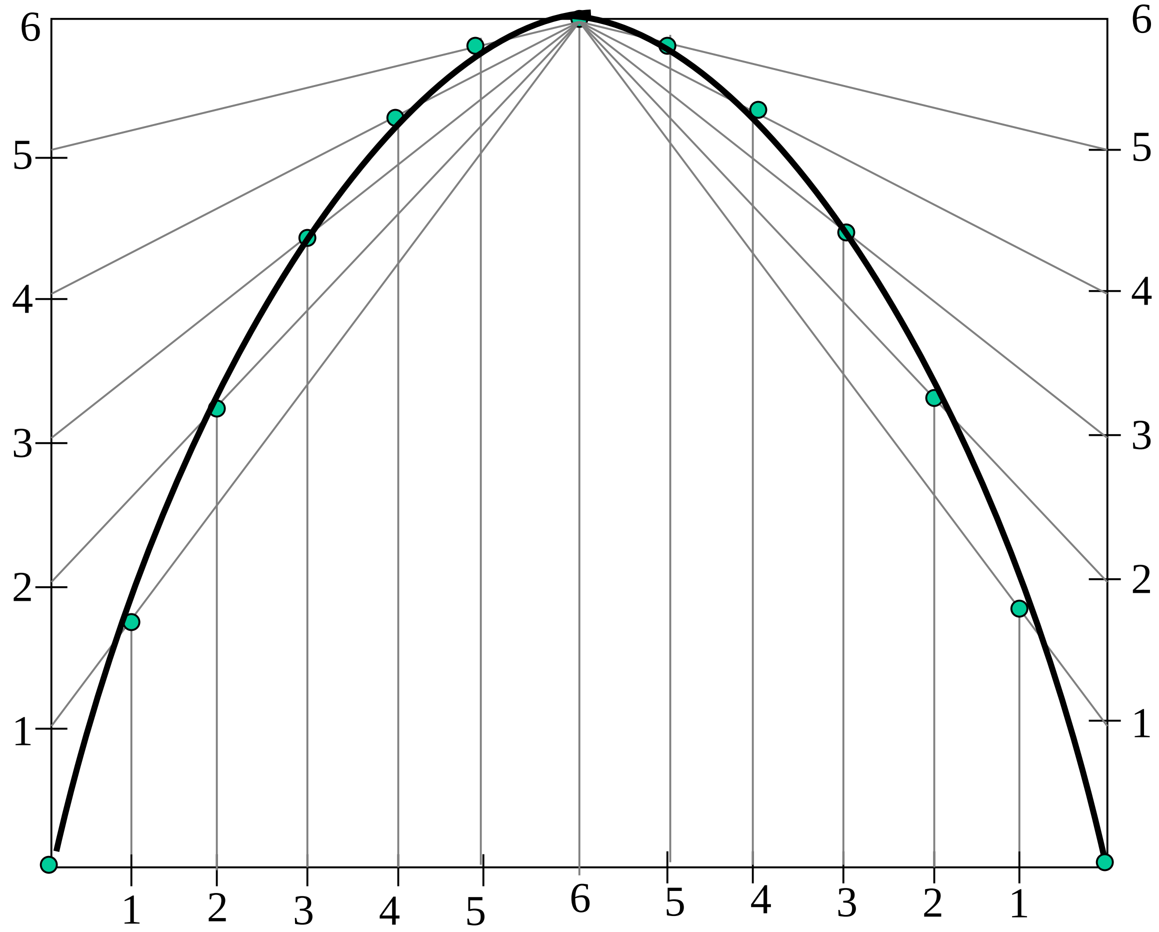
This is required locus of P.It is an ELLIPSE.



PROBLEM 7: A BALL THROWN IN AIR ATTAINS 100 M HIEGHT AND COVERS HORIZONTAL DISTANCE 150 M ON GROUND.
Draw the path of the ball (projectile)-

PARABOLA
RECTANGLE METHOD

STEPS:
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.
.

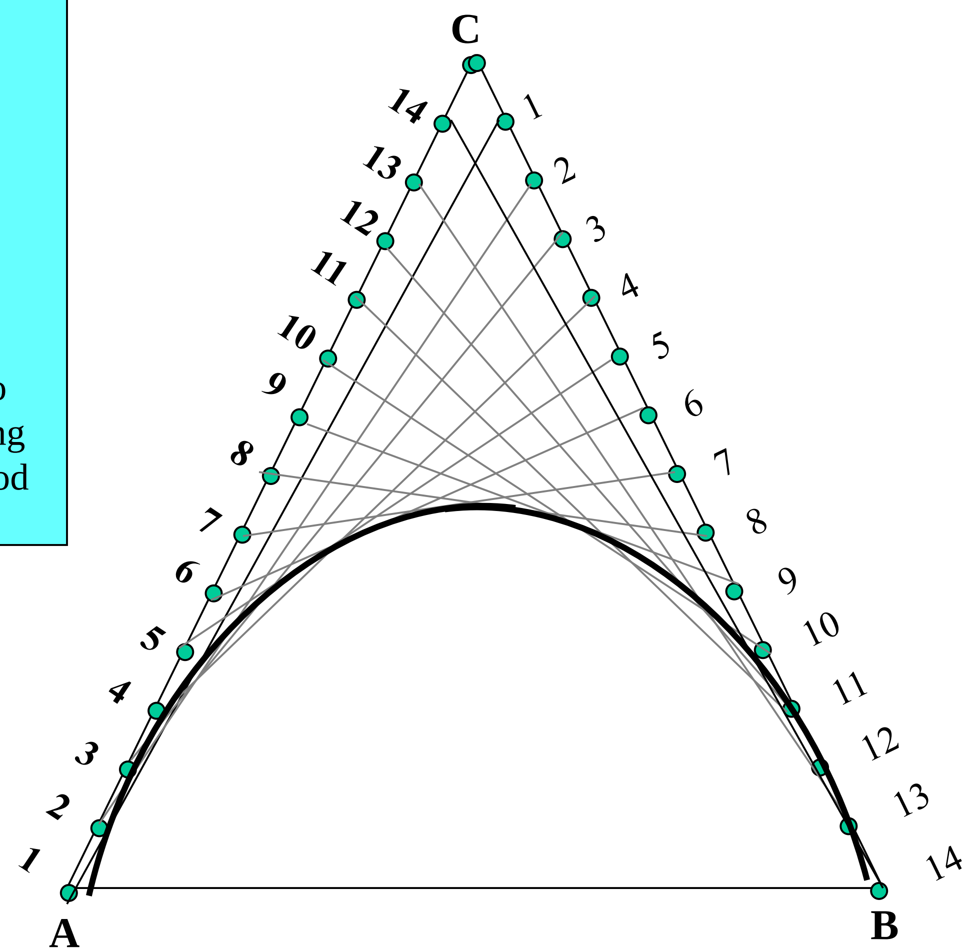


Problem no.8: Draw an isosceles triangle of 100 mm long base and 110 mm long altitude.Inscribe a parabola in it by method of tangents.

PARABOLA
METHOD OF TANGENTS

Solution Steps:

1. Construct triangle as per the given dimensions.
2. Divide it's both sides in to same no.of equal parts.
3. Name the parts in ascending and descending manner, as shown.
4. Join 1-1, 2-2,3-3 and so on.
5. Draw the curve as shown i.e.tangent to all these lines. The above all lines being tangents to the curve, it is called method of tangents.



PROBLEM 9: Point F is 50 mm from a vertical straight line AB. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AB.

PARABOLA

DIRECTRIX-FOCUS METHOD

SOLUTION STEPS:

1.Locate center of line, perpendicular to AB from point F. This will be initial point P and also the vertex.

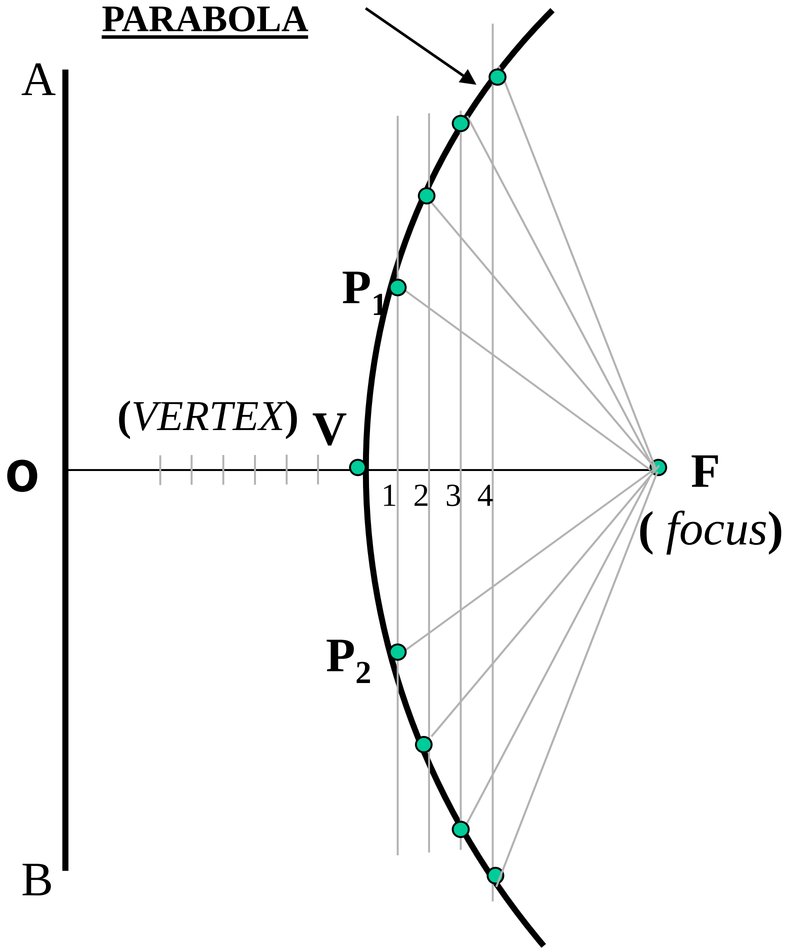
2.Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw lines parallel to AB.

3.Mark 5 mm distance to its left of P and name it 1.

4.Take O-1 distance as radius and F as center draw an arc cutting first parallel line to AB. Name upper point P_1 and lower point P_2. $(FP_1=O1)$

5.Similarly repeat this process by taking again 5mm to right and left and locate P_3P_4.

6.Join all these points in smooth curve.



It will be the locus of P equidistance from line AB and fixed point F.

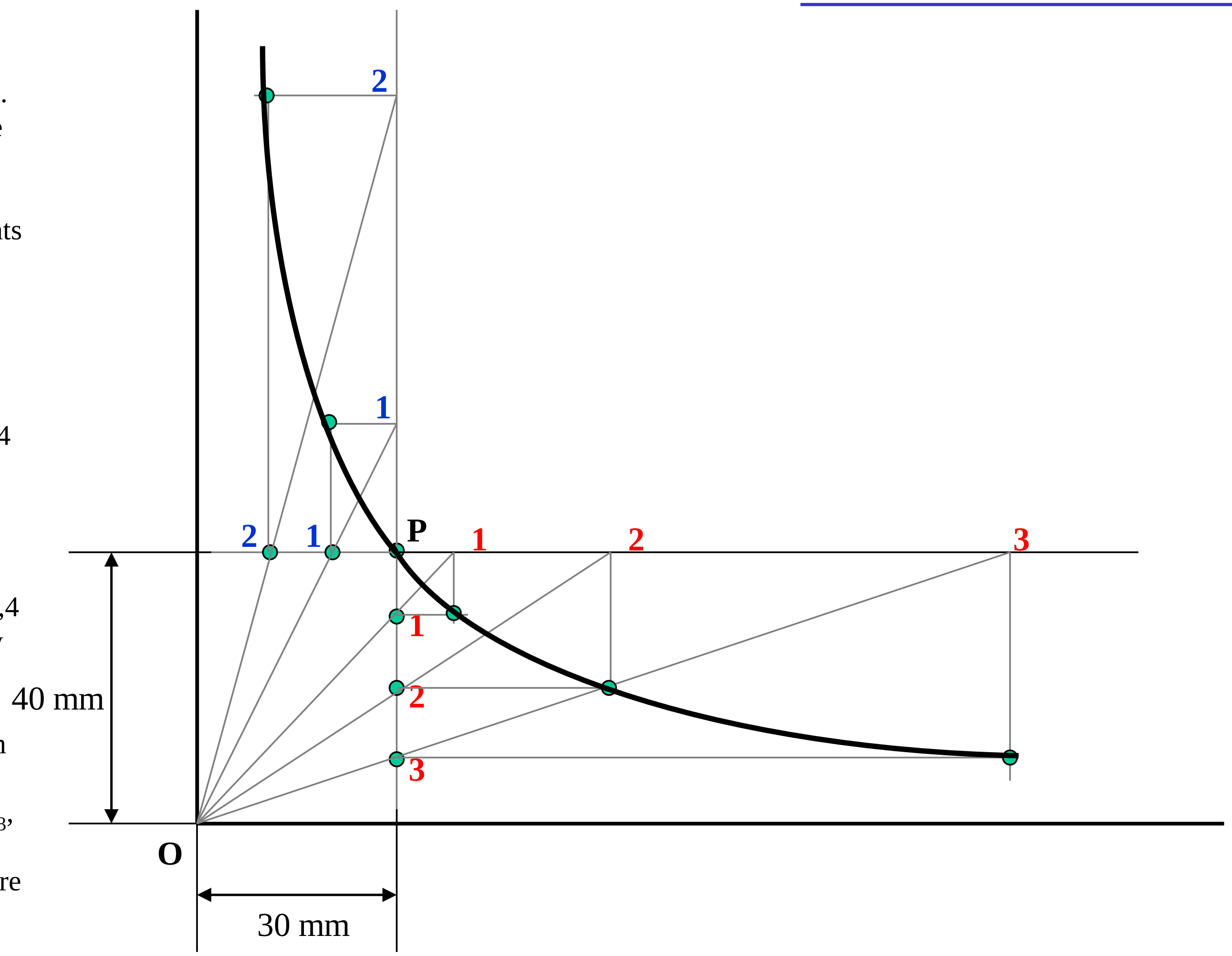
Problem No.10: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively.Draw Hyperbola through it.

HYPERBOLA

THROUGH A POINT OF KNOWN CO-ORDINATES

Solution Steps:

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.



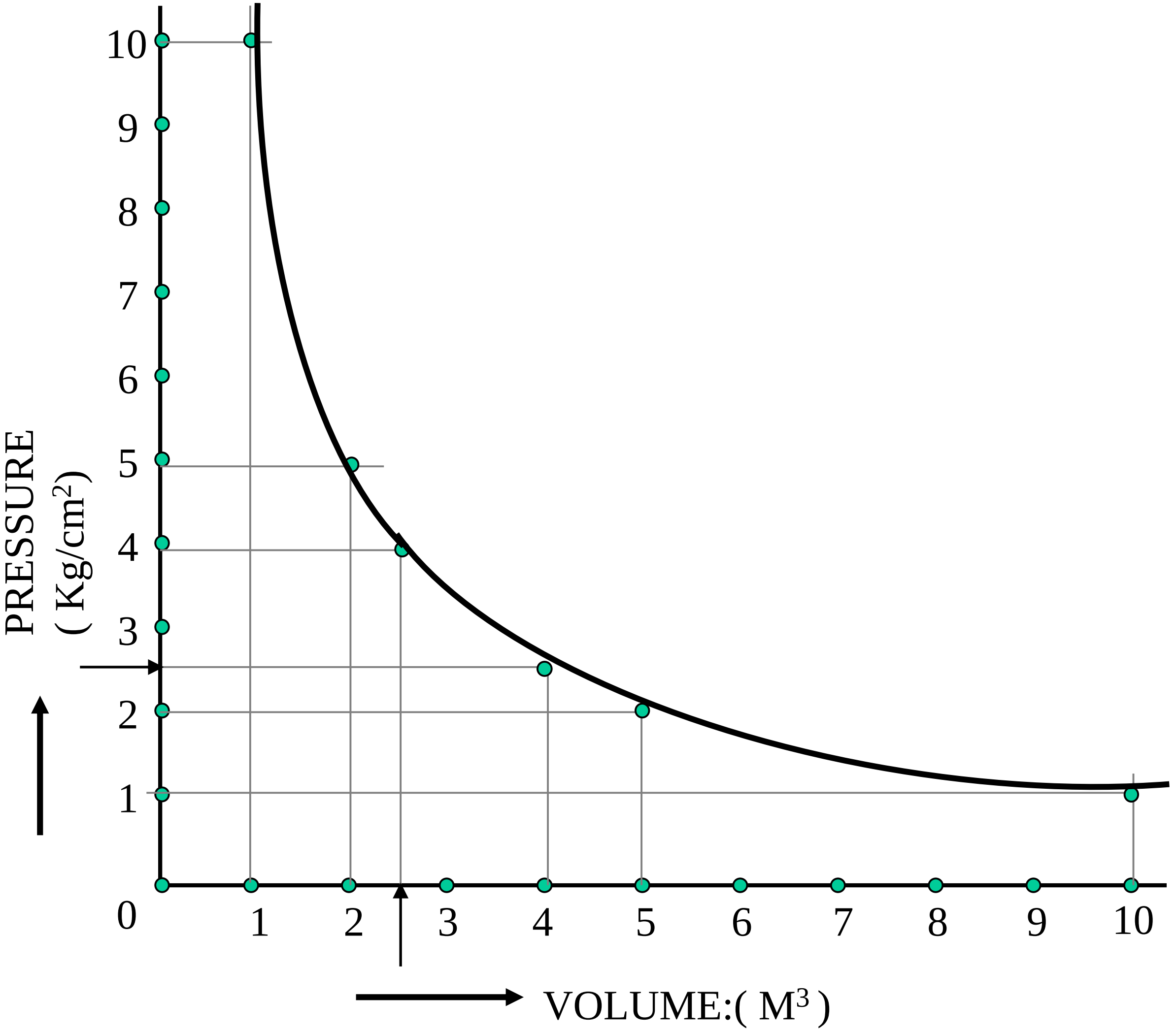
HYPERBOLA
P-V DIAGRAM

Problem no.11: A sample of gas is expanded in a cylinder from 10 unit pressure to 1 unit pressure.Expansion follows law PV=Constant.If initial volume being 1 unit, draw the curve of expansion. Also Name the curve.

Form a table giving few more values of P & V

P	×	V	=	C
10	×	1	=	10
5	×	2	=	10
4	×	2.5	=	10
2.5	×	4	=	10
2	×	5	=	10
1	×	10	=	10

Now draw a Graph of
Pressure against Volume.
It is a PV Diagram and it is Hyperbola.
Take pressure on vertical axis and
Volume on horizontal axis.



PROBLEM 12:- POINT **F** IS 50 MM FROM A LINE **AB.**A POINT **P** IS MOVING IN A PLANE SUCH THAT THE ***RATIO*** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P.** **{ ECCENTRICITY = 2/3 }**

HYPERBOLA
DIRECTRIX
FOCUS METHOD

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 2nd part from F as V. It is 20mm and 30mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 2/3 i.e 20/30

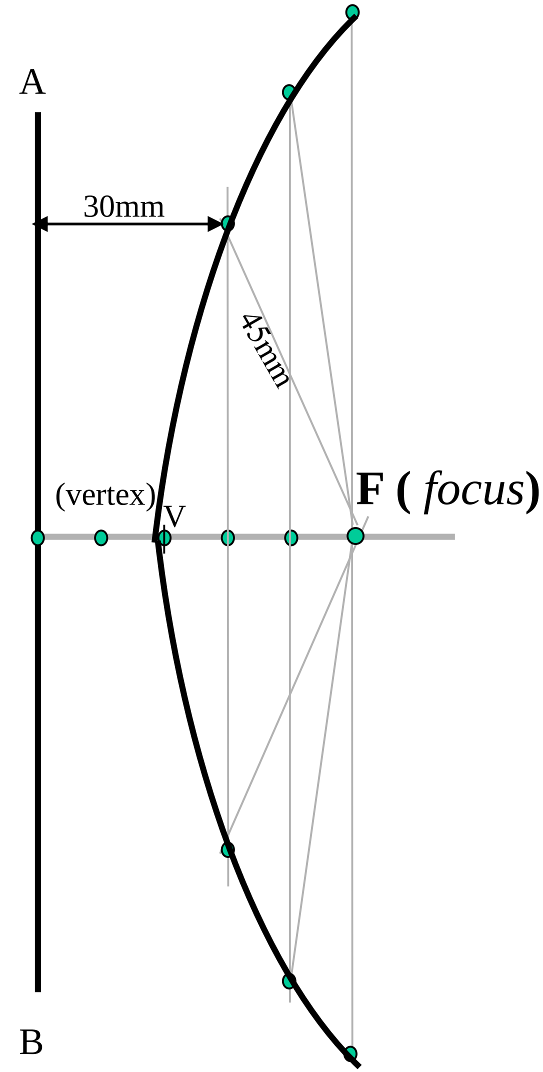
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

5.Taking 45,60 and 75mm distances from line AB, draw three vertical lines to the right side of it.

6. Now with 30, 40 and 50mm distances in compass cut these lines above and below, with F as center.

7. Join these points through V in smooth curve.

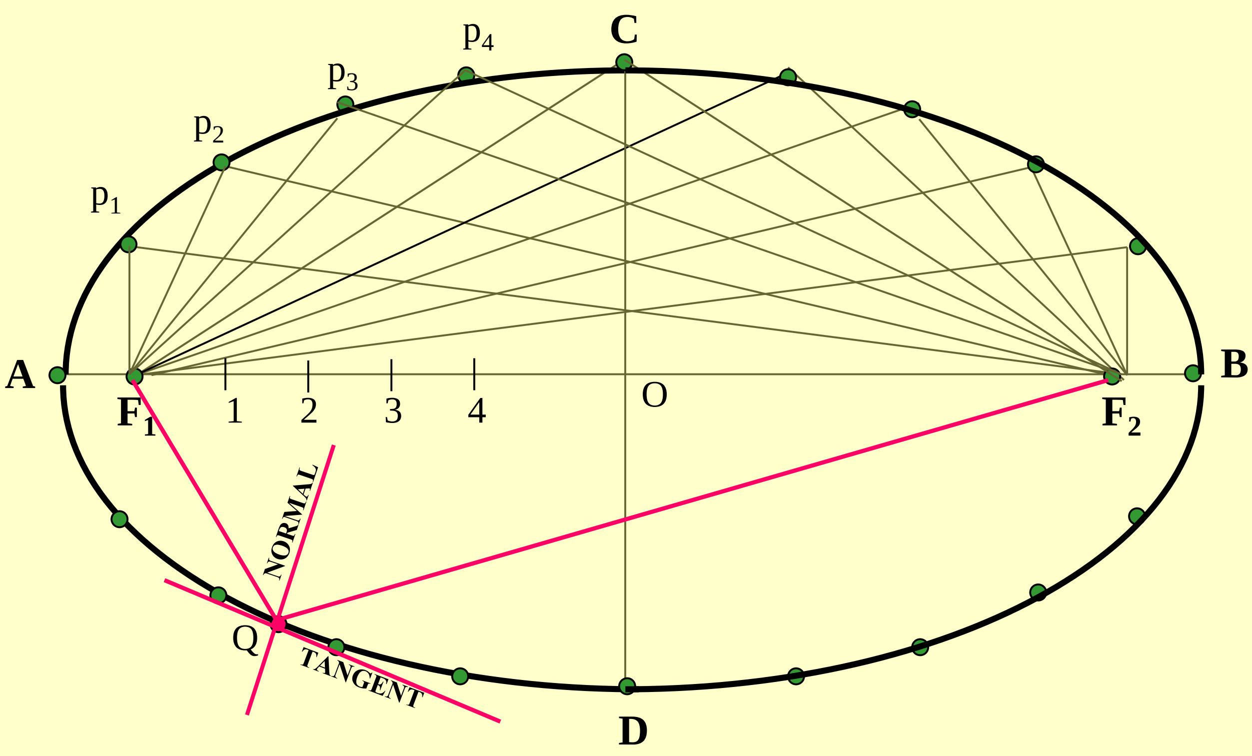
This is required locus of P.It is an ELLIPSE.



Problem 13:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

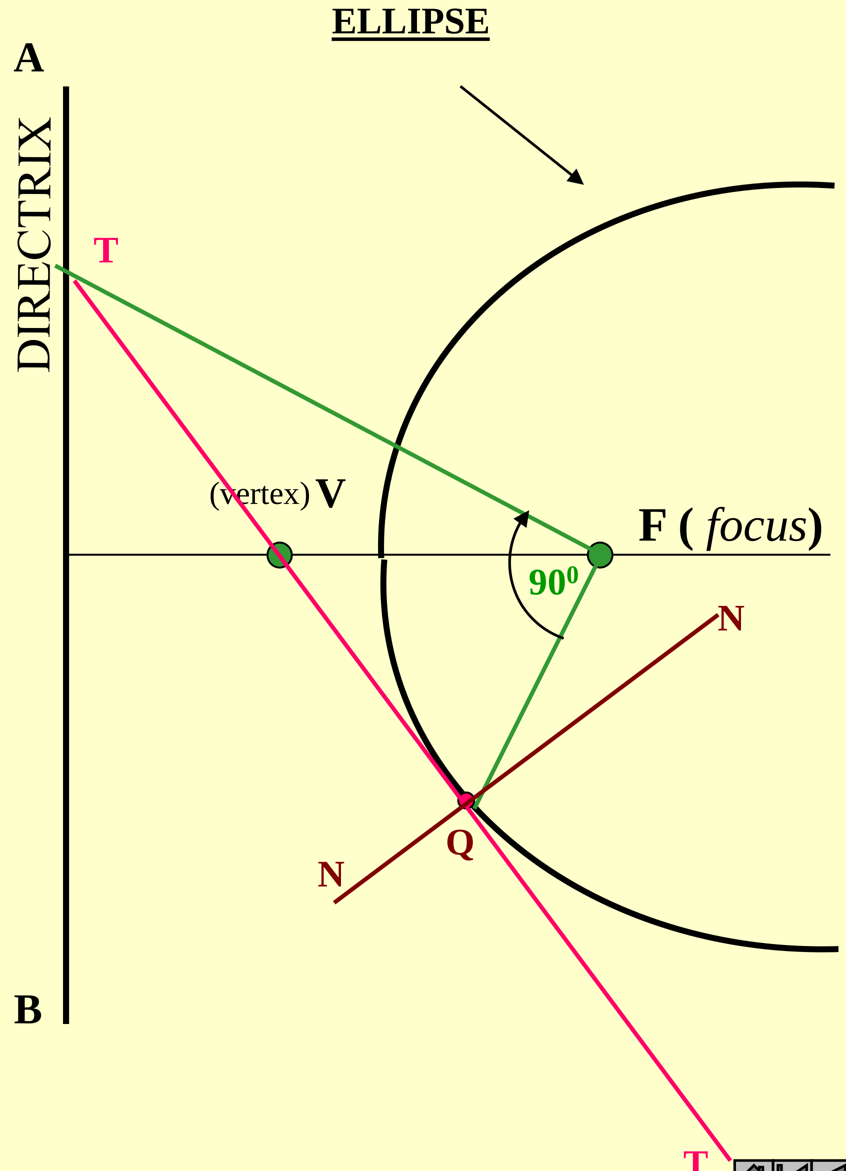
1. JOIN POINT Q TO F_1 & F_2
2. BISECT ANGLE $F_1Q\ F_2$ THE ANGLE BISECTOR IS NORMAL
3. A PERPENDICULAR LINE DRAWN TO IT IS TANGENT TO THE CURVE.



Problem 14:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

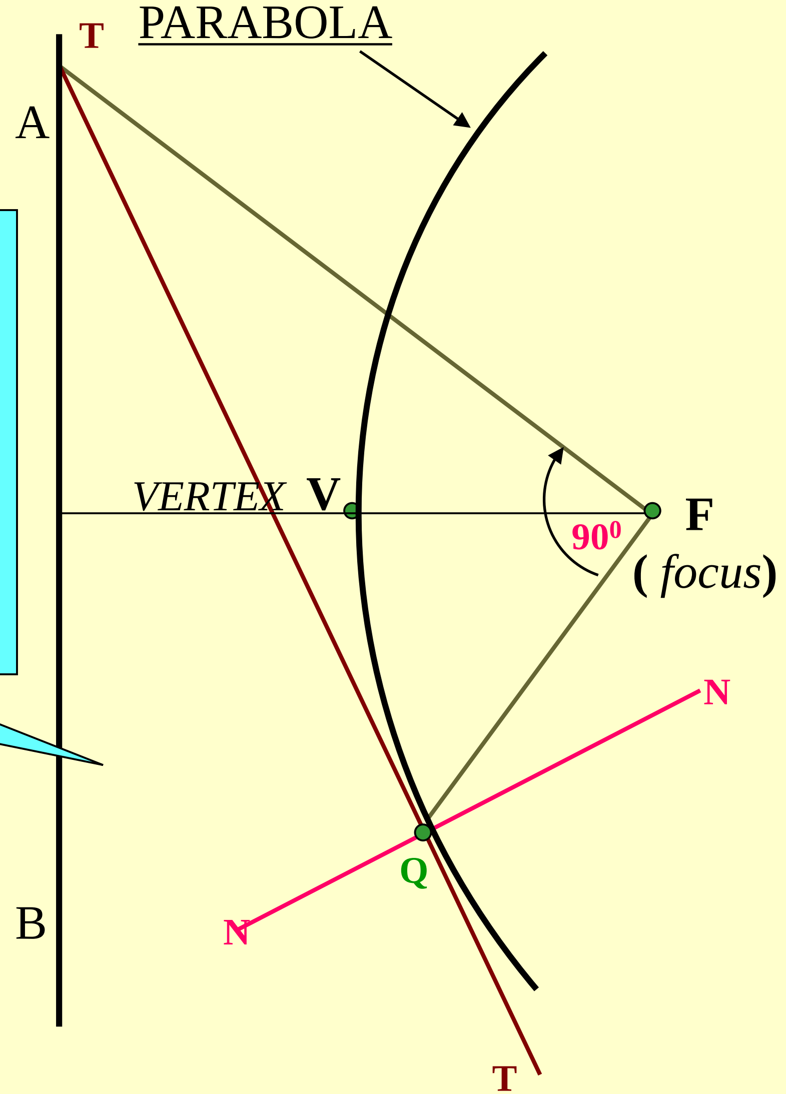
1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



Problem 15:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT **Q** TO **F.**
2. CONSTRUCT **90^0** ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO THE CURVE FROM Q
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.

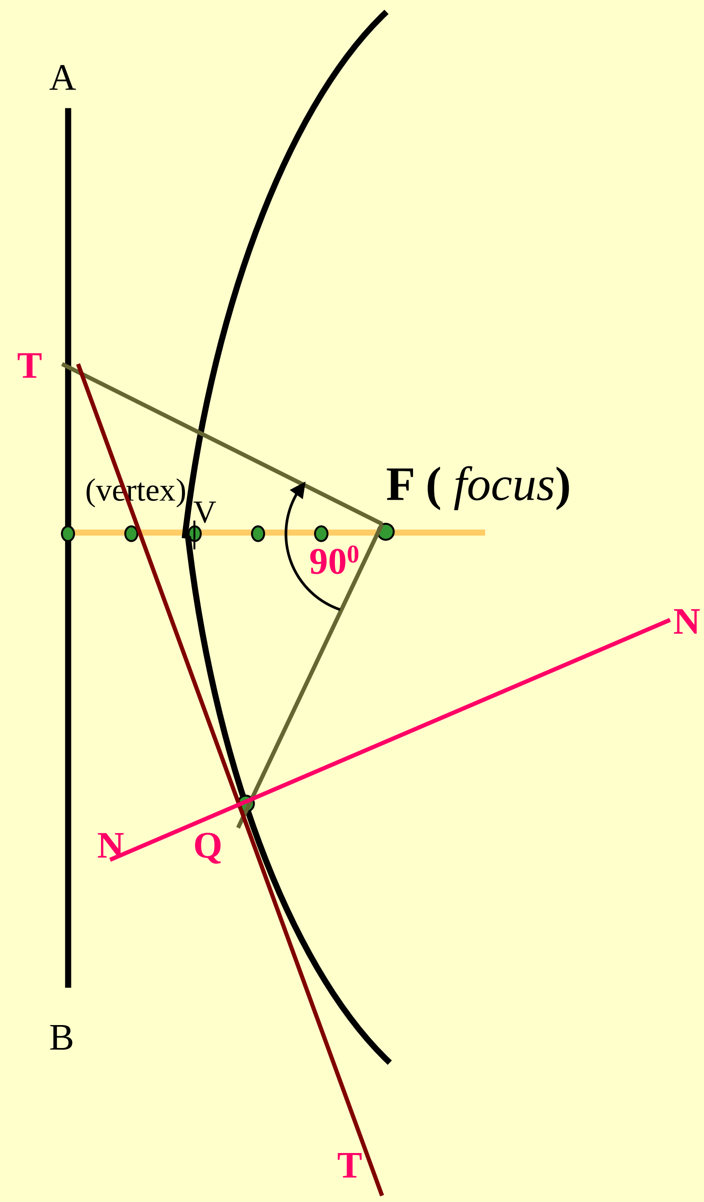


Problem 16

HYPERBOLA
TANGENT & NORMAL

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT **Q** TO **F.**
2. CONSTRUCT 90^0 ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO **Q** AND EXTEND. THIS IS TANGENT TO CURVE FROM **Q**
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM **Q**. IT IS NORMAL TO CURVE.



ENGINEERING CURVES

Part-II

(Point undergoing two types of displacements)

INVOLUTE

1. Involute of a circle
   a)String Length = πD

   b)String Length > πD

   c)String Length < πD

2. Pole having Composite shape.

3. Rod Rolling over a Semicircular Pole.

CYCLOID

1. General Cycloid

2. Trochoid (superior)
3. Trochoid (Inferior)
4. Epi-Cycloid

5. Hypo-Cycloid

SPIRAL

1. Spiral of One Convolution.

2. Spiral of Two Convolutions.

HELIX

1. On Cylinder

2. On a Cone

AND

Methods of Drawing Tangents & Normals To These Curves.

DEFINITIONS

CYCLOID:

IT IS A LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON A STRAIGHT LINE PATH.

SUPERIORTROCHOID:
IF THE POINT IN THE DEFINATION OF CYCLOID IS OUTSIDE THE CIRCLE

INFERIOR TROCHOID.:
IF IT IS INSIDE THE CIRCLE

EPI-CYCLOID
IF THE CIRCLE IS ROLLING ON ANOTHER CIRCLE FROM OUTSIDE

HYPO-CYCLOID.
IF THE CIRCLE IS ROLLING FROM INSIDE THE OTHER CIRCLE,

INVOLUTE:

IT IS A LOCUS OF A FREE END OF A STRING WHEN IT IS WOUND ROUND A CIRCULAR POLE

SPIRAL:

IT IS A CURVE GENERATED BY A POINT WHICH REVOLVES AROUND A FIXED POINT AND AT THE SAME MOVES TOWARDS IT.

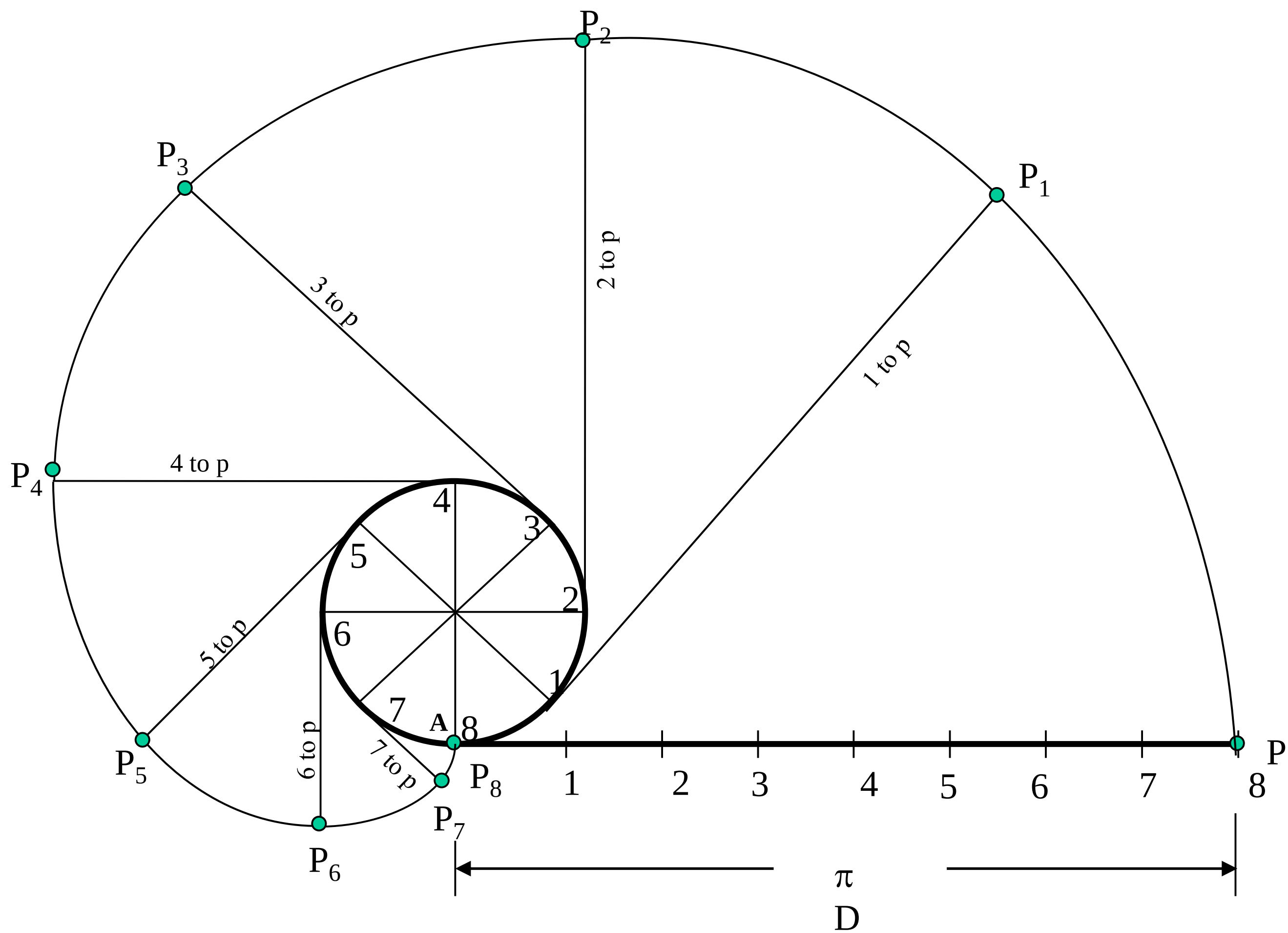
HELIX:

IT IS A CURVE GENERATED BY A POINT WHICH MOVES AROUND THE SURFACE OF A RIGHT CIRCULAR CYLINDER / CONE AND AT THE SAME TIME ADVANCES IN AXIAL DIRECTION AT A SPEED BEARING A CONSTANT RATIO TO THE SPPED OF ROTATION.
(for problems refer topic Development of surfaces)

Problem no 17: Draw Involute of a circle.
String length is equal to the circumference of circle.

Solution Steps:

1) Point or end P of string AP is exactly πD distance away from A. Means if this string is wound round the circle, it will completely cover given circle. B will meet A after winding.
2) Divide πD (AP) distance into 8 number of equal parts.
3) Divide circle also into 8 number of equal parts.
4) Name after A, 1, 2, 3, 4, etc. up to 8 on πD line AP as well as on circle (in anticlockwise direction).
5) To radius C-1, C-2, C-3 up to C-8 draw tangents (from 1,2,3,4,etc to circle).
6) Take distance 1 to P in compass and mark it on tangent from point 1 on circle (means one division less than distance AP).
7) Name this point P1
8) Take 2-B distance in compass and mark it on the tangent from point 2. Name it point P2.
9) Similarly take 3 to P, 4 to P, 5 to P up to 7 to P distance in compass and mark on respective tangents and locate P3, P4, P5 up to P8 (i.e. A) points and join them in smooth curve it is an INVOLUTE of a given circle.



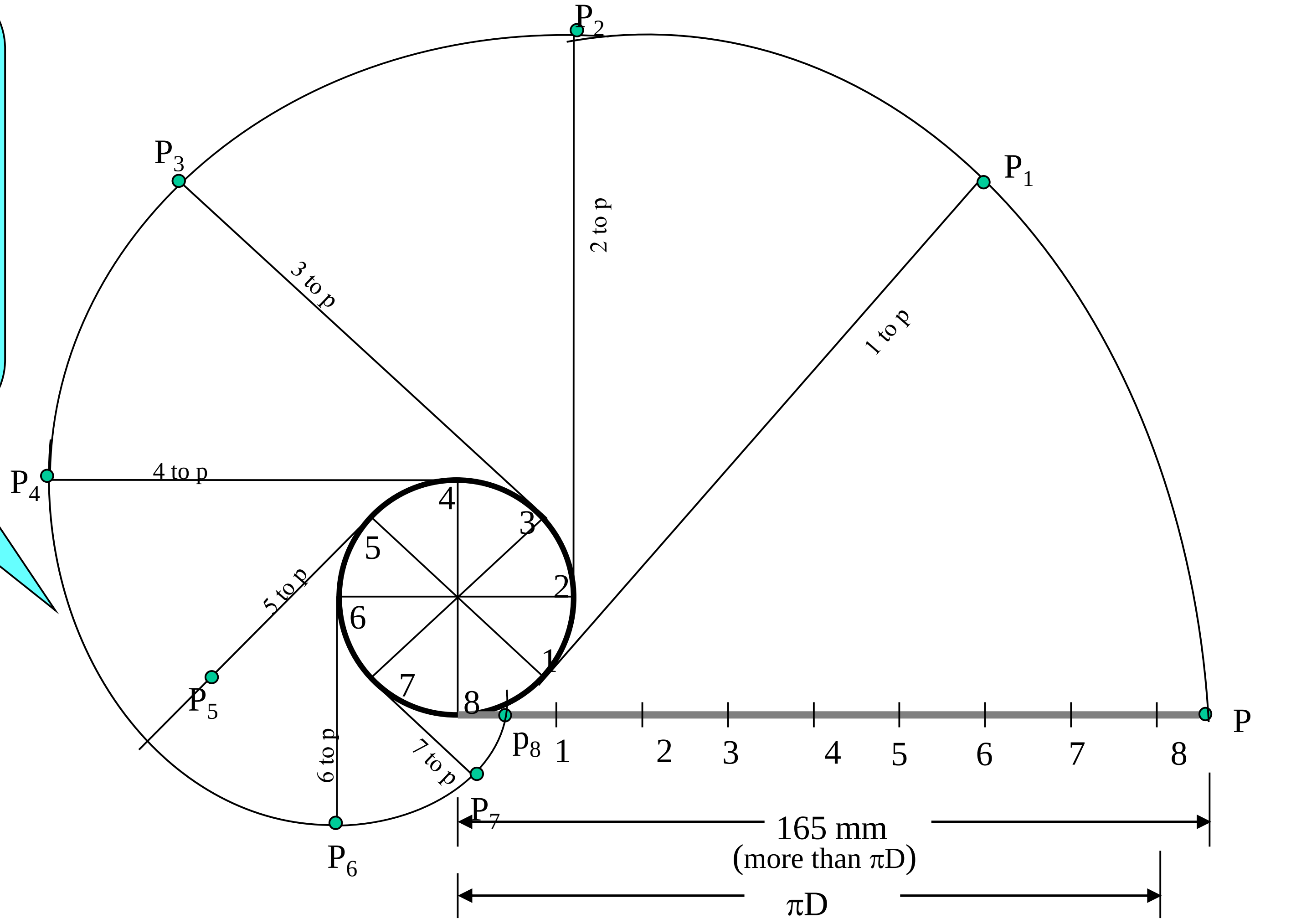
Problem 18: Draw Involute of a circle.
String length is MORE than the circumference of circle.

INVOLUTE OF A CIRCLE

String length MORE than πD

Solution Steps:
In this case string length is more than Π D.

But remember!
Whatever may be the length of string, mark Π D distance horizontal i.e.along the string and divide it in 8 number of equal parts, and not any other distance. Rest all steps are same as previous INVOLUTE. Draw the curve completely.

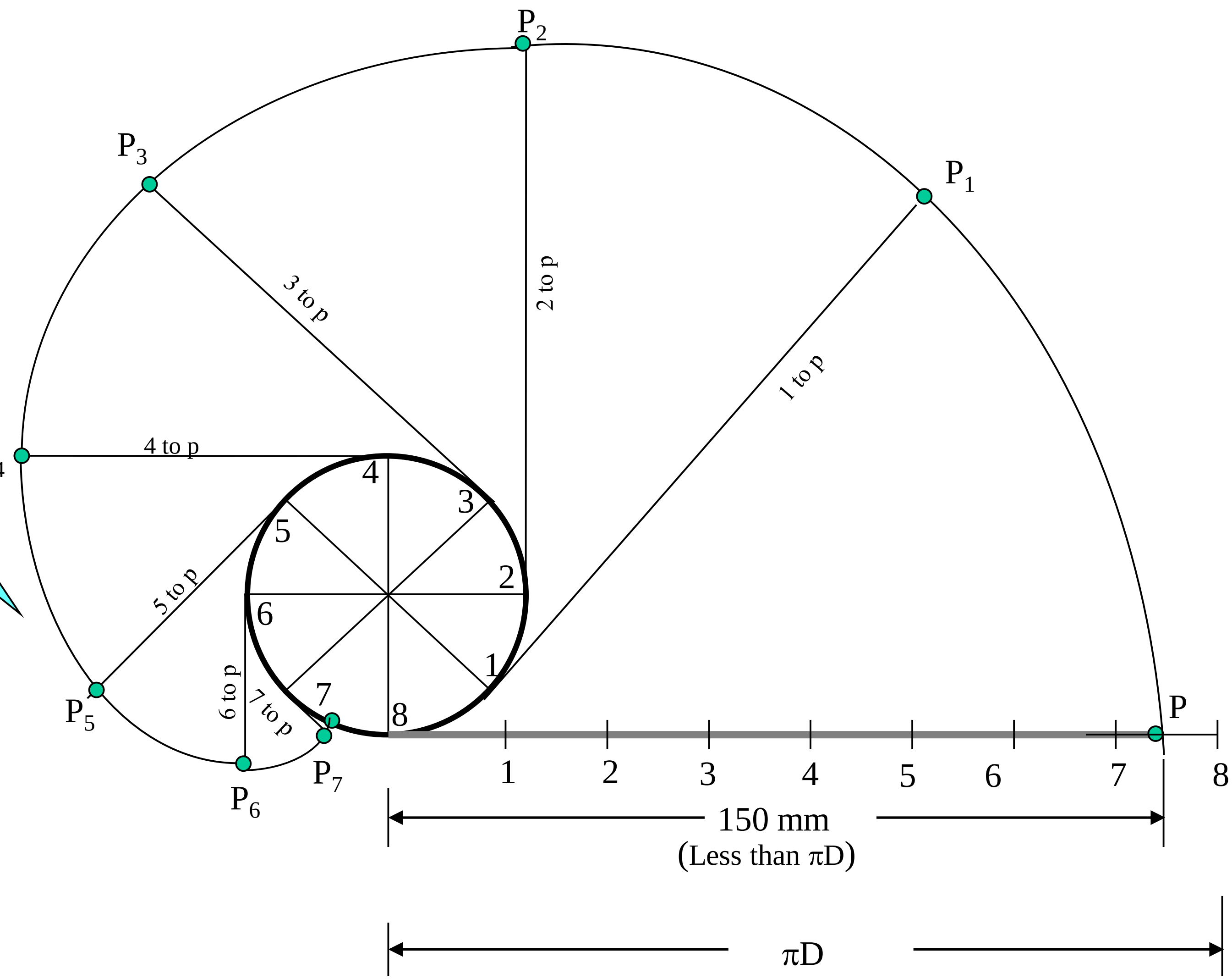


Problem 19: Draw Involute of a circle.
String length is LESS than the circumference of circle.

INVOLUTE OF A CIRCLE

String length LESS than πD

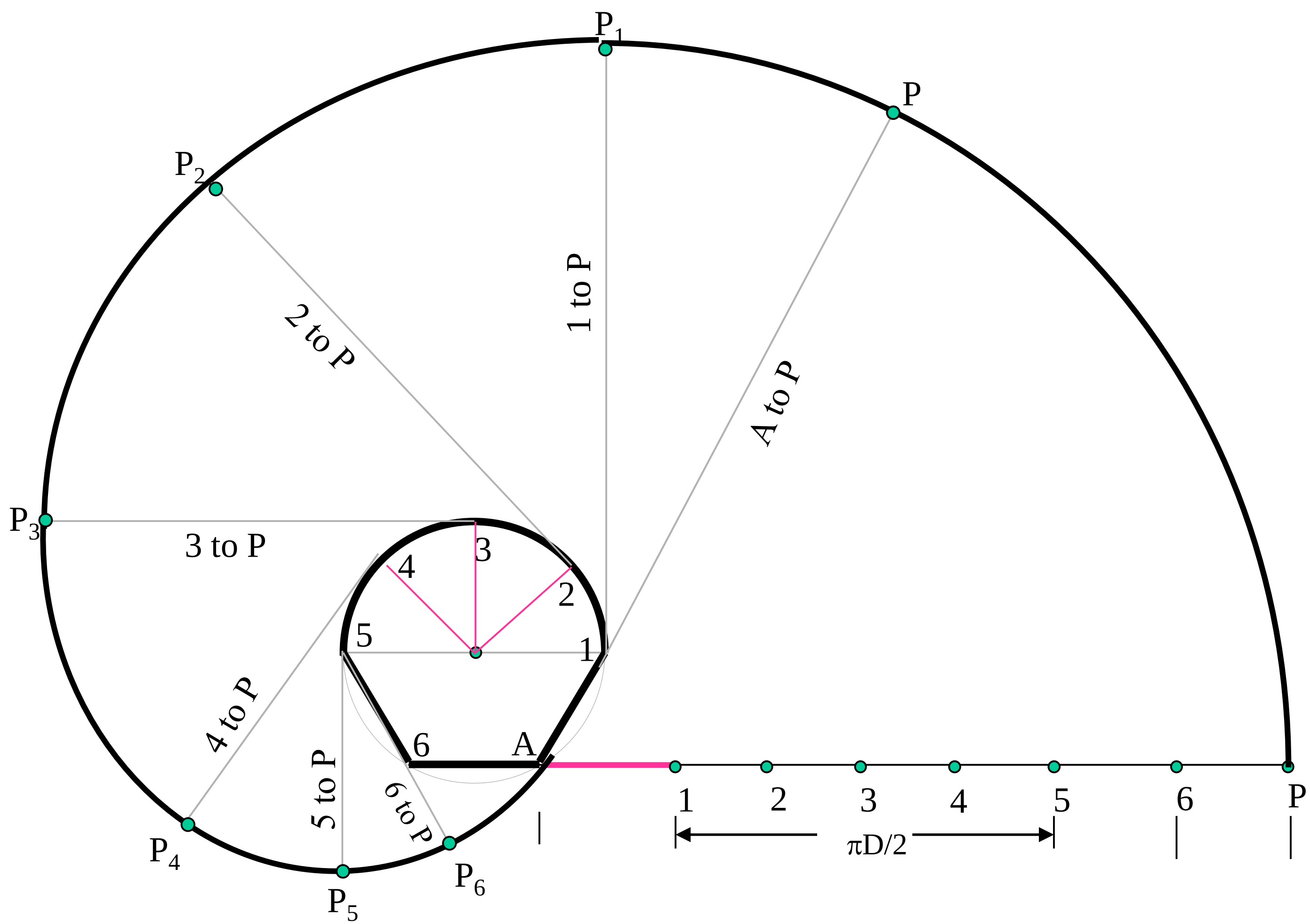
Solution Steps:
In this case string length is Less than Π D.
But remember!
Whatever may be the length of string, mark Π D distance horizontal i.e.along the string and divide it in 8 number of equal parts, and not any other distance. Rest all steps are same as previous INVOLUTE. Draw the curve completely.



PROBLEM 20 : A POLE IS OF A SHAPE OF HALF HEXABON AND SEMICIRCLE. ASTRING IS TO BE WOUND HAVING LENGTH EQUAL TO THE POLE PERIMETER DRAW PATH OF FREE END *P* OF STRING WHEN WOUND COMPLETELY.
(Take hex 30 mm sides and semicircle of 60 mm diameter.)

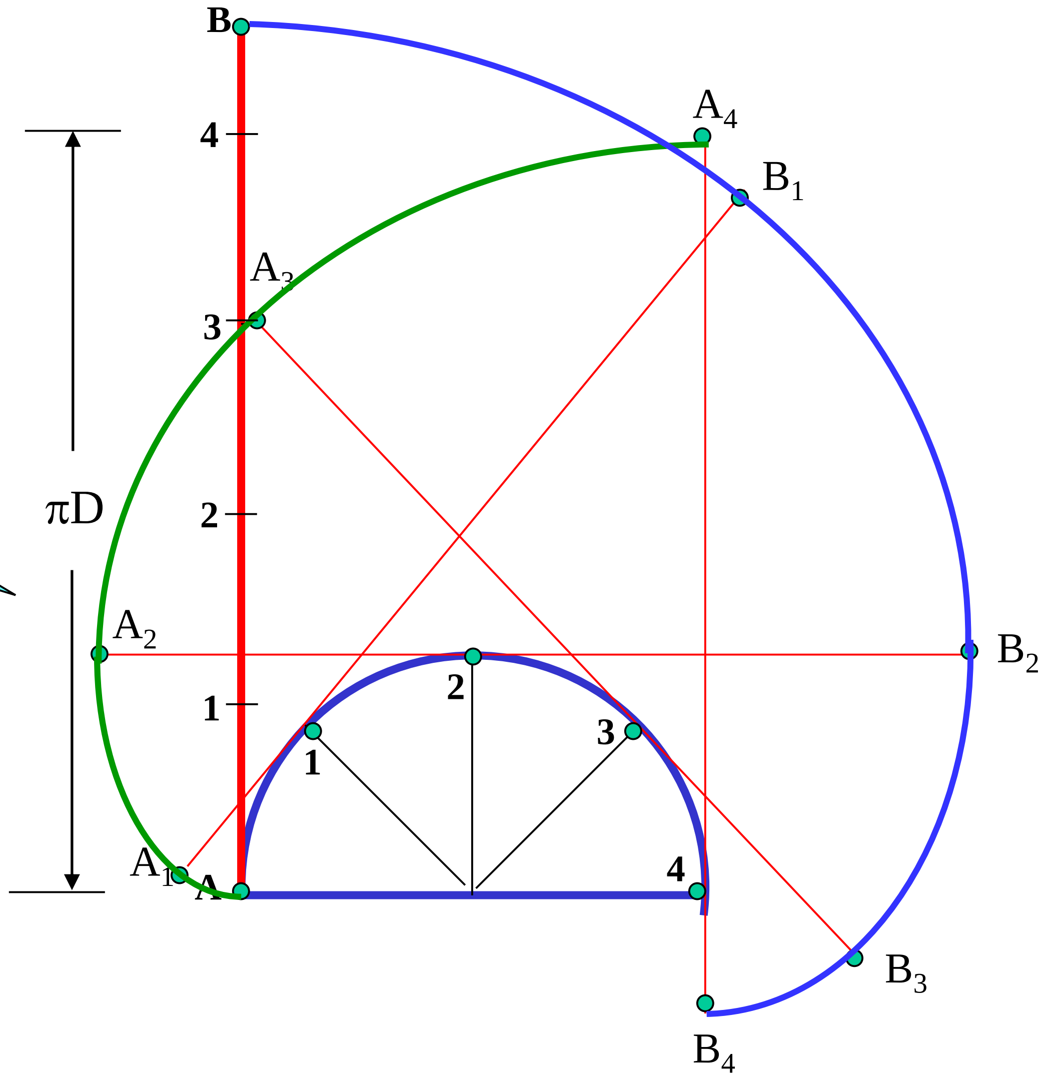
INVOLUTE OF COMPOSIT SHAPED POLE

SOLUTION STEPS:
Draw pole shape as per dimensions.
Divide semicircle in 4 parts and name those along with corners of hexagon.
Calculate perimeter length.
Show it as string AP.
On this line mark 30mm from A
Mark and name it 1
Mark $\pi D/2$ distance on it from 1
And dividing it in 4 parts name 2,3,4,5.
Mark point 6 on line 30 mm from 5
Now draw tangents from all points of pole and proper lengths as done in all previous involute's problems and complete the curve.



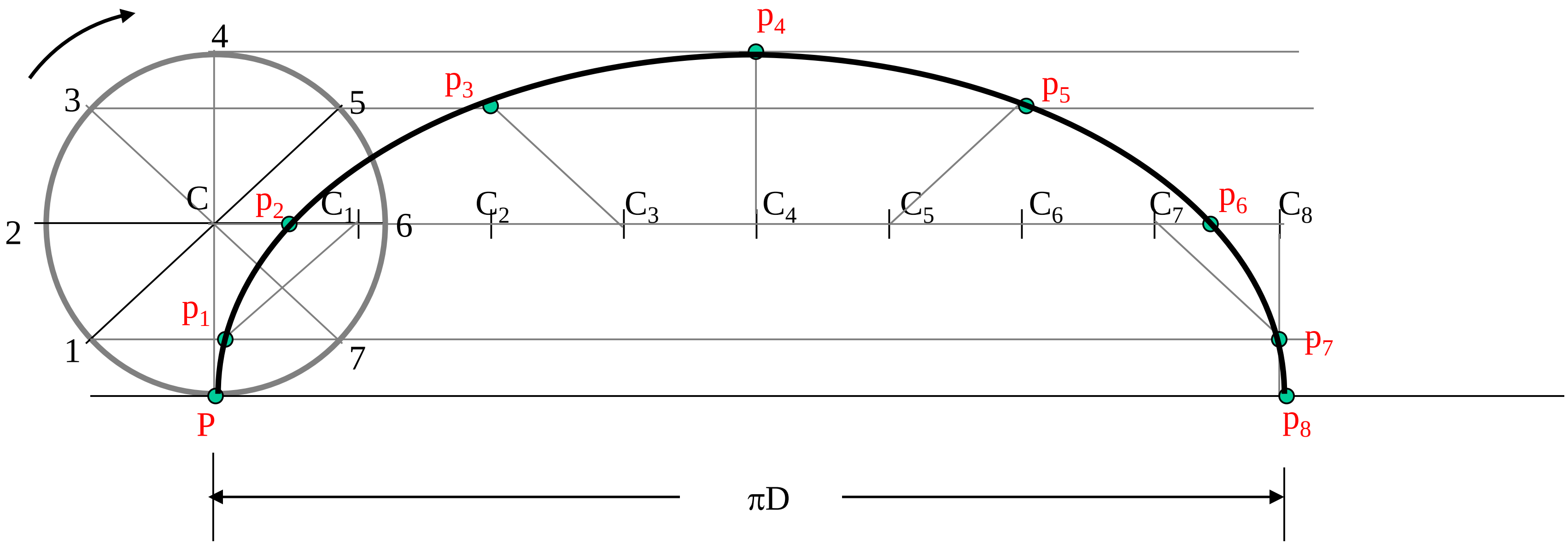
PROBLEM 21 : Rod AB 85 mm long rolls over a semicircular pole without slipping from it's initially vertical position till it becomes up-side-down vertical.
Draw locus of both ends A & B.

Solution Steps?
If you have studied previous problems properly, you can surely solve this also.
Simply remember that this being a rod, it will roll over the surface of pole.
Means when one end is approaching, other end will move away from poll.
OBSERVE ILLUSTRATION CAREFULLY!



PROBLEM 22: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON STRAIGHT LINE PATH. Take Circle diameter as 50 mm

CYCLOID

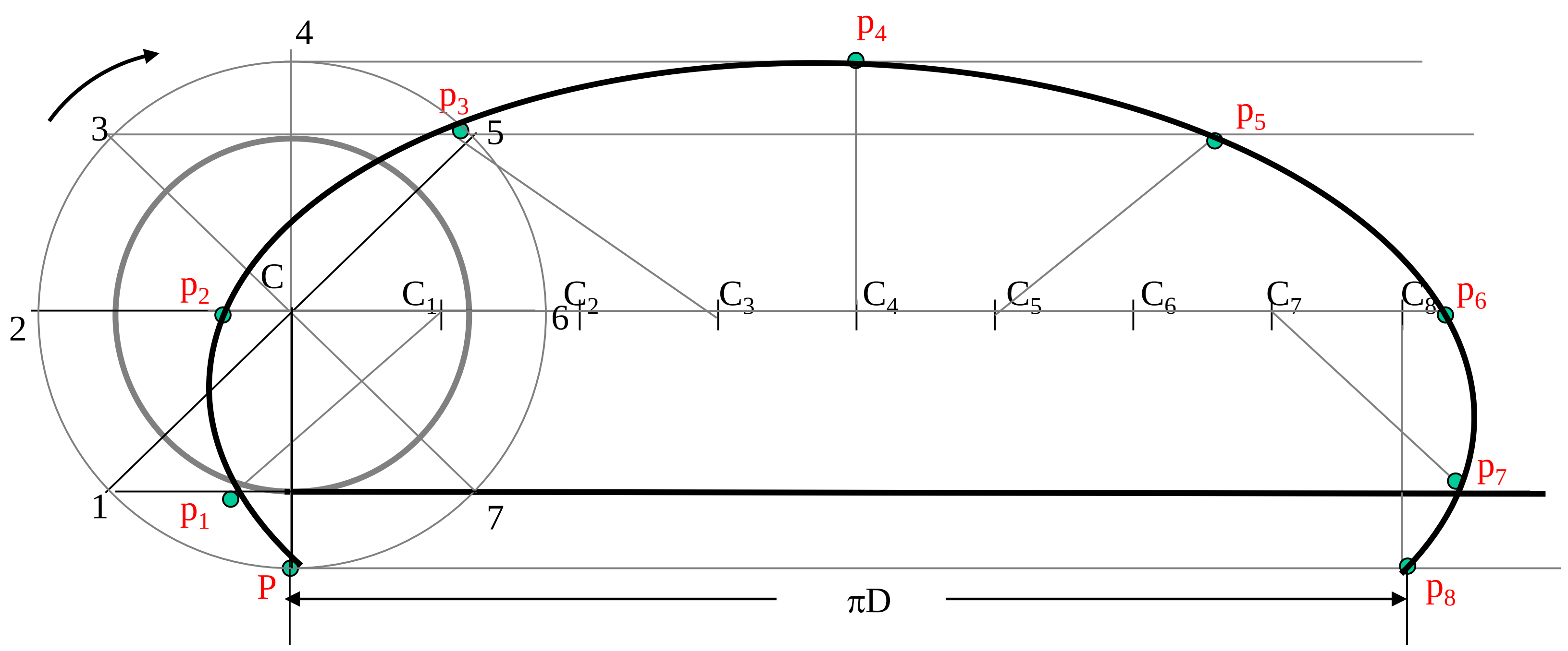


Solution Steps:

1) From center C draw a horizontal line equal to πD distance.
2) Divide πD distance into 8 number of equal parts and name them C1, C2, C3__ etc.
3) Divide the circle also into 8 number of equal parts and in clock wise direction, after P name 1, 2, 3 up to 8.
4) From all these points on circle draw horizontal lines. (parallel to locus of C)
5) With a fixed distance C-P in compass, C1 as center, mark a point on horizontal line from 1. Name it P.
6) Repeat this procedure from C2, C3, C4 upto C8 as centers. Mark points P2, P3, P4, P5 up to P8 on the horizontal lines drawn from 2, 3, 4, 5, 6, 7 respectively.
7) Join all these points by curve. **It is Cycloid**.

PROBLEM 23: DRAW LOCUS OF A POINT , **5 MM** AWAY FROM THE PERIPHERY OF A CIRCLE WHICH ROLLS ON STRAIGHT LINE PATH. **Take Circle diameter as 50 mm**

SUPERIOR TROCHOID

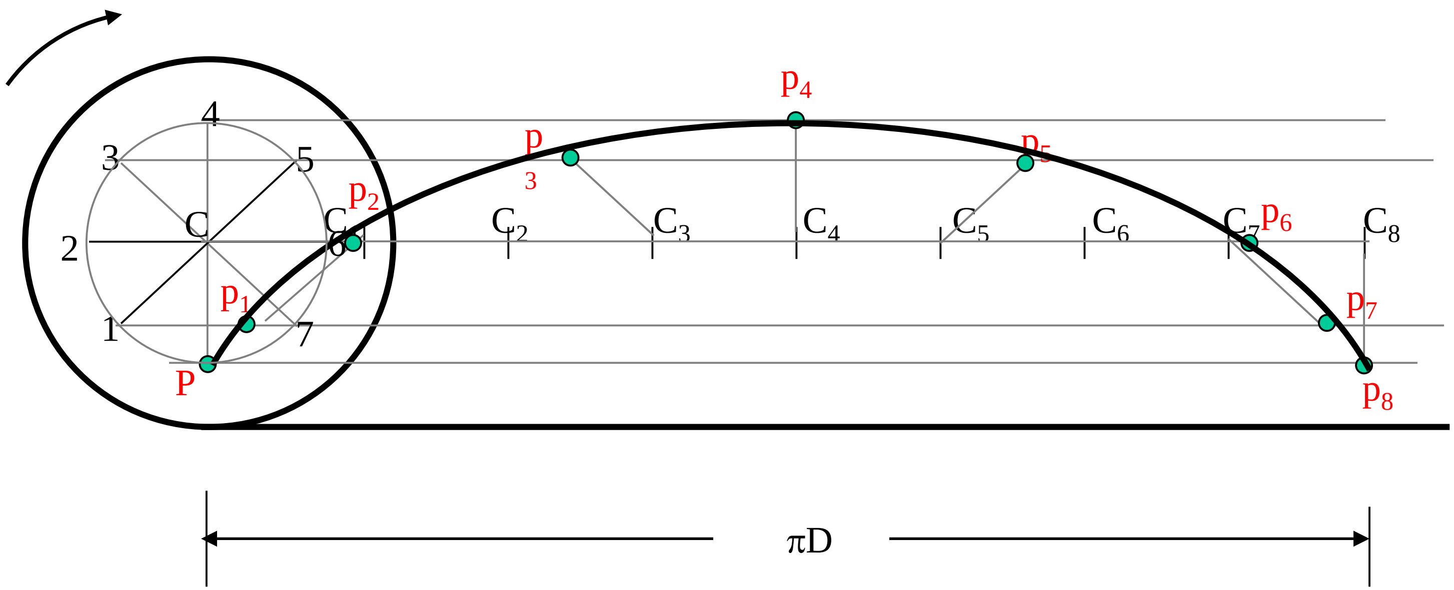


Solution Steps:

1) Draw circle of given diameter and draw a horizontal line from it's center C of length Π D and divide it in 8 number of equal parts and name them C1, C2, C3, up to C8.
2) Draw circle by CP radius, as in this case CP is larger than radius of circle.
3) Now repeat steps as per the previous problem of cycloid, by dividing this new circle into 8 number of equal parts and drawing lines from all these points parallel to locus of C and taking CP radius wit different positions of C as centers, cut these lines and get different positions of P and join
4) This curve is called **Superior Trochoid.**

PROBLEM 24: DRAW LOCUS OF A POINT , **5 MM** INSIDE THE PERIPHERY OF A CIRCLE WHICH ROLLS ON STRAIGHT LINE PATH. **Take Circle diameter as 50 mm**

INFERIOR TROCHOID



Solution Steps:

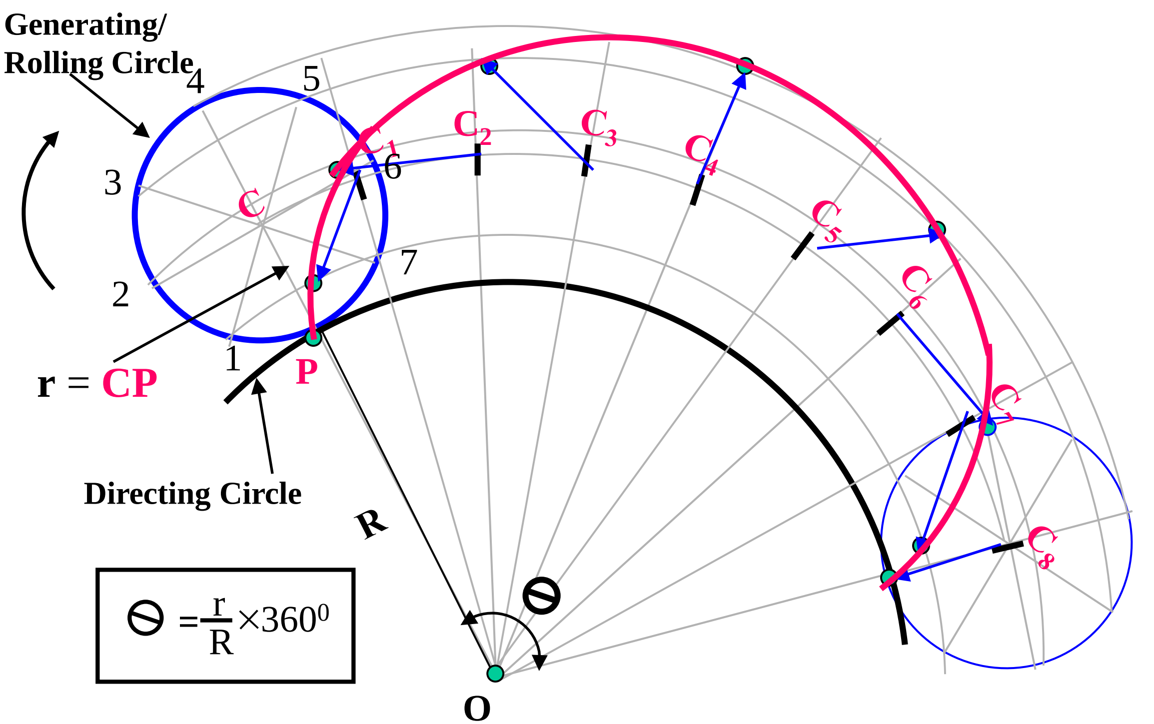
1) Draw circle of given diameter and draw a horizontal line from it's center C of length Π D and divide it in 8 number of equal parts and name them C1, C2, C3, up to C8.
2) Draw circle by CP radius, as in this case CP is SHORTER than radius of circle.
3) Now repeat steps as per the previous problem of cycloid, by dividing this new circle into 8 number of equal parts and drawing lines from all these points parallel to locus of C and taking CP radius with different positions of C as centers, cut these lines and get different positions of P and join those in curvature.
4) This curve is called **Inferior Trochoid**.

PROBLEM 25: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON A CURVED PATH. **Take diameter of rolling Circle 50 mm And radius of directing circle i.e. curved path, 75 mm.**

EPI CYCLOID :

Solution Steps:

1) When smaller circle will roll on larger circle for one revolution it will cover Π D distance on arc and it will be decided by included arc angle θ.
2) Calculate θ by formula θ = (r/R) x 3600.
3) Construct angle θ with radius OC and draw an arc by taking O as center OC as radius and form sector of angle θ.
4) Divide this sector into 8 number of equal angular parts. And from C onward name them C1, C2, C3 up to C8.
5) Divide smaller circle (Generating circle) also in 8 number of equal parts. And next to P in clockwise direction name those 1, 2, 3, up to 8.
6) With O as center, O-1 as radius draw an arc in the sector. Take O-2, O-3, O-4, O-5 up to O-8 distances with center O, draw all concentric arcs in sector. Take fixed distance C-P in compass, C1 center, cut arc of 1 at P1. Repeat procedure and locate P2, P3, P4, P5 unto P8 (as in cycloid) and join them by smooth curve. This is EPI – CYCLOID.

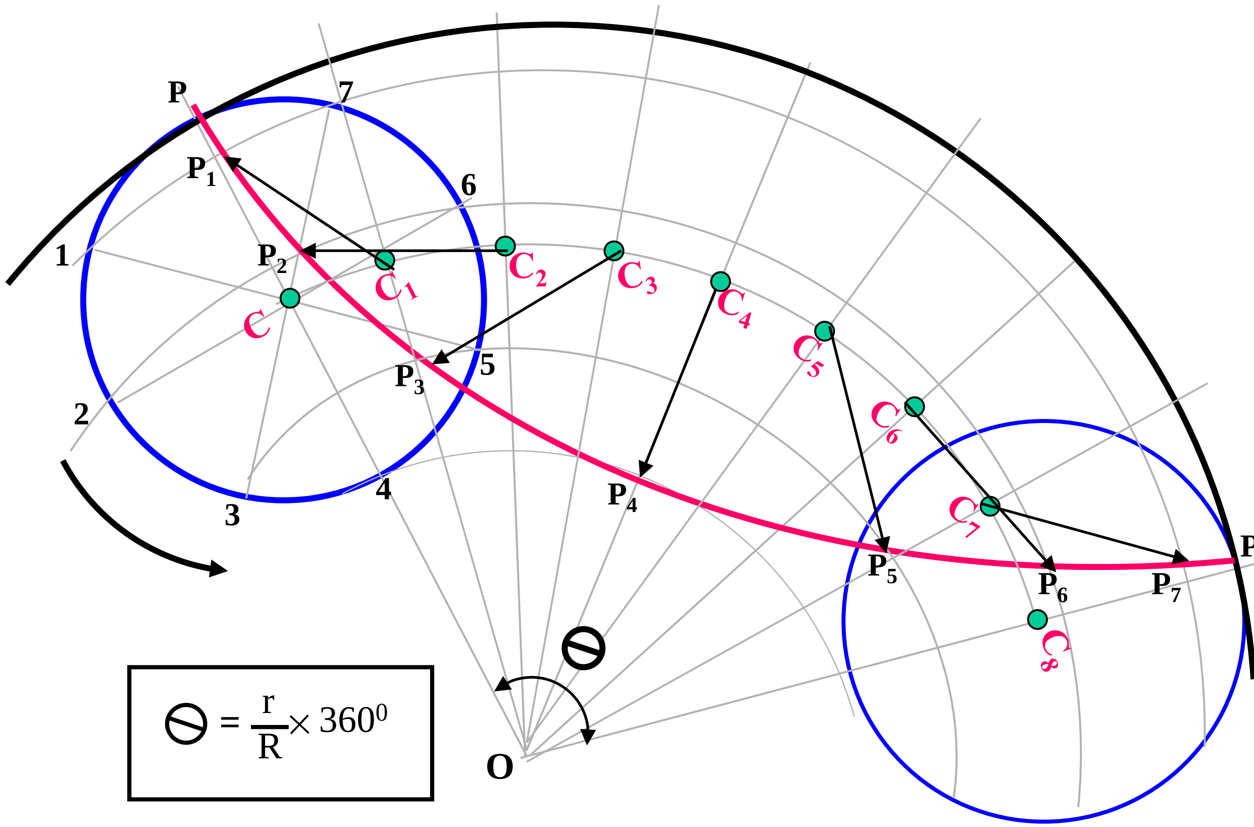


PROBLEM 26: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS FROM THE INSIDE OF A CURVED PATH. **Take diameter of rolling circle 50 mm and radius of directing circle (curved path) 75 mm.**

HYPO CYCLOID

Solution Steps:

1) Smaller circle is rolling here, inside the larger circle. It has to rotate anticlockwise to move ahead.
2) Same steps should be taken as in case of EPI – CYCLOID. Only change is in numbering direction of 8 number of equal parts on the smaller circle.
3) From next to P in anticlockwise direction, name 1,2,3,4,5,6,7,8.
4) Further all steps are that of epi – cycloid. **This is called HYPO – CYCLOID.**



$$\theta = \frac{r}{R} \times 360^0$$

OC = R (Radius of Directing Circle)

CP = r (Radius of Generating Circle)

Problem 27: Draw a spiral of one convolution. Take distance PO 40 mm.

SPIRAL

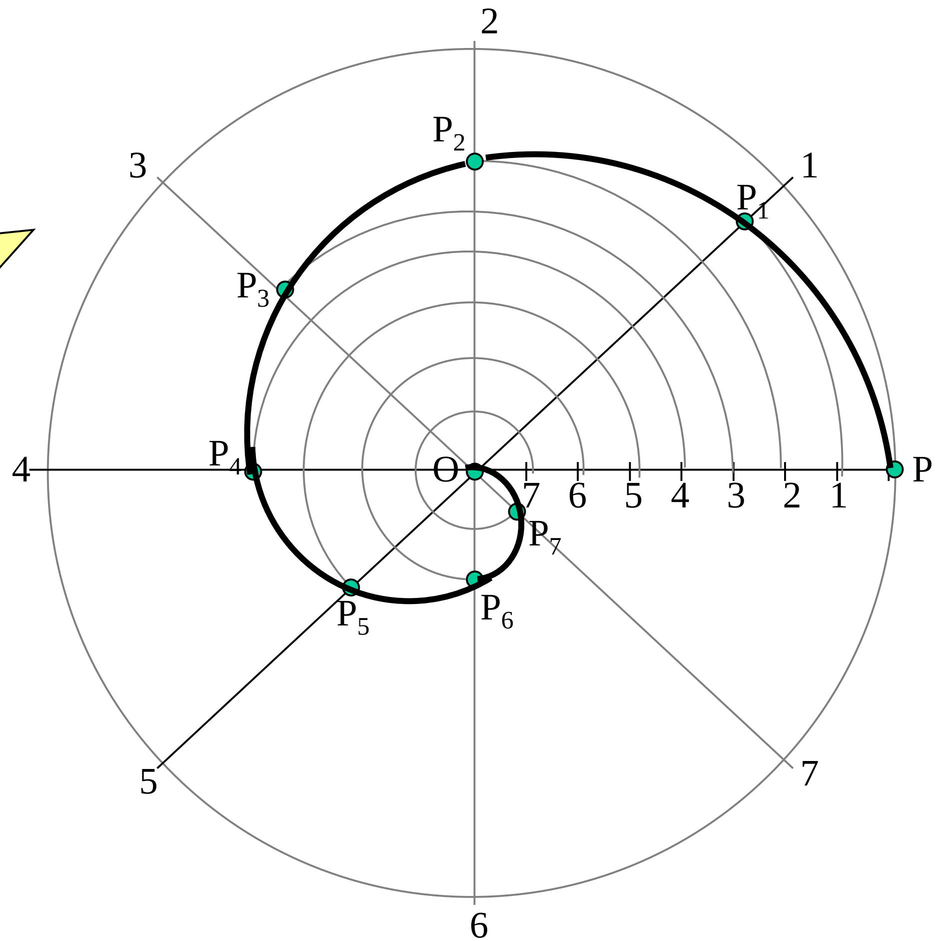
IMPORTANT APPROACH FOR CONSTRUCTION!

FIND TOTAL ANGULAR AND TOTAL LINEAR DISPLACEMENT AND DIVIDE BOTH IN TO SAME NUMBER OF EQUAL PARTS.

Solution Steps

1. With PO radius draw a circle and divide it in EIGHT parts. Name those 1,2,3,4, etc. up to 8
2 .Similarly divided line PO also in EIGHT parts and name those 1,2,3,-- as shown.
3. Take o-1 distance from op line and draw an arc up to O1 radius vector. Name the point P_1
4. Similarly mark points P_2, P_3, P_4 up to P_8 And join those in a smooth curve.

It is a SPIRAL of one convolution.



Problem 28

Point P is 80 mm from point O. It starts moving towards O and reaches it in two revolutions around.it Draw locus of point P (To draw a Spiral of TWO convolutions).

SPIRAL of two convolutions

IMPORTANT APPROACH FOR CONSTRUCTION!

FIND TOTAL ANGULAR AND TOTAL LINEAR DISPLACEMENT AND DIVIDE BOTH IN TO SAME NUMBER OF EQUAL PARTS.

SOLUTION STEPS:

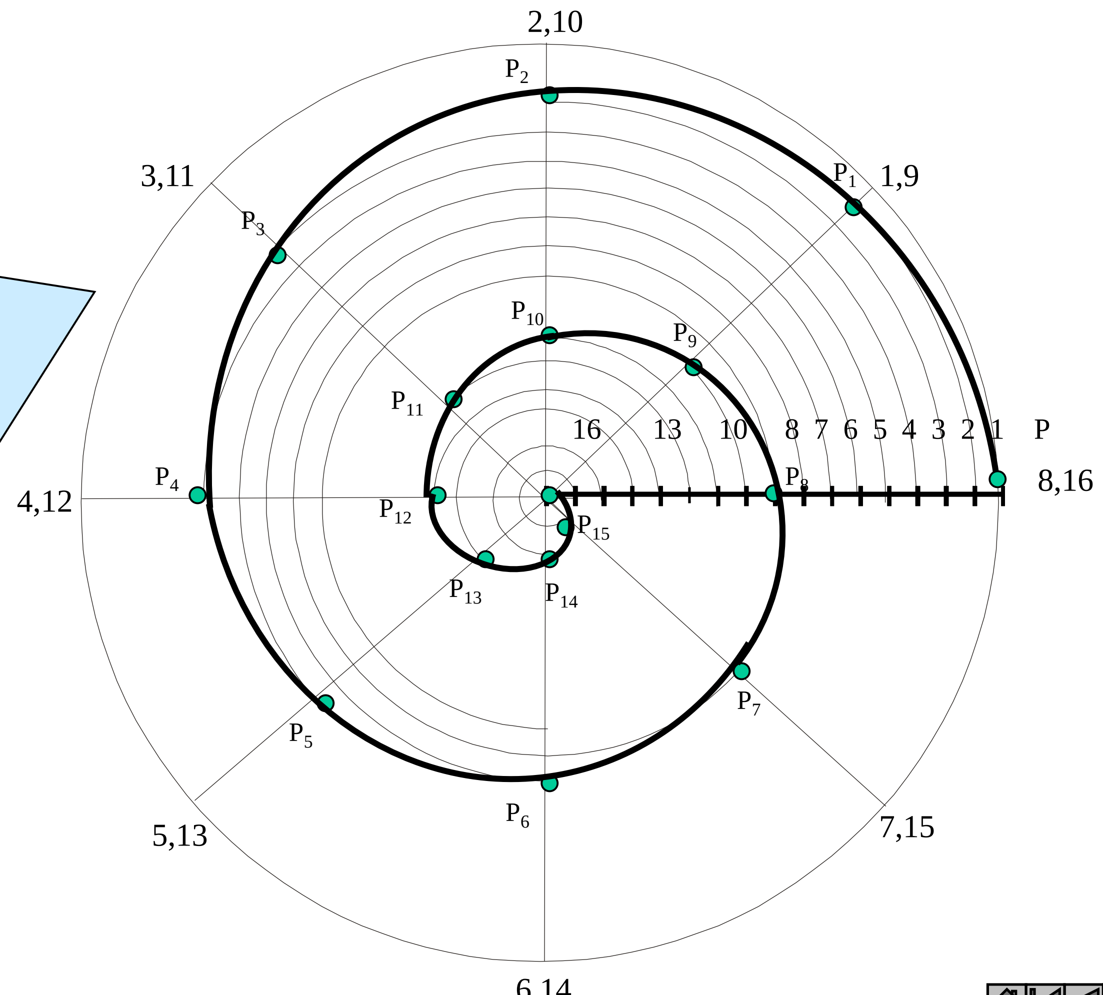
Total angular displacement here is two revolutions And Total Linear displacement here is distance PO.

Just divide both in same parts i.e. Circle in EIGHT parts.

(means total angular displacement in SIXTEEN parts)

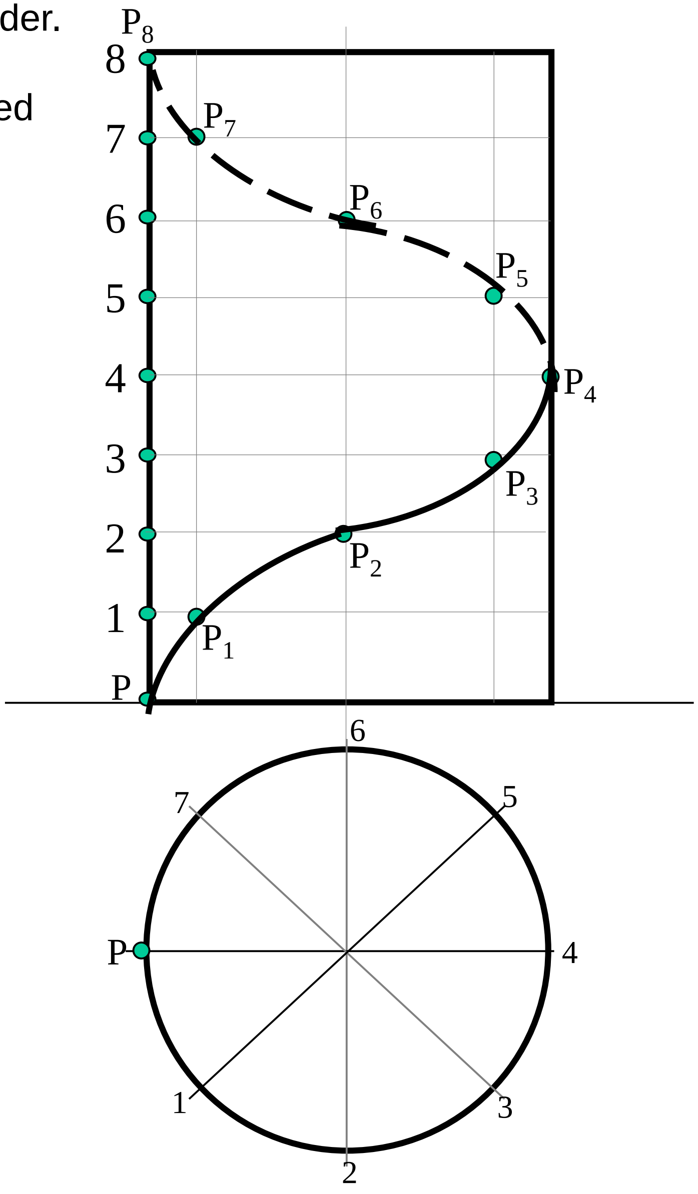
Divide PO also in SIXTEEN parts.

Rest steps are similar to the previous problem.



PROBLEM: Draw a helix of one convolution, upon a cylinder.
Given 80 mm pitch and 50 mm diameter of a cylinder.
(The axial advance during one complete revolution is called
The *pitch* of the helix)

SOLUTION:
Draw projections of a cylinder.
Divide circle and axis in to same no. of equal parts. (8)
Name those as shown.
Mark initial position of point 'P'
Mark various positions of *P* as shown in animation.
Join all points by smooth possible curve.
Make upper half dotted, as it is going behind the solid
and hence will not be seen from front side.

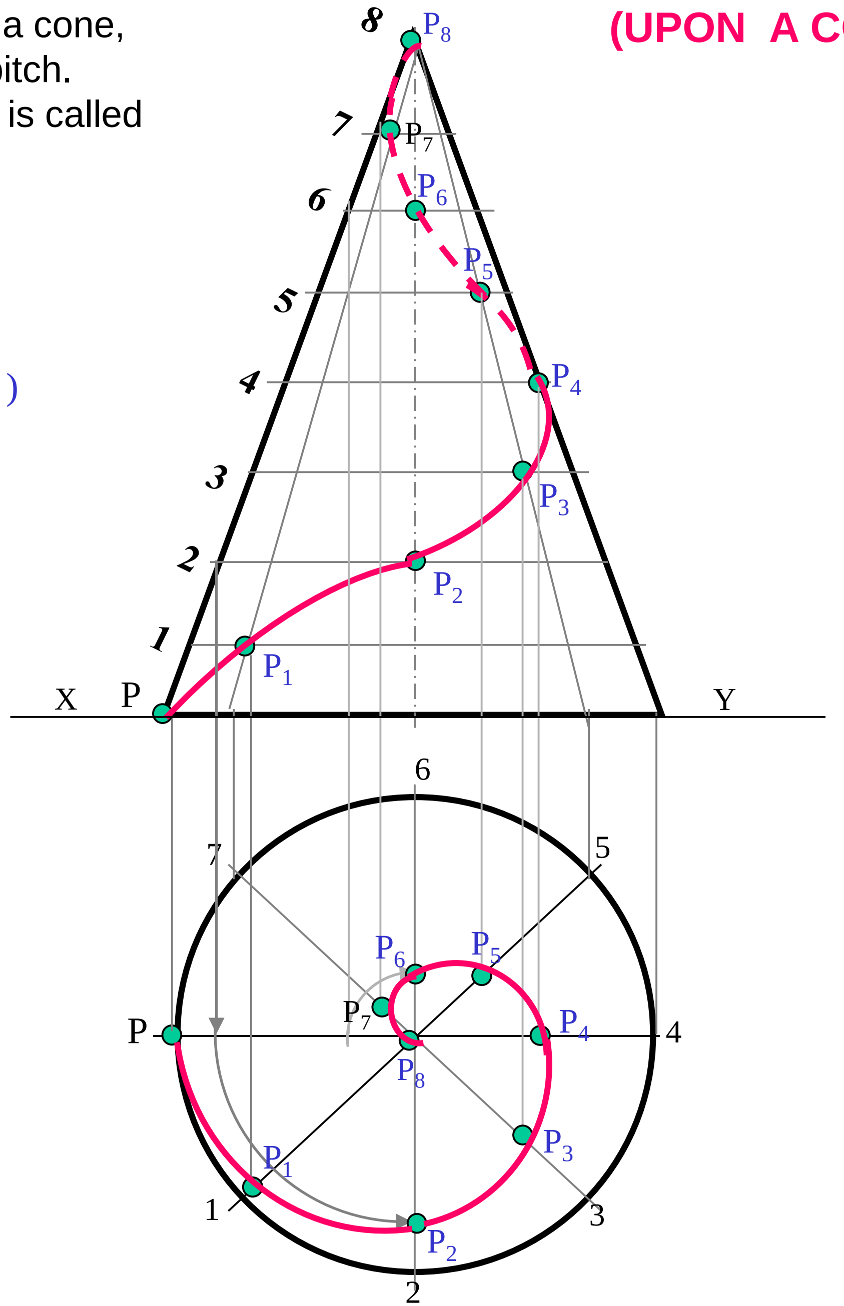


HELIX
(UPON A CONE)

PROBLEM: Draw a helix of one convolution, upon a cone, diameter of base 70 mm, axis 90 mm and 90 mm pitch.
(The axial advance during one complete revolution is called The *pitch* of the helix)

SOLUTION:

Draw projections of a cone
Divide circle and axis in to same no. of equal parts. (8)
Name those as shown.
Mark initial position of point 'P'
Mark various positions of *P* as shown in animation.
Join all points by smooth possible curve.
Make upper half dotted, as it is going behind the solid and hence will not be seen from front side.



Involute
Method of Drawing Tangent & Normal

STEPS:
DRAW INVOLUTE AS USUAL.

MARK POINT **Q** ON IT AS DIRECTED.

JOIN **Q** TO THE CENTER OF CIRCLE **C**.
CONSIDERING **CQ** DIAMETER, DRAW A SEMICIRCLE AS SHOWN.

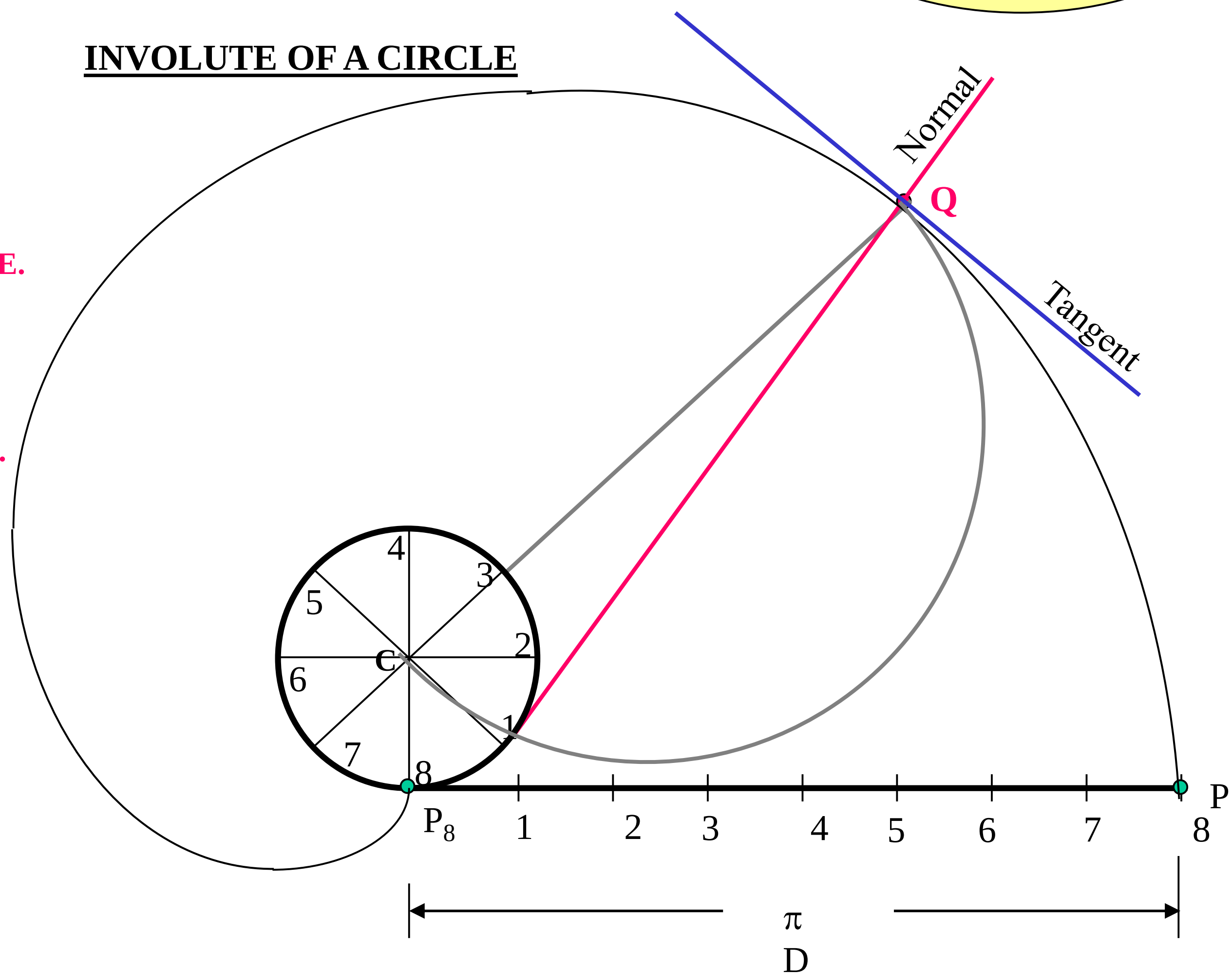
MARK POINT OF INTERSECTION OF THIS SEMICIRCLE AND POLE CIRCLE AND JOIN IT TO **Q.**

THIS WILL BE **NORMAL TO INVOLUTE.**

DRAW A LINE AT RIGHT ANGLE TO THIS LINE FROM **Q.**

IT WILL BE TANGENT TO INVOLUTE.

INVOLUTE OF A CIRCLE



CYCLOID Method of Drawing Tangent & Normal

STEPS:
DRAW CYCLOID AS USUAL.
MARK POINT **Q** ON IT AS DIRECTED.

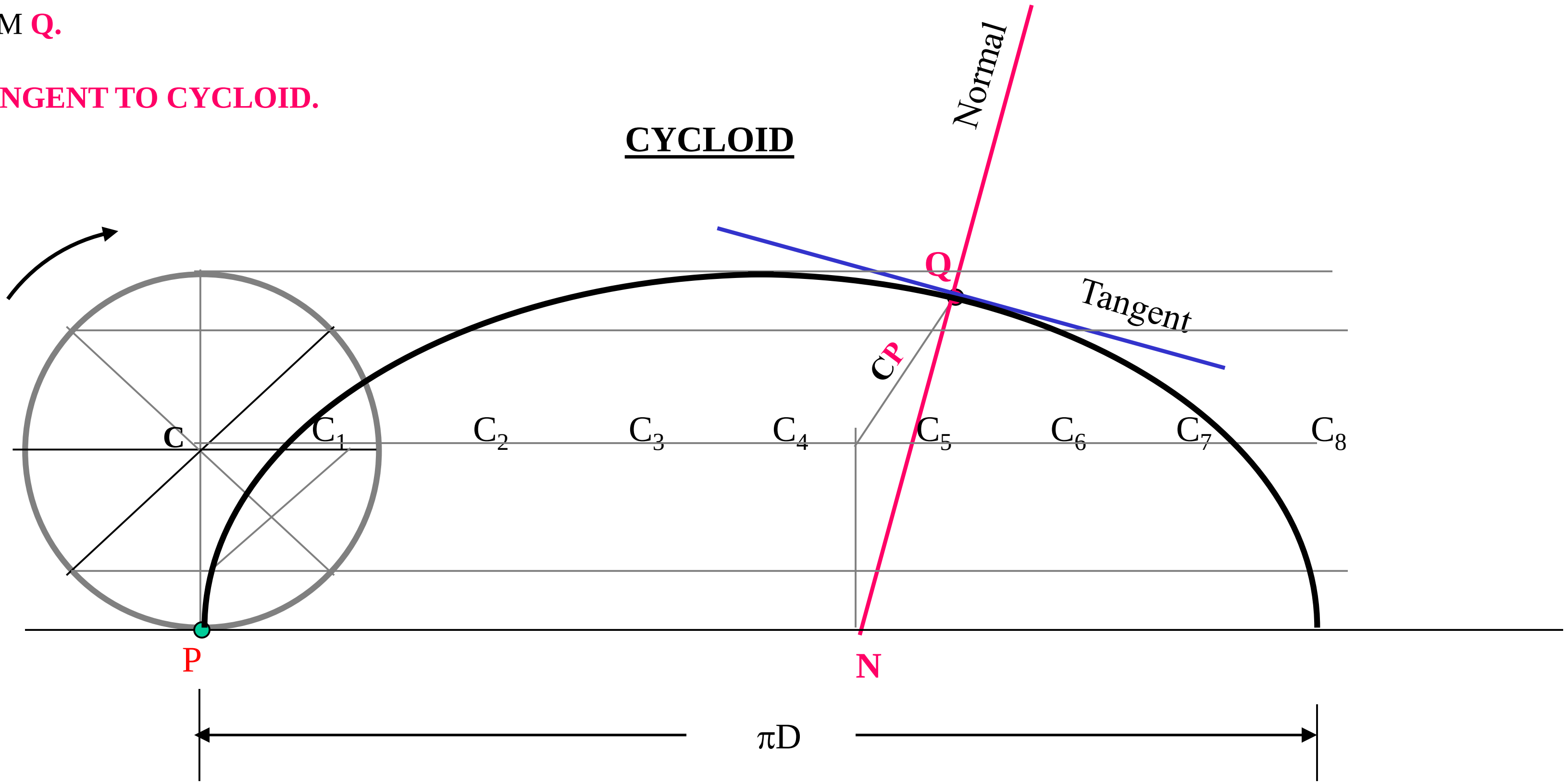
WITH CP DISTANCE, FROM **Q.** CUT THE POINT ON LOCUS OF **C** AND JOIN IT TO **Q.**

FROM THIS POINT DROP A PERPENDICULAR ON GROUND LINE AND NAME IT N

JOIN N WITH Q.THIS WILL BE **NORMAL TO CYCLOID.**

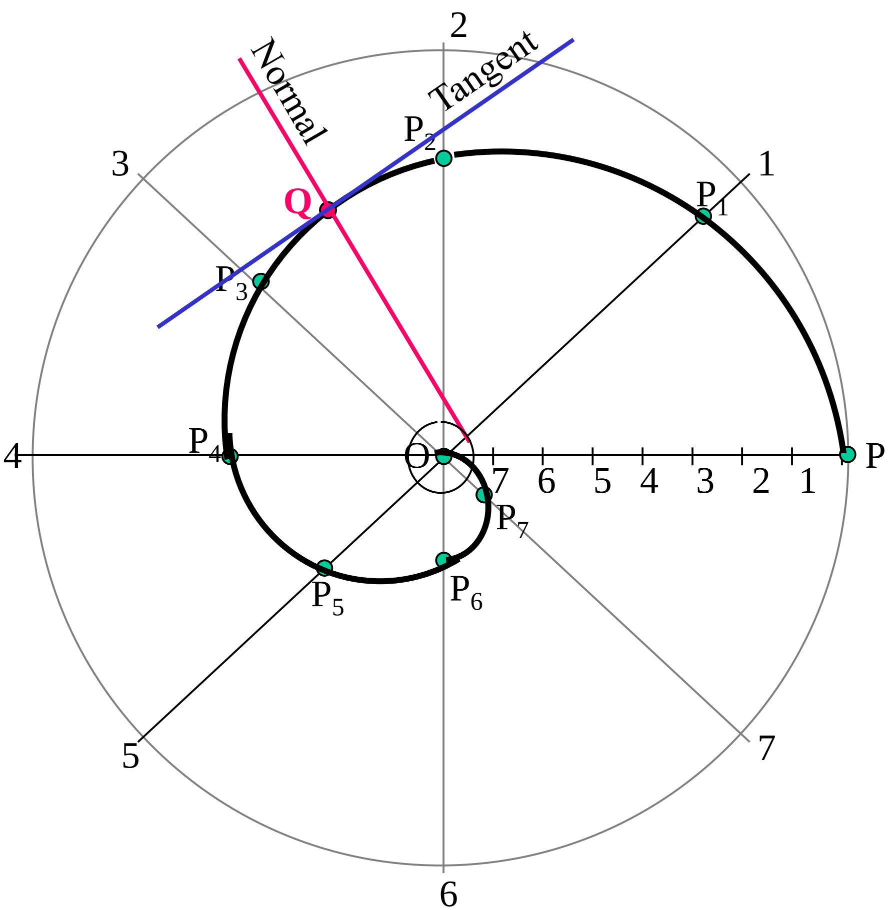
DRAW A LINE AT RIGHT ANGLE TO THIS LINE FROM **Q.**

IT WILL BE TANGENT TO CYCLOID.



Spiral. Method of Drawing Tangent & Normal

SPIRAL (ONE CONVOLUSION.)



$$\text{Constant of the Curve} = \frac{\text{Difference in length of any radius vectors}}{\text{Angle between the corresponding radius vector in radian.}}$$

$$= \frac{OP - OP_2}{\pi/2} = \frac{OP - OP_2}{1.57}$$

$= 3.185$ m.m.

STEPS:

*DRAW SPIRAL AS USUAL.
DRAW A SMALL CIRCLE OF RADIUS EQUAL TO THE CONSTANT OF CURVE CALCULATED ABOVE.

* LOCATE POINT **Q** AS DISCRIBED IN PROBLEM AND THROUGH IT DRAW A TANGENTTO THIS SMALLER CIRCLE.THIS IS A **NORMAL** TO THE SPIRAL.

*DRAW A LINE AT RIGHT ANGLE

*TO THIS LINE FROM **Q.**
IT WILL BE TANGENT TO CYCLOID.

LOCUS

It is a path traced out by a point moving in a plane, in a particular manner, for one cycle of operation.

The cases are classified in THREE categories for easy understanding.

A} Basic Locus Cases.

B} Oscillating Link……

C} Rotating Link………

Basic Locus Cases:

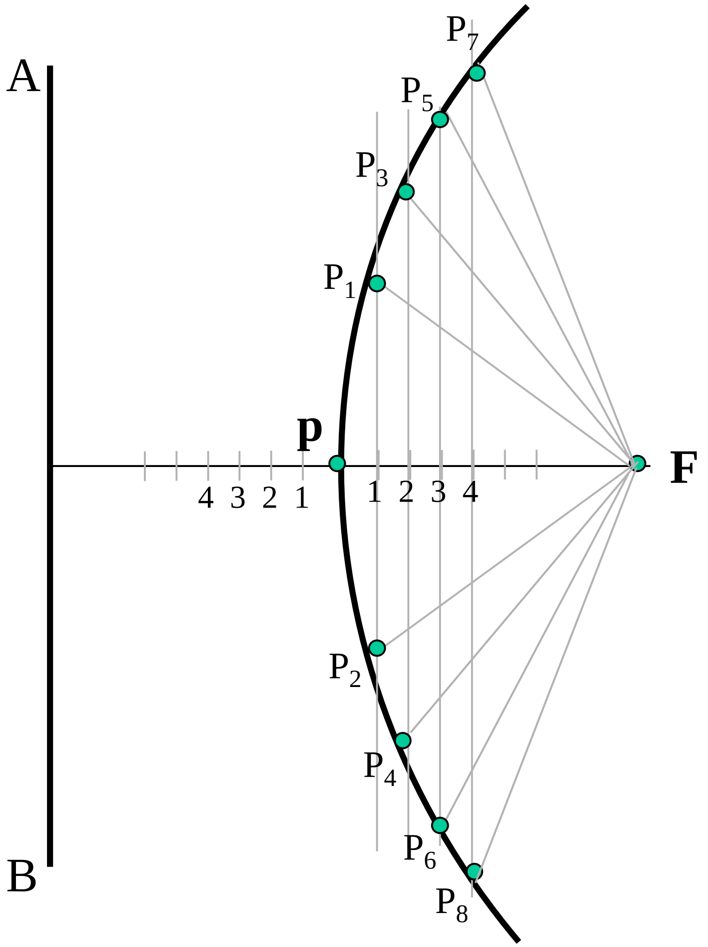
Here some geometrical objects like point, line, circle will be described with there relative Positions. Then one point will be allowed to move in a plane maintaining specific relation with above objects. And studying situation carefully you will be asked to draw it's locus.

Oscillating & Rotating Link:

Here a link oscillating from one end or rotating around it's center will be described. Then a point will be allowed to slide along the link in specific manner. And now studying the situation carefully you will be asked to draw it's locus.

STUDY TEN CASES GIVEN ON NEXT PAGES

PROBLEM 1.: Point F is 50 mm from a vertical straight line AB. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AB.



SOLUTION STEPS:

1.Locate center of line, perpendicular to AB from point F. This will be initial point P.
2.Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw lines parallel to AB.
3.Mark 5 mm distance to its left of P and name it 1.
4.Take F-1 distance as radius and F as center draw an arc cutting first parallel line to AB. Name upper point P_1 and lower point P_2.
5.Similarly repeat this process by taking again 5mm to right and left and locate P_3P_4.
6.Join all these points in smooth curve.

It will be the locus of P equidistance from line AB and fixed point F.

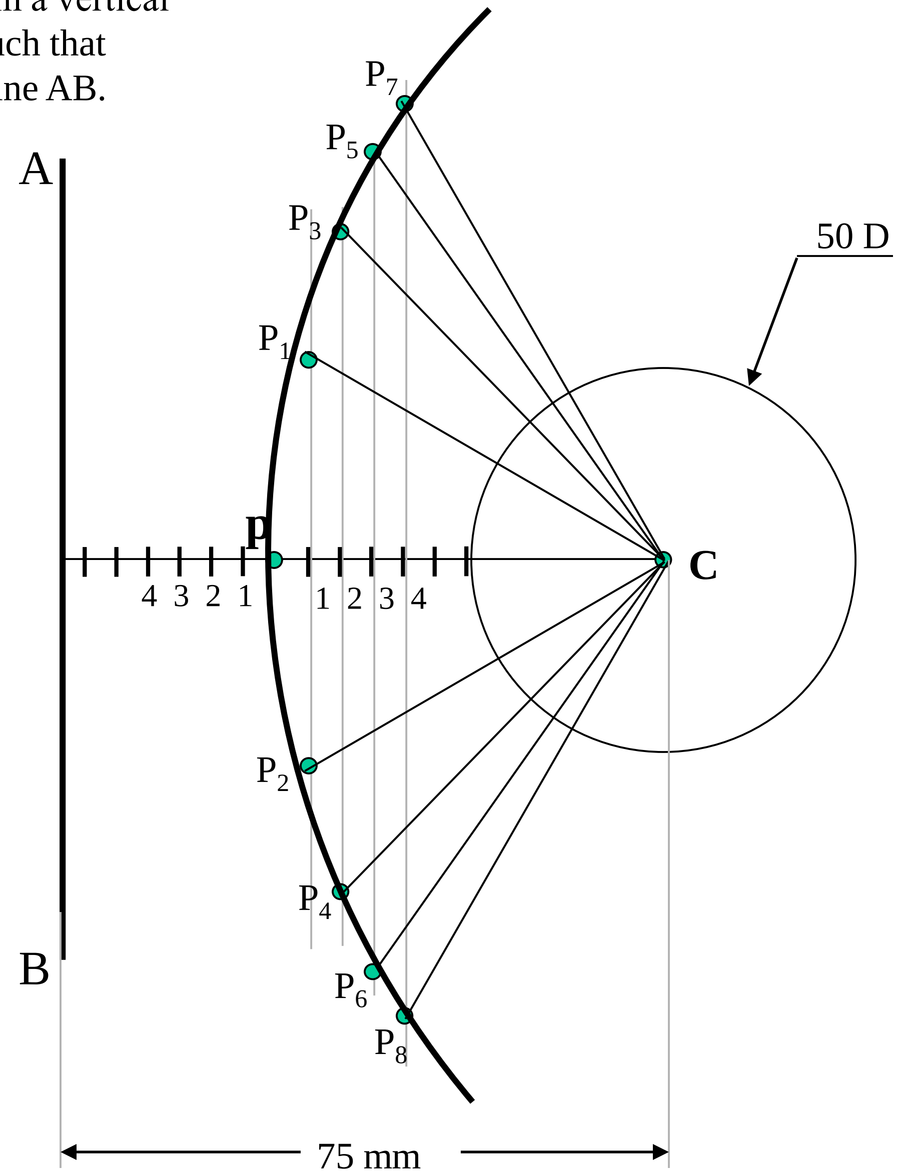
PROBLEM 2 :

A circle of 50 mm diameter has it's center 75 mm from a vertical line AB.. Draw locus of point P, moving in a plane such that it always remains equidistant from given circle and line AB.

SOLUTION STEPS:

1.Locate center of line, perpendicular to AB from the periphery of circle. This will be initial point P.
2.Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw lines parallel to AB.
3.Mark 5 mm distance to its left of P and name it 1,2,3,4.
4.Take C-1 distance as radius and C as center draw an arc cutting first parallel line to AB. Name upper point P_1 and lower point P_2.
5.Similarly repeat this process by taking again 5mm to right and left and locate P_3P_4.
6.Join all these points in smooth curve.

It will be the locus of P equidistance from line AB and given circle.



PROBLEM 3 :

Center of a circle of 30 mm diameter is 90 mm away from center of another circle of 60 mm diameter. Draw locus of point P, moving in a plane such that it always remains equidistant from given two circles.

SOLUTION STEPS:

1.Locate center of line,joining two centers but part in between periphery of two circles.Name it P. This will be initial point P.

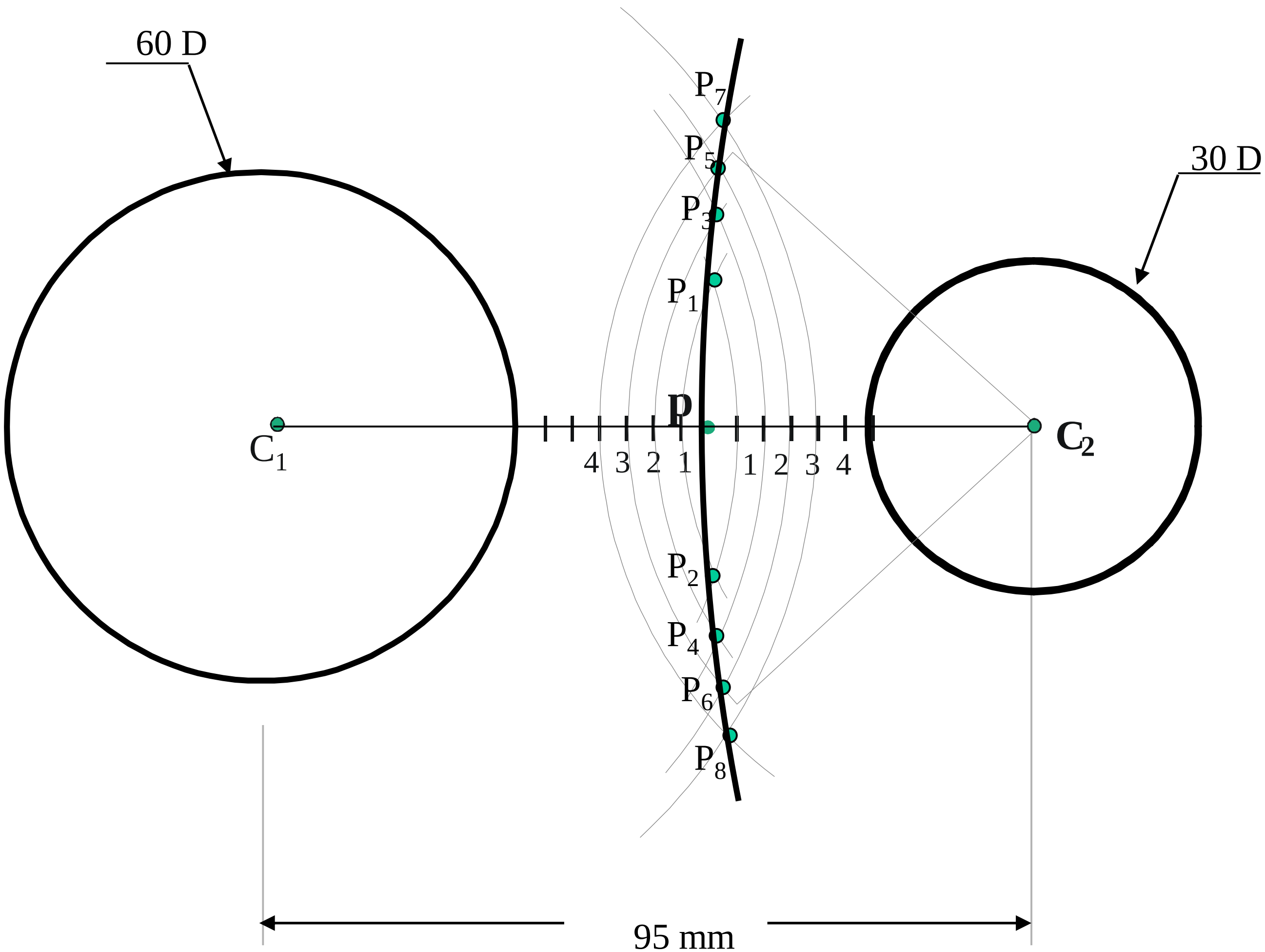
2.Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw arcs from C_1 As center.

3. Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw arcs from C_2 As center.

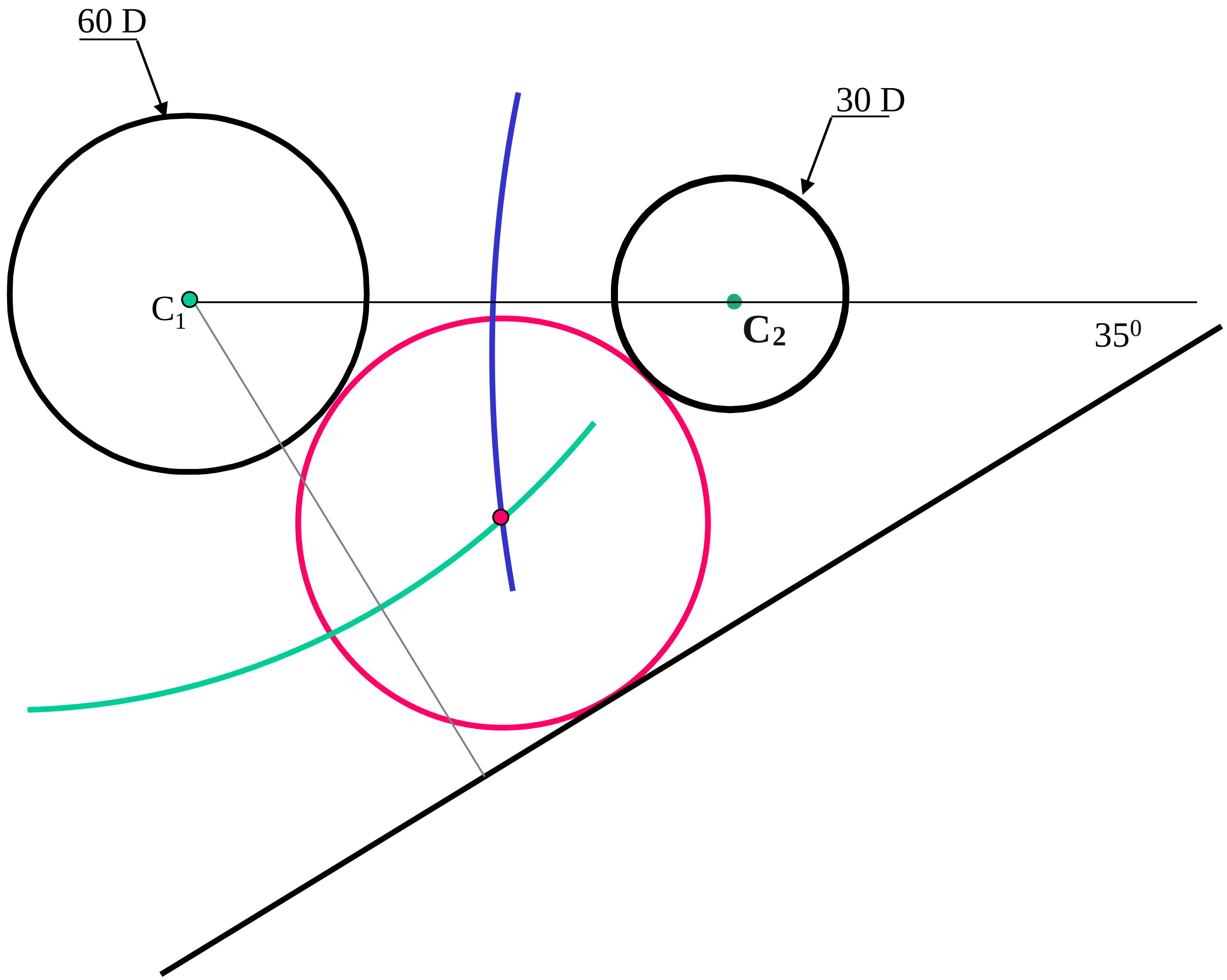
4.Mark various positions of P as per previous problems and name those similarly.

5.Join all these points in smooth curve.

It will be the locus of P equidistance from given two circles.



Problem 4: In the given situation there are two circles of different diameters and one inclined line AB, as shown. Draw one circle touching these three objects.



