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)
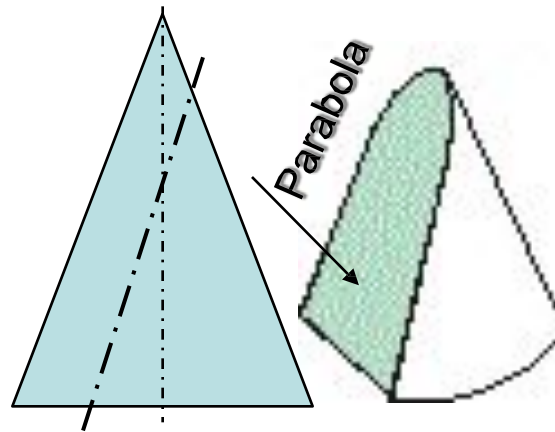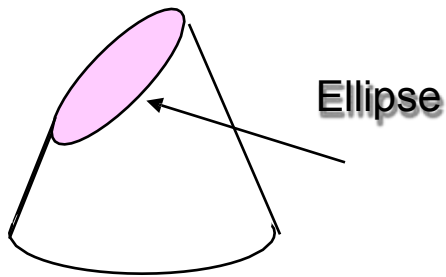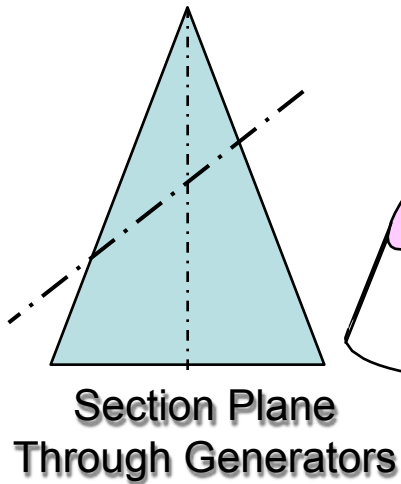
3.Basic Locus Method
  (Directrix – focus)

Methods of Drawing
Tangents &
Normals To These
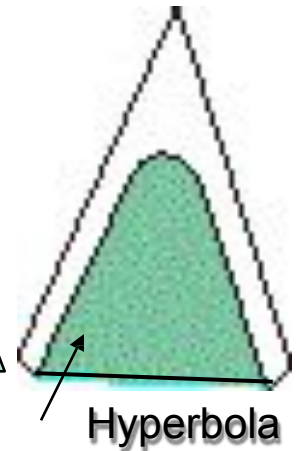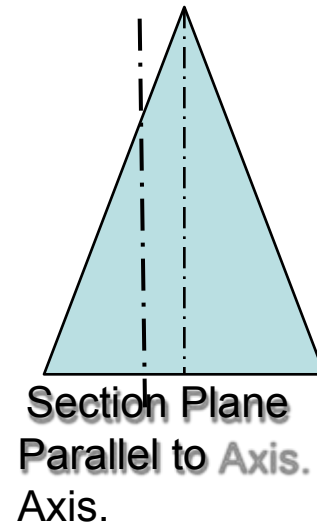Curves.

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..

Ellipse

Section Plane
Through Generators

Parabola

Section Plane Parallel
to end generator.

Section Plane
Parallel to Axis.
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

Refer Problem no.4
### Ellipse by Arcs of Circles Method.

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

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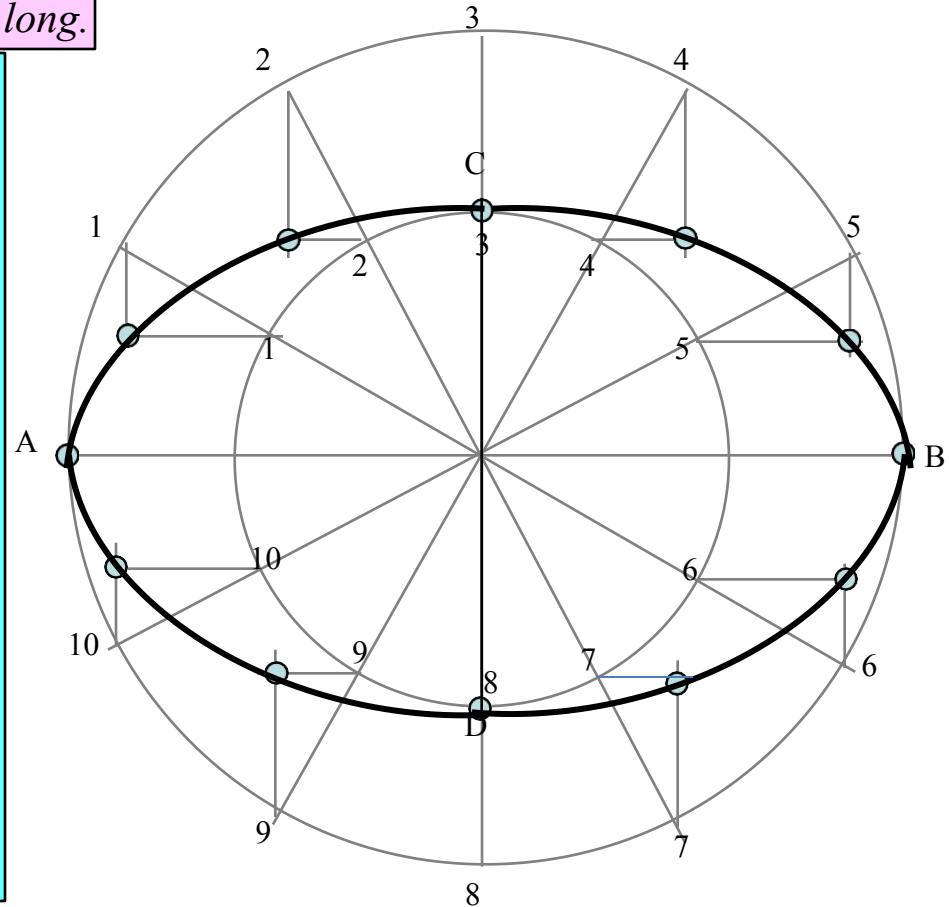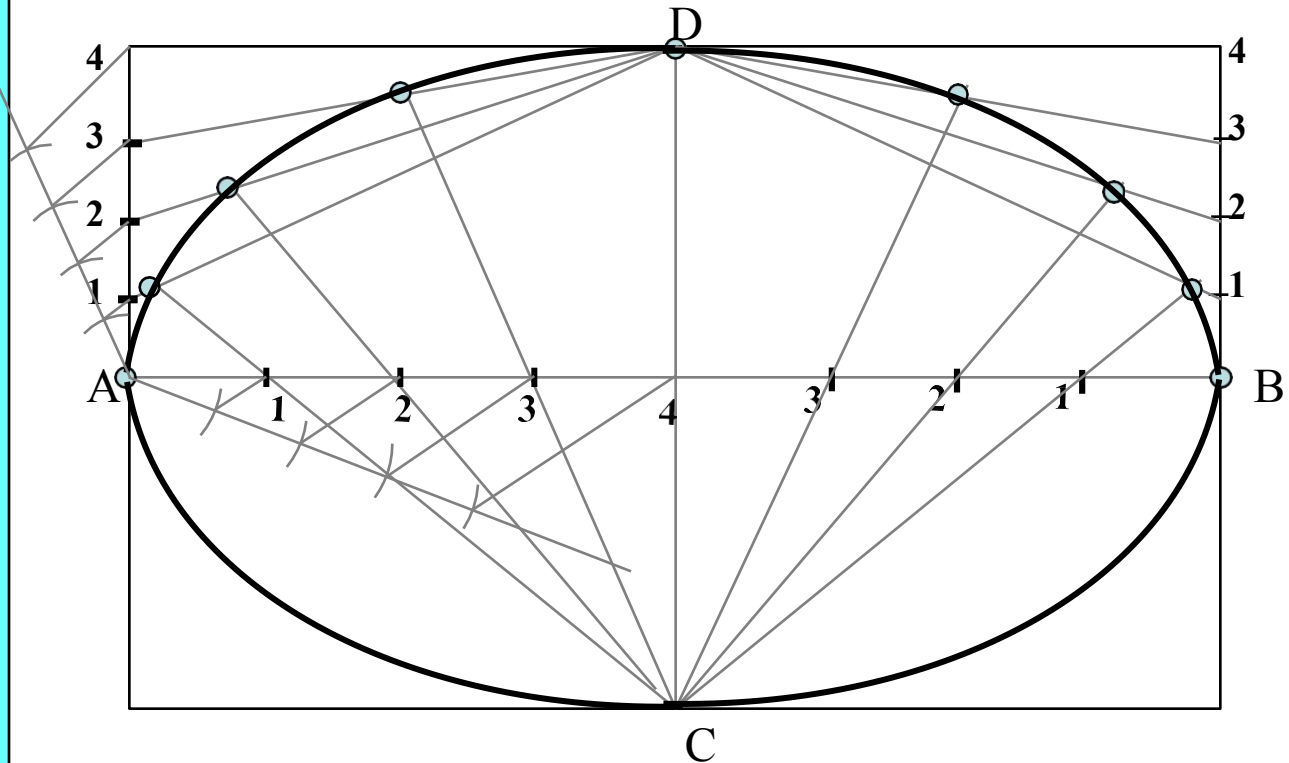
Steps:

1 Draw a rectangle taking major and minor axes as sides.

2. In this rectangle draw both axes as perpendicular bisectors of each other..

3. For construction, select upper left part of rectangle. Divide vertical small side and horizontal long side into same number of equal parts.(here divided in four parts)

4. Name those as shown..

5. Now join all vertical points 1,2,3,4, to the upper end of minor axis. And all horizontal points i.e.1,2,3,4 to the lower end of minor axis.

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

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

It is required ellipse.

Problem 2
Draw ellipse by **Rectangle** *method.*
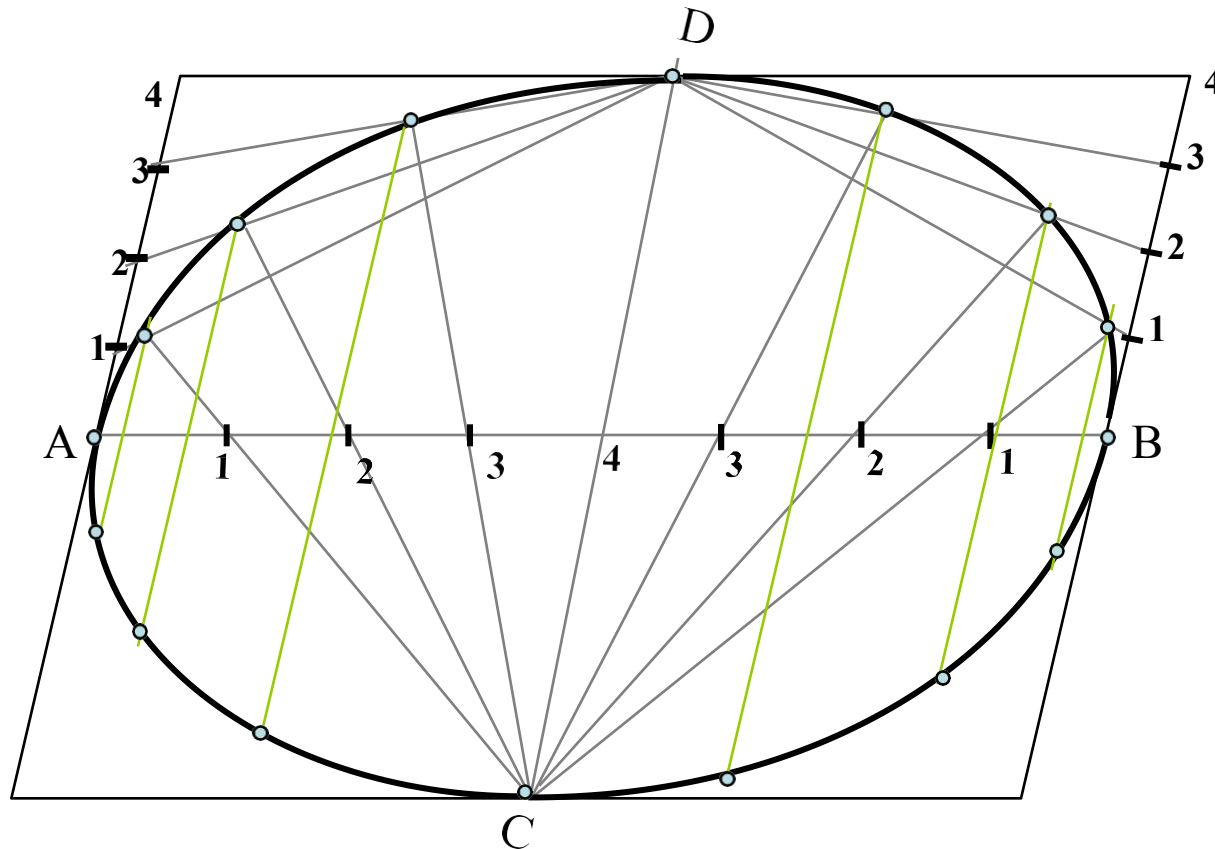*Take major axis 100 mm and minor axis 70 mm long.*

