Activity 21

Objective

To construct different types of conic sections.

Material Required

Transparent sheet, scissors, hard-board, adhesive, white paper.

Method of Construction

1. Take a hardboard of convenient size and paste a white paper on it.
2. Cut a transparent sheet in the shape of sector of a circle and fold it to obtain a right circular cone as shown in Fig.21.1.
3. Form 4 more such cones of the same size using transparent sheet. Put these cones on a hardboard.
4. Cut these cones with a transparent plane sheet in different positions as shown in Fig. 21.2 to Fig. 21.5.

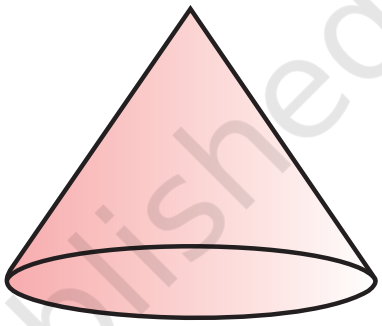

Fig 21.1

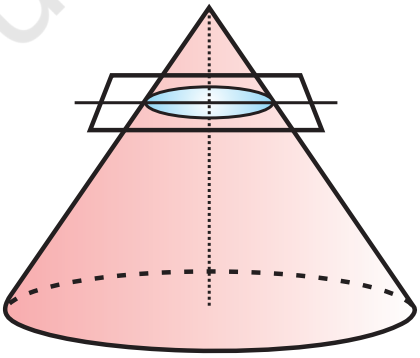

Fig 21.2

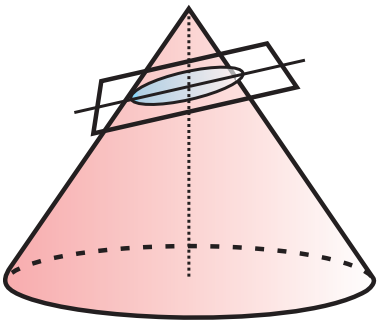

Fig 21.3

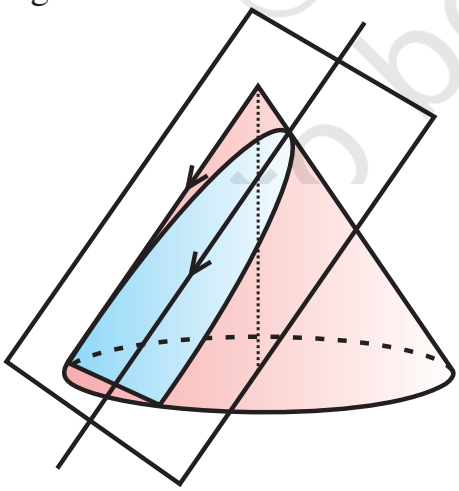

Fig 21.4

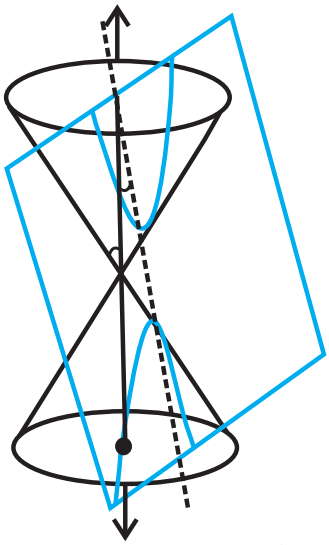

Fig 21.5

Demonstration

1. In Fig. 21.2, the transparent plane sheet cuts the cone in such a way that the sheet is parallel to the base of the cone. The section so obtained is a circle.
2. In Fig. 21.3, the plane sheet is inclined slightly to the axes of the cone. The section so obtained is an ellipse.
3. In Fig. 21.4, the plane sheet is parallel to a generator (slant height) of the cone. The section so obtained is a parabola.
4. In Fig. 21.5 the plane is parallel to the axis of the cone. The sections so obtained is a part of a hyperbola.