Solution Steps:

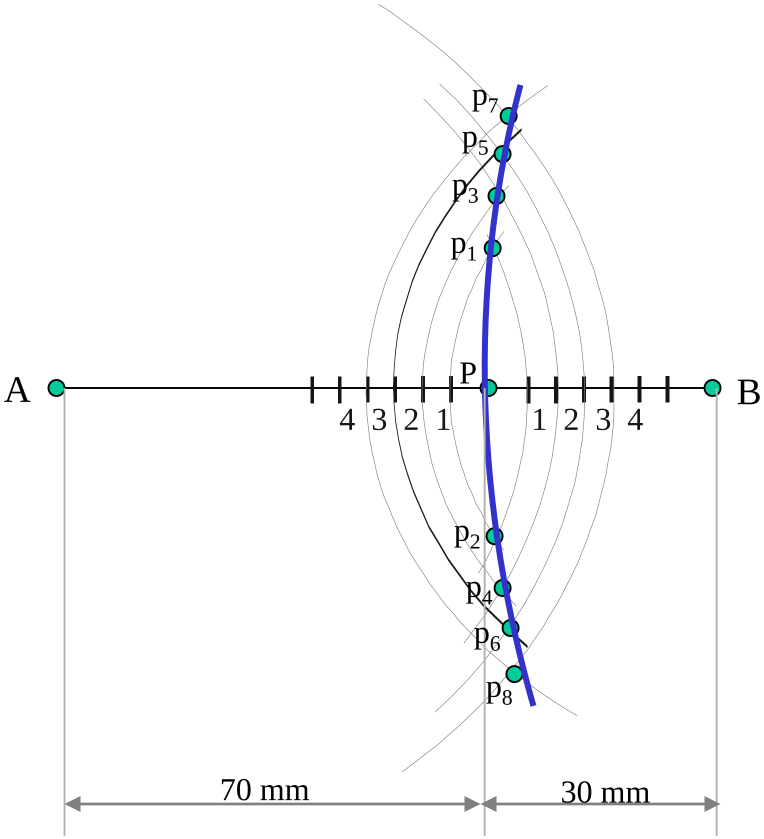
1) Here consider two pairs, one is a case of two circles with centres C_1 and C_2 and draw locus of point P equidistance from them.(As per solution of case D above).

2) Consider second case that of fixed circle (C_1) and fixed line AB and draw locus of point P equidistance from them. (as per solution of case B above).

3) Locate the point where these two loci intersect each other. Name it x. It will be the point equidistance from given two circles and line AB.

4) Take x as centre and its perpendicular distance on AB as radius, draw a circle which will touch given two circles and line AB.

Problem 5:-Two points A and B are 100 mm apart. There is a point P, moving in a plane such that the difference of it's distances from A and B always remains constant and equals to 40 mm. Draw locus of point P.



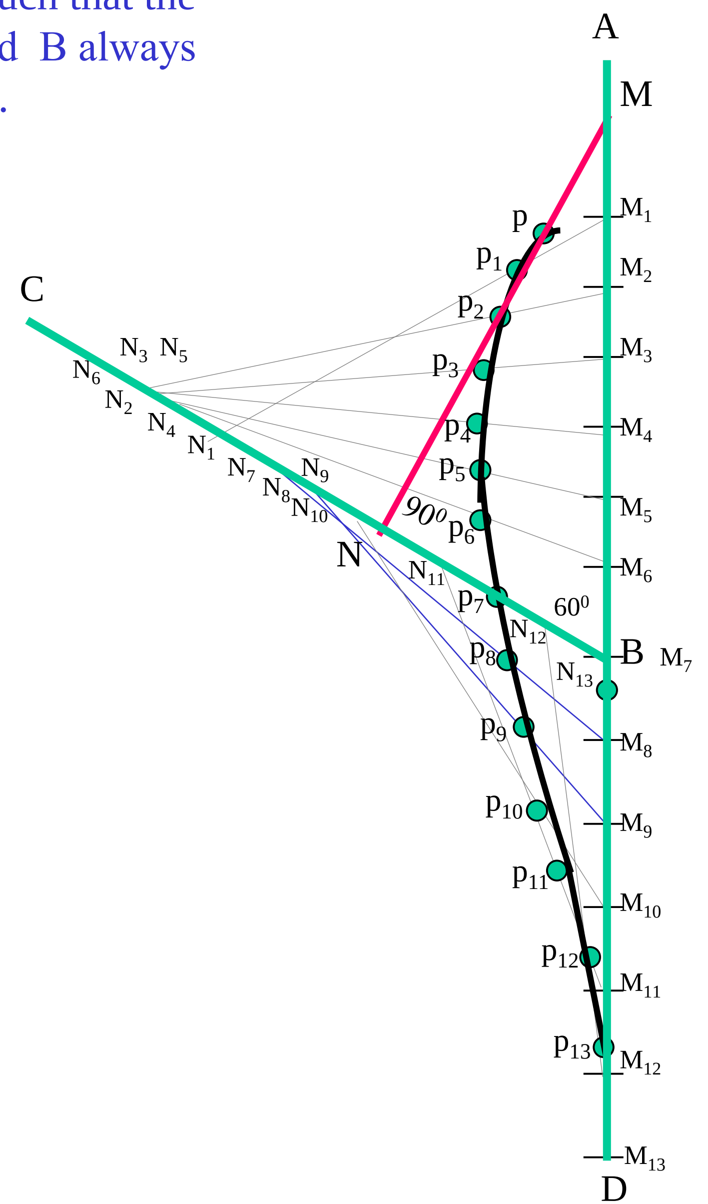
Solution Steps:

1.Locate A & B points 100 mm apart.
2.Locate point P on AB line, 70 mm from A and 30 mm from B As PA-PB=40 (AB = 100 mm)
3.On both sides of P mark points 5 mm apart. Name those 1,2,3,4 as usual.
4.Now similar to steps of Problem 2, Draw different arcs taking A & B centers and A-1, B-1, A-2, B-2 etc as radius.
5. Mark various positions of p i.e. and join them in smooth possible curve.

It will be locus of P

FORK & SLIDER

Problem 6:-Two points A and B are 100 mm apart. There is a point P, moving in a plane such that the difference of it's distances from A and B always remains constant and equals to 40 mm. Draw locus of point P.



Solution Steps:

1) Mark lower most position of M on extension of AB (downward) by taking distance MN (40 mm) from point B (because N can not go beyond B).
2) Divide line (M initial and M lower most) into eight to ten parts and mark them M_1, M_2, M_3 up to the last position of M .
3) Now take MN (40 mm) as fixed distance in compass, M_1 center cut line CB in N_1.
4) Mark point P_1 on M_1N_1 with same distance of MP from M_1.
5) Similarly locate M_2P_2, M_3P_3, M_4P_4 and join all P points.

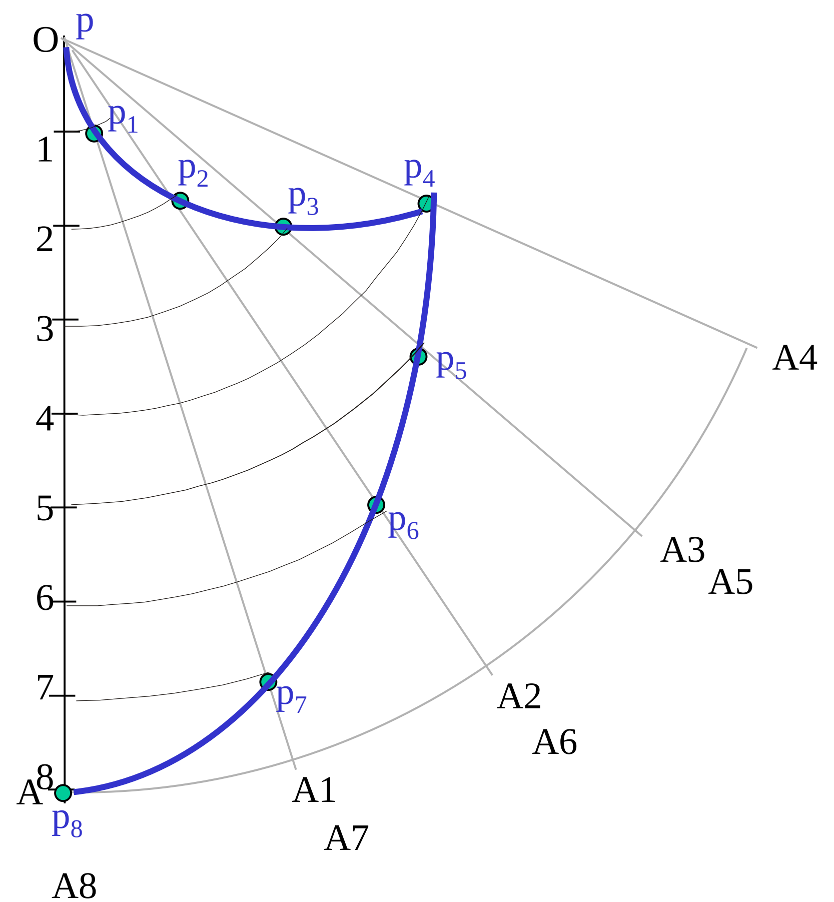
It will be locus of P.

Problem No.7:
A Link **OA**, 80 mm long oscillates around **O**, 60^0 to right side and returns to it's initial vertical Position with uniform velocity.Mean while point **P i**nitially on **O** starts sliding downwards and reaches end **A** with uniform velocity.
Draw locus of point **P**

Solution Steps:

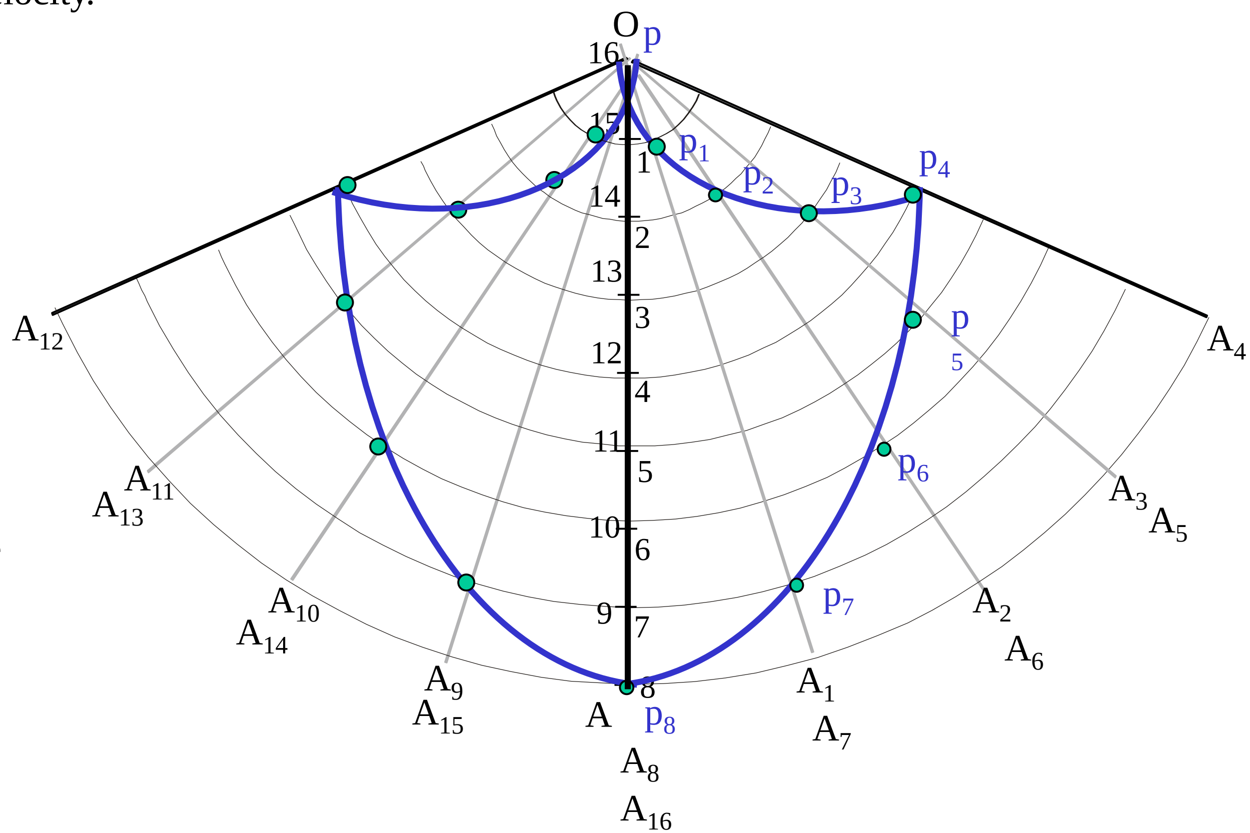
Point P- Reaches End A (Downwards)

1) Divide OA in EIGHT equal parts and from O to A after O name 1, 2, 3, 4 up to 8. (i.e. up to point A).
2) Divide 60^0 angle into four parts (15^0 each) and mark each point by A_1, A_2, A_3, A_4 and for return A_5, A_6, A_7 and A_8. (Initial A point).
3) Take center O, distance in compass O-1 draw an arc upto OA_1. Name this point as P_1.
1) Similarly O center O-2 distance mark P_2 on line O-A_2.
2) This way locate P_3, P_4, P_5, P_6, P_7 and P_8 and join them.
(It will be thw desired locus of P)



OSCILLATING LINK

Problem No 8:
A Link **OA**, 80 mm long oscillates around **O**,
60^0 to right side, 120^0 to left and returns to it's initial vertical Position with uniform velocity.Mean while point **P i**nitially on **O** starts sliding downwards, reaches end **A** and returns to **O** again with uniform velocity.
Draw locus of point **P**

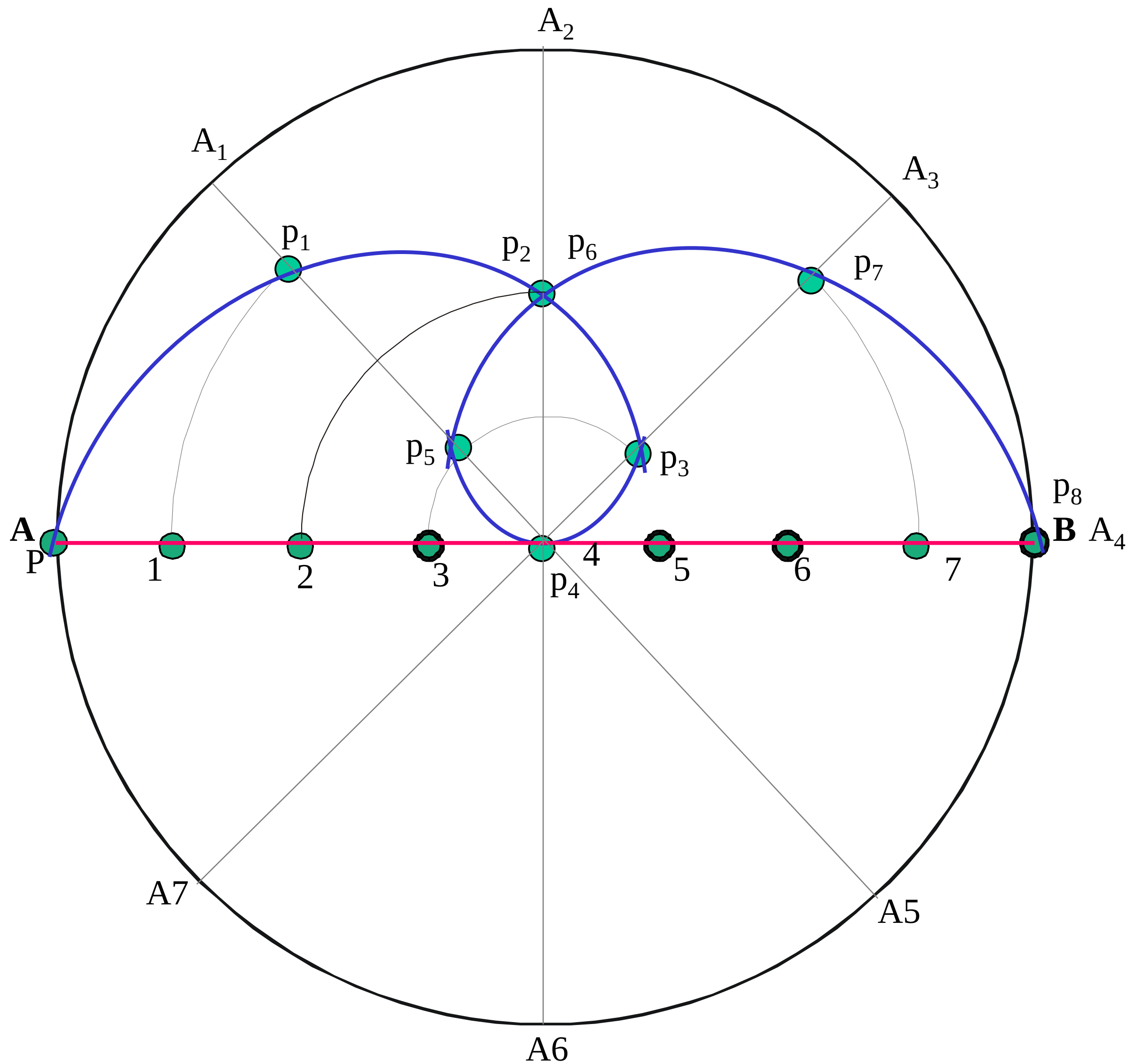


Solution Steps:
(P reaches A i.e. moving downwards.
& returns to O again i.e.moves upwards)
1.Here distance traveled by point P is PA.plus AP.Hence divide it into eight equal parts.(so total linear displacement gets divided in 16 parts) Name those as shown.
2.Link OA goes 60^0 to right, comes back to original (Vertical) position, goes 60^0 to left and returns to original vertical position. Hence total angular displacement is 240^0.
Divide this also in 16 parts. (15^0 each.)
Name as per previous problem.(A, A_1 A_2 etc)
3.Mark different positions of P as per the procedure adopted in previous case.
and complete the problem.

Problem 9:

Rod AB, 100 mm long, revolves in clockwise direction for one revolution.
Meanwhile point P, initially on A starts moving towards B and reaches B.
Draw locus of point P.

1) AB Rod revolves around center O for one revolution and point P slides along AB rod and reaches end B in one revolution.
2) Divide circle in 8 number of equal parts and name in arrow direction after A-A1, A2, A3, up to A8.
3) Distance traveled by point P is AB mm. Divide this also into 8 number of equal parts.
4) Initially P is on end A. When A moves to A1, point P goes one linear division (part) away from A1. Mark it from A1 and name the point P1.
5) When A moves to A2, P will be two parts away from A2 (Name it P2). Mark it as above from A2.
6) From A3 mark P3 three parts away from P3.
7) Similarly locate P4, P5, P6, P7 and P8 which will be eight parts away from A8. [Means P has reached B].
8) Join all P points by smooth curve. It will be locus of P



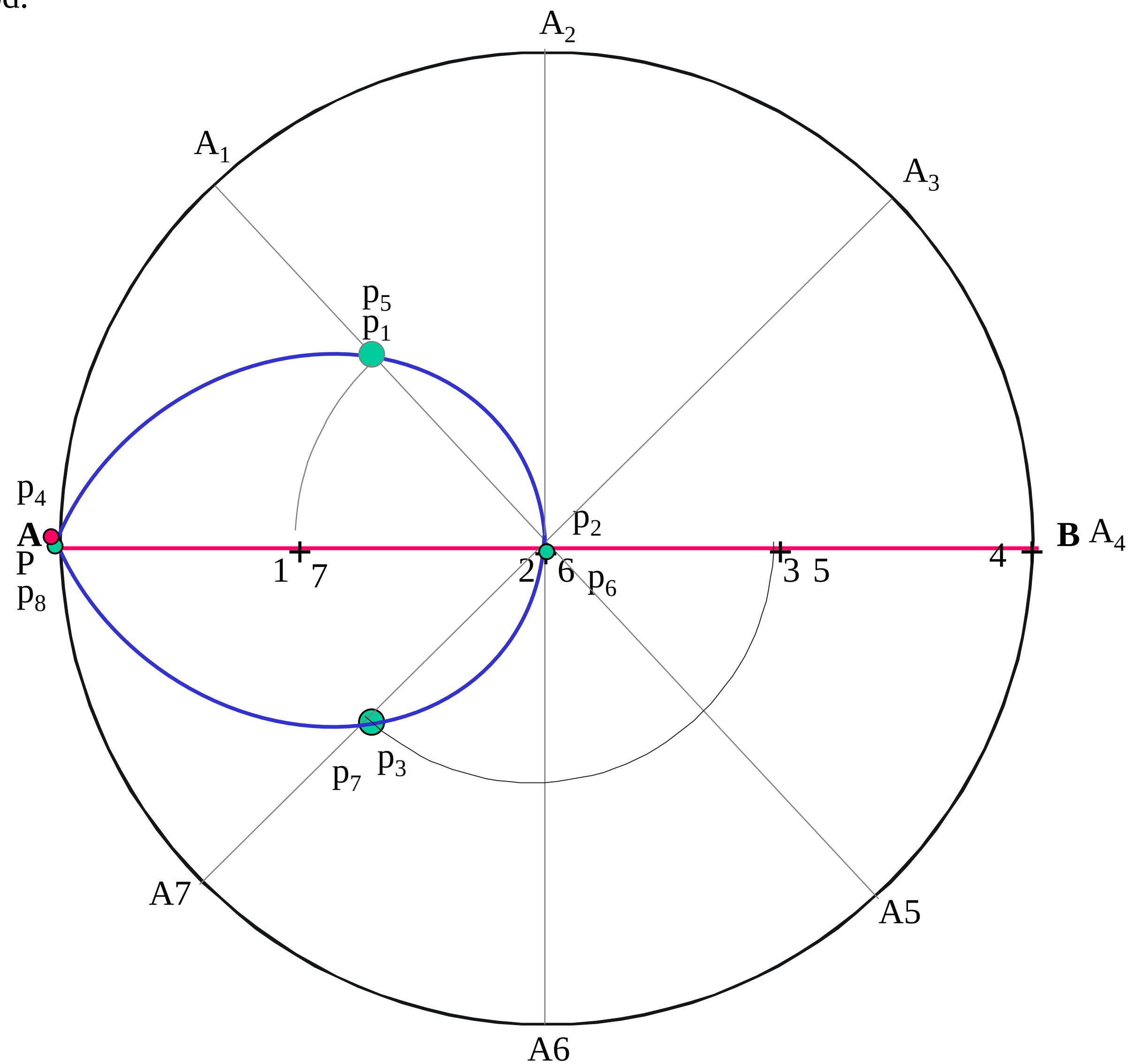
Problem 10 :

Rod AB, 100 mm long, revolves in clockwise direction for one revolution.
Meanwhile point P, initially on A starts moving towards B, reaches B
And returns to A in one revolution of rod.
Draw locus of point P.

Solution Steps

1) AB Rod revolves around center O for one revolution and point P slides along rod AB reaches end B and returns to A.
2) Divide circle in 8 number of equal parts and name in arrow direction after A-A1, A2, A3, up to A8.
3) Distance traveled by point P is AB plus AB mm. Divide AB in 4 parts so those will be 8 equal parts on return.
4) Initially P is on end A. When A moves to A1, point P goes one linear division (part) away from A1. Mark it from A1 and name the point P1.
5) When A moves to A2, P will be two parts away from A2 (Name it P2). Mark it as above from A2.
6) From A3 mark P3 three parts away from P3.
7) Similarly locate P4, P5, P6, P7 and P8 which will be eight parts away from A8. [Means P has reached B].
8) Join all P points by smooth curve. It will be locus of P

The Locus will follow the loop path two times in one revolution.



DRAWINGS:

(A Graphical Representation)

The Fact about:

If compared with Verbal or Written Description,
Drawings offer far better idea about the Shape, Size & Appearance of any object or situation or location, that too in quite a less time.

Hence it has become the Best Media of Communication not only in Engineering but in almost all Fields.

Drawings
(Some Types)

Nature Drawings
(landscape,
scenery etc.)

Geographical
Drawings
(maps etc.)

Botanical Drawings
(plants, flowers etc.)

Zoological Drawings
(creatures, animals etc.)

Portraits
(human faces,
expressions etc.)

Engineering Drawings,
(projections.)

Building Related Drawings.

Machine component Drawings

Orthographic Projections
(Fv,Tv & Sv.-Mech.Engg terms)
(Plan, Elevation- Civil Engg.terms)
(Working Drawings 2-D type)

Isometric (Mech.Engg.Term.)
or Perspective(Civil Engg.Term)
(Actual Object Drawing 3-D)

ORTHOGRAPHIC PROJECTIONS:

IT IS A TECHNICAL DRAWING IN WHICH DIFFERENT VIEWS OF AN OBJECT ARE PROJECTED ON DIFFERENT REFERENCE PLANES OBSERVING PERPENDICULAR TO RESPECTIVE REFERENCE PLANE

Different Reference planes are

Horizontal Plane (HP),
Vertical Frontal Plane (VP)
Side Or Profile Plane (PP)

And

Different Views are Front View (FV), Top View (TV) and Side View (SV)

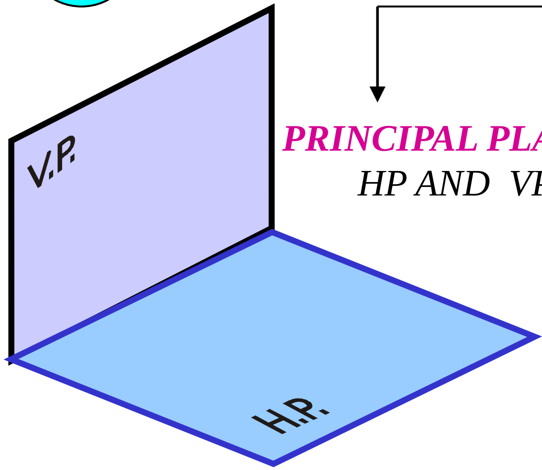
FV is a view projected on VP.
TV is a view projected on HP.
SV is a view projected on PP.

IMPORTANT TERMS OF ORTHOGRAPHIC PROJECTIONS:

1. **Planes.**
2. **Pattern of planes & Pattern of views**
3. **Methods of drawing Orthographic Projections**

1

PLANES

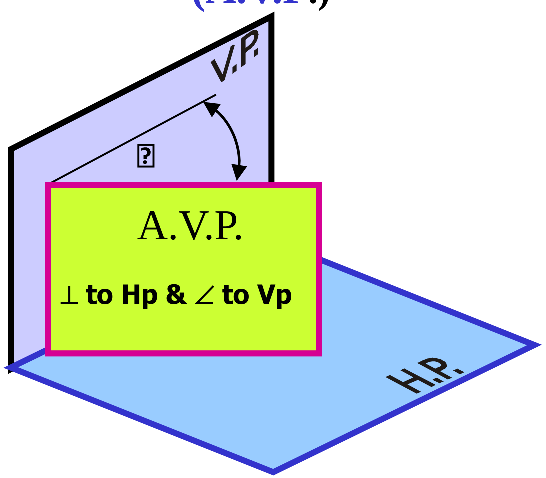


PRINCIPAL PLANES

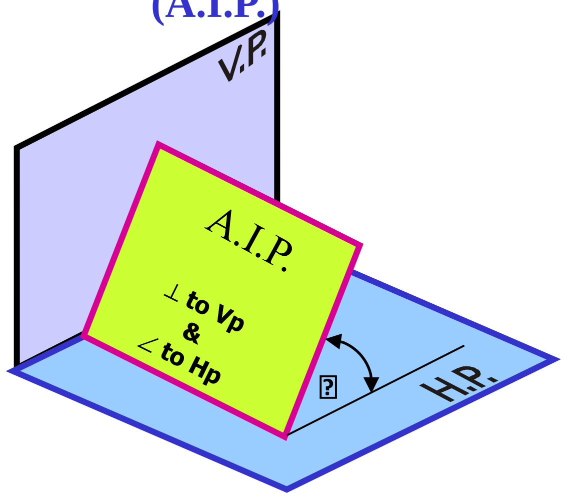
HP AND VP

AUXILIARY PLANES

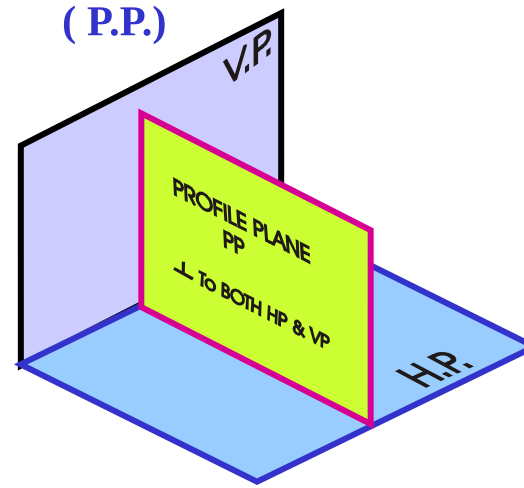
Auxiliary Vertical Plane (A.V.P.)



Auxiliary Inclined Plane (A.I.P.)

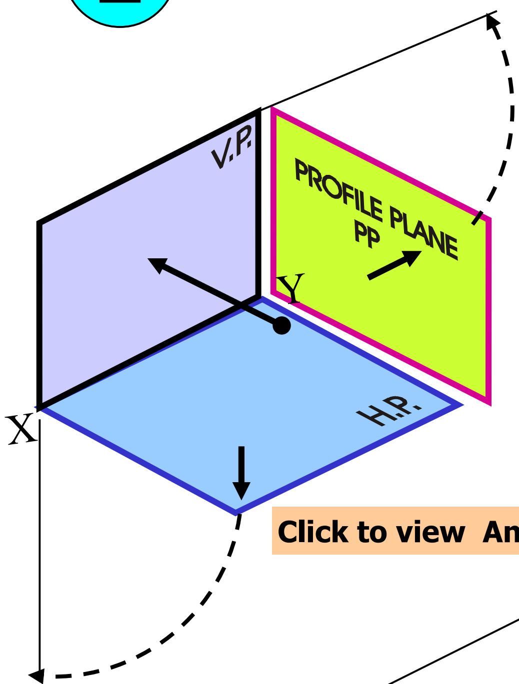


Profile Plane (P.P.)



2

PATTERN OF PLANES & VIEWS (First Angle Method)



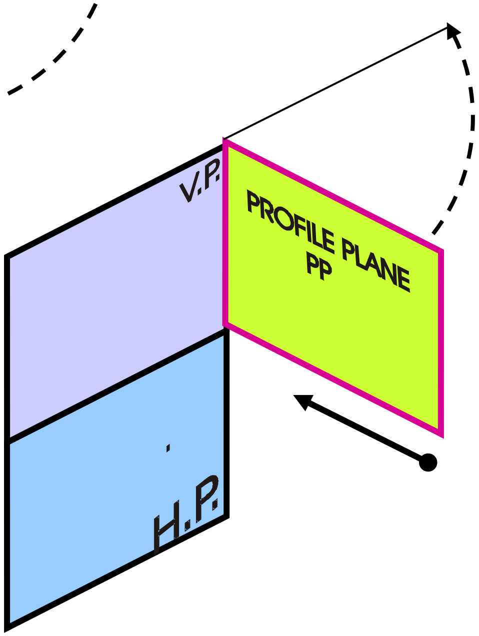
THIS IS A PICTORIAL SET-UP OF ALL THREE PLANES.
ARROW DIRECTION IS A NORMAL WAY OF OBSERVING THE OBJECT.
BUT IN THIS DIRECTION ONLY VP AND A VIEW ON IT (FV) CAN BE SEEN.
THE OTHER PLANES AND VIEWS ON THOSE CAN NOT BE SEEN.

PROCEDURE TO SOLVE ABOVE PROBLEM:-

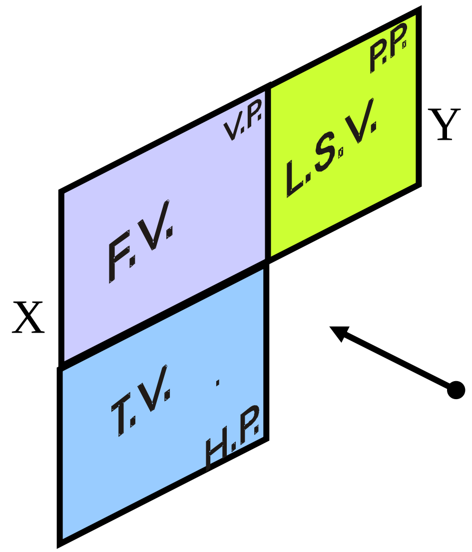
TO MAKE THOSE PLANES ALSO VISIBLE FROM THE ARROW DIRECTION,
A) HP IS ROTATED 90^0 DOUNWARD
B) PP, 90^0 IN RIGHT SIDE DIRECTION.
THIS WAY BOTH PLANES ARE BROUGHT IN THE SAME PLANE CONTAINING VP.

Click to view Animation

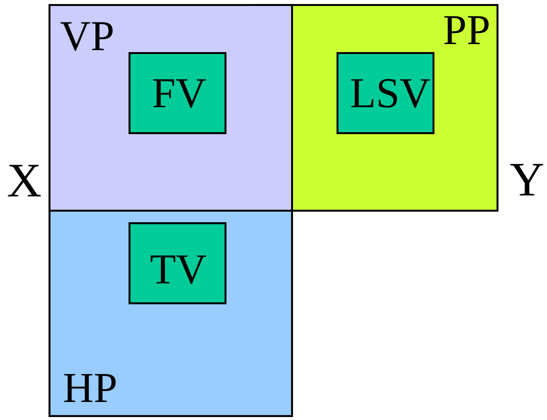
On clicking the button if a warning comes please click YES to continue, this program is safe for your pc.



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



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



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

3

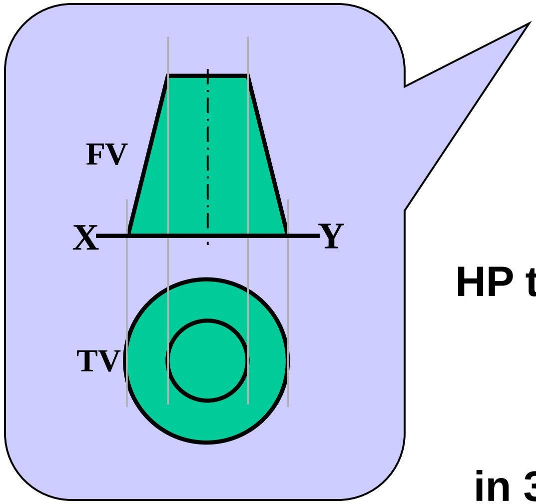
Methods of Drawing Orthographic Projections

First Angle Projections Method

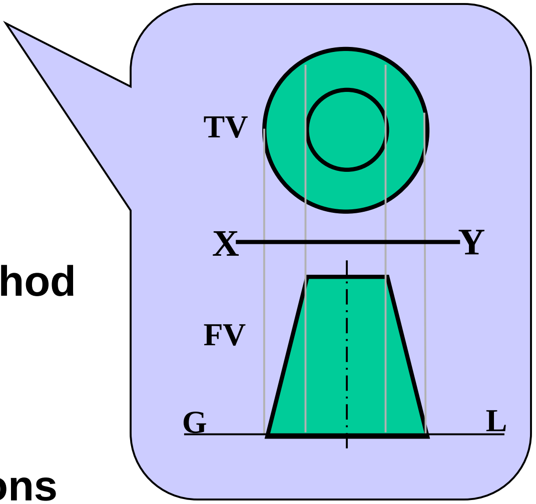
Here views are drawn
by placing object
in 1st Quadrant
(Fv above X-y, Tv below X-y)

Third Angle Projections Method

Here views are drawn
by placing object
in 3rd Quadrant.
(Tv above X-y, Fv below X-y)



SYMBOLIC PRESENTATION OF BOTH METHODS WITH AN OBJECT STANDING ON HP (GROUND) ON IT'S BASE.



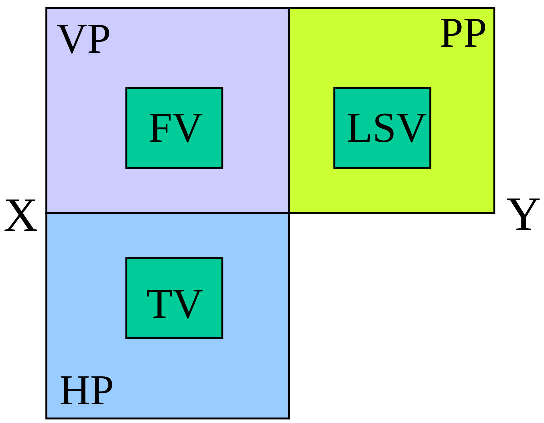
NOTE:-

HP term is used in 1st Angle method
&
For the same
Ground term is used
in 3rd Angle method of projections

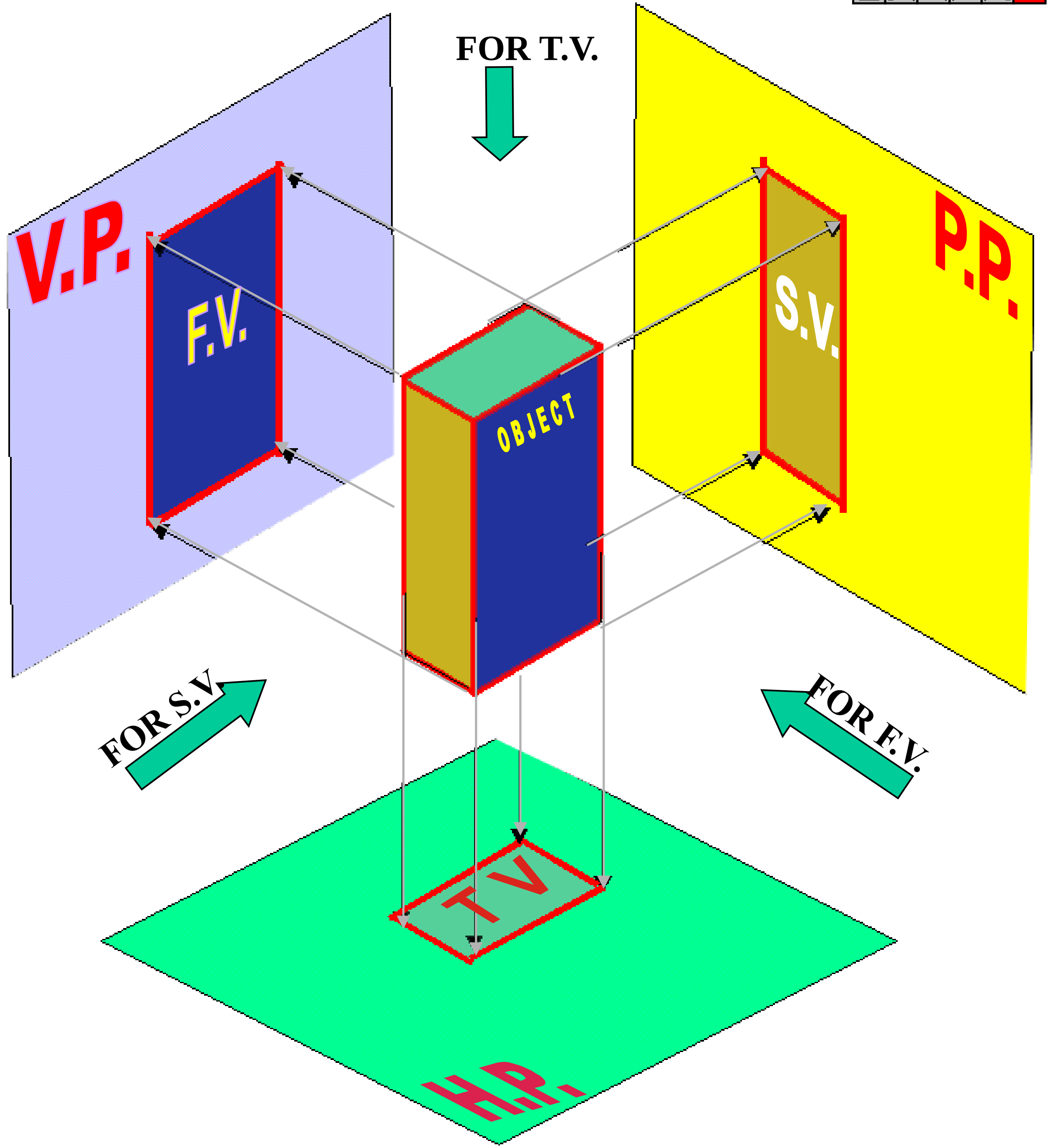
FIRST ANGLE PROJECTION

IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN FIRST QUADRANT
MEANS
ABOVE HP & INFRONT OF VP.

OBJECT IS INBETWEEN OBSERVER & PLANE.



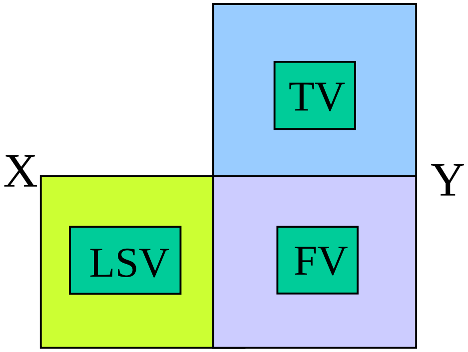
ACTUAL PATTERN OF PLANES & VIEWS IN FIRST ANGLE METHOD OF PROJECTIONS



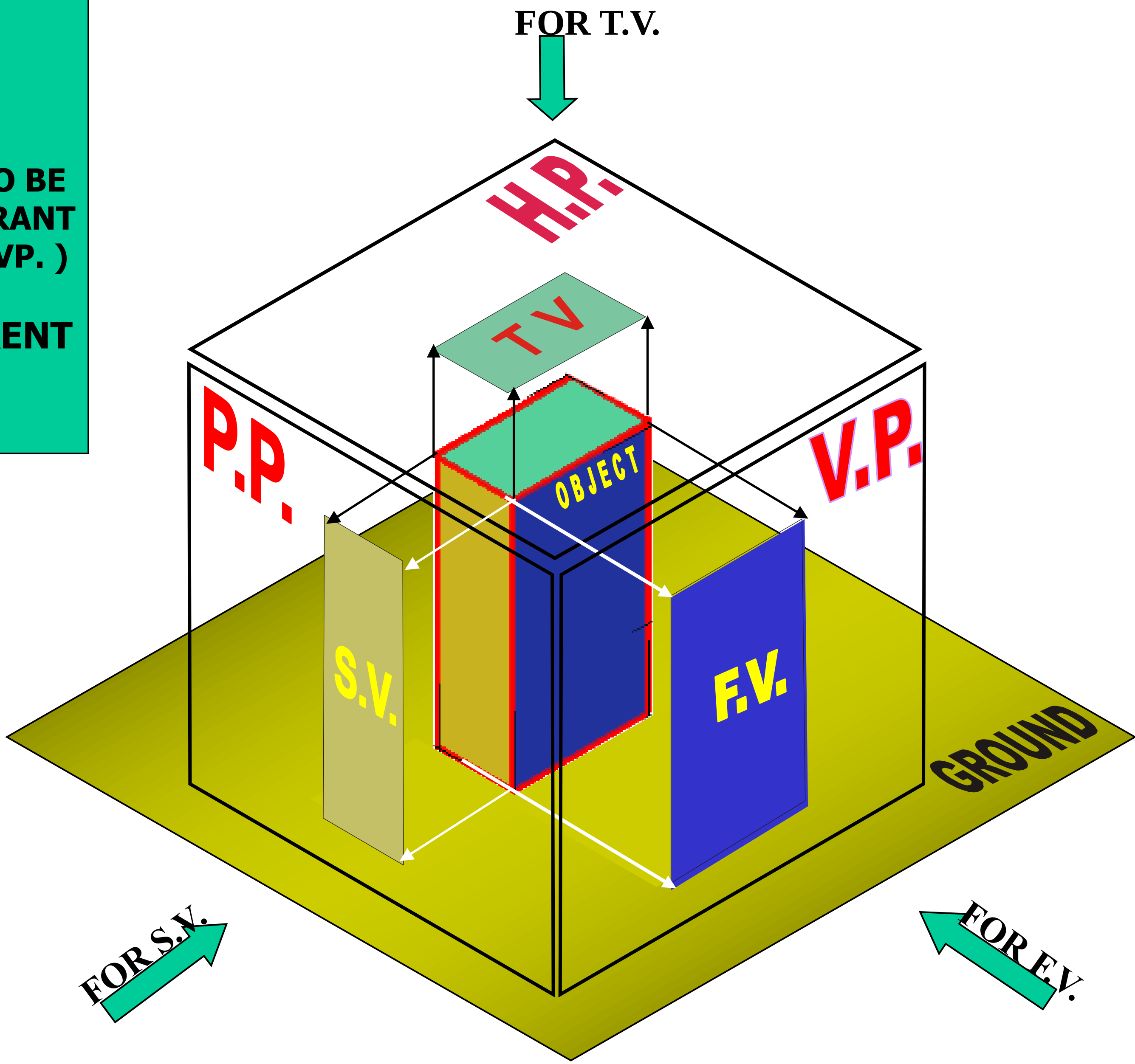
THIRD ANGLE PROJECTION

IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN THIRD QUADRANT (BELOW HP & BEHIND OF VP.)

PLANES BEING TRANSPERENT AND INBETWEEN OBSERVER & OBJECT.



ACTUAL PATTERN OF PLANES & VIEWS OF THIRD ANGLE PROJECTIONS



ORTHOGRAPHIC PROJECTIONS
{ MACHINE ELEMENTS }

OBJECT IS OBSERVED IN THREE DIRECTIONS.
THE DIRECTIONS SHOULD BE NORMAL
TO THE RESPECTIVE PLANES.
AND NOW PROJECT THREE DIFFERENT VIEWS ON THOSE PLANES.
THESE VEWS ARE FRONT VIEW , TOP VIEW AND SIDE VIEW.

FRONT VIEW IS A VIEW PROJECTED ON VERTICAL PLANE (VP)
TOP VIEW IS A VIEW PROJECTED ON HORIZONTAL PLANE (HP)
SIDE VIEW IS A VIEW PROJECTED ON PROFILE PLANE (PP)

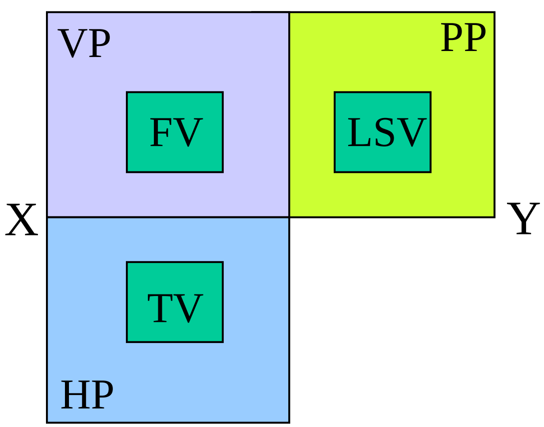
FIRST STUDY THE CONCEPT OF 1ST AND 3RD ANGLE PROJECTION METHODS

AND THEN STUDY NEXT 26 ILLUSTRATED CASES CAREFULLY.
TRY TO RECOGNIZE SURFACES
PERPENDICULAR TO THE ARROW DIRECTIONS

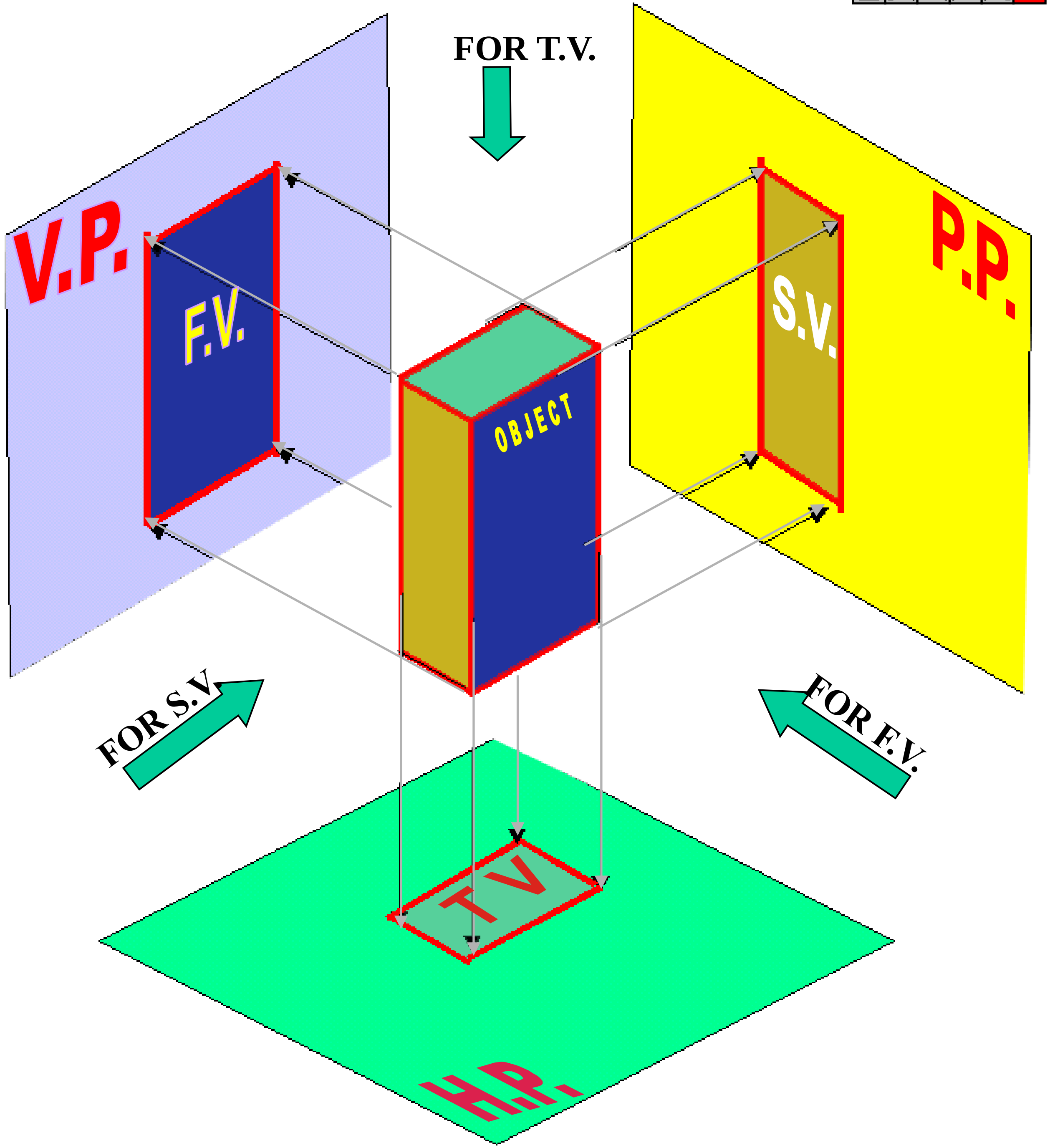
FIRST ANGLE PROJECTION

**IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN FIRST QUADRANT
MEANS
ABOVE HP & INFRONT OF VP.**

OBJECT IS INBETWEEN OBSERVER & PLANE.



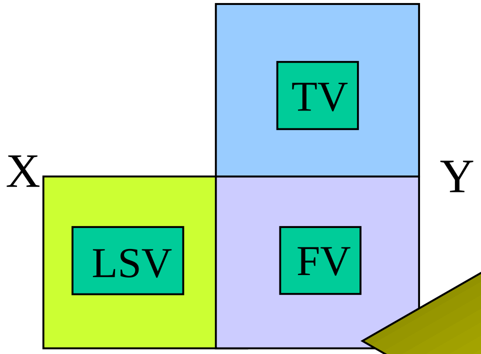
ACTUAL PATTERN OF PLANES & VIEWS IN FIRST ANGLE METHOD OF PROJECTIONS



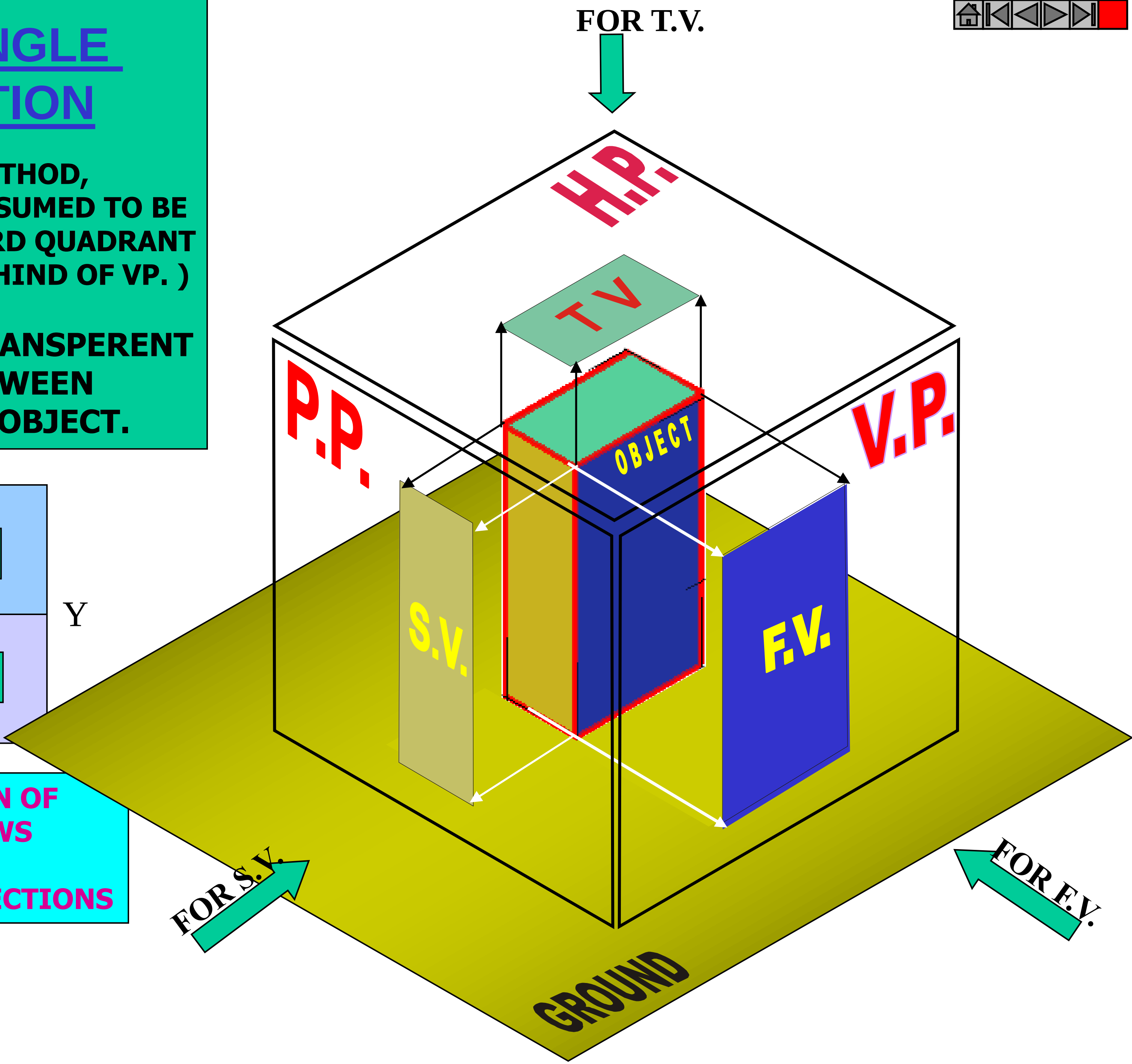
THIRD ANGLE PROJECTION

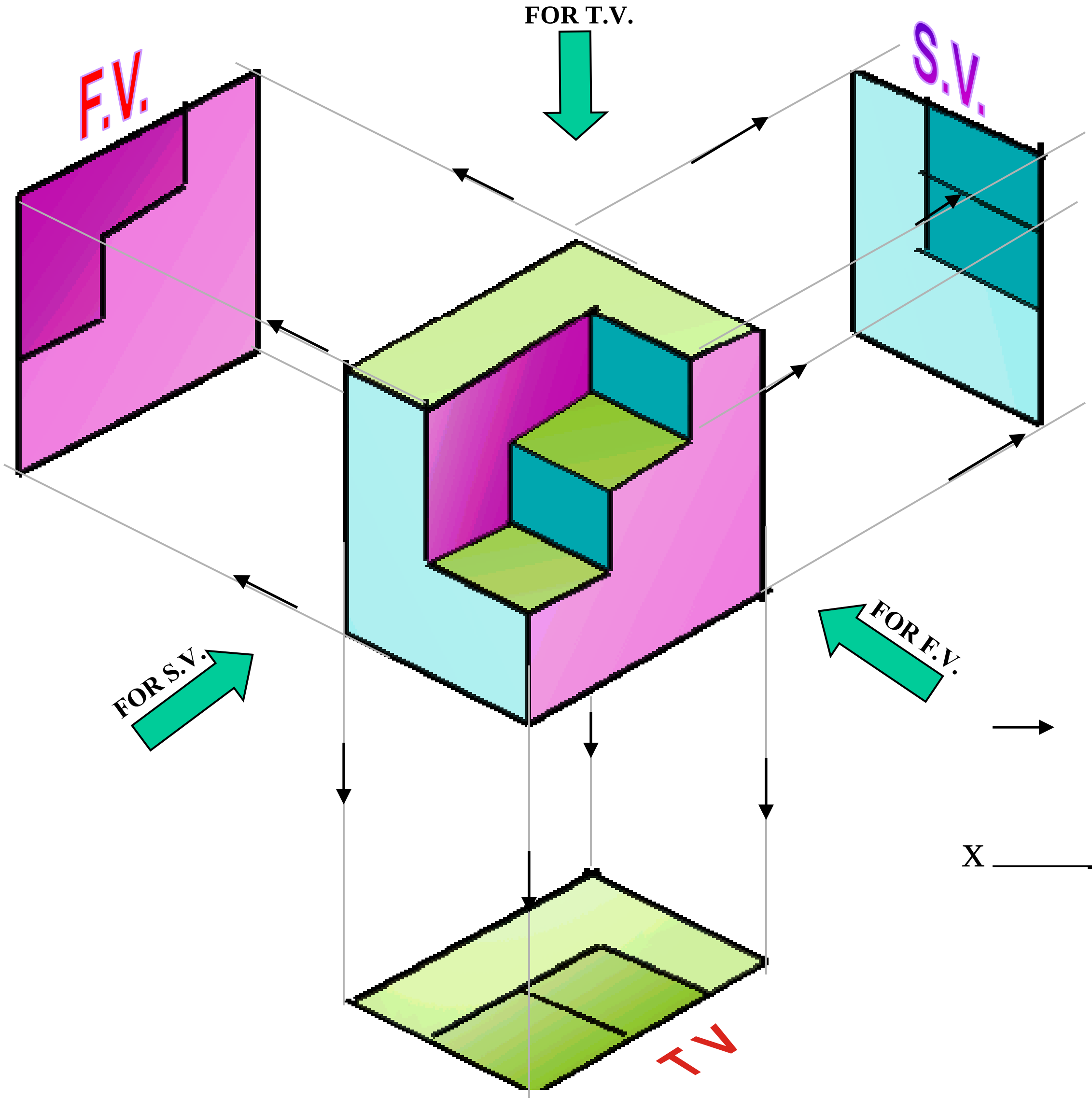
**IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN THIRD QUADRANT
(BELOW HP & BEHIND OF VP.)**

PLANES BEING TRANSPERENT AND INBETWEEN OBSERVER & OBJECT.

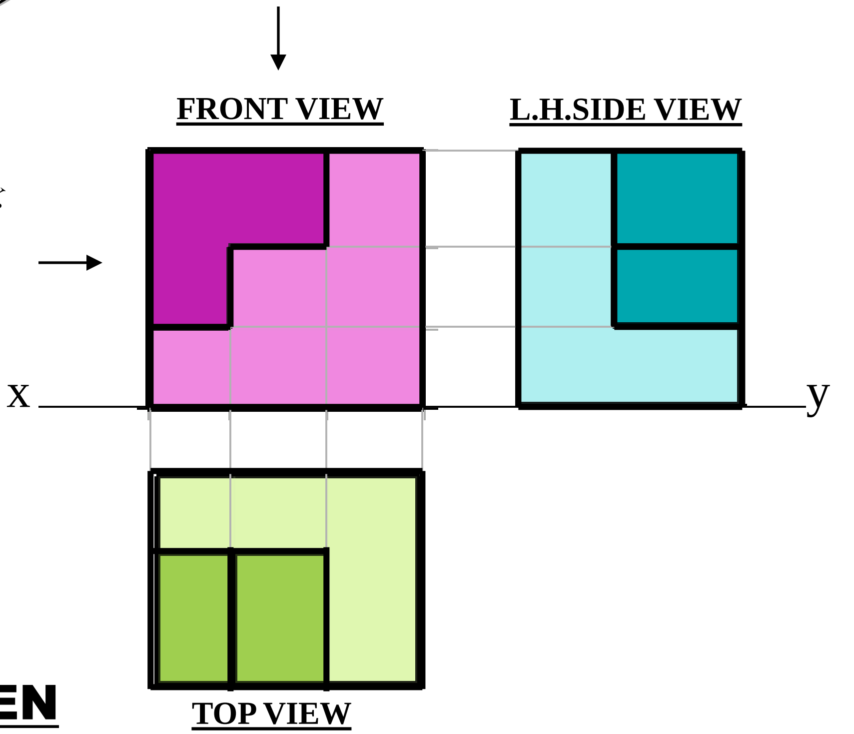


ACTUAL PATTERN OF PLANES & VIEWS OF THIRD ANGLE PROJECTIONS



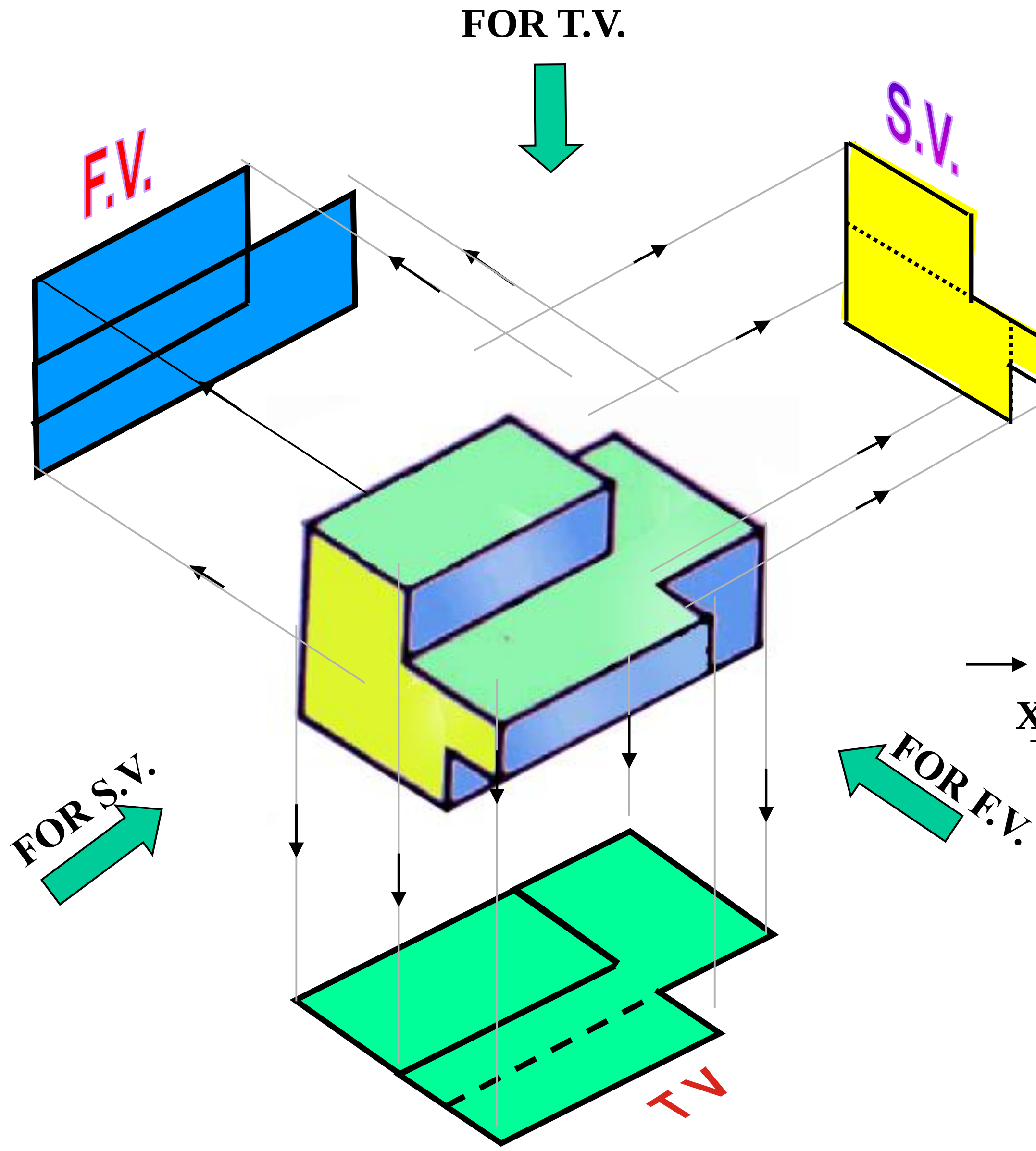


ORTHOGRAPHIC PROJECTIONS

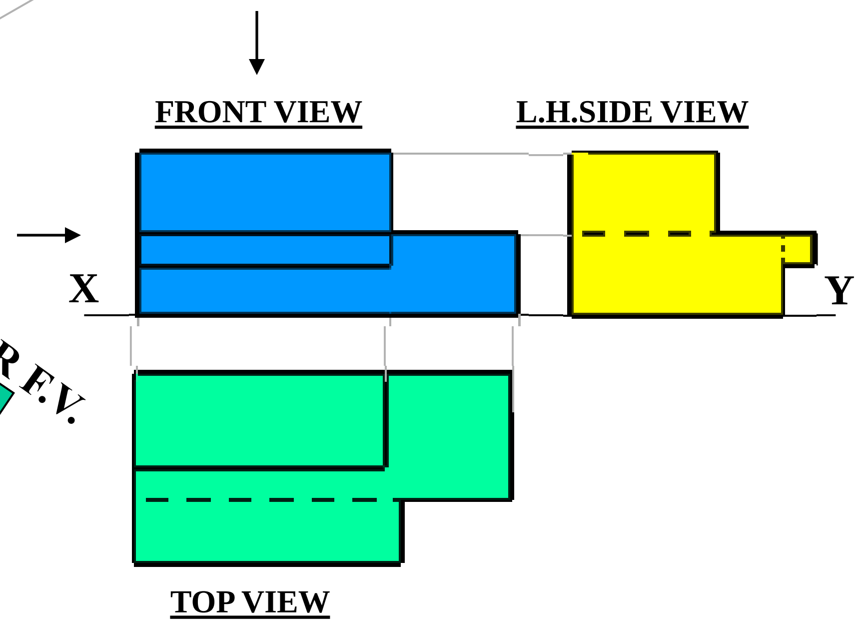


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT BY FIRST ANGLE PROJECTION METHOD

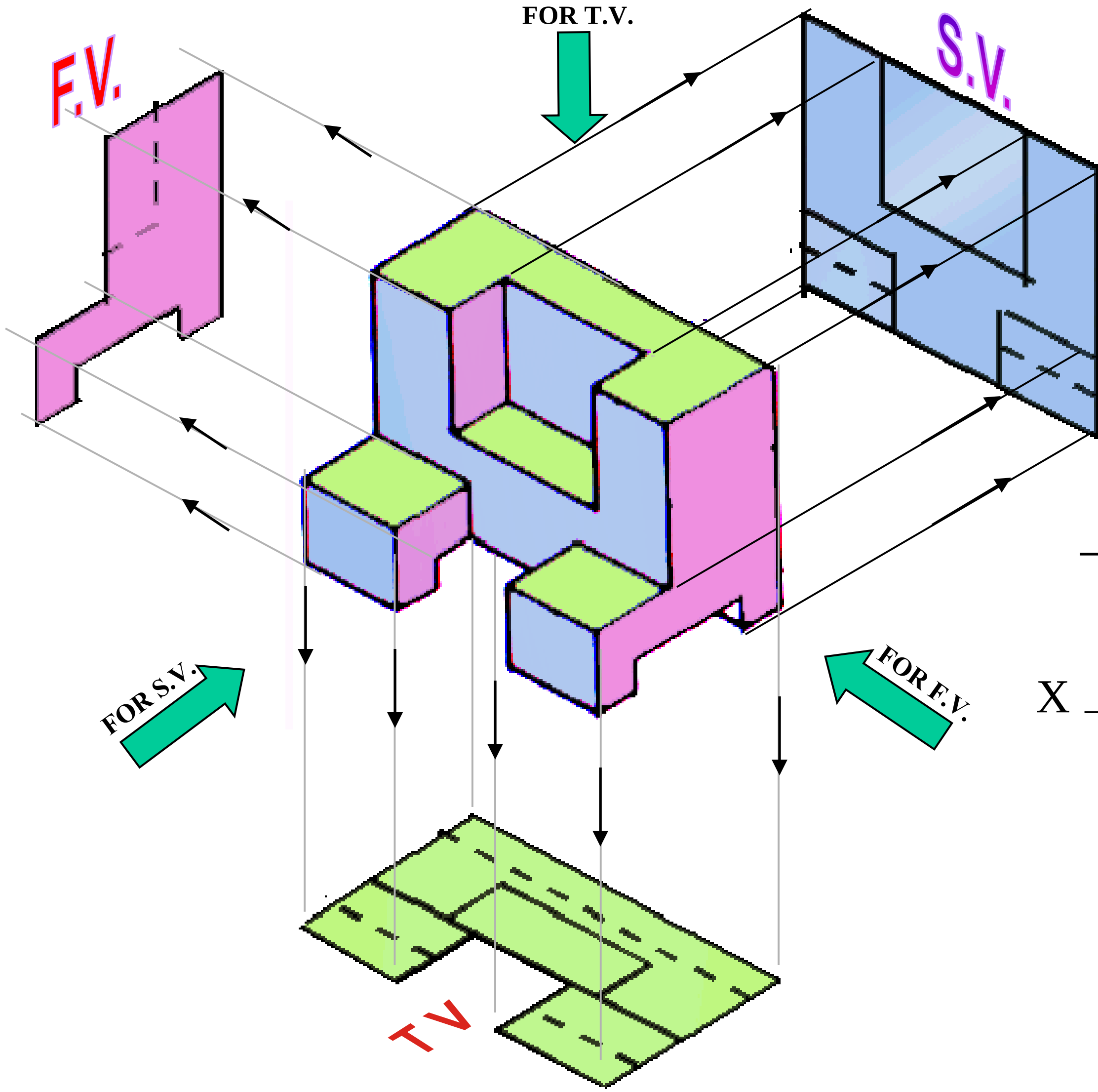


ORTHOGRAPHIC PROJECTIONS

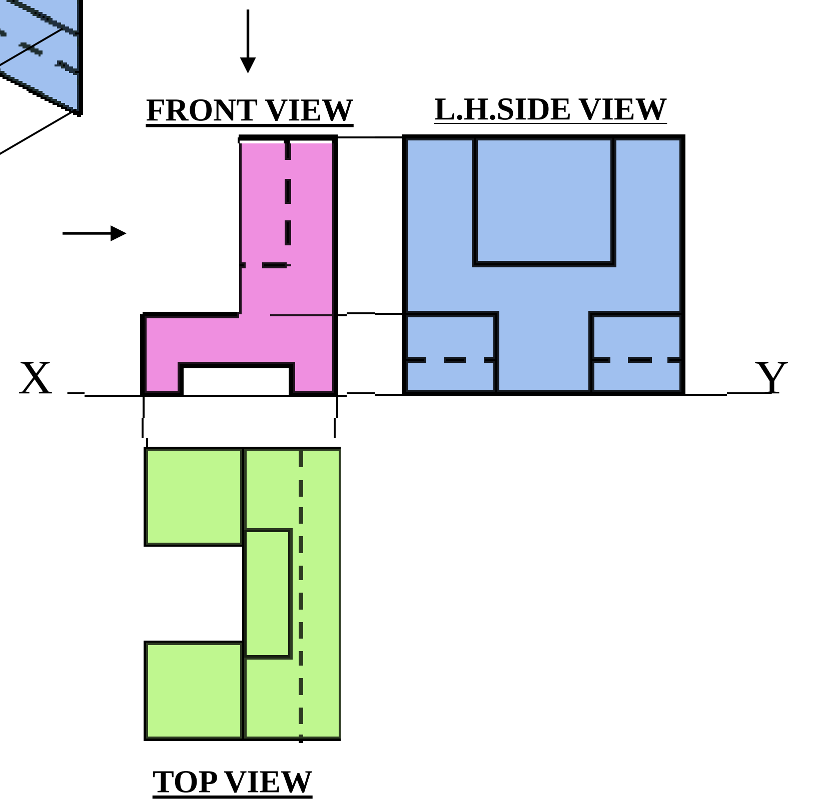


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

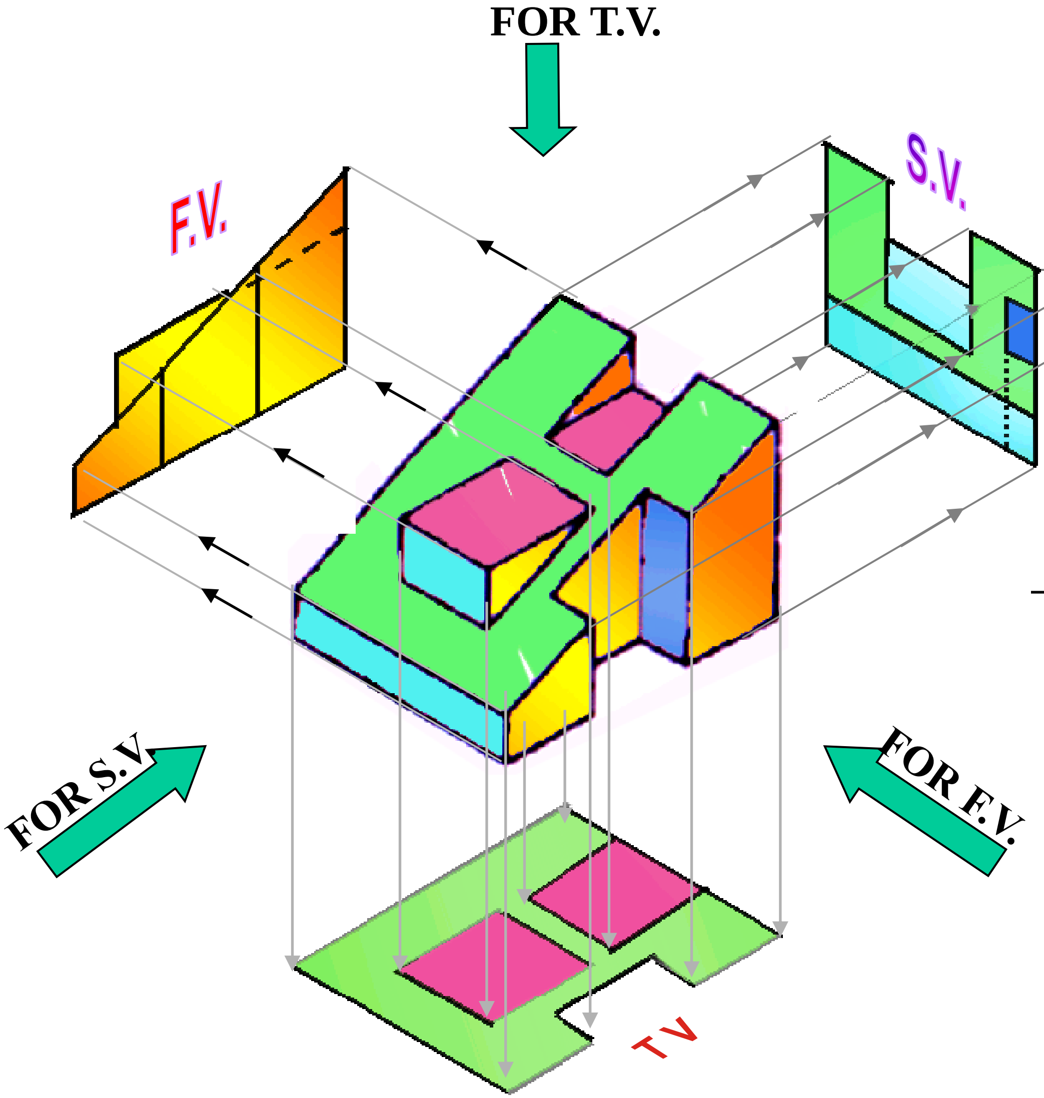


ORTHOGRAPHIC PROJECTIONS



PICTORIAL PRESENTATION IS GIVEN

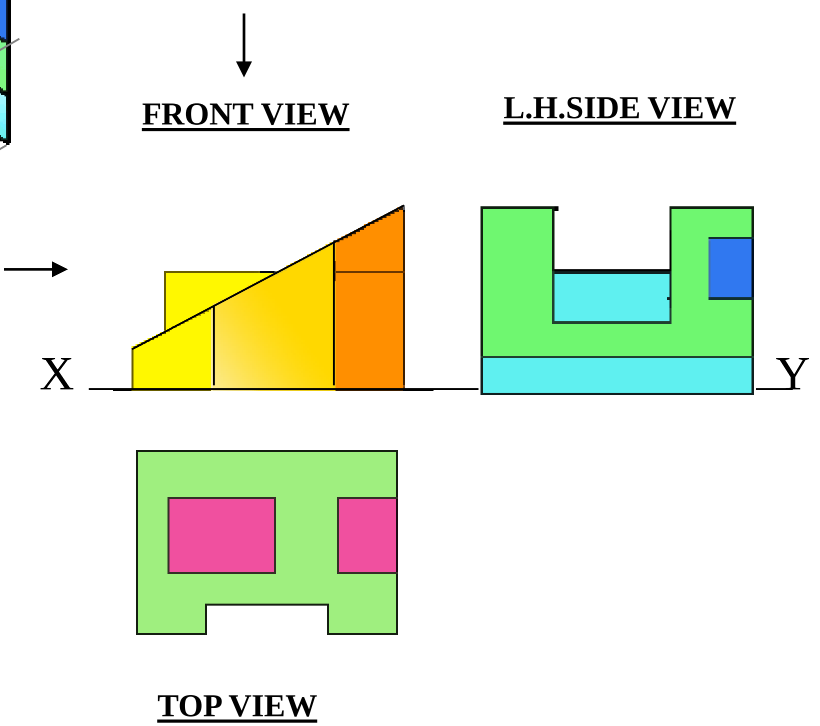
DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

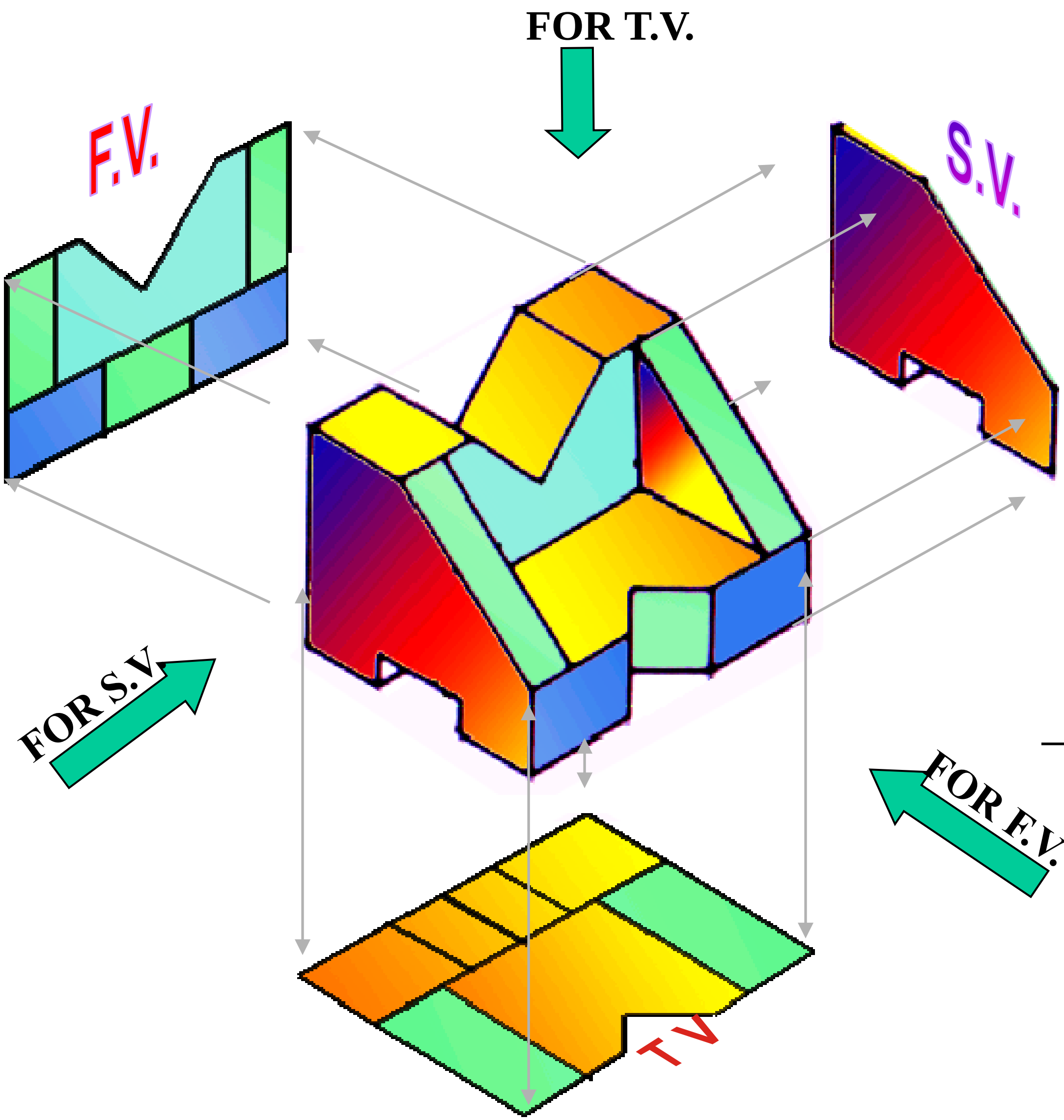


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS





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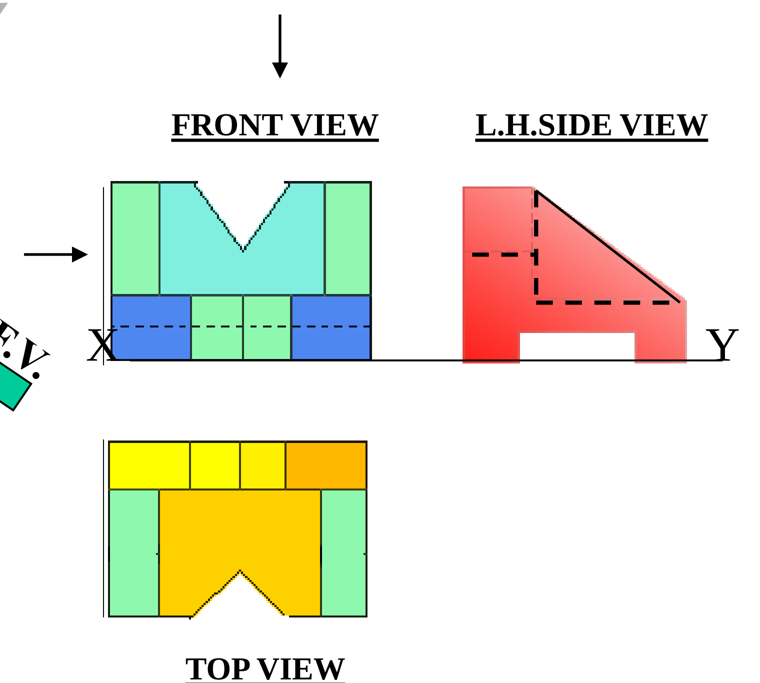
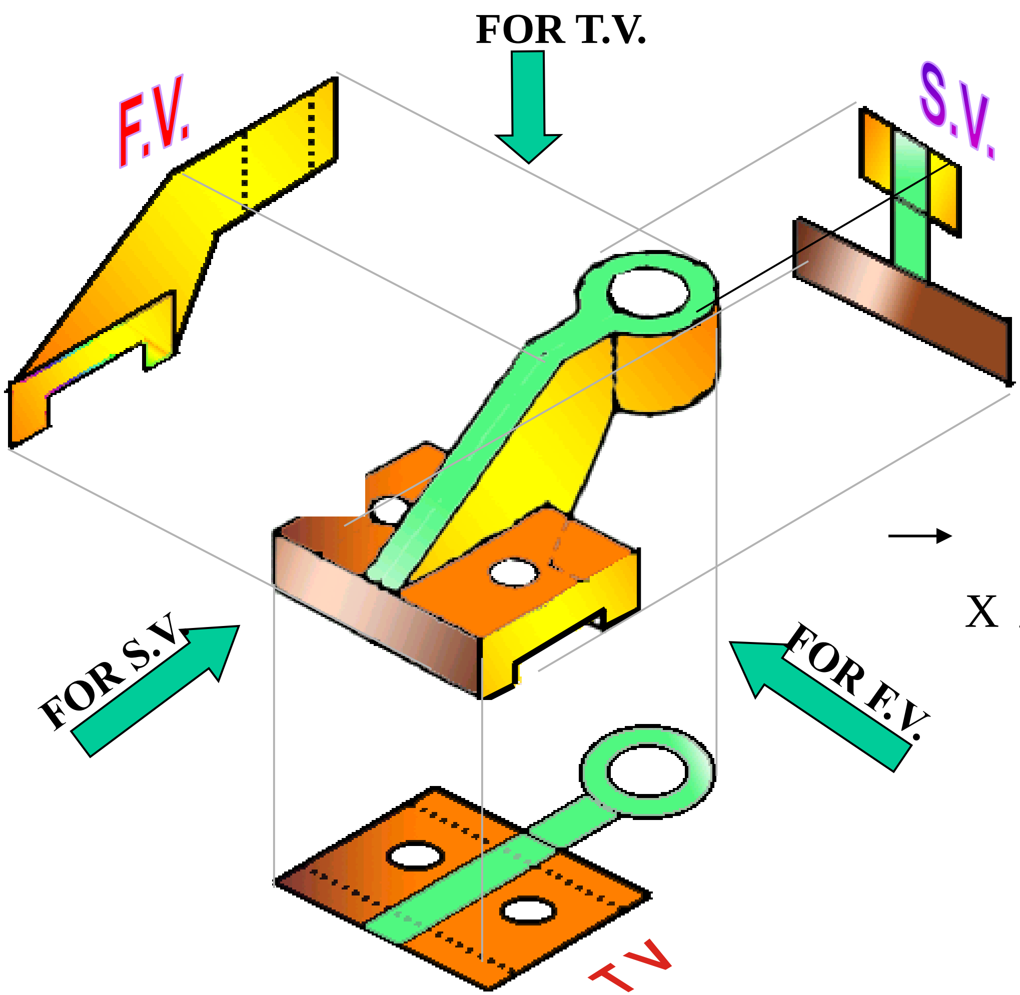
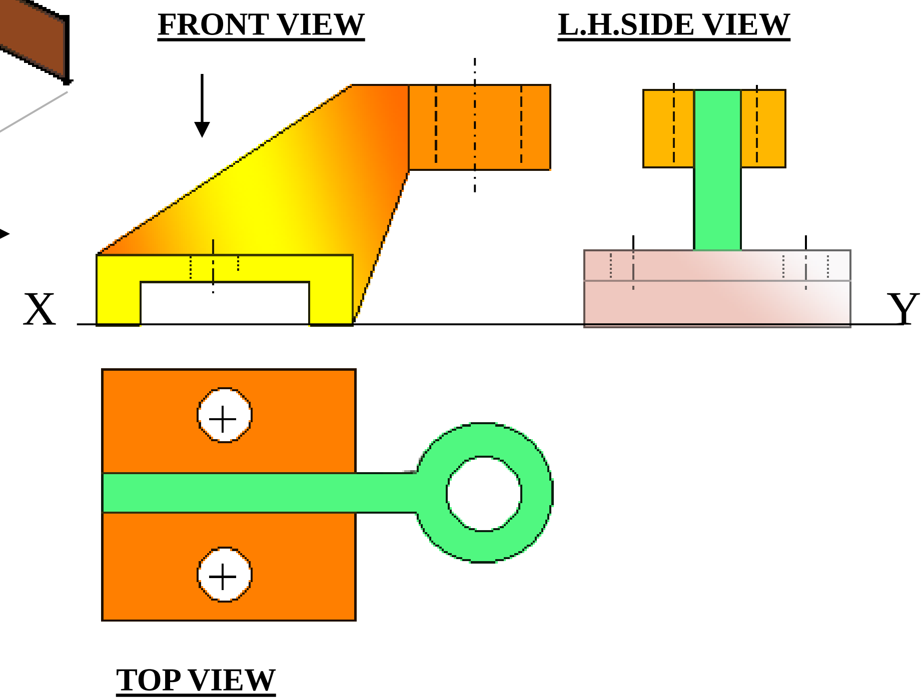


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS

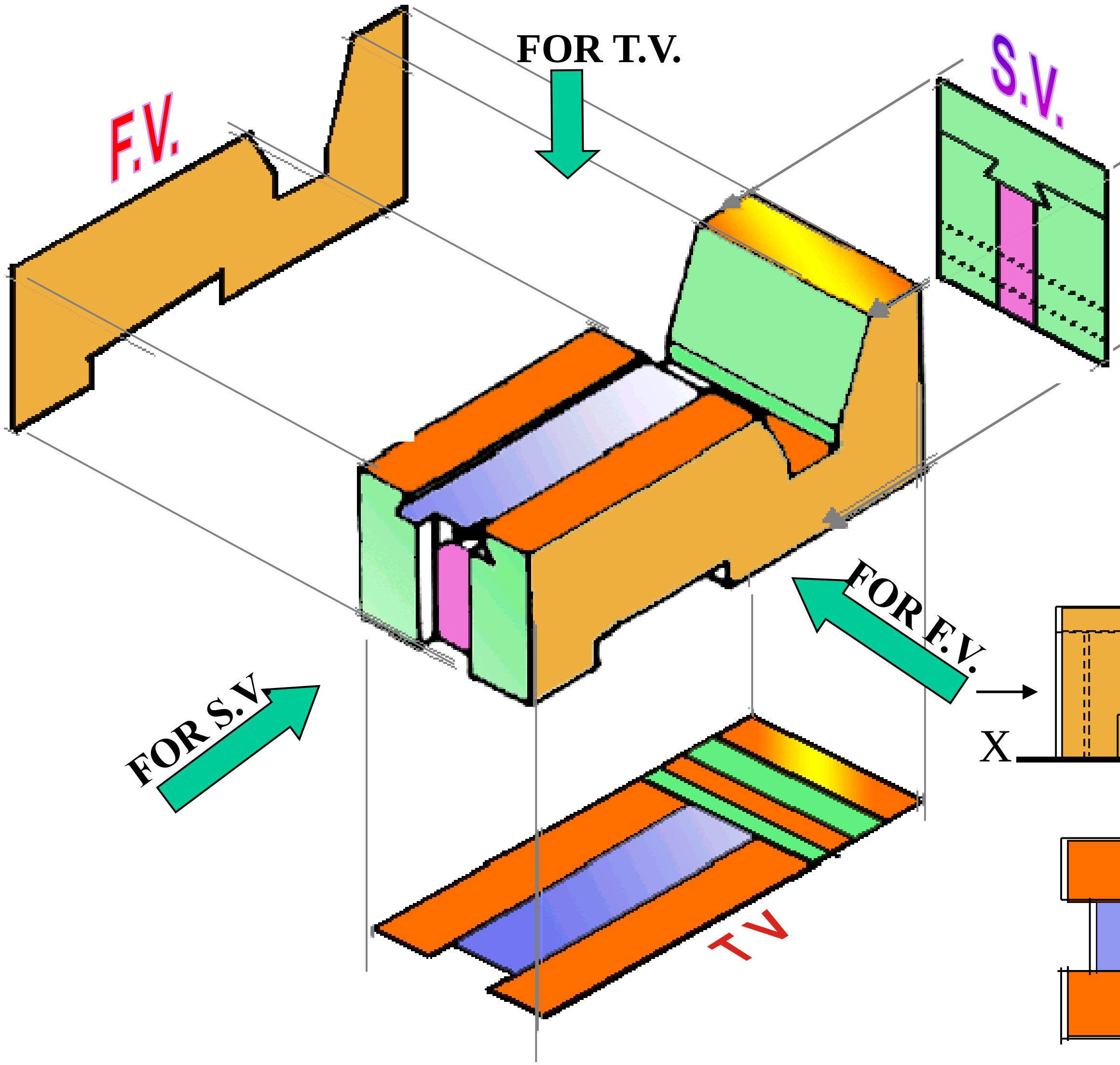




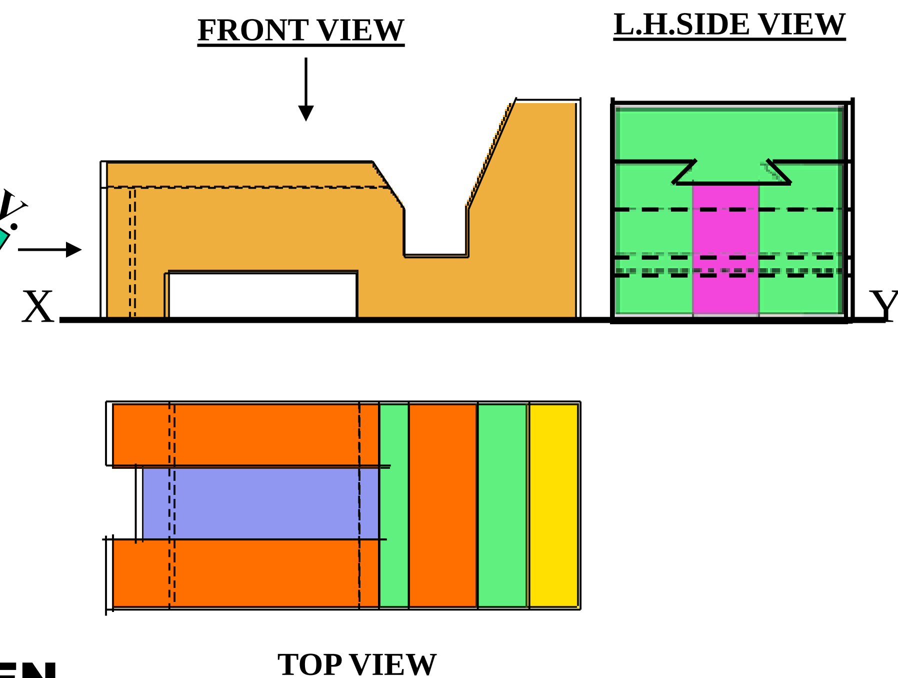
PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT

BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS

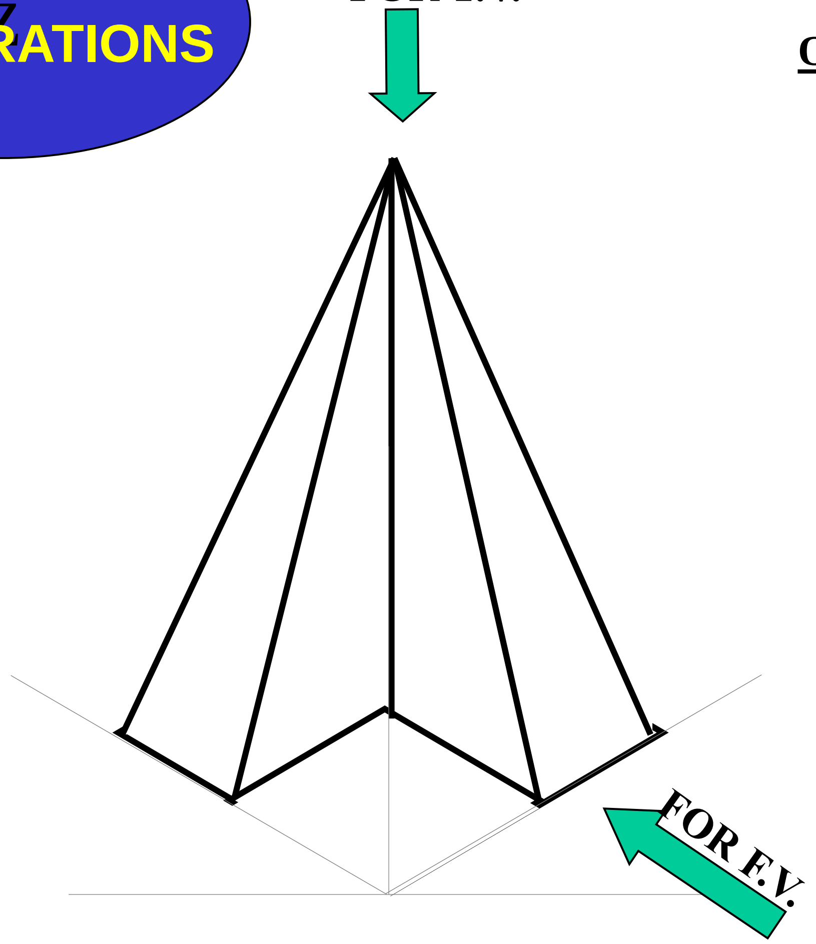


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS

7



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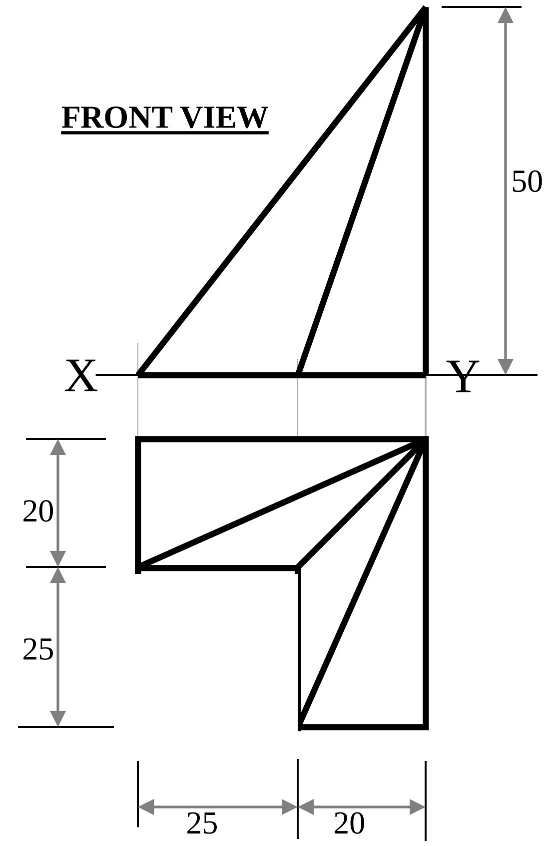
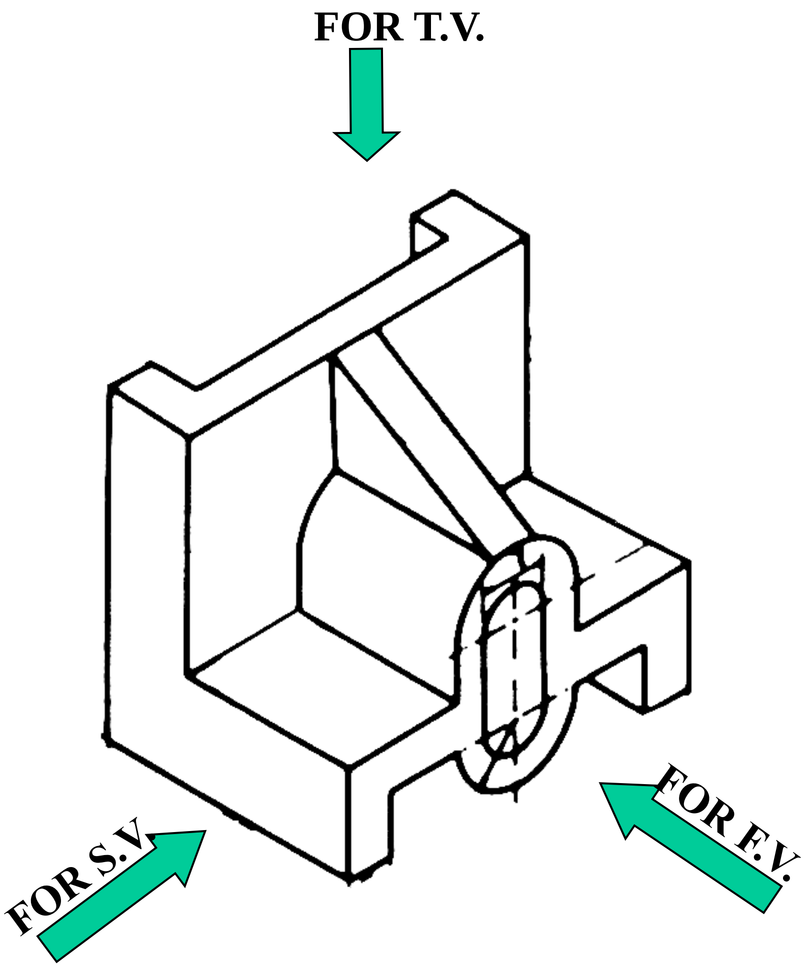


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



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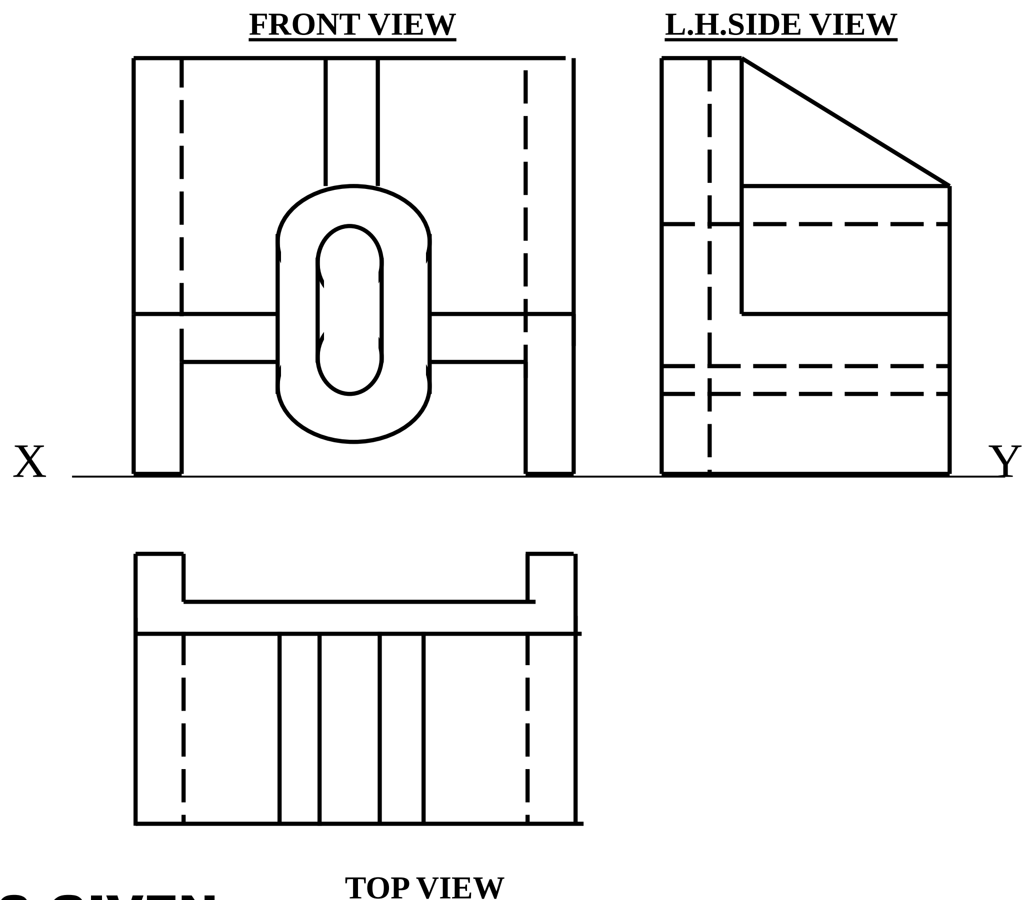
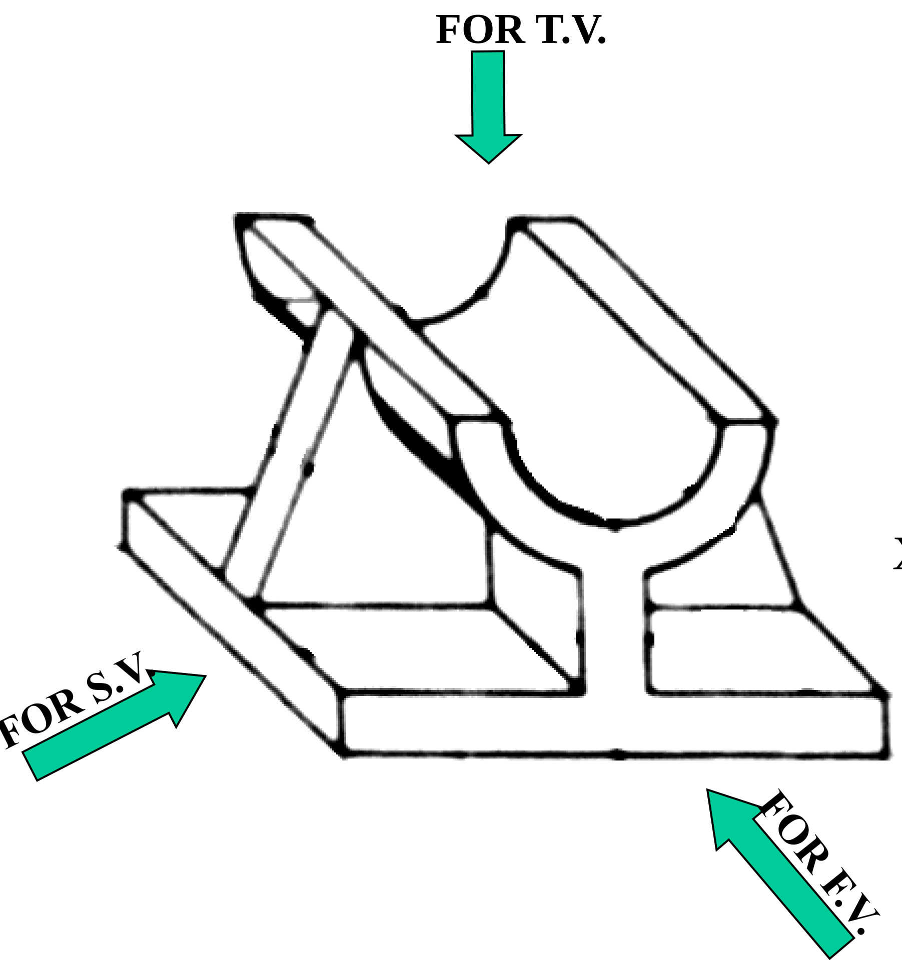
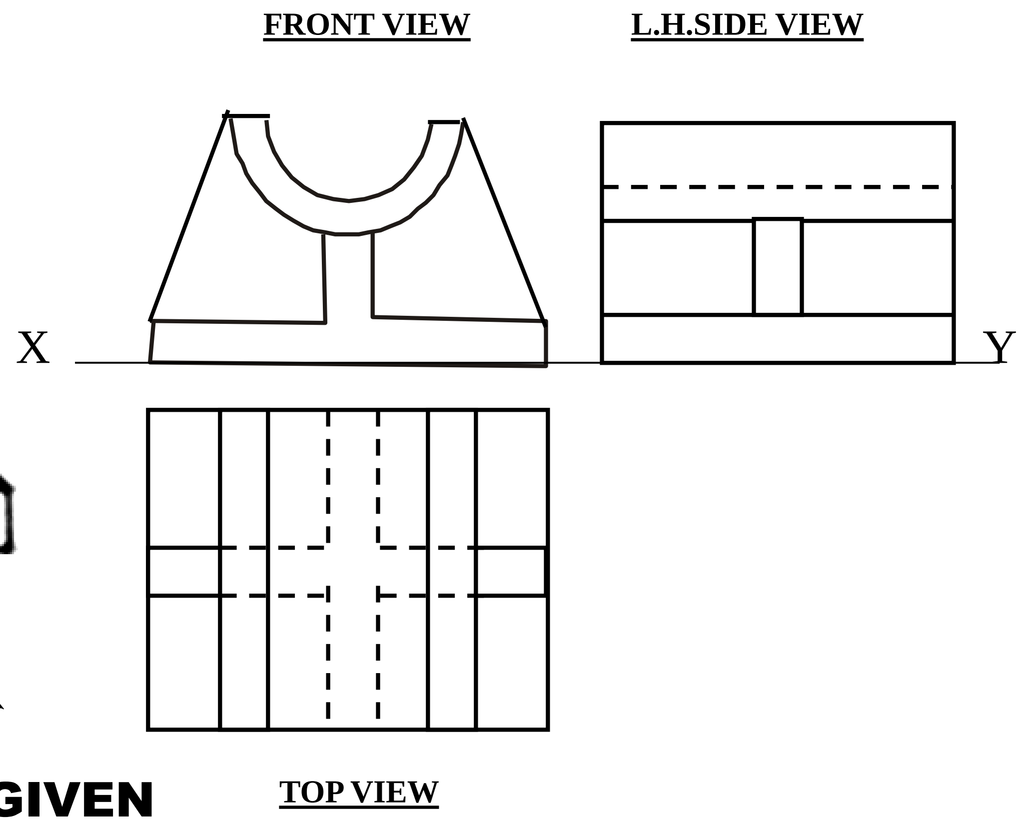


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS

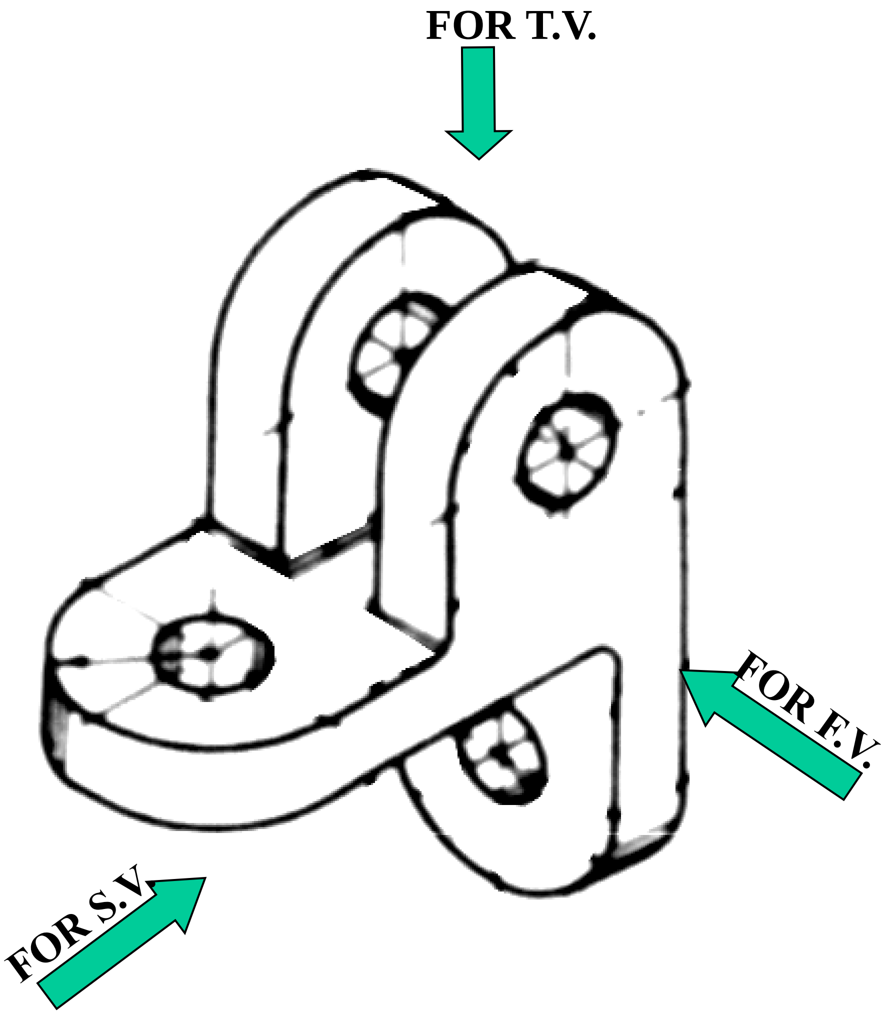


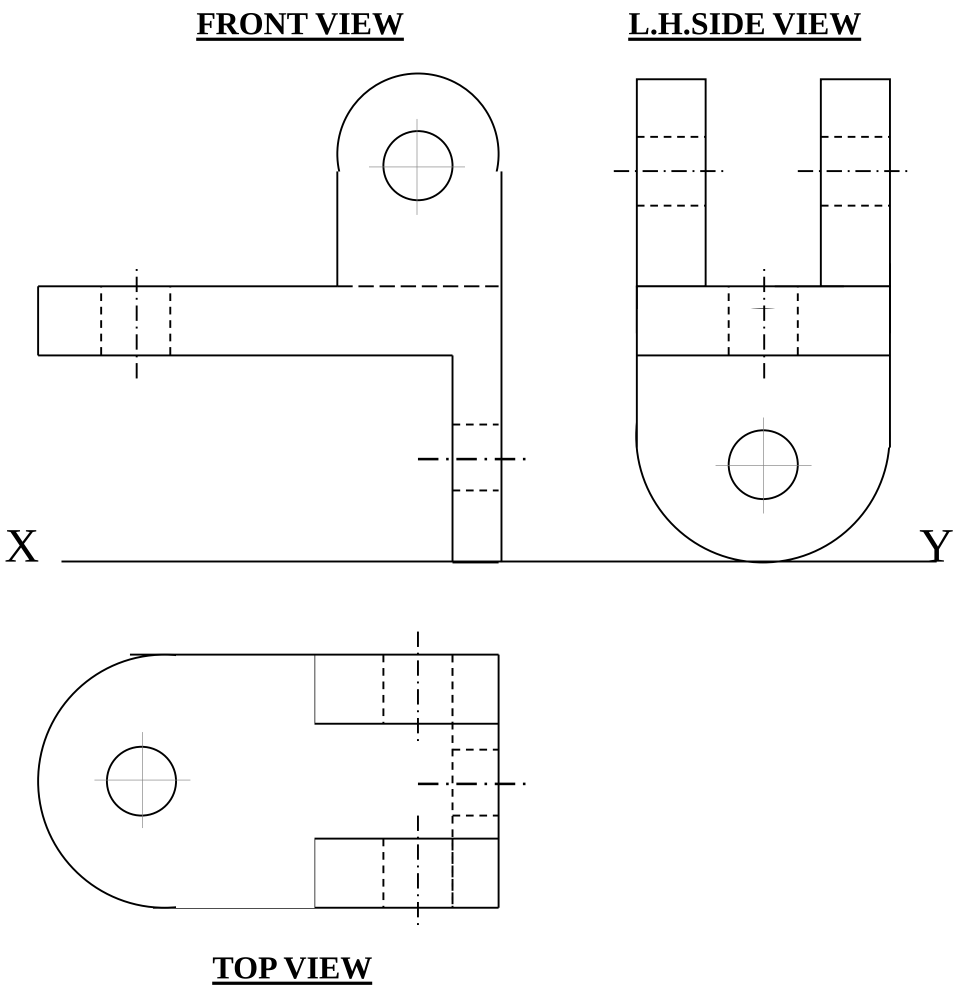


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

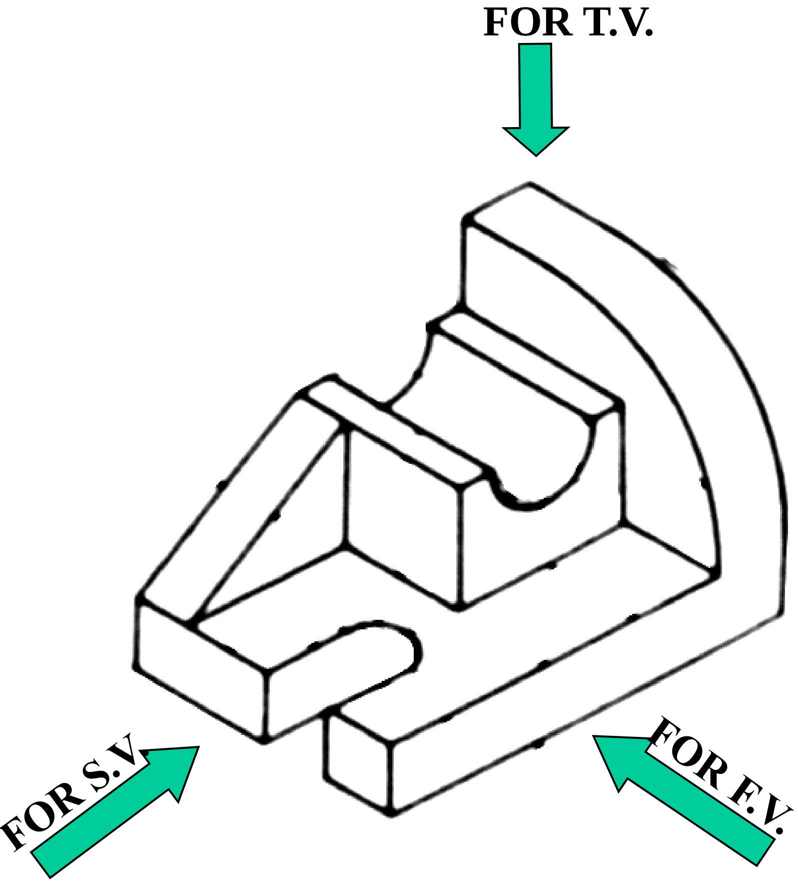
ORTHOGRAPHIC PROJECTIONS





PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



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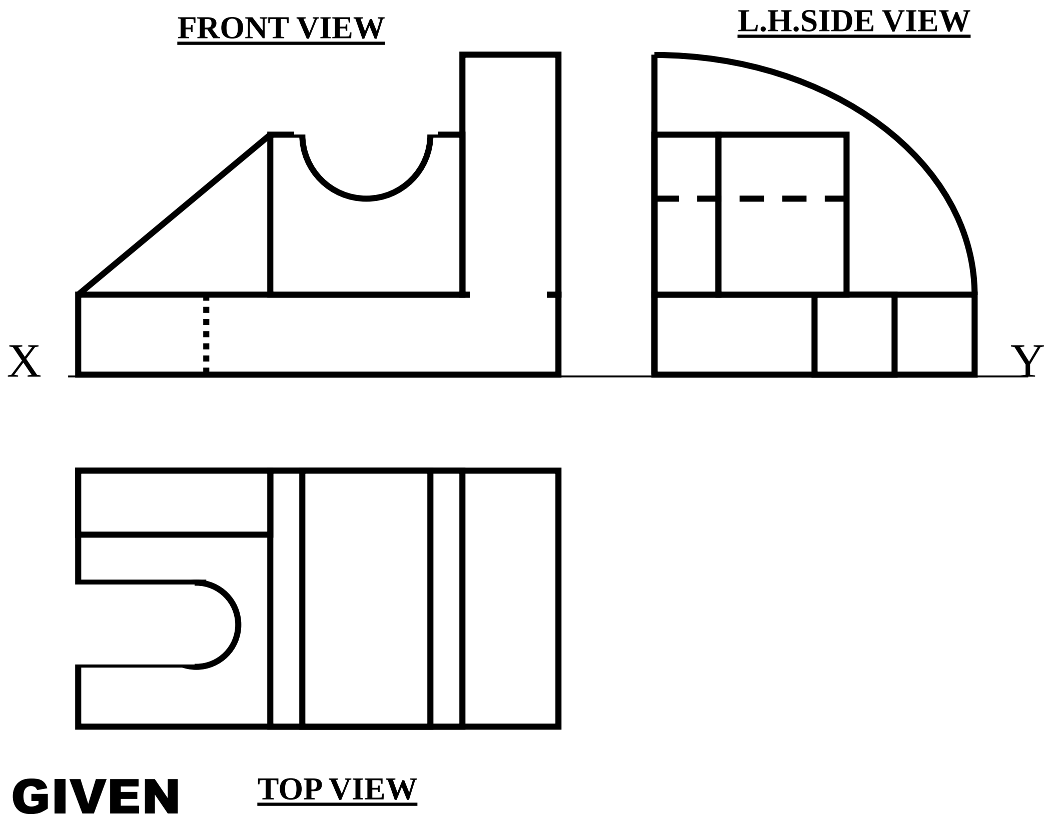
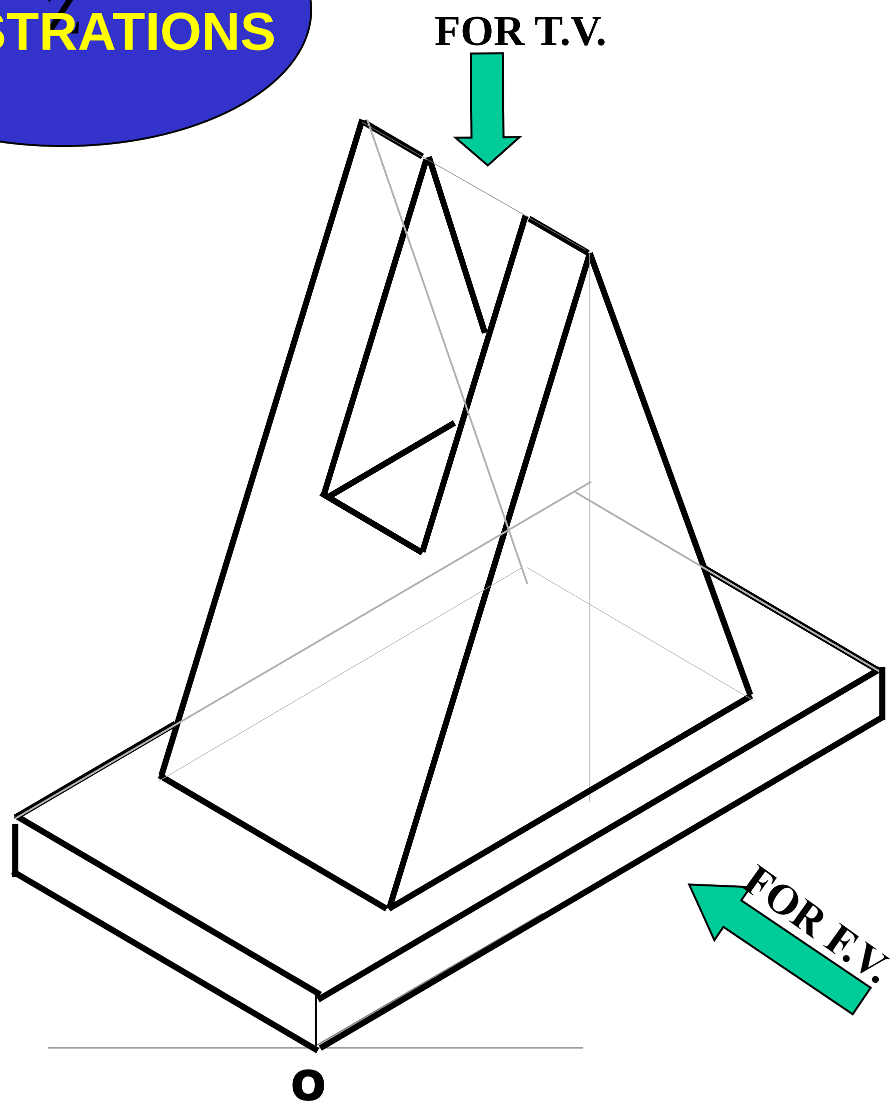