Problem 3:-
*Draw ellipse by **Oblong method.***
Draw a parallelogram of 100 mm and 70 mm long sides with included angle of 75^0. Inscribe Ellipse in it.
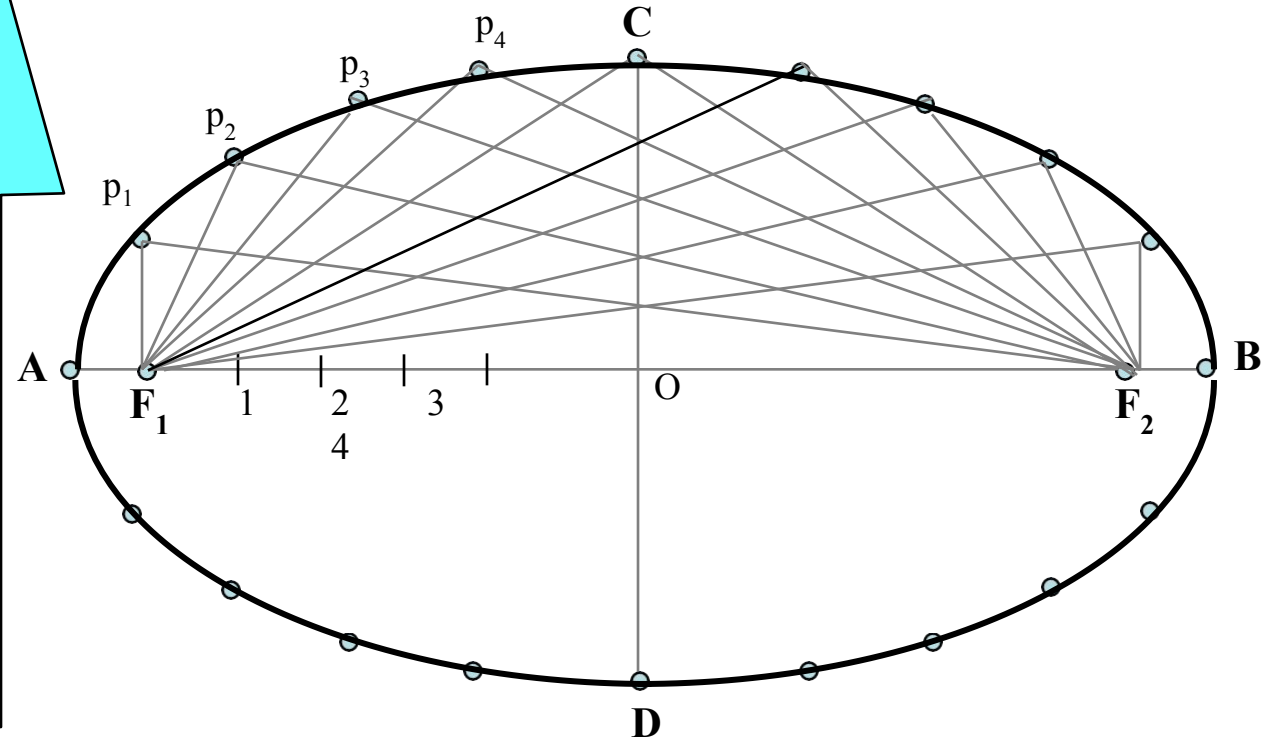
**STEPS ARE SIMILAR TO
THE PREVIOUS CASE
(RECTANGLE METHOD)
ONLY IN PLACE OF RECTANGLE,
HERE IS A PARALLELOGRAM.**

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

ELLIPSE
BY ARCS OF CIRCLE METHOD

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)

p_4 C
p_3
p_2
p_1
A
F_1 1 2 3 O F_2 B
4
D

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

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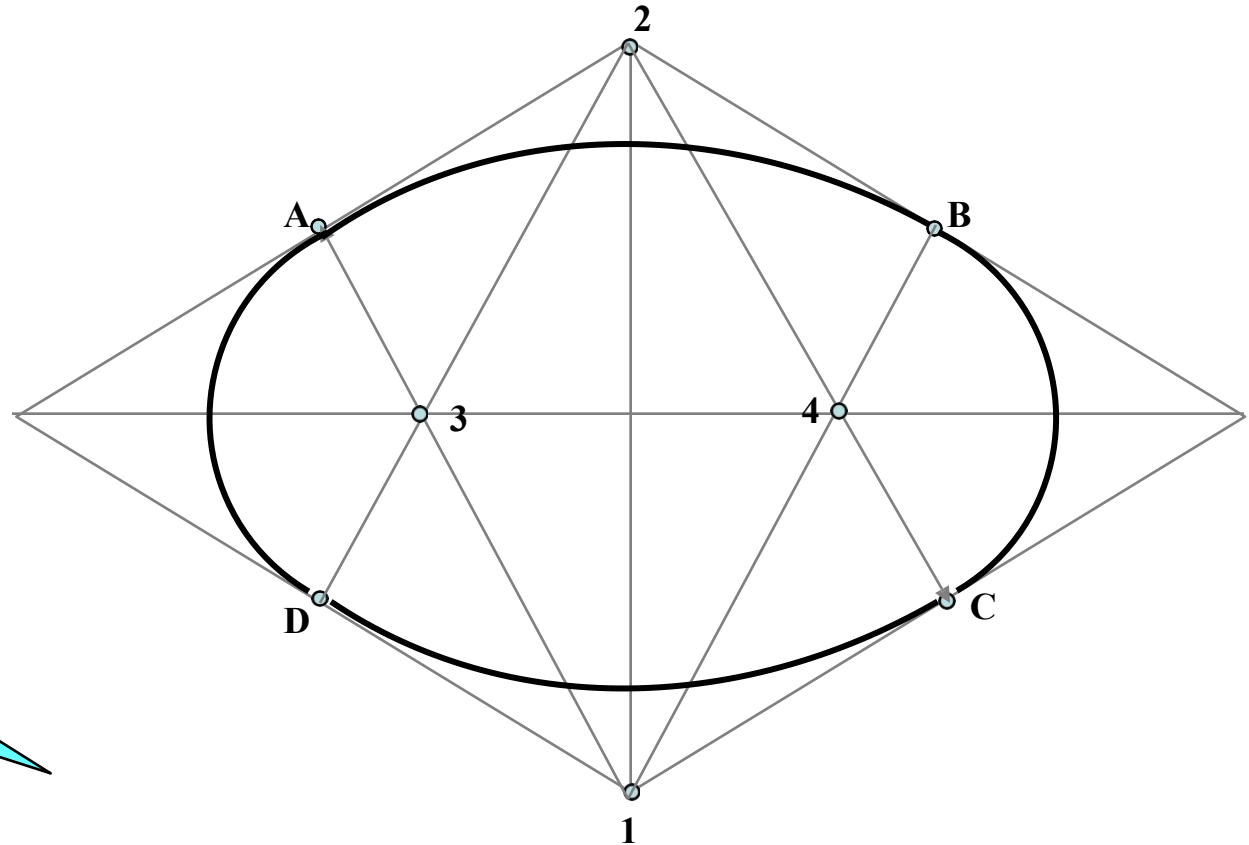
PROBLEM 6:- POINT **F** IS 50 MM FROM A LINE **AB.** A POINT **P** IS MOVING IN A PLANE SUCH THAT THE **RATIO** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P. { ECCENTRICITY = 2/3 }**
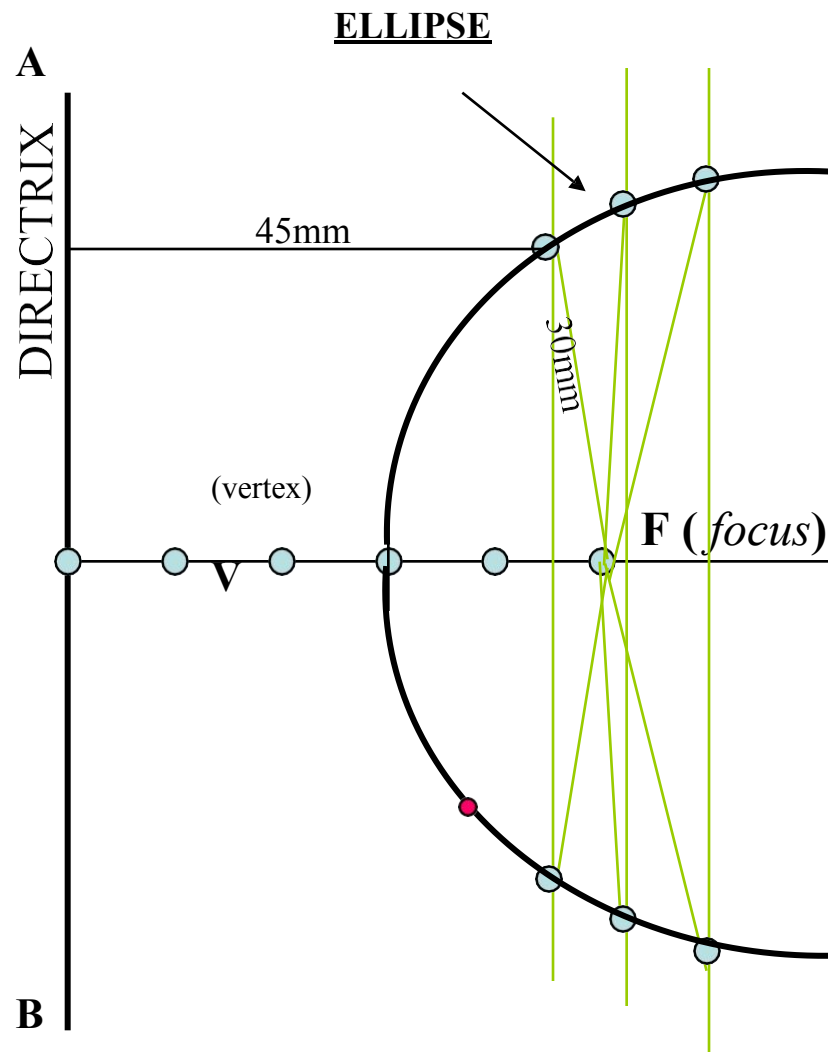
STEPS:

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.

ELLIPSE

A

DIRECTRIX

45mm

30mm

(vertex)

V

F (*focus* **)**

B

**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.
.
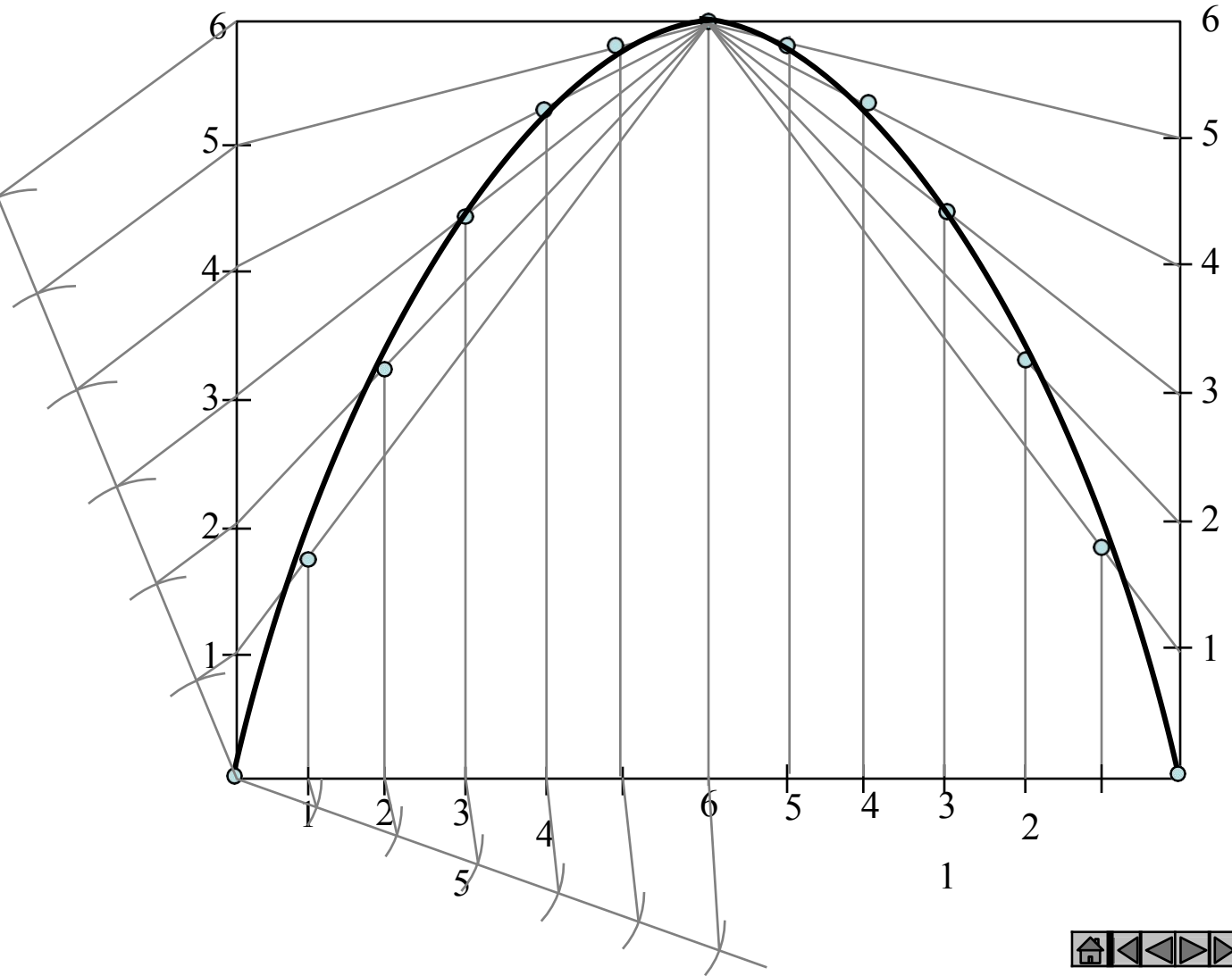
Draw a parabola by tangent method given base 7.5m and axis 4.5m