Observation

1. In Fig. 21.2, the transparent plane sheet is _____ to the base of the cone. The section obtained is _____.
2. In Fig. 21.3, the plane sheet is inclined to _____. The conic section obtained is _____.
3. In Fig. 21.4, the plane sheet is parallel to the _____. The conic section so obtained is _____.
4. In Fig. 21.5, the plane sheet is _____ to the axis. The conic section so obtained is a part of _____.

Application

This activity helps in understanding various types of conic sections which have wide spread applications in real life situations and modern sciences. For example, conics have interesting geometric properties that can be used for the reflection of light rays and beams of sound, i.e.

1. Circular disc reflects back the light issuing from centre to the centre again.
2. Elliptical disc reflects back the light issuing from one focus to the other focus.
3. Parabolic disc reflects back the light issuing from one focus parallel to its axis.
4. Hyperbolic disc reflects back the light issuing from one focus as if coming from other focus.

Activity 22

Objective

To construct a parabola.

Material Required

Cardboard, white paper, sketch pen, pencil, compass, ruler etc.

Method of Construction

1. Take a cardboard of a convenient size and paste a white paper on it.
2. Mark a point S on the white paper on the board (see Fig. 22).
3. Through S draw a line. Draw another line l perpendicular to the line through S at some distance k units to the left of S.

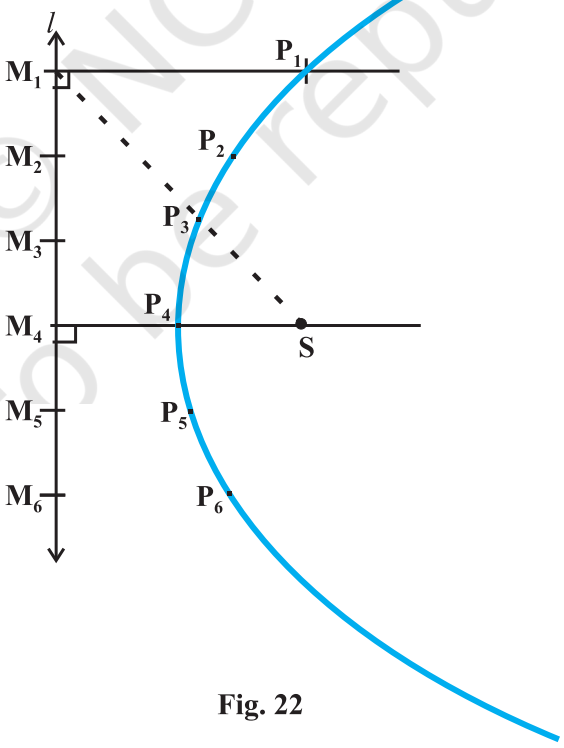

Fig. 22

4. Take any point M_1 on the line l. Draw the perpendicular to l at this point.
5. Join M_1S and draw perpendicular bisector of M_1S meeting the perpendicular through M_1 at the point P_1.
6. Take another point M_2 on the line l and repeat the process as explained in (5) above to obtain the point P_2.
7. Take some more points M_3, M_4, M_5, ... on the line l and repeat the above process to obtain points P_3, P_4, P_5, ..., respectively.
8. Draw a free hand curve through the points P_1, P_2, P_3, P_4, ... (see Fig. 22)

DEMONSTRATION

The points P_1, P_2, P_3, ... are such that the distance of each point from the fixed point S is same as the distance of the point from the line l. So, the free hand curve drawn through these points is a parabola with focus S and directrix l.

OBSERVATION

1. P_1M_1 = _____ P_1S = _____
2. P_2M_2 = _____ P_2S = _____
3. P_3M_3 = _____ P_3S = _____
4. P_4M_4 = _____ P_4S = _____
5. P_5M_5 = _____ P_5S = _____
6. The distance of the point P_1 from M_1 = The distance of P_1 from _____.
7. The distance between the points P_2 and M_2 = The distance of P_2 from _____.