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS



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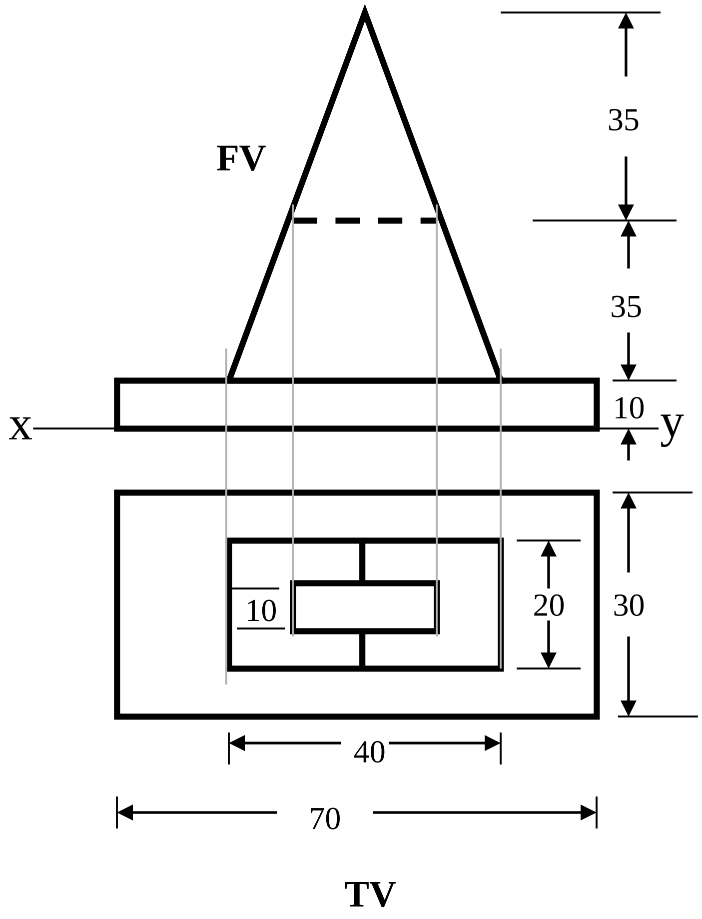
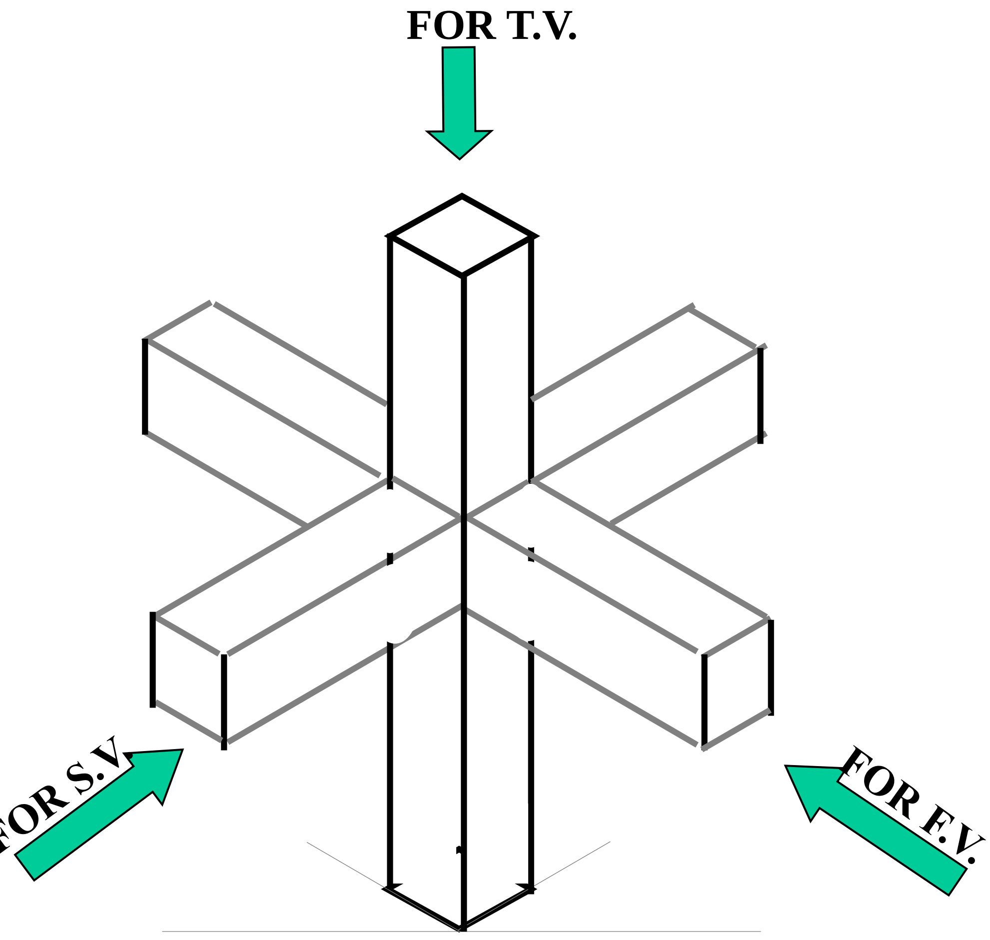


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS



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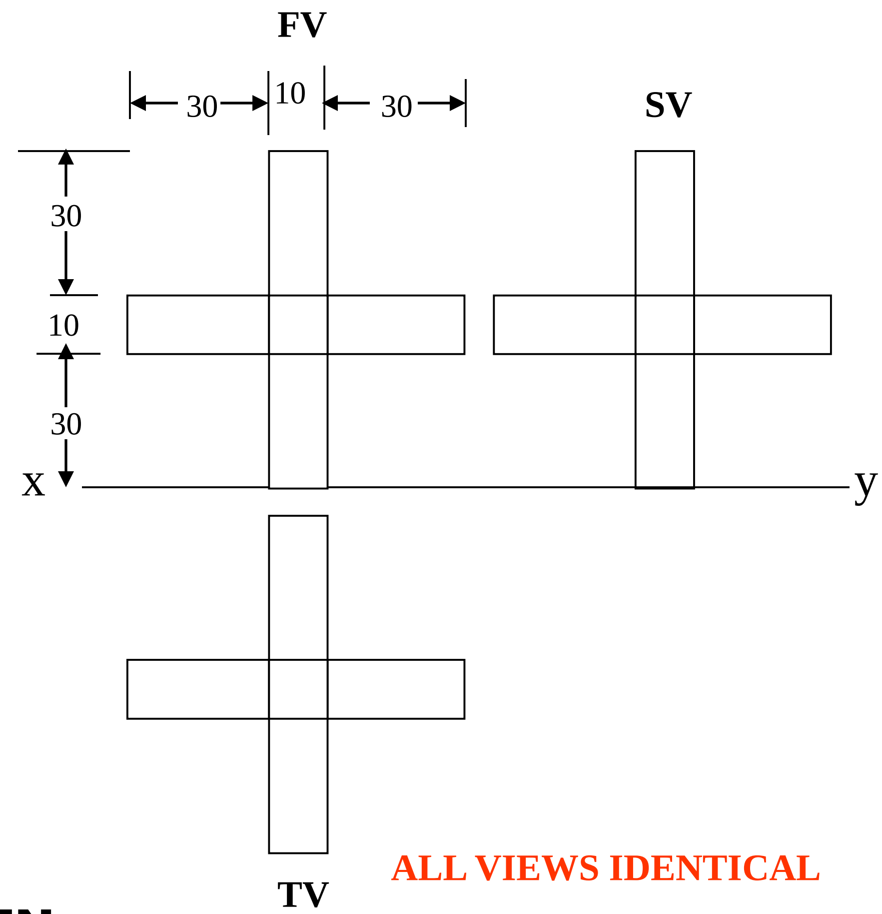


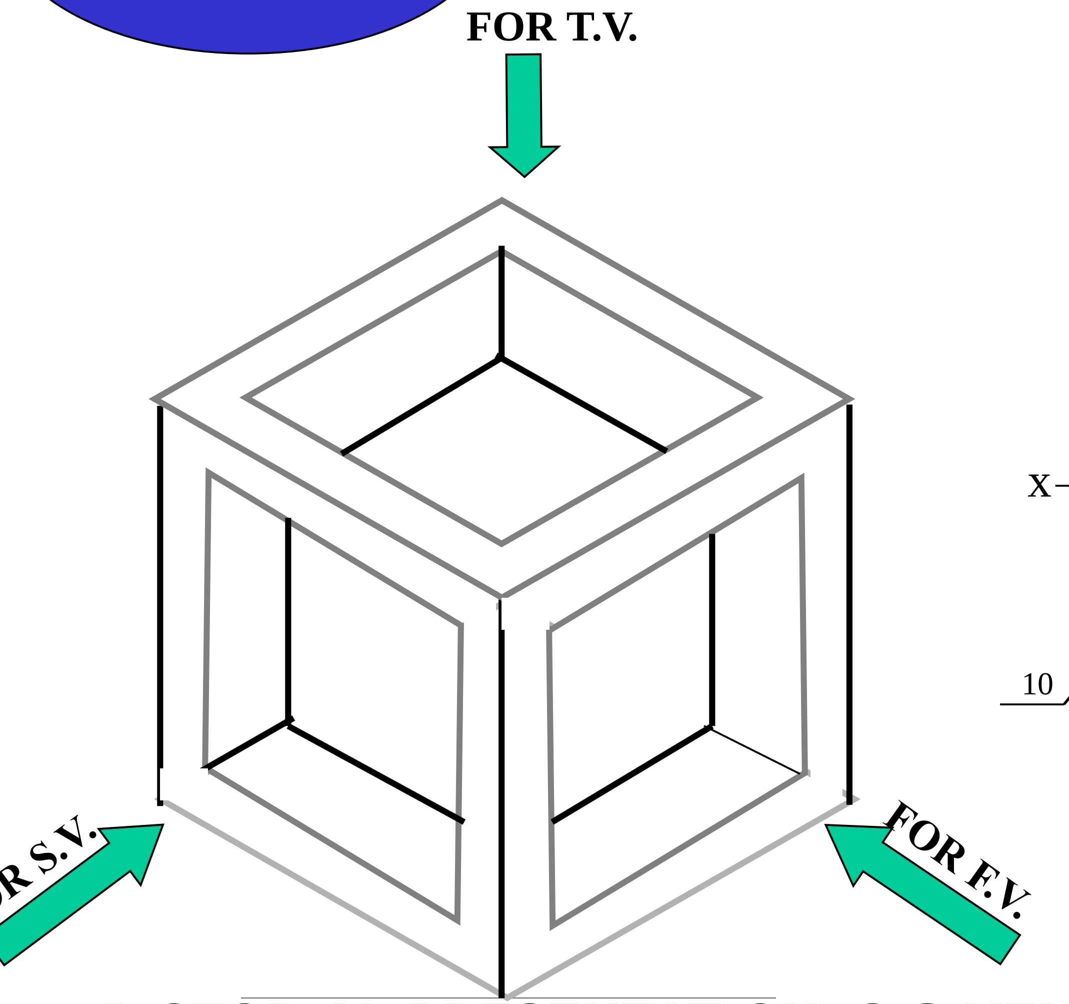
PICTORIAL PRESENTATION IS GIVEN

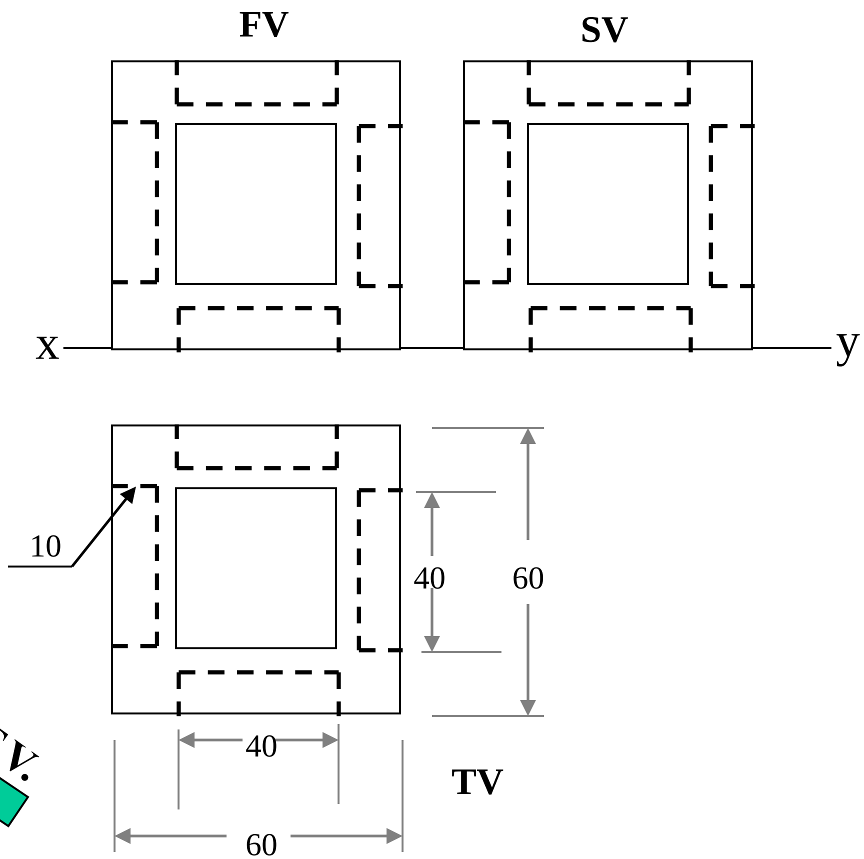
DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS

ORTHOGRAPHIC PROJECTIONS

ALL VIEWS IDENTICAL

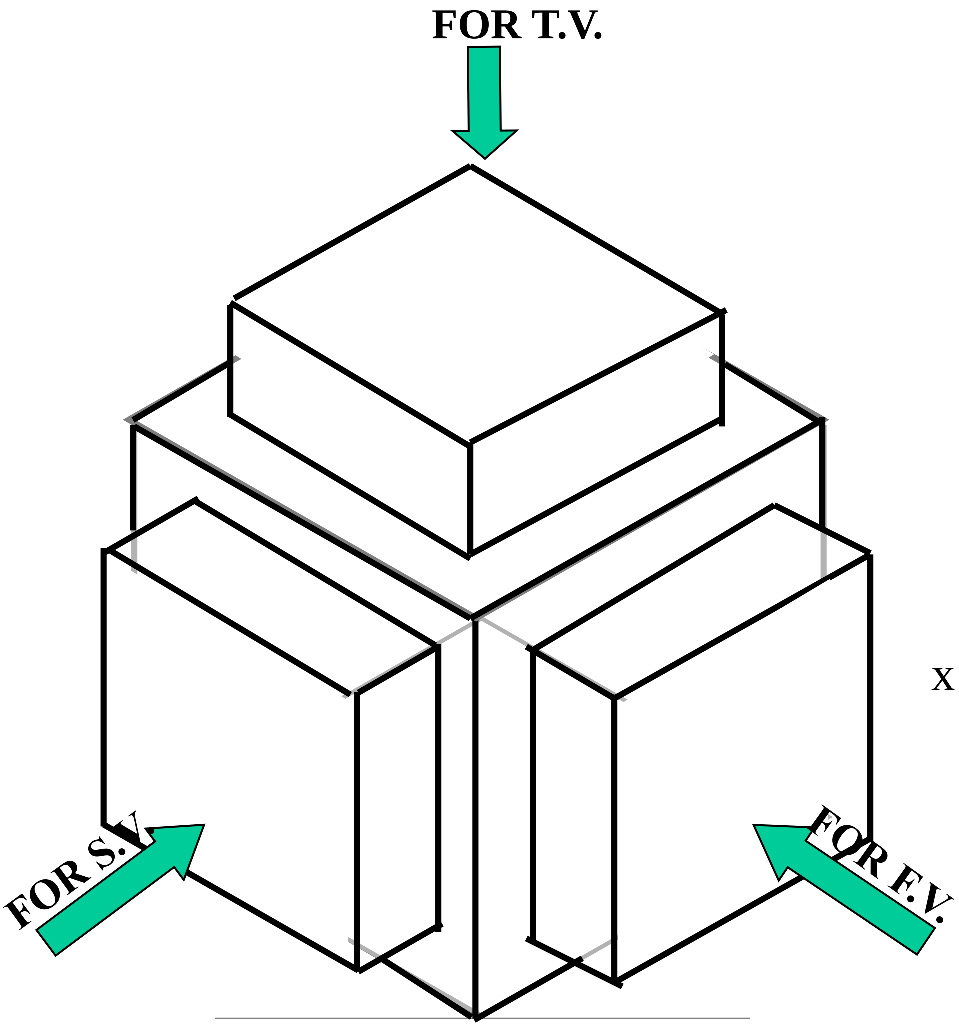


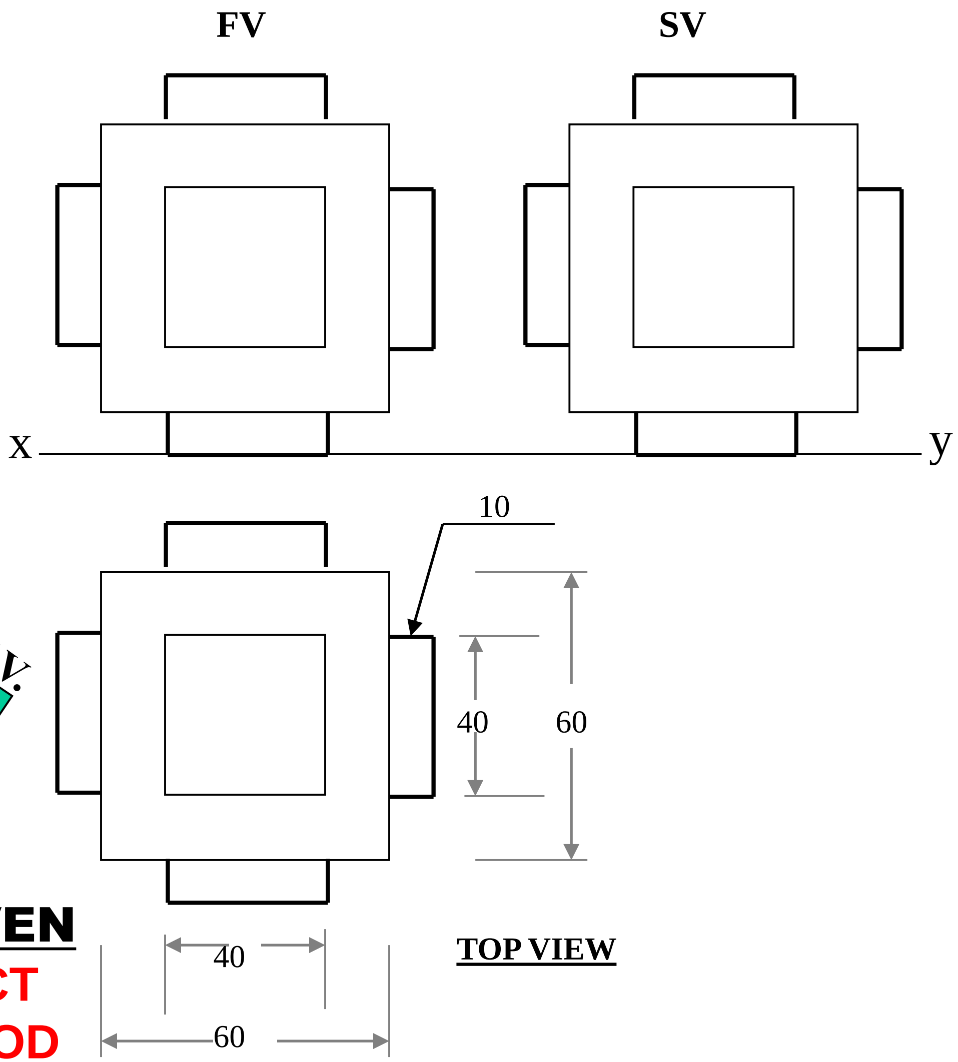


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

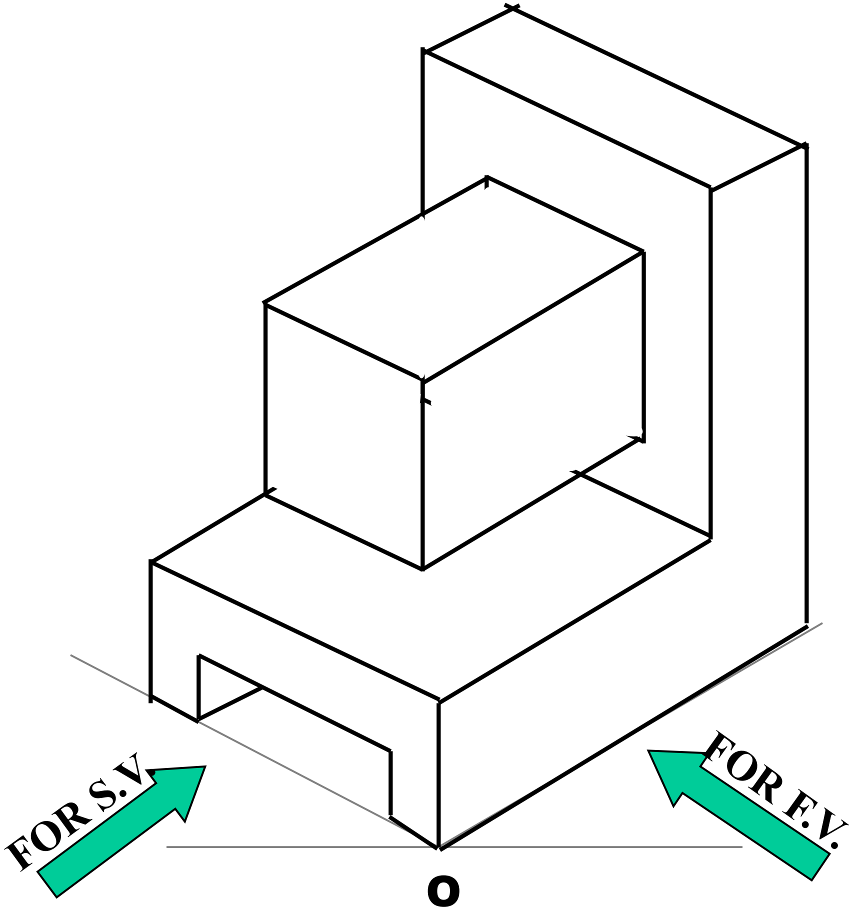
ALL VIEWS IDENTICAL



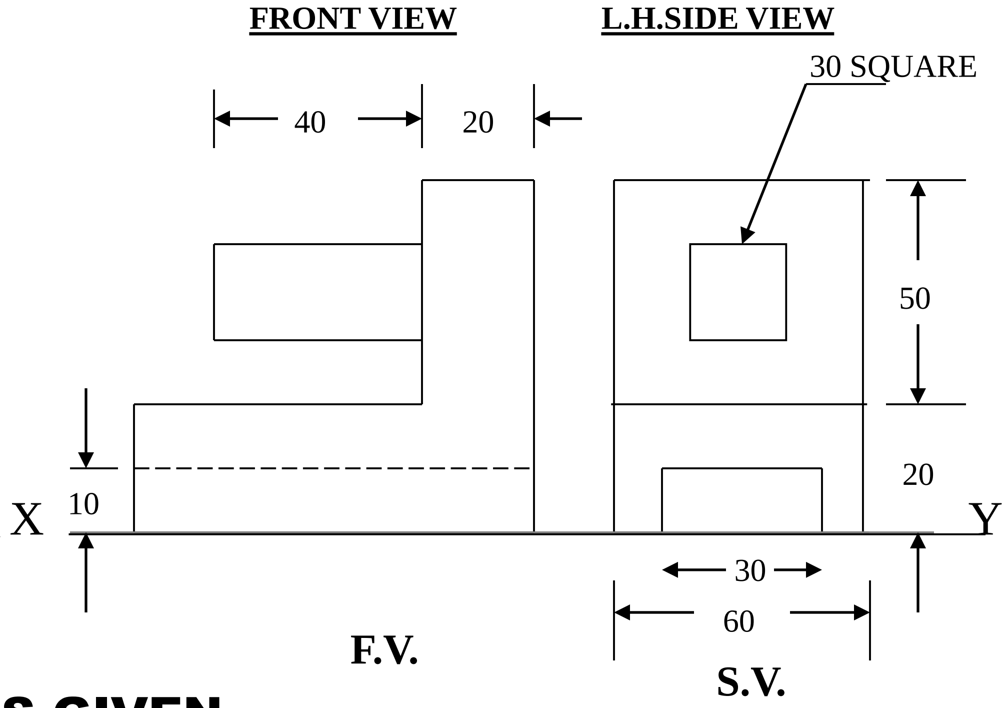


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



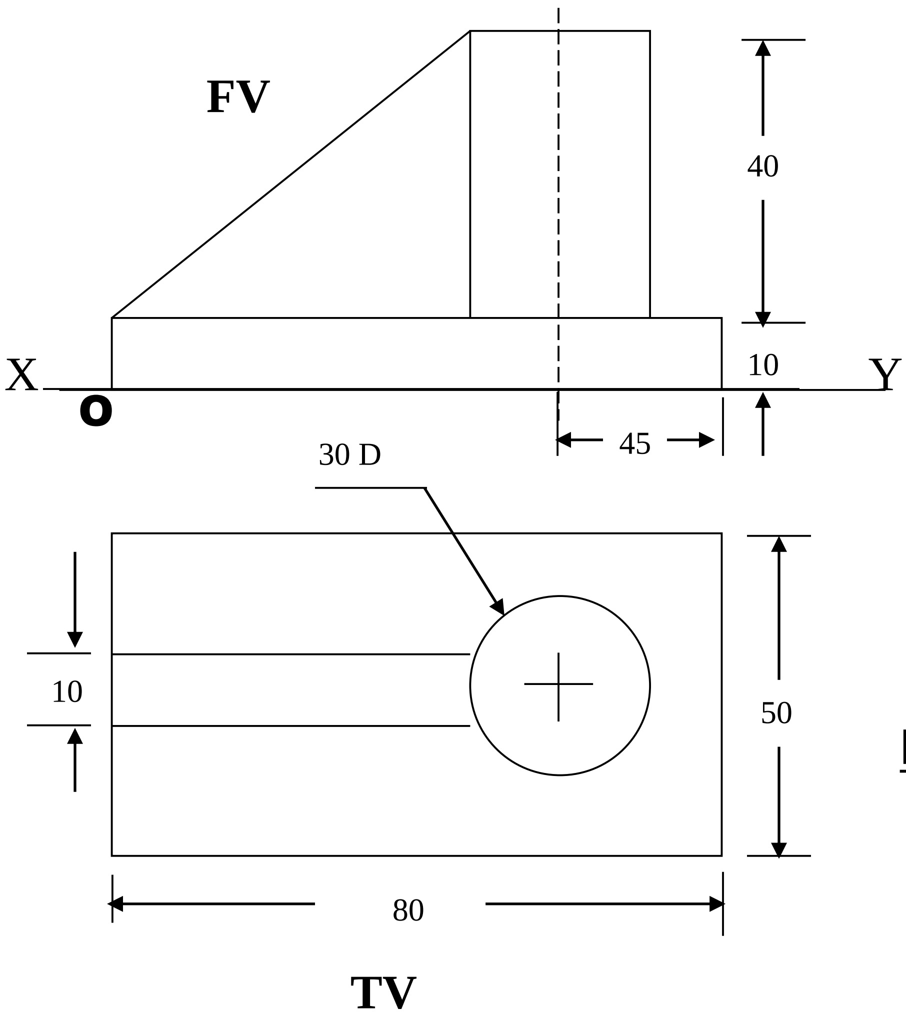
ORTHOGRAPHIC PROJECTIONS

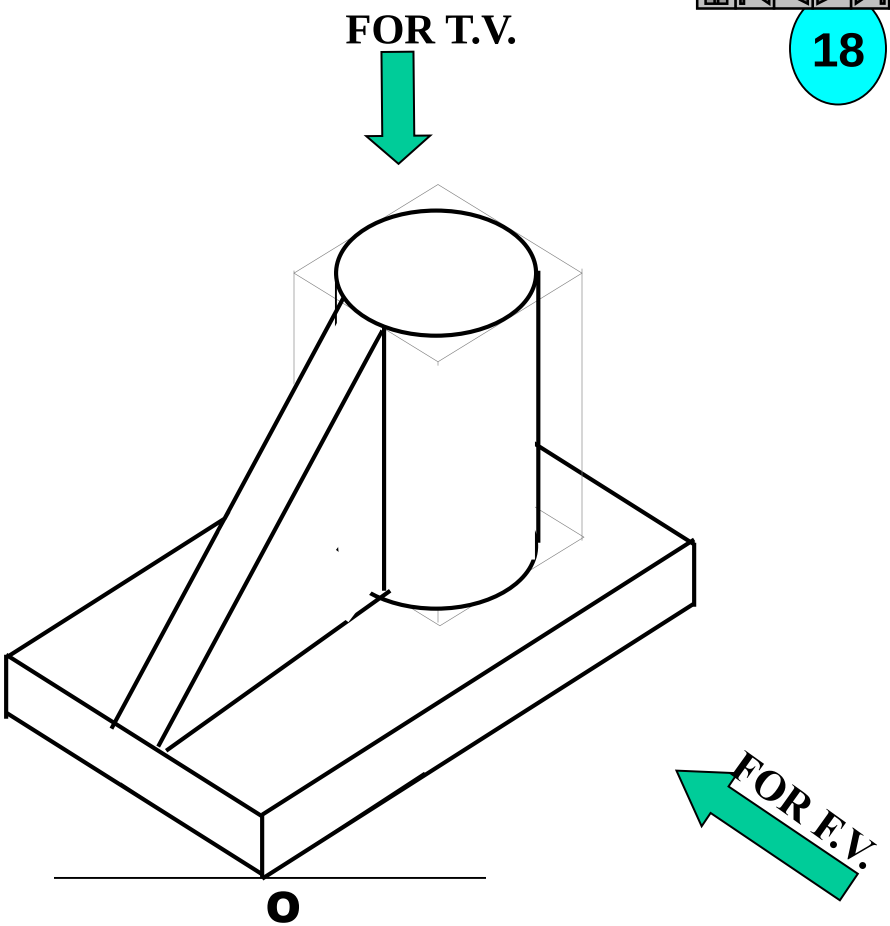


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS

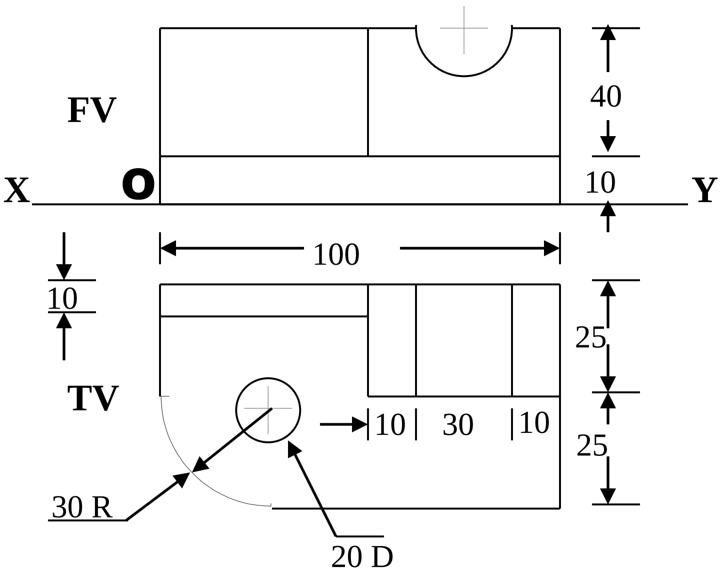


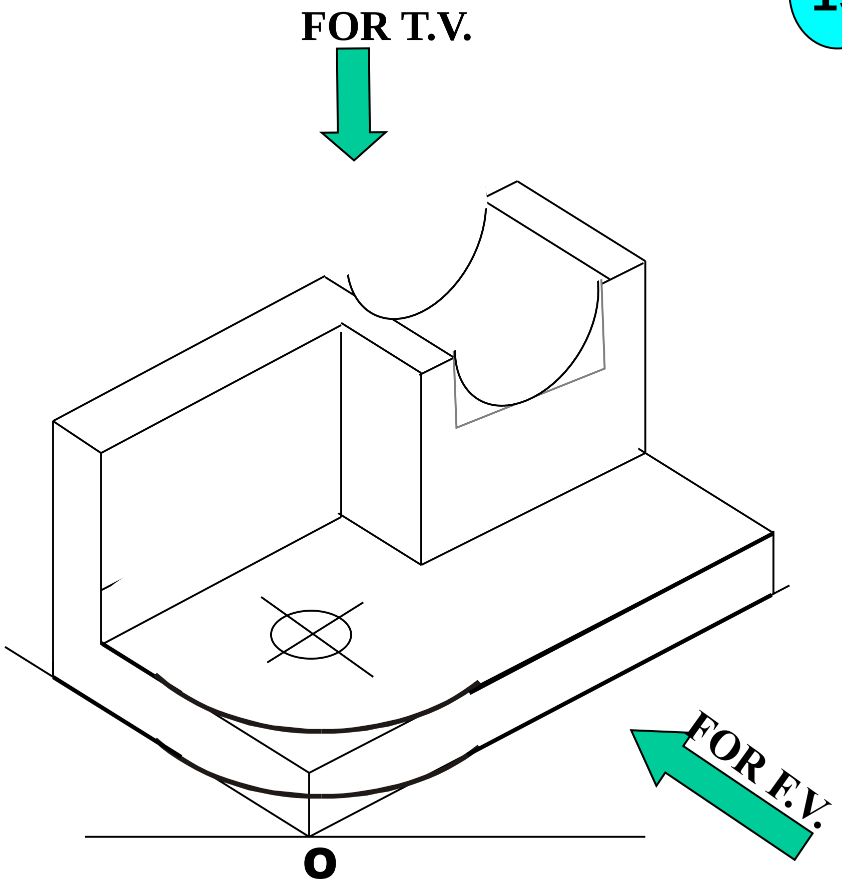


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS



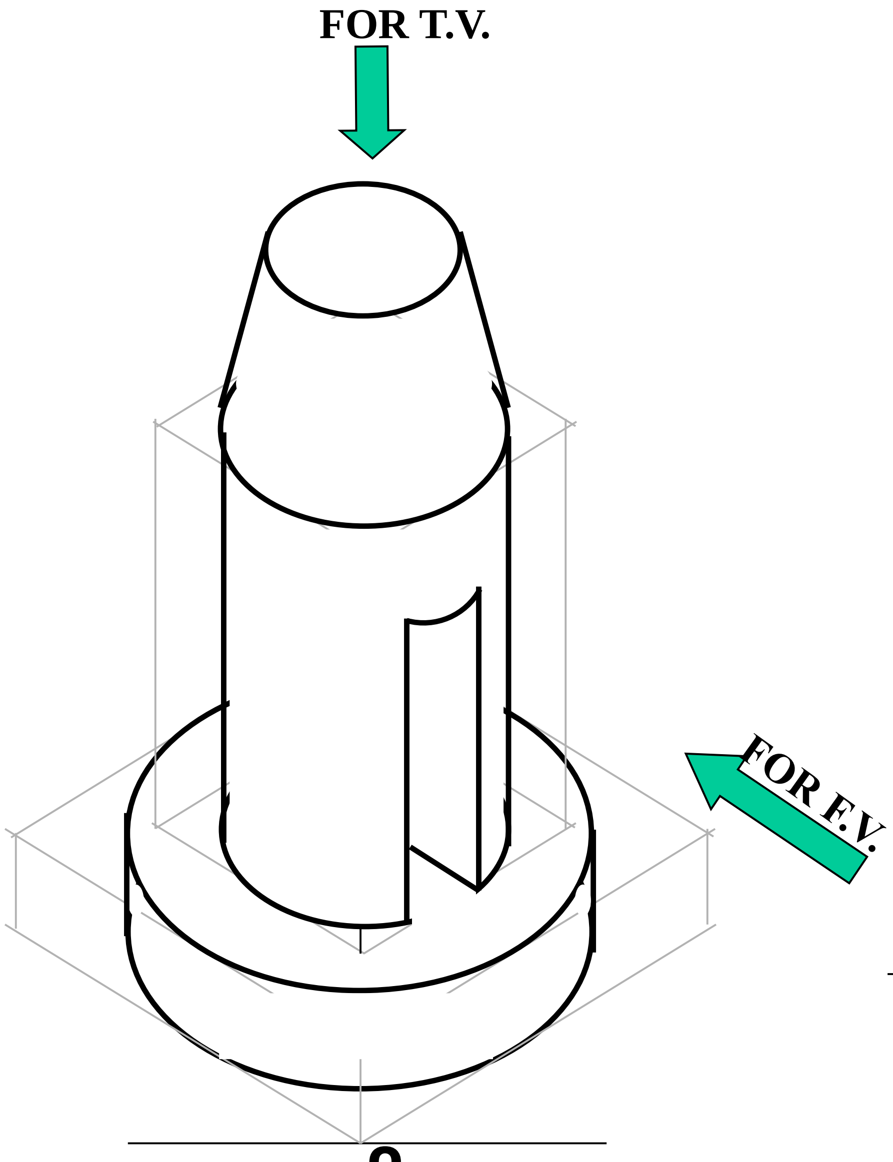


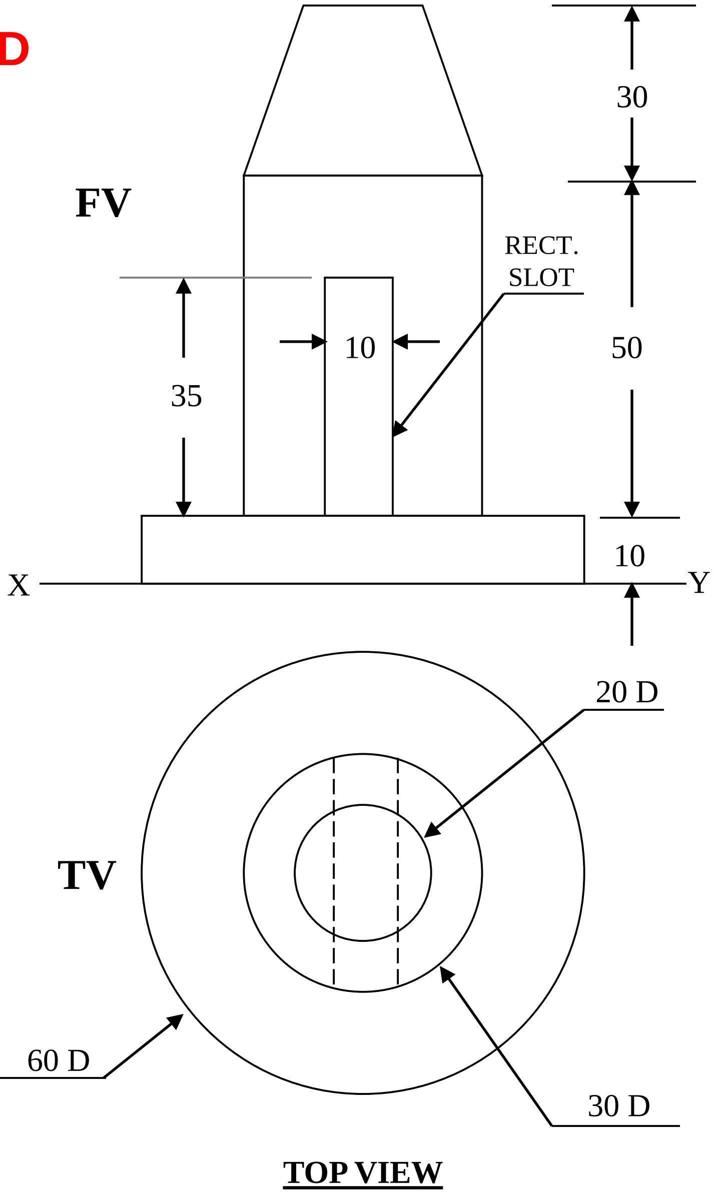
PICTORIAL PRESENTATION IS GIVEN

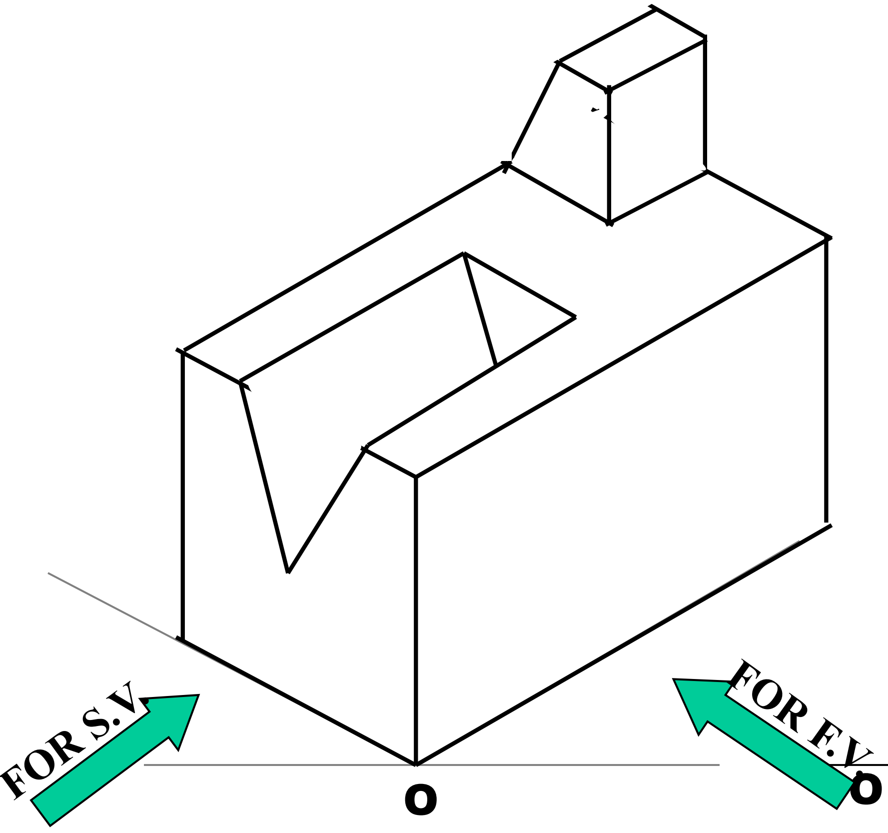
DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

PICTORIAL PRESENTATION IS GIVEN

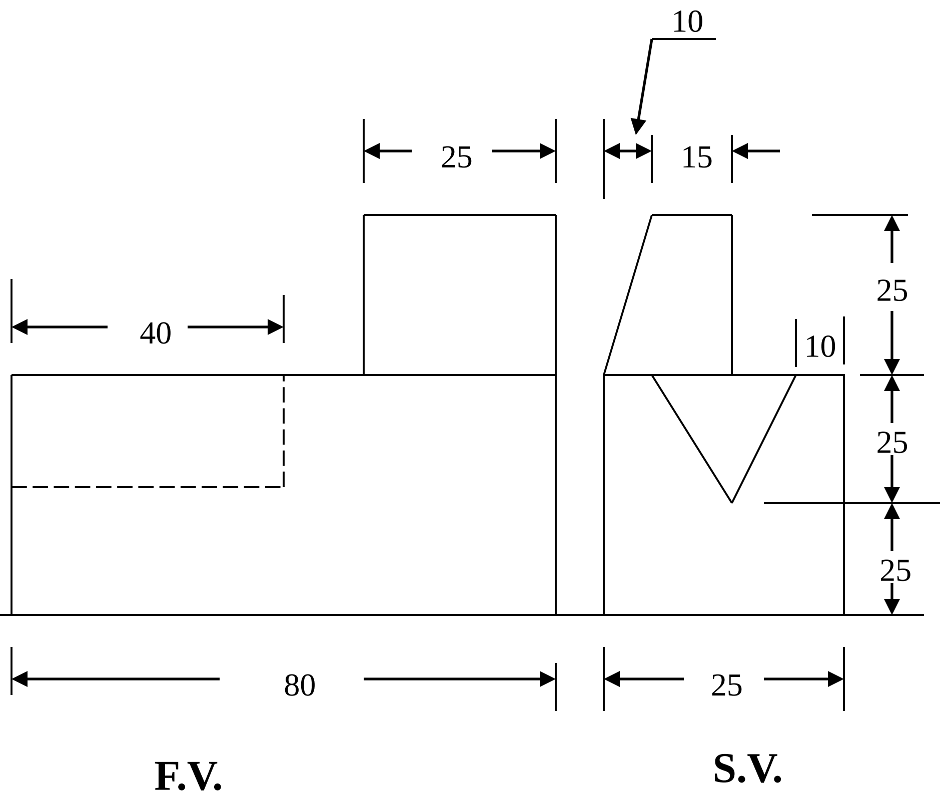
DRAW FV AND TV OF THIS OBJECT BY FIRST ANGLE PROJECTION METHOD







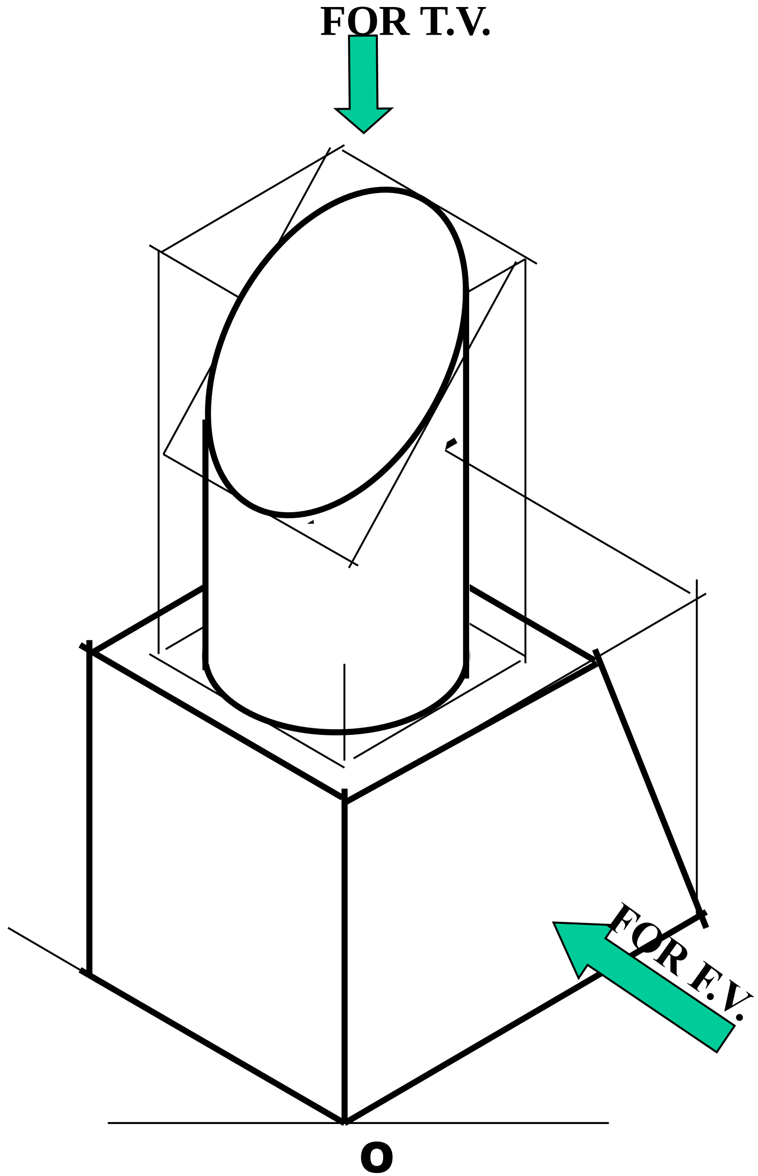
ORTHOGRAPHIC PROJECTIONS

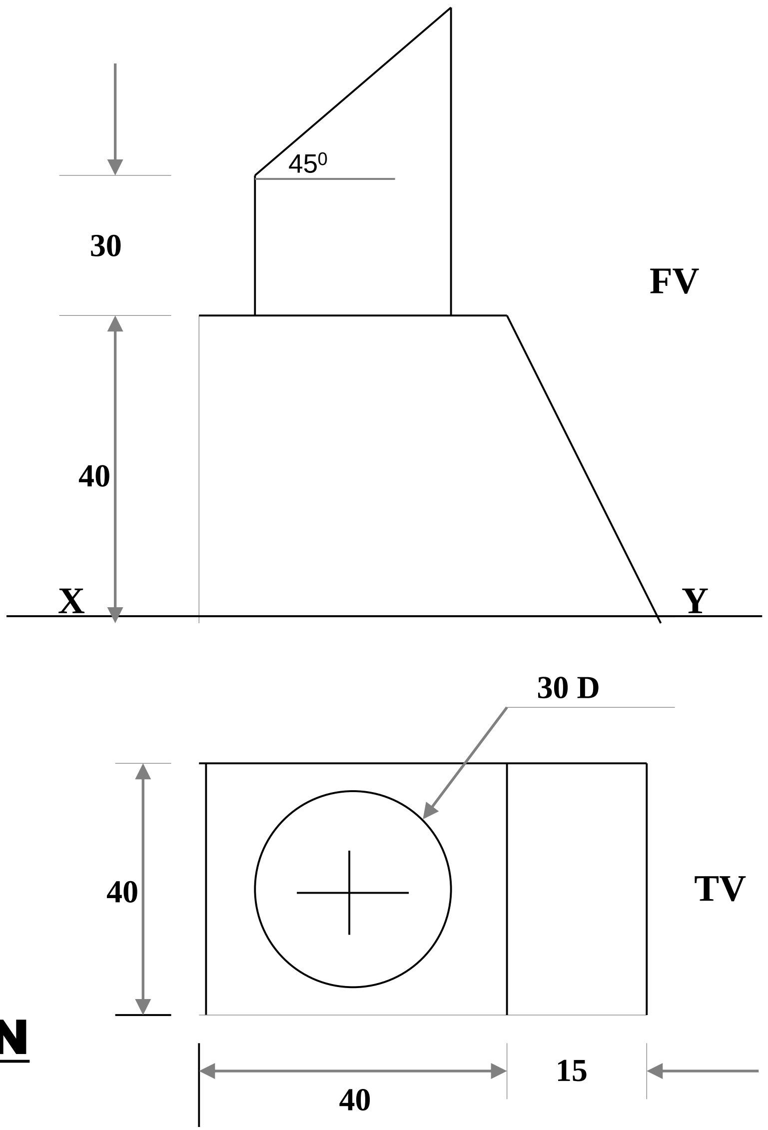


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

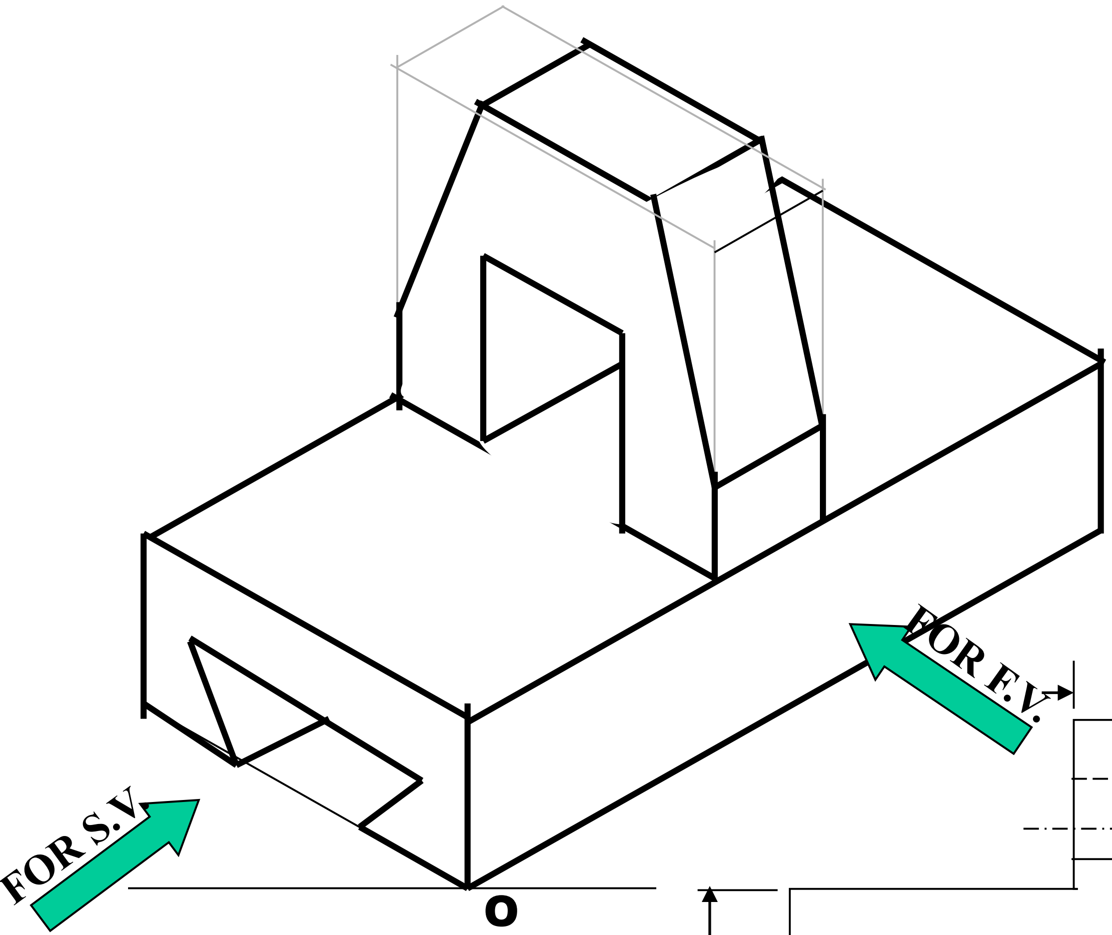
ORTHOGRAPHIC PROJECTIONS



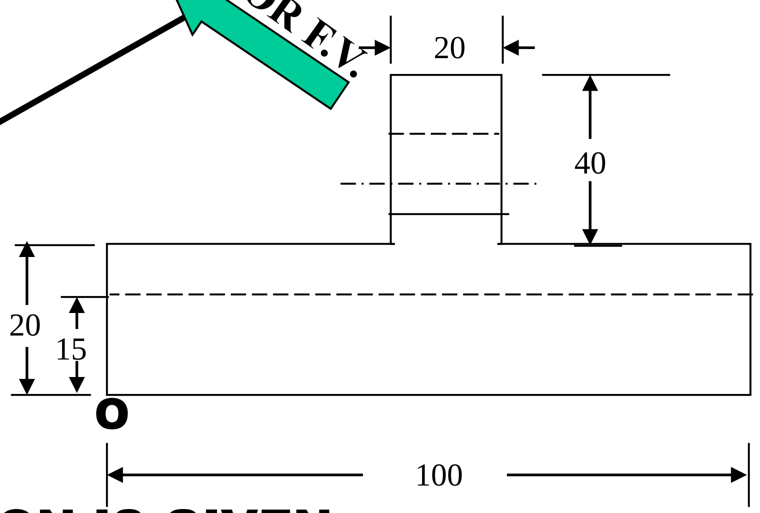


PICTORIAL PRESENTATION IS GIVEN

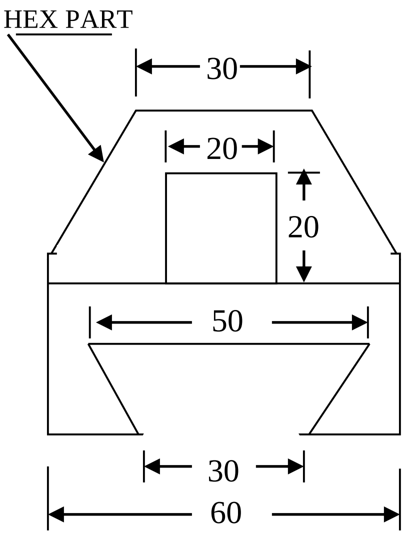
DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS



FRONT VIEW

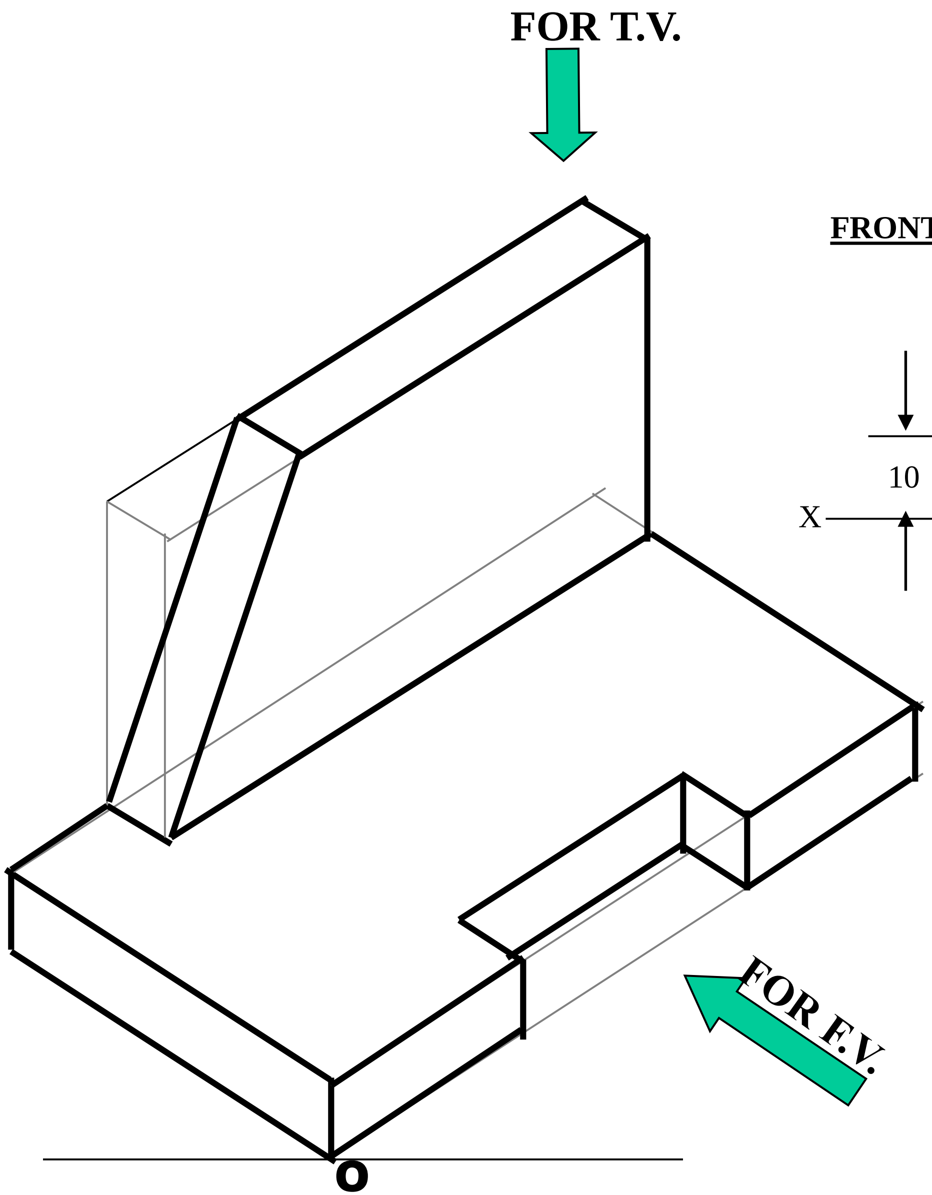


L.H.SIDE VIEW

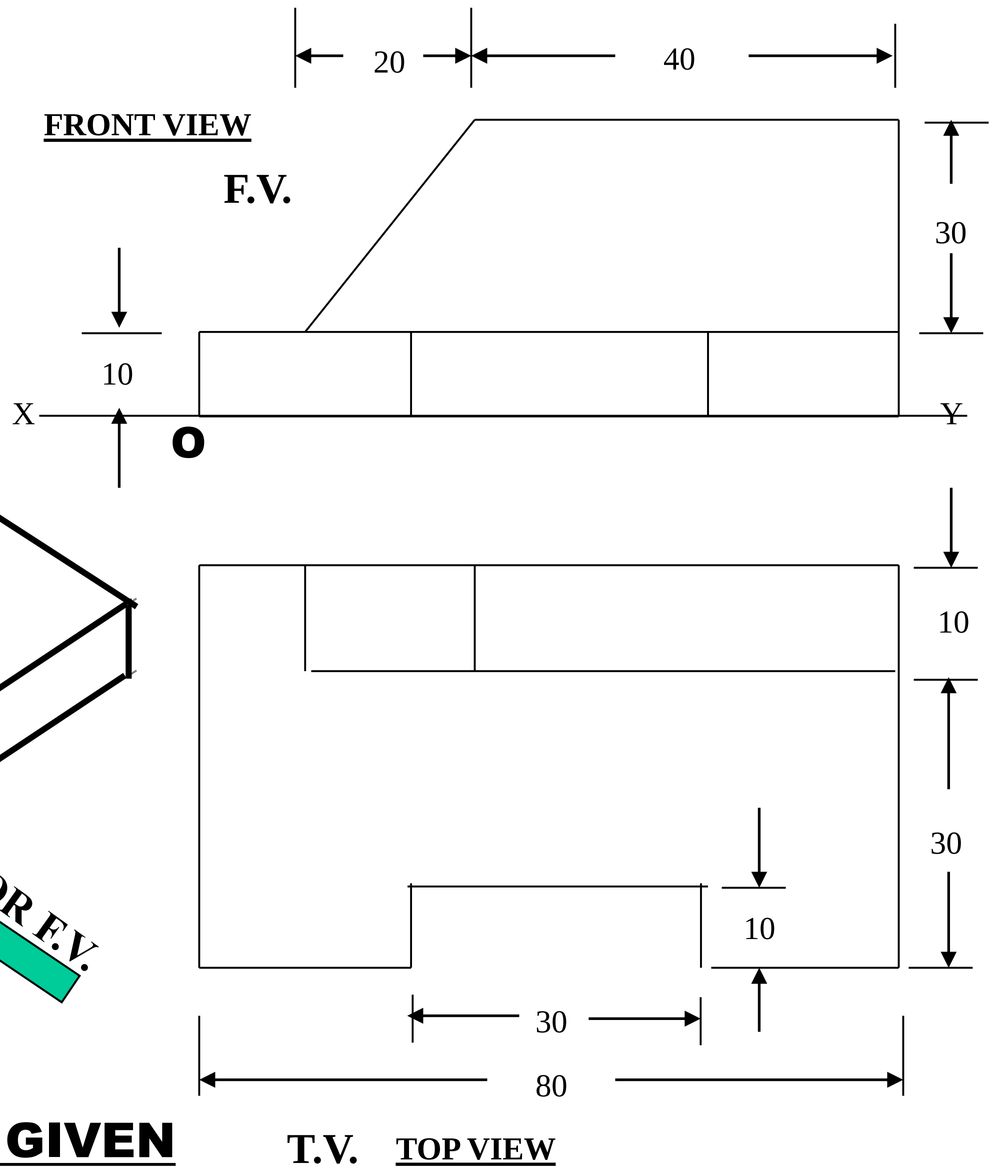
PICTORIAL PRESENTATION IS GIVEN

DRAW FV ABD SV OF THIS OBJECT

BY FIRST ANGLE PROJECTION METHOD



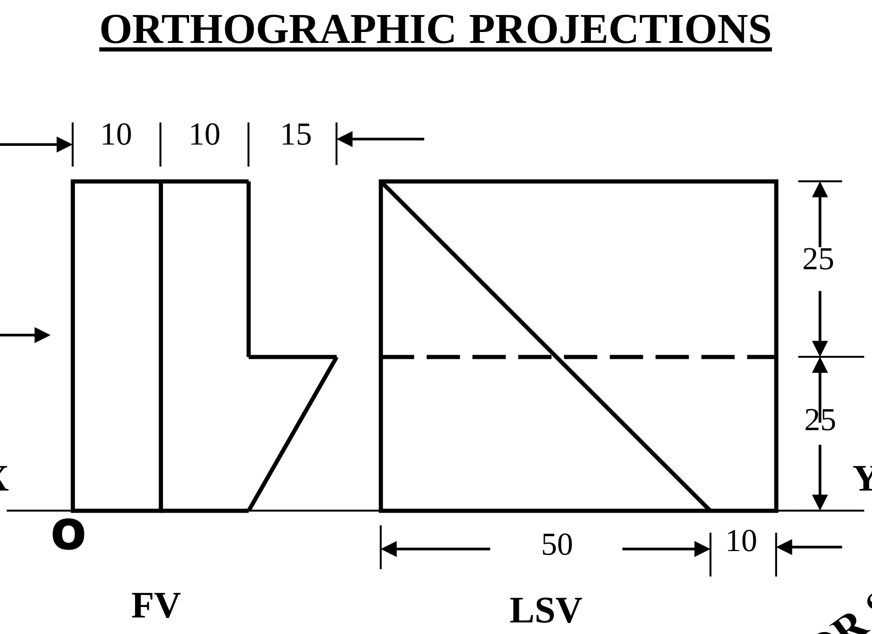
ORTHOGRAPHIC PROJECTIONS

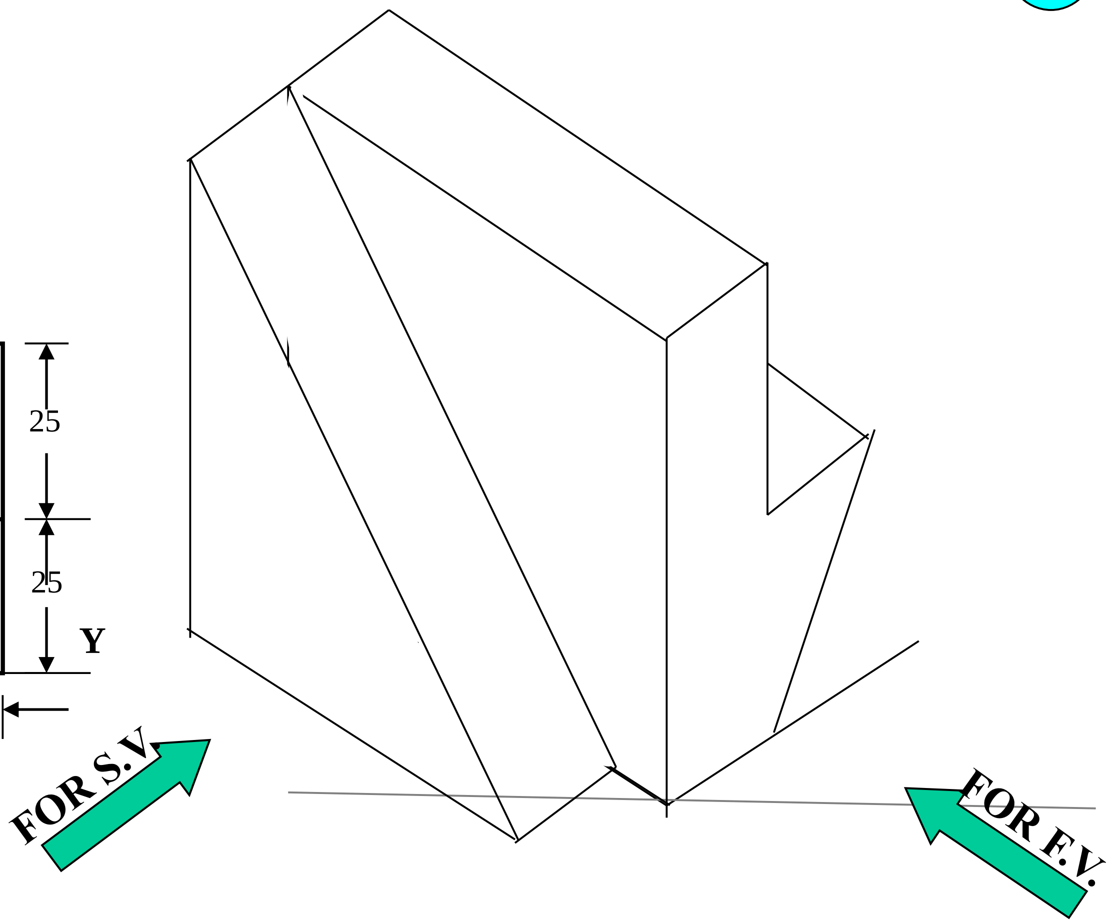


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT

BY FIRST ANGLE PROJECTION METHOD





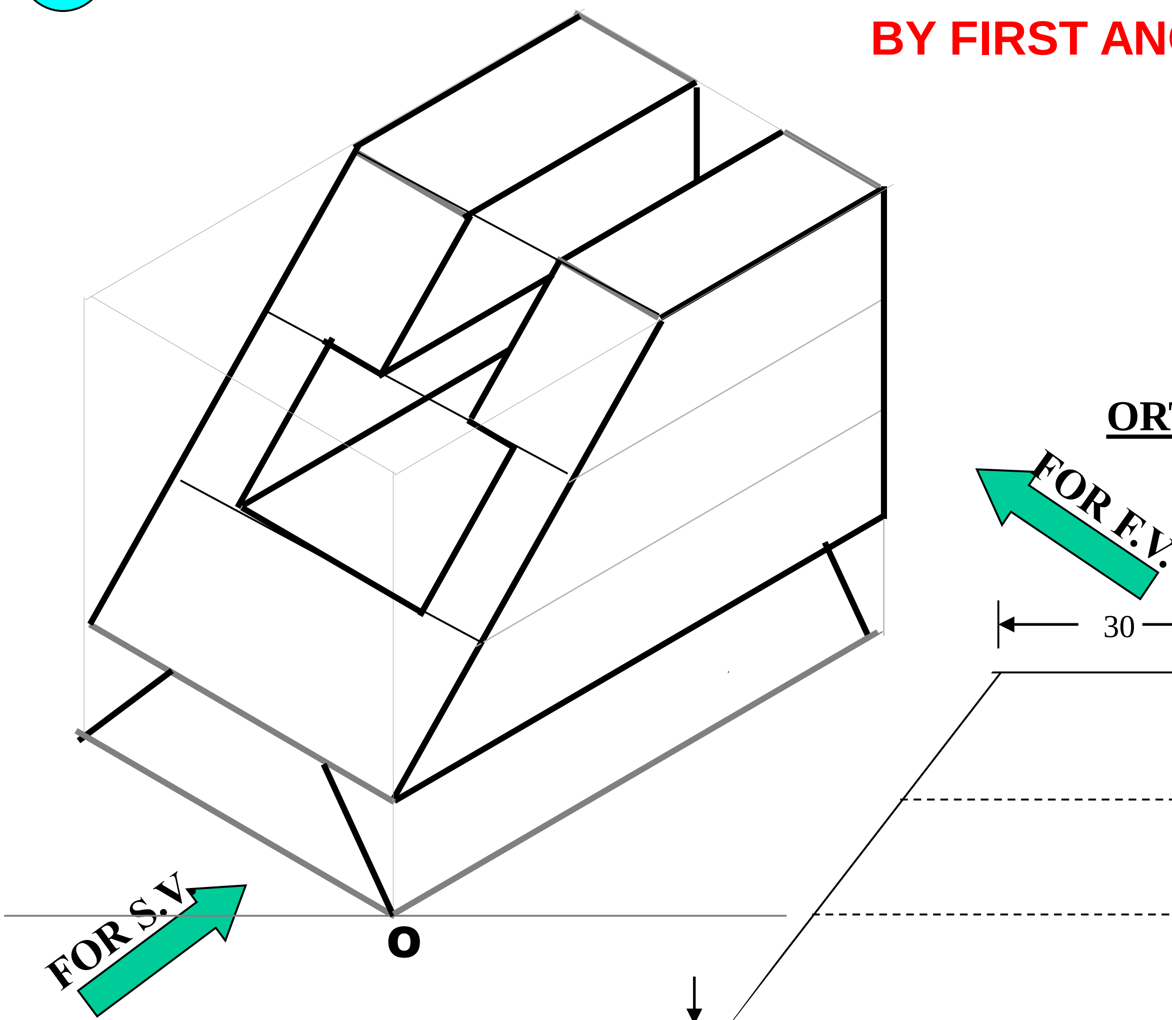
PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND LSV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

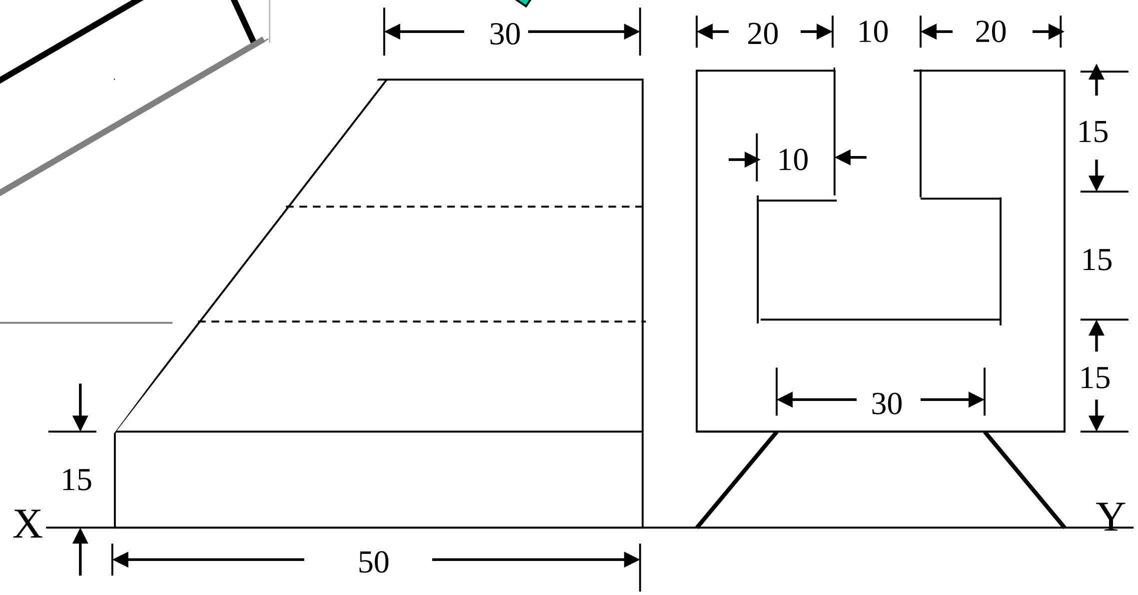
26

PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS



F.V.

LEFT S.V.

ORTHOGRAPHIC PROJECTIONS

OF POINTS, LINES, PLANES, AND SOLIDS.

TO DRAW PROJECTIONS OF ANY OBJECT, ONE MUST HAVE FOLLOWING INFORMATION

A) **OBJECT**

{ WITH IT'S DESCRIPTION, WELL DEFINED.}

B) **OBSERVER**

{ ALWAYS OBSERVING PERPENDICULAR TO RESP. REF.PLANE}.

C) **LOCATION OF OBJECT**,

{ MEANS IT'S POSITION WITH REFFERENCE TO H.P. & V.P.}

TERMS 'ABOVE' & 'BELOW' WITH RESPECTIVE TO H.P.
AND TERMS 'INFRONT' & 'BEHIND' WITH RESPECTIVE TO V.P
FORM 4 QUADRANTS.
OBJECTS CAN BE PLACED IN ANY ONE OF THESE 4 QUADRANTS.

IT IS INTERESTING TO LEARN THE EFFECT ON THE POSITIONS OF VIEWS (FV, TV) OF THE OBJECT WITH RESP. TO X-Y LINE, WHEN PLACED IN DIFFERENT QUADRANTS.

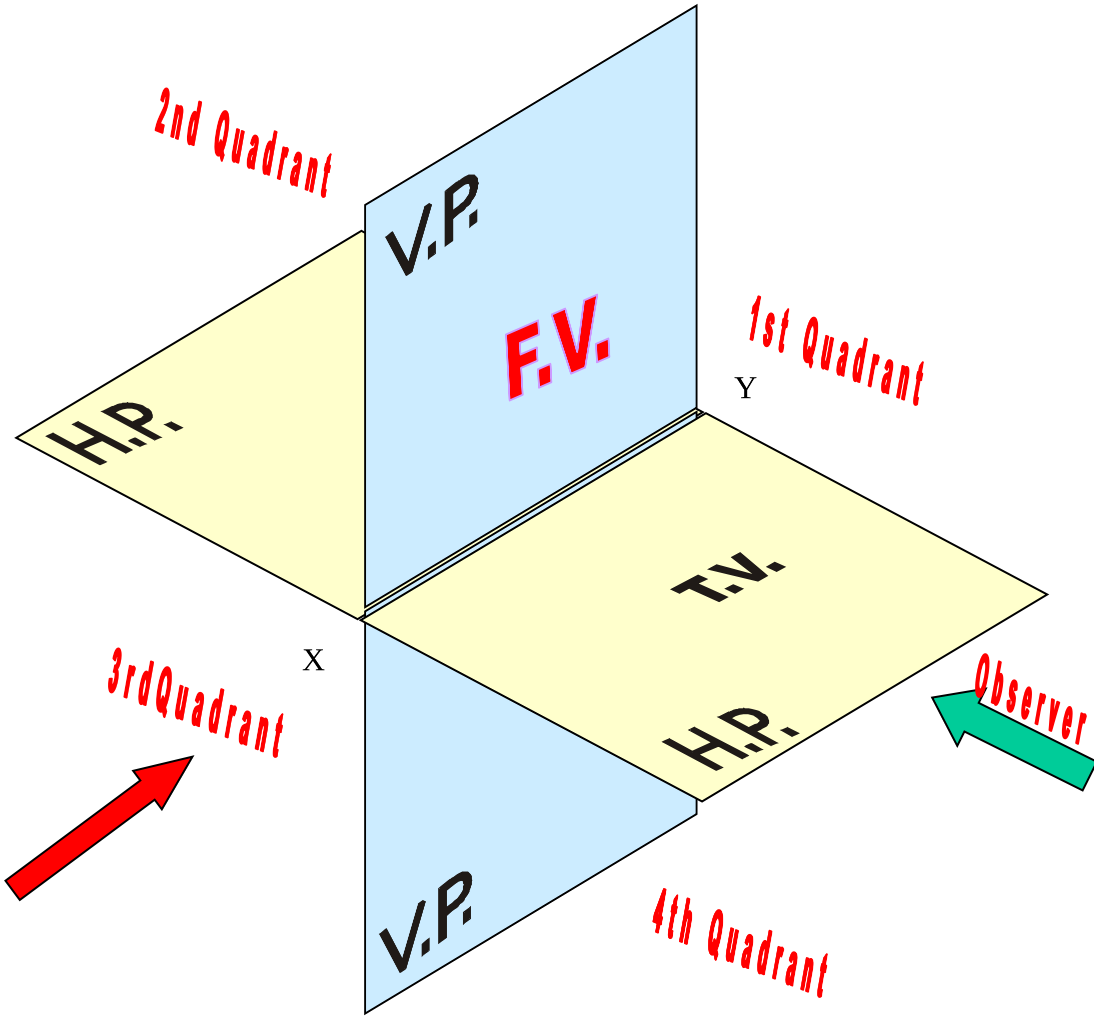
STUDY ILLUSTRATIONS GIVEN ON HEXT PAGES AND NOTE THE RESULTS.TO MAKE IT EASY HERE A POINT A IS TAKEN AS AN OBJECT. BECAUSE IT'S ALL VIEWS ARE JUST POINTS.

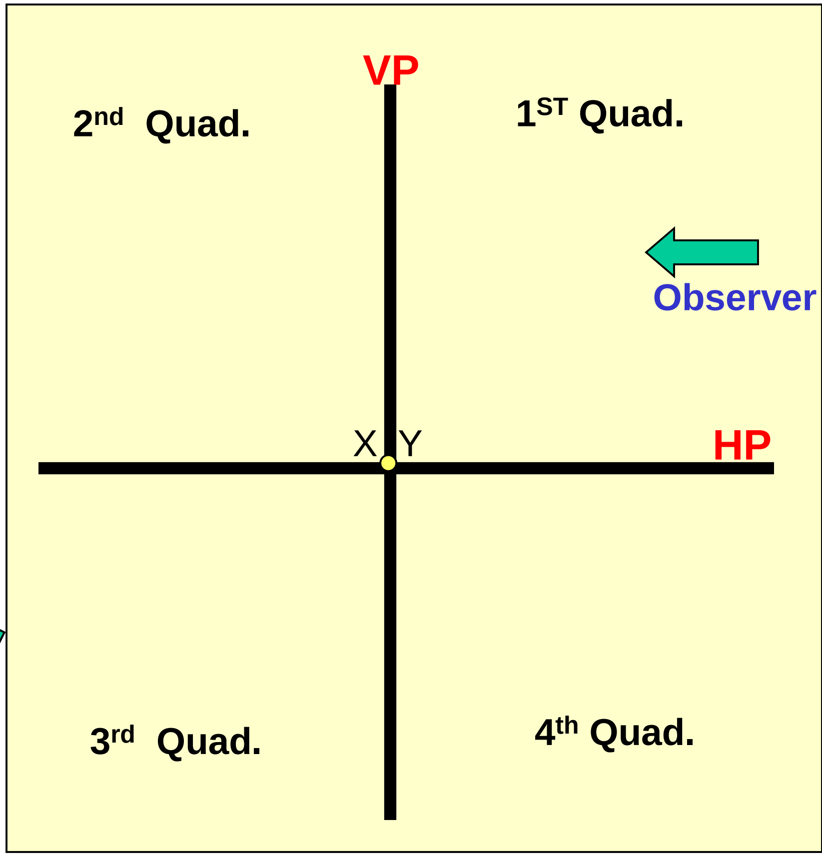
NOTATIONS

FOLLOWING NOTATIONS SHOULD BE FOLLOWED WHILE NAMEING DIFFERENT VIEWS IN ORTHOGRAPHIC PROJECTIONS.

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

SAME SYSTEM OF NOTATIONS SHOULD BE FOLLOWED INCASE NUMBERS, LIKE 1, 2, 3 – ARE USED.



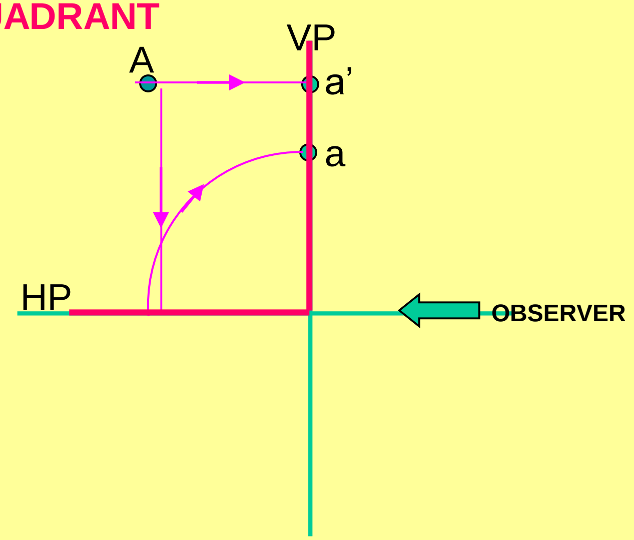


**THIS QUADRANT PATTERN,
IF OBSERVED ALONG X-Y LINE (IN RED ARROW DIRECTION)
WILL EXACTLY APPEAR AS SHOWN ON RIGHT SIDE AND HENCE,
IT IS FURTHER USED TO UNDERSTAND ILLUSTRATION PROPERLLY.**

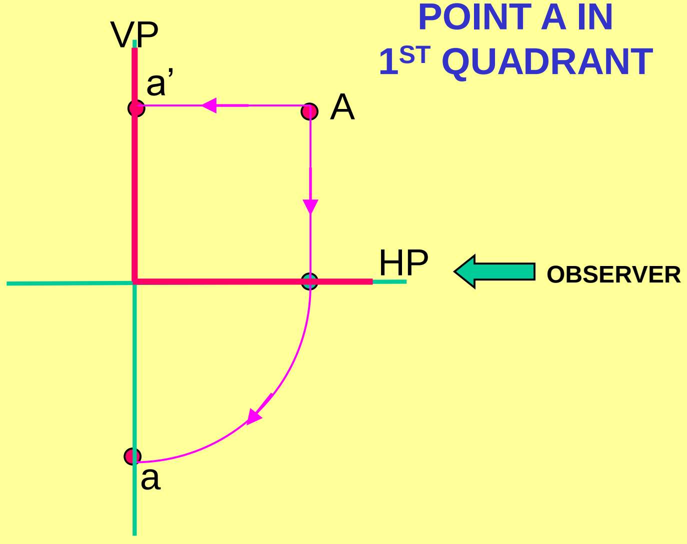
Point A is Placed In different quadrants and it's Fv & Tv are brought in same plane for Observer to see clearly.
Fv is visible as it is a view on VP. But as Tv is is a view on Hp, it is rotated downward 90^0, In clockwise direction.The In front part of Hp comes below xy line and the part behind Vp comes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

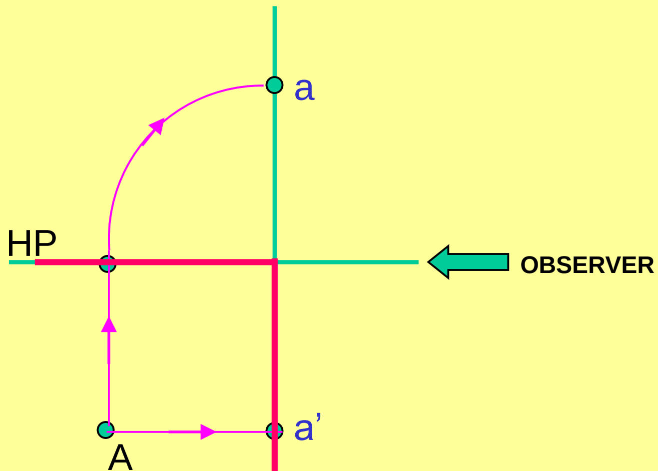
Observe and note the process.

POINT A IN 2ND QUADRANT

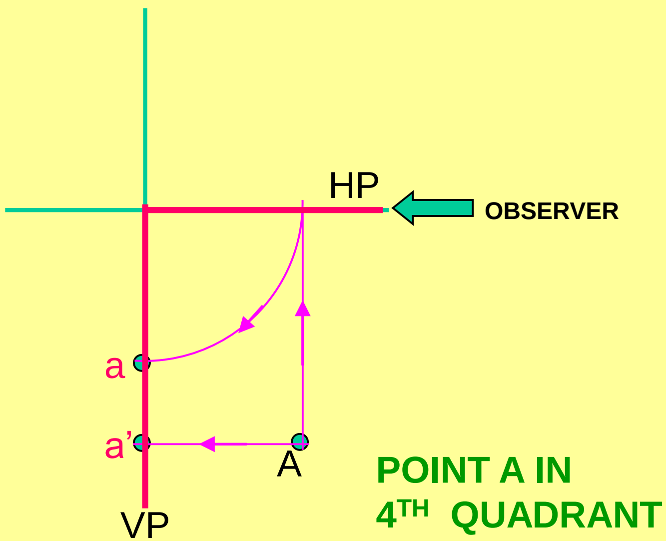


POINT A IN 1ST QUADRANT





POINT A IN 3RD QUADRANT



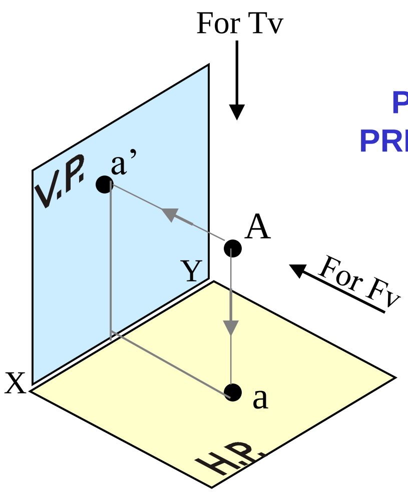
POINT A IN 4TH QUADRANT

PROJECTIONS OF A POINT IN FIRST QUADRANT.

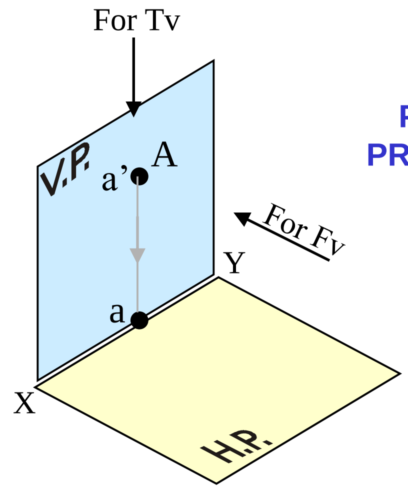
POINT A ABOVE HP & INFRONT OF VP

POINT A ABOVE HP & IN VP

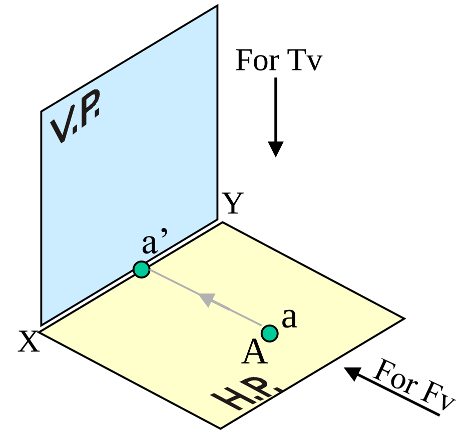
POINT A IN HP & INFRONT OF VP



PICTORIAL PRESENTATION

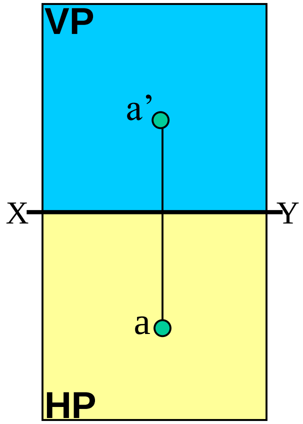


PICTORIAL PRESENTATION

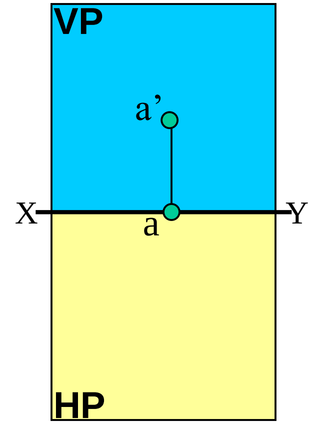


ORTHOGRAPHIC PRESENTATIONS OF ALL ABOVE CASES.

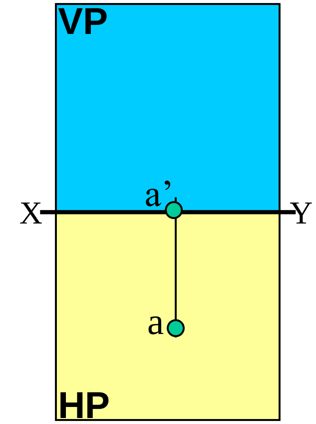
Fv above xy, Tv below xy.



Fv above xy, Tv on xy.



Fv on xy, Tv below xy.



PROJECTIONS OF STRAIGHT LINES.

INFORMATION REGARDING A LINE *means*
IT'S LENGTH,
POSITION OF IT'S ENDS WITH HP & VP
IT'S INCLINATIONS WITH HP & VP WILL BE GIVEN.
AIM:- TO DRAW IT'S PROJECTIONS - MEANS FV & TV.

SIMPLE CASES OF THE LINE

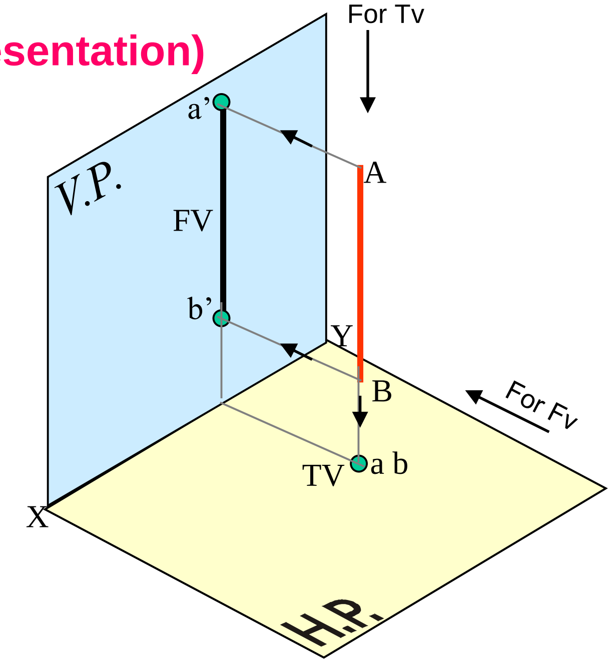
1. A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)
2. LINE PARALLEL TO BOTH HP & VP.
3. LINE INCLINED TO HP & PARALLEL TO VP.
4. LINE INCLINED TO VP & PARALLEL TO HP.
5. LINE INCLINED TO BOTH HP & VP.

STUDY ILLUSTRATIONS GIVEN ON NEXT PAGE SHOWING CLEARLY THE NATURE OF FV & TV OF LINES LISTED ABOVE AND NOTE RESULTS.

(Pictorial Presentation)

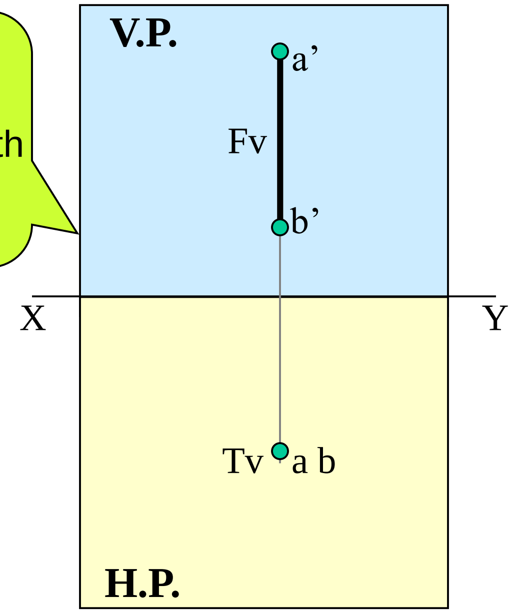
1\.

A Line
perpendicular
to Hp
&
// to Vp



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

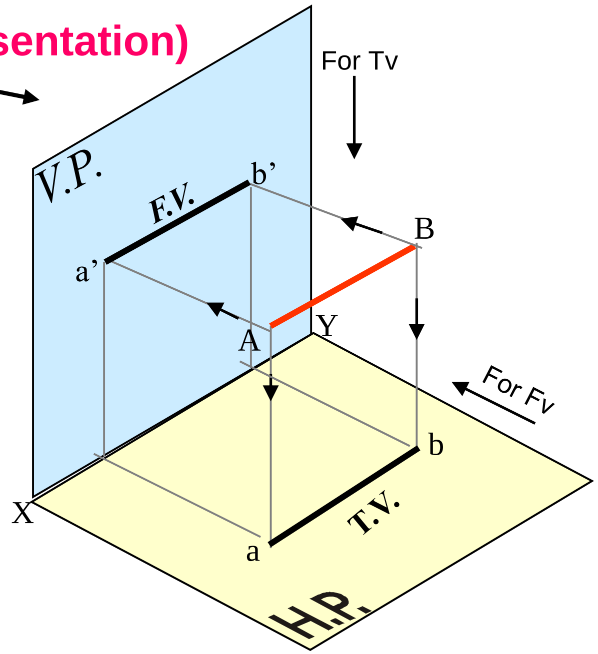
Orthographic Pattern



(Pictorial Presentation)

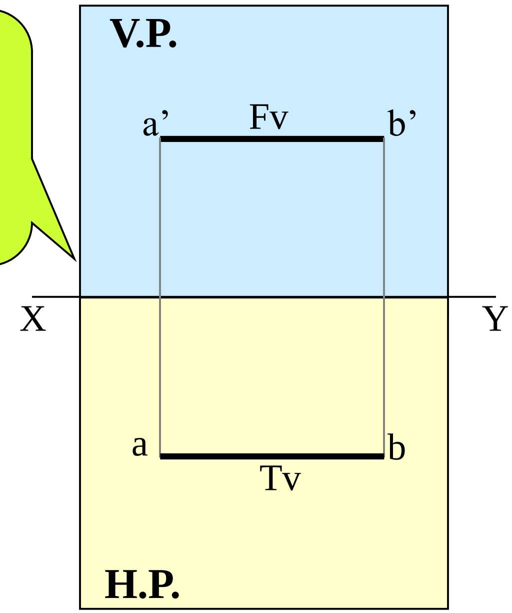
2\.

A Line
// to Hp
&
// to Vp



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

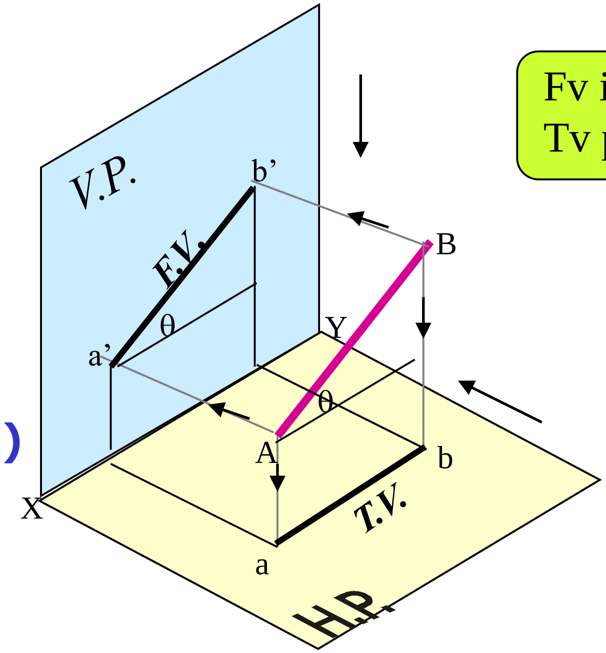
Orthographic Pattern



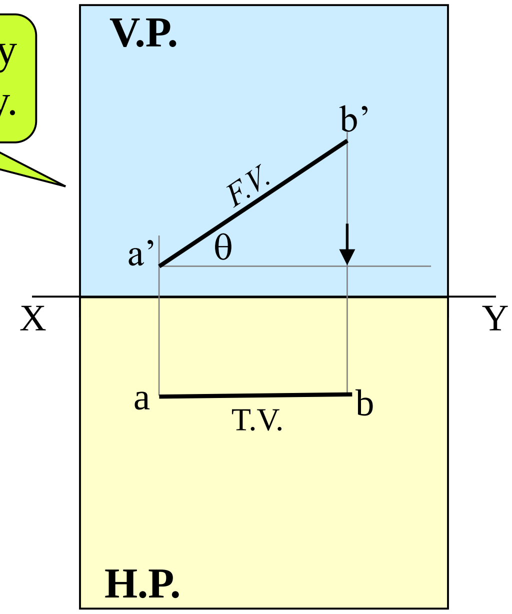
3.

A Line inclined to Hp
and
parallel to Vp

(Pictorial presentation)



Fv inclined to xy
Tv parallel to xy.

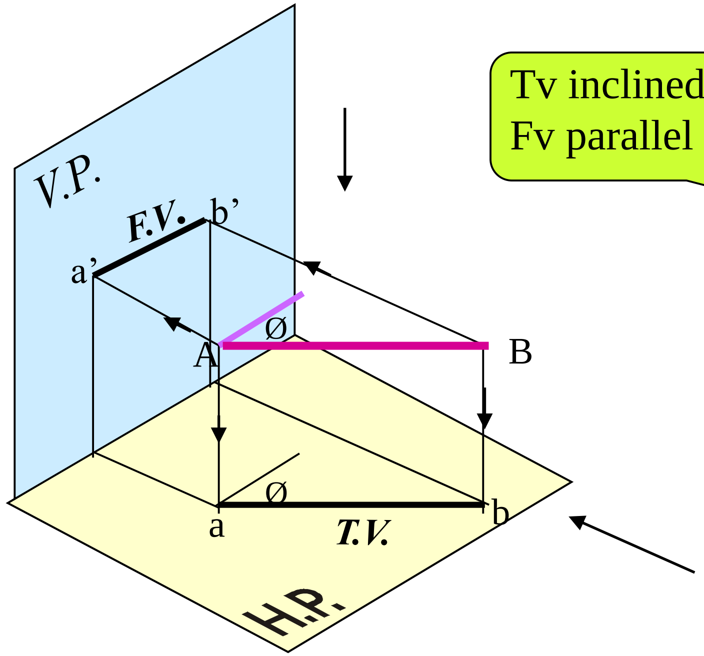


Orthographic Projections

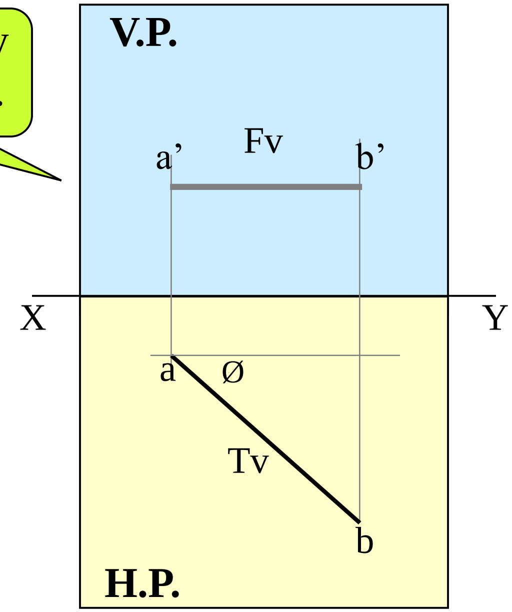
4.

A Line inclined to Vp
and
parallel to Hp

(Pictorial presentation)

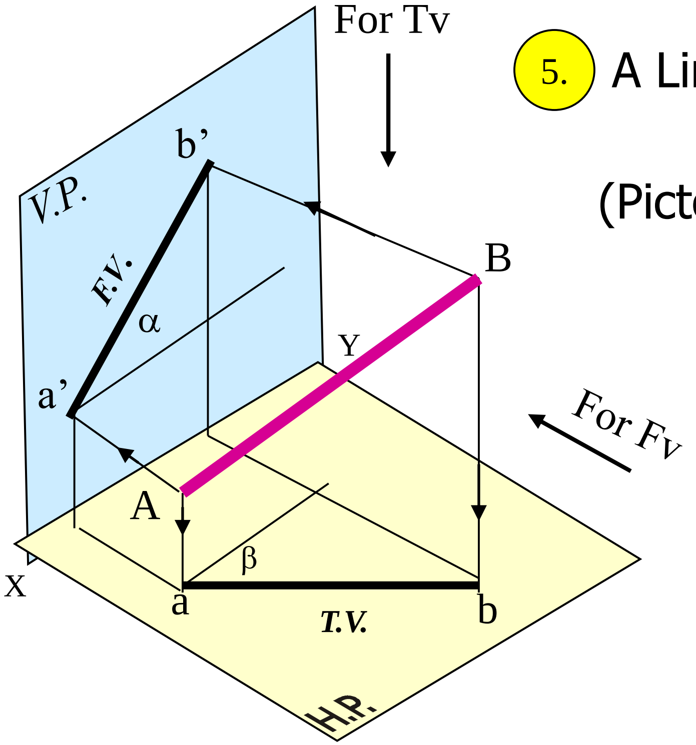


Tv inclined to xy
Fv parallel to xy.

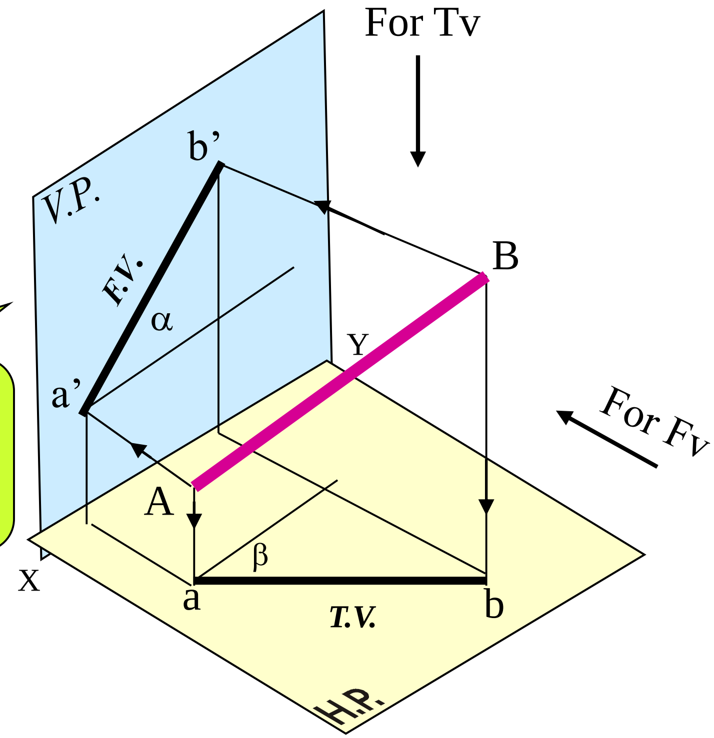


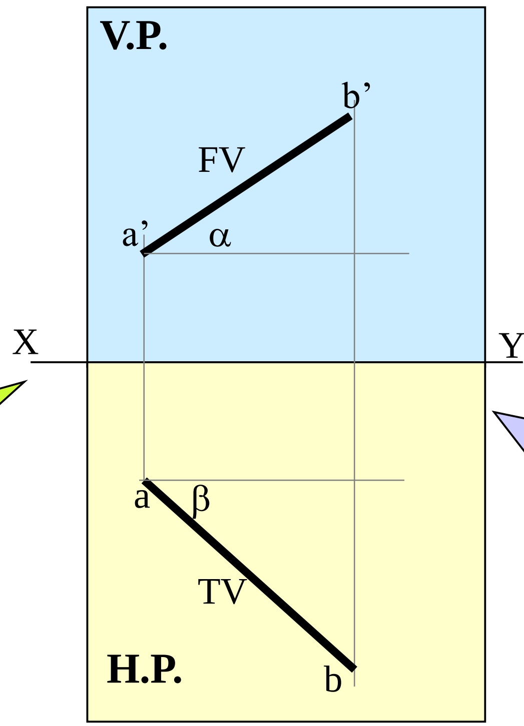
5. A Line inclined to both Hp and Vp

(Pictorial presentation)



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

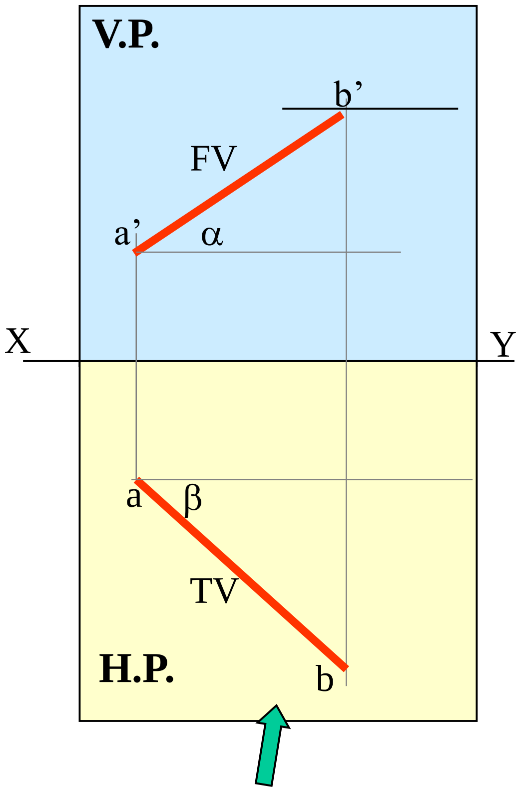




Orthographic Projections
Fv is seen on Vp clearly.
To see Tv clearly, HP is rotated 90^{0} downwards,
Hence it comes below xy.

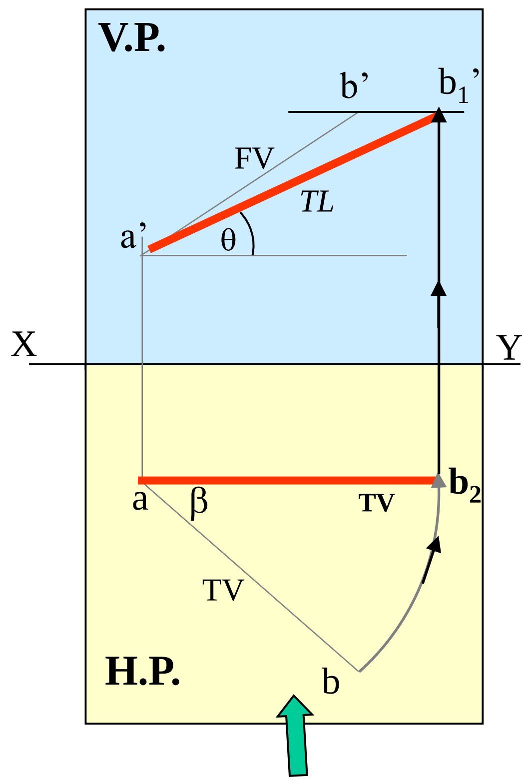
Note These Facts:-
Both Fv & Tv are inclined to xy.
(No view is parallel to xy)
Both Fv & Tv are reduced lengths.
(No view shows True Length)

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



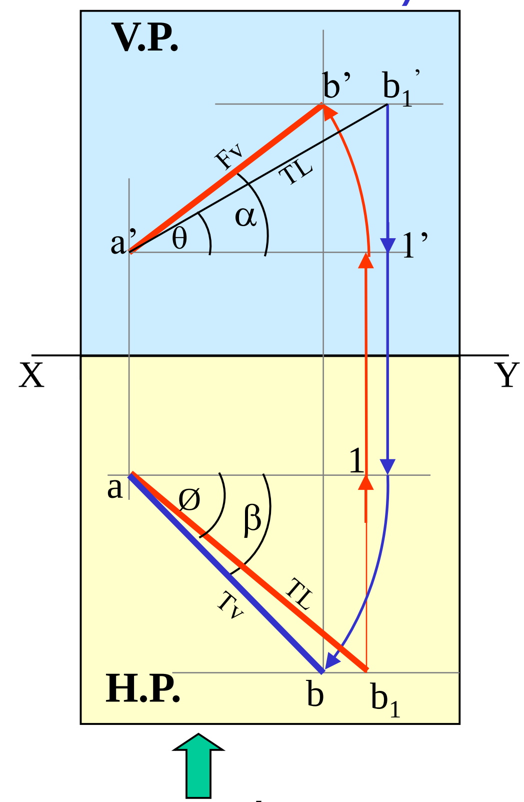
Here TV (ab) is not // to XY line
Hence it’s corresponding FV
a’ b’ is not showing
True Length &
True Inclination with Hp.

Note the procedure
When Fv & Tv known,
How to find True Length.
(Views are rotated to determine
True Length & it’s inclinations
with Hp & Vp).



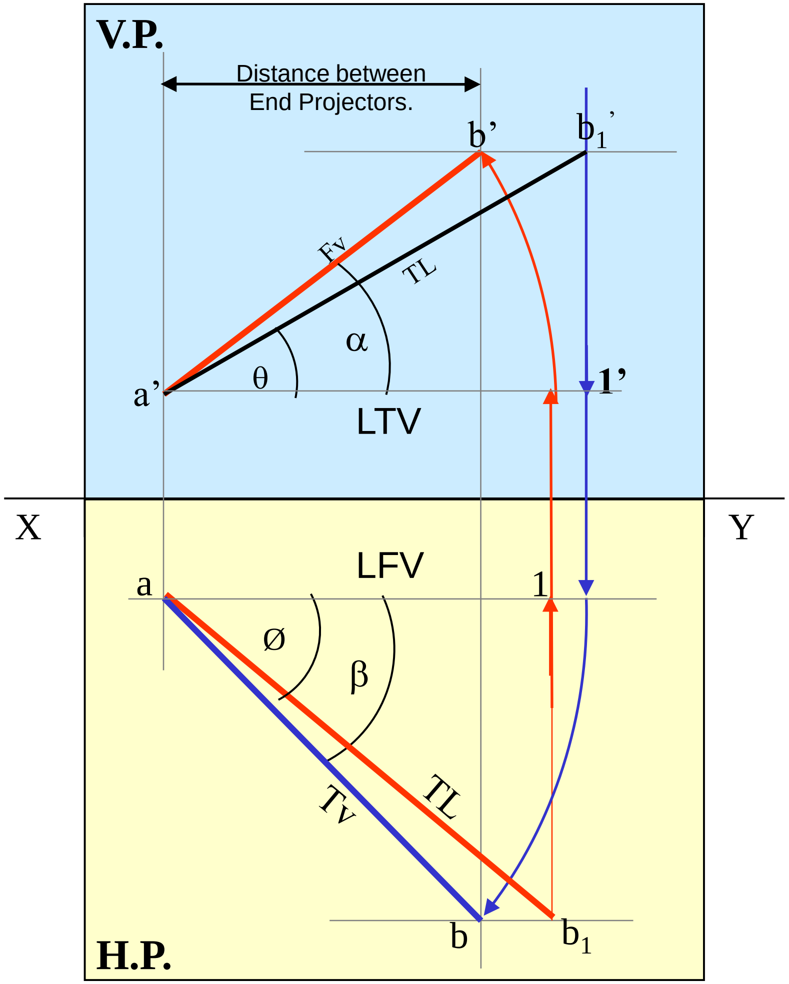
In this sketch, TV is rotated
and made // to XY line.
Hence it’s corresponding
FV a’ b_1’ Is showing
True Length
&
True Inclination with Hp.

Note the procedure
When True Length is known,
How to locate Fv & Tv.
(Component a-1 of TL is drawn
which is further rotated
to determine Fv)



Here a -1 is component
of TL ab_1 gives length of Fv.
Hence it is brought Up to
Locus of a’ and further rotated
to get point b’. a’ b’ will be Fv.
Similarly drawing component
of other TL(a’ b_1‘) Tv can be drawn.

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



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

Important TEN parameters to be remembered with Notations used here onward

NOTE this

θ & α Construct with ***a'***

Ø & β Construct with ***a***

b' & b_1' on same locus.

b & b_1 on same locus.