Take scale 1cm = 0.5m

O
6

5   1'

4   2'

F

3   3'

2   4'

1   5'

6'

A   E   B

7.5m

4.5m

4.5m
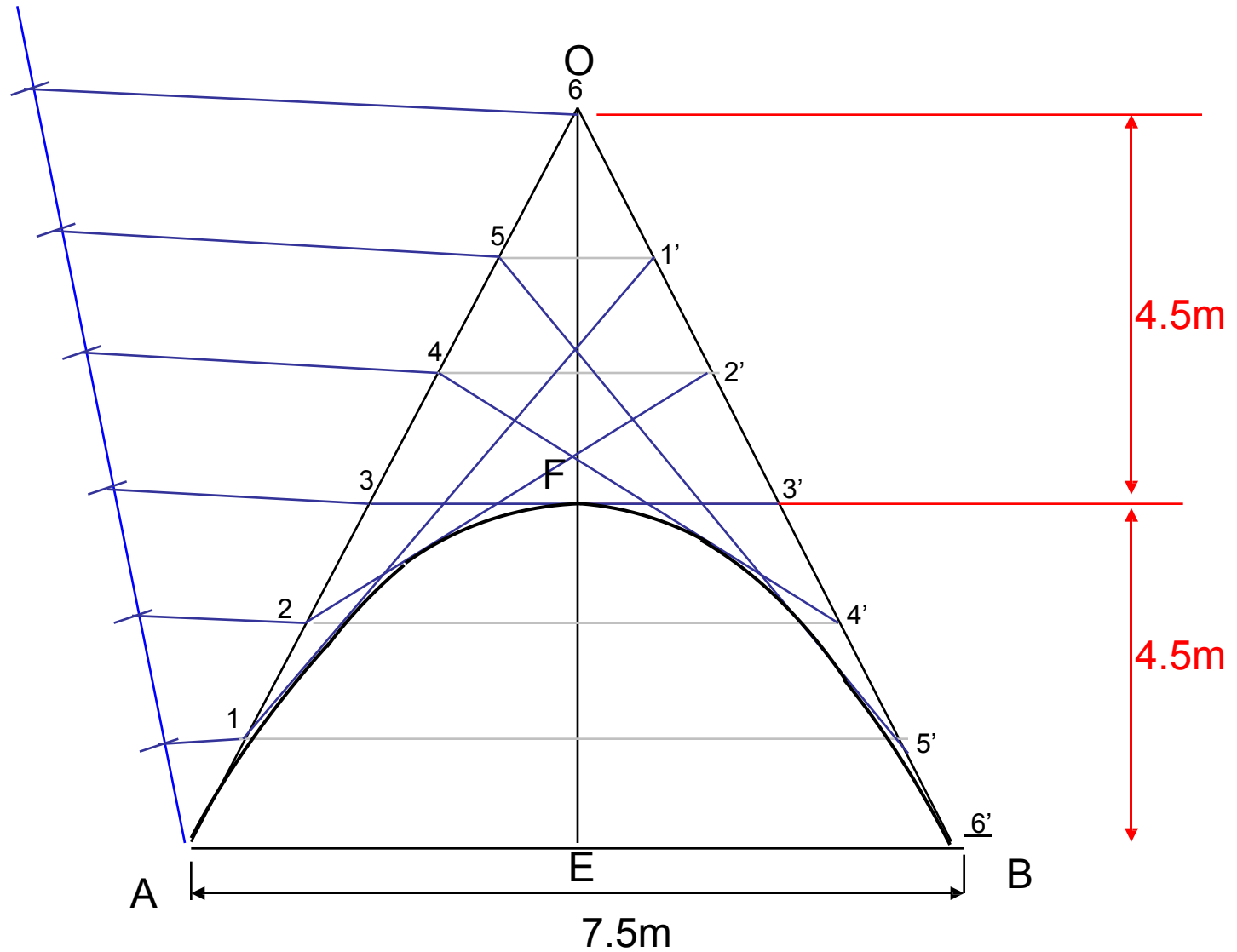
PROBLEM 9: Point F is 50 mm from a vertical straight line AB.
Draw locus of point P, moving in a plane such that
it always remains equidistant from point F and line AB.

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.**

PARABOLA

A

P_1

(VERTEX) V

O

1 2 3 4

F

(focus)

P_2

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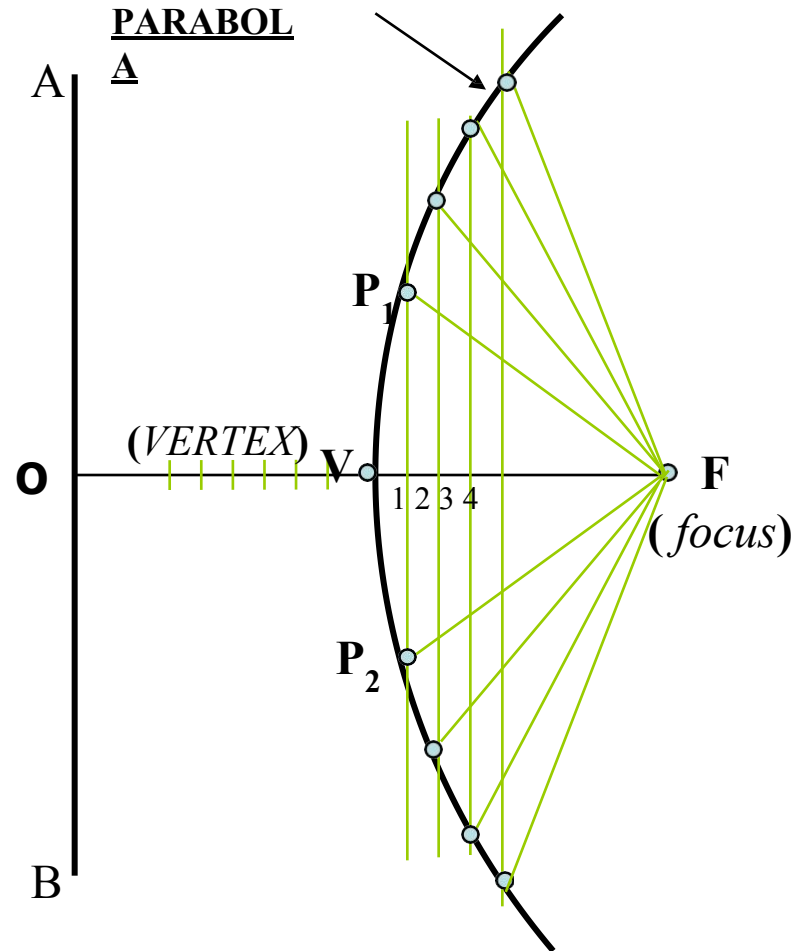
Problem No.10: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively. Draw Hyperbola through it.