   The distance of the point _____ from M_3 = The distance of the point P_3 from _____.
8. Distances of the points P_1, P_2, P_3 .... from the line l are _____ to the distances of these points from the point S.
9. Therefore, the free hand curve obtained by joining P_1, P_2, P_3, ... is a _____ with directrix _____ and focus _____.

10. Distance of the vertex P_4 and S = _____.

11. Distance of the vertex of parabola from the directrix = _____.

APPLICATION

1. This activity is useful in understanding the terms related to parabola, like directrix, focus, property of the point on the parabola.
2. Parabolas have applications in Science and Engineering.

Activity 23

Objective

An alternative method of constructing a parabola.

Material Required

Cardboard, white paper, sketch pen, pencil, compasses, ruler, nails, thread.

Method of Construction

1. Take a cardboard of a convenient size and paste a white paper on it.
2. Take any point S on the white paper fixed on the cardboard.
3. Draw a line through S.
4. Draw another line l perpendicular to the line through S at a distance of k units to the left of S. Let the two lines meet at the point C.

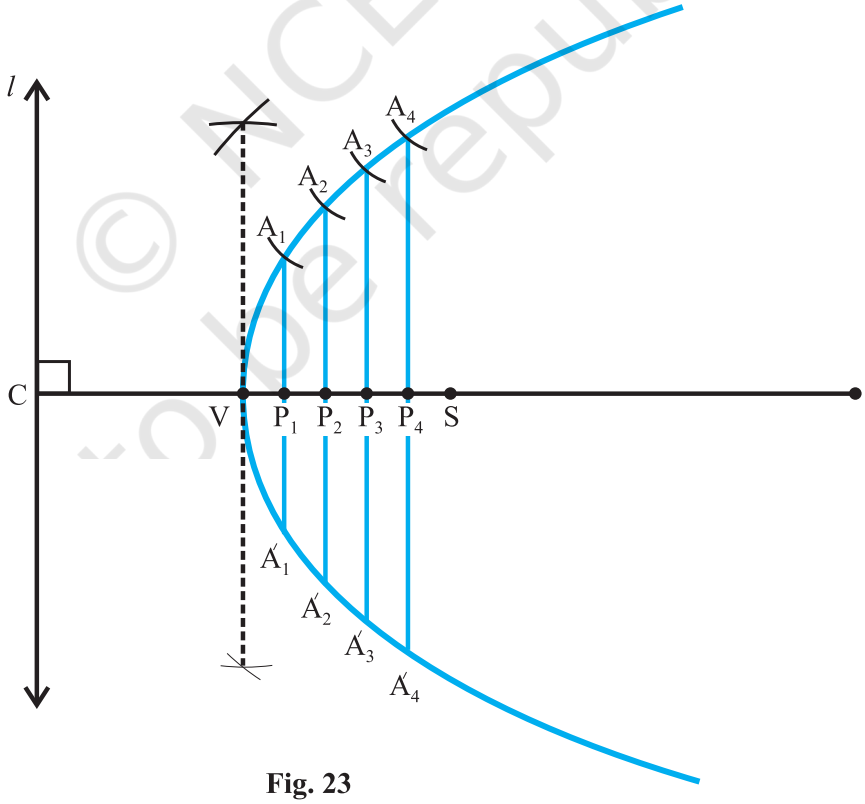

Fig. 23

5. Bisect CS at the point V.
6. Mark the points P_1, P_2, P_3, ... on VS and draw perpendiculars through these points as shown in the Fig. 23.
7. Take S as centre and radius equal to CP_1, draw an arc cutting the perpendicular through P_1 at the point A_1 and A_1'. Similarly with S as the centre and CP_2 as radius, obtain points A_2 and A_2'. Repeat this process for some more points P_3, P_4, ... and obtain points A_3 and A_3', A_4 and A_4';...
8. Fix nails at these points, i.e., $A_1, A_2, \ldots A_1', A_2', \ldots$ and join the foot of the nails by a thread to get a curve as shown in the figure.