Also Remember

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

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

GROUP (A)

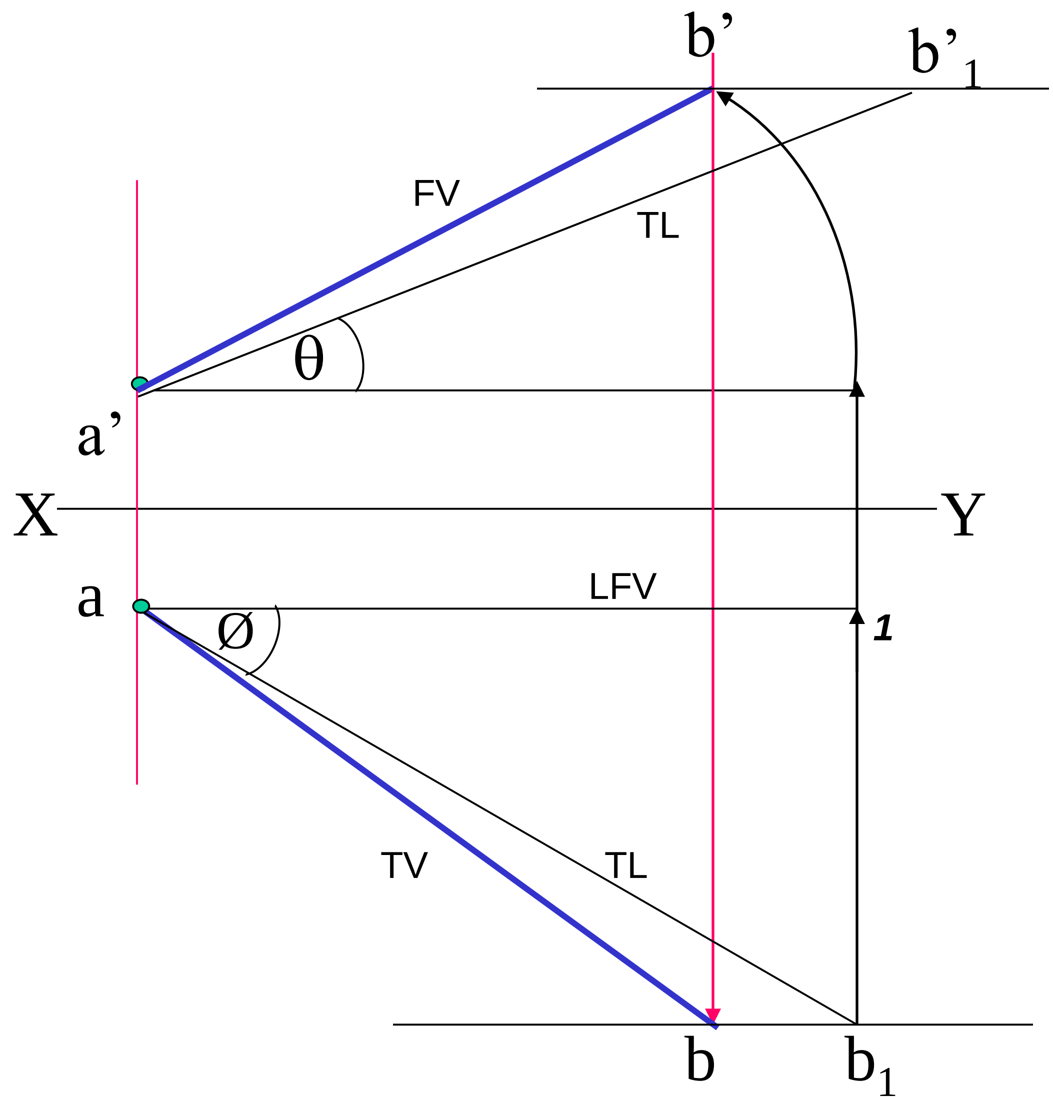
GENERAL CASES OF THE LINE INCLINED TO BOTH HP & VP
(based on 10 parameters).

PROBLEM 1)

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

SOLUTION STEPS:

1) Draw xy line and one projector.
2) Locate a' 12mm above xy line & a 10mm below xy line.
3) Take 30^0 angle from a' & 40^0 from a and mark TL I.e. 75mm on both lines. Name those points b_1' and b_1 respectively.
4) Join both points with a' and a resp.
5) Draw horizontal lines (Locus) from both points.
6) Draw horizontal component of TL a b_1 from point b_1 and name it 1.
(the length a-1 gives length of Fv as we have seen already.)
7) Extend it up to locus of a' and rotating a' as center locate b' as shown. Join a' b' as Fv.
8) From b' drop a projector down ward & get point b. Join a & b I.e. Tv.

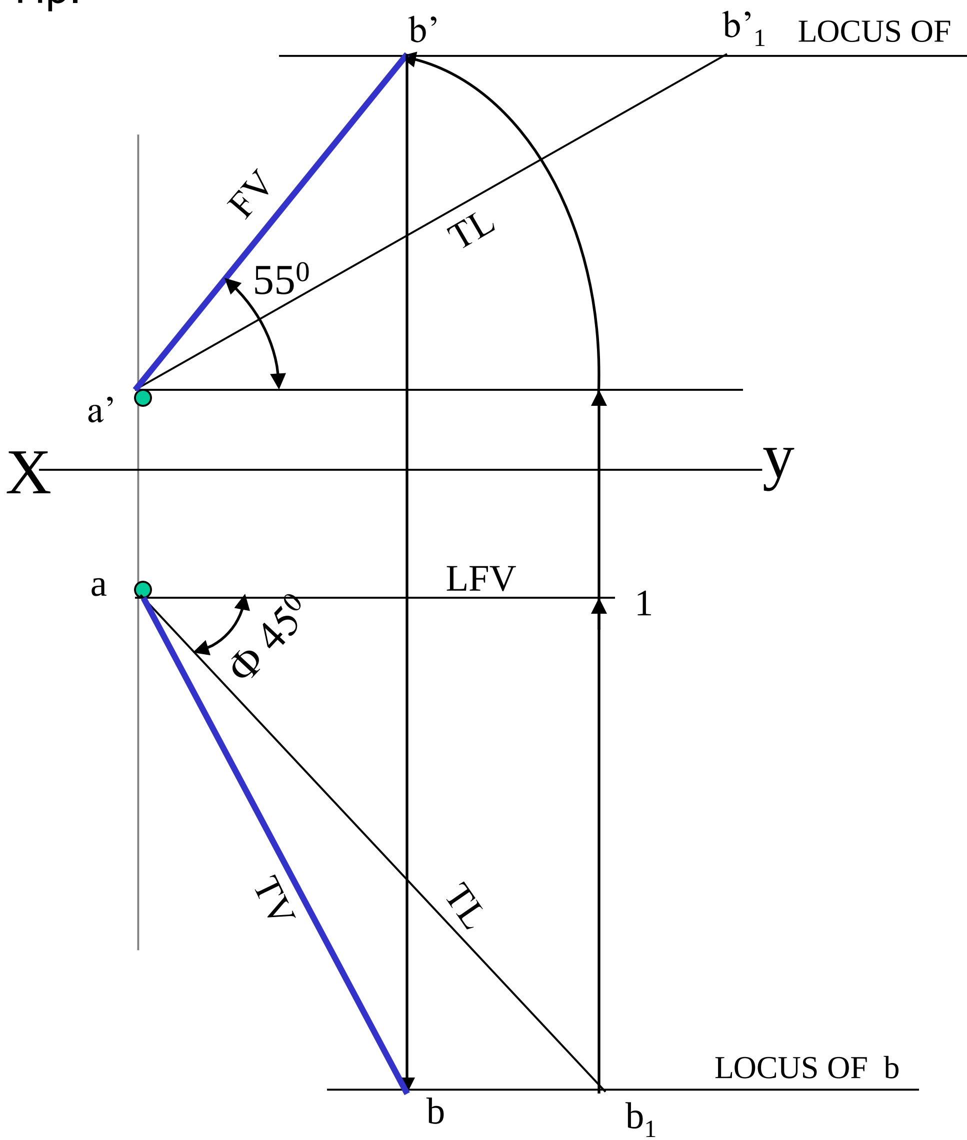


PROBLEM 2:

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

Solution Steps:-

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

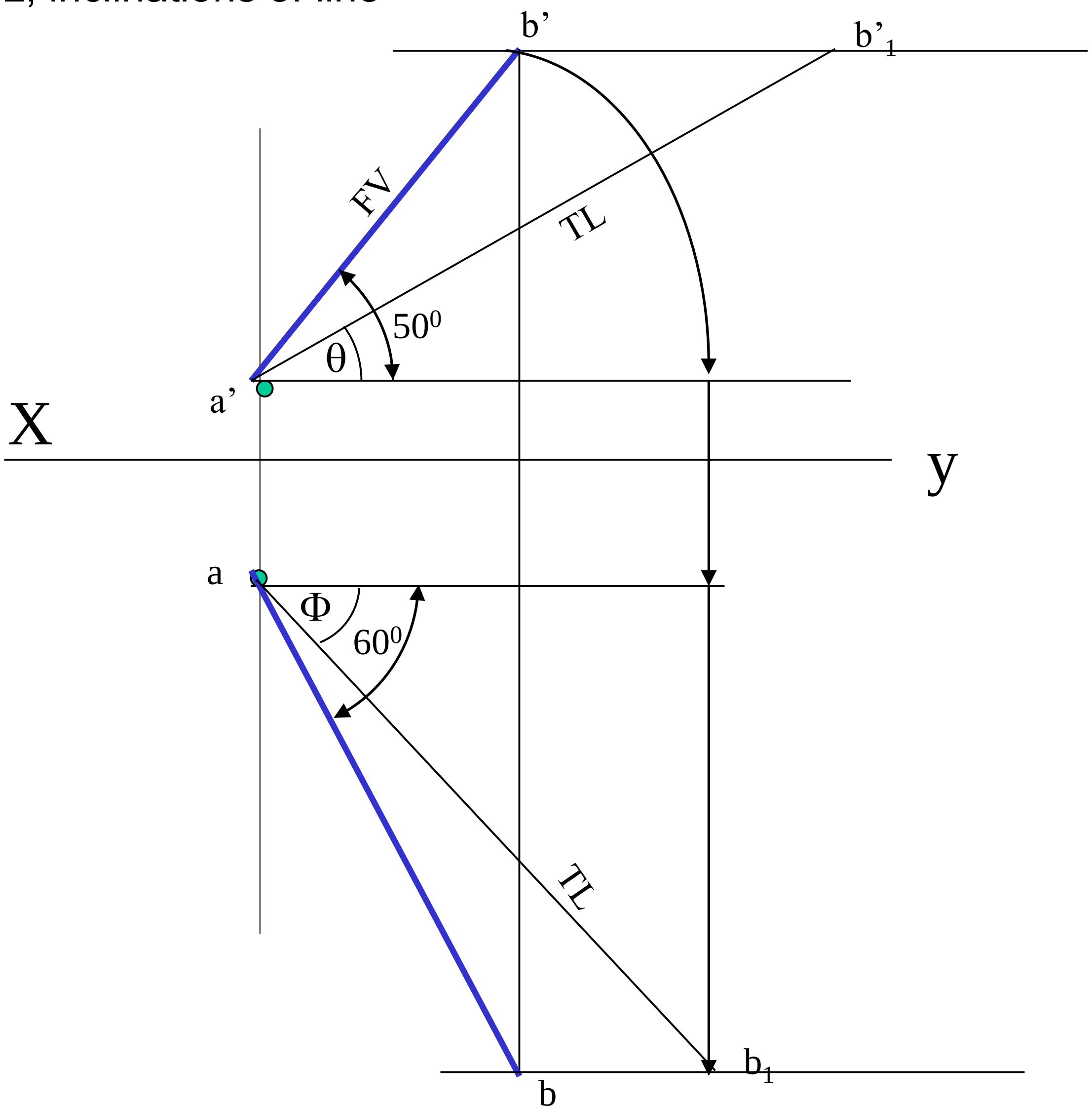


PROBLEM 3:

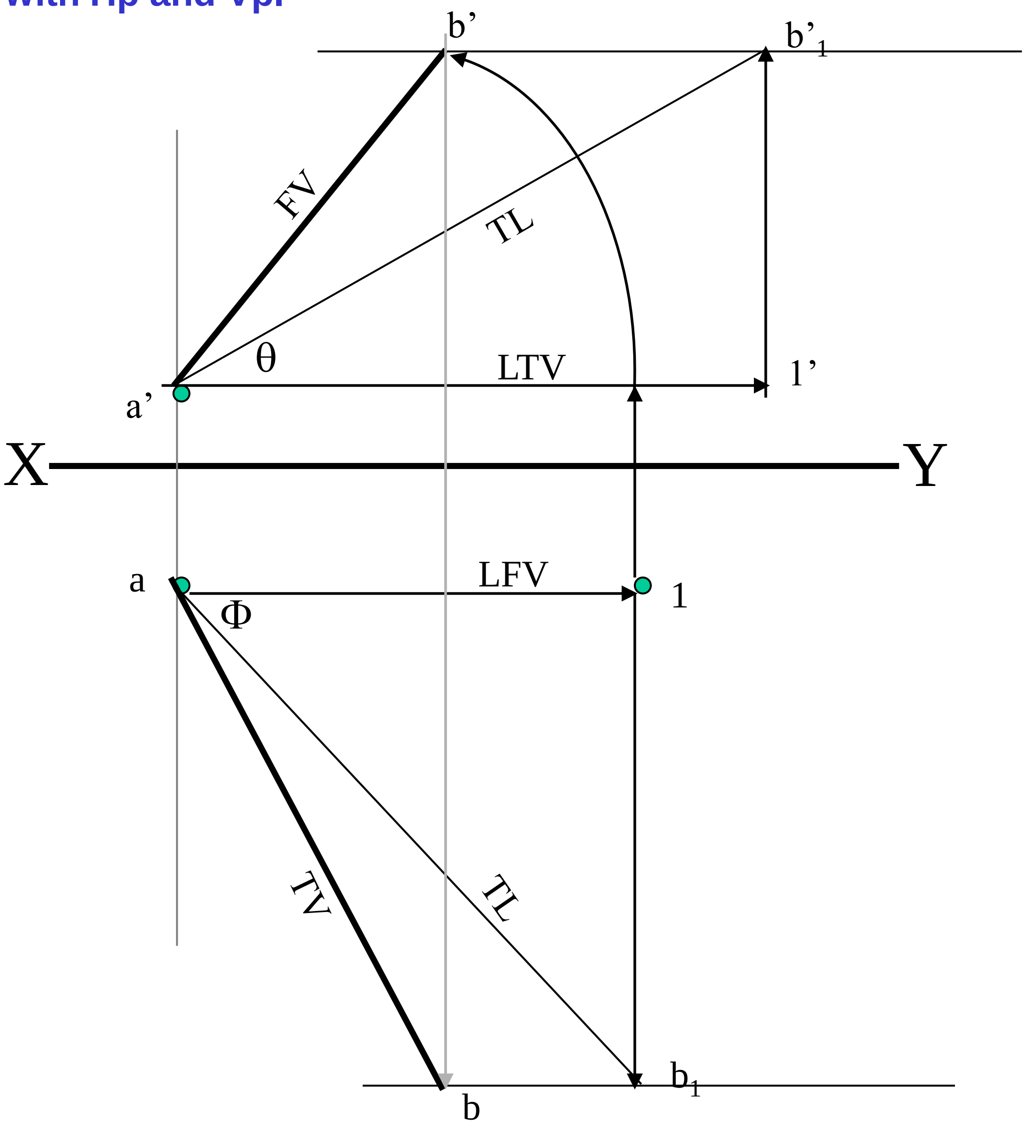
Fv of line AB is 50^0 inclined to xy and measures 55 mm long while it's Tv is 60^0 inclined to xy line. If end A is 10 mm above Hp and 15 mm in front of Vp, draw it's projections,find TL, inclinations of line with Hp & Vp.

SOLUTION STEPS:

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



PROBLEM 4 :-
Line AB is 75 mm long .It's Fv and Tv measure 50 mm & 60 mm long respectively. End A is 10 mm above Hp and 15 mm in front of Vp. Draw projections of line AB if end B is in first quadrant.Find angle with Hp and Vp.

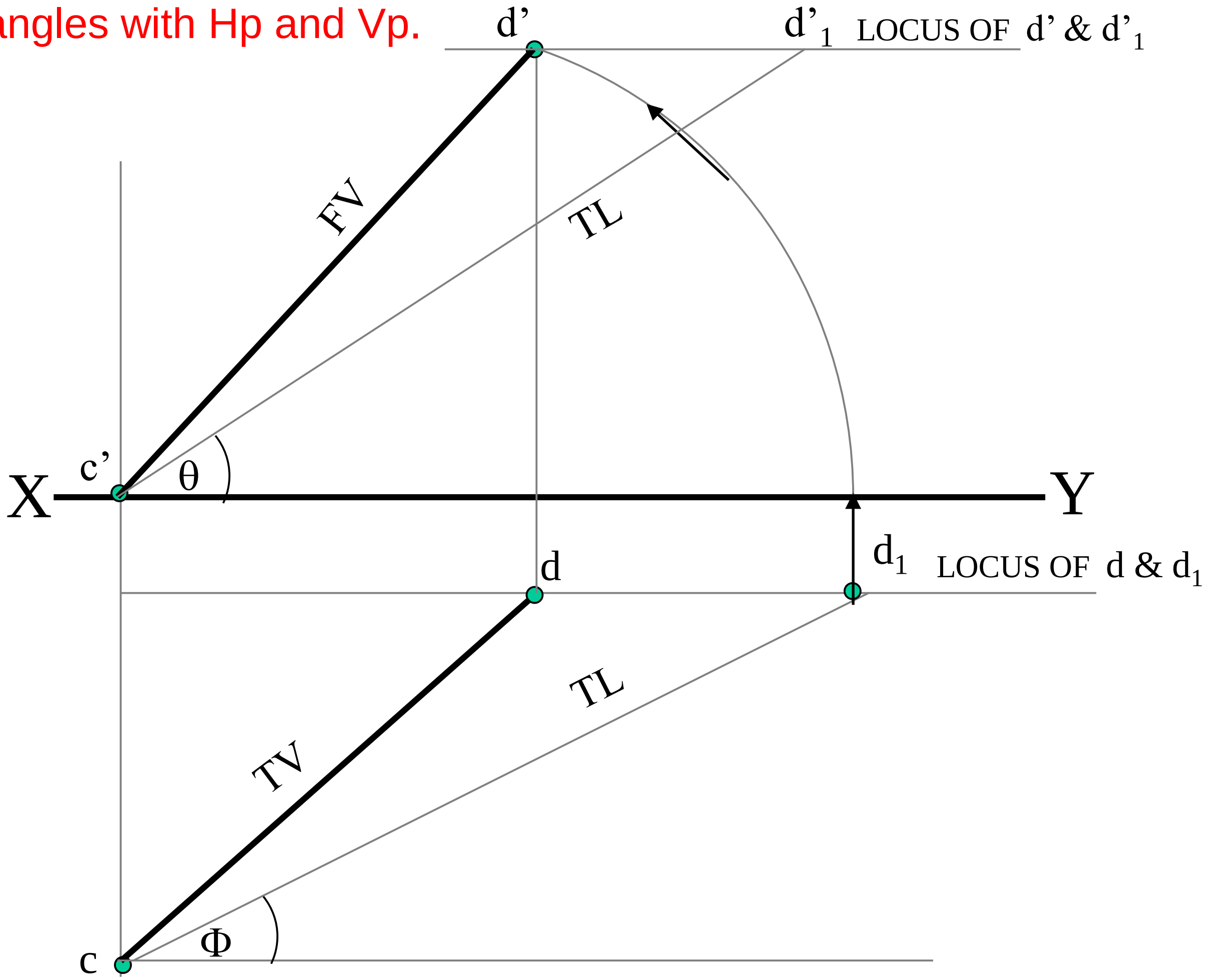


SOLUTION STEPS:

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

PROBLEM 5 :-

T.V. of a 75 mm long Line CD, measures 50 mm.
End C is in Hp and 50 mm in front of Vp.
End D is 15 mm in front of Vp and it is above Hp.
Draw projections of CD and find angles with Hp and Vp.



SOLUTION STEPS:

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

GROUP (B)
PROBLEMS INVOLVING TRACES OF THE LINE.

TRACES OF THE LINE:-

THESE ARE THE POINTS OF INTERSECTIONS OF A LINE (OR IT'S EXTENSION) WITH RESPECTIVE REFFERENCE PLANES.

A LINE ITSELF OR IT'S EXTENSION, WHERE EVER TOUCHES H.P., THAT POINT IS CALLED TRACE OF THE LINE ON H.P.(IT IS CALLED H.T.)

SIMILARLY, A LINE ITSELF OR IT'S EXTENSION, WHERE EVER TOUCHES V.P., THAT POINT IS CALLED TRACE OF THE LINE ON V.P.(IT IS CALLED V.T.)

V.T.:- It is a point on **Vp**.
Hence it is called ***Fv*** of a point in **Vp.**
Hence it's ***Tv*** comes on XY line.(Here onward named as **v)**

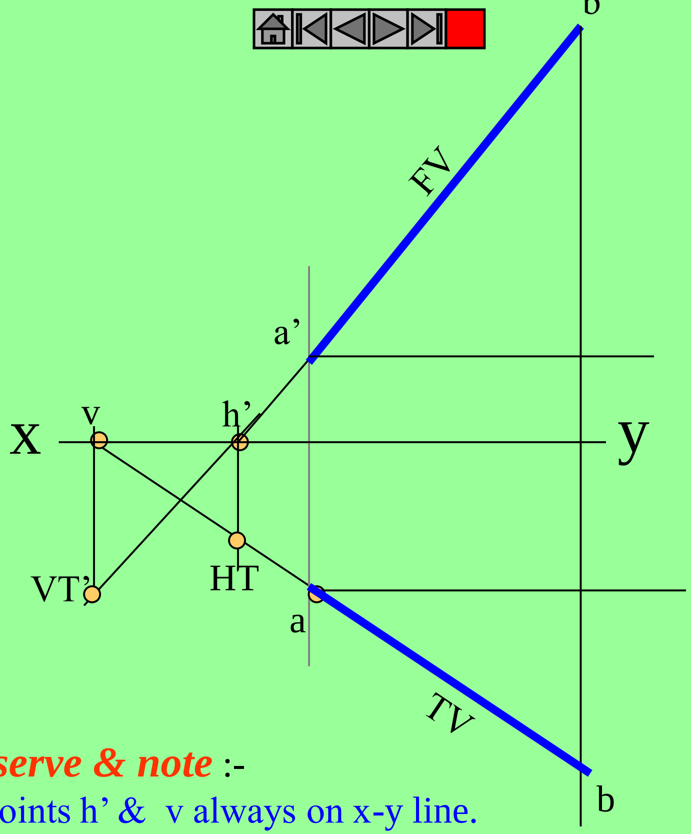
H.T.:- It is a point on **Hp.**
Hence it is called ***Tv*** of a point in **Hp**.
Hence it's ***Fv*** comes on **XY line.**(Here onward named as **'h')**

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

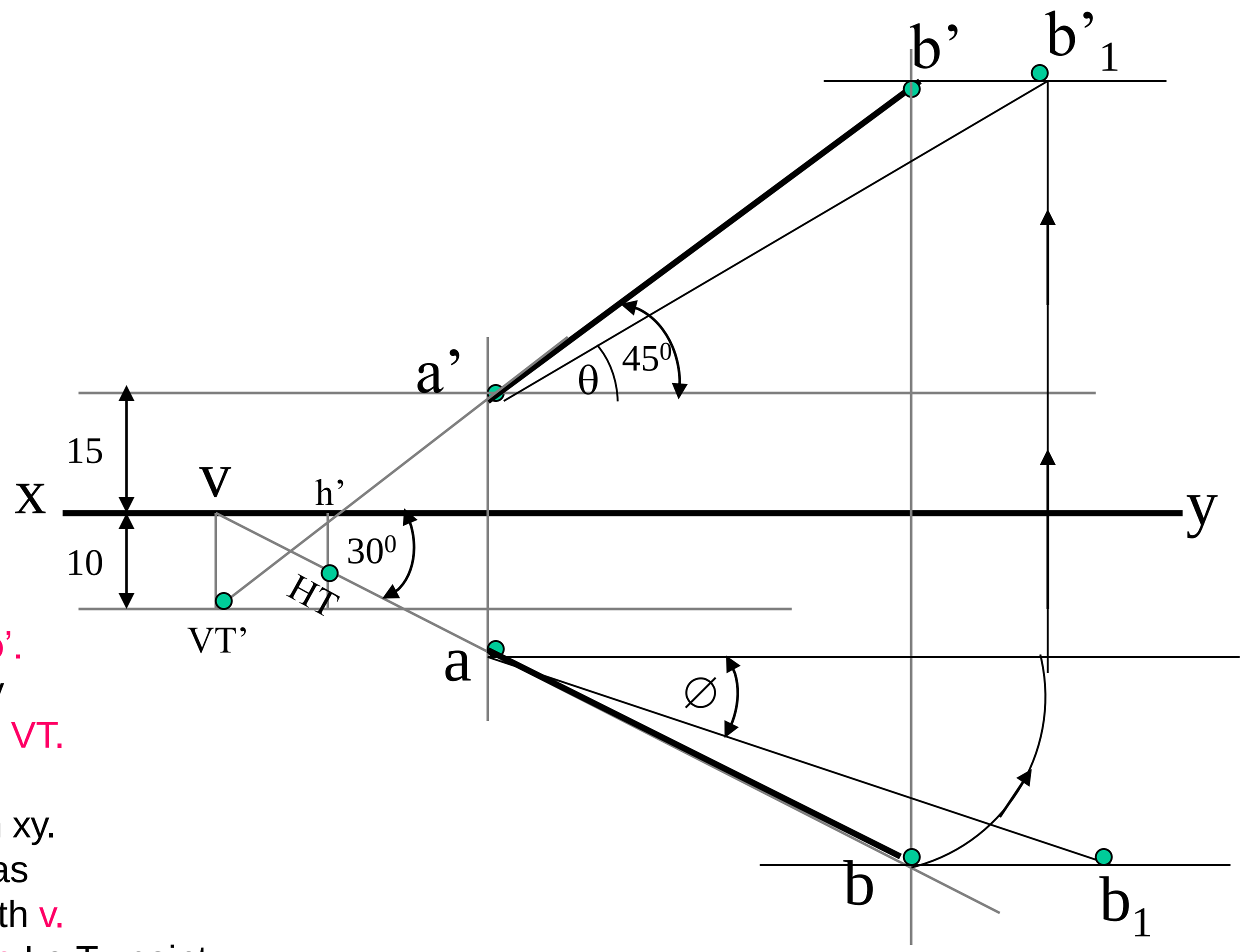


Observe & note :-

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.

These points are used to solve next three problems.

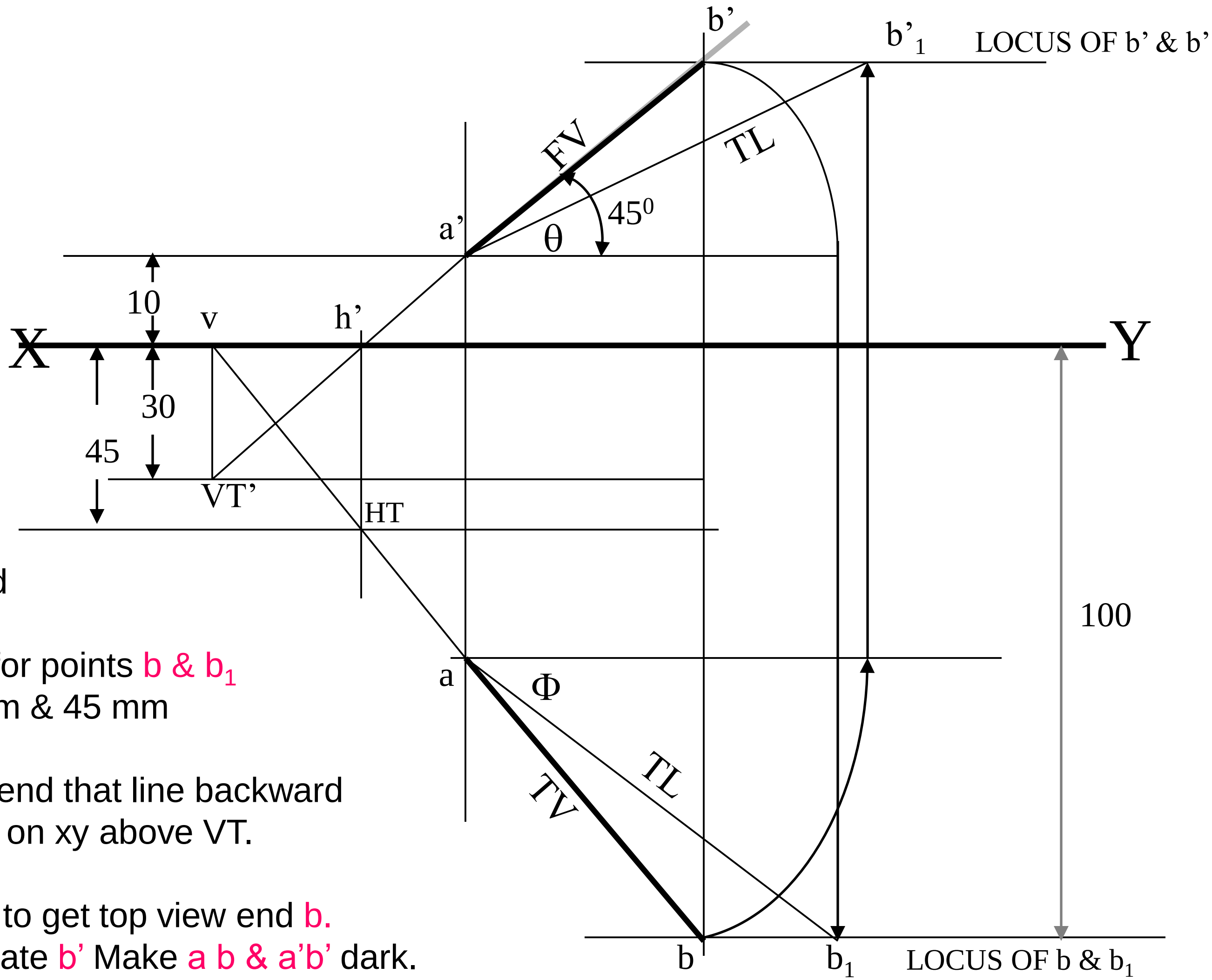
PROBLEM 6 :- Fv of line AB makes 45^0 angle with XY line and measures 60 mm. Line's Tv makes 30^0 with XY line. End A is 15 mm above Hp and it's VT is 10 mm below Hp. Draw projections of line AB, determine inclinations with Hp & Vp and locate HT, VT.



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 it's inclinations can be found.
Name extension of Fv, touching xy as h' and below it, on extension of Tv, locate HT.

PROBLEM 7 :
One end of line AB is 10mm above Hp and other end is 100 mm in-front of Vp.
It's Fv is 45^0 inclined to xy while it's HT & VT are 45mm and 30 mm below xy respectively.
Draw projections and find TL with it's 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 it's inclinations.

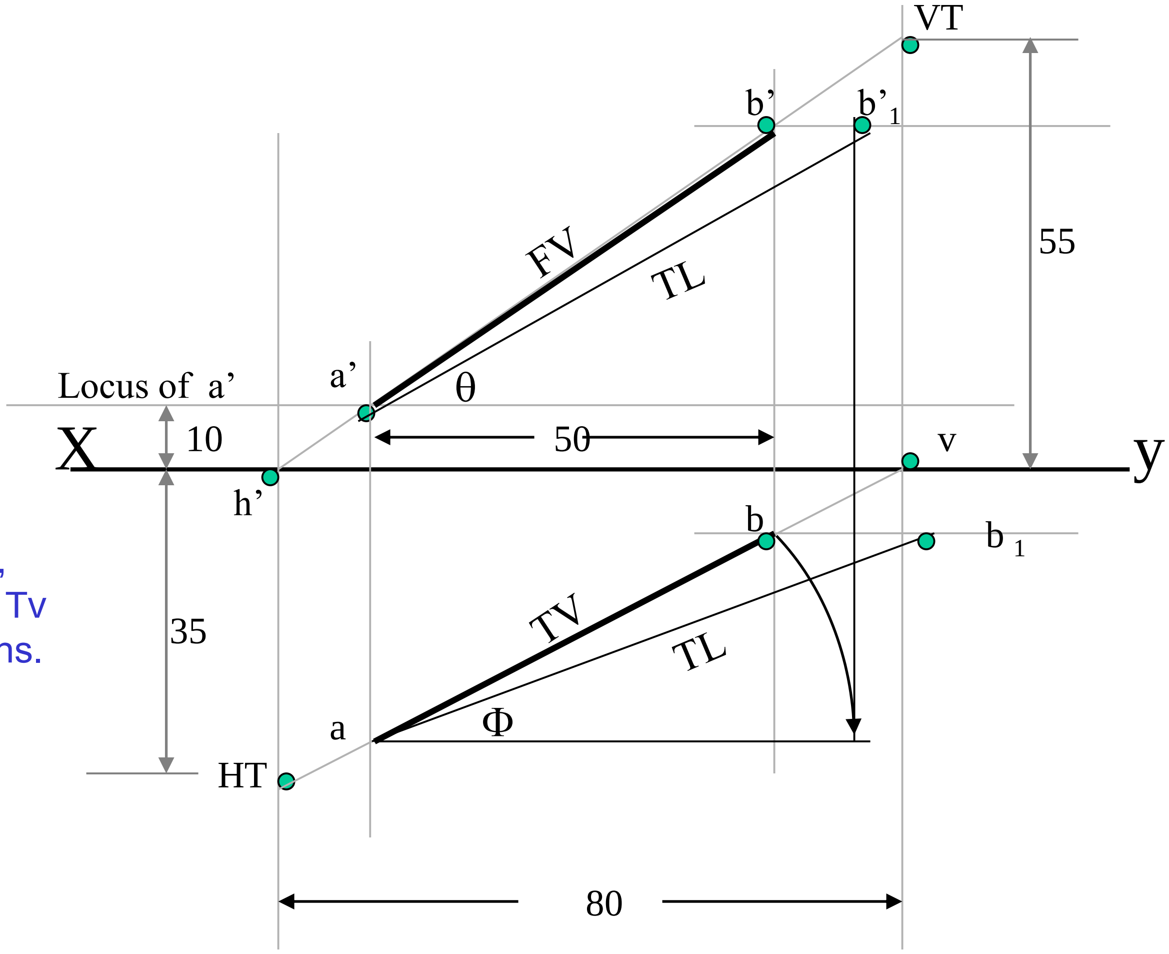
PROBLEM 8 :- Projectors drawn from HT and VT of a line AB are 80 mm apart and those drawn from it's ends are 50 mm apart. End A is 10 mm above Hp, VT is 35 mm below Hp while it's HT is 45 mm in front of Vp. Draw projections, locate traces and find TL of line & inclinations with Hp and Vp.

SOLUTION STEPS:-

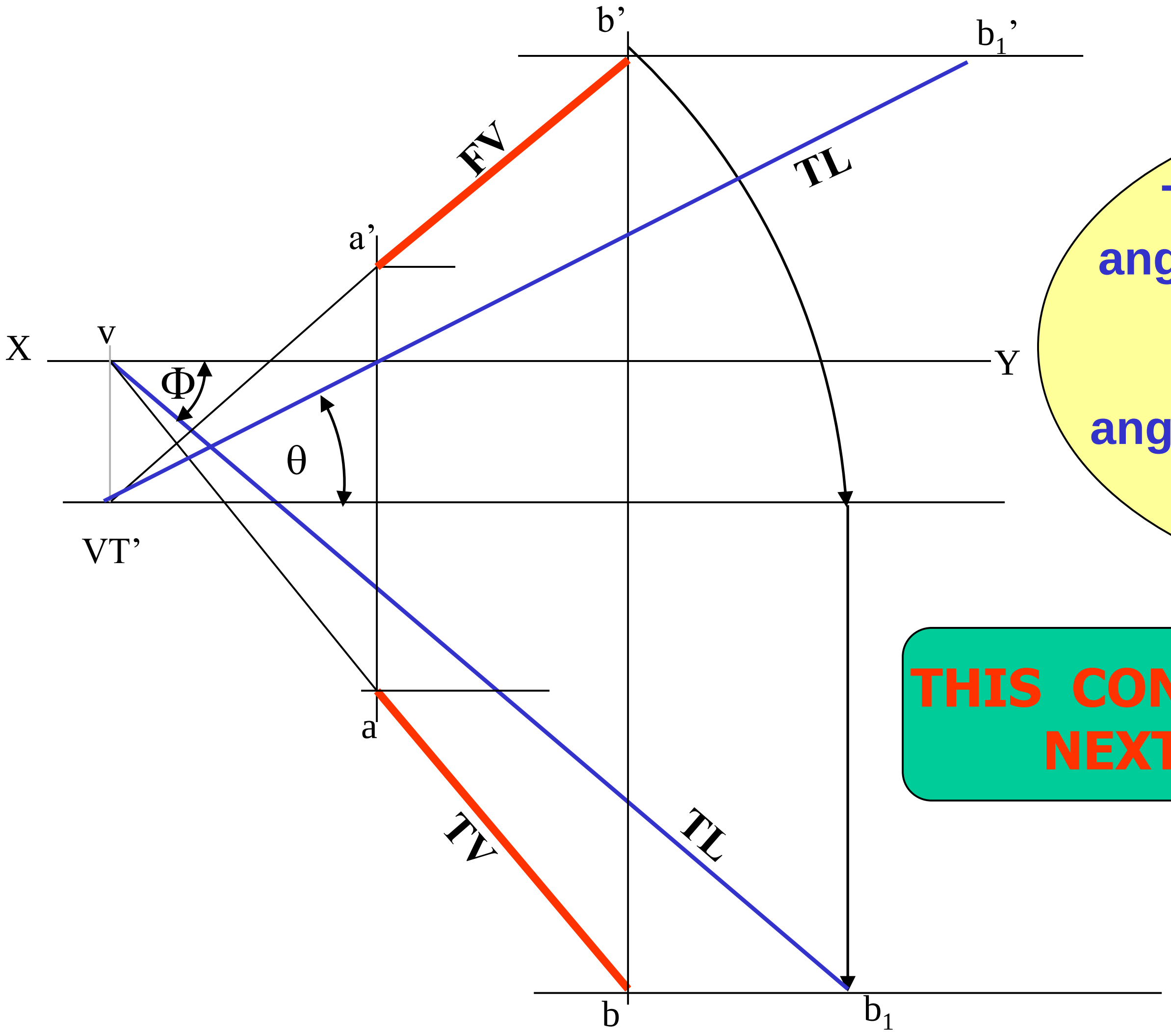
1.Draw xy line and two projectors, 80 mm apart and locate HT & VT , 35 mm below xy and 55 mm above xy respectively on these projectors.

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 it's inclinations.



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



Then from point v & HT angles β & Φ can be drawn.

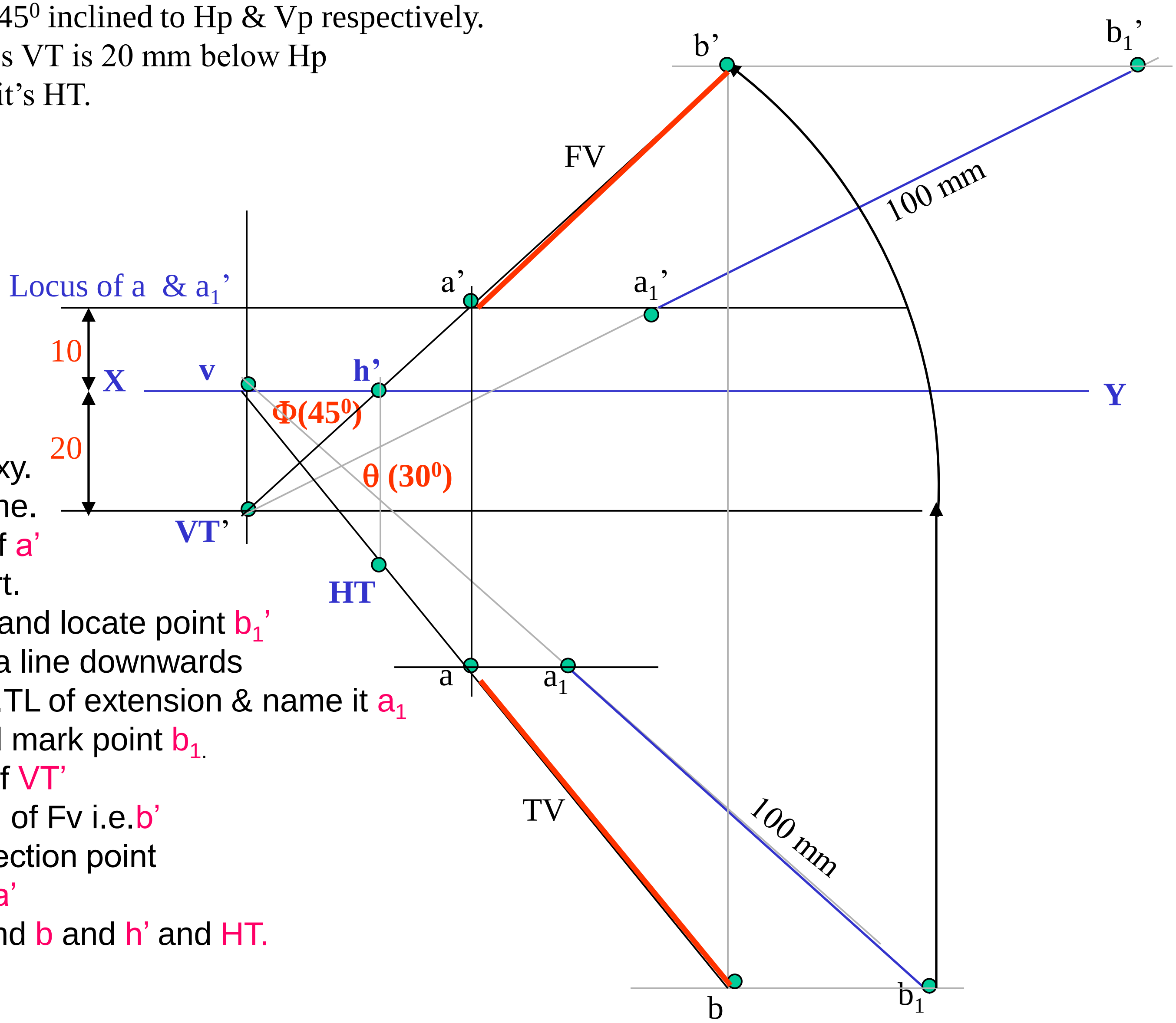
&

From point VT' & h' angles α & θ can be drawn.

THIS CONCEPT IS USED TO SOLVE NEXT *THREE* PROBLEMS.

PROBLEM 9 :-

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

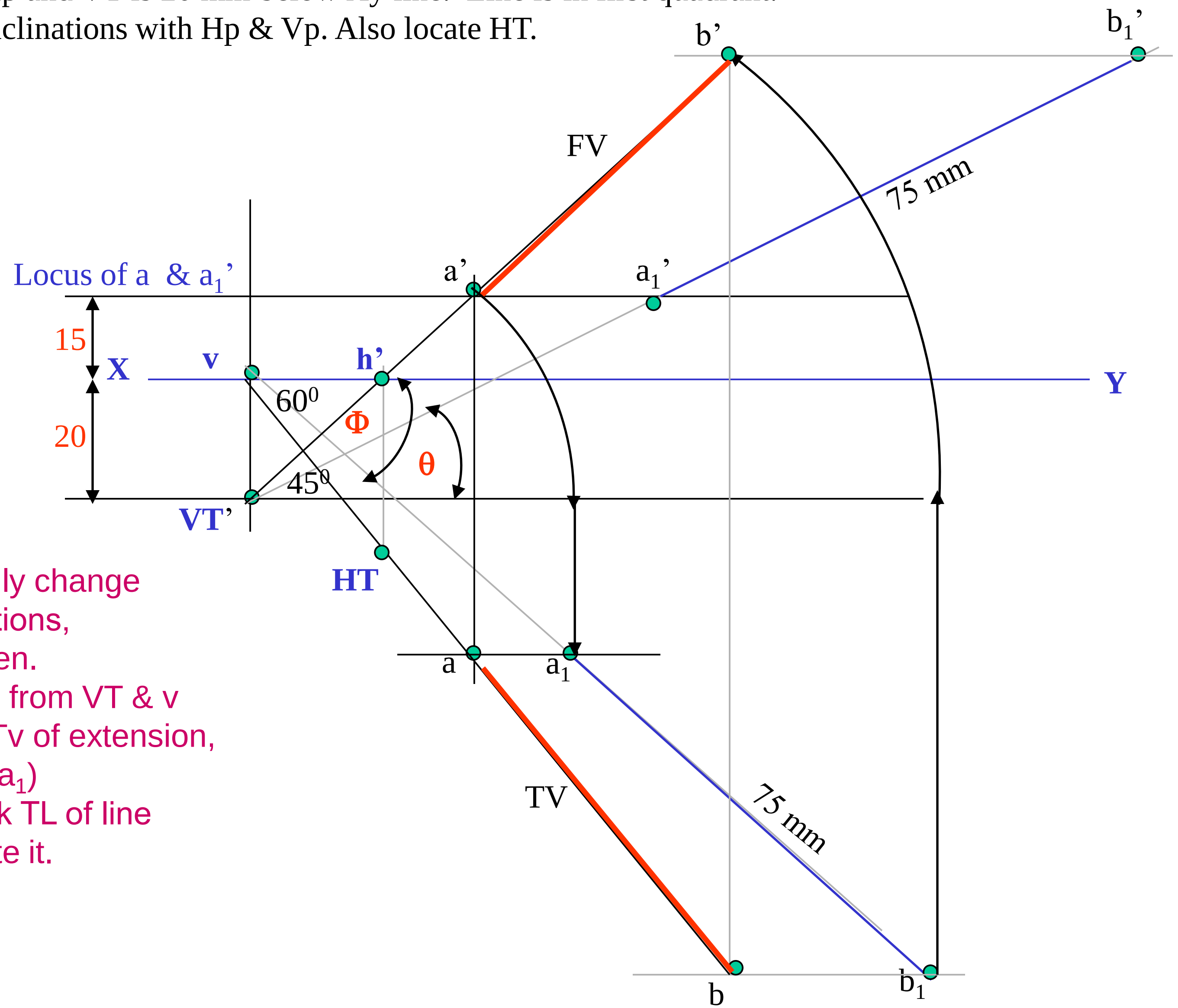


SOLUTION STEPS:-

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
& 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 it's 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.

PROBLEM 10 :-

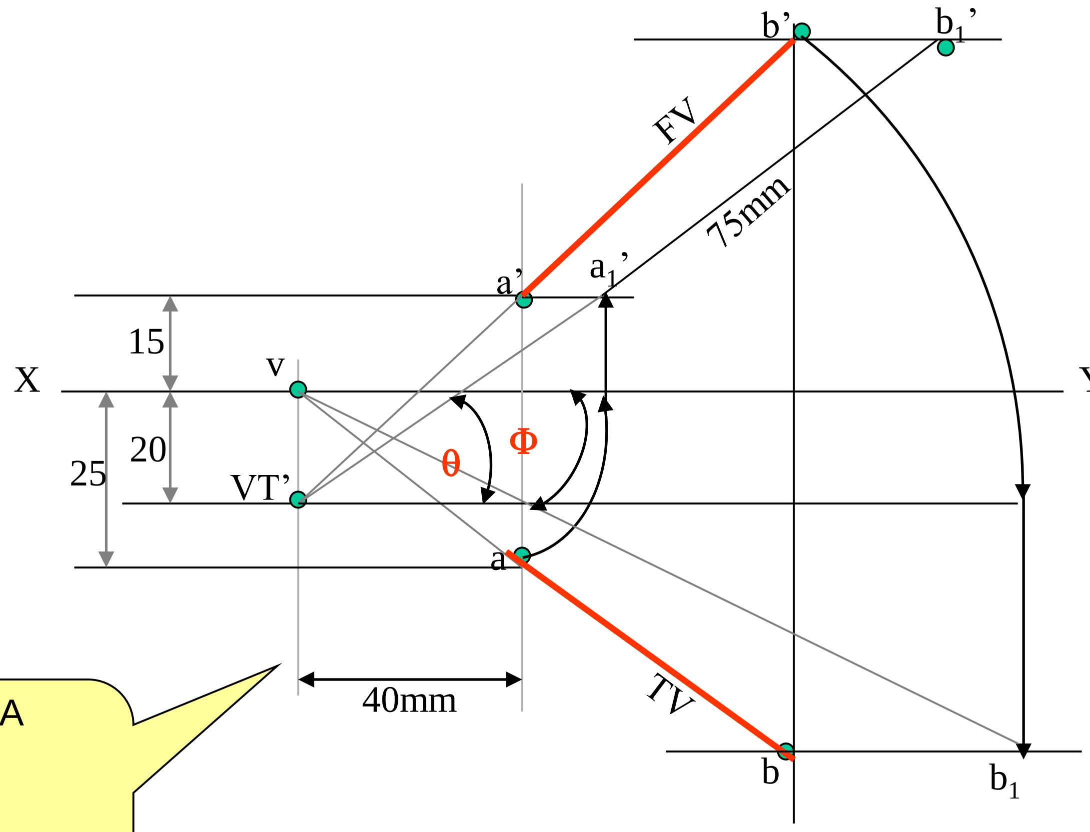
A line AB is 75 mm long. It's Fv & Tv make 45^0 and 60^0 inclinations with X-Y line resp
End A is 15 mm above Hp and VT is 20 mm below Xy line. Line is in first quadrant.
Draw projections, find inclinations with Hp & Vp. Also locate HT.



SOLUTION STEPS:-

Similar to the previous only change
is instead of line's inclinations,
views inclinations are given.
So first take those angles from VT & v
Properly, construct Fv & Tv of extension,
then determine it's TL(V-a_1)
and on it's extension mark TL of line
and proceed and complete it.

PROBLEM 11 :- The projectors drawn from VT & end A of line AB are 40mm apart.
End A is 15mm above Hp and 25 mm in front of Vp. VT of line is 20 mm below Hp.
If line is 75mm long, draw it's projections, find inclinations with HP & Vp

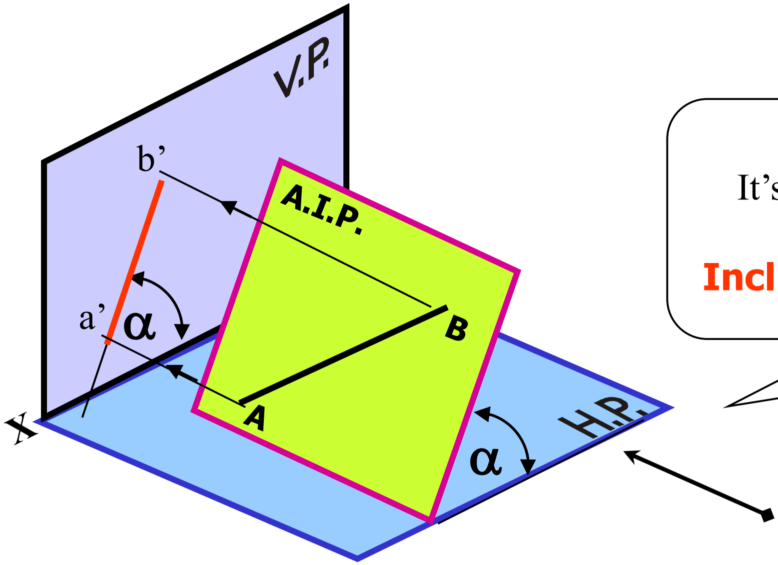


Draw two projectors for VT & end A
Locate these points and then

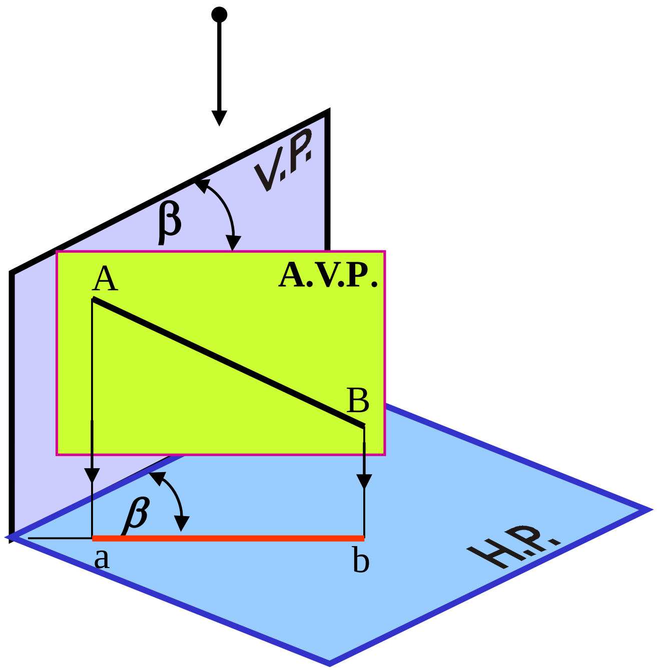
YES !
YOU CAN COMPLETE IT.

GROUP (C)

CASES OF THE LINES IN A.V.P., A.I.P. & PROFILE PLANE.

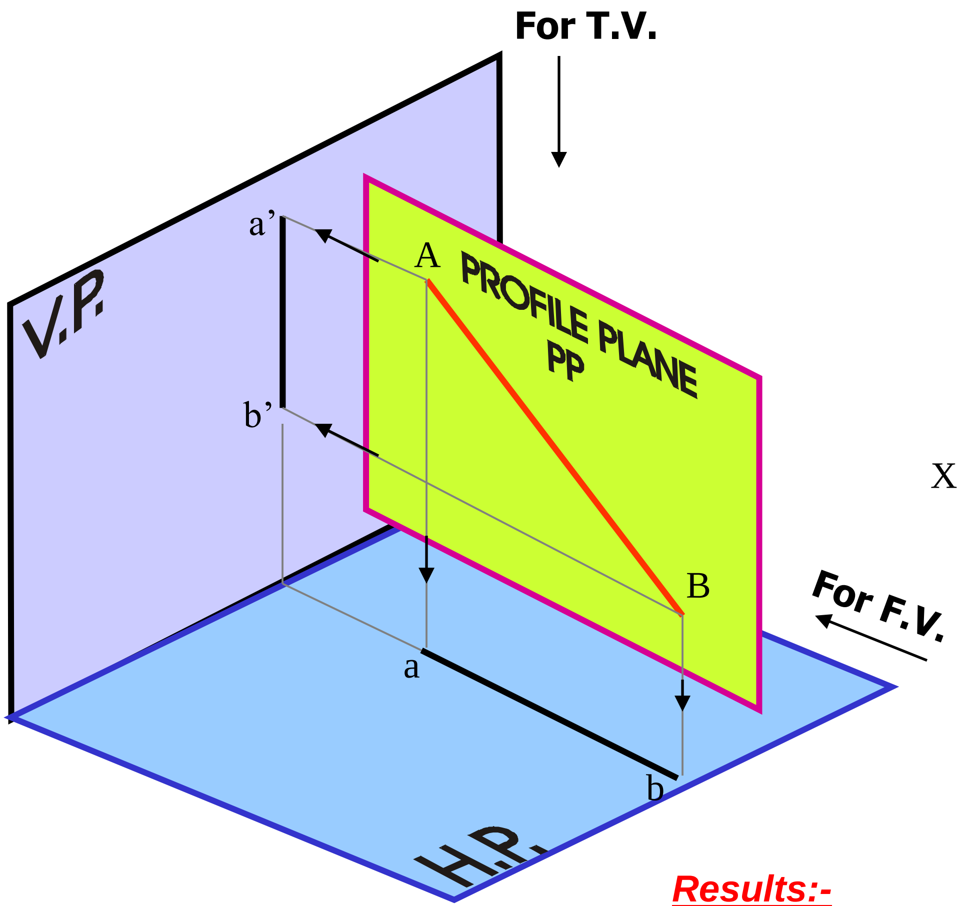


Line AB is in AIP as shown in above figure no 1.
It’s FV (a’b’) is shown projected on Vp.(Looking in arrow direction)
Here one can clearly see that the
Inclination of AIP with HP = Inclination of FV with XY line

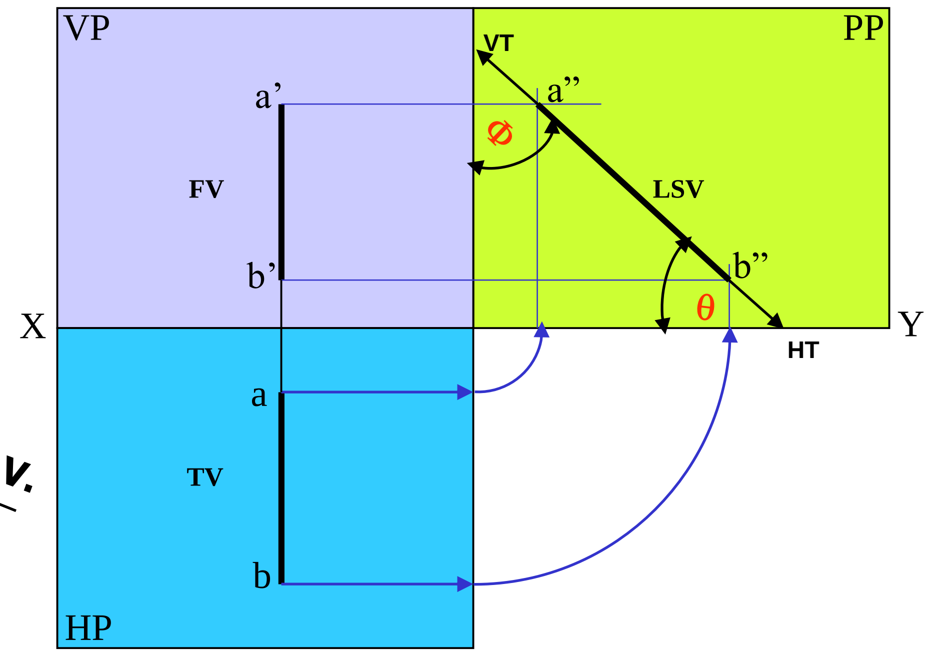


Line AB is in AVP as shown in above figure no 2..
It’s TV (a b) is shown projected on Hp.(Looking in arrow direction)
Here one can clearly see that the
Inclination of AVP with VP = Inclination of TV with XY line

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



ORTHOGRAPHIC PATTERN OF LINE IN PROFILE PLANE

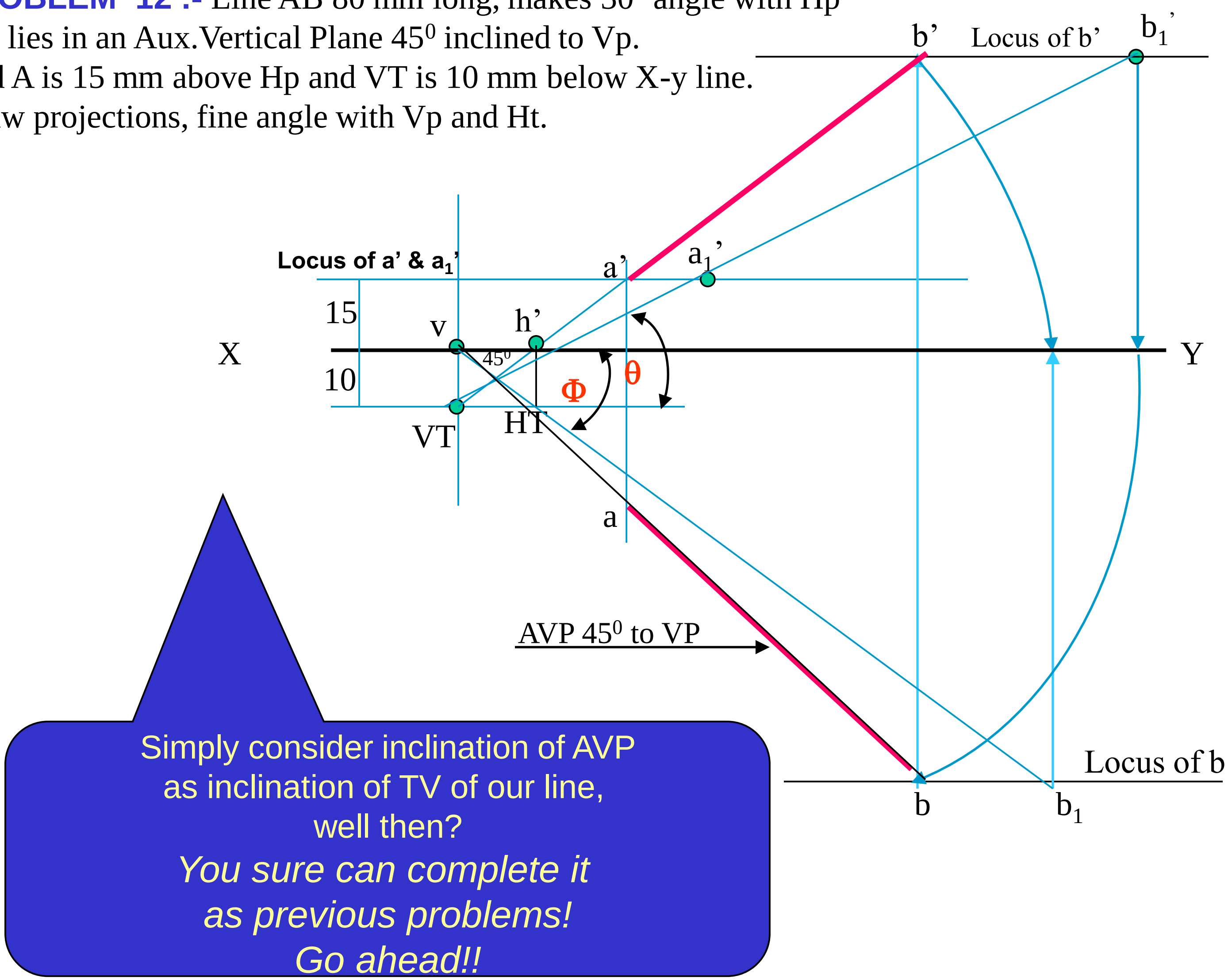


Results:-

1. TV & FV both are vertical, hence arrive on one single projector.
2. It’s Side View shows True Length (TL)
3. Sum of it’s inclinations with HP & VP equals to 90^0 ($\theta + \Phi = 90^0$)
4. It’s HT & VT arrive on same projector and can be easily located From Side View.

OBSERVE CAREFULLY ABOVE GIVEN ILLUSTRATION AND 2nd SOLVED PROBLEM.

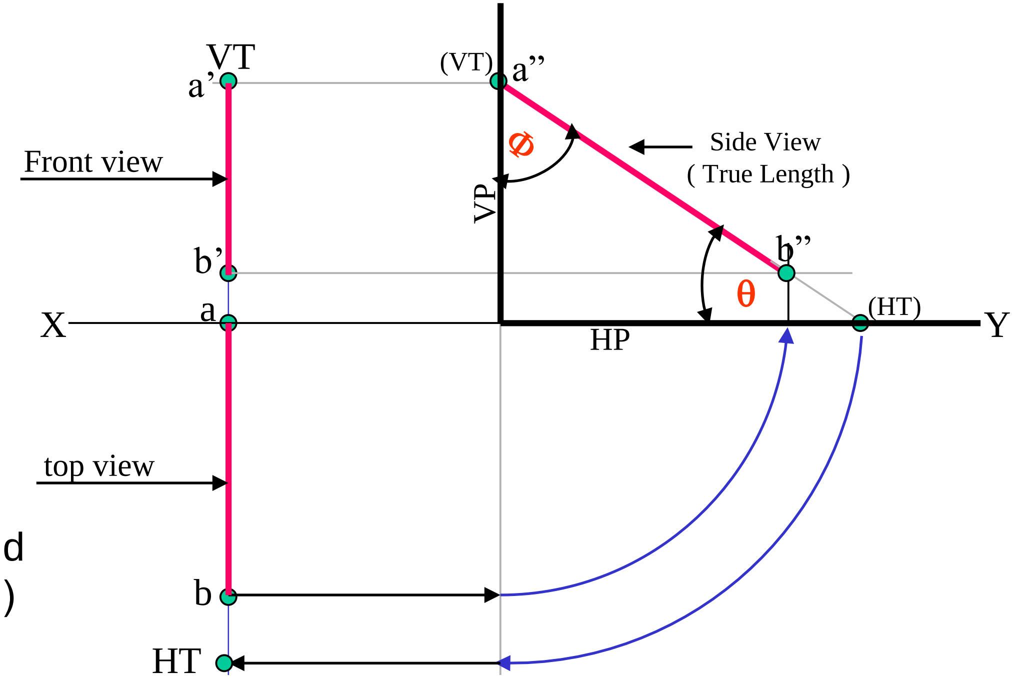
PROBLEM 12 :- Line AB 80 mm long, makes 30^0 angle with Hp and lies in an Aux.Vertical Plane 45^0 inclined to Vp.
End A is 15 mm above Hp and VT is 10 mm below X-y line.
Draw projections, fine angle with Vp and Ht.



PROBLEM 13 :- A line AB, 75mm long, has one end A in Vp. Other end B is 15 mm above Hp and 50 mm in front of Vp.Draw the projections of the line when sum of it's Inclinations with HP & Vp is 90^0, means it is lying in a profile plane. Find true angles with ref.planes and it's traces.

SOLUTION STEPS:-

After drawing xy line and one projector
Locate top view of A I.e point a on xy as
It is in Vp,
Locate Fv of B i.e.b'15 mm above xy as
it is above Hp.and Tv of B i.e. b, 50 mm
below xy asit is 50 mm in front of Vp
Draw side view structure of Vp and Hp
and locate S.V. of point B i.e. b''
From this point cut 75 mm distance on Vp and
Mark a'' as A is in Vp. (This is also VT of line.)
From this point draw locus to left & get a'
Extend SV up to Hp. It will be HT. As it is a Tv
Rotate it and bring it on projector of b.
Now as discussed earlier SV gives TL of line
and at the same time on extension up to Hp & Vp
gives inclinations with those panes.



APPLICATIONS OF PRINCIPLES OF PROJECTIONS OF LINES
IN SOLVING CASES OF DIFFERENT PRACTICAL SITUATIONS.

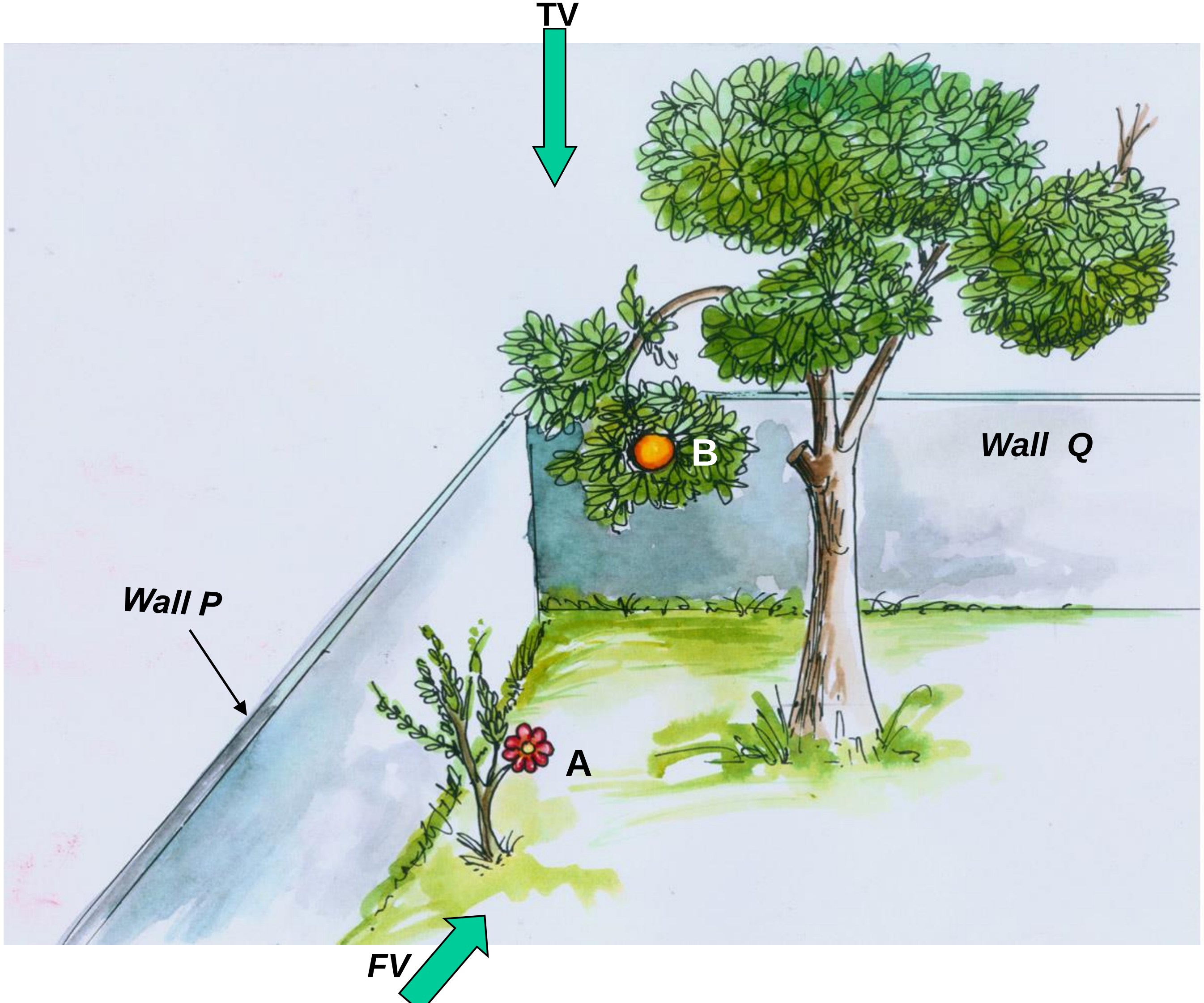
In these types of problems some situation in the field
or
some object will be described .
It's relation with Ground (HP)
And
a Wall or some vertical object (VP) will be given.

Indirectly information regarding Fv & Tv of some line or lines,
inclined to both reference Planes will be given
and
you are supposed to draw it's projections
and
further to determine it's true Length and it's inclinations with ground.

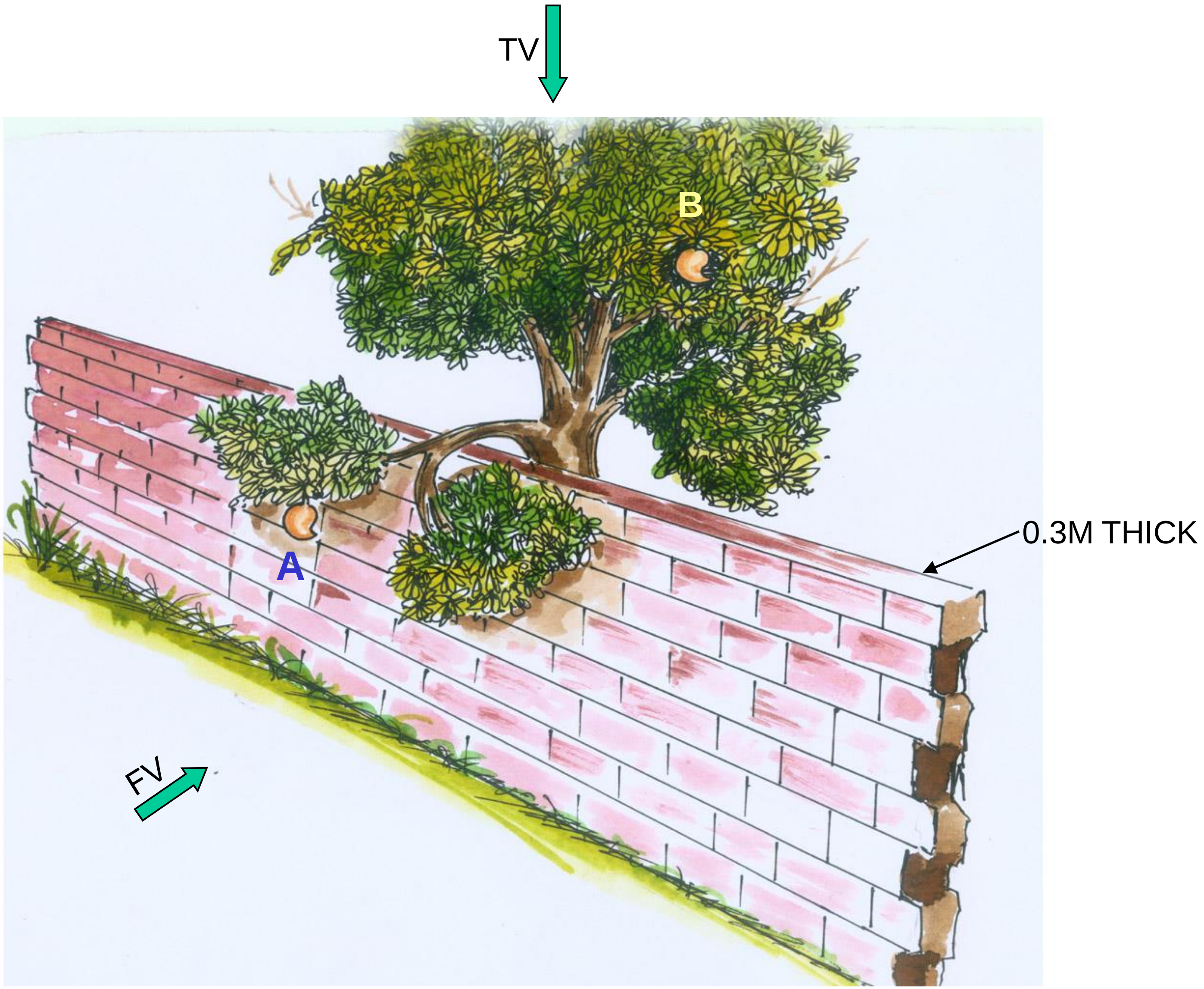
Here various problems along with
actual pictures of those situations are given
for you to understand those clearly.
Now looking for views in given ARROW directions,
YOU are supposed to draw projections & find answers,
Off course you must visualize the situation properly.

CHECK YOUR ANSWERS
WITH THE SOLUTIONS
GIVEN IN THE END.
ALL THE BEST !!

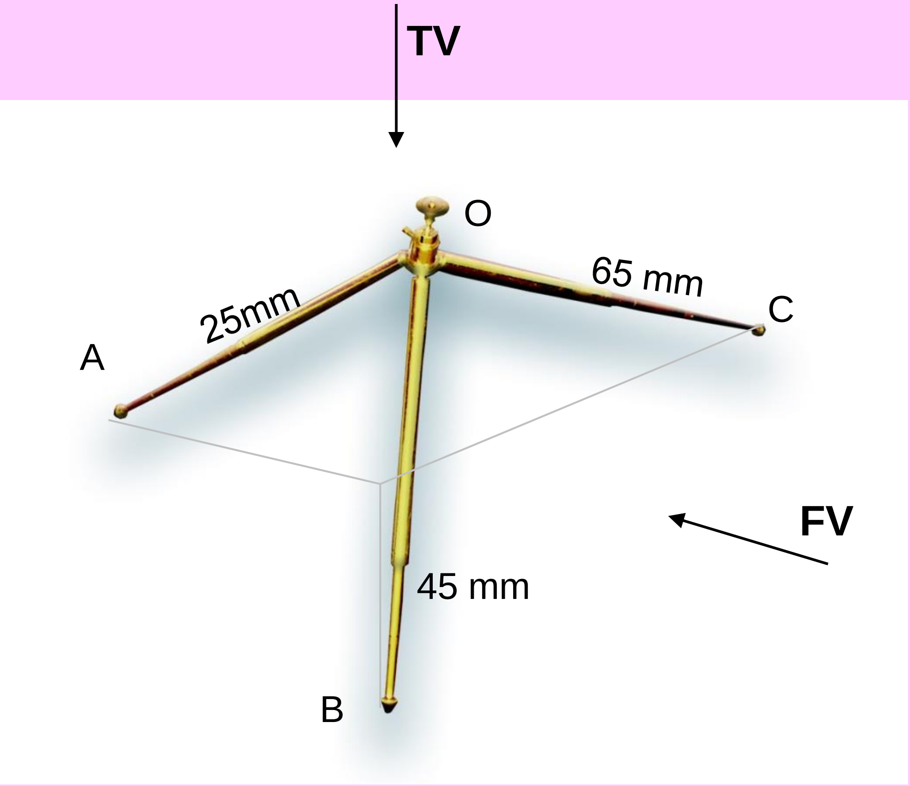
PROBLEM 14:-Two objects, a flower (A) and an orange (B) are within a rectangular compound wall, whose P & Q are walls meeting at 90^0. Flower A is 1M & 5.5 M from walls P & Q respectively. Orange B is 4M & 1.5M from walls P & Q respectively. Drawing projection, find distance between them If flower is 1.5 M and orange is 3.5 M above the ground. Consider suitable scale..



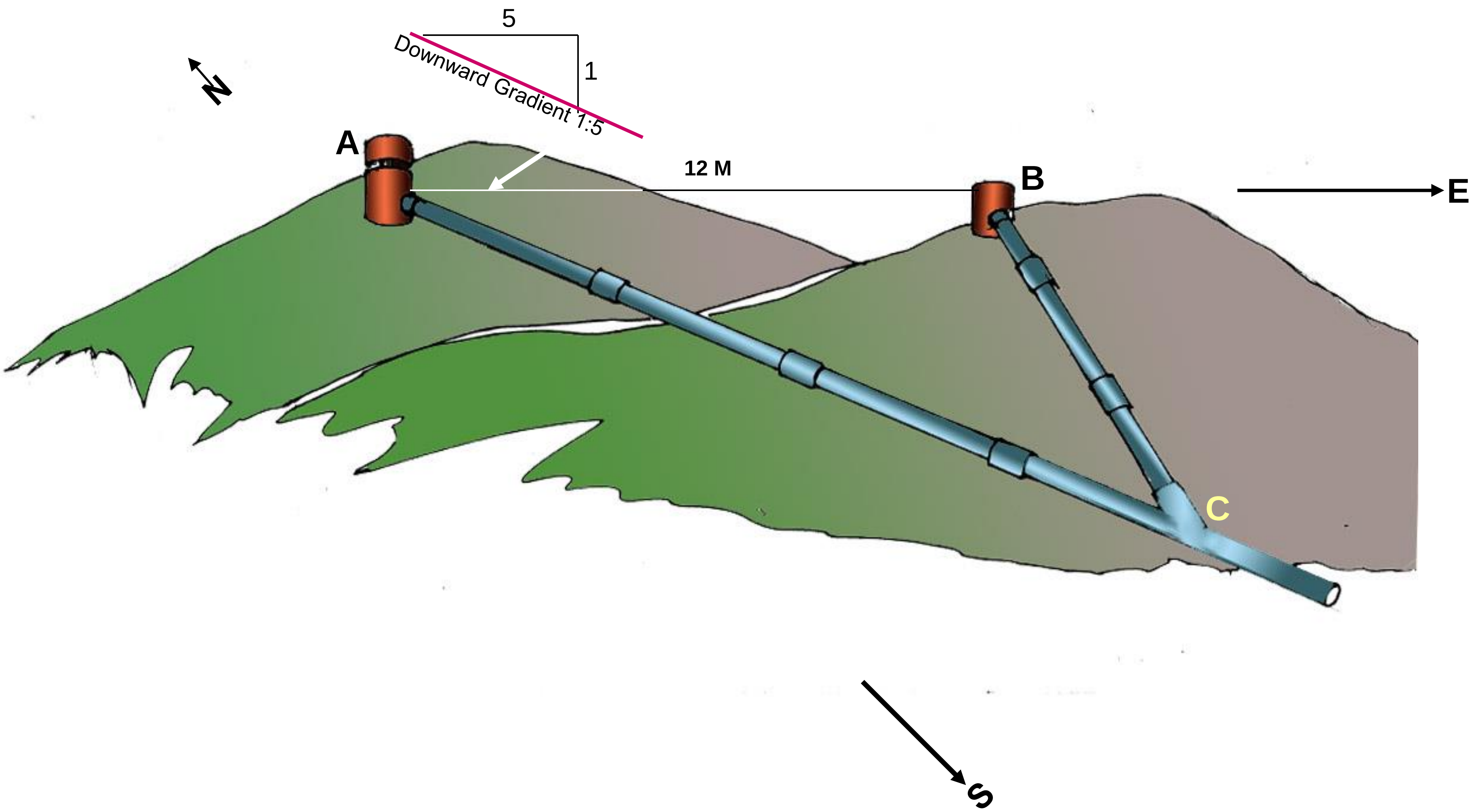
PROBLEM 15 :- Two mangos on a tree A & B are 1.5 m and 3.00 m above ground and those are 1.2 m & 1.5 m from a 0.3 m thick wall but on opposite sides of it. If the distance measured between them along the ground and parallel to wall is 2.6 m, Then find real distance between them by drawing their projections.



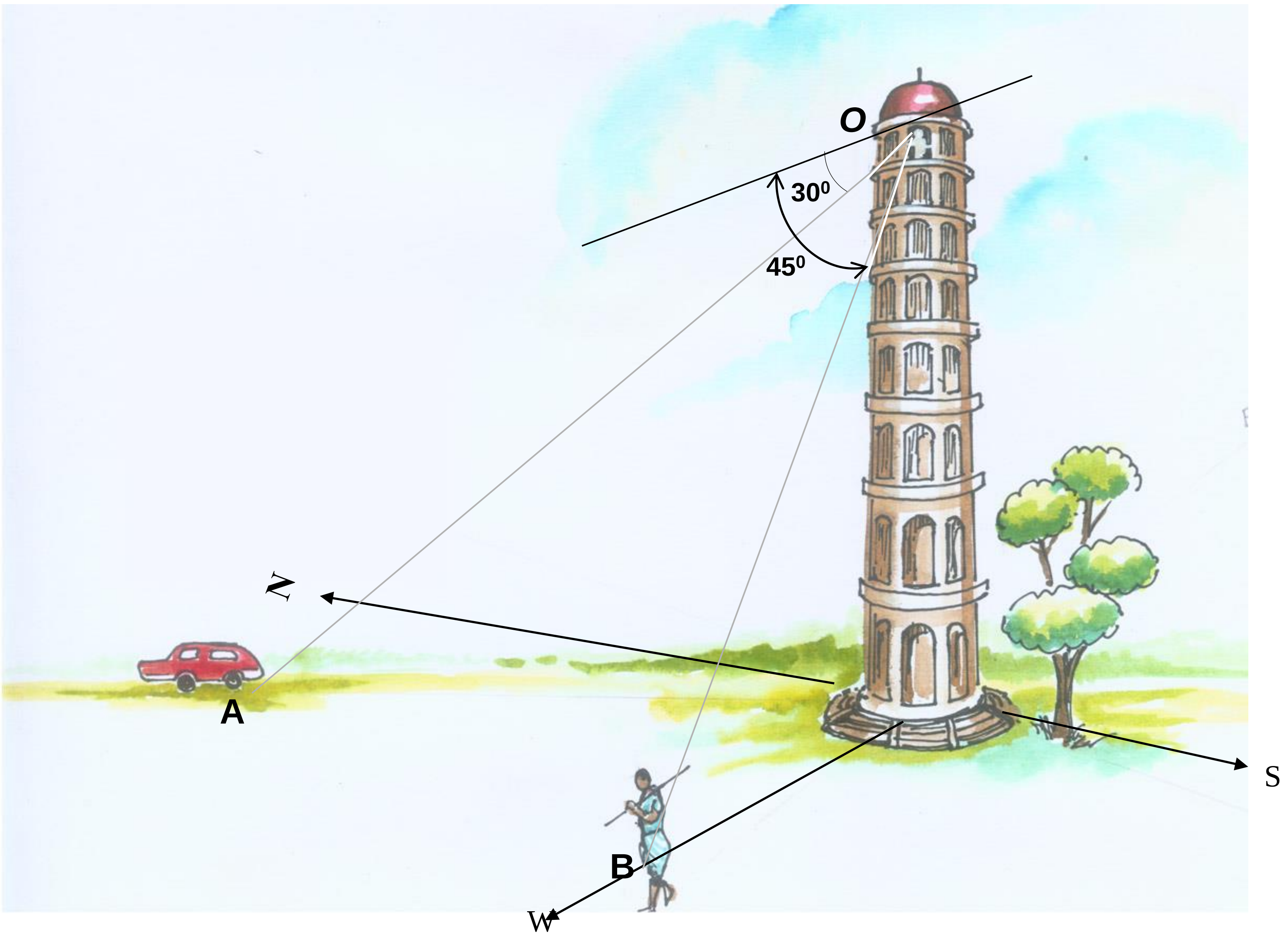
PROBLEM 16 :- oa, ob & oc are three lines, 25mm, 45mm and 65mm long respectively.All equally inclined and the shortest is vertical.This fig. is TV of three rods OA, OB and OC whose ends A,B & C are on ground and end O is 100mm above ground. Draw their projections and find length of each along with their angles with ground.



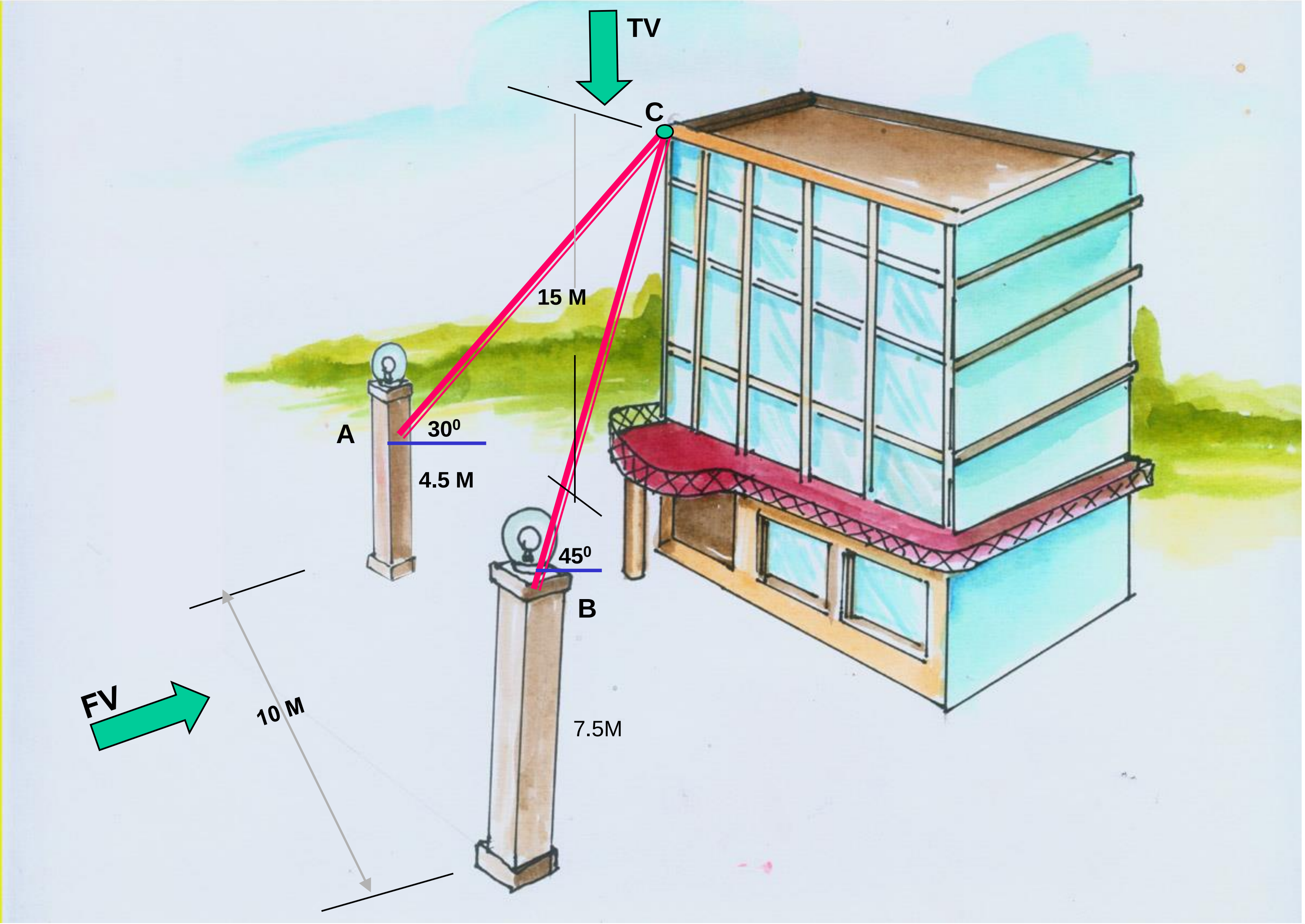
PROBLEM 17:- A pipe line from point **A** has a downward gradient 1:5 and it runs due East-South. Another Point B is 12 M from **A** and due East of **A** and in same level of **A.** Pipe line from **B** runs 20^0 Due East of South and meets pipe line from **A** at point **C.**
Draw projections and find length of pipe line from B and it's inclination with ground.



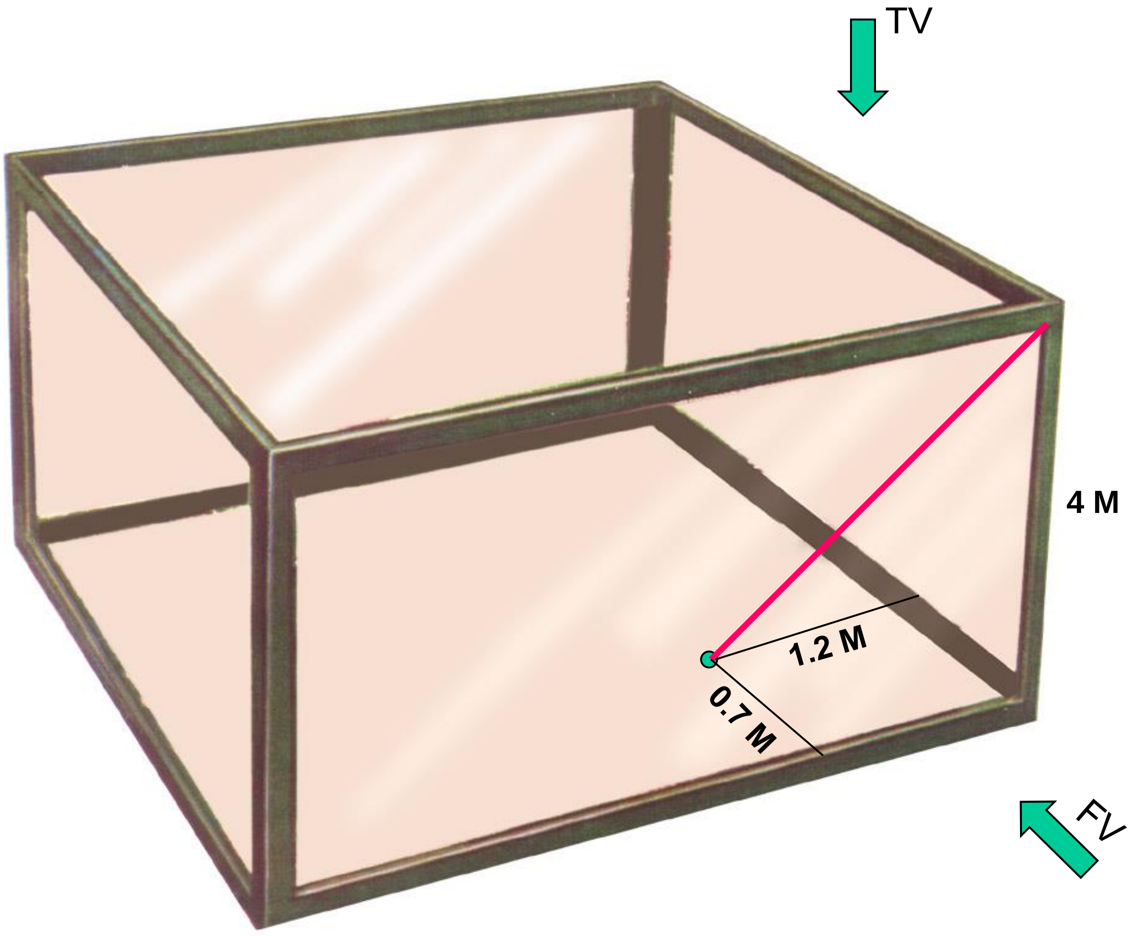
PROBLEM 18: A person observes two objects, A & B, on the ground, from a tower, 15 M high, At the angles of depression 30^0 & 45^0. Object A is is due North-West direction of observer and object B is due West direction. Draw projections of situation and find distance of objects from observer and from tower also.



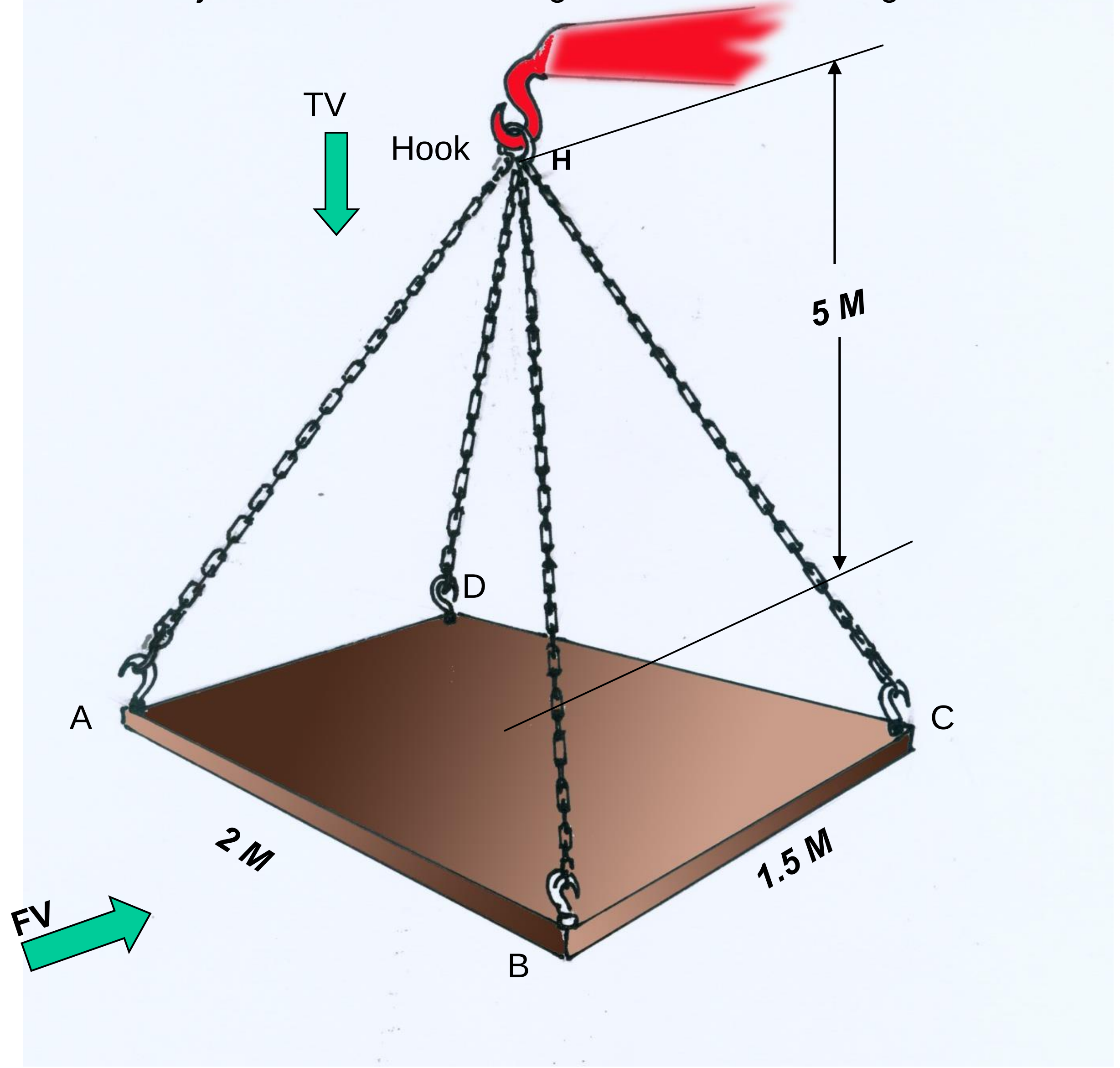
PROBLEM 19:-Guy ropes of two poles fixed at 4.5m and 7.5 m above ground, are attached to a corner of a building 15 M high, make 300 and 450 inclinations with ground respectively.The poles are 10 M apart. Determine by drawing their projections,Length of each rope and distance of poles from building.



PROBLEM 20:- A tank of 4 M height is to be strengthened by four stay rods from each corner by fixing their other ends to the flooring, at a point 1.2 M and 0.7 M from two adjacent walls respectively, as shown. Determine graphically length and angle of each rod with flooring.

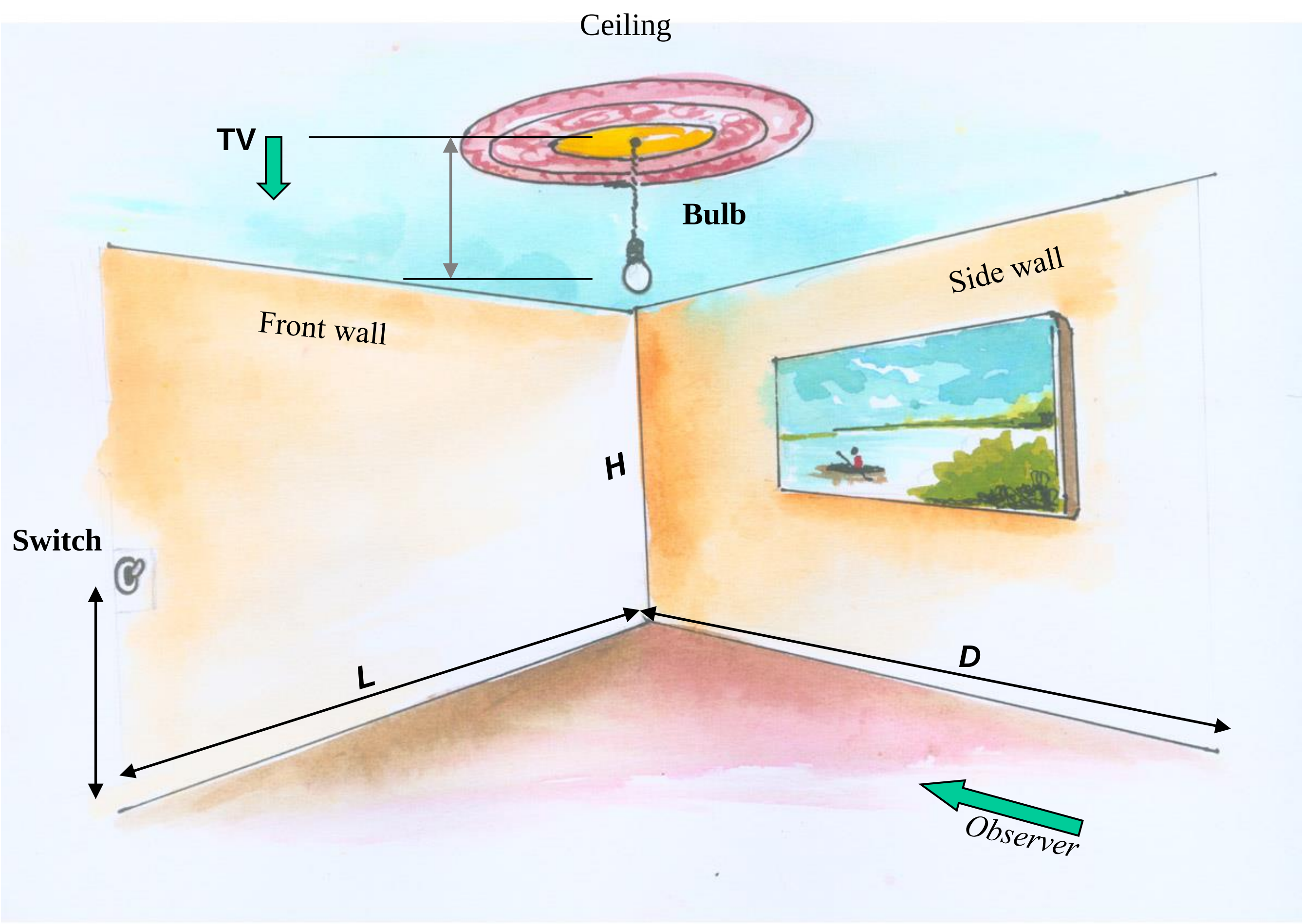


PROBLEM 21:- A horizontal wooden platform 2 M long and 1.5 M wide is supported by four chains from it's corners and chains are attached to a hook 5 M above the center of the platform. Draw projections of the objects and determine length of each chain along with it's inclination with ground.



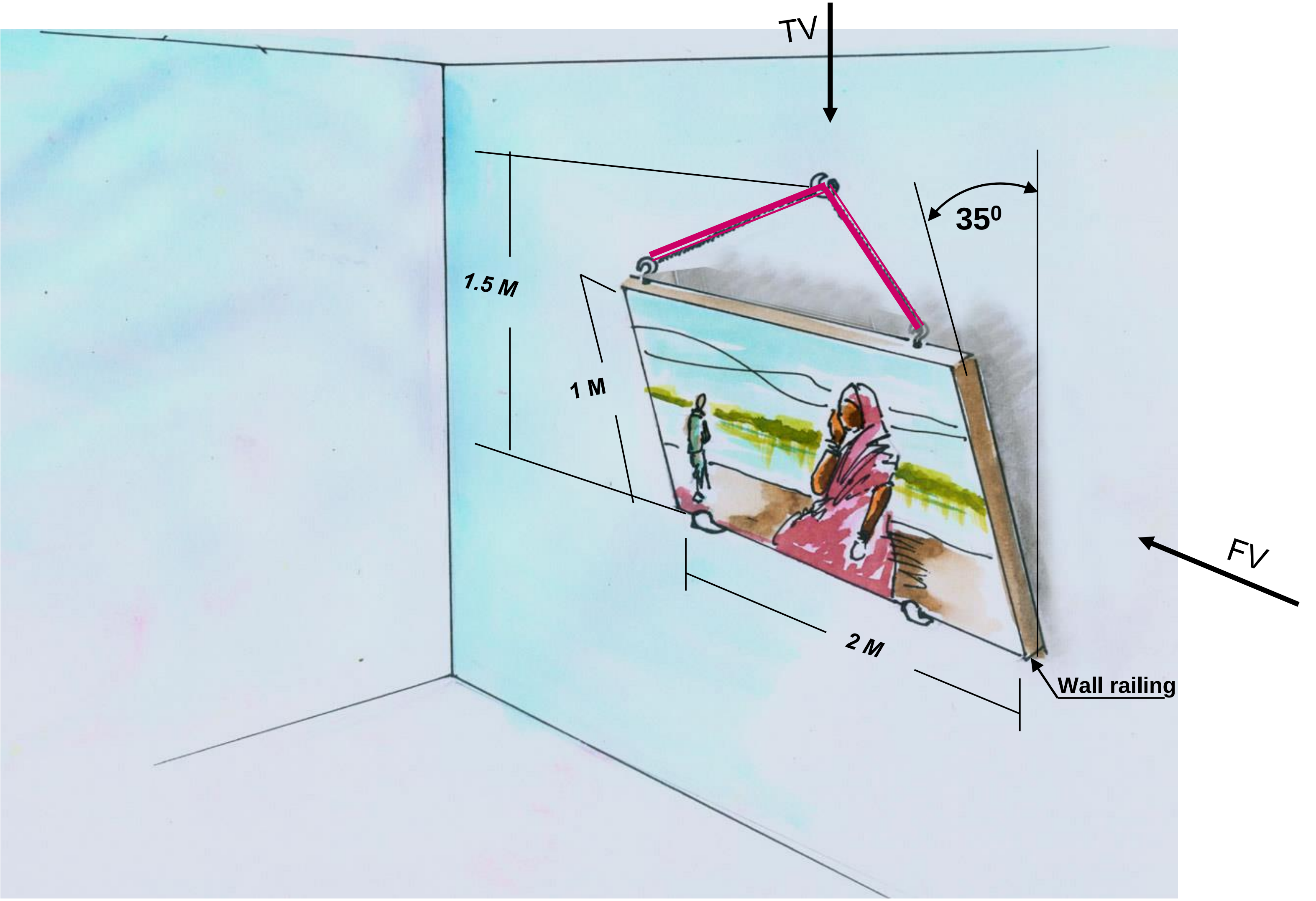
PROBLEM 22.

A room is of size 6.5m L ,5m D,3.5m high.
An electric bulb hangs 1m below the center of ceiling.
A switch is placed in one of the corners of the room, 1.5m above the flooring.
Draw the projections an determine real distance between the bulb and switch.



PROBLEM 23:-

A PICTURE FRAME 2 M WIDE AND 1 M TALL IS RESTING ON HORIZONTAL WALL RAILING MAKES 35^0 INCLINATION WITH WALL. IT IS ATTAACHED TO A HOOK IN THE WALL BY TWO STRINGS. THE HOOK IS 1.5 M ABOVE WALL RAILING. DETERMINE LENGTH OF EACH CHAIN AND TRUE ANGLE BETWEEN THEM

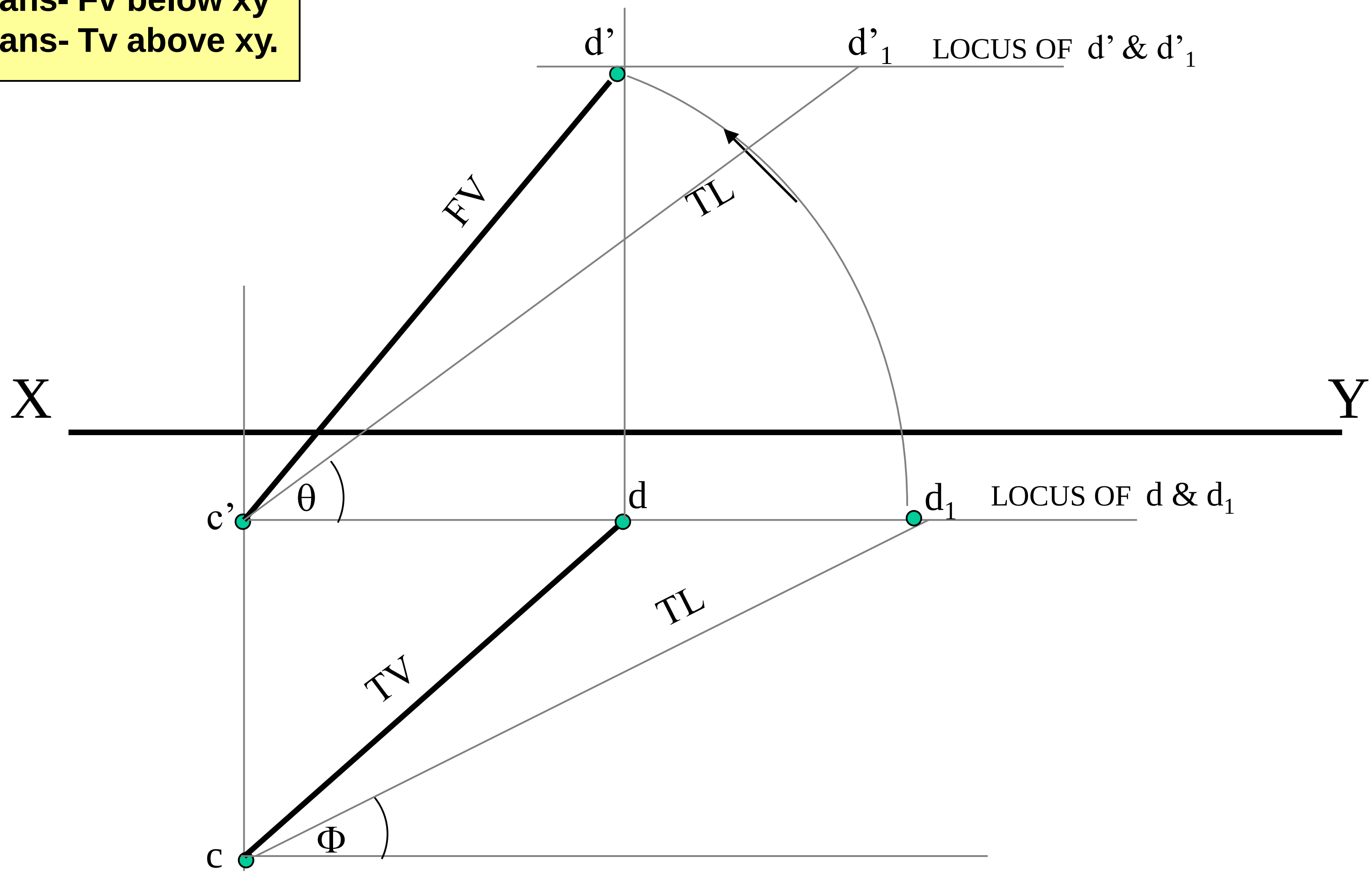


SOME CASES OF THE LINE
IN DIFFERENT QUADRANTS.

REMEMBER:
BELOW HP- Means- Fv below xy
BEHIND V p- Means- Tv above xy.

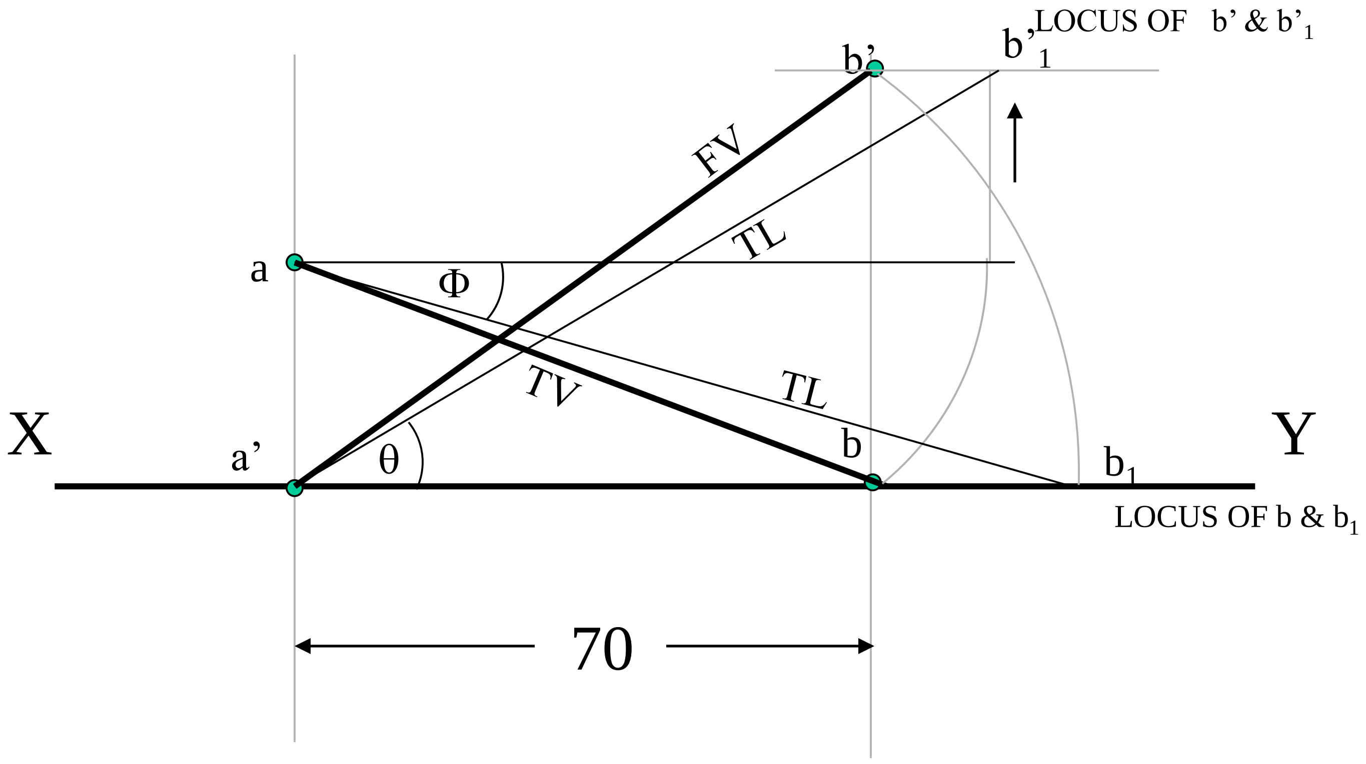
PROBLEM NO.24

T.V. of a 75 mm long Line CD, measures 50 mm.
End C is 15 mm below Hp and 50 mm in front of Vp.
End D is 15 mm in front of Vp and it is above Hp.
Draw projections of CD and find angles with Hp and Vp.



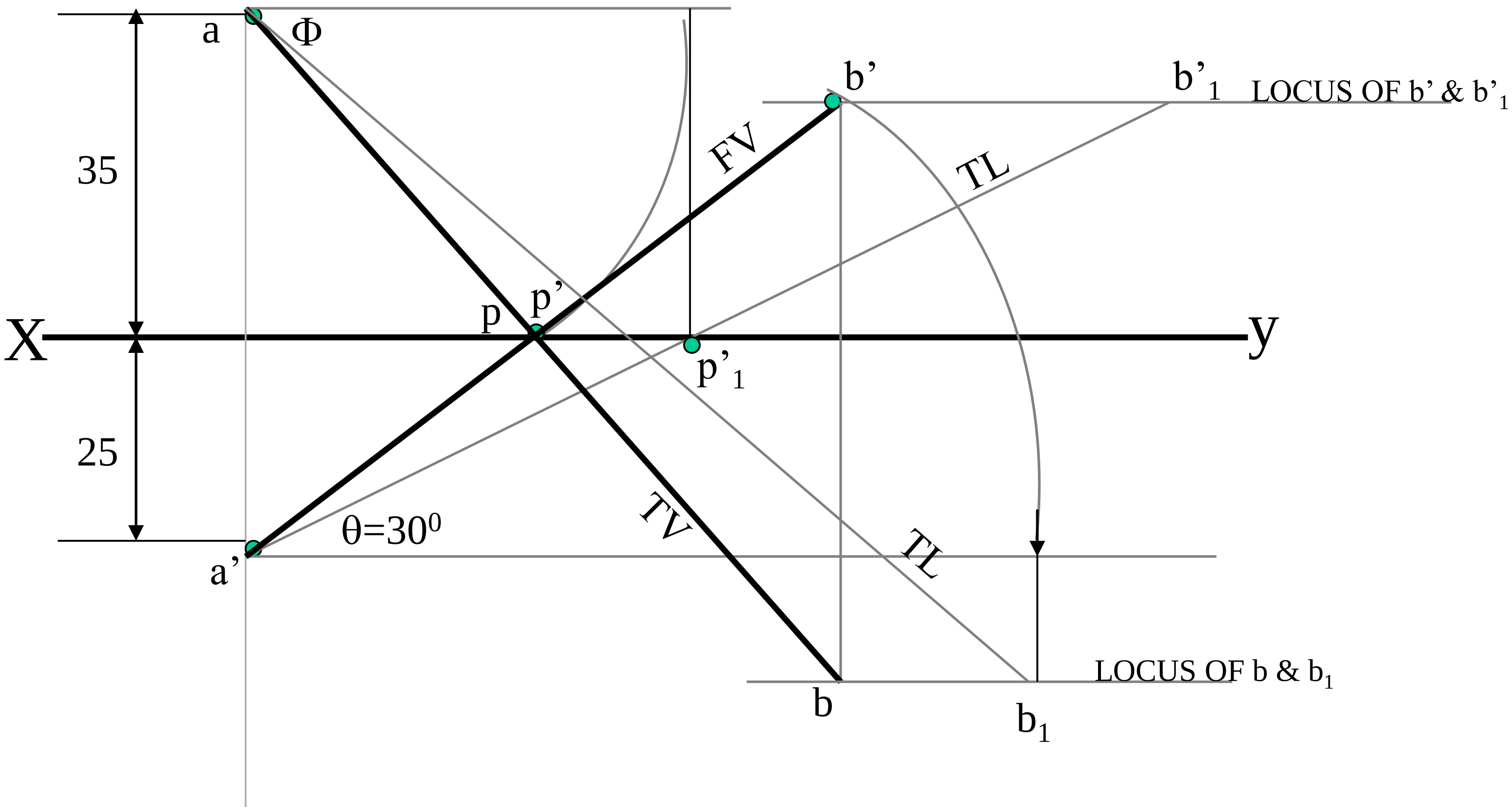
PROBLEM NO.25

End A of line AB is in Hp and 25 mm behind Vp.
End B in Vp.and 50mm above Hp.
Distance between projectors is 70mm.
Draw projections and find it's inclinations with Ht, Vt.



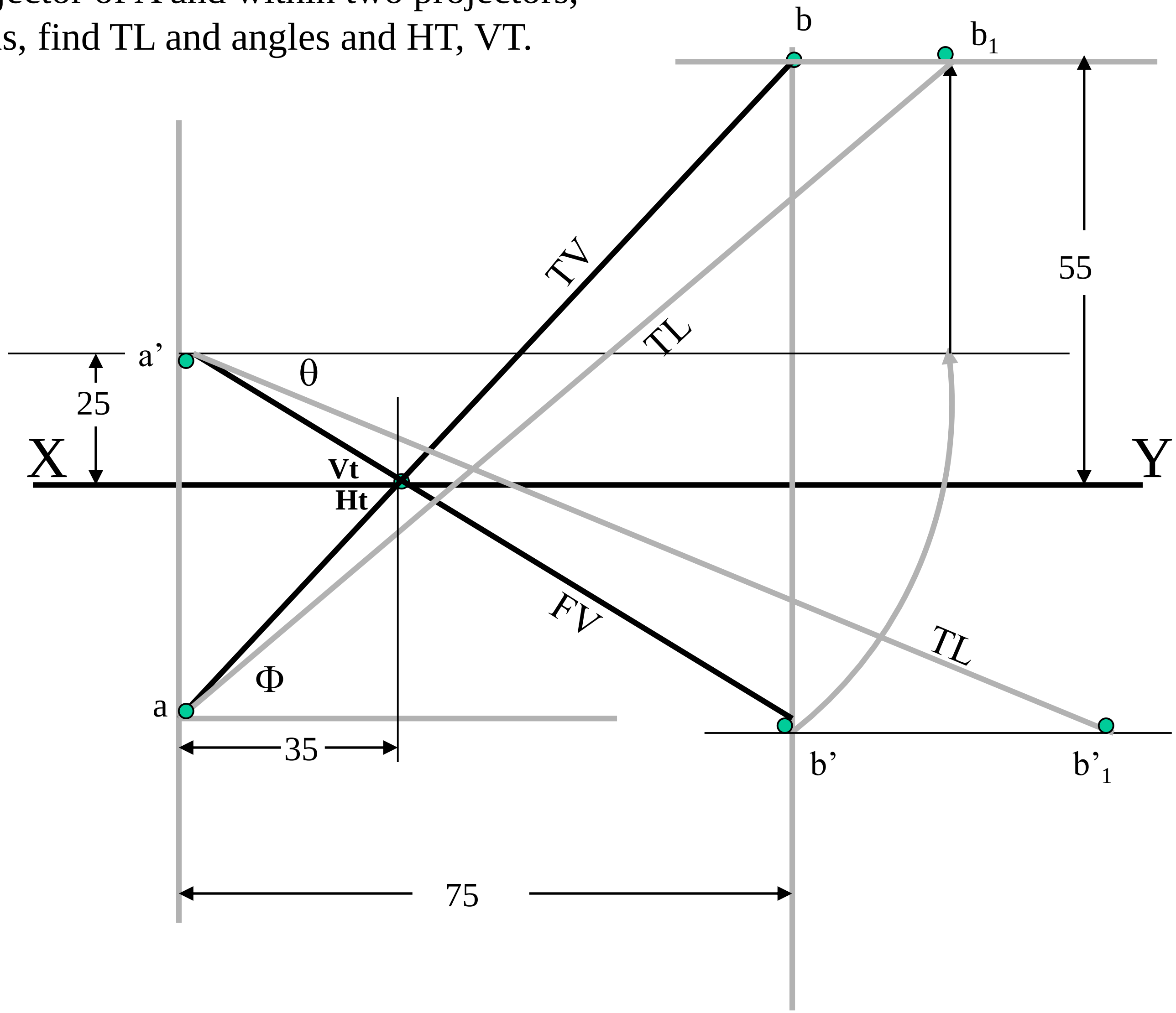
PROBLEM NO.26

End A of a line AB is 25mm below Hp and 35mm behind Vp.
Line is 300 inclined to Hp.
There is a point P on AB contained by both HP & VP.
Draw projections, find inclination with Vp and traces.