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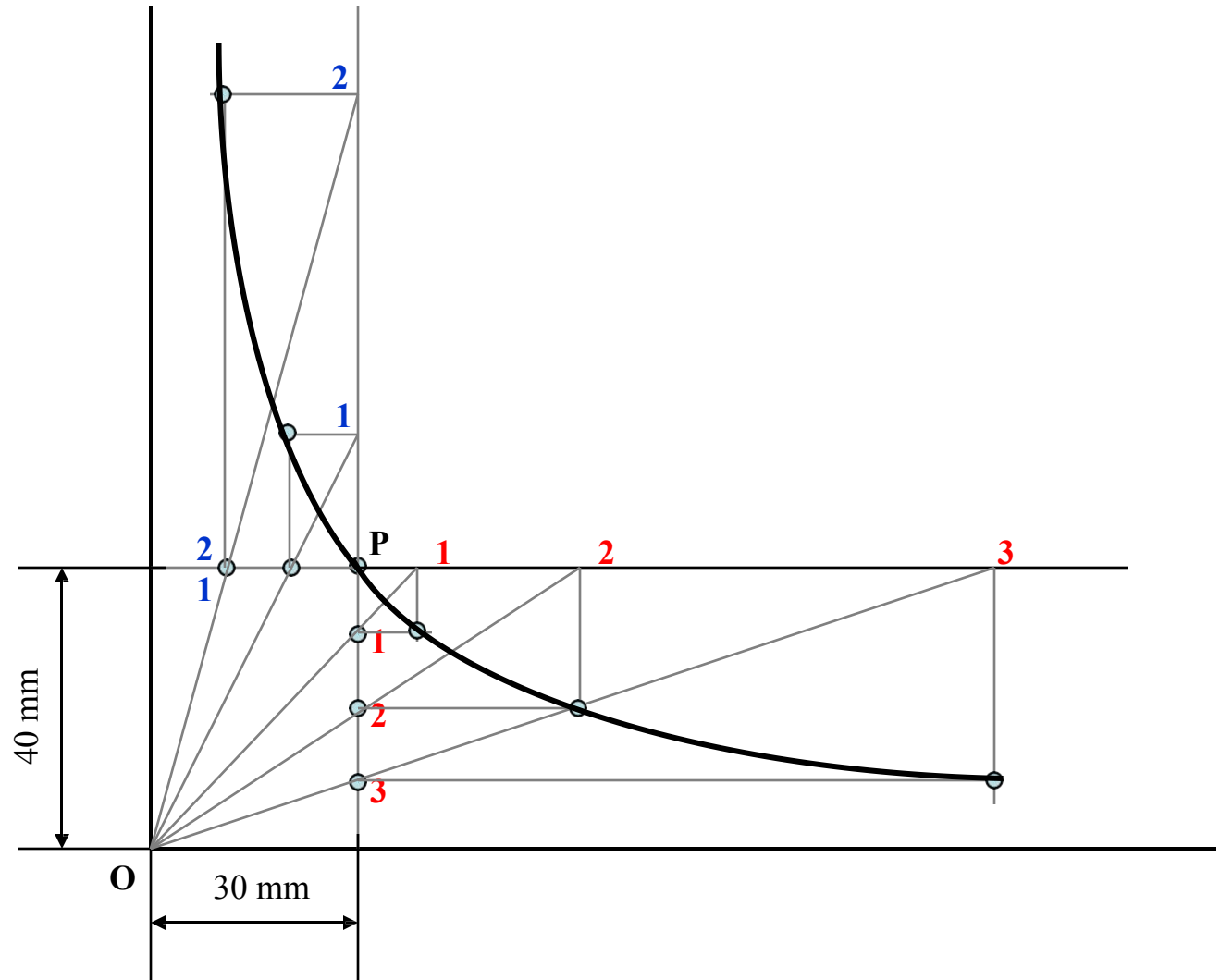
Problem no.11: A sample of gas is expanded in a cylinder from 10 unit pressure to 1 unit pressure.Expansion follows law PV=Constant.If initial volume being 1 unit, draw the curve of expansion. Also Name the curve.

Form a table giving few more values of P & V

HYPERBOLA
P-V DIAGRAM

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.

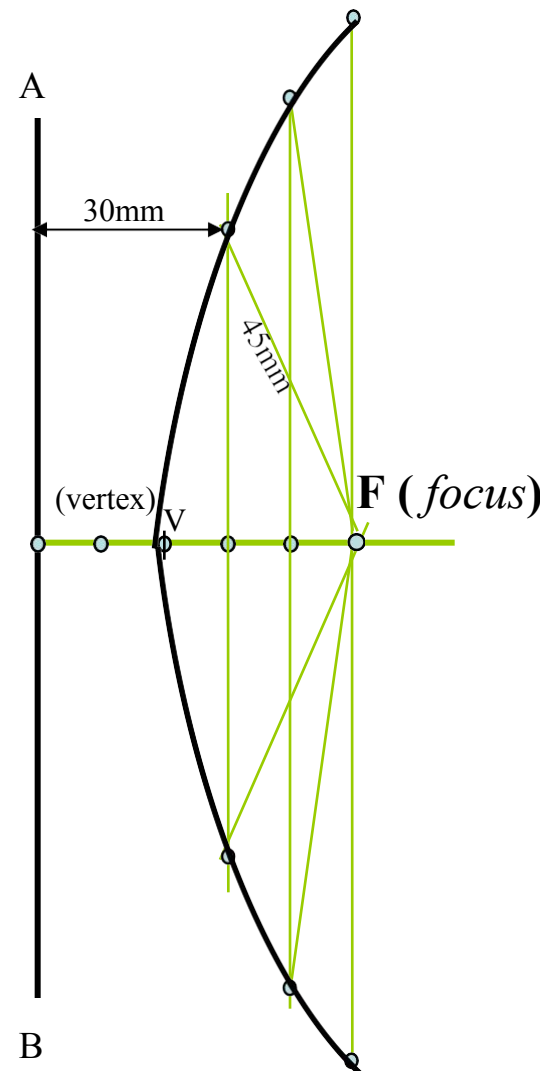It is a PV Diagram and it is Hyperbola. Take pressure on vertical axis and Volume on horizontal axis.

