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)

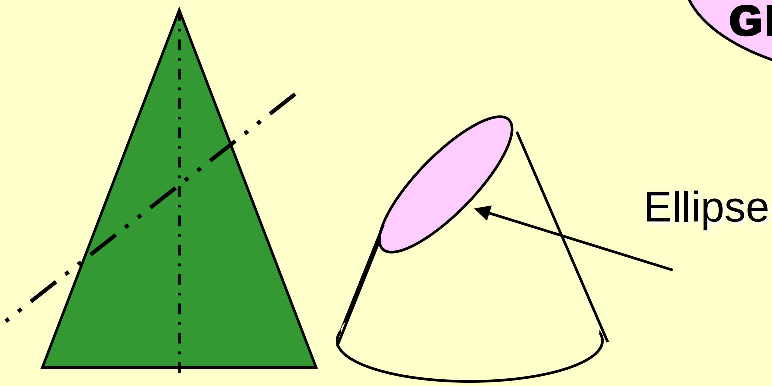
Methods of Drawing Tangents & Normals To These Curves.

CONIC SECTIONS

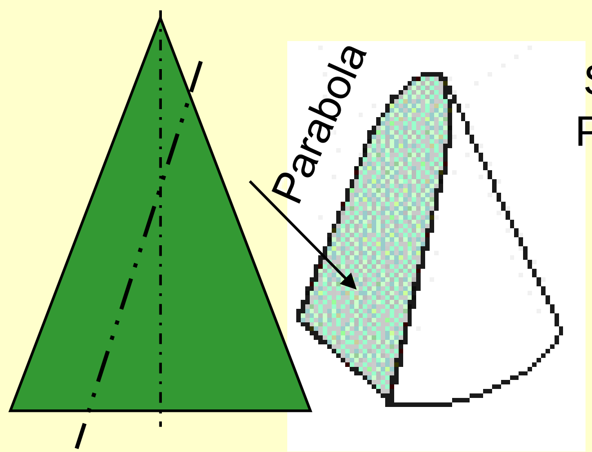
ELLIPSE, PARABOLA AND HYPERBOLA ARE CALLED CONIC SECTIONS BECAUSE

THESE CURVES APPEAR ON THE SURFACE OF A CONE WHEN IT IS CUT BY SOME TYPICAL CUTTING PLANES.

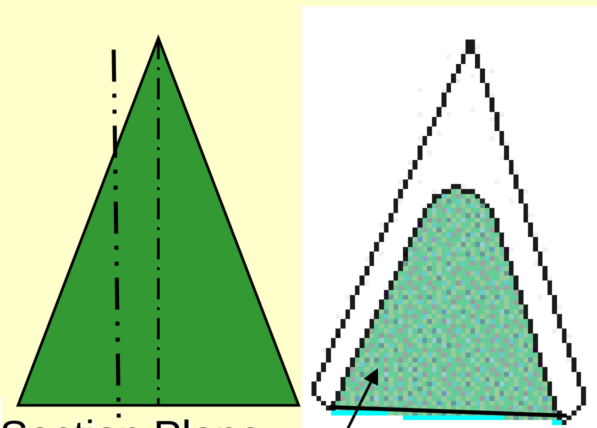
OBSERVE ILLUSTRATIONS GIVEN BELOW..



Section Plane
Through Generators



Section Plane Parallel
to end generator.



Section Plane
Parallel to Axis.

Hyperbola

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

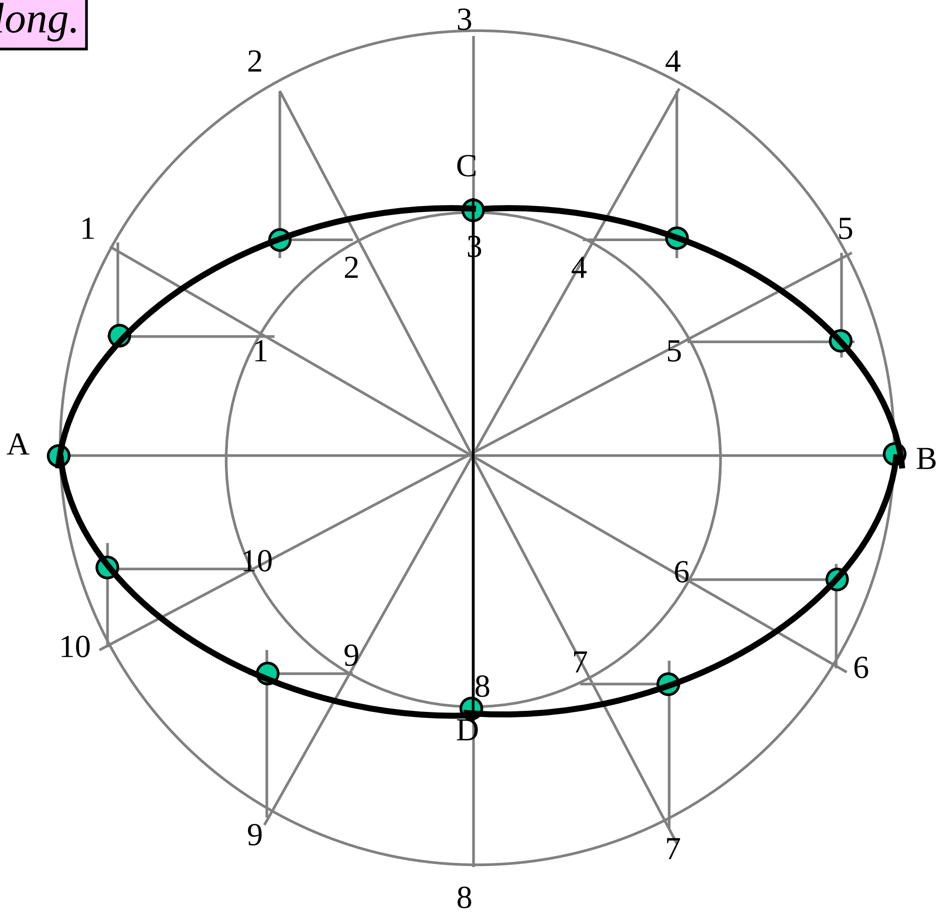
Refer Problem no.4

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.



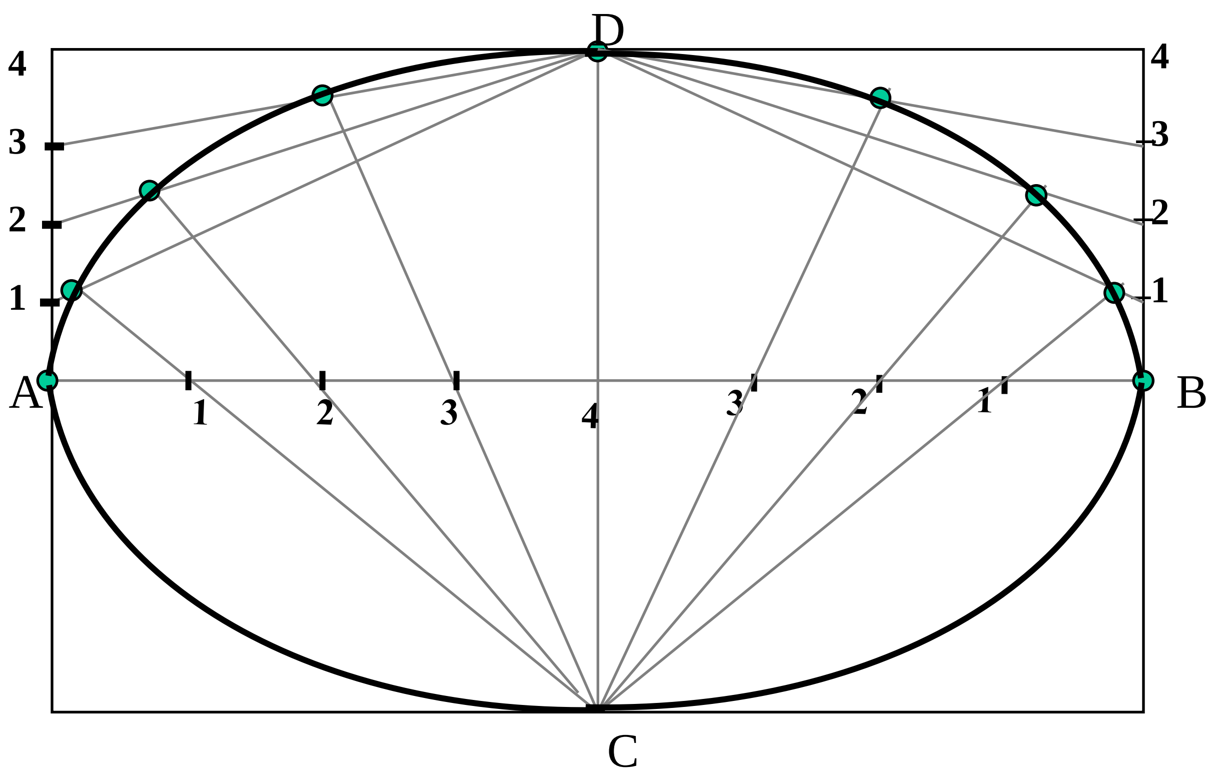
ELLIPSE

BY RECTANGLE METHOD

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.

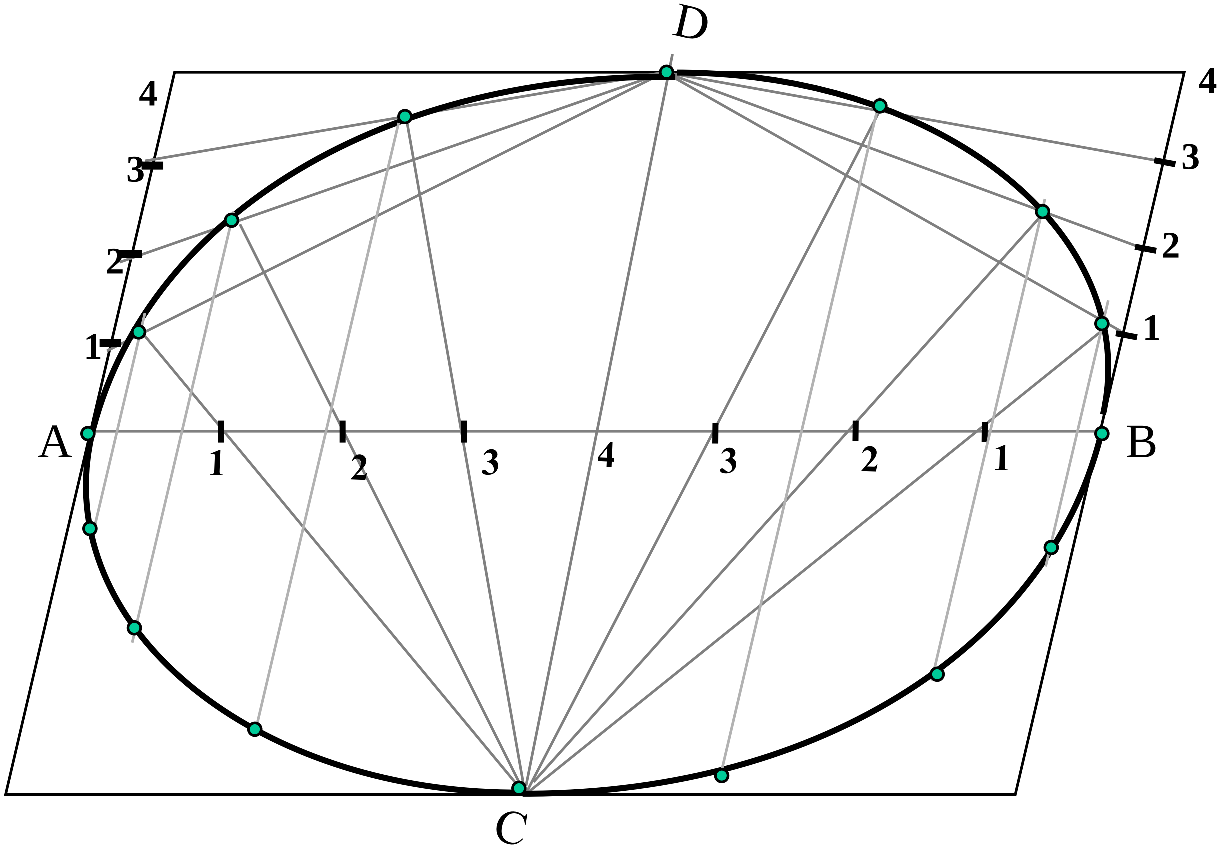


Problem 3:-

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.



ELLIPSE

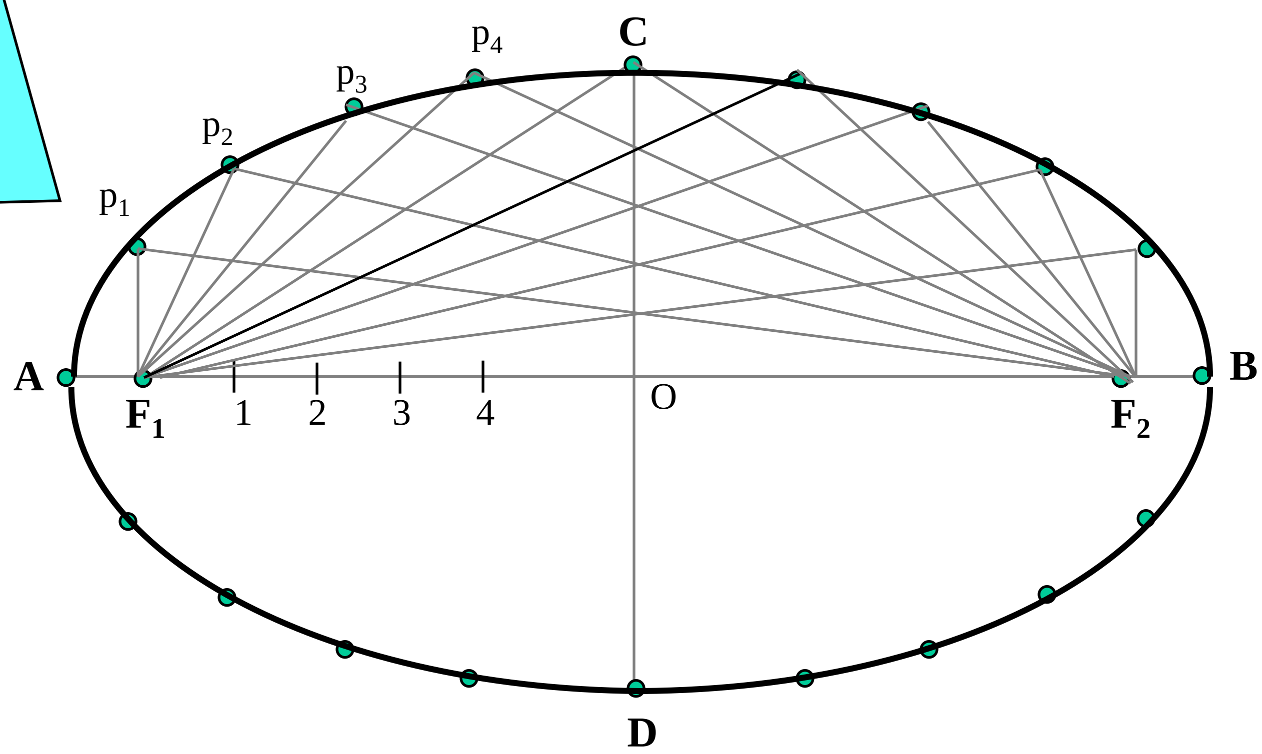
BY ARCS OF CIRCLE METHOD

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

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/

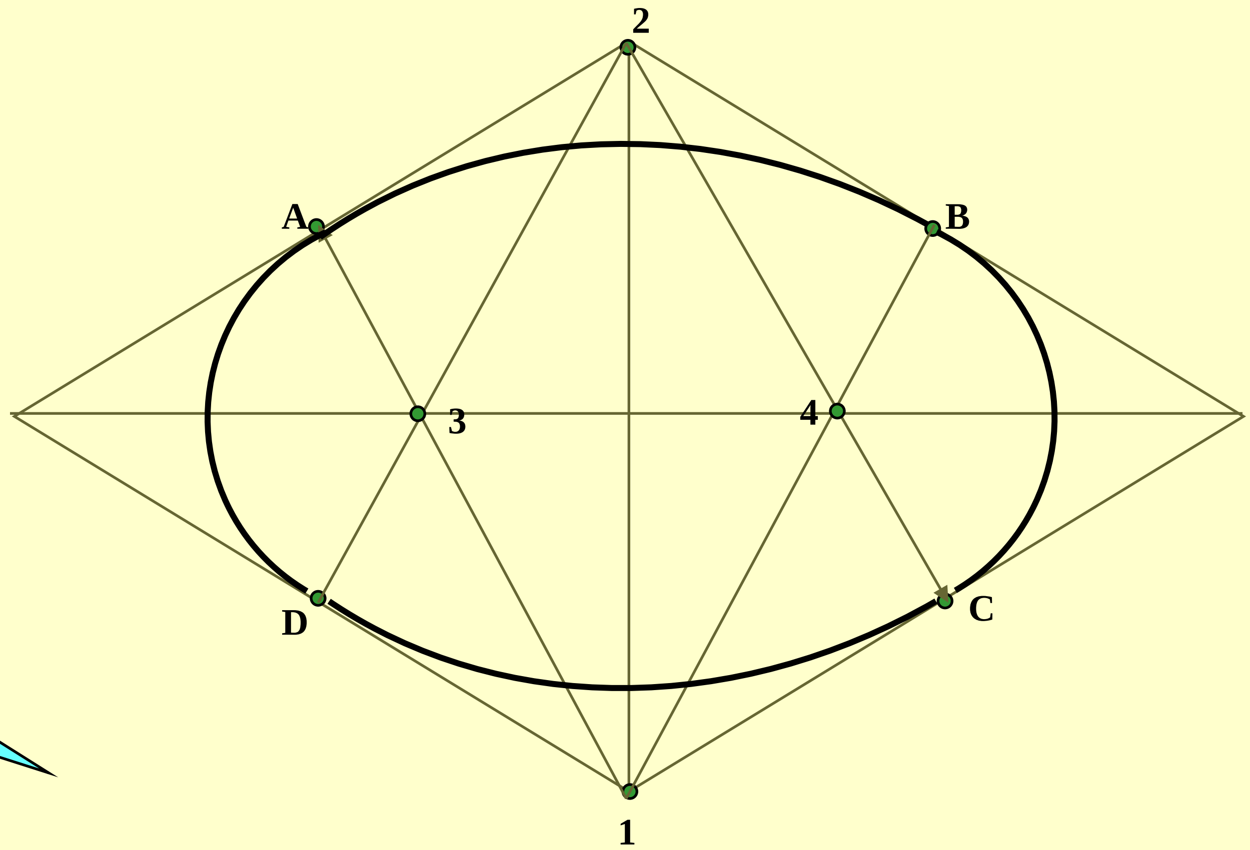
As per the definition Ellipse is locus of point P moving in a plane such that the SUM of it's distances from two fixed points (F_1 & F_2) remains constant and equals to the length of major axis AB.(Note A .1+ B .1=A . 2 + B. 2 = AB)



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

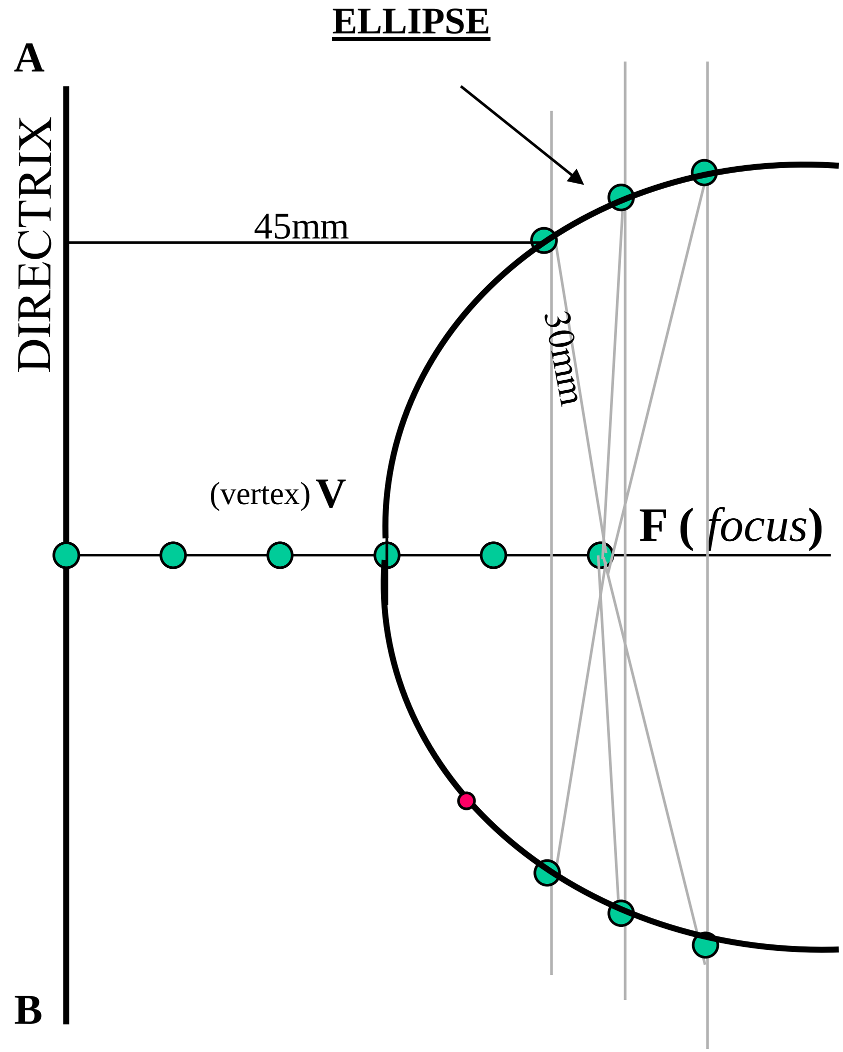
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

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.



PARABOLA
RECTANGLE METHOD

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)-

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.**

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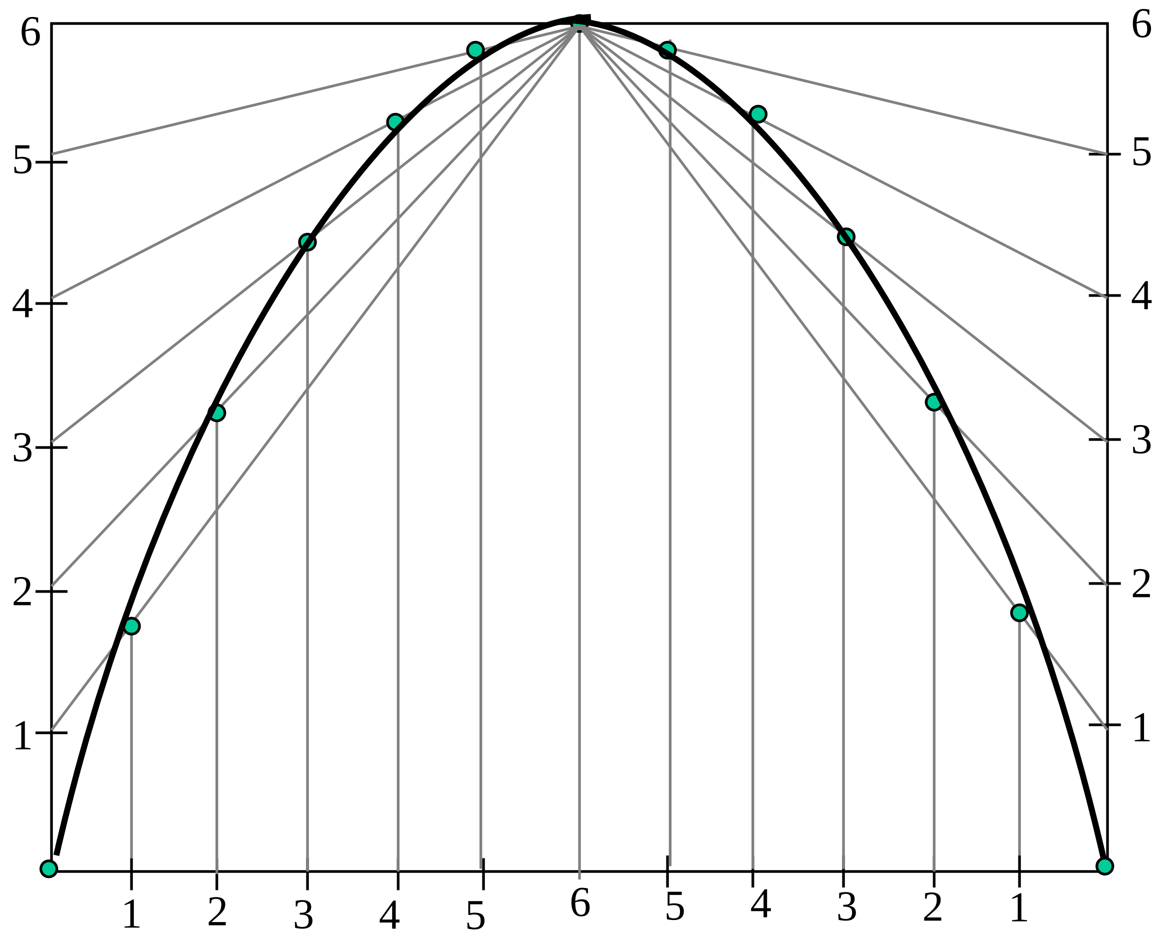
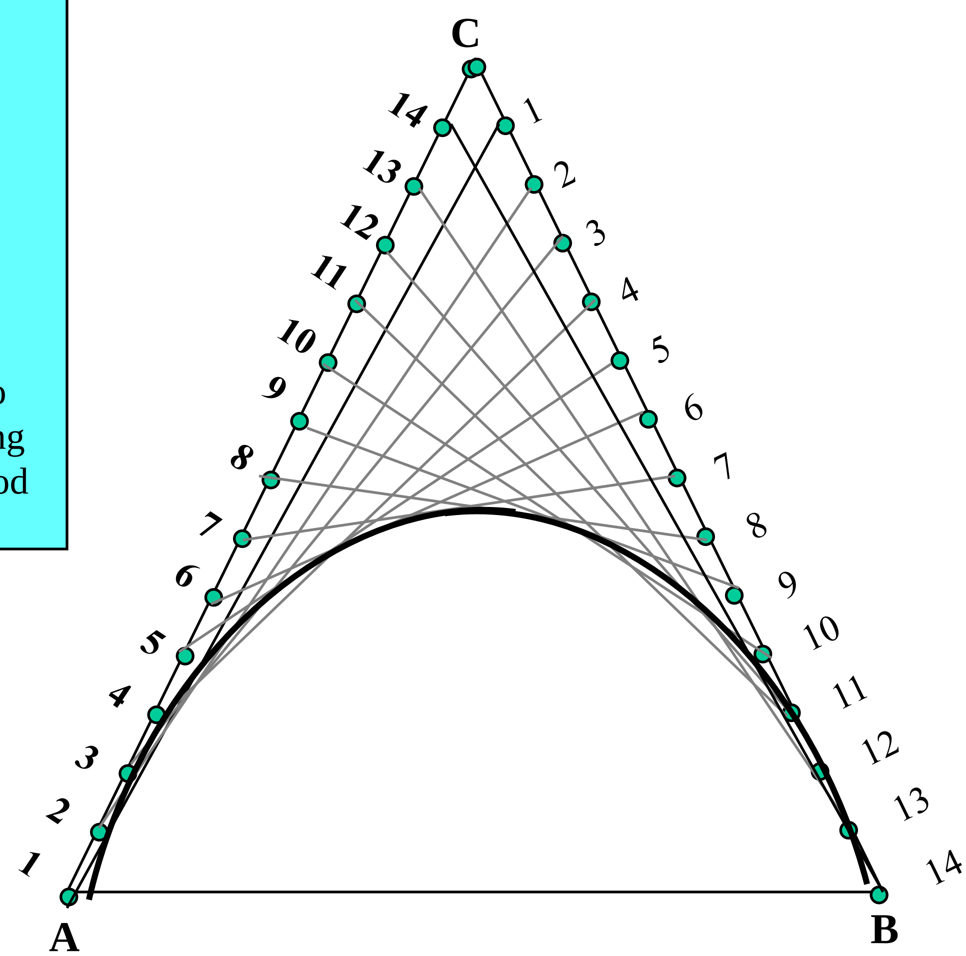


Problem no.8: Draw an isosceles triangle of 100 mm long base and 110 mm long altitude.Inscribe a parabola in it by method of tangents.

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.

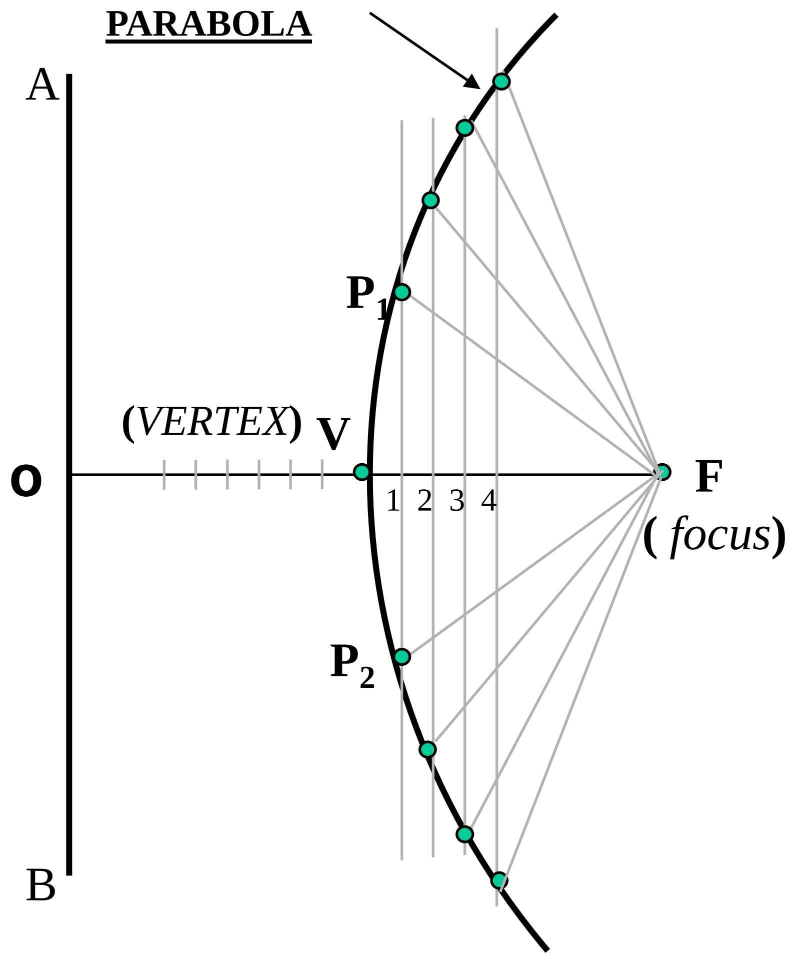
2.Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw lines parallel to AB.

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.

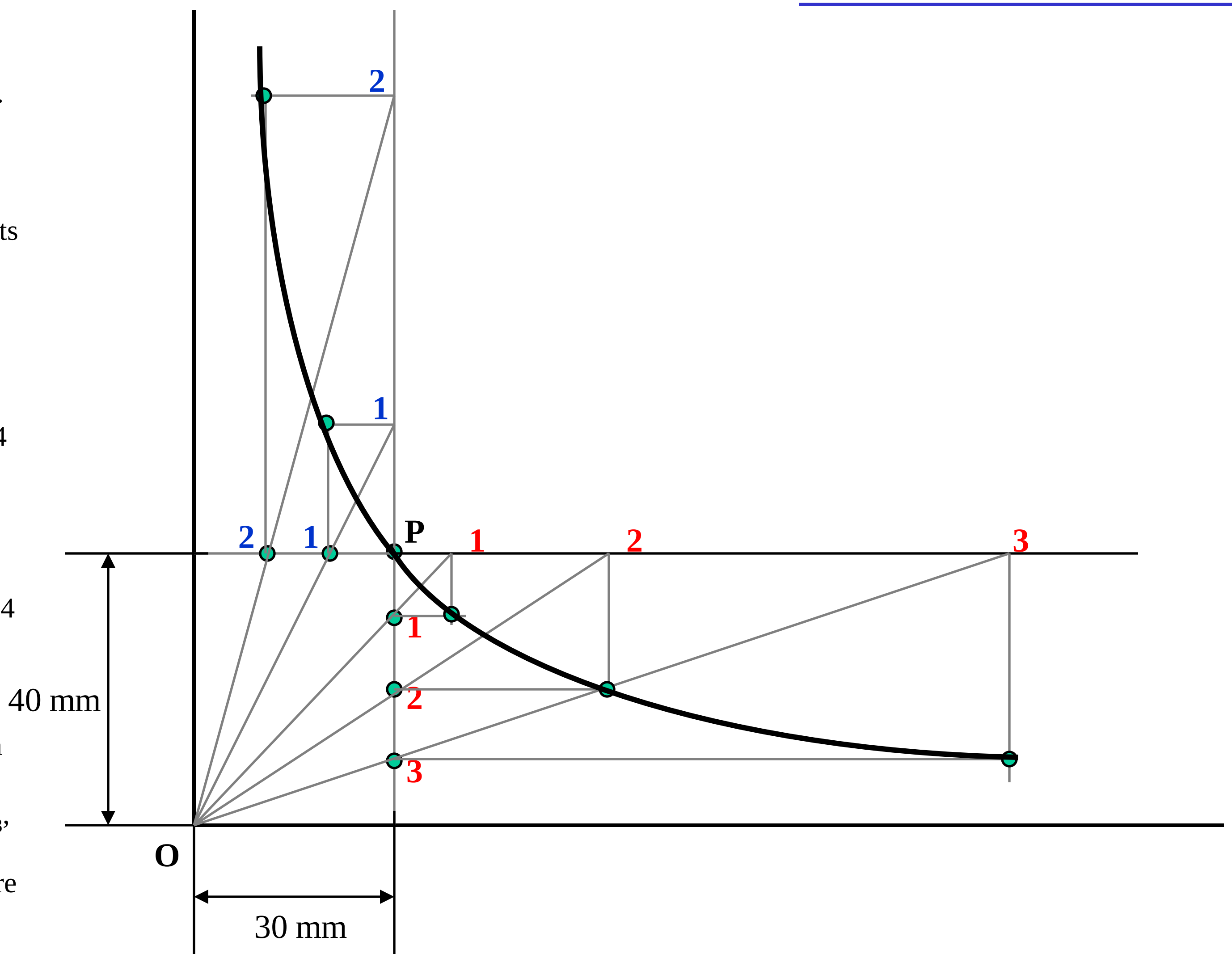
Problem No.10: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively.Draw Hyperbola through it.

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.



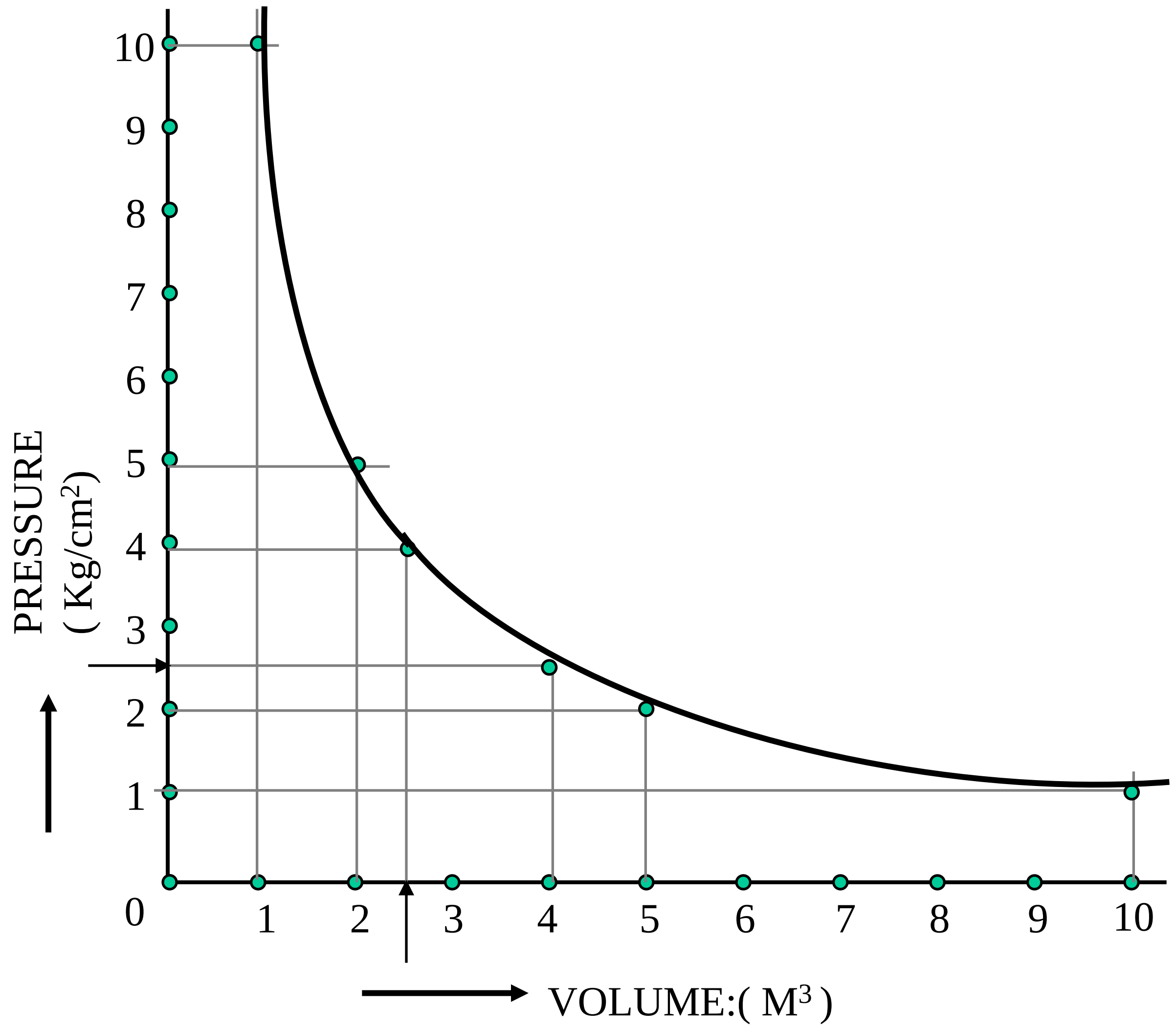
Problem no.11: A sample of gas is expanded in a cylinder from 10 unit pressure to 1 unit pressure.Expansion follows law PV=Constant.If initial volume being 1 unit, draw the curve of expansion. Also Name the curve.

HYPERBOLA
P-V DIAGRAM

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

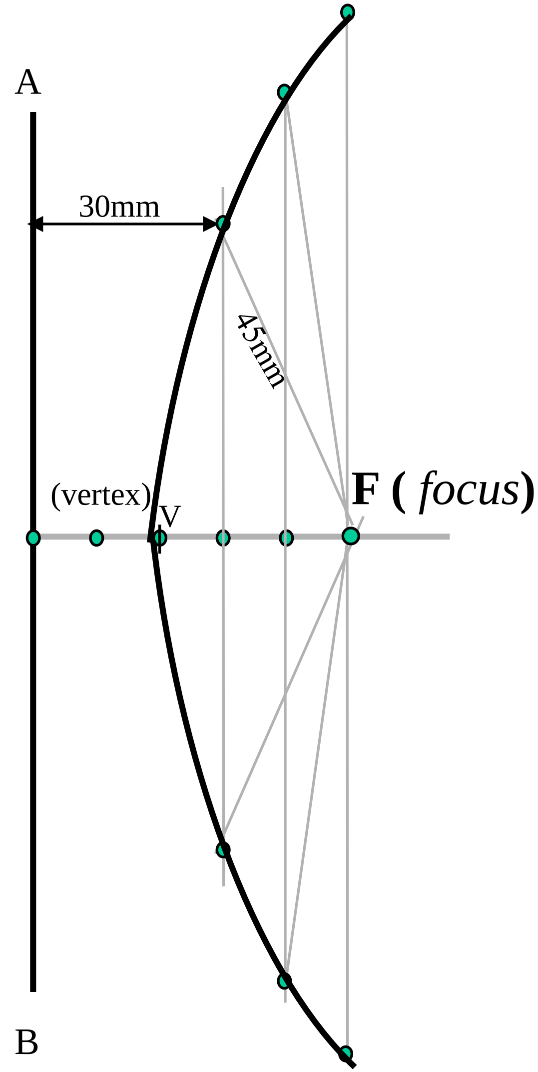
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

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.

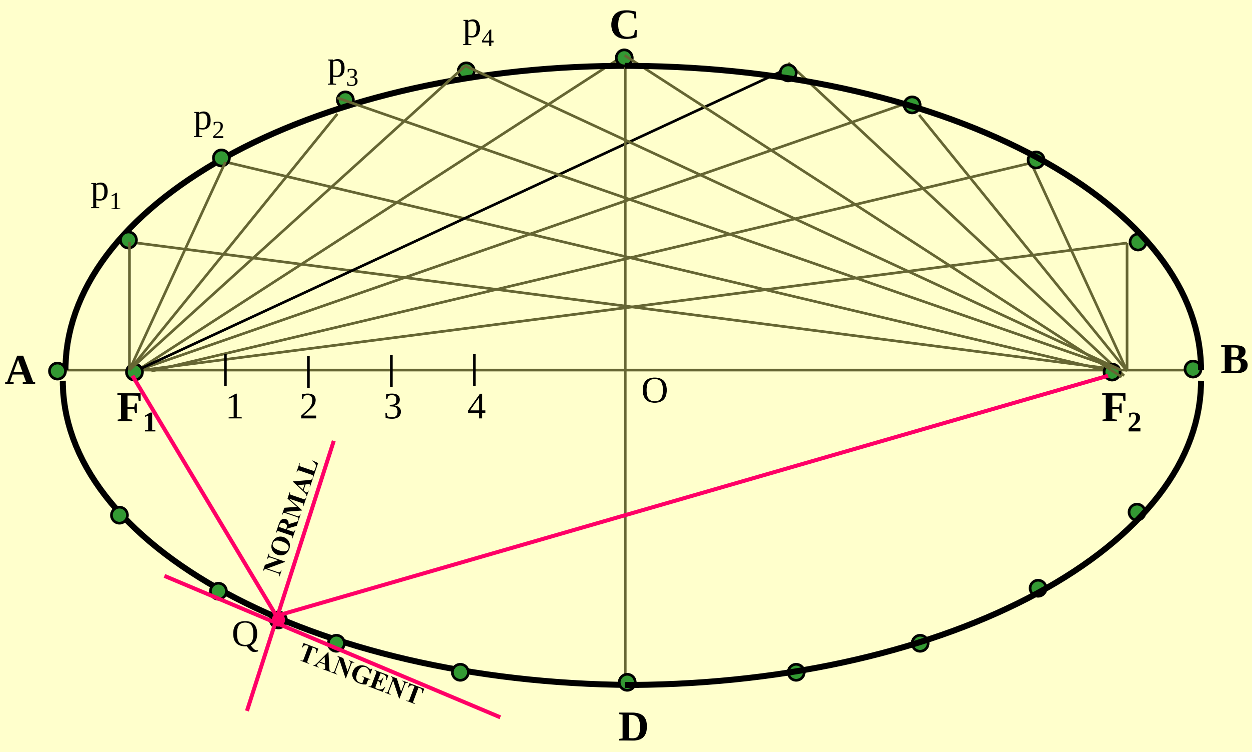
This is required locus of P.It is an ELLIPSE.



Problem 13:

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

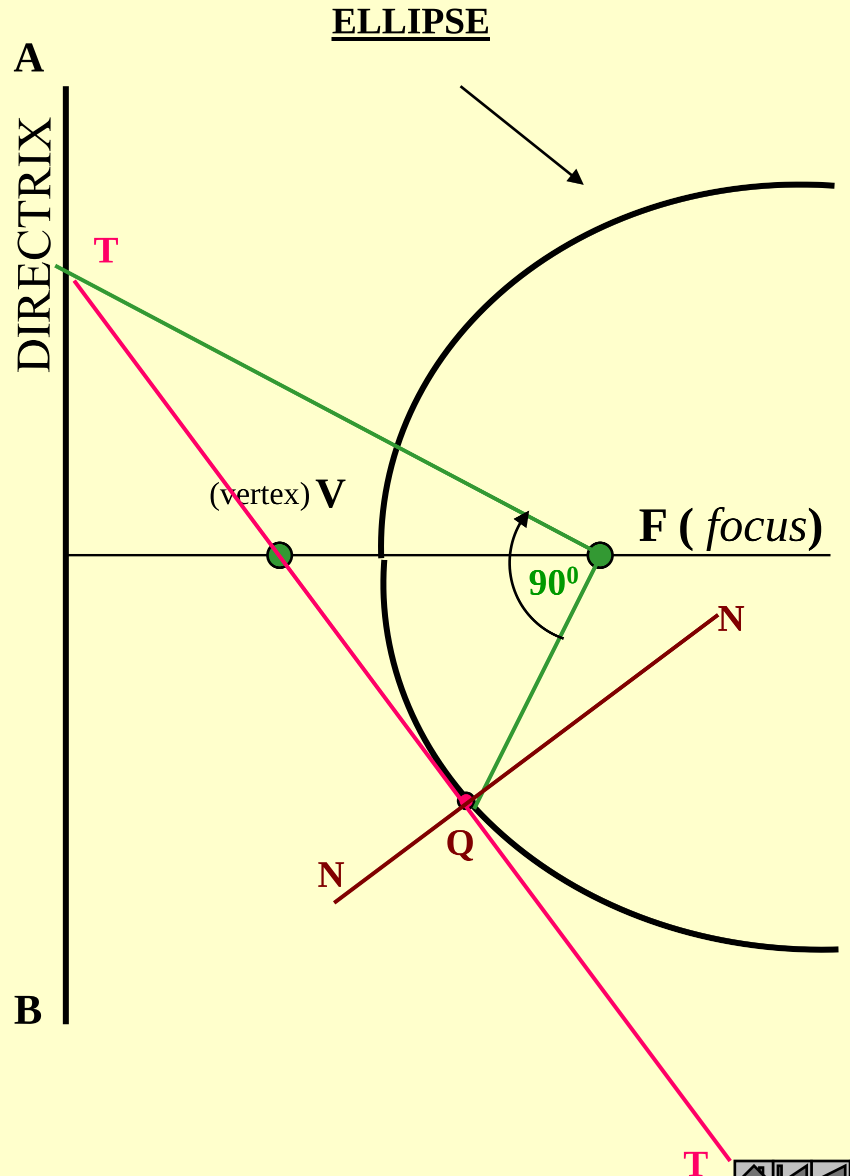
1. JOIN POINT Q TO F_1 & F_2
2. BISECT ANGLE F_1Q F_2 THE ANGLE BISECTOR IS NORMAL
3. A PERPENDICULAR LINE DRAWN TO IT IS TANGENT TO THE CURVE.



Problem 14:

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

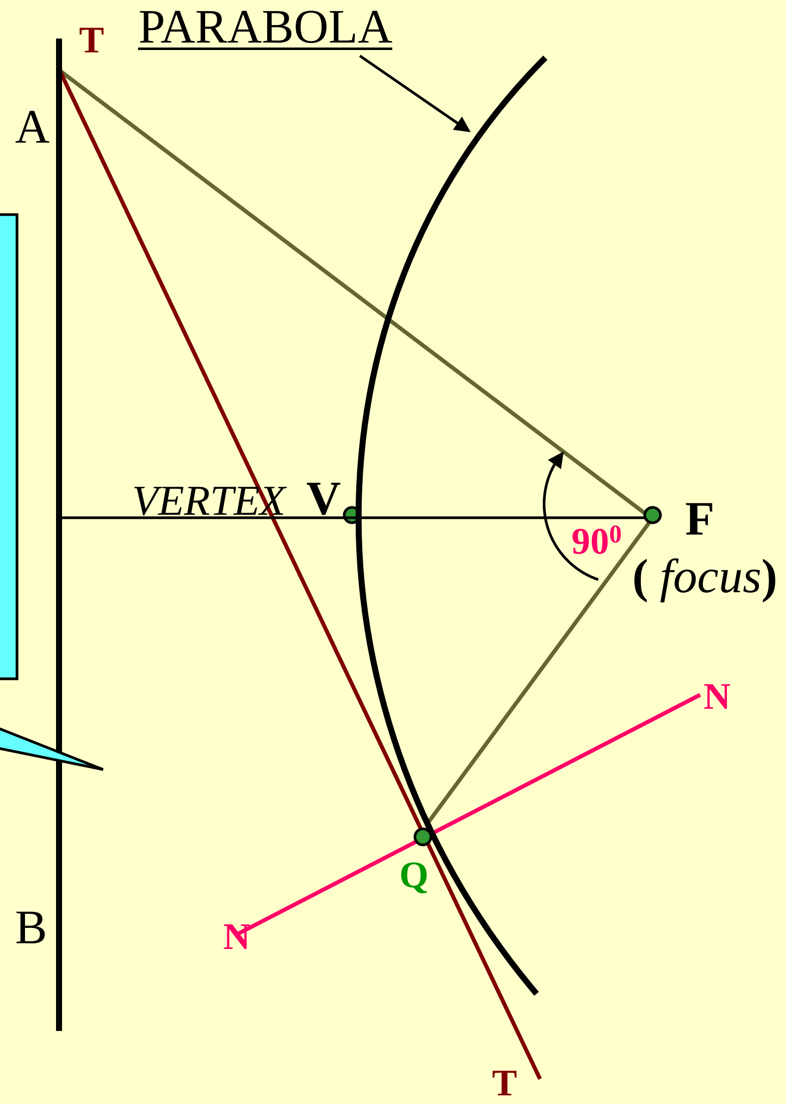
1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



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.