PROBLEM NO.27

End A of a line AB is 25mm above Hp and end B is 55mm behind Vp.
The distance between end projectors is 75mm.
If both it's HT & VT coincide on xy in a point,
35mm from projector of A and within two projectors,
Draw projections, find TL and angles and HT, VT.



PROJECTIONS OF PLANES

In this topic various plane figures are the objects.

What is usually asked in the problem?

To draw their projections means F.V, T.V. & S.V.

What will be given in the problem?

1. Description of the plane figure.
2. It's position with HP and VP.

In which manner it's position with HP & VP will be described?

1. **Inclination of it's SURFACE with one of the reference planes will be given.**
2. Inclination of one of it's EDGES with other reference plane will be given

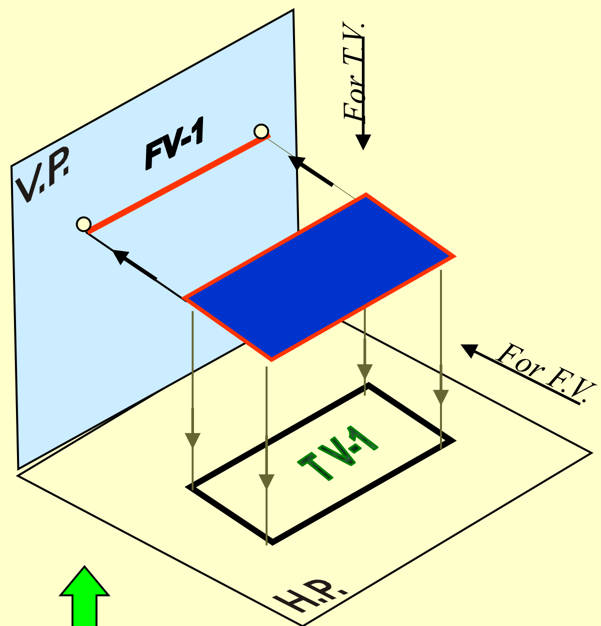
(Hence this will be a case of an object inclined to both reference Planes.)

Study the illustration showing surface & side inclination given on next page.

CASE OF A RECTANGLE – OBSERVE AND NOTE ALL STEPS.

SURFACE **PARALLEL** TO HP

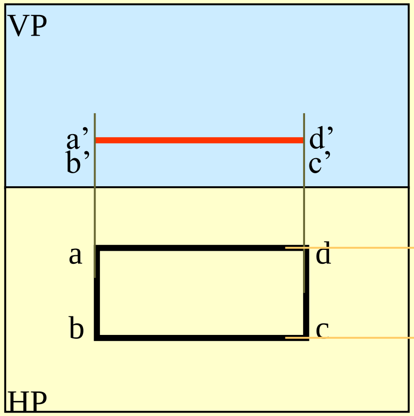
PICTORIAL PRESENTATION



ORTHOGRAPHIC

TV-True Shape

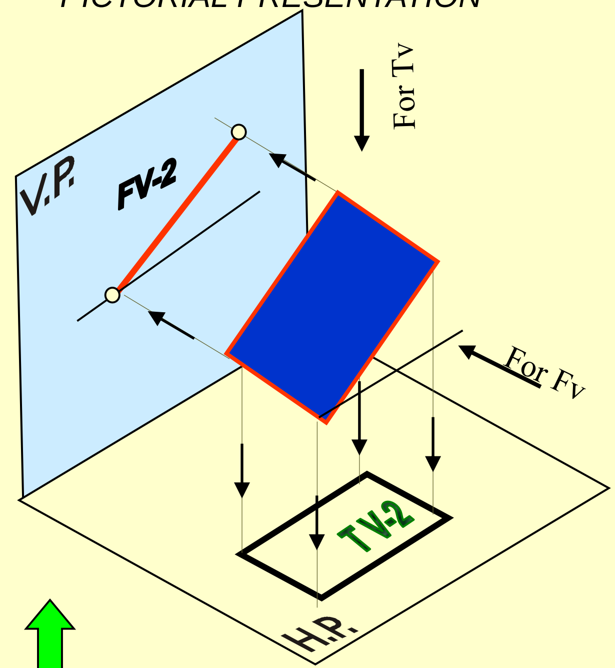
FV- Line // to xy



A

SURFACE **INCLINED** TO HP

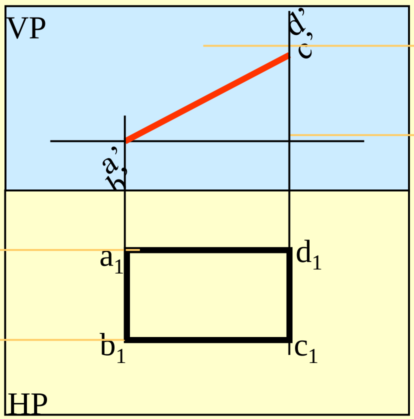
PICTORIAL PRESENTATION



ORTHOGRAPHIC

FV- Inclined to XY

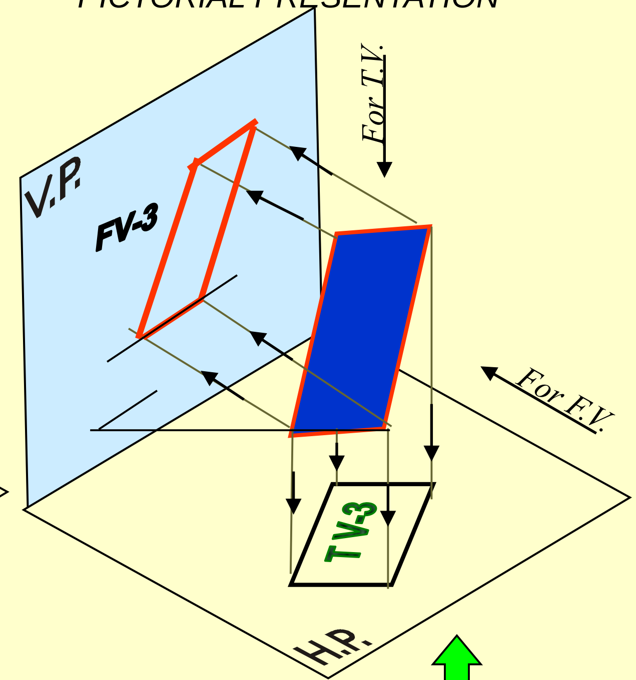
TV- Reduced Shape



B

ONE SMALL SIDE INCLINED TO VP

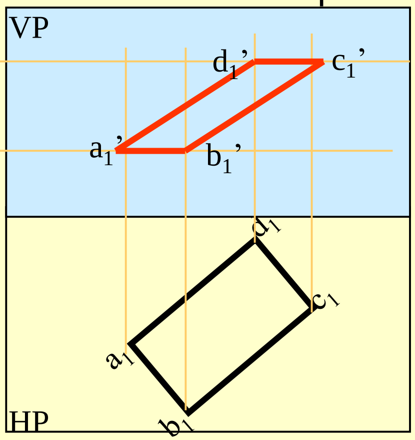
PICTORIAL PRESENTATION



ORTHOGRAPHIC

FV- Apparent Shape

TV-Previous Shape



C

PROCEDURE OF SOLVING THE PROBLEM:

IN THREE STEPS EACH PROBLEM CAN BE SOLVED: **(As Shown In Previous Illustration)**

STEP 1. Assume suitable conditions & draw Fv & Tv of initial position.

STEP 2. Now consider surface inclination & draw 2nd Fv & Tv.

STEP 3. After this,consider side/edge inclination and draw 3rd (final) Fv & Tv.

ASSUMPTIONS FOR INITIAL POSITION:

(Initial Position means assuming surface // to HP or VP)

1.If in problem surface is inclined to HP – assume it // HP

Or If surface is inclined to VP – assume it // to VP

2. Now if surface is assumed // to HP- It's TV will show True Shape.

And If surface is assumed // to VP – It's FV will show True Shape.

3. Hence begin with drawing TV or FV as True Shape.

4. While drawing this True Shape –

keep one side/edge (which is making inclination) perpendicular to xy line

(similar to pair no. A on previous page illustration).

Now Complete STEP 2. By making surface inclined to the resp plane & project it's other view.

(Ref. 2nd pair B on previous page illustration)

Now Complete STEP 3. By making side inclined to the resp plane & project it's other view.

(Ref. 3rd pair C on previous page illustration)

APPLY SAME STEPS TO SOLVE NEXT *ELEVEN* PROBLEMS

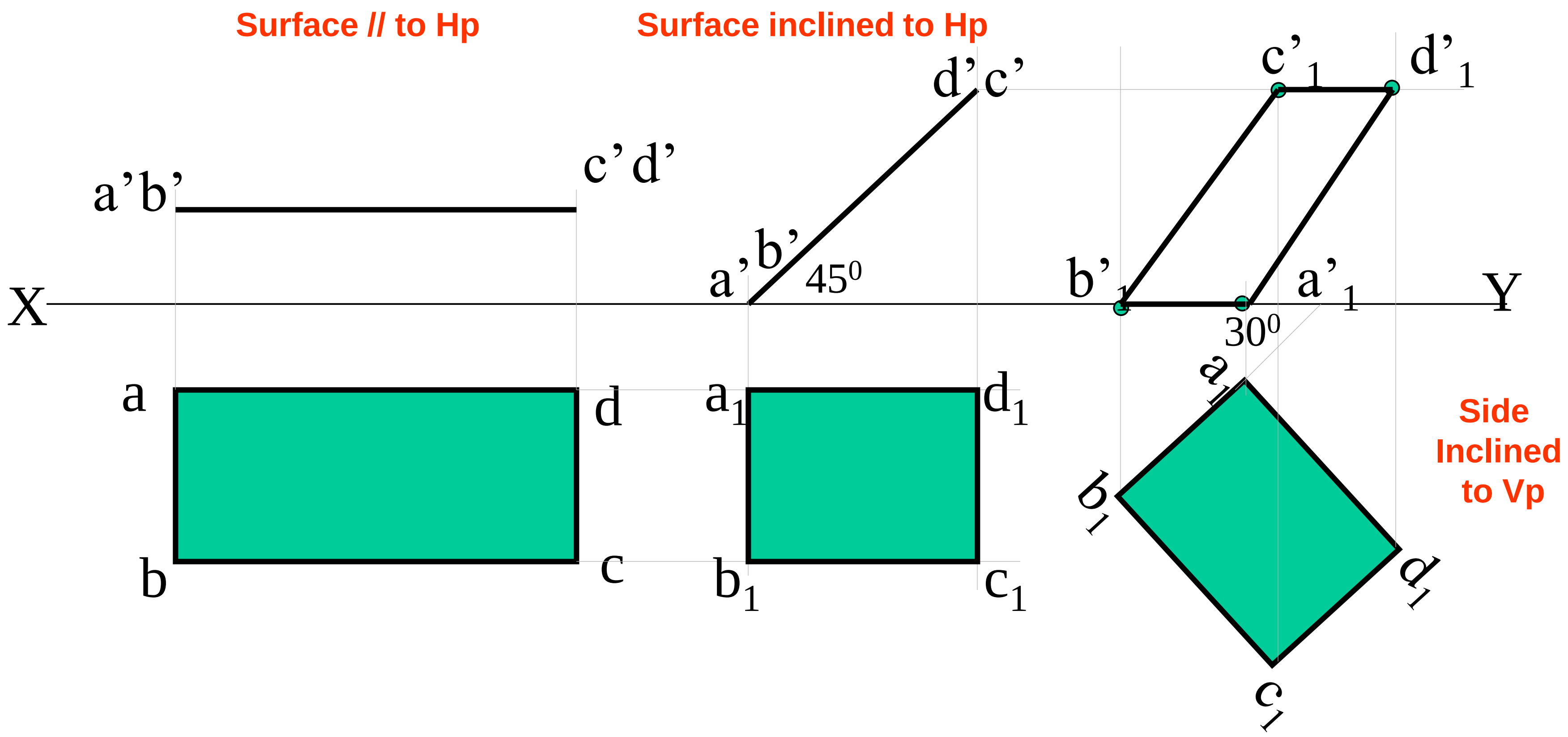
Problem 1:

Rectangle 30mm and 50mm sides is resting on HP on one small side which is 30^0 inclined to VP,while the surface of the plane makes 45^0 inclination with HP. Draw it's 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 side will be vertical? ---One small side.

Hence begin with TV, draw rectangle below X-Y drawing one small side vertical.

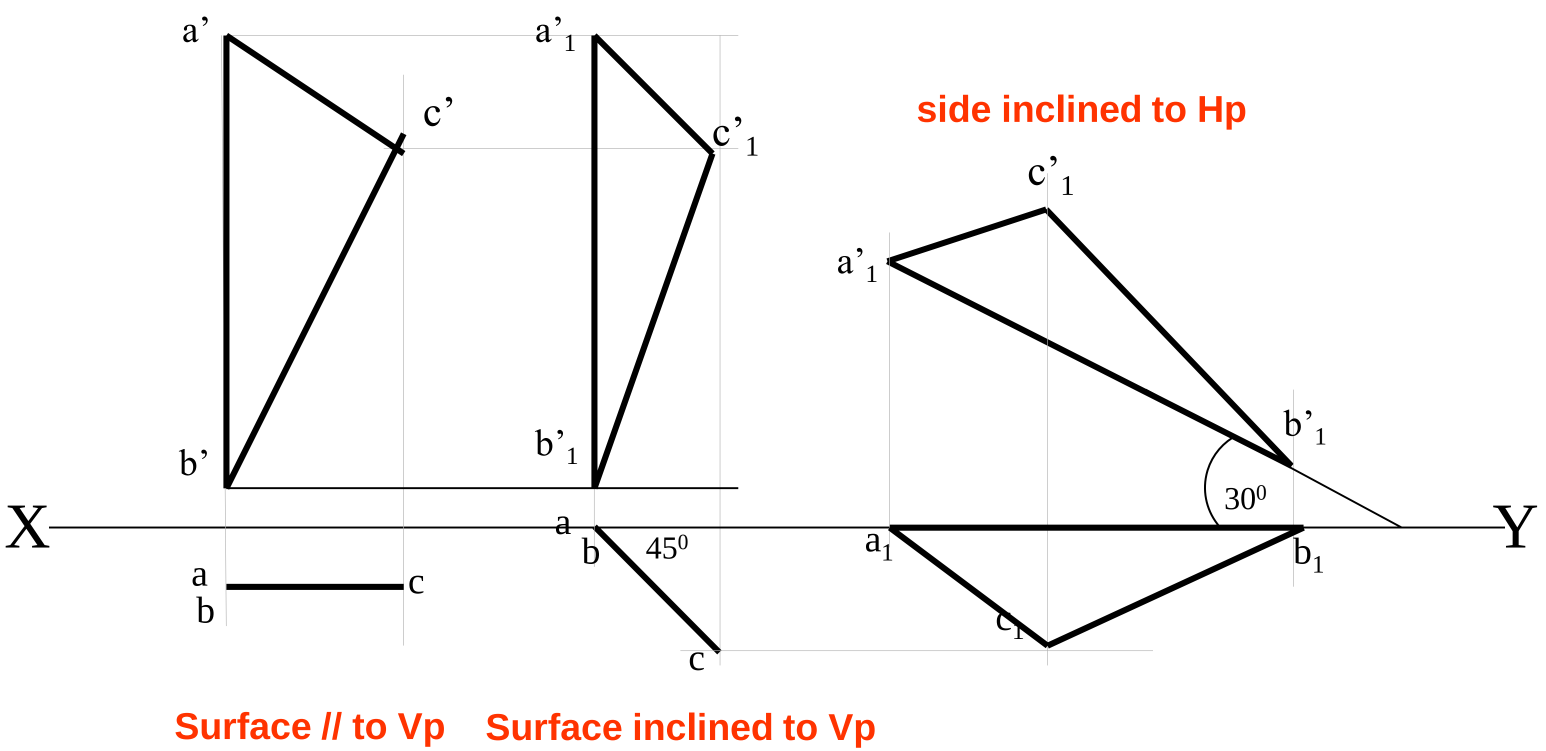


Problem 2:
A $30^0 – 60^0$ set square of longest side 100 mm long, is in VP and 30^0 inclined to HP while it's surface is 45^0 inclined to VP.Draw it's projections

(Surface & Side inclinations directly given)

Read problem and answer following questions
1 .Surface inclined to which plane? ------- VP
2. Assumption for initial position? ------// to VP
3. So which view will show True shape? --- FV
4. Which side will be vertical? ------longest side.

Hence begin with FV, draw triangle above X-Y keeping longest side vertical.



Problem 3:

A $30^0 – 60^0$ set square of longest side 100 mm long is in VP and it's surface 45^0 inclined to VP. One end of longest side is 10 mm and other end is 35 mm above HP. Draw it's projections

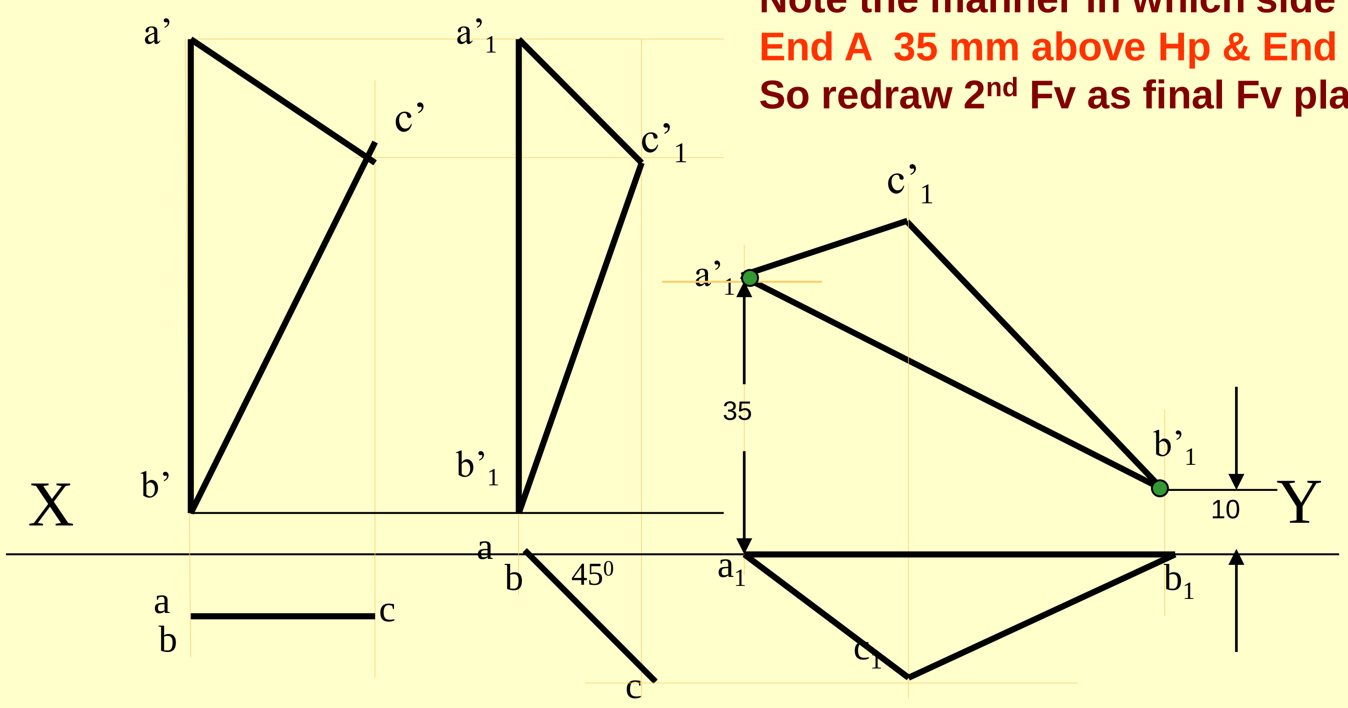
(Surface inclination directly given. Side inclination indirectly given)

Read problem and answer following questions

1 .Surface inclined to which plane? ------- VP
2. Assumption for initial position? ------// to VP
3. So which view will show True shape? --- FV
4. Which side will be vertical? ------longest side.

Hence begin with FV, draw triangle above X-Y keeping longest side vertical.

First TWO steps are similar to previous problem.
Note the manner in which side inclination is given.
End A 35 mm above Hp & End B is 10 mm above Hp.
So redraw 2nd Fv as final Fv placing these ends as said.



Problem 4:

A regular pentagon of 30 mm sides is resting on HP on one of it's sides with it's surface 45^0 inclined to HP.

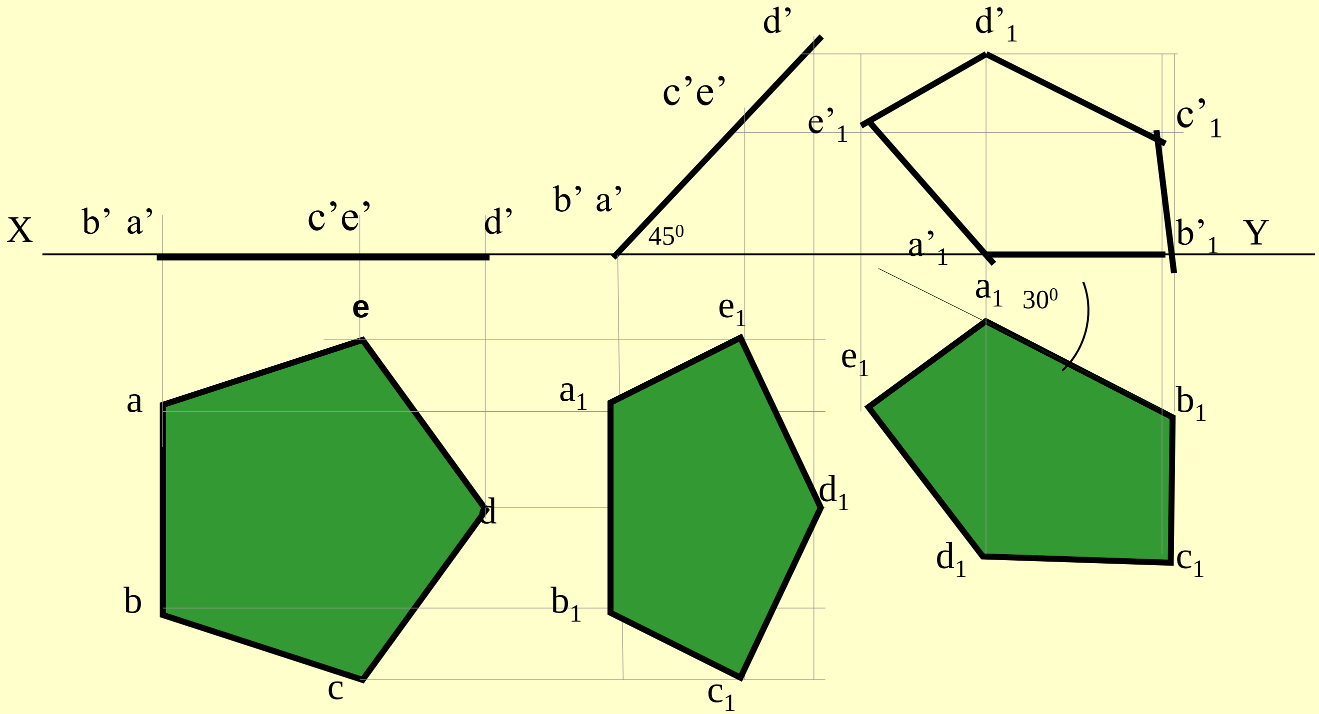
Draw it's projections when the side in HP makes 30^0 angle with VP

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.



Problem 5:

A regular pentagon of 30 mm sides is resting on HP on one of it's sides while it's opposite vertex (corner) is 30 mm above HP.
Draw projections when side in HP is 30^0 inclined to VP.

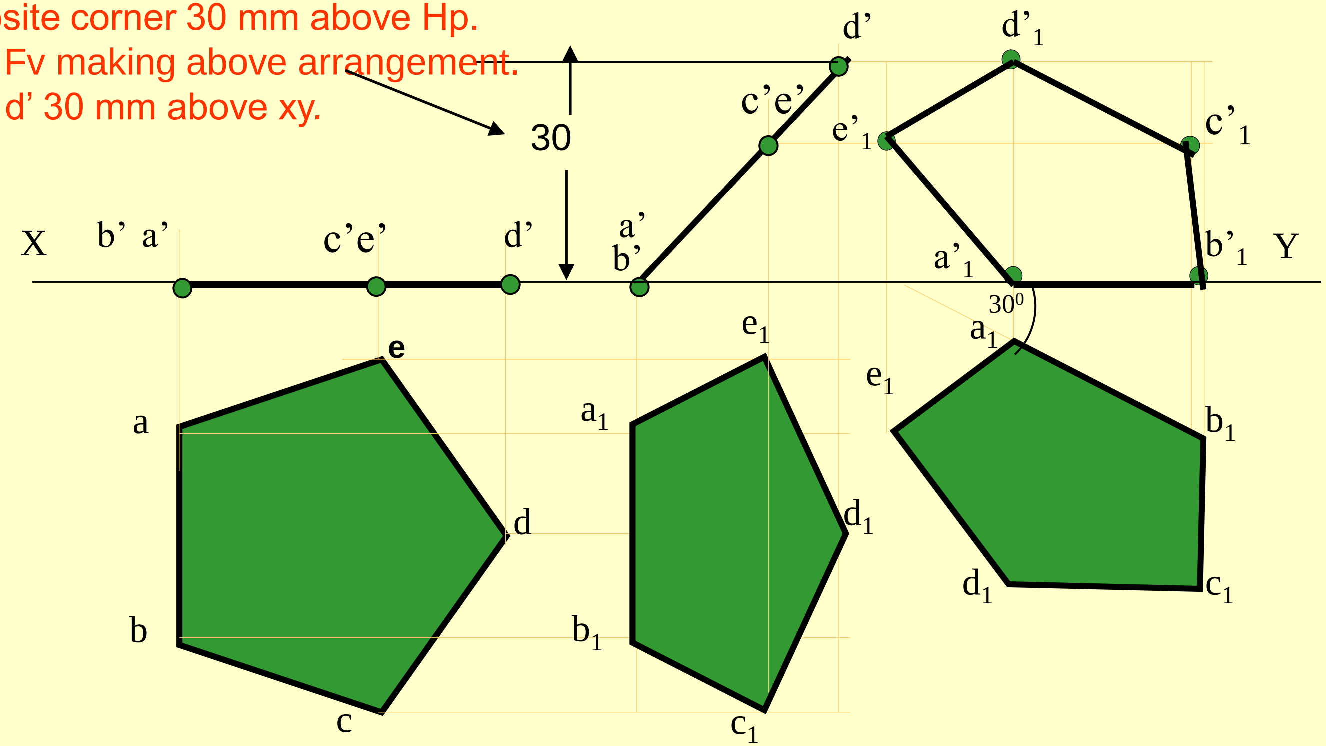
SURFACE INCLINATION INDIRECTLY GIVEN
SIDE INCLINATION DIRECTLY GIVEN:

Read problem and answer following questions

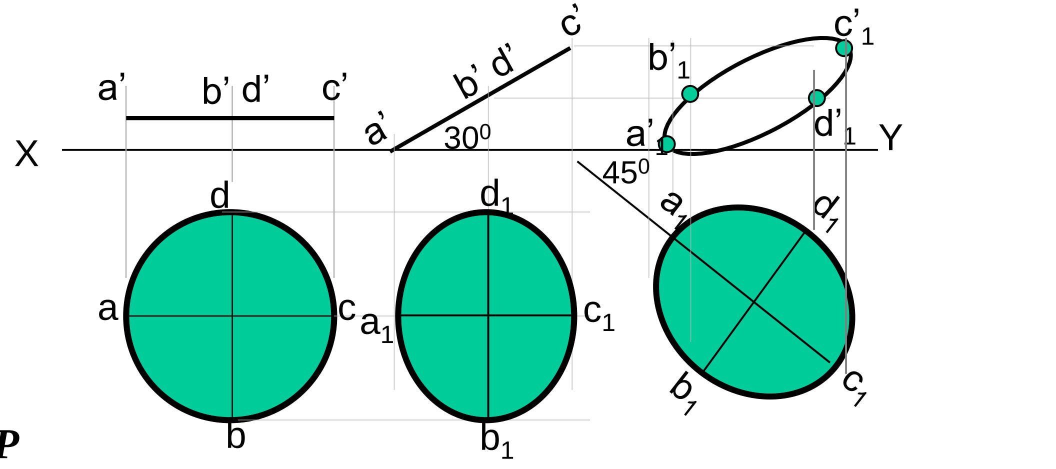
1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which side will be vertical? --------***any side.***

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

ONLY CHANGE is
the manner in which surface inclination is described:
One side on Hp & it's opposite corner 30 mm above Hp.
Hence redraw 1st Fv as a 2nd Fv making above arrangement.
Keep a'b' on xy & d' 30 mm above xy.



Problem 8: A circle of 50 mm diameter is resting on Hp on end A of it's diameter AC which is 30^0 inclined to Hp while it's Tv is 45^0 inclined to Vp.Draw it's projections.



Read problem and answer following questions

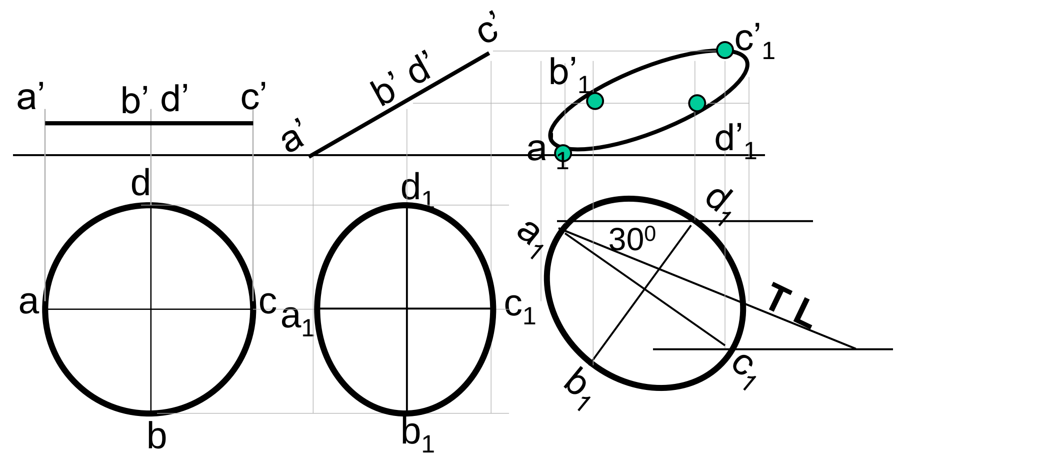
1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AC***

Hence begin with TV,draw rhombus below X-Y line, taking longer diagonal // to X-Y

The difference in these two problems is in step 3 only.
In problem no.8 inclination of Tv of that AC is given,It could be drawn directly as shown in 3rd step.
While in no.9 angle of AC itself i.e. it's 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 9: A circle of 50 mm diameter is resting on Hp on end A of it's diameter AC which is 30^0 inclined to Hp while it makes 45^0 inclined to Vp. Draw it's projections.

Note the difference in construction of 3rd step in both solutions.



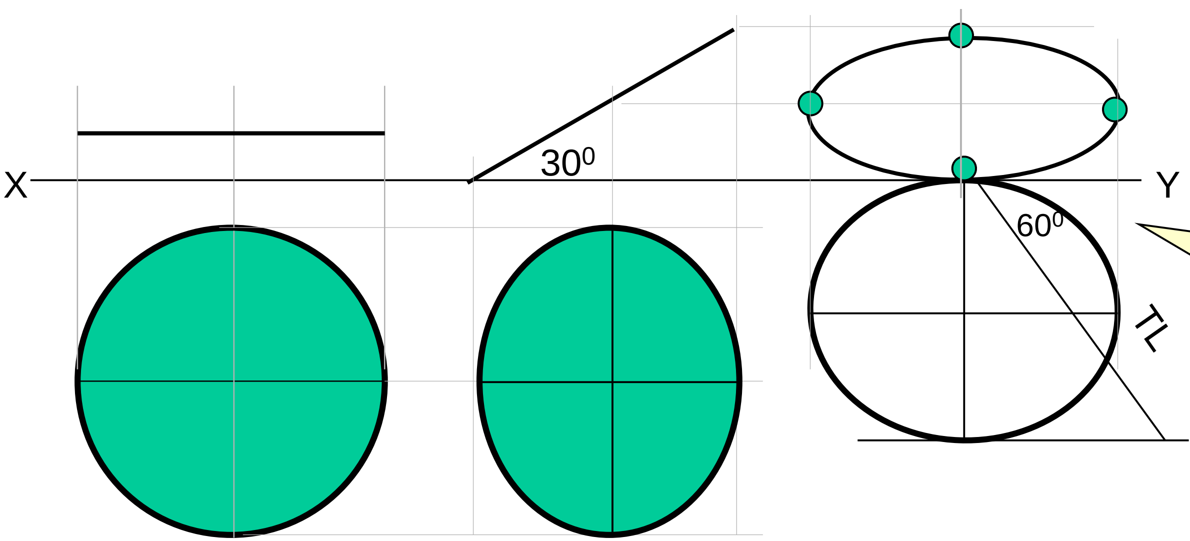
Problem 10: End A of diameter AB of a circle is in HP A nd end B is in VP.Diameter AB, 50 mm long is 30^0 & 60^0 inclined to HP & VP respectively. Draw projections of circle.

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? ---------- ***AB***

Hence begin with TV,draw CIRCLE below X-Y line, taking DIA. AB // to X-Y

The problem is similar to previous problem of circle – no.9.
But in the 3rd step there is one more change.
Like 9th problem True Length inclination of dia.AB is definitely expected but if you carefully note - the the SUM of it's inclinations with HP & VP is 90^0.
Means Line AB lies in a Profile Plane.
Hence it's both Tv & Fv must arrive on one single projector.
So do the construction accordingly AND ***note the case carefully***..



SOLVE SEPARATELY
ON DRAWING SHEET
GIVING NAMES TO VARIOUS
POINTS AS USUAL,
AS THE CASE IS IMPORTANT

Problem 11:

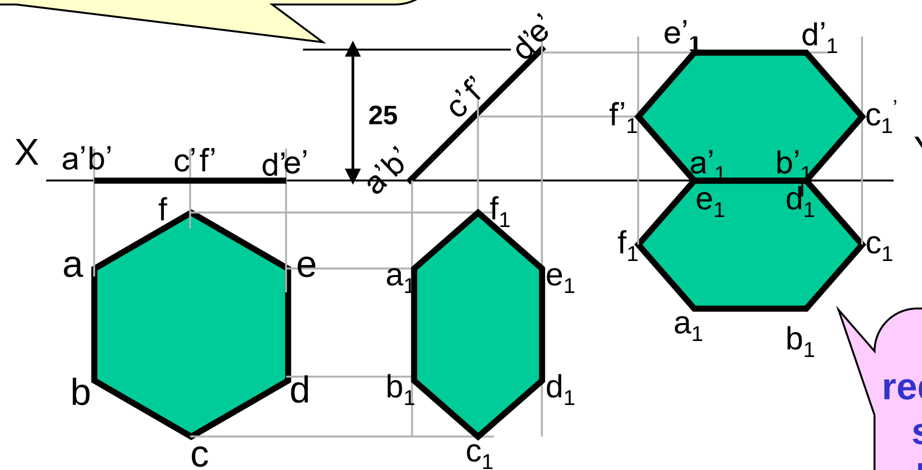
A hexagonal lamina has its one side in HP and
Its apposite parallel side is 25mm above Hp and
In Vp. Draw it's projections.
Take side of hexagon 30 mm long.

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***

Hence begin with TV,draw rhombus below X-Y line, taking longer diagonal // to X-Y

ONLY CHANGE is the manner in which surface inclination is described:
One side on Hp & it's opposite side 25 mm above Hp.
Hence redraw 1st Fv as a 2nd Fv making above arrangement.
Keep a'b' on xy & d'e' 25 mm above xy.



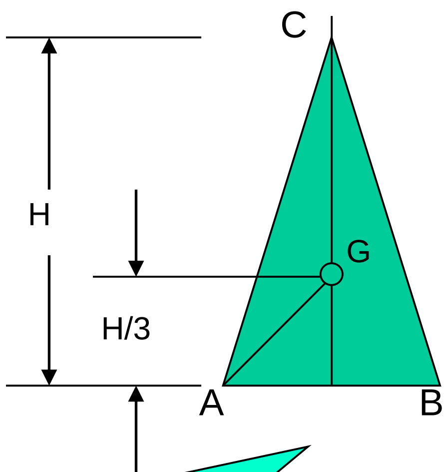
As 3rd step redraw 2nd Tv keeping side DE on xy line. Because it is in VP as said in problem.

FREELY SUSPENDED CASES.

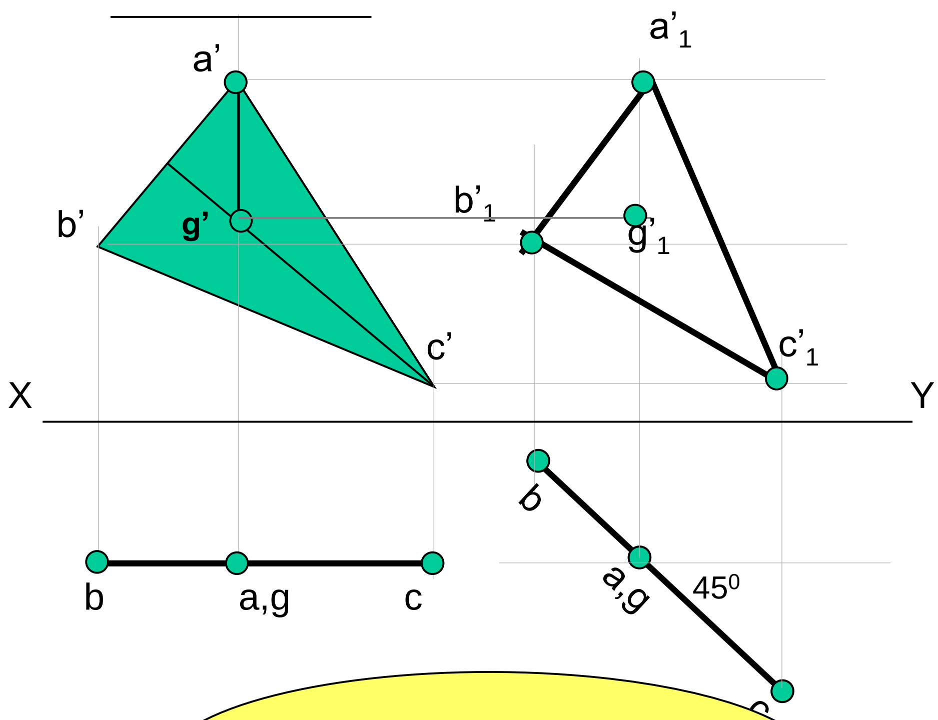
Problem 12:
An isosceles triangle of 40 mm long base side, 60 mm long altitude Is freely suspended from one corner of Base side.It's plane is 45^0 inclined to Vp. Draw it's projections.

IMPORTANT POINTS

1.In this case the plane of the figure always remains ***perpendicular to Hp***.
2.It may remain parallel or inclined to Vp.
3.Hence ***TV*** in this case will be always a ***LINE view.***
4.Assuming surface // to Vp, draw true shape in suspended position as FV.
(Here keep *line joining* ***point of contact & centroid of fig. vertical***)
5.Always begin with FV as a True Shape but in a suspended position.
AS shown in 1[st] FV.



First draw a given triangle
With given dimensions,
Locate it's centroid position
And
join it with point of suspension.



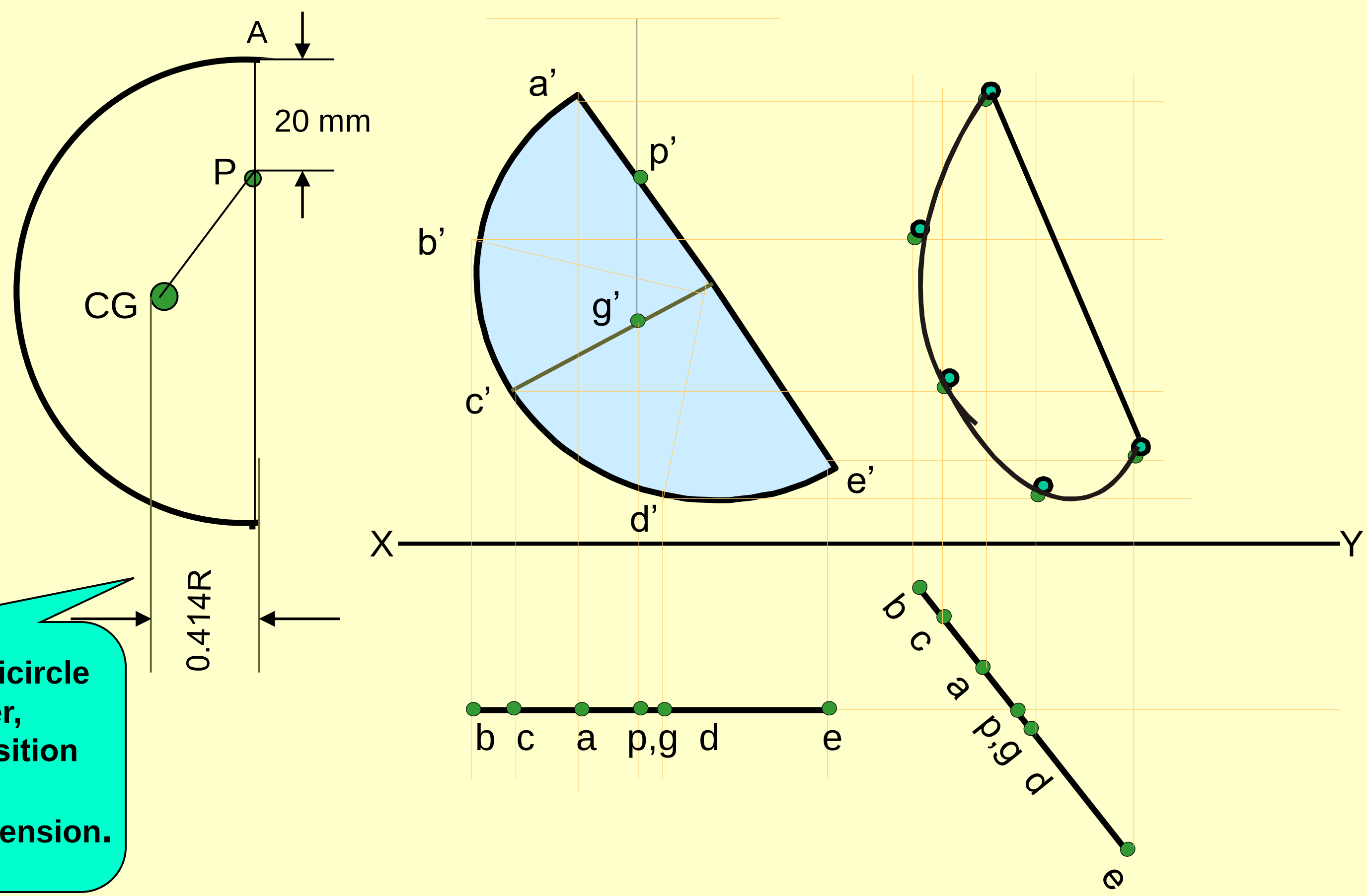
Similarly solve next problem of Semi-circle

IMPORTANT POINTS

Problem 13

:A semicircle of 100 mm diameter is suspended from a point on its straight edge 30 mm from the midpoint of that edge so that the surface makes an angle of 45^0 with VP. Draw its projections.

1. In this case the plane of the figure always remains ***perpendicular to Hp***.
2. It may remain parallel or inclined to Vp.
3. Hence ***TV*** in this case will be always a ***LINE view.***
4. Assuming surface // to Vp, draw true shape in suspended position as FV. (Here keep *line joining* ***point of contact & centroid of fig. vertical***)
5. Always begin with FV as a True Shape but in a suspended position. AS shown in 1st FV.



First draw a given semicircle
With given diameter,
Locate it’s centroid position
And
join it with point of suspension.

To determine true shape of plane figure when it's projections are given.
BY USING AUXILIARY PLANE METHOD

WHAT WILL BE THE PROBLEM?
Description of final Fv & Tv will be given.
You are supposed to determine true shape of that plane figure.

Follow the below given steps:
1. Draw the given Fv & Tv as per the given information in problem.
2. Then among all lines of Fv & Tv select a line showing True Length (T.L.)
   (It's other view must be // to xy)
3. Draw x_1-y_1 perpendicular to this line showing T.L.
4. Project view on x_1-y_1 (it must be a line view)
5. Draw x_2-y_2 // to this line view & project new view on it.

It will be the required answer i.e. True Shape.

The facts you must know:-
If you carefully study and observe the solutions of all previous problems,
You will find
IF ONE VIEW IS A LINE VIEW & THAT TOO PARALLEL TO XY LINE,
THEN AND THEN IT'S OTHER VIEW WILL SHOW TRUE SHAPE:

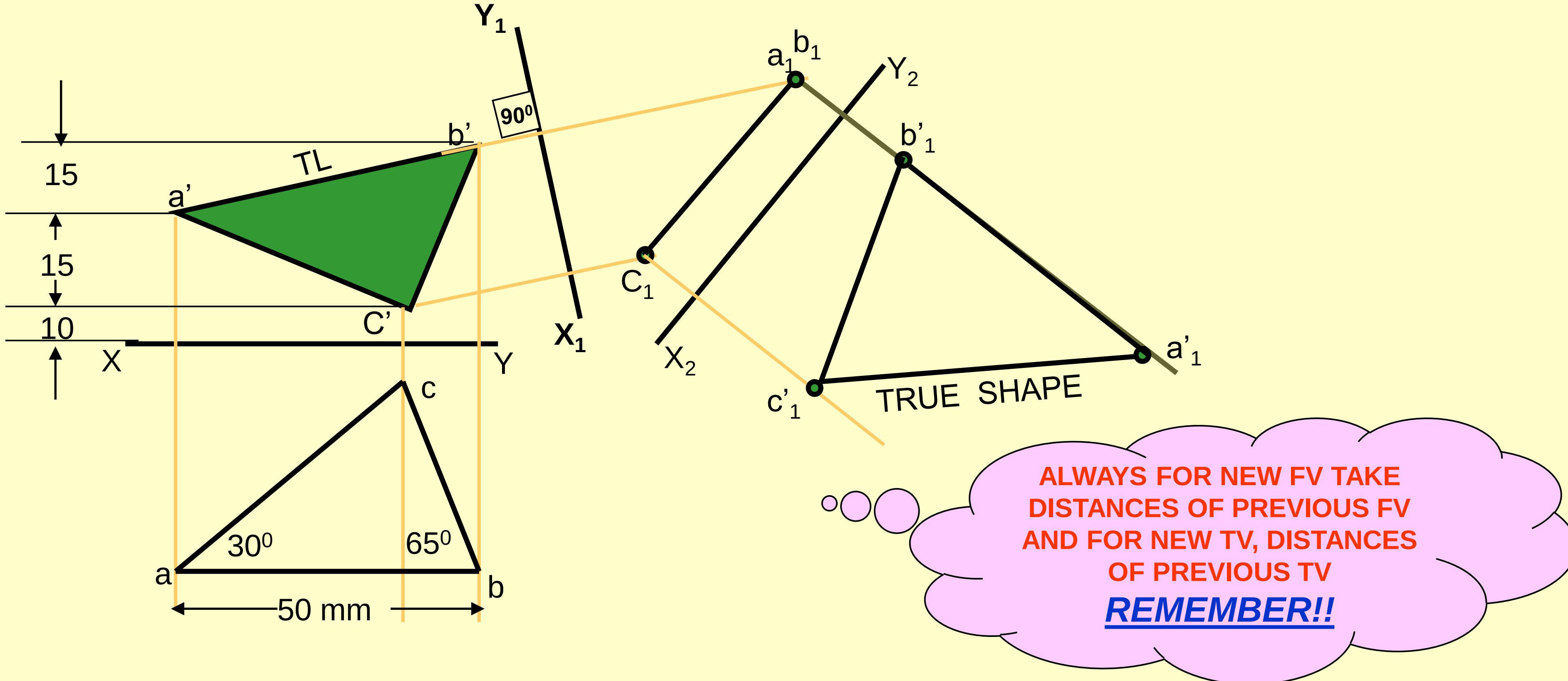
NOW FINAL VIEWS ARE ALWAYS SOME SHAPE, NOT LINE VIEWS:
SO APPLYING ABOVE METHOD:
WE FIRST CONVERT ONE VIEW IN INCLINED LINE VIEW .(By using x1y1 aux.plane)
THEN BY MAKING IT // TO X2-Y2 WE GET TRUE SHAPE.

Study Next Four Cases

Problem 14 **Tv is a triangle abc. Ab is 50 mm long, angle cab is 300 and angle cba is 650. a'b'c' is a Fv. a' is 25 mm, b' is 40 mm and c' is 10 mm above Hp respectively. Draw projections of that figure and find it's true shape.**

As per the procedure-

1.First draw Fv & Tv as per the data.
2.In Tv line ab is // to xy hence it's other view a'b' is TL. So draw x_1y_1 perpendicular to it.
3.Project view on x1y1.
a) First draw projectors from a'b' & c' on x_1y_1.
b) from xy take distances of a,b & c(Tv) mark on these projectors from x_1y_1. Name points a1b1 & c1.
c) This line view is an Aux.Tv. Draw x_2y_2 // to this line view and project Aux. Fv on it.
for that from x_1y_1 take distances of a'b' & c' and mark from x_2y= on new projectors.
4.Name points a'_1 b'_1 & c'_1 and join them. This will be the required true shape.



Problem 15: Fv & Tv of a triangular plate are shown. Determine it's true shape.

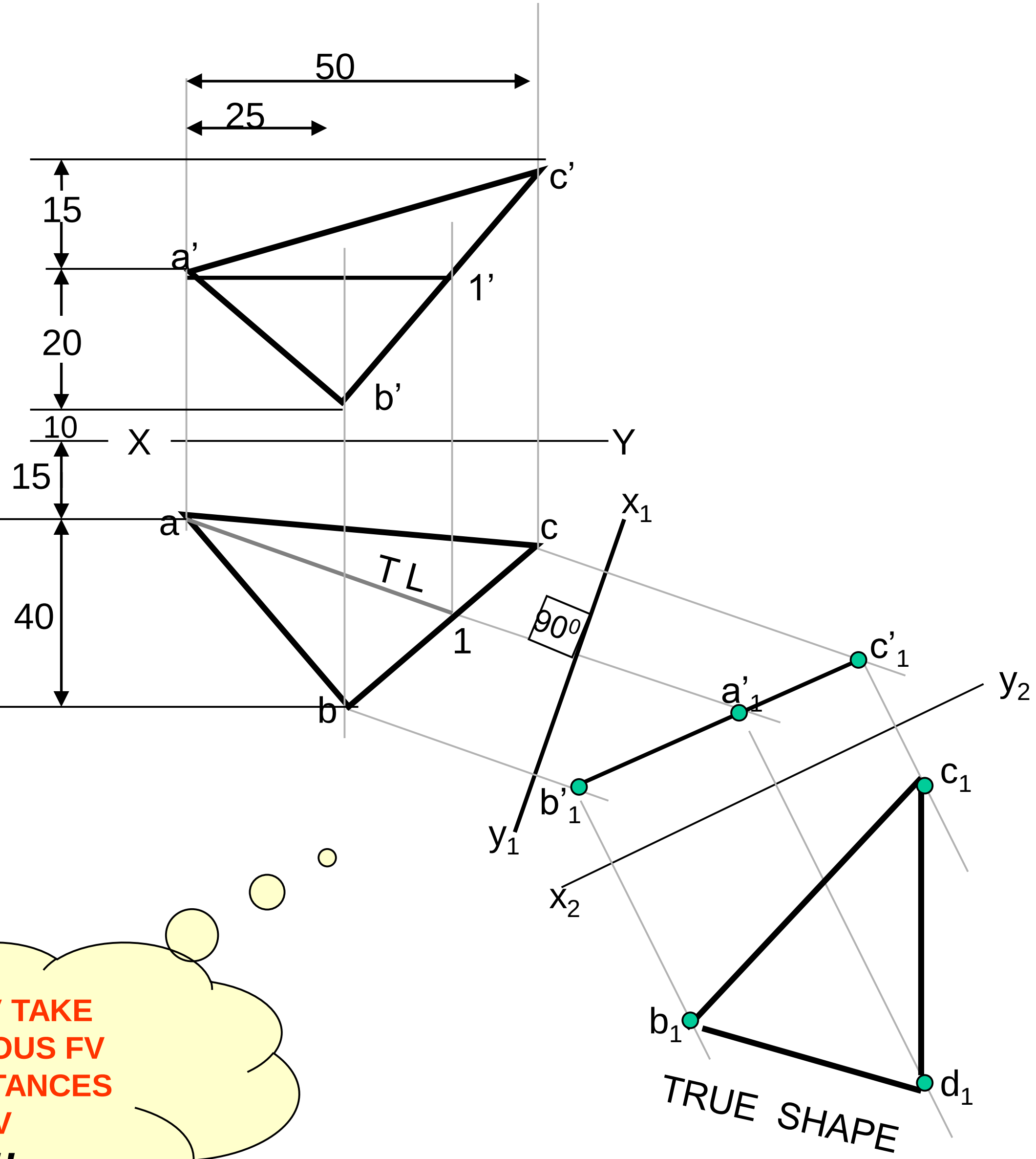
USE SAME PROCEDURE STEPS OF PREVIOUS PROBLEM:
BUT THERE IS ONE DIFFICULTY:

NO LINE IS // TO XY IN ANY VIEW.
MEANS NO TL IS AVAILABLE.

IN SUCH CASES DRAW ONE LINE // TO XY IN ANY VIEW & IT'S OTHER VIEW CAN BE CONSIDERED AS TL FOR THE PURPOSE.

HERE a' 1' line in Fv is drawn // to xy.
HENCE it's Tv a-1 becomes TL.

THEN FOLLOW SAME STEPS AND DETERMINE TRUE SHAPE.
(STUDY THE ILLUSTRATION)



ALWAYS FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

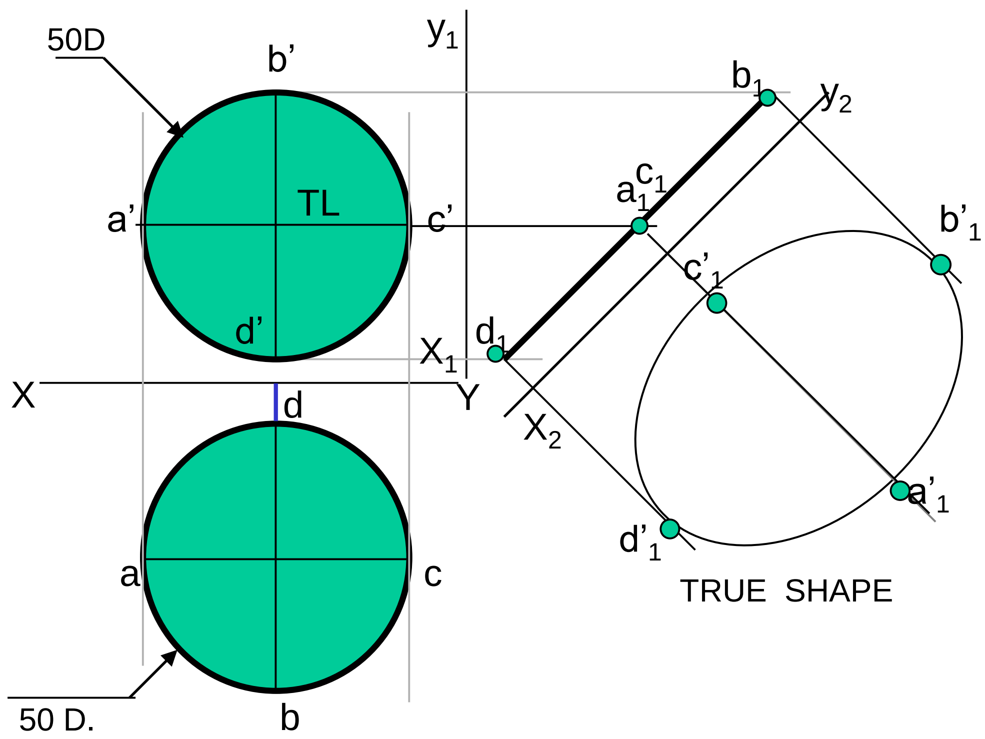
REMEMBER!!

PROBLEM 16: **Fv & Tv both are circles of 50 mm diameter. Determine true shape of an elliptical plate.**

ADOPT SAME PROCEDURE.
a c is considered as line // to xy.
Then a'c' becomes TL for the purpose.
Using steps properly true shape can be
Easily determined.

Study the illustration.

ALWAYS, FOR NEW FV
TAKE DISTANCES OF
PREVIOUS FV AND
FOR NEW TV, DISTANCES
OF PREVIOUS TV
REMEMBER!!

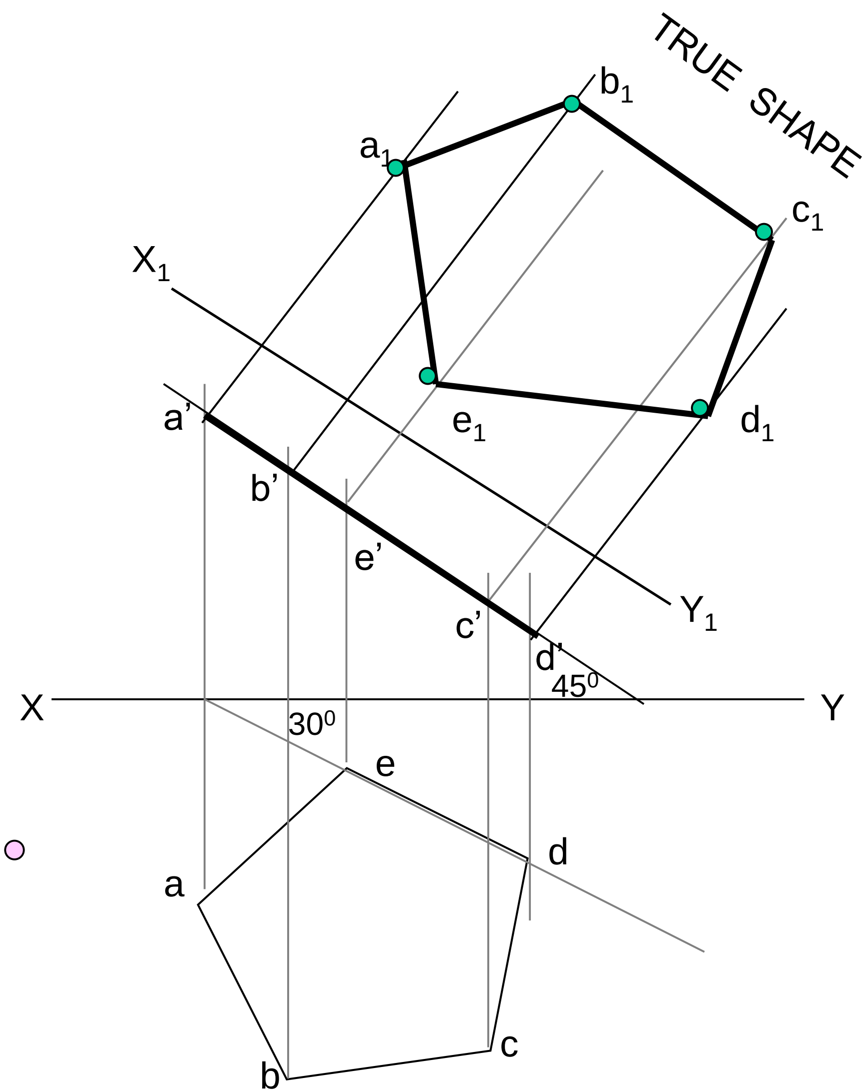


Problem 17 : Draw a regular pentagon of 30 mm sides with one side 30^0 inclined to xy. This figure is Tv of some plane whose Fv is A line 45^0 inclined to xy. Determine it's true shape.

IN THIS CASE ALSO TRUE LENGTH IS NOT AVAILABLE IN ANY VIEW.

BUT ACTUALLY WE DONOT REQUIRE TL TO FIND IT'S TRUE SHAPE, AS ONE VIEW (FV) IS ALREADY A LINE VIEW. SO JUST BY DRAWING X1Y1 // TO THIS VIEW WE CAN PROJECT VIEW ON IT AND GET TRUE SHAPE:

STUDY THE ILLUSTRATION..



ALWAYS FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

REMEMBER!!

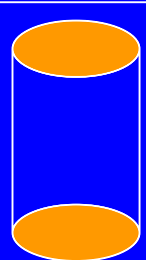
SOLIDS

To understand and remember various solids in this subject properly, those are classified & arranged in to two major groups.

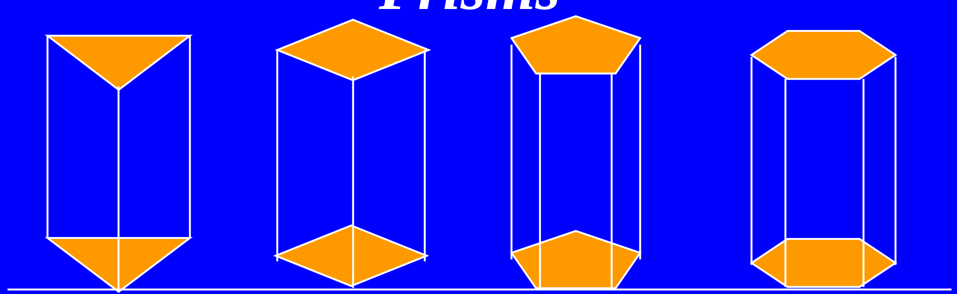
Group A

Solids having top and base of same shape

Cylinder



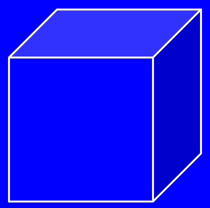
Prisms



Triangular Square Pentagonal Hexagonal

Cube

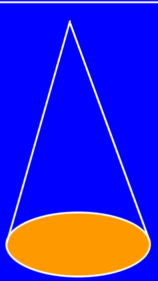
(A solid having six square faces)



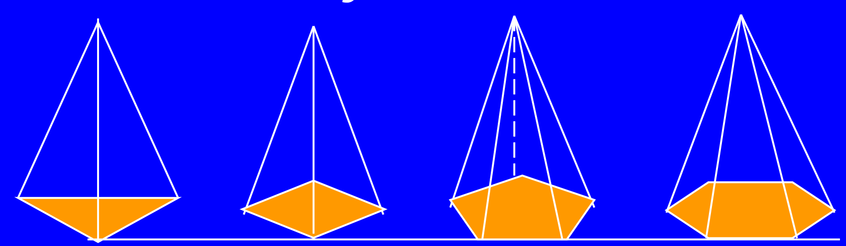
Group B

Solids having base of some shape and just a point as a top, called apex.

Cone



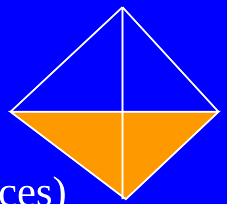
Pyramids



Triangular Square Pentagonal Hexagonal

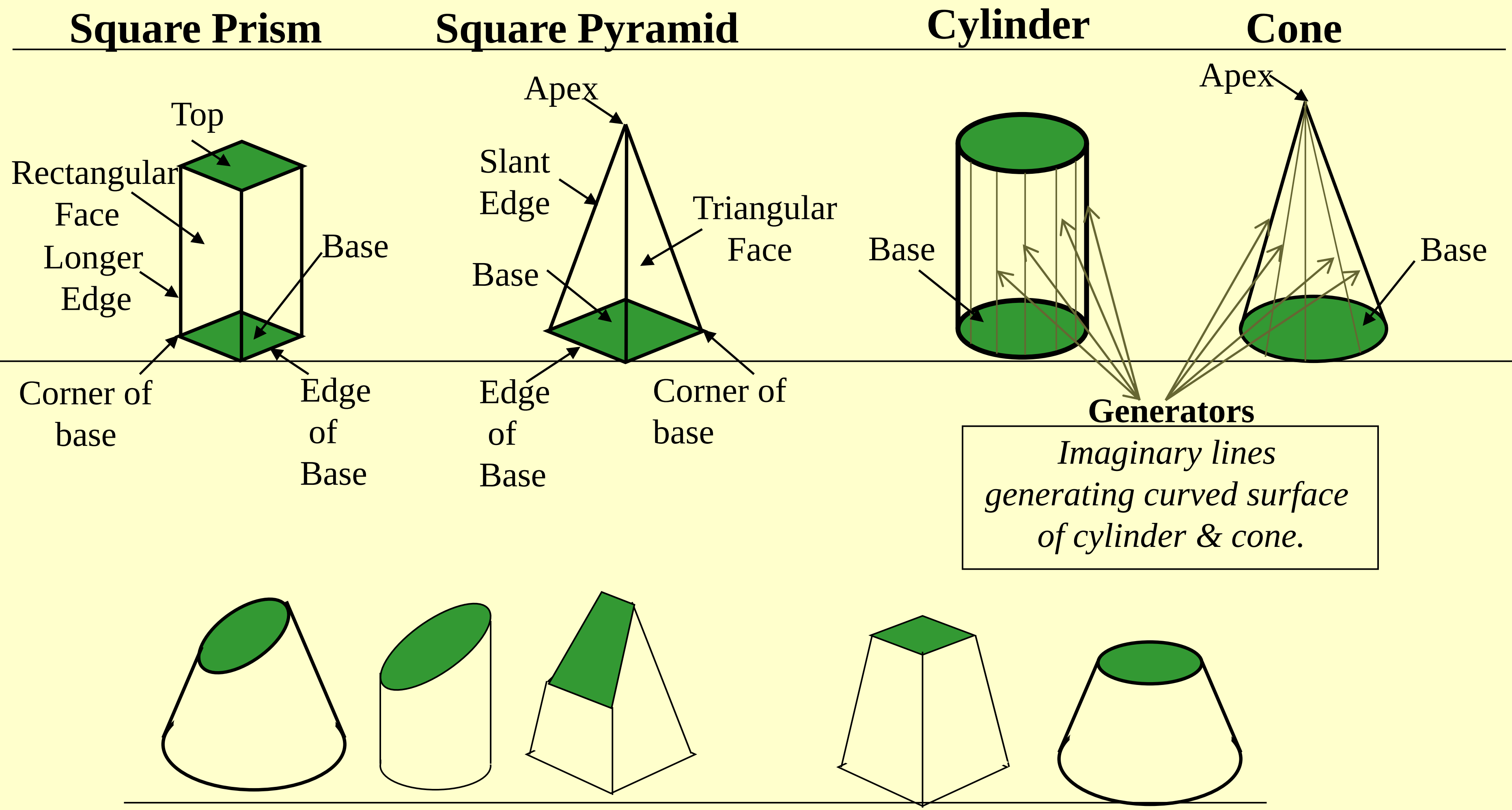
Tetrahedron

(A solid having Four triangular faces)



SOLIDS

Dimensional parameters of different solids.



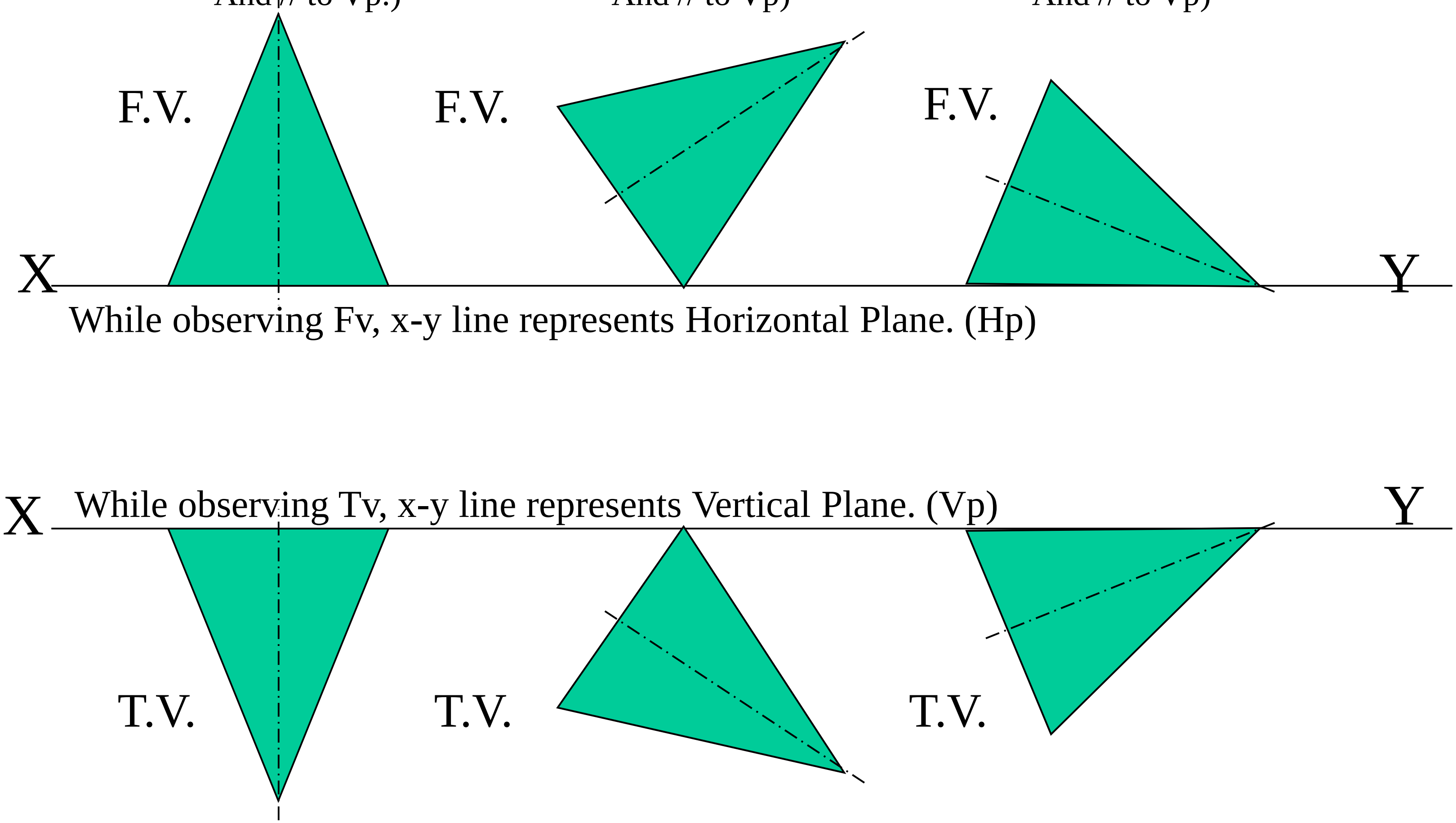
Sections of solids(top & base not parallel)

Frustum of cone & pyramids.
(top & base parallel to each other)

STANDING ON H.P
On it's base.
(Axis perpendicular to Hp
And // to Vp.)

RESTING ON H.P
On one point of base circle.
(Axis inclined to Hp
And // to Vp)

LYING ON H.P
On one generator.
(Axis inclined to Hp
And // to Vp)



STANDING ON V.P
On it's base.
Axis perpendicular to Vp
And // to Hp

RESTING ON V.P
On one point of base circle.
Axis inclined to Vp
And // to Hp

LYING ON V.P
On one generator.
Axis inclined to Vp
And // to Hp

STEPS TO SOLVE PROBLEMS IN SOLIDS

Problem is solved in three steps:

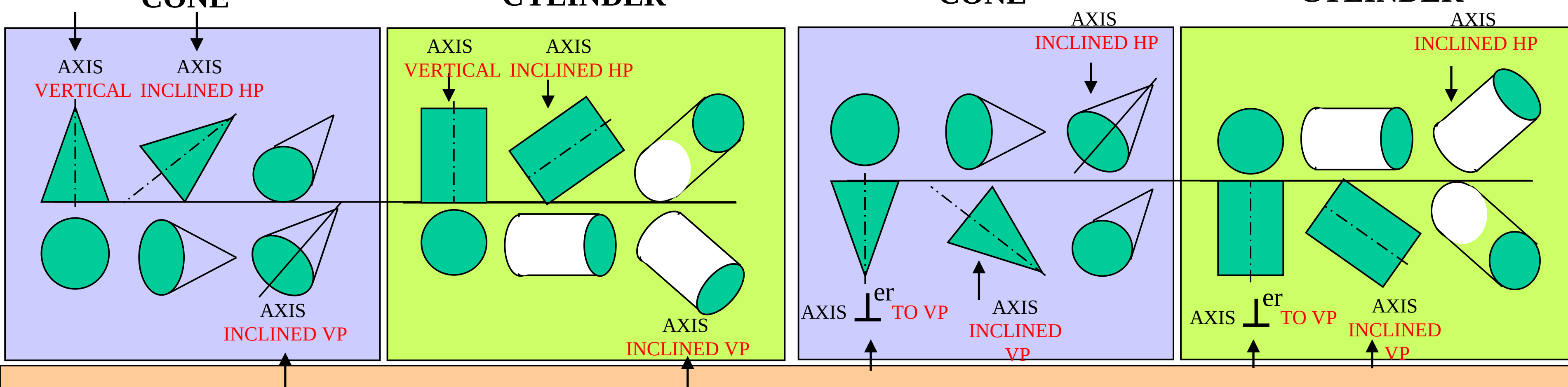
STEP 1: ASSUME SOLID STANDING ON THE PLANE WITH WHICH IT IS MAKING INCLINATION.
(IF IT IS INCLINED TO HP, ASSUME IT STANDING ON HP)
(IF IT IS INCLINED TO VP, ASSUME IT STANDING ON VP)
IF STANDING ON HP - IT'S TV WILL BE TRUE SHAPE OF IT'S BASE OR TOP:
IF STANDING ON VP - IT'S FV WILL BE TRUE SHAPE OF IT'S BASE OR TOP.
BEGIN WITH THIS VIEW:
IT'S OTHER VIEW WILL BE A RECTANGLE (IF SOLID IS ***CYLINDER OR ONE OF THE PRISMS)***:
IT'S OTHER VIEW WILL BE A TRIANGLE (IF SOLID IS ***CONE OR ONE OF THE PYRAMIDS):***
DRAW FV & TV OF THAT SOLID IN STANDING POSITION:

STEP 2: CONSIDERING SOLID'S INCLINATION (AXIS POSITION) DRAW IT'S FV & TV.

STEP 3: IN LAST STEP, CONSIDERING REMAINING INCLINATION, DRAW IT'S FINAL FV & TV.

GENERAL PATTERN (THREE STEPS) OF SOLUTION:

GROUP B SOLID. CONE	GROUP A SOLID. CYLINDER	GROUP B SOLID. CONE	GROUP A SOLID. CYLINDER



Three steps If solid is inclined to Hp	Three steps If solid is inclined to Hp	Three steps If solid is inclined to Vp	Three steps If solid is inclined to Vp

Study Next *Twelve* Problems and Practice them separately !!

CATEGORIES OF ILLUSTRATED PROBLEMS!

PROBLEM NO.1, 2, 3, 4	GENERAL CASES OF SOLIDS INCLINED TO HP & VP
PROBLEM NO. 5 & 6	CASES OF CUBE & TETRAHEDRON
PROBLEM NO. 7	CASE OF FREELY SUSPENDED SOLID WITH SIDE VIEW.
PROBLEM NO. 8	CASE OF CUBE (WITH SIDE VIEW)
PROBLEM NO. 9	CASE OF TRUE LENGTH INCLINATION WITH HP & VP.
PROBLEM NO. 10 & 11	CASES OF COMPOSITE SOLIDS. (AUXILIARY PLANE)
PROBLEM NO. 12	CASE OF A FRUSTUM (AUXILIARY PLANE)

Problem 1. A square pyramid, 40 mm base sides and axis 60 mm long, has a triangular face on the ground and the vertical plane containing the axis makes an angle of 45^0 with the VP. Draw its projections. Take apex nearer to VP

Solution Steps :

Triangular face on Hp , means it is lying on Hp:

1.Assume it standing on Hp.

2.It's Tv will show True Shape of base(square)

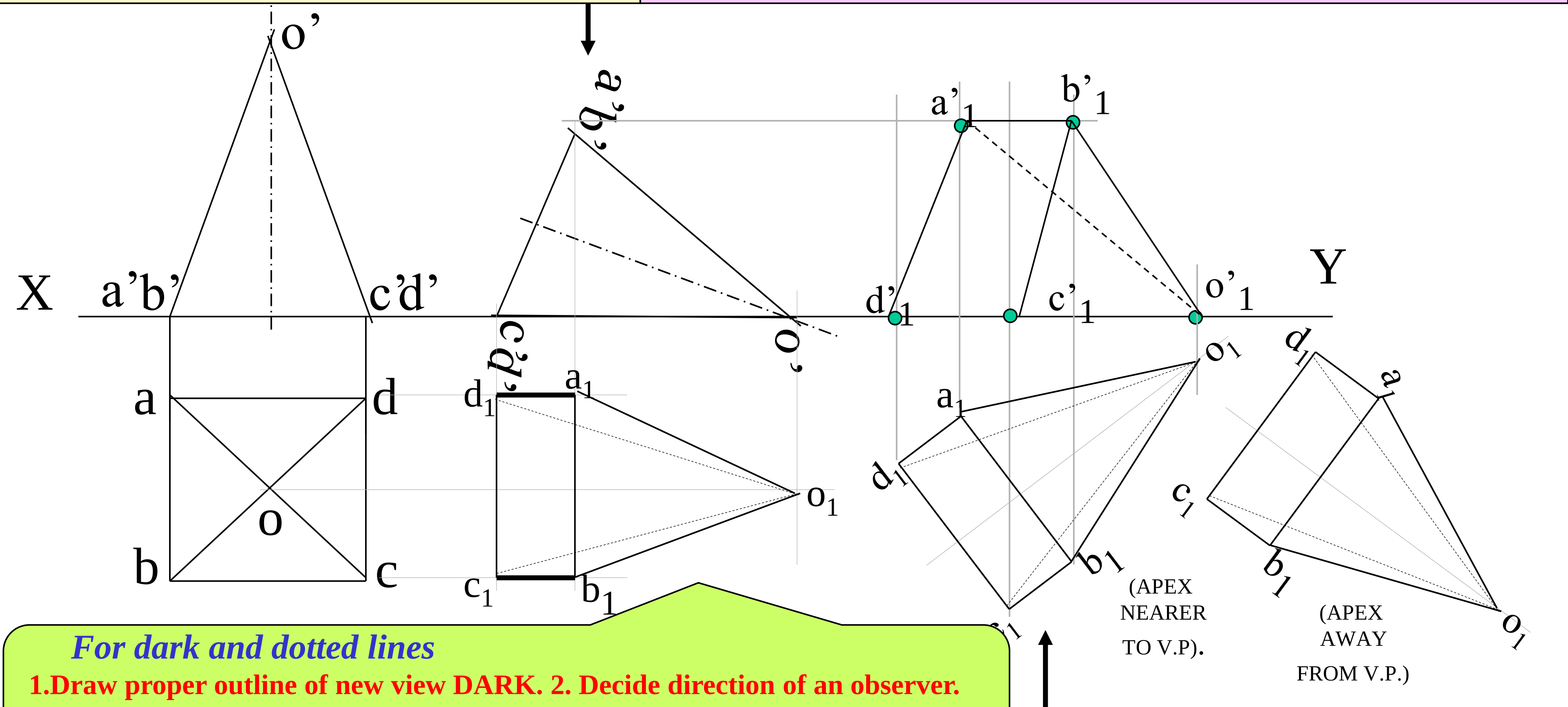
3.Draw square of 40mm sides with one side vertical Tv & taking 50 mm axis project Fv. (a triangle)

4.Name all points as shown in illustration.

5.Draw 2nd Fv in lying position I.e.o'c'd' face on xy. And project it's Tv.

6.Make visible lines dark and hidden dotted, as per the procedure.

7.Then construct remaining inclination with Vp (Vp containing axis ic the center line of 2nd Tv.Make it 45^0 to xy as shown take apex near to xy, as it is nearer to Vp) & project final Fv.



For dark and dotted lines

1.Draw proper outline of new view DARK. 2. Decide direction of an observer.

3. Select nearest point to observer and draw all lines starting from it-dark.

4. Select farthest point to observer and draw all lines (remaining)from it- dotted.

Problem 2:

A cone 40 mm diameter and 50 mm axis is resting on one generator on Hp which makes 30^0 inclination with Vp Draw it's projections.

For dark and dotted lines

1.Draw proper outline of new vie DARK.

2. Decide direction of an observer.

3. Select nearest point to observer and draw all lines starting from it-dark.

4. Select farthest point to observer and draw all lines (remaining) from it- dotted.

Solution Steps:

Resting on Hp on one generator, means lying on Hp:

1.Assume it standing on Hp.

2.It's Tv will show True Shape of base(circle)

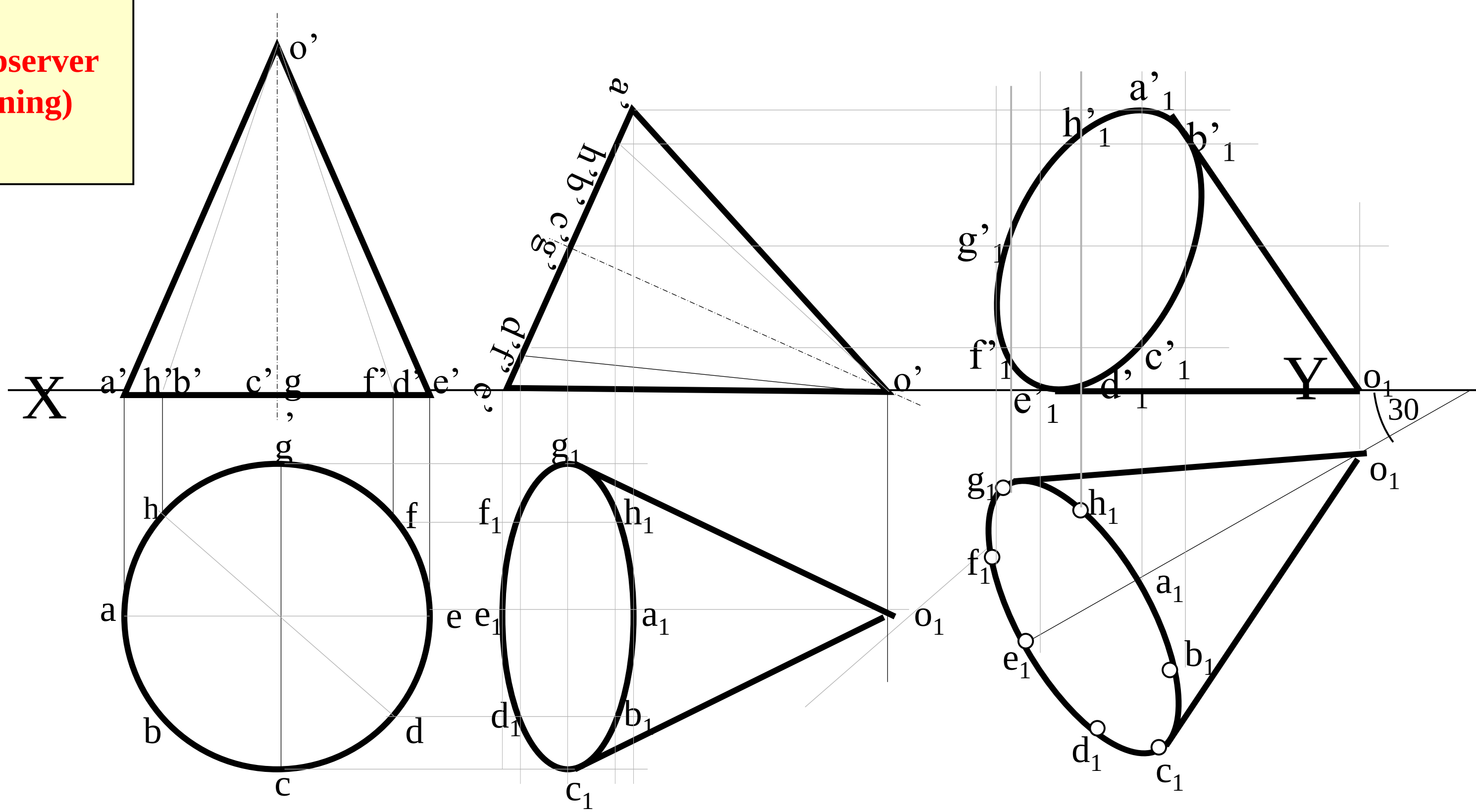
3.Draw 40mm dia. Circle as Tv & taking 50 mm axis project Fv. (a triangle)

4.Name all points as shown in illustration.

5.Draw 2nd Fv in lying position I.e.o'e' on xy. And project it's Tv below xy.

6.Make visible lines dark and hidden dotted, as per the procedure.

7.Then construct remaining inclination with Vp (generator o_1e_1 30^0 to xy as shown) & project final Fv.



Problem 3:

A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on Vp while it's axis makes 45^0 with Vp and Fv of the axis 35^0 with Hp. Draw projections..

Solution Steps:

Resting on Vp on one point of base, means inclined to Vp:

1.Assume it standing on Vp

2.It's Fv will show True Shape of base & top(circle)

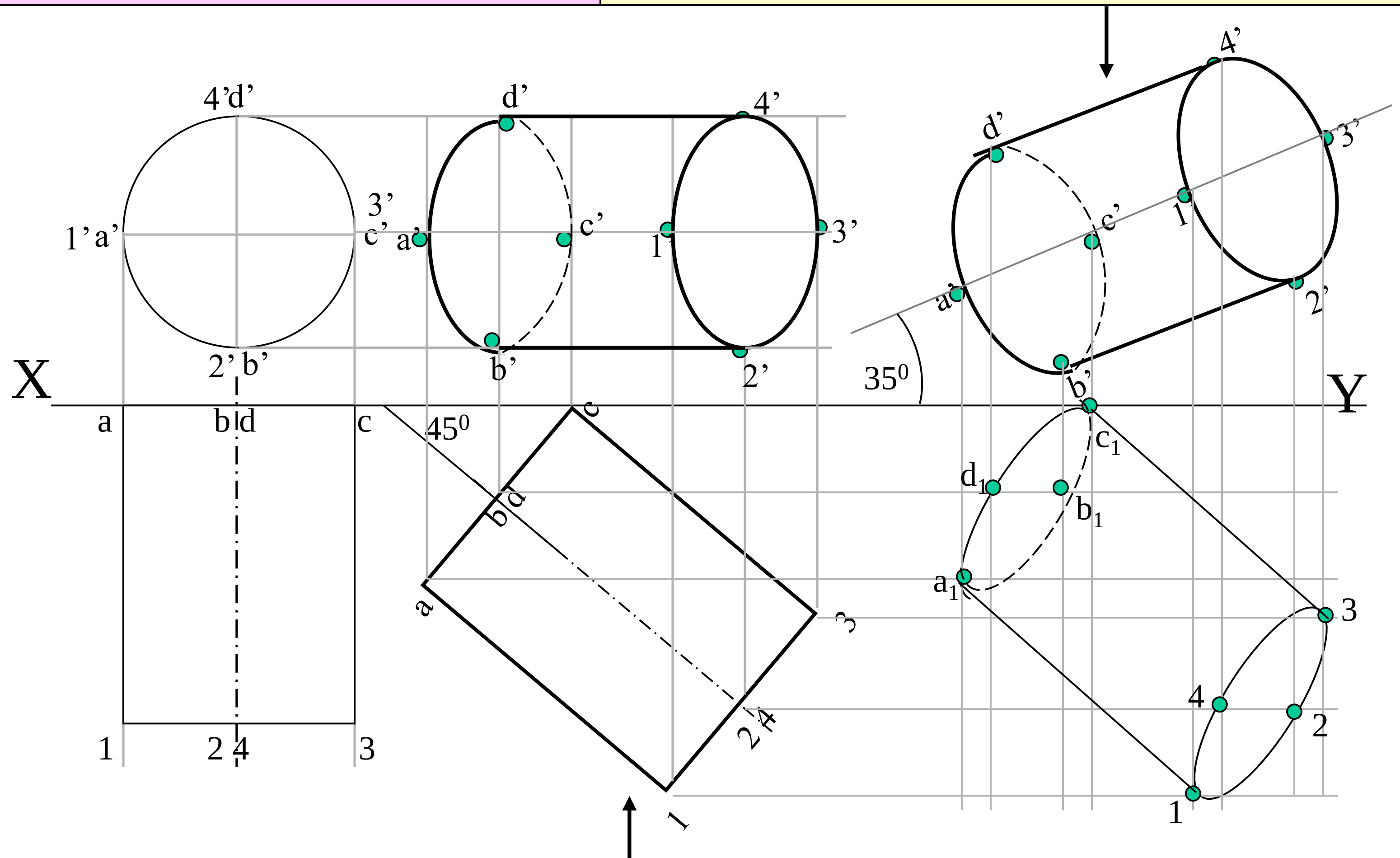
3.Draw 40mm dia. Circle as Fv & taking 50 mm axis project Tv. (a Rectangle)

4.Name all points as shown in illustration.

5.Draw 2^{nd} Tv making axis 45^0 to xy And project it's Fv above xy.

6.Make visible lines dark and hidden dotted, as per the procedure.

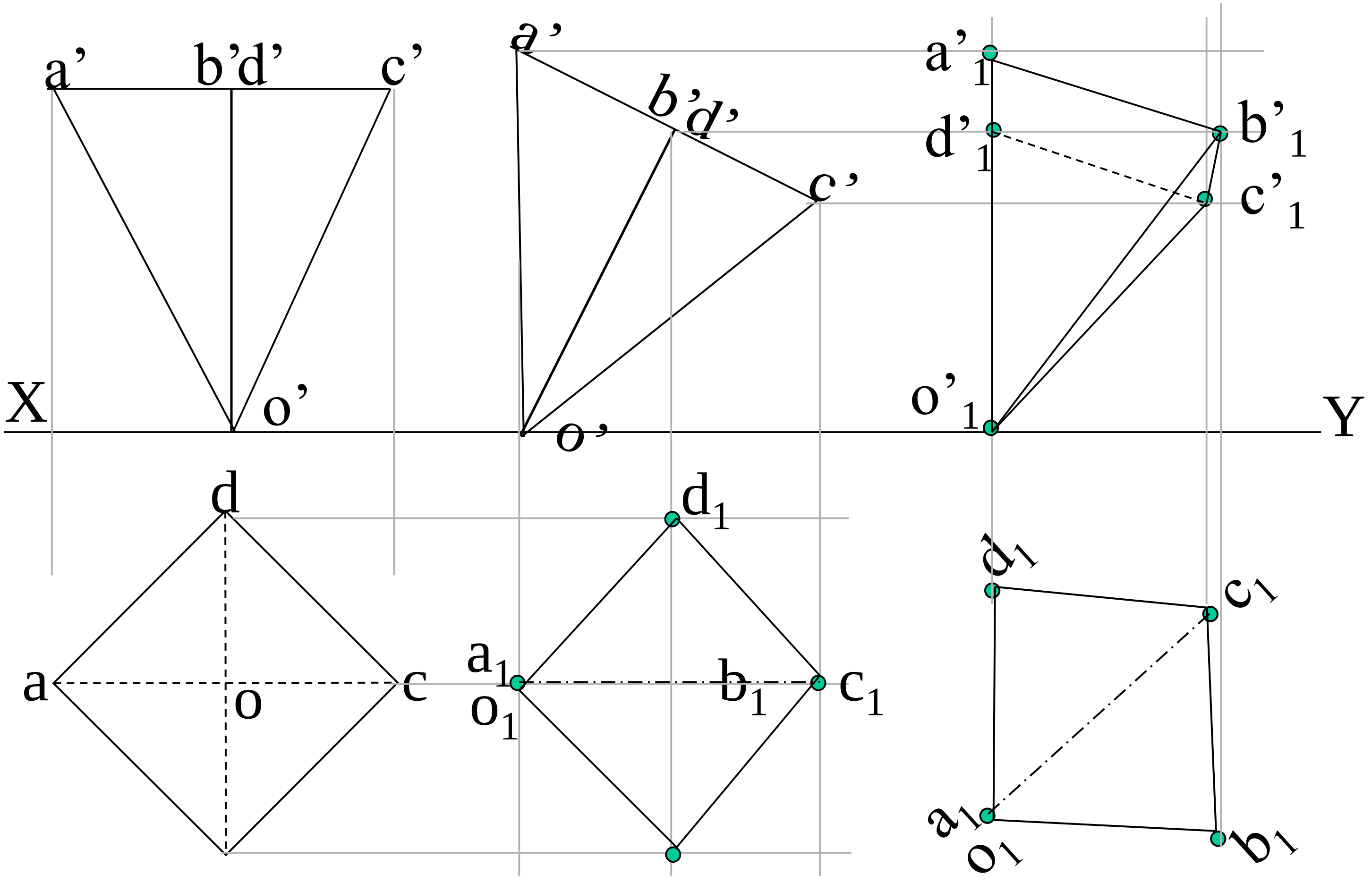
7.Then construct remaining inclination with Hp (Fv of axis I.e. center line of view to xy as shown) & project final Tv.



Problem 4: A square pyramid 30 mm base side and 50 mm long axis is resting on it's apex on Hp, such that it's one slant edge is vertical and a triangular face through it is perpendicular to Vp. Draw it's projections.

Solution Steps :

1. Assume it standing on Hp but as said on apex.(inverted).
2. It's Tv will show True Shape of base(square)
3. Draw a corner case square of 30 mm sides as Tv(as shown) Showing all slant edges dotted, as those will not be visible from top.
4. taking 50 mm axis project Fv. (a triangle)
5. Name all points as shown in illustration.
6. Draw 2nd Fv keeping o'a' slant edge vertical & project it's Tv
7. Make visible lines dark and hidden dotted, as per the procedure.
8. Then redrew 2nd Tv as final Tv keeping $a_1o_1d_1$ triangular face perpendicular to Vp I.e.xy. Then as usual project final Fv.



Problem 5: A cube of 50 mm long edges is so placed on Hp on one corner that a body diagonal is parallel to Hp and perpendicular to Vp Draw it's projections.

Solution Steps:

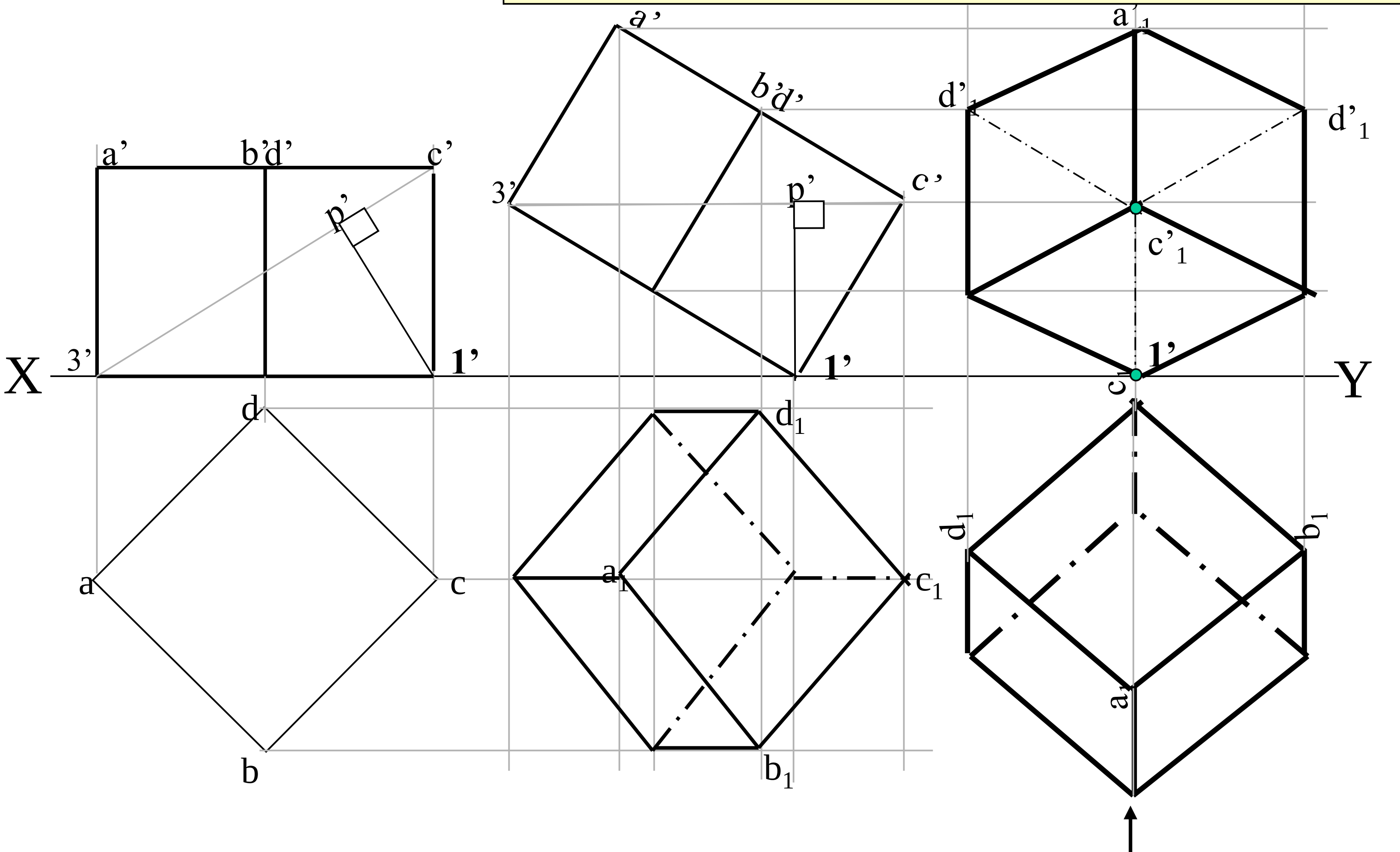
1.Assuming standing on Hp, begin with Tv,a square with all sides equally inclined to xy.Project Fv and name all points of FV & TV.

2.Draw a body-diagonal joining c' with 3'(This can become // to xy)

3.From 1' drop a perpendicular on this and name it p'

4.Draw 2nd Fv in which 1'-p' line is vertical ***means*** c'-3' diagonal must be horizontal. .Now as usual project Tv..

6.In final Tv draw same diagonal is perpendicular to Vp as said in problem. Then as usual project final FV.

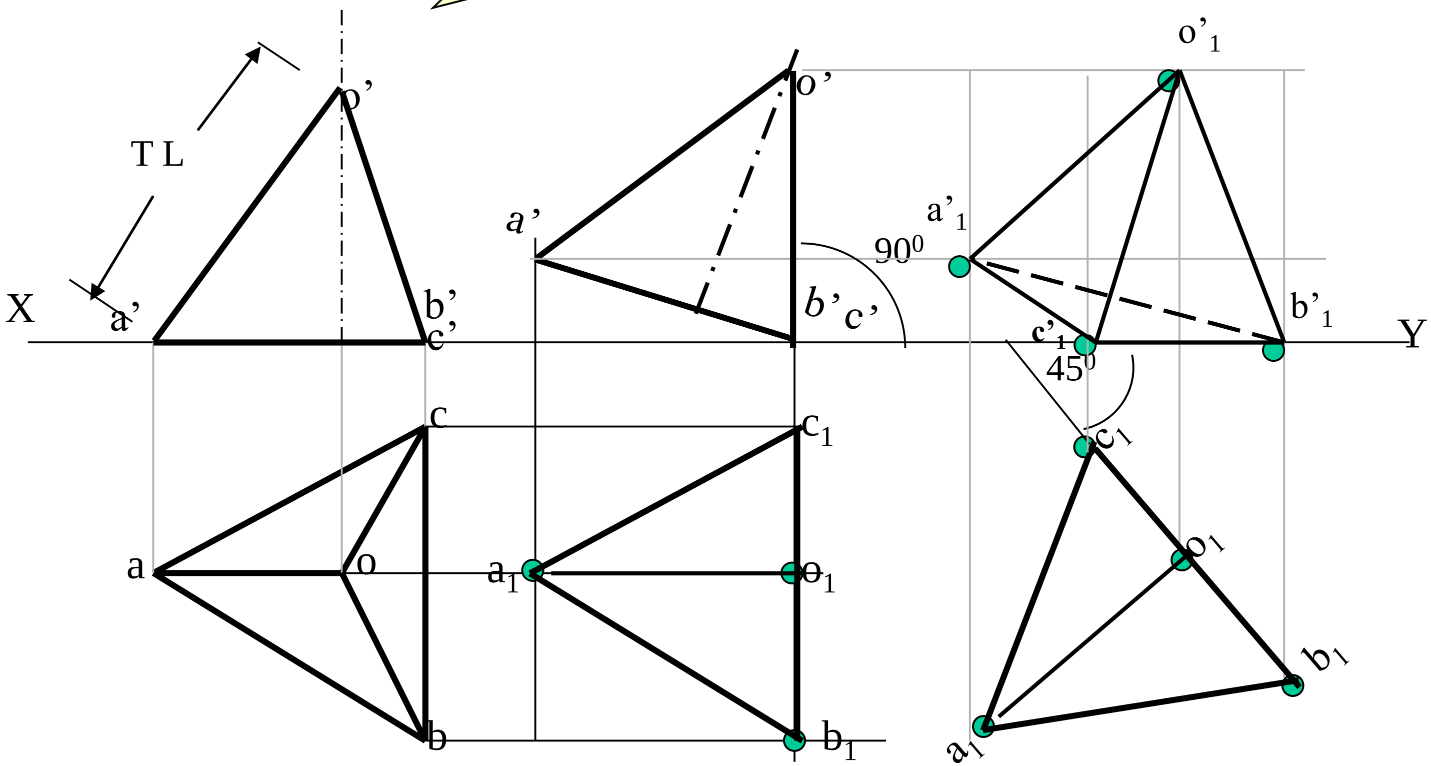


Problem 6: A tetrahedron of 50 mm long edges is resting on one edge on Hp while one triangular face containing this edge is vertical and 45^0 inclined to Vp. Draw projections.

IMPORTANT:
Tetrahedron is a special type of triangular pyramid in which base sides & slant edges are equal in length.
Solid of four faces.
Like cube it is also described by One dimension only..
Axis length generally not given.

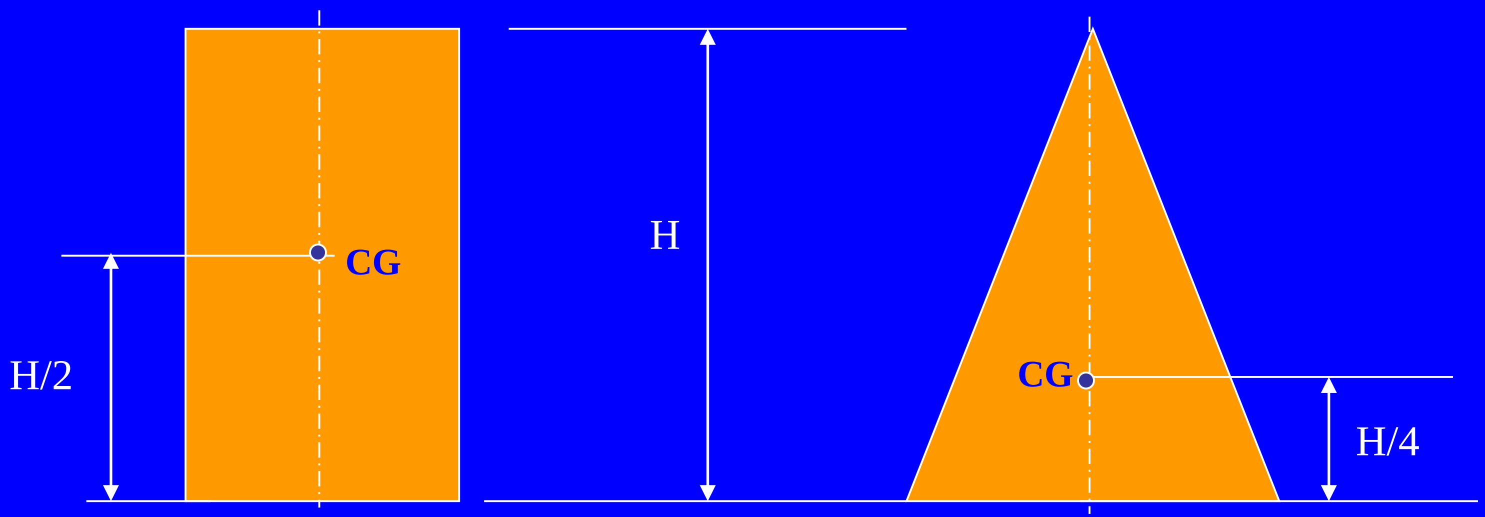
Solution Steps

As it is resting assume it standing on Hp.
Begin with Tv , an equilateral triangle as side case as shown:
First project base points of Fv on xy, name those & axis line.
From a' with TL of edge, 50 mm, cut on axis line & mark o'
(as axis is not known, o' is finalized by slant edge length)
Then complete Fv.
In 2^{nd} Fv make face o'b'c' vertical as said in problem.
And like all previous problems solve completely.



FREELY SUSPENDED SOLIDS:

Positions of CG, on axis, from base, for different solids are shown below.



GROUP A SOLIDS
(Cylinder & Prisms)

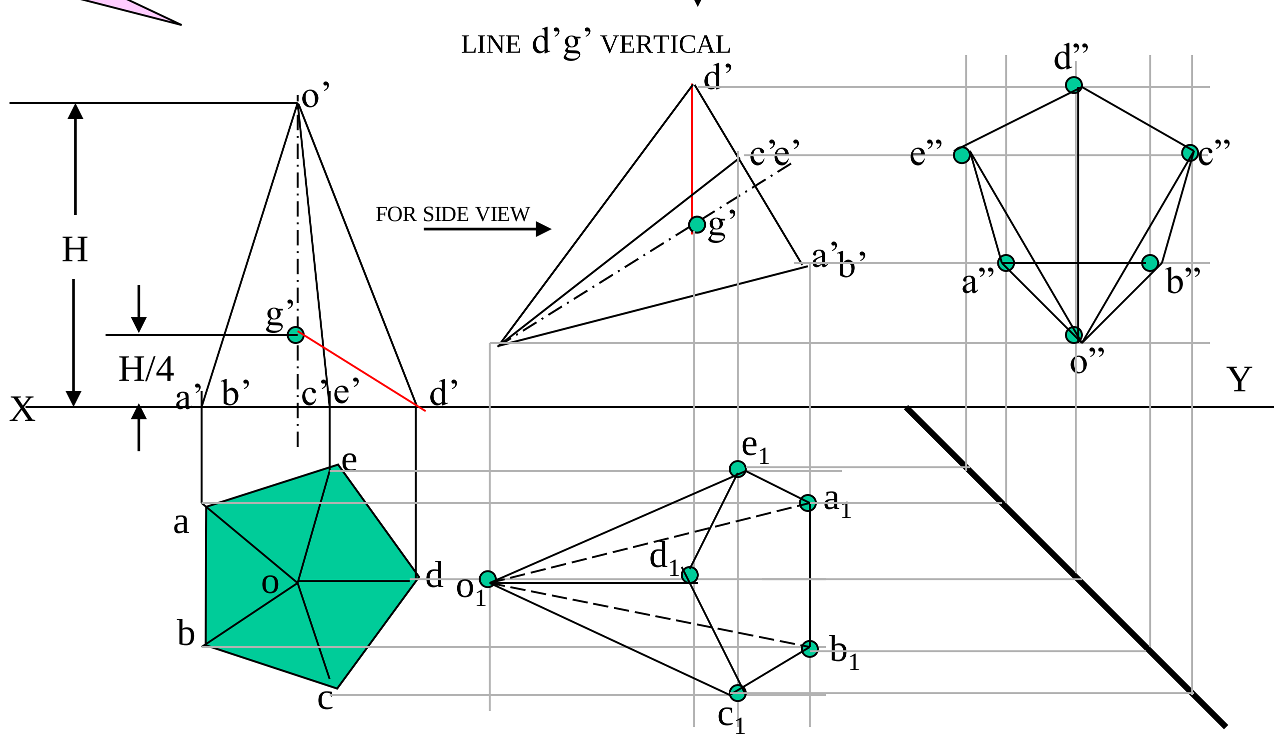
GROUP B SOLIDS
(Cone & Pyramids)

Problem 7: A pentagonal pyramid 30 mm base sides & 60 mm long axis, is freely suspended from one corner of base so that a plane containing it's axis remains parallel to Vp.
Draw it's three views.

Solution Steps:

In all suspended cases axis shows inclination with Hp.

1.Hence assuming it standing on Hp, drew Tv - a regular pentagon,corner case.
2.Project Fv & locate CG position on axis – (¼ H from base.) and name g' and Join it with corner d'
3.As 2nd Fv, redraw first keeping line g'd' vertical.
4.As usual project corresponding Tv and then Side View looking from.



IMPORTANT:
When a solid is freely suspended from a corner, then line joining point of contact & C.G. remains vertical.
(Here axis shows inclination with Hp.)
So in all such cases, assume solid standing on Hp initially.)

Solution Steps:

1.Assuming it standing on Hp begin with Tv, a square of corner case.

2.Project corresponding Fv.& name all points as usual in both views.

3.Join a'1' as body diagonal and draw 2^{nd} Fv making it vertical (I' on xy)

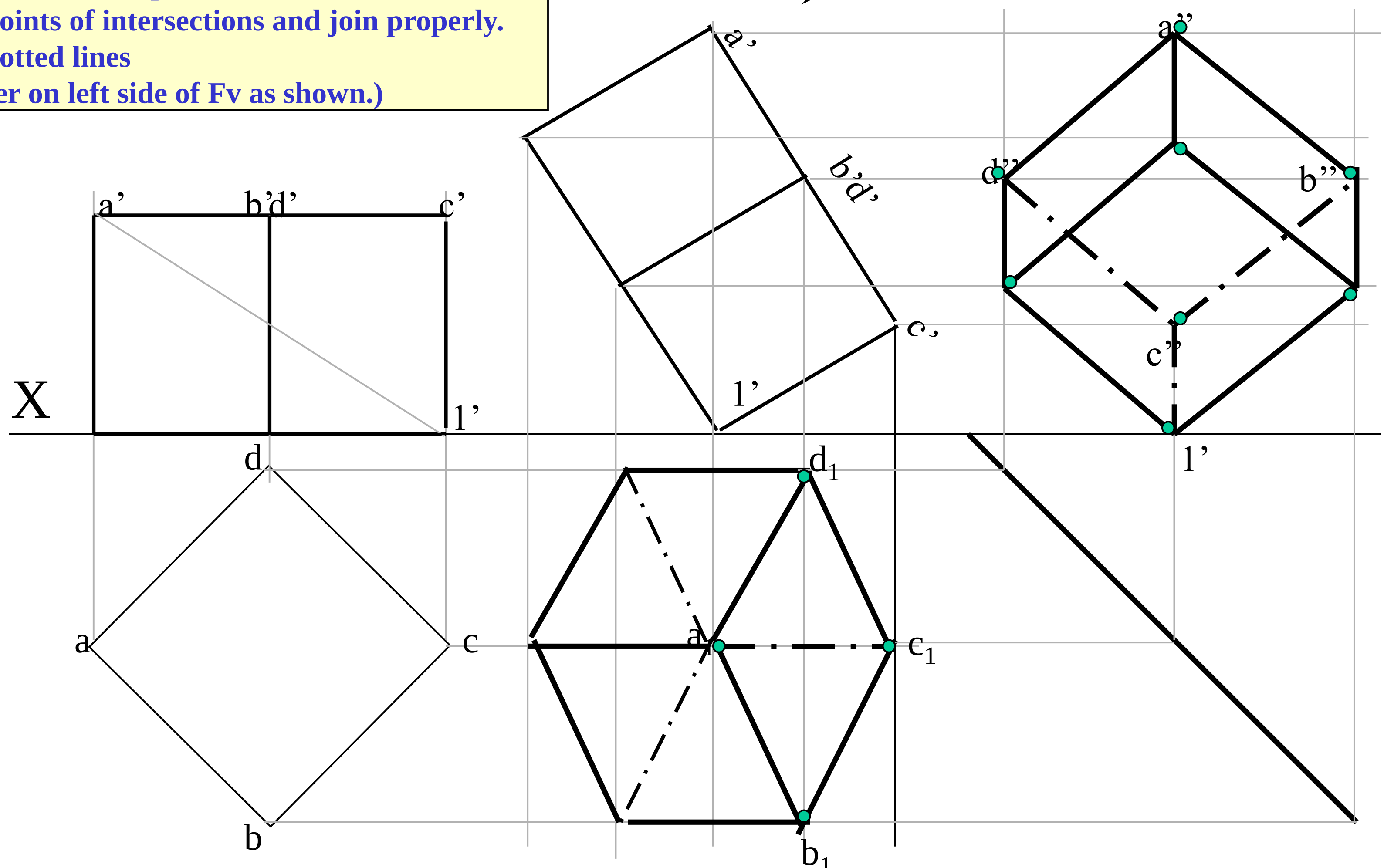
4.Project it's Tv drawing dark and dotted lines as per the procedure.

5.With standard method construct Left-hand side view.

(Draw a 45^0 inclined Line in Tv region (below xy). Project horizontally all points of Tv on this line and reflect vertically upward, above xy.After this, draw horizontal lines, from all points of Fv, to meet these lines. Name points of intersections and join properly. For dark & dotted lines locate observer on left side of Fv as shown.)

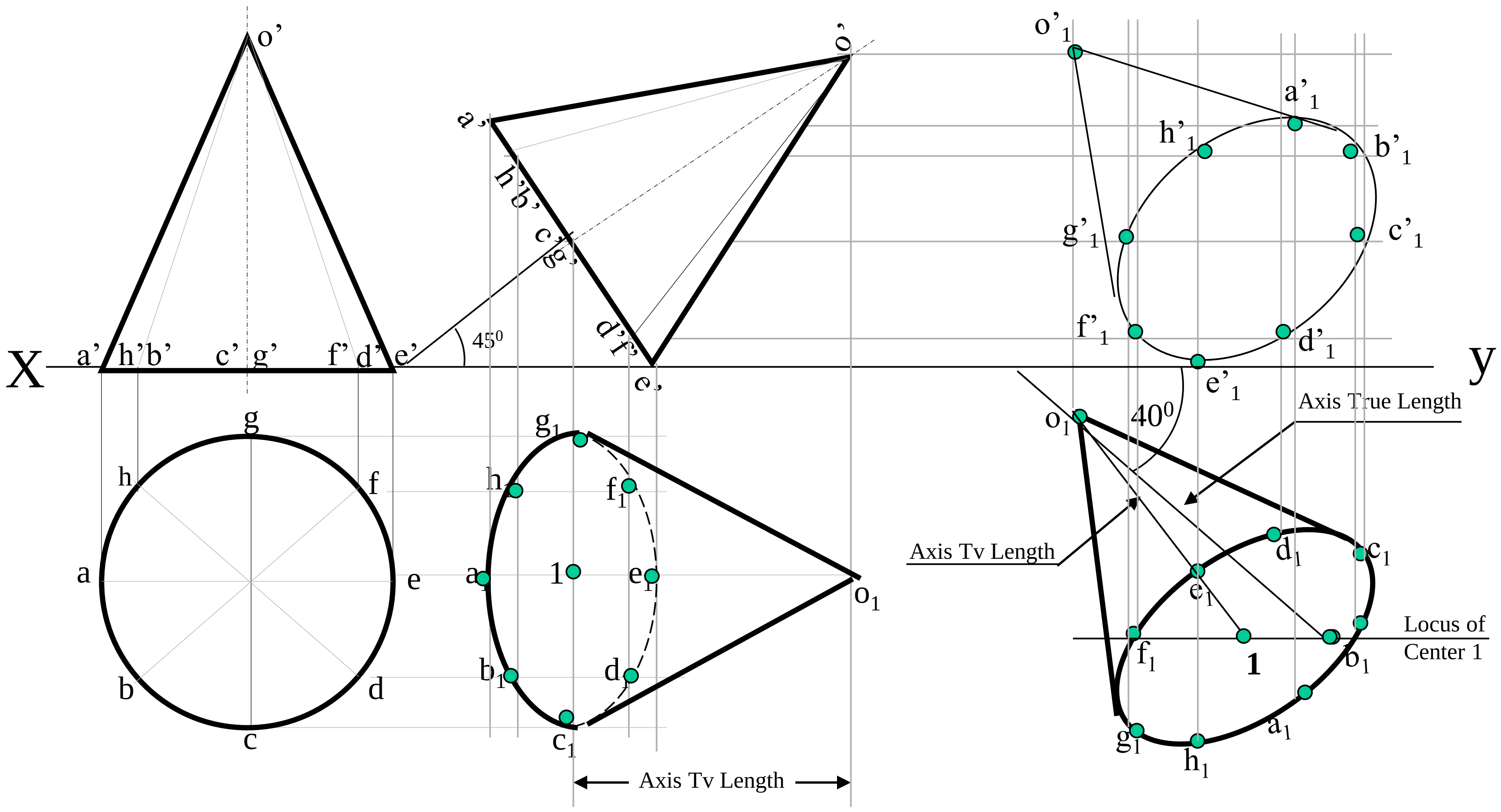
Problem 8:

A cube of 50 mm long edges is so placed on Hp on one corner that a body diagonal through this corner is perpendicular to Hp and parallel to Vp Draw it's three views.