PRESSURE (Kg/cm^2)

VOLUME:(M^3)
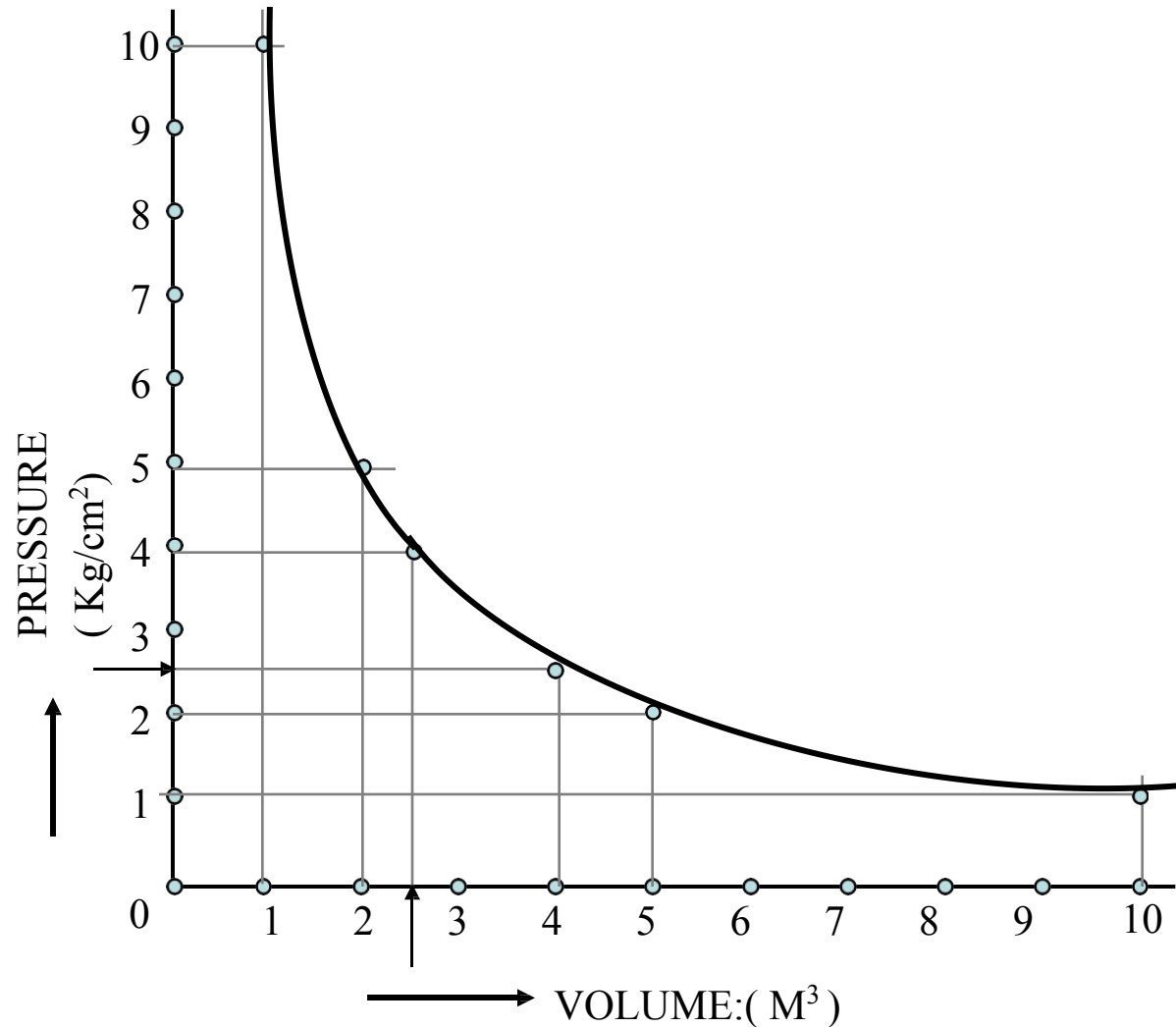
PROBLEM 12:- POINT **F** IS 50 MM FROM A LINE **AB.** A POINT **P** IS MOVING IN A PLANE SUCH THAT THE **RATIO** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P. { ECCENTRICITY = 2/3 }**
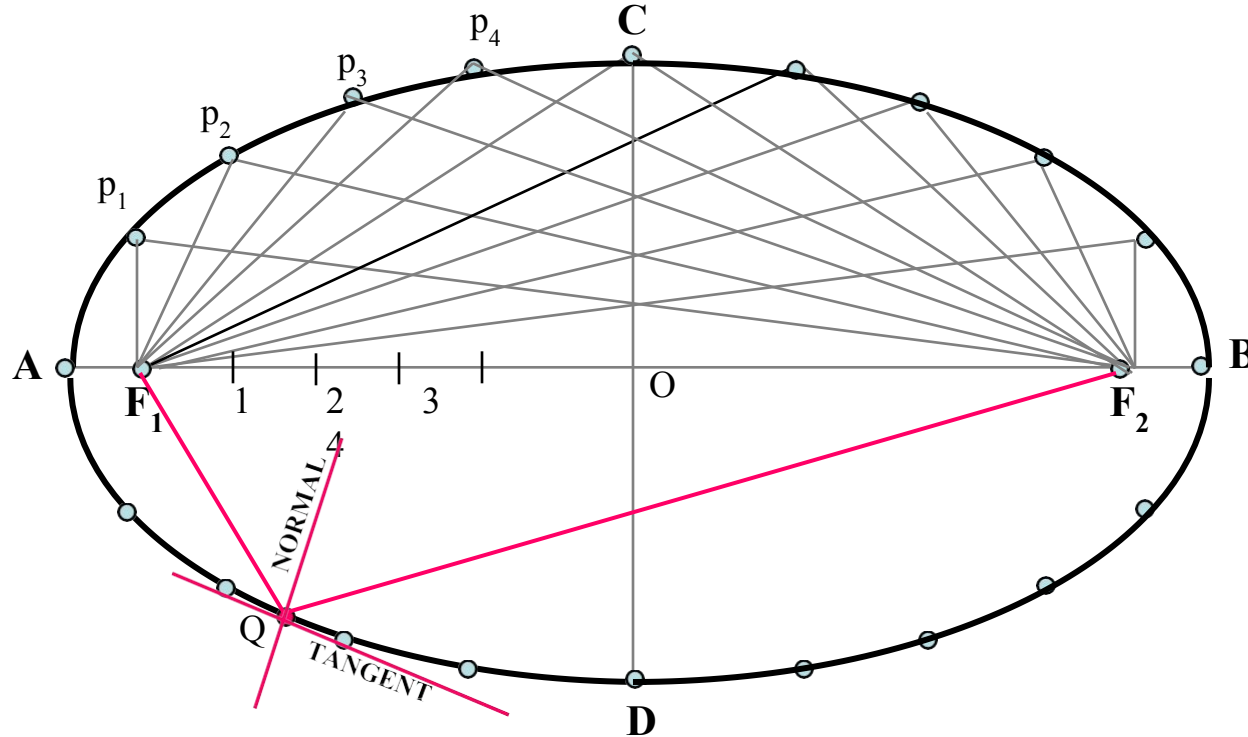
STEPS:
1 .Draw a vertical line AB and point
   F 50 mm from it.
2 .Divide 50 mm distance in 5 parts.
3 .Name 2nd part from F as V. It is 20mm
   and 30mm from F and AB line resp.
   It is first point giving ratio of it's
   distances from F and AB 2/3 i.e 20/30
4 Form more points giving same ratio such
   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.