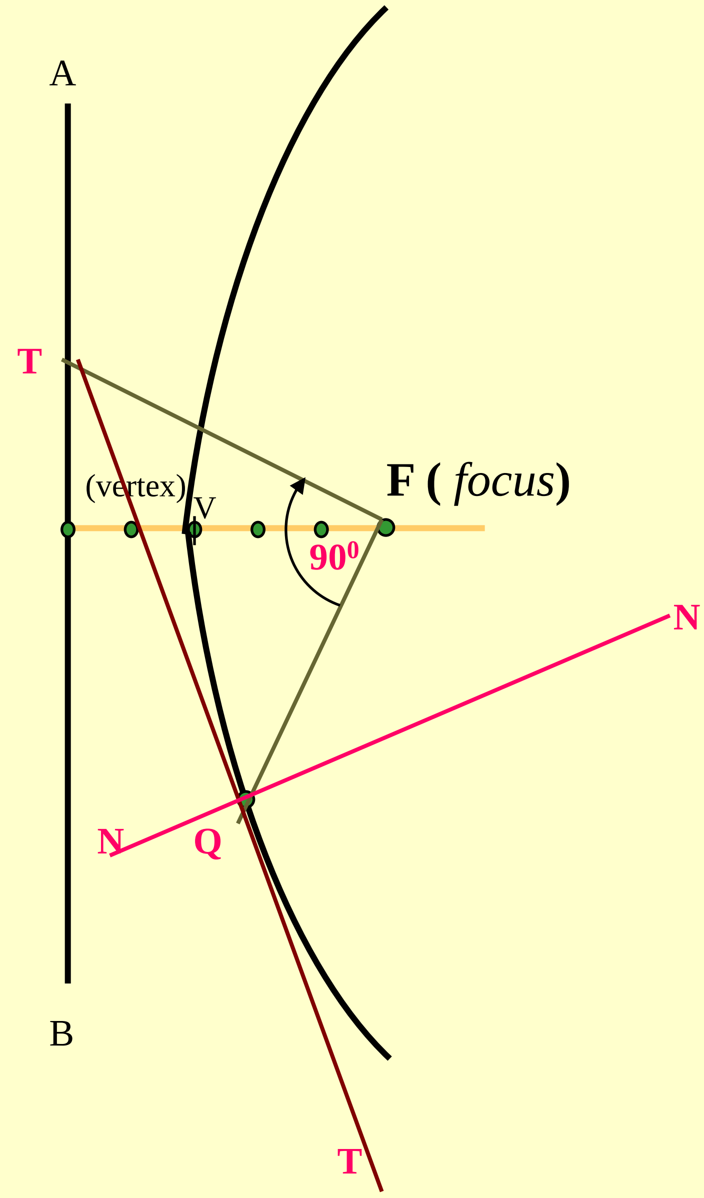


Problem 16

HYPERBOLA
TANGENT & NORMAL

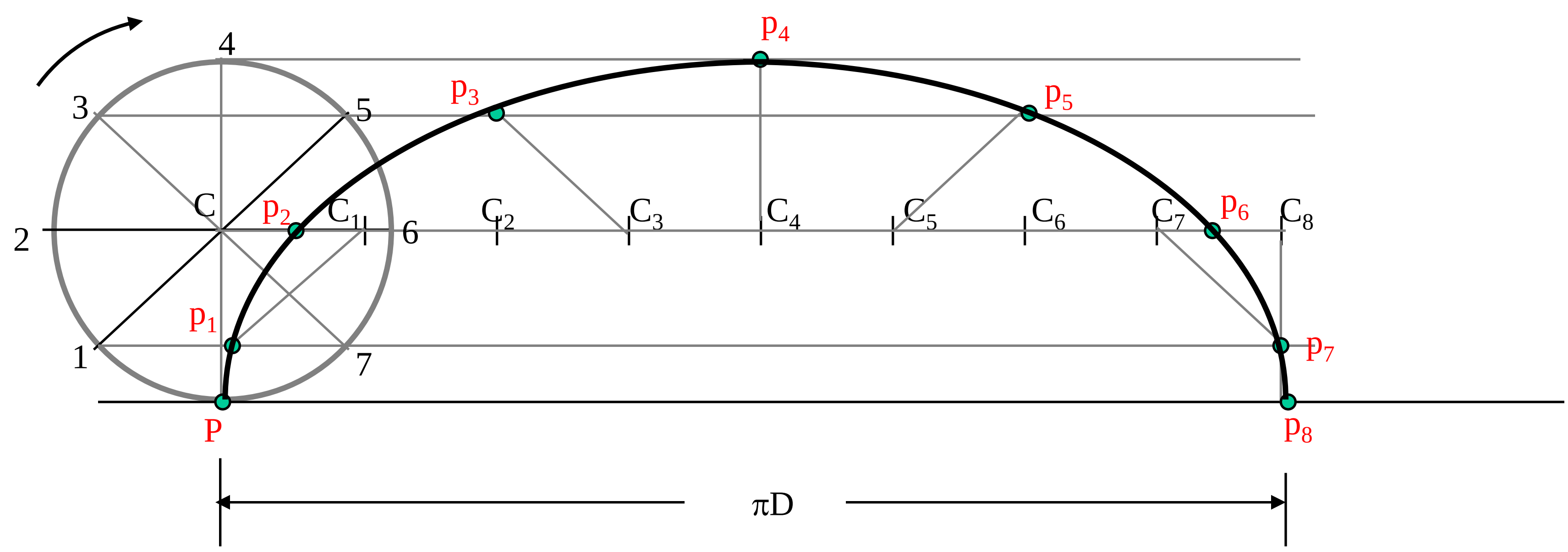
TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

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.



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:

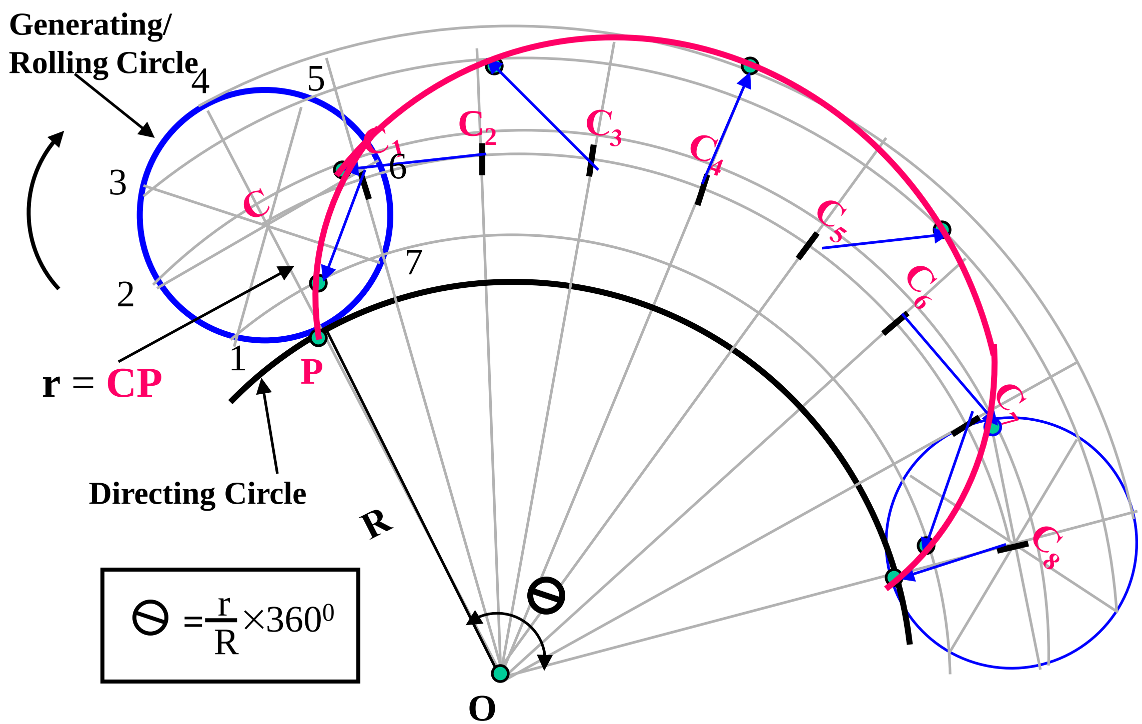
1) From center C draw a horizontal line equal to πD distance.
2) Divide πD distance into 8 number of equal parts and name them C1, C2, C3__ etc.
3) Divide the circle also into 8 number of equal parts and in clock wise direction, after P name 1, 2, 3 up to 8.
4) From all these points on circle draw horizontal 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 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.



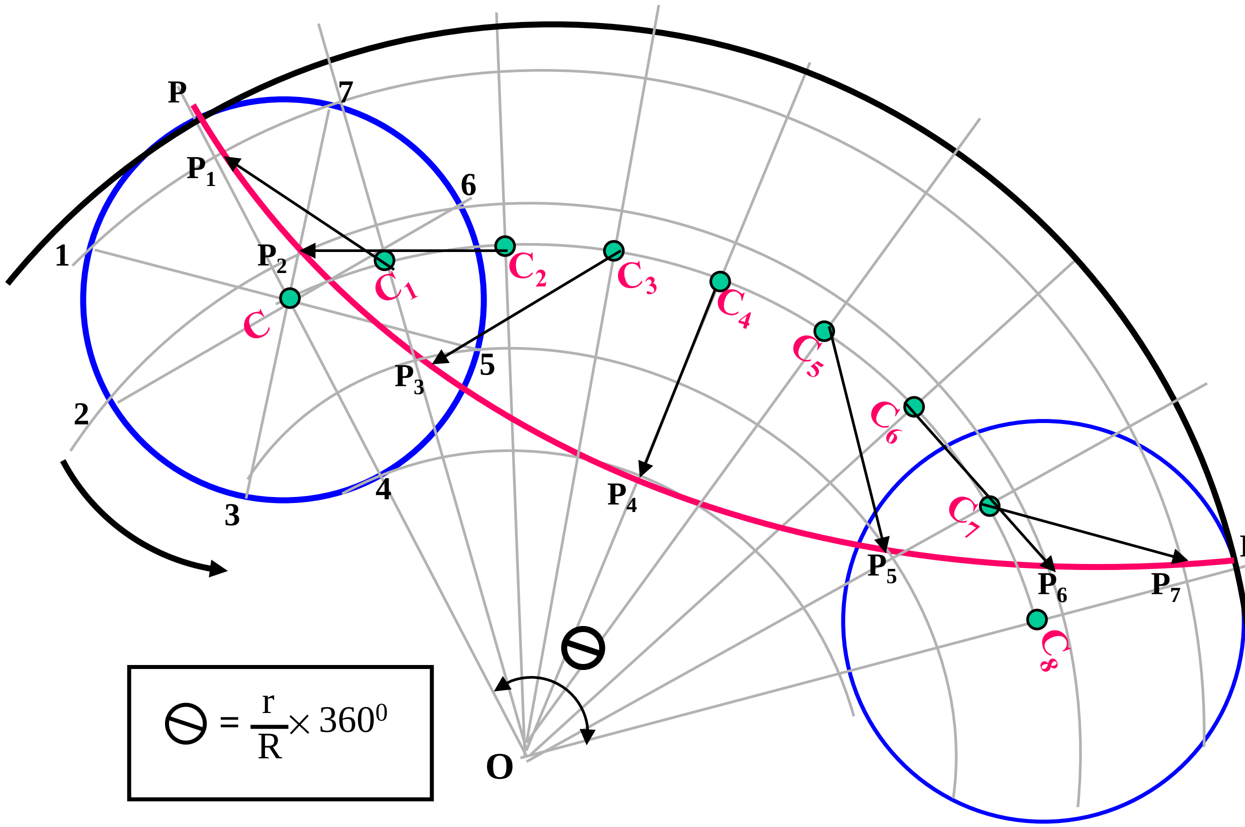
$$\theta = \frac{r}{R} \times 360^0$$

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)

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.**

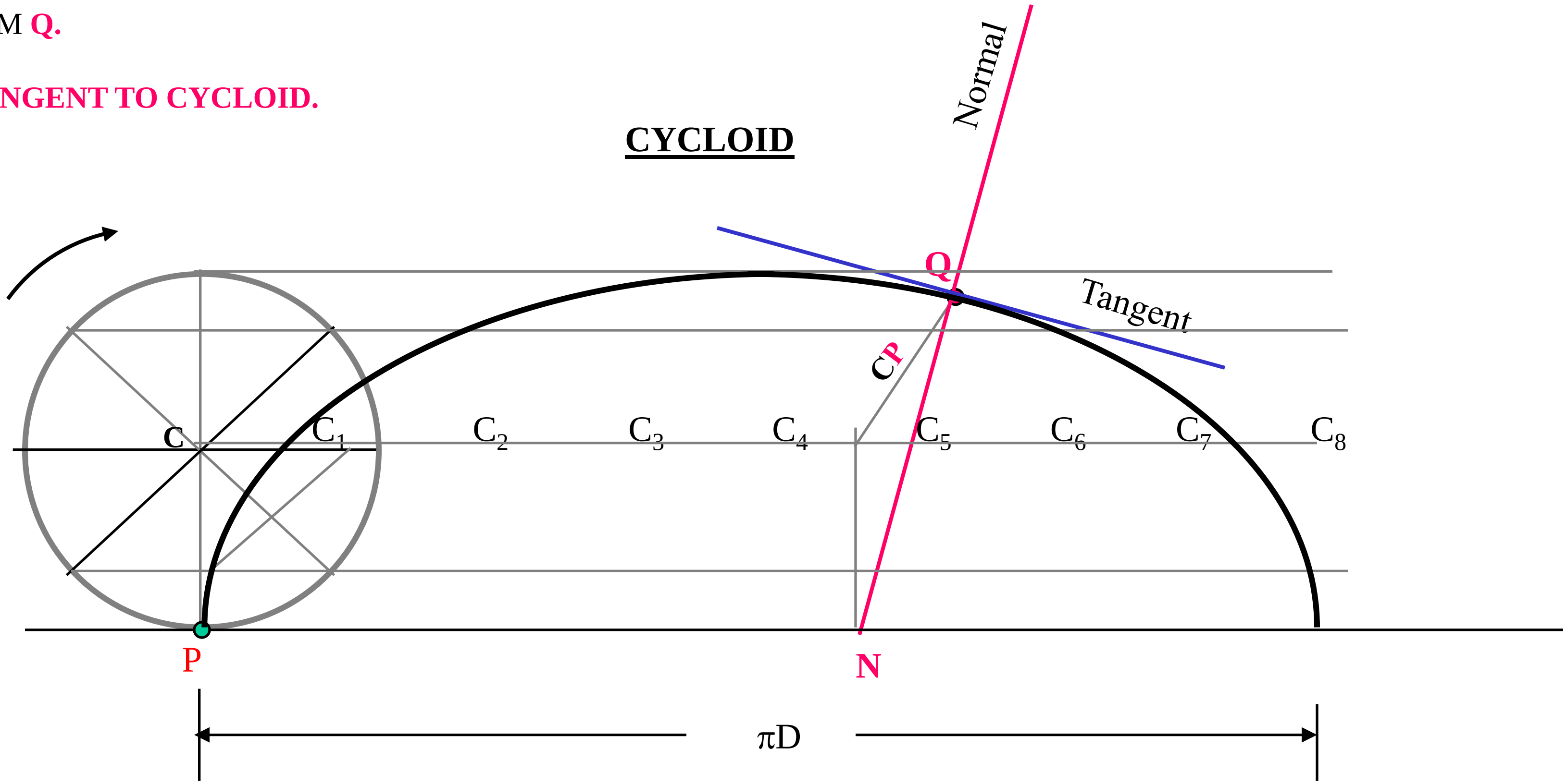
FROM THIS POINT DROP A PERPENDICULAR ON GROUND LINE AND NAME IT N

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.

CYCLOID



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

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

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

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

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

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

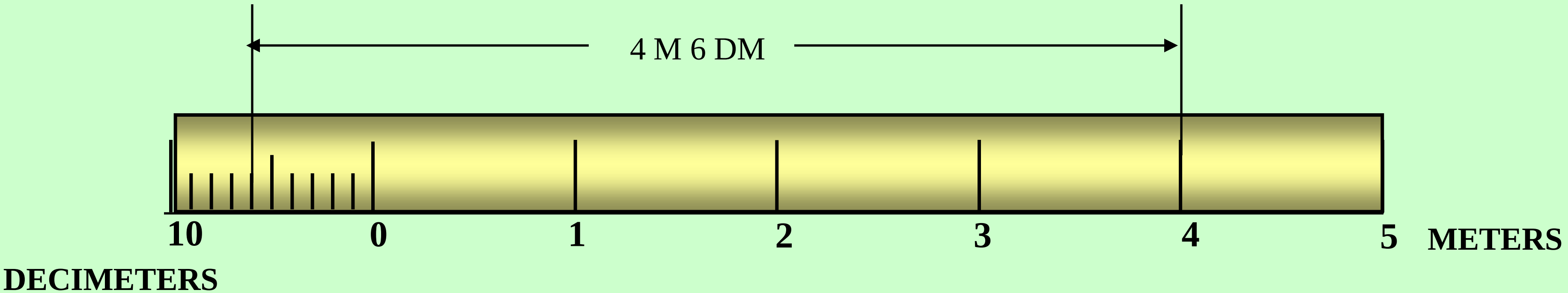
b) Draw a line 6 cm long and divide it in 6 equal parts. Each part will represent larger division unit.

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

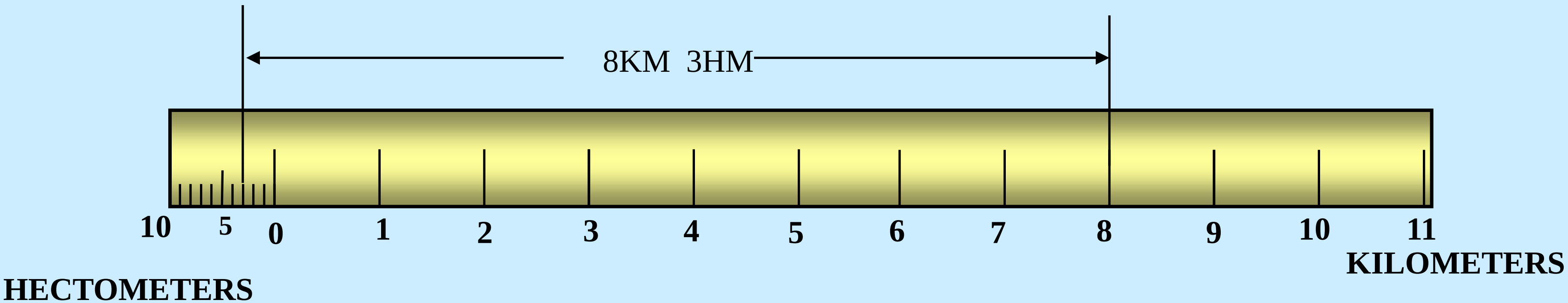
b) Draw a line 15 cm long and divide it in 12 equal parts. Each part will represent larger division unit.

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

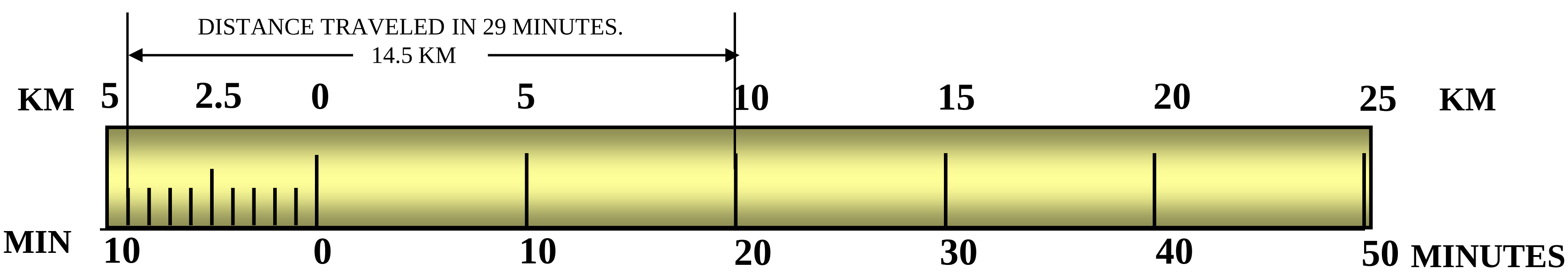
b) 15 cm length will represent 30 km and 1 hour i.e. 60 minutes.
Draw a line 15 cm long and divide it in 6 equal parts. Each part will represent 5 km and 10 minutes.

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.

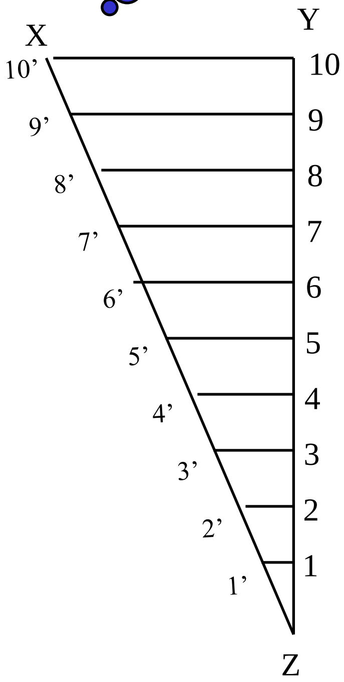
DIAGONAL SCALE

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

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.

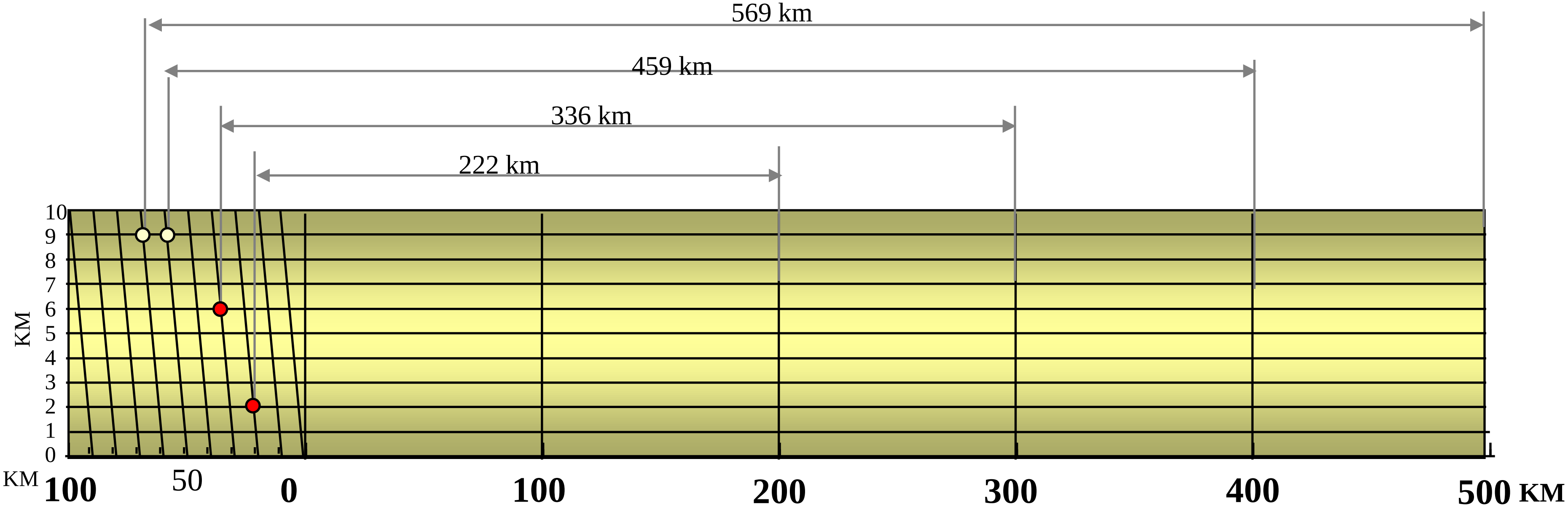
PROBLEM NO. 4 : The distance between Delhi and Agra is 200 km.
In a railway map it is represented by a line 5 cm long. Find it's R.F.
Draw a diagonal scale to show single km. And maximum 600 km.
Indicate on it following distances. 1) 222 km 2) 336 km 3) 459 km 4) 569 km

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

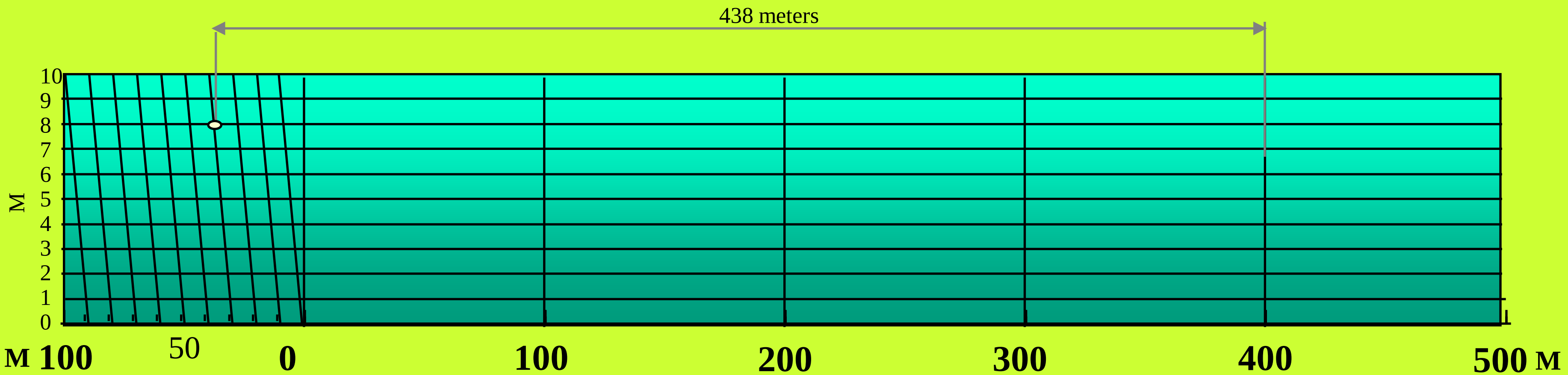
$= \sqrt{1.28 \times 10^4 \times 10^4 / 8}$ cm

= 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.

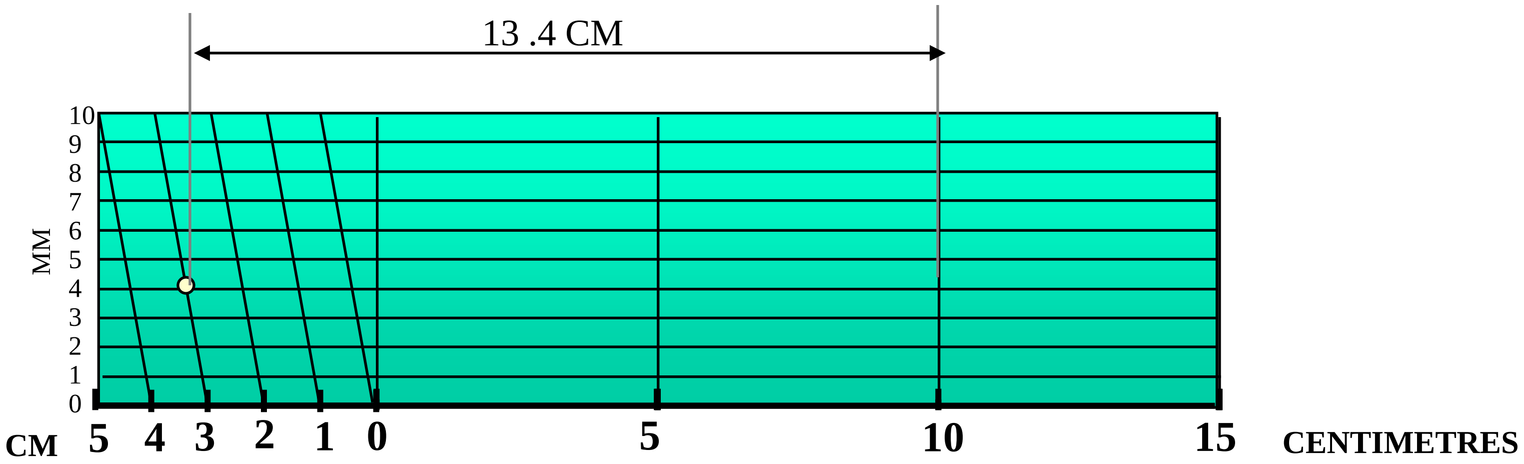
SOLUTION STEPS:

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.

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)

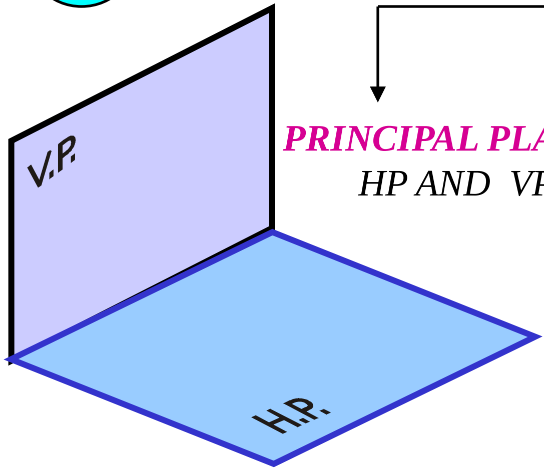
FV is a view projected on VP.
TV is a view projected on HP.
SV is a view projected on PP.

IMPORTANT TERMS OF ORTHOGRAPHIC PROJECTIONS:

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

1

PLANES

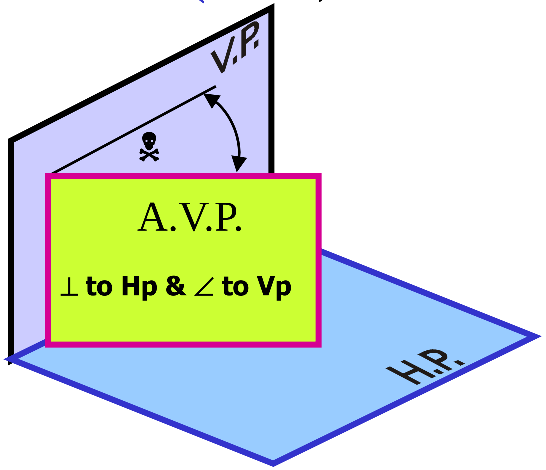


PRINCIPAL PLANES

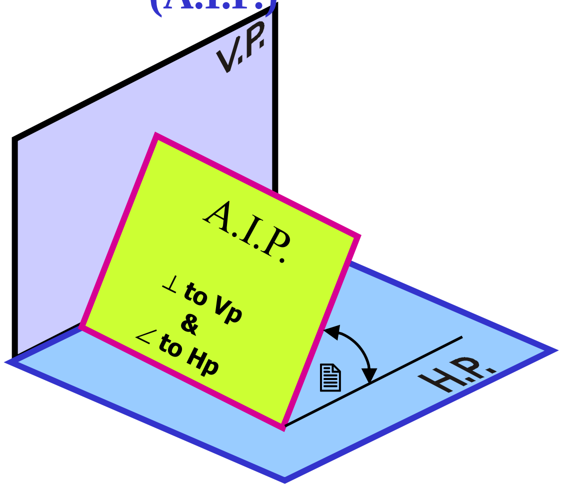
HP AND VP

AUXILIARY PLANES

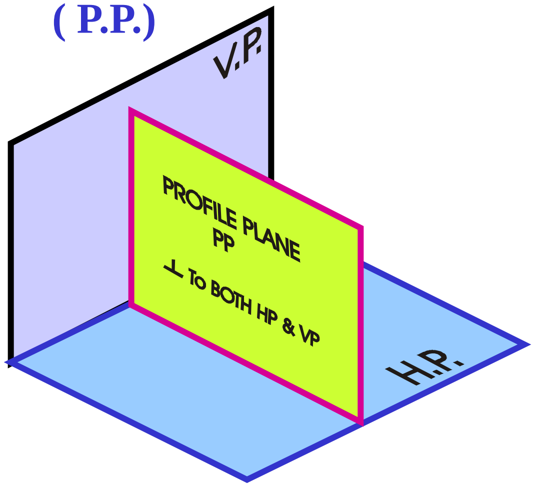
Auxiliary Vertical Plane (A.V.P.)



Auxiliary Inclined Plane (A.I.P.)

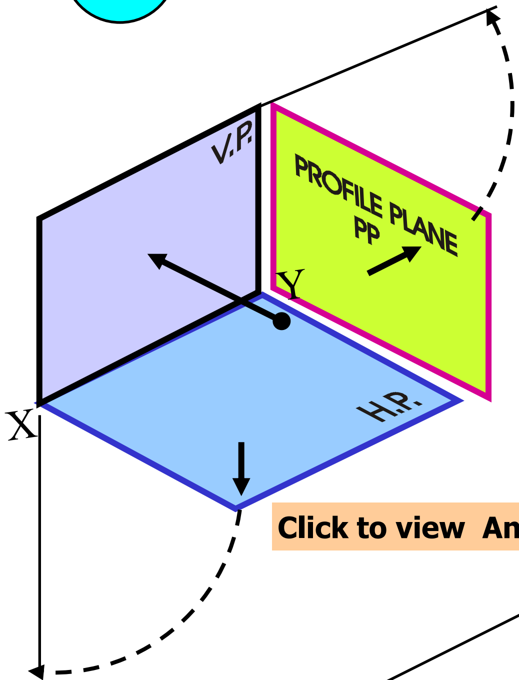


Profile Plane (P.P.)



2

PATTERN OF PLANES & VIEWS (First Angle Method)



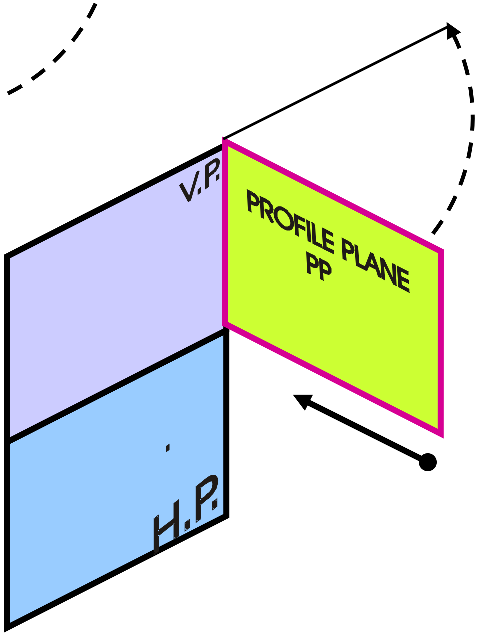
THIS IS A PICTORIAL SET-UP OF ALL THREE PLANES.
ARROW DIRECTION IS A NORMAL WAY OF OBSERVING THE OBJECT.
BUT IN THIS DIRECTION ONLY VP AND A VIEW ON IT (FV) CAN BE SEEN.
THE OTHER PLANES AND VIEWS ON THOSE CAN NOT BE SEEN.

PROCEDURE TO SOLVE ABOVE PROBLEM:-

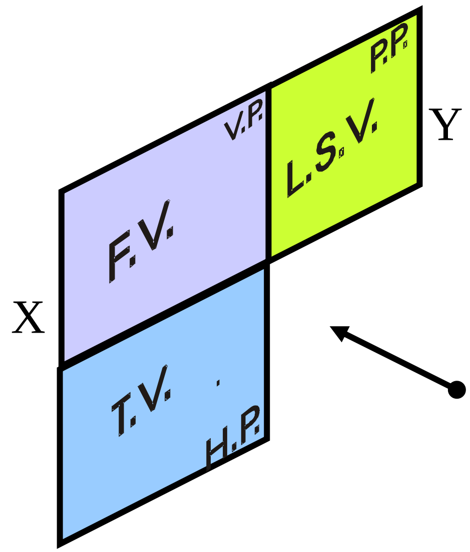
TO MAKE THOSE PLANES ALSO VISIBLE FROM THE ARROW DIRECTION,
A) HP IS ROTATED 90^0 DOUNWARD
B) PP, 90^0 IN RIGHT SIDE DIRECTION.
THIS WAY BOTH PLANES ARE BROUGHT IN THE SAME PLANE CONTAINING VP.

Click to view Animation

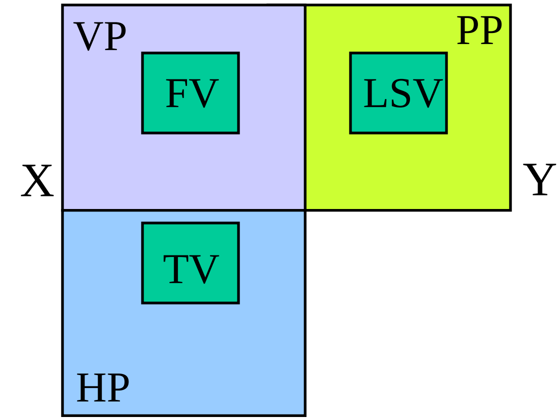
On clicking the button if a warning comes please click YES to continue, this program is safe for your pc.



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

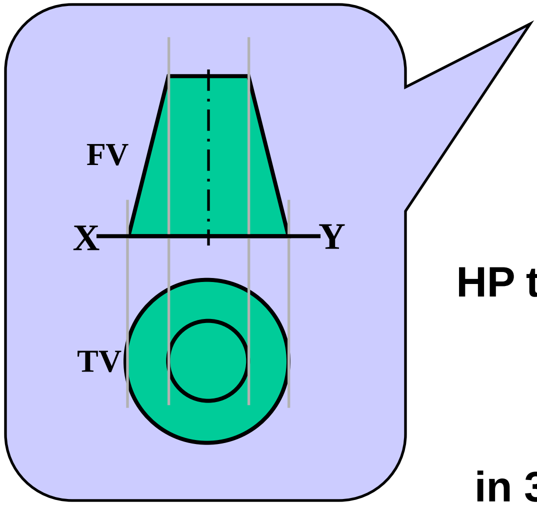
Methods of Drawing Orthographic Projections

First Angle Projections Method

Here views are drawn by placing object

in 1st Quadrant

(Fv above X-y, Tv below X-y)

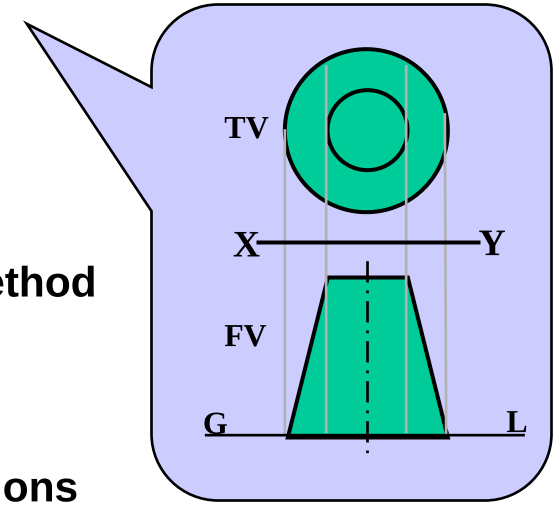


Third Angle Projections Method

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.

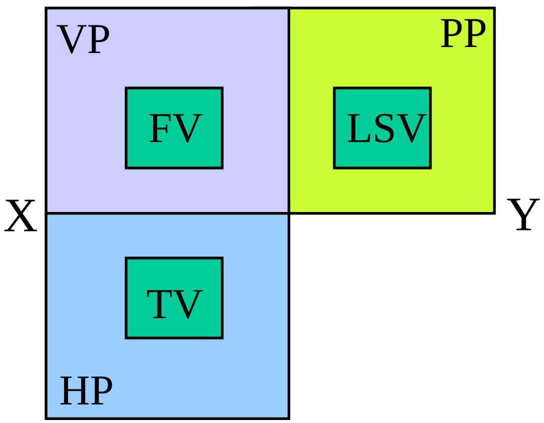
NOTE:-

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

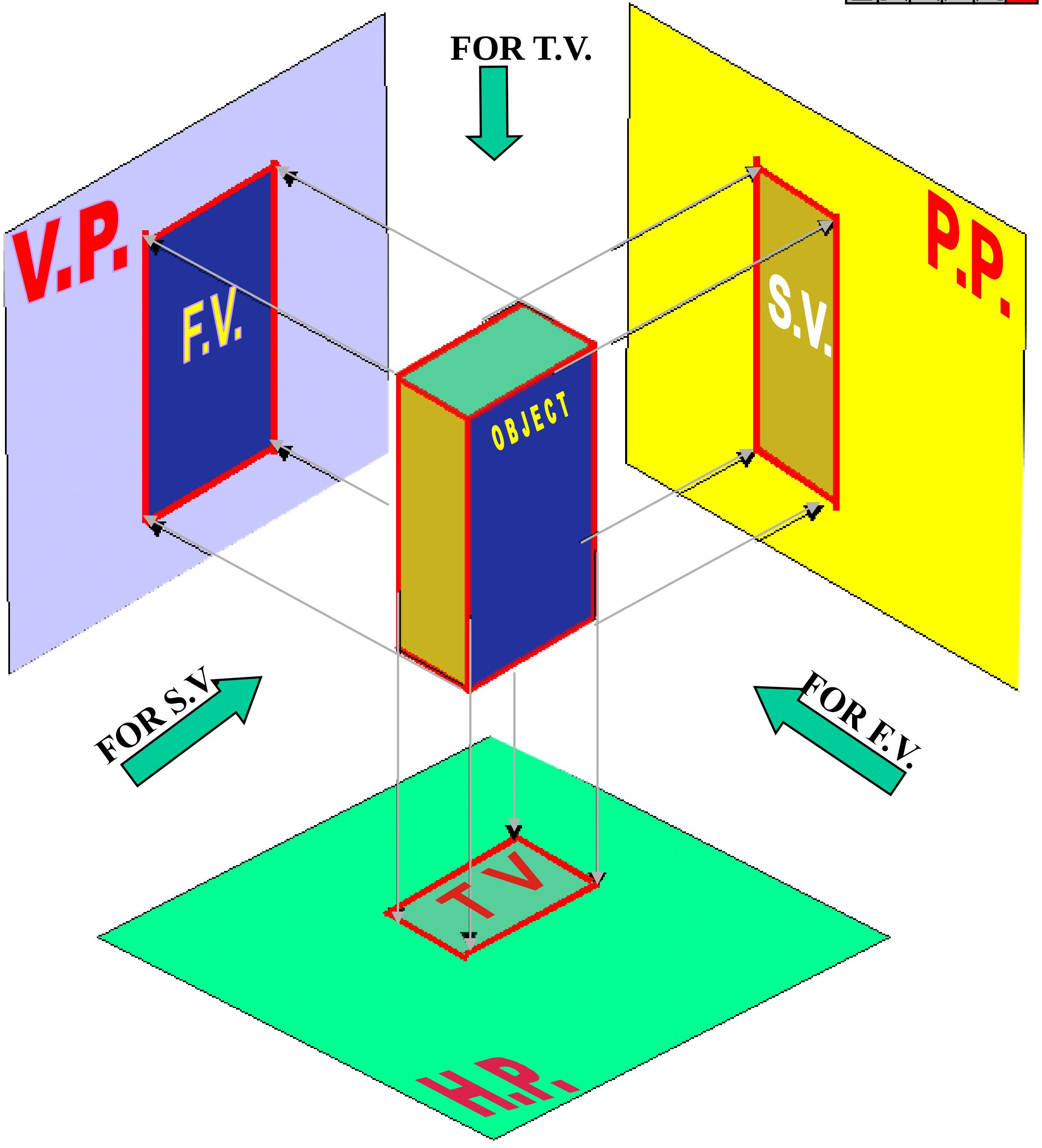
FIRST ANGLE PROJECTION

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

OBJECT IS INBETWEEN OBSERVER & PLANE.



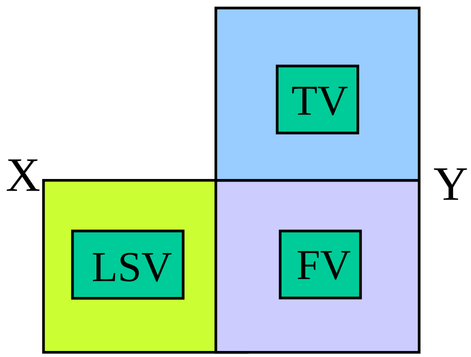
ACTUAL PATTERN OF PLANES & VIEWS IN FIRST ANGLE METHOD OF PROJECTIONS



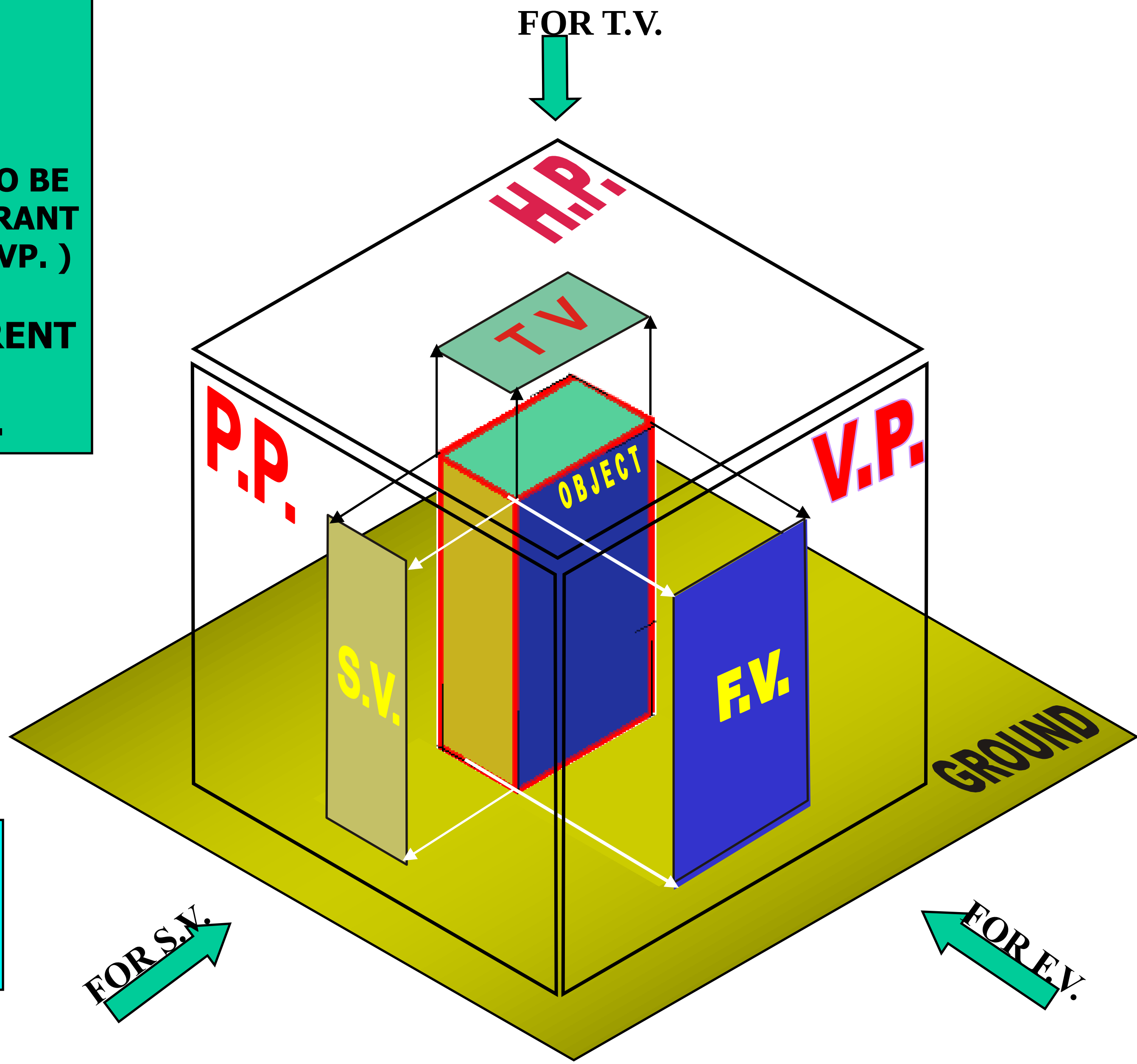
THIRD ANGLE PROJECTION

**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

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.