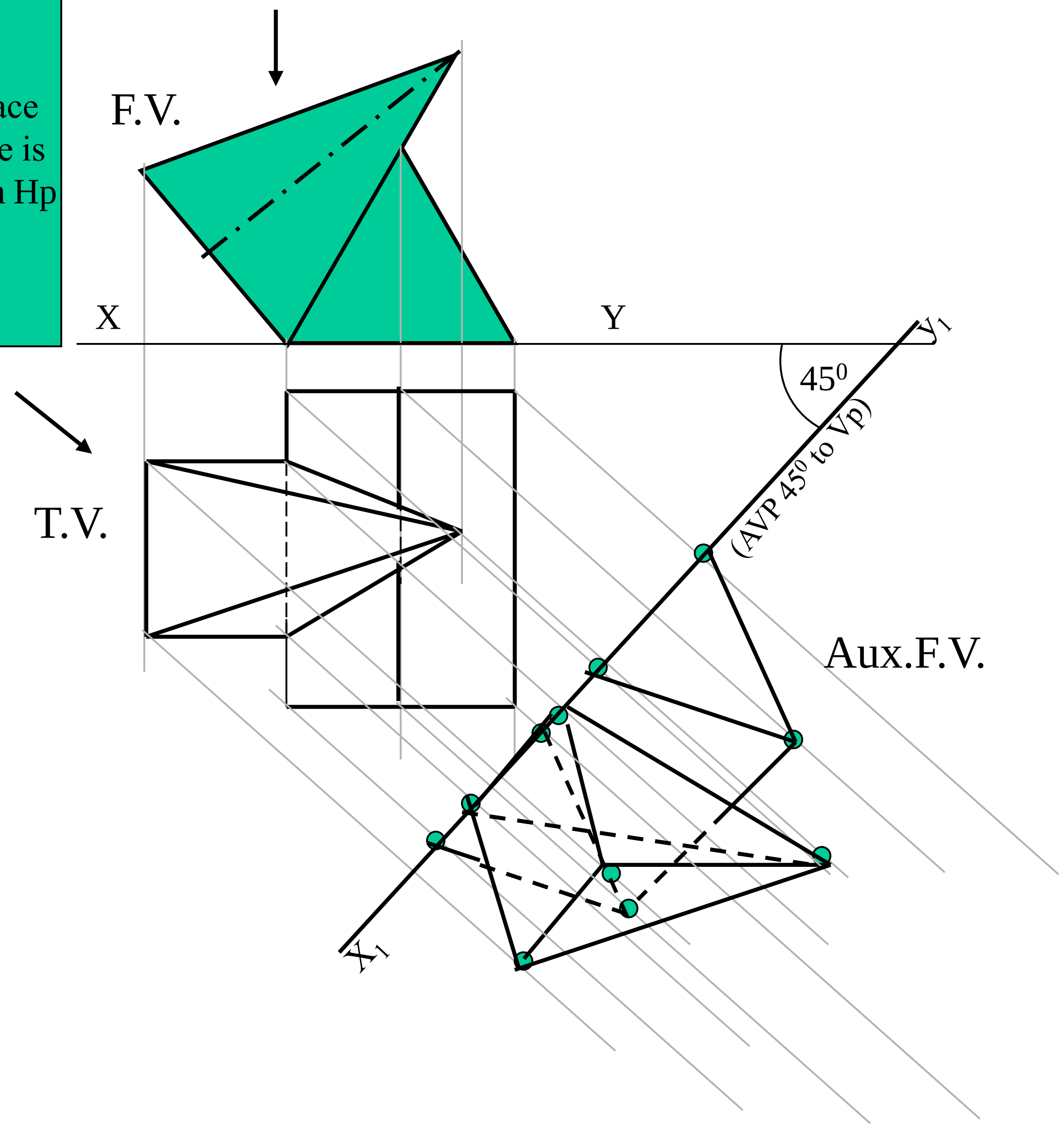
Problem 9: A right circular cone, 40 mm base diameter and 60 mm long axis is resting on Hp on one point of base circle such that it's axis makes 45^0 inclination with Hp and 40^0 inclination with Vp. Draw it's projections.

This case resembles to **problem no.7 & 9 from projections of planes** topic.
In previous all cases 2^{nd} inclination was done by a parameter not showing TL.Like Tv of axis is inclined to Vp etc. But here it is clearly said that the axis is 40^0 inclined to Vp. Means here TL inclination is expected. So the same construction done in those Problems is done here also. See carefully the final Tv and inclination taken there.
So assuming it standing on HP begin as usual.



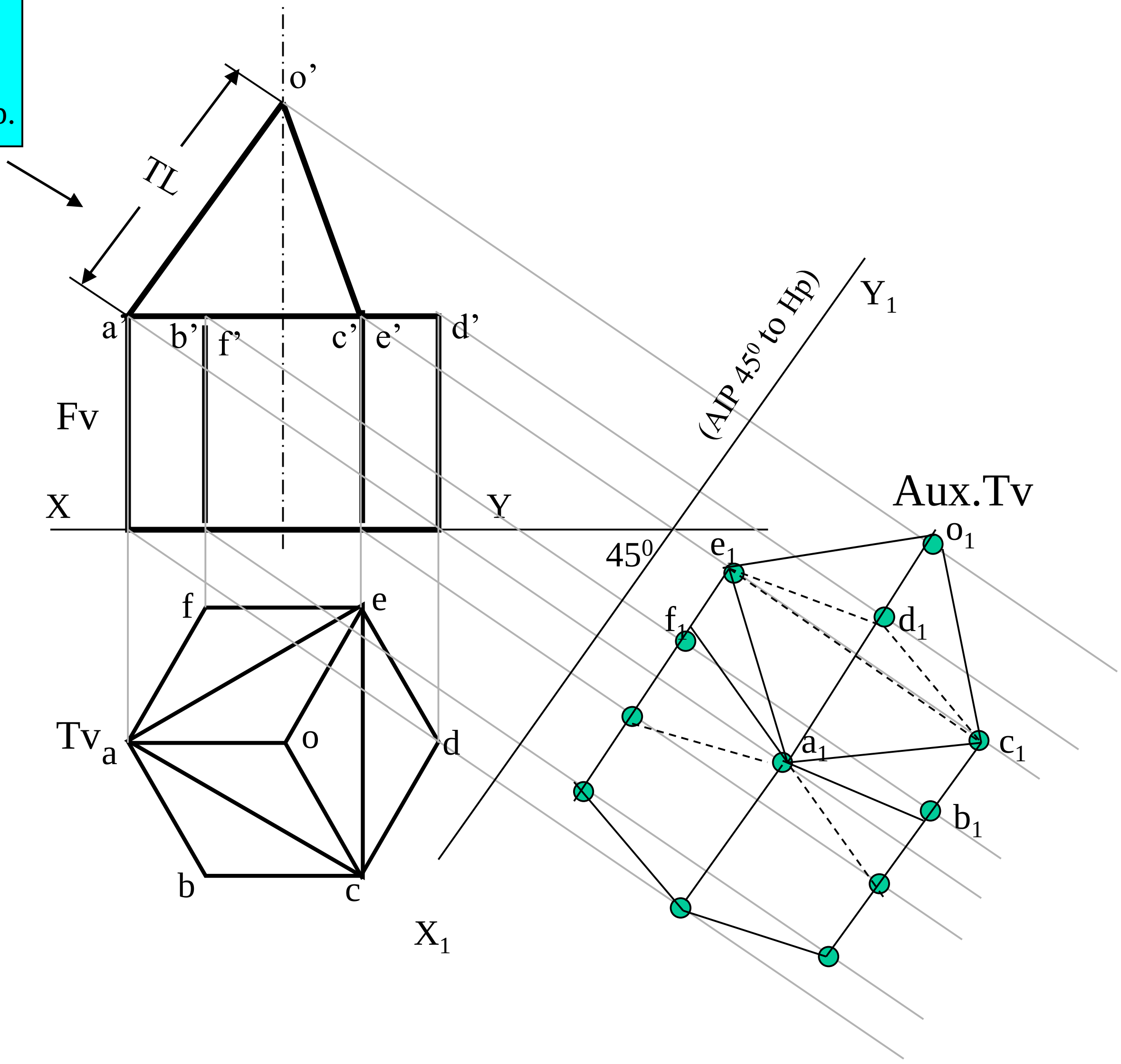
Problem 10: A triangular prism,
40 mm base side 60 mm axis
is lying on Hp on one rectangular face
with axis perpendicular to Vp.
One square pyramid is leaning on it's face
centrally with axis // to vp. It's base side is
30 mm & axis is 60 mm long resting on Hp
on one edge of base.Draw FV & TV of
both solids.Project another FV
on an AVP 45^0 inclined to VP.

Steps :
Draw Fv of lying prism
(an equilateral Triangle)
And Fv of a leaning pyramid.
Project Tv of both solids.
Draw x_1y_1 45^0 inclined to xy
and project aux.Fv on it.
Mark the distances of first FV
from first xy for the distances
of aux. Fv from x_1y_1 line.
Note the observer's directions
Shown by arrows and further
steps carefully.

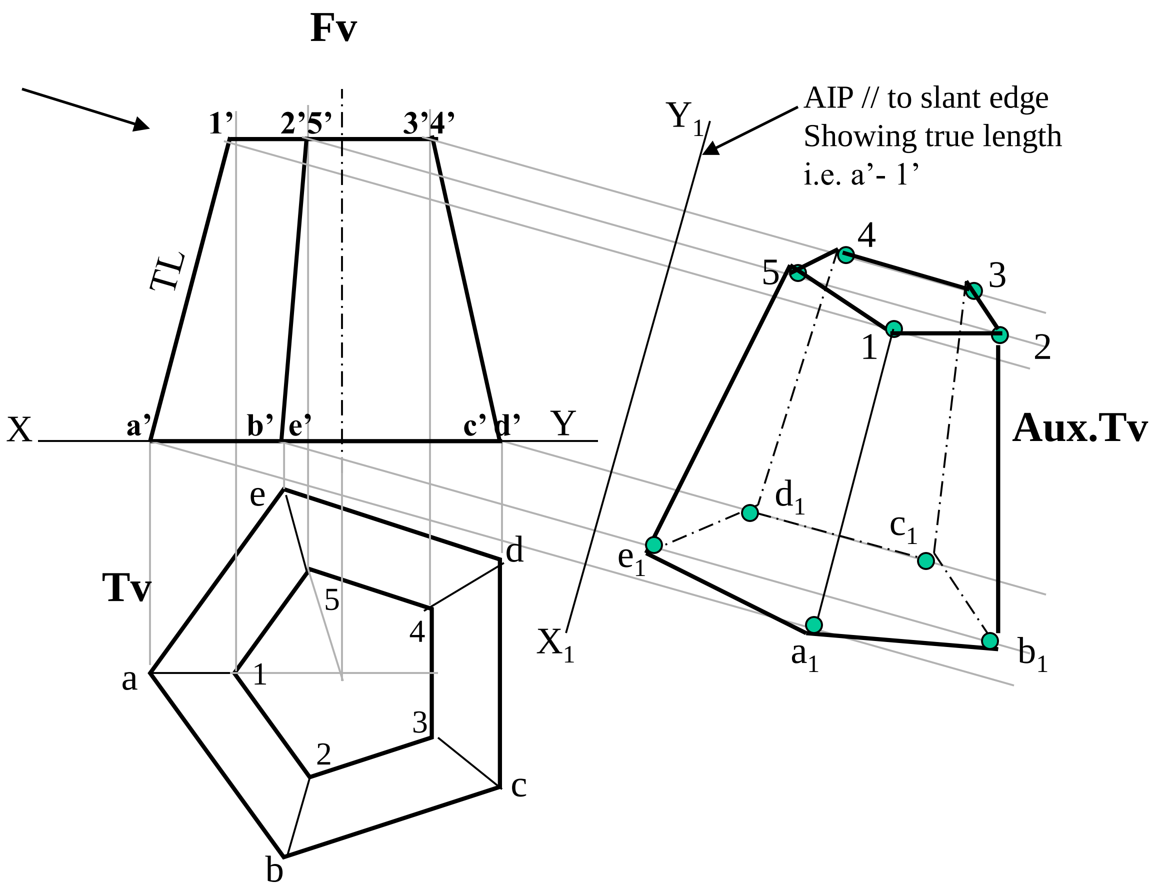


Problem 11: A hexagonal prism of base side 30 mm longand axis 40 mm long, is standing on Hp on it's base with one base edge // to Vp. A tetrahedron is placed centrally on the top of it.The base of tetrahedron is a triangle formed by joining alternate corners of top of prism..Draw projections of both solids. Project an auxiliary Tv on AIP 45^0 inclined to Hp.

STEPS:
Draw a regular hexagon as Tv of standing prism With one side // to xy and name the top points.Project it's Fv – a rectangle and name it's top.
Now join it's alternate corners a-c-e and the triangle formed is base of a tetrahedron as said.
Locate center of this triangle & locate apex o
Extending it's axis line upward mark apex o'
By cutting TL of edge of tetrahedron equal to a-c. and complete Fv of tetrahedron.
Draw an AIP (x1y1) 45^0 inclined to xy And project Aux.Tv on it by using similar Steps like previous problem.



Problem 12: A frustum of regular hexagonal pyramid is standing on it's larger base On Hp with one base side perpendicular to Vp.Draw it's Fv & Tv.
Project it's Aux.Tv on an AIP parallel to one of the slant edges showing TL.
Base side is 50 mm long , top side is 30 mm long and 50 mm is height of frustum.



ENGINEERING APPLICATIONS
OF
THE PRINCIPLES
OF
PROJECTIONS OF SOLIDES.

1. SECTIONS OF SOLIDS.
2. DEVELOPMENT.
3. INTERSECTIONS.

STUDY CAREFULLY
THE ILLUSTRATIONS GIVEN ON
NEXT *SIX* PAGES !

SECTIONING A SOLID.

An object (here a solid) is cut by some imaginary cutting plane to understand internal details of that object.

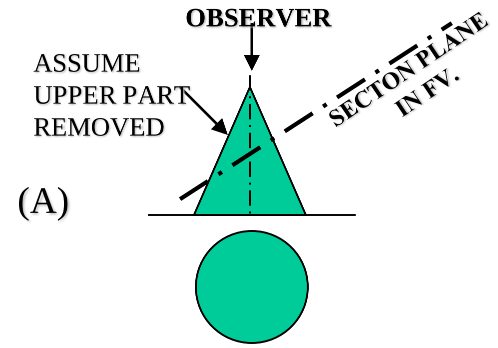
The action of cutting is called SECTIONING a solid
&
The plane of cutting is called SECTION PLANE.

Two cutting actions means section planes are recommended.

A) Section Plane perpendicular to Vp and inclined to Hp.
(This is a definition of an Aux. Inclined Plane i.e. A.I.P.)
NOTE:- This section plane appears as a straight line in FV.

B) Section Plane perpendicular to Hp and inclined to Vp.
(This is a definition of an Aux. Vertical Plane i.e. A.V.P.)
NOTE:- This section plane appears as a straight line in TV.

Remember:-
1. After launching a section plane either in FV or TV, the part towards observer is assumed to be removed.
2. As far as possible the smaller part is assumed to be removed.



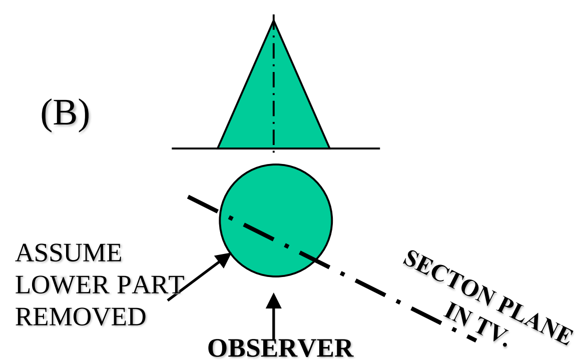
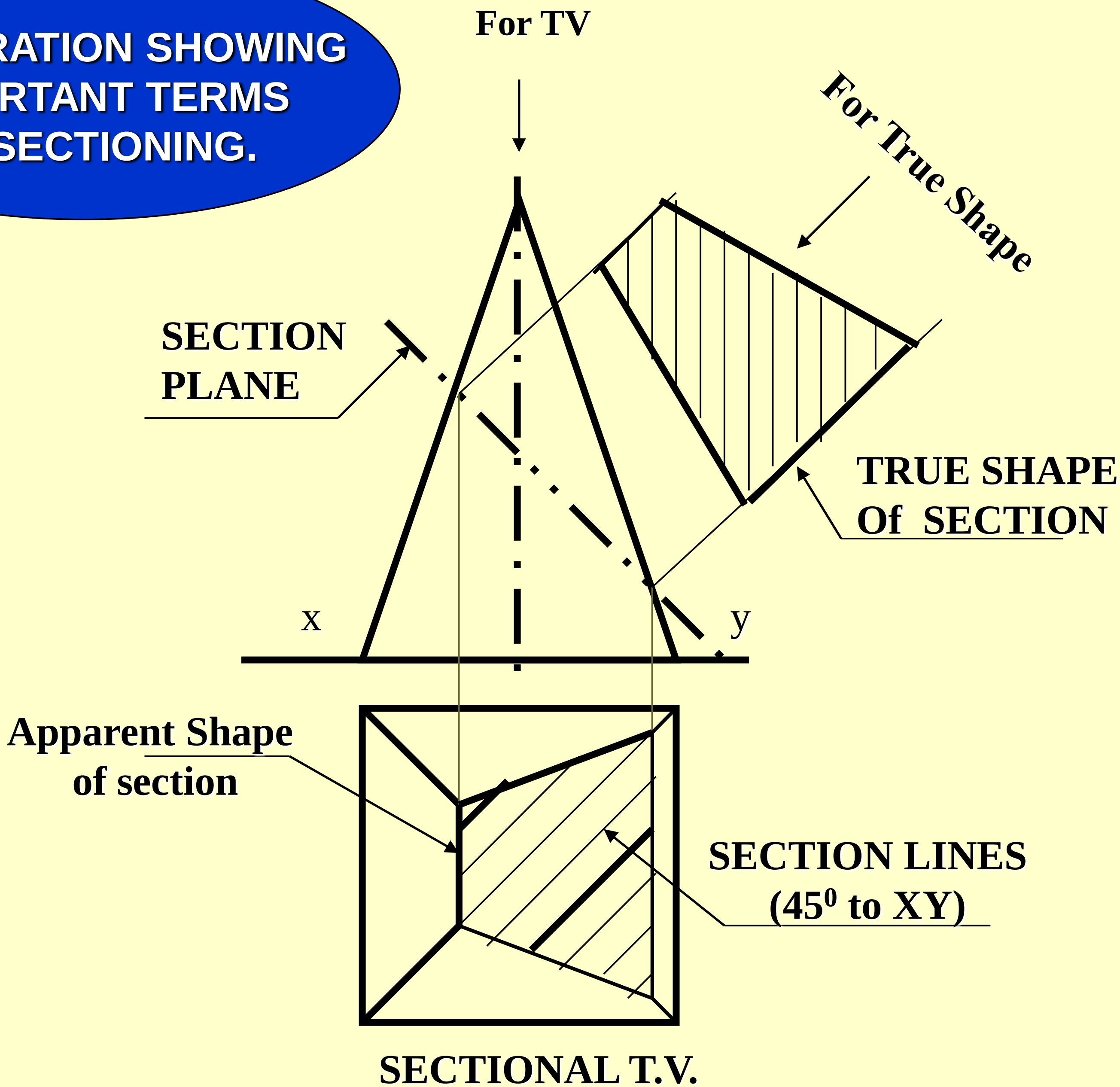
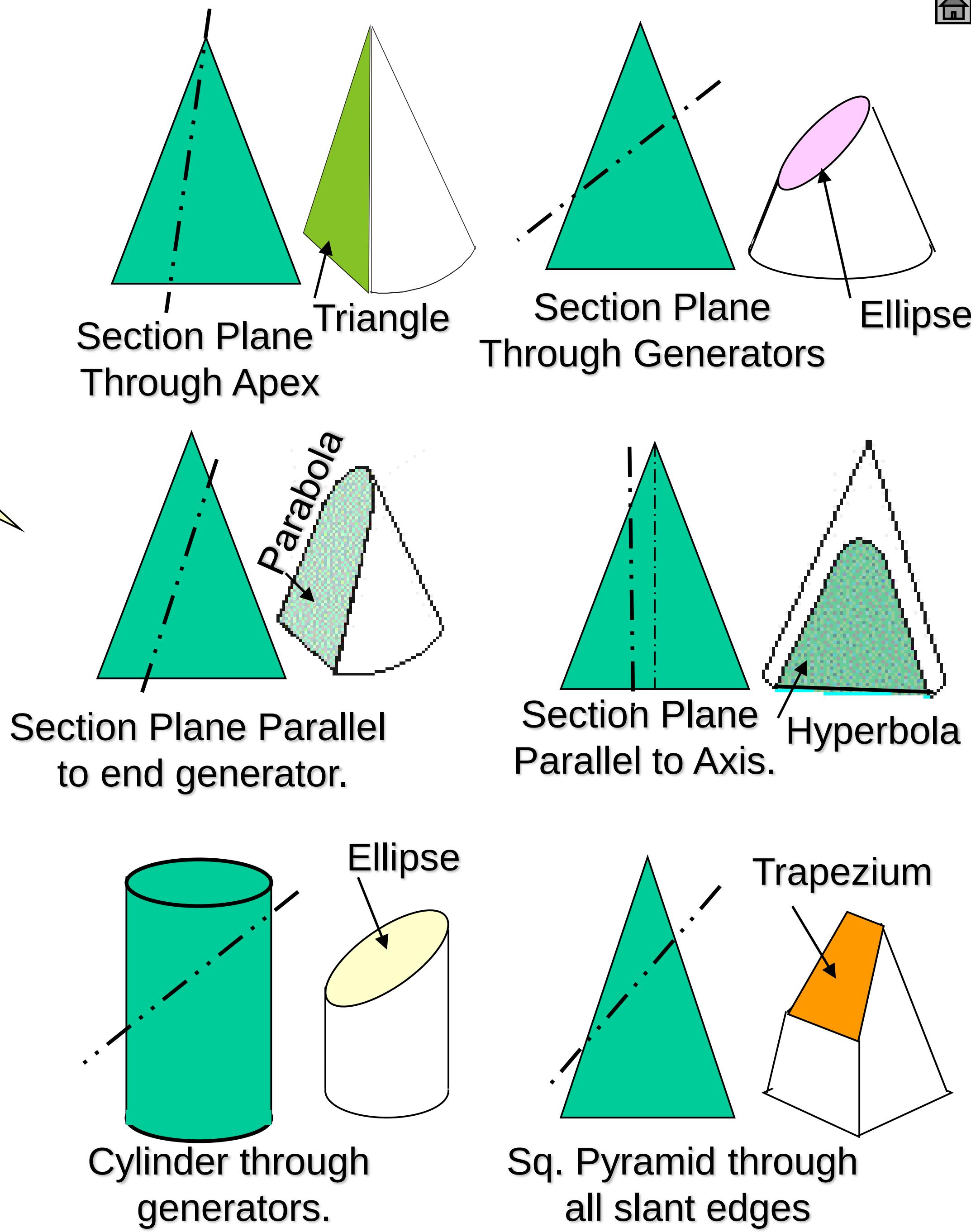


ILLUSTRATION SHOWING IMPORTANT TERMS IN SECTIONING.



Typical Section Planes
&
Typical Shapes
Of
Sections.



DEVELOPMENT OF SURFACES OF SOLIDS.

MEANING:-

ASSUME OBJECT HOLLOW AND MADE-UP OF THIN SHEET. CUT OPEN IT FROM ONE SIDE AND UNFOLD THE SHEET COMPLETELY. THEN THE SHAPE OF THAT UNFOLDED SHEET IS CALLED **DEVELOPMENT OF LATERLAL SUEFACES** OF THAT OBJECT OR SOLID.

LATERLAL SURFACE IS THE SURFACE EXCLUDING SOLID'S TOP & BASE.

ENGINEERING APLICATION:

THERE ARE SO MANY PRODUCTS OR OBJECTS WHICH ARE DIFFICULT TO MANUFACTURE BY CONVENTIONAL MANUFACTURING PROCESSES, BECAUSE OF THEIR SHAPES AND SIZES. THOSE ARE FABRICATED IN SHEET METAL INDUSTRY BY USING DEVELOPMENT TECHNIQUE. THERE IS A VAST RANGE OF SUCH OBJECTS.

EXAMPLES:-

Boiler Shells & chimneys, Pressure Vessels, Shovels, Trays, Boxes & Cartons, Feeding Hoppers, Large Pipe sections, Body & Parts of automotives, Ships, Aeroplanes and many more.

WHAT IS OUR OBJECTIVE IN THIS TOPIC ?

To learn methods of development of surfaces of different solids, their sections and frustums.

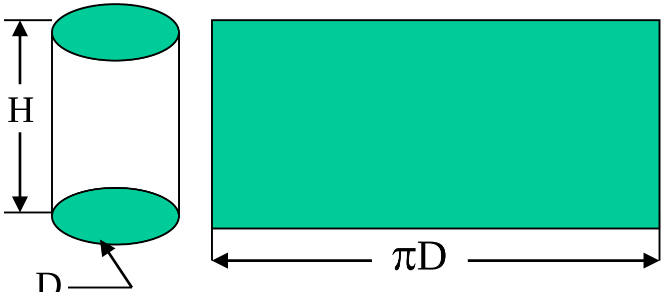
But before going ahead, note following ***Important*** *points.*

1. Development is different drawing than PROJECTIONS.
2. It is a shape showing AREA, means it's a 2-D plain drawing.
3. Hence all dimensions of it must be TRUE dimensions.
4. As it is representing shape of an un-folded sheet, no edges can remain hidden And hence DOTTED LINES are never shown on development.

Study illustrations given on next page carefully.

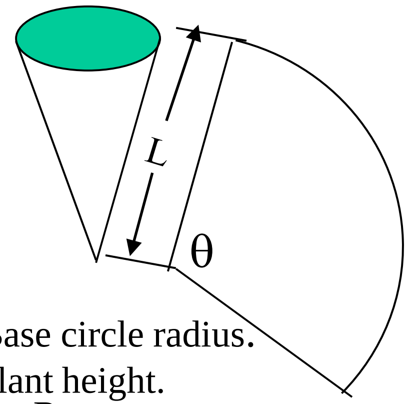
Development of lateral surfaces of different solids.
(Lateral surface is the surface excluding top & base)

Cylinder: A Rectangle



H= Height D= base diameter

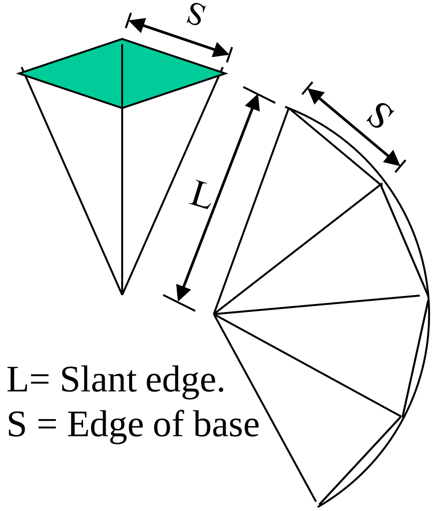
Cone: (Sector of circle)



R=Base circle radius.
L=Slant height.

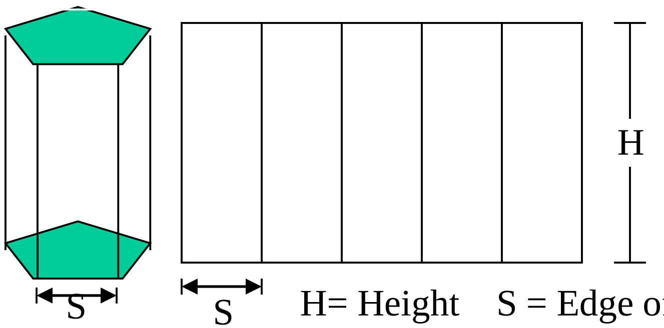
$$\theta = \frac{R}{L} \times 360^0$$

Pyramids: (No.of triangles)



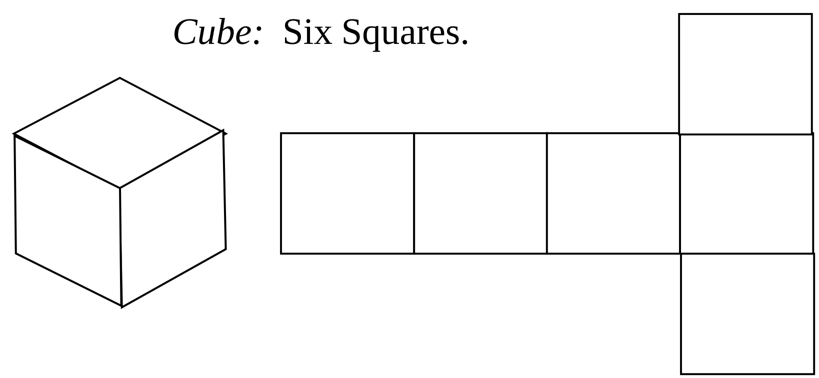
L= Slant edge.
S = Edge of base

Prisms: No.of Rectangles

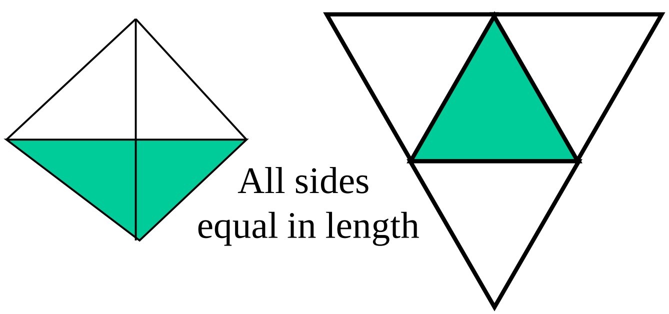


H= Height S = Edge of base

Cube: Six Squares.

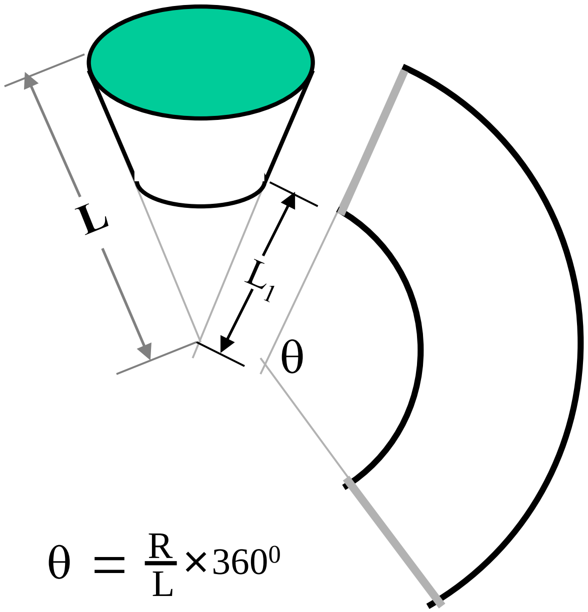


Tetrahedron: Four Equilateral Triangles



FRUSTUMS

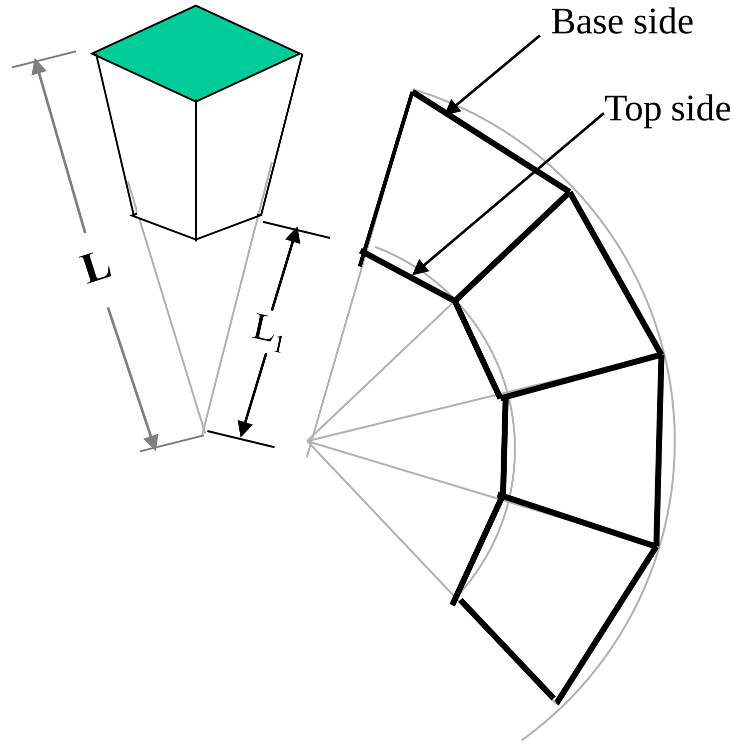
DEVELOPMENT OF
FRUSTUM OF CONE



$$\theta = \frac{R}{L} \times 360^0$$

R= Base circle radius of cone
L= Slant height of cone
L_1 = Slant height of cut part.

DEVELOPMENT OF
FRUSTUM OF SQUARE PYRAMID

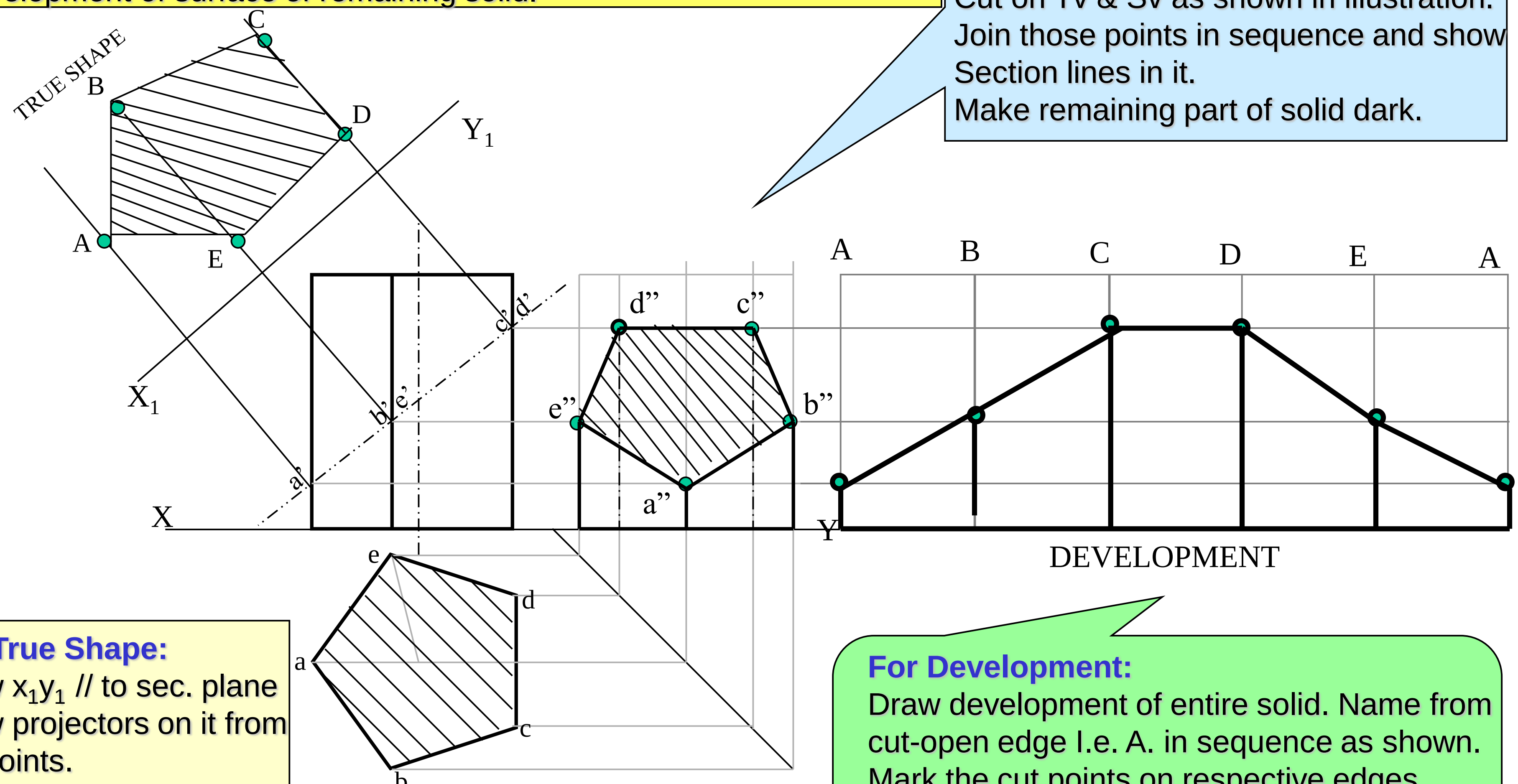


L= Slant edge of pyramid
L_1 = Slant edge of cut part.

STUDY NEXT *NINE* PROBLEMS OF SECTIONS & DEVELOPMENT

Problem 1: A pentagonal prism , 30 mm base side & 50 mm axis is standing on Hp on it’s base whose one side is perpendicular to Vp. It is cut by a section plane 45^0 inclined to Hp, through mid point of axis. Draw Fv, sec.Tv & sec. Side view. Also draw true shape of section and Development of surface of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing prism.
Locate sec.plane in Fv as described.
Project points where edges are getting Cut on Tv & Sv as shown in illustration.
Join those points in sequence and show Section lines in it.
Make remaining part of solid dark.

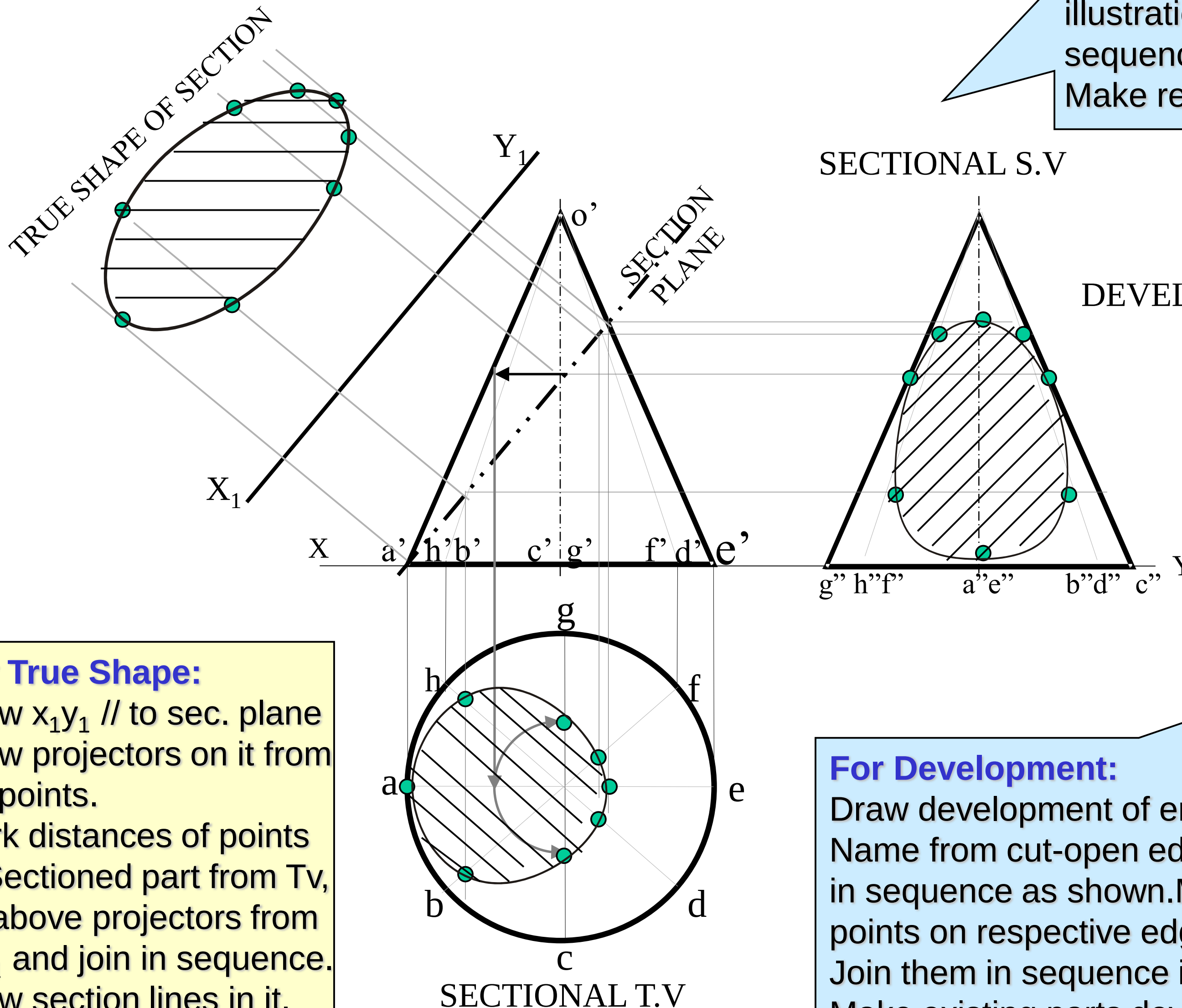


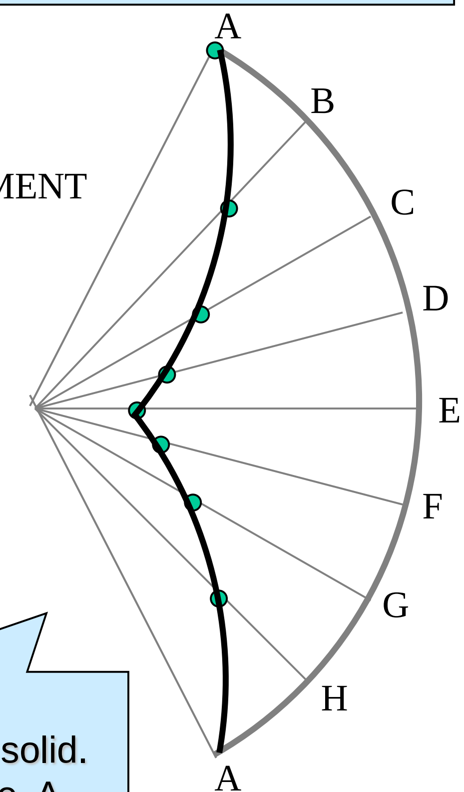
For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid. Name from cut-open edge I.e. A. in sequence as shown.
Mark the cut points on respective edges.
Join them in sequence in st. lines.
Make existing parts dev.dark.

Problem 2: A cone, 50 mm base diameter and 70 mm axis is standing on it's base on Hp. It cut by a section plane 45^0 inclined to Hp through base end of end generator.Draw projections, sectional views, true shape of section and development of surfaces of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing cone.
Locate sec.plane in Fv as described.
Project points where generators are getting Cut on Tv & Sv as shown in illustration.Join those points in sequence and show Section lines in it.
Make remaining part of solid dark.



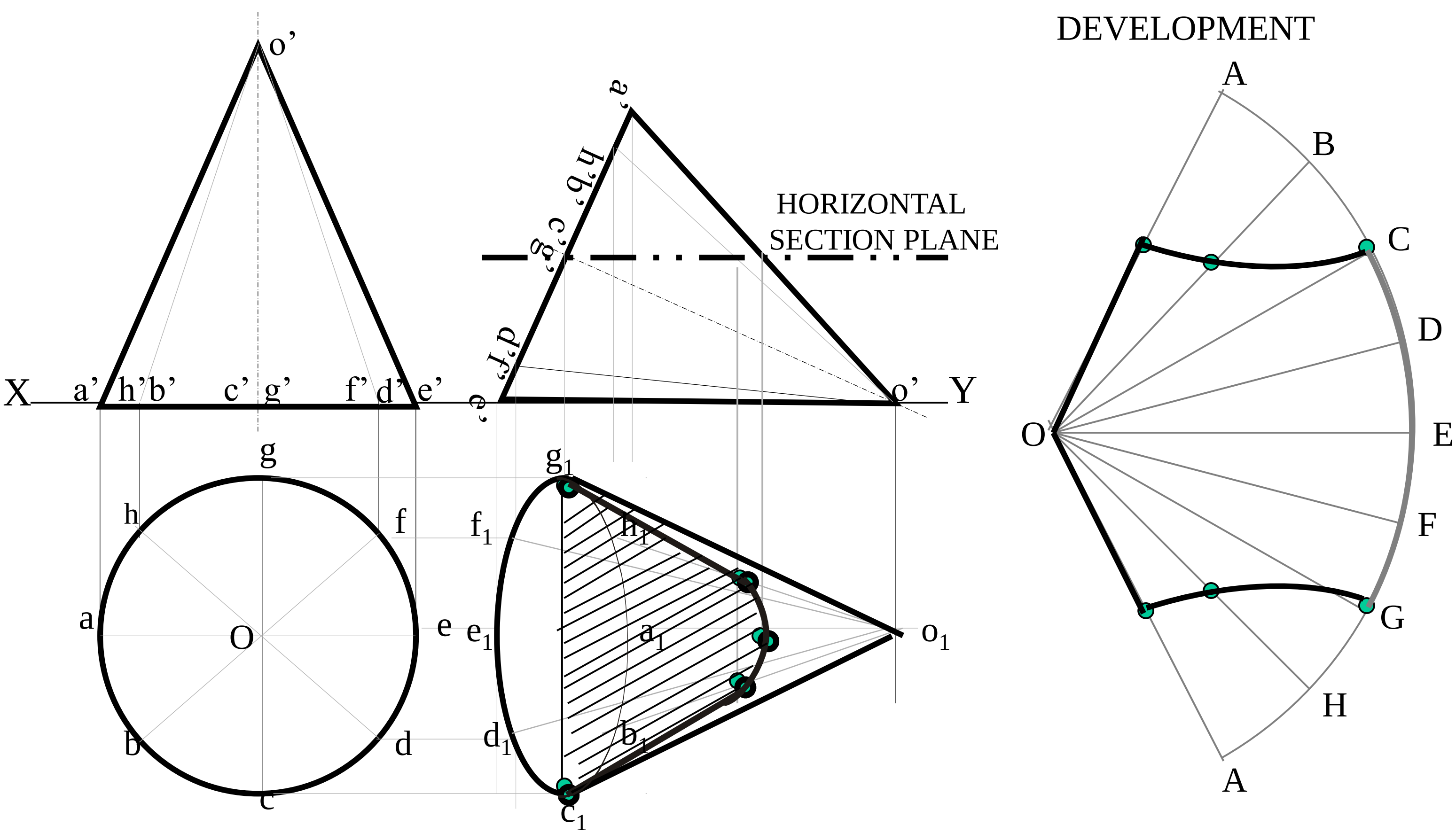


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid.
Name from cut-open edge i.e. A.
in sequence as shown.Mark the cut points on respective edges.
Join them in sequence in curvature.
Make existing parts dev.dark.

Problem 3: A cone 40mm diameter and 50 mm axis is resting on one generator on Hp(lying on Hp) which is // to Vp.. Draw it's projections.It is cut by a horizontal section plane through it's base center. Draw sectional TV, development of the surface of the remaining part of cone.

Follow similar solution steps for Sec.views - True shape – Development as per previous problem!



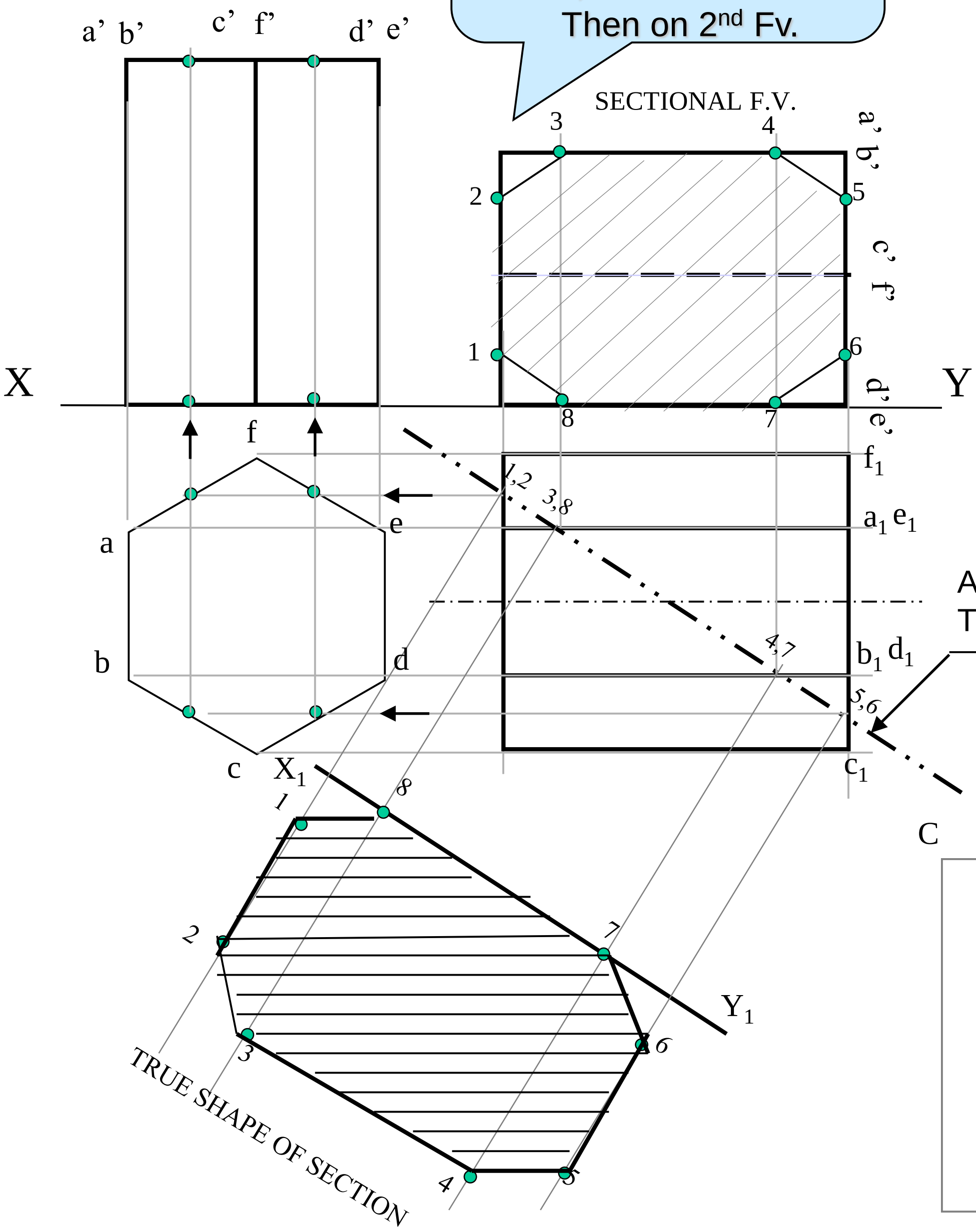
SECTIONAL T.V

(SHOWING TRUE SHAPE OF SECTION)

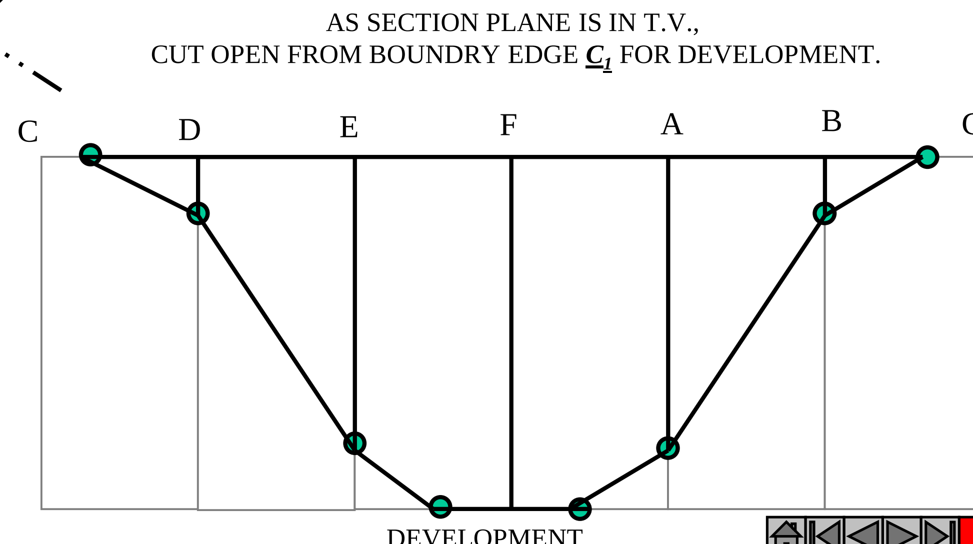
Problem 4: A hexagonal prism. 30 mm base side & 55 mm axis is lying on Hp on it's rect.face with axis // to Vp. It is cut by a section plane normal to Hp and 30^0 inclined to Vp bisecting axis.
Draw sec. Views, true shape & development.

Use similar steps for sec.views & true shape.
NOTE: for development, always cut open object from From an edge in the boundary of the view in which sec.plane appears as a line.
Here it is Tv and in boundary, there is c1 edge.Hence it is opened from c and named C,D,E,F,A,B,C.

Note the steps to locate Points 1, 2 , 5, 6 in sec.Fv: Those are transferred to 1st TV, then to 1st Fv and Then on 2nd Fv.

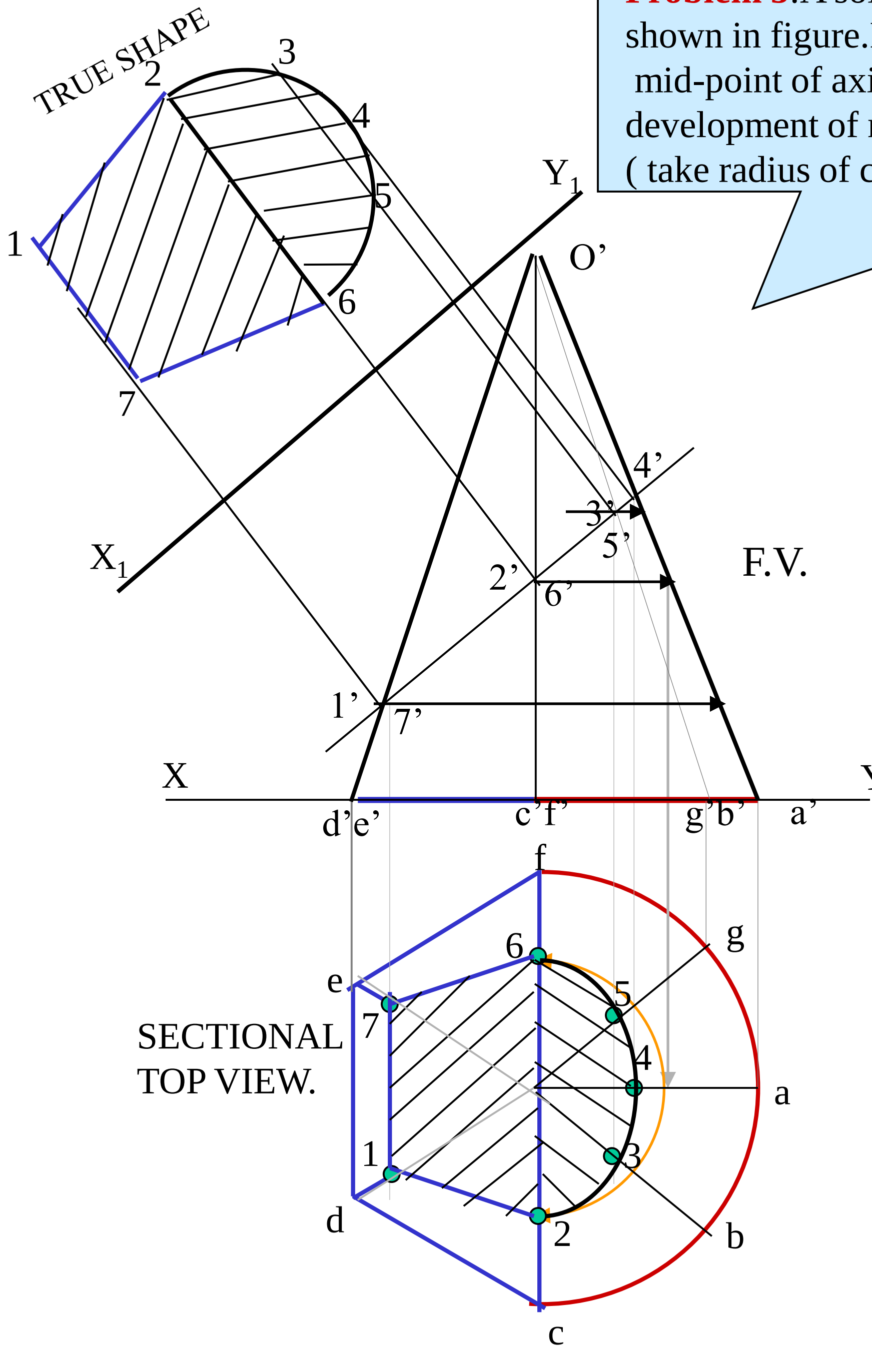


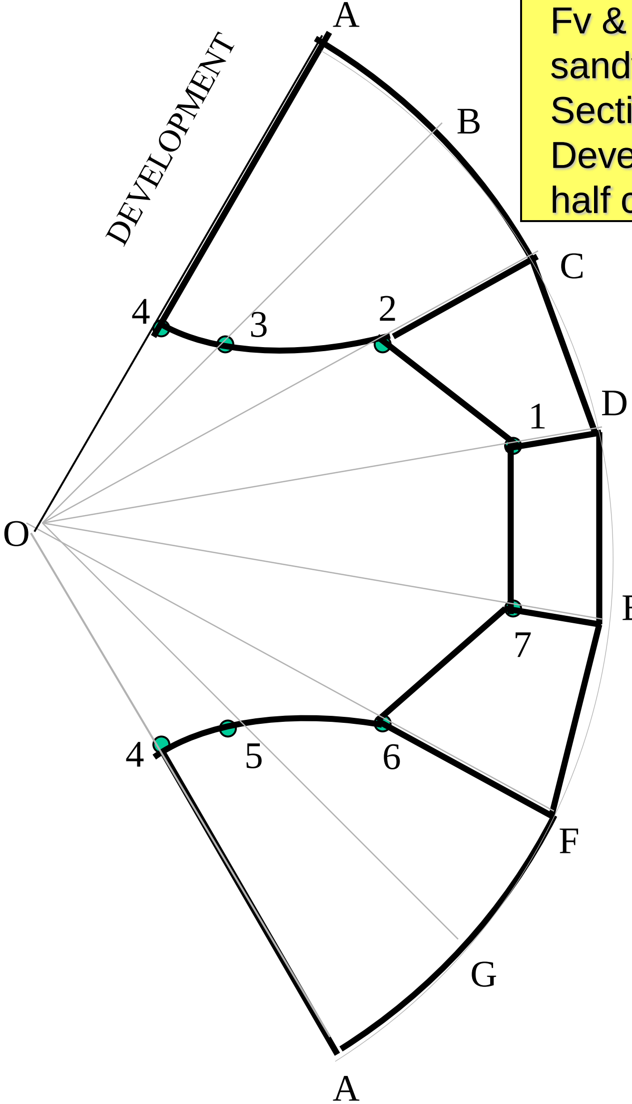
A.V.P30^0 inclined to Vp
Through mid-point of axis.



Problem 5:A solid composed of a half-cone and half- hexagonal pyramid is shown in figure.It is cut by a section plane 45^0 inclined to Hp, passing through mid-point of axis.Draw F.v., sectional T.v.,true shape of section and development of remaining part of the solid.
(take radius of cone and each side of hexagon 30mm long and axis 70mm.)

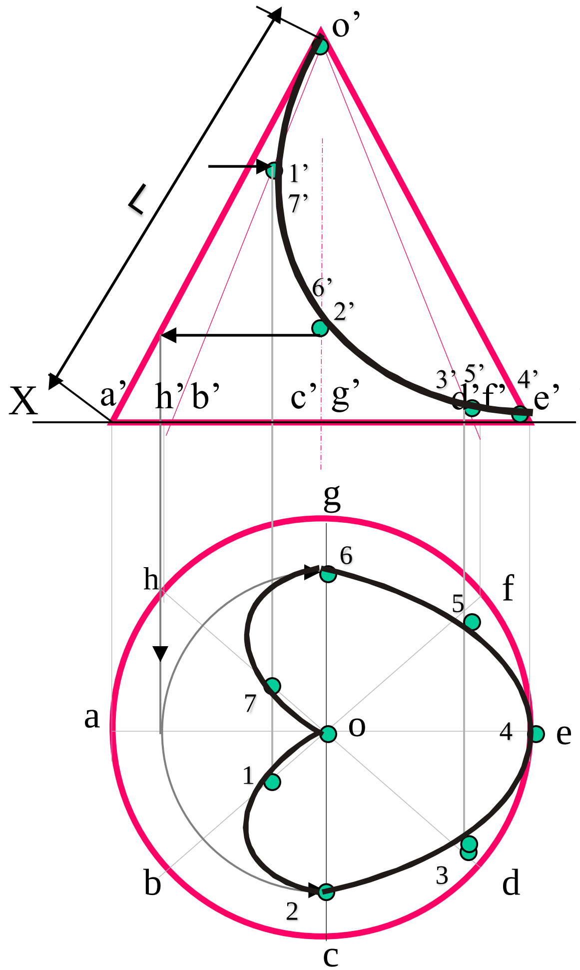
Note:
Fv & TV 8f two solids sandwiched
Section lines style in both:
Development of
half cone & half pyramid:





Problem 6: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest circle.If the semicircle is development of a cone and inscribed circle is some curve on it, then draw the projections of cone showing that curve.

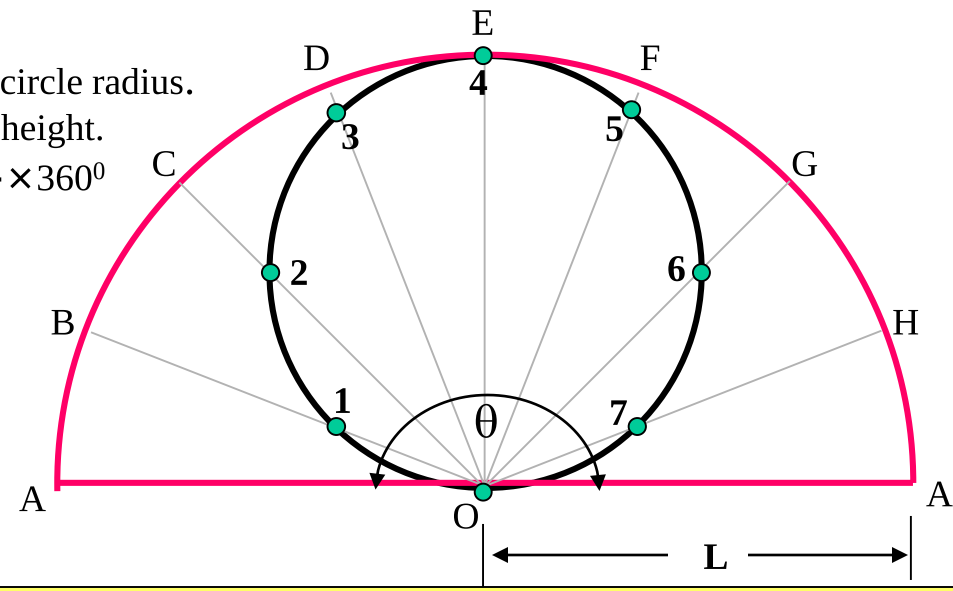
TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.



R=Base circle radius.

L=Slant height.

$$\theta = \frac{R}{L} \times 360^0$$



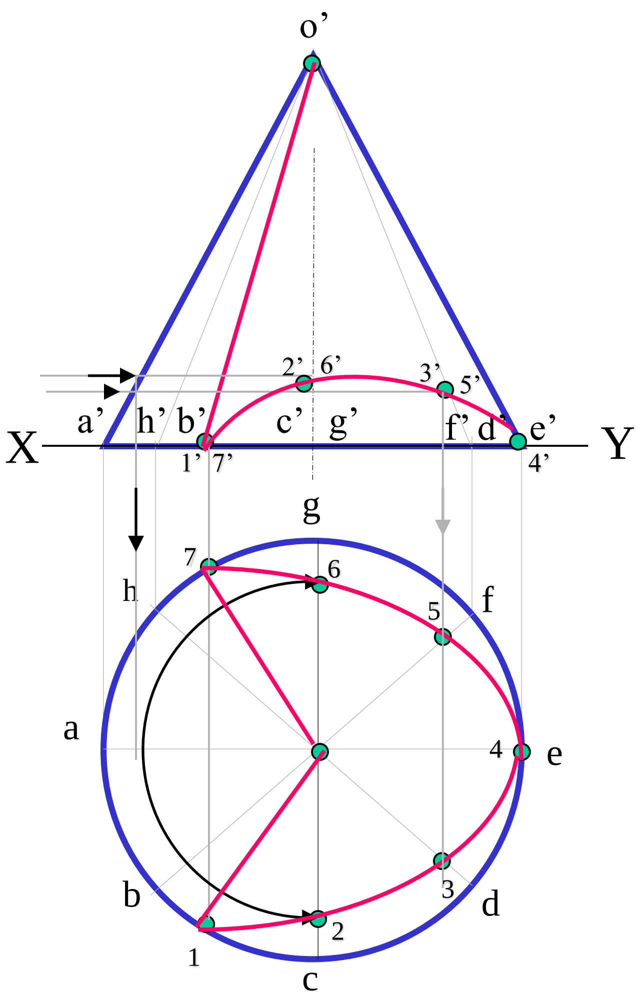
Solution Steps:

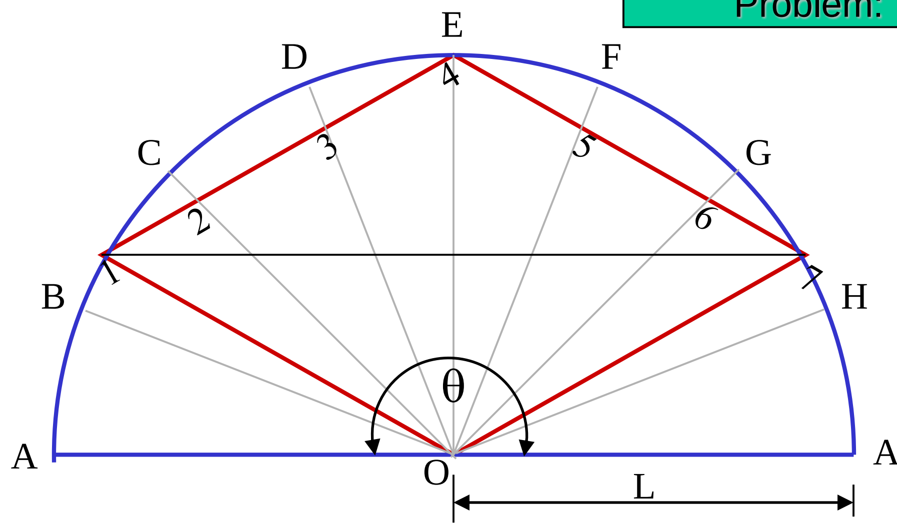
Draw semicircle of given diameter, divide it in 8 Parts and inscribe in it a largest circle as shown.Name intersecting points 1, 2, 3 etc.
Semicircle being dev.of a cone it's radius is slant height of cone.(L)
Then using above formula find R of base of cone. Using this data draw Fv & Tv of cone and form 8 generators and name.
Take o -1 distance from dev.,mark on TL i.e.o'a' on Fv & bring on o'b' and name 1' Similarly locate all points on Fv. Then project all on Tv on respective generators and join by smooth curve.

Problem 7: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest **rhombus**.If the semicircle is development of a cone and rhombus is some curve on it, then draw the projections of cone showing that curve.

TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.

Solution Steps:
Similar to previous Problem:



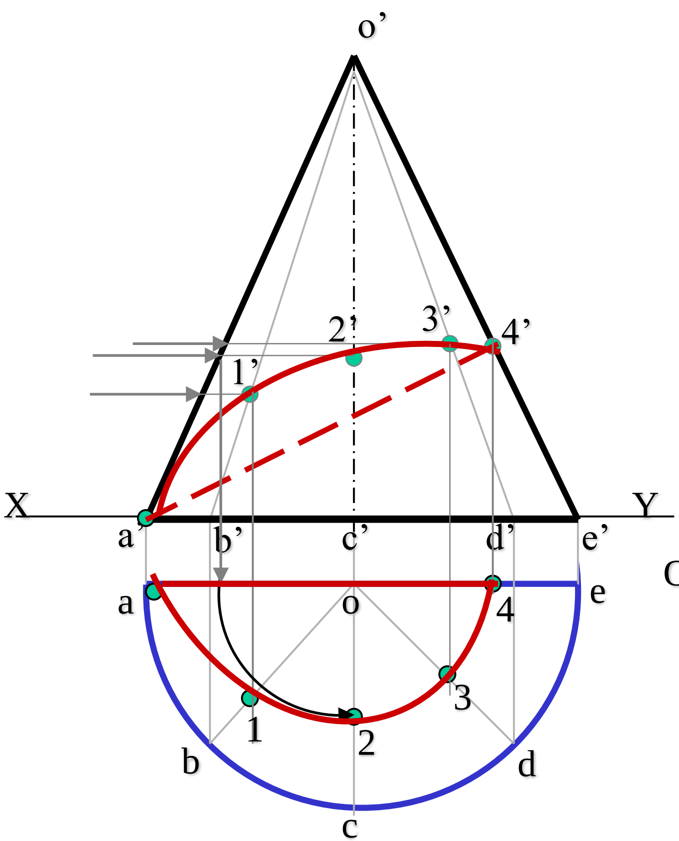


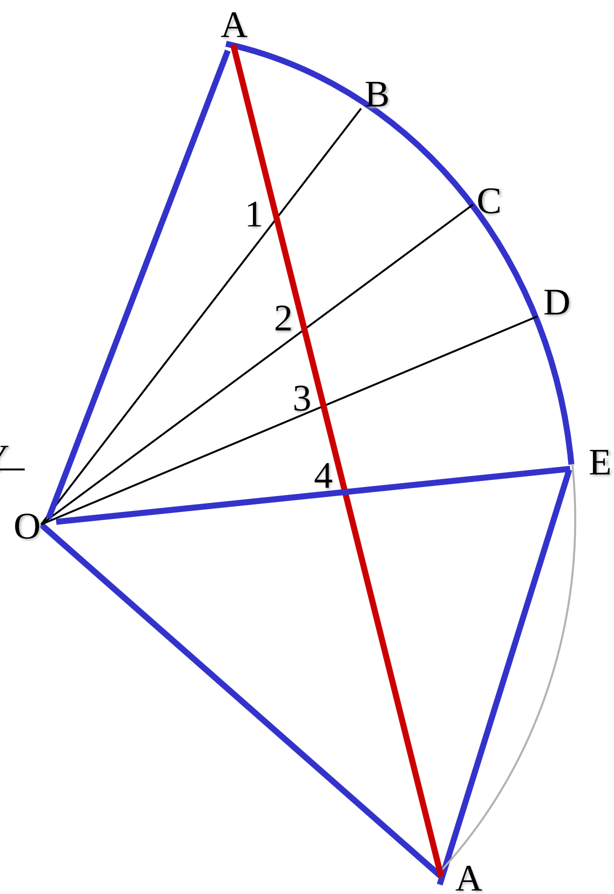
R=Base circle radius.
L=Slant height.

$$\theta = \frac{R}{L} \times 360^0$$

Problem 8: A half cone of 50 mm base diameter, 70 mm axis, is standing on it's half base on HP with it's flat face parallel and nearer to VP.An inextensible string is wound round it's surface from one point of base circle and brought back to the same point.If the string is of ***shortest length***, find it and show it on the projections of the cone.

TO DRAW A CURVE ON PRINCIPAL VIEWS FROM DEVELOPMENT.

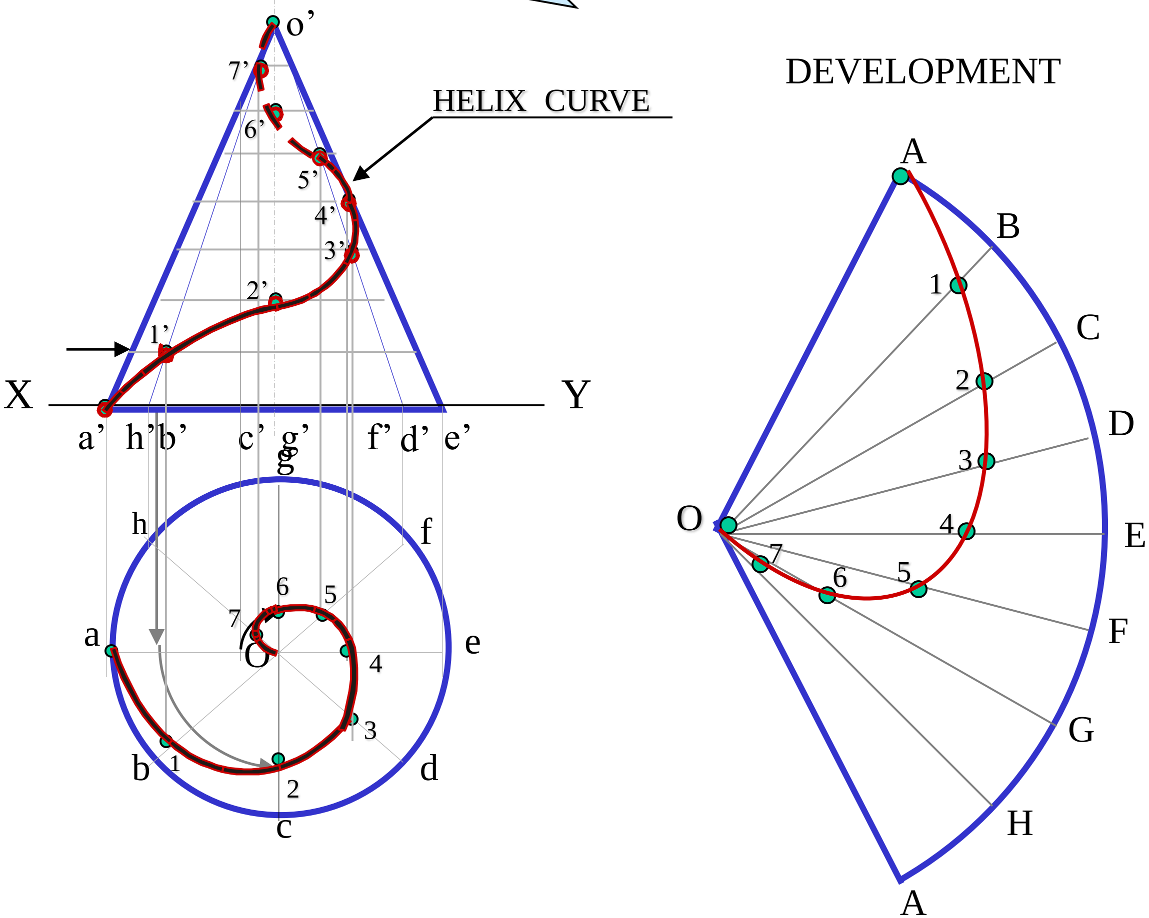




Concept: A string wound from a point up to the same Point, of shortest length Must appear st. line on it's Development.

Solution steps:
Hence draw development, Name it as usual and join A to A This is shortest Length of that string. Further steps are as usual. On dev. Name the points of Intersections of this line with Different generators.Bring Those on Fv & Tv and join by smooth curves. Draw 4' a' part of string dotted As it is on back side of cone.

Problem 9: A particle which is initially on base circle of a cone, standing on Hp, moves upwards and reaches apex in one complete turn around the cone. Draw it's path on projections of cone as well as on it's development.
Take base circle diameter 50 mm and axis 70 mm long.



It's a construction of curve Helix of one turn on cone:

Draw Fv & Tv & dev.as usual
On all form generators & name.

Construction of curve Helix::

Show 8 generators on both views
Divide axis also in same parts.
Draw horizontal lines from those points on both end generators.
1' is a point where first horizontal Line & gen. b'o' intersect.
2' is a point where second horiz. Line & gen. c'o' intersect.
In this way locate all points on Fv.
Project all on Tv.Join in curvature.

For Development:

Then taking each points true Distance From resp.generator from apex, Mark on development & join.

INTERPENETRATION OF SOLIDS

WHEN ONE SOLID PENETRATES ANOTHER SOLID THEN THEIR SURFACES INTERSECT
AND
AT THE JUNCTION OF INTERSECTION A TYPICAL CURVE IS FORMED,
WHICH REMAINS COMMON TO BOTH SOLIDS.

THIS CURVE IS CALLED CURVE OF INTERSECTION
AND
IT IS A RESULT OF INTERPENETRATION OF SOLIDS.

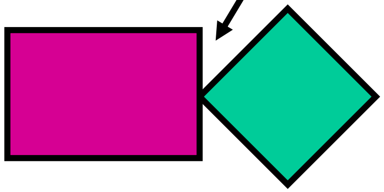
PURPOSE OF DRAWING THESE CURVES:-

WHEN TWO OBJECTS ARE TO BE JOINED TOGATHER, MAXIMUM SURFACE CONTACT BETWEEN BOTH BECOMES A BASIC REQUIREMENT FOR STRONGEST & LEAK-PROOF JOINT.

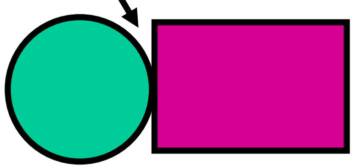
Curves of Intersections being common to both Intersecting solids,
show exact & maximum surface contact of both solids.

Study Following Illustrations Carefully.

Minimum Surface Contact.
(Point Contact)



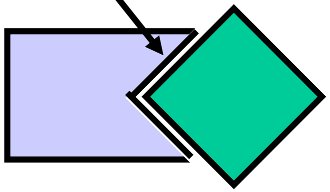
Square Pipes.



Circular Pipes.

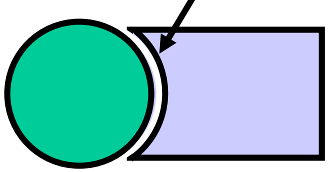
(Maximum Surface Contact)

Lines of Intersections.



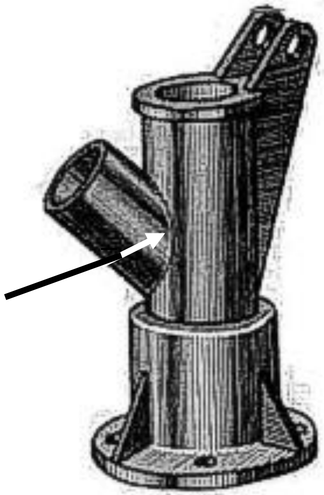
Square Pipes.

Curves of Intersections.

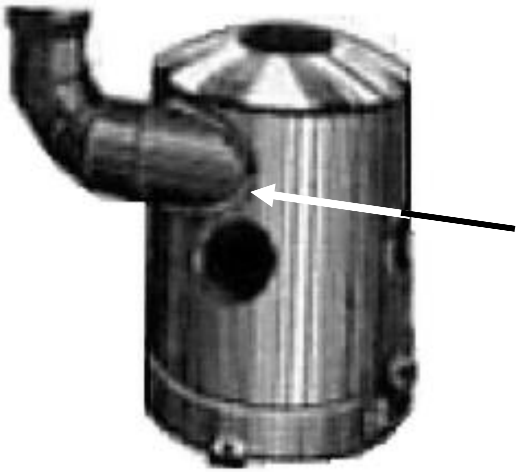


Circular Pipes.

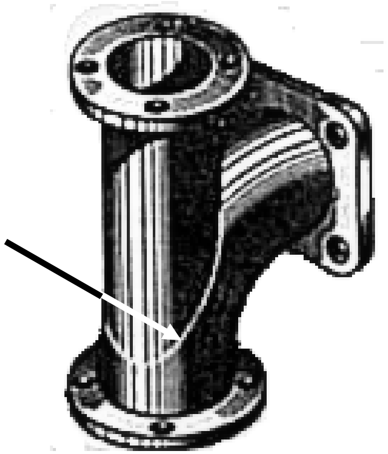
SOME ACTUAL OBJECTS ARE SHOWN, SHOWING CURVES OF INTERSECTIONS. BY WHITE ARROWS.



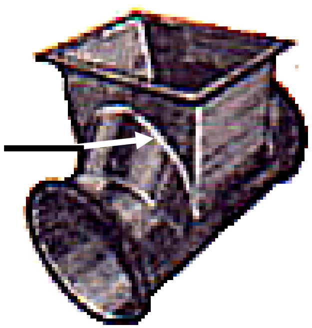
A machine component having two intersecting cylindrical surfaces with the axis at acute angle to each other.



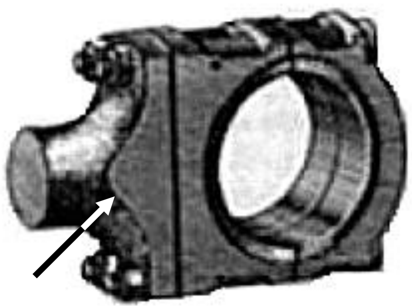
An Industrial Dust collector. Intersection of two cylinders.



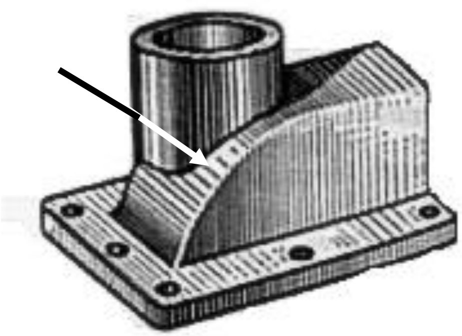
Intersection of a Cylindrical main and Branch Pipe.



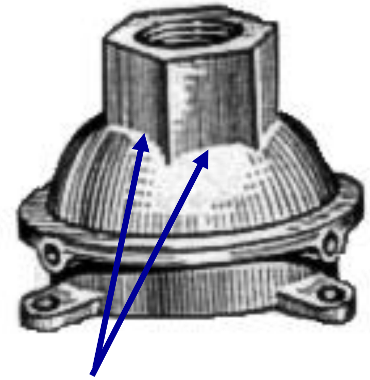
A Feeding Hopper In industry.



Forged End of a Connecting Rod.



Two Cylindrical surfaces.



Pump lid having shape of a hexagonal Prism and Hemi-sphere intersecting each other.

FOLLOWING CASES ARE SOLVED.
REFFER ILLUSTRATIONS
AND
NOTE THE COMMON
CONSTRUCTION
FOR ALL

1.CYLINDER TO CYLINDER2.

2.SQ.PRISM TO CYLINDER

3.CONE TO CYLINDER

4.TRIANGULAR PRISM TO CYLNDER

5.SQ.PRISM TO SQ.PRISM

6.SQ.PRISM TO SQ.PRISM
(SKEW POSITION)
7.SQARE PRISM TO CONE (*from top*)

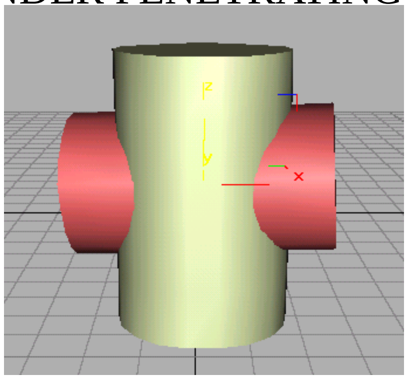
8.CYLINDER TO CONE

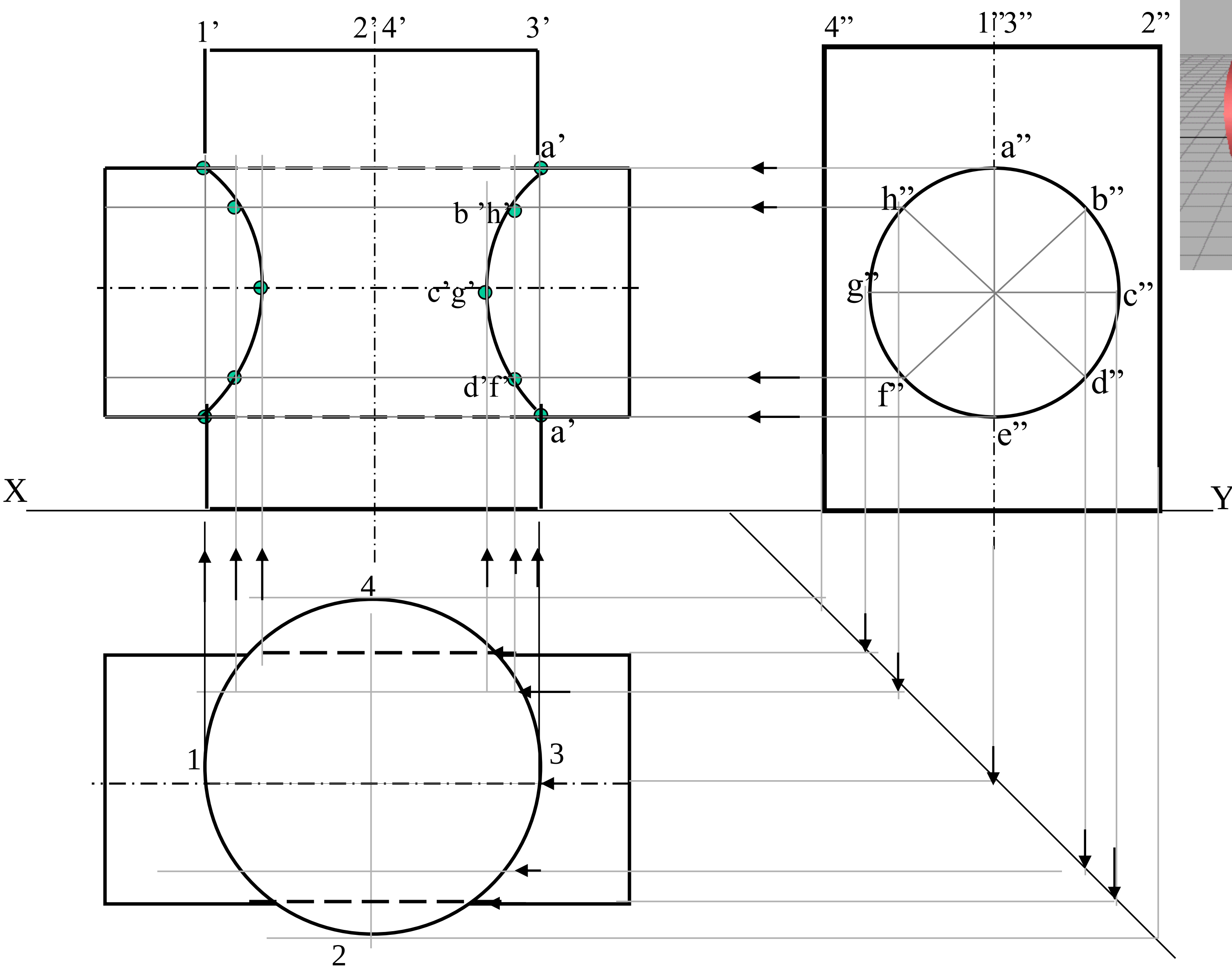
COMMON SOLUTION STEPS
One solid will be standing on HP
Other will penetrate horizontally.
Draw three views of standing solid.
Name views as per the illustrations.
Beginning with side view draw three
Views of penetrating solids also.
On it's S.V. mark number of points
And name those(either letters or nos.)
The points which are on standard
generators or edges of standing solid,
(in S.V.) can be marked on respective
generators in Fv and Tv. And other
points from SV should be brought to
Tv first and then projecting upward
To Fv.
Dark and dotted line's decision should
be taken by observing side view from
it's right side as shown by arrow.
Accordingly those should be joined
by curvature or straight lines.

Note:
Incase cone is penetrating solid Side view is not necessary.
Similarly in case of penetration from top it is not required.

Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by another of 40 mm dia.and 70 mm axis horizontally Both axes intersect & bisect each other. Draw projections showing curves of intersections.

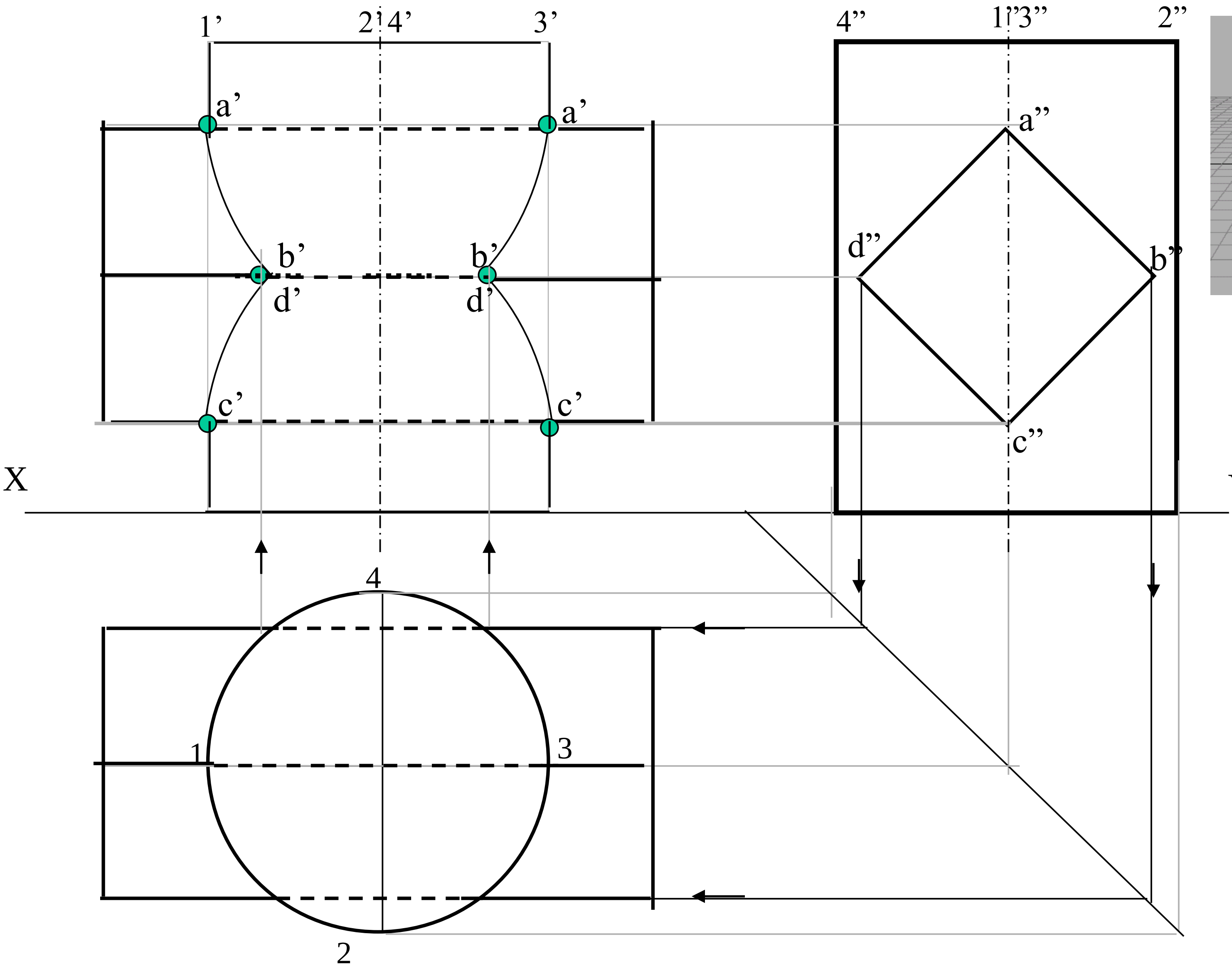
CASE 1.
CYLINDER STANDING
&
CYLINDER PENETRATING

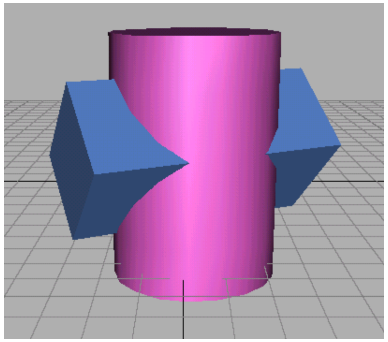




Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersect & bisect each other. All faces of prism are equally inclined to Hp. Draw projections showing curves of intersections.

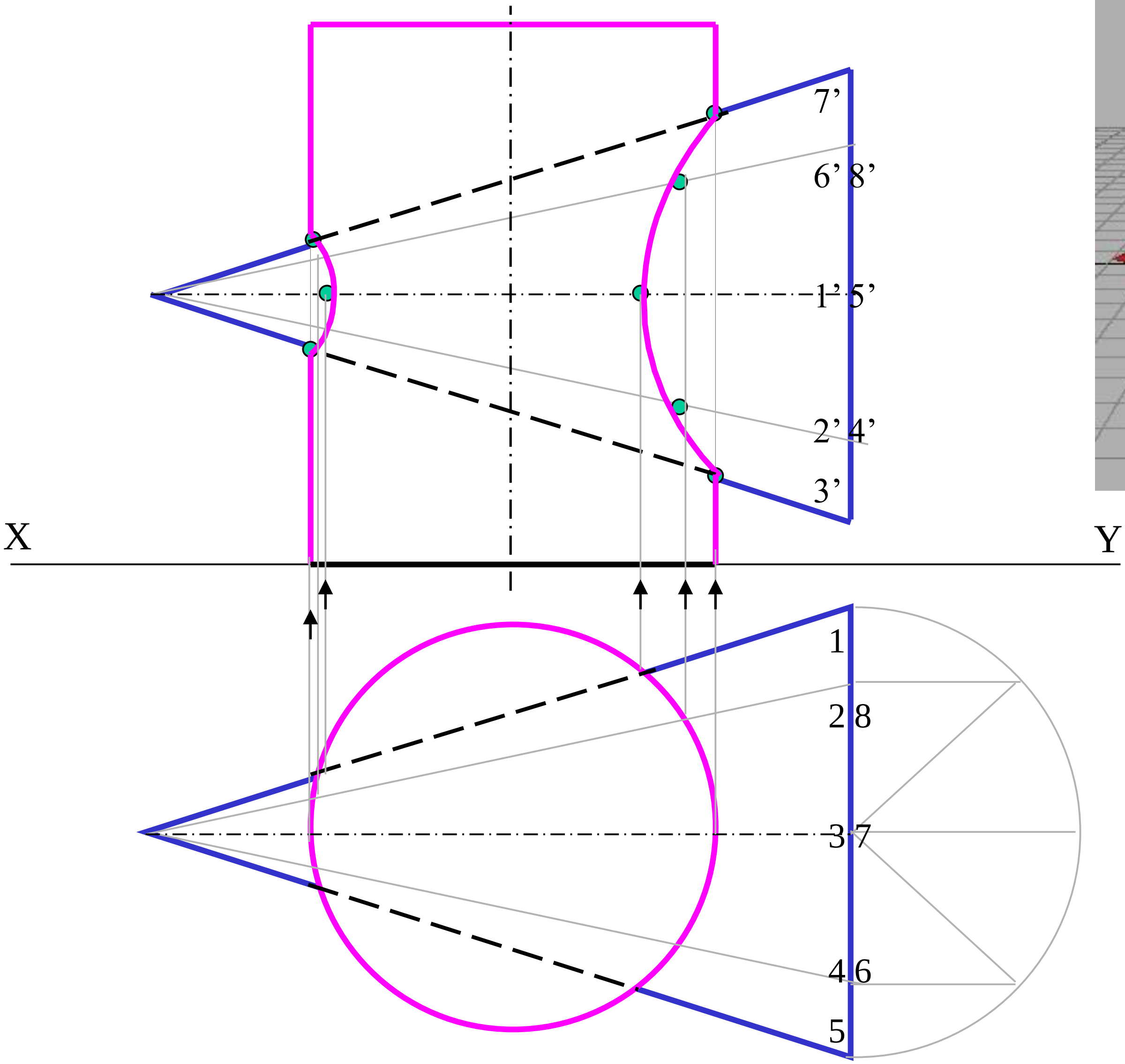
CASE 2.
CYLINDER STANDING
&
SQ.PRISM PENETRATING

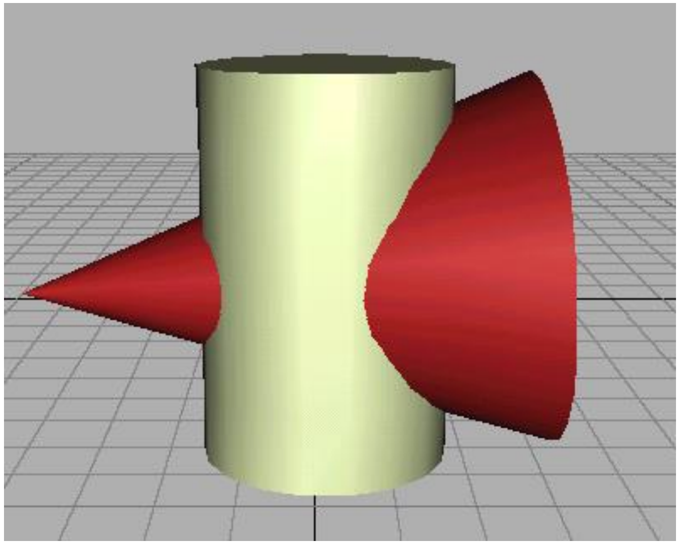




Problem: A cylinder of 80 mm diameter and 100 mm axis is completely penetrated by a cone of 80 mm diameter and 120 mm long axis horizontally.Both axes intersect & bisect each other. Draw projections showing curve of intersections.

CASE 3. CYLINDER STANDING & CONE PENETRATING

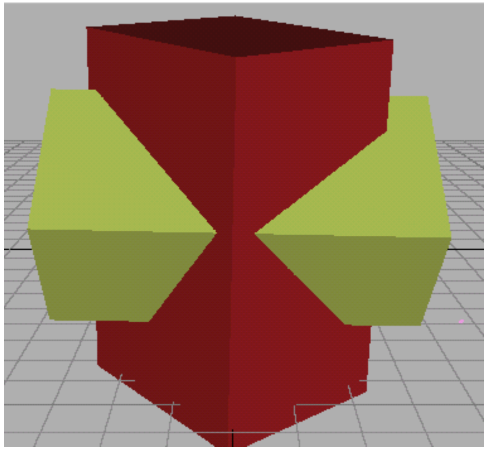


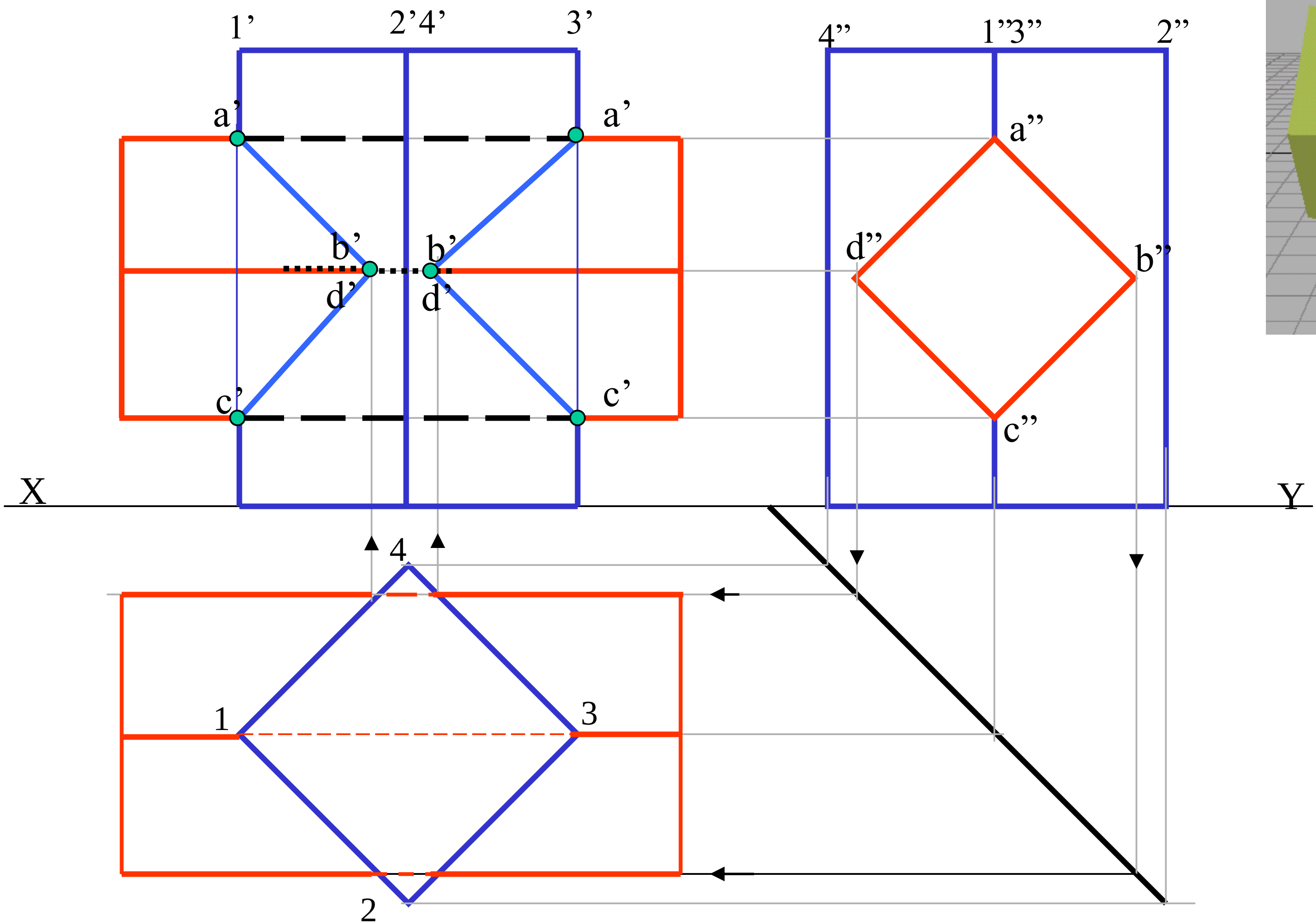


Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersects & bisect each other. All faces of prisms are equally inclined to Vp. Draw projections showing curves of intersections.

CASE 4.

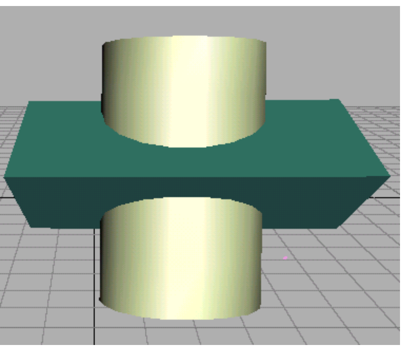
SQ.PRISM STANDING
&
SQ.PRISM PENETRATING

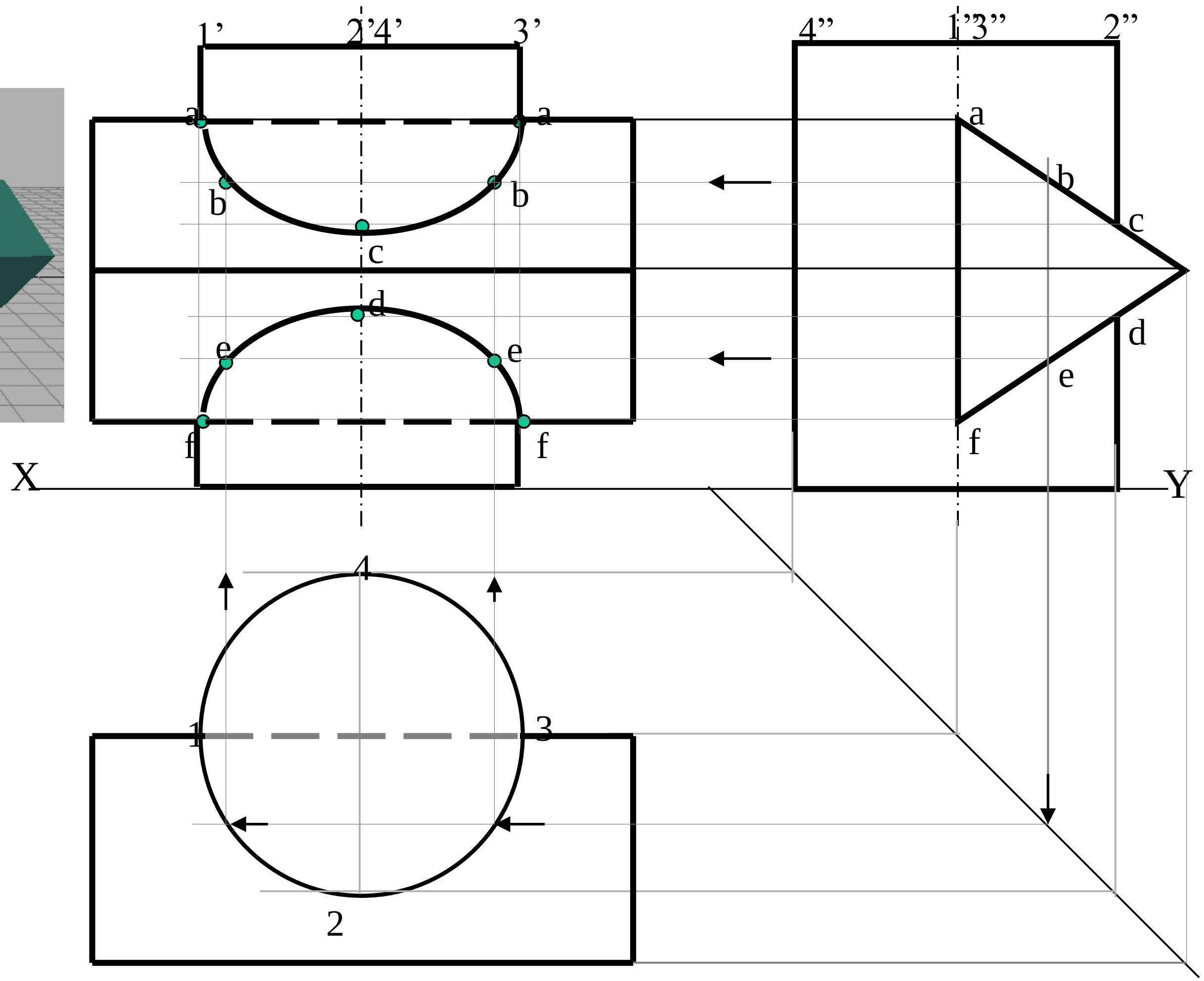


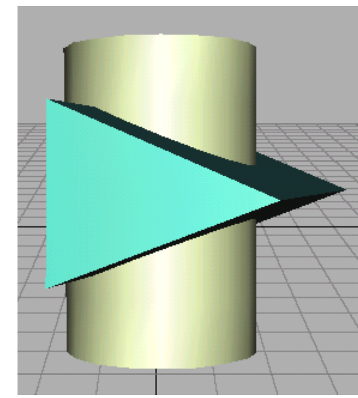


Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a triangular prism of 45 mm sides.and 70 mm axis, horizontally. One flat face of prism is parallel to Vp and Contains axis of cylinder. Draw projections showing curves of intersections.

CASE 5. CYLINDER STANDING & TRIANGULAR PRISM PENETRATING

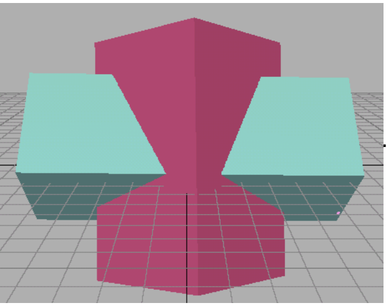


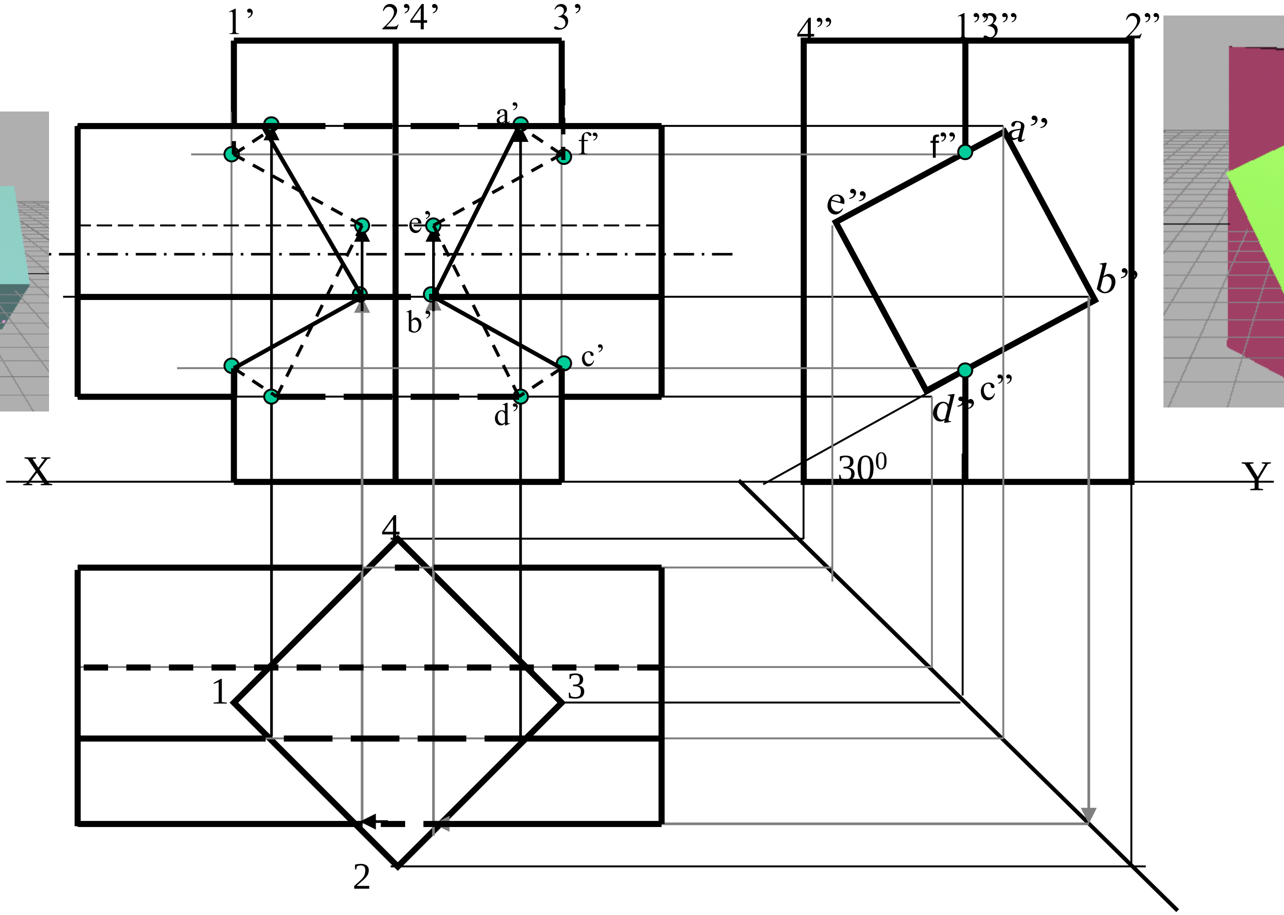


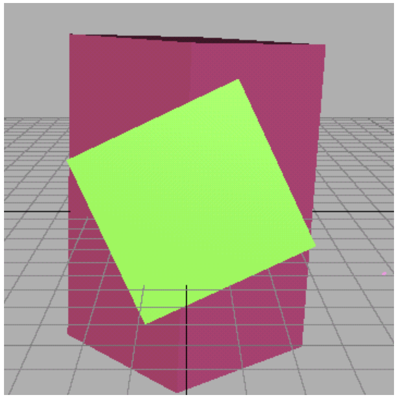


Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm side s.and 70 mm axis, horizontally. Both axes Intersect & bisect each other.Two faces of penetrating prism are 30^0 inclined to Hp. Draw projections showing curves of intersections.

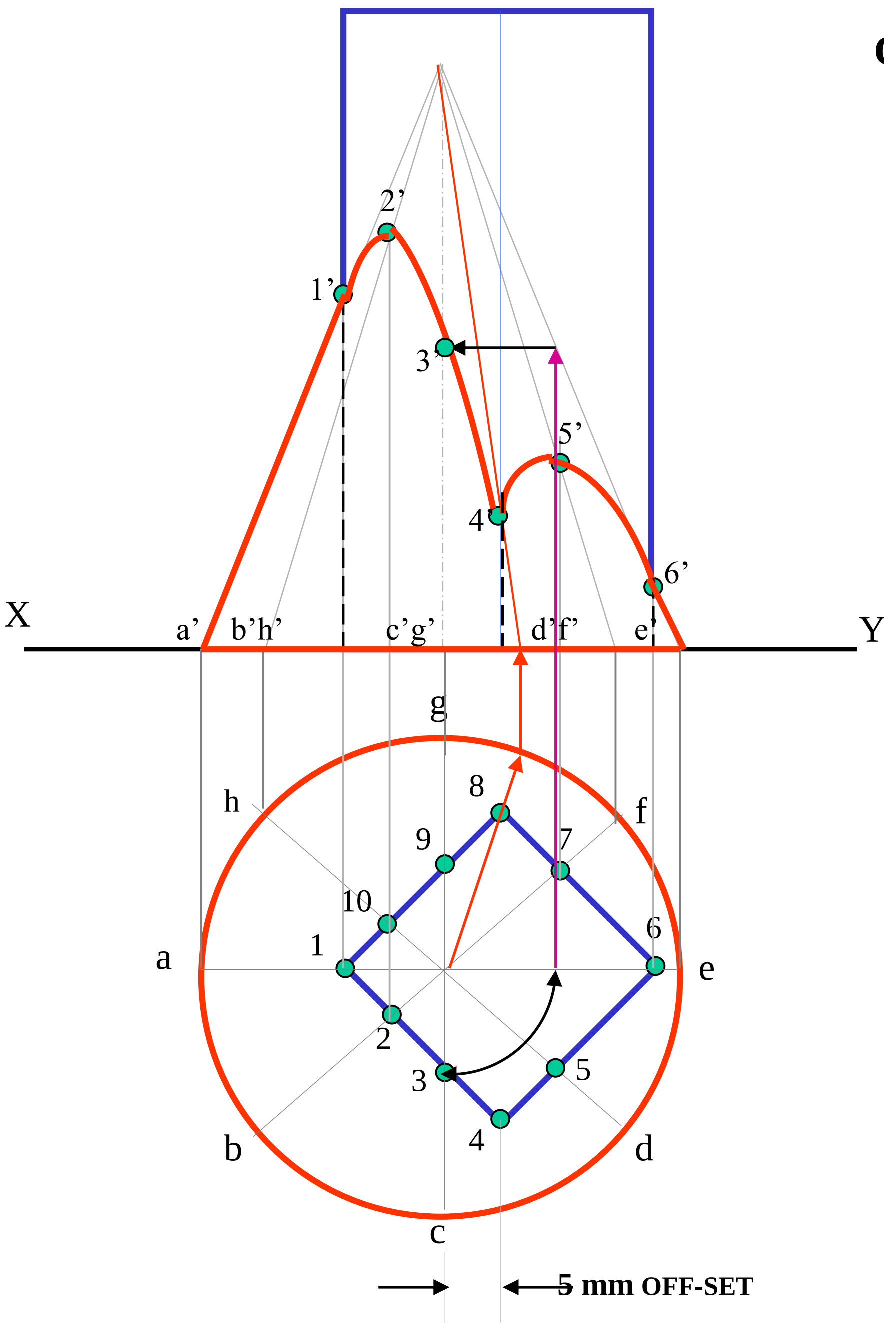
CASE 6.
SQ.PRISM STANDING
&
SQ.PRISM PENETRATING
(30^0 SKEW POSITION)

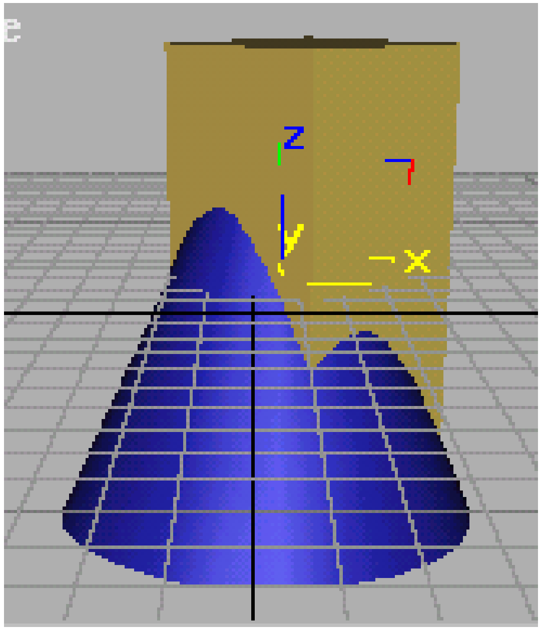






CASE 7.
CONE STANDING & SQ.PRISM PENETRATING (BOTH AXES VERTICAL)

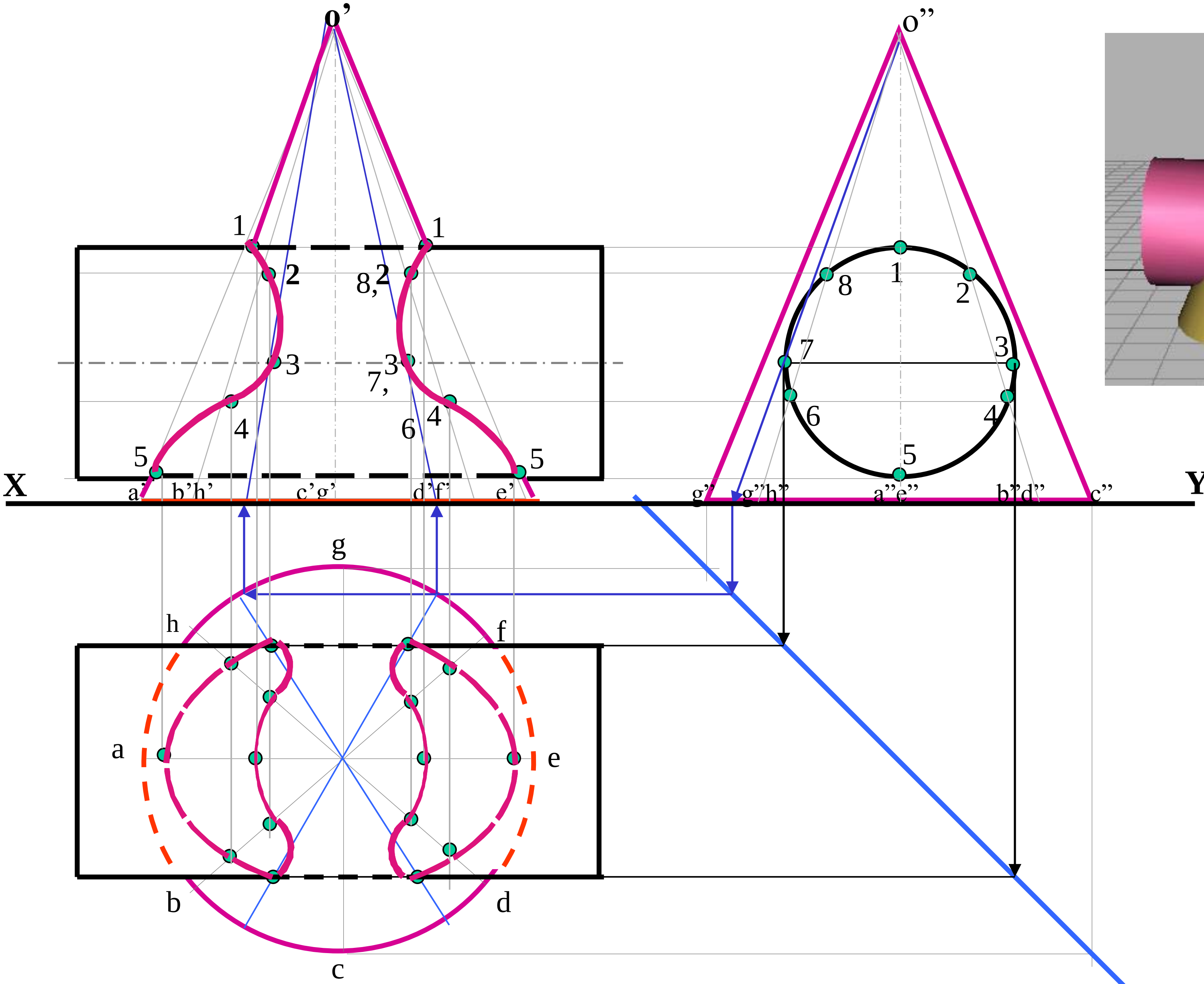


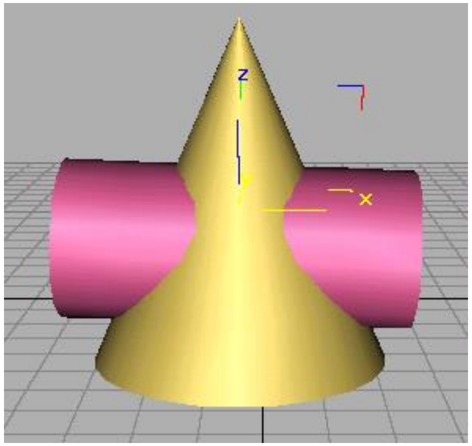


Problem: A cone70 mm base diameter and 90 mm axis is completely penetrated by a square prism from top with it's axis // to cone's axis and 5 mm away from it. a vertical plane containing both axes is parallel to Vp. Take all faces of sq.prism equally inclined to Vp. Base Side of prism is 0 mm and axis is 100 mm long. Draw projections showing curves of intersections.