Demonstration

Distance of the point A_1 from $l = CP_1 = SA_1$
Similarly, distance of the point A_2 from $l = CP_2 = SA_2$
distance of the point A_3 from $l = CP_3 = SA_3$ and so on.

Also distance of the point A_1' from $l = CP_1 = SA_1'$

distance of the point A_2' from $l = CP_2 = SA_2'$ and so on.

Thus, every point on the curve is equidistant from the line l and the point S. So, the curve is a parabola, with focus S and directrix l.

Observation

By actual measurement

1. Distance of A_1 from l = _____, A_1S = _____.
2. Distance of A_2 from l = _____, A_2S = _____.
3. Distance of A_3 from l = _____, A_3S = _____.
4. Distance of A_4 from l = _____, A_4S = _____.
5. Distance of A_1' from l = _____, $A_1'S$ = _____.

6. Distance of A_2' from l = _____, $A_2'S$ = _____.
7. Distance of A_3' from l = _____, $A_3'S$ = _____.
8. Distance of A_4' from l = _____, $A_4'S$ = _____.
9. Distance of any point on the curve from l = Distance of the point from _____.
10. So, the curve is _____ with directrix _____ and focus _____.

APPLICATION

1. This activity is useful in understanding the terms related to a parabola, such as directrix and focus of the parabola.

Activity 24

Objective

To construct an ellipse using a rectangle.

Material Required

A hardboard, white paper, coloured paper, nails, nylon wire/thread, ruler, adhesive.

Method of Construction

1. Take a rectangular hardboard of a convenient size and paste a white paper on it.
2. Cut a rectangle MNBL of suitable dimensions from a coloured paper and paste it on the hardboard.
3. Divide this rectangle into four congruent rectangles as shown in the Fig.24.

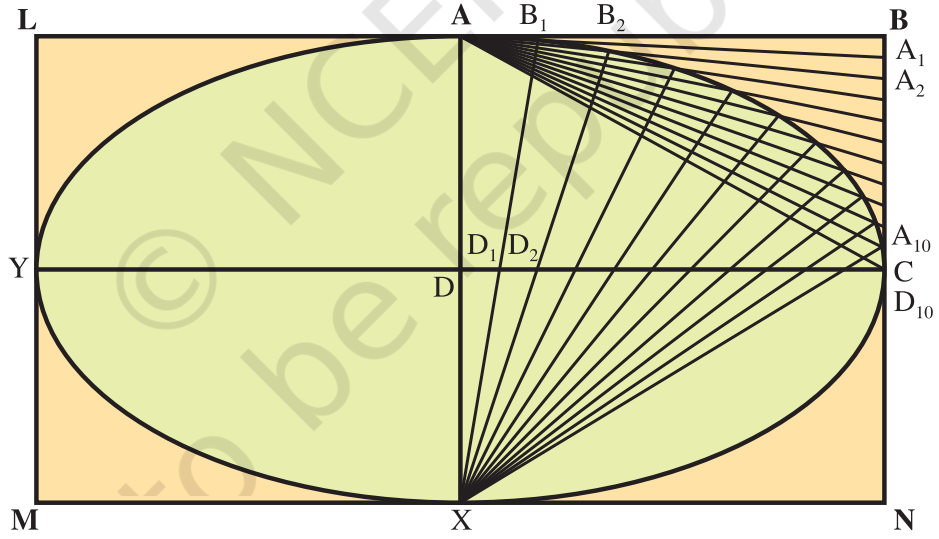

Fig. 24

4. Divide each of the sides BC and DC of the rectangle ADCB, into some equal parts, (say, 11)
5. Mark the point of subdivisions of BC as $A_1, A_2, \ldots\ldots$ and that of DC as D_1, D_2, (See Fig. 24)

6. Join the point A to points, A_1, A_2, ... and draw the lines joining the point X to D_1, D_2, ... (See Fig. 24)
7. Mark the point of intersection of AA_1 and XD_1 as B_1, AA_2 and XD_2 as B_2 and so on.
8. Fix nails at the points B_1, B_2, ..., B_{10}.
9. Join the feet of nails with a nylon wire/thread, as shown in the figure.
10. Repeat the same activity for remaining three congruent rectangles and obtain a curve as shown in Fig. 24.