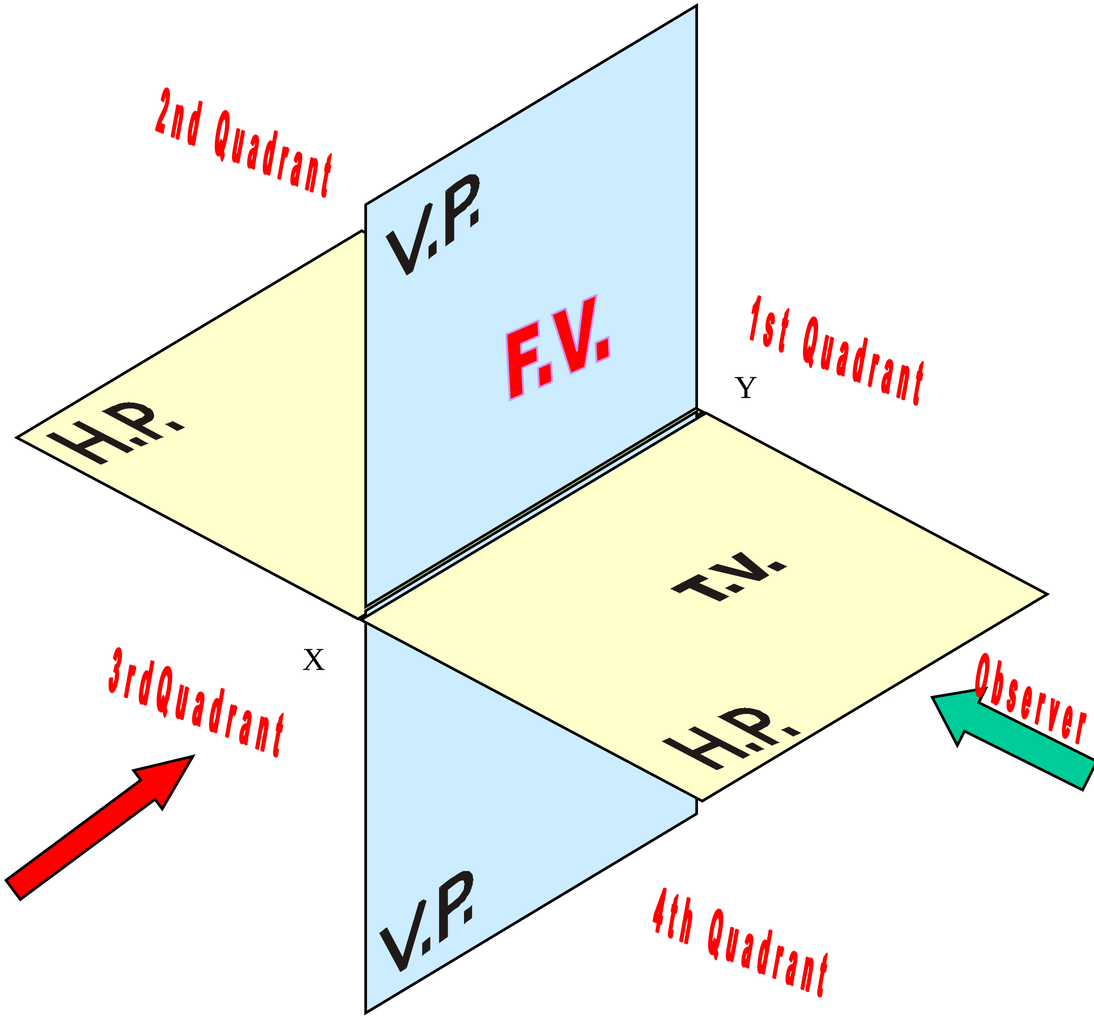
STUDY ILLUSTRATIONS GIVEN ON HEXT PAGES AND NOTE THE RESULTS.TO MAKE IT EASY HERE A POINT (A) IS TAKEN AS AN OBJECT. BECAUSE IT'S ALL VIEWS ARE JUST POINTS.

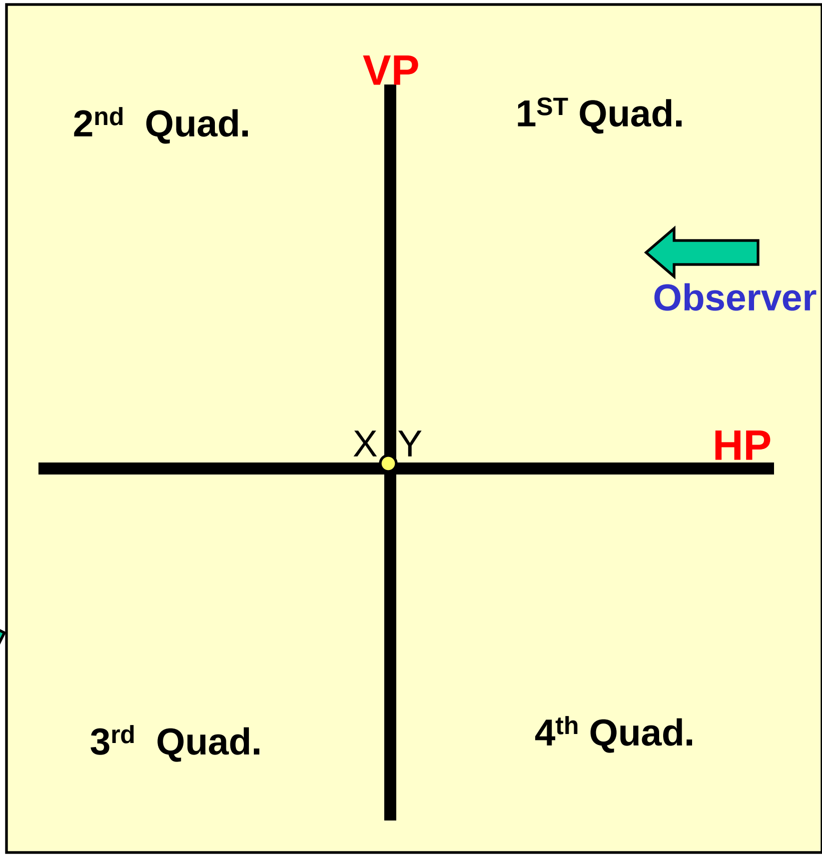
NOTATIONS

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.



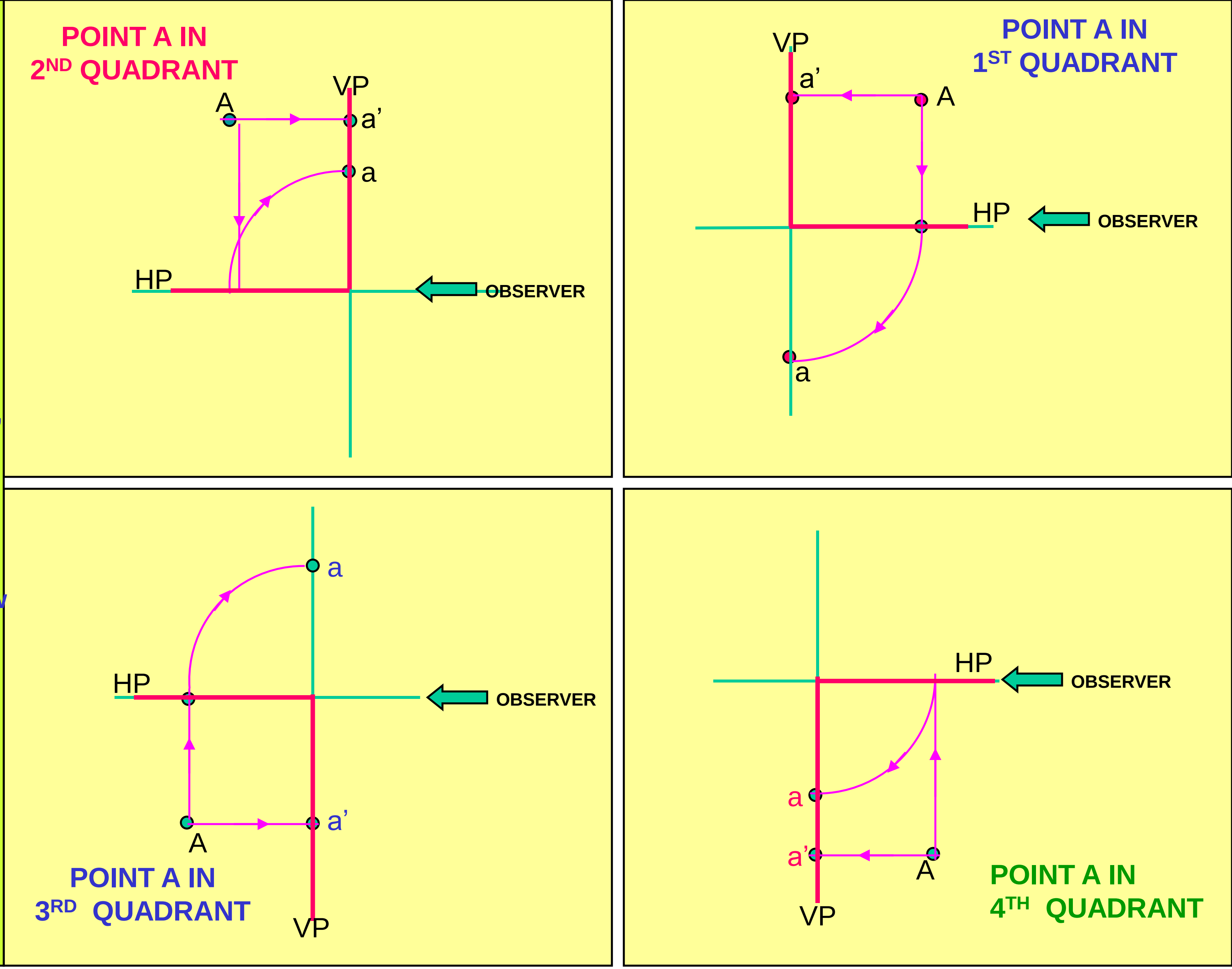


THIS QUADRANT PATTERN,
IF OBSERVED ALONG X-Y LINE (IN RED ARROW DIRECTION)
WILL EXACTLY APPEAR AS SHOWN ON RIGHT SIDE AND HENCE,
IT IS FURTHER USED TO UNDERSTAND ILLUSTRATION PROPERLLY.

Point A is Placed In different quadrants and it's Fv & Tv are brought in same plane for Observer to see clearly.

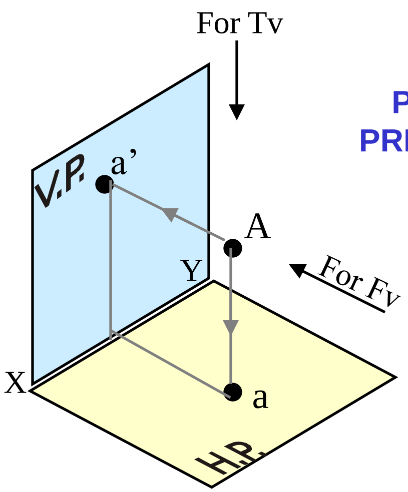
Fv is visible as it is a view on VP. But as Tv is is a view on Hp, it is rotated downward 90^0, In clockwise direction.The In front part of Hp comes below xy line and the part behind Vp comes above.

Observe and note the process.



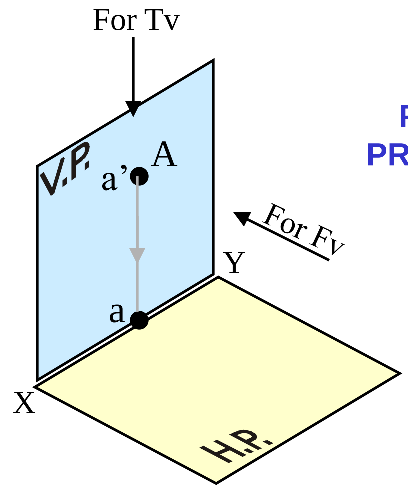
PROJECTIONS OF A POINT IN FIRST QUADRANT.

POINT A ABOVE HP & INFRONT OF VP



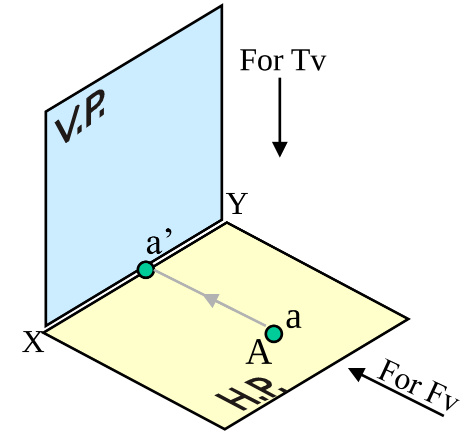
PICTORIAL PRESENTATION

POINT A ABOVE HP & IN VP



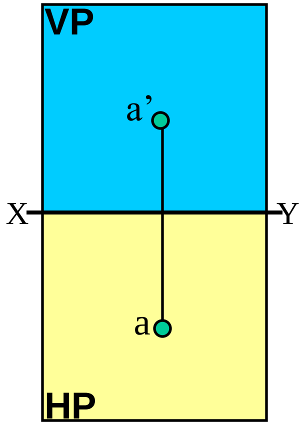
PICTORIAL PRESENTATION

POINT A IN HP & INFRONT OF VP

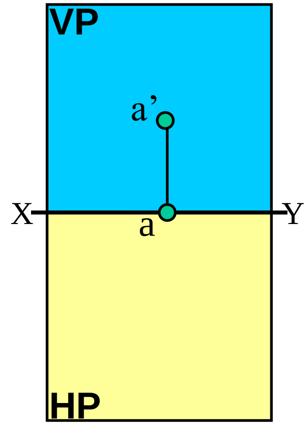


ORTHOGRAPHIC PRESENTATIONS OF ALL ABOVE CASES.

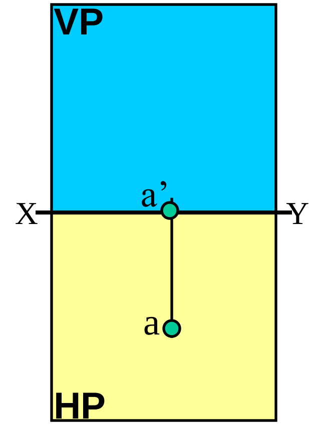
Fv above xy, Tv below xy.



Fv above xy, Tv on xy.



Fv on xy, Tv below xy.



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

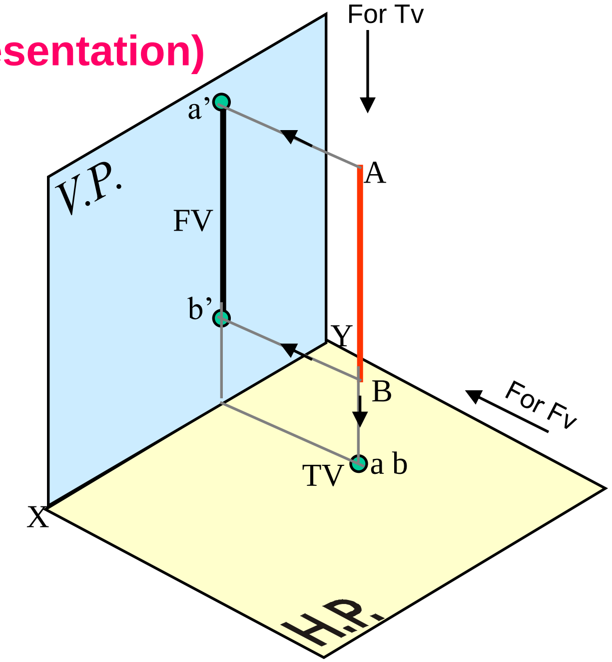
1. A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)
2. LINE PARALLEL TO BOTH HP & VP.
3. LINE INCLINED TO HP & PARALLEL TO VP.
4. LINE INCLINED TO VP & PARALLEL TO HP.
5. LINE INCLINED TO BOTH HP & VP.

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

(Pictorial Presentation)

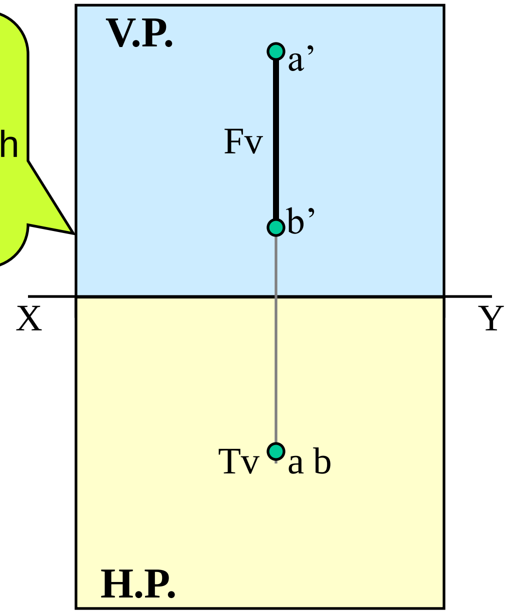
1.

A Line
perpendicular
to Hp
&
// to Vp



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

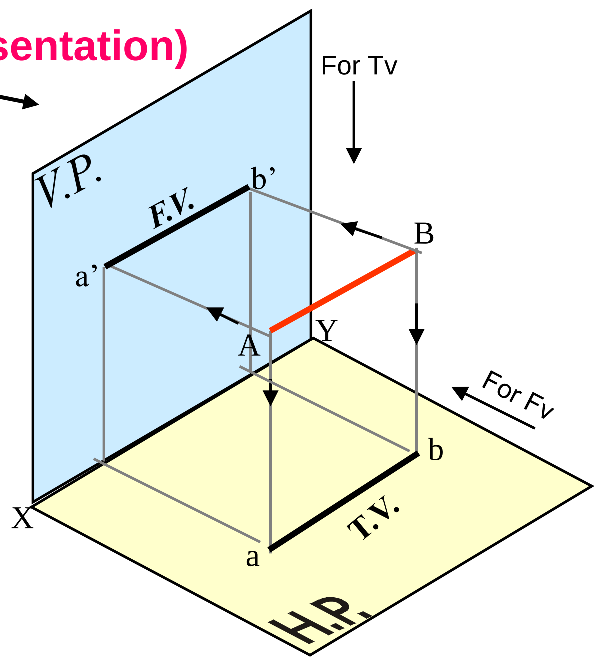
Orthographic Pattern



(Pictorial Presentation)

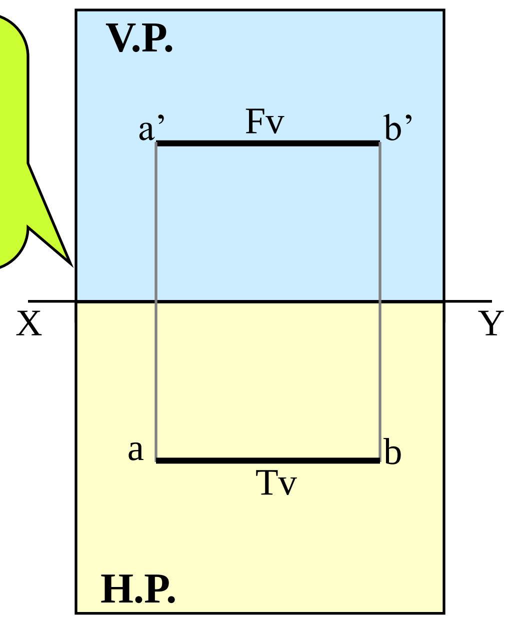
2.

A Line
// to Hp
&
// to Vp



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

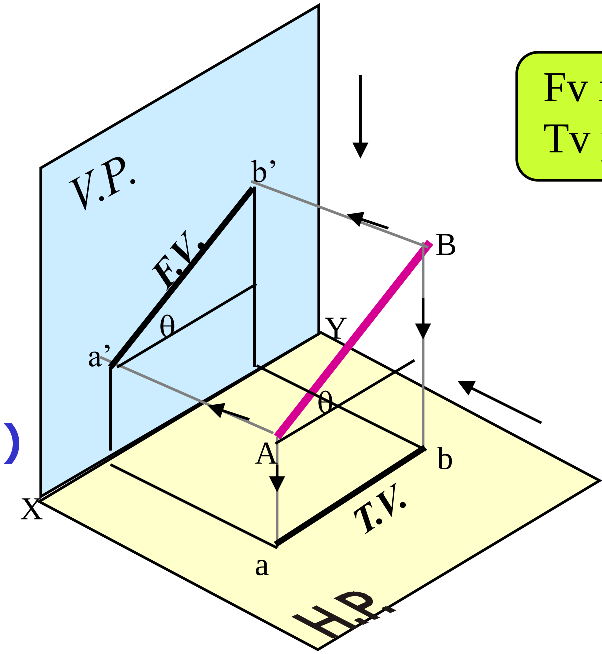
Orthographic Pattern

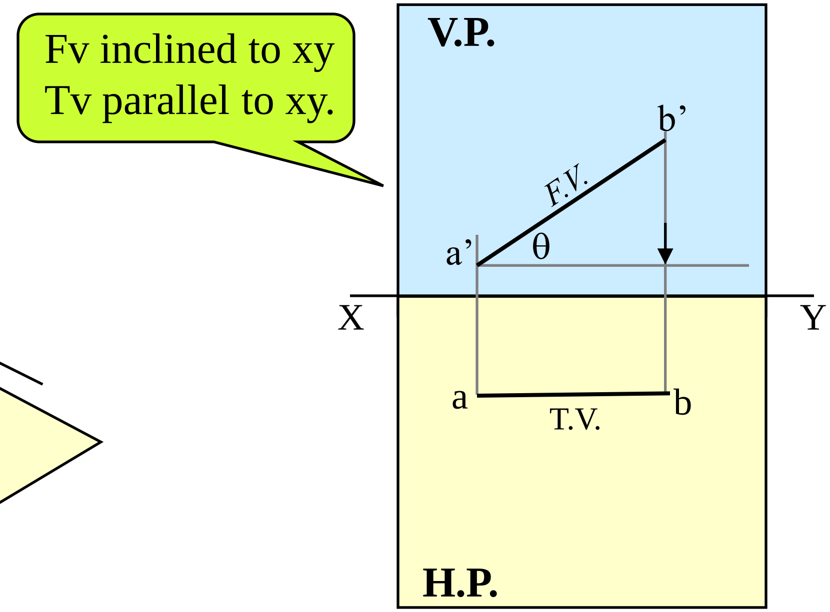


3.

A Line inclined to Hp
and
parallel to Vp

(Pictorial presentation)



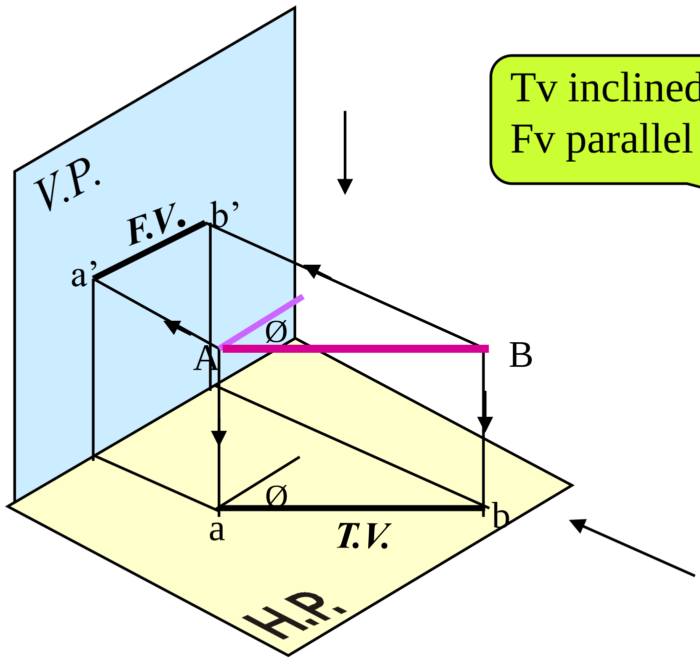


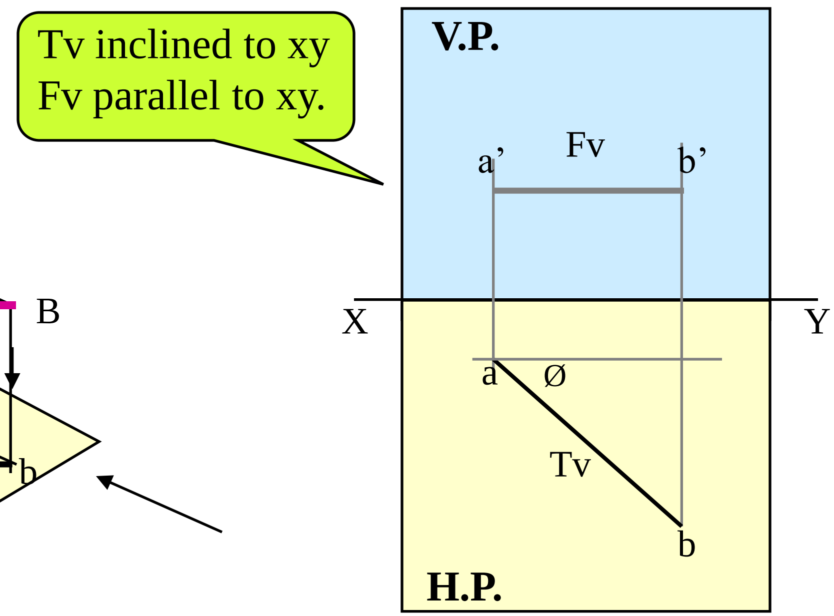
Orthographic Projections

4.

A Line inclined to Vp
and
parallel to Hp

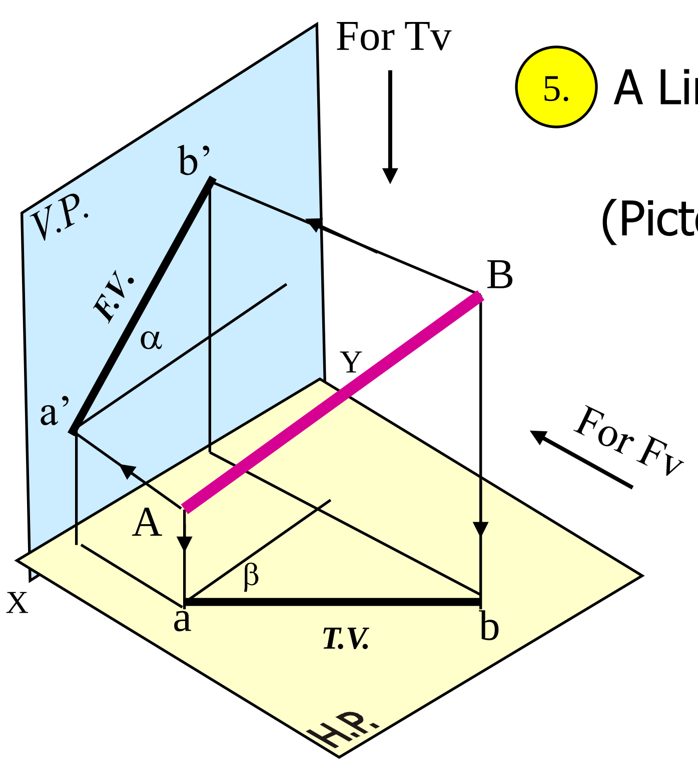
(Pictorial presentation)



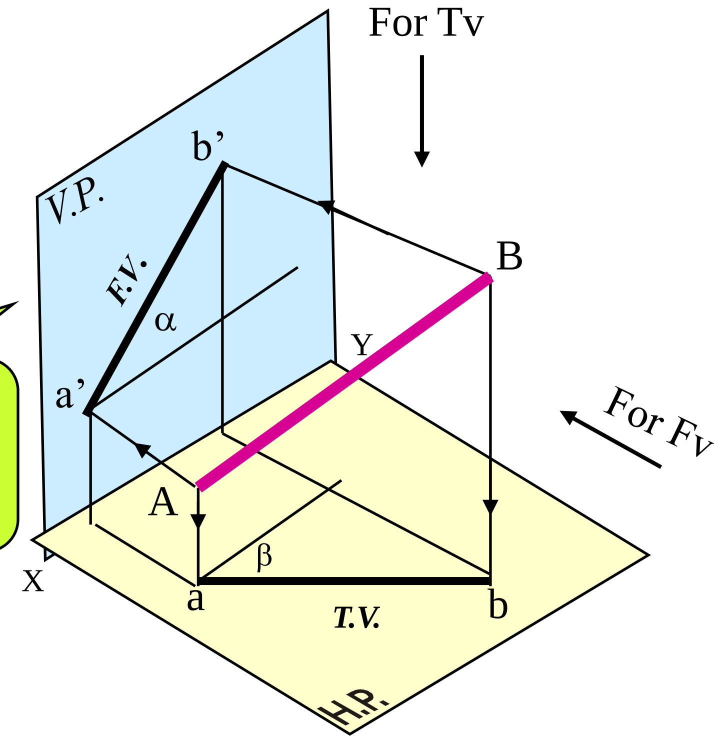


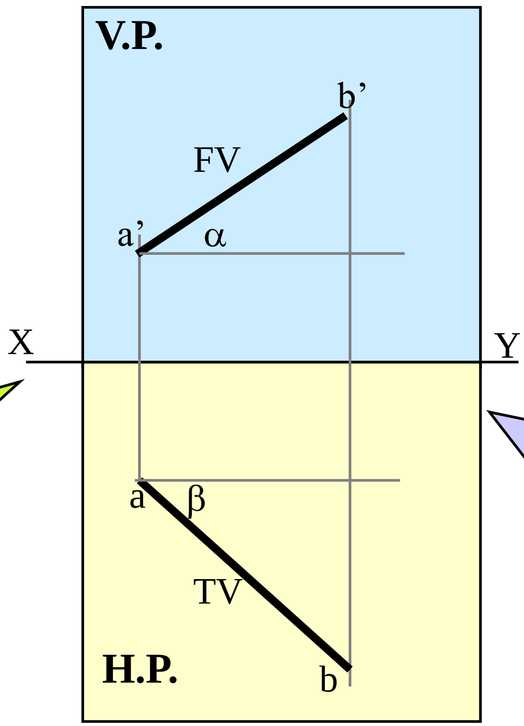
5. A Line inclined to both Hp and Vp

(Pictorial presentation)



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

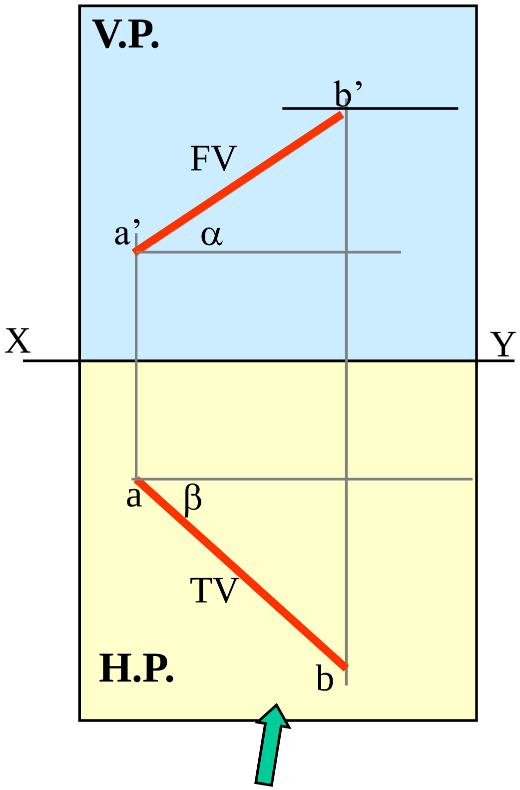




Orthographic Projections
Fv is seen on Vp clearly.
To see Tv clearly, HP is rotated 90⁰ downwards,
Hence it comes below xy.

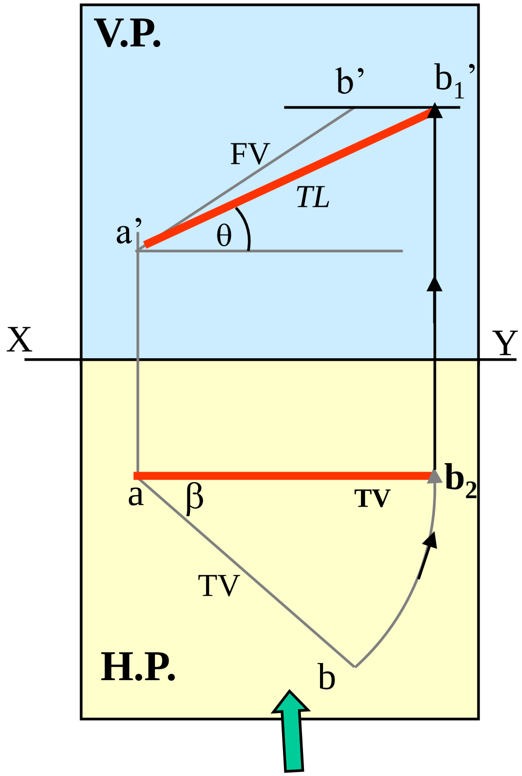
Note These Facts:-
Both Fv & Tv are inclined to xy.
(No view is parallel to xy)
Both Fv & Tv are reduced lengths.
(No view shows True Length)

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



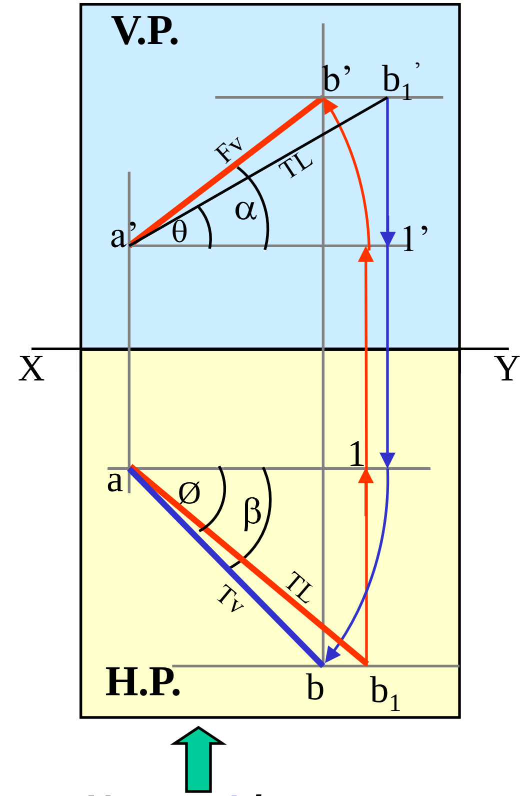
Here TV (ab) is not // to XY line Hence it's corresponding FV a' b' is not showing True Length & True Inclination with Hp.

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.

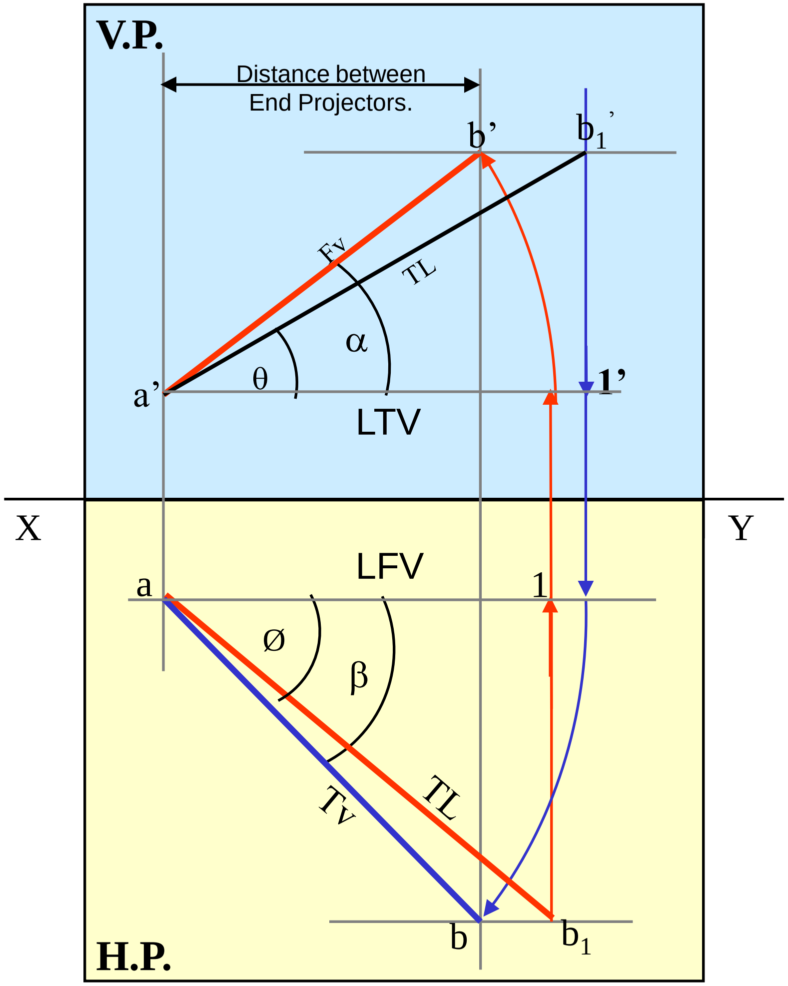
Note the procedure
When True Length is known, How to locate Fv & Tv. (Component a-1 of TL is drawn which is further rotated to determine Fv)



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)

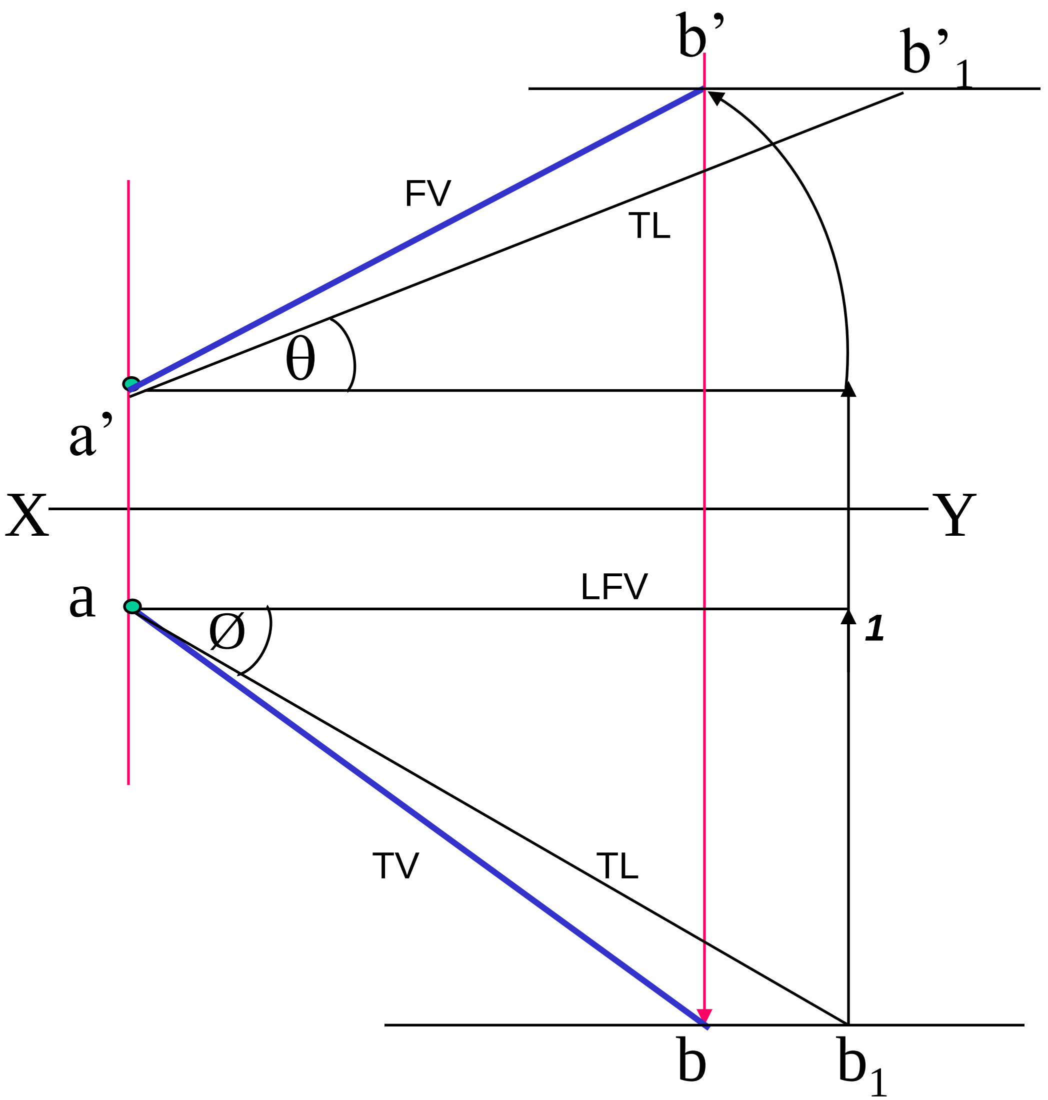
GENERAL CASES OF THE LINE INCLINED TO BOTH HP & VP
(based on 10 parameters).

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 1st quadrant.

SOLUTION STEPS:

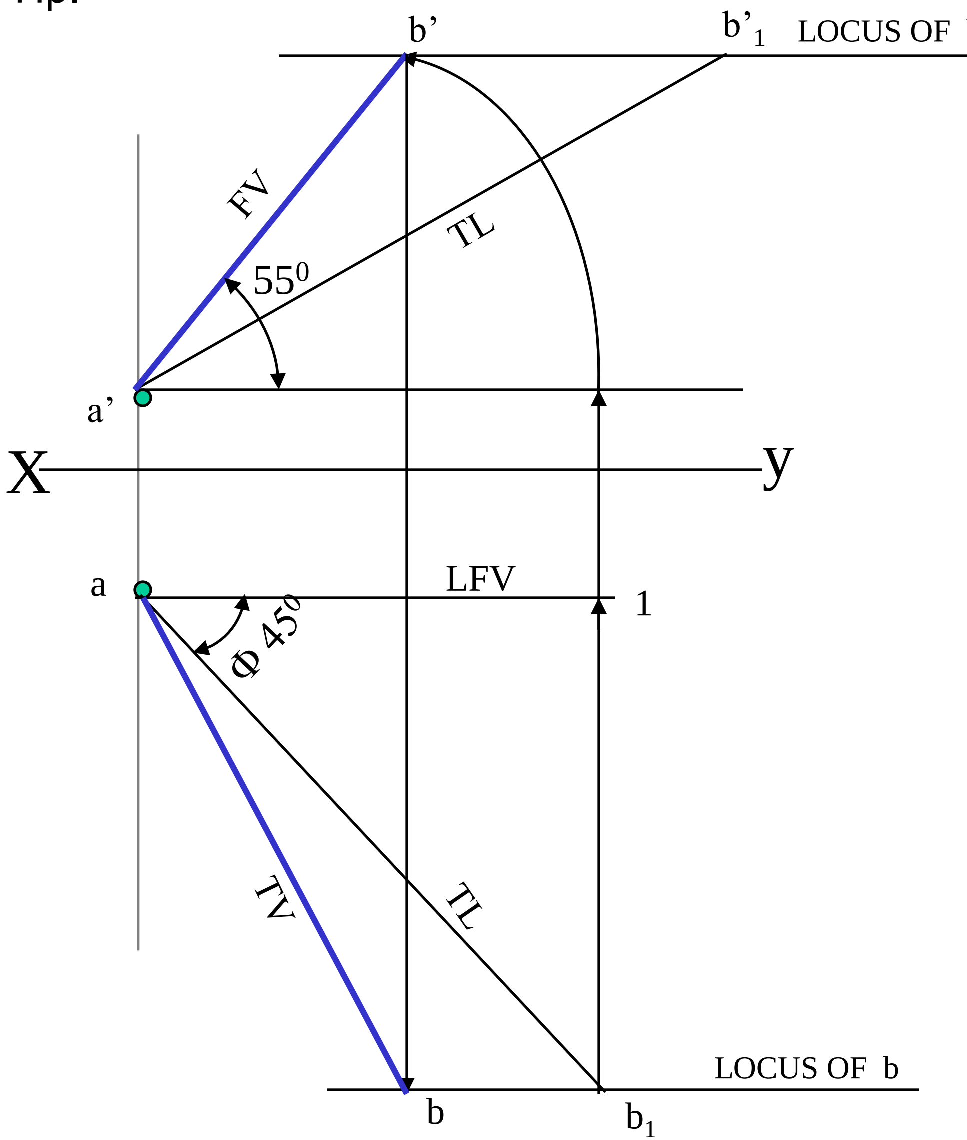
1) Draw xy line and one projector.
2) Locate a' 12mm above xy line & a 10mm below xy line.
3) Take 30^0 angle from a' & 40^0 from a and mark TL I.e. 75mm on both lines. Name those points b_1' and b_1 respectively.
4) Join both points with a' and a resp.
5) Draw horizontal lines (Locus) from both points.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



PROBLEM 2:
Line AB 75mm long makes 45^0 inclination with Vp while it's Fv makes 55^0.
End A is 10 mm above Hp and 15 mm in front of Vp.If line is in 1st quadrant
draw it's projections and find it's inclination with Hp.