Problem: A vertical cone, base diameter 75 mm and axis 100 mm long, is completely penetrated by a cylinder of 45 mm diameter. The axis of the cylinder is parallel to Hp and Vp and intersects axis of the cone at a point 28 mm above the base. Draw projections showing curves of intersection.

CASE 8.
CONE STANDING
&
CYLINDER PENETRATING





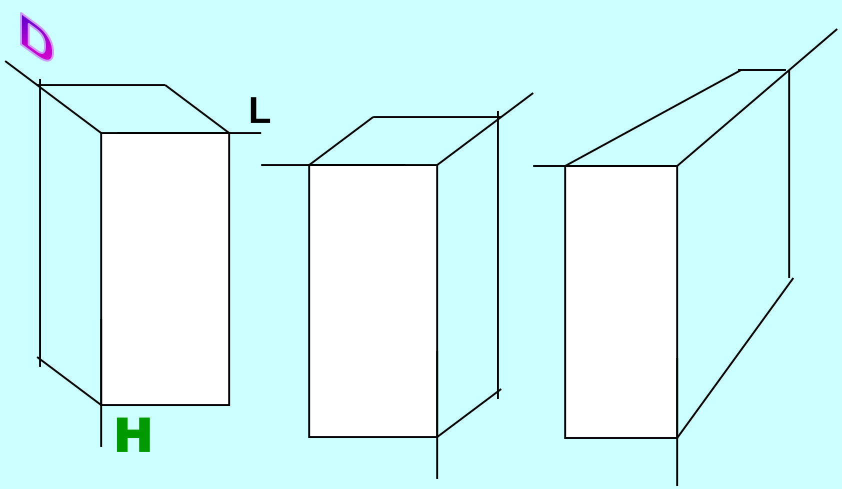
ISOMETRIC DRAWING

IT IS A TYPE OF PICTORIAL PROJECTION IN WHICH ALL THREE DIMENSIONS OF AN OBJECT ARE SHOWN IN ONE VIEW AND IF REQUIRED, THEIR ACTUAL SIZES CAN BE MEASURED DIRECTLY FROM IT.

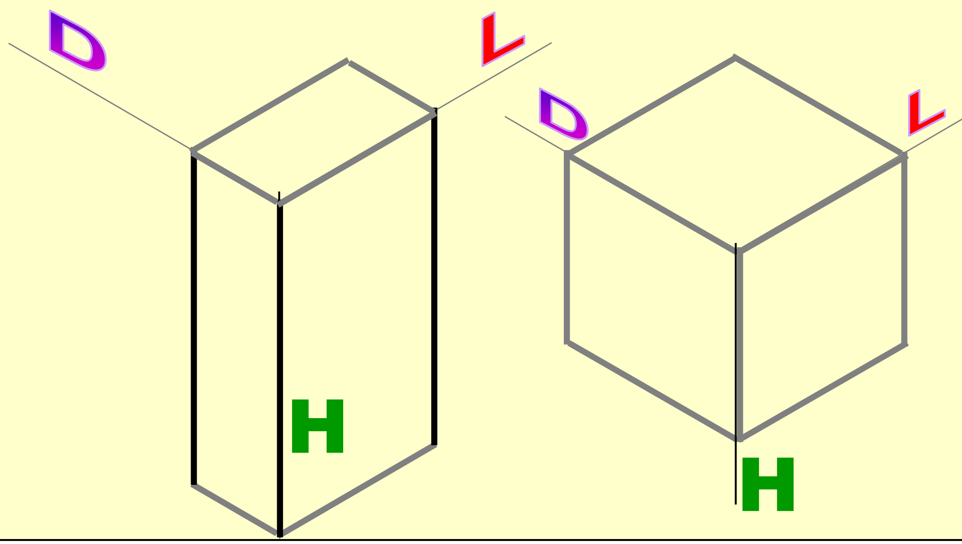
TYPICAL CONDITION.

IN THIS 3-D DRAWING OF AN OBJECT, ALL THREE DIMENSIONAL AXES ARE MENTAINED AT EQUAL INCLINATIONS WITH EACH OTHER.(120^0)

3-D DRAWINGS CAN BE DRAWN IN NUMEROUS WAYS AS SHOWN BELOW. ALL THESE DRAWINGS MAY BE CALLED 3-DIMENSIONAL DRAWINGS, OR PHOTOGRAPHIC OR PICTORIAL DRAWINGS. HERE NO SPECIFIC RELATION AMONG H, L & D AXES IS MENTAINED.



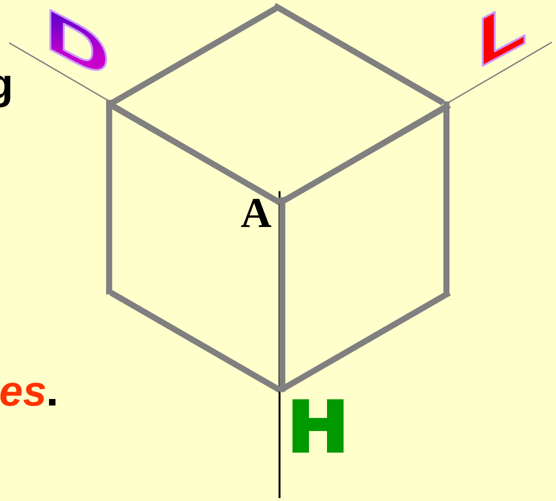
NOW OBSERVE BELOW GIVEN DRAWINGS. ONE CAN NOTE SPECIFIC INCLINATION AMONG H, L & D AXES. ISO MEANS SAME, SIMILAR OR EQUAL. HERE ONE CAN FIND EDUAL INCLINATION AMONG H, L & D AXES. EACH IS 120^0 INCLINED WITH OTHER TWO. HENCE IT IS CALLED ISOMETRIC DRAWING



PURPOSE OF ISOMETRIC DRAWING IS TO UNDERSTAND OVERALL SHAPE, SIZE & APPEARANCE OF AN OBJECT PRIOR TO IT'S PRODUCTION.

SOME IMPORTANT TERMS:

ISOMETRIC AXES, LINES AND PLANES:



The three lines AL, AD and AH, meeting at point A and making 120^0 angles with each other are termed *Isometric Axes.*

The lines parallel to these axes are called *Isometric Lines*.

The planes representing the faces of of the cube as well as other planes parallel to these planes are called *Isometric Planes*.

ISOMETRIC SCALE:

When one holds the object in such a way that all three dimensions are visible then in the process all dimensions become proportionally inclined to observer's eye sight and hence appear apparent in lengths.

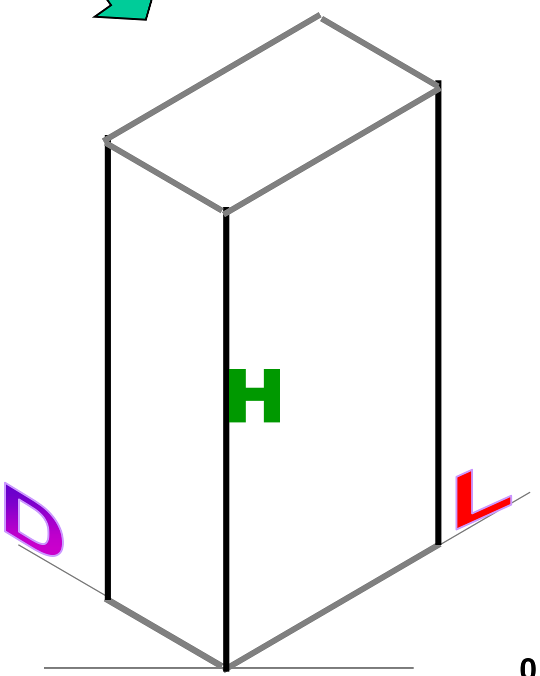
This reduction is 0.815 or 9 / 11 (approx.) It forms a reducing scale which Is used to draw isometric drawings and is called *Isometric scale.*

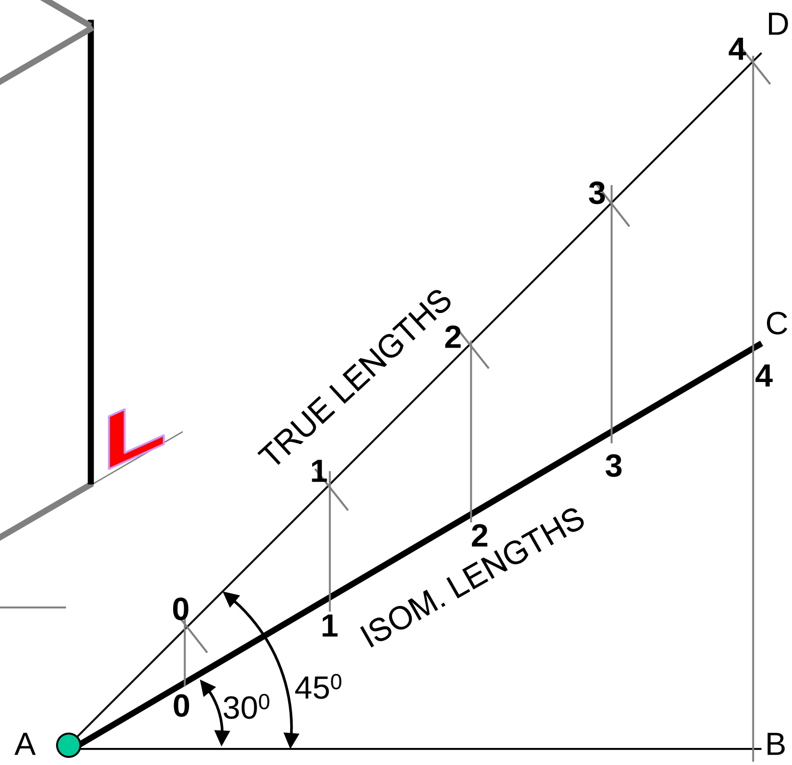
In practice, while drawing isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes. This is conveniently done by constructing an isometric scale as described on next page.

TYPES OF ISOMETRIC DRAWINGS

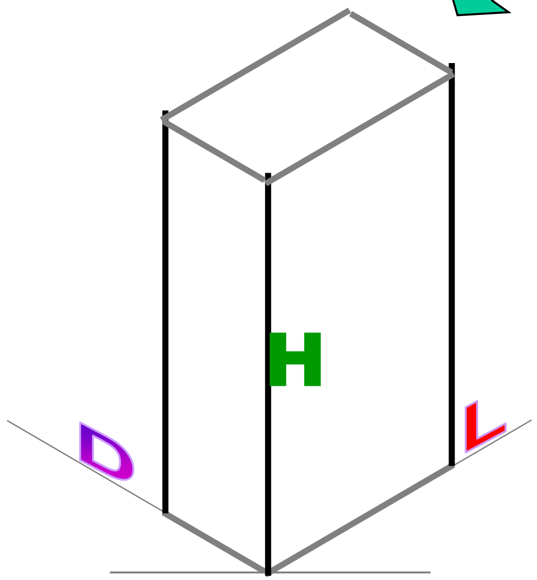
ISOMETRIC VIEW
Drawn by using True scale
(True dimensions)

ISOMETRIC PROJECTION
Drawn by using Isometric scale
(Reduced dimensions)





Isometric scale [Line AC]
required for Isometric Projection



CONSTRUCTION OF ISOM.SCALE.
From point A, with line AB draw 30^0 and 45^0 inclined lines AC & AD resp on AD.
Mark divisions of true length and from each division-point draw vertical lines upto AC line.
The divisions thus obtained on AC give lengths on isometric scale.

1

ISOMETRIC OF PLANE FIGURES

AS THESE ALL ARE 2-D FIGURES WE REQUIRE ONLY TWO ISOMETRIC AXES.

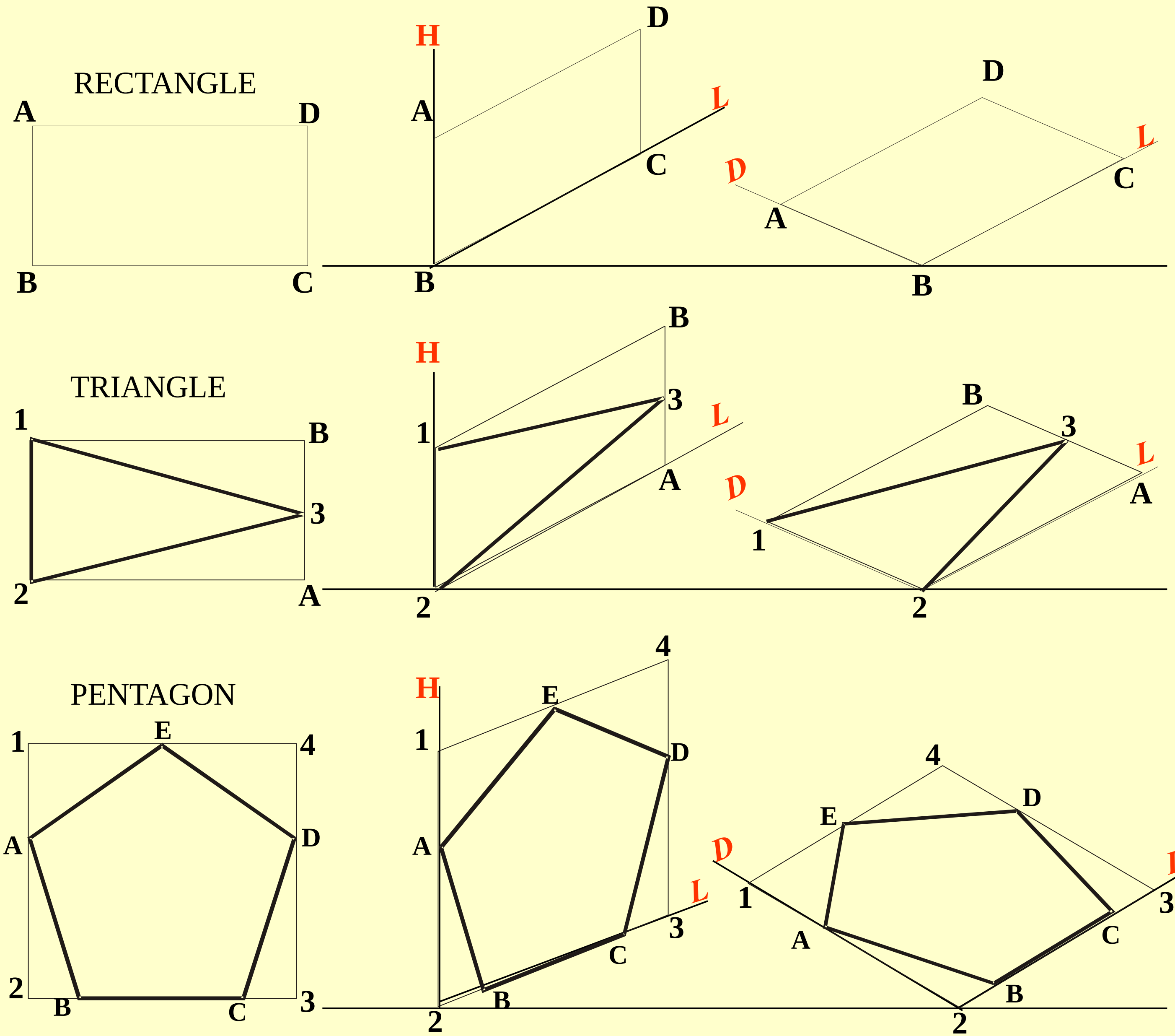
IF THE FIGURE IS FRONT VIEW, H & L AXES ARE REQUIRED.

IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

Shapes containing Inclined lines should be enclosed in a rectangle as shown. Then first draw isom. of that rectangle and then inscribe that shape as it is.

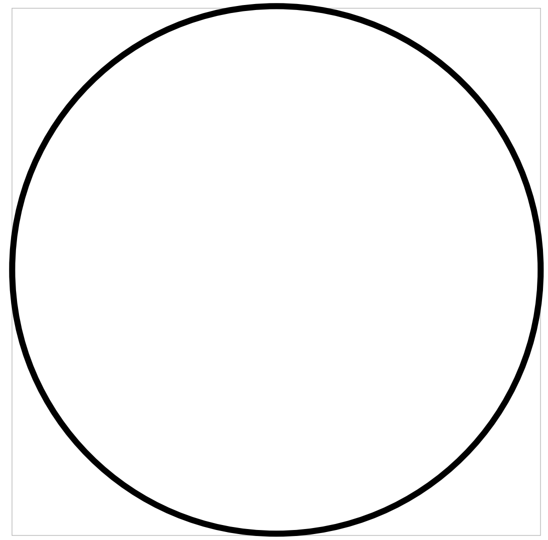
SHAPE

Isometric view if the Shape is F.V. or T.V.

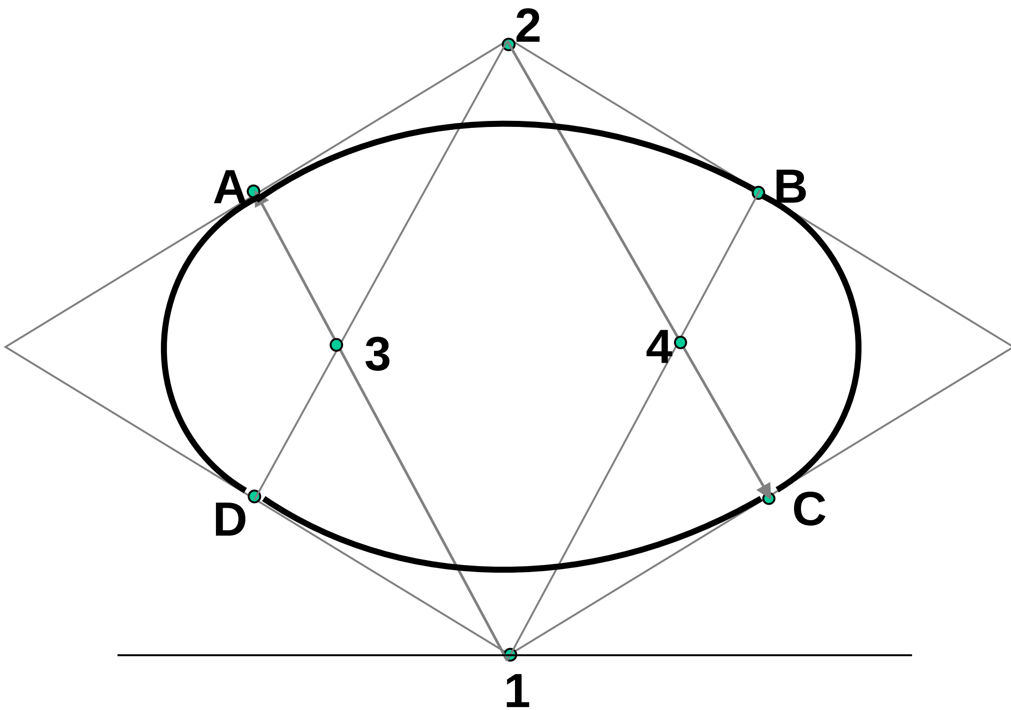


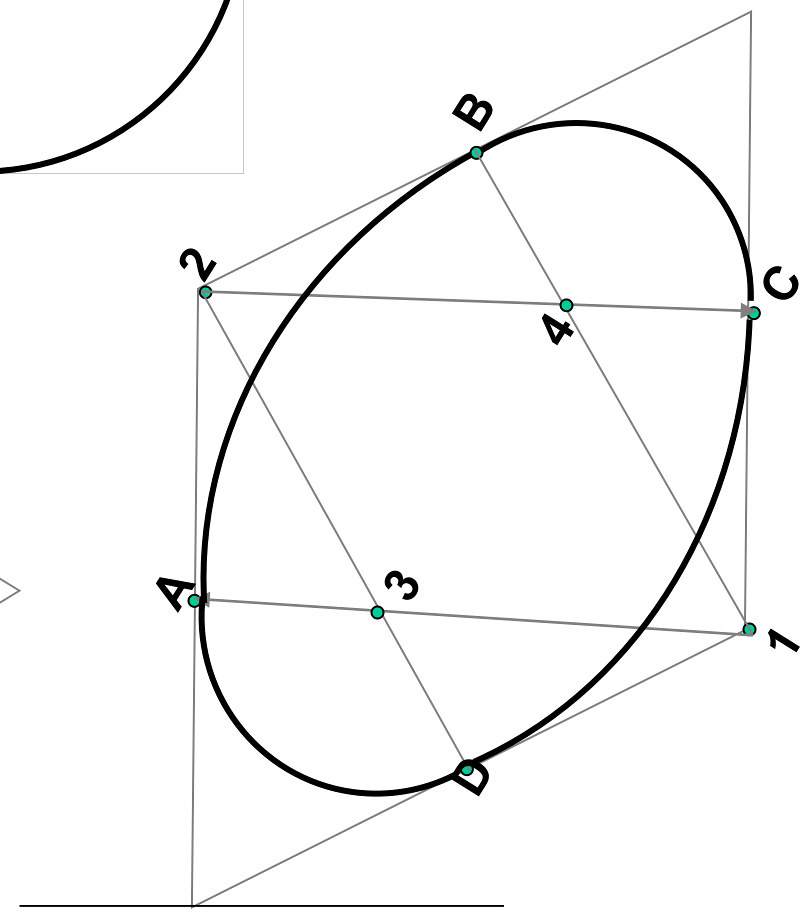
STUDY ILLUSTRATIONS

DRAW ISOMETRIC VIEW OF A CIRCLE IF IT IS A TV OR FV.



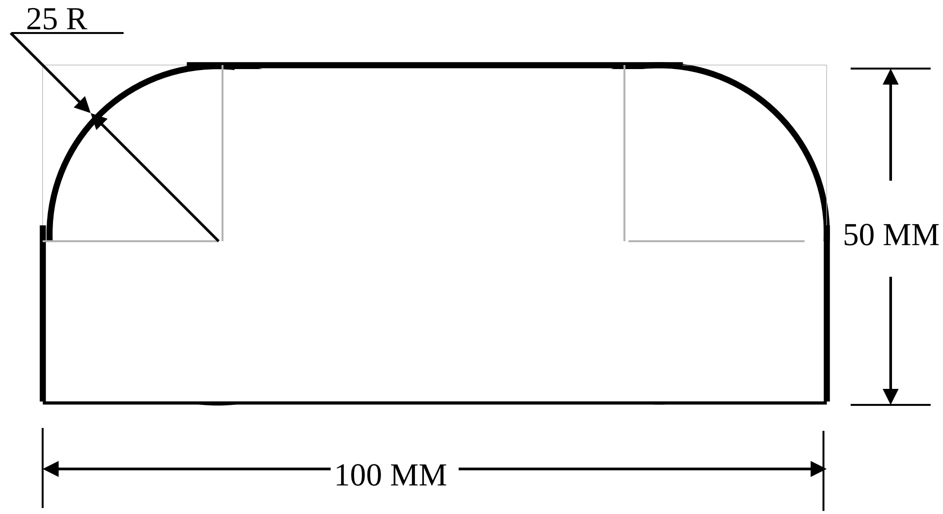
FIRST ENCLOSE IT IN A SQUARE.
IT'S ISOMETRIC IS A RHOMBUS WITH D & L AXES FOR TOP VIEW.
THEN USE H & L AXES FOR ISOMETRIC WHEN IT IS FRONT VIEW.
FOR CONSTRUCTION USE RHOMBUS METHOD SHOWN HERE. STUDY IT.



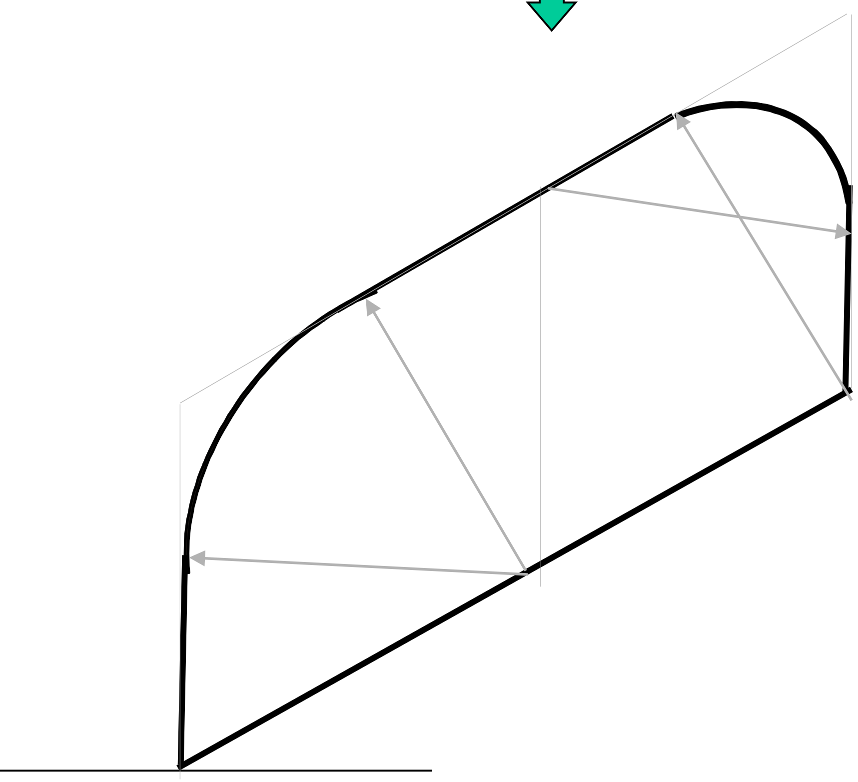


STUDY ILLUSTRATIONS

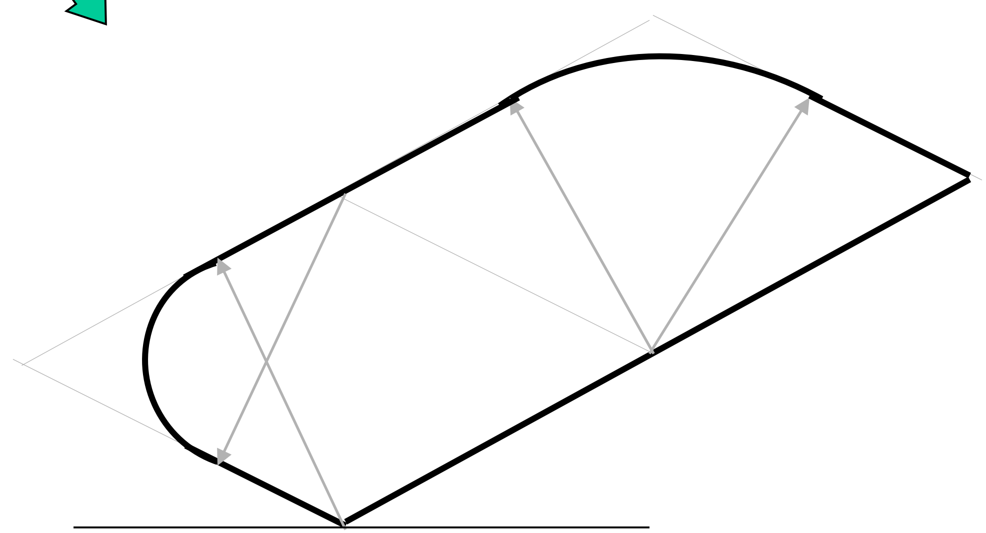
DRAW ISOMETRIC VIEW OF THE FIGURE SHOWN WITH DIMENTIONS (ON RIGHT SIDE) CONSIDERING IT FIRST AS F.V. AND THEN T.V.



IF FRONT VIEW



IF TOP VIEW



ISOMETRIC OF PLANE FIGURES

AS THESE ALL ARE 2-D FIGURES WE REQUIRE ONLY TWO ISOMETRIC AXES.

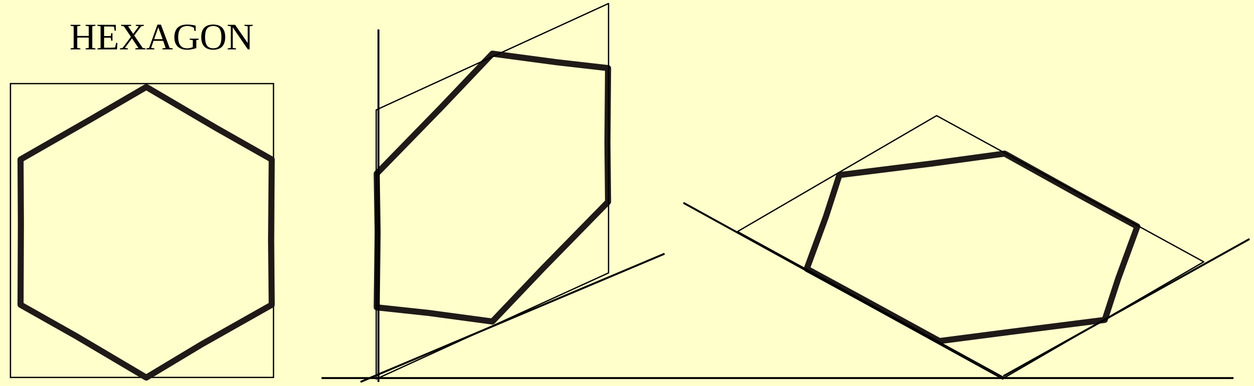
IF THE FIGURE IS FRONT VIEW, H & L AXES ARE REQUIRED.

IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

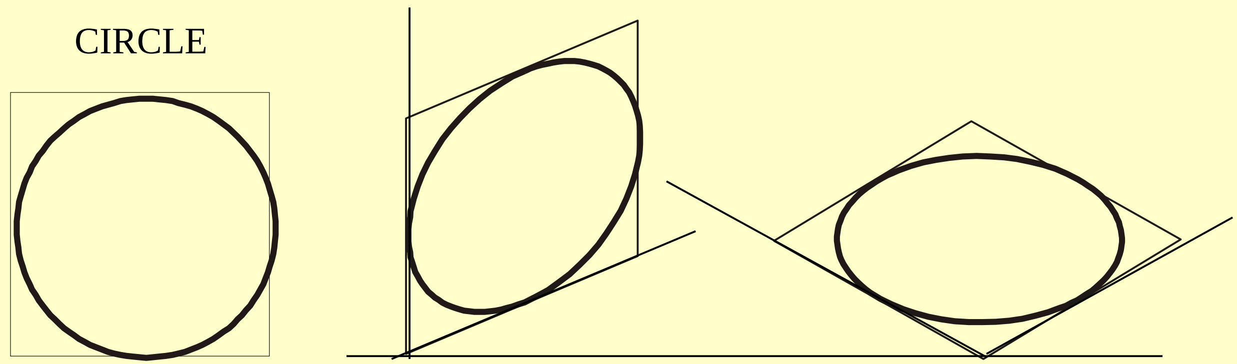
For Isometric of Circle/Semicircle use Rhombus method. Construct it of sides equal to diameter of circle always.
(Ref. Previous two pages.)

SHAPE	IF F.V.	IF T.V.

HEXAGON

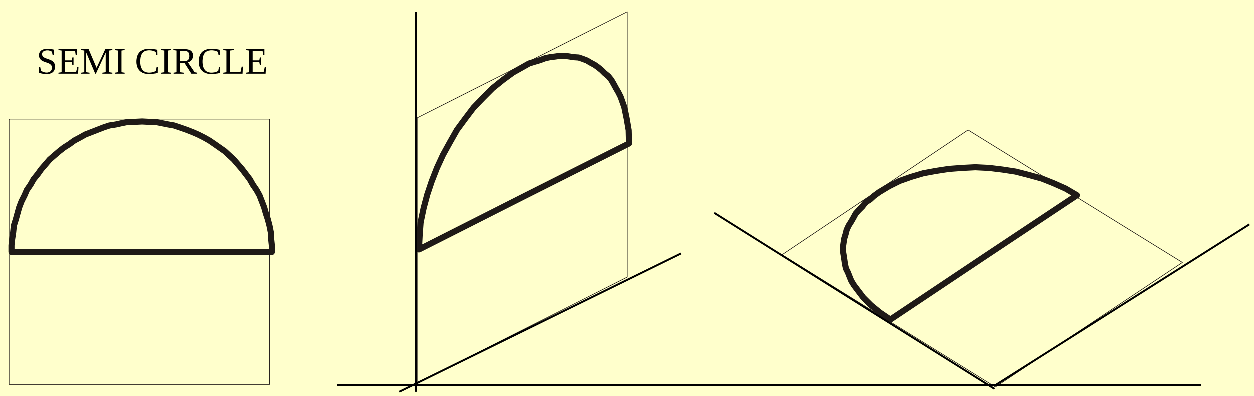


CIRCLE



***For Isometric of Circle/Semicircle use* Rhombus method. *Construct Rhombus of sides equal to Diameter of circle always.* (Ref. topic ENGG. CURVES.)**

SEMI CIRCLE



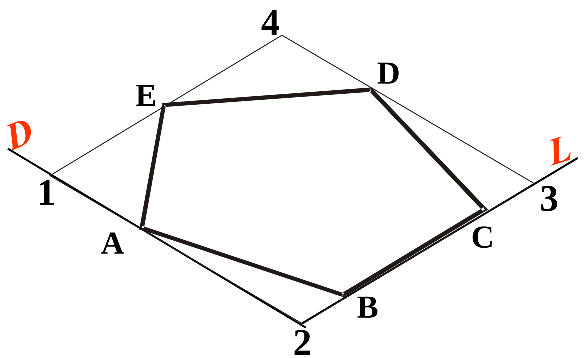
STUDY ILLUSTRATIONS

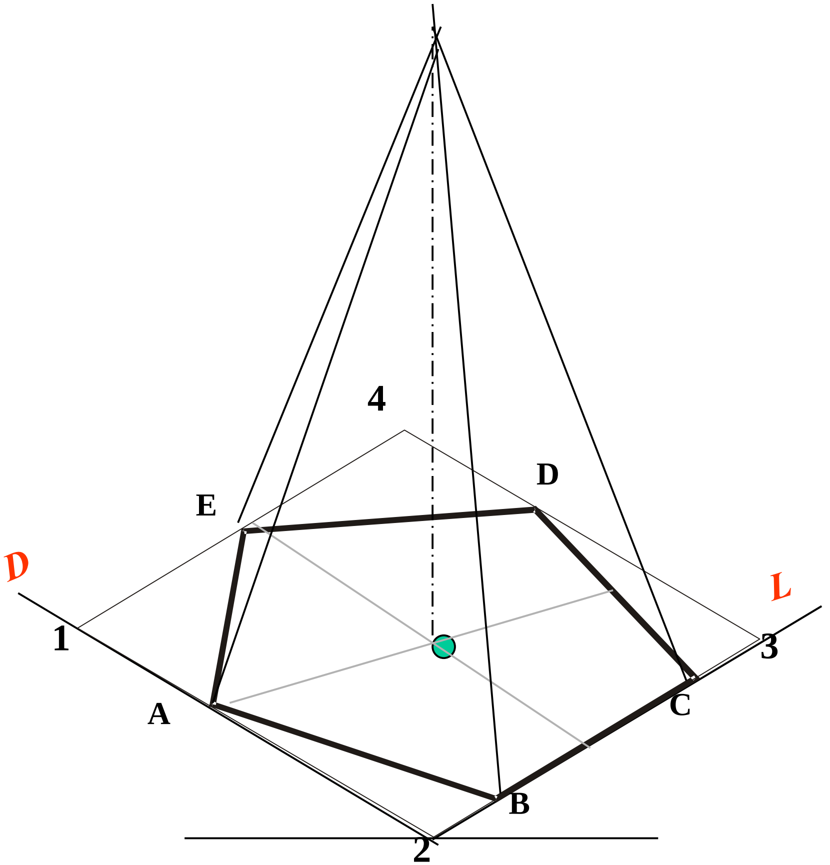
7

ISOMETRIC VIEW OF PENTAGONAL PYRAMID STANDING ON H.P.

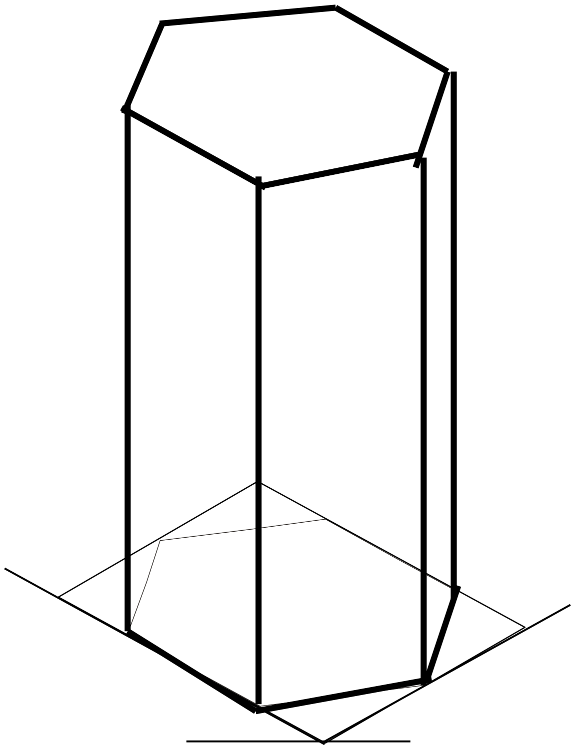
(Height is added from center of pentagon)

ISOMETRIC VIEW OF BASE OF PENTAGONAL PYRAMID STANDING ON H.P.



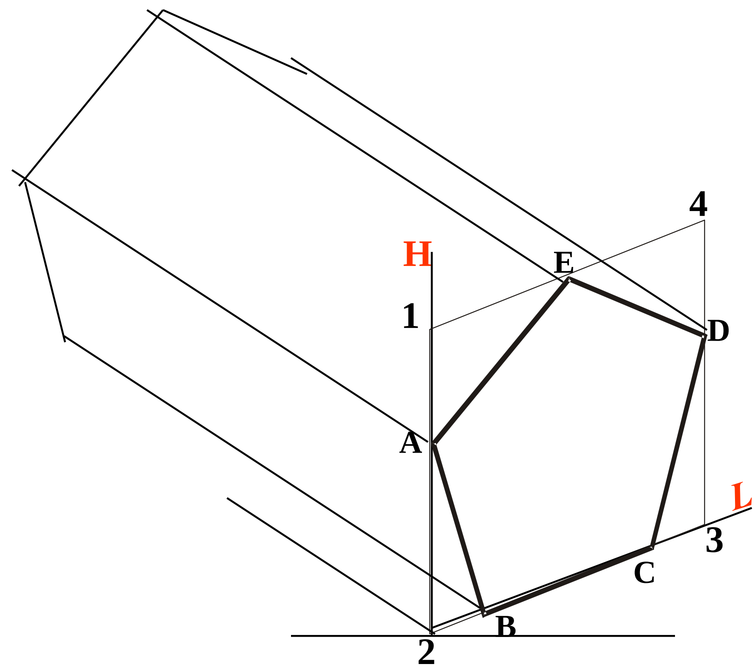


STUDY ILLUSTRATIONS



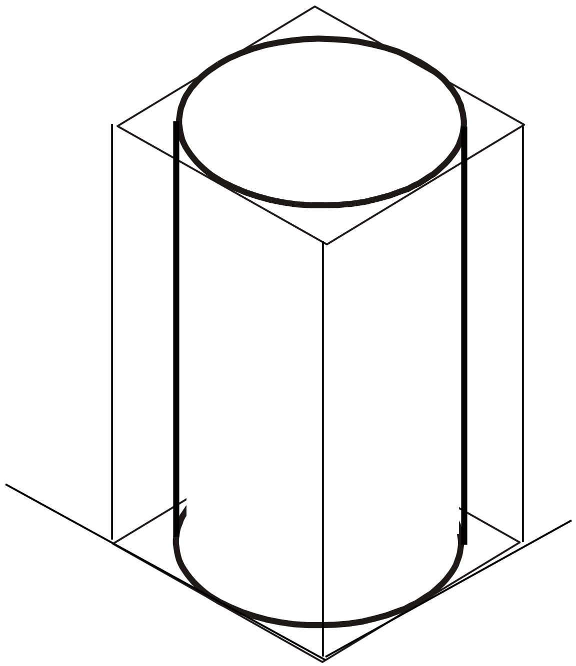
ISOMETRIC VIEW OF
HEXAGONAL PRISM
STANDING ON H.P.

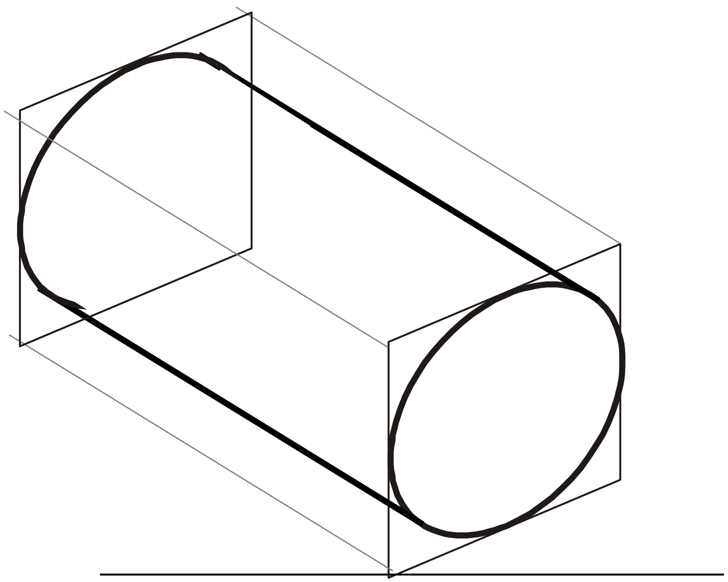
ISOMETRIC VIEW OF
PENTAGONALL PRISM
LYING ON H.P.



STUDY ILLUSTRATIONS

CYLINDER STANDING ON H.P.



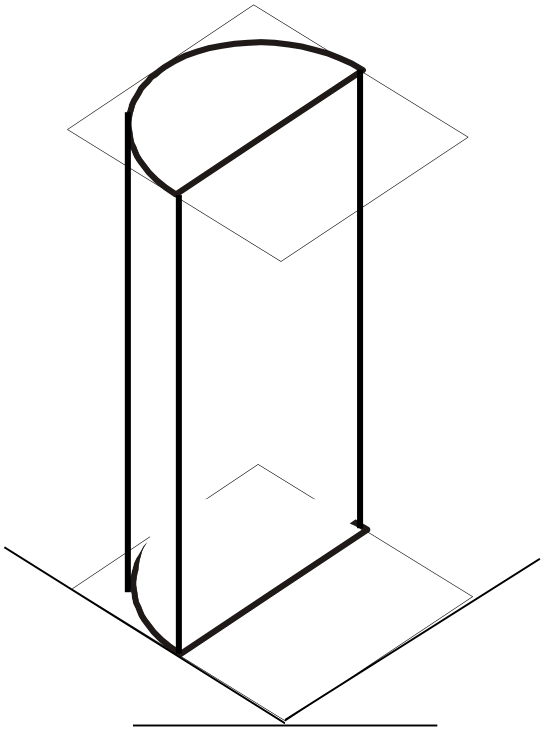


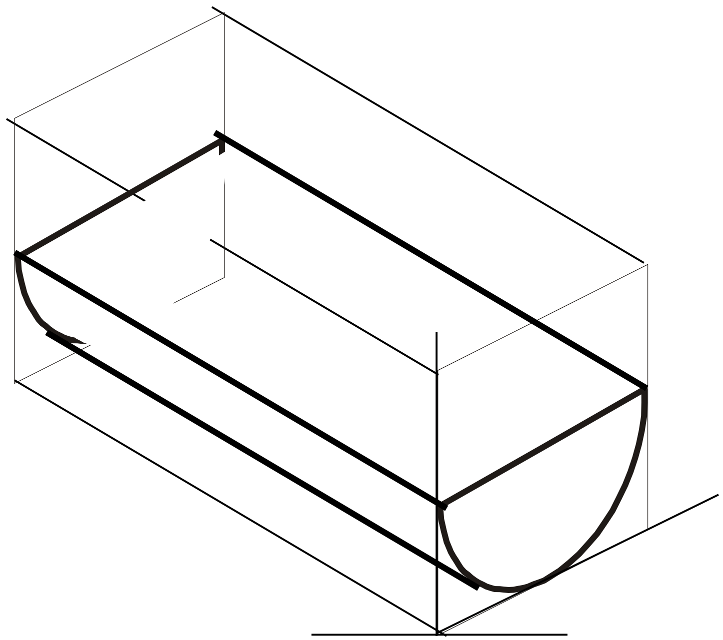
CYLINDER LYING ON H.P.

STUDY ILLUSTRATIONS

HALF CYLINDER STANDING ON H.P.

(ON IT'S SEMICIRCULAR BASE)



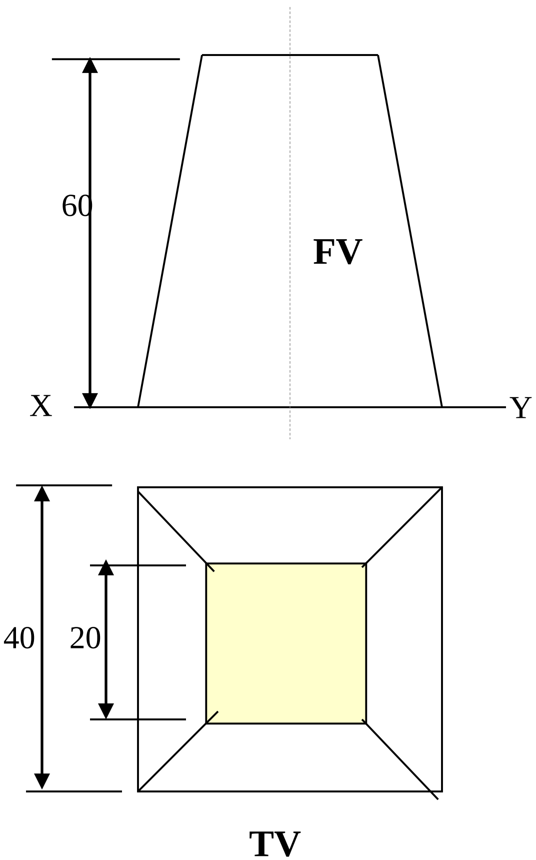


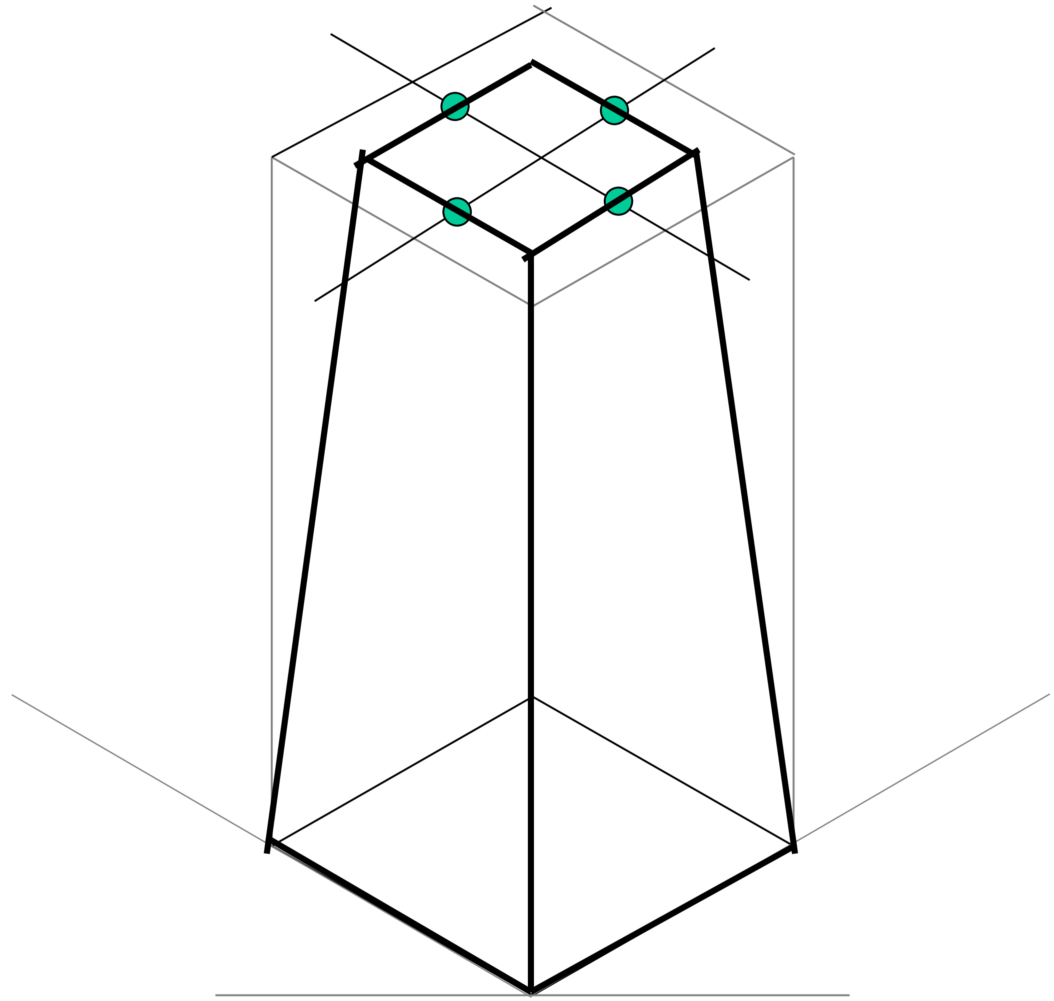
HALF CYLINDER LYING ON H.P.

(with flat face // to H.P.)

STUDY ILLUSTRATIONS

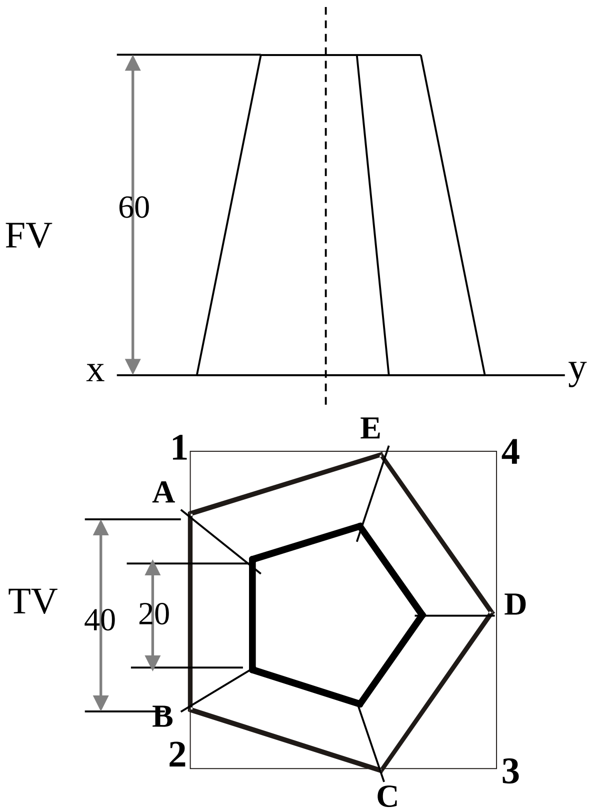
ISOMETRIC VIEW OF
A FRUSTOM OF SQUARE PYRAMID
STANDING ON H.P. ON IT'S LARGER BASE.





STUDY ILLUSTRATION

PROJECTIONS OF FRUSTOM OF PENTAGONAL PYRAMID ARE GIVEN. DRAW IT'S ISOMETRIC VIEW.



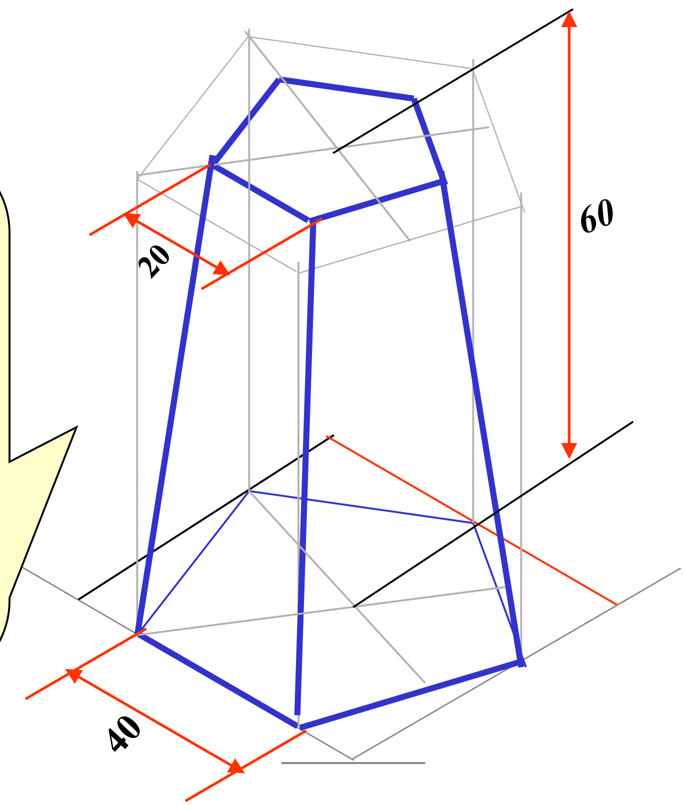
SOLUTION STEPS:

FIRST DRAW ISOMETRIC OF IT'S BASE.

THEN DRAWSAME SHAPE AS TOP, 60 MM ABOVE THE BASE PENTAGON CENTER.

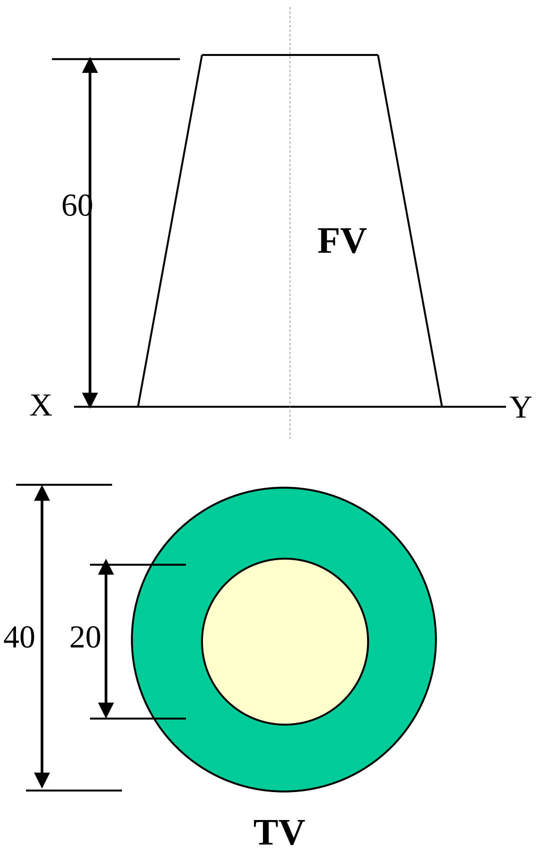
THEN REDUCE THE TOP TO 20 MM SIDES AND JOIN WITH THE PROPER BASE CORNERS.

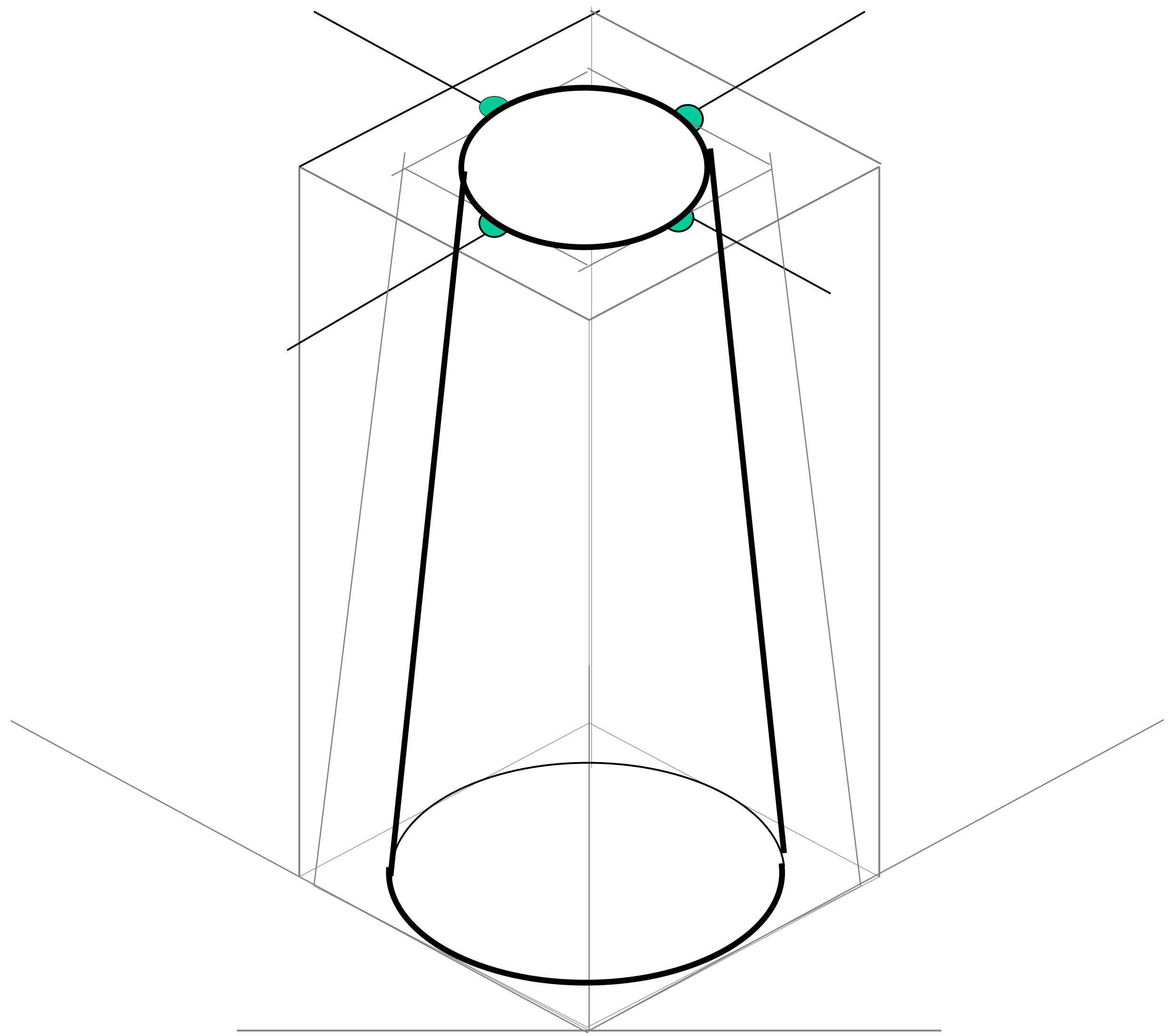
ISOMETRIC VIEW OF FRUSTOM OF PENTAGONAL PYRAMID



STUDY ILLUSTRATIONS

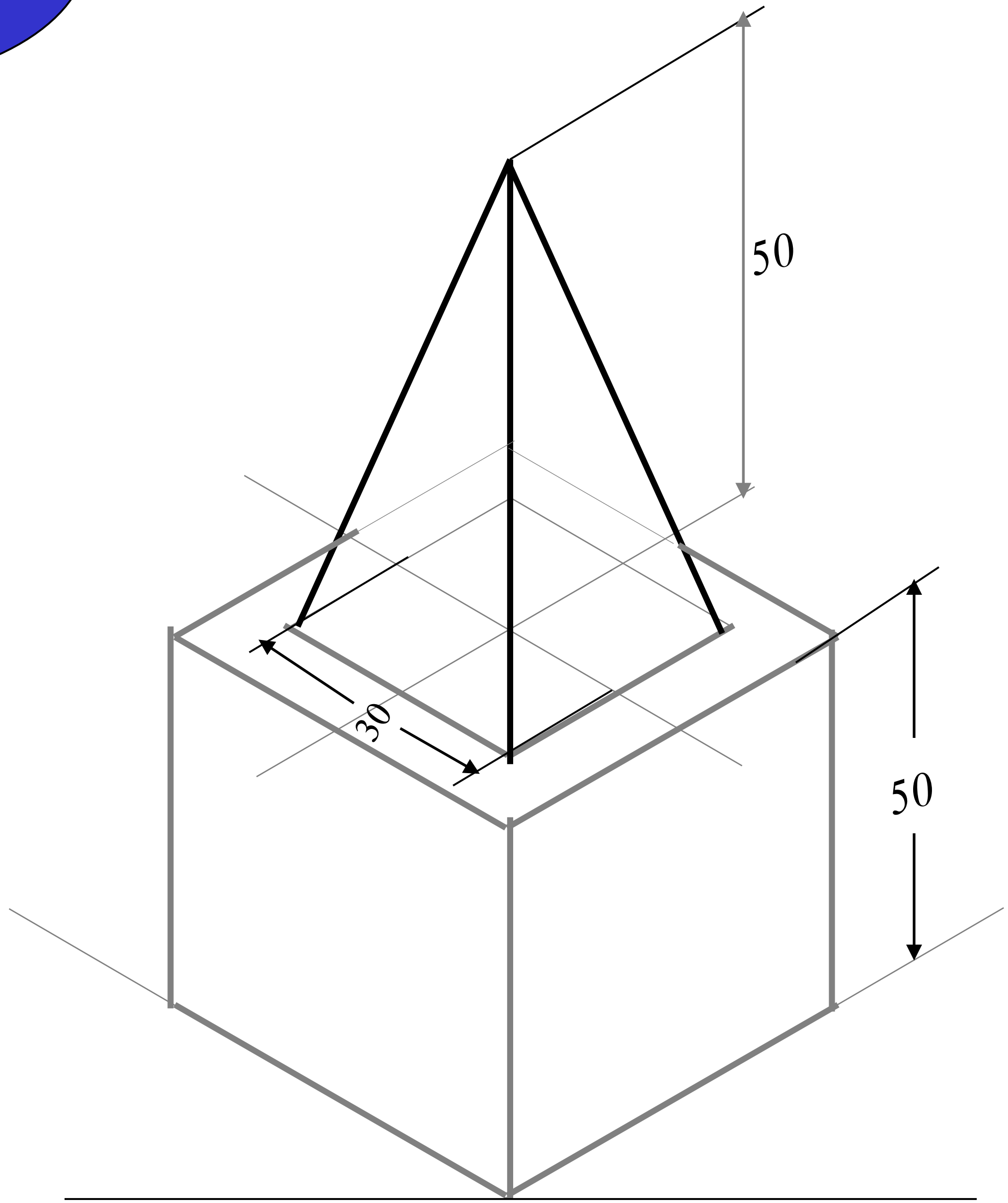
ISOMETRIC VIEW OF
A FRUSTOM OF CONE
STANDING ON H.P. ON IT'S LARGER BASE.





STUDY ILLUSTRATIONS

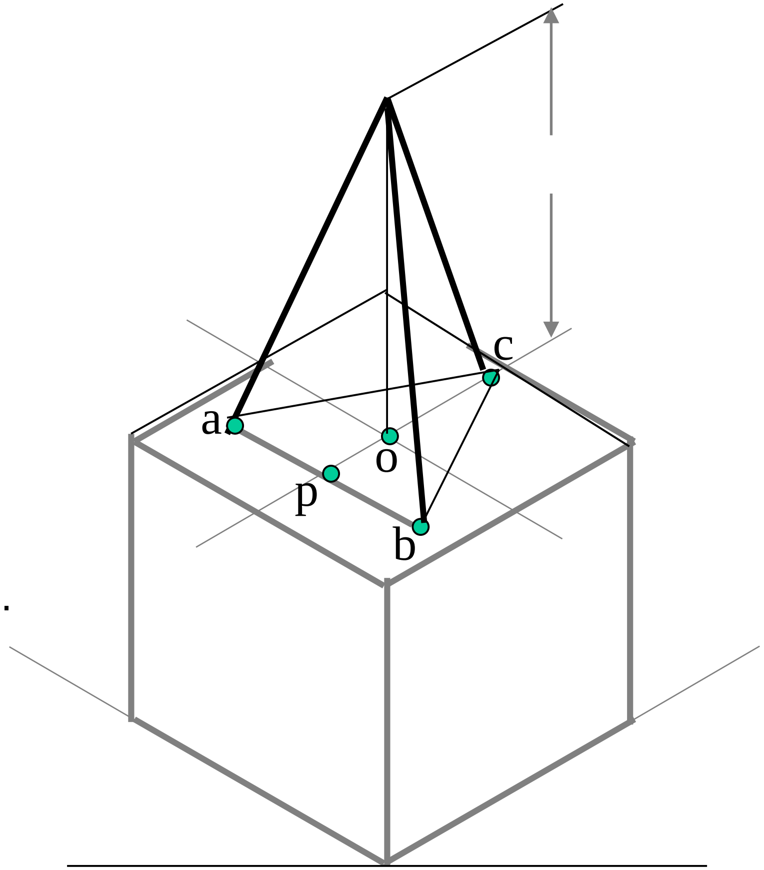
PROBLEM: A SQUARE PYRAMID OF 30 MM BASE SIDES AND 50 MM LONG AXIS, IS CENTRALLY PLACED ON THE TOP OF A CUBE OF 50 MM LONG EDGES.DRAW ISOMETRIC VIEW OF THE PAIR.

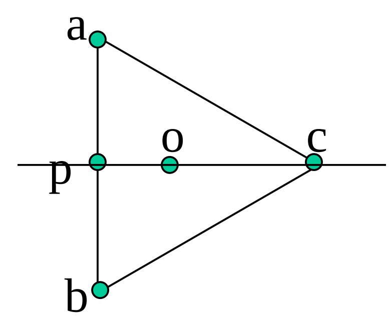


STUDY ILLUSTRATIONS

Z

PROBLEM: A TRIANGULAR PYRAMID OF 30 MM BASE SIDES AND 50 MM LONG AXIS, IS CENTRALLY PLACED ON THE TOP OF A CUBE OF 50 MM LONG EDGES.
DRAW ISOMETRIC VIEW OF THE PAIR.





SOLUTION HINTS.

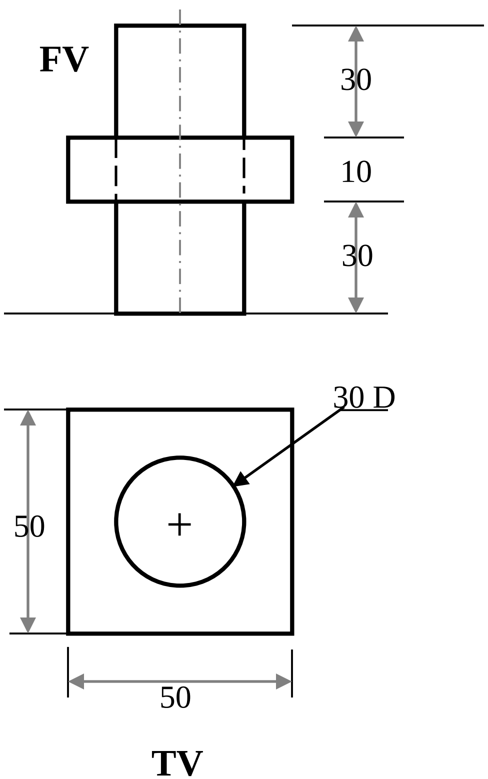
TO DRAW ISOMETRIC OF A CUBE IS SIMPLE. DRAW IT AS USUAL.

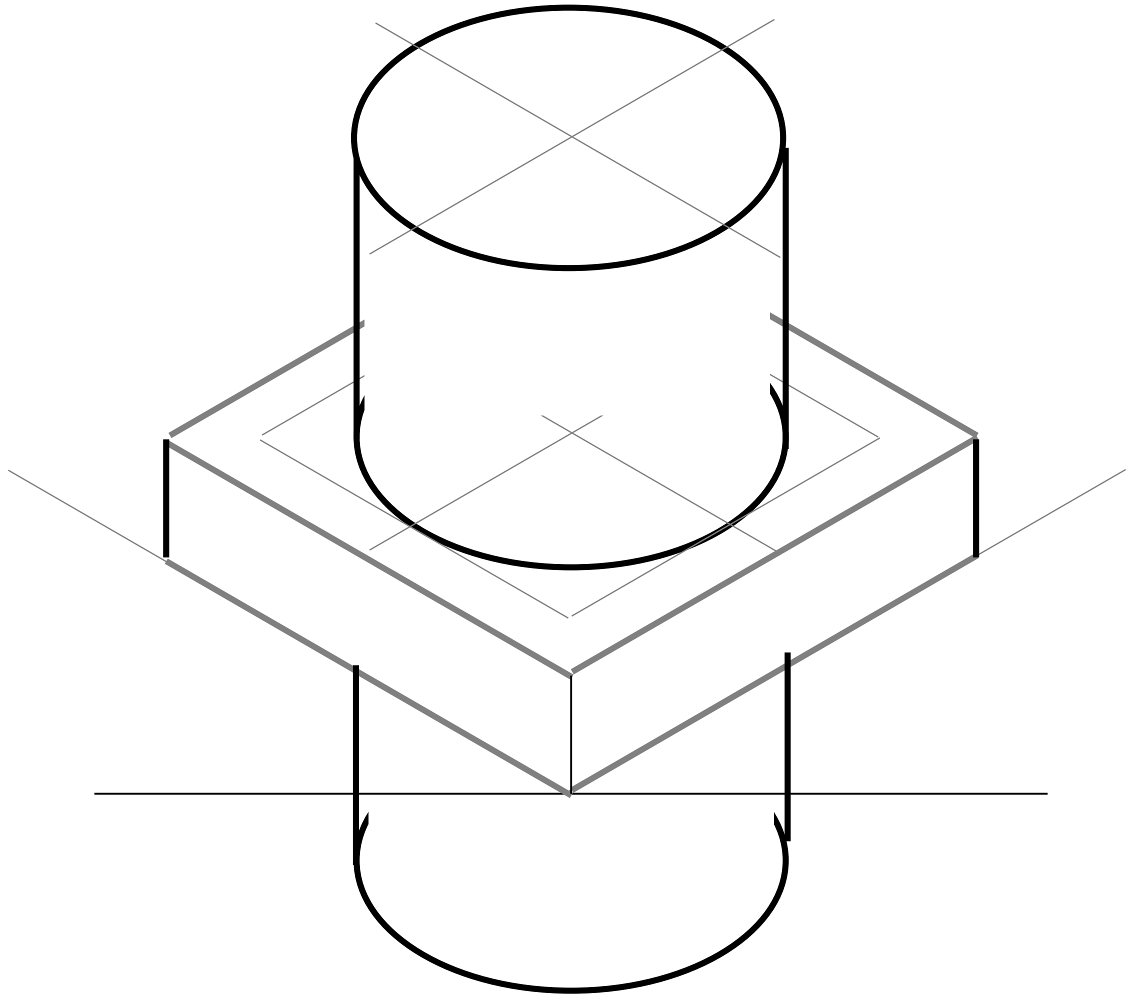
BUT FOR PYRAMID AS IT'S BASE IS AN EQUILATERAL TRIANGLE,
IT CAN NOT BE DRAWN DIRECTLY.SUPPORT OF IT'S TV IS REQUIRED.

SO DRAW TRIANGLE AS A TV, SEPARATELY AND NAME VARIOUS POINTS AS SHOWN.
AFTER THIS PLACE IT ON THE TOP OF CUBE AS SHOWN.
THEN ADD HEIGHT FROM IT'S CENTER AND COMPLETE IT'S ISOMETRIC AS SHOWN.

STUDY ILLUSTRATIONS

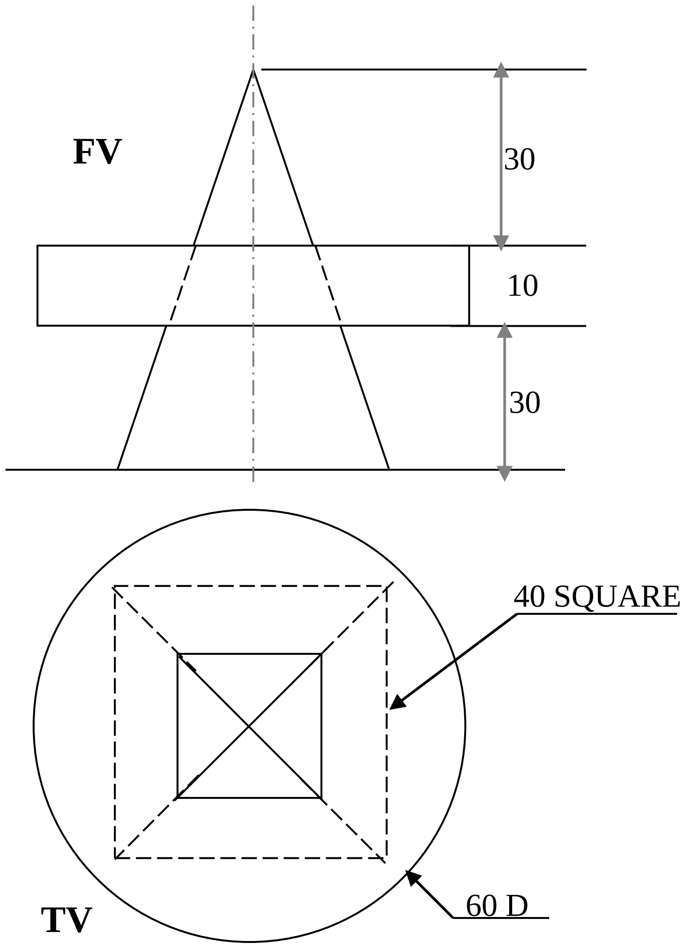
PROBLEM:
A SQUARE PLATE IS PIERCED THROUGH CENTRALLY BY A CYLINDER WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.

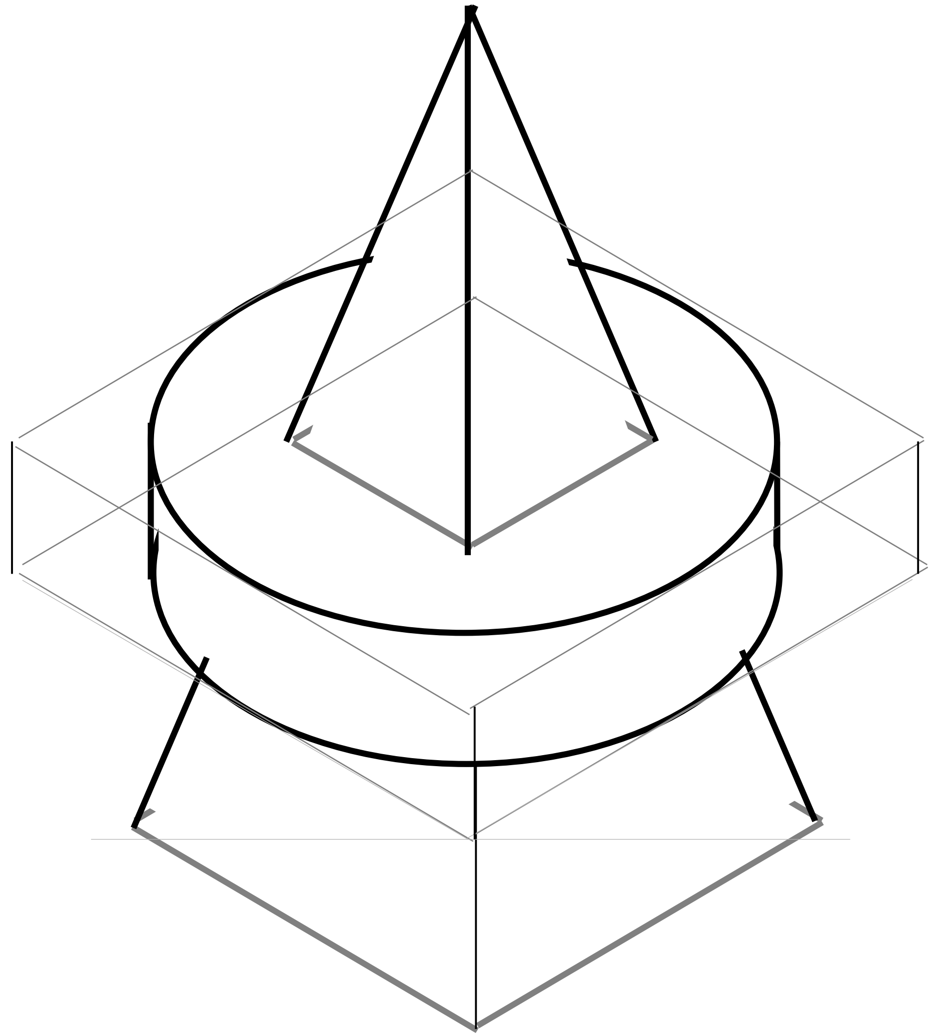




STUDY ILLUSTRATIONS

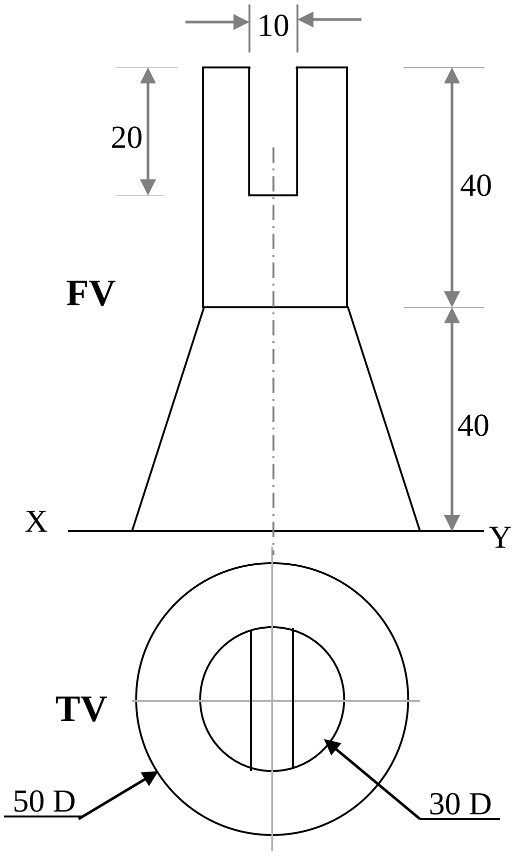
PROBLEM:
A CIRCULAR PLATE IS PIERCED THROUGH CENTRALLY BY A SQUARE PYRAMID WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.

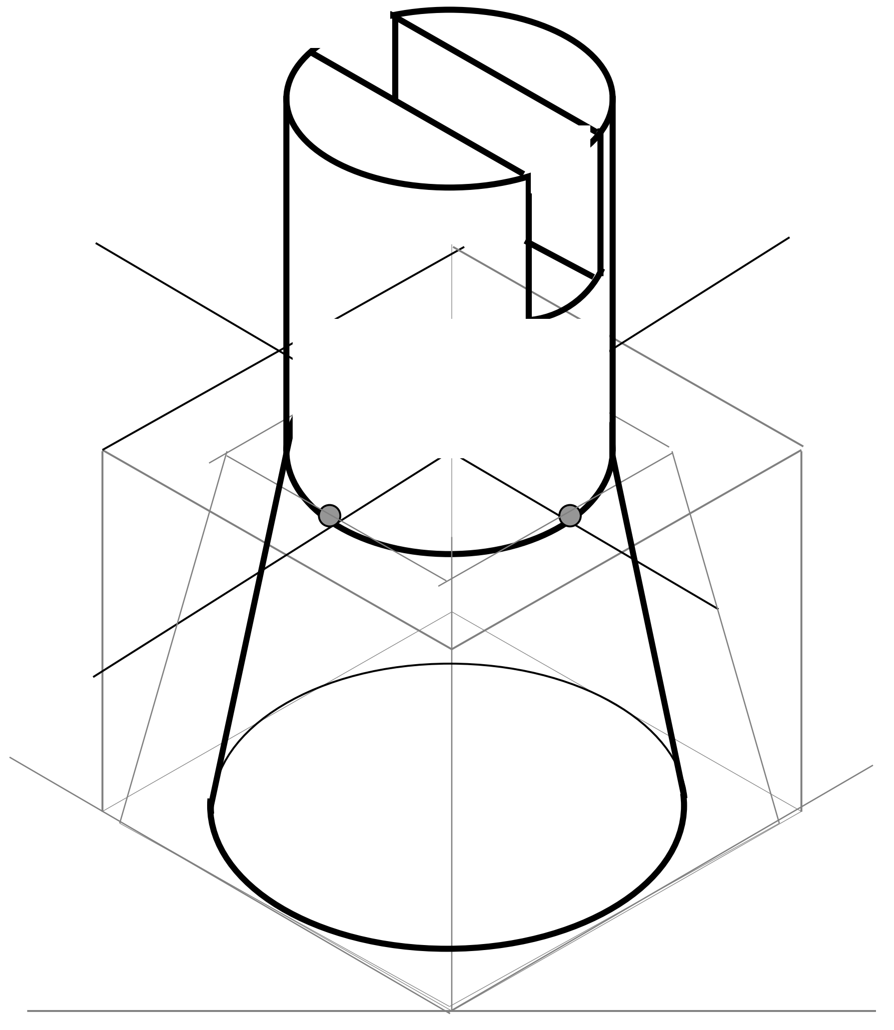




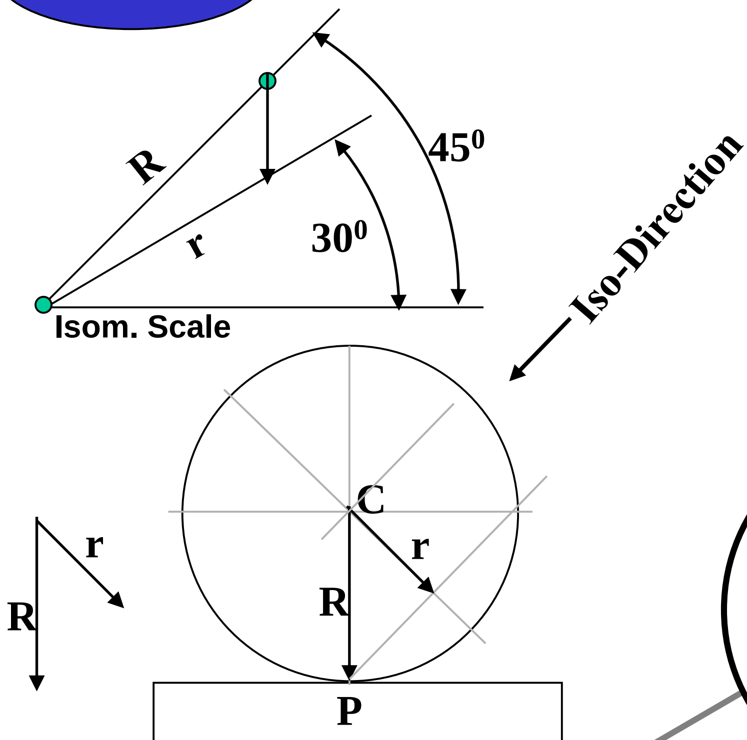
STUDY ILLUSTRATIONS

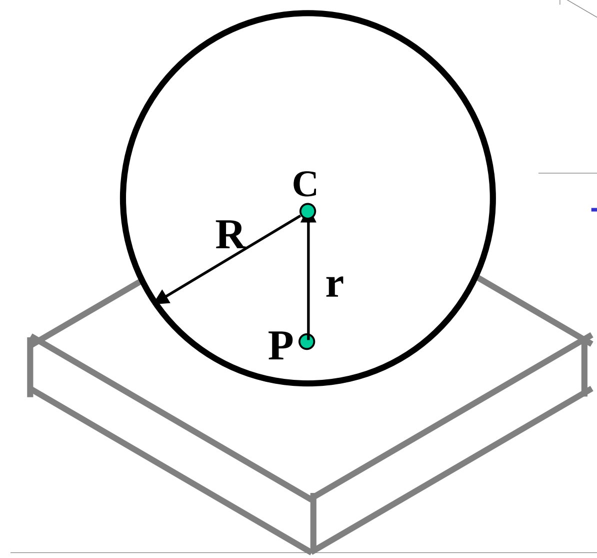
F.V. & T.V. of an object are given. Draw it's isometric view.

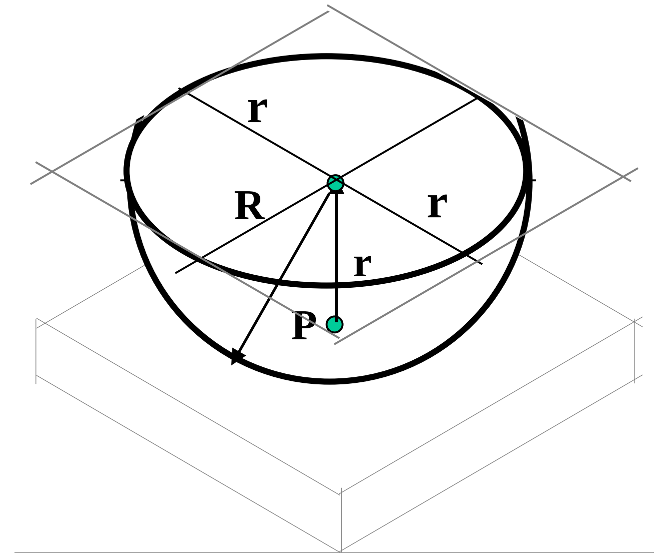




ISOMETRIC PROJECTIONS OF SPHERE & HEMISPHERE







TO DRAW ISOMETRIC PROJECTION OF A HEMISPHERE

C = Center of Sphere.
P = Point of contact
R = True Radius of Sphere
r = Isometric Radius.

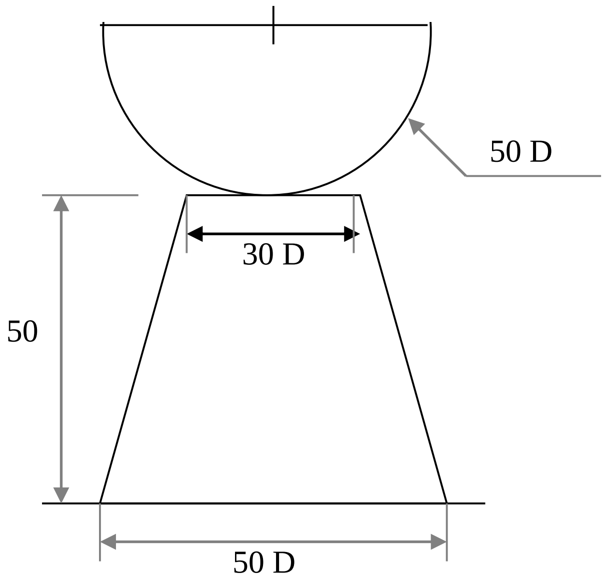
Adopt same procedure.
Draw lower semicircle only.
Then around 'C' construct Rhombus of Sides equal to Isometric Diameter.
For this use iso-scale.
Then construct ellipse in this Rhombus as usual
And Complete Isometric-Projection of Hemi-sphere.

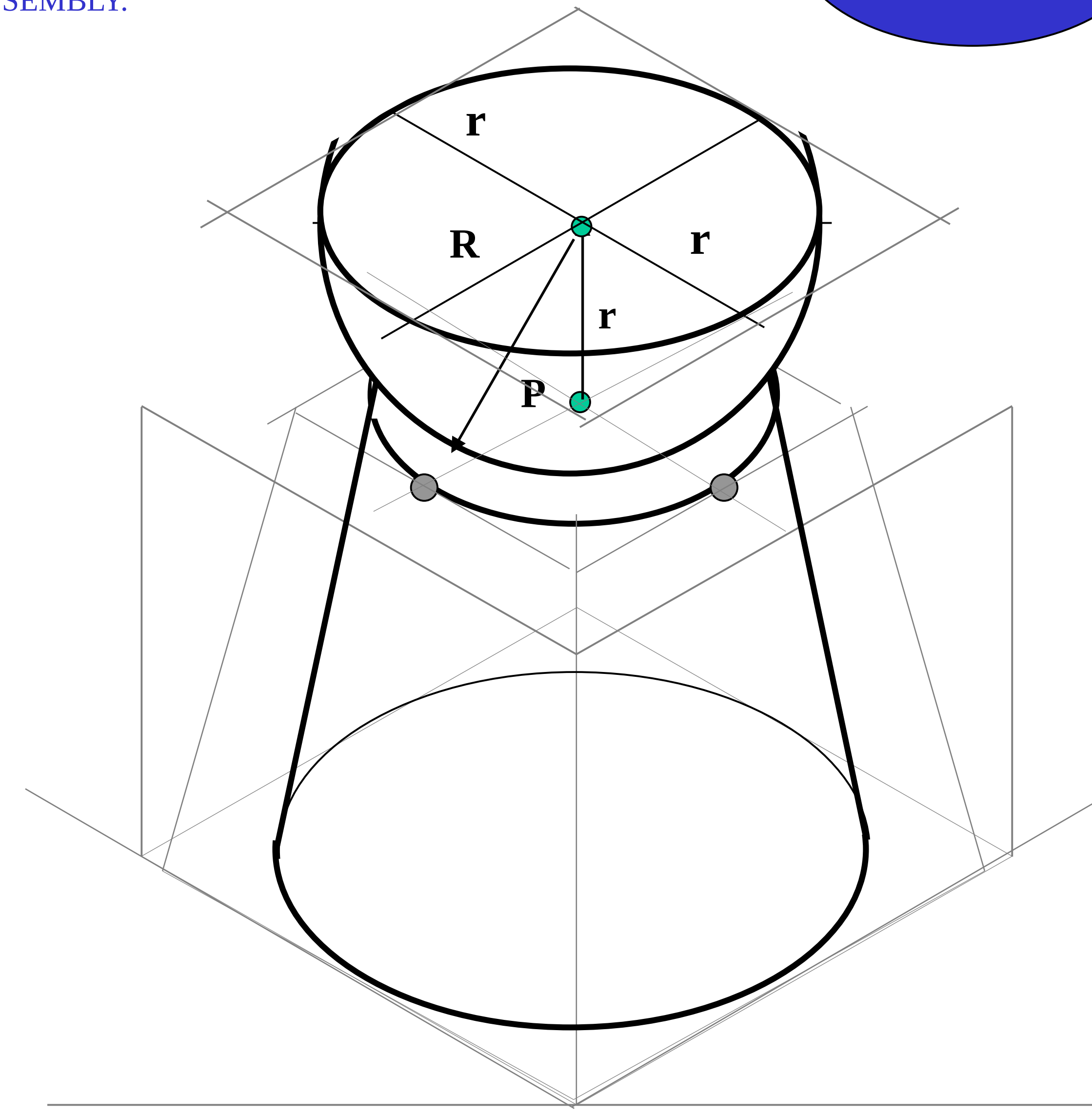
TO DRAW ISOMETRIC PROJECTION OF A SPHERE

1. FIRST DRAW ISOMETRIC OF SQUARE PLATE.
2. LOCATE IT'S CENTER. NAME IT P.
3. FROM PDRAW VERTICAL LINE UPWARD, LENGTH ' r mm' AND LOCATE CENTER OF SPHERE "C"
4. 'C' AS CENTER, WITH RADIUS 'R' DRAW CIRCLE.
   THIS IS ISOMETRIC PROJECTION OF A SPHERE.

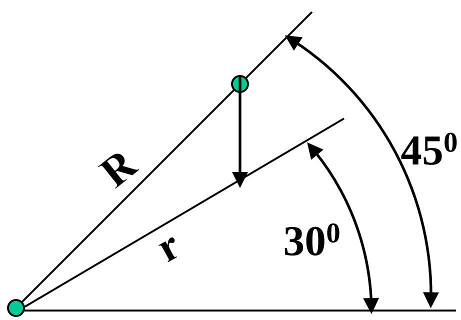
PROBLEM:

A HEMI-SPHERE IS CENTRALLY PLACED
ON THE TOP OF A FRUSTOM OF CONE.
DRAW ISOMETRIC PROJECTIONS OF THE ASSEMBLY.





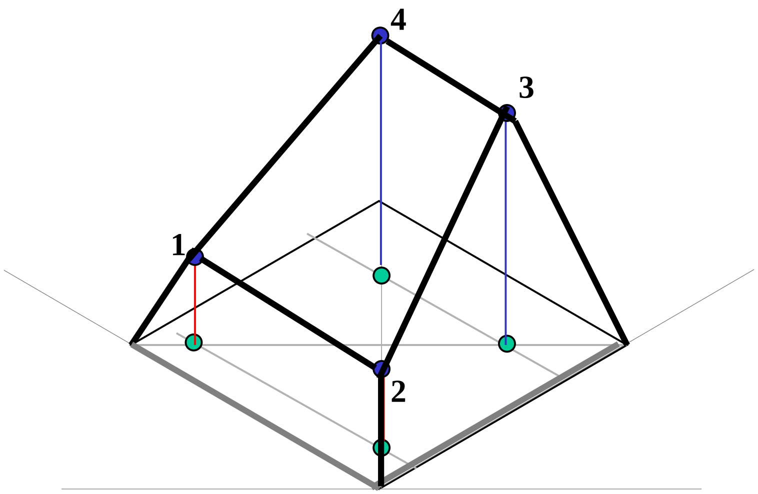
FIRST CONSTRUCT ISOMETRIC SCALE.
USE THIS SCALE FOR ALL DIMENSIONS
IN THIS PROBLEM.

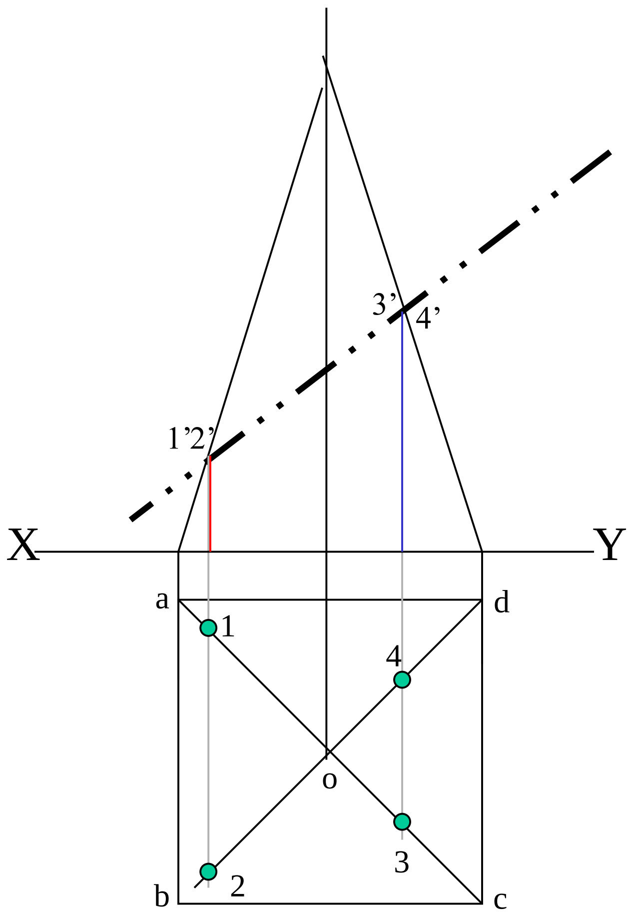


STUDY ILLUSTRATIONS

7

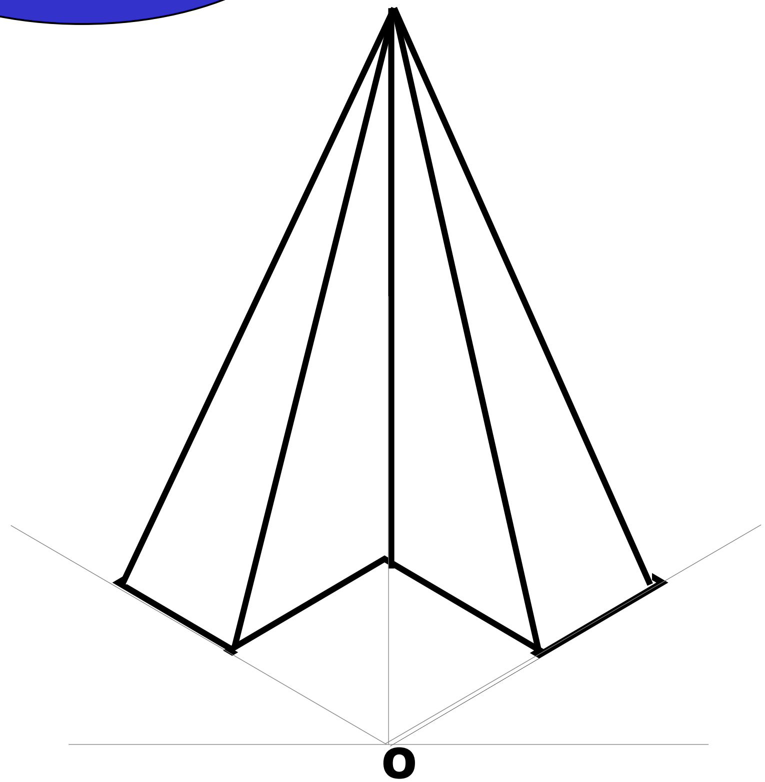
A SQUARE PYRAMID OF 40 MM BASE SIDES AND 60 MM AXIS IS CUT BY AN INCLINED SECTION PLANE THROUGH THE MID POINT OF AXIS AS SHOWN.DRAW ISOMETRIC VIEW OF SECTION OF PYRAMID.

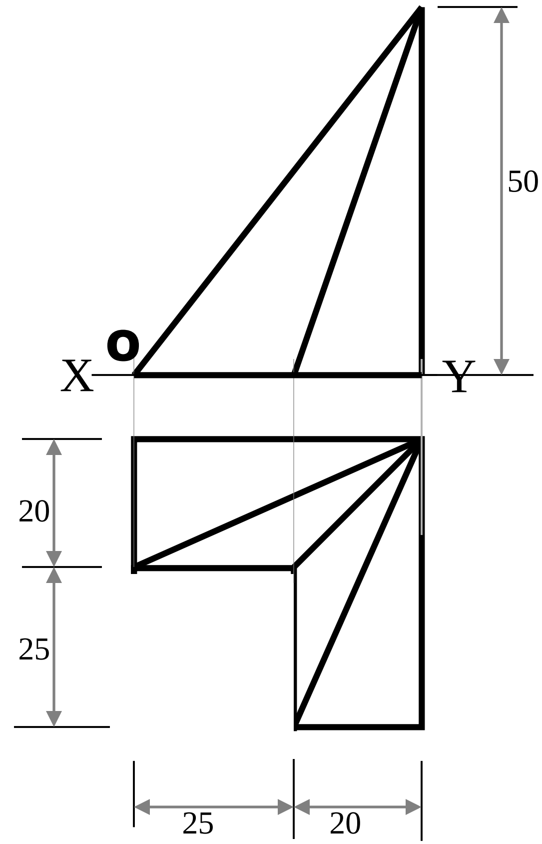




STUDY ILLUSTRATIONS

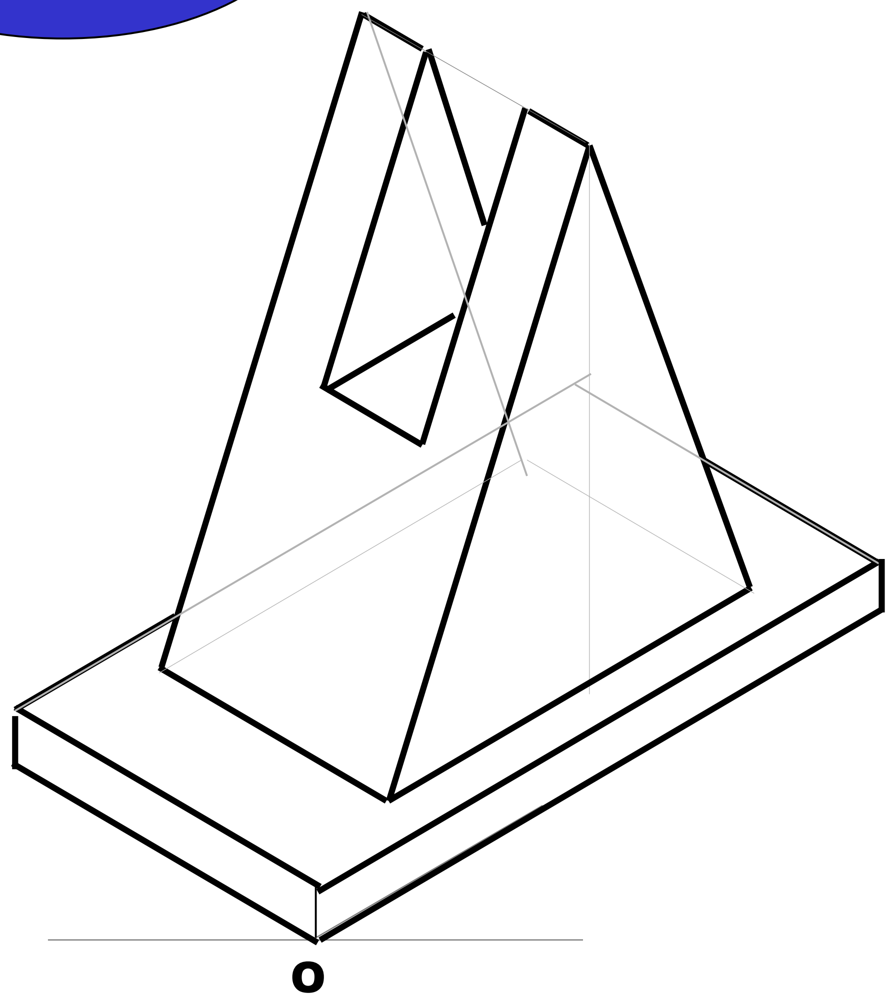
F.V. & T.V. of an object are given. Draw it's isometric view.

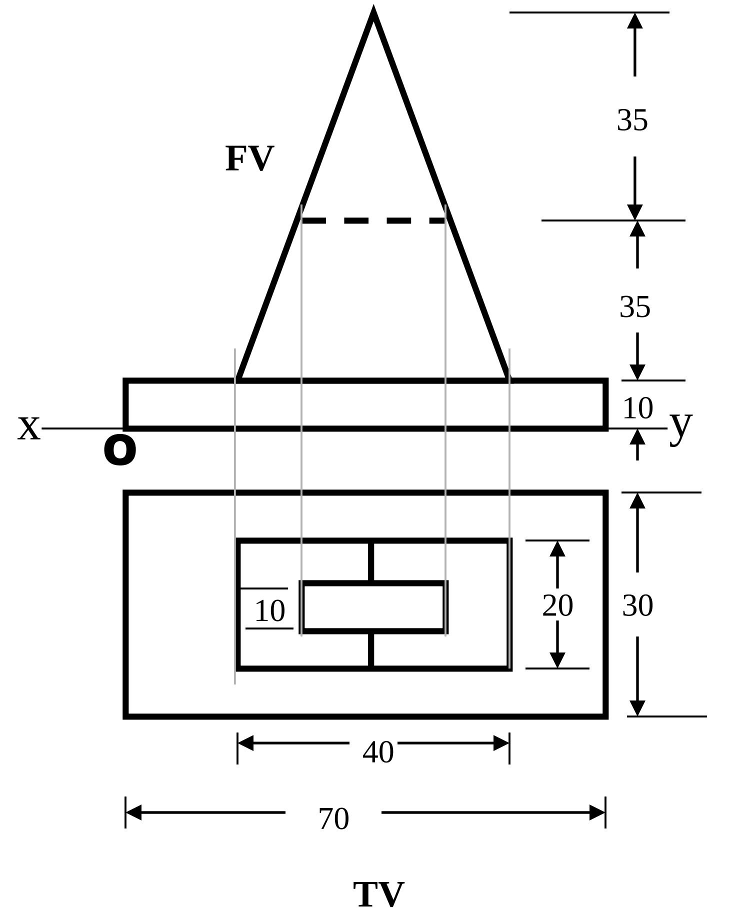




STUDY ILLUSTRATIONS

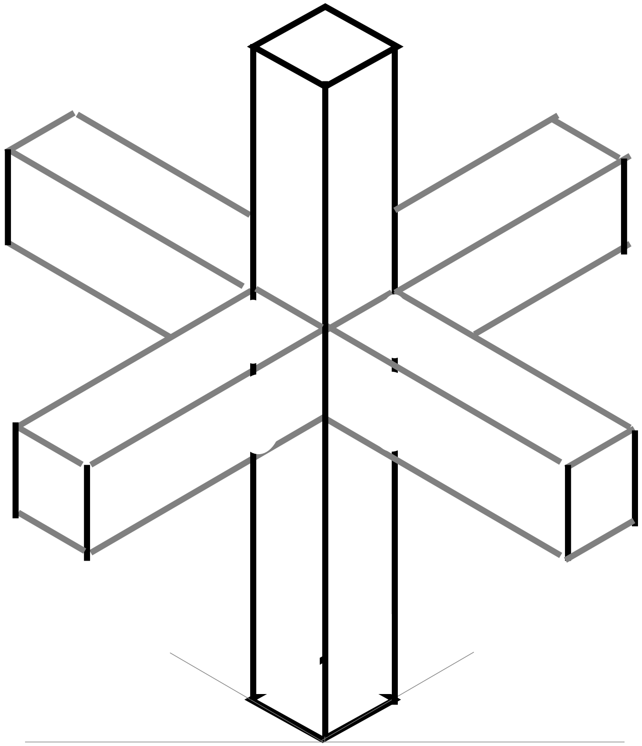
F.V. & T.V. of an object are given. Draw it's isometric view.

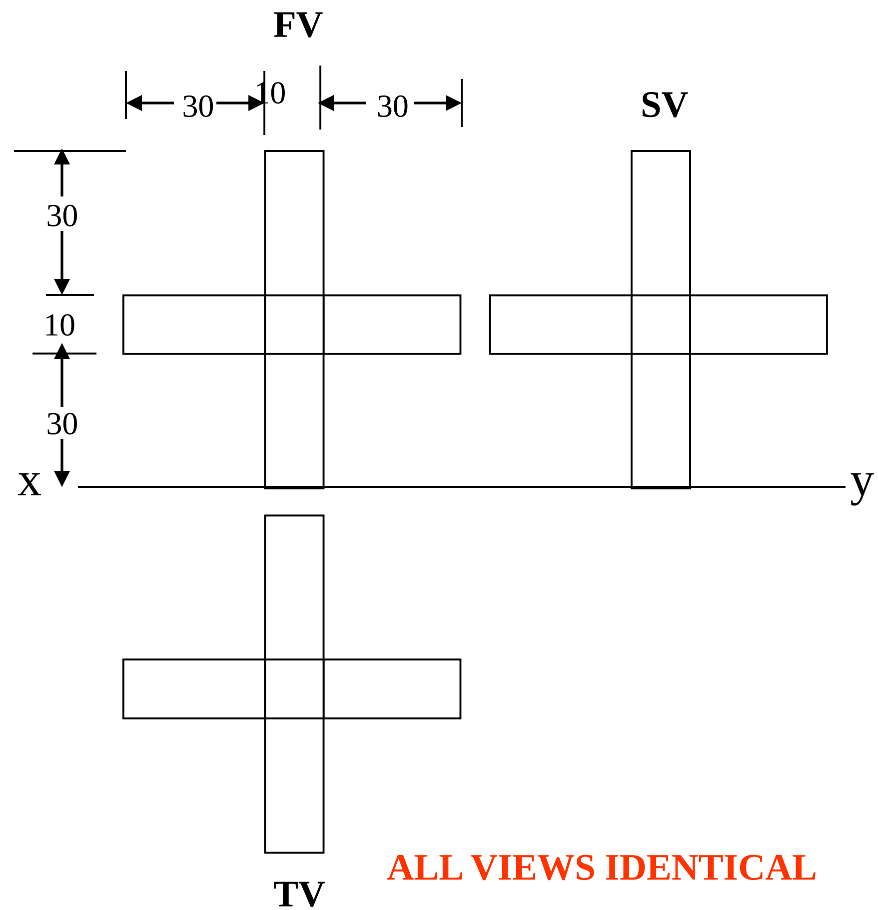




STUDY ILLUSTRATIONS

F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.

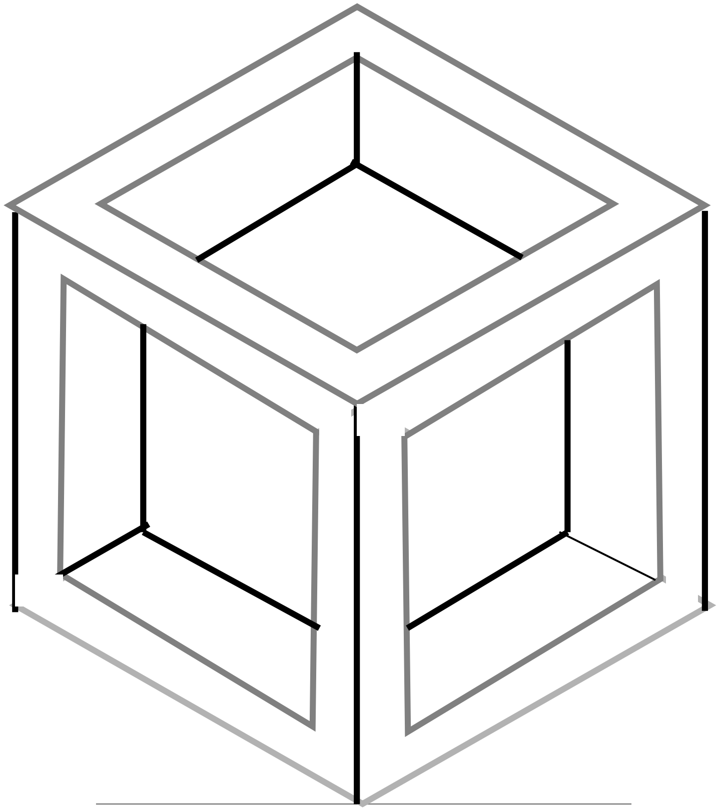




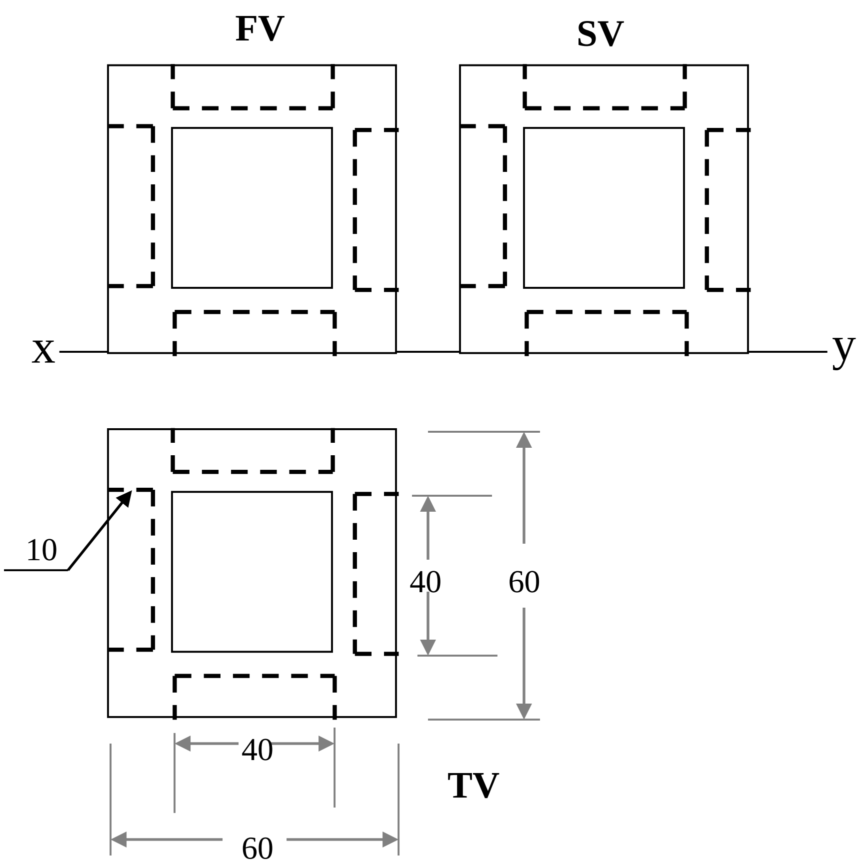
ALL VIEWS IDENTICAL

STUDY ILLUSTRATIONS

F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.



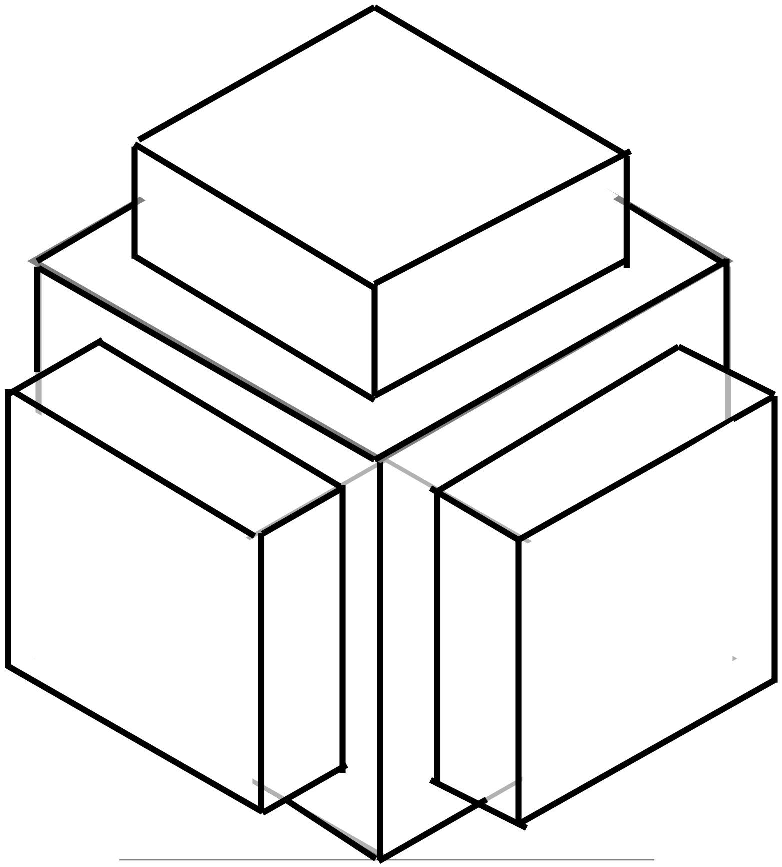
ALL VIEWS IDENTICAL

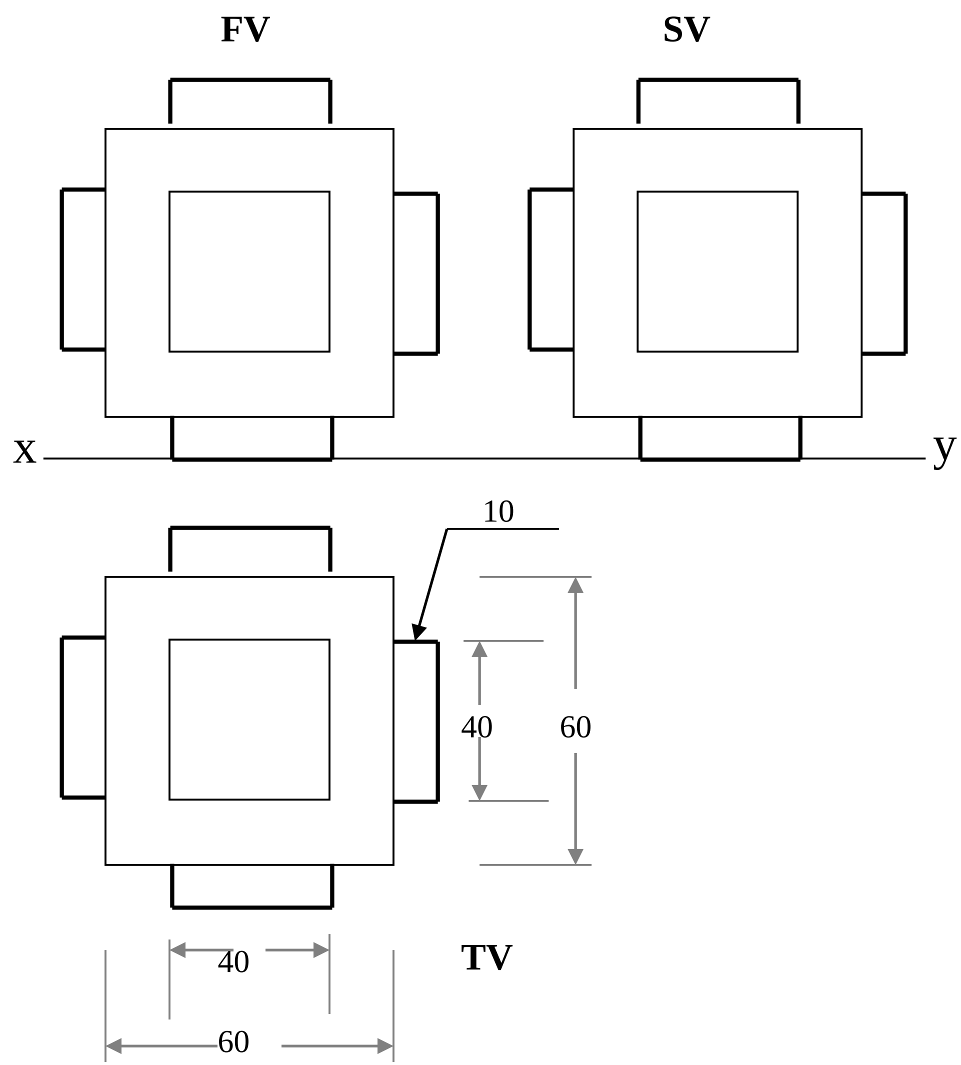


STUDY ILLUSTRATIONS

F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.