A

30mm
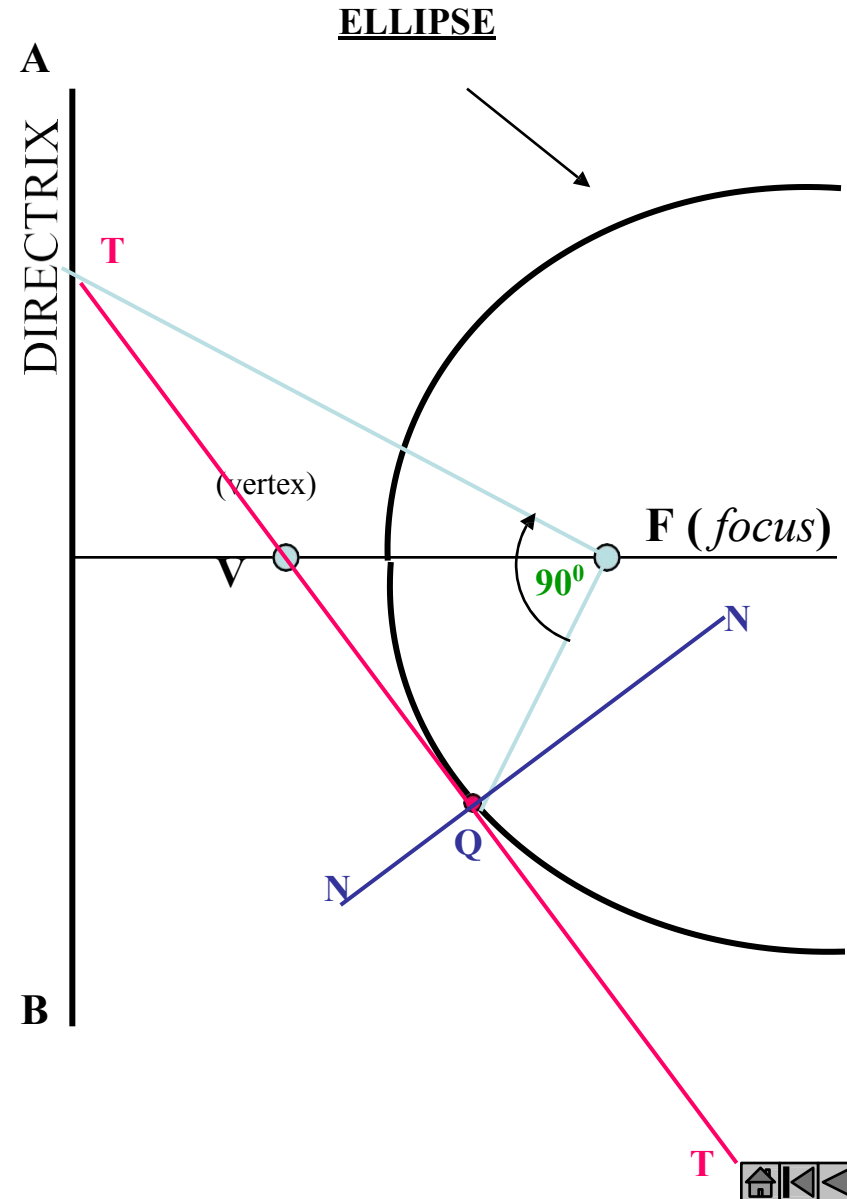
45mm

(vertex)
V

F (focus)

B

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.

ELLIPSE

A

DIRECTRIX

T

(vertex)

V

F (*focus*)

90⁰

N

N

Q

B

T

Problem 15:

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 THE CURVE FROM Q
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.

T

PARABOL
A

A

$VERTEX$ **V**

90⁰
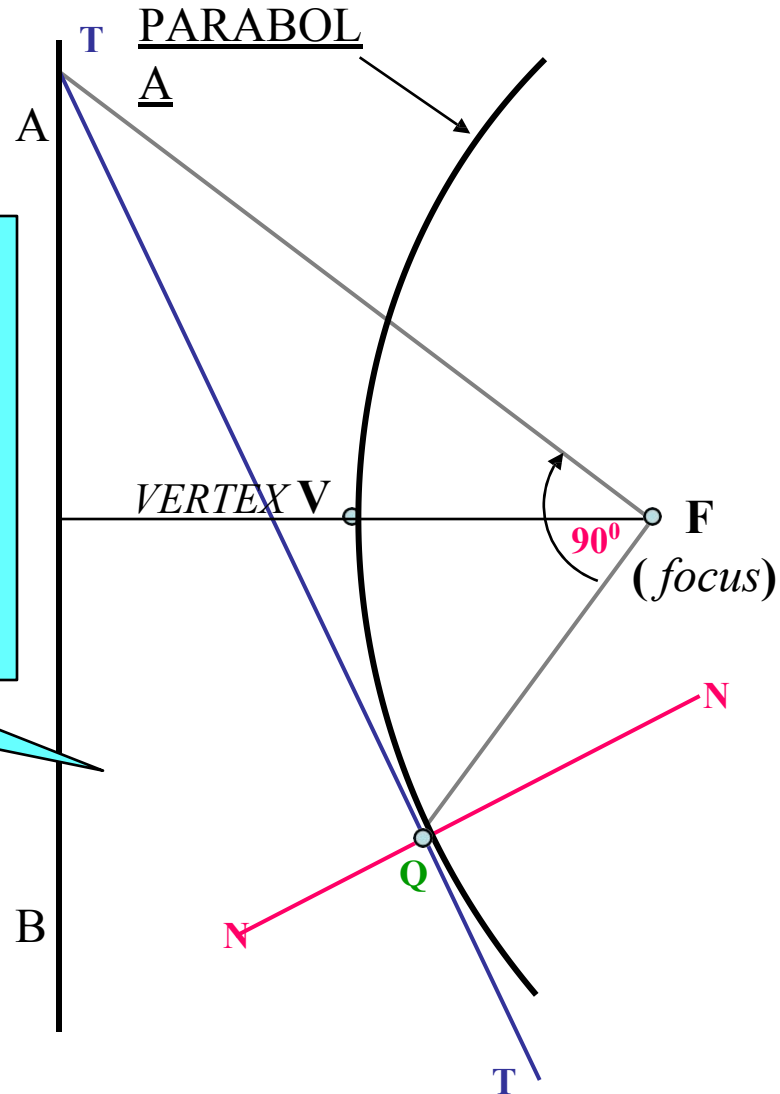
F
(*focus*)

N

N

Q

B

T

Problem 16

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.

A

T

(vertex) V

F (*focus* **)**

90^0

N

N

Q

B

T