Solution Steps:-

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

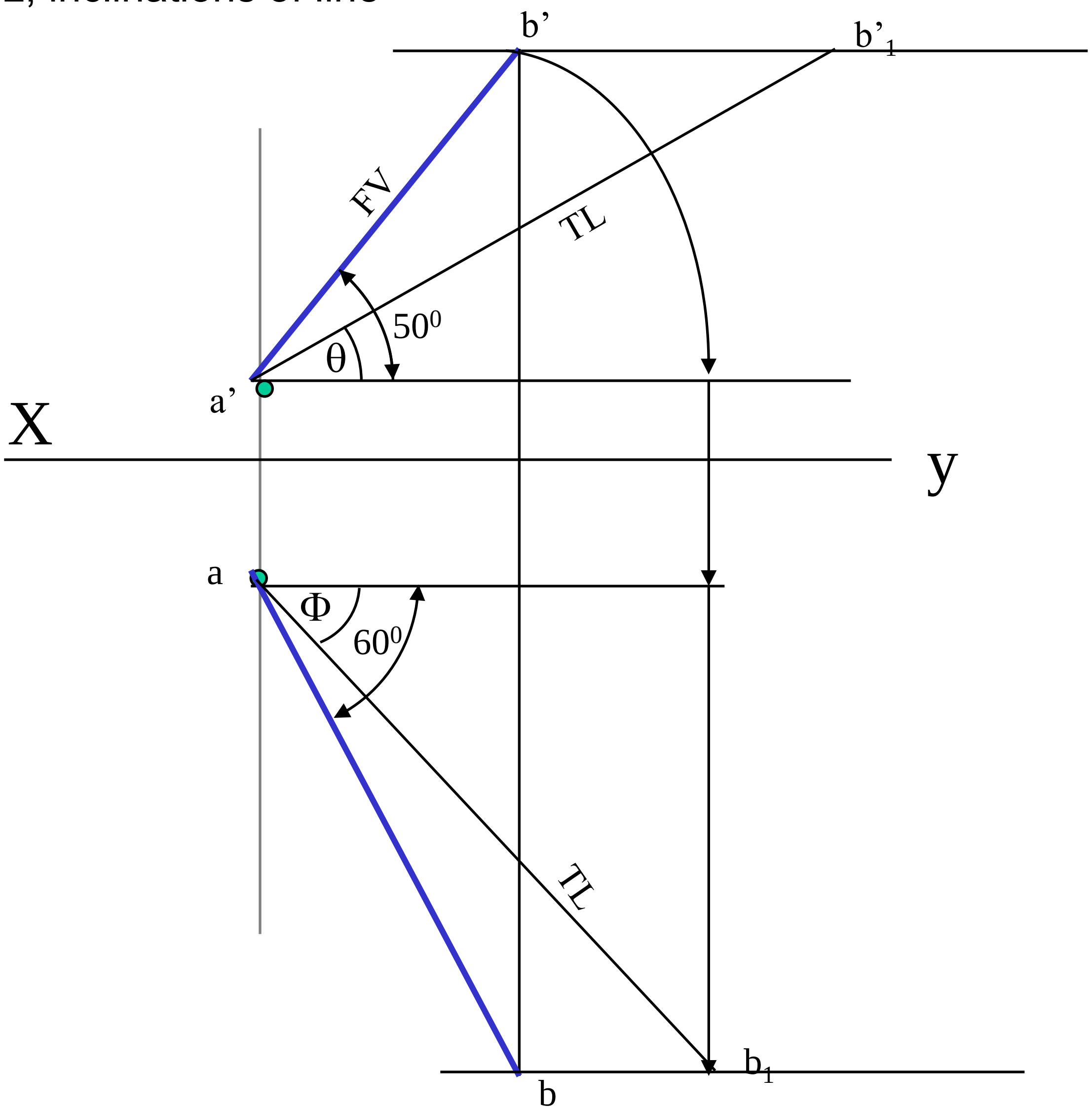


PROBLEM 3:

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

SOLUTION STEPS:

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

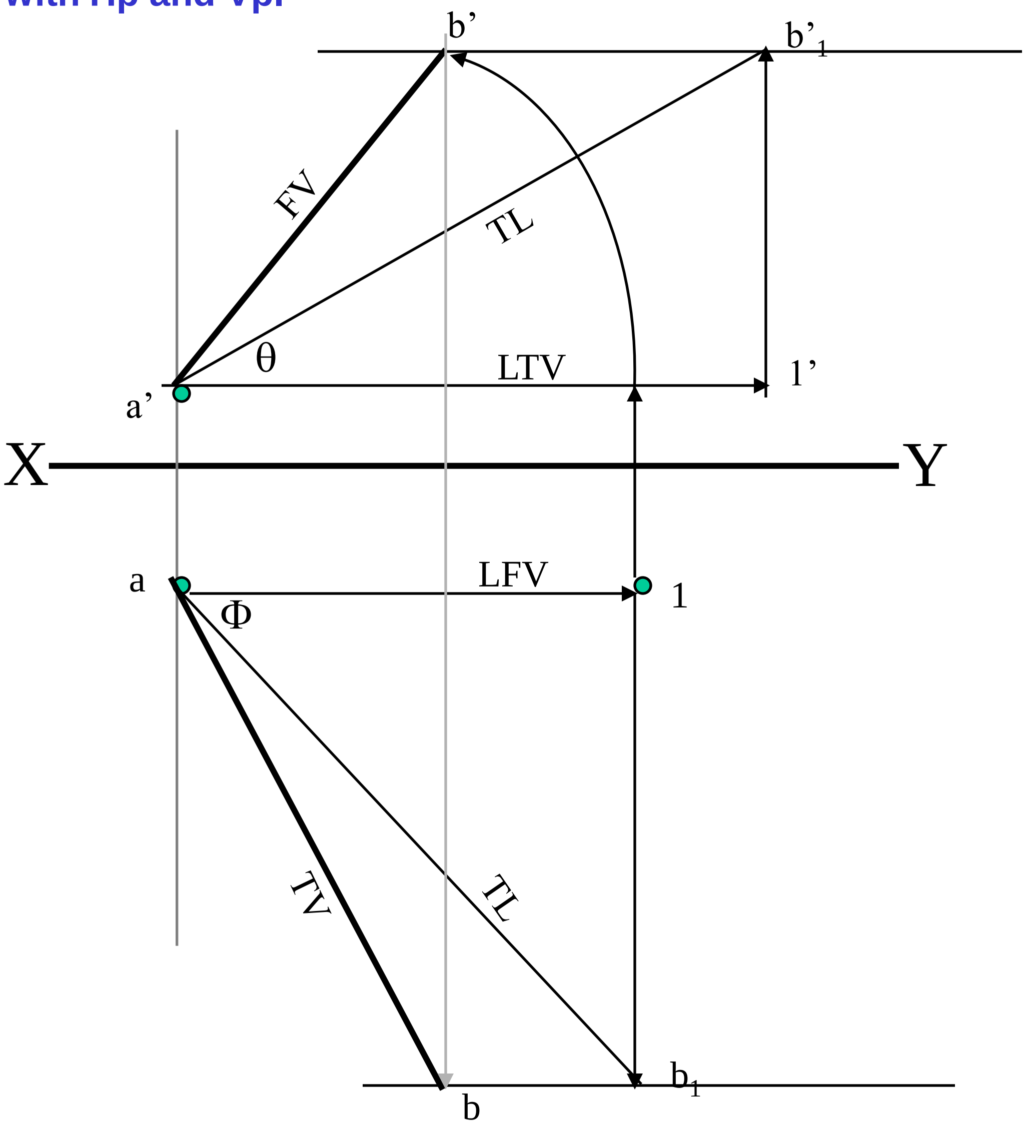


PROBLEM 4 :-

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

SOLUTION STEPS:

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



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?

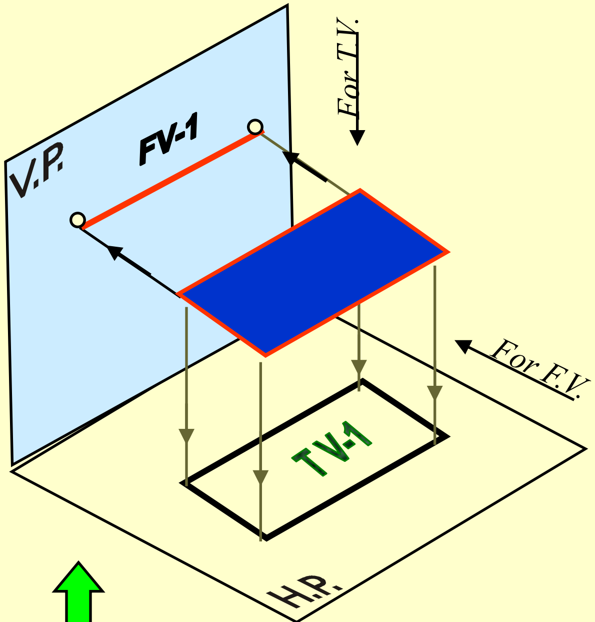
1. **Inclination of it's SURFACE with one of the reference planes will be given.**
2. Inclination of one of it's EDGES with other reference plane will be given

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

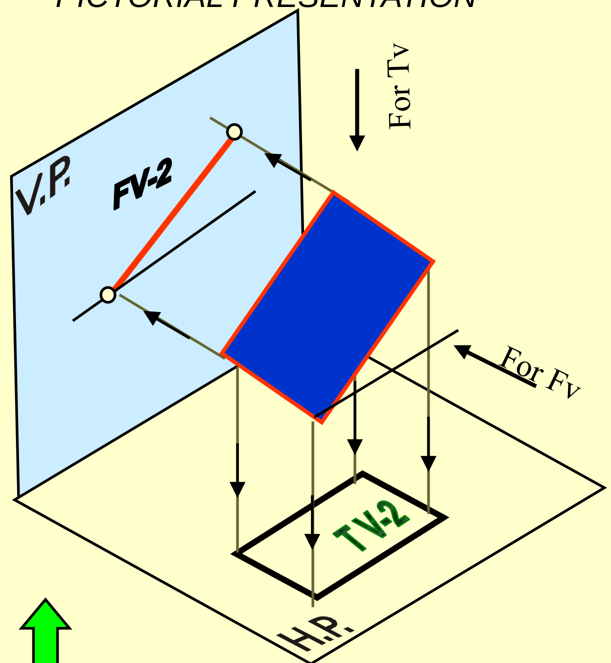
Study the illustration showing surface & side inclination given on next page.

CASE OF A RECTANGLE – OBSERVE AND NOTE ALL STEPS.

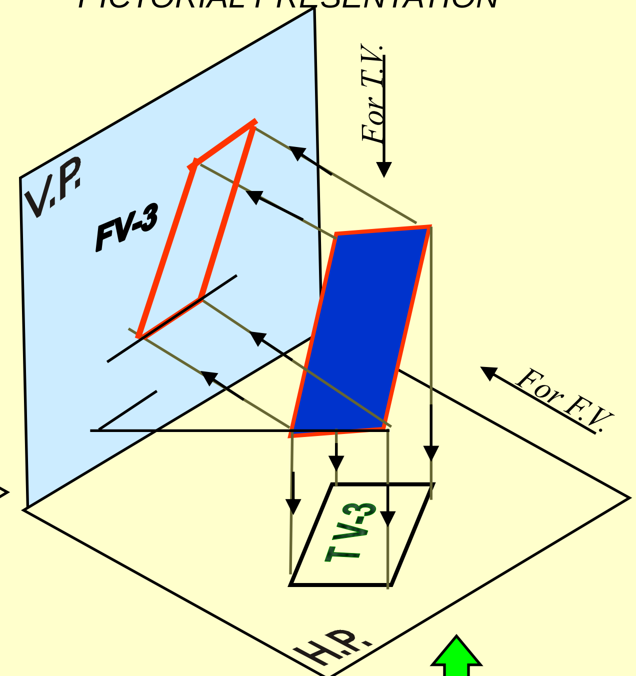
SURFACE **PARALLEL** TO HP
PICTORIAL PRESENTATION



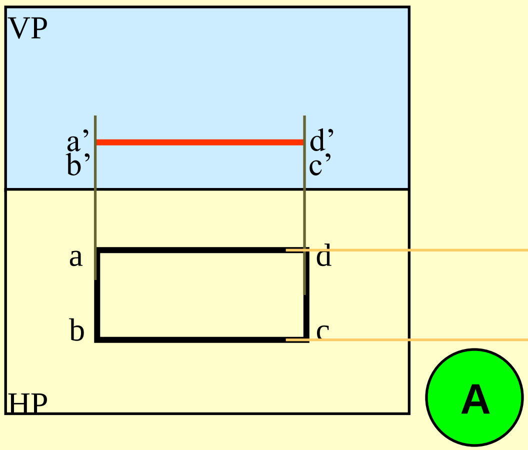
SURFACE **INCLINED** TO HP
PICTORIAL PRESENTATION



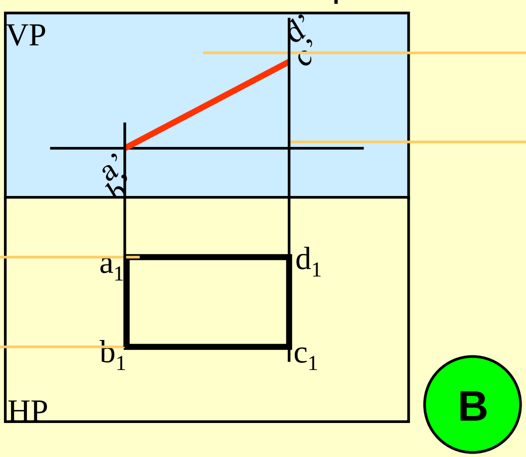
ONE SMALL SIDE INCLINED TO VP
PICTORIAL PRESENTATION



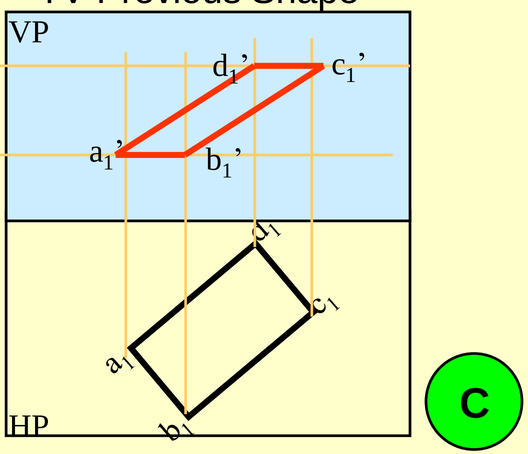
ORTHOGRAPHIC
TV-True Shape
FV- Line // to xy



ORTHOGRAPHIC
FV- Inclined to XY
TV- Reduced Shape



ORTHOGRAPHIC
FV- Apparent Shape
TV-Previous Shape



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 2^{nd} Fv & Tv.

STEP 3. After this,consider side/edge inclination and draw 3^{rd} (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. 2^{nd} pair (B) on previous page illustration)

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

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

APPLY SAME STEPS TO SOLVE NEXT *ELEVEN* PROBLEMS

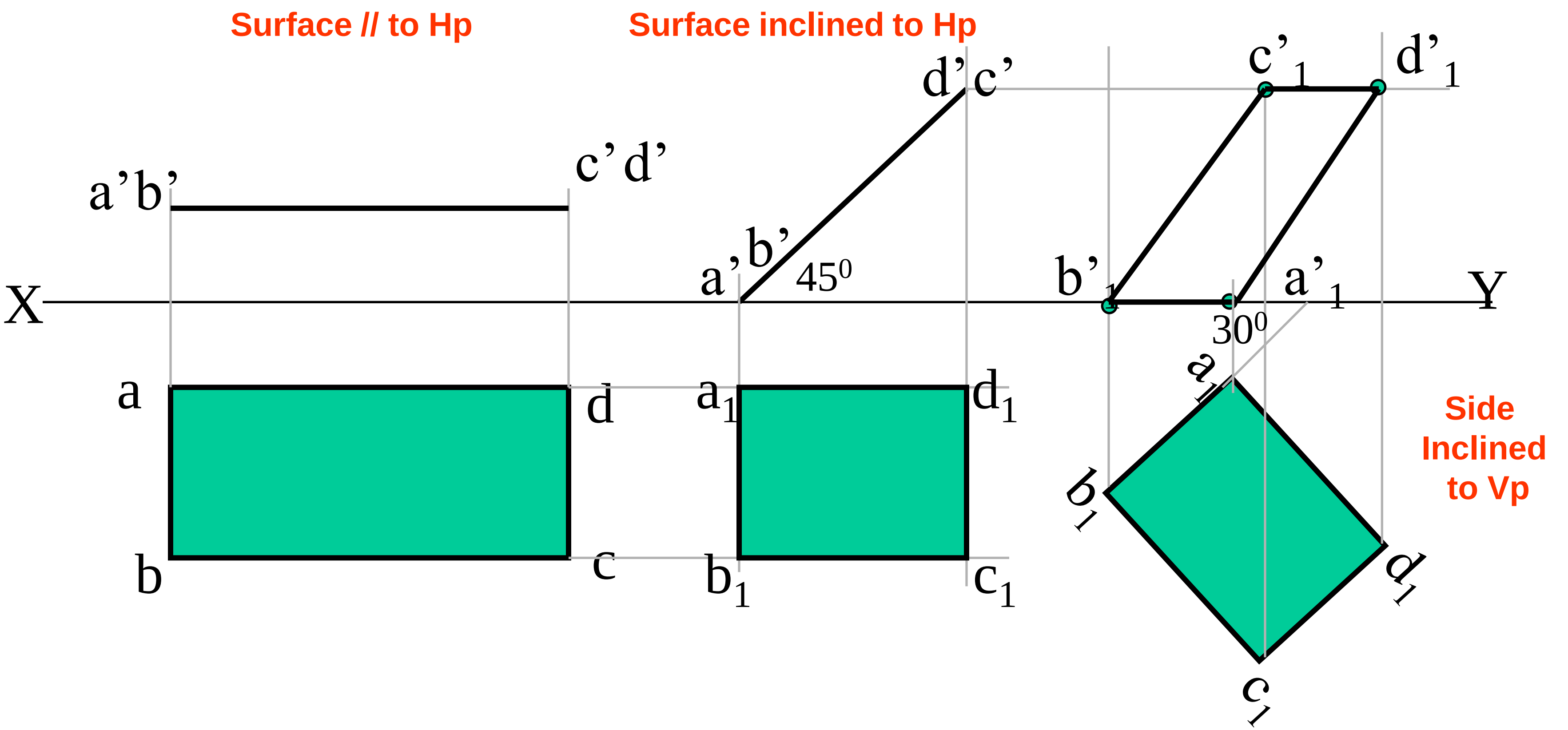
Problem 1:

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

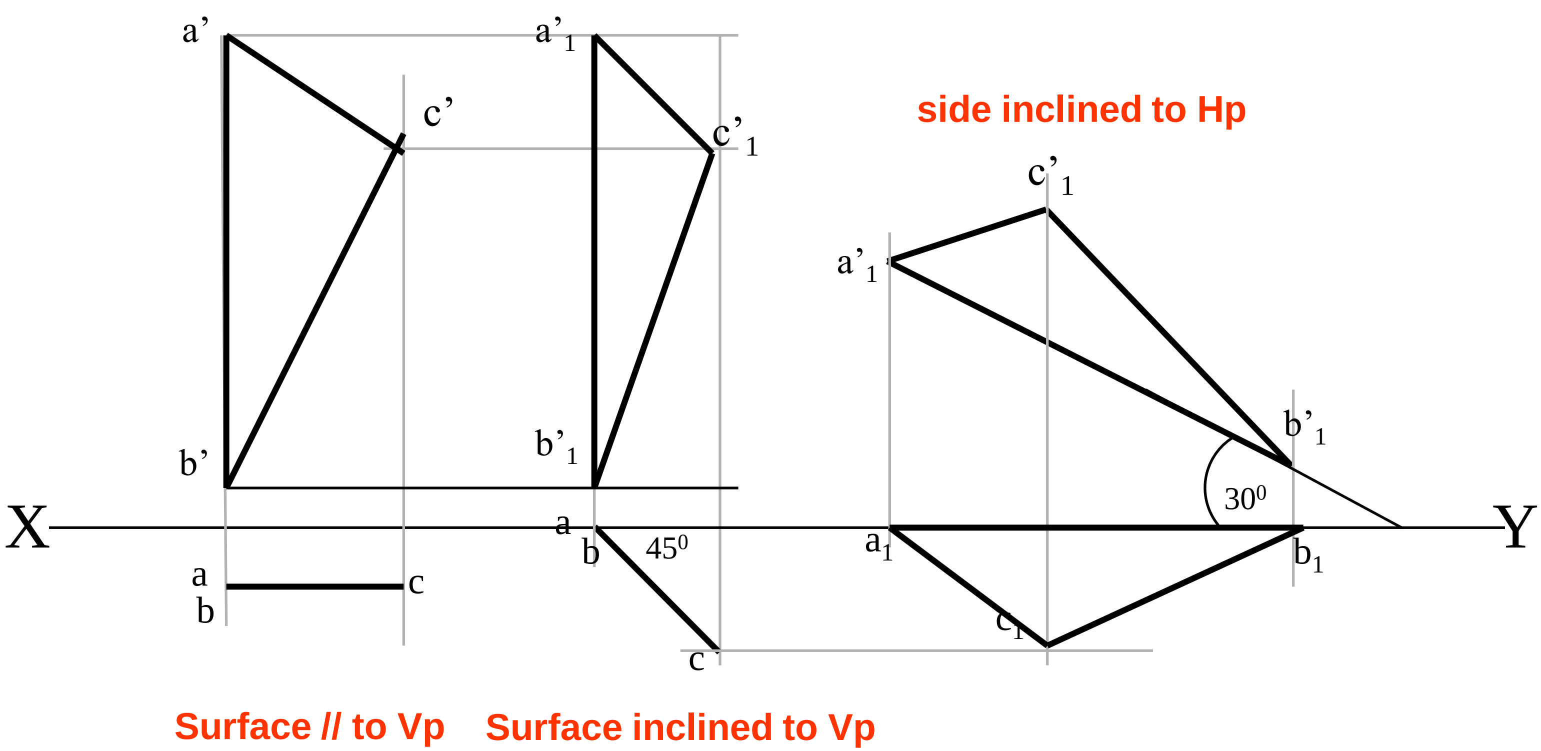
1 .Surface inclined to which plane? ------- VP

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

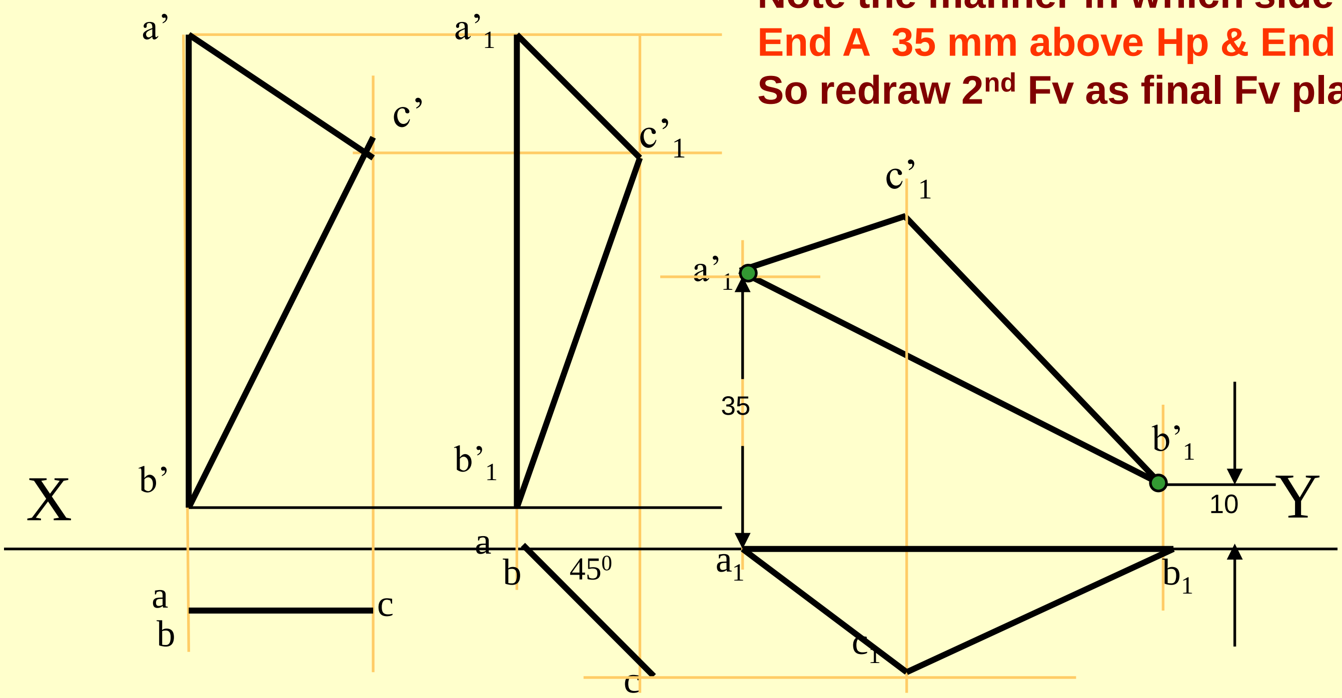
(Surface inclination directly given.
Side inclination indirectly given)

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.



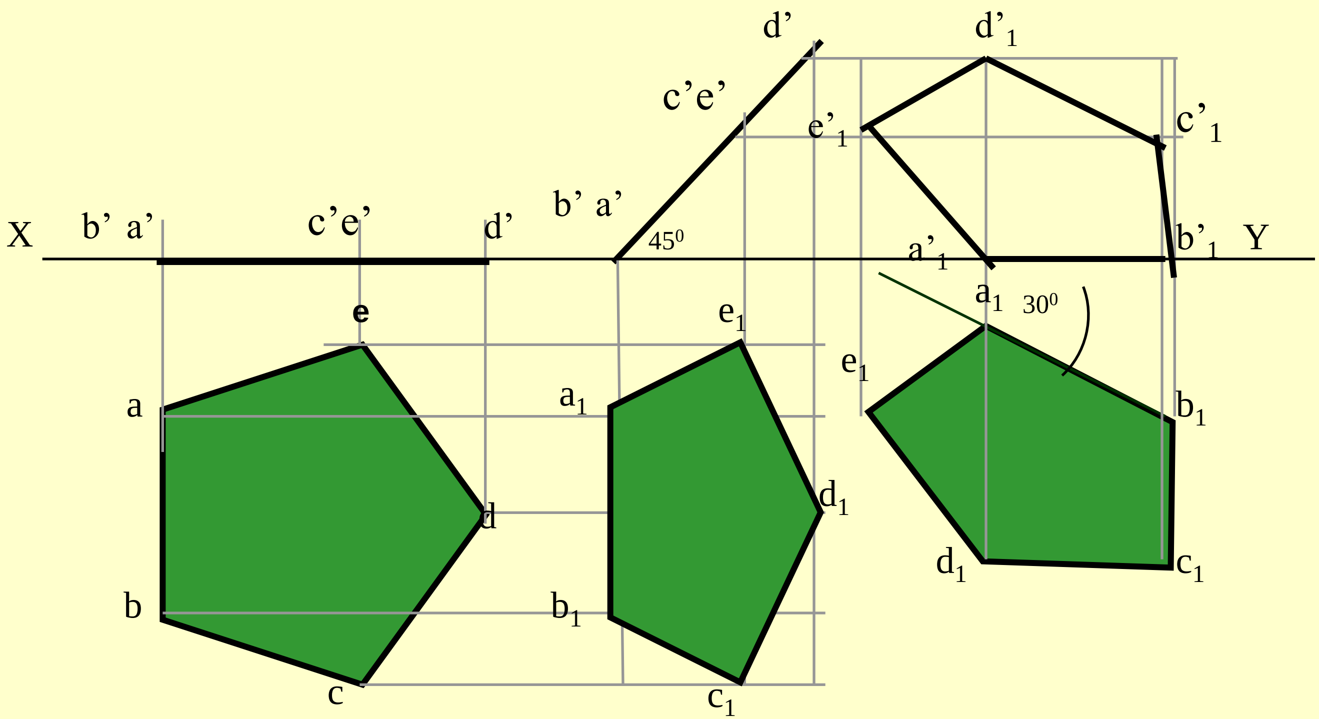
Problem 4:

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.



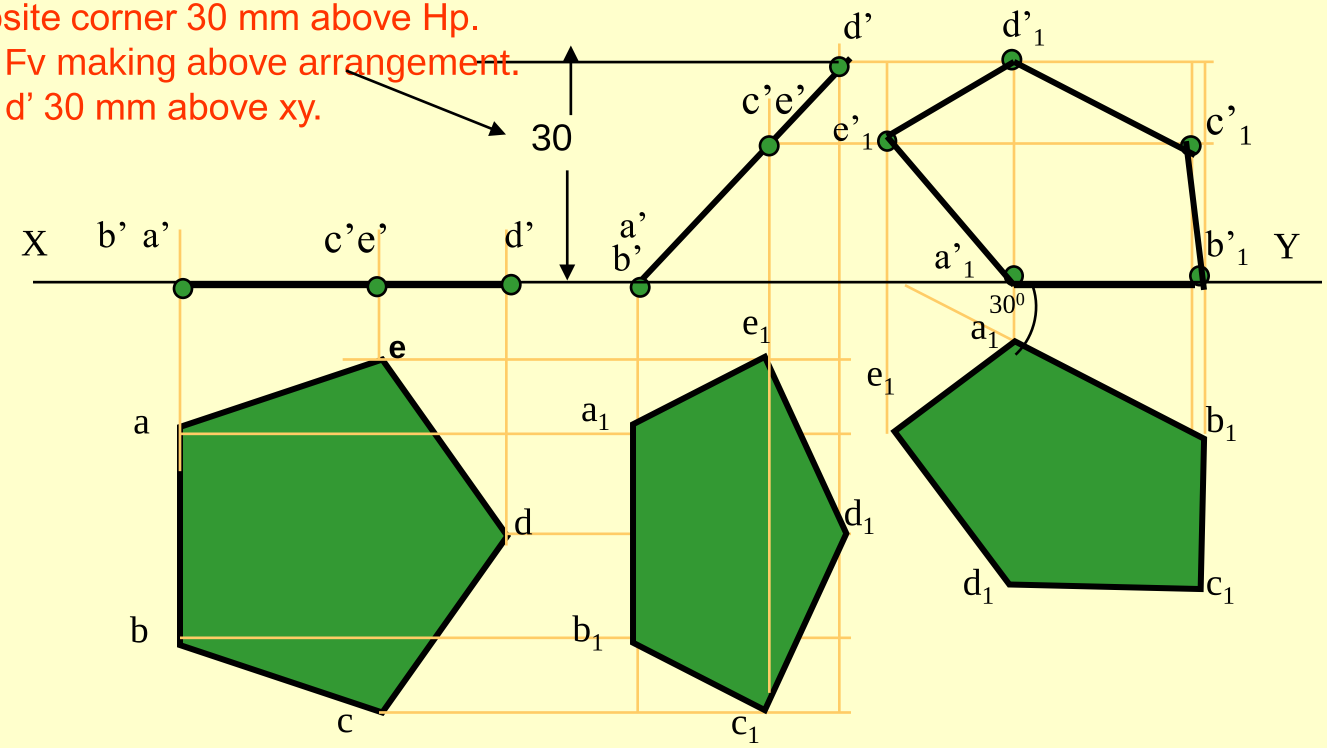
Problem 5:
A regular pentagon of 30 mm sides is resting on HP on one of it's sides while it's opposite vertex (corner) is 30 mm above HP.
Draw projections when side in HP is 30^0 inclined to VP.

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.***

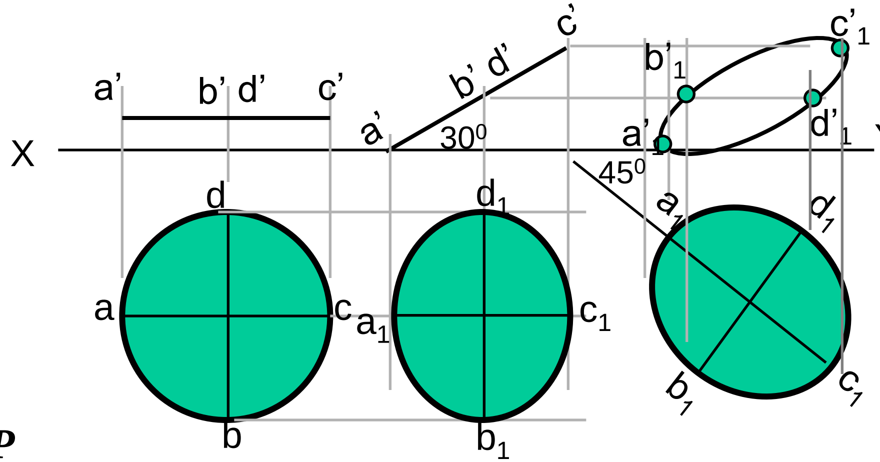
Hence begin with TV,draw pentagon below X-Y line, taking one side vertical.

SURFACE INCLINATION INDIRECTLY GIVEN SIDE INCLINATION DIRECTLY GIVEN:

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 1^{st} Fv as a 2^{nd} 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

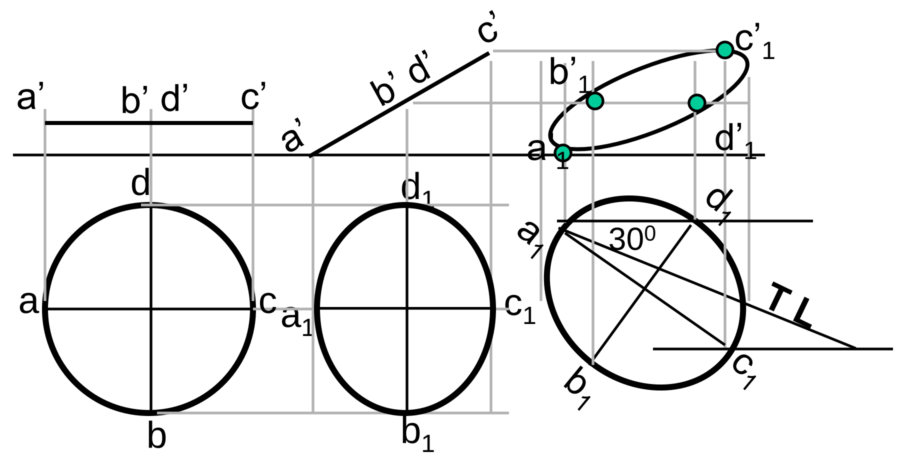
1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AC***

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.



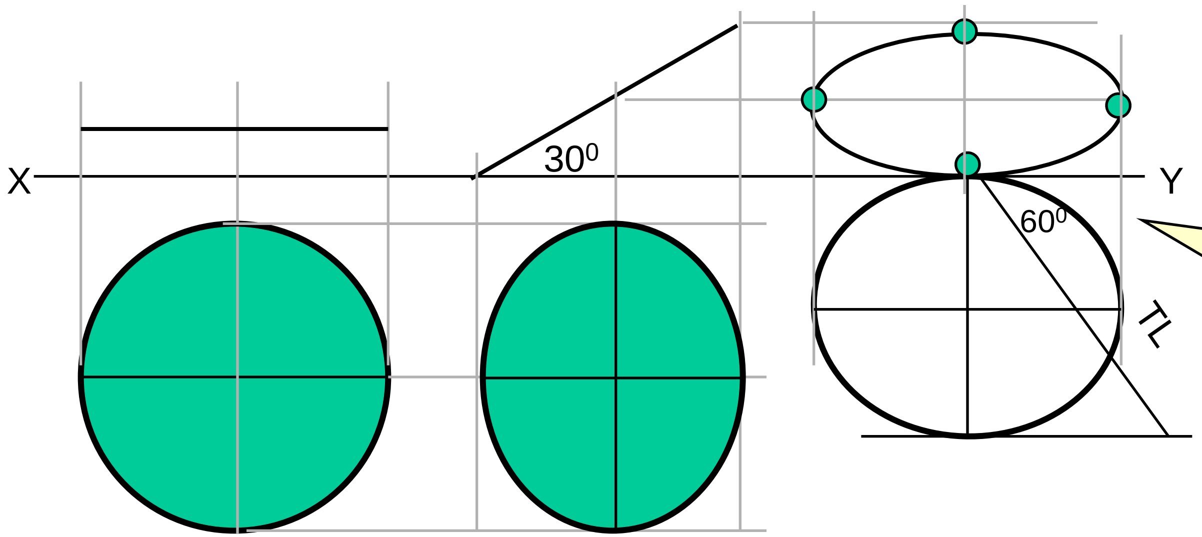
Problem 10: End A of diameter AB of a circle is in HP A nd end B is in VP.Diameter AB, 50 mm long is 30^0 & 60^0 inclined to HP & VP respectively. Draw projections of circle.

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***..



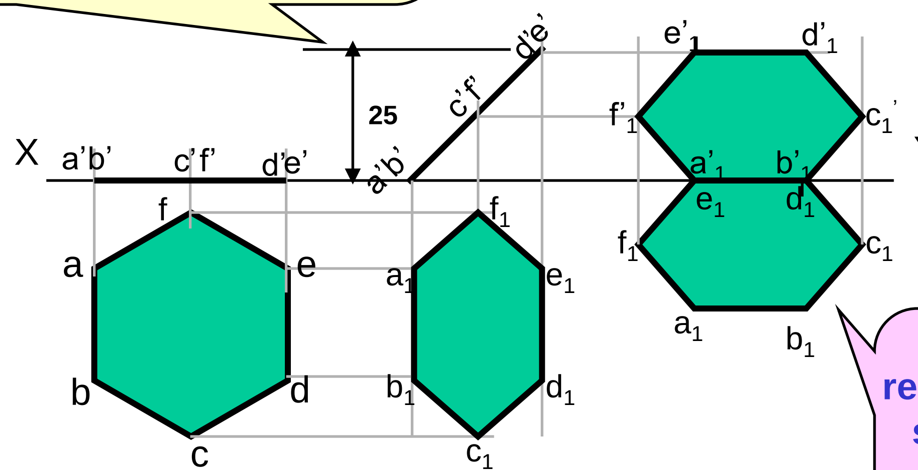
SOLVE SEPARATELY
ON DRAWING SHEET
GIVING NAMES TO VARIOUS
POINTS AS USUAL,
AS THE CASE IS IMPORTANT

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.



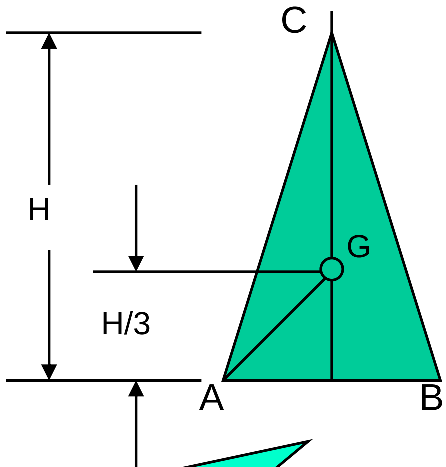
As 3rd step redraw 2nd Tv keeping side DE on xy line. Because it is in VP as said in problem.

FREELY SUSPENDED CASES.

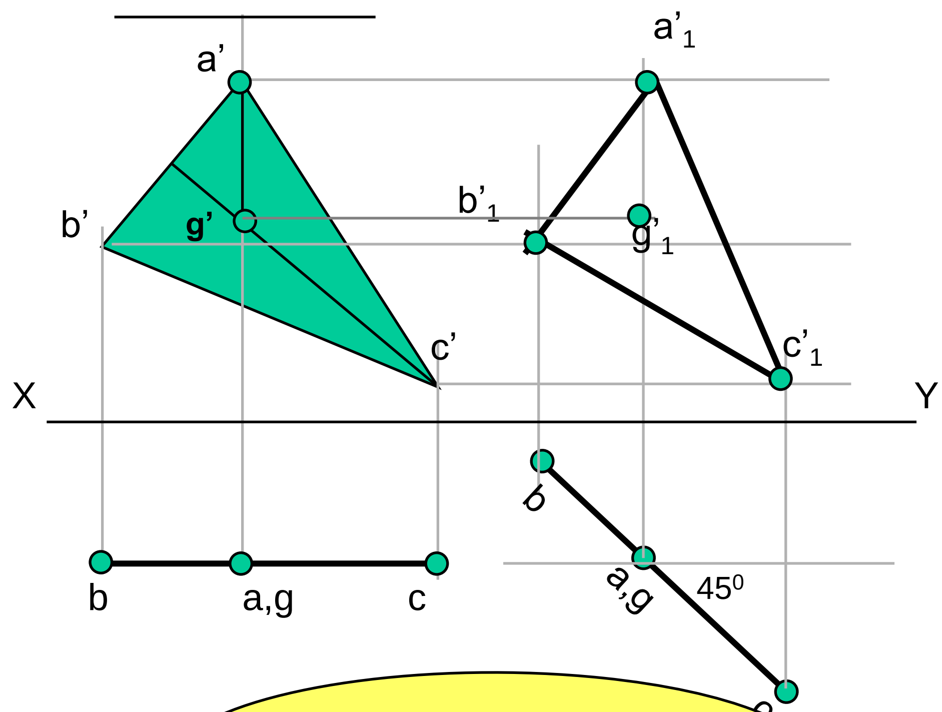
IMPORTANT POINTS

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 1st FV.

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.



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

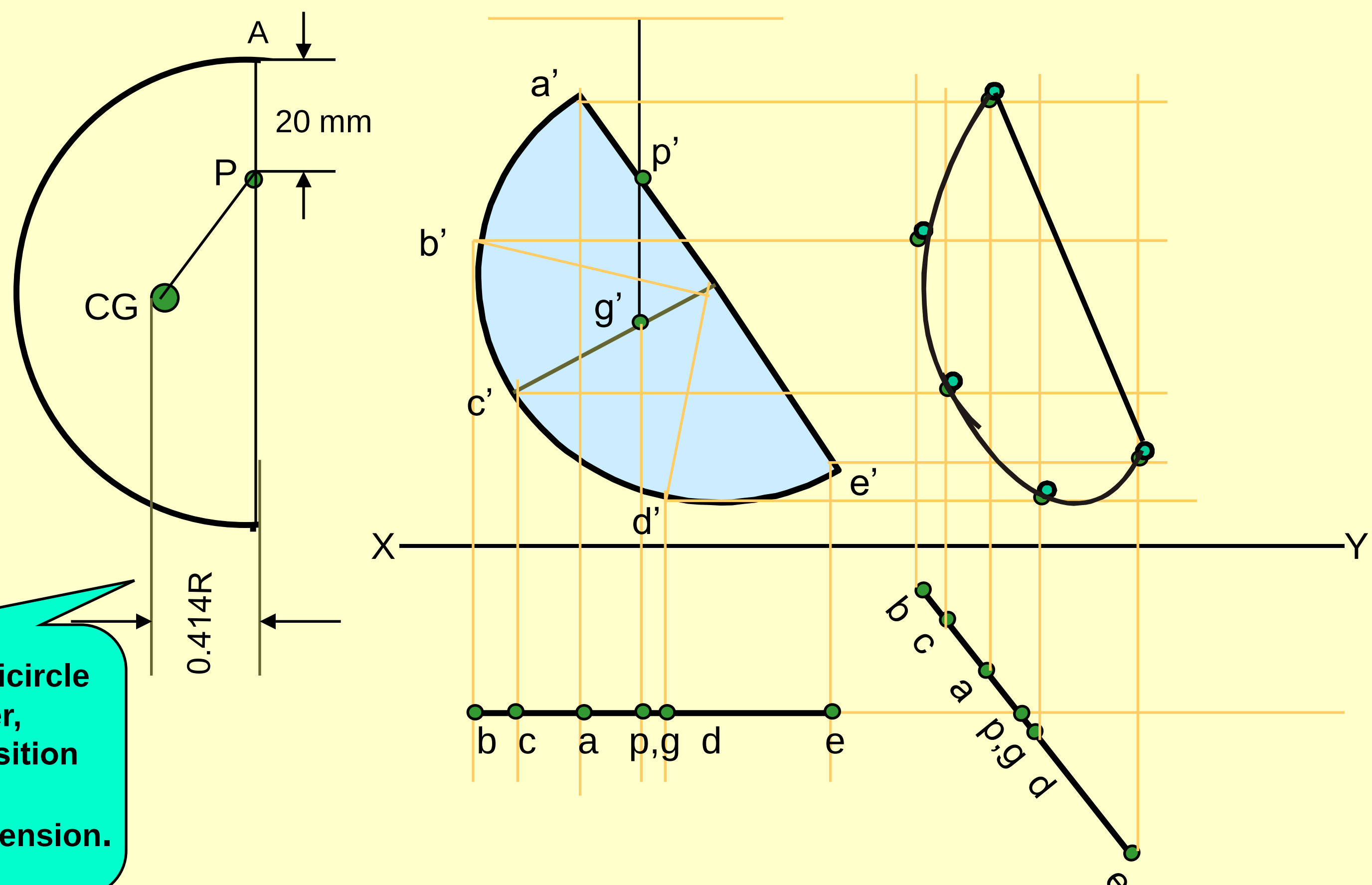


Similarly solve next problem of Semi-circle

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.



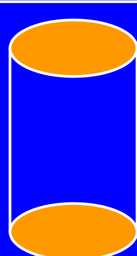
First draw a given semicircle
With given diameter,
Locate it's centroid position
And
join it with point of suspension.

SOLIDS

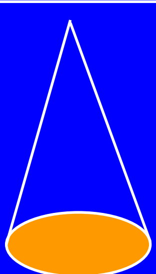
To understand and remember various solids in this subject properly, those are classified & arranged in to two major groups.

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

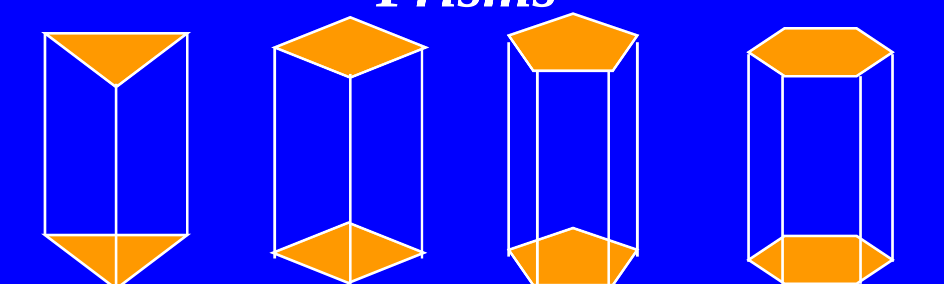
Cylinder



Cone

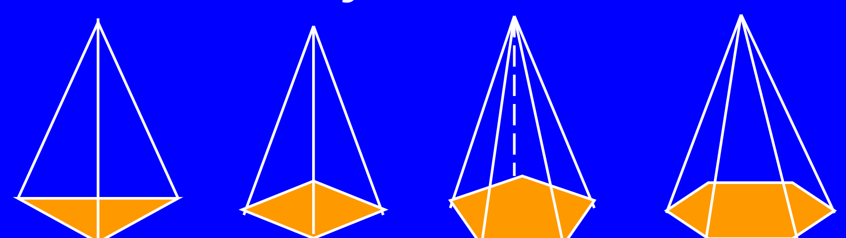


Prisms



Triangular Square Pentagonal Hexagonal

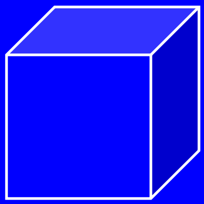
Pyramids



Triangular Square Pentagonal Hexagonal

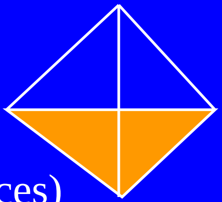
Cube

(A solid having six square faces)



Tetrahedron

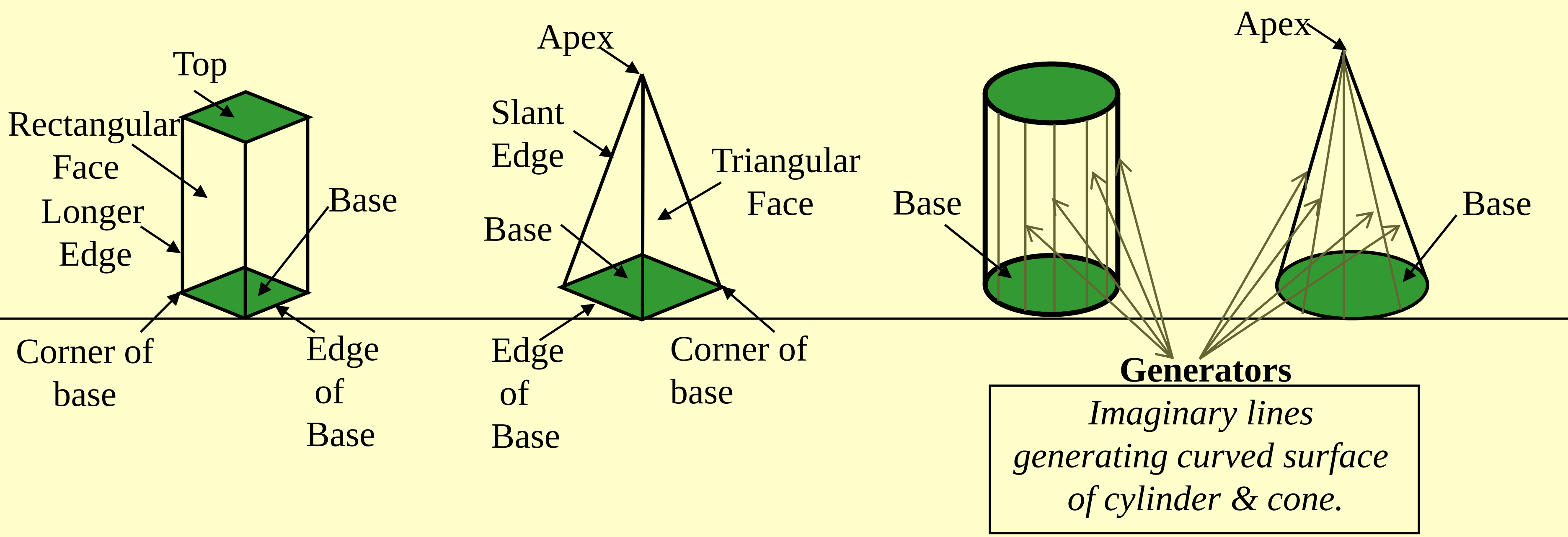
(A solid having Four triangular faces)

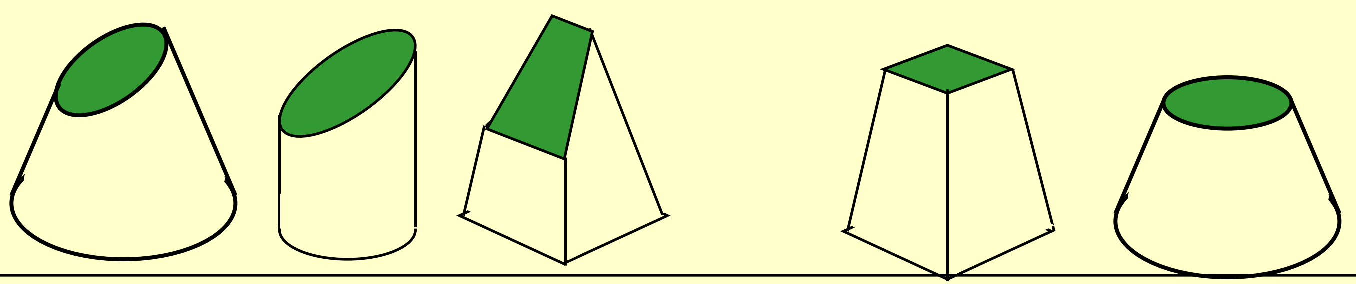


SOLIDS

Dimensional parameters of different solids.