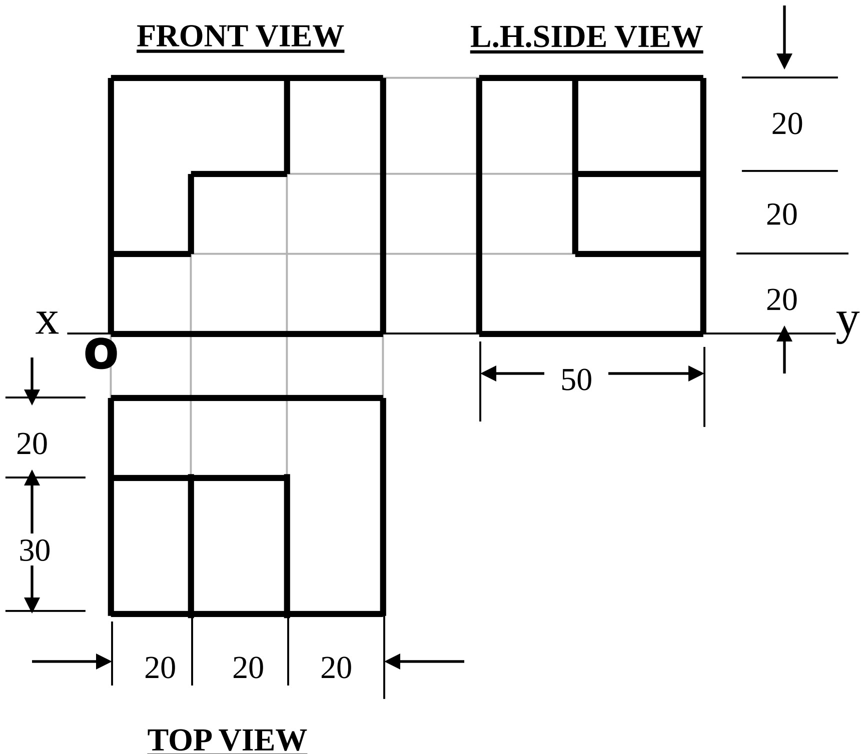
ALL VIEWS IDENTICAL

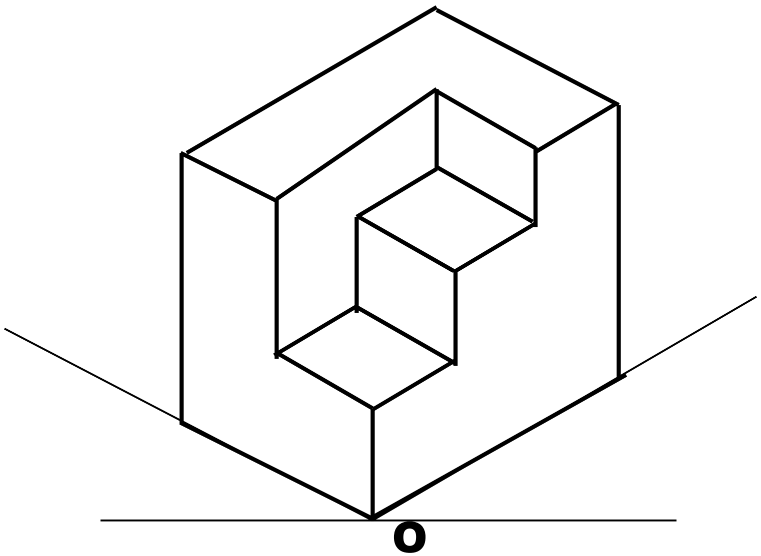




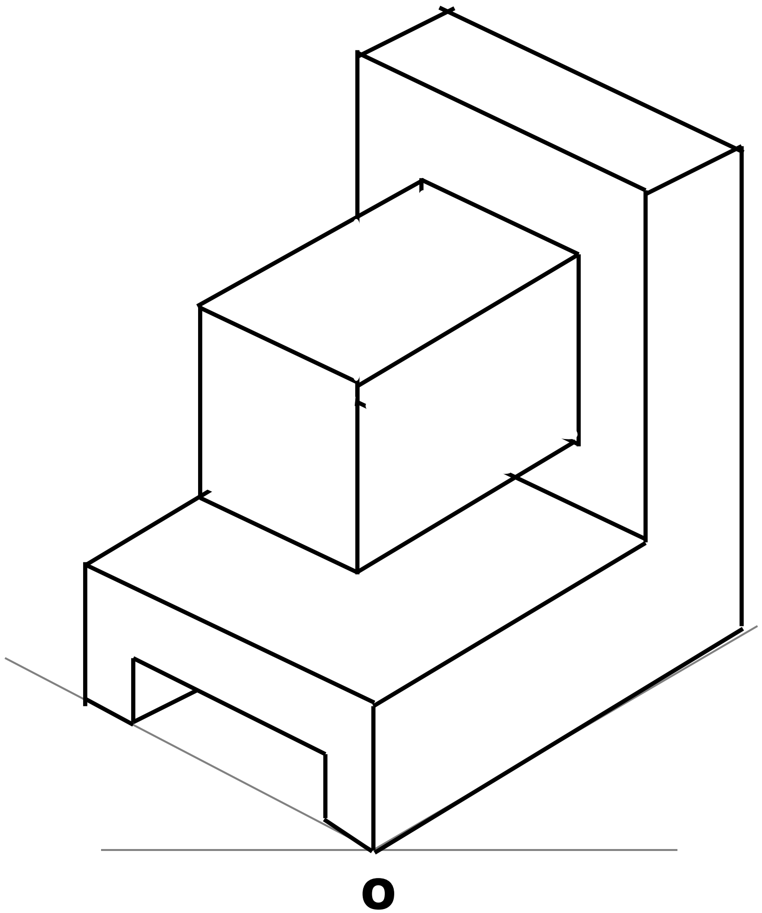
F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.

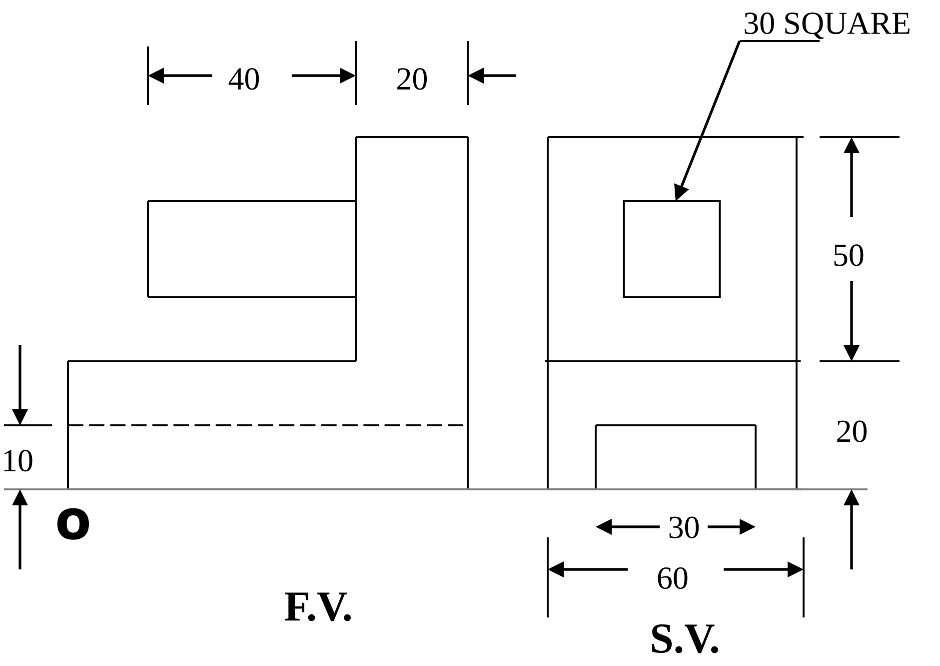
ORTHOGRAPHIC PROJECTIONS



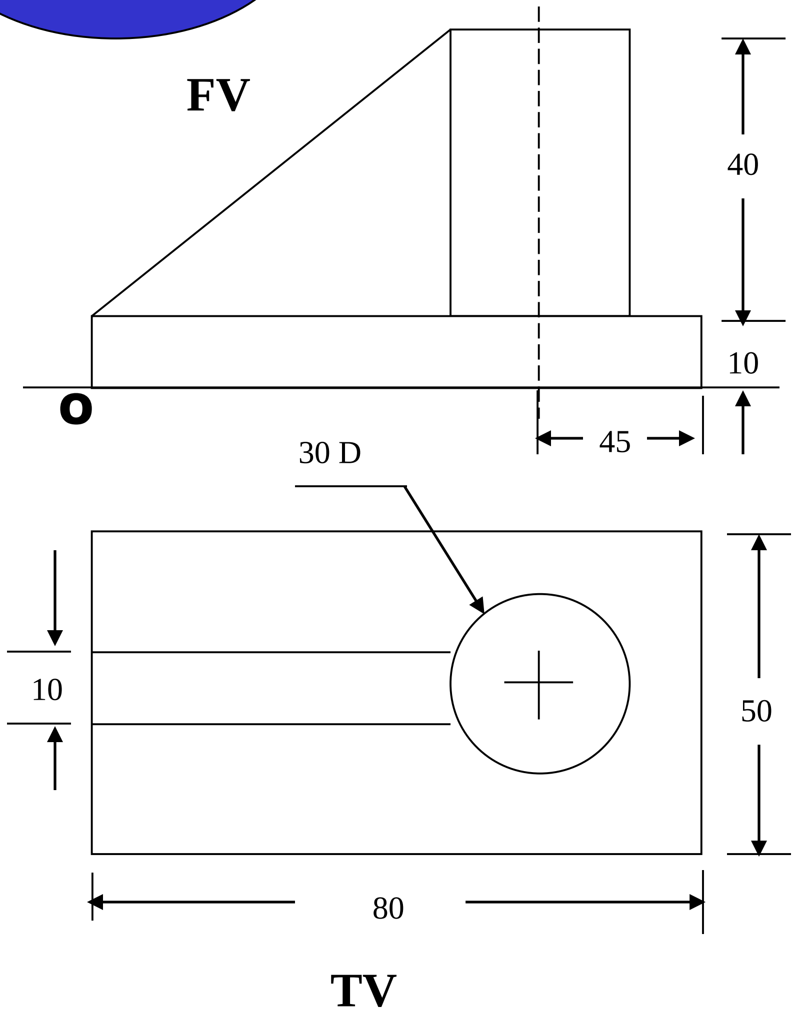


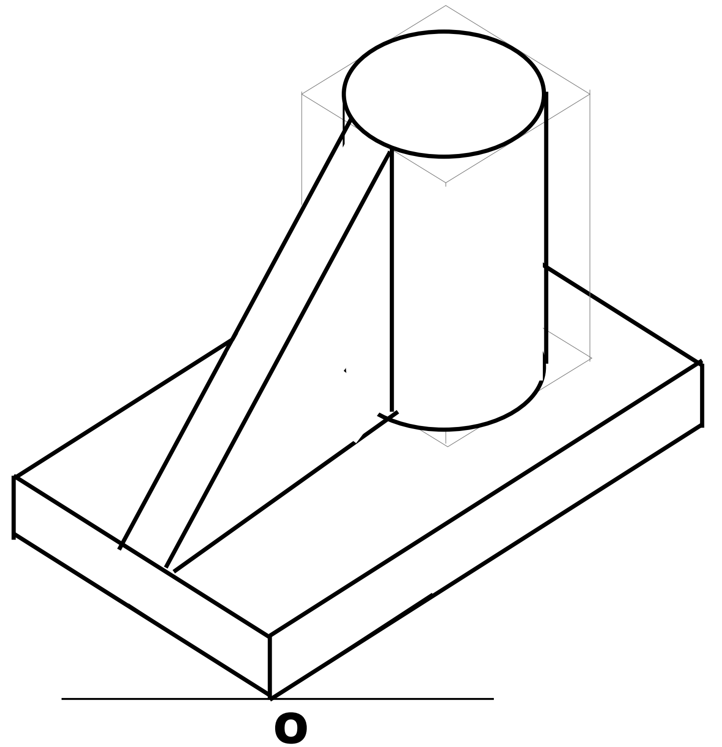
F.V. and S.V.of an object are given. Draw it's isometric view.



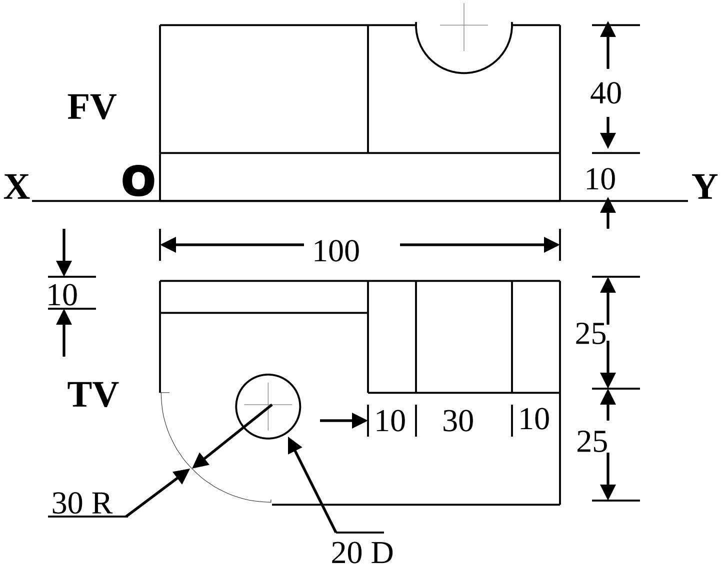


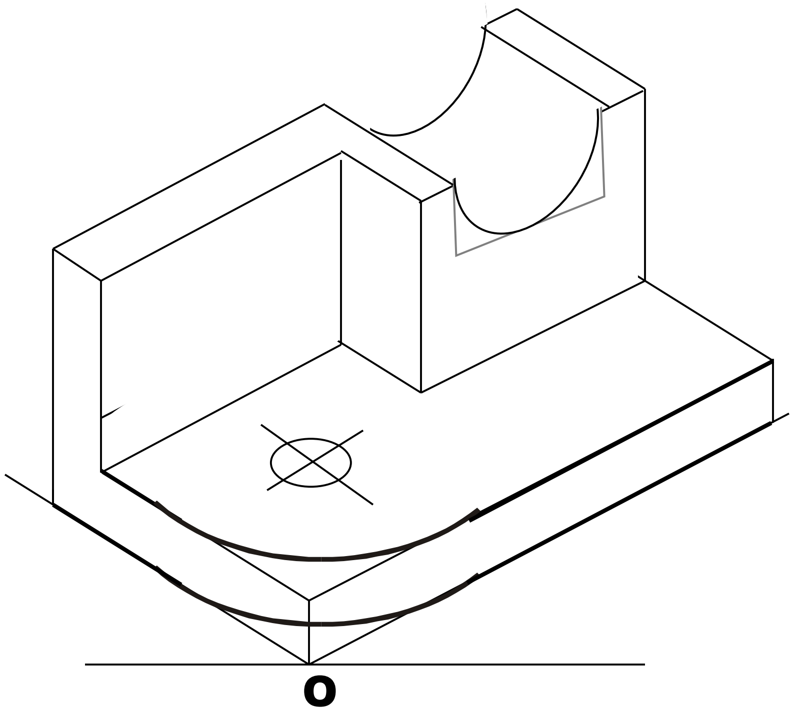
F.V. & T.V. of an object are given. Draw it's isometric view.



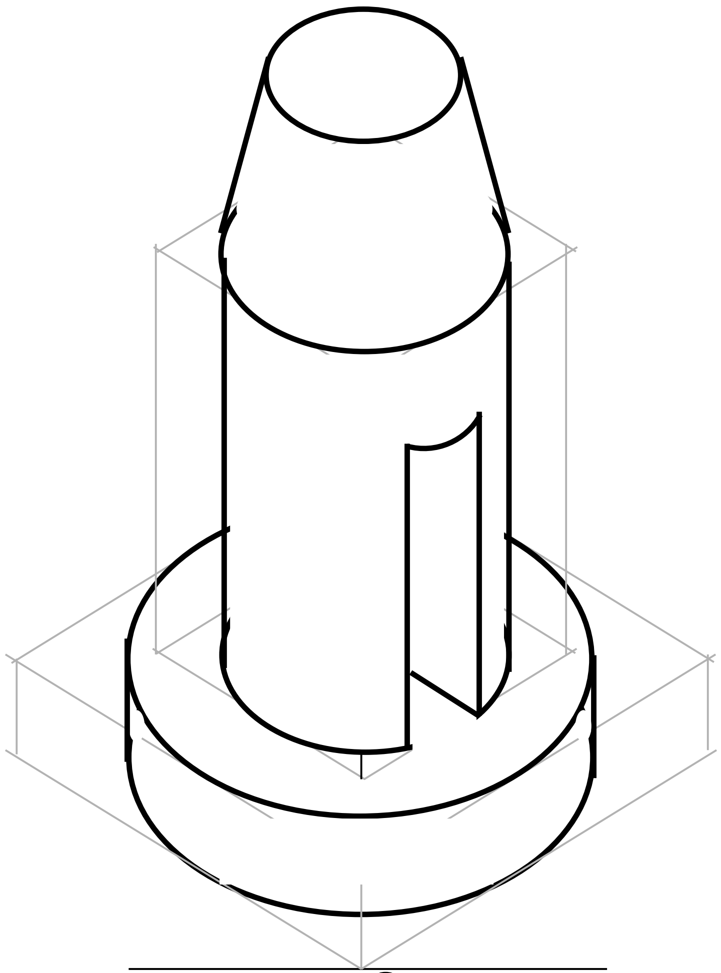


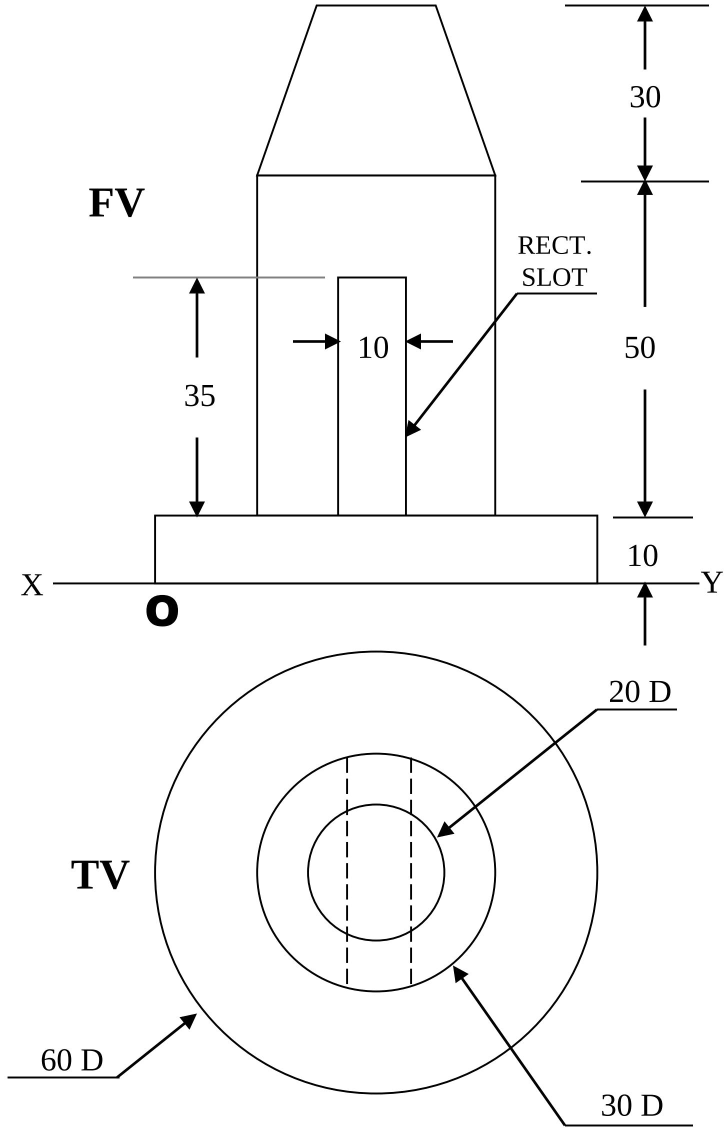
F.V. & T.V. of an object are given. Draw it's isometric view.





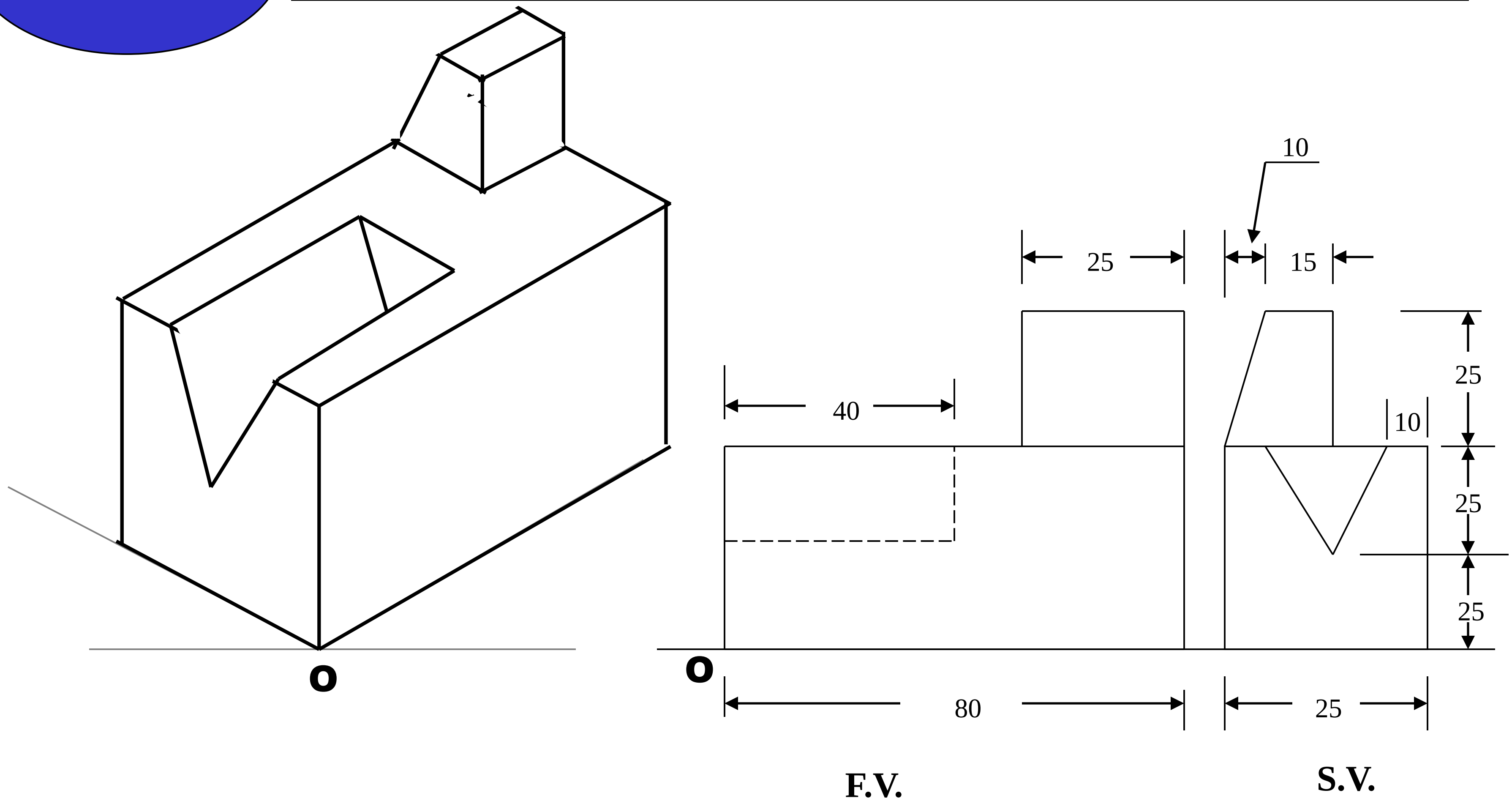
F.V. & T.V. of an object are given. Draw it's isometric view.



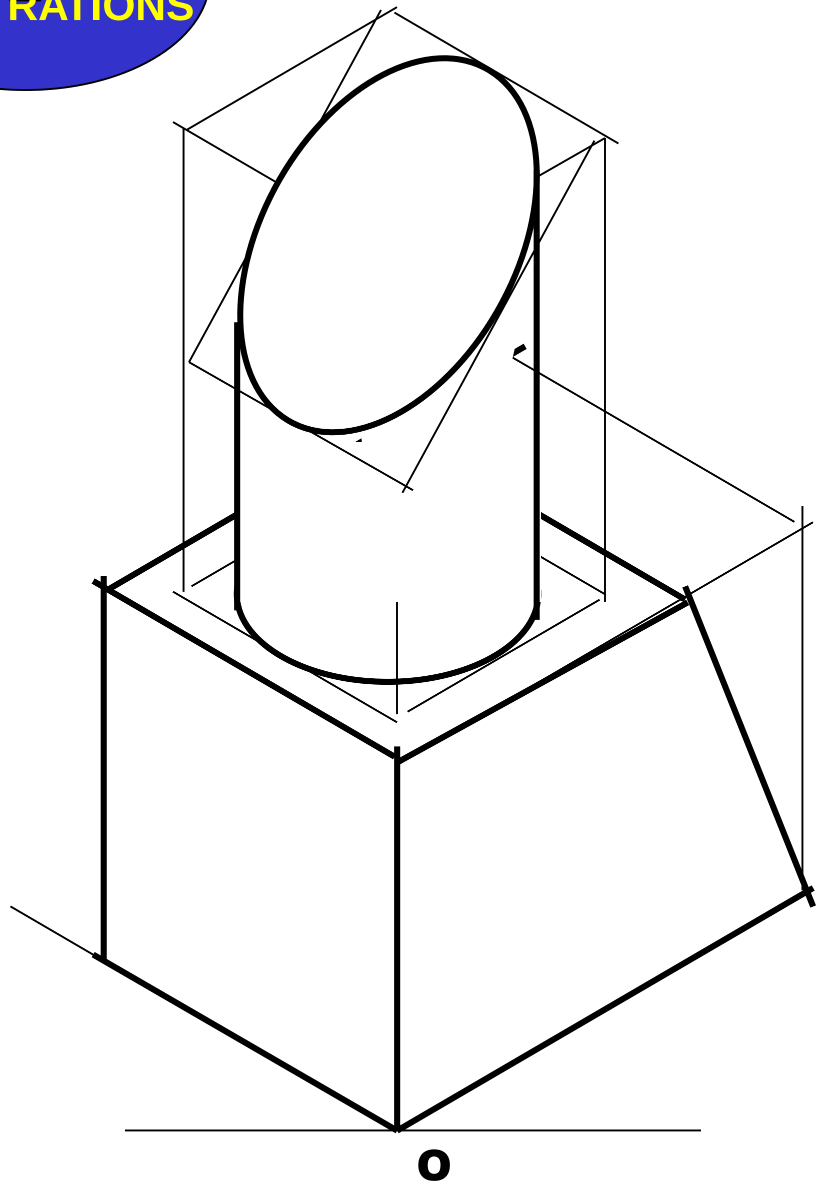


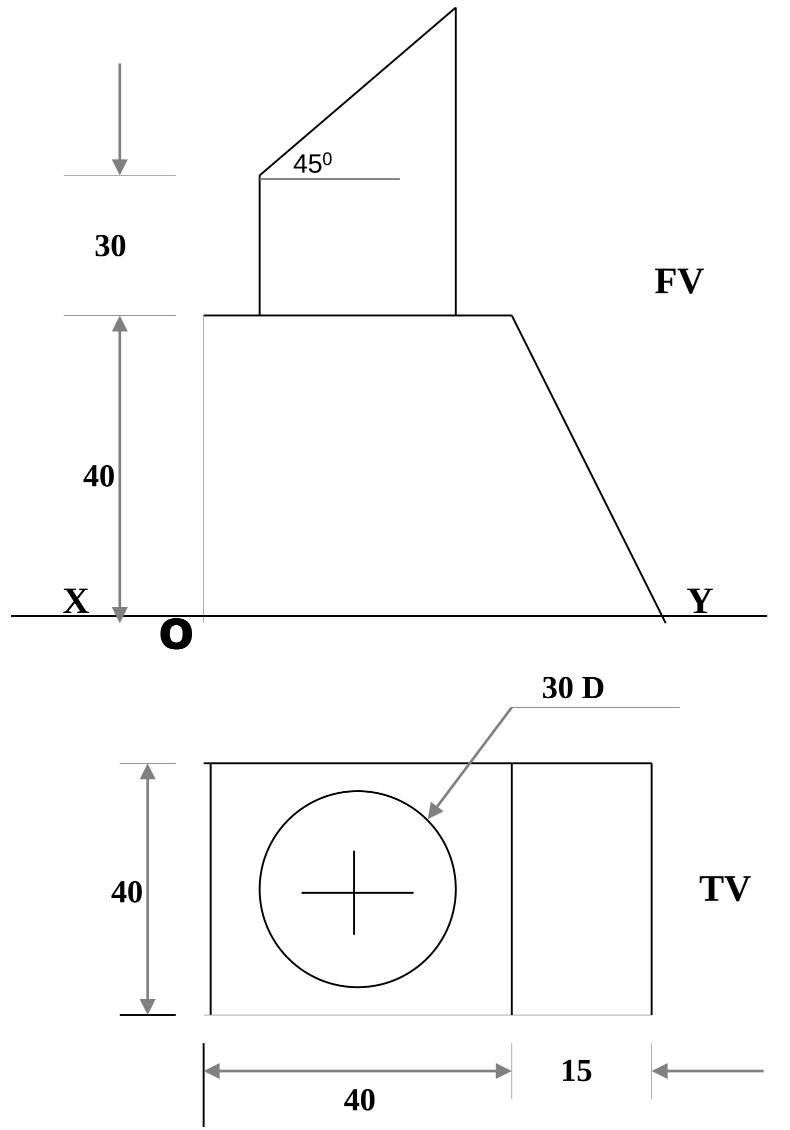
STUDY ILLUSTRATIONS

F.V. and S.V.of an object are given. Draw it's isometric view.

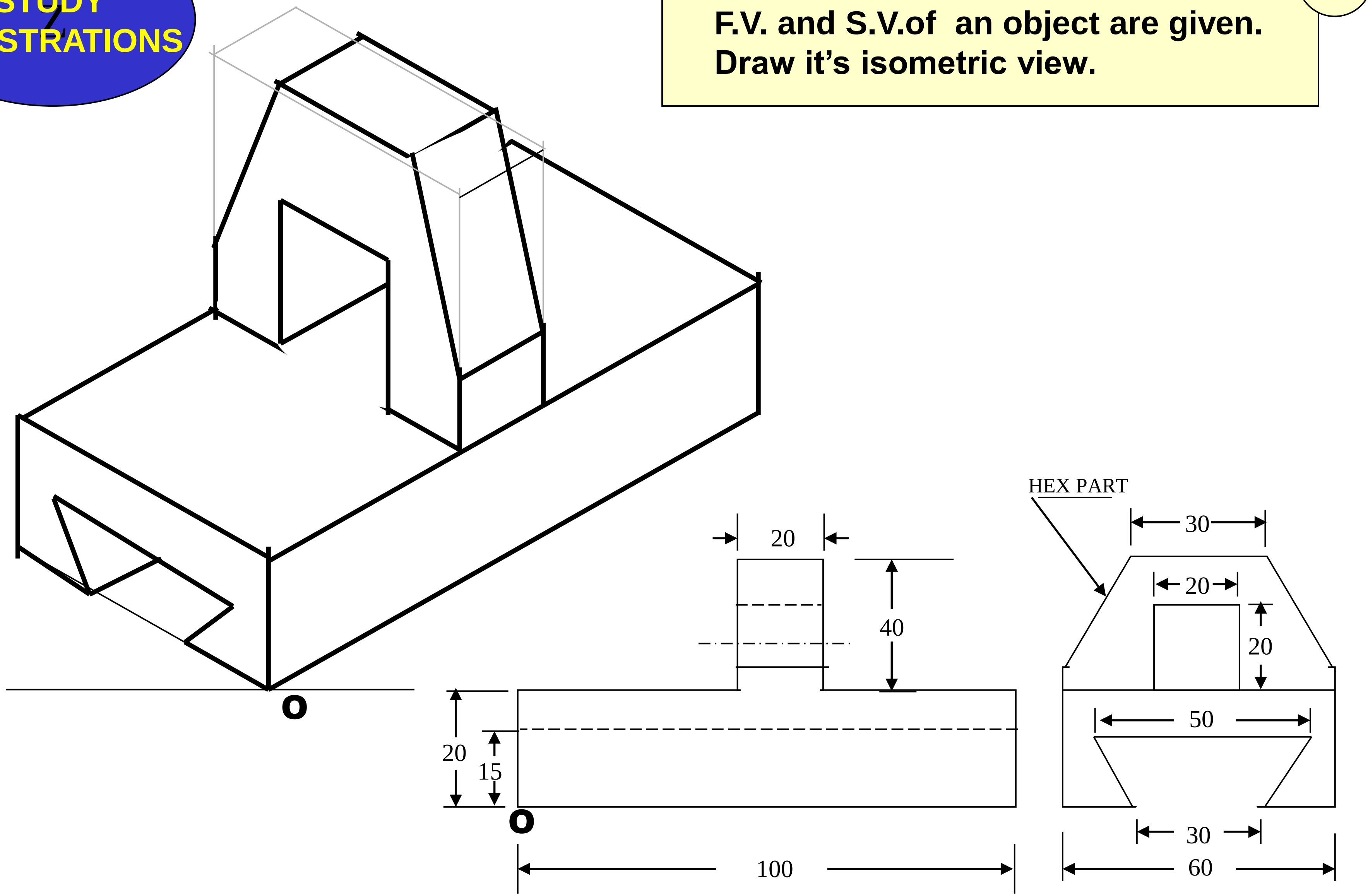


F.V. & T.V. of an object are given. Draw it's isometric view.

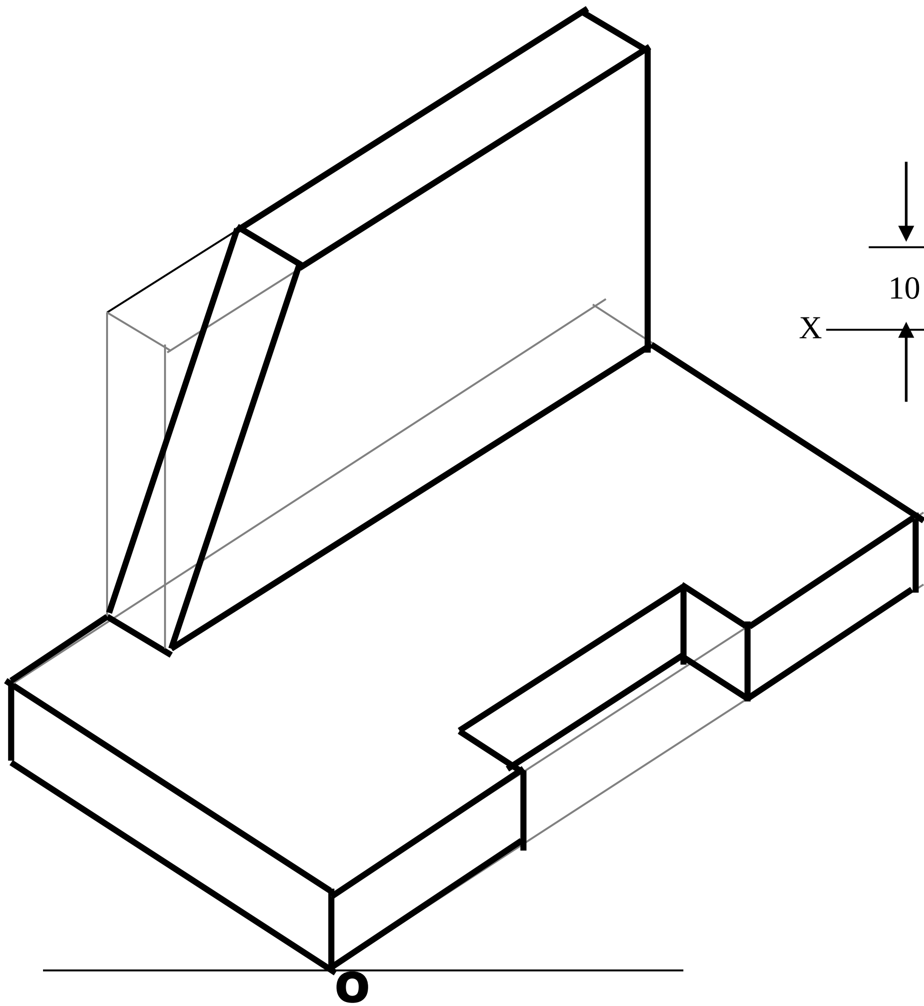


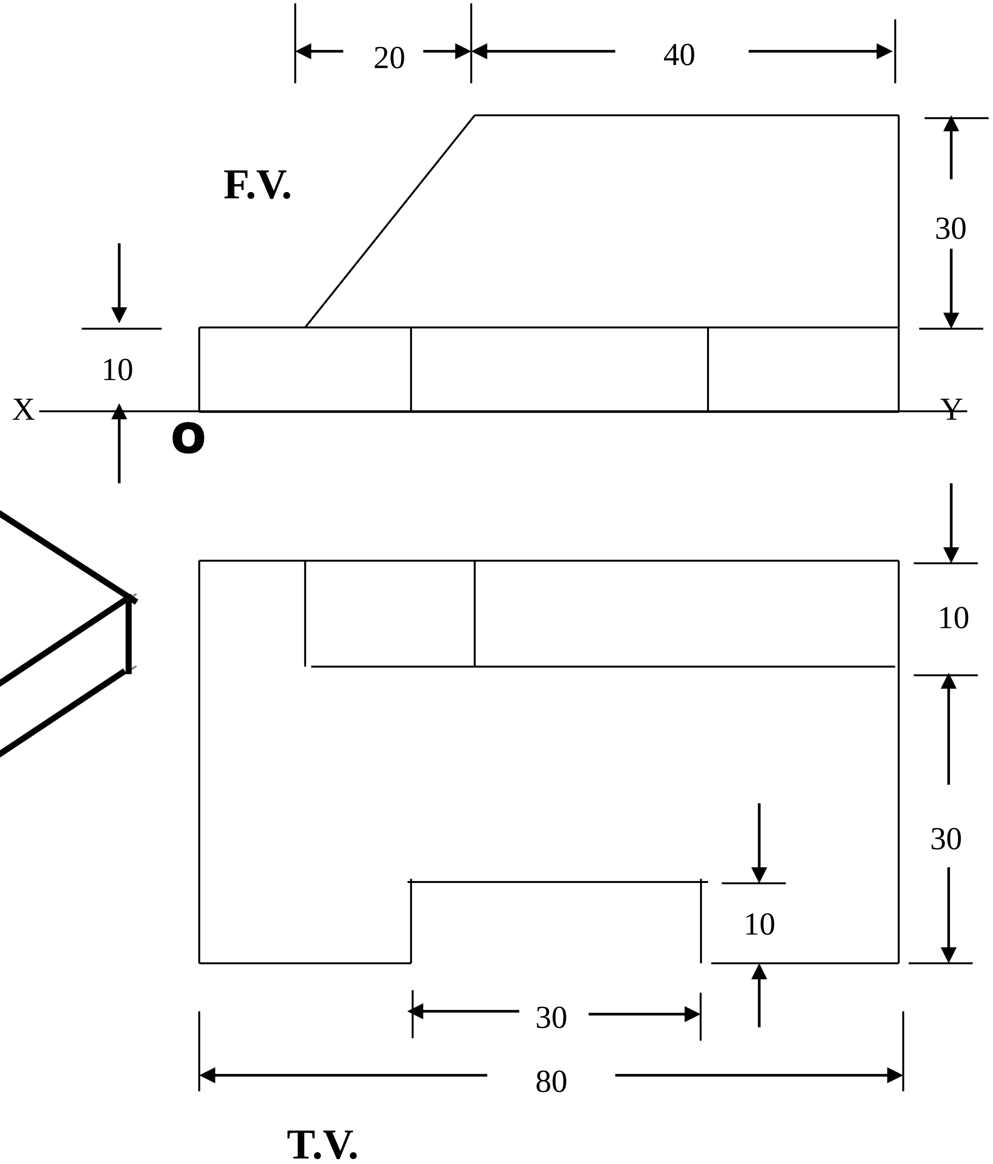


**F.V. and S.V.of an object are given.
Draw it's isometric view.**



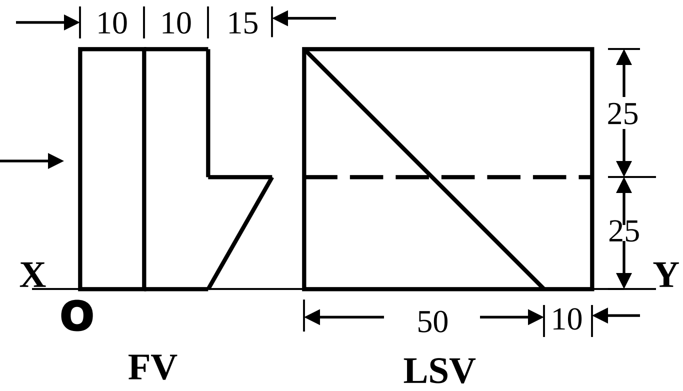
F.V. & T.V. of an object are given. Draw it's isometric view.

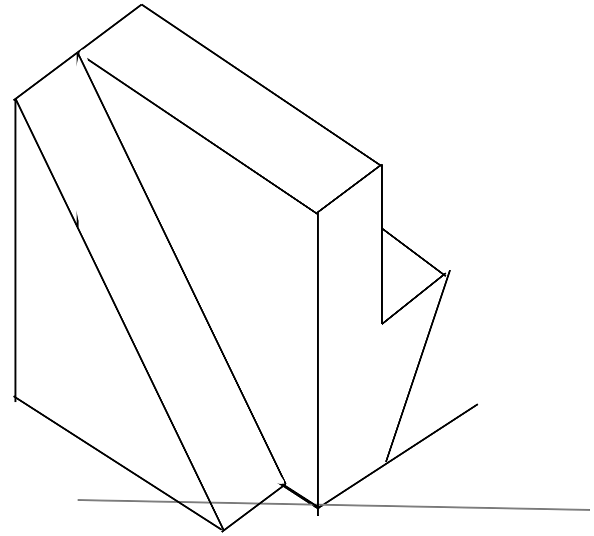




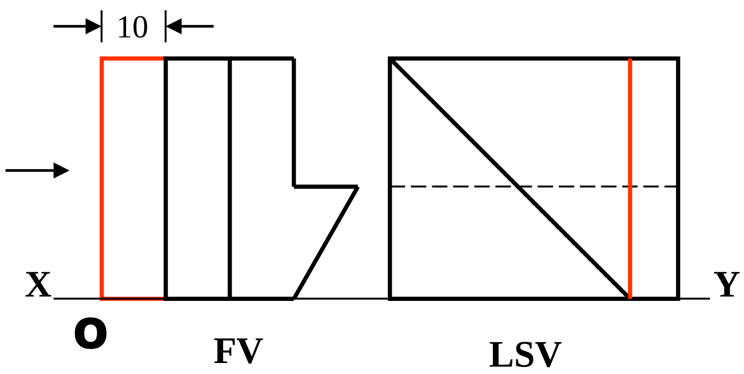
F.V. and S.V.of an object are given.
Draw it's isometric view.

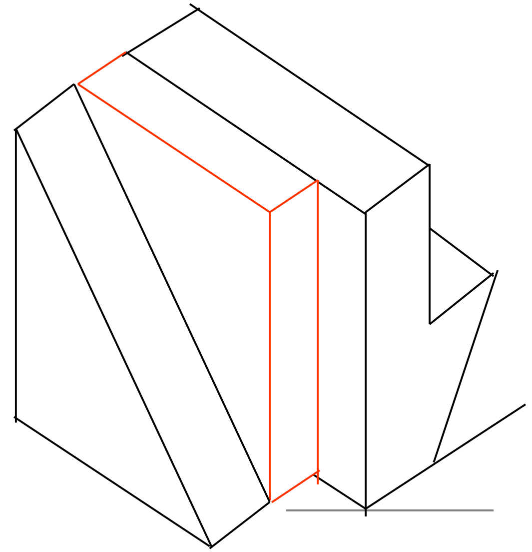
STUDY ILLUSTRATIONS



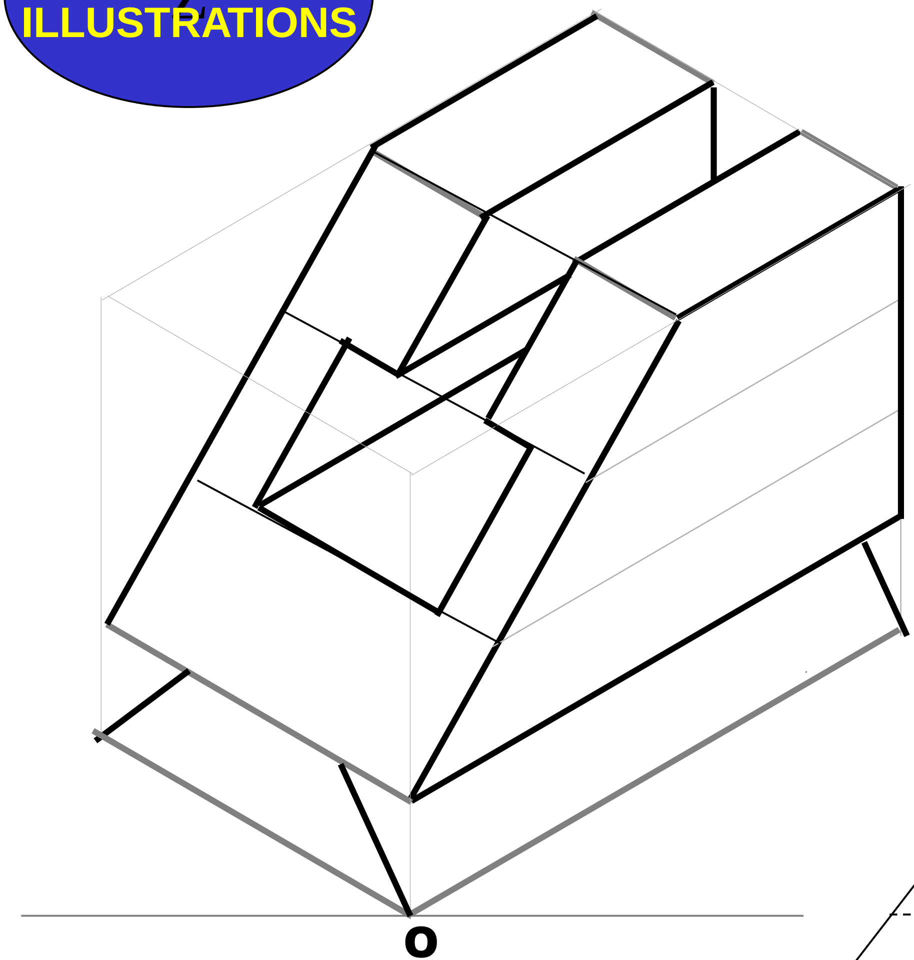


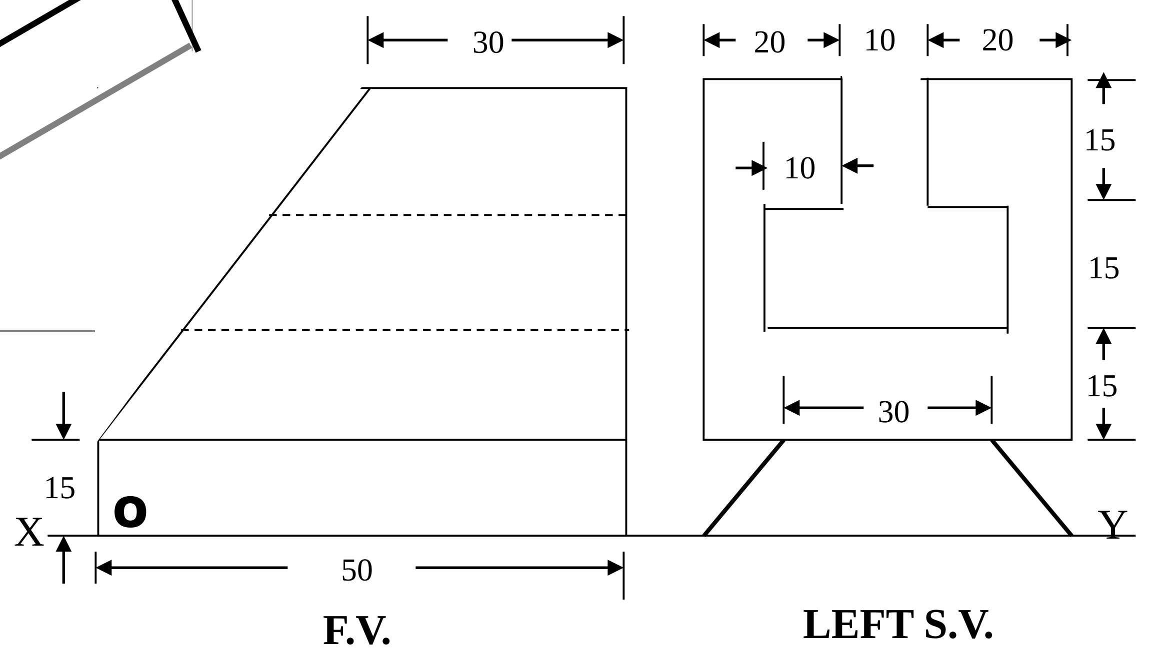
NOTE THE SMALL CHZNGE IN 2ND FV & SV.
DRAW ISOMETRIC ACCORDINGLY.



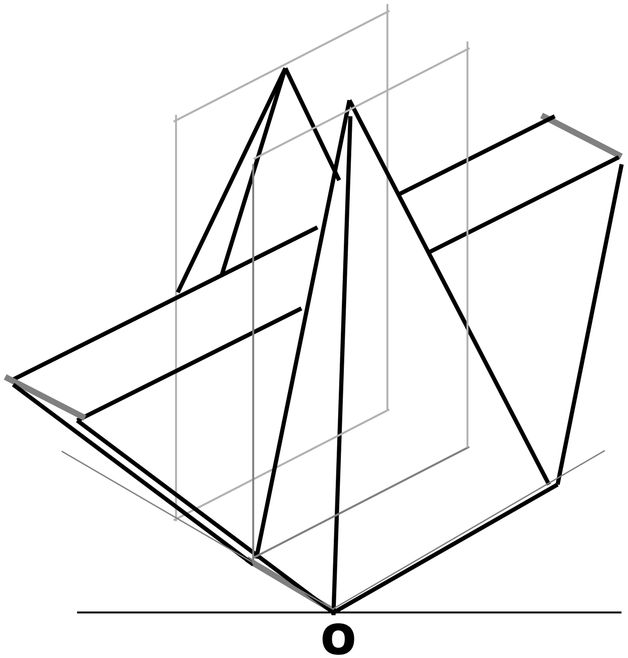


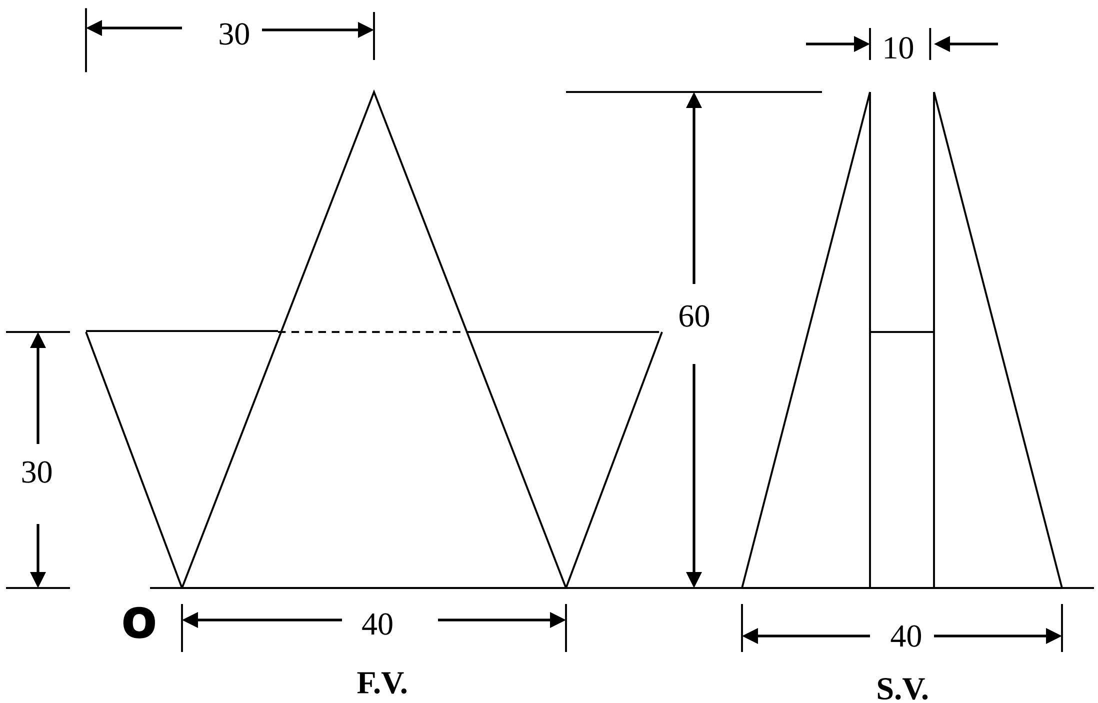
F.V. and S.V.of an object are given. Draw it's isometric view.





F.V. and S.V.of an object are given. Draw it's isometric view.





EXERCISES:

PROJECTIONS OF STRAIGHT LINES

1. A line AB is in first quadrant. Its ends A and B are 25mm and 65mm in front of VP respectively. The distance between the end projectors is 75mm. The line is inclined at 30^0 to VP and its VT is 10mm above HP. Draw the projections of AB and determine its true length and HT and inclination with HP.

2. A line AB measures 100mm. The projections through its VT and end A are 50mm apart. The point A is 35mm above HP and 25mm in front VP. The VT is 15mm above HP. Draw the projections of line and determine its HT and Inclinations with HP and VP.

3. Draw the three views of line AB, 80mm long, when it is lying in profile plane and inclined at 35^0 to HP. Its end A is in HP and 20mm in front of VP, while other end B is in first quadrant. Determine also its traces.

4. A line AB 75 mm long, has its one end A in VP and other end B 15mm above HP and 50mm in front of VP. Draw the projections of line when sum of inclinations with HP and VP is 90^0. Determine the true angles of inclination and show traces.

5. A line AB is 75mm long and lies in an auxiliary inclined plane (AIP) which makes an angle of 45^0 with the HP. The front view of the line measures 55mm. The end A is in VP and 20mm above HP. Draw the projections of the line AB and find its inclination with HP and VP.

6. Line AB lies in an AVP 50^0 inclined to Vp while line is 30^0 inclined to Hp. End A is 10 mm above Hp. & 15 mm in front of Vp.Distance between projectors is 50 mm.Draw projections and find TL and inclination of line with Vp. Locate traces also.

APPLICATIONS OF LINES

Room , compound wall cases

7) A room measures 8m x 5m x4m high. An electric point hang in the center of ceiling and 1m below it. A thin straight wire connects the point to the switch in one of the corners of the room and 2m above the floor. Draw the projections of the and its length and slope angle with the floor.

8) A room is of size 6m\5m\3.5m high. Determine graphically the real distance between the top corner and its diagonally apposite bottom corners. consider appropriate scale

9) Two pegs A and B are fixed in each of the two adjacent side walls of the rectangular room 3m x 4m sides. Peg A is 1.5m above the floor, 1.2m from the longer side wall and is protruding 0.3m from the wall. Peg B is 2m above the floor, 1m from other side wall and protruding 0.2m from the wall. Find the distance between the ends of the two pegs. Also find the height of the roof if the shortest distance between peg A and and center of the ceiling is 5m.

10) Two fan motors hang from the ceiling of a hall 12m x 5m x 8m high at heights of 4m and 6m respectively. Determine graphically the distance between the motors. Also find the distance of each motor from the top corner joining end and front wall.

11) Two mangos on a two tree are 2m and 3m above the ground level and 1.5m and 2.5m from a 0.25m thick wall but on apposite sides of it. Distances being measured from the center line of the wall. The distance between the apples, measured along ground and parallel to the wall is 3m. Determine the real distance between the ranges.

POLES,ROADS, PIPE LINES,, NORTH- EAST-SOUTH WEST, SLOPE AND GRADIENT CASES.

12)Three vertical poles AB, CD and EF are lying along the corners of equilateral triangle lying on the ground of 100mm sides. Their lengths are 5m, 8m and 12m respectively. Draw their projections and find real distance between their top ends.

13) A straight road going up hill from a point A due east to another point B is 4km long and has a slop of 25^0. Another straight road from B due 30^0 east of north to a point C is also 4 kms long but going downward and has slope of 15^0. Find the length and slope of the straight road connecting A and C.

14) An electric transmission line laid along an uphill from the hydroelectric power station due west to a substation is 2km long and has a slop of 30^0. Another line from the substation, running W 45^0 N to village, is 4km long and laid on the ground level. Determine the length and slope of the proposed telephone line joining the the power station and village.

15) Two wire ropes are attached to the top corner of a 15m high building. The other end of one wire rope is attached to the top of the vertical pole 5m high and the rope makes an angle of depression of 45^0. The rope makes 30^0 angle of depression and is attached to the top of a 2m high pole. The pole in the top view are 2m apart. Draw the projections of the wire ropes.

16) Two hill tops A and B are 90m and 60m above the ground level respectively. They are observed from the point C, 20m above the ground. From C angles and elevations for A and B are 45^0 and 30^0 respectively. From B angle of elevation of A is 45^0. Determine the two distances between A, B and C.

PROJECTIONS OF PLANES:-

1. A thin regular pentagon of 30mm sides has one side // to Hp and 30^0 inclined to Vp while its surface is 45^0 inclines to Hp. Draw its projections.

2. A circle of 50mm diameter has end A of diameter AB in Hp and AB diameter 300 inclined to Hp. Draw its projections if

a) the TV of same diameter is 45^0 inclined to Vp, OR b) Diameter AB is in profile plane.

3. A thin triangle PQR has sides PQ = 60mm. QR = 80mm. and RP = 50mm. long respectively. Side PQ rest on ground and makes 30^0 with Vp. Point P is 30mm in front of Vp and R is 40mm above ground. Draw its projections.

4. An isosceles triangle having base 60mm long and altitude 80mm long appears as an equilateral triangle of 60mm sides with one side 30^0 inclined to XY in top view. Draw its projections.

5. A 30^0-60^0 set-square of 40mm long shortest side in Hp appears is an isosceles triangle in its TV. Draw projections of it and find its inclination with Hp.

6. A rhombus of 60mm and 40mm long diagonals is so placed on Hp that in TV it appears as a square of 40mm long diagonals. Draw its FV.

7. Draw projections of a circle 40 mm diameter resting on Hp on a point A on the circumference with its surface 30^0 inclined to Hp and 45^0 to Vp.

8. A top view of plane figure whose surface is perpendicular to Vp and 60^0 inclined to Hp is regular hexagon of 30mm sides with one side 30^0 inclined to xy.Determine it's true shape.

9. Draw a rectangular abcd of side 50mm and 30mm with longer 35^0 with XY, representing TV of a quadrilateral plane ABCD. The point A and B are 25 and 50mm above Hp respectively. Draw a suitable Fv and determine its true shape.

10.Draw a pentagon abcde having side 50^0 to XY, with the side ab =30mm, bc = 60mm, cd =50mm, de = 25mm and angles abc 120^0, cde 125^0. A figure is a TV of a plane whose ends A,B and E are 15, 25 and 35mm above Hp respectively. Complete the projections and determine the true shape of the plane figure.0

PROJECTIONS OF SOLIDS

1. Draw the projections of a square prism of 25mm sides base and 50mm long axis. The prism is resting with one of its corners in VP and axis inclined at 30^0 to VP and parallel to HP.

2. A pentagonal pyramid, base 40mm side and height 75mm rests on one edge on its base on the ground so that the highest point in the base is 25mm. above ground. Draw the projections when the axis is parallel to Vp. Draw an another front view on an AVP inclined at 30^0 to edge on which it is resting so that the base is visible.

3. A square pyramid of side 30mm and axis 60 mm long has one of its slant edges inclined at 45^0 to HP and a plane containing that slant edge and axis is inclined at 30^0 to VP. Draw the projections.

4. A hexagonal prism, base 30mm sides and axis 75mm long, has an edge of the base parallel to the HP and inclined at 45^0 to the VP. Its axis makes an angle of 60^0 with the HP. Draw its projections. Draw another top view on an auxiliary plane inclined at 50^0 to the HP.

5. Draw the three views of a cone having base 50 mm diameter and axis 60mm long It is resting on a ground on a point of its base circle. The axis is inclined at 40^0 to ground and at 30^0 to VP.

6. Draw the projections of a square prism resting on an edge of base on HP. The axis makes an angle of 30^0 with VP and 45^0 with HP. Take edge of base 25mm and axis length as 125mm.

7. A right pentagonal prism is suspended from one of its corners of base. Draw the projections (three views) when the edge of base apposite to the point of suspension makes an angle of 30^0 to VP. Take base side 30mm and axis length 60mm.s

8. A cone base diameter 50mm and axis 70mm long, is freely suspended from a point on the rim of its base. Draw the front view and the top view when the plane containing its axis is perpendicular to HP and makes an angle of 45^0 with VP.

CASES OF COMPOSITE SOLIDS.

9. A cube of 40mm long edges is resting on the ground with its vertical faces equally inclined to the VP. A right circular cone base 25mm diameter and height 50mm is placed centrally on the top of the cube so that their axis are in a straight line. Draw the front and top views of the solids. Project another top view on an AIP making 45^0 with the HP

10.A square bar of 30mm base side and 100mm long is pushed through the center of a cylindrical block of 30mm thickness and 70mm diameter, so that the bar comes out equally through the block on either side. Draw the front view, top view and side view of the solid when the axis of the bar is inclined at 30^0 to HP and parallel to VP, the sides of a bar being 45^0 to VP.

11.A cube of 50mm long edges is resting on the ground with its vertical faces equally inclined to VP. A hexagonal pyramid , base 25mm side and axis 50mm long, is placed centrally on the top of the cube so that their axes are in a straight line and two edges of its base are parallel to VP. Draw the front view and the top view of the solids, project another top view on an AIP making an angle of 45^0 with the HP.

12.A circular block, 75mm diameter and 25mm thick is pierced centrally through its flat faces by a square prism of 35mm base sides and 125mm long axis, which comes out equally on both sides of the block. Draw the projections of the solids when the combined axis is parallel to HP and inclined at 30^0 to VP, and a face of the prism makes an angle of 30^0 with HP. Draw side view also.

SECTION & DEVELOPMENT

1) A square pyramid of 30mm base sides and 50mm long axis is resting on its base in HP. Edges of base is equally inclined to VP. It is cut by section plane perpendicular to VP and inclined at 450 to HP. The plane cuts the axis at 10mm above the base. Draw the projections of the solid and show its development.

2) A hexagonal pyramid, edge of base 30mm and axis 75mm, is resting on its edge on HP which is perpendicular toVP. The axis makes an angle of 300to HP. the solid is cut by a section plane perpendicular to both HP and VP, and passing through the mid point of the axis. Draw the projections showing the sectional view, true shape of section and development of surface of a cut pyramid containing apex.

3) A cone of base diameter 60mm and axis 80mm, long has one of its generators in VP and parallel to HP. It is cut by a section plane perpendicular HP and parallel to VP. Draw the sectional FV, true shape of section and develop the lateral surface of the cone containing the apex.

4) A cube of 50mm long slid diagonal rest on ground on one of its corners so that the solid diagonal is vertical and an edge through that corner is parallel to VP. A horizontal section plane passing through midpoint of vertical solid diagonal cuts the cube. Draw the front view of the sectional top view and development of surface.

5) A vertical cylinder cut by a section plane perpendicular to VP and inclined to HP in such a way that the true shape of a section is an ellipse with 50mm and 80mm as its minor and major axes. The smallest generator on the cylinder is 20mm long after it is cut by a section plane. Draw the projections and show the true shape of the section. Also find the inclination of the section plane with HP. Draw the development of the lower half of the cylinder.

6) A cube of 75mm long edges has its vertical faces equally inclined to VP. It is cut by a section plane perpendicular to VP such that the true shape of section is regular hexagon. Determine the inclination of cutting plane with HP.Draw the sectional top view and true shape of section.

7) The pyramidal portion of a half pyramidal and half conical solid has a base ofthree sides, each 30mm long. The length of axis is 80mm. The solid rest on its base with the side of the pyramid base perpendicular to VP. A plane parallel to VP cuts the solid at a distance of 10mm from the top view of the axis. Draw sectional front view and true shape of section. Also develop the lateral surface of the cut solid.

8) A hexagonal pyramid having edge to edge distance 40mm and height 60mm has its base in HP and an edge of base perpendicular to VP. It is cut by a section plane, perpendicular to VP and passing through a point on the axis 10mm from the base. Draw three views of solid when it is resting on its cut face in HP, resting the larger part of the pyramid. Also draw the lateral surface development of the pyramid.

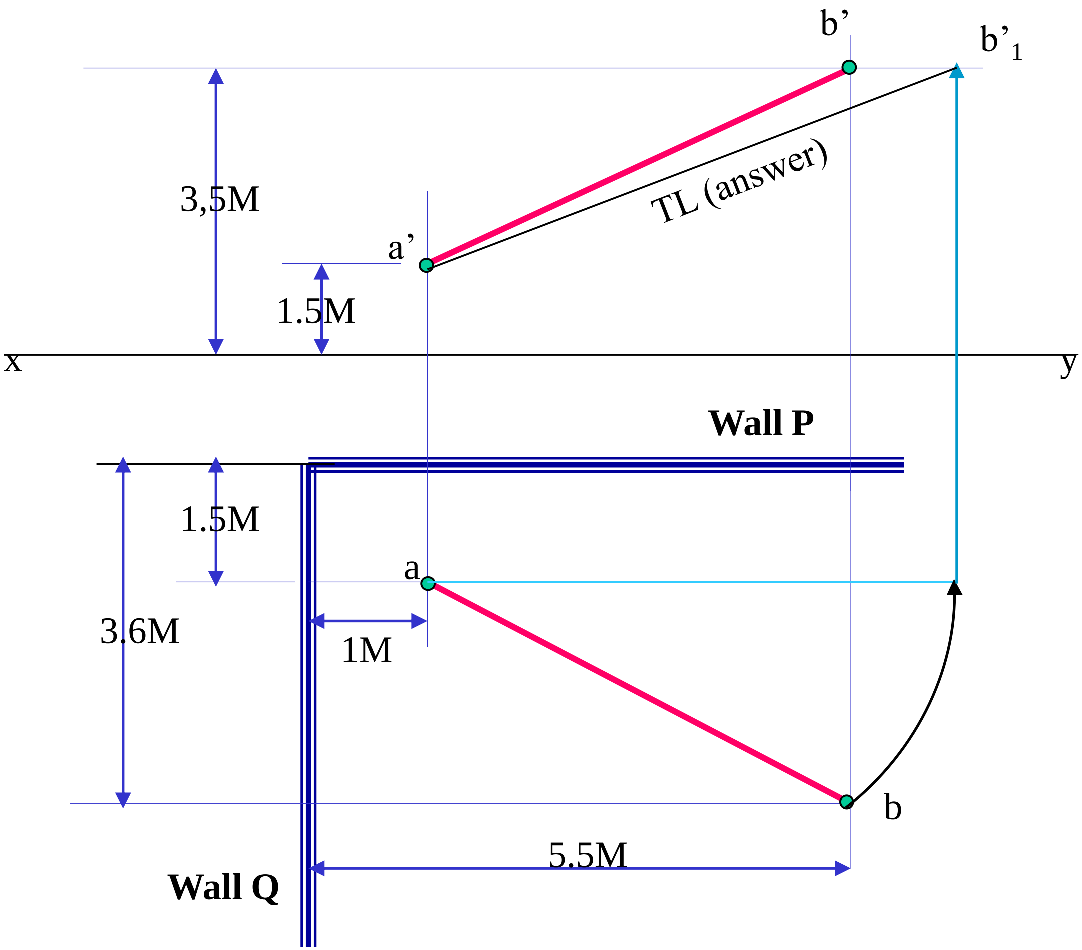
9) A cone diameter of base 50mm and axis 60mm long is resting on its base on ground. It is cut by a section plane perpendicular to VP in such a way that the true shape of a section is a parabola having base 40mm. Draw three views showing section, true shape of section and development of remaining surface of cone removing its apex.

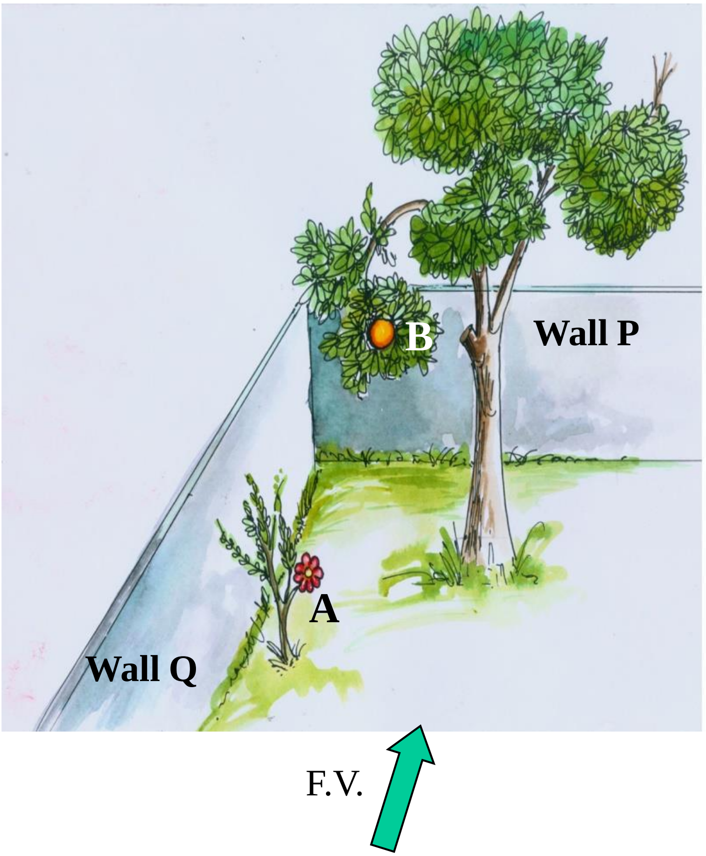
10) A hexagonal pyramid, base 50mm side and axis 100mm long is lying on ground on one of its triangular faces with axis parallel to VP. A vertical section plane, the HT of which makes an angle of 300 with the reference line passes through center of base, the apex being retained. Draw the top view, sectional front view and the development of surface of the cut pyramid containing apex.

11) Hexagonal pyramid of 40mm base side and height 80mm is resting on its base on ground. It is cut by a section plane parallel to HP and passing through a point on the axis 25mm from the apex. Draw the projections of the cut pyramid. A particle P, initially at the mid point of edge of base, starts moving over the surface and reaches the mid point of apposite edge of the top face. Draw the development of the cut pyramid and show the shortest path of particle P. Also show the path in front and top views

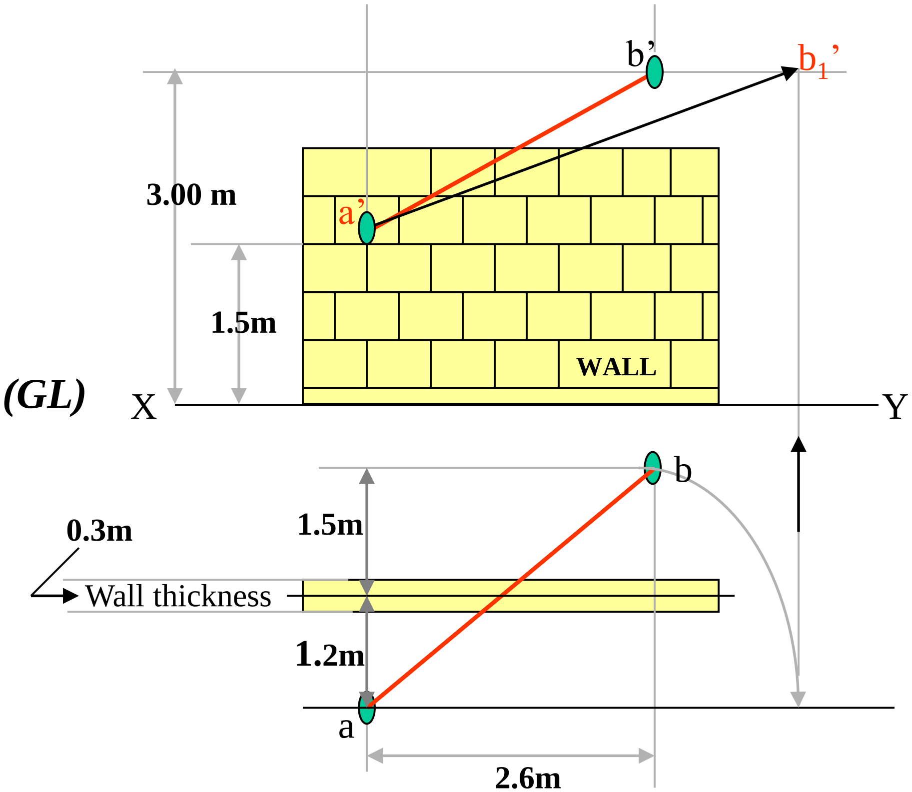
12) A cube of 65 mm long edges has its vertical face equally inclined to the VP. It is cut by a section plane, perpendicular to VP, so that the true shape of the section is a regular hexagon, Determine the inclination of the cutting plane with the HP and draw the sectional top view and true shape of the section.

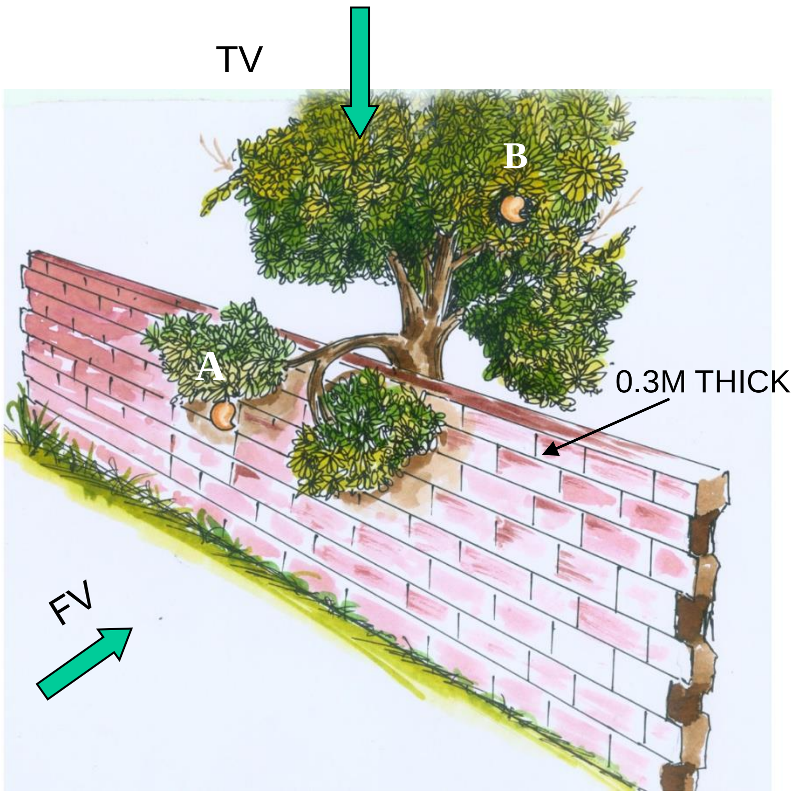
PROBLEM 14:-Two objects, a flower (A) and an orange (B) are within a rectangular compound wall, whose P & Q are walls meeting at 90^0. Flower A is 1.5M & 1 M from walls P & Q respectively. Orange B is 3.5M & 5.5M from walls P & Q respectively. Drawing projection, find distance between them If flower is 1.5 M and orange is 3.5 M above the ground. Consider suitable scale..





PROBLEM 15 :- **Two mangos on a tree A & B are 1.5 m and 3.00 m above ground and those are 1.2 m & 1.5 m from a 0.3 m thick wall but on opposite sides of it. If the distance measured between them along the ground and parallel to wall is 2.6 m, Then find real distance between them by drawing their projections.**

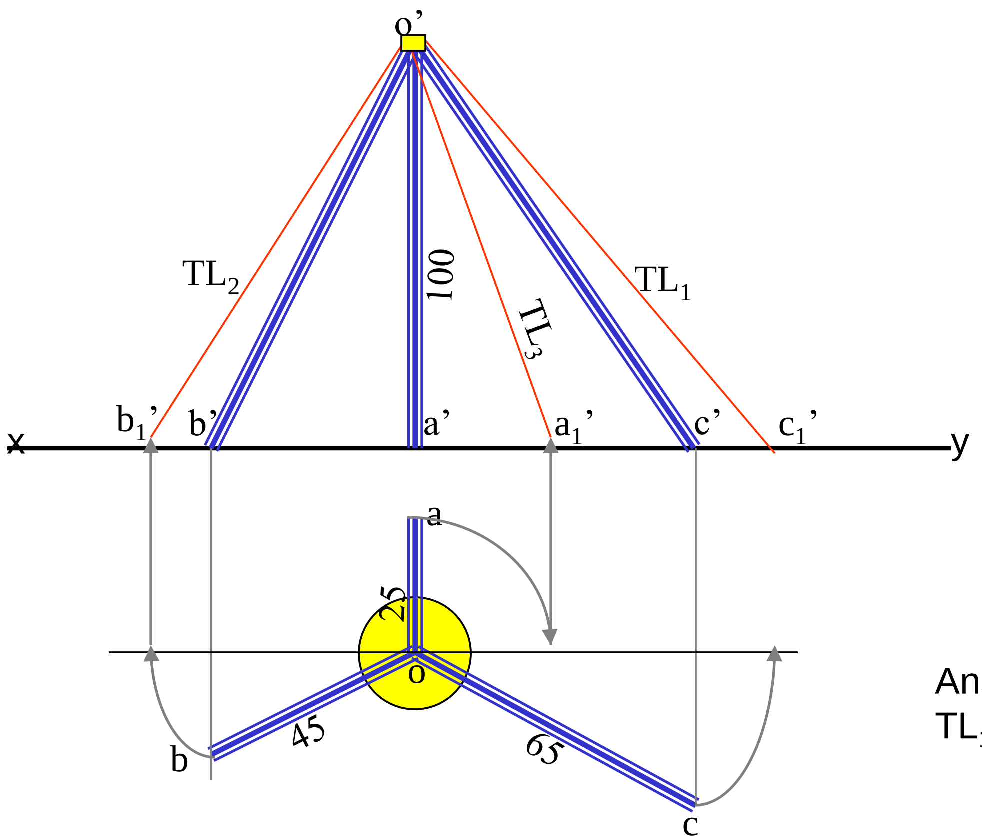


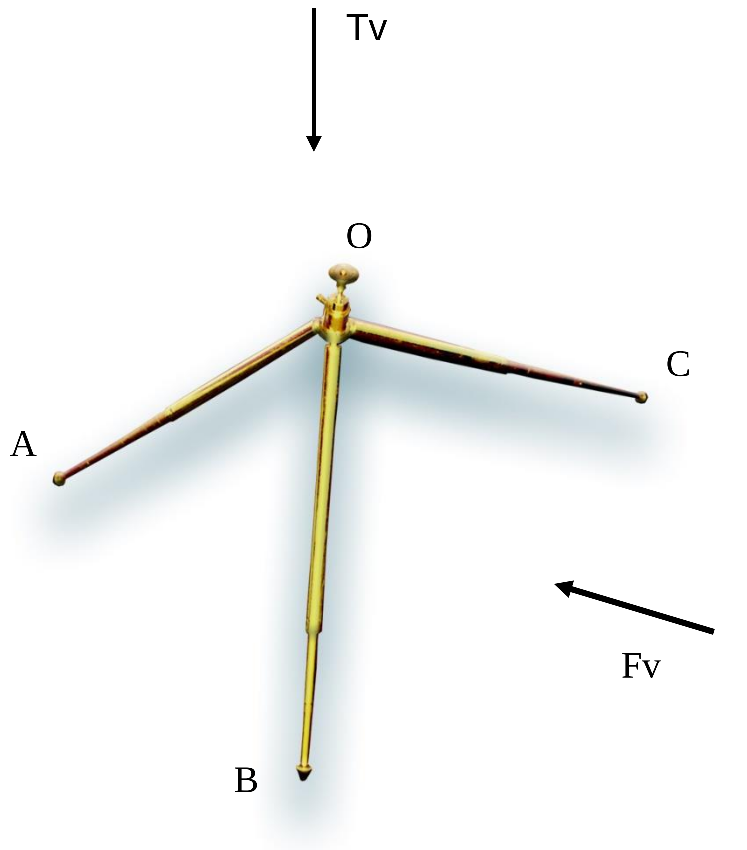


REAL DISTANCE BETWEEN MANGOS A & B IS = a' b_1'

PROBLEM 16 :-

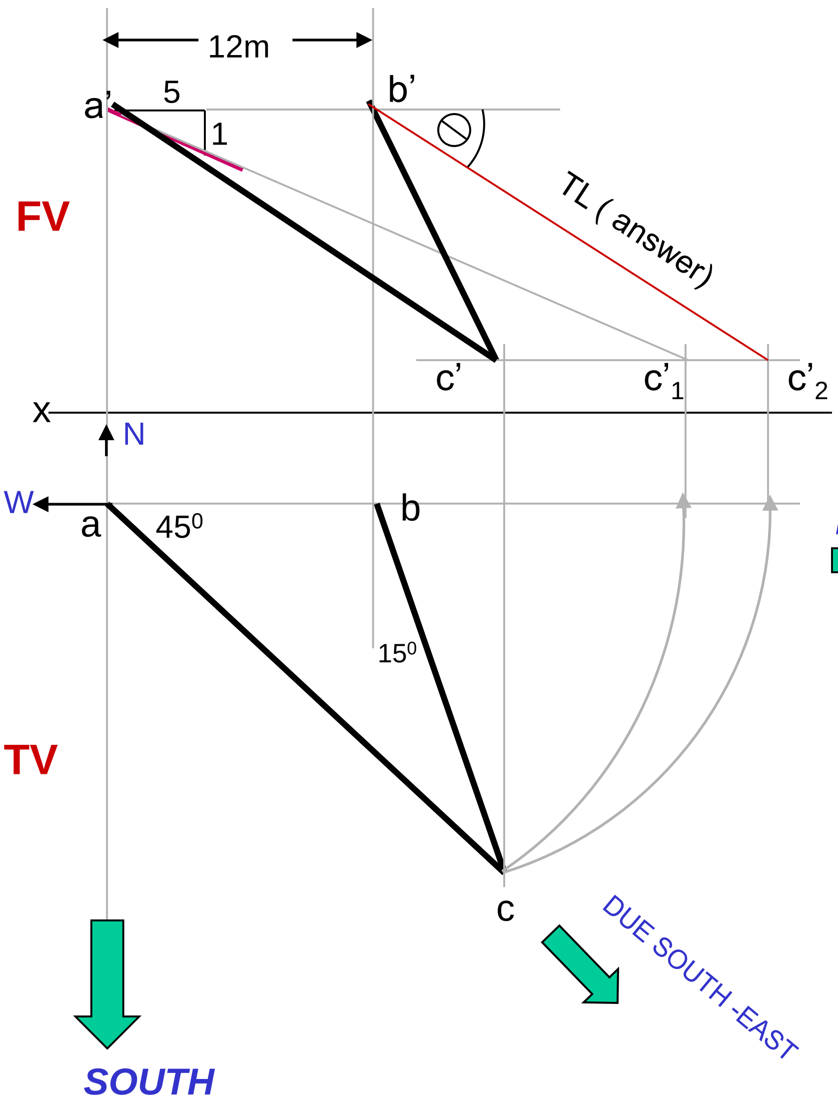
oa, ob & oc are three lines, 25mm, 45mm and 65mm long respectively.All equally inclined and the shortest is vertical.This fig. is TV of three rods OA, OB and OC whose ends A,B & C are on ground and end O is 100mm above ground. Draw their projections and find length o each along with their angles with ground.

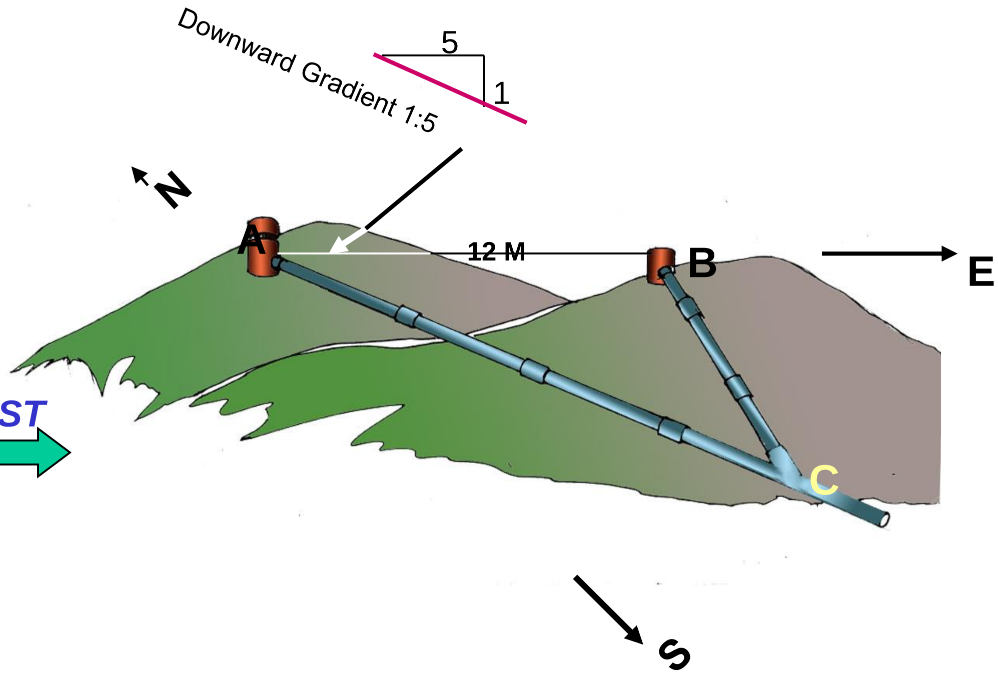




Answers:
TL$_1$ TL$_2$ & TL$_3$

PROBLEM 17:- **A pipe line from point A has a downward gradient 1:5 and it runs due South - East. Another Point B is 12 M from A and due East of A and in same level of A. Pipe line from B runs 15^0 Due East of South and meets pipe line from A at point C.**
Draw projections and find length of pipe line from B and it's inclination with ground.

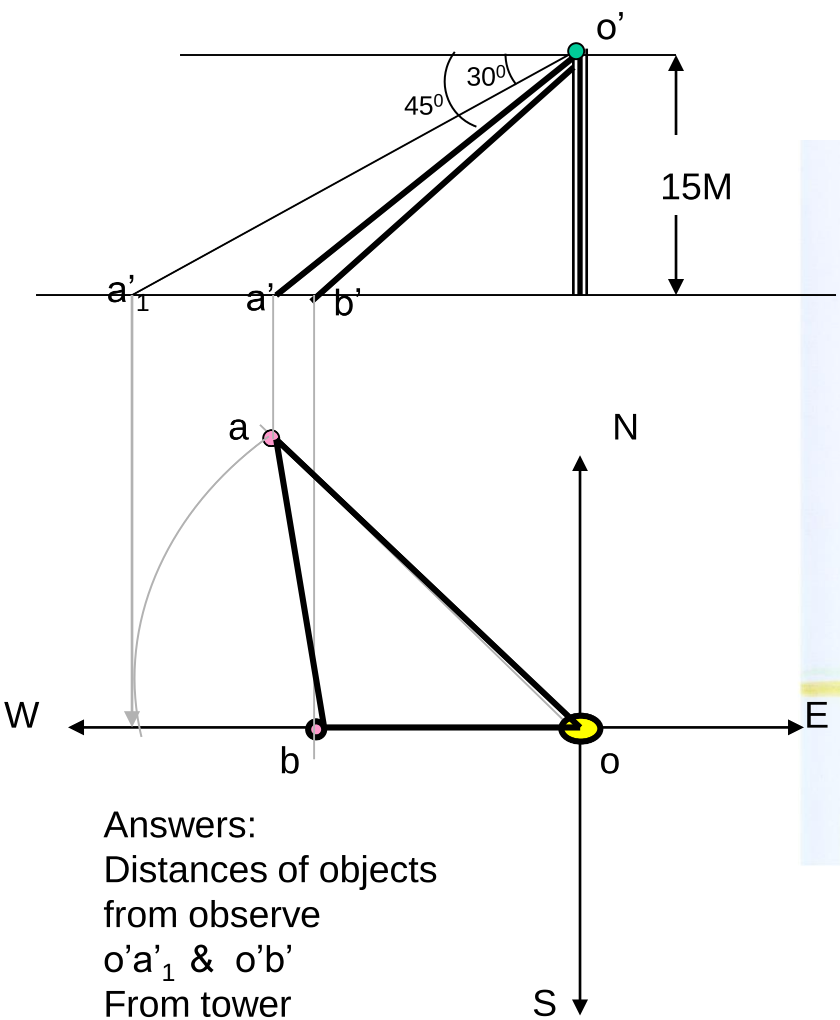


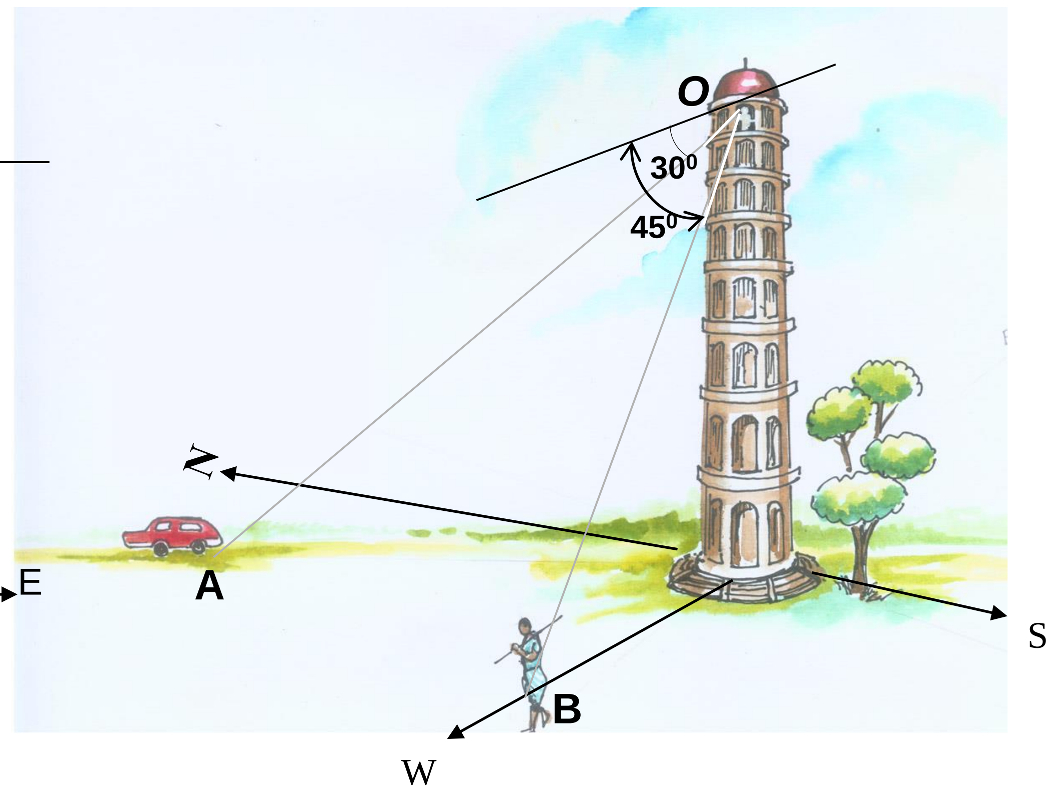


TL (answer) = a' c'_2

⦸ = Inclination of pipe line BC

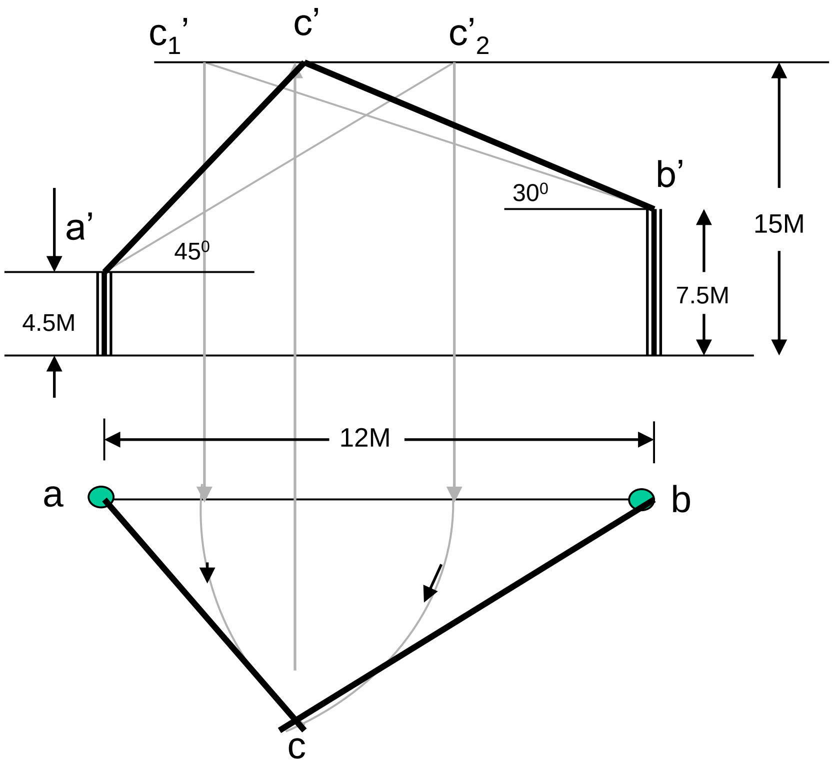
PROBLEM 18: A person observes two objects, A & B, on the ground, from a tower, 15 M high, At the angles of depression 30^0 & 45^0. Object A is is due North-West direction of observer and object B is due West direction. Draw projections of situation and find distance of objects from observer and from tower also.

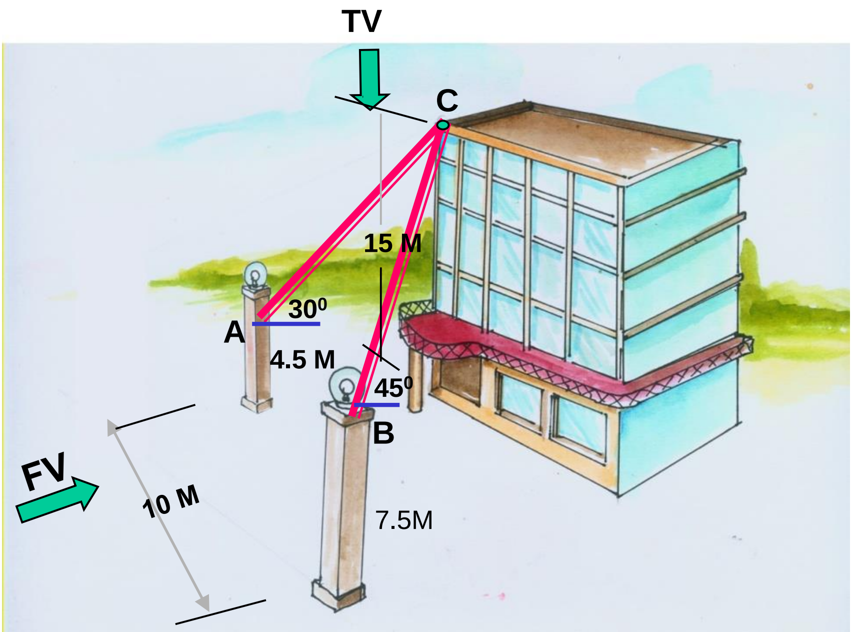




Answers:
Distances of objects
from observe
$o'a'_1$ & $o'b'$
From tower
oa & ob

PROBLEM 19:-Guy ropes of two poles fixed at 4.5m and 7.5 m above ground, are attached to a corner of a building 15 M high, make 30^0 and 45^0 inclinations with ground respectively.The poles are 10 M apart. Determine by drawing their projections,Length of each rope and distance of poles from building.

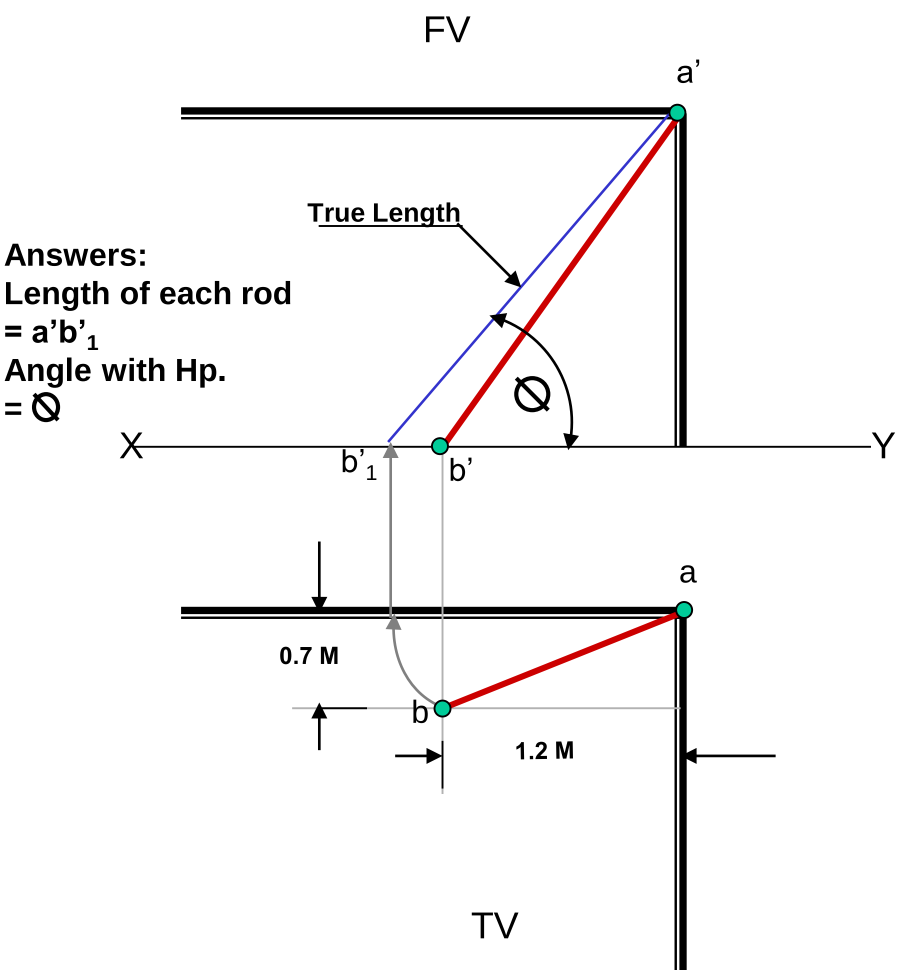


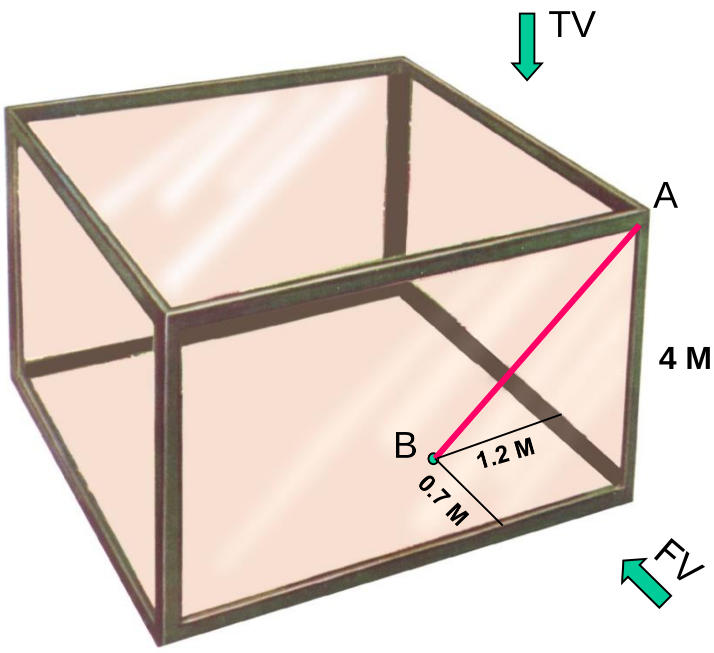


Answers:
Length of Rope BC= $b'c'_2$
Length of Rope AC= $a'c'_1$

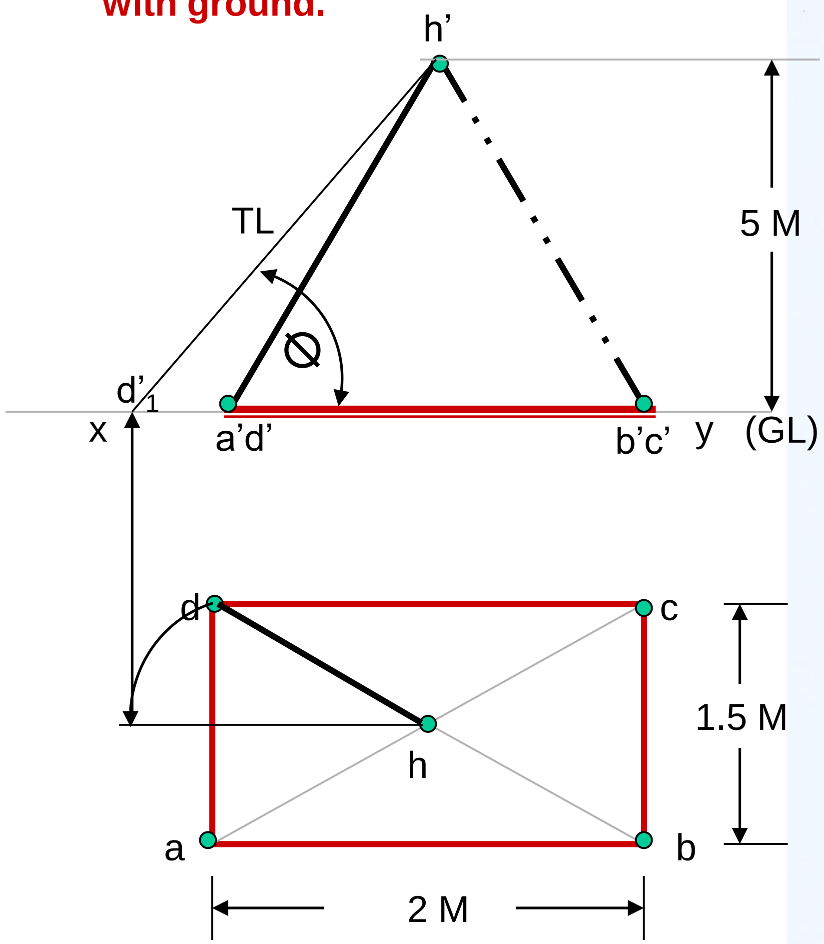
Distances of poles from building = ca & cb

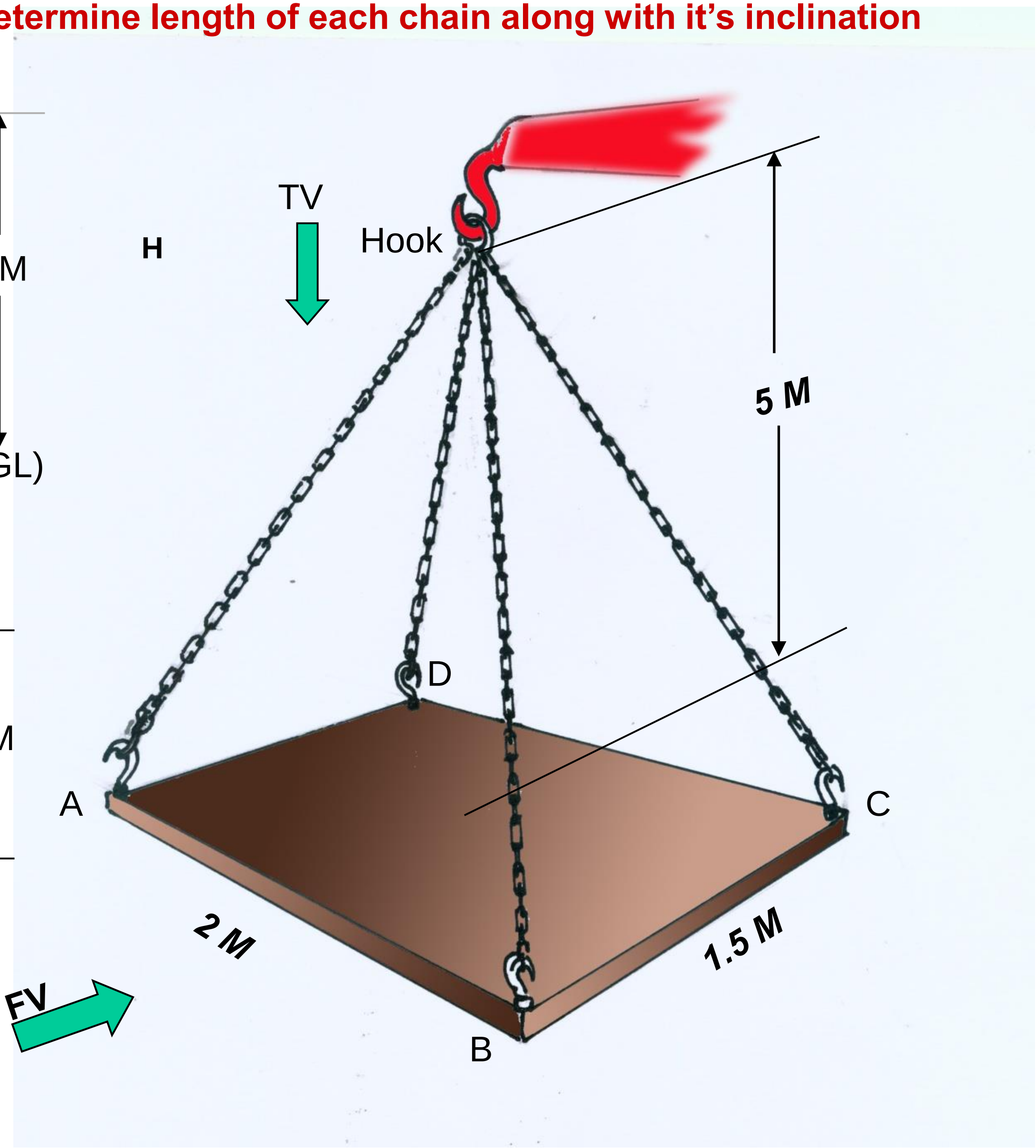
PROBLEM 20:- A tank of 4 M height is to be strengthened by four stay rods from each corner by fixing their other ends to the flooring, at a point 1.2 M and 0.7 M from two adjacent walls respectively, as shown. Determine graphically length and angle of each rod with flooring.





PROBLEM 21:- A horizontal wooden platform 2 M long and 1.5 M wide is supported by four chains from it's corners and chains are attached to a hook 5 M above the center of the platform. Draw projections of the objects and determine length of each chain along with it's inclination with ground.

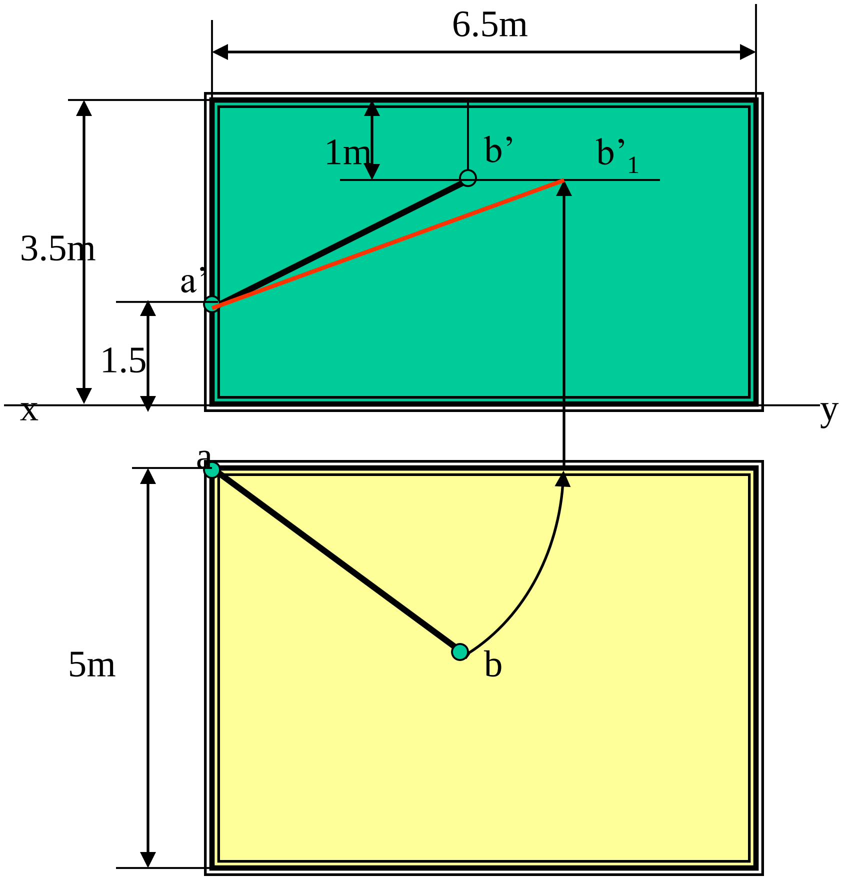


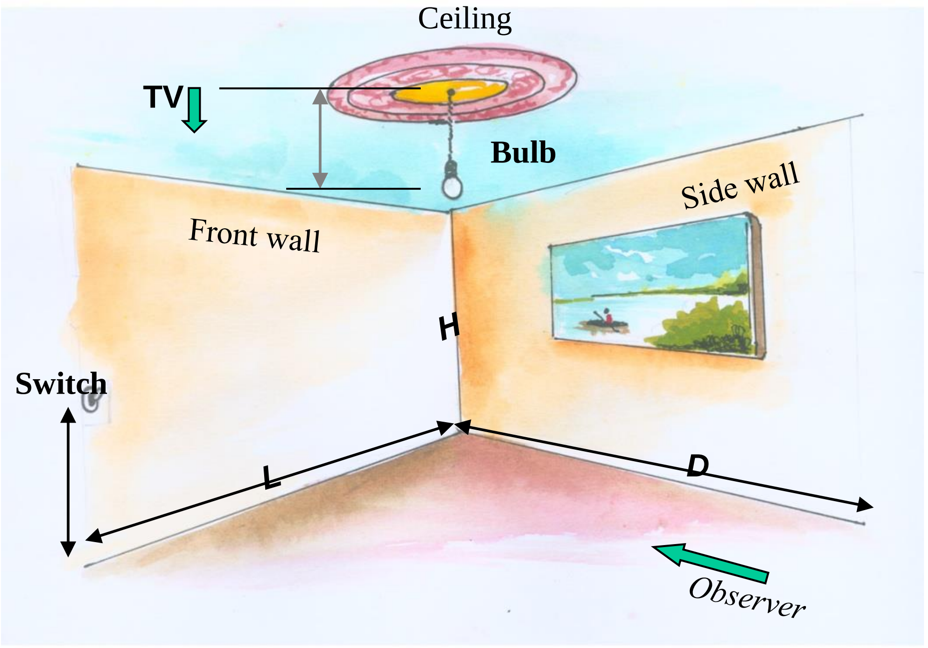


Answers:
Length of each chain
= a'd'$_1$
Angle with Hp.
= Ø

PROBLEM 22.

A room is of size 6.5m L ,5m D,3.5m high.
An electric bulb hangs 1m below the center of ceiling.
A switch is placed in one of the corners of the room, 1.5m above the flooring.
Draw the projections an determine real distance between the bulb and switch.

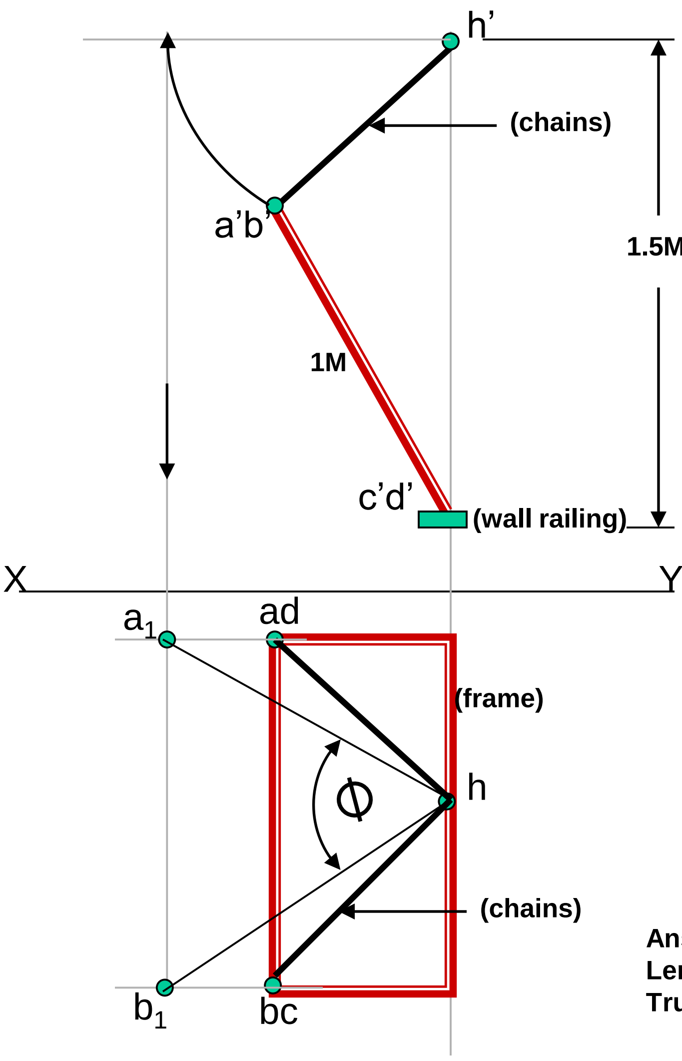


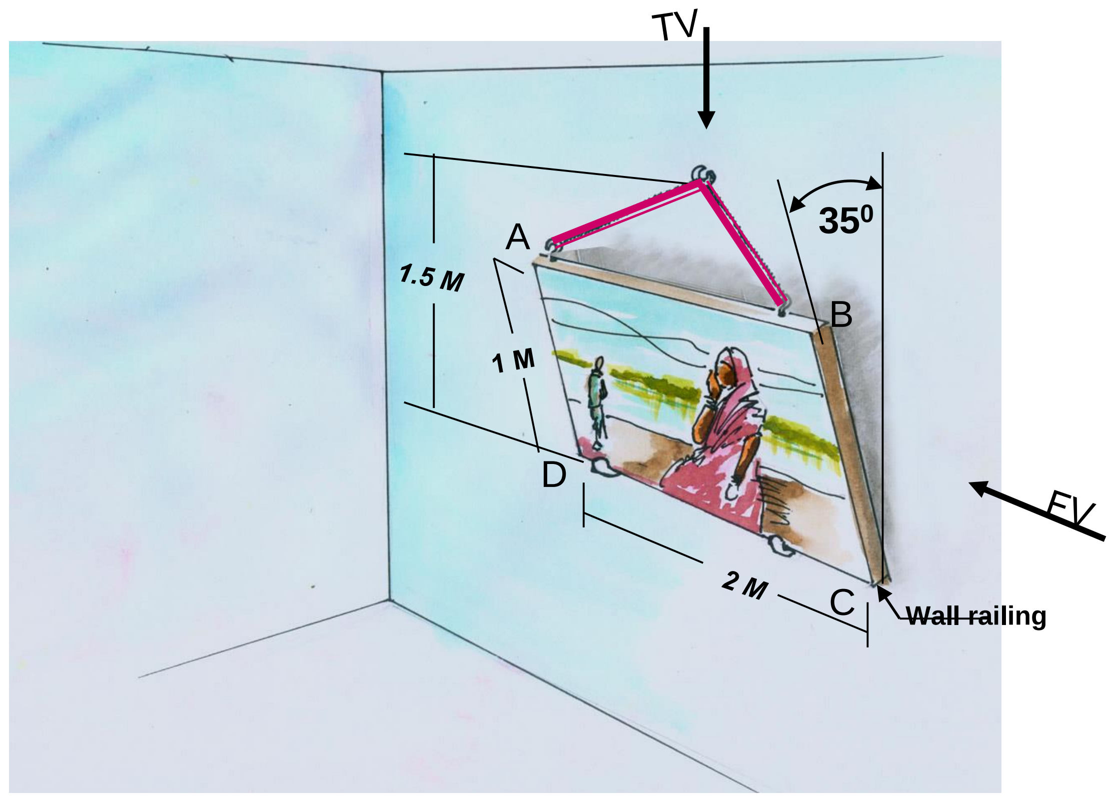


B- Bulb
A-Switch
Answer :- a' b'_1

PROBLEM 23:-

A PICTURE FRAME 2 M WIDE AND 1 M TALL IS RESTING ON HORIZONTAL WALL RAILING MAKES 35^0 INCLINATION WITH WALL. IT IS ATTAACHED TO A HOOK IN THE WALL BY TWO STRINGS. THE HOOK IS 1.5 M ABOVE WALL RAILING. DETERMINE LENGTH OF EACH CHAIN AND TRUE ANGLE BETWEEN THEM





Answers:
Length of each chain= hb_1
True angle between chains = ϕ