Demonstration

The curve obtained looks like an ellipse. The major axis of this ellipse is the length of the rectangle MNBL and the minor axis of the ellipse is the breadth of the rectangle.

Observation

1. Length of the rectangle MNBL = _____.
2. Breadth of the rectangle MNBL = _____.
3. Major axis of the ellipse is _____.
4. Minor axis of the ellipse is _____.

Application

This activity may be helpful in understanding the concept such as major and minor axis of an ellipse. It is also useful in drawing elliptical designs such as in swimming pools, tables, etc.

Activity 25

Objective

To construct an ellipse with given major and minor axes.

Material Required

A hardboard, white paper, nylon wire/thread, adhesive, chart paper.

Method of Construction

1. Take a rectangular sheet of a hardboard of a convenient size and paste a white paper on it.
2. Mark a point O on it and draw two concentric circles with centre O and radii as given semi-major and semi-minor axis of the ellipse. Mark one of the diameter of bigger circle as AOB and call it a horizontal line (see Fig. 25)

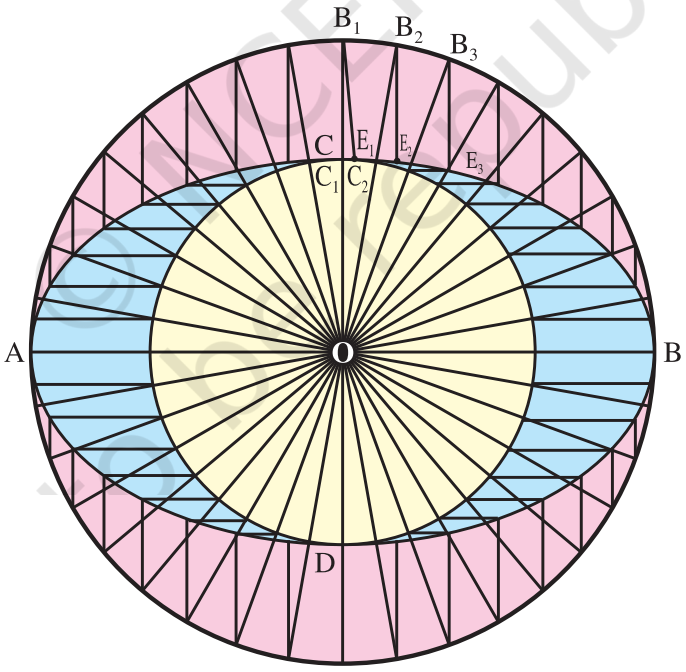

Fig. 25

3. Draw radii of the circles in such a way that the angle between two consecutive radii is the same, say 10º.

4. Take any radius OB_1 of the bigger circle cutting the smaller circle at C_1. Draw a horizontal line through C_1 and draw a perpendicular (vertical line) from B_1 to this horizontal line and obtain point E_1 (see Fig. 25).
5. Repeat this process for all the radii OB_2, OB_3, and so on of the bigger circle and obtain the points E_2, E_3, ... and so on.
6. Fix the nails at the points E_1, E_2, E_3, ... and join the feet of the nails by a nylon wire/thread and obtain a curve (see Fig. 25).

Demonstration

1. The curve obtained looks like an ellipse.
2. Major axis of the ellipse is AOB and the minor axis of the ellipse is COD, where COD is the diameter of the smaller circle perpendicular to diameter AOB.

Observation

1. OA = _____, OB = _____.
2. OC = _____, OD = _____.
3. Major axis of the ellipse _____, Minor axis of the ellipse = _____.
4. Points E_1, E_2, ... lie on _____ .

Application

This activity may be used in constructing elliptical designs using thread work and also in explaining concepts such as major and minor axis of an ellipse.