Square Prism **Square Pyramid** **Cylinder** **Cone**

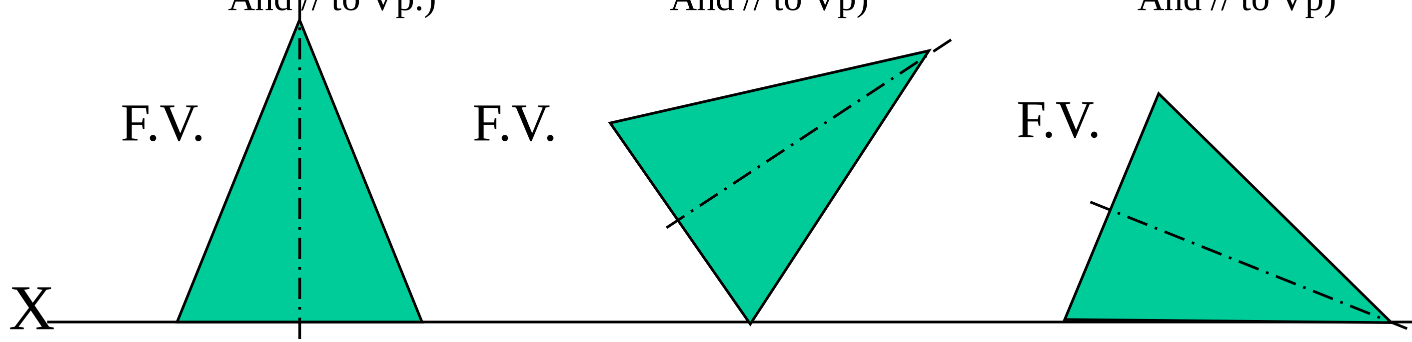




Sections of solids(top & base not parallel)

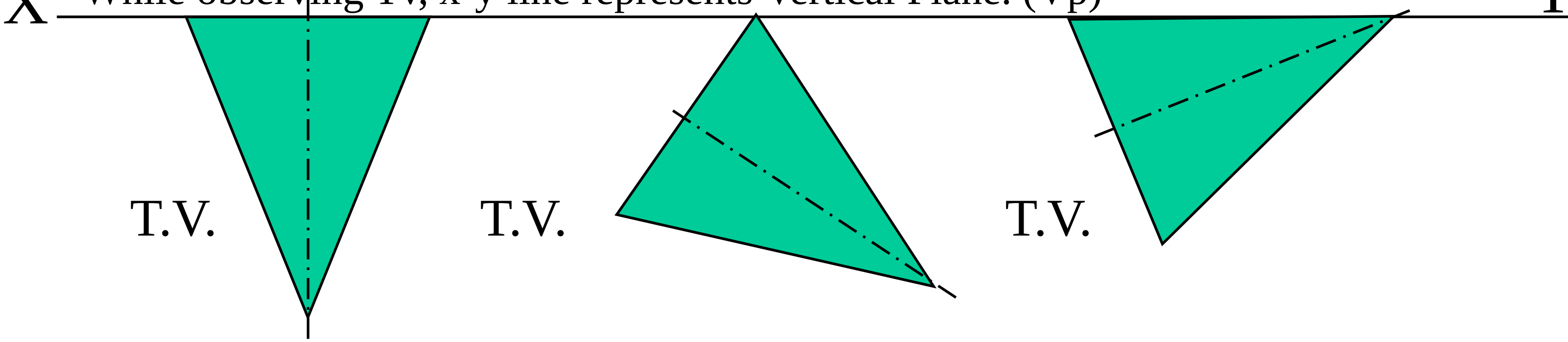
Frustum of cone & pyramids.
(top & base parallel to each other)

STANDING ON H.P	RESTING ON H.P	LYING ON H.P
On it's base.	On one point of base circle.	On one generator.
(Axis perpendicular to Hp And // to Vp.)	(Axis inclined to Hp And // to Vp)	(Axis inclined to Hp And // to Vp)



While observing Fv, x-y line represents Horizontal Plane. (Hp)

While observing Tv, x-y line represents Vertical Plane. (Vp)



STANDING ON V.P	RESTING ON V.P	LYING ON V.P
On it's base.	On one point of base circle.	On one generator.
Axis perpendicular to Vp And // to Hp	Axis inclined to Vp And // to Hp	Axis inclined to Vp And // to Hp

STEPS TO SOLVE PROBLEMS IN SOLIDS

Problem is solved in three steps:

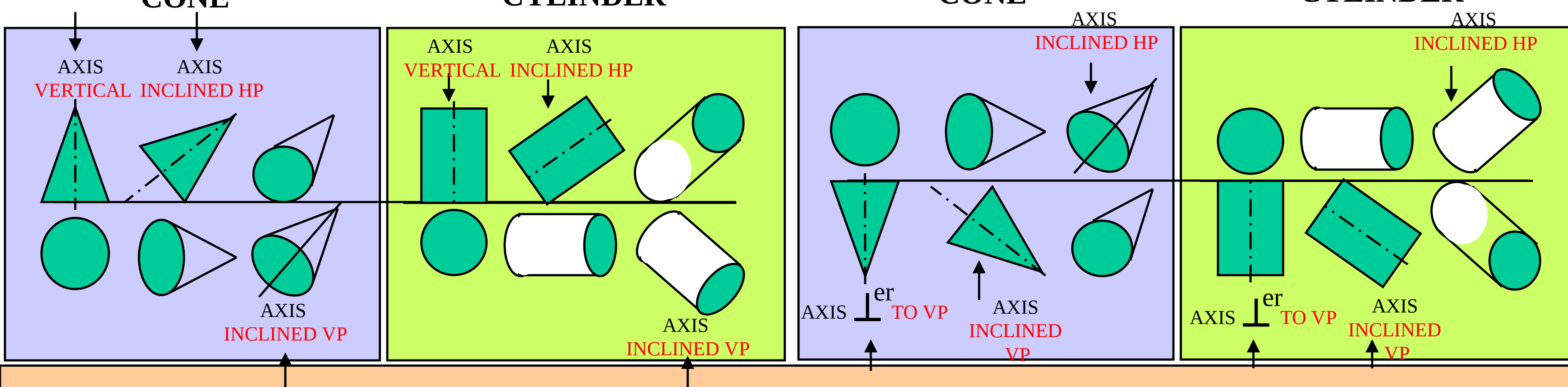
STEP 1: ASSUME SOLID STANDING ON THE PLANE WITH WHICH IT IS MAKING INCLINATION.
(IF IT IS INCLINED TO HP, ASSUME IT STANDING ON HP)
(IF IT IS INCLINED TO VP, ASSUME IT STANDING ON VP)
IF STANDING ON HP - IT'S TV WILL BE TRUE SHAPE OF IT'S BASE OR TOP:
IF STANDING ON VP - IT'S FV WILL BE TRUE SHAPE OF 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)

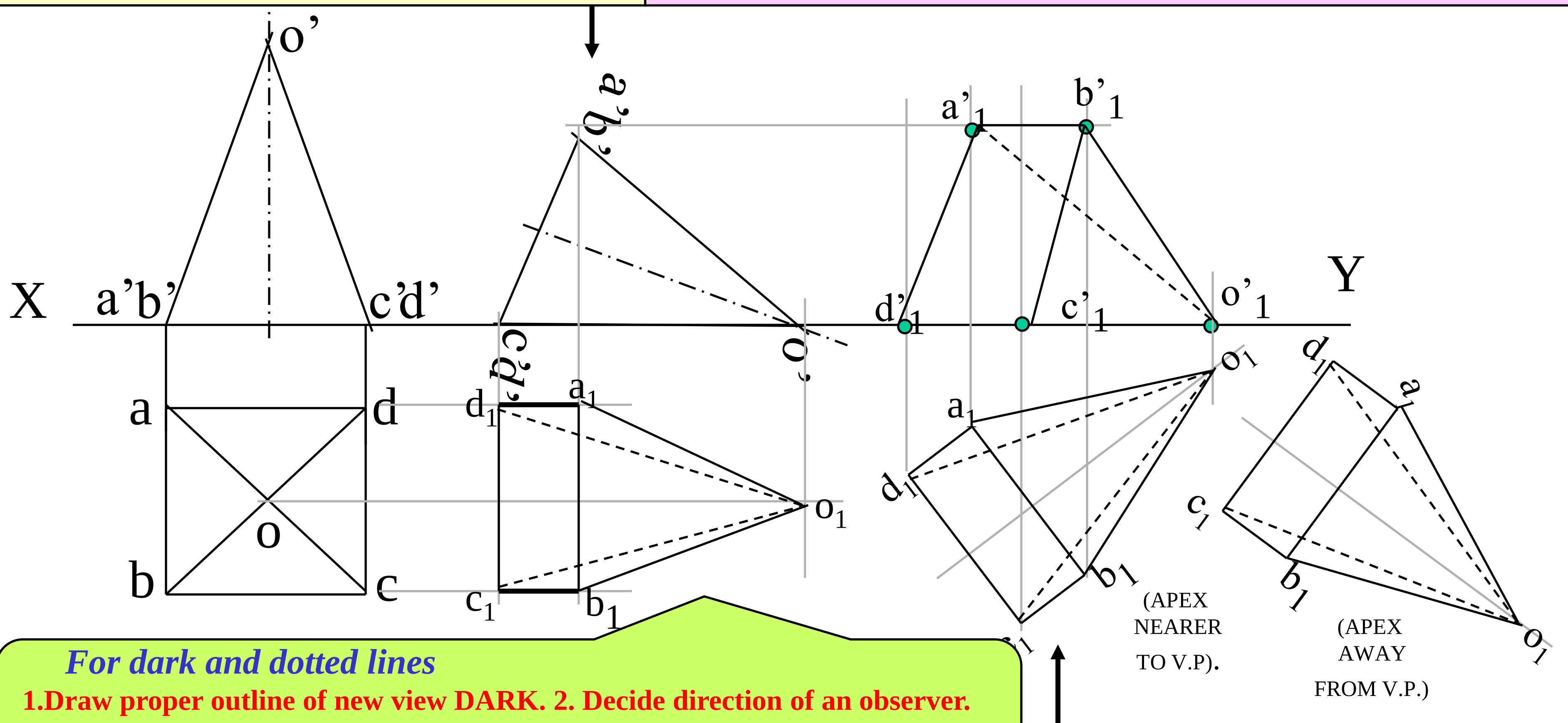
3.Draw square of 40mm sides with one side vertical Tv & taking 50 mm axis project Fv. (a triangle)

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.

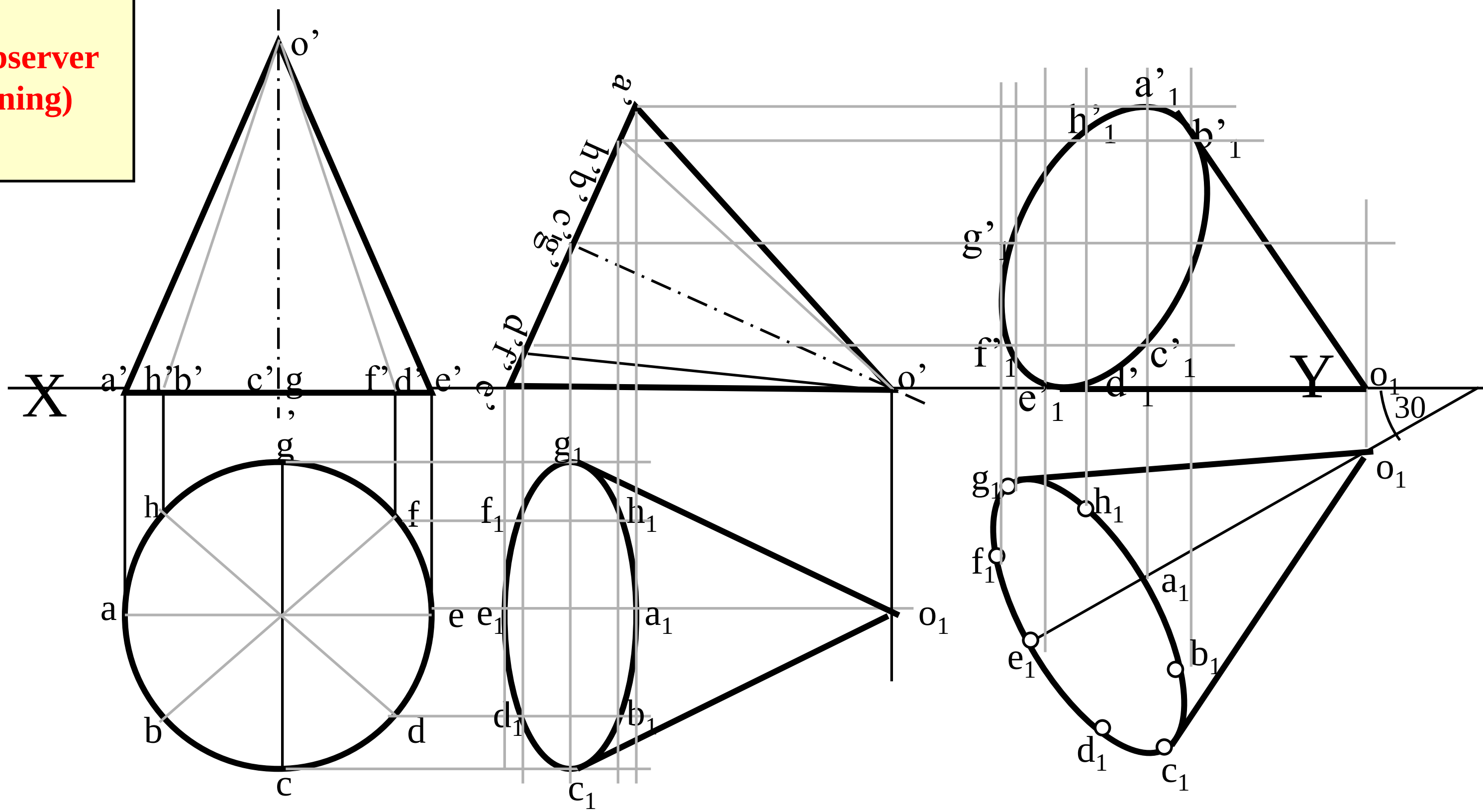
For dark and dotted lines

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 2^{nd} 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)

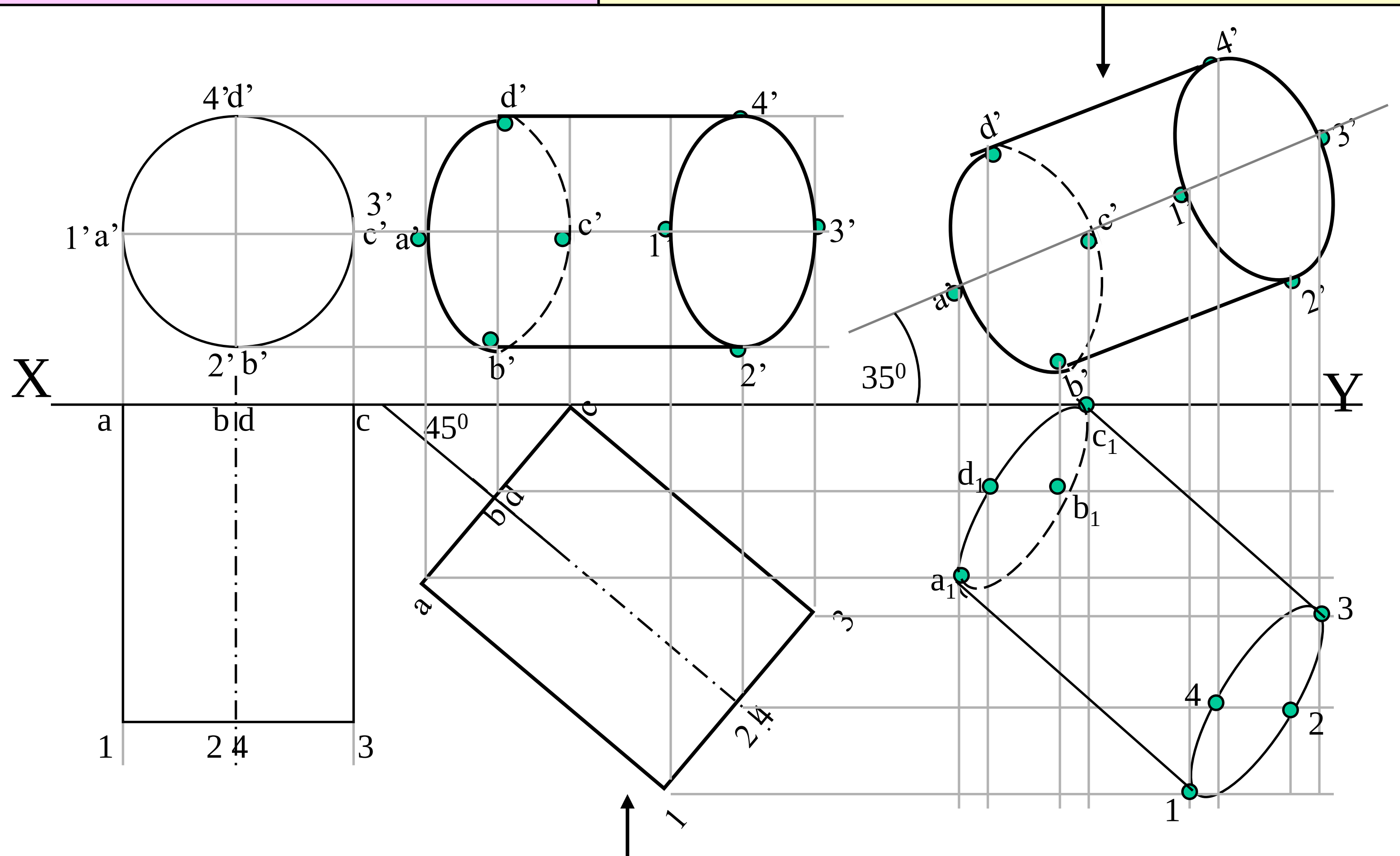
3.Draw 40mm dia. Circle as Fv & taking 50 mm axis project Tv. (a Rectangle)

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.

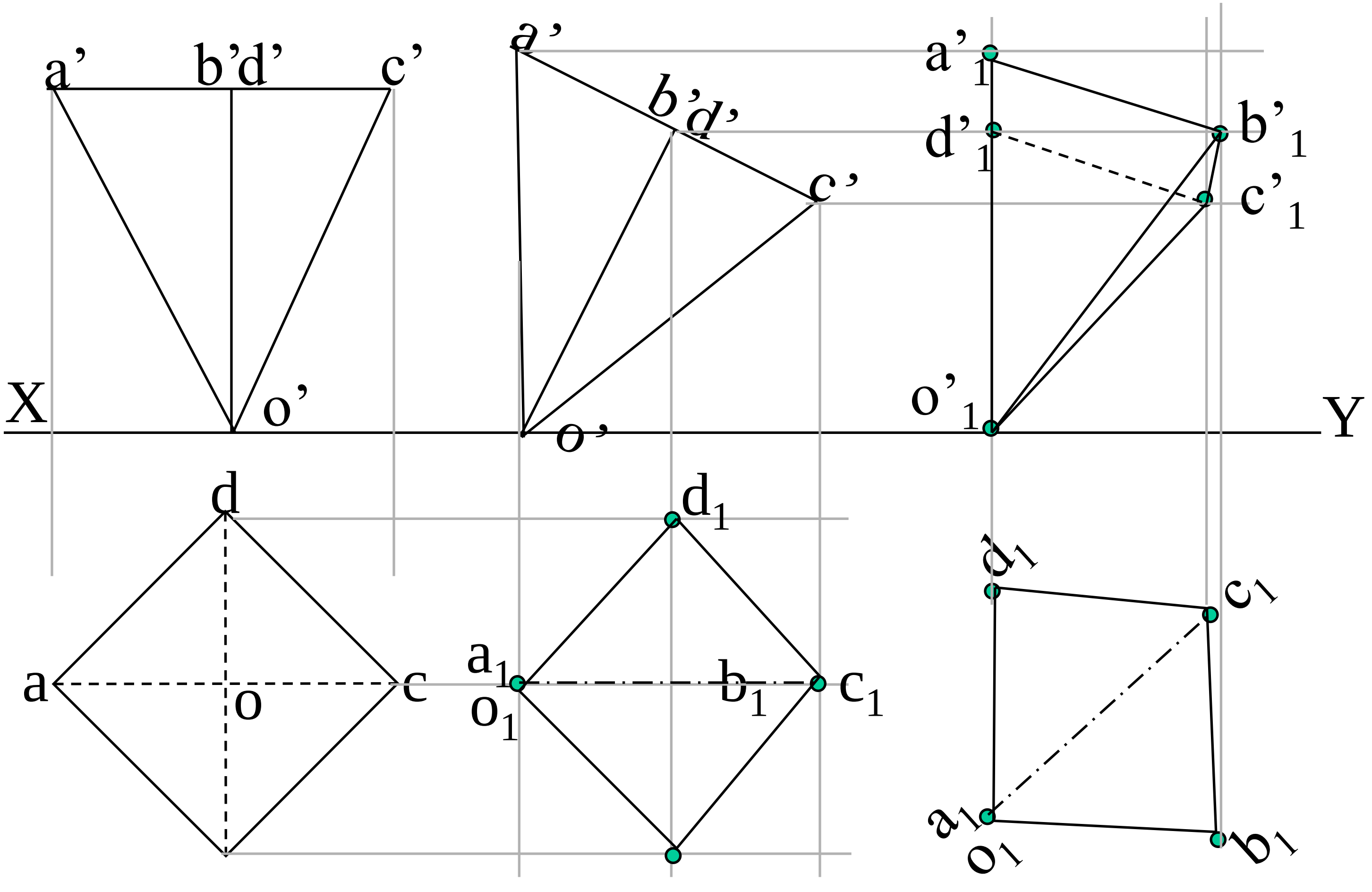
7.Then construct remaining inclination with Hp (Fv of axis I.e. center line of view to xy as shown) & project final Tv.



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:

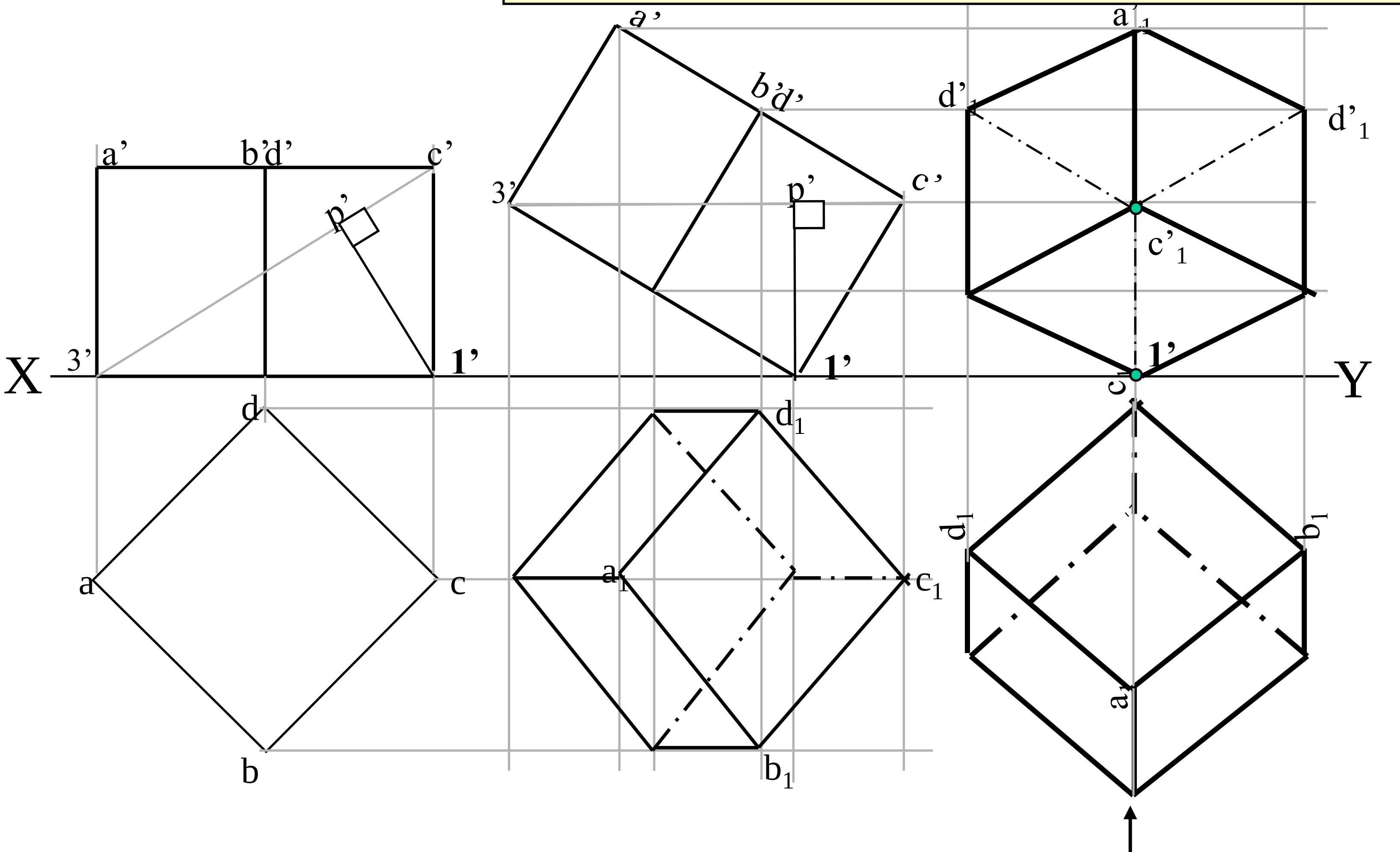
1.Assuming standing on Hp, begin with Tv,a square with all sides equally inclined to xy.Project Fv and name all points of FV & TV.

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.

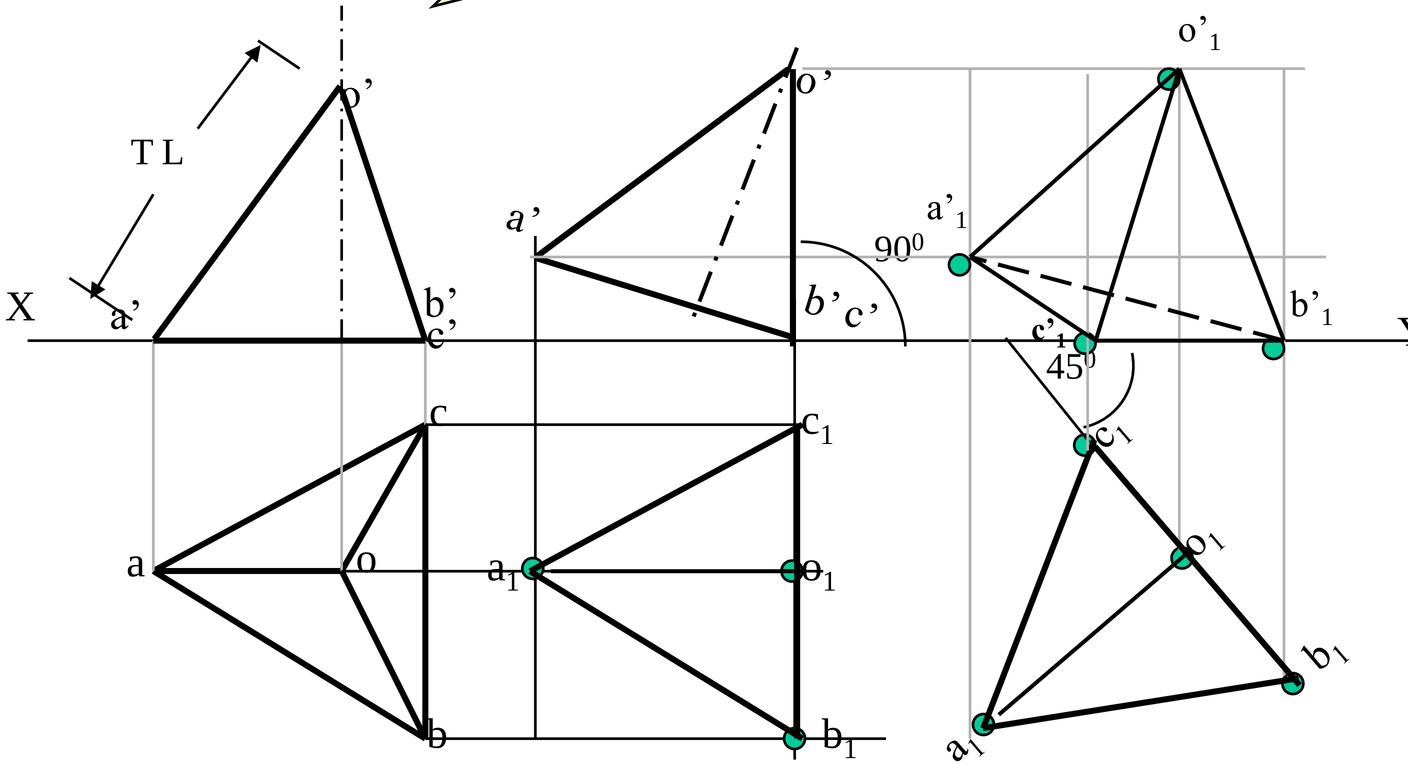


Problem 6: A tetrahedron of 50 mm long edges is resting on one edge on Hp while one triangular face containing this edge is vertical and 45^0 inclined to Vp. Draw projections.

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 2nd Fv make face o'b'c' vertical as said in problem.
And like all previous problems solve completely.



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 !

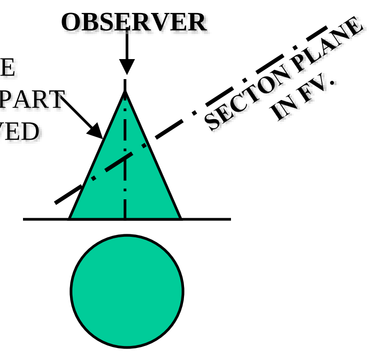
SECTIONING A SOLID.
An object (here a solid) is cut by
some imaginary cutting plane
to understand internal details of that object.

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.

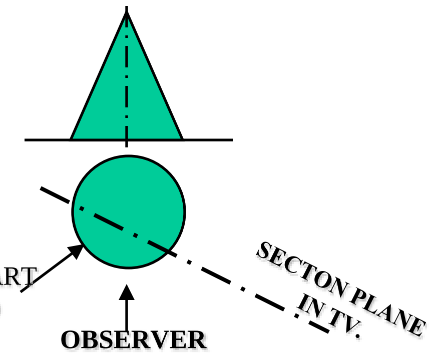
A) Section Plane perpendicular to Vp and inclined to Hp.
(This is a definition of an Aux. Inclined Plane i.e. A.I.P.)
NOTE:- This section plane appears as a straight line in FV.

(A)



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.

(B)

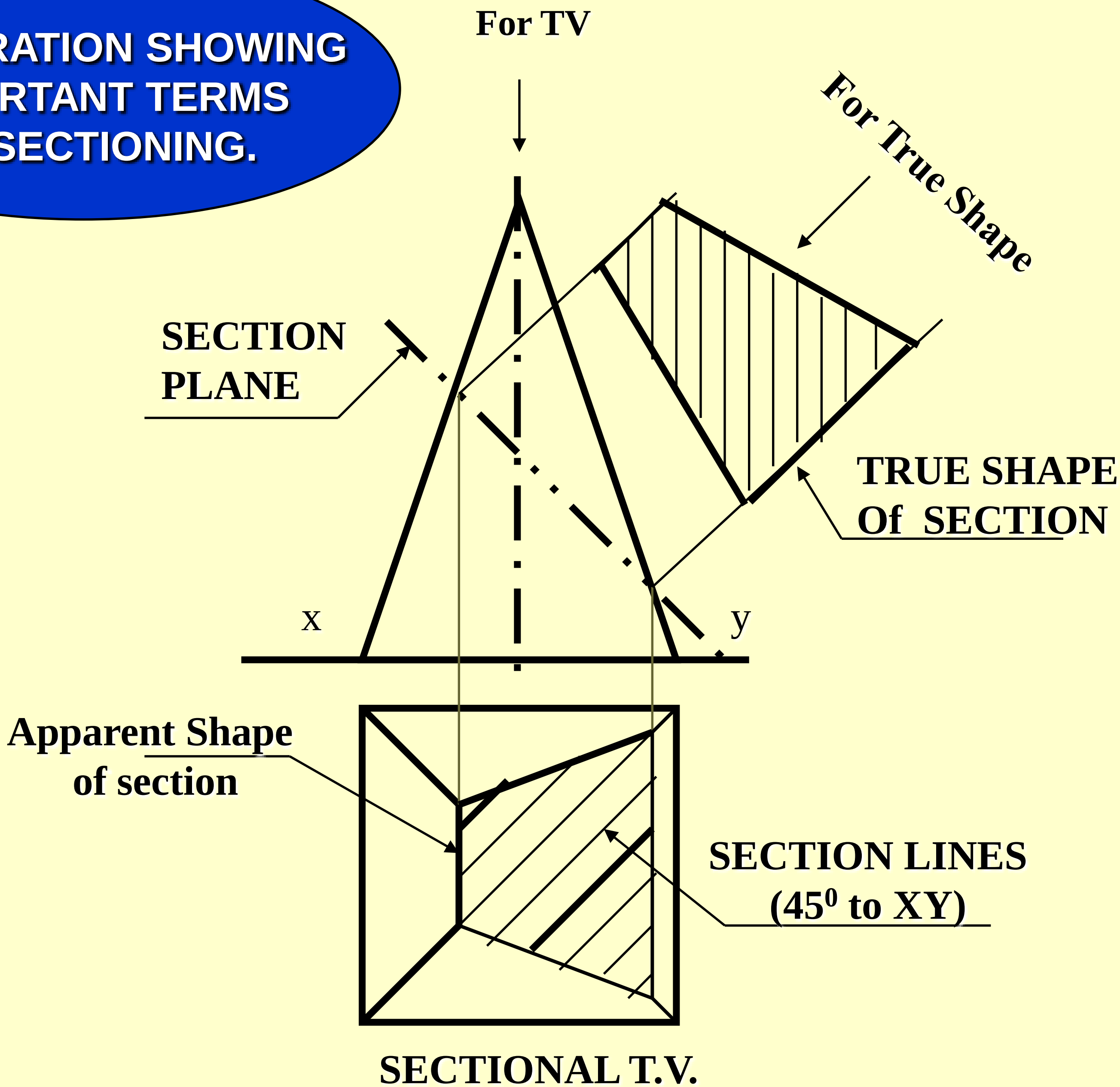


Remember:-

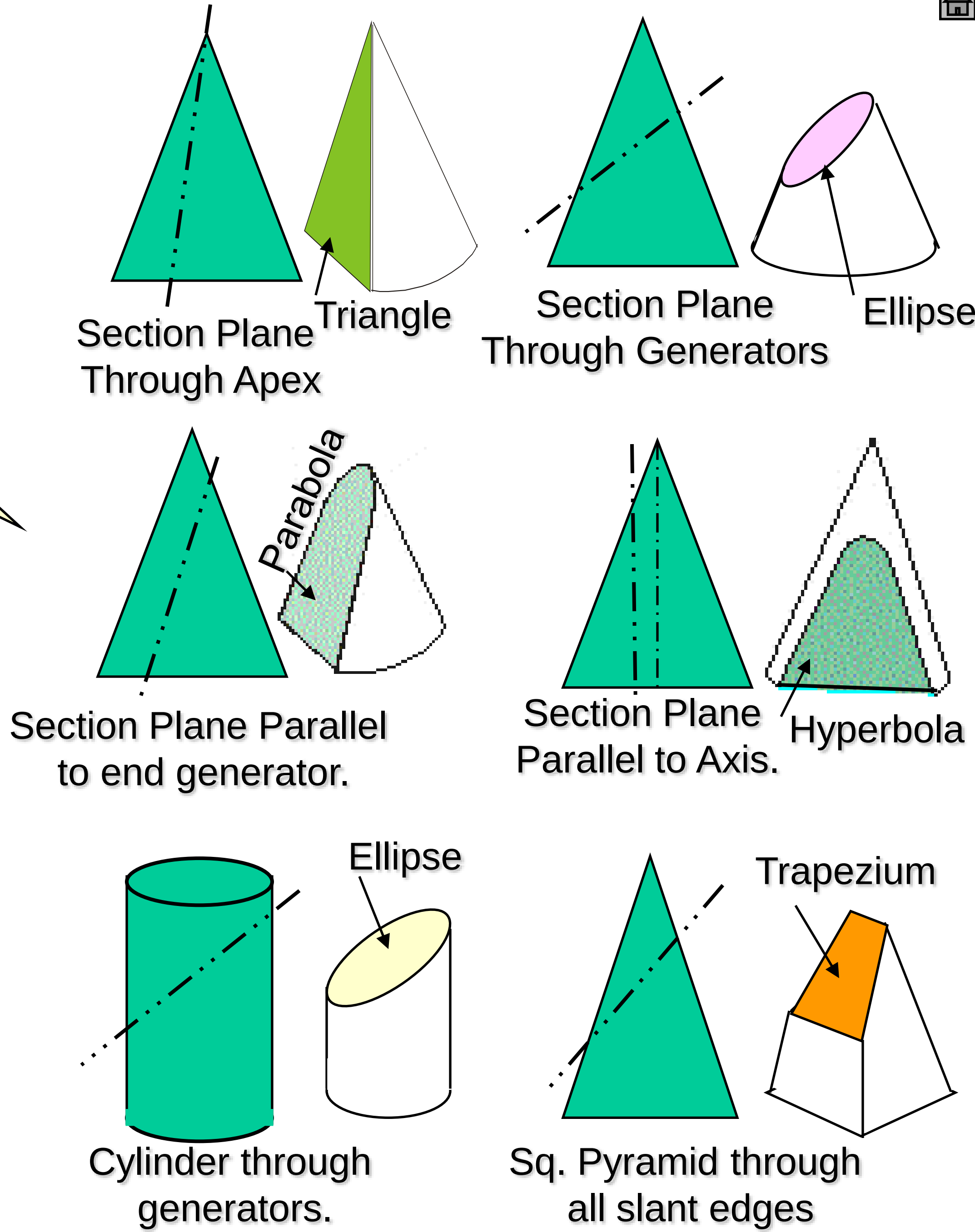
1. After launching a section plane either in FV or TV, the part towards observer is assumed to be removed.

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.

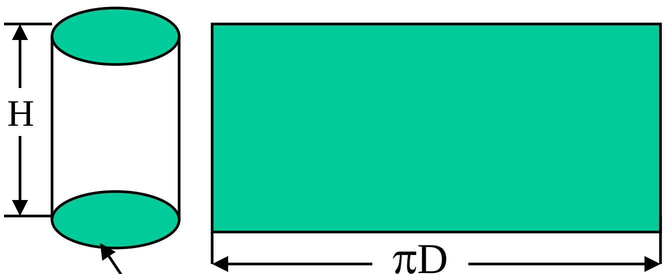
But before going ahead, note following ***Important*** *points.*

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.

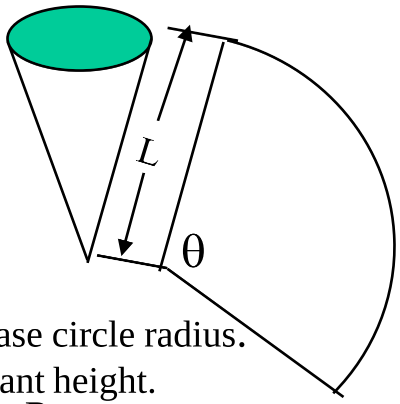
Development of lateral surfaces of different solids.
(Lateral surface is the surface excluding top & base)

Cylinder: A Rectangle



H= Height D= base diameter

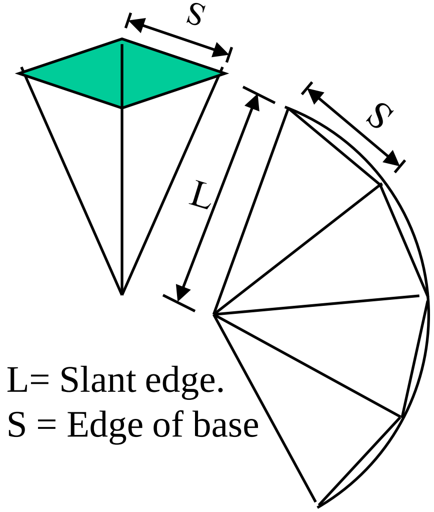
Cone: (Sector of circle)



R=Base circle radius.
L=Slant height.

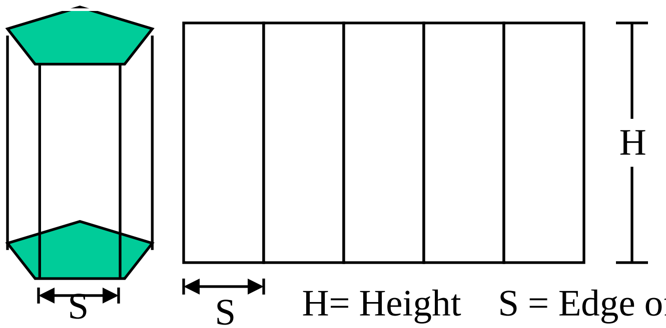
$$\theta = \frac{R}{L} \times 360^0$$

Pyramids: (No.of triangles)



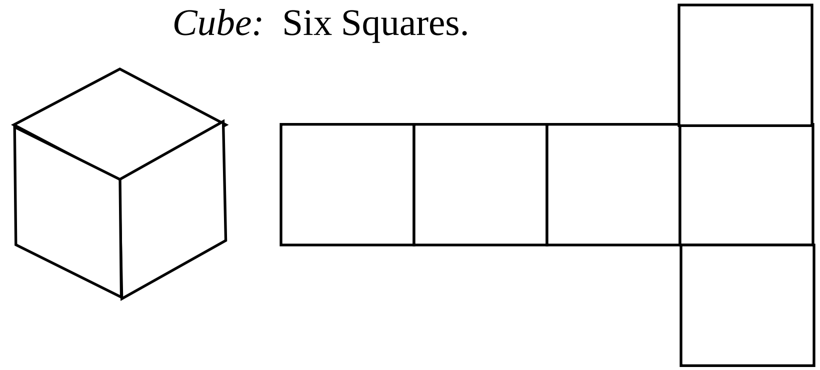
L= Slant edge.
S = Edge of base

Prisms: No.of Rectangles

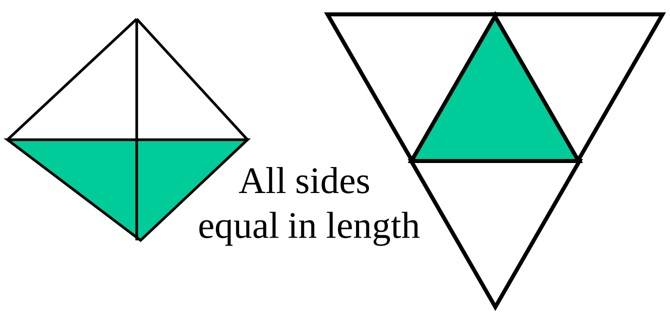


H= Height S = Edge of base

Cube: Six Squares.



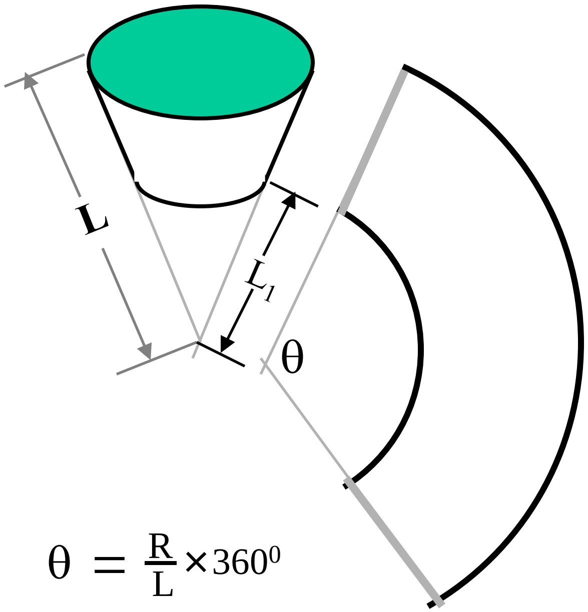
Tetrahedron: Four Equilateral Triangles



All sides
equal in length

FRUSTUMS

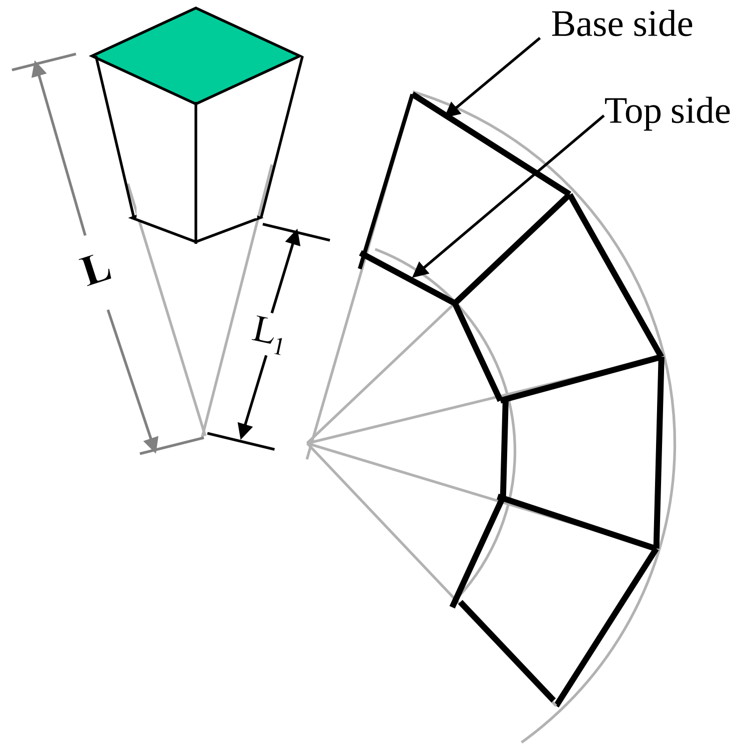
DEVELOPMENT OF
FRUSTUM OF CONE



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

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

DEVELOPMENT OF
FRUSTUM OF SQUARE PYRAMID

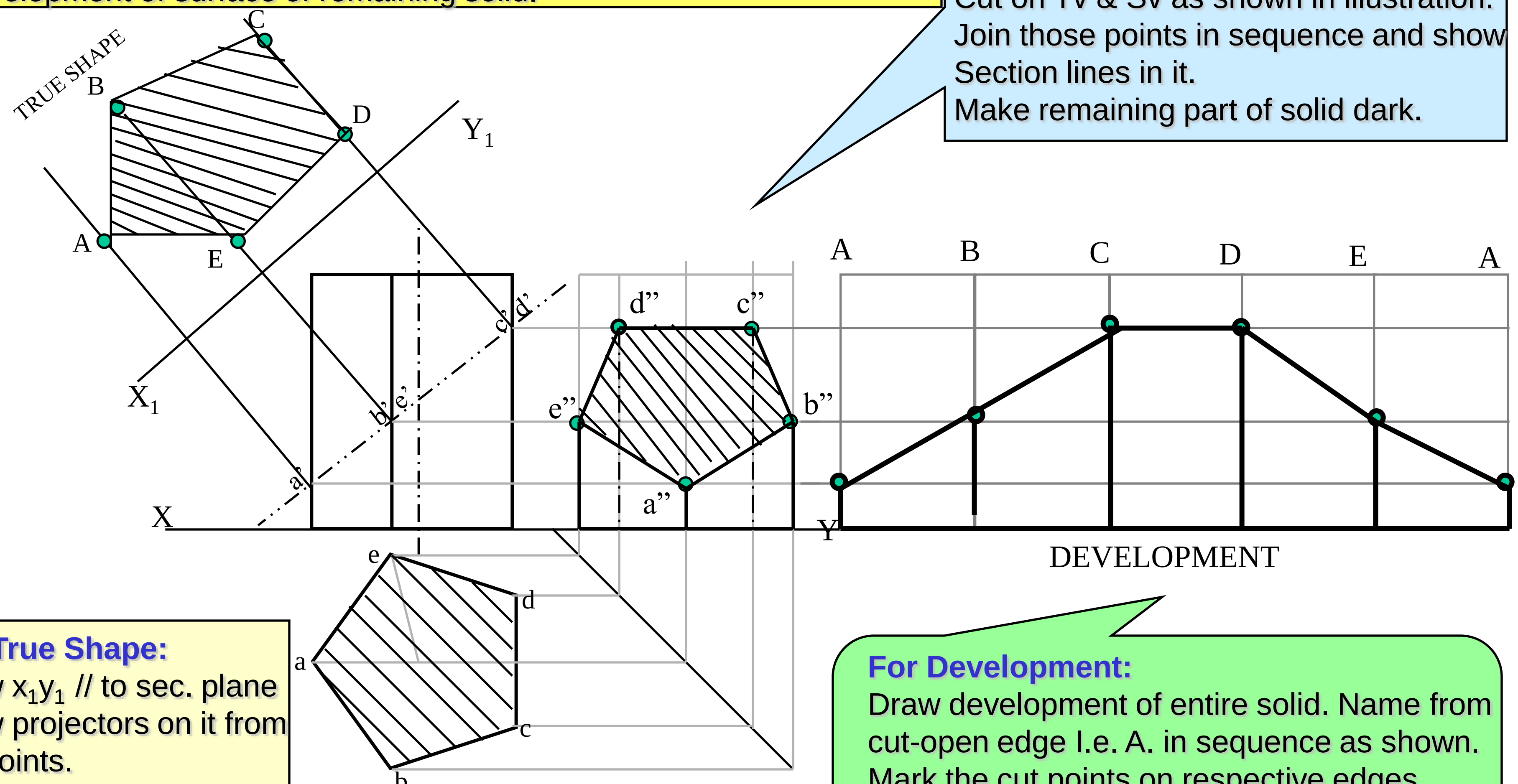


L= Slant edge of pyramid
L_1 = Slant edge of cut part.

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.

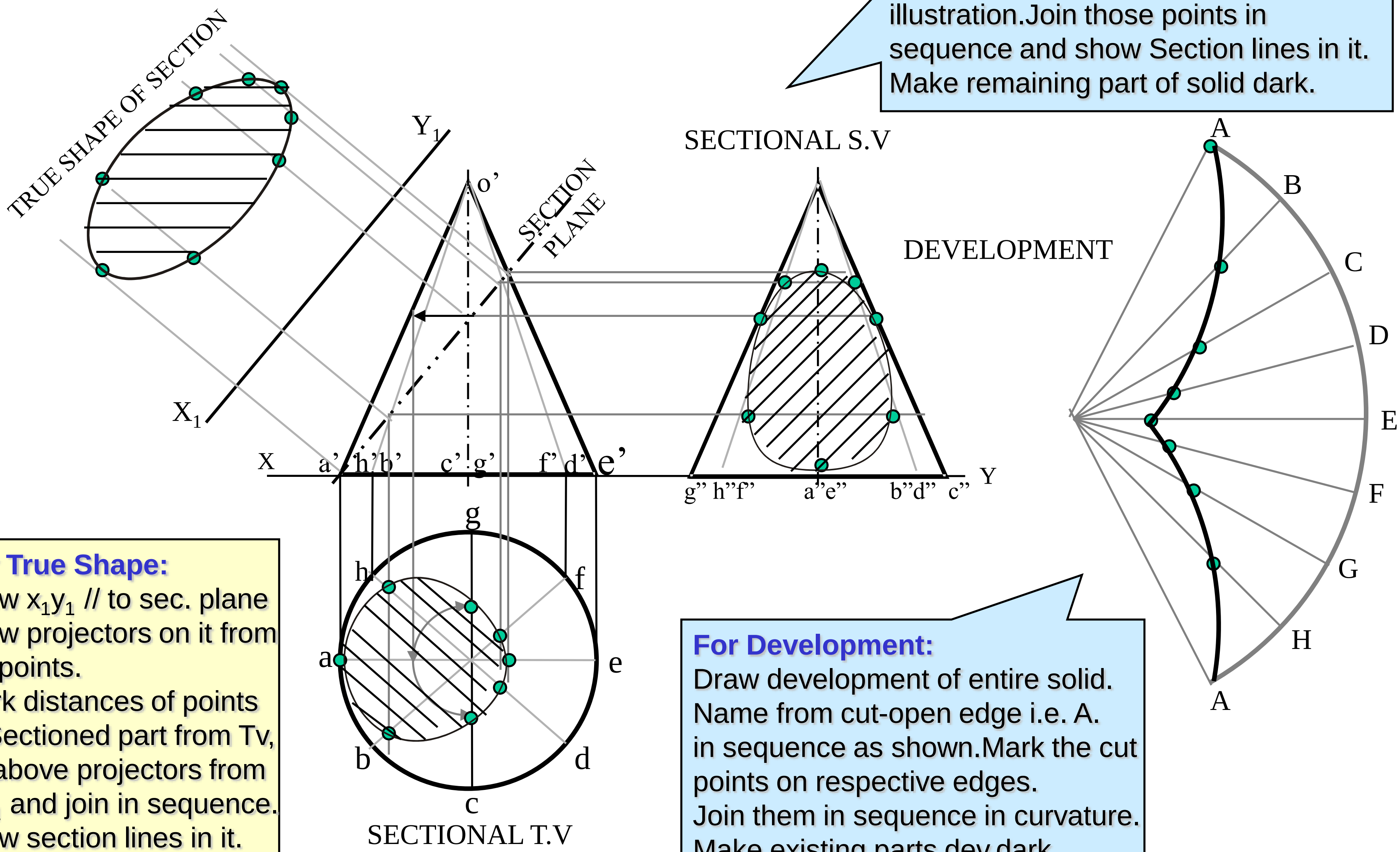


For True Shape:
Draw $x_1 y_1$ // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from $x_1 y_1$ and join in sequence.
Draw section lines in it.
It is required true shape.

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.

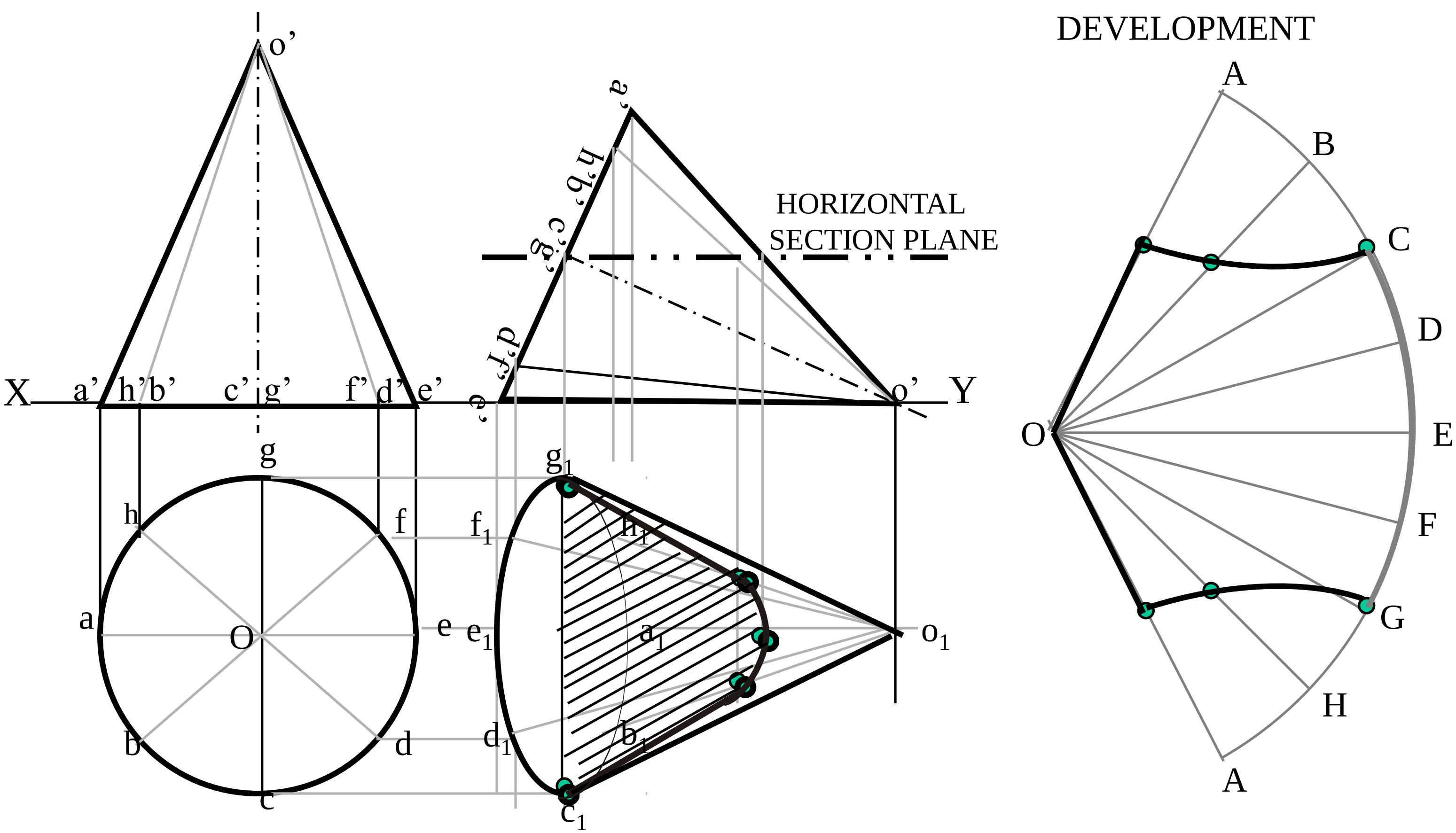


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

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!



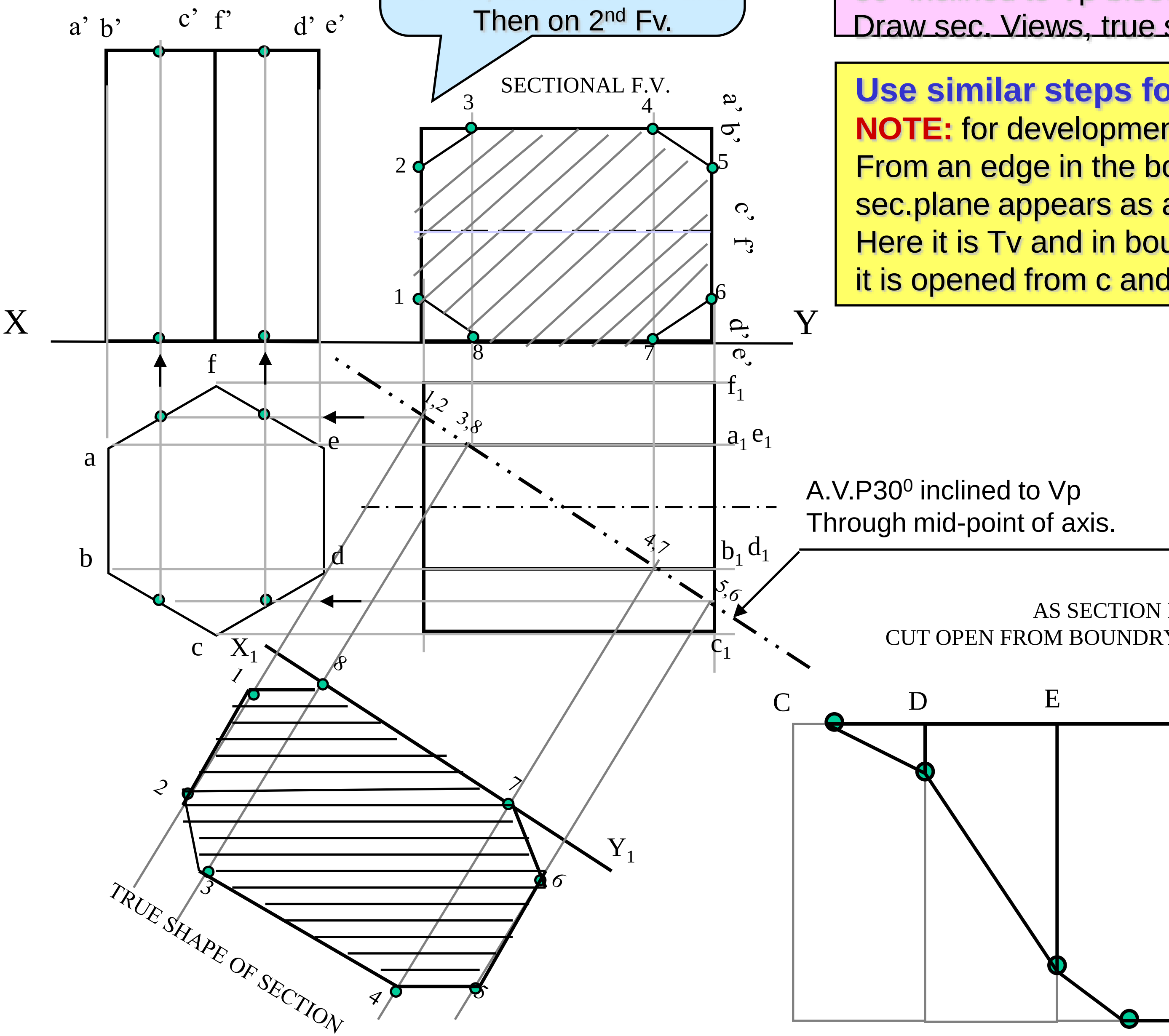
SECTIONAL T.V

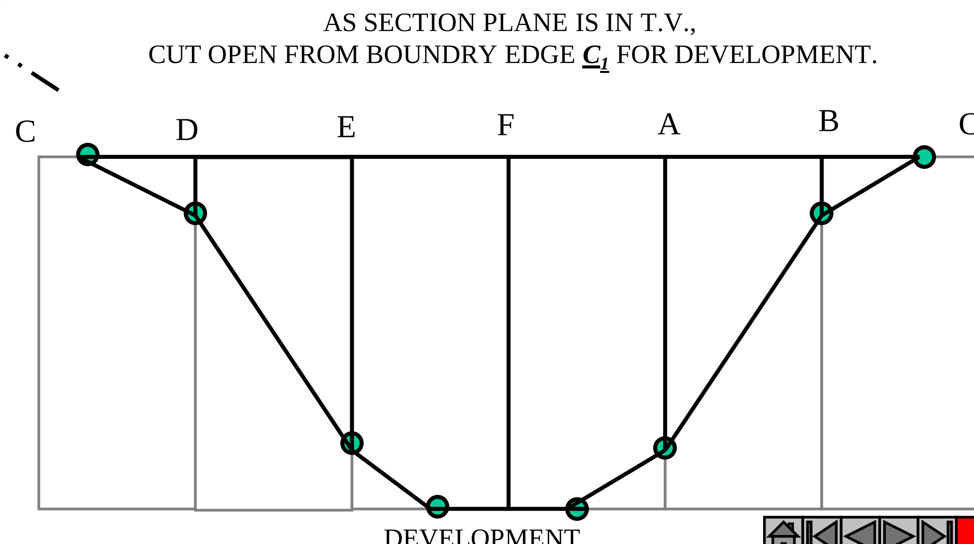
(SHOWING TRUE SHAPE OF SECTION)

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.

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.

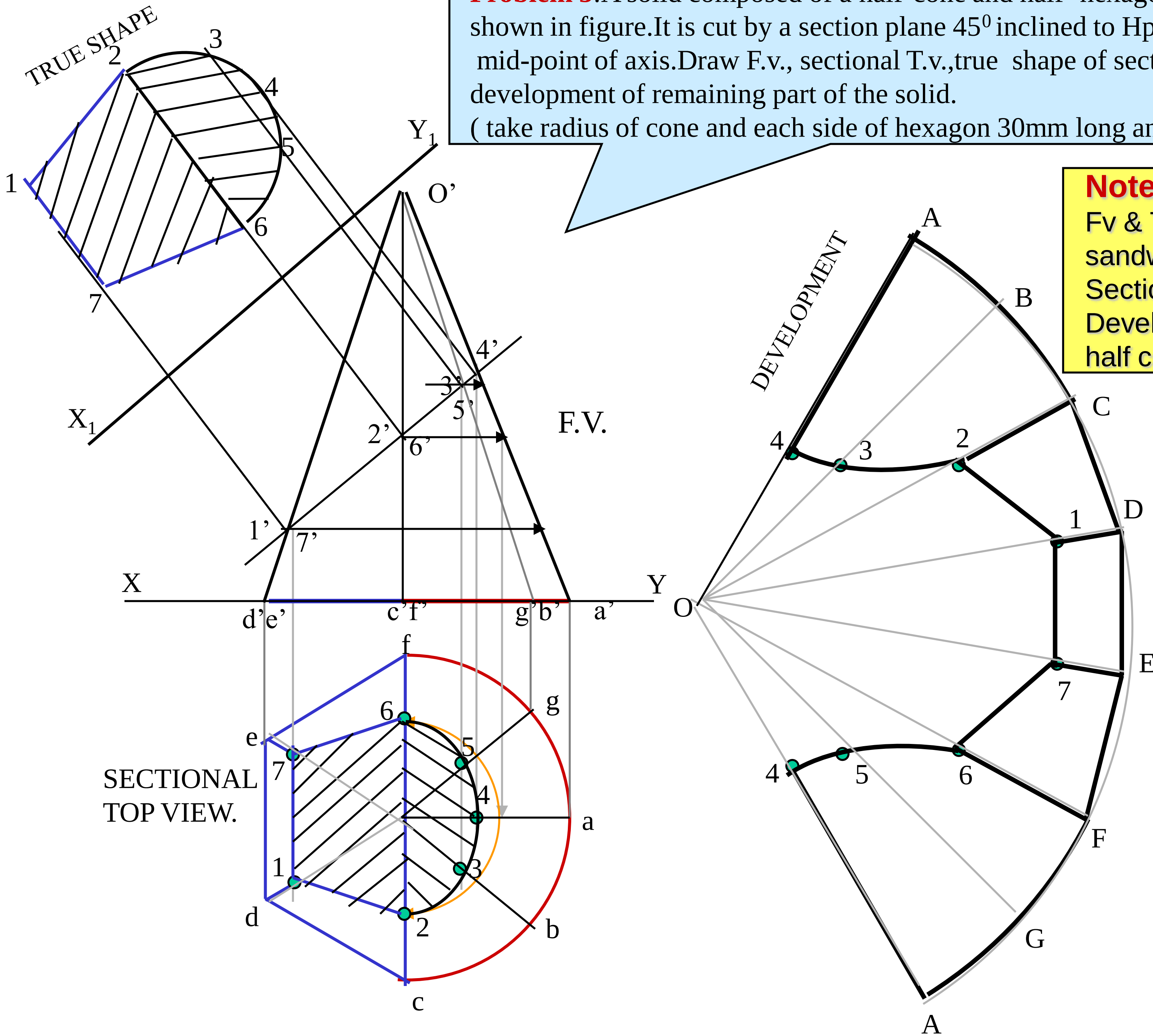
Use similar steps for sec.views & true shape.
NOTE: for development, always cut open object from From an edge in the boundary of the view in which sec.plane appears as a line.
Here it is Tv and in boundary, there is c1 edge.Hence it is opened from c and named C,D,E,F,A,B,C.





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:



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.

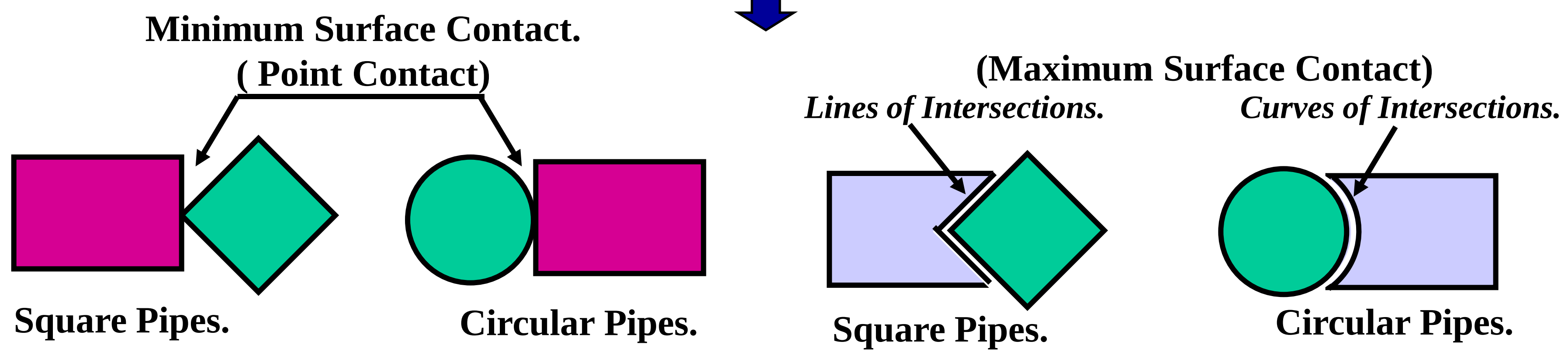
THIS CURVE IS CALLED CURVE OF INTERSECTION
AND
IT IS A RESULT OF INTERPENETRATION OF SOLIDS.

PURPOSE OF DRAWING THESE CURVES:-

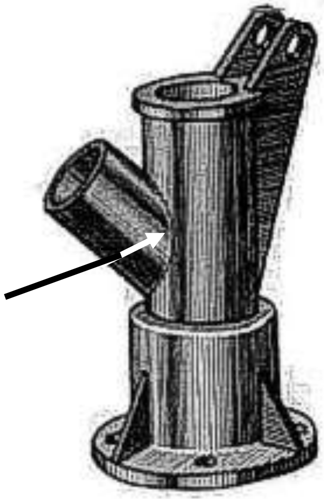
WHEN TWO OBJECTS ARE TO BE JOINED TOGATHER, MAXIMUM SURFACE CONTACT BETWEEN BOTH BECOMES A BASIC REQUIREMENT FOR STRONGEST & LEAK-PROOF JOINT.

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

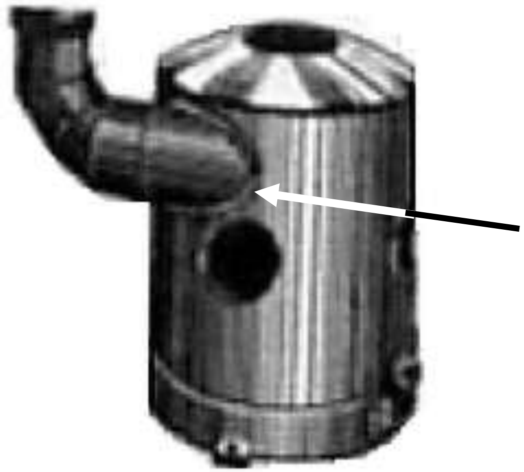
Study Following Illustrations Carefully.



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



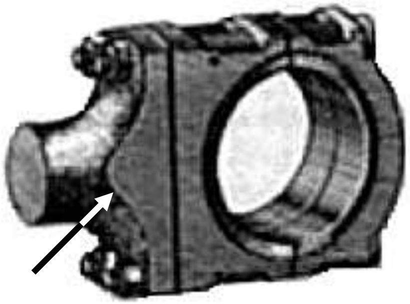
A machine component having two intersecting cylindrical surfaces with the axis at acute angle to each other.



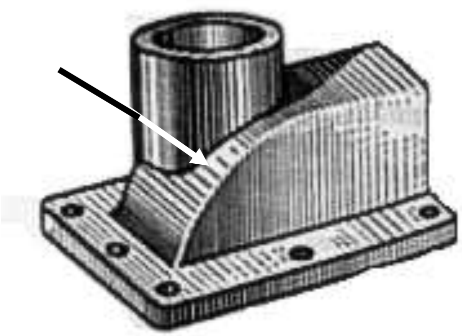
An Industrial Dust collector. Intersection of two cylinders.

Intersection of a Cylindrical main and Branch Pipe.

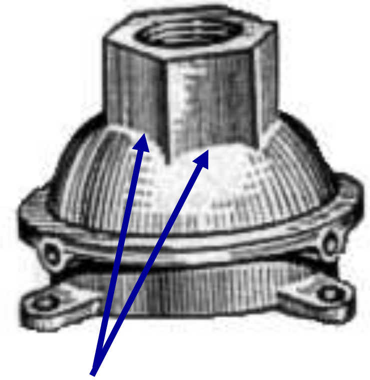
A Feeding Hopper In industry.



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

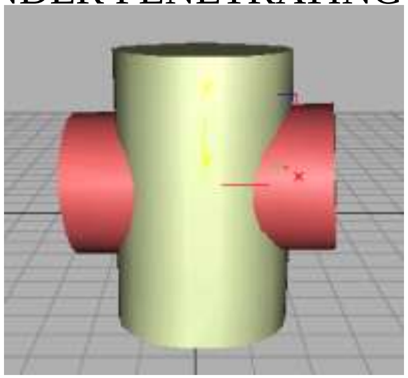
COMMON SOLUTION STEPS

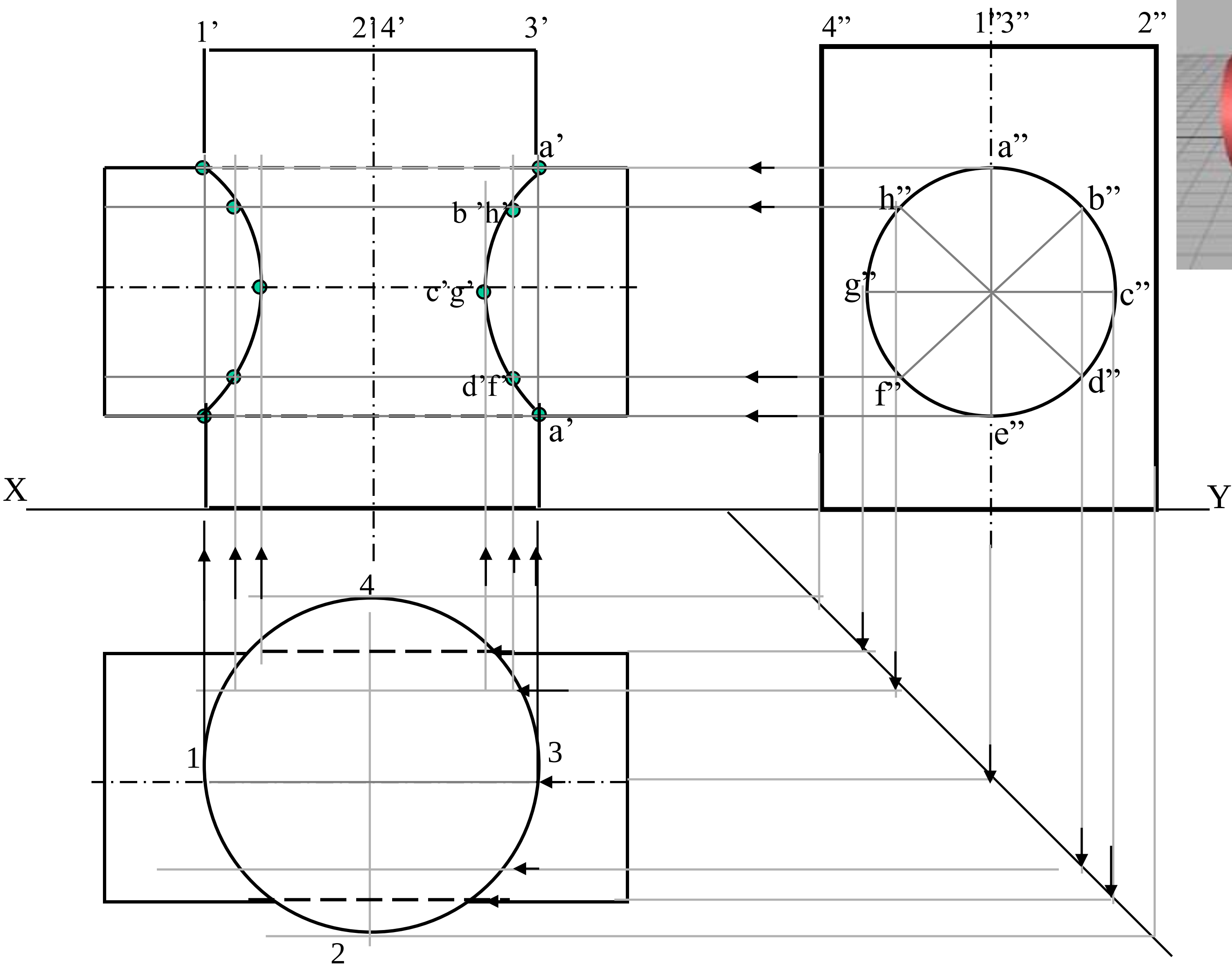
**One solid will be standing on HP
Other will penetrate horizontally.
Draw three views of standing solid.
Name views as per the illustrations.
Beginning with side view draw three
Views of penetrating solids also.
On it's S.V. mark number of points
And name those(either letters or nos.)
The points which 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.

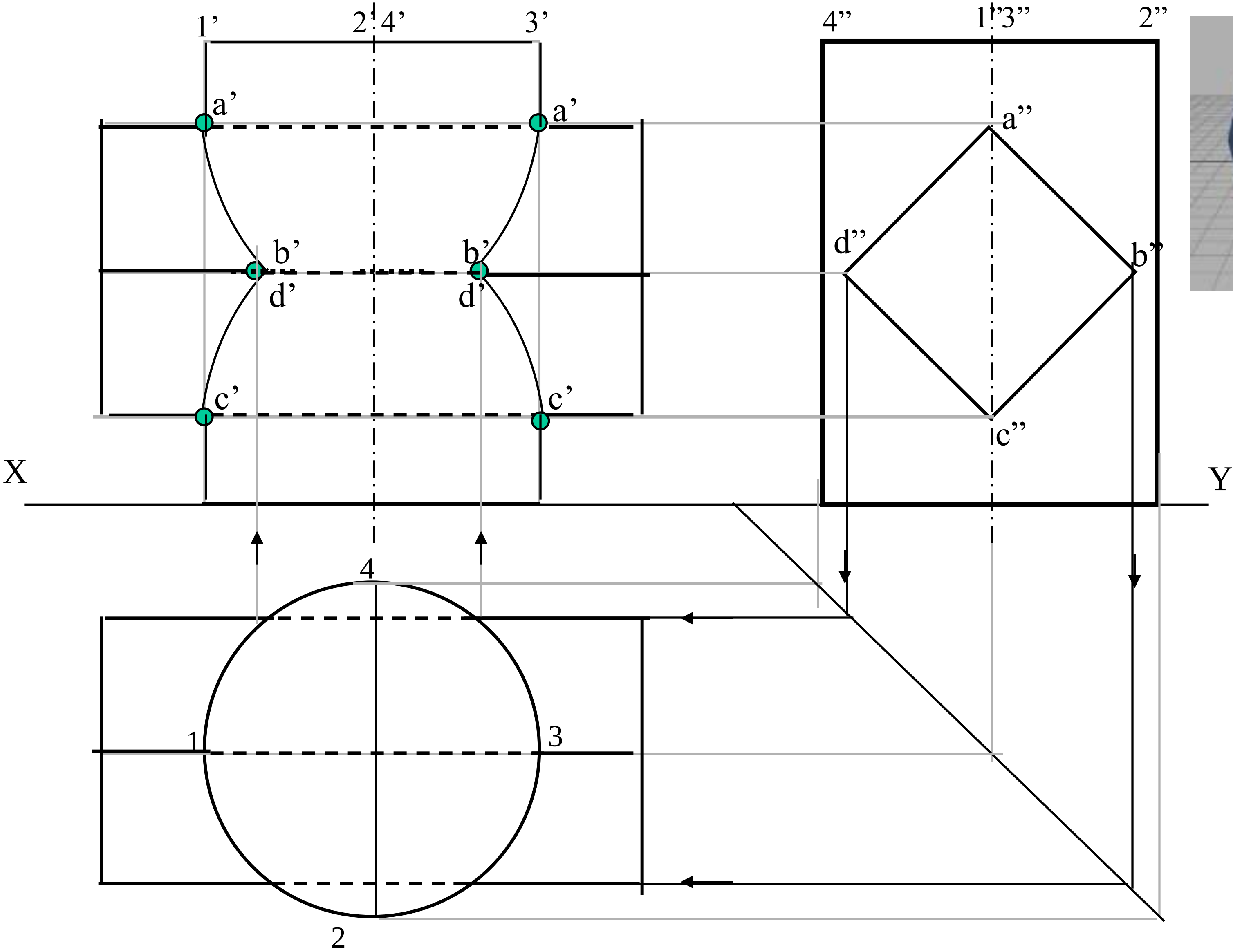
CASE 1.
CYLINDER STANDING
&
CYLINDER PENETRATING

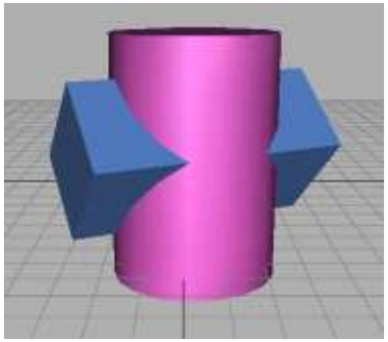




Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersect & bisect each other. All faces of prism are equally inclined to Hp. Draw projections showing curves of intersections.

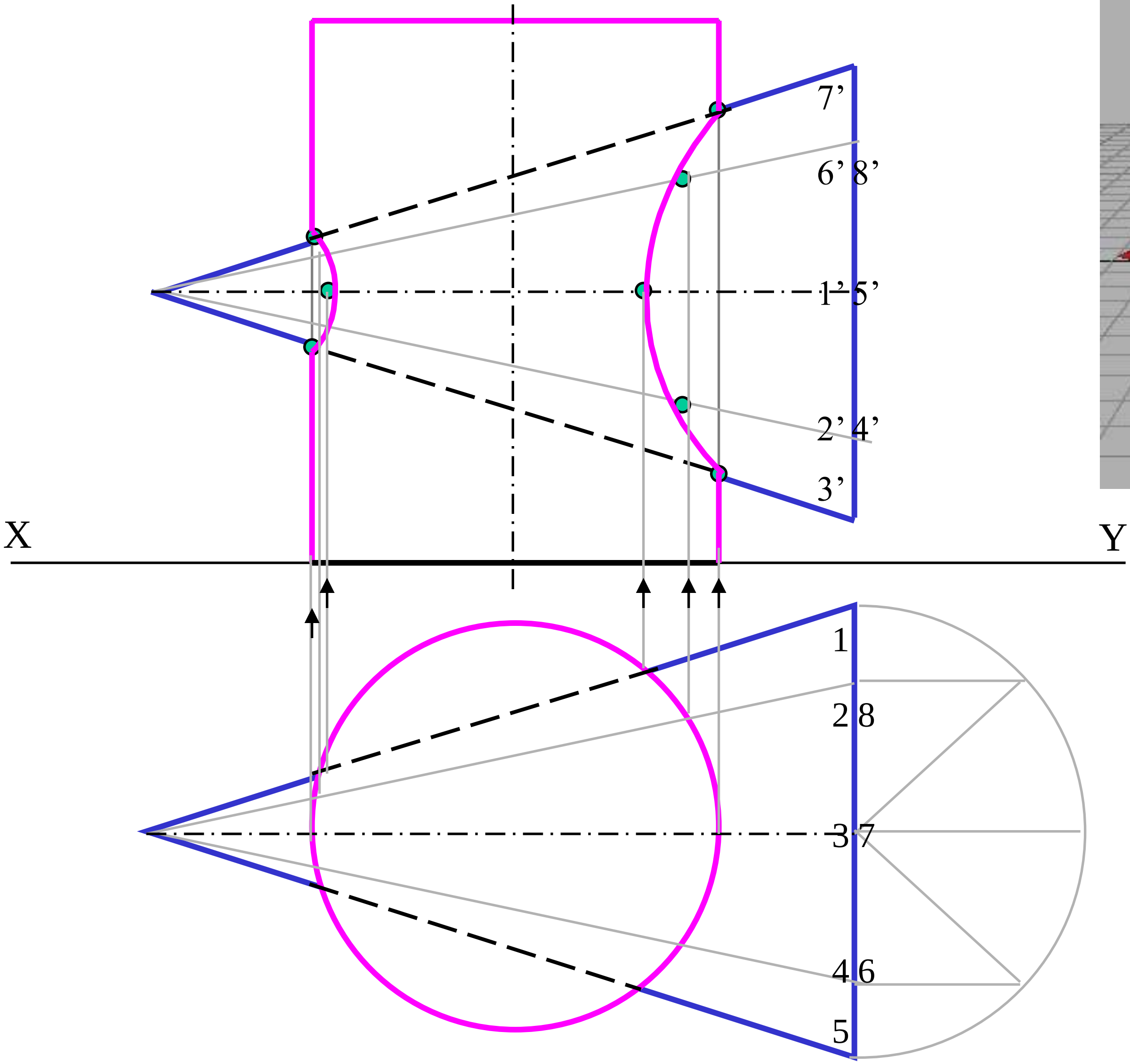
CASE 2.
CYLINDER STANDING
&
SQ.PRISM PENETRATING

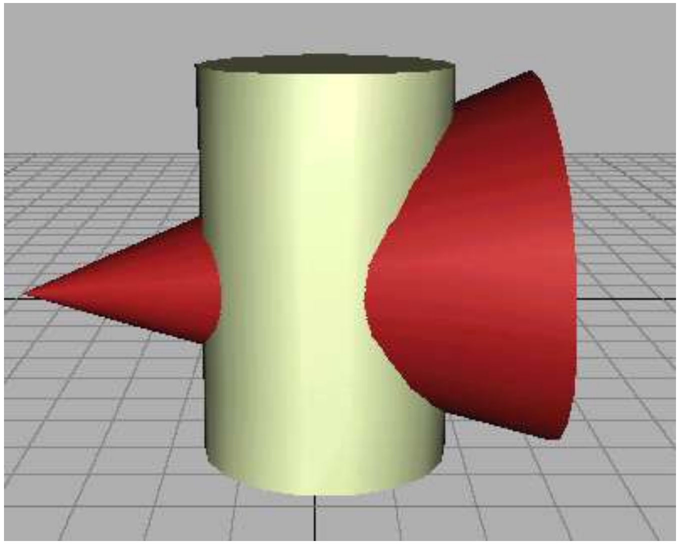




Problem: A cylinder of 80 mm diameter and 100 mm axis is completely penetrated by a cone of 80 mm diameter and 120 mm long axis horizontally.Both axes intersect & bisect each other. Draw projections showing curve of intersections.

CASE 3.
CYLINDER STANDING
&
CONE PENETRATING





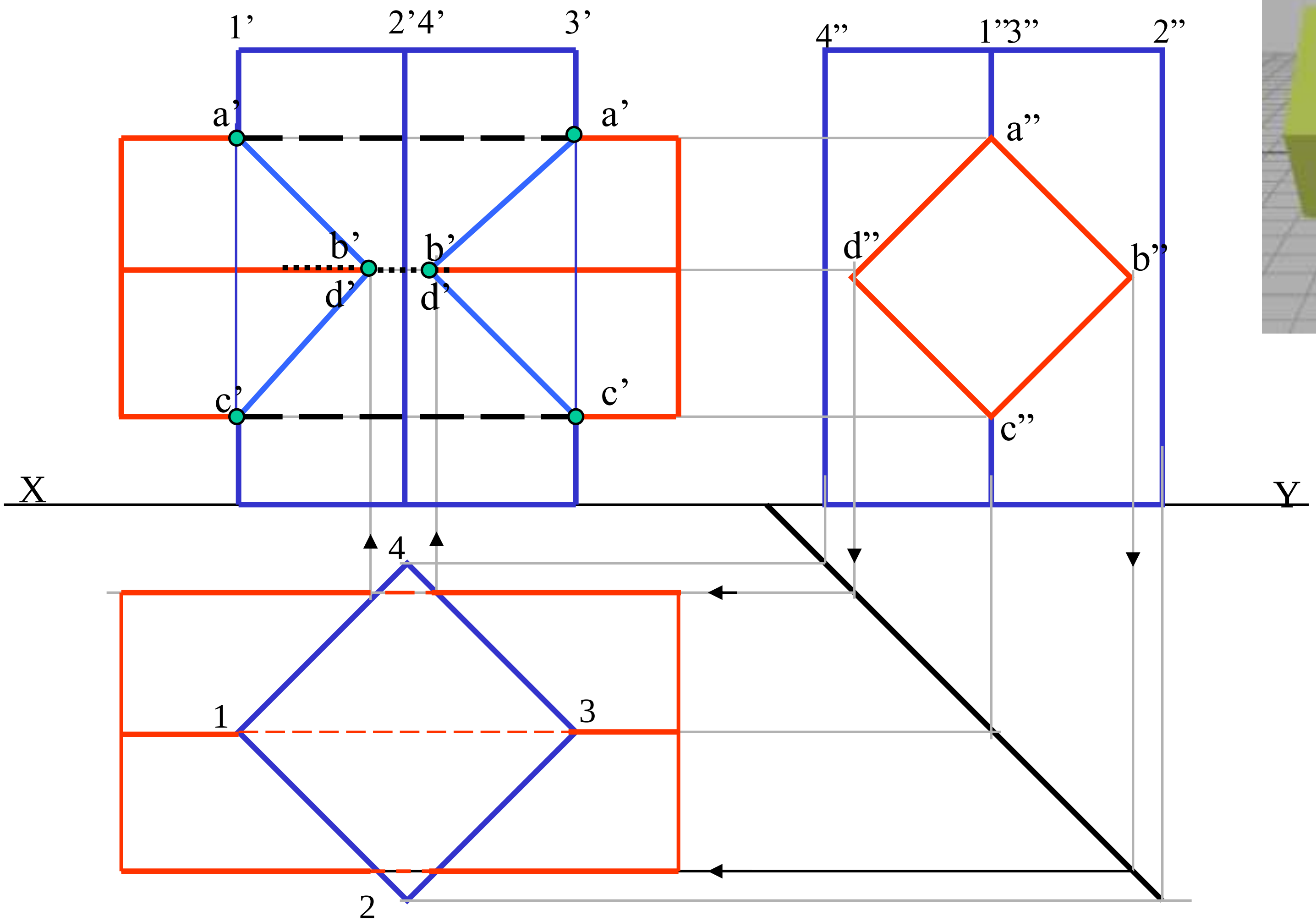
Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersects & bisect each other. All faces of prisms are equally inclined to Vp. Draw projections showing curves of intersections.

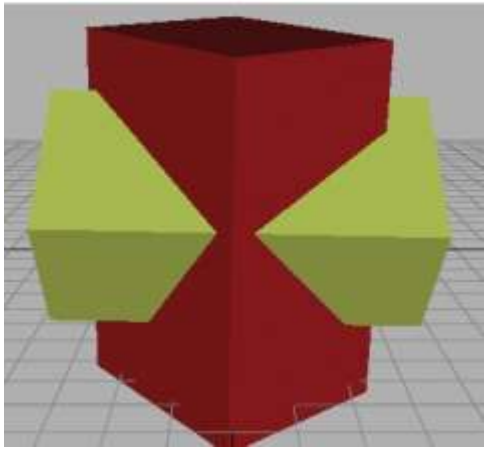
CASE 4.

SQ.PRISM STANDING

&

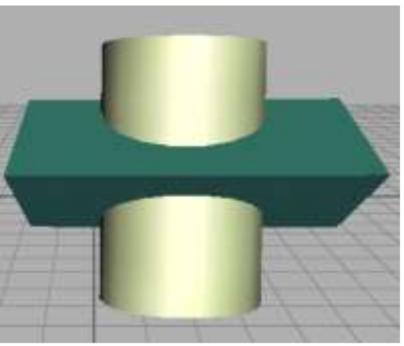
SQ.PRISM PENETRATING

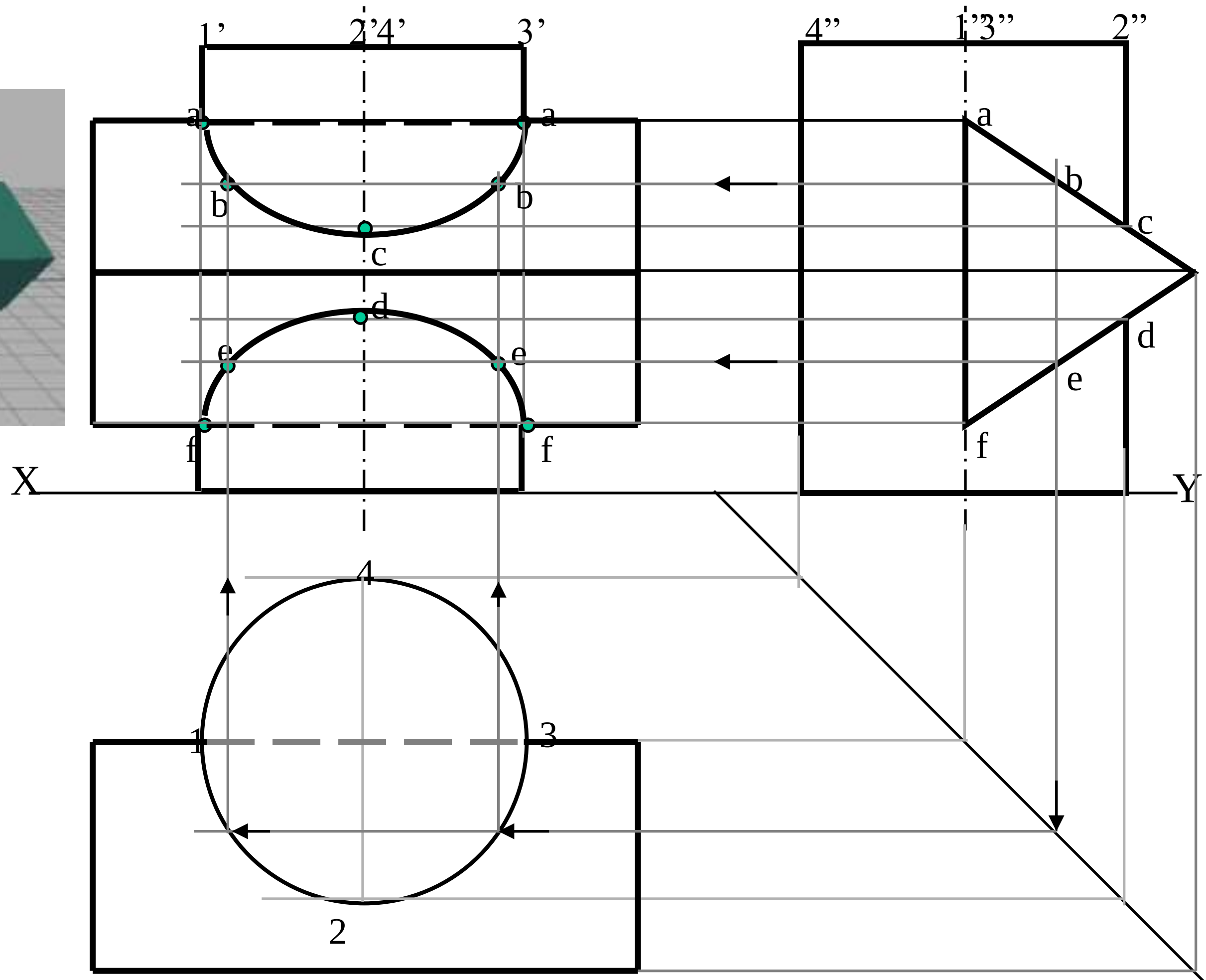


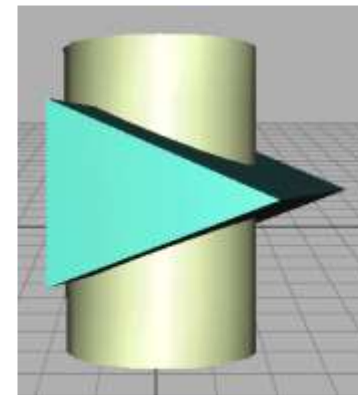


Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a triangular prism of 45 mm sides.and 70 mm axis, horizontally.
One flat face of prism is parallel to Vp and Contains axis of cylinder.
Draw projections showing curves of intersections.

CASE 5. CYLINDER STANDING & TRIANGULAR PRISM PENETRATING

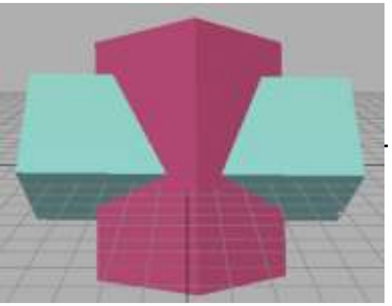


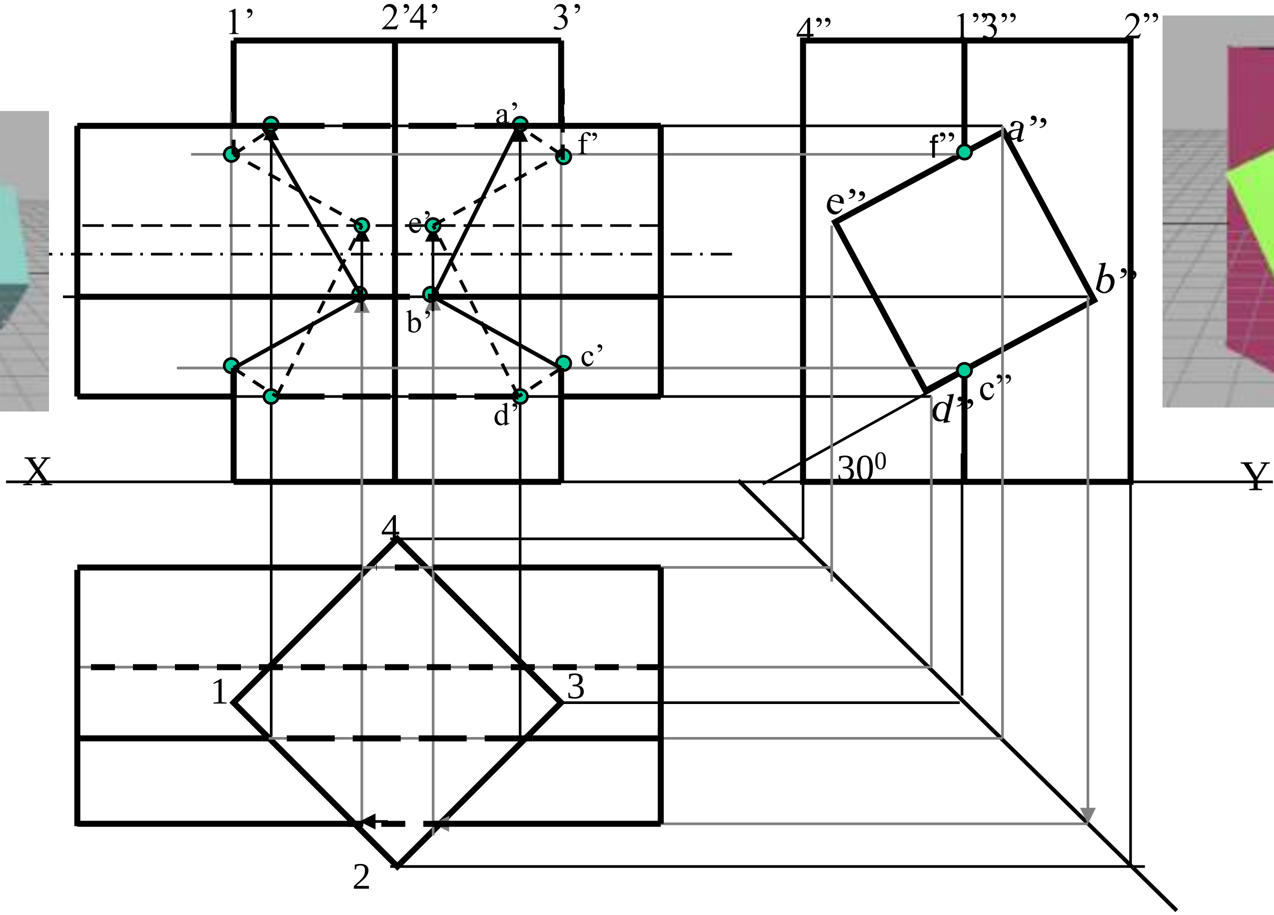


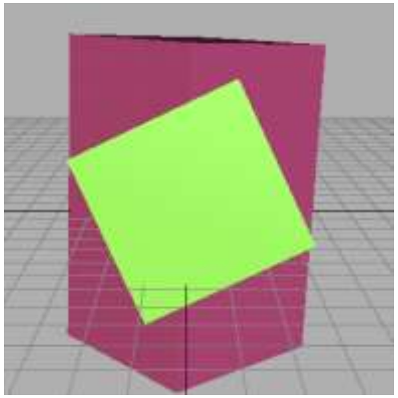


Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm side s.and 70 mm axis, horizontally. Both axes Intersect & bisect each other.Two faces of penetrating prism are 30^0 inclined to Hp. Draw projections showing curves of intersections.

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







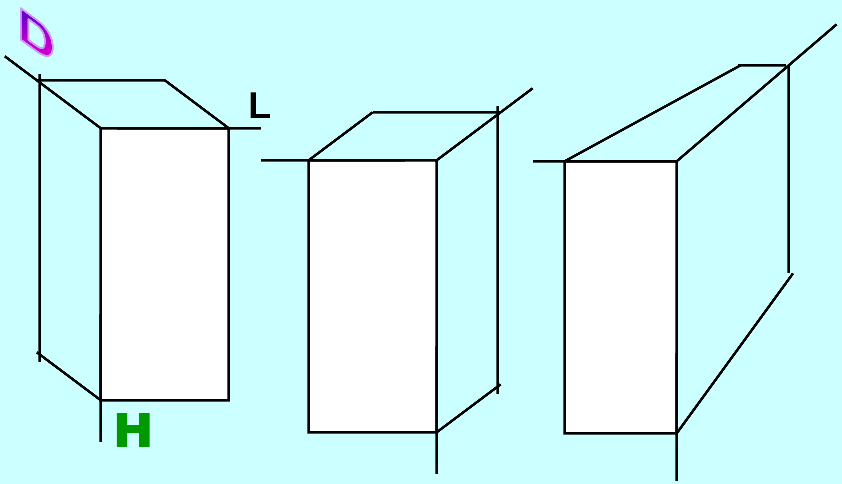
ISOMETRIC DRAWING

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.

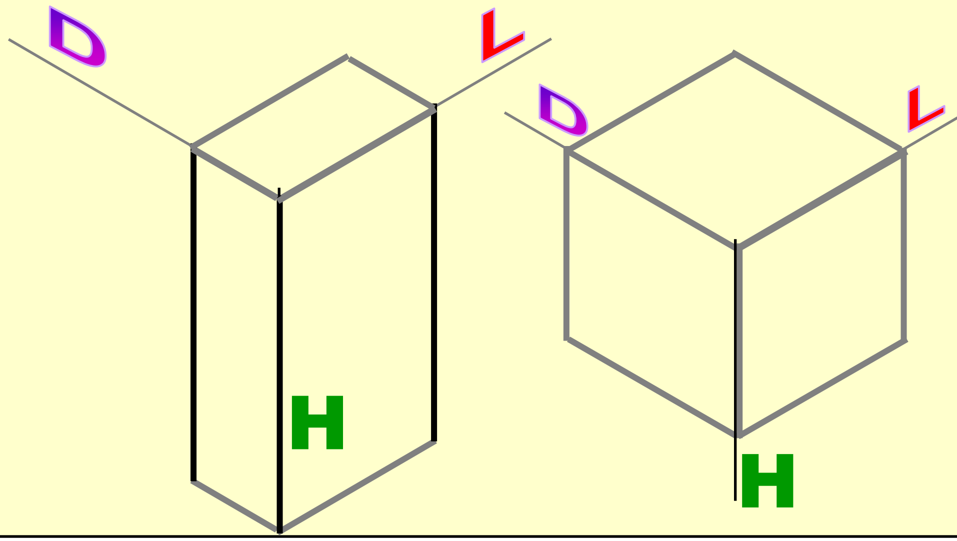
TYPICAL CONDITION.

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.



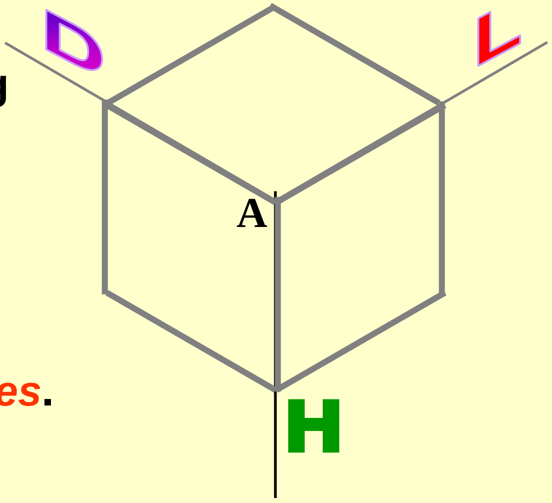
NOW OBSERVE BELOW GIVEN DRAWINGS.
ONE CAN NOTE SPECIFIC INCLINATION
AMONG H, L & D AXES.
ISO MEANS SAME, SIMILAR OR EQUAL.
HERE ONE CAN FIND
EDUAL INCLINATION AMONG H, L & D AXES.
EACH IS 120^0 INCLINED WITH OTHER TWO.
HENCE IT IS CALLED ISOMETRIC DRAWING



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.

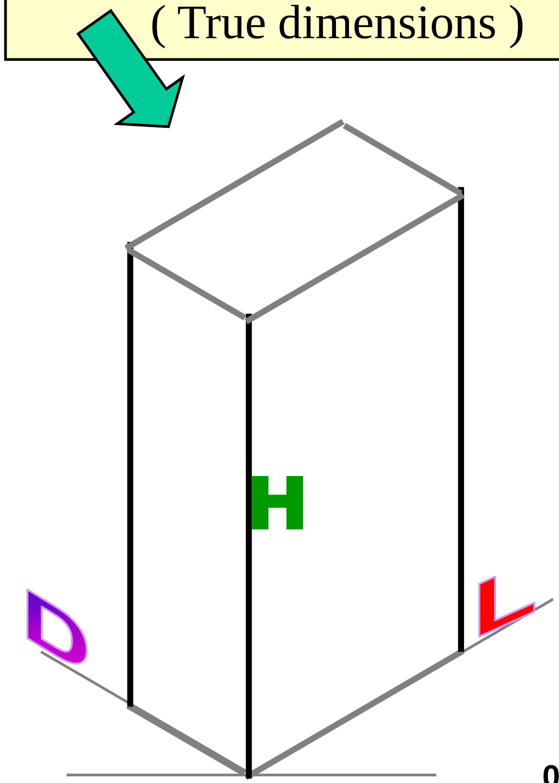
TYPES OF ISOMETRIC DRAWINGS

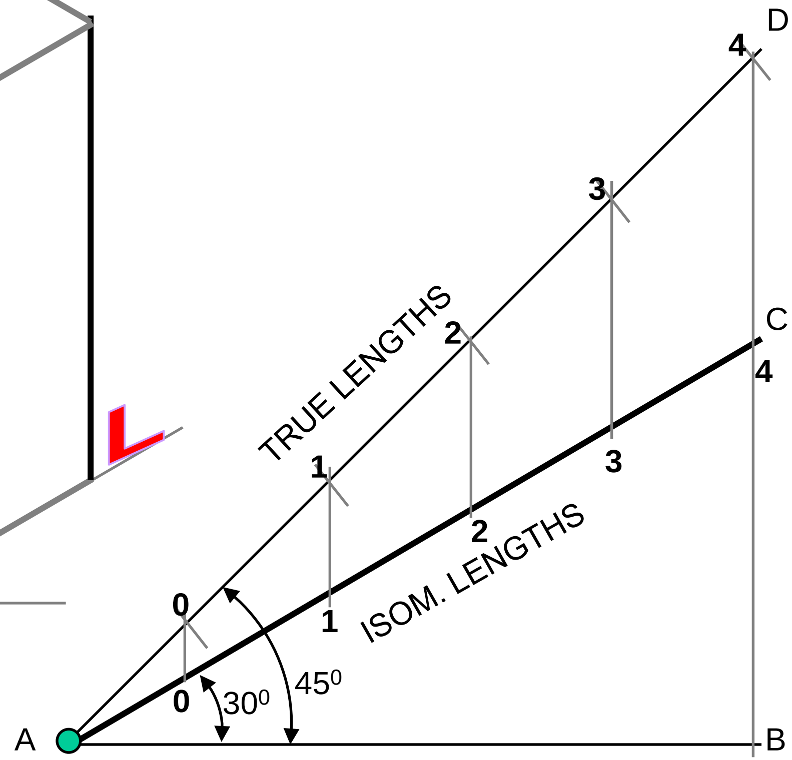
ISOMETRIC VIEW

Drawn by using True scale
(True dimensions)

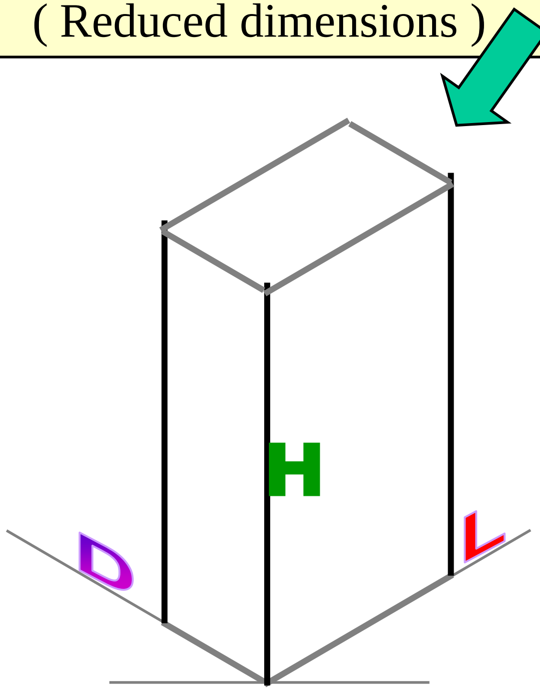
ISOMETRIC PROJECTION

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

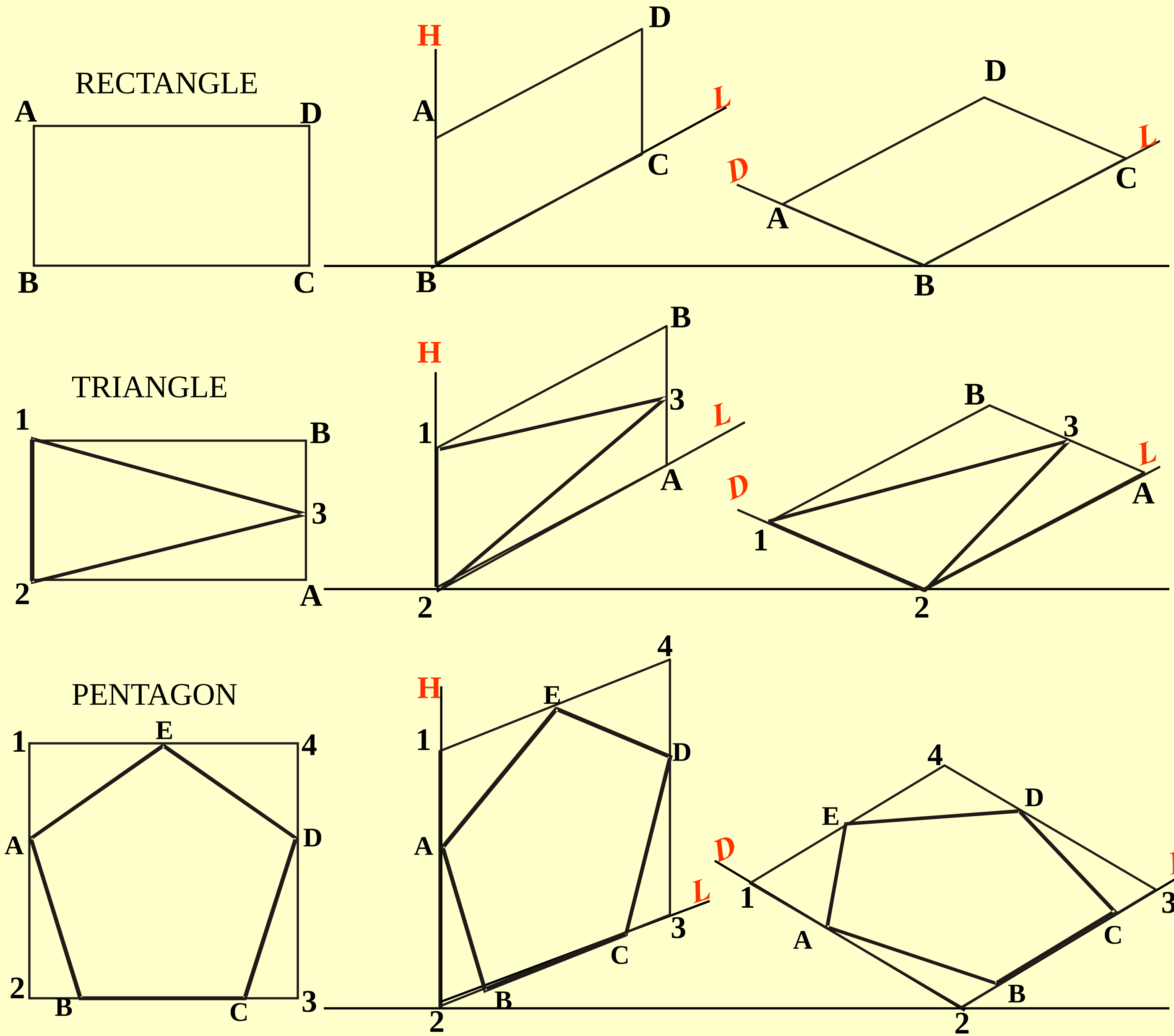
AS THESE ALL ARE 2-D FIGURES WE REQUIRE ONLY TWO ISOMETRIC AXES.

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

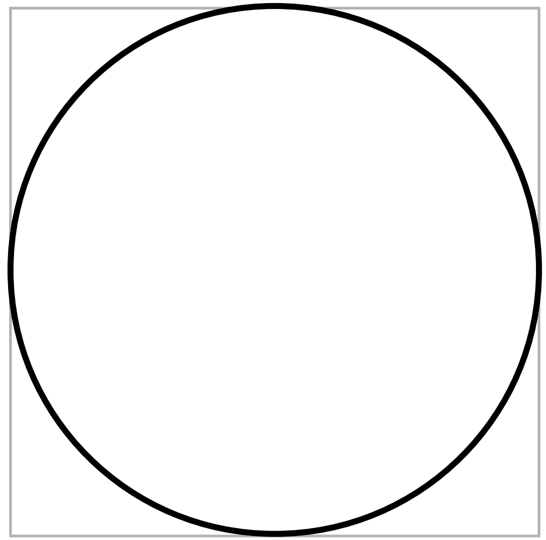
IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

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.

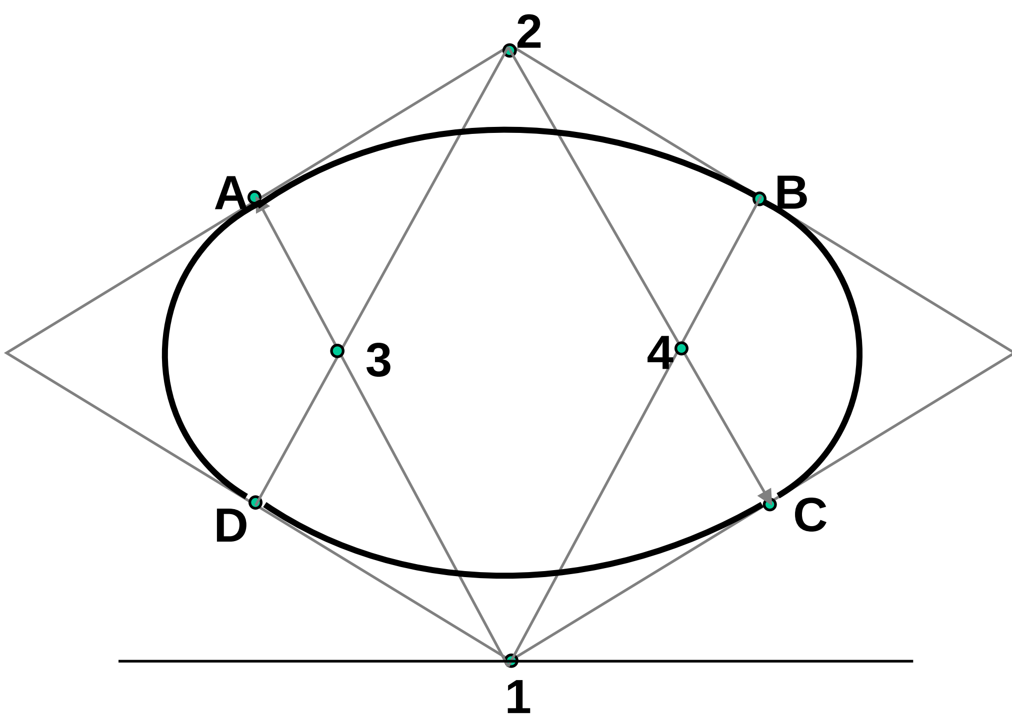
SHAPE	Isometric view if the Shape is F.V.	or T.V.

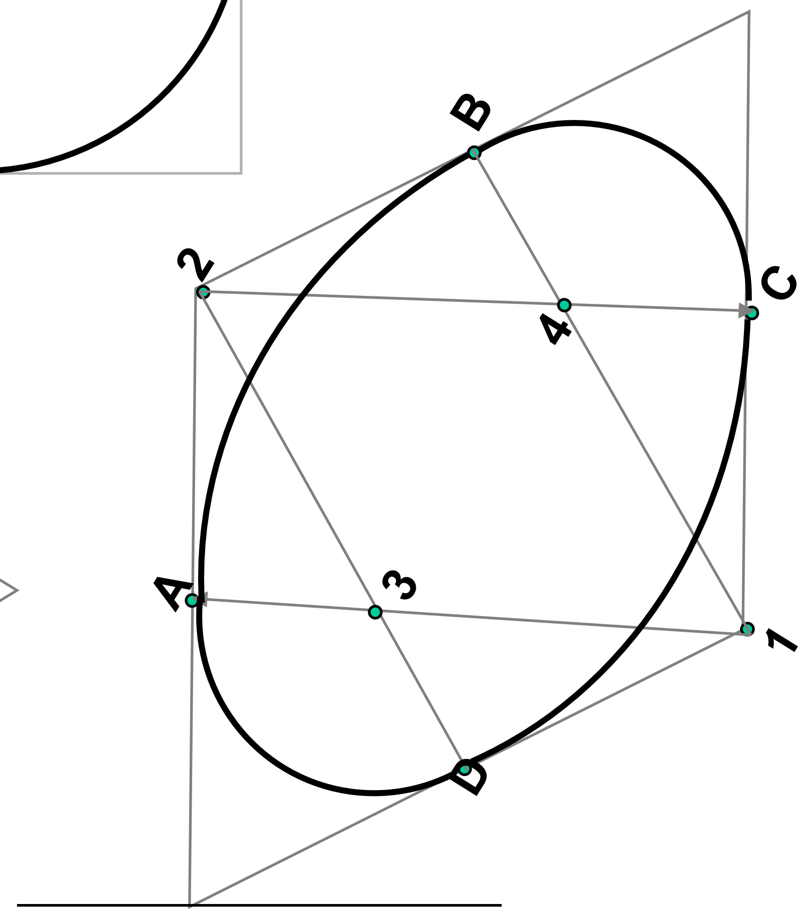


DRAW ISOMETRIC VIEW OF A CIRCLE IF IT IS A TV OR FV.



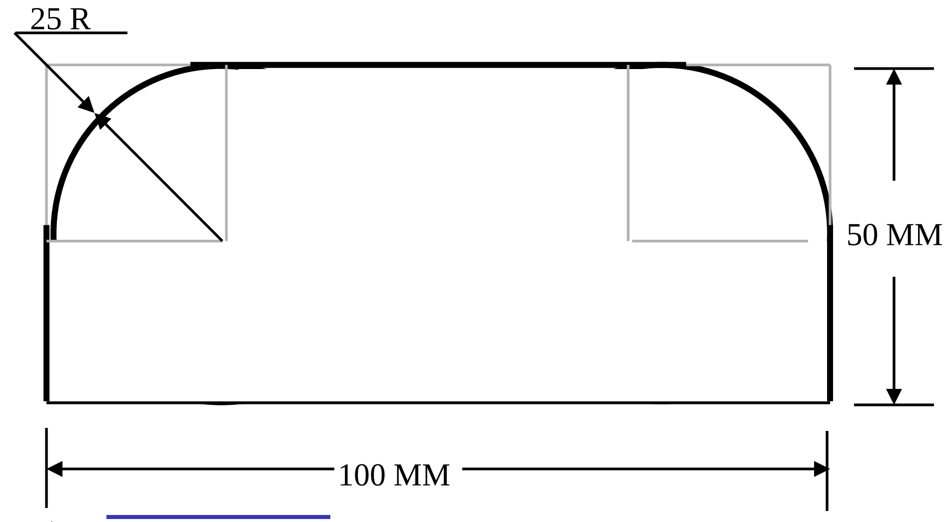
FIRST ENCLOSE IT IN A SQUARE.
IT'S ISOMETRIC IS A RHOMBUS WITH D & L AXES FOR TOP VIEW.
THEN USE H & L AXES FOR ISOMETRIC WHEN IT IS FRONT VIEW.
FOR CONSTRUCTION USE RHOMBUS METHOD SHOWN HERE. STUDY IT.



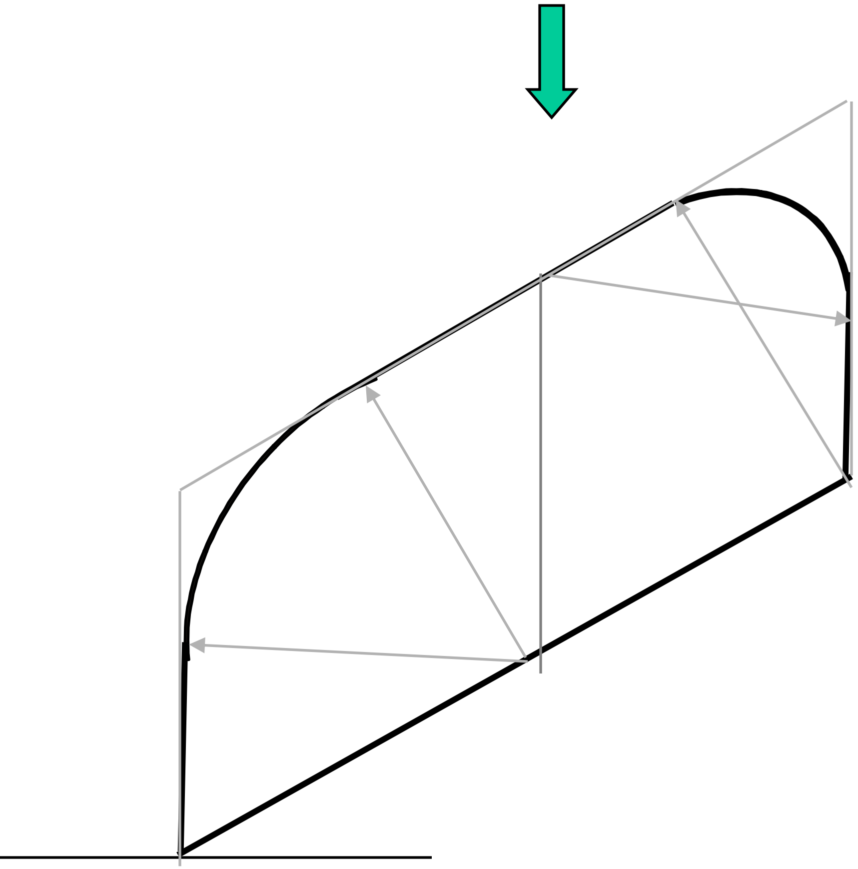


STUDY ILLUSTRATIONS

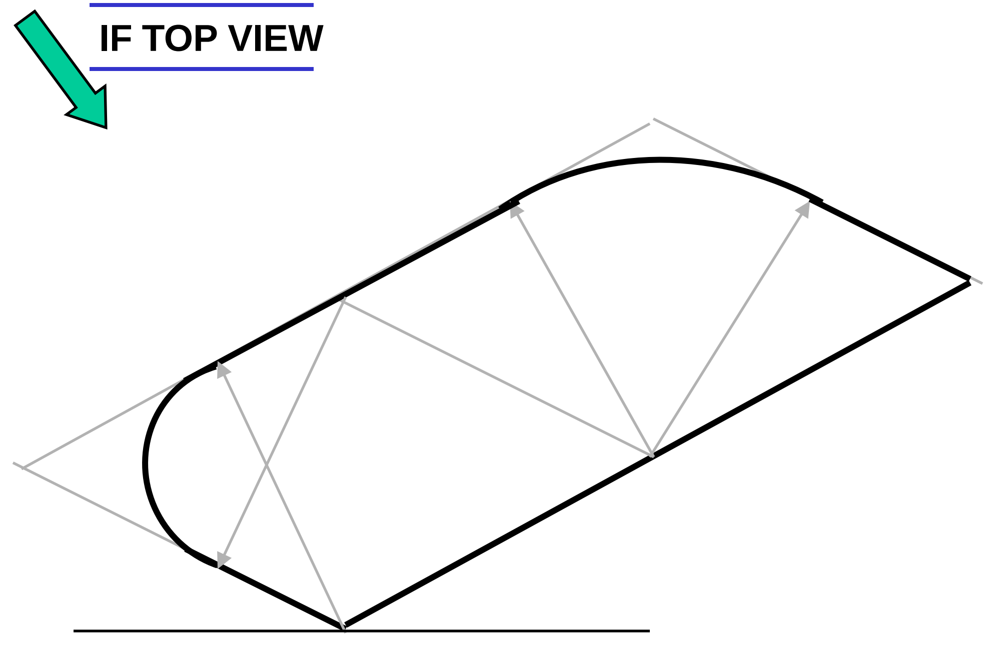
DRAW ISOMETRIC VIEW OF THE FIGURE SHOWN WITH DIMENTIONS (ON RIGHT SIDE) CONSIDERING IT FIRST AS F.V. AND THEN T.V.



IF FRONT VIEW



IF TOP VIEW



ISOMETRIC OF PLANE FIGURES

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

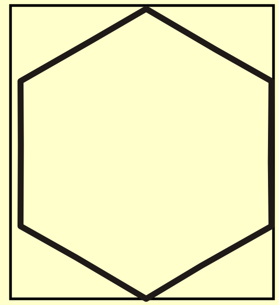
IF THE FIGURE IS FRONT VIEW, H & L AXES ARE REQUIRED.

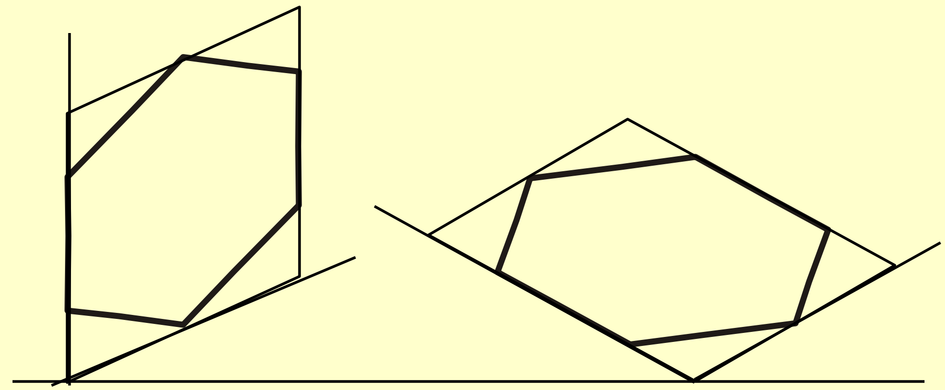
IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

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

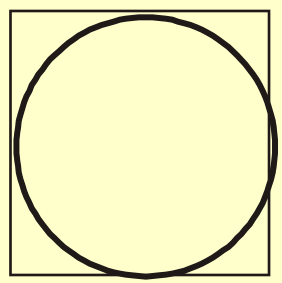
SHAPE	IF F.V.	IF T.V.

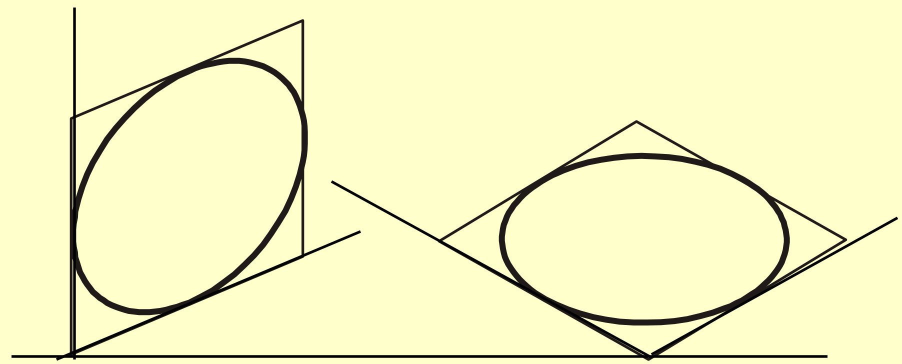
HEXAGON





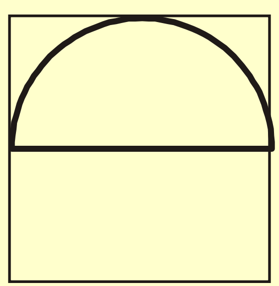
CIRCLE

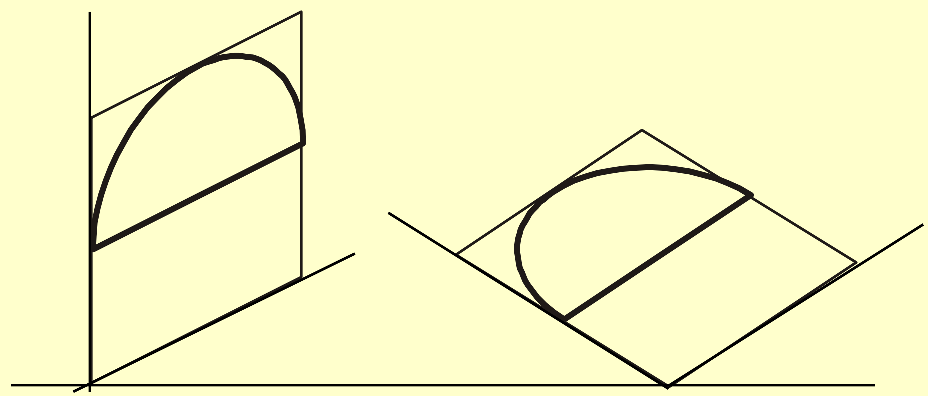




For Isometric of Circle/Semicircle use Rhombus method. *Construct Rhombus of sides equal to Diameter of circle always.* **(Ref. topic ENGG. CURVES.)**

SEMI CIRCLE





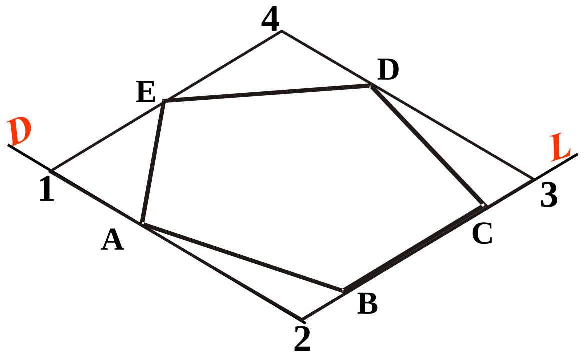
STUDY ILLUSTRATIONS

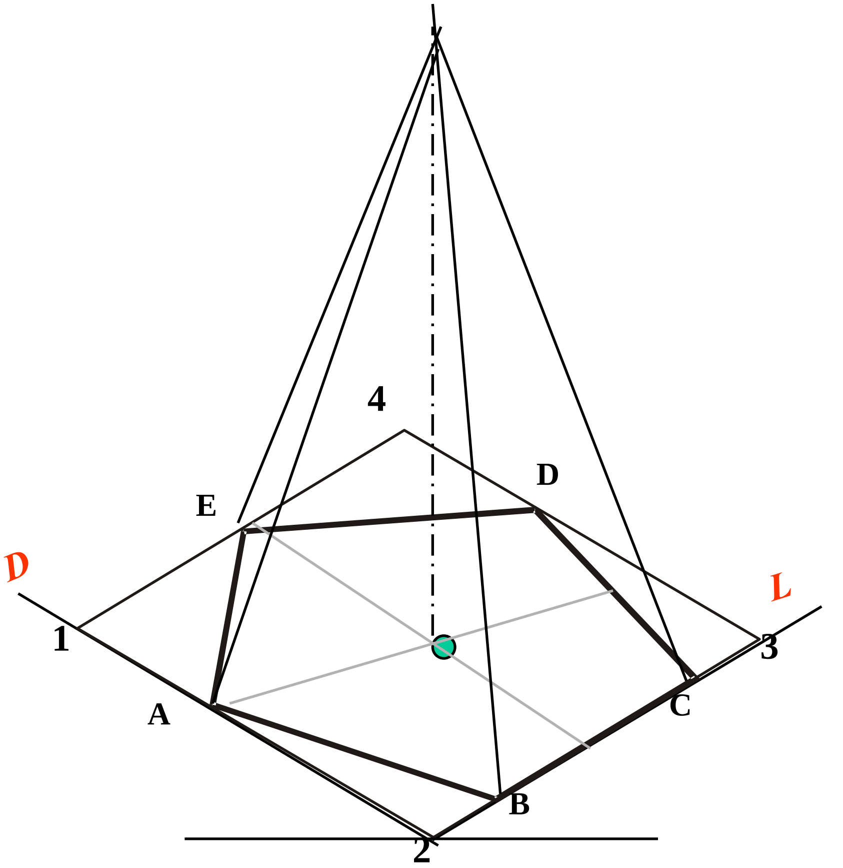
Z

ISOMETRIC VIEW OF PENTAGONAL PYRAMID STANDING ON H.P.

(Height is added from center of pentagon)

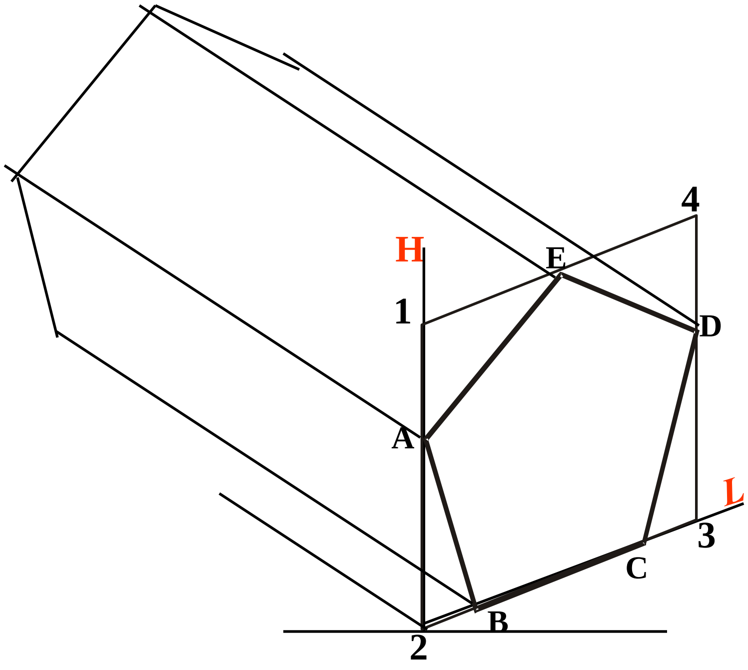
ISOMETRIC VIEW OF BASE OF PENTAGONAL PYRAMID STANDING ON H.P.

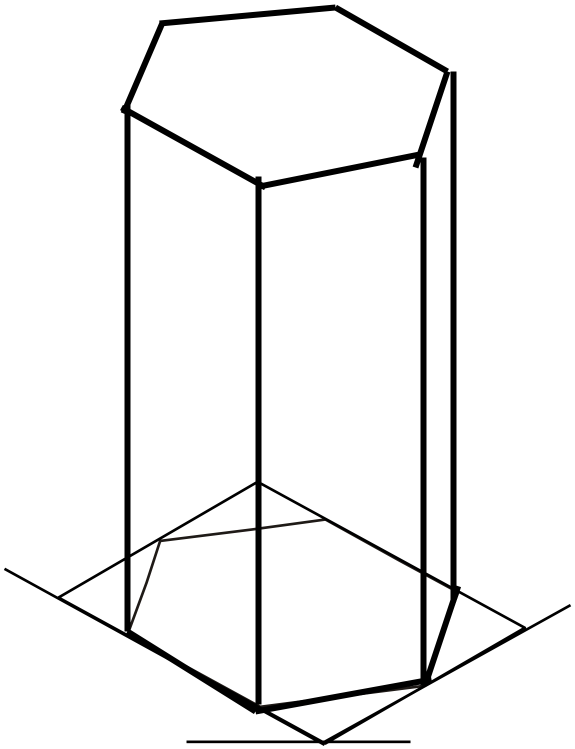




STUDY ILLUSTRATIONS

ISOMETRIC VIEW OF PENTAGONALL PRISM LYING ON H.P.

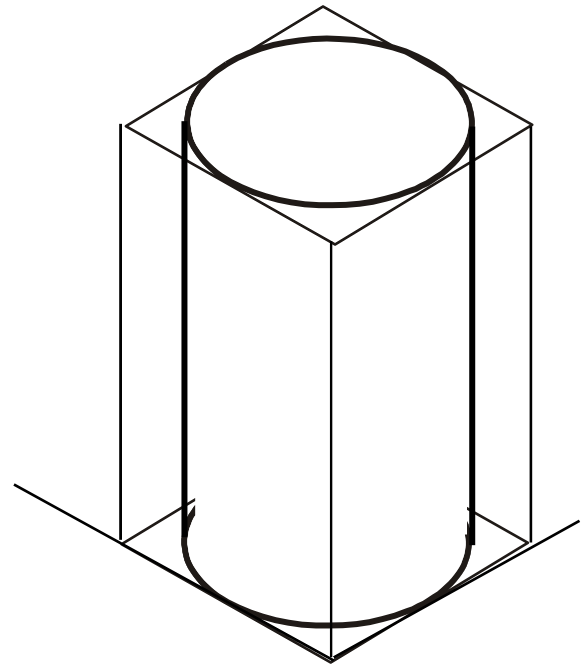


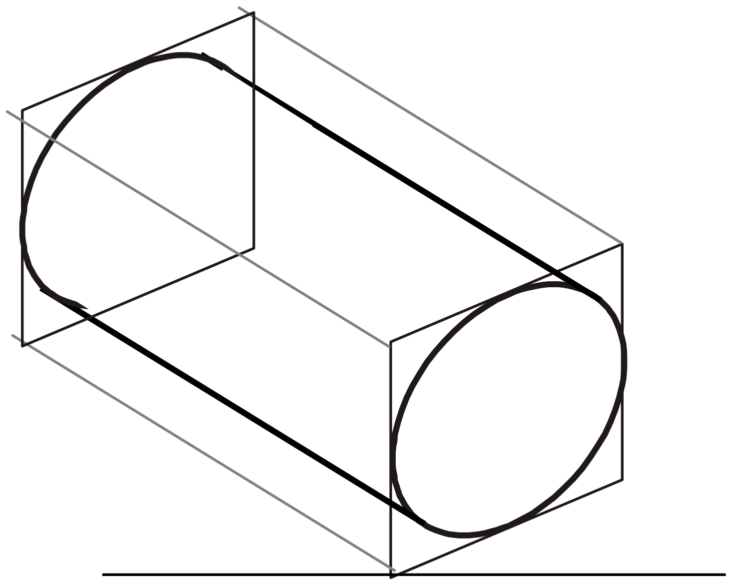


ISOMETRIC VIEW OF HEXAGONAL PRISM STANDING ON H.P.

STUDY ILLUSTRATIONS

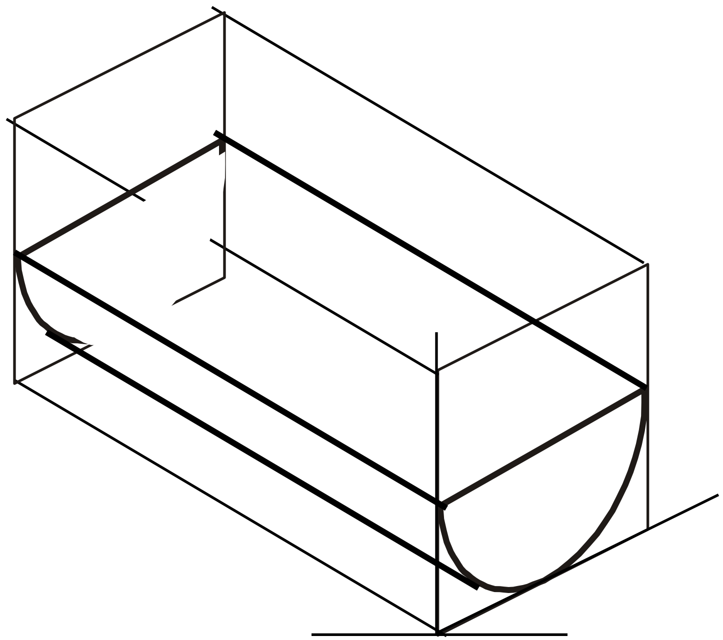
CYLINDER STANDING ON H.P.





CYLINDER LYING ON H.P.

STUDY ILLUSTRATIONS

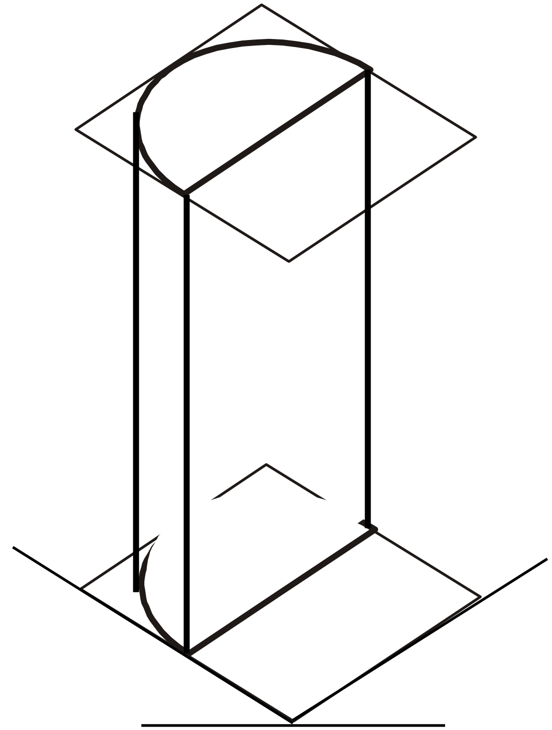


HALF CYLINDER LYING ON H.P.

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

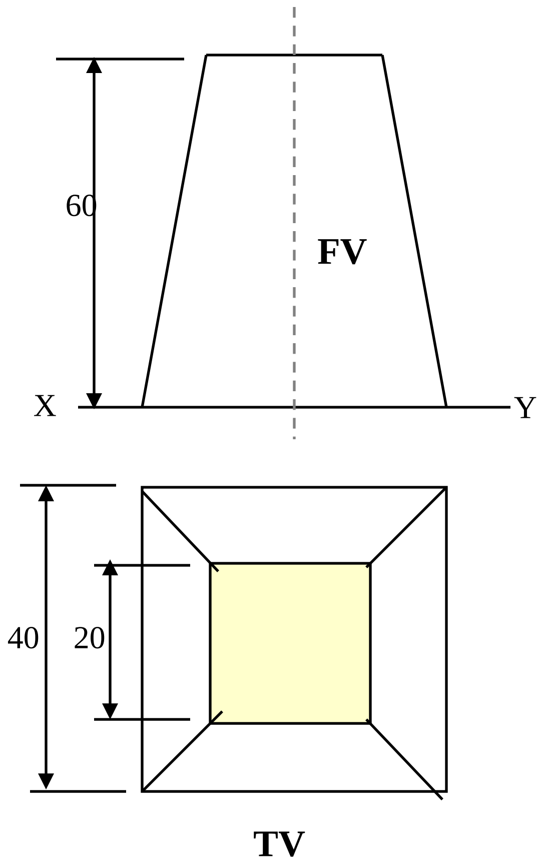
HALF CYLINDER STANDING ON H.P.

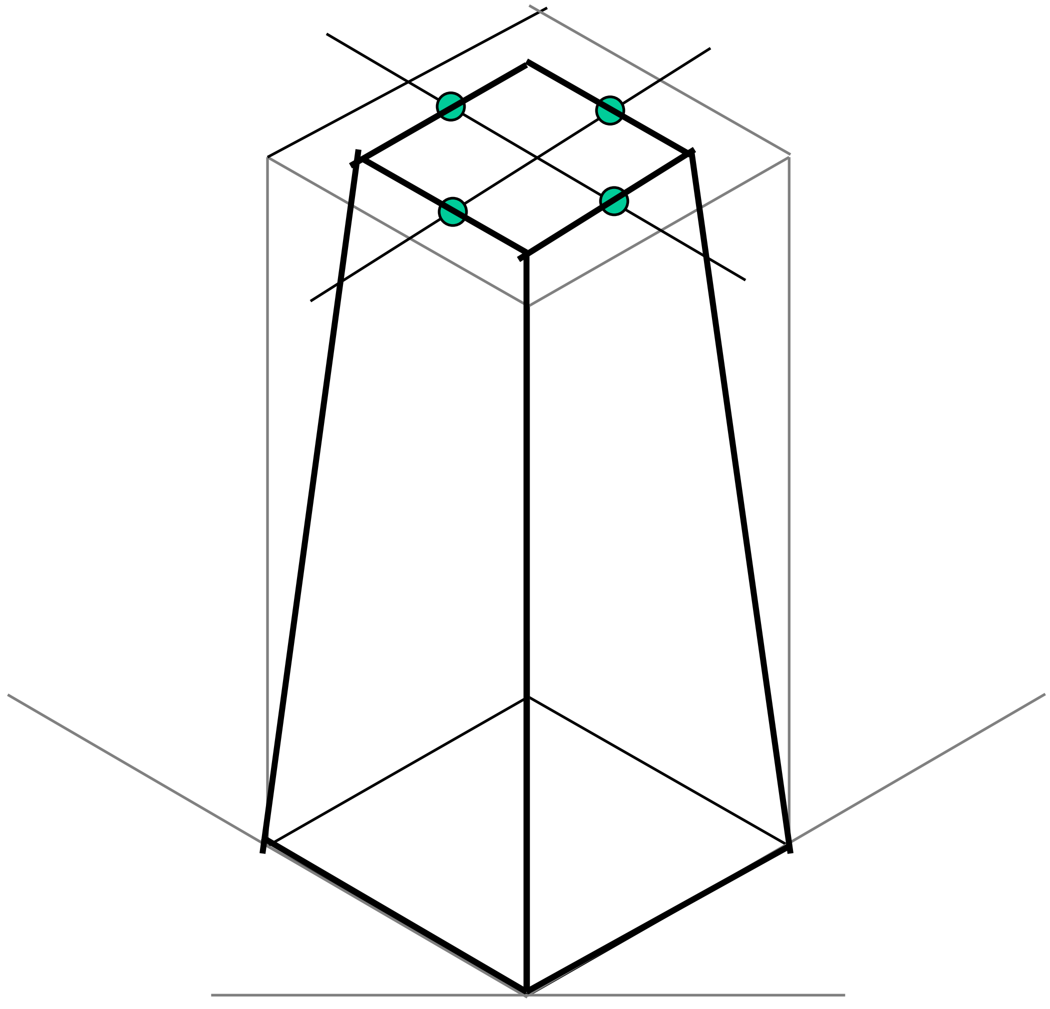
(ON IT'S SEMICIRCULAR BASE)



STUDY ILLUSTRATIONS

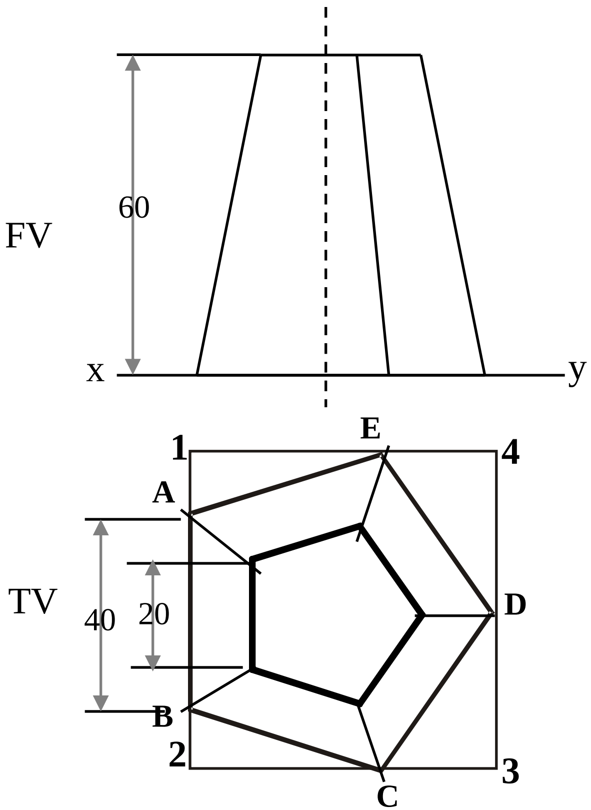
ISOMETRIC VIEW OF A FRUSTOM OF SQUARE PYRAMID STANDING ON H.P. ON IT'S LARGER BASE.





STUDY ILLUSTRATION

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



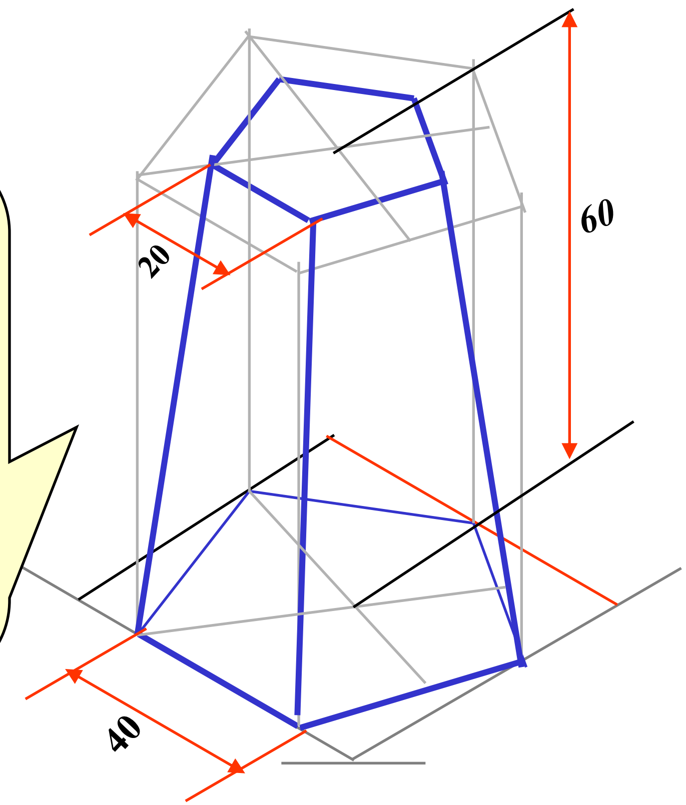
SOLUTION STEPS:

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.

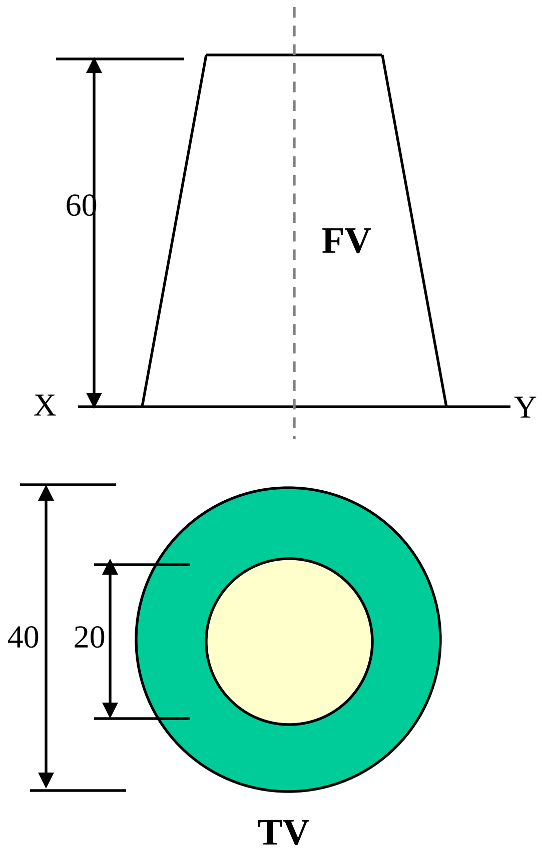
ISOMETRIC VIEW OF FRUSTOM OF PENTAGONAL PYRAMID

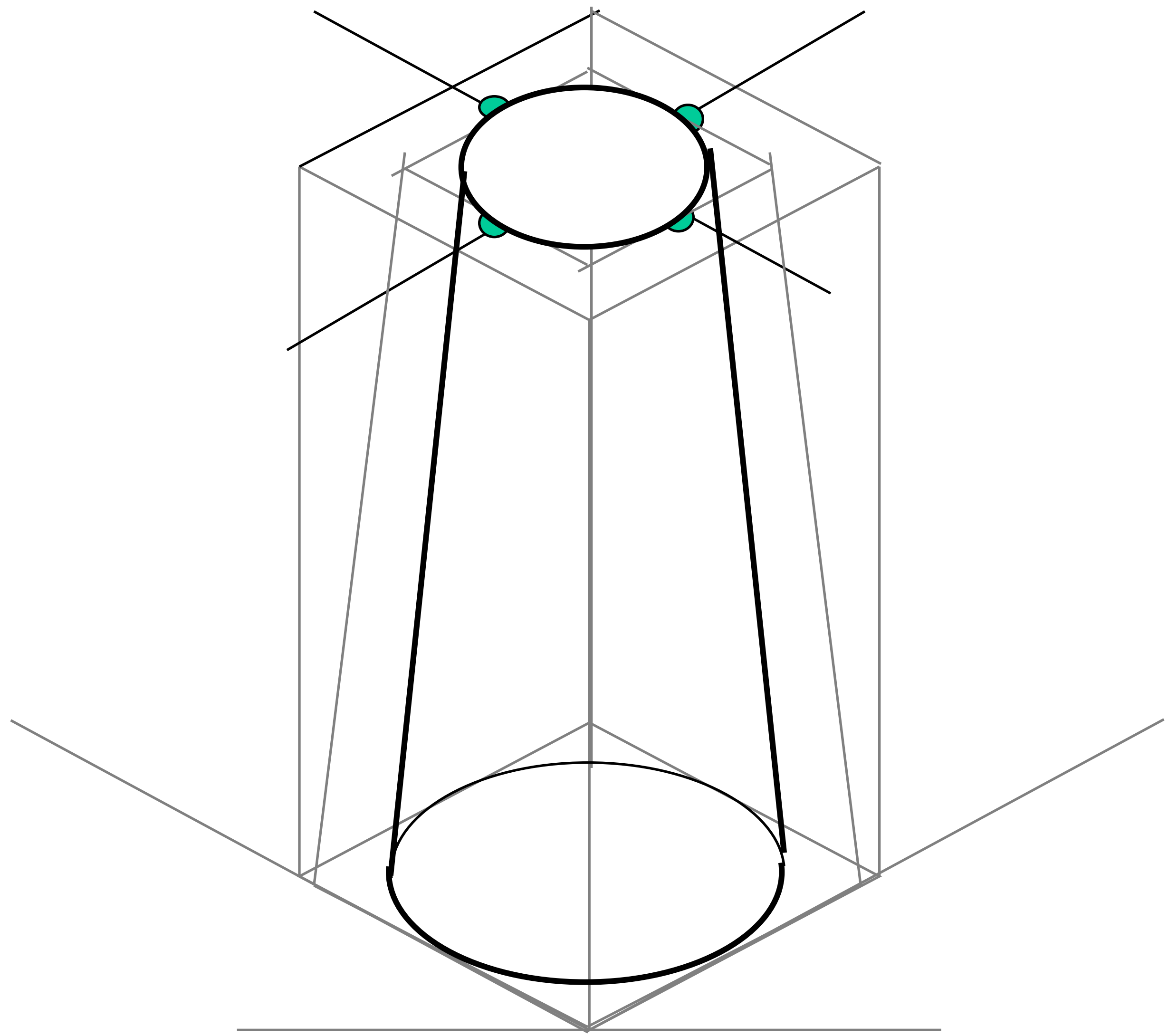


STUDY ILLUSTRATIONS

ISOMETRIC VIEW OF A FRUSTOM OF CONE

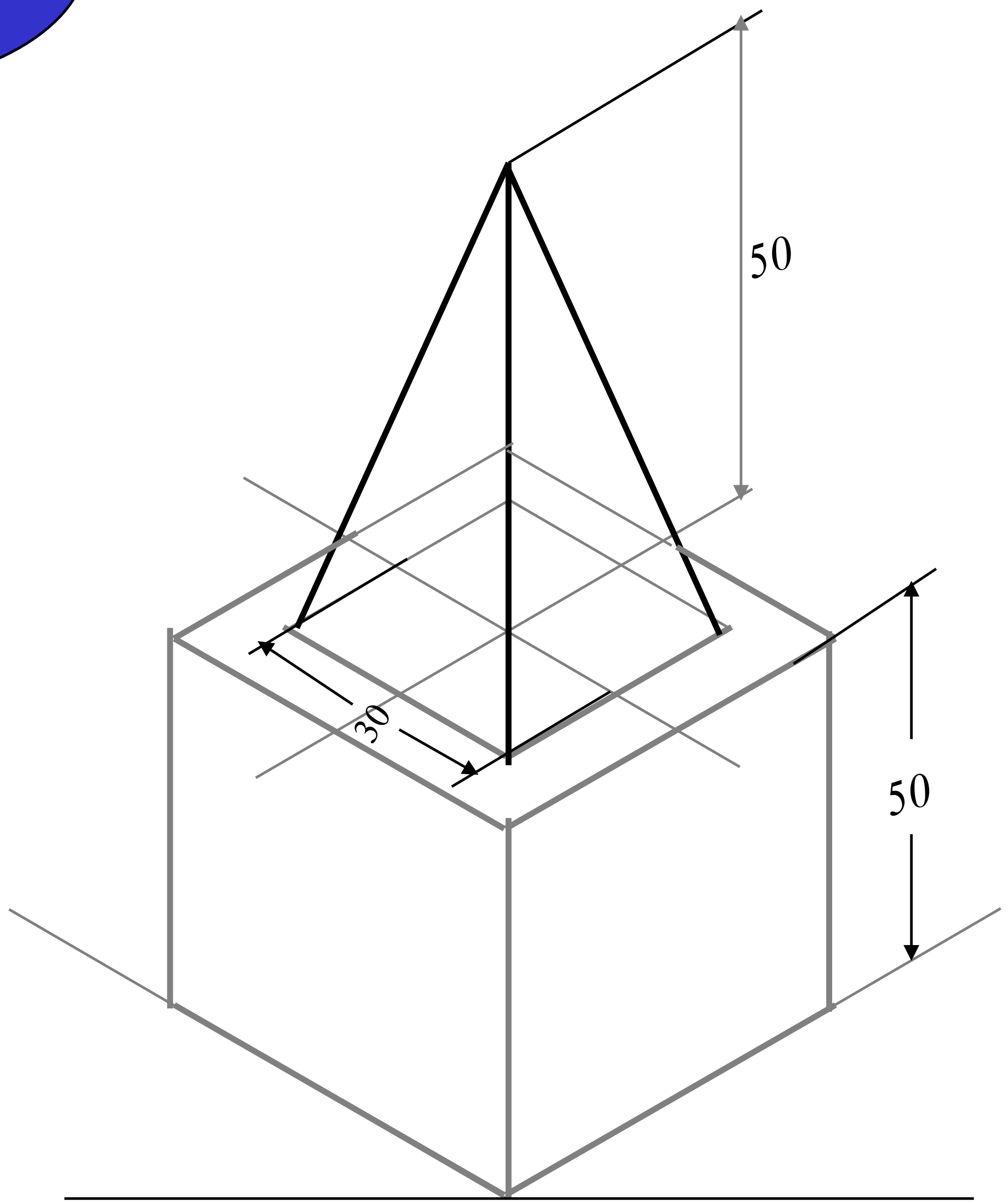
STANDING ON H.P. ON IT'S LARGER BASE.





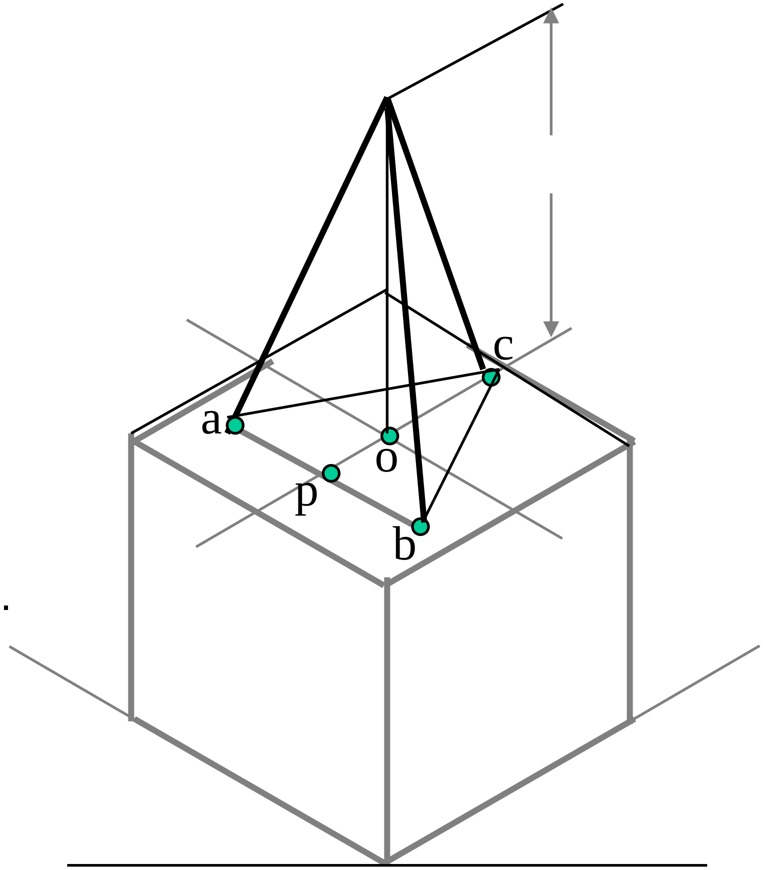
STUDY ILLUSTRATIONS

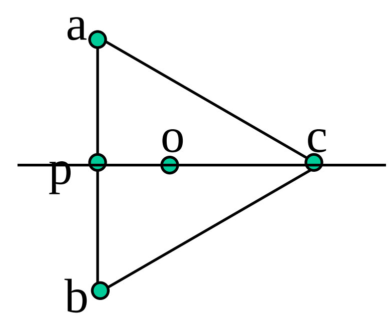
PROBLEM: A SQUARE PYRAMID OF 30 MM BASE SIDES AND 50 MM LONG AXIS, IS CENTRALLY PLACED ON THE TOP OF A CUBE OF 50 MM LONG EDGES.DRAW ISOMETRIC VIEW OF THE PAIR.



STUDY ILLUSTRATIONS

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.

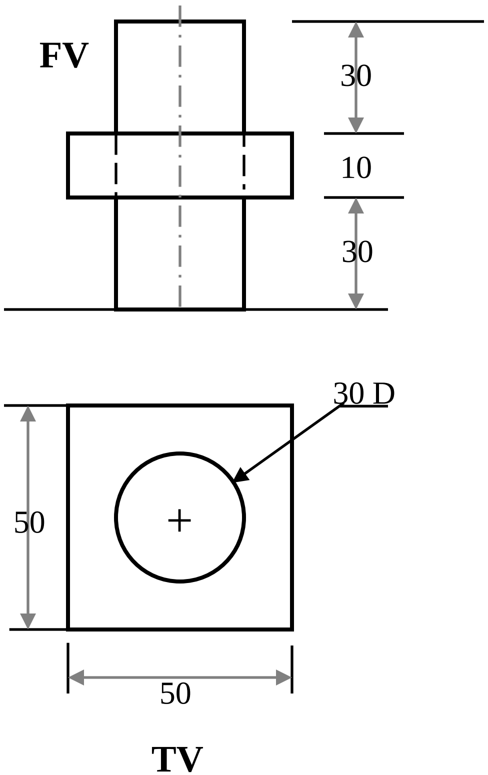
TO DRAW ISOMETRIC OF A CUBE IS SIMPLE. DRAW IT AS USUAL.

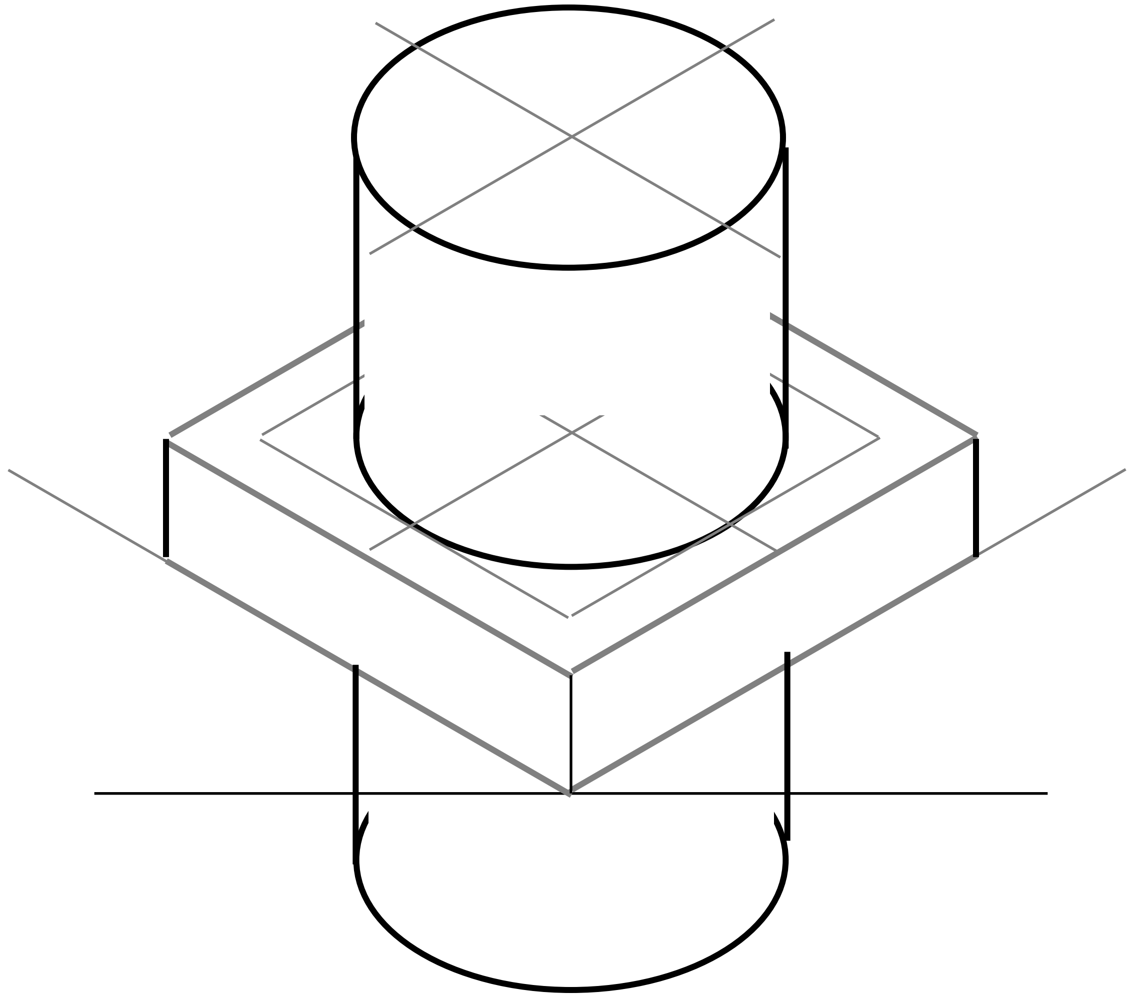
BUT FOR PYRAMID AS IT'S BASE IS AN EQUILATERAL TRIANGLE, IT CAN NOT BE DRAWN DIRECTLY.SUPPORT OF IT'S TV IS REQUIRED.

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

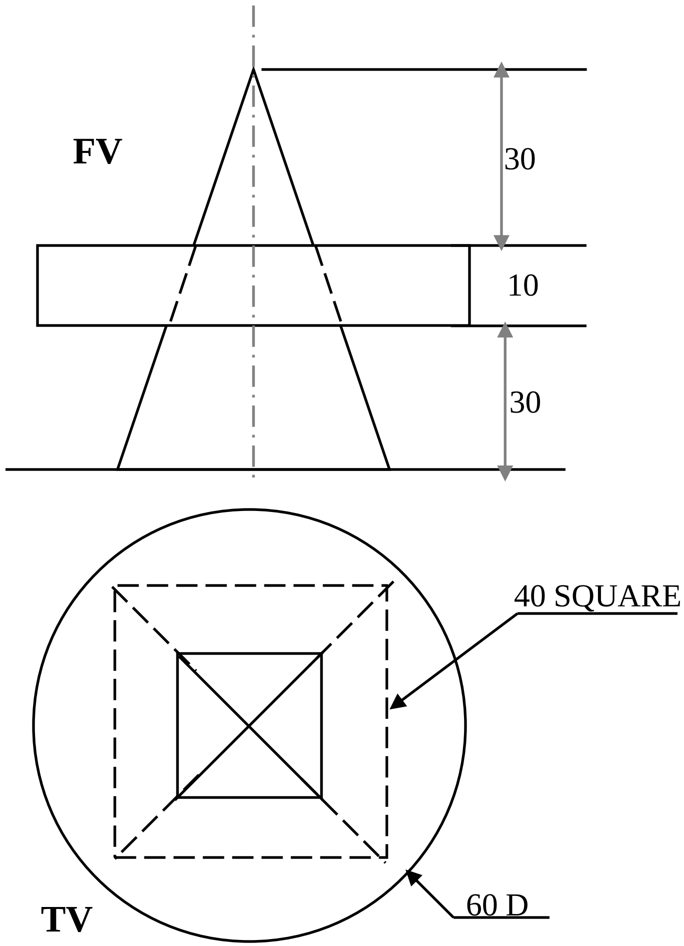
PROBLEM:
A SQUARE PLATE IS PIERCED THROUGH CENTRALLY BY A CYLINDER WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.

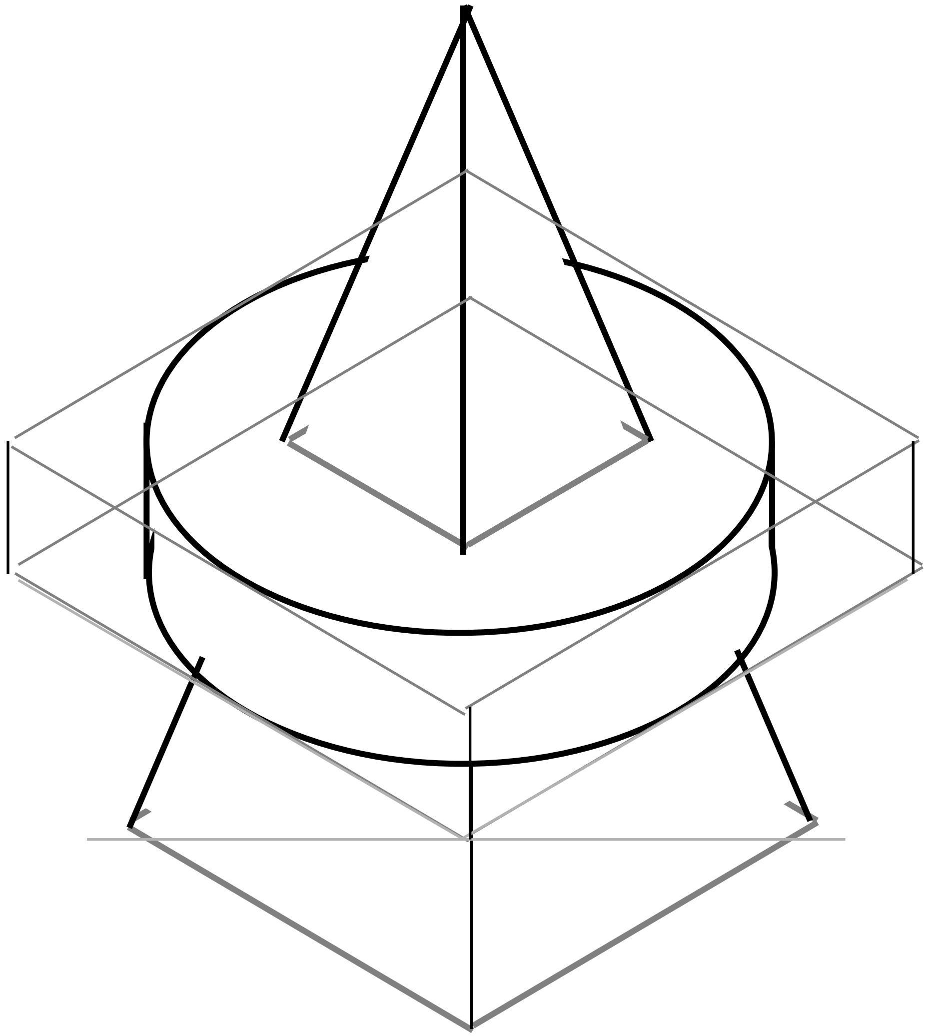




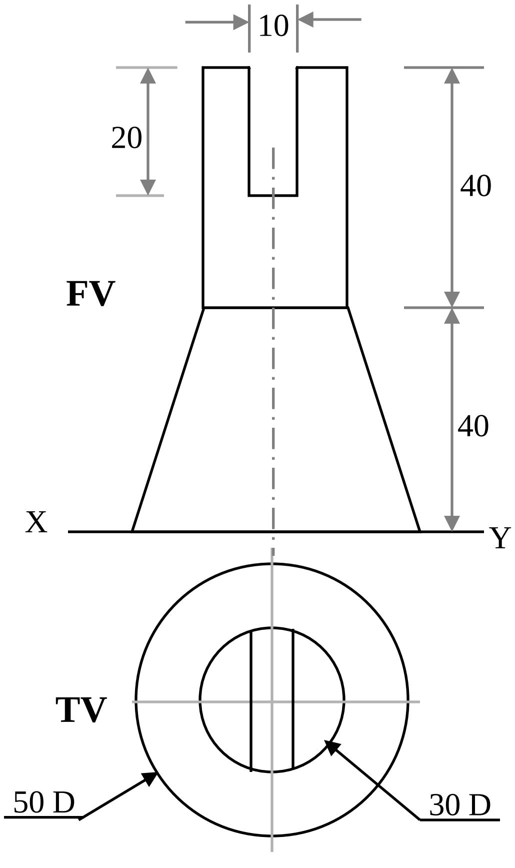
STUDY ILLUSTRATIONS

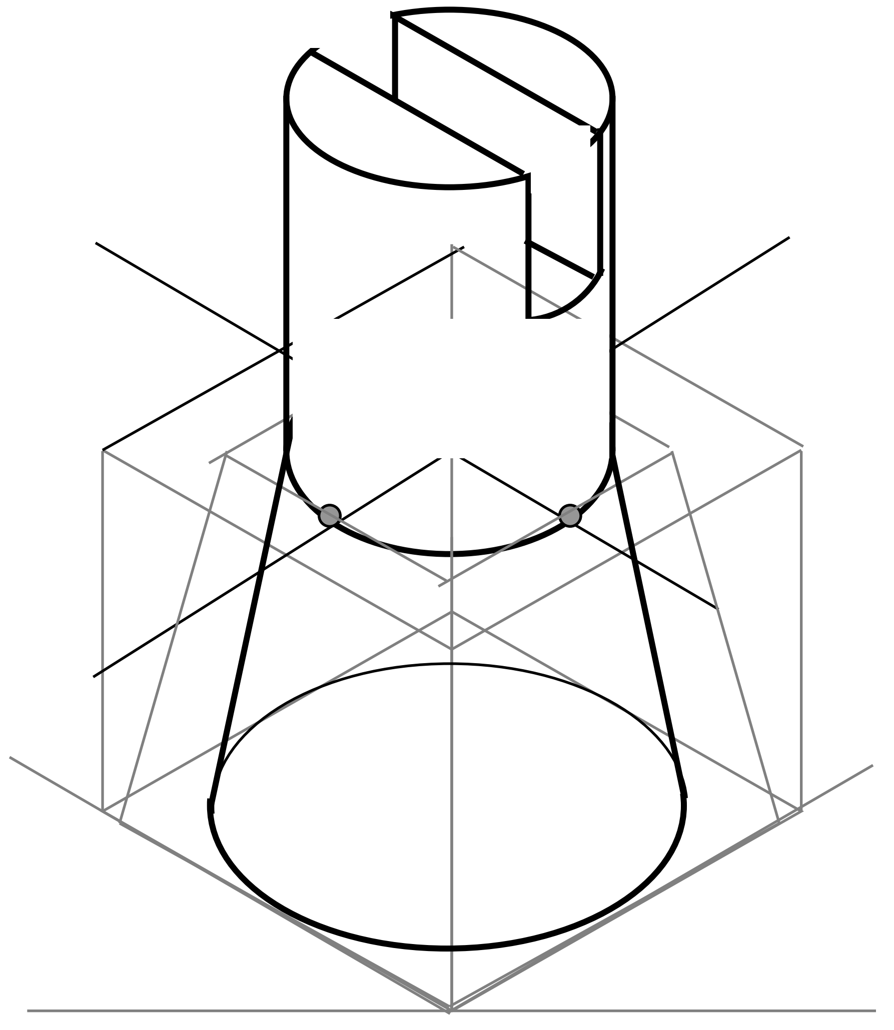
PROBLEM:
A CIRCULAR PLATE IS PIERCED THROUGH CENTRALLY BY A SQUARE PYRAMID WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.



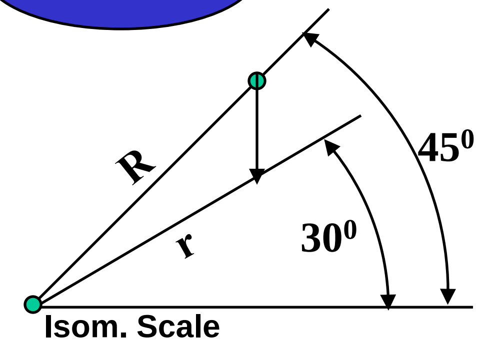


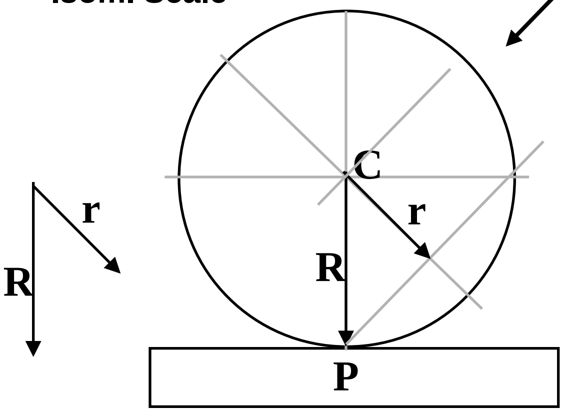
F.V. & T.V. of an object are given. Draw it's isometric view.

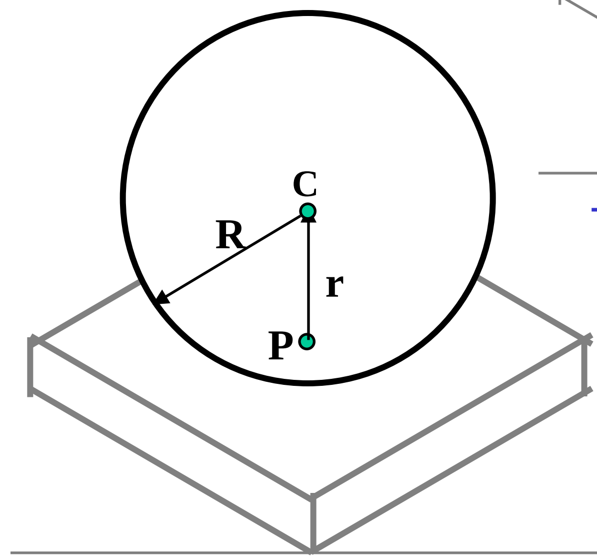


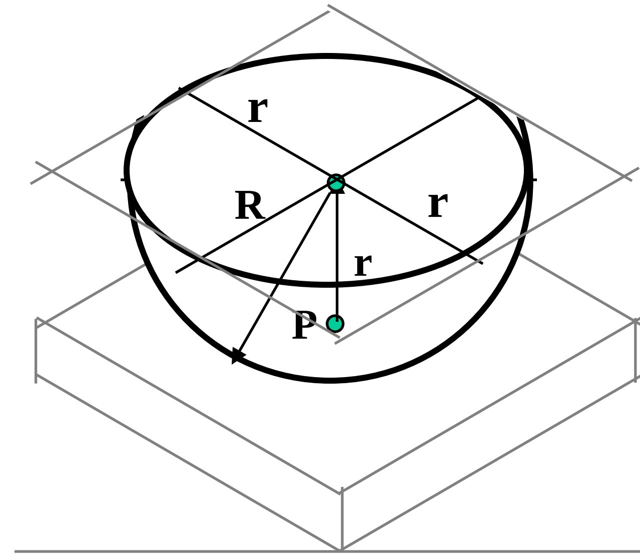


ISOMETRIC PROJECTIONS OF SPHERE & HEMISPHERE









TO DRAW ISOMETRIC PROJECTION OF A HEMISPHERE

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

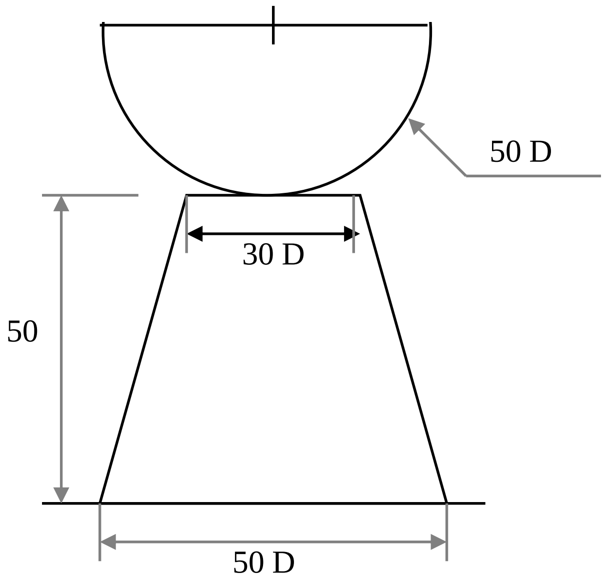
Adopt same procedure.
Draw lower semicircle only.
Then around 'C' construct
Rhombus of Sides equal to
Isometric Diameter.
For this use iso-scale.
Then construct ellipse in
this Rhombus as usual
And Complete
Isometric-Projection
of Hemi-sphere.

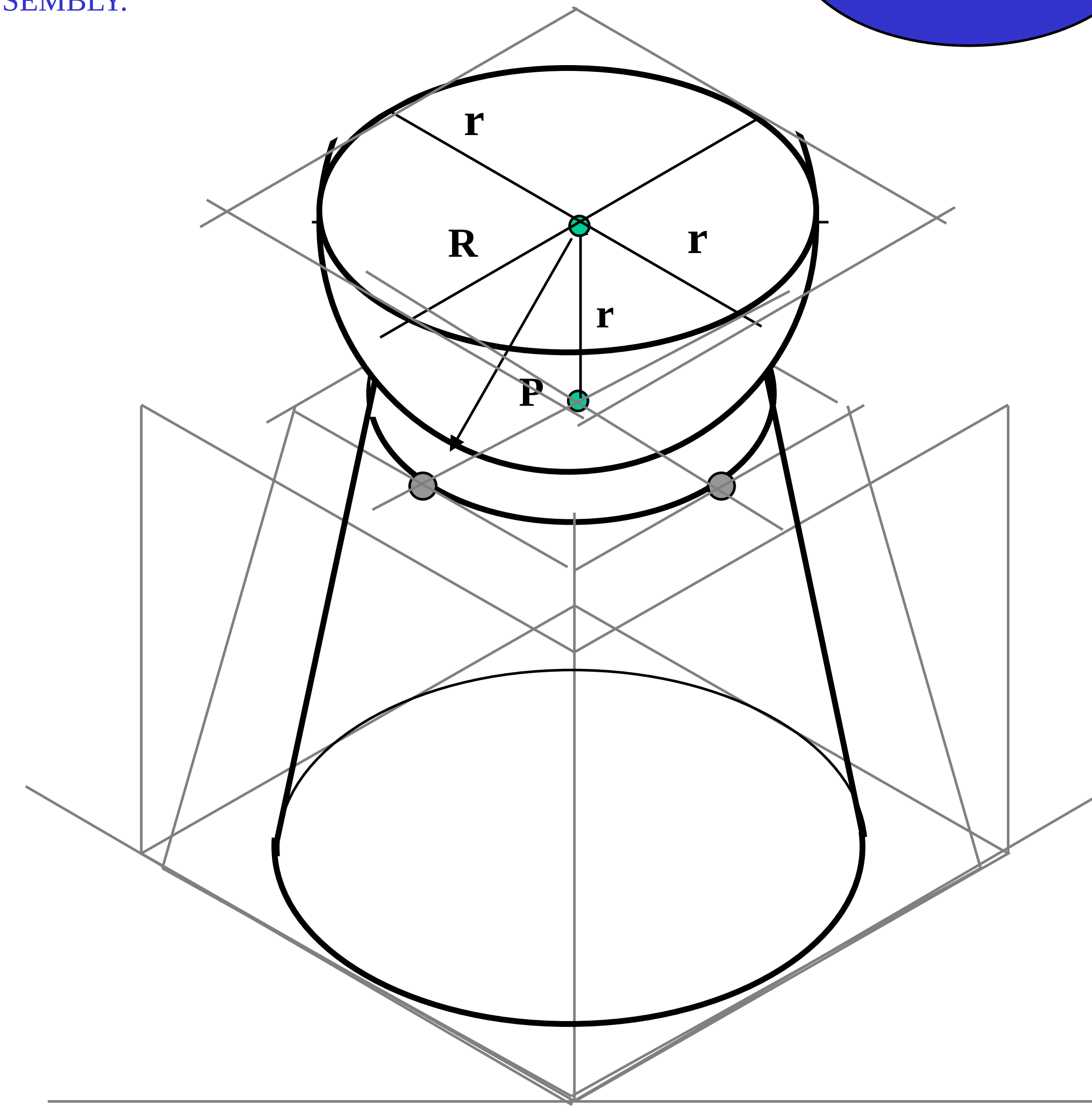
TO DRAW ISOMETRIC PROJECTION OF A SPHERE

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.

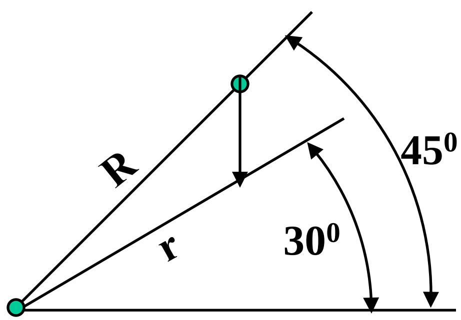
PROBLEM:

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





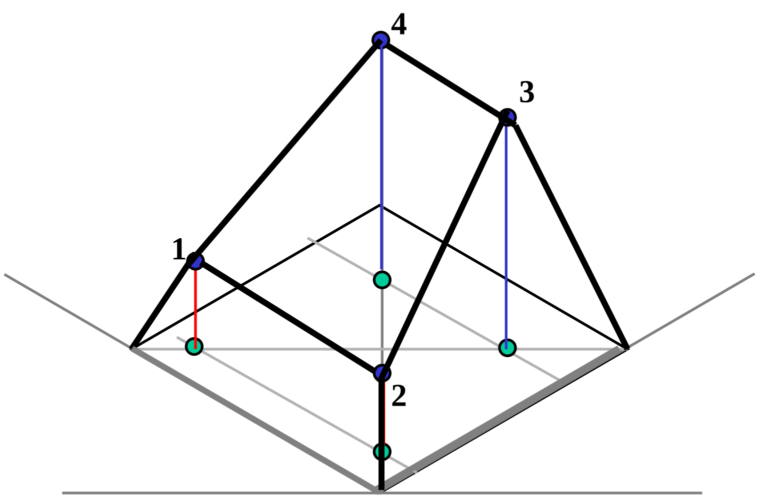
FIRST CONSTRUCT ISOMETRIC SCALE. USE THIS SCALE FOR ALL DIMENSIONS IN THIS PROBLEM.

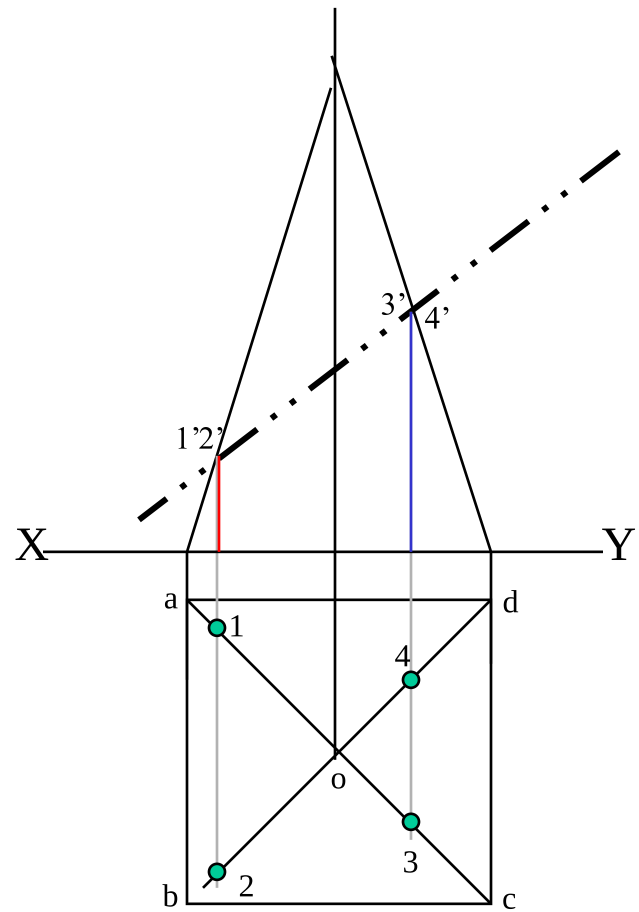


STUDY ILLUSTRATIONS

Z

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.

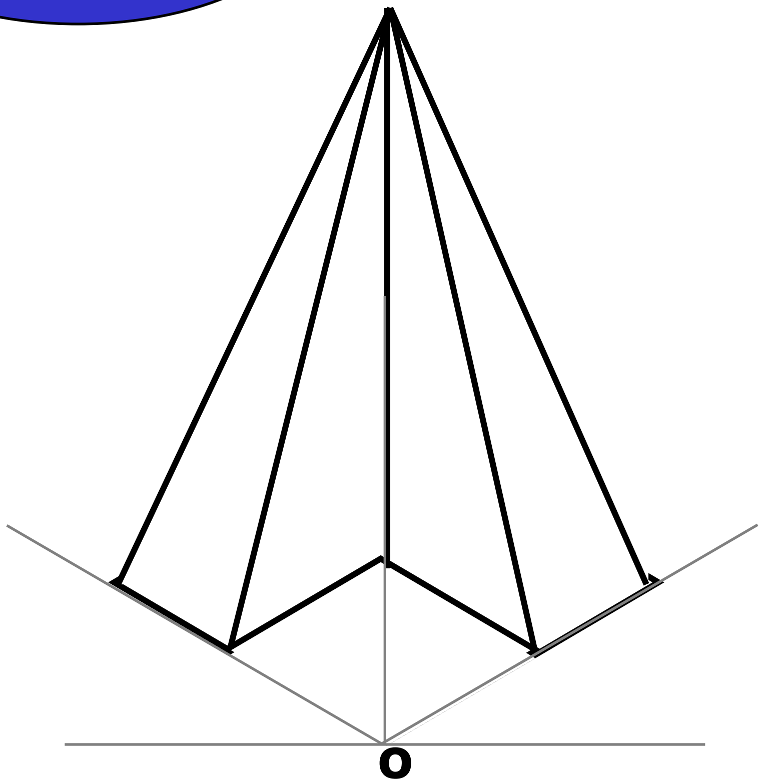


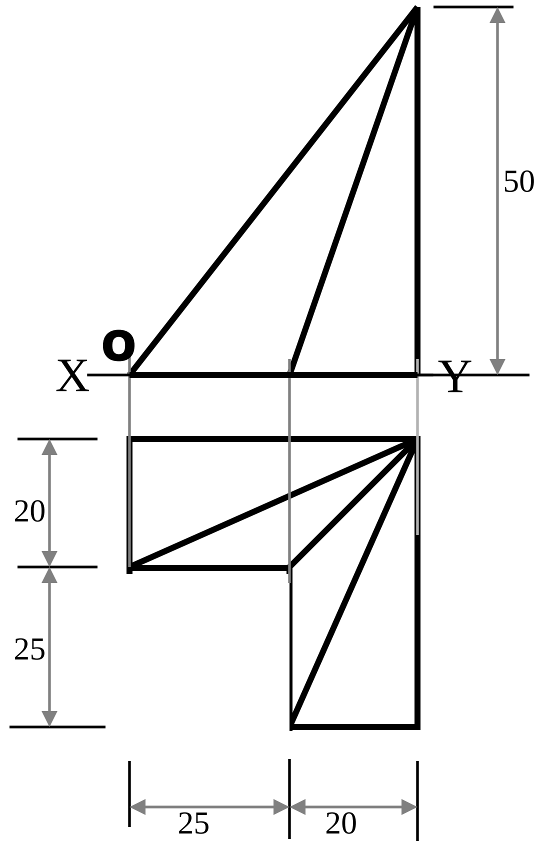


STUDY ILLUSTRATIONS

Z

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.